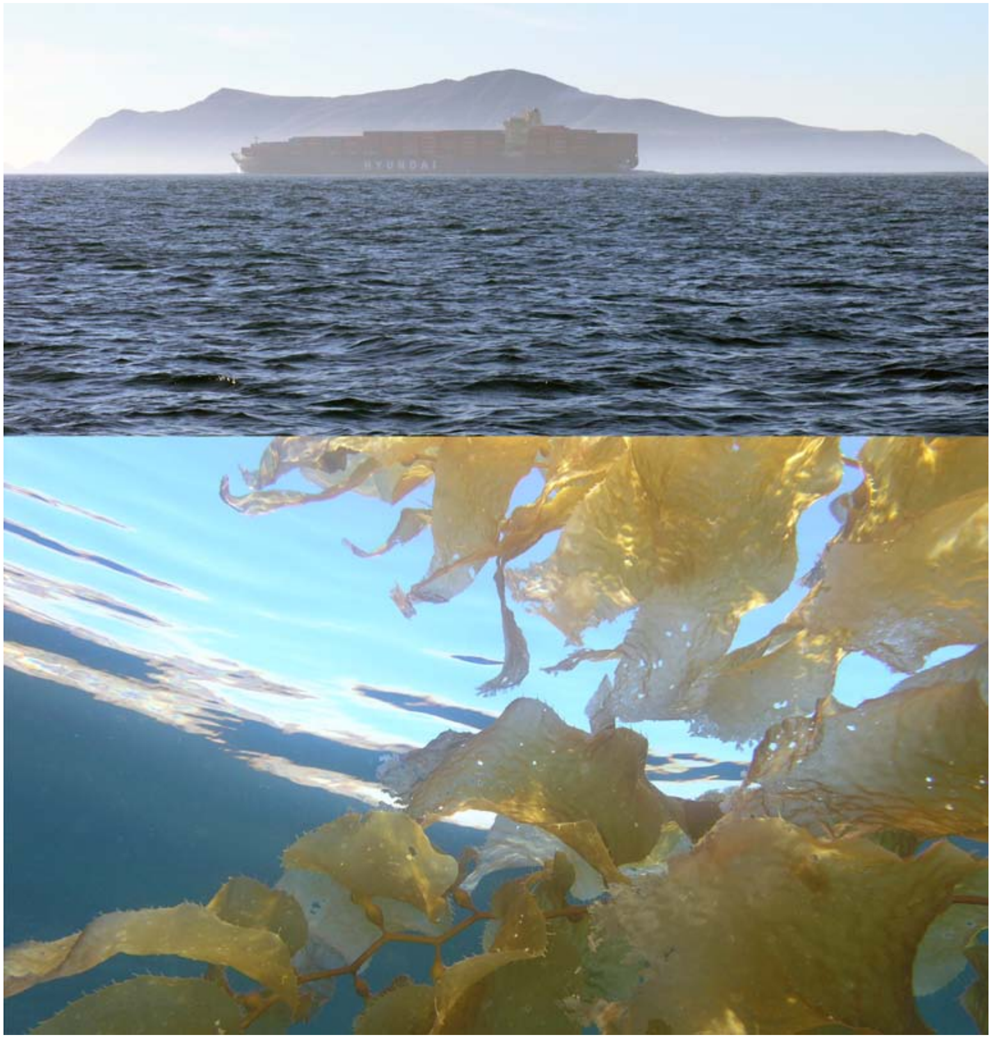
Water Quality Characterization of the Channel Island National Marine Sanctuary and Surrounding Waters



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For the

**National Oceanic and Atmospheric Administration's
Channel Islands National Marine Sanctuary**

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List of Abbreviations

AIS	Automated Identification System
APCD	Air Pollution Control District
APPS	Act to Prevent Pollution from Ships
ASBS	Area of Special Biological Significance
ATBA	Area to be Avoided
AVHRR	Advanced Very High Resolution Radiometer
BAT	Best Available Technology Economically Achievable
BCT	Best Conventional Pollutant Control Technology
BOD	Biological Oxygen Demand
BMP	Best Management Practice
BPTCP	Bay Protection and Toxic Cleanup Program
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CA-SMWP	California State Mussel Watch Program
CARB	California Air Resources Board
CCA	Critical Coastal Area
CCC	California Coastal Commission
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CEC	Chemical of Emerging Concern
CFR	Code of Federal Regulations
CINMS	Channel Islands National Marine Sanctuary
CINP	Channel Islands National Park
COPC	California Ocean Protection Council
CPFV	Commercial Passenger Fishing Vessel
CSLC	California State Lands Commission
CTD	Conductivity/Temperature/Density
CWA	Clean Water Act
CZARA	Coastal Zone Reauthorization Amendments of 1990
CZMA	Coastal Zone Management Act
DDD	Dichloro-diphenyl-dichloroethane
DDE	Dichloro-diphenyl-dichloroethylene
DDT	Dichloro-diphenyl-trichloroethane
DEMS	Digital Elevation Models
DHS	State Department of Health Services
DO	Dissolved Oxygen
EEZ	Exclusive Economic Zone
ENSO	El Niño Southern Oscillation
ERL	Effects Range Low
ERM	Effects Range Median
FACs	Fluorescent Aromatic Compounds
FEIR	Final Environmental Impact Report
FEIS	Final Environmental Impact Statement
HAB	Harmful Algal Bloom
HCH	Hexachlorocyclohexane

IMO	International Maritime Organization
LARWQCB	Los Angeles Regional Water Quality Control Board
LCP	Local Coastal Program
LTER	Long Term Ecological Research Project
LwN(555)	Normalized Water-Leaving Radiance at 555 nm
MEP	Maximum Extent Practicable
MGD	Million Gallons per Day
MMS	US Minerals Management Service
MP	Management Practice
MODIS	Moderate Resolution Imaging Spectroradiometer
MS4	Municipal Separate Storm Sewer System
MSD	Marine Sanitation Device
MTRL	Maximum Tissue Residue Level
NAL	Numeric Action Levels
NCCOS	National Centers for Coastal Ocean Science
NDZ	No Discharge Zone
NEL	Numeric Effluent Limitation
NEPA	National Environmental Policy Act
NM	Nautical Mile
NMSA	National Marine Sanctuaries Act
NOAA	National Oceanic and Atmospheric Administration
NOAA-MWP	NOAA Mussel Watch Project
NPDES	National Pollution Discharge Elimination System
NPS	National Park Service / Nonpoint Source Pollution
NS&T	National Status and Trends
OBGS	Ormond Beach Generating Station
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl Compound
PISCO	Partnership for Interdisciplinary Studies of Coastal Oceans
POTW	Publicly Owned Treatment Works
PPB	Parts Per Billion
PPT	Parts Per Million
PSD	Prevention of Significant Deterioration
PSP	Paralytic Shellfish Poisoning
PSU	Practical Salinity Unit
ROG	Reactive Organic Gas
ROV	Remotely Operated Vehicle
RWQCB	Regional Water Quality Control Board
SAMSAP	Sanctuary Aerial Monitoring Spatial Analysis Program
SAC	Sanctuary Advisory Council
SCCWRP	Southern California Coastal Water Research Project
SeaWiFS	Sea-viewing Wide-Field-of-View sensor
SLAMS	State and Local Air Monitoring Stations
SLC	State Lands Commission

SMWP	State Mussel Watch Program
SSFL	Santa Susana Field Laboratory
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
SWMP	Storm Water Management Program
SWPPP	Storm Water Pollution Prevention Plan
SWQPA	State Water Quality Protection Area
TBT	Tributyltin
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TAC	Technical Advisory Committee
TOC	Total Organic Carbon
UCSB	University of California, Santa Barbara
USACE	US Army Corps of Engineers
USCG	US Coast Guard
USEPA	US Environmental Protection Agency
USFWS	US Fish & Wildlife Service
USGS	US Geological Survey
VCAILG	Ventura County Agriculture Irrigated Lands Group
WDR	Waste Discharge Requirements
WMA	Watershed Management Area
WWTP	Wastewater Treatment Plant
WY	Water Year

1. Introduction

1.1 Purpose of this Report

This report summarizes the current status of water quality in and around the waters of the Channel Islands National Marine Sanctuary (CINMS). It is intended to provide a summary of existing water quality data and conditions for freshwater and marine waters within and draining into the CINMS, as well as an overview of the water quality standards and existing management programs that govern various aspects of water quality in the Sanctuary and greater Santa Barbara Channel region.

Water quality can mean different things to different people depending on whether you ask an oceanographer, a chemist, a surfer, a fisherman or a regulator overseeing discharge permits. Water quality is defined in this context as the chemical, physical, or biological conditions of the water column either in marine or freshwater. This report focuses on existing data related to sediments, nutrients, toxicity and water chemistry as measured in existing water quality monitoring programs.

The report is arranged into nine sections in order to provide the reader with a comprehensive understanding of the many issues concerning water quality in and around the Sanctuary. In the report, we describe the CINMS setting (Section 2) and pertinent watersheds (Section 3), present potential sources of water quality impairments (Section 4), outline applicable water quality standards (Section 5), and provide an overview of the regulatory and management programs pertaining to water quality in and around the Sanctuary (Section 6). Section 7 describes efforts being undertaken by various agencies and groups to conduct monitoring for existing permits, collect information for future regulatory actions, answer scientific questions, or fill data gaps. Section 8 summarizes the findings of best available data at the time of this writing characterizing existing water quality conditions in and around the Sanctuary, and Section 9 lays out conclusions and recommendations for the CINMS staff and Advisory Council to consider in future efforts to craft a water quality protection plan for Sanctuary waters.

1.2 How this Report Relates to the Management Plan Review

The CINMS recently completed a review and update of its Management Plan, as required by the National Marine Sanctuaries Act (NMSA). The CINMS' initial Management Plan was published in 1983. The process of completing the Management Plan review and update commenced in December 1998 and included public scoping meetings, prioritization of issues and development of action plans, and the preparation of draft and final management plans and associated documentation as required by the National Environmental Policy Act (NEPA). The Final Environmental Impact Statement (FEIS) was released by the Sanctuary in November 2008 and was followed by the release of the Final Management Plan and the issuance of the Final Rule (which officially published the Sanctuary's revised set of regulations as analyzed in the FEIS' proposed action) in the Federal Register in March 2009.

The FEIS contains detailed information on the greater Sanctuary region, presents a range of alternatives for modified and new Sanctuary regulations, lays out environmental and socioeconomic impact analyses of those regulatory alternatives, and provides responses to public comments. The revised Management Plan identifies priority management issues and actions proposed to address them, including to expand research, education, outreach, and enforcement programs, create and enhance partnerships, improve wildlife protections, develop a water quality program, and reduce pollution impacts from vessels. The Management Plan also contains information about the Sanctuary's environment, staffing and administration, regulations and boundary, operational and programmatic costs, and performance measures.

In the 2004 CINMS Sanctuary Advisory Council (SAC) Work Plan, the SAC outlined the need for developing near- and long-term water quality recommendations for the Sanctuary. In 2005, a Needs Assessment was conducted by members of the Conservation Working Group, and the resulting report was subsequently adopted by the SAC. Key recommendations were intended to help move CINMS managers toward a water quality planning process.

One of the action plans presented in the revised Management Plan addresses water quality, and specifically the Sanctuary’s need for and commitment to work in partnership with many individuals and entities to find answers to important unanswered questions about water quality, from science to management policies and regulations. The Water Quality Action Plan is comprised of two strategies: an Offshore Water Quality Monitoring Strategy, and a Water Quality Protection Planning Strategy.

The Offshore Water Quality Monitoring strategy aims to better evaluate and understand localized and large-scale spatial and temporal impacts from oceanographic and climatic changes as well as impacts from increases in human population in the coastal zone and subsequent pressure(s) on offshore marine resources. Activities the CINMS will undertake to implement this strategy include continued support for the Plumes and Blooms study and an assessment of the management implications of the study's results; and continued support for the Southern California Bight Regional Monitoring Surveys.

The objective of the Water Quality Protection Planning Strategy is to protect the chemical, physical and biological integrity of the Sanctuary by restoring and maintaining water quality. The four activities the CINMS will undertake to implement this strategy are: 1) completing a water quality characterization report; 2) compiling and synthesizing information on jurisdictional water quality authorities and responsibilities; 3) reviewing State and regional water quality management; and 4) developing and proposing priority corrective actions for managing Sanctuary water quality impacts.

This report aims to help the Sanctuary meet the objectives of these two strategies by synthesizing information about the current status of water quality in the CINMS, outlining the various authorities governing water quality in the Sanctuary, and providing an overview of federal, State and regional water quality management programs and water quality monitoring efforts. As the important first step in the Water Quality Protection Planning process, this report sets the stage for the Sanctuary’s proactive management of existing and emerging water quality concerns.

2. Channel Islands National Marine Sanctuary Setting

This section provides a brief overview of the area discussed within this report, including the CINMS.

Established in 1980, the CINMS encompasses approximately 1,470 square miles (1,100 square nautical miles) of Southern California waters that surround Anacapa, Santa Cruz, Santa Rosa, San Miguel (collectively, the Northern Channel Islands), and Santa Barbara Islands. The Sanctuary extends from the mean high tide line to six nautical miles offshore and includes both California State and federal waters. This boundary overlaps that of the Channel Islands National Park (CINP), which extends one nautical mile around each of the same five islands. Both the CINMS and CINP are within the upper portion of the Southern California Bight, which is formed by a transition in the California coastline wherein the north-south trending coast begins to trend east to west. The CINMS occurs at a biogeographic boundary between the colder water Oregonian province to the north and the warmer water Californian province to the south. In addition to the California Current and seasonal gyres and eddies with the Channel, upwelling also influences circulation in the Sanctuary region. These currents are the result of prevailing winds and the orientation of the coastline. Regional upwelling carries nutrient-rich waters from deep canyons and island shelves to surface waters. This results in increased primary productivity and large zooplankton populations, which support abundant populations of small schooling species.

Oceanographic processes combine warm and cool currents in a unique fashion throughout the Northern Channel Islands to create an exceptional breeding ground for many species of plants and animals. For a more complete description of processes, habitats and common species, see the FEIS, Vol. II, Section 3.0 - Affected Environment (CINMS 2009) and *Assessment of Coastal Water Resources and Water Conditions at Channel Islands National Park, California* (Engle 2006).

There are a number of watersheds located on the Northern Channel Islands, with several perennial streams contributing a small amount of fresh water into the Sanctuary. Most fresh water entering the Channel, however, comes from the streams and rivers along the mainland coast. Watersheds pertinent to Sanctuary water quality are described in detail in Section 3.

Much of the life within the Sanctuary could be affected by poor water quality. Giant kelp and seagrass habitats depend upon sunlight penetrating the water column for successful photosynthesis and thus any factor that decreases water clarity is detrimental. Organisms that inhabit rocky reefs are susceptible to sedimentation. Benthic macrofauna are sensitive to physical and chemical alterations of the sediment. Demersal species live in close proximity to sediment where contaminants can accumulate. Planktonic larvae are susceptible to dissolved or suspended contaminants. Animals that use calcium carbonates for their shells and exoskeletons are very sensitive to minute changes in ocean pH, which alter the chemical equations that allow for dissolved minerals to be available for uptake.

The proximity of the Northern Channel Islands to the mainland coast makes them uniquely accessible from Santa Barbara, Ventura, Port Hueneme, and Channel Islands harbors as well as ports in Los Angeles County (primarily Marina del Rey and San Pedro). Within the region, population growth has risen sharply over the last twenty years. As the number of people increases, so does the number of Sanctuary users involved in a wide variety of activities. These activities are described comprehensively in Section 3.5 of the Final Management Plan FEIS, and for convenience are described here in brief.

Recreational activities in the Sanctuary include sportfishing, scuba diving, whale watching, pleasure boating, kayaking, surfing, and sightseeing. Visitors may use their own private craft or visit as passengers aboard Island Packers, Truth Aquatics or other charter vessels. In 2000, three dozen commercial passenger charter vessels operated out of Santa Barbara, Ventura and Channel Islands harbors. Commercial activities in the Sanctuary include commercial fishing (diving, trapping, hook and line and net fishing) as well as shipping.

Hundreds of academic and professional researchers target the Channel Islands for extensive research activities, most of which include physical and biological sciences, socio-economics, culture and history, and political science. Island field stations accommodate varying numbers, depending on the island. Quarters also exist for Park Service rangers and staff on the islands; all facilities are equipped with plumbing and septic systems. Researchers and resource staff rely upon Park Service vessels in addition to commercial passenger boats for island transportation. A small number of researchers and resource managers use Channel Islands Aviation for air transport to Santa Barbara, Santa Cruz, Santa Rosa and San Miguel Islands. Airstrips are not paved and are mowed periodically. Private aircraft are not permitted to land on the islands.

Department of Defense/Homeland Security activities also take place within the CINMS. The US military maintains a strong presence in the region, operating military bases on San Clemente and San Nicolas Islands, and it legally remains the owner of San Miguel Island. The US Air Force and US Navy, individually and together, conduct training exercises and support military testing and evaluation projects for aircraft, ship, and missile programs.

The US Coast Guard (USCG) operates a Marine Safety Detachment and Coastal Patrol Boat out of Santa Barbara Harbor and a Station and Coastal Patrol Boat at Oxnard. The USCG conducts activities throughout the CINMS area, including search and rescue, drug enforcement, fisheries enforcement, marine environmental protection, marine mammal protection, and monitoring and inspection of all international vessels experiencing mechanical difficulty and distress.

3. Description of Pertinent Watersheds

A watershed is defined as an area of land that ultimately shares a common drainage. Within the study area (Figure 3.1), watersheds vary by their size, average discharge volume and land use, which determine the variety and amount of potential contaminants reaching the Channel. Water quality in the Sanctuary, and in the Santa Barbara Channel more broadly, is affected by the transport of dissolved and particulate substances within the Southern California Bight by regional and meso-scale circulation patterns and by inputs of waterborne and airborne constituents from coastal watersheds in or near the Sanctuary. The land masses which drain directly into Sanctuary waters are San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara Islands.

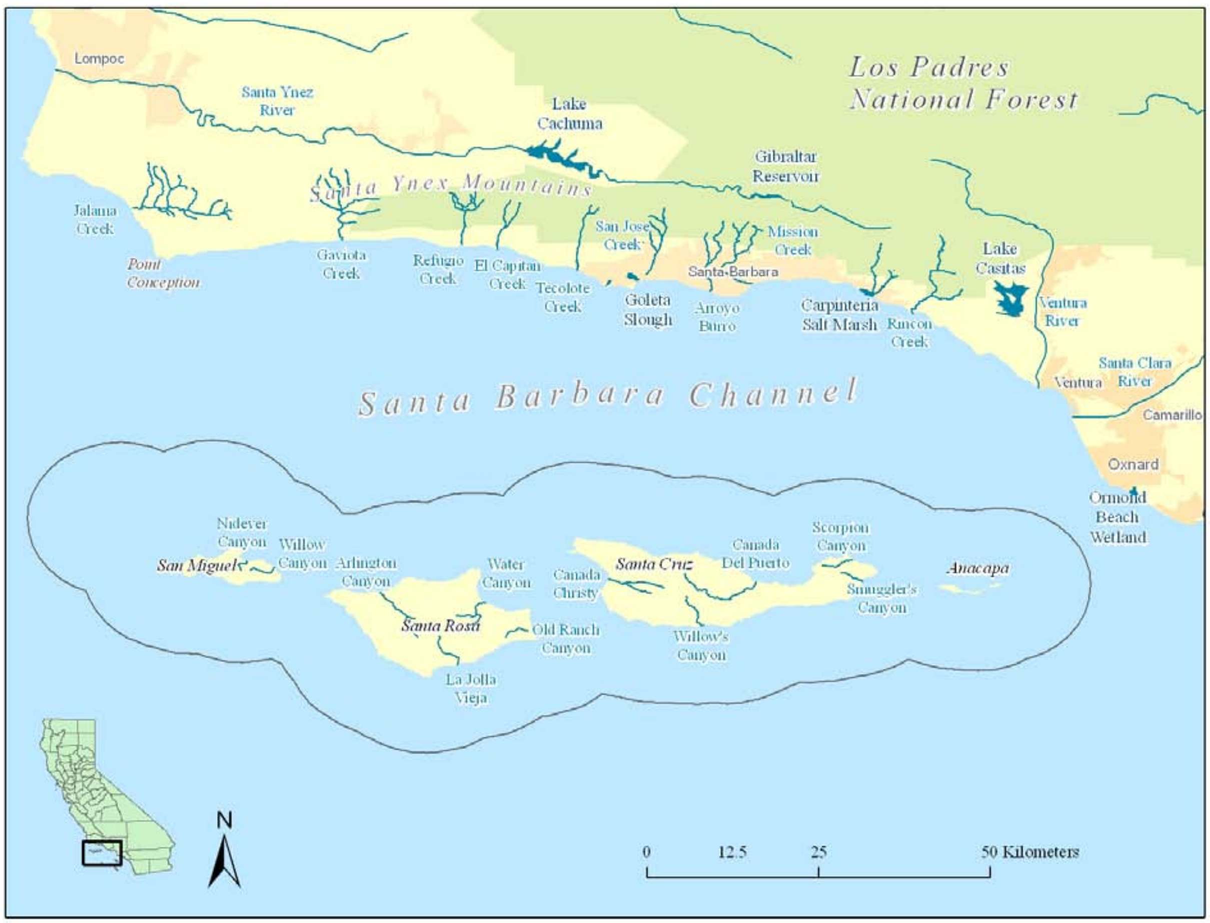

Figure 3.1
Map of the Santa Barbara Channel, CINMS, and major drainages from mainland Santa Barbara and Ventura counties. Santa Barbara Island is not shown.

North of Point Conception, major drainages include the Santa Ynez and Santa Maria Rivers, and the smaller San Antonio Creek watershed. These major rivers have been shown to transport sediment plumes that reach Sanctuary waters.

On the south side of the Santa Ynez Mountain Range, 41 small coastal watersheds drain to the ocean. The creeks of these watersheds provide important nutrients to the marine environment, as well as pollution from agricultural and urban runoff (Schiff and Sutilla 2001).

Depending on the degree of offshore transport, terrestrial runoff and airborne particulates from the mainland coast of the Santa Barbara Channel (for the purposes of this report, defined as extending from Point Arguello in the west to Point Mugu in the east), and from coastal portions of Los Angeles County south of Point Mugu, potentially affect water quality in the Sanctuary. Island and mainland watersheds which contribute runoff directly to the Santa Barbara Channel are described in the following sections. In addition, land uses within the watersheds and resultant threats to water quality are also discussed. The highly urbanized watersheds draining into the coastal ocean south of the Santa Barbara Channel (Santa Monica Bay watersheds - including Malibu, Topanga Canyon and Ballona Creeks; the Dominguez Channel watershed including Los Angeles and Long Beach Harbors; and the Los Angeles River watershed) and from the vicinity of Santa Catalina Island, along with the threats to marine water quality that they pose, are summarized in Engle (2006) and are not presented here.

3.1 Channel Islands

For 13,000 or more years before European contact, the ancestors of today's Chumash Native American peoples lived and thrived on the Channel Islands and surrounding waters. By the 1820s, Island Chumash villages were no longer inhabited as a result of forced removal from the Islands due to European incursions. Island watersheds have been impacted by evolving patterns of human land use over the past two centuries, including ranches and rangeland for cattle, sheep, horses and pigs; trophy hunting operations (mule deer and elk); USCG dwellings and lighthouse operations; and naval exercises and bombing practice. In recent years, cattle, sheep and pigs have been removed or extirpated, and island habitats are beginning to recover from some of the direct and indirect effects of exotic livestock, which included hillside erosion, landslides and increased sediment export, exotic plant infestations, facilitation of golden eagle colonization and consequent near-extirpation of native foxes, bacterial contamination of streams, and alteration of riparian plant communities and stream channel morphology. With the exception of continuing lighthouse operations on Anacapa Island, and trophy hunts for elk and deer on Santa Rosa Island, land use on the islands is controlled by The Nature Conservancy (which owns the majority of Santa Cruz Island) and the National Park Service, and is oriented toward recreation (hiking and camping), conservation, education and research. Past and present land uses on the Channel Islands are described in more detail in Engle (2006). Island land covers and drainage features are briefly summarized below; text and figures were adapted from Engle (2006).

3.1.1 San Miguel Island

At 9,325 acres, San Miguel is the third smallest Channel island. This low, windswept island is mostly a tableland drained by several unnamed arroyos and seasonal flows through drainages in Nidever and Willow Canyons (Figure 3.2). Few year-round water sources exist other than the spring in Nidever, where most modern human use has been centered. The island's coast is 27 miles long and consists of jagged, rocky shoreline interspersed with sandy beaches. Principal land covers on the island are grassland, haplopappus scrub, coastal sage scrub, and unstabilized sand dunes. The island was heavily grazed by sheep during the 19th and into the 20th centuries, leading to an almost total loss of woody vegetation, leaving the thin topsoil vulnerable to blowing winds. Early aerial photos present the island as a series of sand dunes. Sheep were removed during the 1940s but the flora is still recovering.

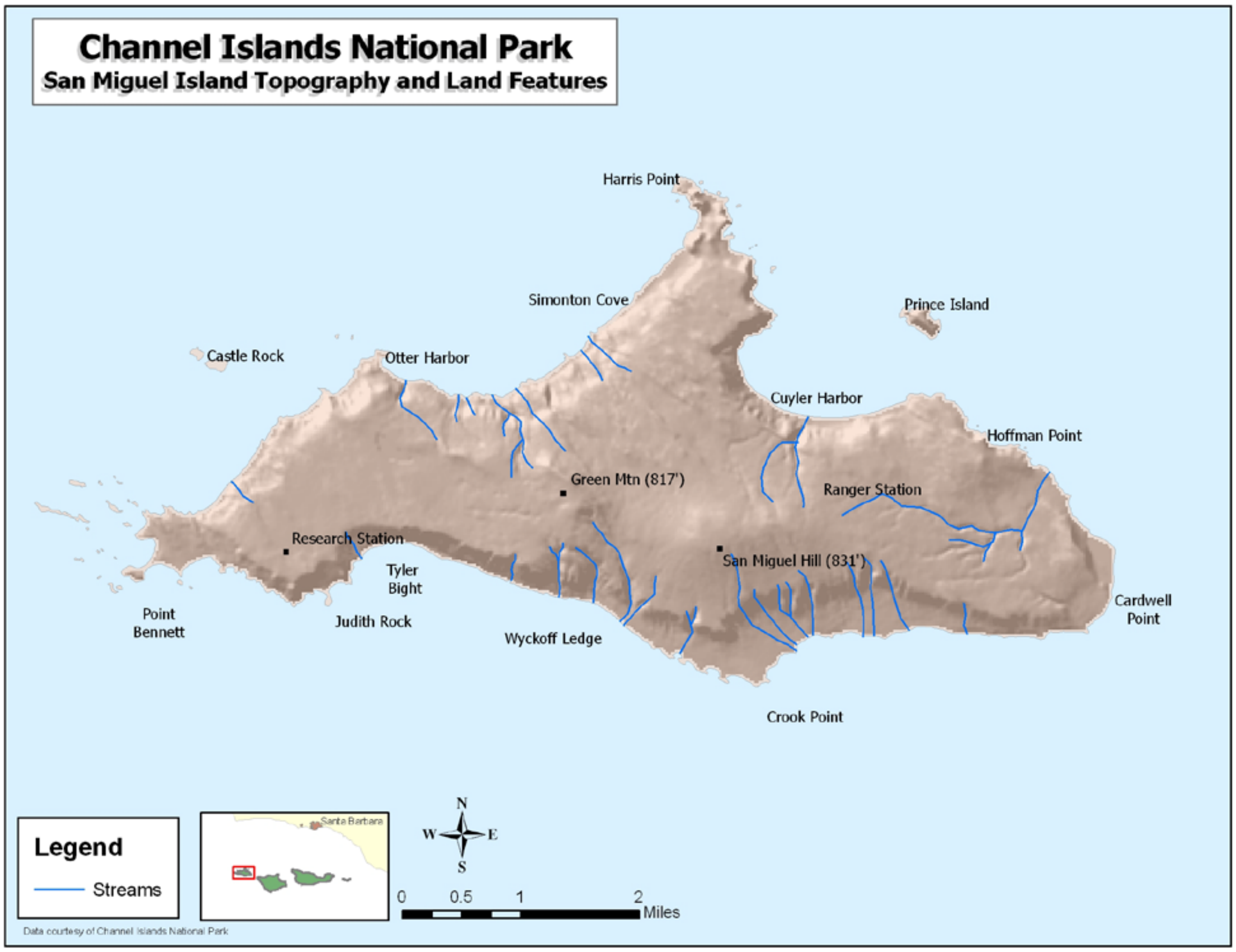

Figure 3.2
Topography (based on 30 m digital elevation models [DEMs]) and drainage features on San Miguel Island, from Engle (2006).

3.1.2 Santa Rosa Island

Santa Rosa Island is the second largest of the Channel Islands at 52,794 acres. Topographic relief on Santa Rosa Island is greater than on San Miguel Island, allowing for the presence of rolling hills, steep canyons, rocky inter-tidal areas and sandy beaches. Principal land covers on the island are grassland, coastal sage scrub and chaparral. Streams with perennial or seasonal flow, or washes, occur in numerous canyons on the island (Figure 3.3). The major drainages originate from a single central highland, producing long stream lengths and many fourth order stream segments (Mertes et al. 1998).

Previously, cattle grazing on uplands and extensive use of streams by cattle, elk and deer transformed streams on Santa Rosa Island into sediment-choked, braided channels with unvegetated banks (Wagner et al. 2004). The native woody and herbaceous riparian plant species, which would ordinarily stabilize the banks, shade the streams, trap the sediment accompanying winter runoff, and dissipate the energy of storm flows, were practically eliminated except in portions of canyons too steep for livestock, elk or deer.

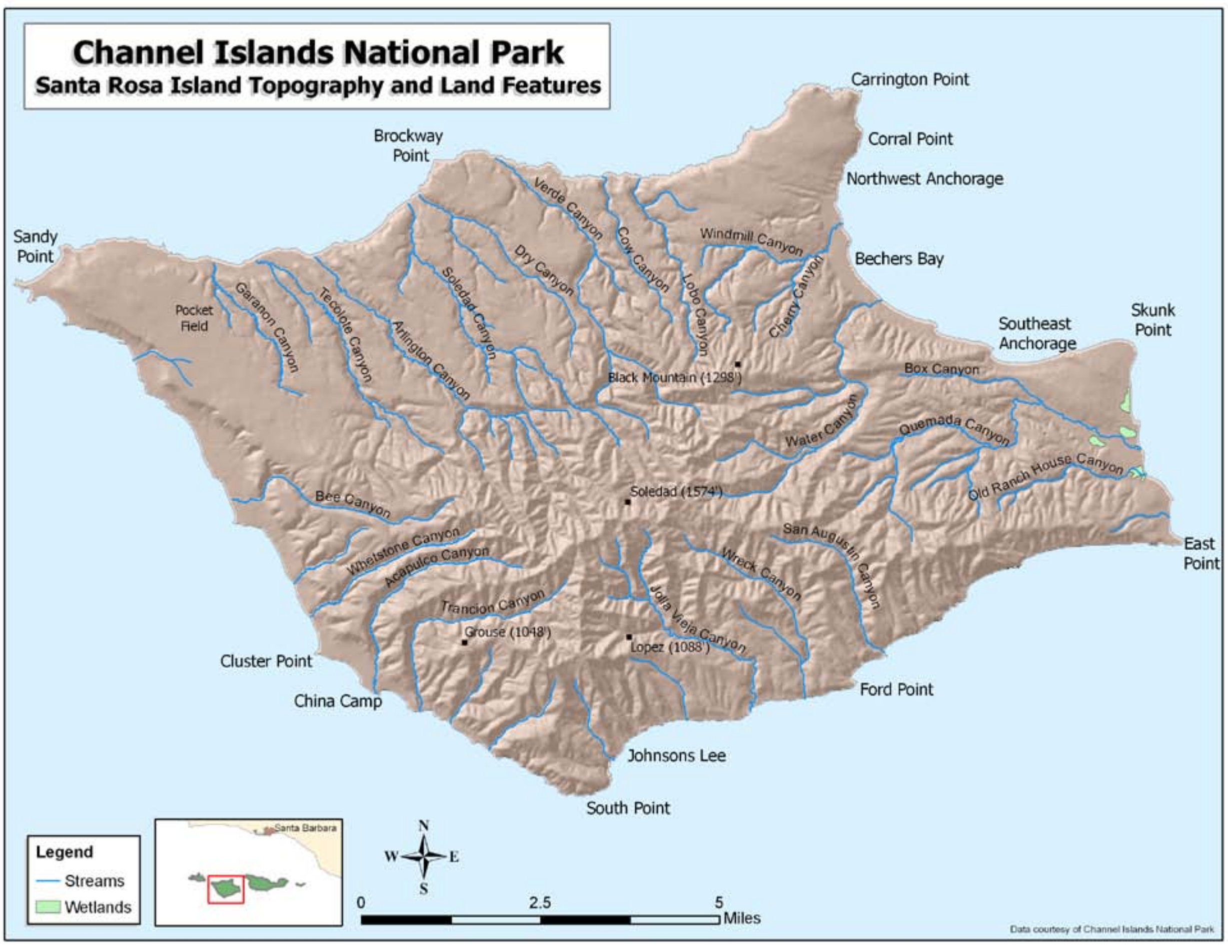

Figure 3.3
Topography (based on 30 m digital elevation models [DEMs]) and drainage features on Santa Rosa Island, from Engle (2006).

The recovery of riparian corridors following cattle removal in 1998 was documented in a pre-removal (1995) and post-removal (2004) study of ten reference stream reaches on the island (Wagner et al. 2004). Cattle removal resulted in 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). Although the return of native perennial herbaceous species is widespread, the reestablishment of woody species, especially arroyo willow and black cottonwoods, continues to be hindered by browsing deer and elk and a postulated lack of seed sources.

3.1.3 Santa Cruz Island

Santa Cruz Island is the largest of all the Channel Islands at 60,645 acres, and is also the most topographically and ecologically diverse. Two east/west trending mountain ranges rise over 2,000 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 (Figure 3.4). The largest watershed is the Central Valley, which runs east/west and drains out to the north shore at Prisoners Harbor. Most of the major watersheds have a mix

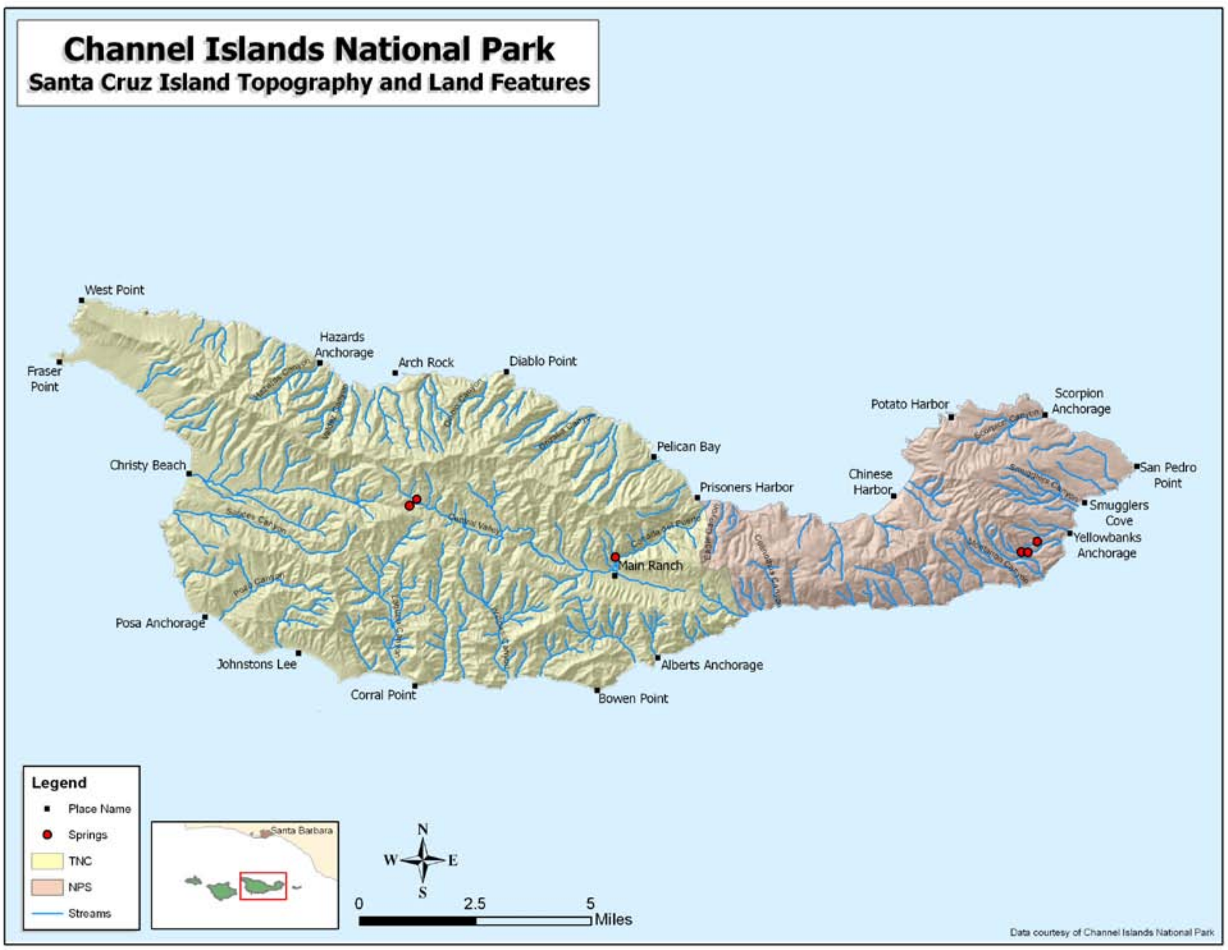

Figure 3.4
Topography (based on 30 m digital elevation models [DEMs]) and drainage features on Santa Cruz Island, from Engle (2006).

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. Over the past 150 years, grazing by cattle, feral sheep and pigs dramatically affected the vegetation on Santa Cruz Island, removing native vegetation cover and contributing to higher 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. The NPS completed removal of feral sheep from the old Gehrini ranch land in 1999, and feral pigs were eradicated from the entire island by 2007. Today, Santa Cruz Island harbors at least 170 introduced plant species, making up 26% of the island's total flora (CINP 2002).

Santa Cruz Island watersheds are characterized by steep, dissected subdrainages with V-shaped valley bottoms that are highly efficient at delivering sediment. The V-shaped valley bottoms, coupled with low vegetation cover (resulting from years of over-grazing), are capable of causing "flash flood" events such as the Scorpion Flood in December 1997 (CINP 2002). Most drainages have only intermittent above-ground stream flow. However, some of the larger watersheds have perennial flow in normal precipitation years. The largest watershed on the island (Central Valley) has intermittent surface flow as the stream alternates above and below ground throughout its length.

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. Past livestock grazing, pig rooting, and extensive vegetation changes have caused localized downward trends in soil resources on 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 2002). Owing to the fact that sheep were removed from the western 90% of Santa Cruz (the part owned by The Nature Conservancy) before they were removed from the eastern 10% of the island (the part owned by the National Park Service), 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. Since the removal of grazers, many temporary streams are experiencing longer flow.

3.1.4 Anacapa Island

Anacapa Island is a chain of three small islets extending 4.5 miles from east to west, totaling 699 acres. East Anacapa is one mile long, a quarter of a mile wide, and rises 250 feet above the water. Middle Anacapa is 1.5 miles long, a quarter of a mile wide and 325 feet at its highest point. Western Anacapa, the largest islet of this group, is two miles long by six tenths of a mile wide, and rises to a peak of 930 feet. Predominant land covers on Anacapa Island are coastal sage scrub, grassland, island chaparral, iceplant (an invasive, non-native species), and Coreopsis dominated bluffs. No streams or other fresh water bodies occur on Anacapa Island.

3.1.5 Santa Barbara Island

Thirty-eight miles west of Palos Verdes Point, Santa Barbara Island (639 acres) is the smallest of the Channel Islands and the only one within the Sanctuary and National Park that is outside of the Santa Barbara Channel. The island is roughly triangular in shape and emerges from the ocean as a twin-peaked mesa with steep cliffs. Santa Barbara Island has a few narrow rocky beaches, six canyons, and a badlands area. An attempted ranching and farming effort during the 1920s left behind cats and introduced rabbits, which wreaked havoc on the sensitive ecosystem. Principal land covers on the island are grassland, invasive iceplant and native shrubland. As is true for Anacapa Island, no streams occur on the island. The NPS is actively performing non-native plant removal.

3.2 Mainland - Santa Barbara and Ventura Counties

The Santa Barbara Channel receives terrestrial runoff from watersheds with coastal outlets between Point Arguello in the west and Point Mugu in the east. Between Point Conception and the mouth of the Ventura River, 74 small coastal catchments, varying in size from 1-50 km^2, drain the Santa Ynez Mountains (Melack & Leydecker 2005). The low order streams draining these catchments originate in steep slopes vegetated by chaparral, southern coastal scrub and woodland. The headwaters of most of these streams are located in the Los Padres National Forest. Before discharging to the Channel, the streams traverse foothills and a narrow coastal terrace. Average flowpath lengths in these streams are less than 10 km. From west to east, land use in the foothills and coastal plain shifts from mostly rangeland to a combination of urban and agricultural land uses. Residential estates and avocado orchards are a common use of the mid-elevation foothills. Orchards, row crops, nurseries, and greenhouses are common agricultural uses of the coastal terraces. Several of the nurseries and greenhouses in these watersheds have direct discharge points to the creek channels. The lowest reaches of several of the streams pass through County or State Parks, including Jalama County Park and Gaviota, Refugio, El Capitan and Carpinteria State Parks.

Several coastal streams pass through the urban areas of the cities of Goleta, Santa Barbara, Montecito and Carpinteria before emptying into the ocean; many of them have been channelized, lined with concrete or riprap, or otherwise modified along their lower reaches. The Goleta Slough watershed includes Los Carneros, Glen Annie, San Jose, San Pedro, Atascadero and Maria Ygnacio Creeks. Each of these creeks is channelized to some extent as they flow through the urban areas of Goleta. Los Carneros, Glen Annie, San Pedro and San Jose Creeks have been converted to cement box channels in the lowest reaches and sediment is mechanically removed annually. Other channelized watersheds include Arroyo Burro, Mission, Sycamore, San Ysidro, Romero, Toro, Arroyo Paredon, Santa Monica and Franklin Creeks. The latter two creeks are contained in cement box channels as they flow through intensive multi-use agriculture in the form of greenhouses and nurseries, as well as residential and light commercial development.

Starting just west of the City of Ventura and extending to Point Mugu, the Santa Barbara Channel receives runoff from three higher order streams with much larger watersheds. From west to east they are the Ventura River, the Santa Clara River and Calleguas Creek.

The Ventura River drains an area of about 270 square miles with headwaters in the Santa Ynez Mountains and a main stem, which drains a coastal plain for about 24 km before emptying into the Pacific Ocean. The watershed is minimally developed, and compared to other watersheds of the Los Angeles region, has large areas of good water quality and aquatic habitat. About 20% of the watershed is woodland and 75% chaparral; half of this area lies within the Los Padres National Forest (Figure 3.5). Urban and agricultural uses (cattle, orchards, vineyards) are concentrated in the Ojai Valley and in lower reaches (Figure 3.6). Industrial use (primarily oil fields) occurs in the lower reaches. About 15,000 acres in the watershed are used for irrigated agriculture (LWA 2008).

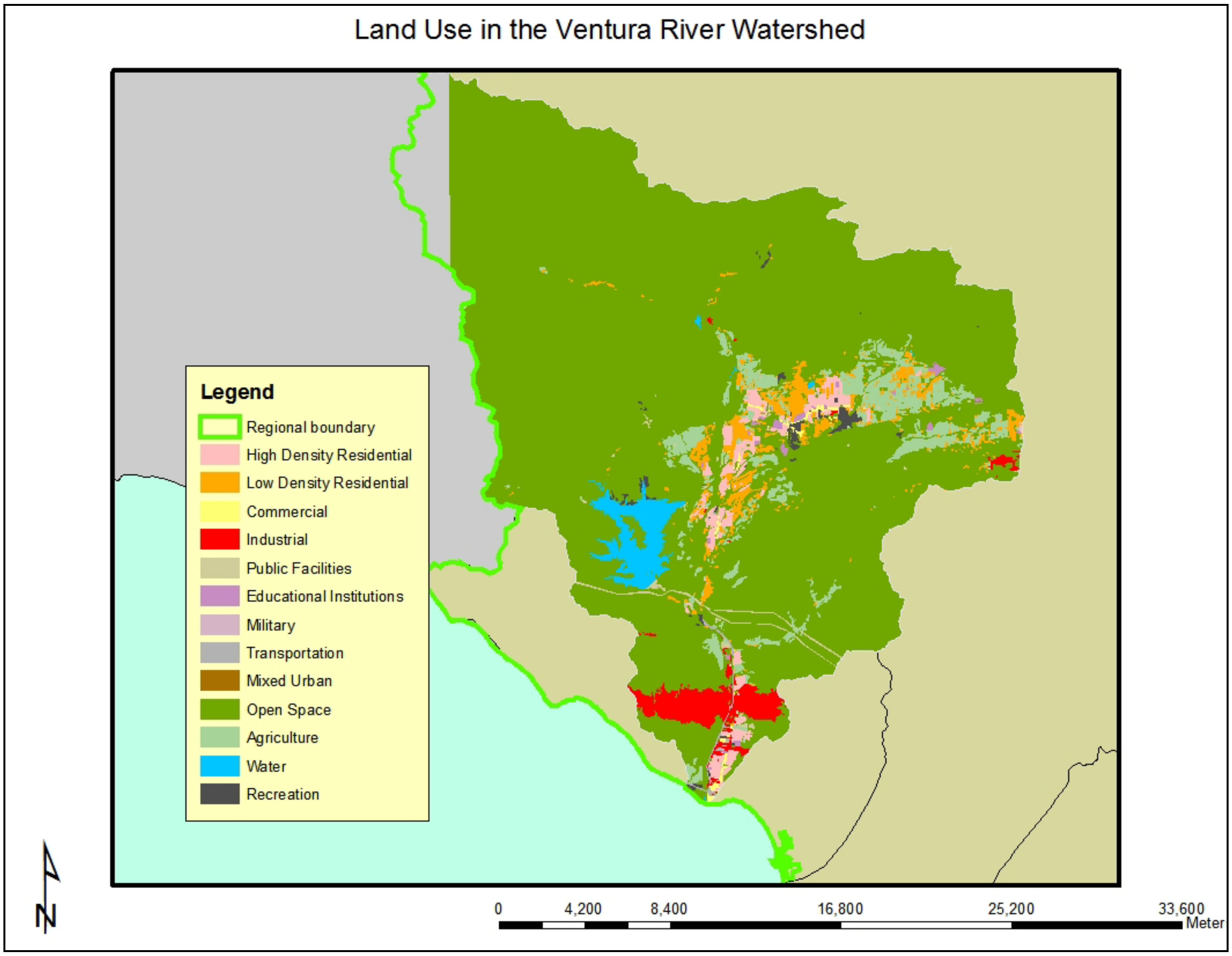

Figure 3.5
Land uses in the Ventura River Watershed (from LARWQCB 2007).

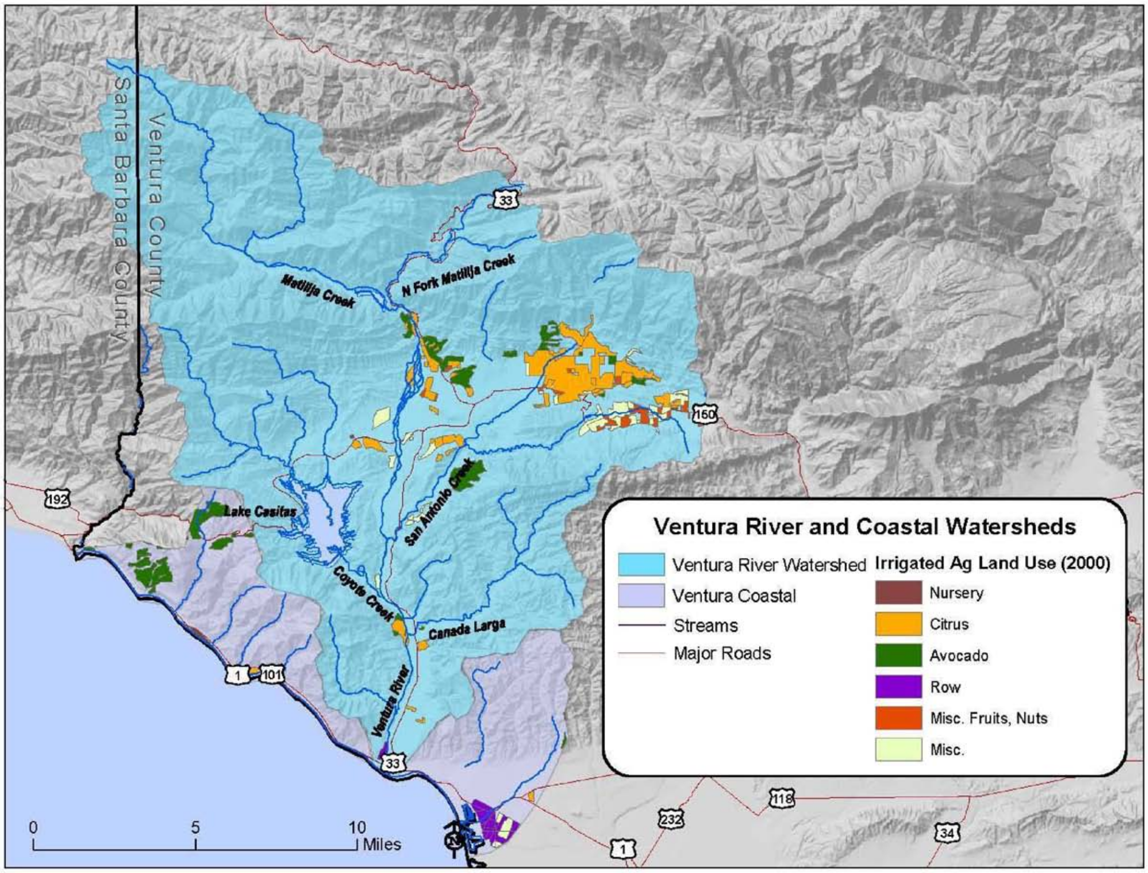

Figure 3.6
Agricultural land use in coastal watersheds between Rincon Point (at the Santa Barbara/Ventura County line) and the Ventura Marina (from LWA 2008).

The Santa Clara River drains an area of about 1,613 square miles and is the largest river system in southern California that has a large proportion of relatively undisturbed natural habitat in its watershed (Figure 3.7). Approximately 40% of the watershed is located in Los Angeles County and 60% is in Ventura County; much of the watershed is in the Angeles National Forest or the Los Padres National Forest. About 62% of the 500-year floodplain of the Santa Clara River is used for agriculture and about 22% for industry. Approximately 50,000 acres in the watershed are used for irrigated agriculture (LWA 2008). Citrus and avocado are the principal crops grown in agricultural areas (Figure 3.8). The headwaters of the river are located at Pacifico Mountain in the San Gabriel Mountains. It flows in a generally western direction for approximately 84 miles through Tie Canyon, Aliso Canyon, Soledad Canyon, the Santa Clarita Valley, the Santa Clara River Valley, and the Oxnard Plain before discharging to the Pacific Ocean near the Ventura Harbor. Major tributaries include Castaic Creek and San Francisquito Creek in Los Angeles County, and Sespe, Piru, and Santa Paula Creeks in Ventura County. About 10% of the watershed occupies relatively flat terrain which includes part of the Oxnard Plain, the Santa Clarita Valley, Castaic Valley, the Santa Clara River Valley, and the floors of the larger canyons, including the upper Soledad and lower Sand, Mint, Bouquet, Placerita, San Francisquito, Piru, Santa Paula, and the Sespe.

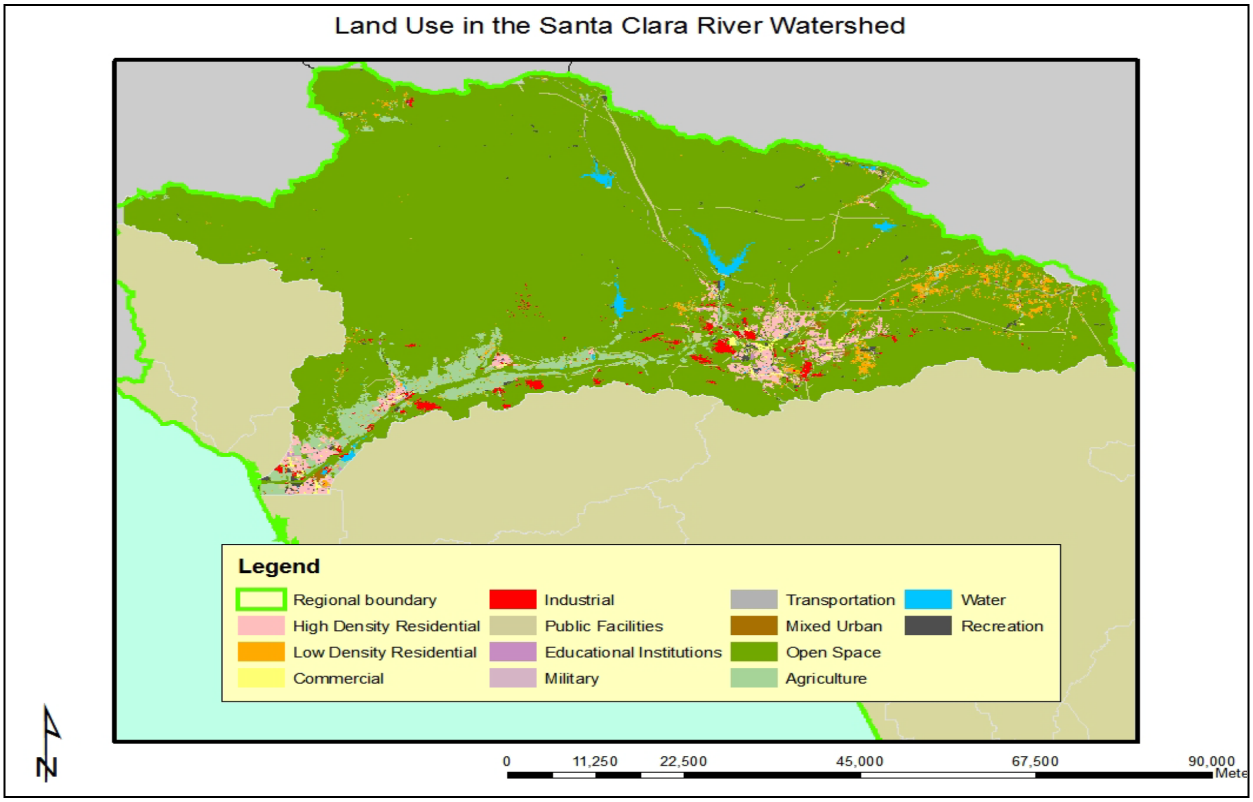

Figure 3.7
Land use in the Santa Clara River watershed (from LARWQCB 2007).

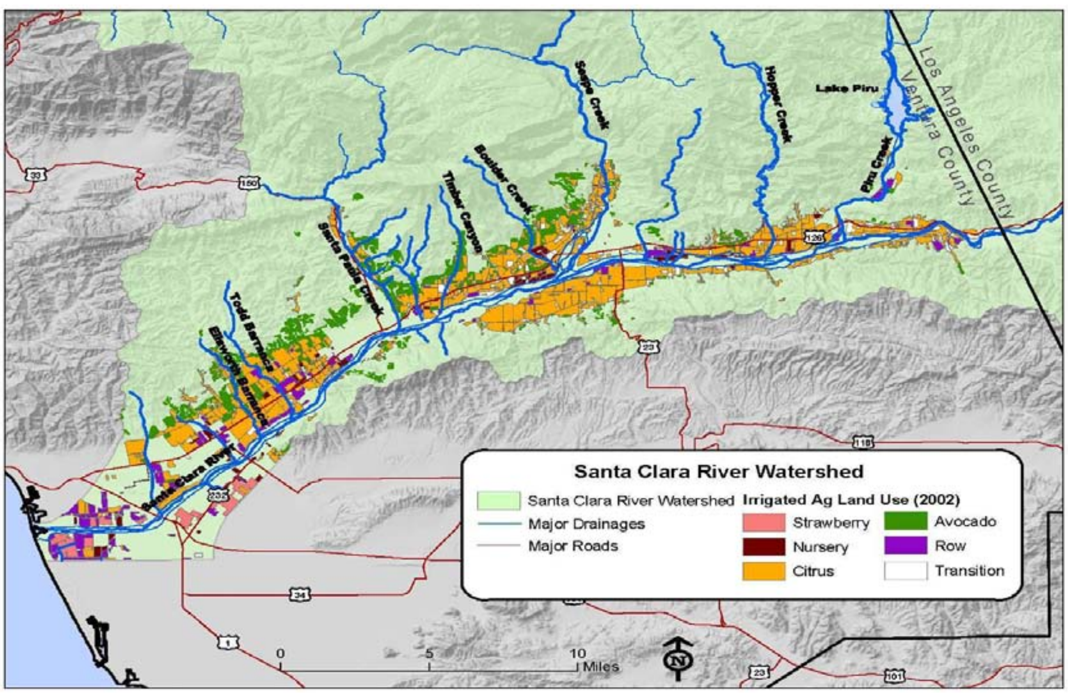

Figure 3.8
Agricultural land use in the Santa Clara River watershed (from LWA 2008).

Calleguas Creek and its major tributaries - Revolon Slough, Conejo Creek, Arroyo Conejo, Arroyo Santa Rosa, Arroyo Las Posas, and Arroyo Simi - drain an area of about 380 square miles in southern Ventura County and a portion of western Los Angeles County. The northern boundary of the watershed is formed by the Santa Susana Mountains, South Mountain, and Oak Ridge; the southern boundary is formed by the Simi Hills and Santa Monica Mountains. Urban development is concentrated within the city limits of Simi Valley, Moorpark, Thousand Oaks, and Camarillo. Roughly 50% of the watershed is undeveloped open space, 25% is agricultural, and the remaining 25% is urban (WCVC 2006) (Figure 3.9). Most upland areas are still undeveloped; however, residential developments and golf courses are increasingly encroaching into open space. About 60,000 acres in the watershed are used for irrigated agriculture (LWA 2008). Avocados and citrus crops (lemons, oranges) are grown in flat areas or foothills (Figure 3.10). The Oxnard Plain contains sod farms and nurseries and is used for a wide variety of row crops, such as strawberries, peppers, green beans, celery, and onions.

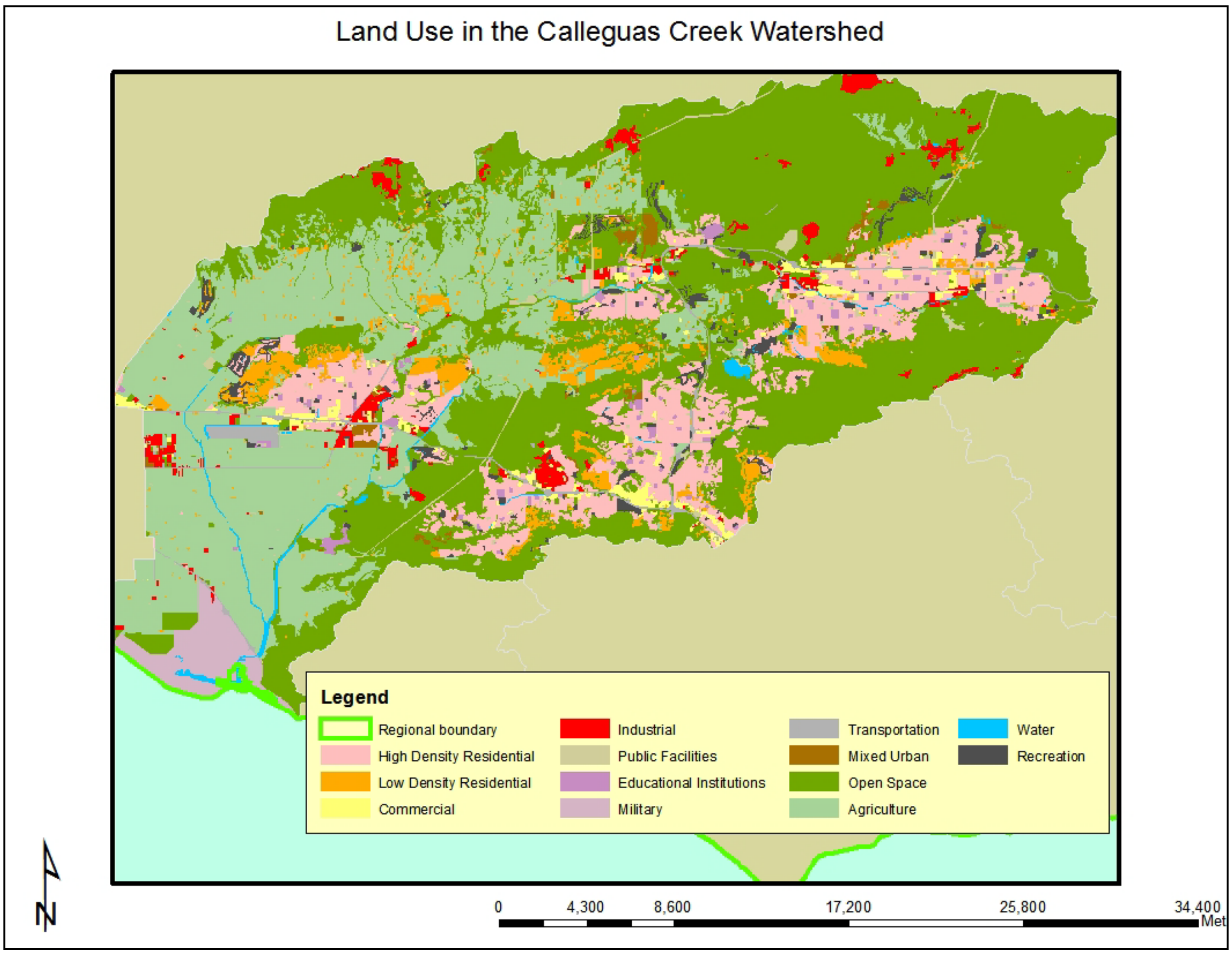

Figure 3.9
Land use in the Calleguas Creek watershed (from LARWQCB 2007).

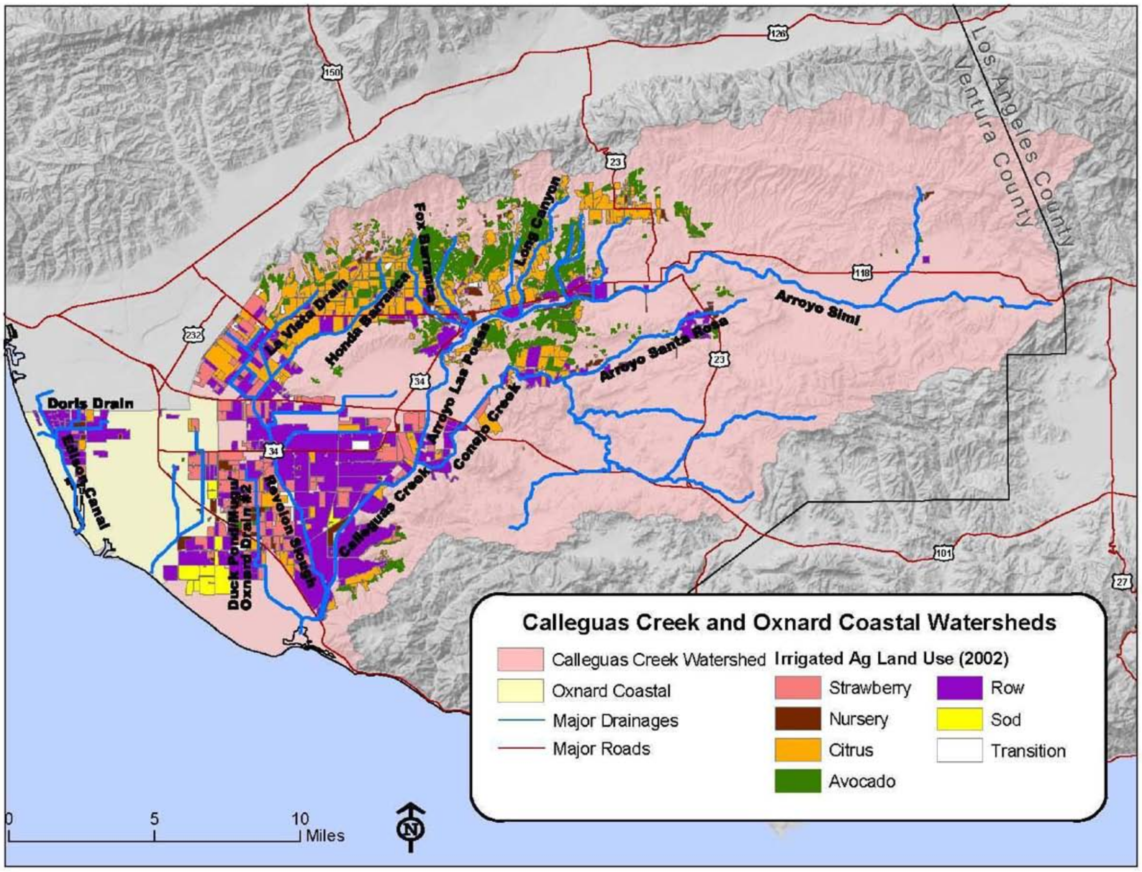

Figure 3.10
Agricultural land uses in the Calleguas Creek watershed and Oxnard Plain (from LWA 2008).

Two much smaller coastal watersheds are located between the Ventura River and Point Mugu: the Hall Canyon/Arundell watershed between the Ventura and Santa Clara River watersheds, and the Ormond Beach watershed (Figure 3.11). Within these two watersheds, some of the agricultural land on the Oxnard plain and some of the area occupied by the cities of Ventura, Oxnard and Port Hueneme drains via channels or ditches to area harbors (Ventura, Channel Islands, and Port Hueneme harbors), McGrath Lake (south of the mouth of the Santa Clara River), or directly to the ocean. For example, the Arundell Barranca, a channel which collects urban and agricultural runoff, enters the Ventura Keys portion of the Ventura Harbor.

Estuaries or lagoons occur at the ocean/land interface of many of the coastal watersheds between Point Conception and Point Mugu. Prominent among these are the Devereux Slough, Goleta Slough, and Carpinteria Salt Marsh in Santa Barbara County, and the Ventura River estuary, Santa Clara River estuary, and Mugu Lagoon in Ventura County. These are discussed in Section 4.3.3.

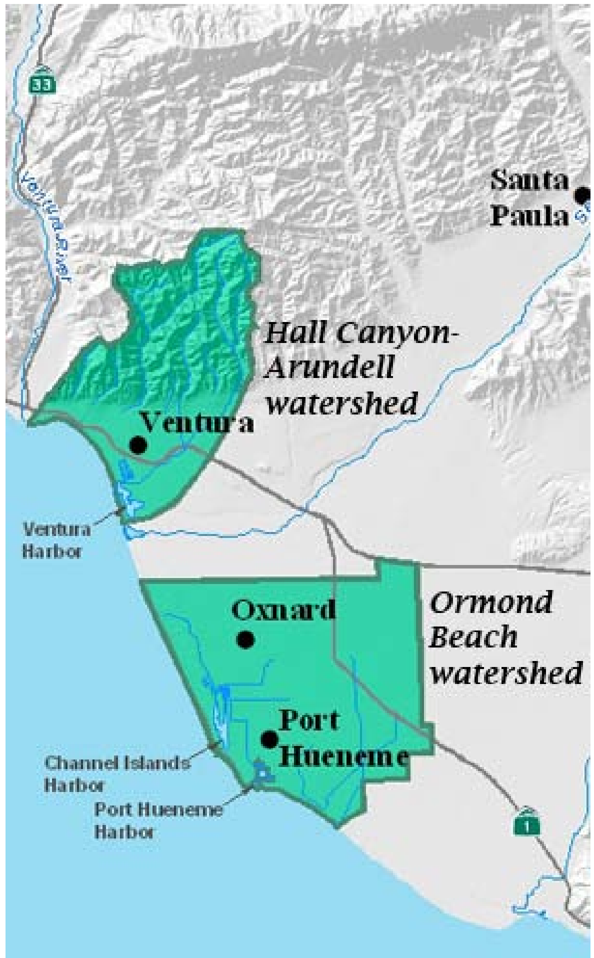

Figure 3.11
The Hall Canyon-Arundell and Ormond Beach watersheds in Ventura County (adapted from following website: http://www.waterboards.ca.gov/losangeles/water_issues/programs/regional_program/wmi/maps/venturacoastal.jpg).

3.3 Mainland – Harbors

Four harbors occur between Point Conception and Point Mugu. They are, from west to east: Santa Barbara Harbor (124 acres), Ventura Harbor (423 acres), Channel Islands Harbor (220 acres), and Port Hueneme (121 acres). Of these, Port Hueneme is the only deep water harbor serving large vessels (e.g., container ships, oil tankers), although cruise ships and the occasional aircraft carrier infrequently anchor offshore from Santa Barbara Harbor. These areas are discussed again in further detail in Section 4.3.3.

3.3.1 Santa Barbara Harbor

From the 1870s to the 1940s, Santa Barbara Harbor served passenger and freight ships (the latter via railroad car loading on Stearns Wharf). The breakwater was built in the 1940s and currently, the harbor has 1,100 slips. Storm drains from Santa Barbara City College and the lower Westside neighborhoods empty into the marina. Commercial uses of the harbor include whale watching and dive charter boats, daily on- and off-loading by oil crew boats that service five offshore platforms, and a small fishing fleet. Regular dredging is required to keep the mouth of the harbor open.

3.3.2 Ventura Harbor

The Ventura Harbor is located between the mouths of the Ventura and Santa Clara Rivers, and contains 1,375 slips for commercial and recreational boats. Two boatyards and a variety of commercial retail businesses are located in the marina. A residential area situated along three canals, called the Ventura Keys, forms part of the harbor. Because the entrance to the harbor is between the mouths of two rivers which discharge large sediment loads, dredging is necessary to keep the entrance to the harbor open. The harbor is surrounded by agricultural land and housing to the west and the Ventura Wastewater Treatment Plant to the east, and a large unlined canal (Arundell Barranca) drains into the harbor in the Keys area (see Figure 4.13). Discussions are currently ongoing concerning the possibility of re-routing the barranca, which drains both agricultural and light industrial areas, away from the marina.

3.3.3 Channels Islands Harbor

Channels Islands Harbor is located several miles south of the mouth of the Santa Clara River and is in the immediate vicinity of considerable residential development and some agricultural land. The harbor has 2,220 slips and contains a residential area of houses and private docks, two boatyards, public marinas for small craft, and berths for commercial fishing boats. Cooling water for the Reliant Energy Mandalay (electric power) Generating Station is drawn 4.2 km through the Edison canal located at the north end of the harbor.

3.3.4 Port Hueneme

Port Hueneme was constructed in 1940 and is located between Channel Islands Harbor and Mugu Lagoon. The port is the only deep water harbor between Los Angeles and the San Francisco Bay area, and is the US Port of Entry for California's Central Coast region. The port is split between Naval Base Ventura County and the Oxnard Harbor District, which runs the commercial operations. It is the only military deep water port between San Diego Bay and Puget Sound, serving ocean carriers from both the Pacific Rim and Europe. Port Hueneme ranks among the top seaports in California for general cargo throughput. Niche markets that Port Hueneme serves include the import and export of automobiles, heavy agricultural equipment and industrial vehicles, fresh produce (especially citrus and bananas), and forest products. A few commercial fishing boats are docked here.

3.4 Relative Drainage Areas of Island and Mainland Watersheds

The sizes of watersheds draining to the coastal ocean between Point Arguello and Point Mugu are contrasted in Figure 3.12. Because they are small and numerous, the watershed areas of the low-order coastal streams between Point Arguello and the mouth of the Ventura River were combined for the figure. Omitted from the mainland drainage area are the smaller areas of the Ventura County coastal plain draining to Ventura and Oxnard area harbors (the Hall Canyon/Arundell and Ormond Beach watersheds, discussed in Section 3.2). The collective area drained by small coastal streams entering the Santa Barbara Channel is about 15% of the total drainage area, and is about twice as large as the combined areas of San Miguel, Santa Rosa, Santa Cruz and Anacapa Islands. Well over half of the land area draining to the Santa Barbara Channel is contained in the watershed of the Santa Clara River. The Ventura River watershed is similar in size to the combined area of the northern Channel Islands, but only about one-seventh as large as the Santa Clara River watershed.

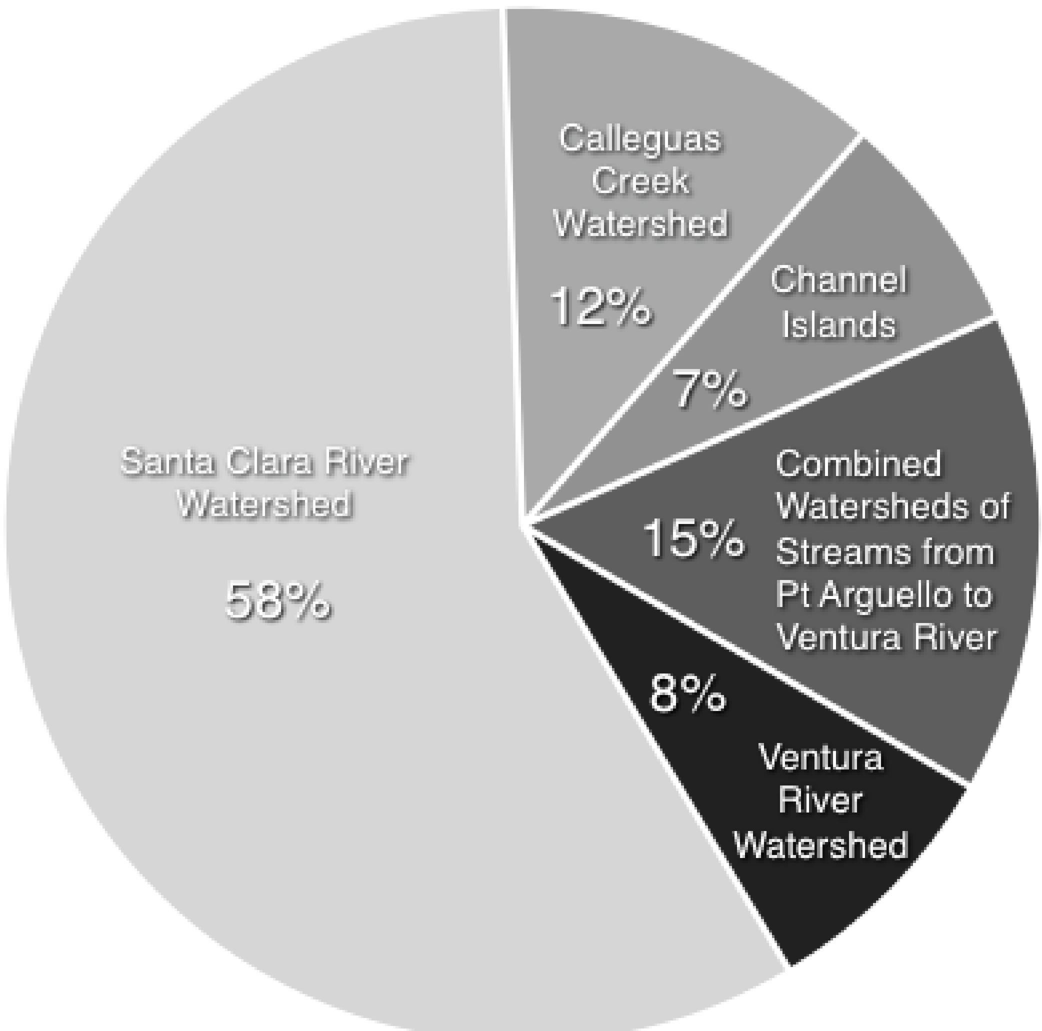

Figure 3.12
Percentages of the total drainage area of the Santa Barbara Channel (mainland and island) contained in specific watersheds. The watersheds of the small coastal streams draining the Santa Ynez Mountains between Point Arguello and the Ventura River were combined. The areas of the Hall Canyon/Arundell and Ormond Beach watersheds were not included in the mainland drainage area as they are relatively quite small.

4. Sources of Water Quality Impairment in the Sanctuary & Channel

This section aims to describe both known and potential origins of pollutants and, in a few cases, the mechanisms by which pollutants may enter the environment. There are a variety of ways in which the waters of the CINMS may become polluted. Sources of pollution may come from offshore or from the land, and may travel through a direct identifiable pathway or originate via an indirect, more diffuse mechanism. Direct sources of pollution to the Sanctuary and Santa Barbara Channel may originate offshore and include oil and gas platforms, oil spills, natural oil seeps, marine vessels, shipwrecks, and chemical, munitions and dredge spoils dumping, or onshore, from the mainland coast and terrestrial runoff from the Channel Islands. Indirect sources, such as transfer of pollutants via the food chain, are discussed as well.

The terms “point source” and “nonpoint source” have legal definitions that are used in the federal Clean Water Act and other regulations. A point source is a single identifiable origin or source such as a sewage treatment plant discharge, and by law requires a discharge permit that sets numerical limits for a list of pollutants. For the purposes of this report, the term “point source” is reserved for those industrial outfalls operating under National Pollution Discharge Elimination System (NPDES) permits. (NPDES permits are discussed in further detail in Section 6.1.1). Any other source that is traceable to a specific incident or origin is referred to a direct source.

Nonpoint source pollution refers to pollution which cannot be traced back to a single origin or source, and primarily occurs as storm water runoff. Nonpoint source pollutants are picked up from the soil and pavement during rain events and are transported into rivers, wetlands, and the Channel. These pollutants may include fertilizers, herbicides and insecticides from residential and agricultural areas, sediment from construction sites or eroding streambanks, and bacteria from livestock, household pets and faulty septic systems. This is the predominant manner by which contaminants from urban landscapes enter the marine environment. The regulation of land use and associated land management practices has been identified as the only effective means of controlling nonpoint-source pollutants. The US Environmental Protection Agency (EPA) has devised lists of management measures to be implemented by State and local resource managers in order to reduce this pollution. Regulation of both point and nonpoint sources are addressed in Sections 6.1 and 6.5 of this report, respectively.

Section 4.1 addresses direct and in some cases point sources that originate offshore and in the Santa Barbara Channel. Section 4.2 addresses those direct point sources that originate on land, including sewage treatment and power plants. Section 4.3 address indirect sources, including the large contributions of storm water runoff.

As the scope of this report is limited to the waters in and around the Santa Barbara Channel and CINMS, the reader is directed to the website of the Southern California Coastal Water Research Project (SCCRWP; http://www.sccwrp.org) for ongoing syntheses and research results concerning water quality throughout the larger Southern California Bight.

4.1 Direct Sources and Discharges - Offshore

4.1.1 Oil & Gas Platforms

There are currently 20 oil and gas platforms located in the Santa Barbara Channel area (Figure 4.1) and all fall under one general discharge permit (see Section 6.1.1). Nineteen are in federal waters, and one is in State waters, although none lie within the CINMS. Most of the oil platforms in the channel are 15-20 miles from the boundary of the CINMS, with the exception of Platform Gail, which is just over six miles from Anacapa Island (less than a mile north of the Sanctuary boundary).

Twenty-two oil fields have been discovered in the Santa Barbara Channel. In addition to the existing platforms, there are six undeveloped or non-producing State leases that could potentially be developed or produce again in the future. A permanent statewide ban was enacted in 1994 to prevent further oil leasing in State waters, but the existing undeveloped leases are still extant. Photos and other information about the platforms are available at the Minerals Management Service (MMS) website (http://www.mms.gov/omm/pacific/index.htm).

Wastewater discharges to the ocean 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 US EPA Region 9, instead of by the State. The permitted discharges may occur at different stages of operation and 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
- H2S Gas Processing Waste Water

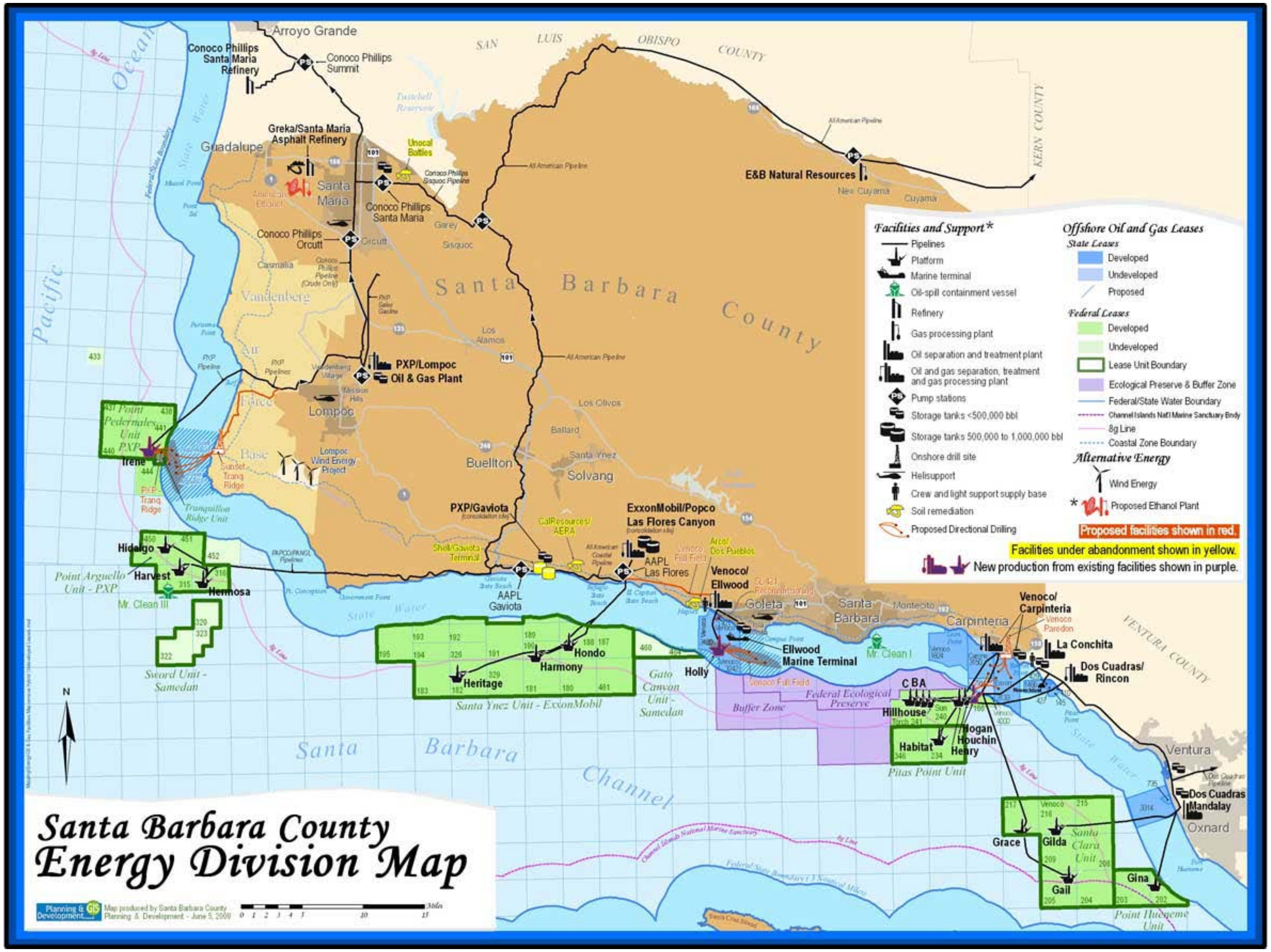

Figure 4.1
Location of federal and State offshore leases and oil and gas platforms in the Santa Barbara Channel.

Engle (2006) provides a description of the types of discharges that occur during drilling (drilling muds and cuttings) and extraction of oil and gas (especially produced water) at the offshore platforms, and evaluated the evidence for adverse biological effects of produced water discharges on marine biota. Interested readers are directed to this report, and the references therein, for more detail. Below are some of the key points discussed in Engle (2006):

- Contaminants in drilling muds include oil, clay, polymers, heavy metals, hydrocarbons, and organophosphates.

- Use of barium (a non-toxic additive in drilling muds) as a tracer of drilling fluid indicates that drilling solids are advected to locations on the sea floor at least 7 km from platforms.

- Ten of the platforms in the Santa Barbara Channel discharge produced water on site. An average of 330 million gallons of produced water is discharged per platform in the Santa Barbara Channel.

- Produced water removed at onshore facilities can be can be discharged through submarine outfalls and/or sent to a platform offshore for injection or overboard discharge.

- Produced water can contain polycyclic aromatic hydrocarbons (PAHs) (e.g., benzene, toluene, naphthalene, phenols), metals (arsenic, chromium, nickel, silver, cadmium, copper, lead, selenium, barium), cyanides, ammonia, organosulfur compounds (in particular, thiocarboxylic acids and novel thiopyranones), organopolysulfides, and inorganic forms of sulfur, such as sulfides, thiosulfates, and polysulfides.

- Combined total mass emissions of trace metals and many other constituents from oil platforms is dwarfed by combined total mass emissions from large Publicly Owned Treatment Works (POTWs) in the region.

- Effects of laboratory exposure to produced water include alteration of swimming, settlement, and metamorphosis of bryozoan, ascidian, sea star and red abalone larvae and reduced fertilization rates of red sea urchin eggs.

- Based on dilution factors for produced water outfalls, acute toxicity has been estimated as confined to within 15 m from diffusers, but chronic toxicity has been predicted for distances ranging from approximately 35 m to less than 1 km from diffusers.

- Adverse biological effects observed within 1 km of a nearshore produced water outfall near Carpinteria included:
    - decreased survivorship, settlement, metamorphosis, and viability of pre-competent red abalone larvae
    - decreased growth rates and condition of mussels
    - alteration of benthic invertebrate species composition

- Oil platforms in the Santa Barbara Channel serve as nursery habitat for a suite of rockfish and other fish species, often have higher densities of fish than nearby natural outcrops, 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.

- Epibiota (e.g., mussels, barnacles, bryozoans, anemones, 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 originated on offshore oil platforms until Ecomar, the company harvesting them, shut down in 2005.

- A study from the 1970s reported no differences in concentrations of contaminants (trace metals, hexane-extractable materials, and volatile solids) in tissues from rockfishes, crabs, and mussels sampled from platforms Hazel and Hilda in the Santa Barbara Channel compared to those sampled at rocky reef control sites (with the exception of vanadium in rockfishes which was significantly higher at the platforms) (Bascom et al. (1976) as cited by Engle (2006)). Another more recent study measured tissue concentrations of heavy metals, PAHs and PCBs from fish at platforms and natural reefs, but at the time of this writing the results were not available.

The support activities associated with oil production are also sources of potential water quality impairment. Although support activities to the platforms are often coordinated, the number of transports required to change crews and restock supplies creates a significant amount of traffic in local harbors and includes more than 5,300 boat trips a year to and from piers at Ellwood and Carpinteria and from Santa Barbara and Port Hueneme Harbors (Table 4.1). In addition, helicopter transports fly to and from the platforms at least 156 days per year. Means of contamination associated with this traffic include discharges of bilge water and other wastewaters, and deposition of particulates from engine exhaust.

Table 4.1
Number of transport trips a year in support of oil production within the Santa Barbara Channel. From MMS (Michael Mitchell, personal communication April 6, 2009).

Port/Airport	Type	Destination	Minimum # trips/year
Ellwood Pier	Crew boat	Hondo, Harmony, Heritage	884
Ellwood Pier	Work boat	Hondo, Harmony, Heritage	312
Santa Barbara Harbor	Crew boat	A,B,C, Hillhouse, Habitat, Henry	1,095
Carpinteria Pier	Crew boat	Hogan, Houchin, Gail, Grace	1,460
Port Hueneme	Crew boat	Gina, Gilda	1,095
Port Hueneme	Work boat	A,B,C, Hillhouse, Habitat, Henry	365
Port Hueneme	Work boat	Gina, Gilda	104
Total Boat Trips per Year			**5,315**
Santa Barbara	Helicopter	Hondo, Harmony, Heritage	156

4.1.2 Oil Spills

The first major (and most significant to date) oil spill to occur in the Santa Barbara Channel was a well blow-out at Union Platform A, six miles off the coast of Summerland, on January 28, 1969, which released an estimated 100,000 barrels, killed at least 3,600 seabirds and harmed many marine mammals (as reported by the California Department of Fish and Game). Ninety-eight percent of the combined volume of hydrocarbon spills from offshore operations in the MMS Pacific Outer Continental Shelf (OCS) Region between 1969 and 1999 occurred during this single spill (Table 4.2). Engle (2006) summarizes the short-term impacts of the 1969 spill to birds, pinnipeds, and intertidal and subtidal organisms at the Channel Islands.

Besides the 1969 spill, only one other spill in the vicinity of the Santa Barbara Channel has resulted in documented mortality to seabirds. In 1997, a spill of 163 barrels from a broken pipeline leading from Platform Irene near Point Arguello fouled approximately 17 miles of coastline, killing at least 700 seabirds, according to the Torch/Platform Irene Oil Spill Final Restoration Plan/Environmental Assessment (2007).

The MMS tracks spills with volumes of one barrel or more of petroleum or other toxic substances resulting from Federal OCS oil and gas activities, and (starting in 1964) provides counts and summaries for spills greater than or equal to 50 barrels (2,100 gallons) on its website (http://www.mms.gov/incidents/index.htm). During the three decades between 1969-1999, less than 1% of incidents resulted in spills of 50 barrels or greater in the Pacific OCS Region (Table 4.2). All spills of 50 barrels or greater that have been reported in the Santa Barbara Channel since 1965 are summarized in Table 4.3.

Table 4.2
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 (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**

Table 4.3
Hydrocarbon spills≥ 50 barrels in and near the Santa Barbara Channel from 1965 - December 2008. Source: http://www.mms.gov/incidents/IncidentStatisticsSummaries.htm, MMS (2008).

Year	Date	# Barrels	Platform (Operator)	Depth of Release (ft)	Dist. to Shore (mi)	Details
1969	Jan 28	100,000	Platform A (Union Oil)	350	6	Natural gas blowout at a drilling site caused 5 breaks in the ocean floor. Eight hundred square miles of ocean were impacted, and 35 miles of mainland coastline were coated with oil up to six inches thick.
1990	May 7	100	Platform Habitat (Texaco Producing Inc.)	290	8	In an effort to free stuck pipe during drilling, mineral oil mud was to be circulated down bore hole. However, the crew incorrectly left a valve closed, and 144 bbls of mineral oil mud (100 bbl of mineral oil) were circulated into the sea.
1991	May 10	50	Platform Gina (Union Oil Co.)	90	4	While a crew was grappling for an anchor chain buoy, a workboat snagged and damaged the 10.75" crude oil & produced water pipeline.
1994	Dec 17	50	Platform Hogan (Pacific Operators, Inc.)	150	6	Emulsion overflowed from the surge tank to the settling tank, and eventually to the disposal tube, when the emulsion shipping pump shut down.
1996	May 1	150	Platform Heritage (Exxon Corp.)	surface	8	Emulsion of oil and produced water from pipeline backed up through the flareboom. Emulsion caught on fire and went into the ocean
1997	Sep 28	163	Platform Irene (Torch)*	122	0	A break in a 20" oil emulsion pipeline resulted in a spill of up to 500 barrels of crude oil. The break in the line occurred approximately 31,000 ft northeast of the platform in 122 ft of water in the State water portion of the pipeline. Spill resulted in the loss of more than 700 birds

* Platform Irene is located northwest of Point Arguello, in the Santa Maria Basin; the other spills in the table occurred in the Santa Barbara Channel. Platform Irene is now operated by Plains Exploration and Production Co.

Oil spills may also come from illegal dumping by seagoing vessels passing by many miles offshore, or from the practice of tank washing and dumping the ‘slops’ at sea (Hampton et al 2003). For example, in 1998, the tanker vessel *Command* left San Francisco Bay bound for Panama. As it traveled in the southbound traffic lane off the San Francisco and San Mateo County coasts, it released an estimated 3,000 gallons of fuel oil. The spill killed more than 1,500 sea birds and scattered tarballs over 15 miles of beaches, mainly in San Mateo County. US military aircraft followed a sheen trail to the vessel off the Guatemala coast, where the captain was apprehended and later arrested along with the vessel owner. The successful prosecution of the *Command* vessel operator and owners and the recovery of natural resource damages mark the only time a tanker vessel has been caught illegally dumping oil in California (Hampton et al 2003).

Orphan oil spills

Orphan oil spills are those that cannot be attributed to any reported incident. Oftentimes, these spills also do not appear to be related to natural seepage. Ongoing studies conducted by MMS, USGS and the Santa Barbara County Energy Division (among others) are developing a library of fingerprints of natural seep tar and oil produced at offshore platforms in order to better trace the source deposits of oil. This growing technology is being used as an important management tool to assess the environmental impact of natural oil seepage in contrast to possible oil spills or illegal dumping at sea. In 2002, chemical fingerprinting matched oil emanating from the *Jacob Luckenbach*, a steamship that sank in the Gulf of the Farallones in 1953, with years of mystery oil spills that oiled birds and perplexed officials. An ongoing investigation may reveal this wreck to be responsible for much of the “chronic oil pollution” between Pt. Reyes and Monterey dating back to 1992 (Luckenbach Trustee Council 2006). Within the Santa Barbara Channel, the sheer number of natural seeps (discussed in the following section) and the common occurrence of surface slicks and sheens often leads to mistaken reports of oil spills from well-meaning observers.

4.1.3 Natural Oil Seeps

Oil seeps are a source of chronic hydrocarbon releases into the marine environment, escaping naturally from seep fields at several locations in the Santa Barbara Channel, including within the CINMS (Hostetler et al. 2004). The seep field at Coal Oil Point off the mainland coast near Goleta is the most prolific seep field in the region (Figure 4.2) 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 (Hornafius et al. 1999). 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 emitted from the seeps consists of both globules of pure oil and oil on the rims of seep bubbles. About half of the seep oil consists of volatile compounds that rapidly evaporate from the slicks at sea; the non-volatile remainder forms tar that is deposited on beaches or transported by ocean currents (Hornafius et al. 1999). Individual slicks formed at Coal Oil Point can cover as much as 100 km^2 of ocean surface and can be entrained tens of kilometers in the alongshore direction and at least 15 km in the offshore direction (DiGiacomo et al. 2004). Oil slicks from the Coal Oil Point seep field would have to be entrained approximately 50 km in the offshore direction before reaching waters near the Channel Islands. There is some evidence to suggest that oil extraction at Platform Holly has decreased the extent and volume of natural seepage at the Coal Oil Point seep field. Using transects of sonar data from 1973 and 1996, Quigley et al. (1999) discovered a 50% decrease in seepage area at Coal 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, and San Miguel Islands and on 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 the islands originated from seeps near the islands. The dominant shallow seepage around the Channel Islands appeared to originate off Fraser Pt. on Santa Cruz Island and accounted for about 65% of the sample set. The data show that the tarballs are of natural and not anthropogenic origin and that all originate from source rock within the Miocene Monterey Formation. Tar balls originating from Channel Island seeps were transported as far north as Pt. Reyes and as far south as San Diego.

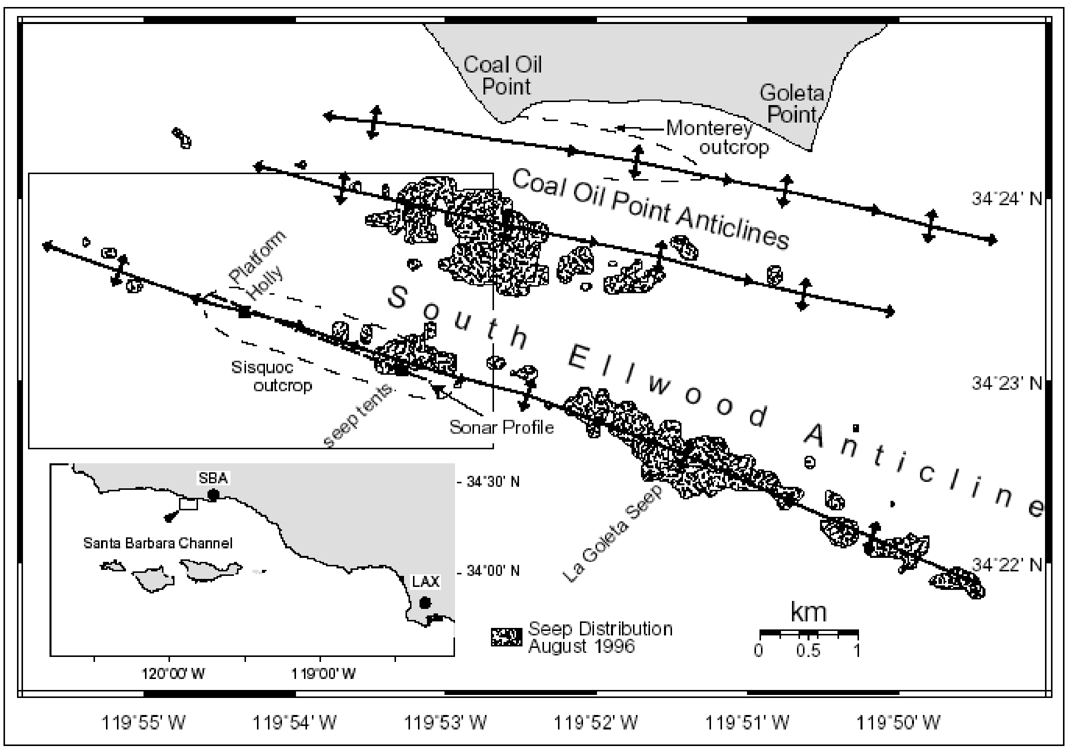

Figure 4.2
Coal Oil Point hydrocarbon seep area. Fault locations and anticline/syncline pairs in Monterey and Sisquoc Formations of northern Santa Barbara Channel shelf determine seep distribution. Mapped distribution of seepage is from 3.5 kHz sonar survey during August 1996 (Quigley et al. 1999).

4.1.4 Marine Vessels

The Santa Barbara Channel is a major thoroughfare for oceangoing ships traveling between domestic and international ports along the Pacific coast of North America, and for large vessels traveling between ports in North America and Asia or Europe. The CINMS is located about 70 miles northwest of the Port of Los Angeles/Long Beach, the busiest container port in North America, and is about 5 miles west of Port Hueneme, which is the US Port of Entry for California's Central Coast region and which serves a high volume of container and cargo ships from the Pacific Rim and Europe. Traffic to and from these ports results in nearly 7,000 transits per year through the Santa Barbara Channel shipping lanes (McKenna 2007), which pass through the northeast corner of the CINMS (Figure 4.3). The CINMS has been designated by the International Maritime Organization (IMO) as an Area to be Avoided (ATBA); while vessels are not prohibited from entering an ATBA, all ships carrying cargo (including tankers and other bulk carriers) are encouraged by IMO guidance to avoid the area to reduce the risk of polluting it. As a result, oil tankers do not typically transit the Channel but instead go around the southern side of the Channel Islands. On average one or two cruise ships call on Santa Barbara Harbor each year, but cruise ship use of CINMS waters has thus far been limited to transit via the shipping lanes (NMSP 2008).

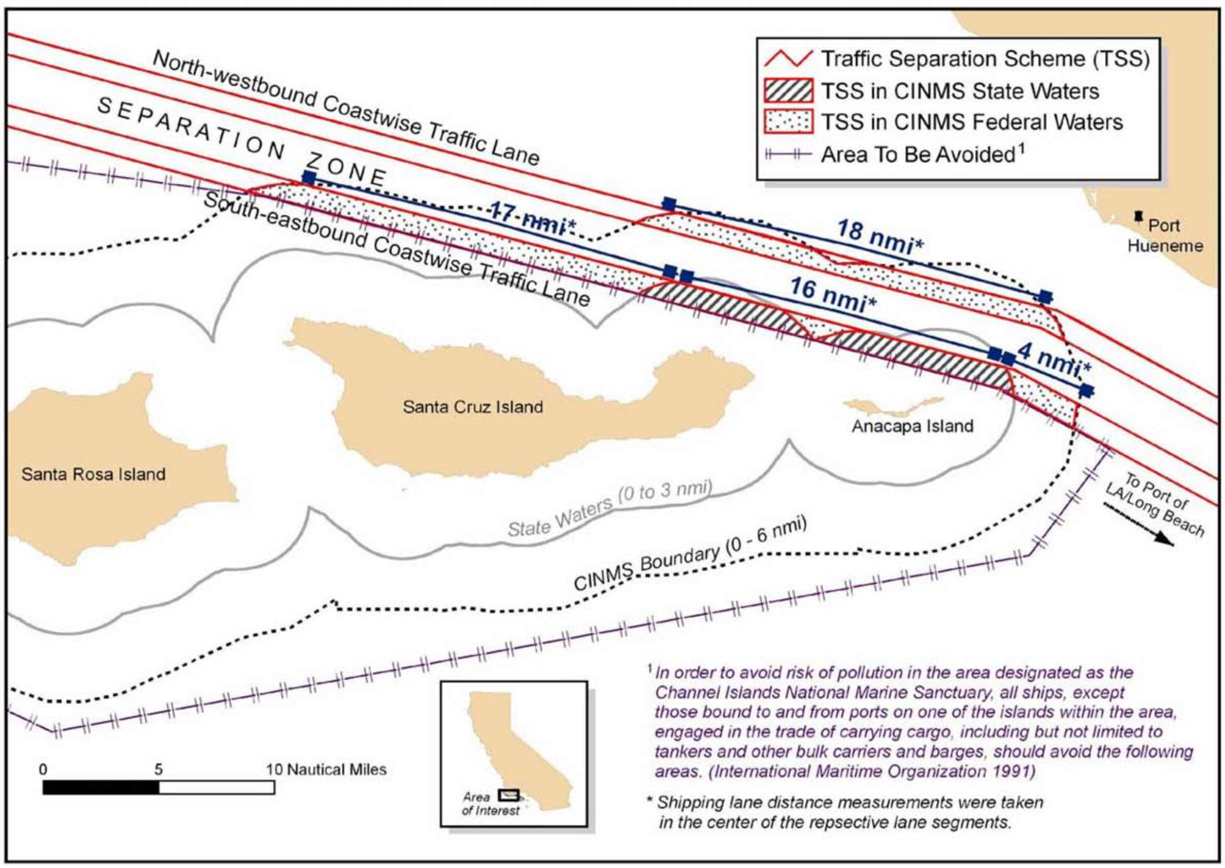

Figure 4.3
Location of the Santa Barbara Channel shipping lanes (NMSP 2008).

Maritime vessels must adhere to discharge regulations as spelled out in international treaties (see Section 6.2.1) but information on compliance is scant (Hampton et al 2003). CINMS plans to monitor large vessel traffic using an Automated Identification System (AIS) which tracks the identities, position and cargo types of large vessels using legally required identification transponders. CINMS staff have taken a lead role in working with the Navy, US Coast Guard and The Marine Exchange of Southern California to install an AIS transceiver station on Santa Cruz Island or Anacapa Island and to integrate the data with a transceiver station on San Nicolas Island. Once completed, NOAA will work with partners to facilitate the distribution and management of incoming AIS data. For more information about CINMS AIS, activities see Strategy CS.8 (AIS Vessel Tracking) in the Final Management Plan.

A good review of the potential threats to water quality in the CINMS posed by large vessel and small vessel traffic appears in Polgar et al. (2005). Several sources of water pollution associated with categories of marine vessels are summarized below:

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

- Bilge water, ballast water, oil spills, fuel spills, faulty operation of Type I or Type II marine sanitation devices (MSDs), black and gray water, anthropogenic debris, cargo spills, leaching of copper, tributyltin (TBT), and emerging alternative biocides used in anti-fouling hull paint.

Cruise Ships

- All of the above, plus hazardous wastes from on-board facilities for dry cleaning, photo-developing, and other services, and deposition of air pollutants from on-board incinerators.

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

- Bilge water, diesel fuel spills, faulty operation of Type I or Type II MSDs or releases from Type III holding tanks, anthropogenic debris, discarded fishing gear, leaching of copper or TBT from anti-fouling paint on hulls (TBT is now only legal on vessels greater than 75 meters in length).

Recreational Motor Boats and Sailboats

- Untreated sewage from Type III MSDs, bilge water, anthropogenic debris, fuel spills, leaching of copper from anti-fouling paint on hulls.

Beginning in August 1997, CINMS staff have conducted aerial surveys of commercial and recreational vessels (location, number, type) as part of the Sanctuary Aerial Monitoring Spatial Analysis Program (SAMSAP). SAMSAP uses an airplane equipped with special data collection software to conduct aerial surveys for boat traffic and marine mammal populations within Sanctuary waters. The plane flies a predetermined inner and outer loop around the five islands, but the frequency of flights depends on plane and pilot availability, weather and other considerations. Data collectors on board enter information into a computer program that automatically records the coordinates for each sighting. Vessels observed during SAMSAP over-flights are categorized into one of four vessel types: consumptive commercial, consumptive recreational, non-consumptive commercial and non-consumptive recreational. If possible, vessels are further described using a set of pre-defined sub-categories within the primary vessel category (see Table 4.4). A summary of vessel activity during 2008 flights is shown in Figure 4.4. In general, there is a predominance of commercial consumptive vessels in the western Channel and recreational vessels in the eastern Channel.

Table 4.4
SAMSAP Vessel Classification System

Consumptive, Commercial	Consumptive, Recreational	Non-consumptive, Commercial	Non-consumptive, Recreational
Gill Netter	Commercial Dive Boat	Coastal Freighter	Jet Ski
Harpoon Boat	Fishing (Head Boat)	Coastal Tanker	Kayak
Lobster Boat	Sport Fishing	Crew Boat	Sailboat
Squid Boat		Cruise Ship	
Squid Light Boat		Freighter	
Trawler		Island Support Vessel	
Urchin Boat		Military Vessel	
		Recreational	
		Research Vessel	
		Seismic Boat	
		Tanker	
		Tug (No Tow)	
		Tug and Tow	
		Whale Watch	

Unfortunately, it is impossible to know how many of the vessels observed during the flights are transient within the CINMS, and how many will anchor or remain anchored in a particular location. While sources of water quality pollution are summarized above by vessel type, without additional information about the resident time and ultimate destination of vessels within the CINMS, it is difficult to quantify the risks to water quality posed by vessel discharges.

In Polgar et al (2005), small vessel traffic was identified as a potentially significant threat to water quality in the Sanctuary. The Sanctuary is a popular destination for small vessels, including private recreational boats, charter vessels and commercial fishing boats. SAMSAP has documented an increase in the number of private boats around the Islands (particularly at Scorpion Anchorage and Prisoners' Cove) over the past few years. Although intentional discharges of wastes from boats are prohibited in the Sanctuary, small vessel pollution remains a threat to water quality. With increased visitorship, small vessel discharges might become a more significant issue for Sanctuary water quality, particularly at anchorage sites that are protected from winds and thus have poorer mixing (which would otherwise flush out and dilute pollutants). From the snapshot sampling conducted by Santa Barbara Channelkeeper in 2005-2007, it appears that bacteria levels around Anacapa and Santa Cruz Islands continue to be generally low.

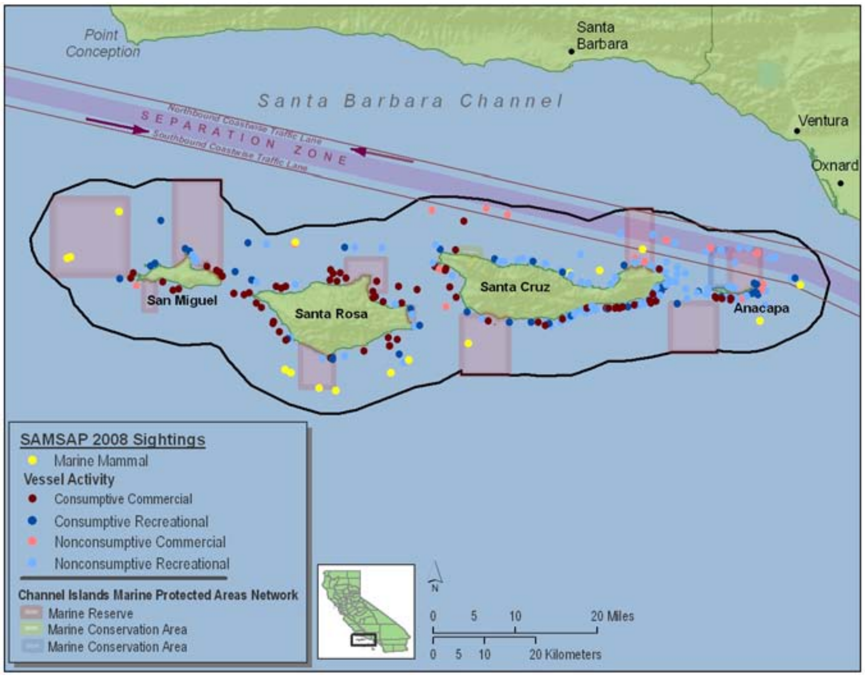

Figure 4.4
Summary of vessel activity from SAMSAP 2008 over-flights.

The few samples collected from seal rookery areas (Keyhole at Santa Rosa, Otter Harbor at San Miguel) were found to have the highest levels of total coliform and *E. coli* outside of mainland sites, although these levels were still fairly low. Smugglers Cove and Yellowbanks were the most commonly used anchorages, as they offer the best protection from prevailing west wind and swells, and are the closest to Ventura and Channel Islands Harbors. However, the eastern end of Santa Cruz Island is very exposed to southerly swell and currents. It should be noted that these are “open roadstead” anchorages, where many vessels can anchor over a range of water depths. In contrast, discrete coves like Coches Prietos, Cueva Valdez, Fry’s and Pelican hold fewer vessels and potentially have less water circulation.

Expansion of the global economy will result in a substantial increase in shipping traffic, with both the number of large ships transiting southern California and their capacity forecasted to double by 2020. The associated risks of water pollution due to spills and accidental and illicit dumping will increase, although newer ships will replace the older, more spill-prone single-hulled vessels currently in use. A share of heavy metal pollutants (cadmium, copper, lead, zinc and iron) and PAHs may come from airborne sources such as ship engine exhaust and on-board trash incinerators. Increases in shipping traffic through the Channel may increase the prevalence of these contaminants that reach the water column and ultimately bioaccumulate in organisms within the CINMS.

4.1.5 Shipwrecks

An inventory of over 140 shipwrecks dating from 1853 to 2008 has been documented for the CINMS (CINMS 2009) and includes Chinese junks, Russian and Mexican sailing ships, American coastal traders and Gold Rush-era steamships. Thirty of these wrecks with known locations are listed in Table 4.5. Excluded from the table because they are not historic shipwrecks in the Sanctuary are the *F/V Reliance*, which grounded and sank off the south point of Santa Rosa Island in June 2003, and the cargo carrier *Pac Baroness*, which collided with an automobile carrier in 1987 and sank offshore near Point Conception with approximately 80,000 lbs. (21,000 metric tonnes) of copper powder concentrate onboard (the auto carrier did not sink). Although the *Pac Baroness* has not been identified as a source of pollution, settling and corrosion of the sunken vessel could lead to releases of copper and fuel oil in the future. The ship carried a total volume of 379,000 gallons of fuel and lubricating oils, of which an estimated 20,000 gallons spilled at the time of the wreck. The depth of the wreckage (1,460 feet) combined with poor surface conditions of high wind and waves makes monitoring of existing conditions and future deterioration very difficult. Sediment sampling around the wreck in 1987 and then again in a 2002 expedition concluded that although hydrocarbons in near-surface sediments have declined over time, total copper concentrations remain relatively high and substantially higher than background (Lindsay 2007). Shipwrecks in general could pose potential threats to water quality due to debris, fuel oil, cargo oil and other hazardous cargos.

Table 4.5
Partial listing of historic shipwrecks with known locations in the CINMS. Reproduced from the CINMS Shipwreck Database at http://channelislands.noaa.gov/shipwreck/cinms1.html.

Year Lost	Vessel Name	Casualty Location	Cargo	Cause	Latitude	Longitude
1853	*Winfield Scott*	Anacapa Island, Middle	Gold Bullion & Mail	Navigation In Fog	34º 00.550 N	119º 23.184 W
1879	*G. W. Prescott*	San Miguel Island, Point Bennett	Railroad ties	Navigation	34º 02.252 N	120º 27.798 W
1892	*Goldenhorn*	Santa Rosa Island, Southwest Side	Coal, bituminous	Northeast currents, 100 miles off course, "strong unknown currents"	33º 58.456 N	120º 13.194 W
1894	*Crown of England*	Santa Rosa Island, Ford Point	Ballast	Navigation	33º 54.957 N	120º 02.847 W
1899	*Magic*	Santa Rosa Island, Lake Anchorage?	None	Lost Mooring	33º 57.118 N	119º 58.292 W
1899	*Santa Rosa*	San Miguel Island, Cuyler Harbor	Lumber	Heavy swell	34º 03.266 N	120º 21.632 W
1902	*Kate and Anna*	San Miguel Island, Cuyler Harbor	Sealing outfit	Anchor chain parted	34º 02.841 N	120º 21.144 W
1905	*J. M. Colman*	San Miguel Island, Point Bennett	Lumber	Navigational	34º 02.424 N	120º 27.110 W
1908	*Anubis**	San Miguel Island, at Castle Rock	Food, lumber, dynamite, tallow, and machinery	Navigation	34º 03.374N	120º 26.484 W
1910	*Dora Bluhm*	Santa Rosa Island, Southwest of Bee Rock	Lumber	Navigation	33º 57.036 N	120º 12.960 W

Year Lost	Vessel Name	Casualty Location	Cargo	Cause	Latitude	Longitude
1911	*Comet*	San Miguel Island, Wilson Rock, Simonton Cove	Lumber, 5000 board feet	Navigation, faulty chronometer	34º 06.694 N	120º 24.807 W
1914	*Pectan**	San Miguel Island, Adams Cove	Ballast	Stormy	34º 01.838 N	120º 26.331 W
1915	*Aggi*	Santa Rosa Island, Talcott Shoal	Barley& Beans	Severe Storm	34º 01.578 N	120º 14.396 W
1921	*H T P Co IX*	Santa Barbara Island, 4 mi off	Fish	Fire	33º 26.781 N	118º 57.313 W
1921	*Lotus*	Anacapa Island, off	General	Fire	34º 00.955 N	119º 25.088 W
1923	*Cuba*	San Miguel Island, Point Bennett	Coffee, Silver	Navigation	34º 01.957 N	120º 27.599 W
1923	*Watson A. West*	San Miguel Island, near Point Bennett	Lumber	Navigation	34º 02.230 N	120º 27.649 W
1926	*Wampas (aka Grey Ghost)*	Santa Cruz Island, Valley Anchorage	-	-	33º 58.802 N	119º 40.297 W
1929	*Jane L. Stanford*	Santa Rosa Island, Skunk Pt.	-	Allision	33º 59.130 N	119º 58.897 W
1930	*Adriatic*	Santa Barbara Island, 5 mi sw	Fish (sardines)	Collision with log	33º 24.534 N	119º 06.853 W
1935	*W T Co No. 3*	San Miguel Island, Point Bennett	Film crew	Unseaworthy	34º 01.676 N	120º 27.013 W
1938	*Dante Alighieri II*	Santa Barbara Island, SW shore	Fish	Navigation	33º 27.898 N	119º 02.377 W
1944	*Blue Fin J 245*	Santa Rosa Island, Becher's	-	Unknown	33º 59.327 N	120º 01.624W
1949	*Aristocratis**	Santa Rosa Island, SW side (near Johnson's Lee)	Coal	Navigation	33º 54.501 N	120º 05.542 W
1952	*Del Rio*	Anacapa Island, 3 miles off light (Frenchy's Cove)	Fish	Fire	34º 00.550 N	119º 24.436 W
1954	*Patria**	Santa Rosa Island, 1 mi n East Point , Skunk Point	Coal	Navigational error	33º 57.516 N	119º 58.275 W
1960	*Santa Cruz*	Santa Cruz Island, Prisoners Harbor	-	Lost mooring	34º 01.515 N	119º 41.349 W
1962	*Chickasaw*	Santa Rosa Island, near South Point	Toys	Navigation	33º 54.231 N	120º 08.295 W
1967	*Legend*	San Miguel Island, Point Bennett	None	Navigation	34º 02.107 N	120º 27.119 W
1997	*Lady Christine**	San Miguel Island, North West End	None	Improper Lookout	34º 02.938 N	120º 25.520 W

* Not a total loss

4.1.6 Chemical, Munitions and Dredge Spoils Dumping

It was once common to use the ocean as a dump for all sorts of hazardous materials. In the years after World War II, chemicals, munitions, equipment and even ships were disposed of at sea, including the highly radioactive World War II aircraft carrier *USS Independence*, exposed in atomic tests at Bikini Atoll in 1946 and sunk by the US Navy in 1951 offshore from San Francisco (Chin and Ota 2001). One of the best examples from Southern California is an estimated 37-53 million liters of DDT-contaminated acid sludge, containing 348-696 metric tons of DDT, which was disposed of in an ocean dump site 16 km northwest of Catalina Island between 1947 and 1961. NOAA charts for the Southern California Bight show several designated munitions disposal grounds. Chart notes refer to the areas as "Chemical Munitions Dumping Areas" and provide the following information: "Site was formerly used or designated for US chemical munitions dumping. Such use has been discontinued." Fears continue within the commercial and recreational fishing fleet that historic disposal in these areas could negatively affect fisheries (McCrea 2003). Sadly, few records exist for these areas. The records that do exist in other regions are scant at best.

One of the most-studied dump sites is offshore of San Francisco in the Gulf of the Farallones. Between 1946 and 1970 (when the practice of dumping of such waste was terminated by the US), approximately 47,800 barrels of low-level radioactive waste were dumped, littering depths from 300-6,000 feet over more than 550 square miles, much of which is now the Gulf of the Farallones National Marine Sanctuary (Chin and Ota 2001). In 1977, benthic biological sampling was done in the vicinity of the dump site (Reish 1983). Cataloging of collected macroinvertebrates found that the infauna was dominated by polycheates, a taxon that can play a major role in bioturbation. The author recommended that due to the abundance of this active polychaete community and the potential for pollutants to work their way up the food chain, that future dumping should not take place in this area. During the 1990s, the US Geological Survey (USGS), the Sanctuary and the US Navy used a combination of side-scan sonar ground-truthing by remotely operated vehicles (ROVs) to map and examine hazards (including waste containers) on the sea floor. Visual observations revealed that the condition of the containers (barrels) ranged from intact to completely deteriorated (Karl 2001). A 1998 joint research cruise with the British Geological Survey using a gamma-ray detector to measure radioactivity on the sea floor found localized increases in radionuclide levels that may have been partially attributable to leaking from nearby barrels. However, not every mapped barrel was accompanied with an increase in levels and the researchers did not find evidence to suggest any significant elevation of radionuclides on a regional scale (Jones et al. 2001). The deeper areas where the majority of the dumping was believed to take place remain virtually unstudied. Public concerns over human health risks from consuming fish caught in these areas continues to surface and affect the market, clearly showing the need for more conclusive studies.

A key concern when pondering the fate of radioactive waste is the potential for both mobilization and biological transport of released radionuclides from a dumpsite through the food chain to humans. Radioactivity is a form of energy released from radioactive elements and the potential for damage depends on the amount of energy absorbed by an organism. Reproductive stages and growing tissues (including eggs) are the most sensitive to radioactivity, which may bioaccumulate. Most studies involving the fate of radionucletides in the marine environment have been done in salt marshes (as many nuclear power plants world-wide are sited near the ocean or within estuaries), and where the high productivity provides more of a risk of the pollutants working into the food chain (Kershaw et al 1992).

Within the Santa Cruz Basin, a deep (approximately 1,920 meters), steep-walled basin located halfway between Santa Cruz and San Nicolas Islands, lies a designated US chemical munitions dumping area. The area was apparently designated as a dump site due to its depth, with the hope that mixing out of the basin would be very slow. Several studies have examined deep ocean basin mixing over the years. A tracer release experiment to study cross-isopycnal, or diapycnal, mixing within the Santa Cruz Basin took place from 1988-1989. Tracer injected midway between the bottom of the basin and the sill (1084 meters) was found to be well mixed to the walls after six months (Ledwell and Bratkovich 1995). Interestingly, the researchers noted that "the very deep water may be stratified by chemical gradients, perhaps associated with a disused chemical munitions dump at the bottom of the basin."

Although disposal activity at this site reportedly ceased in the late 1950s, it remains marked on nautical charts. There is scant information about the amount or type of waste dumped in this area, however it was noted in a 2008 US Senate Oversight Hearing on Cleanup Efforts at Federal Facilities that radioactive wastes from the Santa Susana Field Laboratory (SSFL), 30 miles north of Los Angeles, were dumped in the Santa Cruz Basin for some years. Wastes included mixed fission products and plutonium. When weather was inclement, a process known as "short-dumping" was employed, whereby the wastes were dumped overboard long before reaching the specified ocean dumpsite. Subsequent studies found that initial assumptions of the safety of the procedure were unfounded: despite initial claims that the site was devoid of sea life (and thus could not be harmed), investigations found abundant biological activity on the sea floor where the waste was dumped, and the waste barrels were breached and radioactivity was apparently leaking out and being taken up in the food chain. Chemical wastes from SSFL were similarly dumped in the ocean.[1] Another site, southeast of Santa Barbara Island, is designated on NOAA charts as an "explosives dumping area," but information about activities at this site are not available.

While dredging is essential for maintaining safe navigation in harbors and marinas, not all dredged materials are suitable for beneficial re-use (e.g., construction, wetlands restoration, beach enhancement), and have been traditionally dumped at designated offshore locations. In Southern California, there have been at least four designated ocean dredge material disposal sites: LA-1 off Port Hueneme (inactive); LA-2 off Los Angeles and Long Beach, last used in 2001; LA-3, off Newport Beach in Orange County, an interim site last used in 2006; and LA-5, located offshore of San Diego Bay. Dredged sediments can be used for beach replenishment projects as long as the sediments meet standards for grain size and toxicity (Steinberger et al. 2000) and this occurs regularly in Santa Barbara and elsewhere. Spoils that are highly contaminated must be either left in place or treated and stored offsite. Depending on the situation, some toxic sediment may be stored on site in Confined Aquatic Disposal units such as at Port Hueneme. The amount of pollutant loading into the coastal environment from ocean disposal of dredged sediments is not trivial - from 1991 to 1997 across all disposal sites, dredge

[1] Statement of Daniel Hirsch, President Committee to Bridge the Gap, Before the Committee on Environment and Public Works United States Senate Oversight Hearing on Cleanup Efforts at Federal Facilities Washington, D.C. 18 September 2008.

spoils emitted an estimated 55 metric tons of petroleum hydrocarbons and over 9,000 kilograms of total organotins (Steinberger et al. 2000). Dredge materials also contributed 100% of PCBs, 87% of lead and 72% of total PAHs.

4.2 Direct Sources – Onshore

4.2.1 Publicly Owned Treatment Works

Between Point Arguello and Point Mugu, six municipal wastewater treatment plants (commonly referred to as Publicly Owned Treatment Works, or POTWs) are NPDES-permitted major dischargers of wastewater to the ocean (Table 4.6). One other POTW discharges to the Santa Clara River estuary very close to its coastal confluence (Figure 4.5).

Table 4.6
NPDES permittees that are major direct dischargers of wastewater into the Pacific Ocean between Point Conception and Point Mugu.

NPDES#	Facility	Comments
Publicly Owned Treatment Works		
CA0048160	Goleta Sanitary District Water Treatment Plant	• Blended effluent from primary and secondary treatment is discharged to the ocean through an outfall pipe after disinfection. • Outfall depth is 90 feet, 5,800 feet from shore. • 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.
CA0048143	Santa Barbara ("El Estero") Wastewater Treatment Plant	• Effluent is subjected to secondary treatment with disinfection, and is discharged to ocean through an outfall pipe. • Outfall depth is 79 feet, 8,720 feet from shore. • Up to 4.3 MGD can be recycled.
CA0047899	Montecito Wastewater Treatment Plant	• Effluent is subjected to secondary treatment, with disinfection, discharged to ocean through an outfall pipe. • Outfall depth is 22 feet, 1,550 feet from shore.
CA0048054	Summerland Wastewater Treatment Plant	• Effluent is subjected to tertiary treatment, except when filters are being changed, and is discharged to ocean through an outfall pipe. • Outfall depth is 19 feet, 740 feet from shore.
CA0047364	Carpinteria Wastewater Treatment Plant	• Secondary with disinfection, and is discharged to ocean through an outfall pipe. • Outfall depth is 25 feet, 1,000 feet from shore.
CA0053651	Ventura Water Reclamation Facility	• Effluent is subjected to tertiary treatment, and is discharged to surface water in the estuary of the Santa Clara River just upstream from its outlet to the ocean.

NPDES#	Facility	Comments
CA0054097	Oxnard Wastewater Treatment Plant	• Effluent is subjected to secondary treatment, and is discharged to ocean through an outfall pipe. • Outfall depth is 48 feet, 5,280 feet from shore.
Coastal Electric Power Generating Plants		
CA0001180	Mandalay Generating Station	• Discharges 255 MGD cooling water + misc. low volume wastes directly at the beach.
CA0001198	Ormond Beach Generating Station	• Discharges up to 688 MGD cooling water + misc. low volume wastes. • Outfall depth is 20 feet, 1,790 feet offshore.

Figure 4.5
The Ventura Water Reclamation Facility (wastewater treatment plant), located between the Ventura Harbor and the Santa Clara River estuary. The site where effluent is discharged into the estuary is indicated.

POTWs are potential sources of nutrients, bacteria, viruses, suspended solids, toxic compounds, metals, pharmaceuticals, and marine debris. A summary of and comparison between effluent discharges from the six small POTWs within the Santa Barbara Channel is shown in Table 4.7. Unfortunately, some facilities did not provide data for nitrate, nitrite and organic-N as they are required to monitor only ammonia-N in their permit. Overall, Goleta WWTP discharge was far higher in suspended solids, BOD, oil and grease, turbidity, copper and nickel than the other plants, mainly due to their antiquated primary/secondary level of treatment.

Table 4.7
Effluent discharges to the Santa Barbara Channel from small municipal wastewater treatment facilities in 2005. Adapted from Lyon and Stein (2008).

Constituent	Goleta WWTP	Santa Barbara WWTP	Montecito WWTP	Summerland WWTP	Carpinteria WWTP	Oxnard WWTP
Total Volume Discharged million gallon/day	4.50	8.22	1.14	0.19	1.58	24.48
Treatment Level	Primary/Secondary	Secondary	Secondary	Tertiary	Secondary	Secondary
Suspended Solids (mg/L)	38	18	5.6	2.6	11	6.9
Settleable Solids (mg/L)	0.22	0.75	0.08	<0.1	0.23	<0.1
BOD (mg/L)	58.9	~	5.17	3.09	5.15	17.35
CBOD (mg/L)	~	12.82	~	~	~	~
Oil/grease (mg/L)	11.44	2.31	0.3	<3	3	4.6
Ammonia-N (mg/L)	36.6	17.27	0.03	0.05	0.21	19.07
Nitrate-N (mg/L)	~	~	~	~	~	1.11
Nitrite-N (mg/L)	~	~	~	~	~	0.95
Organic-N (mg/L)	~	~	~	~	~	3.42
Cyanide (ug/L)	~	~	<5	<5	<5	<5
Turbidity (NTU)	44.47	11.56	1.28	0.57	2.34	5.26
Acute Toxicity (TUa)	1.58	0.52	0.69	~	0.1	~
Chronic Toxicity (TUc)	15.9	17.86	31.25	17.86	17.86	17.86
Arsenic (ug/L)	0.17	~	<10	<10	<2	3.11
Cadmium (ug/L)	<0.2	~	<5	<5	<0.2	<0.2
Chromium (ug/L)	3.21	~	<10	<10	4	1.75
Copper (ug/L)	23.35	~	<10	<10	6	<20
Lead (ug/L)	1.13	~	<10	<10	0.4	0.75
Mercury (ug/L)	0.03	~	<0.01	<0.01	0.01	<0.2
Nickel (ug/L)	7.00	~	<10	<10	6	3.55
Selenium (ug/L)	<2	~	~	~	<2	4.04

Constituent	Goleta WWTP	Santa Barbara WWTP	Montecito WWTP	Summerland WWTP	Carpinteria WWTP	Oxnard WWTP
Silver (ug/L)	<1	~	<10	<10	<1	<1
Zinc (ug/L)	59.3	~	40	120	50	5.99
Phenols (ug/L)	<10	<20	<100	<50	<100	0.26
Total DDT (ug/L)	<0.05	~	<0.05	~	<0.05	<0.001
Total PAH (ug/L)	<0.5	~	<10	<10	<10	0.02
Total PCB (ug/L)	<0.5	~	<0.5	~	<0.5	<0.01

~ Constituent was not analyzed or data were not available
< Less than the reporting level

4.2.2 Power Plants

The only power plants along the coast to discharge cooling water to the ocean within the Channel are two natural gas-fired electric power generating stations on the Oxnard Plain. Both "once-through cooling" power plants intake sea water and then discard it into the ocean. Pollution from the discharge includes thermal pollution and sedimentation caused by turbidity plumes. Additionally, there can be pollutants mixed in with the discharged ocean cooling water such as chemicals used to flush out boilers or clean floors and equipment (collectively termed "in-plant" discharges). Entrainment of larvae within intake waters and impingement of larger organisms on intake screens is a major problem, especially with larger power plants such as Edison's San Onofre Nuclear Generating Station and Pacific Gas & Electric's Diablo Canyon Power Plant, which both discharge heated once-through cooling water at the rate of more than 2,500 million gallons a day. The NPDES program requires dischargers to periodically monitor their effluent and to report the results to the Regional Water Quality Control Board (RWQCB) in self-monitoring reports. The two power plants near Oxnard have different intakes and discharge locations and thus their discharge requirements differ slightly. Both plants monitor effluent chemical constituents and toxicity. Receiving water column parameters are monitored twice a year at nine stations. Annual monitoring of seafloor sediments, benthic invertebrate communities and trace elements in bivalve tissue is conducted near the discharge conduit. Potential entrainment of fish and invertebrates on the cooling water intake screens are evaluated every two months. These data are provided to the Los Angeles RWQCB, who oversees the NPDES permits.

Reliant Energy Mandalay Generating Station

Reliant Energy Mandalay Generating Station (REMGS) is a 577 megawatt (MW) facility located on the southern California coast approximately 4.8 km west of the city of Oxnard. The plant consists of two natural gas fired steam-electric generating units, each rated at 215 MW, and one gas turbine unit rated at 147 MW. Cooling water is drawn into the plant through Edison Canal, which originates approximately 4.2 km away at the northern end of Channel Islands Harbor in

Oxnard. Interestingly, before Channel Islands Harbor was built in 1965, the Edison Canal led from Port Hueneme, and was then in part expanded for the new harbor. The facility discharges 255.3 million gallons/day of waste through a single beach outfall (a concrete and rock-revetted structure located at a point directly across Mandalay Beach) west of the plant (Figure 4.6). Wastes consist of once-through cooling water from the two steam electric units, metal cleaning wastes, and low-volume wastes including floor drains and boiler blow-down.

Figure 4.6
The Mandalay Bay Generating Station and its ocean (beach) outfall.

Reliant Energy Ormond Beach Generating Station

Reliant Energy also operates the Ormond Beach Generating Station (OBGS), a 1,500 MW plant in Oxnard southeast of the entrance to Port Hueneme. OBGS is a two-unit, 1,500 MW natural gas-fueled, steam-electric generating facility. The OBGS is permitted to discharge up to 688.2 million gallons per day of wastes consisting of once-through cooling water, metal cleaning wastes, and low volume wastes into the Pacific Ocean. The combined effluent is discharged through an ocean outfall (Discharge Serial No. 001) located approximately 1,790 feet offshore of Ormond Beach at a depth of 20 feet.

4.2.3 Oil and Gas Processing Facilities

Oil and gas processing facilities may produce polluting substances that may be intentionally discharged or accidentally spilled. These include crude or refined oil and produced water.

NPDES permits allow for ocean discharge of produced water, which is the water extracted along with oil from wells. Produced water consists of naturally occurring groundwater or seawater that is injected into the wells during the extraction process. If existing treatment facilities cannot handle the volume of water and cannot treat the water to the applicable NPDES standards, the water may be disposed of by injection into deep formations either onshore or offshore at the platforms. Currently, all produced water within the Channel is either discharged at depth from the platforms or reinjected.

Produced water contains a suite of components, including metals and dissolved hydrocarbons, which must be reduced as much as possible in the effluent before it is discharged into the sea. These components include water-soluble organics such as light aromatics (benzene, toluene and xylene), a variety of other aromatic and aliphatic compounds, and metals such as barium (Ba), chromium (Cr), cadmium (Cd), copper (Cu), zinc (Zn), mercury (Hg), lead (Pb), silver (Ag), and nickel (Ni). Treatment of produced water is accomplished by various mechanical (such as heat, corrugated plates, and electrostatic) and chemical means. All facilities that discharge produced water have a sampling point installed in the pipe that discharges to the ocean where samples for chemical and toxicity analyses are collected. This is the point where both the operator and government inspectors can collect samples to ensure that the produced water stream is meeting the pollutant limits delineated in the NPDES permit in effect at that facility. Operators are required by their permit to self-report exceedances.

Gaviota Oil Terminal and Gaviota Oil and Gas Processing Facility

The Gaviota Oil Terminal is located on the ocean side of Highway 101 just east of the Gaviota Tunnel. This facility was briefly used as a temporary marine terminal in 1991 but was abandoned in 1994. During this time oil produced in the Point Arguello oilfield was stored onsite. Operations ceased in 2005 and the facility is scheduled for demolition.

The Gaviota Oil and Gas Processing Facility is located on the mountain side of Highway 101 opposite the Gaviota Oil Terminal. It receives sweetened oil and gas (oil that has had the hydrogen sulfide removed) from the Point Arguello field west of Point Conception (Platforms Harvest, Hildago and Hermosa). All oil produced from this field is now processed offshore on Platforms Harvest and Hermosa, piped ashore for heating, stored in tanks at the Gaviota Oil Terminal, then transported in the Plains Pipeline to various destinations. As the processing equipment at this onshore facility was no longer in use, decommissioning began in 2005.

Las Flores Canyon Oil and Gas Processing Facility

Las Flores Canyon Oil and Gas Processing Facility is located in Las Flores Canyon, approximately 10 miles west of the City of Goleta on the north side of Highway 101. Pipelines are used to transport oil and gas produced offshore to onshore processing facilities. These facilities use the natural gas processed onsite to generate electricity and steam for use onsite. The processed crude oil is pumped into the All American Pipeline Coastal Line. The facility receives all wet oil produced in the Santa Ynez Unit (Platforms Hondo, Harmony and Heritage) and is permitted for offshore disposal of up to 92,500 barrels of produced water a day.

Ellwood Oil and Gas Processing Facility and Ellwood Marine Terminal

The Ellwood Processing Facility is located south of Highway 101 at the western edge of the City of Goleta. Pipelines are used to transport oil and gas produced offshore at Platform Holly to onshore processing and storage facilities. The oil undergoes water separation and hydrogen sulfide reduction onshore, and then is pumped into storage tanks near Deveruex Slough. Every two weeks, oil is loaded onto the dedicated singled-hulled barge *Jovolon* for shipment to refineries in San Francisco and Los Angeles.

Carpinteria Oil and Gas Processing Facility

The Carpinteria Oil and Gas Processing Facility is located on the coastal bluffs just east of Carpinteria State Beach. Oil and gas produced from Platform Gail is processed to remove water, sediments, carbon dioxide and hydrogen sulfide before being shipped via pipeline to market. The facility The facility possesses gas and crude oil systems as well as recovery and natural gas liquids processing, and includes a large bulk crude oil storage tank, pipeline shipping pumps and metering skids, a gas compression plant, a natural gas liquids recovery plant, field offices, tanks, maintenance shops and other incidental equipment and facilities. Venoco took over the operations of this facility from Chevron in February 1999.

4.3 Indirect Sources of Pollutants

In addition to the direct sources of pollutants to the CINMS and the larger Santa Barbara Channel outlined above, there are also a number of indirect sources that may also impact water quality in the Sanctuary, including terrestrial runoff, marine sediments, deposition of airborne particulates, biological transfer from pinnipeds and piscivorous seabirds that feed on contaminated prey, and harmful algal blooms.

4.3.1 Terrestrial Stormwater Runoff – Channel Islands

Few sources of water pollution are located on the Islands within the CINMS; there are no point source discharges from the islands to the ocean, no harbors or marinas are located there, and no dredging takes place in seawater at the islands (although these sources do occur to the south on Santa Catalina, San Clemente and San Nicolas Islands). Anchorages occur in coves at all of the islands, which are utilized by small craft. Between 2005 and 2007, Santa Barbara Channelkeeper intermittently sampled sea water for indicator bacteria at a suite of popular anchorages at Santa Cruz and Anacapa Islands. This effort is discussed in Section 7.1.9 of this report.

The Natioal Park Service (NPS) provides outhouses for visitors at Scorpion Anchorage, Smugglers Cove and Prisoners Harbor. These outhouse facilities are used by hikers, campers and kayakers, in addition to researchers and resource managers. However, there is no provision for use away from those locations, and with an estimated 30,000 yearly visitors to the Park and anecdotal information that visitors may search for a private area along the beaches and shore, this could be of concern. However, without direct evidence to the contrary, this source of pollution is mostly likely occasional and probably does not threaten water quality.

As there are no point source discharges, terrestrial runoff is the primary avenue by which pollution, whether via sedimentation or otherwise, may enter CINMS waters from the islands. The combined land area of San Miguel, Santa Rosa, Santa Cruz and Anacapa Islands is similar to the watershed area of the Ventura River (see Figure 3.12). Disregarding land use and assuming similar precipitation amounts and evaporative losses in coastal mainland and island watersheds, the combined volume of terrestrial runoff entering the CINMS from the Channel Islands is probably similar to the volume of runoff entering the Santa Barbara Channel from the Ventura River. However, this comparison comes with the major caveat that other than being of similar size and experiencing similar amounts of precipitation, the watersheds are very different.

Runoff following storm events may carry high levels of sediment, which can be documented using ocean color remote sensing via satellites. The size of the watershed coupled with the topography, geology and land use all determine the sediment load entering the ocean. Any feature that increases runoff rate (such as urban development and impervious surfaces) prevents sediment from dropping out along the watershed. Sediment can be a pollutant in itself, as it temporarily reduces water clarity, smothers habitats and can also carry particulates including bacteria and heavy metals. Other than temporary effects during unusually large storm events, terrestrial island sources are unlikely to be an issue for CINMS waters.

4.3.2 Terrestrial Stormwater Runoff - Mainland Coast

Along the mainland coast of Santa Barbara County, terrestrial runoff is conveyed to the ocean principally through the series of low order coastal streams which arise in the chaparral-covered coastal mountains and then drain a coastal plain variably influenced by residential, industrial, and agricultural land uses. In Ventura County, most terrestrial runoff to the Santa Barbara Channel occurs via outflows from three higher order streams with much larger watersheds: the Ventura River, the Santa Clara River, and Calleguas Creek. These outflows export pollutants generated by nonpoint sources in agricultural and urban land uses, constituents in NPDES-permitted discharges to freshwater reaches (including storm drains), and sediment and dissolved substances exported from naturally vegetated areas. Constituents in terrestrial runoff which may affect water quality in the coastal ocean include trash, fecal bacteria, heavy metals and other trace elements, pesticides, fertilizers (nitrate, ammonium, phosphate), sediment, polycyclic aromatic hydrocarbons (PAHs), and synthetic organic compounds such as PCBs (Schiff and Sutilla 2001). A common source of heavy metals is the wear of vehicles. Particulate metals including copper and zinc from vehicles are washed from roadways into storm drains and then into streams and eventually the ocean. Metals are often bound to sediment due to their ionic charges but can go into solution under the right conditions of pH and temperature.

Relative to the CINMS, storm water runoff from the Santa Clara and Ventura Rivers are of primary concern, as they both drain large watersheds with extensive urban and agricultural land uses. During significant storms, runoff plumes from these two rivers can spread several miles offshore, occasionally reaching Anacapa and even Santa Cruz Islands.[2]

Rainfall and Runoff

In the Santa Barbara Channel region, more than 80% of annual rainfall is delivered during winter months (December to March). Large interannual variability in rainfall occurs; El Niño Southern Oscillation (ENSO) events are often associated with exceptionally wet winters in the region. Precipitation is highly influenced by topography; average precipitation is lower in the coastal plain (50 cm over the last 40 years, A. Leydecker, unpub. data) than in the mountains (85 cm over the same time period). The amount of annual precipitation exported as streamflow in any given year depends on precipitation in antecedent years and groundwater deficits, but an analysis of a 14-year record of streamflow in Atascadero Creek (1989-2002), a coastal stream in the Santa Barbara area, showed that on an event basis, an average of 25% of rainfall leaves the watershed as stream runoff (Beighley et al. 2008). Monthly means for daily discharge for Atascadero Creek and the Ventura River are shown in Figures 4.7 and 4.8, respectively, for each month from October 1996 through February 2008 (note the different vertical scales).

Due to the steep topography of coastal watersheds, stream discharge tends to be “flashy” in that once the sediment becomes saturated, the flow may increase dramatically for a short period of time. Thus, peak daily flows during given winter months would be much higher than the monthly means shown in the figures. This period included two very wet winters, the 1997/98 (an El Niño year) and the 2004/05 winter. Annual precipitation (based on a water year, or WY[3]) at San Marcos Pass in Santa Barbara County was 665 mm in WY 97/98 and 721 mm in WY 04/05. The expected local return intervals for these annual rainfall amounts are approximately 25 and 50 years, respectively, meaning that rain events this large only take place every 25 or 50 years.

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[2] See Polgar et al, p. 38.

[3] Any 12-month period, usually selected to begin and end during a relatively dry season, used as a basis for processing streamflow and other hydrologic data; the period from October 1 to September 30 is most widely used in the United States. The water year is designated by the calendar year in which it ends and which includes 9 of the 12 months. For example, the year ending September 30, 1992 is called the "1992 water year."

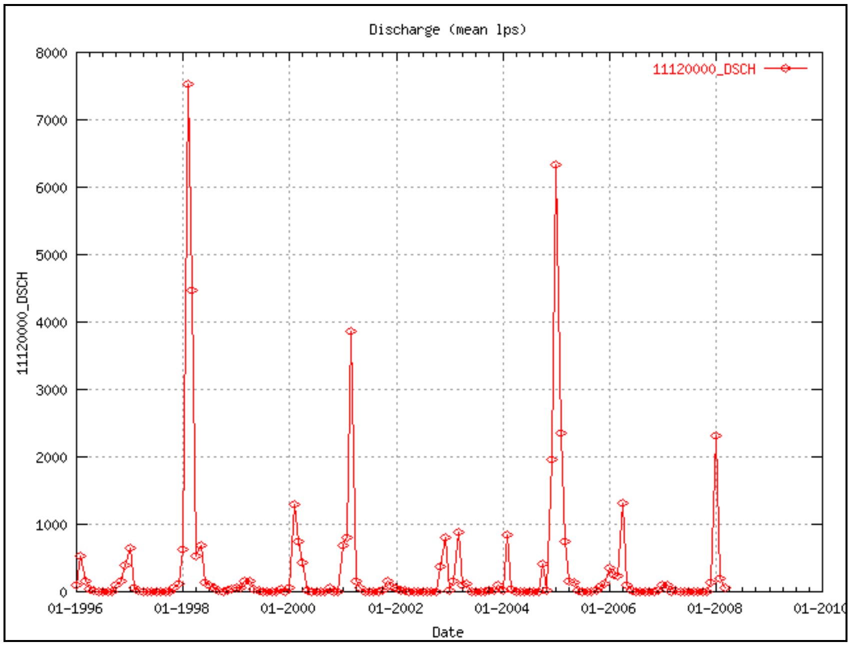

Figure 4.7
Monthly means for daily discharge (liters per second) from Atascadero Creek (measured at USGS gauge 11120000) from October 1996 to February 2008. Stream gauge is close to ocean outlet.

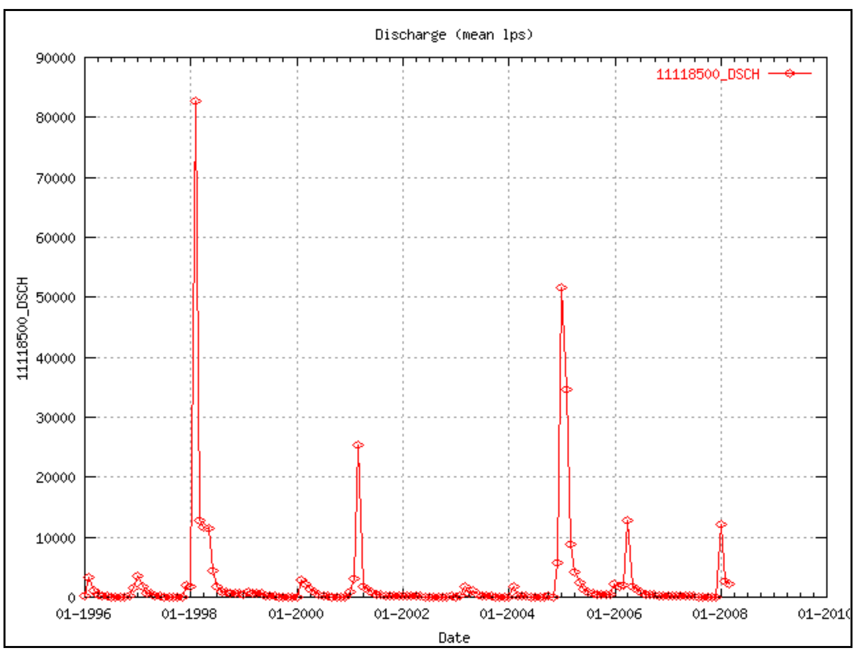

Figure 4.8
Monthly means for daily discharge (liters per second) by month from the Ventura River (measured at USGS gauge 11118500, at Foster Park) from October 1996 to February 2008.

Within a water year, runoff is highly skewed with the majority of annual runoff produced in just a few, short-lived runoff events resulting in high peak discharges and a rapid return to near baseflow conditions (Beighley et al. 2003). A cumulative distribution function for 14 years of runoff data from Atascadero Creek (1989-2002), broken into ranked 15-minute intervals, showed that, given current land use, 23-38% of annual discharge can be delivered in just 24 hours worth of runoff during maximum discharge conditions. Similarly, depending on the year, 70-90% of annual runoff occurs during maximum stream flow conditions over short intervals which would add up to just 10 days (Beighley et al. 2003, Leydecker et al. 2004). These conditions are normal for the area, owing to a combination of topography and meteorological patterns of precipitation reaching southern California. However, historical and current land use patterns can dramatically alter the rate of saturation, stream discharge and runoff, with implications for water quality impacts.

Seasonal Variation in Export

Area streams and rivers receive pollutants during both dry weather and winter storm runoff. Owing to drainage from irrigated lands (agriculture, golf courses, and lawns) and discharge of effluent from wastewater treatment plants, some stream reaches in the region may have higher concentrations of nitrogen and phosphorus compounds during the dry season than during the wet season (Leydecker & Grabowsky 2005, Robinson et al. 2005). Surface flows are artificially maintained by wastewater discharges (treated) year-round in some reaches of Calleguas Creek and the Ventura River, which used to be seasonally dry. Nitrate concentrations in stream water in catchments with greenhouse-based agriculture can be 40 times higher than in undeveloped catchments and 10 times higher than in urban and agricultural catchments (Leydecker et al. 2005). In such reaches, winter storm runoff can actually cause temporary decreases in stream nutrient concentrations. However, even in catchments where stream channels receive concentrated drainage from irrigated lands or other anthropogenic discharges, the majority of the annual flux of water and dissolved and particulate substances from the mainland to the ocean occurs during a few short-lived runoff events during winter storms. Runoff from winter storms accelerates the delivery of nonpoint source pollutants to the marine environment.

Nutrients, suspended sediment, bacteria, and other dissolved and particulate constituents in stream flow are delivered to the nearshore marine environment in a pulsed fashion during storms, which mostly occur during winter months. Concentrations of many constituents are higher during the first runoff event of the water year than they are in subsequent runoff, or higher during the first part of individual storm hydrographs than later - both phenomena are referred to in the literature as "first flush." Storm water constituents for which first flushes have been documented in southern coastal California include PAHs (Stein et al. 2006), trace metals (Tiefenthaler et al. 2007), and nitrogen and phosphorus species (Melack & Leydecker 2005, Leydecker & Grabowsky 2005). In the Los Angeles area, the prevalent PAHs in storm water were pyrogenic (combustion by-products) rather than petrogenic (unburned fossil fuels) except in one catchment (Dominguez Channel) where several oil refineries are located (Stein et al. 2006). In the Mission Creek watershed in Santa Barbara County, two weeks were needed between storms for enough ammonium to accumulate on impervious surfaces to produce a first flush of ammonium in storm runoff in urbanized reaches (Melack & Leydecker 2005).

Role of Storm Size in Nutrient Export

Using data from the SBC-LTER, Leydecker examined the relationships between land use, storm size, annual runoff, and nitrate export for a series of coastal streams draining to the Santa Barbara Channel. On an annual basis, nitrate flux (e.g., kg NO3-N/ha/yr) is linearly related to runoff (e.g., mm/yr). The slope of this relationship is similar for agriculturally influenced and urbanized catchments in the region, although the intercept is higher for agricultural catchments (e.g., the same amount of annual runoff transports more nitrate in an agricultural catchment than in an urban catchment of the same size - compare the green data points with the red data points in Figure 4.9). Along the south coast of Santa Barbara County, urban land cover has increased sevenfold since 1929 and agricultural area has decreased by 70% (Beighley et al. 2008). A hydrologic model incorporating historic and projected land use patterns in Santa Barbara County coastal watersheds predicted that the increase in impermeable substrates accompanying urbanization between 1929 and 2050 will lower the proportion of overall watershed runoff coming from the upland (undeveloped) portions of catchments from 78% to 49%, and will double the quantity of mean event runoff from the coastal plain (Beighley et al. 2008).

Interestingly, annual nitrate flux from undeveloped catchments is also linearly related to annual runoff in the Santa Barbara Channel region, but the slope of the relationship is much higher than the slopes for agricultural and urban catchments (see the blue data points in Figure 4.9). This means that very wet winters boost annual nitrate fluxes in undeveloped catchments to a greater extent than they do in highly agricultural or urban catchments. This may be related to the observation that elevated levels of nitrate in runoff from undeveloped catchments can be maintained for several days after peak discharge, or even for several weeks, after very large storms.

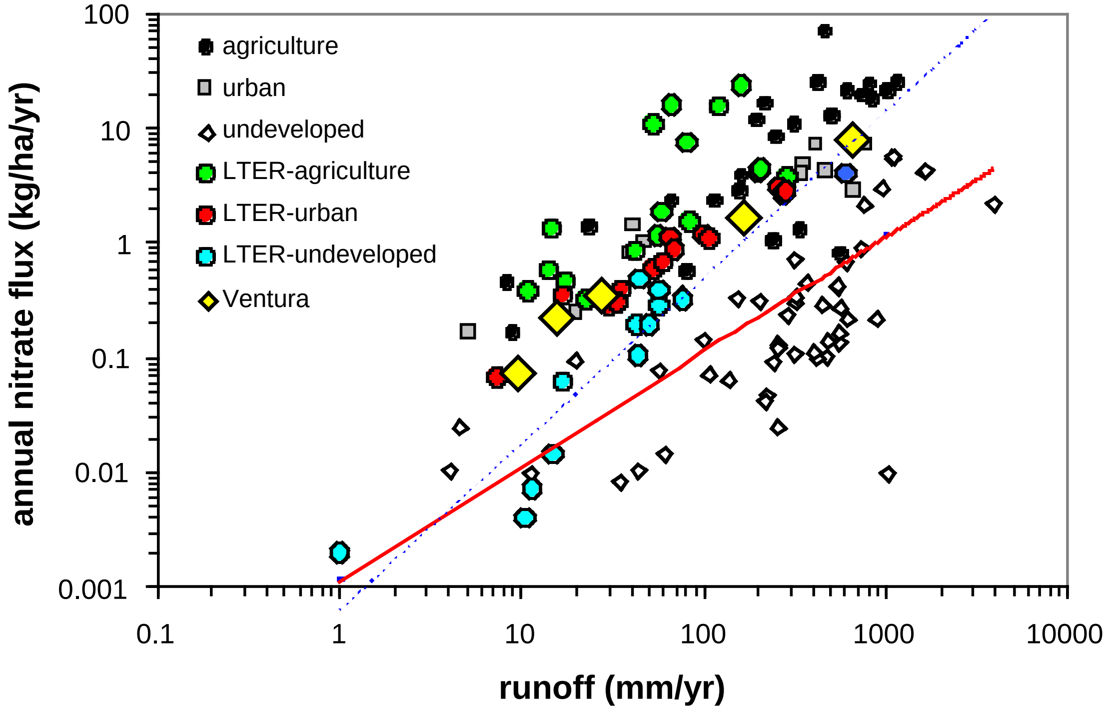

Figure 4.9
Relationship between annual runoff (mm/yr) and annual nitrate flux (kg/ha/yr) in coastal watersheds of the Santa Barbara Channel. Data represented by the top three symbols in the legend are for streams and rivers in agriculturally influenced watersheds, urban watersheds, and undeveloped watersheds in the US West from "National analysis of nutrient concentrations in streams and rivers," by David K. Mueller (http://water.usgs.gov/nawqa/nutrients/datasets/nutconc2000/). Data represented by colored symbols are from the Santa Barbara Coastal LTER (water years 2000-2003) from the following categories of streams: agricultural (Franklin, Santa Monica and Carpinteria Creeks in Carpinteria), urban (Mission, Atascadero and Arroyo Burro Creeks in Santa Barbara), undeveloped (Rattlesnake, Gaviota, Refugio, Upper Mission, San Roque, and Gobernador Creeks), and the Ventura River. Figure is from A. Leydecker (unpublished data).

Data for individual storms (storm runoff as cm/ha versus nitrate export as moles/ha) revealed that storm size affects nitrate export from urban and agricultural catchments in a similar fashion as long as the percent of agricultural land cover in the catchment is around 10% or less (Figure 4.10). As agricultural use increases above 10%, there are dramatic increases in nitrate export, on the order of 10-15 times greater (demonstrated by data from Franklin Creek, a tributary of the Carpinteria Salt Marsh). As long as storm size remains small, nitrate export from relatively pristine watersheds is very small: 10-100 times lower than from urban catchments. However, as storm size increases, there is a disproportional increase in the export of nitrate from naturally vegetated catchments. Consequently, area-weighted nitrate flux from undeveloped zones can exceed that from lower urbanized or agricultural zones during individual storms when storm runoff exceeds 2-5 cm per unit area. In other words, in coastal watersheds of the Santa Barbara

Channel, the biggest nitrate contributor per unit area during large storms is not agricultural nor urban areas, but the undeveloped upper elevation slopes where the primary land cover is chaparral. Modeling work by Beighley et al. (2008) indicated that in El Niño years, one in five rain events produces runoff of 2.5 cm or more and may result in nearshore nitrate and phosphate concentrations approximately 5-10 times above background levels.

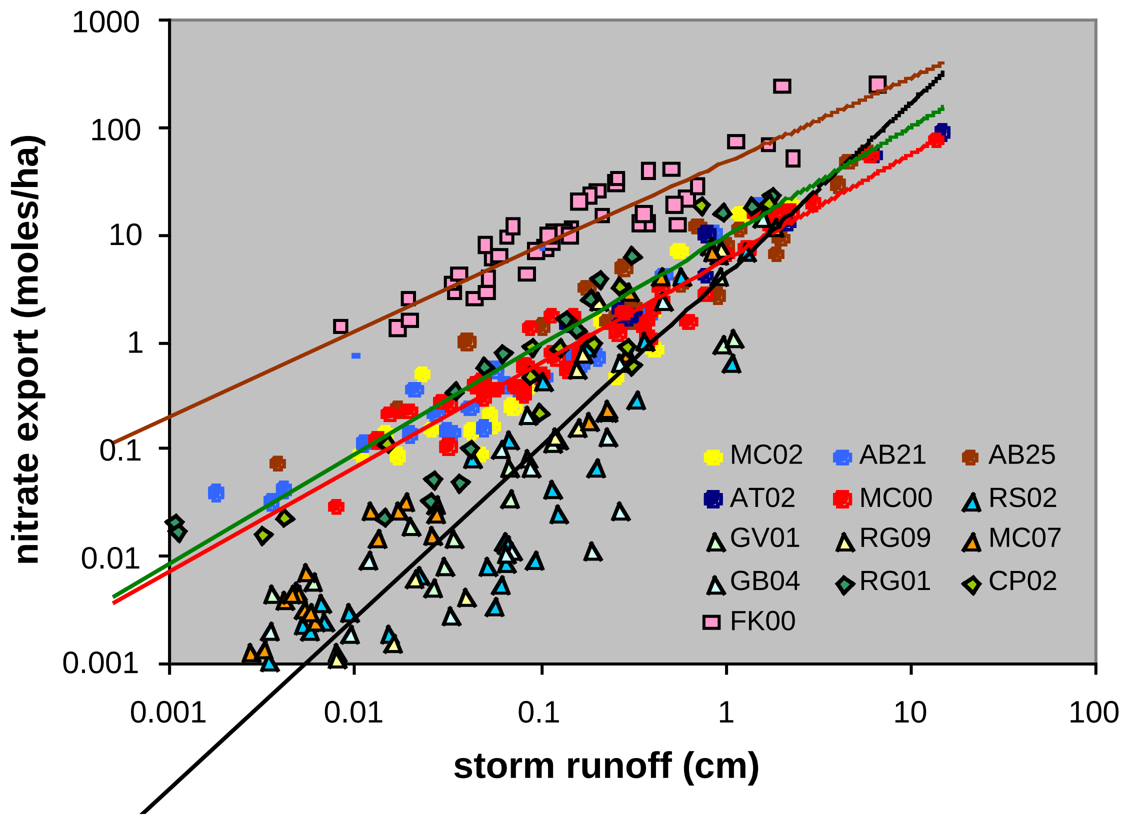

Figure 4.10
Area-weighted nitrate export (moles/ha) as a function of individual storm runoff volume (cm) for undeveloped catchments (triangles), urban and agricultural catchments (the latter with less than 10% agricultural use) (circles), and Franklin Creek (squares). Creek names are as follows RS = Rattlesnake, GV = Gaviota Creek, RG = Refugio Creek, MC = Upper Mission Creek, GB = Gubernador Creek, MC = Mission Creek, AB = Arroyo Burro, AT = Atascadero Creek, FK = Franklin Creek). Figure is from A. Leydecker (unpublished data).

4.3.3 Tidal Flushing of Harbors and Embayments

Harbors and estuarine embayments provide for exchange of pollutants between the land and the ocean, and pose localized threats to coastal marine water quality in several ways. Storm drains and creek channels have been routed in some areas to drain into harbors. Additionally, harbors tend to aggregate potential polluters such as ship and rail yards. Tidal flushing creates a pathway for pollutant transport from enclosed harbors to the coastal ocean. An important source of water quality impairment in harbors is the leaching of biocides from anti-fouling paint on boat hulls, including copper compounds and organotins such as TBT (the latter is currently allowed for use only on vessels greater than 75 meters in length). Alternative biocides being used in hull paint, such as the triazine-based antifouling agent Irgarol 1051, its degradation product "MI", and the herbicide diuron, are now widely detected in estuarine and coastal waters worldwide and are an emerging marine water quality concern (Sapozhnikova et al. 2007). Other sources of water pollution in harbors include leaching of PAHs from creosote impregnated pilings; oil, grease and fuel from bilge water; bacteria and domestic products from marine sanitation devices and holding tanks; anthropogenic debris; fuel spills; and storm water and dry weather wash-off from boat yards, boat washes, parking lots, and other impermeable surfaces.

Dredging of Harbors

Dredging occurs almost annually in the federal navigation channels leading into all four local harbors (Table 4.8); these projects are financed by contracts awarded by the US Army Corps of Engineers. Dredging inside the harbors in areas that are outside of federal jurisdiction also occurs, and is paid for by local agencies (such as the Ventura Port District). Dredging potentially influences coastal water quality in at least two ways. First, contaminated sediments and pore water can be re-suspended into the water column during the dredging operation and thus reintroduced into the food chain. Secondly, disposal of dredged material on area beaches (the predominant fate of dredge spoils in the region) potentially places contaminated sand in areas with high beach erosion rates. Due to these concerns, both dredging and disposal of sediments are regulated by State and federal agencies (see Section 5.5). Dredged material must meet their standards, and scheduled dredging projects may be delayed until a receiver site can be found. A thorough review of the environmental issues surrounding dredging can be found in the 2007 report “Sediment Dredging at Superfund Mega Sites: Assessing the Effectiveness.” The report was a product of the Committee on Sediment Dredging at Superfund Megasites, convened by the National Research Council of the National Academies.

A recent example is the Port of Hueneme Contaminated Sediment Maintenance Dredging and Confined Aquatic Disposal (CAD) Site Construction Project. This dredging project faced various hurdles, including jurisdictional issues, economic concerns and highly contaminated sediments. After years of review from State and federal agencies, dredging began in late 2008 to serve two purposes: returning the turning basin to its authorized depth of 35-40 feet (in order to accommodate the largest naval and container ships), and then excavating a cell to receive approximately 250,000 cubic meters of contaminated sediment previously determined to be unsuitable for unconfined open-ocean disposal by the Oxnard Harbor District, US Navy, and US Army Corps of Engineers (USACE) as part of their maintenance dredging programs.

Table 4.8

US Army Corps of Engineers contracts for dredging of federal navigation channels at harbors in the Santa Barbara Channel. Dredging projects paid for by local authorities are not included.

Year awarded	Purpose	Est. Volume (cu yd)	Dredge Type	Disposal Method	Contractor
Port Hueneme					
1990	maintenance	200,000	Hopper & Bucket	Beach nourishment	Western Pacific Dredge Co.
2001	deepening of channels	500,000			

	and turning basin				
2006	maintenance as needed	---	Pipeline	Beach nourishment	Manson Construction Co.
Channel Islands Harbor					
1990	2-year maintenance	2,000,000	Pipeline	Beach nourishment	Western Pacific Dredge Co.
1992	2-year maintenance	1,800,000	Pipeline	Beach nourishment	Manson Construction Co.
1994	6-year maintenance	6,200,000	Pipeline	Beach and other	Manson Construction Co.
2000	4-year maintenance	5,400,000	Pipeline	Beach nourishment	Manson Construction Co.
2006	maintenance	---	Pipeline	Beach nourishment	Manson Construction Co.
Ventura Harbor					
1991	2-year maintenance	1,000,000	Hopper	Overboard & Ocean	Manson Construction Co.
1993	1-year maintenance	780,000	Pipeline	Mixed	Manson Construction Co.
1995	1-year maintenance	470,000	Pipeline	Mixed	Manson Construction Co.
1995	Emergency Dredging	250,000	Hopper	Mixed	Manson Construction Co.
1996	1-year maintenance	445,000	Pipeline	Beach nourishment	Manson Construction Co.
1997	1-year maintenance	784,800	Pipeline/ Hopper	Beach nourishment	Manson Construction Co.
1998	3-year maintenance	654,000	Pipeline	Mixed	Manson Construction Co.
2001	3-year maintenance	1,500,000	Pipeline	Beach nourishment	Manson Construction Co.
2004	3-year maintenance	2,100,000	Pipeline	Beach nourishment	Nova Dredging LLC
2007	maintenance (? duration)	NA	Pipeline	Beach nourishment	Manson Construction Co.
Santa Barbara Harbor					
1990	1-year maintenance	600,000	Pipeline	Beach nourishment	Dutra Dredging Co.
1992	1-year maintenance	672,000	Pipeline	Beach nourishment	Hunter Corp.
1993	1-year maintenance	300,000	Pipeline	Beach nourishment	J.R. Filanc Inc. Constr. Co.
1994	1-year maintenance	550,000	Pipeline	Beach nourishment	J.R. Filanc Inc. Constr. Co.
1995	3-year maintenance	1,510,740	Pipeline	Beach nourishment	J.R. Filanc Inc. Constr. Co.
1998	2-year maintenance	1,569,600	Pipeline	Beach nourishment	J.R. Filanc Inc. Constr. Co.
2001	3-year maintenance	1,438,746	Pipeline	Beach nourishment	Nova Dredging LLC
2004	3-year maintenance	942,000	Pipeline	Beach nourishment	AIS Construction Co.
2007	3-year maintenance	195,000	---	---	---

Sources: Dredging News Online (archive of contracts and tenders) (http://www.sandandgravel.com/ news/category.asp?v1=2&v2=2008);
US Army Corps of Engineers Navigation Data Center (http://www.iwr.usace.army.mil/NDC/ dredge/dredge.htm).

Contaminants of concern were TBT, DDT, PAHs and PCBs, which had accumulated over decades. The roughly 700’ by 700’ cell was excavated to 80’ deep in order to accommodate a layer of contaminated sediments. Three highly contaminated sites within the harbor were to be dredged using mechanical equipment and sediments placed within the cell using a bottom-dump barge. This layer (expected to about 30’ deep) would then be covered with a 10-foot layer of clean sediments dredged from the remainder of the USACE Federal Channel. The approximately 437,000 m^3 of clean material excavated from the CAD is being used to replenish Hueneme Beach, just south of the harbor entrance jetty.

Invasive Species

The introduction of invasive species to marine systems is considered a form of biological pollution and can pose a significant threat to native marine life and habitats. Invasive species can alter species composition, threaten the abundance and/or diversity of native marine species, interfere with ecosystem function, and disrupt commercial and recreational activities.

Harbors may serve as points of establishment of non-native, introduced species (most frequently algae and invertebrates); these biota enter harbors in ballast water (in large vessels), bait tanks and live wells (in fishing vessels), or attached to vessel hulls, and can spread to adjacent natural habitats. Likewise, vessels docked within a harbor that is infected may then transport those species to other areas along their normal routes. The California Department of Fish and Game's Office of Spill Prevention and Response (OSPR) initiated several baseline field surveys of ports and bays along the California coast for introduced species in 2000/2002, and expanded that baseline to include outer coast sites in 2004 and 2008. Sites along the Santa Barbara Channel included Point Conception, Arroyo Hondo, Carpinteria and Point Dume, as well as Santa Barbara and Channel Islands harbors and Port Hueneme. These studies were initiated in response to State Senate Bill 497 (2006), which expanded the multi-agency Marine Invasive Species Program in an effort to control the introduction on non-indigenous species (NIS) from the ballast of ocean-going vessels. Twenty-two species in Santa Barbara Harbor and 35 species in each of Channel Islands Harbor and Port Hueneme were found to be clearly non-indigenous; by comparison Newport Bay had 37 (Foss et al. 2007, Foss 2008). Roughly half of these species were annelids and arthropods. The shipping vectors, particularly hull fouling, appear to be the primary means of introducing new species to smaller ports.

The invasive Asian kelp *Undaria pinnatifida* (Figure 4.11) was discovered in Channel Islands Harbor in the summer of 2000, in Port Hueneme in November 2000, and became established in Santa Barbara Harbor starting in April 2001 (Silva et al. 2002). In 2007, *Undaria* was found in Ventura Harbor. Santa Barbara Channelkeeper, along with the Santa Barbara Waterfront Department and California Department of Fish and Game, organized several Santa Barbara Harbor-wide removal efforts from 2004-2007. Divers removed all visible stages of *Undaria* from docks and pilings, totaling hundreds of pounds of algae per event. However, in 2007 *Undaria* was again discovered growing on the harbor seafloor between the docks, and removal efforts ceased. Research now suggests a build-up of seed stock that continues to produce new crops despite efforts at removal (Chapman 2005). Despite *Undaria's* presence in all southern California harbors, to date it has only been found in the wild in one area near White's Point, Catalina Island.

Figure 4.11
Undaria pinnatifida (left) and *Sargassum horneri* (right), two species of invasive brown algae found in Southern California harbors that threaten nearshore areas.

Another algal species of concern is *Sargassum horneri* (Figure 4.11). Native to Japan and Korea, the brown alga was first observed in Long Beach Harbor in October 2003. The first island record was Santa Catalina in April 2006, followed by Point Loma in September 2006, San Clemente Island in May 2007 and Mission Bay in August 2007 (Miller et al. 2006, Engle personal communication). The alga appears to be well-established in the rocky subtidal at both southern islands. Although *S. horneri* has not been documented in any of the four harbors in the Channel, mature individuals were discovered at one location at West Anacapa Island in April 2009. It remains unknown if this introduction was from a ship (spores on boat hulls or from within ballast water), or from natural dispersal (drift plants or spore dispersal from islands to the south), but a shipping vector is more likely.

Other Concerns

Periodically, and associated with decay of drift algae carried in by tides and storms, harbor waters become anoxic, leading to fish kills and poor conditions for those commercial fishermen who store receivers of crabs and lobsters in their slips. During these times the Harbor Patrol works to remove accumulating seaweed and debris before it can sink and decay. During warm summer months, the Ventura Port District has installed pumps at the back of the harbor to aid water circulation in an effort to raise dissolved oxygen levels.

Santa Barbara Harbor is not currently identified as impaired on the State's 303(d) List of Impaired Water Bodies. The harbor was included in a survey of water, sediment and tissue quality conducted in September 2003 and June 2004 by the State Water Resources Control Board as part of the Surface Water Ambient Monitoring Program (SWAMP) for Region 3 (Sigala et al. 2007). Santa Barbara ranked "fair" in 50% and "poor" in 17% of water condition samples in respect to bottom dissolved oxygen levels. 83% of sediment samples were ranked as "poor" as the Effects Range Low (ERL) criteria were exceeded for arsenic, copper, nickel, total chlordane, and total DDT. Arsenic in fish and mussel tissue exceeded the human health screening criteria, and low molecular weight PAHs were also high in fish tissue, but overall 75% of tissue samples were ranked “good.” Total chlordane exceeded the Effects Range Median (ERM) guidelines in 83% of the sediment samples and was thus listed as an analyte of concern, suggesting toxic biological effects across the harbor.

The Santa Barbara Waterfront Department, with help from local businesses and organizations, has been conducting a seafloor debris removal project, dubbed “Operation Clean Sweep,” which utilizes divers and mechanical lifts each May to remove anthropogenic debris from marinas inside Santa Barbara Harbor (Figure 4.12). In 2006, the effort focused on Marina 3, and two tons of debris were removed; in 2007, over four tons of debris were removed from the seafloor below Marina 4; and in 2008, 2.12 tons of trash were removed from Marina 2 (SBWD 2007).

Ventura Harbor at Ventura Keys is on the State’s current 303(d) List for impairment by coliform bacteria and the Ventura Marina Jetties are listed as impaired by DDT and PCBs. The City of Ventura monitors six stations within the Keys and the marina for indicator bacteria on a monthly basis from November-March and on a weekly basis from April-October. Metals, DDT, and chlordane were moderately elevated and copper, lead, zinc, cis- and trans-nonachlor, TBT, and endosulfan I were highly elevated in sentinel mussels sampled in the harbor in the late 1980s by the California State Mussel Watch Project (CA-MWP). However, the Ventura Marina is not listed as a site of concern under the Bay Protection and Toxic Cleanup Program (BPTCP), which was established in 1989 by the California State legislature. The BPTCP has four major goals: (1) provide protection of present and future beneficial uses of the bays and estuarine waters of California; (2) identify and characterize toxic hot spots; (3) plan for toxic hot spot cleanup or other remedial or mitigation actions; and (4) develop prevention and control strategies for toxic pollutants that will prevent creation of new toxic hot spots or the perpetuation of existing ones within the bays and estuaries of the State.

Figure 4.12
Debris removed from the seafloor below Marina 4 in Santa Barbara Harbor by Operation Clean Sweep in May 2007.

Figure 4.13
Ventura Harbor. Arundell Barranca is an unlined canal draining agricultural and urban areas. The outlet of the Barranca, inside Ventura Harbor at the southern end of the Ventura Keys, is visible.

The BPTCP lists Channel Islands Harbor as a "site of concern" due to DDT and silver concentrations in sediment. Los Angeles Regional Water Quality Control Board (LARWQCB) staff also measured slightly to moderately elevated levels of copper, zinc, and arsenic in sediment in the harbor (LARWQCB 1999). In the late 1980s, sentinel mussels sampled in the harbor by the CA-MWP contained highly elevated levels of zinc, DDTs, cic-nonachlor, endosulfan sulfate, and oxychlordane. Currently, the harbor is on the 303(d) List for lead and zinc in sediment, and fecal indicator bacteria at two harbor beaches: Channel Islands Harbor Beach and Hobie Beach.

In the late 1980s, sentinel mussels sampled in Port Hueneme by the CA-SMWP contained highly elevated levels of copper, lead, zinc, DDTs, alpha HCH, PAHs, and PCBs. In addition, past use of large amounts of pentachlorophenol (PCP) for treatment of wood pilings on the Navy side of the port is suspected. The harbor is considered a "site of concern" under the BPTCP due to sentinel mussel tissue results from the 1980s and sediment chemistry, toxicity and benthic community monitoring by the BPTCP in the late 1990s (LARWQCB 1999). More recent monitoring conducted as part of dredging projects have found much lower concentrations of many pollutants, at least in sediment. Although Port Hueneme was on the 303(d) List as impaired by TBT as recently as 2002, it is not currently listed for this antifouling agent. Currently, the harbor's back basin is on the 303(d) List for DDT (in tissue) and PCBs, and the pier is listed for PCBs.

Tidal Flushing of Estuarine Embayments

Several natural tidally influenced embayments (lagoons or sloughs) occur between Point Conception and Point Mugu. The four principal embayments are Devereux and Goleta Sloughs and the Carpinteria Salt Marsh in Santa Barbara County, and Mugu Lagoon in Ventura County. The Devereux Slough and Carpinteria Salt Marsh are parts of the University of California Natural Reserve System (the former, within Coal Oil Point Reserve). During most months a sand bar isolates Devereux Slough from the ocean, only breaking open after periods of very heavy rain. The outlets of the Goleta and Carpinteria sloughs are kept open (County Parks uses a bulldozer), thus tidal exchanges of water and suspended material occurs in them, and Mugu Lagoon is open year-round. Mugu Lagoon is now a part of the Naval Air Weapons Station at Point Mugu and is adjacent to a State-designated coastal Area of Special Biological Significance (ASBS).

All of these estuaries have been substantially altered by draining and infill for agricultural, residential, industrial or military uses, and channelization of their tributary creeks. For example, historic sections of the Goleta Slough were filled and are now occupied by the Goleta Sanitary District wastewater treatment plant and the Santa Barbara Municipal Airport, for which a controversial expansion was recently approved. Over a century ago, Mugu Lagoon was a true saltwater lagoon, receiving only minor freshwater input. Calleguas Creek was channelized in the second half of the 19th century as agriculture became established on the Oxnard Plain, and its flows were shunted into Mugu Lagoon in 1884, at which point Mugu Lagoon became an estuary (Onuf 1987, CH2MHill 2008). A 15-hectare plot of upper tidal salt marsh in Mugu Lagoon was converted to sewage oxidation ponds in the 1960s. These ponds were closed in the mid-1990s, but remain contaminated with heavy metals, which complicates plans for salt marsh restoration. A detailed description of the ecology and history of these estuaries is beyond the scope of this report. The reader is referred to the following sources for more information:

- Devereux Slough, via Coal Oil Point Reserve: http://coaloilpoint.ucnrs.org/index.html
- Goleta Slough Management Committee: http://www.goletaslough.org/
- Carpinteria Salt Marsh Reserve: http://nrs.ucop.edu/Reserves/carpinteria/Carpinfo.html
- The Ecology of Mugu Lagoon, California: An Estuarine Profile. US Fish & Wildlife Service Biological Report. 85(7.15): http://handle.dtic.mil/100.2/ADA322697

All four of these embayments are conduits for terrestrial runoff, with its associated waterborne and sediment-borne contaminants. Consequently, water and sediment quality in these estuaries is influenced by historic and present land use in the catchments upstream of the sloughs. The major tributaries draining into these estuaries are:

- Devereux Slough: Devereux Creek
- Goleta Slough: Glen Annie, Los Carneros, Cieneguitas, San Pedro, San Jose, Maria Ygnacio, and Atascadero Creeks
- Carpinteria Salt Marsh: Santa Monica and Franklin Creeks

- Mugu Lagoon: Calleguas Creek, Revolon Slough,[4] Oxnard Drain No. 3 (an agricultural drainage canal).

Land use, nutrient export, and water quality impairments in the catchments draining into Goleta Slough are described in Leydecker & Grabowsky (2005). Analogous information about land use and nutrient export in the Carpinteria Salt Marsh watershed may be found in Robinson et al. (2005). Exceedances of water and sediment quality objectives reported for these four estuaries are summarized in Table 8.6. Generally speaking, the quality of water and sediment in these water bodies follows a trend of increasing impairment from pesticides, sedimentation, and heavy metals going from west (Devereux Slough) to east (Mugu Lagoon); impairments from PCBs have also been reported in Mugu Lagoon.

Mugu Lagoon has the unfortunate distinction of having been designated as a Toxic Hot Spot by the BPTCP; the total volume of contaminated sediments in Mugu Lagoon is estimated to equal a three-foot deep layer covering 150 acres (LARWQCB 1999). In the lagoon, criteria for the protection of aquatic life have been exceeded with respect to the water column (copper, mercury, nickel, and zinc), bird reproduction (DDT), tissue accumulation (arsenic, cadmium, silver, chlordane, DDT, endosulfan, dacthal, toxaphene, PCBs); sediment concentrations (DDT, toxaphene), sediment toxicity and excessive sediment. Fish sampled in the lagoon have exceeded criteria for safe consumption by humans based on concentrations of DDT, PCBs and toxaphene in tissue (LARWQCB 1999). The land area draining to Mugu Lagoon (the entire Calleguas Creek watershed plus some of the Oxnard plain through Oxnard Drain No. 3) is substantially larger than the land areas draining to the other sloughs. Transport of contaminated sediment from agricultural land in upstream catchments and erosion of unlined drainage canals have contributed to the environmental degradation of Mugu Lagoon and will be addressed during the implementation of Total Maximum Daily Loads (TMDLs) for toxicity, historic pesticides and PCBs, and sediment in the Calleguas Creek watershed.

4.3.4 Marine Sediments

There are many ways in which marine sediments can become contaminated. Existing sediment can become polluted from deposition of contaminants through the water column. Ocean outfalls or streams and rivers can convey sediment into the ocean. Aerial photos after large rain events have shown turbid plumes of water flowing out of the Ventura and Santa Clara River watersheds and extending as far as Santa Monica Bay and Anacapa Island on different occasions.

Contaminated sediments cam be found throughout the Southern California Bight, but are not equally distributed (SCCWRP 2007). Approximately 94% of the Bight is enriched (having the presence of a chemical resulting from human activity) in at least one sediment constituent (metals and organics, including DDT, PCBs and PAHs) even though there may not be an apparent source nearby. These contaminants may originate from ocean outfalls, dump sites or industrial activity. Localized sediment contamination may be found directly beneath oil platforms, where deposits of drilling wastes can accumulate. In the 1990s, four platforms were

[4] Revolon Slough is the lowest reach of Beardsley Channel - a long canal draining a mixture of urban and agricultural area from the Camarillo areas through the Oxnard Plain. Revolon Slough empties into Calleguas Creek just upstream of Mugu Lagoon.

decommissioned and removed from State waters off Summerland. Remaining are shell mounds, consisting of cuttings several meters thick covered with a crust of mussel shell debris up to two meters thick. Concerns over remobilization, bioavailability and potential toxicity of chemical contaminants within these mounds have been evaluated by Phillips et al. (2006). Although cores through the mounds contained elevated concentrations of metals associated with drilling wastes (barium, chromium, lead and zinc) in addition to PAHs, caged mussels placed at the mound did not show significant bioaccumulation of these or other contaminants. However, laboratory assays using these sediments demonstrated acute toxicity and bioaccumulation in test organisms. It was concluded that chemical contaminants are not being remobilized from the shell mounds, and that in the absence of physical disturbance, contaminants are expected to remain sequestered. It should be noted that the shell mounds are near halibut trawl grounds, and although trawlers avoid the rigs and resulting mounds over concern of entanglement and loss of gear, such activity might disturb and spread or resuspend toxins.

Contaminated sediments can be resuspended into the water column by storms, vessel propellers, or oil and gas exploration and development activities. Resuspension may expose other marine species beyond just bottom-dwelling organisms to toxic contaminants. Fish exposed to chemical contaminants develop serious health problems, including fin rot, tumors, and reproductive effects. When contaminants bioaccumulate in fish that are consumed by humans, they pose a threat to human health. Possible long-term effects of eating contaminated fish include cancer and neurological defects. A summary of surveys of sediment chemistry and toxicity conducted in the Southern California Bight is provided in Section 8 of this report.

4.3.5 Dry Deposition

Deposition of airborne particulates onto the coastal ocean is a potential source of water quality impairment about which little is known. Instrumentation to measure dry deposition of toxic constituents on the Channel Islands or onto the surface of the ocean in the Santa Barbara Channel is lacking. Sources of particulates that are potentially deposited into the CINMS occur offshore as well as onshore.

The principal offshore sources of particulate pollution in the region are diesel exhaust from marine vessels and emissions from oil and gas platforms. Emissions of reactive organic gases (ROGs), which are smog precursors, from the Coal Oil Point seeps are a large source of hydrocarbon pollution in Santa Barbara County (in 1990, equivalent to twice the emission rate from all on-road traffic in the county; Hornafius et al. [1999]). However, these emissions are gaseous, not particulate, and deposition onto the coastal ocean would require condensation onto existing particles or new aerosol formation.

Chronic onshore sources of particulate pollution include the transportation sector and other mobile sources (including agricultural machinery);[5] suspension of soil and dust from construction and agricultural activities; exhaust from stationary diesel agricultural engines (such

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[5] In September 2003, Senate Bill 700 (SB 700) repealed the Air Pollution Control District permit exemption for all agricultural sources (except motor vehicles) that had existed in the California Health & Safety Code.

as for irrigation pumps);[6] aerosolized pesticides and herbicides; and point sources such as electrical power generating stations, onshore oil and gas facilities, and other industrial facilities. Major episodic sources of airborne particulates in the region include Santa Ana wind events and wildfire plumes (often combined). Airborne toxics that were elevated above air basin baselines (three year means) during the 2003 wildfires in Southern California include benzene, toluene, xylene, formaldehyde, acrolein, acetaldehyde, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, lead, nickel, and arsenic (CARB 2003). Elevated rates of dry deposition of PAH over the tropical Atlantic ocean during Saharan dust storms (Del Vento & Dachs 2007) suggest that settling of dust (carried by Santa Ana winds) or ash (during wildfires) onto the coastal ocean might enhance direct dry deposition rates of volatile hydrocarbons.

Federal air quality standards have been established for only seven pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, respirable particulate matter less than 10 µm in diameter (PM10), fine particulate matter less than 2.5 µm in diameter (PM2.5), and sulfur dioxide. California State air quality standards include all of the federal standards plus standards for sulfates, hydrogen sulfide, vinyl chloride and "visibility reducing particulates." In Santa Barbara County, the California Air Resources Board (CARB) operates two State and Local Air Monitoring Stations (SLAMS) - one each in Santa Barbara and Santa Maria. The Air Pollution Control District (APCD) of Santa Barbara County operates four other SLAMS - in Lompoc, Santa Ynez, El Capitan, and Goleta (Figure 4.14). Of the six SLAMS, five measure ambient concentrations of carbon monoxide, ozone, nitrogen oxides (NOx), PM10, and sulfur dioxide. Monitoring for PM2.5 is conducted hourly at the Lompoc H Street, Santa Barbara, and Santa Maria stations. In addition, eleven Prevention of Significant Deterioration stations (PSD) are located in the vicinity of specific facilities, such as large oil and gas facilities, or at remote sites (such as on Paradise Road in the Los Padres National Forest) to measure background regional air quality. The Ventura County APCD monitors air quality using SLAMS at seven locations: Ventura (Emma Woods State Beach), Ojai, El Rio, Piru, Thousand Oaks, and two locations in Simi Valley.

Oil platforms and marine vessel operations outside of the State APCD jurisdiction are referred to as Outer Continental Shelf (OCS) sources. The CARB toxic air contaminants monitoring program utilizes 26 stations in major urban areas to monitor volatile organic compounds (VOCs), carbonyl compounds, PAH, toxic metals, and hexavalent chromium, and ten sites to monitor dioxin; none of these stations are located near the Santa Barbara Channel.

Title V of the federal Clean Air Act requires major stationary sources of air pollution to obtain operating permits that assure compliance with applicable federal air pollution control requirements. As of April 2008, 27 facilities in Ventura County and 19 facilities in Santa Barbara County were Title V permittees; coastal and offshore facilities in these groups include the operators of offshore oil platforms, the Mandalay Bay and Ormond Beach generating stations (which are both also subject to the acid rain provisions of Title IV of the Clean Air Act), Naval Base Ventura County facilities at Point Mugu and Port Hueneme, onshore Venoco oil and gas facilities at Carpinteria and Ellwood, and the Tajiguas Landfill.

[6] The Airborne Toxic Control Measure for Stationary Compression Ignition Engines (Section 93115 of Title 17 of the California Code of Regulations, sometimes referred to as the stationary Air Toxics Control Measure, or ATCM), and recent amendments to it, require that both new and in-use (in service prior to January 1, 2005) stationary diesel agricultural engines over 50 horsepower must meet Particulate Matter emission limits and other requirements.

Owing to the California Air Toxics "Hot Spots" Information and Assessment Act of 1987 (amended in 1992), businesses which release considerable amounts of toxic air pollutants are required to determine emissions and perform risk assessments. As of April 2008, a search of APCD regulated facilities for the Santa Barbara and Ventura County APCDs using CARB's online tool produced information for 234 and 333 facilities, respectively. Rankings for individual facilities from health risk assessments based on cancer risk and chronic and acute exposure risks, and emissions data for specific toxic constituents, are available through this search tool.

Figure 4.14
Air quality monitoring stations in Santa Barbara County operated by the Santa Barbara Air Quality Control District and the California Air Resources Board.

None of the gaseous compounds routinely monitored by APCDs are likely to impair marine water quality, but toxic compounds contained in suspended particulate matter potentially do. Unfortunately, the chemical composition of PM10 and PM2.5 collected at ambient monitoring stations is not analyzed outside of special studies conducted by CARB, and little is known about the advection of particulate matter offshore or its rate of deposition onto the surface of the ocean. Also, the majority of urban metal dry deposition occurs on particles larger than 10 µm in diameter (Stolzenbach et al. 2000, Lu et al. 2003), but airborne particulates in this size range are not monitored.

The dispersion of air pollution in the region is largely controlled by thermally forced winds, including sea-land breezes and mountain-valley flows. Nocturnal flows during winter months produce much of the seaward air flow (Lu et al. 2003). Modeling conducted by Stolzenbach et al. (2000) suggests that Santa Ana winds are effective in transporting heavy metals from the Los Angeles Basin over the coastal ocean toward Santa Catalina Island, and concentrations of zinc measured in the surface microlayer of Santa Monica Bay, presumably produced by dry deposition, are inversely correlated with distance from shore. The modeling results of Stolzenbach et al. (2000) indicate that airborne heavy metals from the Ventura-Oxnard area are potentially advected seaward (and mostly southward) to a much smaller extent during Santa Ana wind events than they are in the Los Angeles region. Washout during precipitation is one of the avenues by which airborne pollutants generated over land, and subsequently advected seaward, may enter the coastal ocean (see Sabin et al. 2006 for evidence of wash-out of trace metals in the Los Angeles Basin).

Emissions from cargo ships in transit, or at berth in ports, are recognized as a major source of airborne particulates, sulfur dioxide, and nitrogen oxides in California. A combination of CARB regulations, proposed federal and State legislation, and incentive programs at major California ports are currently addressing air pollution from oceangoing vessels through the use of cleaner fuel (low sulfur marine distillate), vessel speed reductions, use of electrical power from shore while at berth ("cold-ironing"), and prohibitions against onboard incineration. A review of existing and pending rules and legislation is not provided here, but information and documents about port and marine vessel-related air pollution issues and regulation are provided on the websites of CARB, the Santa Barbara County APCD, and the US EPA.

4.3.6 Ocean Acidification

Atmospheric carbon dioxide (CO2) levels have risen precipitously since the onset of the industrial revolution as a result of fossil fuel combustion, deforestation and other human activities. The world’s oceans act as a carbon “sink,” and have absorbed approximately one-third of this CO2 since that time. Ocean uptake of CO2 decreases the pH of the water and creates a combination of chemical changes in seawater collectively known as ocean acidification. The reduction in ocean pH reduces the availability of carbonate ions, which play an important role in shell formation for a number of marine organisms such as corals, marine plankton, and shellfish. The implications of ocean acidification for marine ecosystems remain largely unknown and unstudied, but what little scientific study on the topic exists suggests that it is likely to have profound impacts on some of the ocean’s most fundamental biological and geochemical processes in the coming decades.

Ocean acidification could therefore have potentially significant impacts on Sanctuary resources, and thus the CINMS Advisory Council identified ocean acidification as a priority topic for research in its 2008 Work Plan. The SAC’s Conservation Working Group, in partnership with the Commercial Fishing Working Group, assumed responsibility for this research based on their shared commitment to maintain the long-term resilience and productivity of the Sanctuary’s marine ecosystem, and because they view ocean acidification as a direct, long term threat to

Sanctuary resources that defies traditional regulatory or enforcement-based response. Their research was compiled into a report, *Ocean Acidification and the Channel Islands National Marine Sanctuary: Cause, effect and response*, which was adopted by the SAC in September 2008.

The report aims to catalyze an appropriate local response to ocean acidification by raising awareness and understanding of the issue among CINMS stakeholders, staff, and the public, and by identifying and articulating appropriate actions that these parties can take to prepare for and reduce the effects of ocean acidification on Sanctuary resources. It provides an overview of ocean acidification based on a review of scientific research, examines the effects of rising atmospheric CO2 levels on ocean chemistry, and compiles information on known impacts of lowered pH to certain marine organisms. The report explores the nascent body of research on potential impacts to ecosystems from changing ocean chemistry, and discusses the potential impacts to the qualities and resources of the Channel Islands region suggested by this information. The report concludes that the magnitude of the problem facing long-term conservation of CINMS resources and qualities demands action by Sanctuary staff and stakeholders, and provides a set of specific recommendations to help advance such action.[7]

4.3.7 Biological Transfer

Pinnipeds and piscivorous seabirds that feed on contaminated fish or other prey at some distance from the Channel Islands and then return to the islands to roost, haul-out, or breed may be an important pathway by which toxic constituents enter the nearshore marine environment at the islands. Bioaccumulation of DDT, and its final metabolite DDE, are acknowledged factors in the decline of the California brown pelican (*Pelecanus occidentalis*) and the bald eagle (*Haliaeetus leucocephalus*), and the loss of the peregrine falcon (*Falco peregrinus*) at the Channel Islands (see Engle 2006 and the references cited therein for more detail). p,p'-DDE and PCBs have been measured in the blubber of California sea lions (*Zalophus californianus*) from San Miguel Island in three separate studies (DeLong et al. 1973, Gilmartin et al. 1976, and Costa et al. 1994), and were previously suggested as factors responsible for premature pupping in the species (DeLong et al. 1973). Concentrations of DDT and PCBs still averaged 150 mg/kg wet weight in the blubber of marine mammals such as California sea lions in 2000 (Kannan et al. 2004).

The array of pesticides, other synthetic organics, PAHs, and trace metals that have been detected in sentinel mussels collected at the Channel Islands (reviewed in Engle 2006 and in Section 8.1 of this report) bears evidence that pollutants that were not originally discharged at the Channel Islands reside at least part-time in the nearshore water column at the islands. Mussel data indicate that, as recently as 1996, DDT and PCBs have been concentrated enough in nearshore waters at the islands to cause exceedances of State or federal screening criteria for mussel body burdens. The highest DDT levels in the available record for Channel Islands sites were found in mussels at San Miguel Island in 1977-78 (Engle 2006). More recent data are unavailable to indicate whether or not San Miguel Island remains a DDT hot spot. The above was true despite the fact that, among all the islands, San Miguel Island is the furthest from the most significant source of DDT and PCB 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

[7] http://channelislands.noaa.gov/sac/pdf/cwg-oar.pdf

San Miguel (65.8 ppb wet wgt) contained 39% as much total DDT as was contained in mussels at White's Point in 1982 (170.8 ppb wet wgt). Mussel data indicate that other synthetic organics (alpha- beta, delta-, and gamma-HCH; endosulfan II, endosulfan sulfate, endrin, heptachlor-epoxide, hexachlorobenzene, and naphthalene) have been present in the water column at Santa Cruz Island in high enough concentrations to result in mussel body burdens that exceed State or federal screening criteria (see Section 8.1.3).

Regardless of its route of entry, total DDT has accumulated in shelf sediments surrounding the Channel Islands sufficiently to exceed NOAA's ERL threshold at 34% of Channel Islands sites (at nine nearshore sites at Santa Cruz and Anacapa Islands) sampled by SCCWRP during Bight '03 (see Figure 8.9). Although DDT is widely detected in sediments throughout the Bight, the only shallow shelf sites sampled during Bight '03 in the Santa Barbara Channel area which also yielded sediment with total DDT concentrations higher than NOAA's ERL were on the mainland coast in the vicinities of Oxnard/Port Hueneme, Point Mugu and Rincon Point. During the Bight '03 survey, two sites at the Channel Islands (one each off Santa Cruz and Anacapa Islands) were the only locations north of Santa Monica Bay where concentrations of total PCBs in sediment were above the lowest strata (see Figure 8.10).

The extent to which pinnipeds and piscivorous sea birds could serve as pathways for contaminants to reach the Channel Islands from sources outside CINP or the CINMS depends on how far afield from the islands foraging takes place and what sources of contamination are responsible for body burdens in prey (in turn affected by the trophic level, mobility, and life span of prey species). For example, prey that are bottom-dwellers with limited home ranges are likely to have body burdens that more closely reflect background contamination at the point of capture than long-lived pelagic prey species. Close relationships have been shown between flatfish tissue and DDT and PCB contaminated sediments (Allen et al. 2004).

Connolly & Glaser (2002) modeled the relationship between p,p'-DDE body burdens in female sea lions from San Miguel Island and regional prey contaminant levels and determined that the more highly contaminated lactating females must have consumed prey with levels only found in fish from the Palos Verdes Shelf and the Santa Monica Bay. Many common sport fish caught from the ocean in the Los Angeles area have levels of DDT 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.[8] In addition, because of especially high levels of DDT and PCBs in white croaker, the State has banned commercial fishing for this species in the vicinity of the Palos Verdes Shelf.

Jarvis et al. (2007) measured PCBs and DDT in four pelagic prey species (northern anchovy [*Engraulis mordax*], Pacific sardine [*Sardinops sagax*], Pacific chub mackerel [*Scomber japonicus*], and California market squid [*Loligo opalescens*]) in commercial landings at southern California docks from July 2003-February 2004. The California brown pelican is reported to

[8] Fish for which only limited consumption is advised in the Los Angeles area (one meal every two weeks) are sculpin, black croaker, white seaperch, California corbina, barred surfperch, queenfish, calico surfperch, rubberlip seaperch, pile perch, shiner perch, black perch, walleye surfperch, dwarf perch, spotfin surfperch, striped seaperch, water column surfperches, kelp perch, all rockfish (*Sebastes*), and kelp bass.

feed consistently on northern anchovy, and both northern anchovy and California market squid are primary prey items for California sea lions in the Bight (Jarvis et al. 2007). Approximately 99%, 86%, and 33% of Bight-wide commercial landings of northern anchovy, Pacific sardine, and Pacific chub mackerel, respectively, exceeded wildlife risk screening values for total DDT. Although DDT and PCBs were detected in California market squid, none of the market squid landings analyzed exceeded wildlife risk screening criteria. Among the geographic strata within the Bight utilized by Jarvis et al. (2007) in their data analysis, total DDT was highest in northern anchovy caught along the mainland coast from Point Dume to Point Conception, and at offshore islands (the latter stratum included San Miguel, Santa Rosa, Santa Cruz, Anacapa, Santa Catalina, San Clemente Islands). Total PCBs were highest in northern anchovy caught in coastal waters between Dana Point and Point Dume.

Few data are available for concentrations of organic contaminants in fish directly sampled at the Channel Islands. A figure in Connolly & Glaser (2002)[9] shows that DDE was detected in kelp bass at Anacapa and Santa Barbara Islands. 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 eleven stations near San Miguel, Santa Cruz, Anacapa and Santa Barbara Islands at depths of 31-202 m. Channel Island sanddabs contained far less (up to an order of magnitude) FACs than California halibut collected in mainland bays and harbors. The molecular signature of PAHs in Channel Islands sediment samples suggests a petrogenic rather than a pyrogenic origin for these compounds (Schiff et al. 2006). Thus the PAHs detected in sediments, fish, and mussels in the vicinity of the Channel Islands may be resulting from offshore oil and gas extraction and natural seeps rather than from the combustion of fuels on the mainland or in the shipping lanes.

4.3.8 Harmful Algal Blooms (HABs)

Algal blooms occur naturally when phytoplankton undergoes rapid reproduction and growth, and not all of them are harmful. In the Santa Barbara Channel, this usually occurs after upwelling events (circulation patterns in which deep, cold, nutrient-laden water moves towards the surface). High phytoplankton biomass is regularly associated with colder, nutrient-enriched waters. Although blooms can occur throughout the year, the strongest upwelling is in early spring. The increase in nutrients to well-lit surface waters from upwelling stimulates primary production. During a bloom, the water may become discolored from green to brown to red, depending on the species composition and prevalence of the phytoplankton present. The general term “red tide” describes a plankton bloom that turns the water a reddish-brown, although many of the plankton species causing red tide are not toxic. Upwelling zones are mosaics of rapidly changing small-scale habitats for which different species may be better adapted. Although timing of the phytoplankton community remains unpredictable at the species level, different levels of tolerance for irradiance, stratified waters and current patterns can help form some generalizations. Blooms of toxic dinoflagellate species along the US west coast generally form when upwelling ceases or becomes sporadic, between May and October. The relaxation events that follow coastal upwelling, brought about by a change in wind speed or direction, may carry established blooms toward shore, resulting in rapid increases in toxicity in nearshore shellfish (Chang & Dickey 2006).

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[9] The figure in Connolly & Glaser (2002) cites a 1987 report by RW Risebrough, submitted to the State Water Resources Control Board, as the source of the data points for Anacapa and Santa Barbara Islands.

Effects of HABs

The term "harmful algal blooms," or HABs, is used to describe a diverse array of marine algal blooms which have negative impacts on humans, marine environments, and/or coastal economies. HABs are a natural feature in coastal ecosystems, but human activities are thought to contribute to their increasing frequency. Virtually every coastal state has now reported recurring blooms. Impacts of HABs include the devastation of critical coastal habitats, loss of economically and culturally vital shellfish resources, illness and death in populations of protected marine species, and serious threats to human health posed by algal toxins. Other types of harmful algae are non-toxic to humans but cause harm to fish and invertebrates by damaging or clogging their gills. Some may form such large blooms that the death and subsequent decay of the algae lead to hypoxia (oxygen depletion) in the bottom waters of lakes, estuaries, and coastal environments. A massive bloom of the dinoflagellate *Ceratium furca* led to low-oxygen-induced rock lobster mortality in South Africa in 1997, and an increase in the incidence of these mortalities over the past decade has raised serious concern about the future rock lobster stocks in this area (Kudela et al. 2005). This has not been described for the Channel region other than low-oxygen events in local harbors, such as in Ventura Harbor in 2003.

Visible “red tide” conditions do not always mean that a HAB is occurring. Conversely, for some species, concentrations of only a few cells per liter may produce harmful toxic effects (Boesch et al. 1997). Some HABs cover large areas and can be detected with standard ocean color imagery. While standard ocean color products can be used to map large-scale HABs, typical HABs occur in coastal environments at much smaller scales (Kahru 2007).

Within the Santa Barbara Channel, of greatest concern are the HABs that cause paralytic shellfish poisoning (PSP) and domoic acid poisoning (DAP)/amnesiac shellfish poisoning (ASP). Caused by several closely related species in the dinoflagellate genus *Alexandrium*, PSP toxins are responsible for persistent problems due to their accumulation in filter feeding shellfish, but they also move through the food chain, affecting zooplankton, fish larvae, adult fish, and even birds and marine mammals. PSP is a recurrent annual problem along the coasts of northern California, Oregon, Washington, and Alaska. Overall, PSP affects more coastline than any other HAB problem and is the rationale for the routine closures of shellfish harvesting during the months of May through August. Although uncommon in the Santa Barbara Channel, *Alexandrium* is toxic at low numbers, and its presence within a sample triggers State agency response.

Of increasing concern are blooms of various species of the diatom *Pseudonitzschia*, which produce domoic acid poisoning (DAP). Domoic acid production has been confirmed for three species of this diatom on the west coast: *P. australis*, *P. multiseries*, and *P. pungens.* In recent years in some areas, the spring bloom has become dominated with these species. DAP first became a noticeable problem in 1991 when pelicans and cormorants in Monterey Bay suffered from unusual neurological symptoms similar to ASP. This neurotoxin has serious health effects over a range of afflicted species, ranging from fish and birds to marine mammals. Symptoms include vomiting, nausea, diarrhea and abdominal cramps within 24 hours of ingestion. In more severe cases, neurological symptoms develop and may include headache, dizziness, confusion, disorientation, loss of short-term memory, motor weakness, seizures, profuse respiratory secretions, cardiac arrhythmias, coma and possibly death. *Pseudonitzschia* is often common within plankton samples and so its density must be monitored to watch for potentially toxic blooms. However, the presence of this diatom does not mean that toxicity is present, and research continues on the timing of toxin accumulation versus bloom status.

Domoic acid has been shown to affect many species throughout the food chain. A strong DAP event occurred in 2002, with more than 1,000 sea lions and 100 common dolphins succumbing to the toxin (Graham 2003). NOAA's National Centers for Coastal Ocean Science (NCCOS) and the Marine Mammal Center identified domoic acid as a cause of reproductive failure in California sea lions, which indicated for the first time possible population-level consequences of repeated HAB events to marine mammals. In the spring of 2003 off Montecito, sardines were observed on the sea floor apparently undergoing seizures. Since 1998, hundreds of mostly female California sea lions have stranded alive along the coast with clinical signs of DAP. Pregnant females intoxicated with domoic acid frequently abort or give birth to stillborn or abnormal young that fail to survive, as research has shown that the toxin crosses the placenta and can therefore affect fetal development. Persistent toxicity can manifest later in juvenile and adult life (Ramsdell and Zabka 2008). Domoic acid producing algal blooms tend to occur along the California coast during months immediately prior to the sea lion breeding season. Results published in the July 2006 issue of the journal *Marine Mammal Science* prompted a population risk assessment by the joint NOAA Fisheries/National Ocean Service (NOS) Marine Animal Health Program and will be used to improve management plans for affected marine mammals. Examination of blue whale feces found that contamination occurred during blooms of toxic *Pseudonitzschia*. Fish as diverse as benthic sanddabs and pelagic albacore were found to contain the neurotoxin, suggesting that domoic acid permeates benthic as well as pelagic communities (Lefebvre et al 2002).

During April 2007, scientists from NCCOS confirmed the presence of domoic acid in urine samples from sea lions (*Zalophus californianus*) on San Miguel Island. The investigation was part of a large-scale study of mortality of marine mammals, seabirds, and other marine life occurring along the California coast (CINMS 2007). Researchers detected levels of domoic acid in minke whale feces in the spring of 2007 at concentrations exceeding the highest reported values for any marine mammals in this region (Fire et al. 2007).

In May 2007, Santa Barbara County health officials issued a consumer advisory on the consumption of sport-harvested shellfish, sardines, oysters, clams, scallops and the viscera of lobster, crab or anchovies due to the highest concentration of domoic acid ever recorded (Santa Barbara County Health Department 2007). This advisory followed an early mussel quarantine, also due to elevated domoic acid levels. In November 2008, NOS researchers published a study showing that HAB toxins are carried by prey species long after a bloom event and that these toxins can be transferred to dolphin predators (Fire et al. 2007). Recent research indicates that exposure by pregnant animals to domoic acid and DDT can lead to synergistic effects that cause greater harm to fetal brain development than from either substance alone (Tiedeken and Ramsdell 2009). The researchers had previously noted that exposure to domoic acid during fetal development in sea lions can lead to brain seizures when they attain juvenile age. The new findings point to exposure to residual environmental DDT as contributing to the increased seizure behavior that has been noted in the Channel Island sea lions.

In 2004, Stanford University researchers published their discovery of a direct link between intense irrigation for agriculture and massive coastal blooms around river mouths in the Sea of Cortez, Mexico. On a larger geographic scale, researchers have linked nutrient outflow from the Mississippi River to red tides along the northwestern shore of Florida (NOAA 2007).

New tools for harmful algal bloom research such as molecular probes ("fingerprints" for organisms), satellite remote sensing, and rapid toxin analysis are constantly evolving.

4.4 Constituents of Emerging Concern

The US currently has more than 85,000 chemicals in commerce. There are approximately 2,500 “high production volume” chemicals which are manufactured at a rate of more than one million pounds annually, with nearly 45% of these chemicals lacking adequate toxicological studies to evaluate their health effects on humans and wildlife. Furthermore, about 2,000 new chemicals are introduced into commerce annually in the US.

Many of these chemicals, which are collectively referred to as chemicals or constituents of emerging concern (CECs), are increasingly being detected at low levels in surface water, and there is concern that these compounds may have deleterious impacts on aquatic life as well as human health. These chemicals include pharmaceuticals, personal care products, pesticides, hormones and other trace organic chemicals.

Recent scientific studies have shown that some of these chemicals can act as endocrine disruptors, disrupting normal hormone function, and can produce effects at the parts per billion or parts per trillion level. Chemicals such as serotonin (from anti-depressants), estrodiols (from birth control pills and other estrogen treatment) and steroid hormones (from pesticides) all alter sexual development and sexual differentiation in fishes and invertebrates. Bisphenol A, a chemical used extensively in the manufacture of certain types of plastics, has been shown to affect the central nervous system and to act as an endocrine disruptor when present in very low doses (Okada et al. 2008). Also, effects of some CECs can be transgenerational - when animals are exposed *in utero*, effects are transmitted not only to the offspring, but are inherited for many generations thereafter, from exposures to the grandmother or the great-grandmother animal. In addition, scientists are concerned that combining chemicals may have an additive or synergistic biochemical effect.

Pharmaceuticals and personal care products mostly enter the environment through wastewater discharges, since wastewater treatment plants are not designed to remove them. To date, none of the POTWs discharging to the Santa Barbara Channel have conducted monitoring for these constituents, so their potential effects on water quality and aquatic species in the Channel cannot be evaluated at this time. The growing concern over discharges containing these contaminants and the potential risks to human health and the marine environment is driving the development of programs to monitor their levels in POTW effluent (NACWA 2005). See Section 6.8.6 of this report for more information about current efforts to develop monitoring programs for CECs in California.

5. Water Quality Standards

There are several different sources of standards, criteria and guidance that apply to water quality in Sanctuary waters, including the Water Quality Control Plan for Ocean Waters of California, also known as the California Ocean Plan, and the Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California, also known as the Thermal Plan. The Central Coast and Los Angeles Regional Water Quality Control Plans (or Basin Plans), US EPA's Ocean Discharge Criteria and current Water Quality Criteria, and federal statutes governing ocean dumping and dredged material management and vessel discharges also regulate marine discharges that could affect water quality in the Sanctuary. Each of these is summarized in detail below.

5.1 California Ocean Plan

The California Ocean Plan governs point and nonpoint discharges into State waters (from shore to three miles out from both the mainland coast and the islands), with the exception of vessel wastes and dredged material, and sets limits or levels of water quality characteristics to ensure the reasonable protection of the various beneficial uses of the ocean waters of the State[10] and the prevention of nuisance. Discharges of waste are prohibited from causing violations of these "Water Quality Objectives."

The Ocean Plan lays out Water Quality Objectives to protect water contact recreation in coastal waters from bacterial contamination. They are as follows:

Within a zone bounded by the shoreline and a distance of 1,000 feet from the shoreline or the 30-foot depth contour, whichever is further from the shoreline, and in areas outside this zone used for water contact sports, as determined by the RWQCB, but including all kelp beds, the following bacterial objectives shall be maintained throughout the water column:

30-day Geometric Mean – The following standards are based on the geometric mean of the five most recent samples from each site:

- Total coliform density shall not exceed 1,000 per 100 ml;
- Fecal coliform density shall not exceed 200 per 100 ml; and
- Enterococcus density shall not exceed 35 per 100ml.

Single Sample Maximum:

- Total coliform density shall not exceed 10,000 per 100 ml;
- Fecal coliform density shall not exceed 400 per 100ml;
- Enterococcus density shall not exceed 104 per 100 ml; and
- Total coliform density shall not exceed 1,000 per 100 ml when the fecal coliform/total coliform ratio exceeds 0.1.

[10] The beneficial uses of the ocean waters of the State that are protected by the Ocean Plan include industrial water supply; water contact and non-contact recreation, including aesthetic enjoyment; navigation; commercial and sport fishing; mariculture; preservation and enhancement of designated Areas of Special Biological Significance (ASBS); rare and endangered species; marine habitat; fish migration; fish spawning and shellfish harvesting.

Areas where shellfish may be harvested for human consumption must meet the following bacterial objectives:

- The median total coliform density shall not exceed 70 per 100 ml, and not more than 10 percent of the samples shall exceed 230 per 100 ml.

In addition to these bacteria standards, water quality must meet the following objectives:

Physical Characteristics
- Floating particulates and grease and oil shall not be visible.
- The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface.
- Natural light shall not be significantly reduced at any point outside the initial dilution zone as the result of the discharge of waste.
- The rate of deposition of inert solids and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded.

Chemical Characteristics
- The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste materials.
- The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.
- The dissolved sulfide concentration of waters in and near sediments shall not be significantly increased above that present under natural conditions.
- The concentration of substances set forth in Chapter II, Table B, in marine sediments shall not be increased to levels which would degrade indigenous biota.
- The concentration of organic materials in marine sediments shall not be increased to levels that would degrade marine life.
- Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota.
- Numerical Water Quality Objectives
    - Table B water quality objectives apply to all discharges (see Table 5.1).

Biological Characteristics
- Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded.
- The natural taste, odor, and color of fish, shellfish, or other marine resources used for human consumption shall not be altered.
- The concentration of organic materials in fish, shellfish or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.

Radioactivity
- Discharge of radioactive waste shall not degrade marine life.

Table 5.1 California Water Quality Objectives (California Ocean Plan Table B)

TABLE B
WATER QUALITY OBJECTIVES

	Units of Measurement	Limiting Concentrations: 6-Month Median	Daily Maximum	Instantaneous Maximum
OBJECTIVES FOR PROTECTION OF MARINE AQUATIC LIFE				
Arsenic	ug/l	8.	32.	80.
Cadmium	ug/l	1.	4.	10.
Chromium (Hexavalent) (see below, a)	ug/l	2.	8.	20.
Copper	ug/l	3.	12.	30.
Lead	ug/l	2.	8.	20.
Mercury	ug/l	0.04	0.16	0.4
Nickel	ug/l	5.	20.	50.
Selenium	ug/l	15.	60.	150.
Silver	ug/l	0.7	2.8	7.
Zinc	ug/l	20.	80.	200.
Cyanide (see below, b)	ug/l	1.	4.	10.
Total Chlorine Residual (For intermittent chlorine sources see below, c)	ug/l	2.	8.	60.
Ammonia (expressed as nitrogen)	ug/l	600.	2400.	6000.
Acute* Toxicity	TUa	N/A	0.3	N/A
Chronic* Toxicity	TUc	N/A	1.	N/A
Phenolic Compounds (non-chlorinated)	ug/l	30.	120.	300.
Chlorinated Phenolics	ug/l	1.	4.	10.
Endosulfan	ug/l	0.009	0.018	0.027
Endrin	ug/l	0.002	0.004	0.006
HCH*	ug/l	0.004	0.008	0.012
Radioactivity	Not to exceed limits specified in Title 17, Division 1, Chapter 5, Subchapter 4, Group 3, Article 3, Section 30253 of the California Code of Regulations. Reference to Section 30253 is prospective, including future changes to any incorporated provisions of federal law, as the changes take effect.			

Chemical	30-day Average (ug/l) Decimal Notation	Scientific Notation
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – NONCARCINOGENS		
acrolein	220.	2.2×10^{2}
antimony	1,200.	1.2×10^{3}
bis(2-chloroethoxy) methane	4.4	4.4×10^{0}
bis(2-chloroisopropyl) ether	1,200.	1.2×10^{3}
chlorobenzene	570.	5.7×10^{2}
chromium (III)	190,000.	1.9×10^{5}
di-n-butyl phthalate	3,500.	3.5×10^{3}
dichlorobenzenes*	5,100.	5.1×10^{3}
diethyl phthalate	33,000.	3.3×10^{4}
dimethyl phthalate	820,000.	8.2×10^{5}
4,6-dinitro-2-methylphenol	220.	2.2×10^{2}
2,4-dinitrophenol	4.0	4.0×10^{0}
ethylbenzene	4,100.	4.1×10^{3}
fluoranthene	15.	1.5×10^{1}
hexachlorocyclopentadiene	58.	5.8×10^{1}
nitrobenzene	4.9	4.9×10^{0}
thallium	2.	$2. \times 10^{0}$
toluene	85,000.	8.5×10^{4}
tributyltin	0.0014	1.4×10^{-3}
1,1,1-trichloroethane	540,000.	5.4×10^{5}
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS		
acrylonitrile	0.10	1.0×10^{-1}
aldrin	0.000022	2.2×10^{-5}
benzene	5.9	5.9×10^{0}
benzidine	0.000069	6.9×10^{-5}
beryllium	0.033	3.3×10^{-2}
bis(2-chloroethyl) ether	0.045	4.5×10^{-2}
bis(2-ethylhexyl) phthalate	3.5	3.5×10^{0}
carbon tetrachloride	0.90	9.0×10^{-1}
chlordane*	0.000023	2.3×10^{-5}
chlorodibromomethane	8.6	8.6×10^{0}

Chemical	30-day Average (ug/l) Decimal Notation	Scientific Notation
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS		
chloroform	130.	1.3×10^{2}
DDT*	0.00017	1.7×10^{-4}
1,4-dichlorobenzene	18.	1.8×10^{1}
3,3'-dichlorobenzidine	0.0081	8.1×10^{-3}
1,2-dichloroethane	28.	2.8×10^{1}
1,1-dichloroethylene	0.9	9×10^{-1}
dichlorobromomethane	6.2	6.2×10^{0}
dichloromethane	450.	4.5×10^{2}
1,3-dichloropropene	8.9	8.9×10^{0}
dieldrin	0.00004	4.0×10^{-5}
2,4-dinitrotoluene	2.6	2.6×10^{0}
1,2-diphenylhydrazine	0.16	1.6×10^{-1}
halomethanes*	130.	1.3×10^{2}
heptachlor	0.00005	5×10^{-5}
heptachlor epoxide	0.00002	2×10^{-5}
hexachlorobenzene	0.00021	2.1×10^{-4}
hexachlorobutadiene	14.	1.4×10^{1}
hexachloroethane	2.5	2.5×10^{0}
isophorone	730.	7.3×10^{2}
N-nitrosodimethylamine	7.3	7.3×10^{0}
N-nitrosodi-N-propylamine	0.38	3.8×10^{-1}
N-nitrosodiphenylamine	2.5	2.5×10^{0}
PAHs*	0.0088	8.8×10^{-3}
PCBs*	0.000019	1.9×10^{-5}
TCDD equivalents*	0.0000000039	3.9×10^{-9}
1,1,2,2-tetrachloroethane	2.3	2.3×10^{0}
tetrachloroethylene	2.0	2.0×10^{0}
toxaphene	0.00021	2.1×10^{-4}
trichloroethylene	27.	2.7×10^{1}
1,1,2-trichloroethane	9.4	9.4×10^{0}
2,4,6-trichlorophenol	0.29	2.9×10^{-1}
vinyl chloride	36.	3.6×10^{1}

Table B Notes:

a) Dischargers may at their option meet this objective as a total chromium objective.

b) If a discharger can demonstrate to the satisfaction of the Regional Board (subject to EPA approval) that an analytical method is available to reliably distinguish between strongly and weakly complexed cyanide, effluent limitations for cyanide may be met by the combined measurement of free cyanide, simple alkali metal cyanides, and weakly complexed organometallic cyanide complexes. In order for the analytical method to be acceptable, the recovery of free cyanide from metal complexes must be comparable to that achieved by the approved method in 40 CFR PART 136, as revised May 14, 1999.

c) Water quality objectives for total chlorine residual applying to intermittent discharges not exceeding two hours, shall be determined through the use of the following equation:

$$\log y = -0.43 (\log x) + 1.8$$

where: y = the water quality objective (in ug/l) to apply when chlorine is being discharged;
x = the duration of uninterrupted chlorine discharge in minutes.

The Ocean Plan also sets forth General Requirements for Management of Waste Discharge to the Ocean, as follows:

a. Waste management systems that discharge to the ocean must be designed and operated in a manner that will maintain the indigenous marine life and a healthy and diverse marine community.

b. Waste discharged to the ocean must be essentially free of:

1. Material that is floatable or will become floatable upon discharge.
2. Settleable material or substances that may form sediments which will degrade benthic communities or other aquatic life.
3. Substances which will accumulate to toxic levels in marine waters, sediments or biota.
4. Substances that significantly decrease the natural light to benthic communities and other marine life.
5. Materials that result in aesthetically undesirable discoloration of the ocean surface.

c. Waste effluents shall be discharged in a manner which provides sufficient initial dilution to minimize the concentrations of substances not removed in the treatment.

d. Location of waste discharges must be determined after a detailed assessment of the oceanographic characteristics and current patterns to assure that:

1. Pathogenic organisms and viruses are not present in areas where shellfish are harvested for human consumption or in areas used for swimming or other body-contact sports.
2. Natural water quality conditions are not altered in areas designated as being of special biological significance or areas that existing marine laboratories use as a source of seawater.
3. Maximum protection is provided to the marine environment.

In addition, the Ocean Plan prohibits the discharge of any radiological, chemical, or biological warfare agent or high-level radioactive waste, as well as of municipal and industrial waste sludge.

Finally, the Ocean Plan prohibits the discharge of waste into areas designated as being of special biological significance. In the CINMS, San Miguel, Santa Rosa and Santa Cruz Islands comprise a designated Area of Special Biological Significance (ASBS, now known as a State Water Quality Protection Area or SWQPA), and Anacapa and Santa Barbara Islands comprise another. As such, all waste discharges into State waters off the islands are prohibited.

5.2 Thermal Plan

The Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California, also known as the Thermal Plan, prohibits the discharge of elevated temperature waste into cold interstate waters. For warm interstate waters, the Thermal Plan also prohibits thermal waste discharges (cooling water and industrial process water) having a maximum temperature greater than 5°F above natural receiving water temperature, and prohibits elevated temperature wastes from causing the temperature of warm interstate waters to increase by more than 5°F above natural temperature. The Plan also requires, for coastal waters, that elevated temperature wastes from existing discharges comply with limitations necessary to assure protection of beneficial uses and ASBS, and that elevated temperature wastes from new discharges be discharged to the open ocean away from the shoreline to achieve dispersion through the vertical water column and a sufficient distance from ASBS to assure the maintenance of natural temperature in these areas. The Thermal Plan requires that the maximum temperature of thermal waste discharges not exceed the natural temperature of receiving waters by more than 20°F, and that the discharge of elevated temperature wastes shall not result in increases in the natural water temperature exceeding 4°F at the shoreline, the surface of any ocean substrate, or the ocean surface beyond 1,000 feet from the discharge system.

5.3 Basin Plans

In addition to provisions of the Ocean Plan and Thermal Plan, the Central Coast Regional Water Quality Control Plan (also known as the Central Coast Basin Plan) sets out additional objectives which also apply to State ocean waters surrounding San Miguel, Santa Rosa and Santa Cruz Islands (which fall under the jurisdiction of the Central Coast Region). These require that:

- the mean annual dissolved oxygen concentration shall not be less than 7.0 mg/l, nor shall the minimum dissolved oxygen concentration be reduced below 5.0 mg/l at any time;
- the pH value shall not be depressed below 7.0, nor raised above 8.5; and
- radionuclides shall not be present in concentrations that are deleterious to human, plant, animal, or aquatic life, or result in the accumulation of radionuclides in the food web to an extent which presents a hazard to human, plant, animal, or aquatic life.

While Anacapa and Santa Barbara Islands fall under the jurisdiction of the Los Angeles Regional Water Quality Control Plan, that plan has no equivalent additional Water Quality Objectives for ocean waters beyond those laid out in the California Ocean Plan and Thermal Plan.

5.4 Ocean Discharge Criteria

Section 403 of the Clean Water Act (CWA) (33 US Code Sec. 1343) requires that point source discharges to waters of the US must obtain a National Pollutant Discharge Elimination System (NPDES) permit, which requires compliance with technology- and water quality-based treatment standards. Discharges to the territorial seas (0-12 miles from shore) and beyond must comply with additional regulatory requirements under Section 403, which specifically addresses impacts from point sources on marine resources. The requirements aim to ensure that no unreasonable degradation[11] of the marine environment will occur as a result of the discharge and that sensitive ecological communities are protected. These requirements can include ambient monitoring programs designed to determine degradation of marine waters, alternative assessments designed to further evaluate the consequences of various disposal options, and pollution prevention techniques designed to further reduce the quantities of pollutants requiring disposal and thereby reduce the potential for harm to the marine environment.

US EPA assesses the potential effects of a marine discharge on the biological community based on ecological, social, and economic factors in order to determine whether or not to issue a permit for said discharge. Permit writers must consider ten ecological, social, and economic factors, known as the Ocean Discharge Guidelines (40 CFR Part 125, Subpart M), in their evaluation of the impact of a discharge on the marine environment and their determination of whether unreasonable degradation of the environment would occur. The Ocean Discharge Guidelines are as follows:

1. Quantities, composition, and potential bioaccumulation or persistence of the pollutants to be discharged.
2. Potential transport of the pollutants by biological, physical or chemical processes.
3. Composition and vulnerability of potentially exposed biological communities, including unique species or communities, endangered or threatened species, and species critical to the structure or function of the ecosystem.
4. Importance of the receiving water area to the surrounding biological community, e.g., spawning sites, nursery/forage areas, migratory pathways, and areas necessary for critical life stages / functions of an organism.
5. The existence of special aquatic sites, including (but not limited to): marine sanctuaries/refuges, parks, monuments, national seashores, wilderness areas, and coral reefs/seagrass beds.
6. Potential direct or indirect impacts on human health.
7. Existing or potential recreational and commercial fishing.
8. Any applicable requirements of an approved Coastal Zone Management Plan.
9. Such other factors relating to the effects of the discharge as may be appropriate.
10. Marine water quality criteria.

If EPA determines, on the basis of available information, that the discharge will not cause unreasonable degradation of the marine environment after application of any necessary conditions, a permit may be issued containing such conditions. All permits which are issued under Section 403 must:

1. Require that a discharge of pollutants will: (i) Following dilution as measured at the boundary of the mixing zone, not exceed the limiting permissible concentration for the liquid and suspended particulate phases of the waste material as described in

[11] Unreasonable degradation is defined as: significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities; threat to human health through direct exposure to pollution or through consumption of exposed aquatic organisms; or unreasonable loss of aesthetic, recreational, scientific, or economic value in relation to the benefit derived from the discharge.

certain sections of the Ocean Dumping Criteria; and (ii) not exceed the limiting permissible concentration for the solid phase of the waste material or cause an accumulation of toxic materials in the human food chain as described in §227.27 (b) and (d) of the Ocean Dumping Criteria;

2. Specify a monitoring program, which is sufficient to assess the impact of the discharge on water, sediment, and biological quality including, where appropriate, analysis of the bioaccumulative and/or persistent impact on aquatic life of the discharge;
3. Contain any other conditions, such as performance of liquid or suspended particulate phase bioaccumulation tests, seasonal restrictions on discharge, process modifications, dispersion of pollutants, or schedule of compliance for existing discharges, which are determined to be necessary because of local environmental conditions, and
4. Contain the following clause: In addition to any other grounds specified herein, this permit shall be modified or revoked at any time if, on the basis of any new data, the director determines that continued discharges may cause unreasonable degradation of the marine environment.

EPA must not issue an NPDES permit if Section 403 requirements for protection of the ecological health of marine waters are not met.

5.5 Ocean Dumping and Dredged Material Management

There are two primary federal statutes governing the disposal of dredged material: the Marine Protection, Research and Sanctuaries Act (MPRSA, also known as the Ocean Dumping Act), which governs transportation for the purpose of disposal into ocean waters, and CWA Section 404 (US Code Sec. 1344), which governs the discharge of dredged or fill material into US coastal (and inland) waters. The dumping of material at sea is prohibited unless a permit is issued under one of these two statutes. EPA and the US Army Corps of Engineers share responsibility for regulating dredged material. The Corps issues permits under Section 404 of the CWA and MPRSA, and EPA establishes environmental criteria that must be met to receive a permit under either law. Permits are subject to EPA review and concurrence.

EPA's ocean dumping regulations lay out the criteria and procedures for ocean dumping permits. EPA's ocean dumping criteria require consideration of the environmental impacts of the dumping; the need for the dumping; the effect of the dumping on aesthetic, recreational and economic values; and the adverse effects on other uses of the ocean.

Dredged materials, and any other materials proposed for ocean disposal, must undergo a series of tests and evaluations to determine whether they meet EPA's criteria. These evaluations are designed to protect against toxicity and bioaccumulation that may adversely impact the marine environment or human health. EPA's regulations also cover the criteria and procedures for designation and management of ocean dumping sites. Ocean dredged material disposal sites are required to have site management and monitoring plans.

5.6 Vessel Discharges

There are a number of federal and State laws that regulate discharges from vessels, including sewage, graywater, ballast water, oil and garbage. These statutes are summarized below.

5.6.1 Sewage

Section 312 of the CWA (33 US Code Sec. 1322) prohibits the dumping of untreated or inadequately treated sewage into the navigable waters of the US (within three miles of shore). Beyond the three-mile limit, raw sewage can be dumped into the ocean. Section 312 requires all commercial and recreational vessels with installed toilets to have a US Coast Guard-approved marine sanitation device (MSD) to treat sewage.

There are three types of MSDs used to meet different needs and effluent level requirements. Vessels under 65 feet in length with installed toilets must be equipped with a Type I, Type II, or Type III MSD. Vessels over 65 feet in length are required to equip all installed toilets with a Type II or Type III MSD. A Type I MSD is a flow-through device where the sewage travels through an on-board treatment system and is directly discharged. Type I MSDs must produce an effluent having a fecal coliform bacterial count not greater than 1,000 per 100 milliliters of water with no visible floating solids. A Type II MSD is similar to a Type I device, except it is required to produce an effluent having a fecal coliform bacteria count not greater than 200 per 100 milliliters of water and suspended solids not greater than 150 milligrams per liter of water. Type III MSDs are commonly called holding tanks because the sewage is deposited into a holding tank until it can be properly disposed. However, no regulations exist to require that MSDs or their discharges be tested to ensure that they are meeting these effluent standards in use.

The CINMS Management Plan, as revised in 2009, prohibits discharges from Type I and Type II MSDs from large vessels (300 gross registered tons or more).

5.6.2 Graywater

The California Clean Coast Act of 2005 (Public Resources Code Sec. 72420.2) prohibits large passenger vessels and oceangoing ships with sufficient holding tank capacity from releasing graywater (defined as drainage from dishwasher, shower, laundry, bath, and washbasin drains) into the marine waters of the State.

The US EPA's Vessel General Permit, adopted in 2008 (73 Federal Register 249), requires all non-recreational vessels 79 feet in length or longer, with the exception of fishing vessels (unless they discharge ballast water), to comply with technology-based and water-quality-based effluent limits for 26 types of vessel discharges, including graywater. The permit requires all applicable vessels to minimize the discharge of graywater while in port, and those vessels that cannot store graywater are required to minimize the production of graywater in port. All vessels that have the capacity to store graywater shall not discharge that graywater into waters that are federally protected for conservation purposes (including national marine sanctuaries). For vessels that cannot store graywater, vessel operators must minimize the production of graywater while in those waters.

For vessels greater than 400 gross tons that regularly travel more than one nautical mile (nm) from shore and that have the capacity to store graywater for a sufficient period, graywater must be discharged greater than one nm from shore while the vessel is underway, unless the vessel meets treatment standards laid out in the permit (see below). Vessels that do not travel more than one nm from shore must minimize the discharge of graywater and, provided the vessel has available graywater storage capacity, must dispose of graywater on shore if appropriate facilities are available and such disposal is economically practicable and achievable, unless the vessel meets the treatment standards.

The discharge of treated graywater must meet the following standards:

1. The discharge must satisfy the minimum level of effluent quality specified in 40 CFR 133.102;[12]
2. The geometric mean of the samples from the discharge during any 30-day period may not exceed 20 fecal coliform/100 milliliters (ml) and not more than 10 percent of the samples may exceed 40 fecal coliform/100 ml; and
3. Concentrations of total residual chlorine may not exceed 10.0 micrograms per liter (μg/l).

If graywater will be discharged, the introduction of kitchen oils to the graywater system must be minimized. Vessel owner/operators must use phosphate free and non-toxic soaps and detergents if they will be discharged. These detergents must be free from toxic or bioaccumulative compounds and not lead to extreme shifts in receiving water pH.

The permit imposes additional requirements for eight specific types of vessels which have unique characteristics resulting in discharges not shared by other types of vessels, including large cruise ships. Large cruise ships (authorized to carry 500 people or more for hire) are required to use appropriate graywater reception facilities while pierside, if reasonably available, unless the vessel uses a graywater treatment device that meets the effluent standards outlined above. If pierside reception facilities are not reasonably available, graywater must be treated with a device to meet the effluent standards or held for discharge while the vessel is underway. When cruise ships operate within one nm from shore, discharges of graywater are prohibited unless they meet the effluent standards. If operating between one nm and three nm from shore, discharges of graywater must either meet the effluent standards or be released while the cruise ship is sailing at

[12] 40 CFR 133.102 lays out the standards for secondary treatment of sewage, as follows: (a) BOD-5: (1) The 30-day average shall not exceed 30 mg/l; (2) The 7-day average shall not exceed 45 mg/l; (3) The 30-day average percent removal shall not be less than 85 percent; (4) At the option of the NPDES permitting authority, in lieu of the parameter BOD5and the levels of the effluent quality specified in paragraphs (a)(1), (a)(2) and (a)(3), the parameter CBOD-5may be substituted with the following levels of the CBOD-5effluent quality provided: (i) The 30-day average shall not exceed 25 mg/l; (ii) The 7-day average shall not exceed 40 mg/l; (iii) The 30-day average percent removal shall not be less than 85 percent. (b) SS. (1) The 30-day average shall not exceed 30 mg/l; (2) The 7-day average shall not exceed 45 mg/l; (3) The 30-day average percent removal shall not be less than 85 percent; (c) pH. The effluent values for pH shall be maintained within the limits of 6.0 to 9.0 unless the publicly owned treatment works demonstrates that: (1) Inorganic chemicals are not added to the waste stream as part of the treatment process; and (2) contributions from industrial sources do not cause the pH of the effluent to be less than 6.0 or greater than 9.0.

a speed of at least six knots in waters that are not federally protected for conservation purposes (including national marine sanctuaries).

Degreasers must be non-toxic if they will be discharged as part of any waste stream. Waste from mercury-containing products, dry cleaners or dry cleaner condensate, photo processing labs, medical sinks or floor drains, chemical storage areas, and print shops using traditional or non-soy based inks and chlorinated solvents must be prevented from entering the ship's graywater, blackwater, or bilgewater systems if water from these systems will ever be discharged into waters subject to the permit. Vessel owners/operators must not discharge any toxic or hazardous materials, including products containing acetone, benzene, or formaldehyde into salon and day spa sinks or floor drains if those sinks or floor drains lead to any system which will ever be discharged into waters subject to the permit. This includes using these materials on passengers (or crew) and rinsing residuals into these sinks. Alternate waste receptacles or holding tanks must be used for these materials. Addition of these materials to any system which will discharge into waters subject to the permit is a permit violation.

Cruise ship graywater discharges are also subject to monitoring requirements. Owners/operators must maintain records estimating all discharges of untreated graywater, including date, location and volume discharged and speed of the vessel at the time of discharge in their recordkeeping documentation.

Prior to entering US waters, vessel operators must demonstrate that they have an effective treatment system that complies with the effluent standards above if they will discharge graywater within one nm of shore or within three nm of shore and sailing less than six knots.

The CINMS Management Plan as revised in 2009 prohibits the discharge of graywater from large vessels (300 gross registered tons or greater) into waters of the CINMS, with exception for oceangoing ships which do not have sufficient holding tank capacity to hold this waste stream while in Sanctuary waters.

5.6.3 Ballast Water

The US Coast Guard (USCG) has established regulations and guidelines pursuant to the National Invasive Species Act of 1996 (NISA, 16 US Code Sec. 4701 et seq) (33 CFR 151), known as the Ballast Water Management Program, to prevent the introduction and spread of aquatic nuisance species into US waters through the ballast water of commercial vessels. This program applies to all vessels equipped with ballast water tanks that operate in US waters and are bound for US ports or places. The program requires mandatory ballast water management practices for all vessels that operate in US waters; establishes additional practices for vessels entering US waters after operating beyond the US Exclusive Economic Zone (EEZ); and requires reporting and recordkeeping of ballasting operations by all vessels. Mandatory practices include the following:

- All vessels transiting to US waters with ballast water that was taken on within 200 nm of any coast after operating beyond the US EEZ must:
    - Conduct mid-ocean ballast water exchange prior to entering US waters;
    - Retain the ballast water on board while in US waters; or
    - Use a USCG-approved environmentally sound alternative treatment method.

- All vessels with ballast tanks on all US waters, regardless of EEZ entry must:
    - Avoid ballast operations in or near marine sanctuaries, marine preserves, marine parks, or coral reefs.
    - Clean ballast tanks to remove sediment regularly.
    - Only discharge minimal amounts of ballast water in coastal and internal waters.
    - Rinse anchors and anchor chains during retrieval to remove organisms and sediments at their place of origin.
    - Remove fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state and federal regulations.
    - Maintain a vessel specific ballast water management plan.
    - Train vessel personnel in ballast water and sediment management and treatment procedures.
    - Avoid or minimize ballast water uptake:
        - Where infestation, harmful organisms and pathogens are located.
        - Near sewage outfalls.
        - Near dredging operations.
        - Where tidal flushing is poor or when a tidal stream is known to be more turbid.
        - In darkness when organisms may rise up in the water column.
        - In shallow water or where propellers may stir up the sediment.
        - Areas with pods of whales, convergence zones and boundaries of major current.

In California, the California State Lands Commission (CSLC) has developed Ballast Water Regulations for Vessels Operating Within the Pacific Coast Region. These regulations require vessels that arrive at a California port or place from another port or place within the Pacific Coast Region to employ at least one of several ballast water management practices. These include:

1. Exchanging the vessel's ballast water in near-coastal waters, before entering the waters of the state, if that ballast water has been taken on in a port or place within the Pacific Coast region.

2. Retaining all ballast water on board the vessel.

3. Using an alternative, environmentally sound method of ballast water management that, before the vessel begins the voyage, has been approved by the commission or the United States Coast Guard (USCG) as being at least as effective as exchange, using mid-ocean waters, in removing or killing nonindigenous species.

4. Discharging the ballast water to a reception facility approved by the CSLC.

5. Under extraordinary circumstances where compliance with the above is not practicable, perform a ballast water exchange within an area agreed to by the CSLC in consultation with the USCG at or before the time of the request (California Code of Regulations Title 2, Division 3, Chapter 1, Article 4.5 Section 2284).

The CSLC has also developed Performance Standards for the Discharge of Ballast Water for Vessels Operating in California Waters (California Code of Regulations Title 2, Division 3, Chapter 1, Article 4.7). The standards require vessels to conduct ballast water treatment before discharging ballast water in State waters so that ballast water discharged will contain:

a. No detectable living organisms greater than 50 micrometers in minimum dimension;
b. Less than 0.01 living organisms per milliliter that are less than 50 micrometers in minimum dimension and more than 10 micrometers in minimum dimension;
c. For living organisms that are less than 10 micrometers in minimum dimension:
    1. less than 1,000 bacteria per 100 milliliter;
    2. less than 10,000 viruses per 100 milliliter;
    3. concentrations of microbes that are less than:
        A. 126 colony forming units per 100 milliliters of E. coli;
        B. 33 colony forming units per 100 milliliters of Intestinal enterococci; and
        C. 1 colony forming unit per 100 milliliters or 1 colony forming unit per gram of wet weight of zoological samples of Toxicogenic *Vibrio cholerae* (serotypes 01 and 0139).

These standards will be phased in for different sized vessels, entering into effect in January 2009 for new vessels with a ballast water capacity of less than or equal to 5,000 metric tons; in January 2012 for new vessels with a ballast water capacity greater than 5,000 metric tons; in January 2014 for older vessels with capacity between 1,500-5,000 metric tons; and in January 2016 for older vessels with capacity of less than 1,500 metric tons or greater than 5,000 metric tons. Beginning in 2020, all large vessels that discharge ballast water will be required conduct ballast water treatment before discharging in State waters such that discharged ballast water will contain zero detectable living organisms for all organism size classes.

In addition to the above laws regulating the discharge of ballast water, the US EPA has developed a new NPDES permits for discharges incidental to the normal operation of a vessel, which includes ballast water among several others. Previously, EPA had a long-standing regulation (40 CFR 122.3(a)) that excluded certain discharges incidental to the normal operation of vessels, including ballast water, from the requirement to obtain a NPDES permit under the CWA, and in 2005 environmental groups prevailed in court proceedings challenging that exclusion as inconsistent with the intent of the CWA. As a result, EPA developed and circulated for public comment a general vessel NPDES permit, which entered into effect in February 2009.

As described above, the Vessel General Permit (73 Federal Register 249) applies to non-recreational vessels 79 feet in length or longer, such as cruise ships or oil and cargo tankers, but excludes fishing vessels of any length unless they discharge ballast water. The new permit incorporates the USCG's mandatory ballast water management and exchange standards, and provides technology-based and water-quality-based effluent limits for 26 other types of discharges, including deck runoff from rain or cleaning, ballast water used to stabilize ships and graywater. It also establishes specific corrective actions, inspections and monitoring, recordkeeping and reporting requirements. The permit imposes additional requirements for eight specific types of vessels which have unique characteristics resulting in discharges not shared by other types of vessels; these include medium and large cruise ships, large ferries, barges, oil or petroleum tankers, research vessels, rescue boats, and vessels employing experimental ballast water treatment systems. EPA estimates that approximately 61,000 domestically flagged commercial vessels and approximately 8,000 foreign flagged vessels will be affected by this permit.

5.6.4 Oil

The federal Oil Pollution Act (33 US Code Sec. 2701-2761) prohibits the discharge of oil or hazardous substances, in such quantities as may be harmful, into or upon US navigable waters, adjoining shorelines, or into or upon the waters of the contiguous zone or which may affect natural resources in the US EEZ. The Act's implementing regulations prohibit the discharge of oil within 12 miles of shore unless it is passed through an oil-water separator and does not cause a visible sheen or exceed 15 parts per million (ppm). Beyond 12 miles, oil or oily mixture can be discharged while proceeding en route and if the oil content of the effluent without dilution is less than 100 ppm (33 CFR 151.10).

California’s Harbors and Navigation Code (Section 133) prohibits, except in limited circumstances, the discharge of oil from a vessel into navigable waters of the State. The California Ocean Plan provides that oil shall not be visible on State waters, and the California Clean Coast Act (Public Resources Code Sec. 72420.2) prohibits large passenger vessels and oceangoing ships from discharging oily bilgewater, hazardous or other waste into the marine waters of the State or a marine sanctuary.

5.6.5 Garbage

All vessels operating on US navigable waters and within the US EEZ are prohibited from discharging plastics, including synthetic ropes, fishing nets, plastic bags and biodegradable plastics. Discharges of floating dunnage, lining and packing materials are prohibited in navigable waters and waters less than 25 nm from shore. Other garbage, including paper products, rags, glass, metal, bottles, crockery, and food waste, may not be discharged into navigable waters or waters within twelve nm from shore unless it is macerated into pieces of less than one inch. However, even macerated wastes cannot be discharged within three miles of land (33 CFR 151 et seq).

5.7 US EPA’s Current National Recommended Water Quality Criteria

Section 304(a) of the CWA directed EPA to develop criteria for water quality that accurately reflect the latest scientific knowledge about the effects of pollutants on aquatic life and human health. In developing these criteria, EPA examined the effects of specific pollutants on plankton, fish, shellfish, wildlife, plant life, aesthetics, and recreation in any body of water. This includes specific information on the concentration and dispersal of pollutants through biological, physical, and chemical processes as well as the effects of pollutants on biological communities as a whole. EPA has compiled national recommended water quality criteria for the protection of aquatic life and human health in surface water for approximately 150 pollutants, and is currently developing sediment and biological criteria. These criteria are complementary; each is designed to protect specific types of living organisms or ecological systems from the adverse effects of pollution. The criteria are listed in Tables 5.2 and 5.3.

Table 5.2

US EPA's National Recommended Water Quality Criteria for Priority Toxic Pollutants

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR PRIORITY TOXIC POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Priority Pollutant	CAS Number	CMC (• g/L)	CCC (• g/L)	CMC (• g/L)	CCC (• g/L)	Water + Organism (• g/L)	Organism Only (• g/L)	FR Cite/ Source
1	Antimony	7440360					5.6 B	640 B	65FR66443
2	Arsenic	7440382	340 A,D,K	150 A,D,K	69 A,D,bb	36 A,D,bb	0.018 C,M,S	0.14 C,M,S	65FR31682 57FR60848
3	Beryllium	7440417					Z		65FR31682
4	Cadmium	7440439	2.0 D,E,K,bb	0.25 D,E,K,bb	40 D,bb	8.8 D,bb	Z		EPA-822-R-01-001 65FR31682
5a	Chromium (III)	16065831	570 D,E,K	74 D,E,K			Z Total		EPA820/B-96-001 65FR31682
5b	Chromium (VI)	18540299	16 D,K	11 D,K	1,100 D,bb	50 D,bb	Z Total		65FR31682
6	Copper	7440508	13 D,E,K,cc	9.0 D,E,K,cc	4.8 D,cc,ff	3.1 D,cc,ff	1,300 U		65FR31682
7	Lead	7439921	65 D,E,bb,gg	2.5 D,E,bb,gg	210 D,bb	8.1 D,bb			65FR31682
8a 8b	Mercury Methylmercury	7439976 22967926	1.4 D,K,hh	0.77 D,K,hh	1.8 D,ee,hh	0.94 D,ee,hh		0.3 mg/kg J	62FR42160 EPA823-R-01-001
9	Nickel	7440020	470 D,E,K	52 D,E,K	74 D,bb	8.2 D,bb	610 B	4,600 B	65FR31682
10	Selenium	7782492	L,R,T	5.0 T	290 D,bb,dd	71 D,bb,dd	170 Z	4200	62FR42160 65FR31682 65FR66443
11	Silver	7440224	3.2 D,E,G		1.9 D,G				65FR31682
12	Thallium	7440280					0.24	0.47	68FR75510
13	Zinc	7440666	120 D,E,K	120 D,E,K	90 D,bb	81 D,bb	7,400 U	26,000 U	65FR31682 65FR66443
14	Cyanide	57125	22 K,Q	5.2 K,Q	1 Q,bb	1 Q,bb	140 jj	140 jj	EPA820/B-96-001 57FR60848 68FR75510
15	Asbestos	1332214					7 million fibers/L I		57FR60848
16	2,3,7,8-TCDD (Dioxin)	1746016					5.0E-9 C	5.1E-9 C	65FR66443
17	Acrolein	107028					190	290	65FR66443
18	Acrylonitrile	107131					0.051 B,C	0.25 B,C	65FR66443
19	Benzene	71432					2.2 B,C	51 B,C	IRIS 01/19/00 &65FR66443
20	Bromoform	75252					4.3 B,C	140 B,C	65FR66443
21	Carbon Tetrachloride	56235					0.23 B,C	1.6 B,C	65FR66443
22	Chlorobenzene	108907					130 Z,U,	1,600 U	68FR75510
23	Chlorodibromomethane	124481					0.40 B,C	13 B,C	65FR66443
24	Chloroethane	75003							

25	2-Chloroethylvinyl Ether	110758							
26	Chloroform	67663					5.7 C,P	470 C,P	62FR42160
27	Dichlorobromomethane	75274					0.55 B,C	17 B,C	65FR66443
28	1,1-Dichloroethane	75343							
29	1,2-Dichloroethane	107062					0.38 B,C	37 B,C	65FR66443
30	1,1-Dichloroethylene	75354					330	7,100	68FR75510
31	1,2-Dichloropropane	78875					0.50 B,C	15 B,C	65FR66443
32	1,3-Dichloropropene	542756					0.34 C	21 C	68FR75510
33	Ethylbenzene	100414					530	2,100	68FR75510
34	Methyl Bromide	74839					47 B	1,500 B	65FR66443
35	Methyl Chloride	74873							65FR31682
36	Methylene Chloride	75092					4.6 B,C	590 B,C	65FR66443
37	1,1,2,2-Tetrachloroethane	79345					0.17 B,C	4.0 B,C	65FR66443
38	Tetrachloroethylene	127184					0.69 C	3.3 C	65FR66443
39	Toluene	108883					1,300 Z	15,000	68FR75510
40	1,2-Trans-Dichloroethylene	156605					140 Z	10,000	68FR75510
41	1,1,1-Trichloroethane	71556					Z		65FR31682
42	1,1,2-Trichloroethane	79005					0.59 B,C	16 B,C	65FR66443
43	Trichloroethylene	79016					2.5 C	30 C	65FR66443
44	Vinyl Chloride	75014					0.025 C,kk	2.4 C,kk	68FR75510
45	2-Chlorophenol	95578					81 B,U	150 B,U	65FR66443
46	2,4-Dichlorophenol	120832					77 B,U	290 B,U	65FR66443
47	2,4-Dimethylphenol	105679					380 B	850 B,U	65FR66443
48	2-Methyl-4,6-Dinitrophenol	534521					13	280	65FR66443
49	2,4-Dinitrophenol	51285					69 B	5,300 B	65FR66443
50	2-Nitrophenol	88755							
51	4-Nitrophenol	100027							
52	3-Methyl-4-Chlorophenol	59507					U	U	
53	Pentachlorophenol	87865	19 F,K	15 F,K	13 bb	7.9 bb	0.27 B,C	3.0 B,C,H	65FR31682 65FR66443
54	Phenol	108952					21,000 B,U	1,700,000 B,U	65FR66443
55	2,4,6-Trichlorophenol	88062					1.4 B,C	2.4 B,C,U	65FR66443
56	Acenaphthene	83329					670 B,U	990 B,U	65FR66443
57	Acenaphthylene	208968							
58	Anthracene	120127					8,300 B	40,000 B	65FR66443
59	Benzidine	92875					0.000086 B,C	0.00020 B,C	65FR66443
60	Benzo(a)Anthracene	56553					0.0038 B,C	0.018 B,C	65FR66443
61	Benzo(a)Pyrene	50328					0.0038 B,C	0.018 B,C	65FR66443
62	Benzo(b)Fluoranthene	205992					0.0038 B,C	0.018 B,C	65FR66443
63	Benzo(ghi)Perylene	191242							
64	Benzo(k)Fluoranthene	207089					0.0038 B,C	0.018 B,C	65FR66443
65	Bis(2-Chloroethoxy)Methane	111911							
66	Bis(2-Chloroethyl)Ether	111444					0.030 B,C	0.53 B,C	65FR66443
67	Bis(2-Chloroisopropyl)Ether	108601					1,400 B	65,000 B	65FR66443
68	Bis(2-Ethylhexyl)Phthalate X	117817					1.2 B,C	2.2 B,C	65FR66443
69	4-Bromophenyl Phenyl Ether	101553							
70	Butylbenzyl Phthalate W	85687					1,500 B	1,900 B	65FR66443
71	2-Chloronaphthalene	91587					1,000 B	1,600 B	65FR66443
72	4-Chlorophenyl Phenyl Ether	7005723							

73	Chrysene	218019					0.0038 B,C	0.018 B,C	65FR66443
74	Dibenzo(a,h)Anthracene	53703					0.0038 B,C	0.018 B,C	65FR66443
75	1,2-Dichlorobenzene	95501					420	1,300	68FR75510
76	1,3-Dichlorobenzene	541731					320	960	65FR66443
77	1,4-Dichlorobenzene	106467					63	190	68FR75510
78	3,3'-Dichlorobenzidine	91941					0.021 B,C	0.028 B,C	65FR66443
79	Diethyl Phthalate[W]	84662					17,000 B	44,000 B	65FR66443
80	Dimethyl Phthalate[W]	131113					270,000	1,100,000	65FR66443
81	Di-n-Butyl Phthalate[W]	84742					2,000 B	4,500 B	65FR66443
82	2,4-Dinitrotoluene	121142					0.11 C	3.4 C	65FR66443
83	2,6-Dinitrotoluene	606202							
84	Di-n-Octyl Phthalate	117840							
85	1,2-Diphenylhydrazine	122667					0.036 B,C	0.20 B,C	65FR66443
86	Fluoranthene	206440					130 B	140 B	65FR66443
87	Fluorene	86737					1,100 B	5,300 B	65FR66443
88	Hexachlorobenzene	118741					0.00028 B,C	0.00029 B,C	65FR66443
89	Hexachlorobutadiene	87683					0.44 B,C	18 B,C	65FR66443
90	Hexachlorocyclopentadiene	77474					40 U	1,100 U	68FR75510
91	Hexachloroethane	67721					1.4 B,C	3.3 B,C	65FR66443
92	Ideno(1,2,3-cd)Pyrene	193395					0.0038 B,C	0.018 B,C	65FR66443
93	Isophorone	78591					35 B,C	960 B,C	65FR66443
94	Naphthalene	91203							
95	Nitrobenzene	98953					17 B	690 B,H,U	65FR66443
96	N-Nitrosodimethylamine	62759					0.00069 B,C	3.0 B,C	65FR66443
97	N-Nitrosodi-n-Propylamine	621647					0.0050 B,C	0.51 B,C	65FR66443
98	N-Nitrosodiphenylamine	86306					3.3 B,C	6.0 B,C	65FR66443
99	Phenanthrene	85018							
100	Pyrene	129000					830 B	4,000 B	65FR66443
101	1,2,4-Trichlorobenzene	120821					35	70	68FR75510
102	Aldrin	309002	3.0 G		1.3 G		0.000049 B,C	0.000050 B,C	65FR31682 65FR66443
103	alpha-BHC	319846					0.0026 B,C	0.0049 B,C	65FR66443
104	beta-BHC	319857					0.0091 B,C	0.017 B,C	65FR66443
105	gamma-BHC (Lindane)	58899	0.95 K		0.16 G		0.98	1.8	65FR31682 68FR75510
106	delta-BHC	319868							
107	Chlordane	57749	2.4 G	0.0043 G,aa	0.09 G	0.004 G,aa	0.00080 B,C	0.00081 B,C	65FR31682 65FR66443
108	4,4'-DDT	50293	1.1 G,ii	0.001 G,aa,ii	0.13 G,ii	0.001 G,aa,ii	0.00022 B,C	0.00022 B,C	65FR31682 65FR66443
109	4,4'-DDE	72559					0.00022 B,C	0.00022 B,C	65FR66443
110	4,4'-DDD	72548					0.00031 B,C	0.00031 B,C	65FR66443
111	Dieldrin	60571	0.24 K	0.056 K,O	0.71 G	0.0019 G,aa	0.000052 B,C	0.000054 B,C	65FR31682 65FR66443
112	alpha-Endosulfan	959988	0.22 G,Y	0.056 G,Y	0.034 G,Y	0.0087 G,Y	62 B	89 B	65FR31682 65FR66443
113	beta-Endosulfan	33213659	0.22 G,Y	0.056 G,Y	0.034 G,Y	0.0087 G,Y	62 B	89 B	65FR31682 65FR66443
114	Endosulfan Sulfate	1031078					62 B	89 B	65FR66443
115	Endrin	72208	0.086 K	0.036 K,O	0.037 G	0.0023 G,aa	0.059	0.060	65FR31682 68FR75510
116	Endrin Aldehyde	7421934					0.29 B	0.30 B,H	65FR66443

117	Heptachlor	76448	0.52 G	0.0038 G,aa	0.053 G	0.0036 G,aa	0.000079 B,C	0.000079 B,C	65FR31682 65FR66443
118	Heptachlor Epoxide	1024573	0.52 G,V	0.0038 G,V,aa	0.053 G,V	0.0036 G,V,aa	0.000039 B,C	0.000039 B,C	65FR31682 65FR66443
119	Polychlorinated Biphenyls PCBs:			0.014 N,aa		0.03 N,aa	0.000064 B,C,N	0.000064 B,C,N	65FR31682 65FR66443
120	Toxaphene	8001352	0.73	0.002 aa	0.21	0.002 aa	0.00028B,C	0.00028 B,C	65FR31682 65FR66443

Footnotes:

A This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the arsenic criteria document (EPA 440/5-84-033, January 1985), Species Mean Acute Values are given for both arsenic (III) and arsenic (V) for five species and the ratios of the SMAVs for each species range from 0.6 to 1.7. Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.

B This criterion has been revised to reflect The Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.

C This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

D Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The recommended water quality criteria value was calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and multiplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are not currently available. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs). See "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria," October 1, 1993, by Martha G. Prothro, Acting Assistant Administrator for Water, available from the Water Resource center, USEPA, 401 M St., SW, mail code RC4100, Washington, DC 20460; and 40CFR§131.36(b)(1). Conversion Factors applied in the table can be found in Appendix A to the Preamble- Conversion Factors for Dissolved Metals.

E The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to a hardness of 100 mg/L. Criteria values for other hardness may be calculated from the following: CMC (dissolved) = exp{m_A [ln(hardness)]+ b_A} (CF), or CCC (dissolved) = exp{m_C [ln (hardness)]+ b_C} (CF) and the parameters specified in Appendix B- Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent.

F Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH, and are calculated as follows: CMC = exp(1.005(pH)-4.869); CCC = exp(1.005(pH)-5.134). Values displayed in table correspond to a pH of 7.8.

G This Criterion is based on 304(a) aquatic life criterion issued in 1980, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endosulfan (EPA 440/5-80-046), Endrin (EPA 440/5-80-047), Heptachlor (EPA 440/5-80-052), Hexachlorocyclohexane (EPA 440/5-80-054), Silver (EPA 440/5-80-071). The Minimum Data Requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a "CMC" derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines.

H No criterion for protection of human health from consumption of aquatic organisms excluding water was presented in the 1980 criteria document or in the *1986 Quality Criteria for Water*. Nevertheless, sufficient information was presented in the 1980 document to allow the calculation of a criterion, even though the results of such a calculation were not shown in the document.

I This criterion for asbestos is the Maximum Contaminant Level (MCL) developed under the Safe Drinking Water Act (SDWA).

J This fish tissue residue criterion for methylmercury is based on a total fish consumption rate of 0.0175 kg/day.

K This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water*, (EPA-820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes.

L The CMC = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 • g/l and 12.82 • g/l, respectively.

M EPA is currently reassessing the criteria for arsenic.

N This criterion applies to total pcbs, (e.g., the sum of all congener or all isomer or homolog or Aroclor analyses.)

O The derivation of the CCC for this pollutant (Endrin) did not consider exposure through the diet, which is probably important for aquatic life occupying upper trophic levels.

T This recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor (0.996- CMC or 0.922- CCC) that was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.

U The organoleptic effect criterion is more stringent than the value for priority toxic pollutants.

V This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide.

W Although EPA has not published a completed criteria document for butylbenzyl phthalate it is EPA's understanding that sufficient data exist to allow calculation of aquatic criteria. It is anticipated that industry intends to publish in the peer reviewed literature draft aquatic life criteria generated in accordance with EPA Guidelines. EPA will review such criteria for possible issuance as national WQC.

X There is a full set of aquatic life toxicity data that show that DEHP is not toxic to aquatic organisms at or below its solubility limit.

Y This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan.

Z A more stringent MCL has been issued by EPA. Refer to drinking water regulations (40 CFR 141) or Safe Drinking Water Hotline (1-800-426-4791) for values.

aa This criterion is based on a 304(a) aquatic life criterion issued in 1980 or 1986, and was issued in one of the following documents: Aldrin/Dieldrin (EPA 440/5-80-019), Chlordane (EPA 440/5-80-027), DDT (EPA 440/5-80-038), Endrin (EPA 440/5-80-047), Heptachlor (EPA 440/5-80-052), Polychlorinated biphenyls (EPA 440/5-80-068), Toxaphene (EPA 440/5-86-006). This CCC is currently based on the Final Residue Value (FRV) procedure. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria. Therefore, the Agency anticipates that future revisions of this CCC will not be based on the FRV procedure.

bb This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Arsenic (EPA 440/5-84-033), Cadmium (EPA-822-R-01-001), Chromium (EPA 440/5-84-029), Copper (EPA 440/5-84-031), Cyanide (EPA 440/5- 84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene, (EPA 440/5-86-006), Zinc (EPA 440/5-87- 003).

cc When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of Water-Effect Ratios might be appropriate.

dd The selenium criteria document (EPA 440/5-87-006, September 1987) provides that if selenium is as toxic to saltwater fishes in the field as it is to freshwater fishes in the field, the status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 • g/L in salt water because the saltwater CCC does not take into account uptake via the food chain.

ee This recommended water quality criterion was derived on page 43 of the mercury criteria document (EPA 440/5-84-026, January 1985). The saltwater CCC of 0.025 ug/L given on page 23 of the criteria document is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria.

ff This recommended water quality criterion was derived in *Ambient Water Quality Criteria Saltwater Copper Addendum* (Draft, April 14, 1995) and was promulgated in the Interim final National Toxics Rule (60FR22228-222237, May 4, 1995).

gg EPA is actively working on this criterion and so this recommended water quality criterion may change substantially in the near future.

hh This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, this criterion does not account for uptake via the food chain because sufficient data were not available when the criterion was derived.

ii This criterion applies to DDT and its metabolites (i.e., the total concentration of DDT and its metabolites should not exceed this value).

jj This recommended water quality criterion is expressed as total cyanide, even though the IRIS RFD we used to derive the criterion is based on free cyanide. The multiple forms of cyanide that are present in ambient water have significant differences in toxicity due to their differing abilities to liberate the CN-moiety. Some complex cyanides require even more extreme conditions than refluxing with sulfuric acid to liberate the CN-moiety. Thus, these complex cyanides are expected to have little or no 'bioavailability' to humans. If a substantial fraction of the cyanide present in a water body is present in a complexed form (e.g., $Fe_4[Fe(CN)_6]_3$), this criterion may be over conservative.

kk This recommended water quality criterion was derived using the cancer slope factor of 1.4 (LMS exposure from birth).

Table 5.3

US EPA's National Recommended Water Quality Criteria for Non-Priority Pollutants

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR NON PRIORITY POLLUTANTS

			Freshwater		Saltwater		Human Health For Consumption of:		
	Non Priority Pollutant	CAS Number	CMC (• g/L)	CCC (• g/L)	CMC (• g/L)	CCC (• g/L)	Water + Organism (• g/L)	Organism Only (• g/L)	FR Cite/Source
1	Alkalinity	--		20000 F					Gold Book
2	Aluminum pH 6.5 - 9.0	7429905	750 G,I	87 G,I,L					53FR33178
3	Ammonia	7664417	FRESHWATER CRITERIA ARE pH, Temperature and Life-stage DEPENDENT -- SEE DOCUMENT D SALTWATER CRITERIA ARE pH AND TEMPERATURE DEPENDENT						EPA822-R-99-014 EPA440/5-88-004
4	Aesthetic Qualities	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
5	Bacteria	--	FOR PRIMARY RECREATION AND SHELLFISH USES -- SEE DOCUMENT						Gold Book
6	Barium	7440393					1,000 A		Gold Book
7	Boron	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
8	Chloride	16887006	860000 G	230000 G					53FR19028
9	Chlorine	7782505	19	11	13	7.5	C		Gold Book
10	Chlorophenoxy Herbicide (2,4,5,-TP)	93721					10 A		Gold Book
11	Chlorophenoxy Herbicide (2,4-D)	94757					100 A,C		Gold Book
12	Chloropyrifos	2921882	0.083 G	0.041 G	0.011 G	0.0056 G			Gold Book
13	Color	--	NARRATIVE STATEMENT-- SEE DOCUMENT F						Gold Book

14	Demeton	8065483		0.1 F		0.1 F			Gold Book
15	Ether, Bis(Chloromethyl)	542881					0.00010 E, H	0.00029 E,H	65FR66443
16	Gases, Total Dissolved	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
17	Guthion	86500		0.01 F		0.01 F			Gold Book
18	Hardness	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
19	Hexachlorocyclo-hexane-Technical	319868					0.0123	0.0414	Gold Book
20	Iron	7439896		1000 F			300 A		Gold Book
21	Malathion	121755		0.1 F		0.1 F			Gold Book
22	Manganese	7439965					50 A,O	100 A	Gold Book
23	Methoxychlor	72435		0.03 F		0.03 F	100 A,C		Gold Book
24	Mirex	2385855		0.001 F		0.001 F			Gold Book
25	Nitrates	14797558					10,000 A		Gold Book
26	Nitrosamines	--					0.0008	1.24	Gold Book
27	Dinitrophenols	25550587					69	5300	65FR66443
28	Nonylphenol	1044051	28	6.6	7.0	1.7			71FR9337
29	Nitrosodibutylamine,N	924163					0.0063 A,H	0.22 A,H	65FR66443
30	Nitrosodiethylamine,N	55185					0.0008 A,H	1.24 A,H	Gold Book
31	Nitrosopyrrolidine,N	930552					0.016 H	34 H	65FR66443
32	Oil and Grease	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
33	Oxygen, Dissolved Freshwater	7782447	WARMWATER AND COLDWATER MATRIX -- SEE DOCUMENT N						Gold Book
	Oxygen, Dissolved Saltwater		SALTWATER – SEE DOCUMENT						EPA-822R-00-012
34	Diazinon	333415	0.17	0.17	0.82	0.82			71FR9336
35	Parathion	56382	0.065 J	0.013 J					Gold Book
36	Pentachlorobenzene	608935					1.4 E	1.5 E	65FR66443
37	pH	--		6.5 - 9 F		6.5 - 8.5 F,K	5 - 9		Gold Book
38	Phosphorus Elemental	7723140				0.1 F,K			Gold Book
39	Nutrients	--	See EPA's Ecoregional criteria for Total Phosphorus, Total Nitrogen, Chlorophyll *a* and Water Clarity (Secchi depth for lakes; turbidity for streams and rivers) (& Level III Ecoregional criteria)						P
40	Solids Dissolved and Salinity	--					250,000 A		Gold Book
41	Solids Suspended and Turbidity	--	NARRATIVE STATEMENT -- SEE DOCUMENT F						Gold Book
42	Sulfide-Hydrogen Sulfide	7783064		2.0 F		2.0 F			Gold Book
43	Tainting Substances	--	NARRATIVE STATEMENT-- SEE DOCUMENT						Gold Book
44	Temperature	--	SPECIES DEPENDENT CRITERIA -- SEE DOCUMENT M						Gold Book
45	Tetrachlorobenzene,1,2,4,5-	95943					0.97 E	1.1 E	65FR66443
46	Tributyltin (TBT)	--	0.46 Q	0.072 Q	0.42 Q	0.0074 Q			EPA 822-F-00-008
47	Trichlorophenol,2,4,5-	95954					1,800 B,E	3,600 B,E	65FR66443

Footnotes:

A This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not utilize the fish ingestion BCF approach. This same criterion value is now published in the Gold Book.

B The organoleptic effect criterion is more stringent than the value presented in the non priority pollutants table.

C A more stringent Maximum Contaminant Level (MCL) has been issued by EPA under the Safe Drinking Water Act. Refer to drinking water regulations 40CFR141 or Safe Drinking Water Hotline (1-800-426-4791) for values.

D According to the procedures described in the *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, except possibly where a very sensitive species is important at a site, freshwater aquatic life should be protected if both conditions specified in Appendix C to the Preamble- Calculation of Freshwater Ammonia Criterion are satisfied.

E This criterion has been revised to reflect EPA's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of May 17, 2002. The fish tissue bioconcentration factor (BCF) used to derive the original criterion was retained in each case.

F The derivation of this value is presented in the Red Book (EPA 440/9-76-023, July, 1976).

G This value is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) and was issued in one of the following criteria documents: Aluminum (EPA 440/5-86-008); Chloride (EPA 440/5-88-001); Chloropyrifos (EPA 440/5-86-005).

H This criterion is based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

I This value for aluminum is expressed in terms of total recoverable metal in the water column.

J This value is based on a 304(a) aquatic life criterion that was issued in the *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water* (EPA-820-B-96-001). This value was derived using the GLI Guidelines (60FR15393-15399, March 23, 1995; 40CFR132 Appendix A); the differences between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. No decision concerning this criterion was affected by any considerations that are specific to the Great Lakes.

K According to page 181 of the Red Book:

For open ocean waters where the depth is substantially greater than the euphotic zone, the pH should not be changed more than 0.2 units from the naturally occurring variation or any case outside the range of 6.5 to 8.5. For shallow, highly productive coastal and estuarine areas where naturally occurring pH variations approach the lethal limits of some species, changes in pH should be avoided but in any case should not exceed the limits established for fresh water, i.e., 6.5-9.0.

L There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1)The value of 87• micro-g/l is based on a toxicity test with the striped bass in water with pH= 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles, which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 • g aluminum/L, when either total recoverable or dissolved is measured.

M U.S. EPA. 1973. Water Quality Criteria 1972. EPA-R3-73-033. National Technical Information Service, Springfield, VA.; U.S. EPA. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA-600/3-77-061. National Technical Information Service, Springfield, VA.

N U.S. EPA. 1986. Ambient Water Quality Criteria for Dissolved Oxygen. EPA 440/5-86-003. National Technical Information Service, Springfield, VA.

O This criterion for manganese is not based on toxic effects, but rather is intended to minimize objectionable qualities such as laundry stains and objectionable tastes in beverages.

P Lakes and Reservoirs in Nutrient Ecoregion: II EPA 822-B-00-007, III EPA 822-B-01-008, IV EPA 822-B-01-009, V EPA 822-B-01-010, VI EPA 822-B-00-008 , VII EPA 822-B-00-009, VIII EPA 822-B-01-015, IX EPA 822-B-00-011, XI EPA 822-B-00-012, XII EPA 822-B-00-013, XIII EPA 822-B-00-014, XIV EPA 822-B-01-011; Rivers and Streams in Nutrient Ecoregion: I EPA 822-B-01-012, II EPA 822-B-00-015, III EPA 822-B-00-016, IV EPA 822-B-01-013, V EPA 822-B-01-014, VI EPA 822-B-00-017, VII EPA 822-B-00-018, VIII EPA 822-B-01-015, IX EPA 822-B-00-019, X EPA 822-B-01-016, XI EPA 822-B-00-020, XII EPA 822-B-00-021, XIV EPA 822-B-00-022; and Wetlands in Nutrient Ecoregion XIII EPA 822-B-00-023.

Q EPA announced the availability of a draft updated tributyltin (TBT) document on August 7, 1997 (62FR42554). The Agency has reevaluated this document and anticipates releasing an updated document for public comment in the near future.

Table 5.4

US EPA's National Recommended Water Quality Criteria for Organoleptic Effects

NATIONAL RECOMMENDED WATER QUALITY CRITERIA FOR ORGANOLEPTIC EFFECTS

	Pollutant	CAS Number	Organoleptic Effect Criteria (• g/L)	FR Cite/Source
1	Acenaphthene	83329	20	Gold Book
2	Monochlorobenzene	108907	20	Gold Book
3	3-Chlorophenol	--	0.1	Gold Book
4	4-Chlorophenol	106489	0.1	Gold Book
5	2,3-Dichlorophenol	--	0.04	Gold Book
6	2,5-Dichlorophenol	--	0.5	Gold Book
7	2,6-Dichlorophenol	--	0.2	Gold Book
8	3,4-Dichlorophenol	--	0.3	Gold Book
9	2,4,5-Trichlorophenol	95954	1	Gold Book
10	2,4,6-Trichloropehnol	88062	2	Gold Book
11	2,3,4,6-Tetrachlorophenol	--	1	Gold Book
12	2-Methyl-4-Chlorophenol	--	1800	Gold Book
13	3-Methyl-4-Chlorophenol	59507	3000	Gold Book
14	3-Methyl-6-Chlorophenol	--	20	Gold Book
15	2-Chlorophenol	95578	0.1	Gold Book
16	Copper	7440508	1000	Gold Book
17	2,4-Dichlorophenol	120832	0.3	Gold Book
18	2,4-Dimethylpehnol	105679	400	Gold Book
19	Hexachlorocyclopentadiene	77474	1	Gold Book
20	Nitrobenzene	98953	30	Gold Book
21	Pentachlorophenol	87865	30	Gold Book
22	Phenol	108952	300	Gold Book
23	Zinc	7440666	5000	45 FR79341

General notes:

1. These criteria are based on organoleptic (taste and odor) effects. Because of variations in chemical nomenclature systems, this listing of pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service (CAS) registry numbers, which provide a unique identification for each chemical.

Additional Notes:

1. Criteria Maximum Concentration and Criterion Continuous Concentration

The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. The Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. The CMC and CCC are just two of the six parts of an aquatic life criterion; the other four parts are the acute averaging period, chronic averaging period, acute frequency of allowed exceedence, and chronic frequency of allowed exceedence. Because 304(a) aquatic life criteria are national guidance, they are intended to be protective of the vast majority of the aquatic communities in the United States.

2. Criteria Recommendations for Priority Pollutants, Non Priority Pollutants and Organoleptic Effects

This compilation lists all priority toxic pollutants and some non priority toxic pollutants, and both human health effect and organoleptic effect criteria issued pursuant to CWA §304(a). Blank spaces indicate that EPA has no CWA §304(a) criteria recommendations. For a number of non-priority toxic pollutants not listed, CWA §304(a) "water + organism" human health criteria are not available, but EPA has published MCLs under the SDWA that may be used in establishing water quality standards to protect water supply designated uses. Because of variations in chemical nomenclature systems, this listing of toxic pollutants does not duplicate the listing in Appendix A of 40 CFR Part 423. Also listed are the Chemical Abstracts Service CAS registry numbers, which provide a unique identification for each chemical.

3. Human Health Risk

The human health criteria for the priority and non priority pollutants are based on carcinogenicity of 10^{-6} risk. Alternate risk levels may be obtained by moving the decimal point (e.g., for a risk level of 10^{-5}, move the decimal point in the recommended criterion one place to the right).

4. Water Quality Criteria published pursuant to Section 304(a) or Section 303(c) of the CWA

Many of the values in the compilation were published in the California Toxics Rule. Although such values were published pursuant to Section 303(c) of the CWA, they represent the Agency's most recent calculation of water quality criteria and are thus the Agency's 304(a) criteria.

5. Calculation of Dissolved Metals Criteria

The 304(a) criteria for metals, shown as dissolved metals, are calculated in one of two ways. For freshwater metals criteria that are hardness-dependent, the dissolved metal criteria were calculated using a hardness of 100 mg/l as $CaCO_3$ for illustrative purposes only. Saltwater and freshwater metals' criteria that are not hardness-dependent are calculated by multiplying the total recoverable criteria before rounding by the appropriate conversion factors. The final dissolved metals' criteria in the table are rounded to two significant figures. Information regarding the calculation of hardness dependent conversion factors are included in the footnotes.

6. Maximum Contaminant Levels

The compilation includes footnotes for pollutants with Maximum Contaminant Levels (MCLs) more stringent than the recommended water quality criteria in the compilation. MCLs for these pollutants are not included in the compilation, but can be found in the appropriate drinking water regulations (40 CFR 141.11-16 and 141.60-63), or can be accessed through the Safe Drinking Water Hotline (800-426-4791) or the Internet (http://www.epa.gov/waterscience/drinking/standards/dwstandards.pdf).

7. Organoleptic Effects

The compilation contains 304(a) criteria for pollutants with toxicity-based criteria as well as non-toxicity based criteria. The basis for the non-toxicity based criteria are organoleptic effects (e.g., taste and odor) which would make water and edible aquatic life unpalatable but not toxic to humans. The table includes criteria for organoleptic effects for 23 pollutants. Pollutants with organoleptic effect criteria more stringent than the criteria based on toxicity (e.g., included in both the priority and non-priority pollutant tables) are footnoted as such.

8. Gold Book

The "Gold Book" is Quality Criteria for Water: 1986. EPA 440/5-86-001.

9. Correction of Chemical Abstract Services Number

The Chemical Abstract Services number (CAS) for Bis(2-Chlorisoprpyl) Ether, has been revised in IRIS and in the table. The correct CAS number for this chemical is 108-60-1. The previous CAS number for this pollutant was 39638-32-9.

10. Contaminants with Blanks

EPA has not calculated criteria for contaminants with blanks. However, permit authorities should address these contaminants in NPDES permit actions using the States' existing narrative criteria for toxics.

11. Specific Chemical Calculations

A. Selenium

Aquatic Life

This compilation contains aquatic life criteria for selenium that are the same as those published in the proposed CTR. In the CTR, EPA proposed an acute criterion for selenium based on the criterion proposed for selenium in the Water Quality Guidance for the Great Lakes System (61 FR 58444). The GLI and CTR proposals take into account data showing that selenium's two prevalent oxidation states in water, selenite and selenate, present differing potentials for aquatic toxicity, as well as new data indicating that various forms of selenium are additive. The new approach produces a different selenium acute criterion concentration, or CMC, depending upon the relative proportions of selenite, selenate, and other forms of selenium that are present.

EPA is currently undertaking a reassessment of selenium, and expects the 304(a) criteria for selenium will be revised based on the final reassessment (63FR26186). However, until such time as revised water quality criteria for selenium are published by the Agency, the recommended water quality criteria in this compilation are EPA's current 304(a) criteria.

Appendix A - Conversion Factors for Dissolved Metals

Metal	Conversion Factor freshwater CMC	Conversion Factor freshwater CCC	Conversion Factor saltwater CMC	Conversion Factor saltwater CCC[1]
Arsenic	1.000	1.000	1.000	1.000
Cadmium	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]	0.994	0.994
Chromium III	0.316	0.860	--	--
Chromium VI	0.982	0.962	0.993	0.993
Copper	0.960	0.960	0.83	0.83
Lead	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]	0.951	0.951
Mercury	0.85	0.85	0.85	0.85
Nickel	0.998	0.997	0.990	0.990
Selenium	--	--	0.998	0.998
Silver	0.85	--	0.85	--
Zinc	0.978	0.986	0.946	0.946

Appendix B - Parameters for Calculating Freshwater Dissolved Metals Criteria That Are Hardness-Dependent

Chemical	m_A	b_A	m_C	b_C	Freshwater Conversion Factors (CF)	
					CMC	CCC
Cadmium	1.0166	-3.924	0.7409	-4.719	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.59	--	--	0.85	--
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

Hardness-dependant metals' criteria may be calculated from the following:
CMC (dissolved) = $\exp\{m_A [\ln(\text{hardness})] + b_A\}$ (CF)
CCC (dissolved) = $\exp\{m_C [\ln(\text{hardness})] + b_C\}$ (CF)

Appendix C - Calculation of Freshwater Ammonia Criterion

1. The one-hour average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CMC (acute criterion) calculated using the following equations.

Where salmonid fish are present:

CMC = 0.275 / ------------------- + 39.0 / -----------------------

$$1 + 10^{7.204\text{-pH}} \qquad 1 + 10^{\text{pH-}7.204}$$

Or where salmonid fish are not present:

$$CMC = \frac{0.411}{1 + 10^{7.204\text{-pH}}} + \frac{58.4}{1 + 10^{\text{pH-}7.204}}$$

2A. The thirty-day average concentration of total ammonia nitrogen (in mg N/L) does not exceed, more than once every three years on the average, the CCC (chronic criterion) calculated using the following equations.

When fish early life stages are present:

$$CCC = \left(\frac{0.0577}{1 + 10^{7.688\text{-pH}}} + \frac{2.487}{1 + 10^{\text{pH-}7.688}}\right) \cdot MIN\left(2.85,\ 1.45 \cdot 10^{0.028 \cdot (25-T)}\right)$$

When fish early life stages are absent:

$$CCC = \left(\frac{0.0577}{1 + 10^{7.688\text{-pH}}} + \frac{2.487}{1 + 10^{\text{pH-}7.688}}\right) \cdot 1.45 \cdot 10^{0.028 \cdot (25-MAX(T,7))}$$

2B. In addition, the highest four-day average within the 30-day period should not exceed 2.5 times the CCC.

6. Existing Water Quality Management Programs

In addition to the water quality standards outlined above that regulate discharges that might affect water quality in the CINMS, there are also numerous federal, State and local programs that manage various aspects of water quality in the Sanctuary and, more broadly, in the Santa Barbara Channel and mainland and Island watersheds. These programs are described below, organized by the type or source of pollution: point sources, vessels, oil and gas facilities, aquaculture, nonpoint source pollution, dredged or fill materials, and other programs.

6.1 Point Source Pollution

Point source pollution enters the aquatic environment from a discrete facility, such as a pipeline outfall system, and can be generated from a variety of industrial and municipal facilities, such as vessels, sewage treatment plants, storm water outfalls, oil refineries or platforms, or power plants.

6.1.1 Federal Programs

In 1972, the US Congress enacted the federal Water Pollution Control Act (now known as the Clean Water Act). Section 301 of the Clean Water Act (CWA) prohibits the discharge of any pollutant from a point source into US waters except in compliance with permits and other CWA requirements. Section 402 of the CWA established the National Pollutant Discharge Elimination System (NPDES) permit program to regulate the discharge of pollutants from point sources to US waters. The US EPA issues NPDES permits in federal waters and has delegated authority to the State Water Resources Control Board (SWRCB) to issue these permits in California State waters. Permits are issued for discharges from sources such as offshore oil and gas platforms, Publicly Owned Treatment Works (POTWs), refineries, and storm water discharges.

An NPDES permit allows a facility to discharge a specified amount of a pollutant into a receiving water body under certain conditions. Under NPDES permitting, two CWA sections deal specifically with discharges to marine and ocean waters: Sections 301(h) and 403. Section 301(h) allows waivers from EPA requirements that POTWs provide secondary treatment of municipal wastewater for those POTWs that discharge to marine waters in certain cases. POTWs with waivers from secondary treatment must demonstrate that their discharge does not adversely affect the marine environment. The Goleta Sanitary District is one of three remaining sewage treatment plants in California that operates under a 301(h) waiver, but will upgrade to full secondary treatment by November 2014.

Section 403 of the CWA requires that NPDES permits for discharges into territorial seas, the contiguous zone and oceans be issued in compliance with EPA's guidelines for determining the degradation of marine waters.[13] This includes discharges associated with offshore oil and gas exploration, development and production on the Outer Continental Shelf (OCS).

[13] EPA makes a determination of whether a discharge will cause unreasonable degradation of the marine environment based on consideration of the following criteria: (1) The quantities, composition and potential for bioaccumulation or persistence of the pollutants to be discharged; (2) The potential transport of such pollutants by biological, physical or chemical processes; (3) The composition and vulnerability of the biological communities

In 2004, EPA issued a general NDPES permit for all offshore oil and gas facilities located in the southern California OCS. The permit establishes effluent limitations (equivalent to those promulgated by EPA in 1993 for the oil and gas industry), prohibitions and other conditions for discharges from the 22 existing platforms as well as from any new exploratory drilling operations located in the Pacific OCS lease blocks offshore of southern California. The permit also required platform operators to complete assessments of alternatives to discharging to the ocean for each individual platform by 2006. Based on the results of these studies, EPA is currently proposing to modify the permit to include additional effluent limitations and monitoring requirements for those discharges for which the studies showed a reasonable potential to cause or contribute to exceedances of marine water quality criteria (produced water, cooling water and fire control system test water). For produced water discharges, EPA is also proposing to use a different water quality criterion undissociated sulfide from the one in the existing permit based on the results of a new study concerning the toxicity of undissociated sulfide to marine organisms.

As a result of the California Coastal Commission's determination of the permit's consistency with the State's coastal management program, as allowed under the federal Coastal Zone Management Act, the permit also includes a provision stating that the more stringent of State (Ocean Plan) or federal (CWA 304(a)) discharge effluent standards shall apply, and provides for third party monitoring of discharges.

Sec. 401 of the CWA allows States to review, approve, condition or deny all federal permits or licenses that might result in a discharge to State waters. States typically base these decisions on whether the activity will comply with State water quality standards.

Sec. 404 of the CWA, administered by the US Army Corps of Engineers, regulates the discharge of dredged or fill material into waters of the US for beneficial use as fill material such as port landfill and beach fill. It allows the discharge of dredged material into US waters for disposal if the material meets certain requirements and is placed at an ocean dredged material disposal site approved by the EPA.

Sec. 303(d) of the CWA requires states to create a list, every two years, of surface waters not attaining (or not expected to attain) water quality standards after the application of technology-based effluent limits, and to develop Total Maximum Daily Loads (TMDLs) for all waters on

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which may be exposed to such pollutants, including the presence of unique species or communities of species, the presence of species identified as endangered or threatened pursuant to the Endangered Species Act, or the presence of those species critical to the structure or function of the ecosystem, such as those important for the food chain; (4) The importance of the receiving water area to the surrounding biological community, including the presence of spawning sites, nursery/forage areas, migratory pathways, or areas necessary for other functions or critical stages in the life cycle of an organism; (5) The existence of special aquatic sites including, but not limited to marine sanctuaries and refuges, parks, national and historic monuments, national seashores, wilderness areas and coral reefs; (6) The potential impacts on human health through direct and indirect pathways; (7) Existing or potential recreational and commercial fishing, including finfishing and shellfishing; (8) Any applicable requirements of an approved Coastal Zone Management plan; (9) Such other factors relating to the effects of the discharge as may be appropriate; (10) Marine water quality criteria developed pursuant to section 304(a)(1) of the CWA. 40 CFR 125.122(a).

their Section 303(d) list. The TMDL program provides an assessment and planning framework for identifying load reductions or other actions needed to attain water quality standards. A TMDL must account for all sources of the pollutant(s) that caused the water body to be listed (including both point and nonpoint sources), and must include a margin of safety to ensure that the water body can satisfy its designated beneficial uses. For each TMDL developed, the RWQCB develops an implementation or water quality control plan for each water body and associated pollutant on the list. The TMDL and the implementation plan serve as the means to attain and maintain water quality standards for the impaired water body.

Water bodies on the Channel Islands have not been listed as impaired on California's 303(d) list, so TMDLs are not required, but several mainland water bodies that discharge into the Santa Barbara Channel have been listed and therefore TMDLs have or will be developed for these water bodies, including the Santa Clara River, the Ventura River, Calleguas Creek, and several coastal beaches.

6.1.2 California State Programs

The SWRCB has the primary responsibility to protect California's coastal and ocean water quality pursuant to the Porter-Cologne Water Quality Control Act (Water Code, Division 7). Porter-Cologne requires that the quality of State waters shall be protected and that all activities and factors affecting the quality of water be regulated to attain the highest possible water quality. Porter-Cologne has provisions for enforcing water quality standards through issuance of Waste Discharge Requirements (WDRs), waivers of WDRs, and Basin Plan prohibitions (see below). All dischargers of waste that can affect water quality, including both point and nonpoint sources, are subject to regulation under Porter-Cologne via one of these administrative tools. The SWRCB has been delegated authority by the USEPA to administer the NPDES program for discharges in State waters. The Regional Water Quality Control Boards (RWQCBs) issue both State WDRs and NPDES permits to individual dischargers, subject to the approval of the SWRCB and USEPA.

The SWRCB has established regulations to implement Porter-Cologne through water quality control plans, including the California Ocean Plan, Regional Water Quality Control Plans (also known as Basin Plans), and the Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan). Both the Ocean and Basin Plans identify beneficial uses within the area being addressed and lay out numerical and narrative objectives for waste discharges, as well as implementation procedures for achieving these objectives.

Ocean Plan

The California Ocean Plan establishes water quality objectives for California’s ocean waters and provides the basis for regulation of wastes discharged into the State’s coastal waters. It applies to point and nonpoint source discharges to the ocean, with the exception of vessel wastes or dredged material. The SWRCB adopts (and updates every three years) the Ocean Plan, and both the SWRCB and the six coastal RWQCBs implement the Ocean Plan. The Plan identifies the applicable beneficial uses of marine waters, including preservation and enhancement of designated Areas of Special Biological Significance (ASBS), rare and endangered species, marine habitat, fish migration, fish spawning, shellfish harvesting, recreation, commercial and sport fishing, mariculture, industrial water supply, aesthetic enjoyment, and navigation. It establishes a set of narrative and numerical water quality objectives to protect beneficial uses. These objectives are based on bacterial, physical, chemical, and biological characteristics as well as radioactivity. A summary of the Ocean Plan water quality objectives is provided in Section 5.1 of this report. The Ocean Plan also lays out the procedures by which ASBS should be designated.

Marine Managed Areas

Since 1983, the Ocean Plan has prohibited waste discharges to ASBS. Similar to previous versions of the Ocean Plan, the 2005 Ocean Plan states: "Waste shall not be discharged to areas designated as being of special biological significance. Discharges shall be located a sufficient distance from such designated areas to assure maintenance of natural water quality conditions in these areas." The concept of "special biological significance" recognizes that certain biological communities, because of their value or fragility, deserve very special protection that consists of preservation and maintenance of natural water quality conditions.

An ASBS, now known as a State Water Quality Protection Area (SWQPA),[14] is "a nonterrestrial marine or estuarine area 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 that have been designated by the SWRCB through its water quality control planning process." The SWRCB has primary management authority within SWQPAs. Point source waste and thermal discharges are prohibited or limited by special conditions, and nonpoint source pollution is to be controlled to the extent practicable (Public Resources Code Sec. 36710(f)).

As noted above, the California Ocean Plan prohibits the discharge of waste into SWQPAs. Despite this prohibition, numerous discharges do exist, and therefore in 2006 the SWRCB began developing Special Protections to address storm water and nonpoint source discharges into ASBS', which are intended to require the removal of waste materials from runoff to the extent that: 1) natural water quality in the ASBS is not altered, and 2) marine life in the ASBS is protected.

San Miguel, Santa Rosa and Santa Cruz Islands comprise ASBS No.17; Anacapa and Santa Barbara Islands comprise ASBS No. 22. They are thus afforded the protections assigned to ASBS.[15]

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[14] An ASBS, or SWQPA, is one of several types of managed areas in California. Prior to 2000, the State had 18 different classifications for ocean and coastal managed areas. To help streamline and improve the management of these areas, the State enacted the Marine Managed Areas Improvement Act of 2000 to reorganize these areas into a logical and simplified system of six classifications (State Marine Reserves, State Marine Parks, State Marine Conservation Areas, State Marine Cultural Preservation Areas, State Marine Recreational Management Areas, and State Water Quality Protection Areas) and to set clear criteria for creating, administering and enforcing management measures in these areas. See Public Resources Code Sec. 36600 et seq.

[15] These ASBS include waters surrounding the Islands to a distance of one nautical mile offshore or to the 300-foot isobath, whichever is the greatest distance.

Thermal Plan

The Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California, also known as the Thermal Plan, prohibits the discharge of elevated temperature waste into interstate waters. A summary of the Thermal Plan requirements is provided in Section 5.2 of this report.

Anti-Degradation Policy

A key policy of California's water quality program is the State's Anti-degradation Policy, which restricts degradation of surface and ground waters. It protects water bodies where existing quality is higher than necessary for the protection of beneficial uses. Under the Policy, any actions that can adversely affect water quality in all surface and ground waters must: 1) be consistent with maximum benefit to the people of the State; 2) not unreasonably affect present and anticipated beneficial use of the water; and 3) not result in water quality less than that prescribed in water quality plans and policies. Any actions that can adversely affect surface waters are also subject to the Federal Antidegradation Policy (40 CFR 131.12) under the CWA.

Basin Plans

Water Quality Control Plans, also known as Basin Plans, identify existing and potential beneficial uses of surface waters, establish numerical and narrative water quality objectives that must be met to protect designated beneficial uses and conform with the State's anti-degradation policy, and outline implementation, surveillance and monitoring plans to protect waters covered by the Basin Plan. Basin Plans include enforceable prohibitions against certain types of discharges. These objectives and prohibitions are summarized in Section 5.3 of this report.

Regions 3 (Central Coast) and 4 (Los Angeles) encompass the watersheds nearest to the CINMS, and their RWQCBs share jurisdiction over the Channel Islands (Region 3 includes San Miguel, Santa Rosa and Santa Cruz Islands, while Region 4 includes Anacapa, San Nicolas, Santa Barbara, Santa Catalina and San Clemente Islands).

Waste Discharge Requirements

The RWQCBs have the primary responsibility for issuing WDRs. They may issue individual WDRs to cover individual discharges, or general WDRs to cover a category of discharges. WDRs can prohibit the discharge of waste or certain types of waste, or may include effluent limitations or other requirements designed to implement applicable water quality control plans. As with a Basin Plan prohibition, a WDR may specify certain conditions under which, or areas where, the discharge of waste or certain types of waste is prohibited.

Waivers of WDRs

A RWQCB may waive the requirement to issue a WDR for a specific discharge or type of discharge if it determines, after a public meeting, that the waiver is consistent with applicable State or regional water quality control plans and is in the public interest. All waivers are conditional and can be terminated at any time. Except for waivers for discharges that the SWRCB or RWQCB determine do not pose a significant threat to water quality, waiver conditions must include individual, group or watershed-based monitoring (Water Code Sec. 13269).

6.1.3 Storm Water

The 1987 Amendments to the CWA added Section 402(p), which required urban storm water outfall systems to be considered point sources, and called on EPA to establish phased NPDES permit requirements for storm water discharges. Pursuant to the 1987 CWA amendments, EPA developed Phase I of the NPDES Storm Water Program in 1990. The Phase I program addressed sources of storm water runoff that had the greatest potential to negatively impact water quality by requiring NPDES permit coverage for storm water discharges from medium and large municipal separate storm sewer systems (MS4s) located in incorporated places or counties with populations of 100,000 or more, and from eleven categories of industrial activity, including construction activity that disturbs five or more acres of land.

The Phase II regulations, promulgated in December 1999, expanded the scope of the NPDES storm water program to include smaller municipalities serving populations of less than 100,000, as well as construction activities that disturb between one and five acres.

Construction Storm Water Runoff

The SWRCB adopted a statewide General Storm Water Permit for Discharges Associated with Construction Activities (General Construction Permit) in 1992. The permit is reissued every five years; the last time it was reissued was in 2009.

The current General Construction Permit (Water Quality Order 2009-0009-DWQ) requires entities undertaking construction activity that will disturb one acre or more to develop and implement a Storm Water Pollution Prevention Plan (SWPPP) which specifies Best Management Practices (BMPs) that will prevent all construction pollutants from coming into contact with storm water and will keep all products of erosion from moving off site into receiving waters; eliminate or reduce non-storm water discharges to storm sewer systems and other waters of the US; and perform inspections of all BMPs.

All dischargers are required to prepare and implement a SWPPP prior to disturbing a construction site. The SWPPP has two major objectives: to help identify the sources of sediment and other pollutants that affect the quality of storm water discharges; and to describe and ensure the implementation of BMPs to reduce or eliminate sediment and other pollutants in storm water as well as non-storm water discharges. The SWPPP must include BMPs which address source control and, if necessary, must also include BMPs which address pollutant control.[16]

Another major feature of the General Construction Permit is the development and implementation of a monitoring program. All dischargers are required to conduct inspections of

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[16] A SWPPP must contain a site map(s) which shows the construction site perimeter, existing and proposed buildings, lots, roadways, storm water collection and discharge points, general topography both before and after construction, and drainage patterns across the project. The SWPPP must list BMPs the discharger will use to protect storm water runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for "non-visible" pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment.

the construction site prior to anticipated storm events and after actual storm events. During extended storm events, inspections must be made during each 24-hour period. The goals of these inspections are to identify areas contributing to a storm water discharge; to evaluate whether measures to reduce pollutant loadings identified in the SWPPP are adequate and properly installed and functioning in accordance with the terms of the General Permit; and to allow a determination of whether additional control practices or corrective maintenance activities are needed.

The 2009 permit differs from the previous 1999 permit in the following significant ways:

- It includes technology-based Numeric Action Levels (NALs) for pH and turbidity.

- It includes technology-based Numeric Effluent Limitations (NELs) for pH during any construction phase where there is a high risk of pH discharge and turbidity for all discharges.

- It employs a Risk-based Permitting Approach, laying out calculations for three levels of risk associated with a particular construction site that is subject to the permit. Risk is calculated based on project sediment risk and receiving water risk.

- It provides an option for small construction sites (1-5 acres) to certify to the SWRCB that the "rainfall erosivity" value ("R value") for their project's location and time frame (generally quite short) is less than or equal to 5. This allows a waiver from permit coverage for such projects, consistent with EPA's storm water Phase II Final Rule.

- It specifies more minimum BMPs and requirements that were previously only required as elements of the SWPPP or were suggested by guidance.

- It provides the option for dischargers to monitor and report the soil characteristics at the project location in order to provide better risk determination and eventually better program evaluation.

- It requires effluent monitoring and reporting for pH and turbidity in storm water discharges in order to determine compliance with the NELs and evaluate whether NALs are exceeded.

- It requires some Risk Level 3 dischargers to monitor receiving waters and conduct bioassessments.

- It specifies runoff reduction requirements for all sites not covered by a Phase I or Phase II MS4 NPDES permit, to avoid, minimize and/or mitigate post-construction storm water runoff impacts.

- It requires sites to develop and implement a Rain Event Action Plan designed to protect all exposed portions of the site within 48 hours prior to any likely precipitation event.

- It requires all projects that are enrolled for more than one continuous three-month period to submit information and annually certify that their site is in compliance with these requirements. The primary purpose of this requirement is to provide information needed for overall program evaluation and public information.

- It requires that key personnel (e.g., SWPPP preparers, inspectors, etc.) have specific training or certifications to ensure their level of knowledge and skills are adequate to ensure their ability to design and evaluate project specifications that will comply with Permit requirements.

- It adds permitting requirements for all linear underground/overhead projects (water lines, cable lines, etc.). These previously had been permitted separately and are now included in the General Construction Permit.

Industrial Storm Water Runoff

The Industrial Storm Water General Permit (General Industrial Permit – Water Quality Order 97-03-DWQ) is an NPDES permit that regulates discharges associated with ten broad categories of industrial activities:

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, and 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. Certain facilities (often referred to as "light industry") where industrial materials, equipment, or activities are exposed to storm water.

The General Industrial Permit generally requires facility operators to: eliminate unauthorized non-storm water discharges; develop and implement a SWPPP; and perform monitoring of storm water discharges and authorized non-storm water discharges[17]. All facilities covered under the

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[17] NPDES Permits for storm water discharges must meet all applicable provisions of Sections 301 and 402 of the CWA, which require control of pollutant discharges using best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT) to prevent and reduce pollutants and any more stringent controls necessary to meet water quality standards. US EPA regulations (40 CFR Subchapter N) establish effluent limitation guidelines for storm water discharges from facilities in these ten industrial categories; for these facilities,

General Industrial Permit are required to implement BMPs to prevent the discharge of polluted storm water from the site. The Permit requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT). The SWPPP has two major objectives: to help identify the sources of pollution that affect the quality of industrial storm water discharges and authorized non-storm water discharges; and to describe and ensure the implementation of BMPs to reduce or prevent pollutants in industrial storm water discharges and authorized non-storm water discharges.[18]

The General Industrial Permit also requires development and implementation of a monitoring program. The objectives of the monitoring program are to demonstrate compliance with the Permit, aid in the implementation of the SWPPP, and measure the effectiveness of the BMPs in reducing or preventing pollutants in storm water discharges and authorized non-storm water discharges.

Permit holders are required to sample their storm water runoff during a minimum of two storm events each rainy season. Samples must be analyzed for pH, Total Suspended Solids, total organic carbon (TOC), specific conductance, toxic chemicals, and other pollutants which are likely to be present in storm water discharges in significant quantities, and additional parameters listed in the US EPA Multi-Sector General Permit. All facility operators are required to perform visual observations of storm water discharges and authorized non-storm water discharges throughout the rainy season. The monitoring and sampling results are recorded in an annual report which is submitted to the SWRCB by July 1 of each year.

The SWRCB has been in the process of reissuing the General Industrial Permit for several years. Major differences between the most recent proposed draft and the existing 1997 permit include minimum BMPs that all dischargers must include in their SWPPPs; additional sampling requirements for indicator parameters; corrective actions required when exceedances of US EPA storm water numeric benchmark values occur; and a one-time comprehensive pollutant scan. The industrial permit reissuance is on hold until the reissued General Construction Permit is adopted.

Municipal Storm Water Runoff

Congress amended the CWA in 1987 mandating the US EPA to regulate storm water discharges under the NPDES program. In 1990, EPA promulgated regulations that required operators of large municipal separate storm sewer systems (MS4s) (as well as certain types of industrial sites and construction sites disturbing five or more acres) to obtain permits governing storm water discharges. These regulations are known as the Phase I storm water permit regulations.

Under Phase I, the RWQCBs have adopted NPDES storm water permits for medium (serving between 100,000 and 250,000 people) and large (serving 250,000 people or more) municipalities. The most significant requirement of the permit was the development of storm

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compliance with the effluent limitation guidelines constitutes compliance with BAT and BCT for the specified pollutants and must be met to comply with the General Permit. Ibid.

[18] An Industrial Stormwater Permit SWPPP must contain the following elements: 1) site map; 2) list of significant materials handled and stored onsite; 3) description of potential pollutant sources; 4) assessment of potential pollutant sources; 5) stormwater BMPs; and 6) annual comprehensive site compliance evaluations.

water management programs that would meet the standard of "reducing pollutants to the Maximum Extent Practicable (MEP)." Storm water management programs for medium and large MS4s included measures to identify major outfalls and pollutant loadings; detect and eliminate non-storm water discharges to the system; reduce pollutants in runoff from industrial, commercial, and residential areas; and control storm water discharges from new development and redevelopment areas.[19]

In 1999, EPA promulgated the Phase II regulations, requiring permits for storm water discharges from smaller MS4s (serving populations over 50,000) as well as from construction sites disturbing between one and five acres. These regulations require California's SWRCB to issue NDPES storm water permits to these categories of dischargers in the State. The SWRCB therefore adopted a General Permit for the Discharge of Storm Water from Small MS4s (Water Quality Order No. 2003-0005-DWQ) to provide permit coverage for smaller municipalities, including non-traditional Small MS4s, which include governmental facilities such as military bases, public campuses, and prison and hospital complexes.

The MS4 permit requires municipalities to develop and implement a Storm Water Management Plan/Program (SWMP) with the goal of reducing the discharge of pollutants to the MEP. MEP is the performance standard specified in Section 402(p) of the CWA. The SWMPs specify what BMPs will be used to address the following program areas: public education and outreach; public participation; illicit discharge detection and elimination; construction and post-construction runoff control; and good housekeeping for municipal operations. In general, medium and large municipalities are required to conduct chemical monitoring, though small municipalities are not.

The Phase II Small MS4 permit expired on May 1, 2008, and the SWRCB is in the process of drafting an updated permit. The existing permit will remain in effect until the new permit is issued. The updated permit is likely to include additional requirements in the areas of water quality monitoring, industrial/commercial facility inspections, program effectiveness assessment, and Low Impact Development/hydromodification management. The SWRCB expects to release a preliminary draft of the permit for public comment in late 2010.

The California Coastal Commission’s Model Urban Runoff Program (MURP) is a “how-to” guide for local governments to address the issues of polluted runoff in the urban environment. The program consists of a manual and associated workshops that will help small municipalities develop, finance, implement, and enforce a comprehensive program for managing storm water pollution and improving water quality.

6.2 Vessels

6.2.1 MARPOL

The International Maritime Organization (IMO) is a United Nations organization charged with regulating international commercial shipping activities. The International Convention on the

[19] US EPA, Permit Application Requirements for Medium and Large MS4s, http://cfpub.epa.gov/npdes/stormwater/lgpermit.cfm.

Prevention of Pollution from Ships, drafted in 1973 and modified in 1978 (MARPOL 73/78), is an international treaty comprised of six annexes that regulate various types of discharges from ships into the marine environment.

Annex I establishes regulations for the prevention of pollution by oil by limiting operational discharges of oil and phases in requirements for new oil tankers to be double-hulled.

Annex II details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk. Some 250 substances were evaluated and included in the list appended to the Convention. The discharge of their residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with. Annex II also prohibits the discharge of residues containing noxious substances within 12 miles of the nearest land.

Annex III establishes regulations for the prevention of pollution by harmful substances carried by sea in packaged form, with detailed standards on packing, marking, labeling, documentation, stowage, quantity limitations, exceptions and notifications for shipping of harmful substances.

Annex IV establishes regulations for the prevention of pollution by sewage from ships. It is an optional Annex - not all Parties to MARPOL are required to sign it. A revised Annex IV entered into force in August 2005 and applies to new ships engaged in international voyages of 400 gross tonnage or more or which are certified to carry more than 15 people. Existing ships must comply by August 2010. The revised Annex requires ships to be equipped with either a sewage treatment plant, a sewage comminuting and disinfecting system, or a sewage holding tank. The Annex prohibits the discharge of vessel sewage into the sea within three nm of shore. Discharges between 3-12 nm must be comminuted and disinfected using an approved sewage treatment system. Beyond twelve miles no treatment is required, but in all cases sewage stored in holding tanks cannot be discharged instantaneously but at a moderate rate when the ship is en route and proceeding at not less than four knots.

Annex V establishes regulations for the prevention of pollution by garbage from ships by establishing volumes and distances from land for garbage discard, and bans dumping into the sea of all forms of plastic.

Annex VI establishes regulations for the prevention of air pollution from ships by limiting sulfur oxide and nitrogen oxide emissions from ship exhausts, prohibits deliberate emissions of ozone depleting compounds, and establishes requirements for platforms and drilling rigs at sea.

The US has ratified Annexes I, II, III, and V of MARPOL 73/78, which establishes those annexes as law for US-flagged ships and enforcement responsibility for the USCG in US waters.

6.2.2 Act to Prevent Pollution from Ships

In the US, the Act to Prevent Pollution from Ships, or APPS (33 US Code Sec. 1901-1912), implements the provisions of MARPOL and the annexes to which the US is a party. APPS applies to all US-flagged ships anywhere in the world and to all foreign-flagged vessels operating in navigable waters of the US or while in port under US jurisdiction. The USCG has primary responsibility to prescribe and enforce regulations necessary to implement APPS in these waters. APPS requirements limit discharges of oil and noxious substances from seagoing vessels (including cruise ships), establish reporting requirements for discharges, and establish specific requirements for monitoring equipment and record-keeping aboard vessels. Vessels subject to APPS must record all discharges, disposal and transfers of oil in Oil Record Books, which are subject to USCG inspection.

In 1987, APPS was amended by the Marine Plastic Pollution Research and Control Act (33 US Code Sec. 1901 et seq), which implements the provisions of Annex V of MARPOL relating to garbage and plastics. It applies to all vessels (seagoing or not and regardless of flag) operating on US navigable waters and within the US EEZ, and applies to US-flagged vessels wherever they are operating. The implementing regulations prohibit the discharge of plastics, including synthetic ropes, fishing nets, plastic bags and biodegradable plastics. Discharges of floating dunnage, lining and packing materials are prohibited in navigable waters and waters less than 25 nm from shore. Other garbage, including paper products, rags, glass, metal, bottles, crockery, and food waste, may not be discharged into navigable waters or waters within 12 nm from shore unless it is macerated into pieces of less than one inch. However, even macerated wastes cannot be discharged within three miles of land (33 CFR 151 et seq).

Under APPS, the definition of a ship includes fixed or floating platforms. However, there are separate garbage discharge provisions applicable to these units. For these platforms, and for any ship within 500 meters of these platforms, disposal of all types of garbage is prohibited. Additionally, all manned, oceangoing US-flagged vessels of 12.2 meters or more in length that are engaged in commerce, as well as all manned fixed or floating platforms subject to US jurisdiction, are required to keep records of discharges, disposals and incineration of garbage in a Garbage Record Book (33 CFR 151 et seq).

6.2.3 Oil Pollution Act

The Oil Pollution Act (33 US Code Sec. 2701-2761) amended the CWA in 1990 to prohibit the discharge of oil or hazardous substances, in such quantities as may be harmful, into or upon US navigable waters, adjoining shorelines, or into or upon the waters of the contiguous zone or which may affect natural resources in the US EEZ. The Act's implementing regulations prohibit the discharge of oil within 12 miles of shore unless it is passed through an oil-water separator and does not cause a visible sheen or exceed 15 parts per million (ppm). Beyond 12 miles, oil or oily mixture can be discharged while proceeding en route and if the oil content of the effluent without dilution is less than 100 ppm (33 CFR 151.10). Vessels are required to maintain an Oil Record Book, which must, among others, record the disposal of oily residues and the discharge overboard or disposal of bilge water (33 CFR 151.25). The Act makes vessel owners/operators liable for clean-up costs and damages for oil spills, and requires vessels and oil storage facilities to submit plans for how they will respond to large spills to the federal government. This law explicitly states that it does not pre-empt State laws regarding oil spills.

6.2.4 Shore Protection Act

The Shore Protection Act (33 US Code Sec. 2601-2623) was enacted in 1988 to minimize trash, medical debris, and other potentially harmful materials from being deposited in US coastal waters as a result of inadequate waste handling procedures by vessels transporting wastes on US coastal waters and associated loading and off-loading facilities. US EPA is responsible for developing regulations governing the handling of wastes, and the Department of Transportation is responsible for issuing permits and enforcing the regulations. The Act outlines waste handling practices for vessels and waste transfer stations.

6.2.5 US EPA Vessel General Permit

In late 2008, the US EPA adopted a Vessel General Permit (73 Federal Register 249), requiring all non-recreational vessels 79 feet in length or longer, with the exception of fishing vessels (unless they discharge ballast water), to comply with the USCG's mandatory ballast water management and exchange standards, as well as technology-based and water-quality-based effluent limits for 26 other types of vessel discharges, including deck runoff, graywater, bilge water, ballast water, anti-fouling leachate from anti-fouling hull coatings, and others. The permit establishes effluent limits pertaining to the constituents found in these effluent types, including BMPs designed to decrease the amount of constituents entering the waste stream.

6.2.6 Clean Water Act Section 312

While sewage is defined as a pollutant under the CWA, sewage from vessels is exempt from this definition (33 US Code Sec. 1362(6)), and is therefore also exempt from the requirement to obtain an NPDES permit (40 CFR 122.3(a)). CWA Section 312 (33 US Code 1322) seeks to address this gap by prohibiting the dumping of untreated or inadequately treated sewage into the navigable waters of the US (within three miles of shore). Beyond the three-mile limit, raw sewage can be dumped into the ocean. Section 312 requires all commercial and recreational vessels with installed toilets to have a USCG-approved marine sanitation device (MSD) to treat sewage.

There are three types of MSDs used to meet different needs and effluent level requirements. The three MSD types and their associated effluent limits are outlined in Section 5.6.1 of this report. Section 312 of the CWA also allows for the establishment of No Discharge Zones (NDZs) for vessel sewage. US EPA can issue regulations as such if a State certifies that the waters in the proposed NDZ contain environmentally sensitive areas in need of additional protection or if the waters are used as a source of drinking water. One of the factors EPA takes into consideration when establishing a NDZ is whether there are safe and adequate pump-out facilities for shoreside disposal of vessel sewage in the vicinity.

The California Harbors and Navigation Code (Sec. 72400-72442) requires vessel terminals to have sewage pumpout facilities, and prohibits the disabling of MSDs on vessels in transit from one state to another.

6.2.7 Large Vessel and Cruise Ship Discharge Regulations

As a result of several bills passed by the California legislature in recent years, cruise ships are prohibited from discharging graywater, sewage (treated or untreated), oily bilge water and hazardous waste into California State waters. Cruise ships are also prohibited from burning garbage, paper, sewage sludge and other materials in onboard incinerators while operating in State waters. The California Clean Coast Act of 2005 (Public Resources Code Sec. 72400-72442), which entered into force on January 1, 2006, extends the existing bans on cruise ship wastewater discharges and incineration to all commercial ocean-going vessels, including container and cargo ships that call on California ports. The Act prohibits large passenger vessels and other ocean-going ships (of 300 gross registered tons or more) from discharging hazardous waste, oily bilgewater, photo lab chemicals, dry cleaning chemicals and medical waste into State waters. It further requires the State to request federal approval to prohibit the discharge of sewage (treated and untreated) and sewage sludge from oceangoing and large passenger vessels into State and federal Sanctuary waters, and to prohibit the discharge of the other prohibited wastes into California's four national marine sanctuaries. Any such discharges that do occur must be reported to the SWRCB within 24 hours, and are subject to $25,000 in civil penalties. Finally, the Act requires the California State Lands Commission to collect information on vessels calling on California ports regarding their vessel-specific wastewater management capabilities, port of call information, and crew requirements.

The City of Santa Barbara requires that cruise ships that call on Santa Barbara commit to no dumping of sewage or graywater within 12 nm of the Santa Barbara coast.

6.2.8 California Harbors and Navigation Code

The California Harbors and Navigation Code (Sec. 111) prohibits the sale and use of TBT-based marine antifouling paint or coating in California. Section 133 prohibits the discharge of oil into navigable State waters.

6.2.9 Santa Barbara Clean Marina Program

In June 2002, the Santa Barbara City Council adopted the Clean Water Program, later renamed the Clean Marina Program, in order to achieve and maintain, via feasible means and alternatives, a clean harbor environment for people, aquatic life and seabirds. The Clean Marina Program requires annual review by the Harbor Commission.

6.2.10 Boating Clean and Green Campaign

The Boating Clean and Green Campaign is an education and outreach program that promotes environmentally sound boating practices to marine business and boaters in California. The program is administered by the California Coastal Commission and the California Department of Boating and Waterways. Launched in April 1997, the Campaign conducts boater education throughout the State in partnership with many public and private agencies that share a concern about educating boaters about environmentally sound boating practices.

6.2.11 Santa Barbara Waterfront

The Central Coast RWQCB has required the City of Santa Barbara to include a prohibition in its Storm Water Management Program against discharges of wash water containing soaps and disinfectants. As a result, the Santa Barbara Waterfront Department's Marina Rules and Regulations and Business Activity Permits require boaters to use biodegradable soaps for boat washing. The regulatory authority for this requirement is codified in the General Industrial Storm Water Permit, which prohibits non-storm water discharges that contain significant quantities of pollutants.

6.2.12 Vessel Pumpout Program

In 1992, Congress passed the Clean Vessel Act to help reduce pollution from vessel sewage discharges into US waters. The Act established a grant program to help fund the construction, renovation, operation, and maintenance of pumpout and dump stations to service pleasure craft. The Department of Boating and Waterways serves as the State coordinator for the grant program, and also provides boater education programs to promote public awareness about boat sewage and its proper disposal. Three head pumpout stations are available to the public within Santa Barbara Harbor, in addition to facilities for pumping contaminated bilge water at the fuel dock.

6.2.13 Marine Protection, Research, and Sanctuaries Act

In 1972, Congress enacted the Marine Protection, Research, and Sanctuaries Act (MPRSA, 33 US Code Sec. 1401) to prohibit the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. MPRSA was amended by the Ocean Dumping Ban Act (Public Law 100-688) in 1988. The Act makes it illegal to transport garbage from the US for the purpose of dumping it into ocean waters, and to dump any garbage transported from a location outside the US into US territorial seas or the contiguous zone (12 miles from shore). The dumping of sewage sludge, industrial waste, radiological, chemical and biological warfare agents, high-level radioactive waste and medical waste into the ocean are all prohibited under MPRSA. Routine discharges of effluent incidental to the propulsion of vessels are excluded from the definition of dumping. Ocean dumping cannot occur unless a permit is issued under MPRSA. In the case of dredged material, the decision to issue a permit is made by the US Army Corps of Engineers, using EPA's environmental criteria and subject to EPA's concurrence. For all other materials, EPA is the permitting agency. EPA is also responsible for designating recommended ocean dumping sites for all types of materials.

MPRSA also established the National Marine Sanctuary Program to identify, designate and manage marine environmental areas with nationally significant aesthetic, ecological, historical or recreational values as National Marine Sanctuaries. As amended in 1988, MPRSA has provisions for compensation for the destruction or loss of sanctuary resources, including vessel liability provisions, which apply to oil spills, groundings, or other actions that damage marine sanctuary resources. Management plans prepared by NOAA for each sanctuary may address pollutant streams from vessels such as cruise ships that operate within that particular sanctuary.

MPRSA underwent significant amendments again in 1992. It was renamed the National Marine Sanctuaries Act (NMSA) and, most importantly, new language was added on prohibited activities, making it explicitly unlawful to injure or destroy sanctuary resources that are managed under law or regulations for that sanctuary; violate any provision of the NMSA or regulations issued pursuant to it; possess any sanctuary resources taken illegally; or interfere with the enforcement of the NMSA.

6.2.14 CINMS Regulations

CINMS regulations prohibit cargo vessels (including but not limited to tankers and other bulk carriers and barges) and vessels engaged in the trade of servicing offshore installations from operating within one nautical mile of the Channel Islands. As part of the recent CINMS Management Plan review, this regulation was revised to extend the prohibition against nearshore (within one nm) operation of vessels to any vessel of 300 registered gross tons or more (such as cruise ships) (CINMS 2009).

Additionally, CINMS regulations, as revised in the 2009 Management Plan, prohibit discharging or depositing any material or other matter except: fish or fish parts and chumming materials (bait) used in or resulting from lawful fishing activity within the Sanctuary, provided that such discharge or deposit is during the conduct of lawful fishing activity within the Sanctuary; biodegradable matter from vessel deck wash down and engine cooling water, as well as graywater and effluent from MSDs from vessels less than 300 gross registered tons; vessel engine or generator exhaust; and effluent incidental to hydrocarbon exploration and exploitation activities otherwise allowed by CINMS regulations. An exception to the large vessel sewage and graywater discharge prohibitions is provided for oceangoing ships without sufficient holding tank capacity to hold these waste streams while in Sanctuary waters. The discharge prohibition also prohibits discharges and deposits of any material or other matter from beyond the boundary of the Sanctuary that subsequently enters the Sanctuary and injures a Sanctuary resource or quality (CINMS 2009).

Also as part of the recent CINMS Management Plan Review, the Sanctuary adopted a Water Quality Action Plan, which includes two strategies: Offshore Water Quality Monitoring and Water Quality Protection Planning. The Offshore Water Quality Monitoring strategy aims to better evaluate and understand localized and large-scale spatial and temporal impacts from oceanographic and climatic changes and impacts from increases in human population in the coastal zone and subsequent pressure(s) on offshore marine resources. Activities the CINMS will undertake to implement this strategy include continued support for the Plumes and Blooms study and an assessment of the management implications of the study's results; and continued support for the Southern California Bight Regional Monitoring Surveys. The objective of the Water Quality Protection Planning strategy is to protect the chemical, physical and biological integrity of the Sanctuary by restoring and maintaining water quality. Activities the CINMS will undertake to implement this strategy include: 1) compiling and synthesizing information on jurisdictional water quality authorities and responsibilities; 2) reviewing State and regional water quality management; and 3) developing and proposing priority corrective actions for managing Sanctuary water quality impacts.

6.3 Oil and Gas Facilities

6.3.1 Submerged Lands Act

Pursuant to the federal Submerged Lands Act, submerged land three nautical miles from the coast and its resources belong to the coastal state. These areas are waters of the State and are referred to as the marginal or territorial sea. Some areas outside the marginal sea are also considered State waters. For example, the Channel Islands present a special case as California courts have considered the area three miles surrounding these offshore islands as part of California State waters.

6.3.2 Outer Continental Shelf Lands Act

Beyond the State's jurisdition, the federal government exercises control under the Outer Continental Shelf Lands Act (OCSLA). The OCSLA authorizes the Secretary of Interior to lease federal offshore lands for mineral exploration, development and production with some coastal state involvement. OCSLA allows the federal Bureau of Land Management within the Department of Interior to lease these lands for offshore oil and gas development, with post-lease exploration and development managed by the federal Minerals Management Service (MMS), an agency within the Department of the Interior.

MMS is responsible for managing the nation's natural gas, oil and other mineral resources on the outer continental shelf (OCS), including ensuring that oil and gas development operations comply with the Oil Pollution Act, Clean Water Act and other relevant environmental laws. The agency also collects, accounts for and disburses more than $8 billion per year in revenues from federal offshore mineral leases and from onshore mineral leases on federal and Indian lands. MMS has two environmental programs to further the understanding and protection of the marine and coastal environments: the Environmental Studies Program, which includes planning and managing a large environmental studies program; and the Environmental Analysis Program, which conducts environmental reviews and analyses of proposed industry projects and ensures compliance with environmental conditions of project approvals.

As part of its Environmental Analysis Program, the MMS implements an Environmental Compliance Monitoring Program to ensure industry conformity with environmental laws, regulations, lease stipulations, and project mitigations. The Pacific OCS Region currently employs a three-tiered environmental compliance monitoring program that includes a MMS Regional and District Office field presence, industry responsibility and environmental monitoring studies. The Pacific Region has an extensive inspection program to ensure safe and environmentally sound offshore oil and gas operations. Through this program, MMS inspectors visit offshore drilling rigs and production platforms on a daily basis to check operator compliance with safety and environmental protection requirements. In the 1990s, the Pacific Region instituted an Environmental Liaison Program; under this program, MMS Environmental Scientists work with MMS District Inspectors to enhance the inspection program. The Environmental Liaison's field inspections are primarily related to monitoring compliance and effectiveness of environmental protection mitigation measures placed on projects during the NEPA review, while District Inspectors are primarily engaged in ensuring regulatory compliance. The Environmental Liaisons additionally assist other agencies with offshore inspections and field observations as appropriate.

6.3.3 EPA NPDES Permit for Offshore Oil and Gas Facilities

In 2004, the US EPA adopted a NDPES General Permit for Offshore Oil and Gas Facilities in the Southern California OCS (Permit No. CAG280000), which establishes effluent limitations, prohibitions and other conditions for discharges from the 22 existing oil and gas platforms as well as from any new exploratory drilling operations to be undertaken in Pacific OCS leases off of southern California. This permit is currently being revised by US EPA to include additional effluent limitations and monitoring requirements for those discharges for which studies undertaken pursuant to the existing permit showed a reasonable potential to cause or contribute to exceedances of marine water quality criteria (produced water, cooling water and fire control system test water). For produced water discharges, EPA is also proposing to use a different water quality criterion undissociated sulfide from the one in the existing permit based on the results of a new study concerning the toxicity of undissociated sulfide to marine organisms.

Platform discharges are prohibited in State waters.

6.3.4 Oil and Gas Leasing Moratoria

Beginning in 1981 and renewed annually until 2008, Congress created through its annual Interior Appropriations bill a federal moratorium on new oil and gas production and development leases in federal waters off the California coast. The moratorium was extended by an executive directive during the Clinton administration until mid-2012. The federal moratorium was rescinded by presidential and Congressional action in October 2008 (although the moratorium on exploration in existing national marine sanctuaries was maintained), but in March 2010 President Obama announced a new offshore drilling plan that reinstated the moratorium in federal waters offshore of California.

Pursuant to the California Coastal Sanctuary Act of 1994 (Public Resources Code Sec. 6240 et seq), the sale or lease of any State waters subject to tidal flow (except those areas subject to a lease in effect on January 1, 1995) for the purposes of oil and gas development and production is generally prohibited in California State waters, with the following exceptions:

- A legislative determination that, following a finding of a severe interruption in the supply of energy by the President of the United States, the energy reserves within the sanctuary will contribute significantly toward alleviating such interruption.

- The State Lands Commission determines that oil and gas deposits contained in tidelands are being drained by means of wells upon adjacent federal lands and leasing of the tidelands for oil or gas production is in the best interest of the State.

- The State Lands Commission may adjust the boundaries of existing oil and gas leases to encompass all of a field partially contained within the existing lease subject to specific conditions.

6.3.5 California Harbors and Navigation Code

California's Harbors and Navigation Code prohibits, except in limited circumstances, the discharge of oil from a vessel into navigable waters of the State, and establishes the liability of parties responsible for intentional or negligent discharges for reasonable costs incurred and actual damages suffered by a government agency in abating or cleaning up the discharge. It also establishes the liability of owners or operators of vessels engaged in commercial transportation, storage or transfer of fuel oil or petroleum for property damage and injury to natural resources caused by the discharge or leak of such substances into navigable State waters, without regard to fault. This same liability is established for discharges or leaks of natural gas, oil or drilling waste from offshore wells, facilities, rigs, platforms, vessels or pipelines.

6.3.6 Lempert-Keene-Seastrand Oil Spill Prevention and Response Act

California's Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990 (Government Code Sec. 8670.1 and Public Resources Code Sec. 8750 et seq) created an elaborate framework for the prevention, removal, abatement, response, containment, and cleanup of oil spills in marine waters of the State. It required the Governor to establish a State Oil Spill Contingency Plan that provides for an integrated and effective procedure to combat the results of major oil spills. The plan includes a Marine Oil Spill Contingency Planning Section that provides for the best achievable protection of the coast and marine waters. The Act established an Administrator for Oil Spill Response in the Department of Fish and Game, who is required to adopt regulations regarding marine safety including regulations regarding marine terminals, tugboat escorts for tank ships, and harbor safety plans. The Act also required the Administrator to adopt and implement regulations and guidelines for the development of individual oil spill contingency plans for similar vessels, pipelines, terminals, and facilities within a single company or organization, and across companies and organizations. Finally, the Act provided the California State Lands Commission (CSLC) with specific authority over marine terminals.

The CSLC is tasked with providing the best achievable protection of the marine environment at all the State's 80 marine oil terminals, both offshore and onshore, by stressing the prevention of oil spills. The CSLC has adopted regulations that govern the inspection and monitoring of oil transfer operations; require oil spill prevention training and certification of marine terminal personnel; establish structural standards for vapor control systems; and require the inspection and testing of oil pipelines at marine terminals. The CSLC's Marine Facilities Division (MFD) is tasked with ensuring the safe and pollution-free transfer of crude oil and product between tank vessels and land-based facilities; adopting marine terminal regulations which ensure the best achievable protection of public health, safety and the environment; and coordinating with federal, State and local agencies having similar goals. MFD Marine Terminal Safety Inspectors monitor marine terminal operations on a daily basis. Inspections at fixed and mobile marine oil terminals include the observation and assessment of oil transfers to and from oil tankers and barges, with an emphasis on pollution prevention. MFD inspectors also conduct comprehensive annual inspections at each marine oil terminal, making structural and marine oil pipeline assessments and reviewing operational procedures and training. There are three marine oil terminals in Ventura and Santa Barbara counties: the Venoco Ellwood Terminal in Santa Barbara County; and the Navy Outlying Field terminal (which is on San Nicolas Island with administrative headquarters at Point Mugu), and Tractide Marine Corp. at Port Hueneme in Ventura County.

MFD also has environmental review responsibilities. MFD personnel review proposed research and monitoring projects, lease applications, Natural Resource Damage Assessments, and subsequent Environmental Impact Reports/Statements for environmental impacts to public lands. They design scientific investigations to evaluate the impacts of marine oil spills on natural resources and the impacts of mineral resource extraction and facility construction, operations and abandonment on marine environments. Finally, pursuant to the State's Ballast Water Management for Control of Non-Indigenous Species Act, the CSLC is leading the development of a State General Ballast Water Management Program, which requires vessels entering California waters to manage ballast water according to prescribed measures in order to minimize the introduction of non-native marine species from foreign waters to California (see Section 5.6.3 of this report).

The California Department of Conservation’s Division of Oil, Gas and Geothermal Resources also plays an oversight role in oil and gas development in California. The Division oversees the drilling, operation, maintenance, and plugging and abandonment of oil, natural gas, and geothermal wells. The regulatory program emphasizes the wise development of oil, natural gas, and geothermal resources in the State through sound engineering practices that protect the environment, prevent pollution, and ensure public safety.

6.3.7 California Coastal Act

The California Coastal Commission has permit authority over offshore development in State waters under the California Coastal Act. All oil and gas facilities are subject to the provision that encourages coastal-dependent industry to locate or expand within existing facilities. New facilities are allowed only where alternative sites are infeasible, the new sites do not adversely affect public welfare, and the adverse environmental effects are mitigated to the maximum extent feasible. Detailed standards are laid out in the Coastal Act for oil and gas development. Facilities must use existing sites or consolidate where feasible; hazards to vessel traffic, subsurface subsidence and visual impacts are to be avoided; all oil produced offshore of California must be transported onshore by pipeline only utilizing the best achievable technology; drilling operations must initiate monitoring programs to record land surface and near-shore ocean floor movements where new large-scale fluid extraction operations are undertaken; and abandoned wells must use the best achievable technology for abandonment in order to maximize the protection of marine habitat and environmental quality. Leasing operations in federal waters are also subject to Coastal Commission review for consistency with the California Coastal Act.

6.3.8 CINMS Regulations

CINMS regulations as outlined in the CINMS Management Plan include a prohibition on exploring for, developing or producing hydrocarbons within the Sanctuary except pursuant to leases executed prior to March 30, 1981 and except the laying of pipeline pursuant to exploring for, developing or producing hydrocarbons. The 2009 update of the Management Plan also added a new prohibition against exploring for, developing or producing minerals within the Sanctuary, except producing by-products incidental to authorized hydrocarbon production (CINMS 2009).

6.4 Aquaculture

The California Legislature enacted the Sustainable Oceans Act in 2006, prohibiting a person from engaging in marine finfish aquaculture in State waters without a lease from the California Fish and Game Commission. It requires lessees to provide financial assurances to ensure that restoration is performed, and mandates the preparation of a programmatic EIR to provide a framework for managing marine finfish aquaculture sustainably. The Department of Fish and Game (DFG) is currently undertaking this EIR in cooperation with the Ocean Protection Council to evaluate current aquaculture best management practices. Other regulations governing broodstock acquisition, leasing of State water bottoms, disease control and importation of aquatic plants and animals are laid out in Division 12 of the Fish and Game Code (Sec. 15000-15703).

The State Department of Health Services (DHS) has authority regarding the cultivation of bivalve mollusks (mussels, oysters, clams, scallops) for human consumption. DHS is responsible for ensuring that shellfish grown in marine waters meet a standard of cleanliness, and for approving handling, packaging, and quality standards of the product. To this end, the DHS conducts investigations of shellfish waters and watershed areas, recommends waste discharge requirements to protect shellfish waters, and places restrictions on harvesting operations, such as from areas subject to sewage contamination. DHS establishes standards for ocean discharges for waters used for shellfish cultivation and harvesting (as well as for water contact recreation).

DHS also directs a program to prevent paralytic shellfish poisoning (PSP) caused by an extremely rapid growth of certain toxins in marine water, which then accumulate in filter feeding shellfish (mussels, clams, and oysters) and cause human illness or death. The PSP prevention program includes public information, annual mussel quarantine, and a coastal shellfish monitoring program.

In addition to these state-level efforts to address aquaculture, NOAA launched a revived Aquaculture Program in 2004 in order to integrate and coordinate the agency's aquaculture policies, research, outreach, and international obligations. NOAA's Program addresses coastal and onshore marine shellfish and finfish farming, as well as enhancement (hatchery) activities that support commercial and recreational fishing and the restoration of some endangered species. The goals of the Program are to (1) establish a comprehensive regulatory program for the conduct of marine aquaculture operations; (2) develop appropriate technologies to support commercial marine aquaculture and the enhancement of wild fish and shellfish stocks; (3) conduct education and outreach activities to heighten public awareness of issues related to marine aquaculture; and (4) meet international obligations to promote environmentally sustainable practices for the conduct of marine aquaculture. NOAA's Aquaculture Program is guided by the policy objectives in the National Aquaculture Act of 1980,[20] the US Department of Commerce Aquaculture Policy,[21] and the NOAA Aquaculture Policy.[22, 23] The program is also guided by national fisheries and ocean legislation, including the Magnuson-Stevens Fishery Conservation and Management Act, the Coastal Zone Management Act, the Endangered Species Act, and the Marine Mammal Protection Act.[24] Congresswoman Lois Capps (D-Santa Barbara) also recently introduced a bill, entitled the National Sustainable Offshore Aquaculture Act, which would establish a regulatory framework for aquaculture operations in federal waters.[25]

Finally, the CINMS Advisory Council recently produced a comprehensive report on Open Ocean Aquaculture and the CINMS. The report provides an overview of the potential environmental implications of open ocean finfish aquaculture in the Santa Barbara Channel, surveys the existing

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[20] 16 U.S.C. 2801, *et seq.*, at http://www.nmfs.noaa.gov/sfa/sfweb/aqua_act.htm
[21] http://aquaculture.noaa.gov/pdf/18_docaqpolicy.pdf
[22] http://swr.nmfs.noaa.gov/fmd/bill/aquapol.htm
[23] According to testimony at a September 2009 US House of Representatives Natural Resource Committee hearing on offshore aquaculture by James Balsiger, Acting Assistant Administrator for NOAA Fisheries, NOAA is currently reassessing the existing Department of Commerce and NOAA Aquaculture Policies with the goal of creating a comprehensive framework that facilitates safe and sustainable aquaculture operations in US federal waters.
[24] http://aquaculture.noaa.gov/about/welcome.html#6
[25] http://www.caaquaculture.org/2010/01/19/new-rules-planned-for-fish-farming-in-federal-waters/

regulatory framework for federal management of open ocean aquaculture, and lays out recommendations which emphasize the need for a precautionary approach to open ocean aquaculture in the Santa Barbara Channel.[26]

6.5 Nonpoint Source Pollution

6.5.1 Clean Water Act Nonpoint Source Management Program

The 1987 Amendments to the CWA established the Section 319 Nonpoint Source Management Program, which requires states to develop Assessment Reports that describe their nonpoint source (NPS) pollution problems, establish NPS Management Programs to address these problems, and provide funding to implement the programs.

6.5.2 Coastal Zone Reauthorization Amendments

In 1990 Congress identified NPS pollution as a significant factor contributing to coastal water degradation, noting the link between coastal water quality and land use activities. As a result, Congress amended the Coastal Zone Management Act (CZMA) (16 US Code Sec. 1451 et seq) by passing the Coastal Zone Reauthorization Amendments of 1990 (CZARA). Section 6217 of CZARA required states with approved coastal management programs to develop Coastal Nonpoint Pollution Control Programs to implement management measures to restore and protect coastal waters from adverse impacts of NPS pollution. The USEPA and NOAA jointly administer this program at the federal level, while the California Coastal Commission, SWRCB and six coastal RWQCBs are required to develop and administer it at the State level.

6.5.3 California Nonpoint Source Management Plan

In response to these amendments, the SWRCB adopted California's Nonpoint Source Management Plan in 1988, which outlined a general approach to address persistent NPS problems using education and outreach, financial and technical assistance, and regulatory authorities when necessary. Then, in response to the addition of Section 319 to the CWA as a result of the 1987 CWA amendments as well as CZARA, the SWRCB initiated a comprehensive review of the Plan using technical advisory committees (TACs) for ten categories of NPS pollution.[27] The SWRCB and the Coastal Commission submitted California’s initial CZARA response to USEPA and NOAA in September 1995.

The response included two documents: California’s Coastal Nonpoint Pollution Control Submittal, detailing the State’s existing programs related to NPS pollution management, and the Initiatives in Nonpoint Source Management, based on the recommendations of the TACs. In 1999, the State adopted the Plan for California's Nonpoint Source Pollution Control Program (NPS Program Plan), which focuses and expands the State's efforts for the 15-year period from 1998-2013 to prevent and control NPS pollution (SWRCB 2000).

[26] http://channelislands.noaa.gov/sac/pdf/7-27-07.pdf
[27] Irrigated agriculture, nutrient application, pesticide application, confined animal facilities, grazing, urban runoff, on-site sewage disposal systems, boating and marinas, hydromodification and wetlands, and abandoned mines.

The NPS Program Plan addresses both surface water and groundwater quality. It provides a coordinated approach for dealing with NPS pollution by achieving, by the year 2013, implementation of 61 management measures, which serve as general goals for the control and prevention of polluted runoff. This is being accomplished through land-owner and resource manager implementation of NPS pollution control management practices in six critical land use categories: agriculture; forestry; urban; marinas and recreational boating; hydromodification; and wetlands.

The goals of the NPS Program Plan are as follows:

1. Track, monitor, assess, and report NPS Program activities.
    a. Improve monitoring and assessment of State water quality and the effectiveness of management practices (MPs) that are implemented to prevent and control NPS pollution.
    b. Ensure consistent, accurate reporting and dissemination of information related to water quality and related environmental data, sources of NPS pollutants, and pollution control and prevention activities.

2. Target NPS Program activities.
    a. Manage NPS pollution, where feasible, at the watershed level – including pristine areas and watersheds that contain water bodies on the CWA section 303(d) list – where local stewardship and site-specific MPs can be implemented through comprehensive watershed protection or restoration plans.
    b. Apply previous experiences to future decisions (e.g., through the use of pilot projects and the incorporation of "lessons learned").

3. Coordinate with public and private partners in all aspects of the NPS Program.
    a. Build the NPS Program upon a foundation of public involvement and support and encourage public participation throughout all stages of the NPS Program.
    b. Encourage innovative approaches to NPS pollution control and prevention through interagency, interdisciplinary, and volunteer activities.
    c. Strive to make regulatory, planning, and monitoring processes and programs more effective, efficient, and user-friendly and to coordinate related programs to avoid duplication where possible.

4. Provide financial and technical assistance and education.
    a. Enhance the leadership roles of the SWRCB, RWQCBs, CCC, and other agencies in providing local governments and the public with technical and financial assistance and educational programs related to NPS pollution control, land use management, and watershed management.
    b. Support applied research to expand NPS Program implementation (e.g., development of improved, cost-effective MPs and environmentally friendly products).

5. Implement Management Measures (MMs) and associated MPs.

a. Ensure the protection and restoration of the State's water quality, existing and potential beneficial uses, critical coastal areas, and pristine areas by implementing MMs to prevent and control NPS pollution. All MMs will be implemented, where needed, by 2013. MMs serve as general goals for the control and prevention of polluted runoff. Site-specific MPs are then used to achieve the goals of each MM.
b. Target implementation of MMs using a combination of non-regulatory activities and enforceable policies and mechanisms with self-determined cooperation preferred over prescriptive measures.

Implementation of the NPS Program Plan by the SWRCB, the nine RWQCBs, the California Coastal Commission and the participating NPS Interagency Coordinating Committee was structured on development of three sequential five-year implementation plans.

The Critical Coastal Areas (CCA) Program is part of the State's NPS Plan and is a non-regulatory planning tool to coordinate the efforts of multiple agencies and stakeholders and direct resources to CCAs. The program seeks to ensure that effective NPS management measures are implemented to protect or restore coastal water quality in CCAs. A multi-agency statewide CCA Committee selected initial criteria for identifying CCAs, resulting in the current (2002) list of 101 CCAs along the coast and within San Francisco Bay. The CCA Committee, with public input, will reevaluate the criteria and revise the CCA list periodically. The criteria for identifying CCAs reflect the dual goals of improving degraded water quality and providing extra protection from NPS pollution to marine areas with recognized high resource value. The CCA program relies on existing designations of degraded water quality (e.g., the CWA 303(d) list of impaired and threatened water bodies), and marine or estuarine areas with high resource value (e.g., California Marine Managed Areas, including State Water Quality Protection Areas). In August 2005, the Statewide CCA Committee selected one pilot CCA in each of the four regions of the coast and one within San Francisco Bay. For these five pilot CCAs, the CCA Program is forming teams of local stakeholders and State, federal, and local government agencies to develop community-based NPS Watershed Assessment and Action Plans for addressing polluted runoff that threatens coastal resources within these CCAs. In or near the CINMS, San Miguel, Santa Rosa and Santa Cruz Islands are classified as a CCA (#55), as are Santa Barbara and Anacapa Islands (#56), the Santa Ynez River (#52), Goleta Slough (#53) and Carpinteria Salt Marsh (#54).

6.5.4 Watershed Management Initiative

The Watershed Management Initiative (WMI), approved as part of the SWRCB's 1995 Strategic Plan, is designed to integrate various surface and ground water regulatory and non-regulatory programs while promoting cooperative, collaborative efforts within a watershed. It is also designed to focus limited resources on key issues and use sound science. The WMI employs an integrated approach, using water quality to identify and prioritize water resource problems within individual watersheds, coordinating point source and nonpoint source regulatory efforts, and coordinating local, State and federal activities and programs, especially those relating to regulations and funding, to assist local watershed groups.

WMI chapters have been developed by the SWRCB, each of the nine RWQCBs, and the US EPA, which collectively comprise the WMI "Integrated Plan." The RWQCB chapters delineate watershed management strategies that consider local conditions and pollution sources for their priority watersheds. They also identify priorities, where baseline resources will be spent, and where more resources are needed.

Of relevance to the CINMS, the Central Coast RWQCB (Region 3) has identified the following water quality priorities:

- Agriculture - Addressing water quality impacts from irrigated agriculture, a major land use in the region that has been identified as a potential source of impairment for many of the water bodies on the CWA 303(d) list (constituents of concern include nutrients, pesticides and sediment) by implementing the Conditional Waiver for Irrigated Lands;
- Total Maximum Daily Loads – Developing and implementing TMDLs throughout the region;
- Urban Runoff – Addressing beach closure issues, implementing Phase II of the NPDES Storm Water Program;
- Point Source Regulatory Programs – Streamlining permit writing, renewing major permits and several existing Waste Discharge Requirements, performing inspections;
- Basin Planning – Developing a riparian corridor policy, revising or developing water quality objectives;
- Monitoring – Maintaining the Central Coast Ambient Monitoring Program, integrating data from the agricultural cooperative monitoring program; and
- Clean-up – Overseeing perchlorate, MTBE, military base, hazardous waste, and underground storage tank cleanups.

Targeted projects and activities for the South Coast watersheds are agricultural waiver implementation (monitoring, education and BMP implementation), and riparian and wetland protection and restoration (CCRWQCB 2004).

The Los Angeles RWQCB (Region 4) encompasses ten watershed management areas, five of which have the potential to influence water quality in the CINMS: the Ventura River, Santa Clara River and Calleguas Creek watersheds, the “Miscellaneous Ventura Coastal Watershed Management Area,” and the Channel Islands watershed management area. The significant issues identified for each of these management areas is as follows:

Ventura River Watershed

- Eutrophication, especially in estuary
- Total Dissolved Solids (TDS) concerns in some subwatersheds
- One major NPDES discharge (POTW)
- Eight discharges covered under general NPDES permits
- Industrial storm water – 36 discharges
- Construction storm water – 33 discharges
- Impediments (dams, diversions) to steelhead trout migration
- 15 impairments including: DDT, algae, coliform, low dissolved oxygen, diversions, selenium, other metals, trash
- Currently scheduled TMDLs: Ventura River Estuary trash

Miscellaneous Ventura Coastal WMA

- Three major NPDES discharges (one POTW), six minor NPDES discharges, and eight discharges covered by general NPDES permits
- Industrial storm water – 67 discharges
- Construction storm water – 91 discharges
- 21 impairments

The harbors

- Accumulation of metals, PCBs, and historic pesticides in sediment and tissue
- Considerable marine life subject to impacts
- Impairments: DDT, PCBs, PAHs, metals, TBT, coliform
- Currently scheduled TMDLs: pesticides FY08/09 and coliform FY08/09

The wetlands and coast

- Historic pesticide contamination
- Loss of quality habitat
- Impacts from oil spills and agriculture
- Use by endangered species
- Impairments: historic pesticides and effects, coliform
- Currently scheduled TMDLs: Ventura beaches coliform

Santa Clara River Watershed

- High quality natural resource
- Four major NPDES discharges (POTWs)
- Eight minor NPDES discharges
- 48 discharges covered under general NPDES permits
- Industrial storm water – 125 dischargers
- Construction storm water – 367 dischargers
- Impacts from exotic vegetation
- Impacts from agriculture
- Increasing urbanization, flows, and channelization in upper watershed; impacts on middle and lower watershed
- 43 impairments including: nitrogen and effects, salts, coliform, trash, historic pesticides
- Completed TMDLs: Upper Santa Clara chloride (2005); nutrients (2004)
- Currently scheduled TMDLs: Lake Elizabeth, Munz Lake, Lake Hughes trash

Calleguas Creek Watershed

- Five major NPDES discharges (POTWs)
- Three minor NPDES discharges
- Thirteen discharges covered under general permits
- Industrial storm water – 90 dischargers
- Construction storm water – 292 dischargers
- Highly modified watershed
- Impacts from agriculture and naval facility
- Sediment inputs to Mugu Lagoon, one of the largest wetlands in southern California
- Competing urban uses; development pressures, particularly in upper watershed
- Severe lack of benthic and riparian habitat in watershed

- 159 impairments including: nitrogen and effects, water-soluble pesticides and effects, salts, historic pesticides, PCBs, siltation, selenium, mercury, other metals, trash
- Completed TMDLs: nitrogen (2003); toxicity (2006); organochlorine pesticides, PCBs, and siltation (2006); metals and selenium (2006)
- Currently scheduled TMDLs: trash; salts

Channel Islands WMA

- Anacapa, San Nicolas, Santa Barbara, Santa Catalina, and San Clemente Islands
- One major NPDES discharge, four minor discharges
- One discharge covered by general NPDES permit
- Four discharges covered by the industrial storm water permit
- One discharge covered by the construction storm water permit
- Areas offshore of islands designated as Areas of Special Biological Significance
- High quality marine and rocky intertidal habitat
- Heavy use by marine mammals and endangered species
- Impairment: coliform (Avalon Beach)
- Lack of information on water quality

The Initiative is implemented on a five-year cycle, the most recent beginning in FY 2007-08.

6.5.5 Conditional Waiver for Discharges from Irrigated Lands

As discussed earlier, California's Porter Cologne Water Quality Control Act requires that all dischargers of waste that could affect the quality of State waters to file reports of discharges and, as needed, implement waste discharge requirements (WDRs) that ensure that those discharges will not impact the use of State waters. The local RWQCB then determines whether the discharge should be regulated through WDRs, or through a waiver of WDRs accompanied by certain conditions. Nothing was done to implement this requirement until the early 1980s, when most RWQCBs added to their Basin Plans a waiver of WDRs for polluted runoff with essentially no conditions.

Therefore, agricultural operations have been exempt from most of the requirements of California's clean water laws for decades. Then, Senate Bill (SB) 390, enacted in 1999 and effective January 1, 2003, eliminated all waivers from WDRs, while allowing RWQCBs to issue new waivers for agricultural properties if consistent with the region's Basin Plan and in the public interest. The law also required that waivers be subject to review every five years, as is required for NPDES permits. Then SB 923 was enacted in late 2003, requiring waivers to include basic monitoring requirements and authorizing RWQCBs to collect fees from dischargers of polluted runoff operating under waivers to pay for the costs of the program.

In July 2004, the Central Coast RWQCB adopted a Conditional Waiver of WDRs for Discharges from Irrigated Lands (Water Quality Order R3-2004-0117) (also known as the Ag Waiver). The waiver is the primary vehicle for the RWQCB's efforts to improve water quality in agricultural areas, and is a mandatory program for all commercial, irrigated farming operations in the Central Coast region. It regulates wastewater discharges from irrigated lands producing commercial crops in order to ensure that discharges do not cause or contribute to water quality impairment. The waiver requires farmers to enroll in the program by January 1, 2005; develop farm water quality management plans that address, at a minimum, irrigation management, nutrient management, pesticide management and erosion control; begin implementing best management practices (BMPs) identified in their plans; complete 15 hours of farm water quality education within three years; and conduct monitoring to ensure compliance with the waiver requirements.

Monitoring is a mandatory component of the Ag Waiver; growers are given the option to either conduct individual monitoring or participate in the Cooperative Monitoring Program. All growers who selected the latter are obligated to pay fees to Central Coast Water Quality Preservation, Inc., which runs the Cooperative Monitoring Program. The program conducts monthly monitoring at 50 sites throughout the agricultural areas of the region, with follow-up monitoring where problems are identified. The RWQCB uses the monitoring data to identify areas where there is need for improvement in irrigation management.

As of June 2008, nearly 400,000 acres were enrolled in the Ag Waiver, representing approximately 93% of irrigated acreage in the Central Coast region.

The Central Coast Ag Waiver expired in July 2009, so the Central Coast RWQCB began convening local stakeholders in December 2008 to develop recommendations for the renewal of the waiver. The renewed waiver is expected to be adopted by the RWQCB in late 2010.

The Los Angeles RWQCB adopted a Conditional Waiver of WDRs for Discharges from Irrigated Lands within the Los Angeles Region (Water Quality Order R4-2005-0080) in November 2005, with the intent to attain water quality objectives in waters of the State by regulating discharges from irrigated lands in the Los Angeles region (e.g., the coastal watersheds of Ventura and Los Angeles counties). Dischargers may form groups or apply individually for coverage under the waiver. In order to comply with the conditions of the waiver, dischargers were required to submit a Notice of Intent, Monitoring and Reporting Program Plan and a Quality Assurance Project Plan to the LA RWQCB by August 3, 2006.

As in the Central Coast, dischargers in the Los Angeles region are given the option to enroll under the waiver as a member of a discharger group or as an individual discharger, both of which are required to conduct water quality monitoring. In instances where monitoring results indicate an exceedence of receiving water limitations listed in the waiver, the discharger/group must prepare a Water Quality Management Plan, which must identify the source of the exceedence and determine the impact of the impairment through follow up monitoring, if necessary. Once the source is identified, the grower must implement and maintain BMPs to reduce or eliminate the impairment. Dischargers must also complete eight hours of training on water quality management practices.

There are currently two established discharger groups participating in the LA Ag Waiver: the Ventura County Agriculture Irrigated Lands Group (VCAILG), which represents growers in Ventura County and the Nursery Growers Association, and the Los Angeles County Irrigated Lands Group, which represents growers in Los Angeles County. The VCAILG was formed in 2006 with the expressed purpose of acting as a county-wide discharger group for compliance with the waiver. The VCAILG Notice of Intent identifies 1,080 landowner members representing 73,697 enrolled acres across Ventura County, which represents 60% of the total irrigated acreage in Ventura County. Their monitoring and reporting program identifies 24 monitoring locations throughout Ventura County: 12 sites in the Calleguas Creek watershed, seven in the Santa Clara River, three in the Oxnard Coastal and two in the Ventura River.

6.6 Dredged or Fill Materials

The US Army Corps of Engineers develops, controls, maintains and conserves the nation's navigable waters and wetlands, regulating development of any project involving fill, construction or modification of waters of the US. However, the RWQCBs also have oversight over projects involving discharges of dredged or fill material to waters of the US, including wetlands and other water bodies. Such discharges may result from navigational dredging, flood control channelization, levee construction, channel clearing, fill of wetlands for development, and other activities. These projects involve the removal or placement of soil, sediment, and other materials in or near water bodies and require a permit from the US Army Corps of Engineers under Section 404 of the CWA (33 US Code Sec. 1344). In addition, under Section 401, every applicant for a federal permit or license for any activity which may result in a discharge to a water body must obtain State Water Quality Certification that the proposed activity will comply with State water quality standards. The appropriate RWQCB reviews these applications, and if it determines that the proposed project will comply with water quality standards, it certifies the project. The RWQCB may impose certification conditions to mitigate potential impacts to beneficial uses and other standards, and those conditions must be included in the Corps' 404 permit. If the RWQCB finds that the project will not comply with water quality standards, it can deny certification and the federal permit for the project cannot be issued.

For dredge or fill projects, a Stream and Lakebed Alteration Agreement from the California Department of Fish and Game (CDFG) may also be required. Proponents of projects that may substantially modify a river, stream, or lake must notify CDFG, and if CDFG determines that the activity could substantially adversely affect an existing fish and wildlife resource, a Lake or Streambed Alteration Agreement is required. If an agreement is required, the CDFG conducts an onsite inspection, if necessary, and submits an agreement to the project applicant. The agreement includes measures to protect fish and wildlife resources while conducting the project. Private parties must obtain a streambed alteration permit from CDFG prior to taking any such action; failure to do so is a criminal offense (Fish and Game Code Sec. 1600-1616).

The Army Corps evaluates permit applications for essentially all construction activities that occur in US waters, including wetlands. Corps permits are also necessary for any work, including construction and dredging, in navigable waters. The Corps makes permit decisions that recognize the essential values of the nation's aquatic ecosystems to the general public, as well as the property rights of private citizens who want to use their land. The adverse impacts to the aquatic environment are offset by mitigation requirements, which may include restoring, enhancing, creating and preserving aquatic functions and values.

For modifications to coastal water bodies, permits may also be required from the California Coastal Commission.

6.7 Other Federal Management Programs

6.7.1 National Park Service Regulations

Under the federal regulations governing National Parks (36 CFR 2.14), it is prohibited in the Channel Islands National Park to pollute or contaminate park area waters or watercourses, or to dispose of human body waste within 100 feet of a water source or high water mark of a water body.

6.7.2 Harmful Algal Bloom Control

In December 2004, Congress reauthorized and expanded the Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 (Public Law 108-456), otherwise known as HABHRCA, by passing the Harmful Algal Bloom and Hypoxia Amendments Act of 2004 (Public Law 105-383). This Act, originally enacted to combat the growing threat of HABs and hypoxia, reaffirms and expands the mandate for NOAA to advance the scientific understanding and ability to detect, monitor, assess, and predict HAB events. HABHRCA also calls for the development of programs to research methods of prevention, control, and mitigation of HABs. The Administration further recognizes the importance of HABs and hypoxia as high priority national issues by specifically calling for the implementation of HABHRCA in the President's US Ocean Action Plan.

In 2006, NCCOS coordinated the development of a multi-agency strategy for human dimensions research critical to mitigate the environmental, public health, and socioeconomic impacts of HABs. The *Harmful Algal Research and Response: A Human Dimensions Strategy* includes research objectives and example projects to improve communication of scientific information to at-risk communities; identify susceptible human populations; improve monitoring, documentation, and response to algal toxins in drinking and recreational waters; assess socio-cultural and economic impacts; and help fulfill other priorities. The research framework is already being used by State, federal, and international resource management agencies and will help implement the Harmful Algal Bloom and Hypoxia Amendments Act of 2004 and the National Plan for Algal Toxins and Harmful Algal Blooms.

6.8 Other State Laws and Programs

There are a variety of other statutes that regulate discharges into State waters, including:

- Health and Safety Code Section 117475 establishes fines for dumping garbage into the navigable waters of the State;
- Health and Safety Code Section 5215.2 prohibits the disposal of lead battery acid in marine waters, surface waters, or watercourses;
- Health and Safety Code Section 25250.5 prohibits the disposal of used oil in marine waters, surface waters, groundwater, or watercourses; and
- Health and Safety Code Section 114780 charges the Coastal Commission with the prevention of dumping of radioactive waste in the Pacific Ocean by a public or private entity, unless the Commission finds that the dumping would be consistent with the California Coastal Act.

- The Water Recycling Act (Water Code Sec. 13567 et seq) establishes a prescribed statewide water recycling goal and requires RWQCBs to establish water quality objectives in Basin Plans, and requires each regional board to consider specified factors in establishing water quality objectives including, but not limited to, reducing discharge of waste into the ocean, and the enhancement of groundwater basins, recreation, fisheries, and wetlands.

Other laws and programs, including the California Environmental Quality Act, the Ocean Protection Act, the Coastal Act and others, are outlined in more detail below.

6.8.1 California Environmental Quality Act

California is one of 20 states with an environmental impact assessment law modeled after the National Environmental Policy Act (NEPA). The SWRCB, RWQCBs, and all State and local government agencies must analyze and where feasible avoid or mitigate development impacts on coastal and wetland areas pursuant to California Environmental Quality Act (CEQA). CEQA applies to discretionary activities proposed to be carried out by government agencies, including approval of permits and other entitlements. CEQA has six objectives:

1. to disclose to decision-makers and the public the significant environmental effects of proposed activities;
2. to identify ways to avoid or reduce environmental damage;
3. to prevent environmental damage by requiring implementation of feasible alternatives or mitigation measures;
4. to disclose to the public reasons for agency approvals of projects with significant environmental effects;
5. to foster interagency coordination; and
6. to enhance public participation.

CEQA lays out procedural requirements to ensure that these objectives are met, and requires agencies to avoid or mitigate, when feasible, impacts disclosed in an Environmental Impact Report (EIR).

6.8.2 California Ocean Resources Management Program

The California Ocean Resources Management Act of 1990 (Public Resources Code Sec. 36000 et seq) created the California Ocean Resources Management Program to ensure comprehensive and coordinated management, conservation and enhancement of California's ocean resources.

The goals of the Program are:

1. To assess, conserve, and manage California's ocean resources and the ecosystem that supports those resources.
2. To encourage environmentally sound, sustainable, and economically beneficial ocean resource development activities.
3. To advance research, educational programs, and technology developments to meet future needs and uses of the ocean.

4. To maximize California's interests within State Tidelands, the Territorial Sea, and the Exclusive Economic Zone.

The California Ocean Resources Management Act also required the California Resources Agency to develop a strategy which addresses California's economic, environmental, aesthetic, recreational, and scientific needs regarding the use and enjoyment of the State's outstanding ocean resources. In 1997, Program staff prepared *California's Ocean Resources: An Agenda for the Future* (Ocean Agenda), which describes California's ocean ecosystem, identifies the contribution of selected ocean-dependent industries to the California economy, and summarizes the statutes and agency management roles that relate to ocean management. The Ocean Agenda also analyzes some major ocean management issues, offers specific recommendations for addressing these issues, and provides an approach for the Governor, the Legislature, government agencies, industry, and the public to use in improving the management of California's precious ocean resources. The Agenda identifies and addresses nine ocean management issues that face the State of California now, or are likely to in the reasonably foreseeable future: 1) habitats and living resources; 2) water quality; 3) shoreline erosion; 4) ports and harbors; 5) oil, gas and other mineral resource extraction; 6) vessel traffic safety; 7) tourism and recreation; 8) education, research and technology; and 9) desalination.

6.8.3 California Ocean Resources Stewardship Act

The California Ocean Resources Stewardship Act (Public Resources Code Sec. 36990-36995), signed into law in 2000, aims to improve the coordination of ocean resources management science in California. It created the California Ocean Science Trust, and required the Secretary for Resources to prepare an inventory of ocean resource science coordination efforts in California.[28] The Ocean Science Trust is a non-profit organization tasked with directly funding and developing new funding sources for ocean resource science projects, and with encouraging coordinated, multi-agency, multi-institution approaches to translating ocean science into management and policy applications. Its mission is to ensure that science is informing California policy and management to maintain a healthy, resilient, and productive ocean and coast for the benefit of current and future generations. Projects of the Trust involve improving coordination and collaboration, and research and monitoring activities related to a variety of scientific questions about coastal and ocean habitats, fisheries, water quality, and coastal erosion.

6.8.4 California Ocean Protection Act

The California Ocean Protection Act (Public Resources Code Sec. 35500-35650), signed into law in 2004, called for the improved integration and coordination of the State's efforts to protect and conserve ocean resources. Its specific objectives are to provide a set of guiding principles for State agencies to follow in protecting ocean and coastal resources; encourage cooperative management with federal agencies; establish a cabinet level council to improve coordination and management of State ocean protection and conservation efforts; more effectively use California's private and charitable resources in developing ocean protection and conservation strategies; and enhance public access to the ocean and its resources (COPC 2007).

[28] In response to this directive, the Resources Agency produced a draft *Preliminary Inventory of Ocean Resource Science Coordination Efforts in California* in December 2002, available at http://resources.ca.gov/ocean/CORSA/Research_Report.html.

The California Ocean Protection Council (COPC) was established pursuant to the Ocean Protection Act. The COPC is tasked with the following responsibilities:

1. Coordinate activities of ocean-related State agencies to improve the effectiveness of State efforts to protect ocean resources within existing fiscal limitations.
2. Establish policies to coordinate the collection and sharing of scientific data related to coast and ocean resources between agencies.
3. Identify and recommend to the Legislature changes in law.
4. Identify and recommend changes in federal law and policy to the Governor and Legislature.

The COPC approves grants and expenditures to public agencies, nonprofit organizations and private entities from the California Ocean Protection Trust Fund, also created pursuant to the Ocean Protection Act, for projects and activities related to coastal and ocean resources. The COPC also works to coordinate and improve the protection and management of California's ocean and coastal resources and implement the Governor's Ocean Action Plan, released in October 2004.

The Ocean Action Plan aims to develop a plan of action for ocean and coastal management in California, and to respond to the crisis in marine resource management identified by the Pew Oceans Commission and the US Commission on Ocean Policy and to the need to meet the demands of California's growing population.

The Action Plan's four fundamental goals are to:

1. increase the abundance and diversity of aquatic life in California's ocean, bays, estuaries and coastal wetlands;
2. make the water in those bodies cleaner;
3. provide a marine and estuarine environment that Californians can productively use and safely enjoy; and
4. support ocean-dependent economic activities.

The Plan outlines immediate and ongoing actions, and comprehensive and long-term actions for the State to undertake to achieve these goals in the areas of governance, economics and funding, research, education and technology development, and ocean and coastal stewardship.

In February 2007, the COPC formally designated the Executive Director of the California Ocean Science Trust (CalOST) to act as Science Adviser to the OPC and Co-Chair of the COPC Science Advisory Team (SAT). CalOST is tasked with establishing the COPC SAT in accordance with the COPC’s Five-year Strategic Plan, *A Vision for Our Ocean and Coast*, adopted by the COPC in June 2006. The Strategic Plan highlights the need to improve scientific understanding of our ocean and coastal ecosystems and fulfill the Ocean Protection Act’s mandate. It evaluates necessary actions in the areas of governance, research and monitoring, ocean water quality, physical processes/habitat structure, ocean and coastal ecosystems, and education and outreach.

6.8.5 California Coastal Act

The California Coastal Act (Public Resources Code Sec. 30000 et seq) provides for the conservation and planned development of the State's coastline, and mandates the protection and restoration of coastal waters. Mandated activities pertaining to water quality protection and management include:

- To maintain, enhance, and, where feasible, restore marine resources.
- To maintain and, where feasible, restore biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes through, among other means, minimizing adverse effects of wastewater discharges and entrainment, controlling runoff, preventing depletion of groundwater supplies and substantial interference with surface water flow, encouraging wastewater reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams.
- To protect against spillage of crude oil, gas, petroleum products, or hazardous wastes.
- To limit the alteration of wetlands, coastal waters, and estuaries and provide for feasible mitigation measures to minimize adverse environmental effects.
- To phase out or upgrade, where feasible, existing marine structures causing water stagnation contributing to pollution problems and fish kills.
- To limit hydromodification of rivers and streams. Channelization, dams, and other substantial alterations of rivers and streams shall incorporate best mitigation measures feasible.
- To protect environmentally sensitive habitat areas (ESHAs). Site and design new development in areas adjacent to ESHAs to prevent significant adverse impacts.
- To site and design new development so as to not have significant adverse impacts either individually or cumulatively on coastal resources.
- To assure that new development is stable, has structural integrity, and does not contribute significantly to erosion.
- To control impacts of dredging in specified port areas.
- To minimize harmful effects to coastal waters, including water quality, from fill within ports.
- To locate, design, and construct port-related development to minimize substantial environmental impacts and protect beneficial uses.

The California Coastal Commission (CCC) is the primary agency responsible for implementing the Coastal Act. The Act requires local governments with jurisdictions in the coastal zone to prepare a Local Coastal Program (LCP) for that portion of the coastal zone within its jurisdiction (although not all local governments have approved LCPs at this time). The CCC determines the adequacy of and then certifies LCPs, after which time the local government is delegated the authority to issue coastal development permits (CDPs) for most development within its jurisdiction. The CCC has authority to issue CDPs for proposed developments that will alter coastal land or water use where the local government does not have an approved plan. In addition, the CCC approves CDPs for energy projects and federal projects consistent with the Coastal Act policies. The CCC retains permanent coastal permit jurisdiction over development proposed on tidelands, submerged lands, and public trust lands, and also acts on appeals of certain local government coastal permit decisions.

LCPs are basic planning tools used by local governments to guide development in the coastal zone. LCPs contain the ground rules for future development and protection of coastal resources in coastal cities and counties. They specify the appropriate location, type, and scale of new or changed uses of land and water. Each LCP includes a land use plan and measures to implement the plan (such as zoning ordinances). Prepared by local governments, these programs govern decisions that determine the short- and long-term conservation and use of coastal resources. Following adoption by a city council or county board of supervisors, an LCP is submitted to the Coastal Commission for review for consistency with Coastal Act requirements.

The CCC has developed general policies that guide the development of all LCPs (Public Resources Code Sec. 30230-30255). Among these are preservation of public access and views; and restrictions on development, which require that LCPs seek to maintain and enhance public access to the coast, that scenic and visual qualities of coastal areas are considered and protected, that new development be located in close proximity to existing developed areas able to accommodate it or where it won't have significant adverse effects on coastal resources. Other policies state that LCPs should support public recreational activities in coastal and oceanfront areas and protect oceanfront land suitable for recreation and for coastal dependent aquaculture for those uses; that marine resources are to be maintained, enhanced, and, where feasible, restored; that environmentally sensitive habitat areas should be protected against significant disruption of habitat values and only uses dependent on these values are to be allowed therein; and that inappropriate coastal development is to be prevented and risks to life and certain rules for development within coastal planning areas be implemented.

Pursuant to the federal Coastal Zone Management Act (CZMA) (16 US Code 1451 et seq), which aims to protect the coastal environment from growing demands associated with residential, recreational, commercial, and industrial uses (e.g., State and federal offshore oil and gas development), activities of federal agencies and federally licensed or permitted activities that have reasonably foreseeable effects on land use, water use, or natural resources in the coastal zone must be consistent with the policies of a state's coastal management policy, which in California's case is the Coastal Act. The CCC makes these consistency determinations (although the federal government can override a state's consistency determination if it finds the activity to be consistent with the objectives of the CZMA or is otherwise necessary for national security).

In practice, the CCC protects water quality primarily by: (1) managing coastal development that generates runoff or creates spills; (2) assisting local coastal governments and other agencies to address land-use and development activities that may produce NPS pollution; and (3) implementing educational and technical assistance programs.

6.8.6 Recycled Water Policy

In an effort to foster increased use of recycled water from municipal wastewater sources to address the water shortage in California, the SWRCB adopted a Recycled Water Policy (Resolution No. 2009-0011) in May 2009. The Policy lays out specific goals for increased use of recycled water and storm water, for increased water conservation in urban and industrial uses, and for the substitution of recycled water for potable water. It requires local water and wastewater entities, together with stakeholders, to develop salt/nutrient management plans for each groundwater basin /sub-basin in California by 2014. The Policy also delineates criteria to be used by the State and Regional Water Boards to streamline the issuance of permits for recycled water projects.

One challenge in developing this policy was how to address new classes of chemicals, such as pharmaceuticals, personal care products, currently used pesticides, and industrial chemicals, collectively referred to as chemicals or constituents of emerging concern (CECs). This diverse group of relatively unmonitored chemicals has been found to occur at trace levels in wastewater discharges, ambient receiving waters, and drinking water supplies, but many of them are so new that standardized measurement methods and toxicological data for interpreting their potential human or ecosystem health effects are unavailable. This lack of basic information and technology to efficiently measure CECs hampers the State's ability to assess their potential risks and develop regulatory protocols. For many of these chemicals, even information about product-specific applications is unavailable, making it difficult to ascertain the probability of exposure and the potential to impact beneficial uses of California's water resources.

Recognizing that consideration of CEC effects on human health and aquatic life is a rapidly evolving field and that regulatory requirements need to be based on best available science, the SWRCB included a provision in the Recycled Water Policy to establish a Science Advisory Panel to provide guidance in developing monitoring programs that assess the potential health threat of CECs from various water recycling practices. The Panel was formed in May 2009 and includes six national experts in the fields of chemistry, biochemistry, toxicology, epidemiology, risk assessment and engineering. The Panel was asked to review the occurrence, relevance, and quantification of CECs in recycled water in California with the goal of providing recommendations for the development of a monitoring program for CECs in recycled water. The Panel was asked to focus on three reuse practices in which CECs may represent a potential threat to human and aquatic health: 1) indirect potable reuse via surface spreading of recycled water; 2) indirect potable reuse via subsurface injection of recycled water into a potable aquifer; and 3) urban landscape irrigation with recycled water.

The Panel chose to focus its recommendations on the toxicological relevance of CECs to human health, since most water reuse practices have limited impact on ecological receptors. Other reuse practices that could result in the discharge of recycled water to surface water, estuaries, and the ocean were also not addressed by the Panel. However, the SWRCB, in collaboration with the Packard Foundation, established another Science Advisory Panel in January 2010 that was charged to address CEC discharge to the ocean and potential exposure to human health and ocean life from this practice. This panel's report will be released in spring 2011.

The original panel released its draft report in April 2010. The report provides four "products" to assist the State in refining its Recycled Water Policy: a conceptual framework for determining which CECs to monitor; application of the framework to identify a list of chemicals that should be monitored presently; a sampling design and approach for interpreting results from CEC monitoring programs; and priorities for future improvements in monitoring and interpretation of CEC data. [29]

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[29] *Monitoring Strategies for Chemicals of Emerging Concern in Recycled Water*, at ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/CECpanel/CA_CEC_RW_Draft_Report_2010Apr15.pdf

After receiving and reviewing public comments on the draft report, the Panel will revise and submit a final report to the SWRCB in the summer of 2010.

6.8.7 Shellfish and Beach Sanitation and Monitoring

The California Department of Public Health's (CDPH) Environmental Management Branch administers the Preharvest Shellfish Protection and Marine Biotoxin Monitoring Program, which conducts, surveys, classifies and monitors commercial shellfish growing areas in conformance with the National Shellfish Sanitation Program. The program also monitors numerous points along the California coastline for marine biotoxins in shellfish and toxigenic phytoplankton in the waters. Warnings are issued or quarantines established as needed for recreational and commercial shellfish harvesting.

CDPH's Recreational Health Program also promotes and assures the safety of recreational waters through the development of protective standards, regulations, and monitoring requirements. They have established standards for ocean recreational waters as well as for ocean discharges for waters used for recreation and shellfish harvesting and cultivation. They allocate $1.5 million in funding to local governments through contracts to test ocean and bay waters along public beaches to ensure their safety for recreational activities.

The California Legislature enacted several bills in recent years directing State and local agencies to monitor and manage water quality at public beaches. Assembly Bill (AB) 411, enacted in 1998, requires local health officers to test water quality adjacent to public beaches with annual visitorship of 50,000 or more in their jurisdictions from April 1-October 31 and to take related action in the event of a sewage spill. It also requires such officers to post warning signs and establish a phone hotline to inform the public about beaches that fail to meet Department of Health Services' bacteriological standards (see Health and Safety Code Sec. 115875-115915).

AB 538, enacted in 2000, directed the SWRCB to develop source investigation protocols for use in conducting source investigations of storm drains that produce exceedences of bacteriological standards at frequently visited beaches, and to report to the Legislature on the methods by which it intends to do so (see Water Code Sec. 13178).

AB 1946, also enacted in 2000, requires local health officers to submit a monthly survey to the SWRCB outlining information on beach postings and closures due to failure to meet bacteriological standards, and requires the SWRCB to make this information available to the public on a monthly basis and publish it in an annual report (see Health and Safety Code Sec. 115910).

6.8.8 Beach Erosion

The California Public Beach Restoration Act established the California Public Beach Restoration Program and charged the Department of Boating and Waterways with specific actions to restore, enhance and maintain public beaches and coastal areas. The State Lands Commission regulates the deposit, removal or extraction of material from specific State waters, the construction or alteration of structures on or near tide or submerged lands, and salvage operations. The Department of State Parks and Recreation is also involved in preventing erosion and controlling marine sediments through the construction of beach erosion control works that affect recreational beaches and other recreational areas within its purview.

The California Sediment Management Work Group, comprised of State and federal agencies, is developing regional approaches to protecting the State's coastal beaches and watersheds through cooperative federal, State and local efforts. It is modeled after the Beach Erosion Authority for Clean Oceans and Nourishment (BEACON) in Santa Barbara and Ventura counties, which provides a forum for various stakeholders to discuss issues associated with coastal erosion and beach loss and serves as a project planning and management entity for regional projects, including the Opportunistic Nourishment Program.

6.9 Local Ordinances and Programs

In addition to the federal and State water quality management programs outlined above, there are various municipal programs pertaining to the management of water quality along the mainland coast in the vicinity of the CINMS.

6.9.1 County of Ventura

Since 1992, the cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Bueanventura, Santa Paula, Simi Valley and Thousand Oaks, the Ventura County Flood Control District and the County of Ventura have worked collaboratively to meet water quality regulations as the Countywide Stormwater Program. Each of these public entities operates separate municipal storm drain systems that discharge storm water pursuant to the Ventura Countywide Stormwater NPDES permit. Issued by the Los Angeles RWQCB, the first municipal storm water permit for Ventura County was issued in 1994 and a second in 2000. Under the permit, the permittees are required to implement the Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan (SQUIMP), which mandates the implementation of Best Management Practices (BMPs) to reduce the discharge of pollutants in storm water from new development and significant redevelopment. Other permit requirements include a public education program, an educational site inspection program for industrial and commercial facilities, a program for construction sites, public agency activities, and a storm water monitoring program.

In May 2009, the LA RWQCB adopted a revised permit for Ventura County that is among the strictest in the nation. There are approximately 75 new or additional requirements identified in the permit, including requirements to install screens on all storm drain inlets preventing entry of any materials larger than 5 mm; for storm water runoff from storm drains to meet certain pollutant levels; to impose new requirements for new and redevelopment projects; and to incorporate TMDLs. The Building Industry Association of Southern California petitioned the SWRCB to reverse the RWQCB's approval of the permit, and the SWRCB responded by remanding the permit in March 2010. The entire permit has been reopened for review and revision, and a new public hearing will take place in July 2010.

Ventura County also has zoning, subdivision and urban area development ordinances to protect and promote public health, safety and general welfare; to provide the environmental, economic and social advantages which result from an orderly, planned use of resources; to establish the most beneficial and convenient relationships among land uses; and to implement the County's General Plan.

6.9.2 County of Santa Barbara

Project Clean Water is Santa Barbara County's primary agency responsible for addressing creek and ocean water pollution. Project Clean Water's mission is to protect public health and enhance environmental quality in Santa Barbara County watersheds and beaches. Its specific goals include protecting the health of the recreational public and the environment, meeting CWA mandates through compliance with Phase II NPDES Permit requirements and applicable regulations, and fostering maximum public involvement and awareness in these efforts.

Project Clean Water staff walk local creeks to perform visual surveys, note problems areas and take corrective action as necessary. Project Clean Water also holds quarterly meetings with interested members of the public to share ideas, information and give an update on Project Clean Water efforts.

Project Clean Water's primary responsibility is overseeing the implementation of the County's Storm Water Management Program (SWMP), which constitutes the County's coverage under the State General Permit for the Discharge of Storm Water from Small Municipal Separate Storm Sewer Systems. Santa Barbara County's SWMP was approved by the Central Coast RWQCB and went into effect in July 2006. The SWMP establishes the County's legal responsibility for water quality in storm drains and surface drainages in certain unincorporated areas on the South Coast, in the Santa Ynez Valley, and in the Orcutt area of the Santa Maria Valley, and describes the County's program to protect water quality in those areas.

Pursuant to the SWMP, the County passed a storm water pollution control ordinance in September 2007. The ordinance prohibits illicit connections and discharges to the County's storm sewer system and provides the County with legal authority to carry out all inspection, surveillance monitoring and enforcement procedures necessary to ensure compliance.

The County also has a Grading Ordinance, which seeks to control runoff from construction sites and includes associated inspection and enforcement procedures under the Building and Safety Division of the Planning and Development (P&D) Department. Under the grading ordinance, a permit is required when 50 cubic yards or more are graded, and all grading operations that require a grading permit must also prepare and implement erosion and sediment control and storm water BMPs. The ordinance also prohibits non-storm water construction related discharges (e.g., concrete truck washout, disposal of discarded building materials, construction vehicle leaks and maintenance, etc.), requires the submittal of copies of the Notice of Intent and Storm Water Pollution Prevention Plan for sites of one or more acres of land disturbance in accordance with the Phase II construction storm water program, and includes specific guidance on the use of approved BMP manuals.

6.9.3 City of Santa Barbara

The City of Santa Barbara created the Creek Restoration and Water Quality Improvement Division in 2000, pursuant to Ballot Measure B, which raised the hotel occupancy tax from 10% to 12% to fund the Creeks Restoration and Water Quality Improvement Program. The Program seeks to improve creek and ocean water quality and restore natural creek systems through storm water and urban runoff pollution reduction, creek restoration, and community education programs. The Program has installed capital projects to improve water quality, including low flow diversions at Hope Avenue and Haley Street to divert summer flow from these storm drains to the sewage treatment plant. Other capital projects, to treat storm water and incidental runoff at the Santa Barbara Golf Club through the installation of detention basins and bioswales, to disinfect water from the Laguna Channel before it discharges to East Beach, and to use detention and biofiltration to improve water quality in Old Mission Creek during rain events, are currently under development. The Division also has a Water Quality Enforcement Program, through which two full-time water resource specialists respond to and resolve water quality violations. They have authority to issue notices of violation and administrative fines under Title 16 of the City's Municipal Code. Other elements of the Creeks Division's Water Quality Improvement Program include a water quality monitoring program, microbial source tracking research, weekly creek clean-ups, installation and maintenance of storm drain filters, and a street sweeping program.

The City's SWMP was approved by the Central Coast RWQCB in late 2008. As required by the State's municipal storm water permit, the City's SWMP lays out strategies and guidelines for the protection of water quality and reduction of pollutant discharges within the incorporated areas of the City as well as the waterfront area and Santa Barbara Airport. The SWMP specifies Best Management Practices (BMPs) and associated measurable goals that will be implemented over a five-year period, from 2008-2012, in the areas of public education and outreach, public participation, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention and good housekeeping for municipal operations.

6.9.4 Other Entities

The RWQCB recently approved the SWMPs developed by the cities of Goleta and Carpinteria and the University of California Santa Barbara. The five-year SWMPs include BMPs and measurable goals in the areas of public education and outreach; public participation; illicit discharge detection and elimination; construction and post-construction runoff control; and good housekeeping for municipal operations. If fully implemented, these BMPs and measurable goals should result in a reduction in the discharge of pollutants in storm water to the Maximum Extent Practicable.

7. Water Quality Monitoring Programs

This section describes the variety of monitoring programs or studies that have collected or are collecting data on various aspects of water quality in and around the CINMS. Results of monitoring efforts to date are presented in Section 8. The approach followed by each program varies due to the range of issues, constraints or research questions. A brief description of the different types of monitoring programs is shown in Table 7.1.

Synoptic surveys can provide an instantaneous overview of contaminants in the marine environment. This approach is especially useful in the absence of reliable data from a region, and may allow an appraisal of pollution hot spots. Ambient monitoring involves the regular measurement of a set of parameters. Both the frequency of measurements and the time scale of surveillance can vary from days to years, depending upon the purpose. Similarly, the media examined can include water, sediments and/or biota. The data can be used to estimate the trans-boundary transport of contaminants. With time and sufficient data, trend analysis may be used to judge the efficacy of environmental protection regulations and policies. Biological effects monitoring measures biochemical or physiological responses to ambient pollution in organisms.

Compliance monitoring involves measurements at the point of discharge and is essential for reliable estimates of emission inventories and assessment of land-based sources of pollution, but gives little information regarding the environment itself. Complementary to monitoring are research programs, which may range from the development or adoption of new analytical techniques to the introduction of new technologies. Environmental case studies may focus on novel or emerging pollution issues. Pilot studies can be used as the first step in expanding a regional monitoring program through the introduction of new parameters to be measured in a limited spatial context. Finally, pollution history and analysis of contaminant concentrations at a specific site may be useful when considering other areas.

Table 7.1
Monitoring and Study of Marine Pollution (adapted from UNEP/RSP 2006).

Activity	**Potential Applications**	**Example Programs**
Synoptic Survey	• Contaminant Screening • Hot spot identification • State of the environment	Bight surveys, “snapshot” surveys
Ambient Monitoring	• State of the environment • Trend analysis • Contaminant fate analysis	Mussel Watch programs, Plumes and Blooms, CalCOFI, SBCK Stream Team, CCAMP
Biological effects	• Biochemical responses	Bight surveys
Compliance Monitoring	• End of pipe measurements • Emission inventories	Wastewater treatment plants, oil platforms, NPDES permits
Research	• Pollution history • Emerging pollutants • Special case studies	SSCWRP studies, universities

Periodic oceanographic cruises, moored instruments within CINMS waters and remote sensing provide time series measurements of basic oceanographic parameters (temperature, salinity, chlorophyll a, dissolved nutrients) (CalCOFI, LTER, PISCO). These research efforts are mostly interested in tracking natural phenomena such as shifts in Channel and Bight-wide current patterns and ENSO/El Niño events, and thus the data may not be indicative of anthropogenic influences. One exception may be the growing attention focused on toxic algal blooms relating to storm water runoff and other mainland inputs. Some focused data might also provide evidence for, and define the chance of, mainland storm water plumes reaching the islands. New technology is needed, however, as currently the episodic events that produce large plumes would have to coincide with a regularly scheduled research cruise to be captured. Additionally, ship speed may be too slow to collect data over the short duration of a rain event that may produce a plume over many kilometers of ocean. To address this, work is underway to build models linking plume constituents with ocean color.

The most comprehensive program to track water quality in the Santa Barbara Channel is the pentannual Bight Regional Monitoring Program run by SCCWRP. This program expands with each iteration, bringing in new partners and adding analysis at an expanding number of sites throughout the Southern California Bight. One of the most useful features of the Bight program is the ability to incorporate and build upon existing datasets to provide the framework for evaluating trends. SCCWRP also works on watershed dynamics, so they are well-positioned to examine the effects of mass emissions from storm water and its potential effects on the marine environment.

7.1 Water Quality Monitoring Programs within the CINMS and Santa Barbara Channel

The following sections are divided into programs collecting data within the CINMS and the Santa Barbara Channel, and programs that are occurring either within mainland watersheds or very close to shore. The scope of several may overlap. Regular and comprehensive water quality monitoring efforts in the Sanctuary are lacking. Table 7.2 provides a summary of the programs collecting information closest to CINMS waters.

Table 7.2
Summary of Water Quality Monitoring Programs within the CINMS

Group	Type	Parameters	Location	Interval	Length of Data Series	For More Information
Southern California Bight Regional Monitoring Program	NGO/Agency/ Governmental/ University partnership	Toxicity, sediment, tissue sampling, organo-pesticides, PCB, trace metals, PAHs, bacteria	Bight-wide	Every 5 years	1994, 1998, 2003, 2008	Southern California Coastal Water Research Program www.sccwrp.org
NOAA Mussel Watch Program (NOAA-MWP)	Federal	Organo-pesticides, PCB, trace metals, PAHs in sentinel mussels	San Miguel, Santa Cruz Islands	Every two years	1988 1986-2002	NOAA Status and Trends Program http://ccma.nos.noaa.gov/about/coast/nsandt/musselwatch.html
State Mussel Watch Program (SMWP)	State partners	Organo-pesticides, PCB, trace metals, PAHs in sentinel mussels	San Miguel Santa Cruz Anacapa Santa Barbara	Summer/winter and irregularly	1977-1978 1977, 1978, 2001 1977, 1978, 1979, 1980 1977, 1978	Cal. Dept. Fish and Game State Water Resources Control Board http://www.swrcb.ca.gov
California Cooperative Oceanic Fisheries Investigations (CalCOFI)	Agency-University partnership	Hydrographic Nutrients, salinity, dissolved oxygen, nutrients, chlorophyll A	So Cal coast & offshore	quarterly	1949 to present	www.calcofi.org
Plumes and Blooms	Agency-University partnership	Temperature, salinity, color, chlorophyll A, nutrients	cross channel from Santa Rosa to Goleta	Twice monthly	1996 to present	Institute of Computational Earth System Science (ICESS) at UCSB Www.icess.ucsb.edu
Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)	University partners	Temperature, water current; nutrients at moorings	Along coast, island sites	regular	1999 to present	www.piscoweb.edu
Santa Barbara Coastal Long-Term Ecological Research Program (SBC-LTER)	University partners	Hydrographic, nutrient, biologic, temp, salinity, turbidity, chlorophyll A, CTD	Along coast, cross SB channel	quarterly	2000 to present	http://sbc.lternet.edu
California Current Ecosystem Long-Term Ecological Research Program (CC-LTER)	University partners	Hydrographic, nutrient, biologic, temp, salinity, turbidity, chlorophyll A, CTD	California Current, southern Bight	quarterly	2000 to present	http://cce.lternet.edu
Channel Islands National Park (CINP)	Federal	Temperature loggers	32 island kelp bed sites	Ongoing	1990s to present	David Kushner, CINP
CINP	Federal	Common WQ parameters	Santa Rosa streams	irregularly	1993-98, 2002, 2005	David Kushner, CINP
Santa Barbara Channelkeeper	NGO-CINMS	Bacterial indicators	Waters around Santa Cruz, Anacapa Islands	irregularly	2005 - 2007	Santa Barbara Channelkeeper www.sbck.org

7.1.1 Bight Surveys

The Southern California Coastal Water Research Project (SCCWRP) is a research institute focusing on the coastal ecosystems of southern California, from watersheds to the ocean. SCCWRP was formed in 1969 as a joint powers agency. The common mission of member agencies is to contribute to the scientific understanding of linkages among human activities, natural events, and the health of the southern California coastal environment; communicate this understanding to decision makers and other stakeholders; and recommend strategies for protecting the coastal environment for present and future generations. SCCWRP led a consortium of 13 organizations in conducting the first integrated, coordinated regional monitoring survey for the Southern California Bight in 1994. This survey, referred to as the Southern California Bight Pilot Project, included measurements of chemistry, toxicity, benthic infauna, and fish assemblages at 261 sites between Point Conception and the Mexican border.

SCCWRP conducted a second regional monitoring study in the summer of 1998 and a third in the summer of 2003. Sixty-five organizations participated in at least one of the Bight ’03 components, including State and federal regulatory agencies, the discharging entities they regulate, universities, and environmental advocacy groups. Bight '03 was organized into three technical components: (1) Coastal Ecology; (2) Shoreline Microbiology; and (3) Water Quality. This report presents the results of the Demersal Fishes and Megabenthic Invertebrate portion of Bight '03, which is part of the Coastal Ecology component. Other Coastal Ecology components include sediment toxicology, sediment chemistry, and benthic macrofauna.

Sampling for Bight 2008 took place between July 1 and September 30, 2008, and included 360 sediment chemistry samples, 360 infauna samples, 150 trawl samples and 210 sediment toxicity samples. Of these, 32 sites were within the eastern Santa Barbara Channel, 17 within the western channel and 29 around the northern Channel Islands (Figure 7.1). A complete report from Bight ’08 is not expected until late 2010 or later.

Bight sampling is grouped into three categories: Biological Response (benthic infaunal assemblages, fish assemblages, fish external pathology, fish tissue contaminants); Pollutant Exposure (sediment contaminants, sediment toxicity, dissolved oxygen, and marine debris); and Habitat Condition (sediment characteristics, salinity, temperature, depth, transmissivity). A complete list and description of each of these individual parameters can be found at http://www.sccwrp.org/regional/indilist.htm.

Figure 7.1
Sampling sites around the Santa Barbara Channel for Bight '08

7.1.2 Mussel Watch Programs

Two long-term programs have analyzed mussel tissue for a suite of organic and inorganic constituents, with varying frequency, at locations within the CINMS and along the mainland coast of the Santa Barbara Channel: NOAA's Mussel Watch Project (NOAA-MWP) and the California State Mussel Watch Program (CA-SMWP). Concentrations of heavy metals, synthetic organic compounds, and fossil fuel by-products in sentinel mussels have provided indirect evidence for seawater contamination in the Santa Barbara Channel since the late 1970s. Evidence comes from sites along the open coast, estuaries at the discharge point of coastal watersheds and enclosed basins (harbors, lagoons) principally flushed by tidal action. Presence of a contaminant in mussel tissue indicates that it resided at least part time in the water column at the site, but does not indicate how the contaminant arrived at the site or the extent to which the contaminant resides in other parts of the ecosystem, such as sediment or other biota. Between the two programs, records of varying length are available from sites in the following categories:

Channel Islands

- San Miguel, Santa Cruz, Anacapa, and Santa Barbara Islands

Mainland Coast

- Open coast: Point Conception
- Gaviota: Point Santa Barbara, Point Mugu

- Sloughs and lagoons: Goleta Slough, Carpinteria Marsh, Mugu Lagoon
- Harbors and Marinas: Santa Barbara Harbor, Ventura Marina, Channel Island Harbor, Port Hueneme

Constituents Measured in Sentinel Mussels

The analytes measured by NOAA-MWP and SMWP include (1) synthetic organic biocides and their metabolites (insecticides, herbicides, fungicides, preservatives, antifouling agents), including legacy compounds such as DDT and chlordanes, (2) polychlorinated biphenyls (PCBs), (3) polycyclic aromatic hydrocarbons (PAHs), and (4) trace elements (mostly heavy metals). The two Mussel Watch programs evaluate slightly different suites of contaminants in these four broad categories; analytes that have been measured by the two programs in mussels from sites in the Santa Barbara Channel area are contrasted in Table 7.3. Analytes which occur on the EPA's current Priority Chemical list are labeled in the table.

Several of these substances are now banned for use in the US or California. For example, the pesticide lindane (alpha-hexachlorocyclohexane, or alpha HCH) is banned in California, but elsewhere in the US 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 has been detected in mussels from the Channel Islands (Engle 2006), although not in high concentrations. All uses of DDT and dieldrin were banned in the US in the 1970s. Chlordane use on US crops ended in 1983, and its use for termite control effectively ended in 1988. However, residual chlordane persists in soil. Organotins (mono-, di-, tri- and tetra-butyltin) have been used as antifouling agents in paints commonly used on boat hulls and some underwater marine facilities. Organotin use on vessels under 75 feet long was banned in 1988 by the US Organotin Anti-Fouling Paint Act (O'Connor 2002).

PCBs are chlorinated compounds first used in the 1920s for a number of industrial purposes, especially electrical transformers and capacitors. PCB use in the US began to be 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. There are 209 structurally distinct congeners of PCB that are defined by the orientation and position of the chlorine atoms on the biphenyl skeleton of the PCB molecule, and this may be used to determine the origin and/or manufacturer of the chemical.

Table 7.3
Trace elements and synthetic organics measured by the NOAA-MWP and the CA-SWMP in sentinel mussels from the Santa Barbara Channel area. Constituents on the EPA's list of priority chemicals are labeled (PC).

	NOAA-MWP	CA-SWMP		NOAA-MWP	CA-SWMP
Trace Elements			**Synthetic Organics (cont.)**		
Silver (Ag)	X	X	Dieldrin	X	
Aluminum (Al)	X	X	Dacthal		X
Arsenic (As)	X	X	Diazinon		X
Cadmium (Cd) (PC)	X	X	Dichlorobenzide		X
Chromium (Cr)	X	X	Dicofol		X
Copper (Cu)	X	X	endosulfan I (PC)	X	X
Iron (Fe)	X		endosulfan II (PC)	X	X
Mercury (Hg) (PC)	X	X	endosulfan sulfate	X	X
Methymercury		X	Endrin	X	X
Manganese (Mn)	X	X	Ethion		X
Nickel (Ni)	X	X	heptachlor (PC)	X	X
Lead (Pb) (PC)	X	X	heptachlor-epoxide (PC)	X	X
Antimony (Sb)	X		hexachlorobenzene (PC)	X	X
Selenium (Se)	X	X	methoxychlor (PC)		X
Tin (Sn)	X		Ethylparathion		X
Titanium (Ti)		X	Methylparathion		X
Zinc (Zn)	X	X	Mirex	X	
Synthetic Organics			Oxadiazon		X
2,4'-DDD	X	X	pentachloroanisole	X	
2,4'-DDE	X	X	pentachlorophenol (PC)		X
2,4'-DDT	X	X	pentachlorobenzene (PC)	X	
4,4'-DDD	X	X	Phenol		X
4,4'-DDE	X	X	Ronel		X
4,4'-DDT	X	X	polychlorinated terphenyl		X
4,4'-DDMS		X	Monobutyltin	X	
4,4'-DDMU		X	Dibutyltin	X	
aldrin	X	X	Tributyltin	X	X
alpha-HCH	X	X	Tetrabutyltin	X	
beta-HCH	X	X	Tetrachlorophenol		X
delta-HCH	X	X	Tetradifon		X
gamma-HCH (PC)	X	X	Toxaphene		X
chlorbenside		X			
alpha-chlordane	X				
alpha-chlordene		X			
cis-chlordane		X			
gamma-chlordane	X				
gamma-chlordene		X			
oxychlordane	X	X			
chlordene		X			
trans-nonachlor	X	X			
cis-nonachlor	X	X			
chlorpyrifos	X	X			

In recent years, polybrominated diphenyl ethers (PBDEs) have generated international concern due to their global distribution and associated adverse environmental and human health effects (Kimbrough et al. 2009). The chemical structure of PBDEs are similar to that of PCBs. Laboratory studies indicate that PBDEs may impair liver, thyroid, and neurobehavioral development, and the most sensitive populations are likely to be pregnant women, developing fetuses, and infants. PBDE production has been banned throughout Europe and Asia, and production of some PBDE mixtures has been voluntarily discontinued by US industry, although one form of PBDE is still produced. While production of PBDE flame retardants began in the 1970s and peaked in 1999, they are still found in many consumer products including many household items. PBDEs enter the environment during manufacturing, through the improper disposal of consumer products in landfills or by incineration, and through household dust. Because the application of PBDEs has been so widespread – including in many consumer plastics, textiles, electronics, mattresses, carpet padding and furniture – scientists speculate that they may present an ongoing and growing problem in coastal environments. PBDE levels in Americans have been rising over the past 30 years and are generally 10-100 times higher than levels measured in Europe and Asia. PBDEs behave like many other persistent organic contaminants that accumulate in biota and sediment, and are more likely to be associated with particles than dissolved in the water.

PAHs are a class of organic compounds consisting of two or more fused benzene rings. Naphthalene, consisting of two fused rings, is the simplest. Because of their association with many industrial and municipal activities (e.g., refineries, smelters, former manufactured gas plants, coal-fired power plants, wastewater treatment, storm water runoff, oil spills) as well as their natural origin (oil seeps, erosion), PAHs are ubiquitous and are usually found as a result of mixtures of sources. Petrogenic PAHs are formed through slow, long-term, moderate temperatures (100−300°C), and are associated with fossil fuels (petroleum and coal). Pyrogenic PAHs are formed through rapid, high temperature combustion (>700°C) of motor (automobile), bunker (shipping), and power plant (coals and petroleum) fuels. A multitude of human activities, from coal and wood burning to waste incineration, create PAH compounds in excess of those that would exist naturally. The production, transport, and use of petroleum release more PAHs to the environment, on a globally averaged basis, than does natural seepage (NRC 1985). Leaching of PAHs from creosote impregnated pilings and discharge of bilge water from large ocean vessels has been a considerable source of PAH contamination in harbors and bays (Engle & Largier 2006). Aerial deposition of combustion byproducts on land, and subsequent wash-off during wet weather, is apparently the dominant source of PAH in urban storm water in the greater Los Angeles area (Stein et al. 2006). In the Santa Barbara Channel, prodigious natural oil seepage can affect the interpretation of PAH loads in biota and sediments from certain sites.

Trace elements occur naturally, but they can also be indicators of industrial pollution. Cadmium, mercury, and lead are three heavy metals currently on the US EPA's List of Priority Chemicals. Most cadmium use in the US is for metal plating and manufacture of pigments, batteries, and plastics. Coal-burning power plants are the largest anthropogenic source of mercury emissions to the air in the US, accounting for over 40% of all domestic anthropogenic mercury emissions. EPA has estimated that about one quarter of US emissions from coal-burning power plants are deposited within the contiguous US and the remainder enters the global cycle. There are no coal- burning power plants in California, although a significant percentage of the State’s energy is derived from such plants in the southwest. The closest plant, the Mohave Generating Station, was 90 miles southeast of Las Vegas and shut down in 2005 as a result of environmental litigation. Burning hazardous wastes and the production of chlorine as well as the improper treatment and disposal of products or wastes containing mercury can also release it into the environment. Current estimates are that less than half of all mercury deposition within the US comes from US sources. Mercury in the air eventually settles into water or onto land where it can be washed into water. Once deposited, certain microorganisms can change mercury into methylmercury, a highly toxic form that bioaccumulates in fish, shellfish and up the foodchain.

Transportation emissions accounted for over 80% of total lead emissions in 1970, and lead emissions declined by more than 99% from 1970 to 2002, according to the EPA National Emissions Inventory 2007. Lead concentrations were expected to decline in aquatic organisms following the ban of lead in gasoline.

The locations of the sampling stations and sampling histories are presented in Table 7.4. Differences between the two mussel watch programs are summarized below.

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 Mussel Watch Project began to monitor spatial and temporal trends of chemical contamination by chemically analyzing mussels and oysters collected at fixed sites throughout the coastal US. 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. *M. edulis* and *M. californianus* are the mussels collected on the West Coast. The Mussel Watch Program is the longest continuous, nationwide contaminant monitoring program in US coastal waters. The program analyzes sediment and bivalve tissue chemistry for a suite of organic contaminants and trace metals to identify trends at over 300 selected coastal sites from 1986 to the present. The program samples its sites every other year and only uses resident mussels and bivalves, not bagged transplants. A full report of the program's findings from 1986-2005 can be found at http://ccma.nos.noaa.gov/about/coast/nsandt/welcome.html.

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. Nearly half of the sites were selected in waters near urban areas, within 20 km of population centers in excess of 100,000 people. NOAA sites are resampled every two years.

Table 7.4
Sentinel mussel sampling locations in the Santa Barbara Channel area.

Code	Station Name	Latitude °N	Longitude °W	Years Sampled
California State Mussel Watch Program				
450.0	Point Conception	34.4486	120.4625	1977, '78, '89, '91, '97
455.0	Gaviota	34.4703	120.2247	1988, 1989
460.0	Goleta Slough 1	34.4174	119.8260	1988
470.0	Santa Barbara Harbor	34.4052	119.6938	1988
475.0	Carpinteria Marsh	34.3973	119.5310	1988,1999
485.0	Ventura Marina	34.2414	119.2614	1988
500.0	San Miguel Island/West	34.0258	120.4275	1977, 1978
501.0	San Miguel Island/East	34.0600	120.3553	1977, 1978
502.0	Santa Cruz Island	34.0583	119.9250	1977, 1978
503.0	Anacapa Island	34.0056	119.3861	1977-1980
504.0	Santa Barbara Island	33.4833	119.0458	1977, 1978
505.0	Channel Island Harbor	34.1633	119.2242	1980, 1982
505.2	Channel Island Harbor/North	34.1800	119.2267	1986
506.0	Port Hueneme	34.1450	119.2103	1980-1982
506.1	Port Hueneme/Wharf B	34.1535	119.2096	1985-1988
506.2	Port Hueneme/Wharf 1	34.1480	119.2038	1985-1988
506.3	Port Hueneme/Entrance	34.1465	119.2112	1988
507.0	Point Mugu	34.0859	119.0578	1977, 1978
507.1	Mugu Lagoon/L Street	34.1067	119.1075	1986-1990
507.2	Mugu Lagoon/Laguna Road	34.1017	119.0950	1986-1990
507.3	Mugu Lagoon/Calleguas Creek	34.1090	119.0916	1985-1994
NOAA's National Status & Trends Mussel Watch Project				
PCPC	Point Conception	34.4438	120.4570	1986-2004
SBSB	Point Santa Barbara	34.3957	119.7275	1986-2004
SANM	San Miguel Island-Tyler Bight	34.0280	120.4193	1988
SCFP	Santa Cruz Island-Fraser Point	34.0580	119.9203	1986-2004

In southern California, there are only five sites within or near the Santa Barbara Channel. A site at San Miguel Island was only sampled once, in 1988. The four remaining sites are Fraser Point on Santa Cruz Island, Point Conception, Santa Barbara Point and Point Dume.

The most recent sampling took place in 2007-08 as a collaborative effort between NOAA and SCCWRP for Bight ’08, for which samples were collected at additional sites throughout southern California, including 13 long-term intertidal sites monitored by the Multi-Agency Intertidal Network (MARINe) partners. PBDEs were added to the list of constituents analyzed. At the time of this writing, the most recent year for which NOAA data were publicly available was 2004.

California State Mussel Watch Program

For 26 years (1977-2002), the California State Mussel Watch Program (SMWP) collected transplanted and resident mussels and clams from the waters of California's bays, harbors and estuaries. In contrast with the NOAA-MWP, SMWP primarily targeted areas with known or suspected impaired water quality. Unfortunately, not all sites were sampled over the life of the program. Five sites around the Channel Islands (two at San Miguel and one each on Santa Cruz, Anacapa and Santa Barbara Islands) were sampled from 1978 to 1980 (see Table 7.4). The mussels were collected (in addition, Anacapa received transplants which were left at the site for five months) and then analyzed for trace elements and synthetic organics. Only one site within in the CINMS was sampled again - Fraser Point at Santa Cruz Island in 2001. The SMWP program was discontinued in 2002 due to a lack of funding.

7.1.3 CalCOFI

The California Cooperative Oceanic Fisheries Investigation (CalCOFI) program is a partnership that includes the NOAA Fisheries Service, California Department of Fish and Game and Scripps Institution of Oceanography. It 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. CalCOFI researchers measure the physical and chemical properties of the California Current System and census populations of organisms from phytoplankton to avifauna. Data are collected at a series of stations along a zig-zag track throughout the waters of southern California. Research cruises are conducted quarterly. Each cruise covers a grid of 75 stations offshore of southern California (Figure 7.2).

Four of these stations are within or near the waters of the CINMS, including one south of Santa Rosa Island (CalCOFI station ID 83.51) and three within the eastern Channel north of Santa Cruz and Anacapa Islands (from west to east, CalCOFI station ID 82.47, 83.42, 83.40.6). At each station a suite of physical and chemical measurements are made to characterize the environment and map the distribution and abundance of phytoplankton, zooplankton and fish eggs and larvae. Parameters measured by CalCOFI partners include temperature, salinity and oxygen, water masses and currents, nutrients, primary production, phyto- and zooplankton biomass and biodiversity, meteorological observations, distribution and abundance of fish eggs and larvae, marine birds and mammals. The data help scientists to understand the physical dynamics of El Niño and La Niña conditions, as well as to track changes in the biological community affected by ocean climate. For example, the recent range expansion of the Humboldt Squid, *Dosidicus gigas*, in the eastern Pacific Ocean appears to have been triggered by the major ENSO event in 1997–98 (Rodhouse 2008). CalCOFI datasets provide an opportunity to explore associated changes in the pelagic ecosystem over a very large area with the interacting effects of environmental variability and change, as well as with ecological change caused by fishing. More information about sampling techniques, collaborations, results and cruise reports can be found at http://www.calcofi.org.

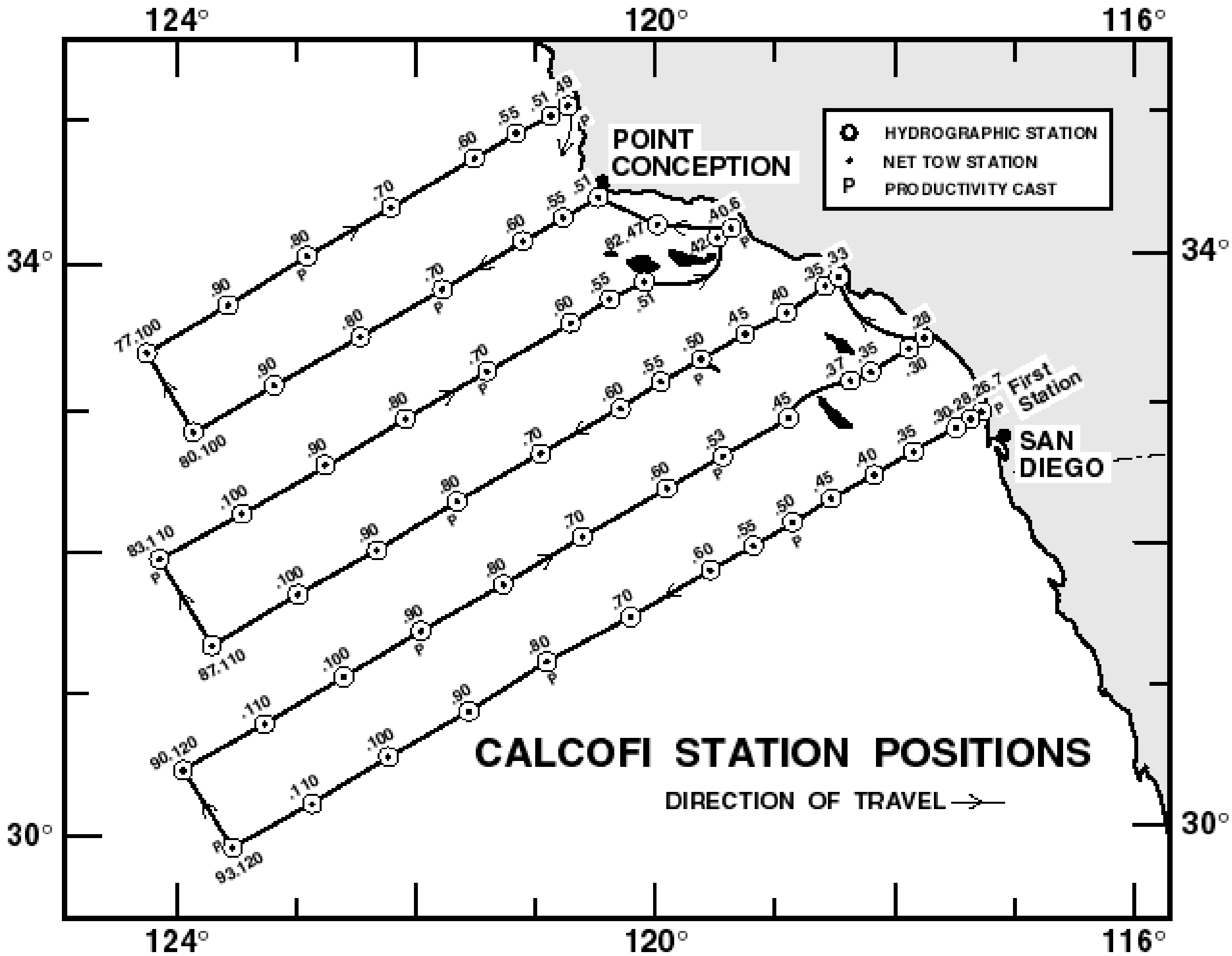

Figure 7.2
Permanent stations sampled during CalCOFI cruises

7.1.4 Long-Term Ecological Research Program Network

A network of 26 Long-Term Ecological Research (LTER) sites encompasses unique ecosystems and research approaches, investigators, students and management systems. The geographic distribution of sites ranges from Alaska to Antarctica and from the Caribbean to French Polynesia and includes agricultural lands, alpine tundra, barrier islands, coastal lagoons, cold and hot deserts, coral reefs, estuaries, forests, freshwater wetlands, grasslands, kelp forests, lakes, open ocean, savannas, streams, and urban landscapes. Each site shares a common mission and develops individual research programs in five core areas: pattern and control of primary production; spatial and temporal distribution of populations selected to represent trophic structure; pattern and control of organic matter accumulation in surface layers and sediments; patterns of inorganic inputs and movements of nutrients through soils, groundwater and surface waters; and patterns and frequency of site disturbances. There are two sites within the Southern California Bight: California Current Ecosystem and Santa Barbara Coastal.

California Current Ecosystem Long-Term Ecological Research Program

The California Current Ecosystem (CCE) LTER Program is focused on the coastal upwelling biome of the California Current System off southern California and is housed at the Scripps Research Institute. The program builds upon nearly sixty years of observations from the CalCOFI coastal ocean time series, but focuses on parameters such as currents, thermal stratification and the rate of upwelling. The CCE field sampling includes a grid of stations off the coast of southern California, a subset of the larger historical CalCOFI full grid reaching along the Pacific coast of the US from the tip of Baja to the Columbia River. A novel approach is the ongoing development of models fabricating a physical and climatic context in which to understand measurements made over the history of CalCOFI cruises. At the time of this writing, three yearly process cruises have taken place, in 2006, 2007 and 2008. Cruise reports and other information can be found on the project's website, http://cce.lternet.edu/.

Santa Barbara Coastal Long Term Ecological Research Project

The Santa Barbara Coastal Long Term Ecological Research project (SBC-LTER) is housed at the University of California, Santa Barbara (UCSB). The primary research objective of the SBC-LTER is to investigate the relative importance of land and ocean processes in structuring giant kelp (*Macrocystis pyrifera*) forest ecosystems. Focus topics include patterns, transport, and processing of organic and inorganic inputs to coastal reefs, patterns of rainfall, land use, constituents of runoff, rainfall and streamflow data for hydrologic modeling and instream processing, and ocean monitoring of biogeochemical parameters. The project maintains oceanographic moorings at four sites along the mainland (at Arroyo Quemado, Naples, Arroyo Burro, and Carpinteria). These moorings measure phytoplankton abundance (optical measure of the pigment chlorophyll A at midwater), salinity, seawater temperature, turbidity and currents. Although there are biological monitoring stations along the north side of Santa Cruz Island, no oceanographic or water quality data is collected at these locations.

7.1.5 Plumes and Blooms

The Plumes and Blooms (PnB) program seeks to understand the sources of sediment plumes and phytoplankton blooms as they relate to ocean color and to the sediment geochronology of the Santa Barbara Basin. PnB is a joint collaboration among UCSB faculty, student and staff researchers at the Institute of Computational Earth System Science (ICESS), NOAA researchers at the Coastal Services Center (in Charleston, SC) and the NOAA managers of the CINMS. Since 1996, twice-monthly research cruises visit a permanent transect of seven stations stretching across the Santa Barbara Channel from Goleta to Santa Rosa Island. Data measurements include temperature and salinity, ocean color spectra, and water column profiles of red light transmission and chlorophyll fluorescence (indices of suspended particulate load and phytoplankton abundance). These data are then related to simultaneous ocean color images from the MODIS (and SeaWiFS) satellite sensors (Figure 7.3). The project's goal is to develop new satellite ocean color algorithms to use in coastal waters influenced by terrigenous materials (sediments, dissolved organic materials, etc.) to better understand and describe the composition, concentration, and origin of suspended and dissolved materials in coastal ocean waters.

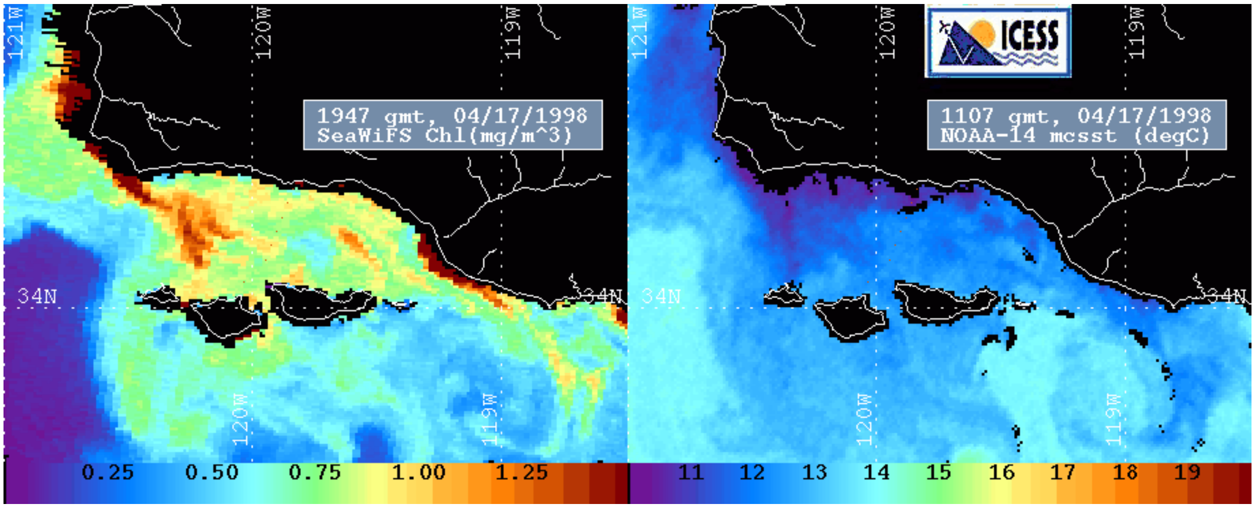

Figure 7.3
SeaWiFS/AVHRR Paired Images, April 17, 1998 of chlorophyll and sea surface temperature.

PnB, along with the SBC-LTER Project, have provided many of the physical, chemical, and biological data necessary to understand local *Pseudonitzschia* bloom dynamics. These data were used to define the optimal ranges of environmental conditions for *Pseudonitzschia* bloom development in the Santa Barbara Channel. A statistical model that combines these assessments of optimal bloom conditions with satellite ocean color (MODIS-Aqua & SeaWiFS), sea surface temperature (AVHRR), and high frequency radar determinations of surface currents will assess the probability that a remotely sensed phytoplankton bloom contains a significant population of toxic *Pseudonitzschia* (Anderson et al. 2006).

7.1.6 PISCO

The Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) is an interdisciplinary collaboration of scientists from UC Santa Barbara, UC Santa Cruz, Stanford University and Oregon State University that integrates long-term monitoring of ecological and oceanographic processes at dozens of coastal sites. With regard to water quality, PISCO partners maintain semi-permanent moorings around the Channel Islands and along the mainland which record physical oceanographic parameters including backscatter, water column temperature and current speed and direction. Sites include two at San Miguel Island, two at Santa Rosa Island and eight around Santa Cruz Island. Several sites along the mainland are shared with the SBC-LTER project. PISCO also collects biological data on a wide range of parameters in order to understand patterns of recruitment of subtidal and intertidal species along the West coast.

7.1.7 Harmful Algal Blooms Monitoring Programs and Partnerships

The Preharvest Shellfish Protection and Marine Biotoxin Monitoring Program, part of the Environmental Management Branch of the California Department of Health Services (CDHS), conducts, surveys, classifies and monitors commercial shellfish growing areas in conformance with the National Shellfish Sanitation Program. The program also monitors numerous points along the California coastline for marine biotoxins in shellfish and toxigenic phytoplankton in the water. Since 1992, the CDHS has enlisted the help of more than 20 research institutions to collect water samples along the California coast on a weekly basis. These water samples are then shipped to the CDHS in northern California for laboratory analyses (species identification, cell concentration, chemical analyses, etc.). The CDHS then compiles the data and releases Monthly Biotoxin Reports that describe the health of California's coastal waters. Warnings are issued or quarantines established as needed for recreational and commercial shellfish harvesting. The purpose of the program is to establish sanitary requirements for shellfish-growing waters and to regulate the commercial growth and harvest of shellfish to assure that shellfish are safe for human consumption.

HAB-TrAC (Harmful Algal Blooms and Trophic Associations along the Californian Coast) is funded by the University of California Marine Council (UCMC) and is a collaboration among researchers at UC Santa Cruz, UC Santa Barbara and UC San Diego. Project researchers are studying toxic phytoplankton species along 500 miles of Californian coastline in order to give a spatial and temporal perspective on toxic species in California, to better identify the toxin threat to humans, marine animals, and fisheries, and to assist with the State's existing monitoring program.

7.1.8 Body Burdens and Tissue Testing

Organochloride pollutants (DDTs and PCBs) are ubiquitous environmental contaminants that have been banned in most countries, but considerable amounts continue to cycle the ecosphere. Top trophic level predators like sea birds and marine mammals bioaccumulate these lipophilic compounds, reflecting their presence in the environment. Although there is no comprehensive ongoing program to test these contaminants in higher predators, there have been several recent studies within the geographic scope of this report.

Sea Lions

A study in 2002 by researchers from UC Santa Cruz examined pesticide residues in sea lions throughout central and southern California (Le Boeuf et al 2002). See Section 8.1.3 for a discussion of the results.

Bald Eagles

Bald eagles have been recently reintroduced to the Northern Channel Islands and are nesting on Santa Cruz and Santa Rosa Islands. The effect of legacy contaminants still in the food chain will be examined by researchers from the Institute of Wildlife Studies and National Fish and Wildlife Service. Samples of eagle blood and prey tissue have been collected but at the time of this writing the results were not available.

Fish

Resource managers are concerned that offshore oil platforms in the Santa Barbara Channel may be contributing to environmental contaminants accumulated by marine fishes. To examine this possibility, 18 kelp bass (*Paralabrax clathratus*), 80 kelp rockfish (*Sebastes atrovirens*), and 98 Pacific sanddab (*Citharichthys sordidus*) were collected from five offshore oil platforms and ten natural areas during 2005-2006 for whole-body analysis of 63 elements. The final report, titled *Whole-body Concentrations of Elements in Kelp Bass, Kelp Rockfish, and Pacific Sanddab from Offshore Oil Platforms and Natural Areas in the Santa Barbara Channel, California,* is available online at http://www.mms.gov/omm/pacific/enviro/Studies/2009-019-Reproductive-Ecolog.pdf.

During Bight '03, fish were collected in trawl samples from 210 stations from Point Conception to the US-Mexico border at depths of 2-476 meters. Demersal fish and invertebrate fauna of the upper slope (200-500 m) were surveyed in addition to the mainland shelf, bays and harbors, and Channel Islands sampled during Bight '98. This study included many of the same assessments of the health of the fauna for comparison to previous surveys. However, it included a detailed study of ectoparasitism in fishes relative to POTW areas and an assessment of bioaccumulation in pelagic forage fish and squid to better assess potential health risks to seabird and marine mammal predators.

Another recent study conducted under the auspices of California's Office of Environmental Health Hazard Assessment (OEHHA) examined levels of certain contaminants in fish from coastal areas of Southern California in order to determine whether harmful health effects might occur in humans from regular consumption of these fish. A total of 1,373 fish from 22 species were collected from coastal waters from Ventura Harbor to San Mateo Point in Orange County. Fish were analyzed for one or more of the following contaminants: PCBs, DDT, chlordane, dieldrin and mercury. After evaluating the data, OEHHA developed a health advisory and safe eating guidelines for fish from these areas. For a summary of the study and its results, see http://www.oehha.ca.gov/fish/so_cal/socal061709.html.

7.1.9 Water Quality at Island Anchorages

In partnership with the CINMS, Santa Barbara Channelkeeper conducted a pilot project at selected island anchorages from 2005 to 2007. The specific goals of the project were to assess and identify suitable monitoring locations for longer term water quality assessment in the Sanctuary; collect water samples at popular anchorages as well as areas that support large marine mammal or seabird colonies; and analyze those samples for the three common bacterial indicators routinely tested for in coastal communities (total coliform, *E. coli* and Enterococcus). Channelkeeper used the IDEXX Laboratories, Inc. Quanti-Tray® methodology, which has become the standard in ambient and wastewater testing facilities worldwide.

From May to October 2005, Channelkeeper collected 35 samples from 14 locations around Santa Cruz and Anacapa Islands. Between May 2006 and May 2007, Channelkeeper processed a total of 46 water samples collected at 27 locations around the four Northern Channel Islands. Sampling ceased in May 2007. See Section 8.1.5 for a summary of the results.

7.1.10 Channel Islands National Park Service Kelp Forest Monitoring Program

The Channel Islands National Park (CINP) has been conducting annual monitoring at 36 nearshore island sites since 1982 as part of the Kelp Forest Monitoring Program (KFM). The only relevant water quality parameter monitored as part of this program is bottom temperature, via in-situ loggers, although the program also includes extensive surveys of algal, invertebrate, and fish abundances. Data points can be recorded every few minutes, which can detect rapid changes in temperature due to tidal current or upwelling events, in addition to seasonal trends. The loggers are uploaded periodically during KFM research cruises. This information will be critical for evaluating ecosystem stress during future El Niño events, as warm water may trigger diseases such as Withering Foot Syndrome and Echinoderm Wasting Disease. Sea surface temperature often differs from that along the bottom even in near-shore habitats. Additionally, bottom temperatures can change by 10 degrees F or more due to tidal or wind-driven currents.

7.1.11 Channel Islands Streams

Water quality in streams discharging to the ocean has not been widely monitored at the islands. Suspended sediment is detected in water surrounding the islands after runoff events, which may be the combined product of resuspension of marine sediment on the coastal shelf combined with sediment discharge from coastal streams.

A history of stream sampling at the Channel Islands and the results of basic water quality measurements were summarized in Engle (2006). Synthetic organics, trace metals, and other anthropogenic contaminants have not been measured in stream water on the islands. There are no current urban, agricultural or industrial land uses on the islands, but herbicide (Garlon 3A) was used to reduce fennel (a non-native invasive species) on Santa Cruz Island during the recent feral pig eradication program. Ongoing efforts by the National Park Service, The Nature Conservancy and others to control non-native plants occasionally include the limited use of this and other herbicides. Stream water quality data are available from only one site on Santa Cruz Island (in 1993), while none are available for San Miguel Island. Anacapa and Santa Barbara Islands have no streams, so runoff from these islands is diffuse.

Two hundred and fifty years of sheep and cattle ranching on Santa Rosa led to extensive watershed and stream channel degradation, with streams impaired by high levels of turbidity, bacteria, nutrients and pH. In 1995, the California Central Coast Regional Water Quality Control Board, through a Cleanup and Abatement Order, directed the Channel Islands National Park to correct cattle grazing and road-related water quality problems on Santa Rosa Island. The order alleged that the park, by permitting improper road and riparian grazing management practices, was discharging unlawful concentrations of bacteria and sediment into waters of the State in violation of the Central Coast Basin Plan (Wagner et al 2006). Due to growing concerns over the effects of grazing, three streams on Santa Rosa were monitored for basic water quality parameters[30] approximately yearly from 1993-1998, and less frequently afterwards (2002, 2005, and more recently by UCSB). In 1998, cattle were removed from the island, and the introduced deer population was reduced by a third. By 2002, turbidity was the only water quality parameter measured at stream sites on Santa Rosa that continued to exceed water quality standards.

7.2 Water Quality Monitoring Programs along the Mainland Coast

Table 7.5 provides a summary of the programs collecting information from along the mainland coast.

[30] Parameters monitored included temperature, pH, conductivity, turbidity, dissolved oxygen, nitrogen, phosphorous, total suspended solids, total dissolved solids, and indicator bacteria.

Table 7.5
Summary of monitoring programs along mainland coast and watersheds.

Group	Type	Parameters	Location	Interval	Length of Data Series	For More Information
USGS	Federal partnership	Stage height, flow	30 sites throughout SB and Ventura counties	continuous	25+ years	http://waterdata.usgs.gov/nwis
CCAMP-RWQCB	State-Regional Agency	Bacteria, VOC, metals, pesticides, nutrients	31 sites within SB County coastal region	Every 5 years	2001, 2008	www.ccamp.org
City of Santa Barbara	Local Agency	7 WQ parameters, bacteria	4 creeks within city	weekly	2001-2003, ongoing	http://www.santabarbaraca.gov/NR/exeres/50166303-1F6C-412A-8451-8570FBD5D86B,frameless.htm?NRMODE=Published
Santa Barbara County Environmental Health Service	Local Agency	bacteria	20 beaches within SB County	weekly	1996-present	http://www.sbcphd.org/ehs/ocean.htm
Santa Barbara County Project Clean Water	Local Agency	benthic macro invertebrate (BMI)	7 creeks in southern SB County	annually	2000-2008	http://www.sbprojectcleanwater.org/oceancreek.htm
Santa Barbara County Project Clean Water	Local Agency	Bacteria, VOCs, metals, pesticides, nutrients	Urban creeks in SB County	Dependent on storms	'first flush' / 4 major storms 1999-2003	http://www.sbprojectcleanwater.org/oceancreek.htm
Ventura County Environmental Health	Local Agency	bacteria	53 beach sites	weekly	1998-2008	http://www.ventura.org/envhealth/programs/ocean/mission.htm
Ventura County Stormwater Quality Management Program	Local Agency	Numerous parameters	Numerous sites throughout Ventura County	Varies	1997-present	http://www.vcstormwater.org/programs_monitor.html
Santa Barbara Channelkeeper Stream Team	NGO-volunteer	7 WQ parameters, nutrients, bacteria	17 sites Ventura River watershed; 16 sites Goleta Slough watershed	monthly	2001-present, ongoing	www.sbck.org www.stream-team.org

7.2.1 Federal Programs

The US Geological Survey (USGS) collects and analyzes chemical, physical, and biological properties of water, sediment and tissue samples from across the nation. The discrete sample results comprise a large and complex set of data that has been collected by a variety of projects ranging from national programs to studies in small watersheds. The USGS National Water Information System (NWIS) is a comprehensive and distributed application that supports the acquisition, processing, and long-term storage of water data. NWISWeb serves as the publicly available portal to much of the water data maintained within NWIS.

There are 16 sites in southern Santa Barbara County and 14 within the Ventura River watershed where automated equipment records real-time data on flow rate and stage height, representing the most current hydrologic conditions.

7.2.2 State Programs

Surface Water Ambient Monitoring Program

The Surface Water Ambient Monitoring Program (SWAMP) is a statewide monitoring effort designed to assess the conditions of surface waters throughout California. SWAMP integrates the existing water quality monitoring activities of the SWRCB and the nine Regional Water Quality Control Boards and coordinates with other monitoring programs. The program is administered by the SWRCB, while responsibility for the implementation of monitoring activities resides with the RWQCBs. Monitoring is conducted through the Department of Fish and Game and USGS master contracts as well as local RWQCB monitoring contracts.

For the purposes of SWAMP, ambient monitoring refers to these activities as they relate to the characteristics of water quality. Only a small portion of SWAMP can be implemented by each region at current funding levels. As a result, resources are focused where monitoring information is most needed to support regional program priorities, such as maintaining high quality waters or supporting restoration of priority watersheds.

SWAMP also aims to capture monitoring information collected under other SWRCB and RWQCB programs such as the State's Total Maximum Daily Load (TMDL), Nonpoint Source, and Watershed Project Support programs. SWAMP does not conduct effluent or discharge monitoring.

No monitoring of Channel Islands coastal waters (including Anacapa and Santa Barbara Islands) has been conducted by SWAMP to date because this area has been sampled by the Bight-wide comprehensive monitoring projects conducted in 1994, 1998, 2003 and 2008.

Central Coast Region Ambient Monitoring Program

The Central Coast Ambient Monitoring Program (CCAMP), a component of SWAMP, is the Central Coast RWQCB's regionally scaled water quality monitoring and assessment program. The purpose of the program is to provide scientific information to RWQCB staff and the public to protect, restore, and enhance the quality of the waters of Central California. CCAMP has a number of objectives, including to determine the status and trends of surface, estuarine and coastal water quality and associated beneficial uses in the Central Coast region; to coordinate with other data collection efforts; and to provide information in easily accessible forms to support decision-making.

The CCAMP monitoring strategy for watershed characterization divides the Central Coast region into five watershed rotation areas and conducts synoptic, tributary-based sampling each year in one of the areas. Over a five-year period, all of the hydrologic units in the region are to be monitored and evaluated. Additional monitoring sites are established in each area to provide focused attention on watersheds and water bodies of special concern. Thirty-one sites are allocated within the sampling area; in addition, long-term coastal confluence sites are monitored continuously on a monthly basis at eight creek mouths throughout the region. The CCAMP program design includes monthly monitoring for conventional water quality parameters at all selected sites. At a subset of sites, generally selected based on hydrogeomorphological considerations or local issues of concern, other monitoring approaches are applied. These include sediment chemistry and toxicity, fish and freshwater clam tissue chemistry, benthic macroinvertebrate assessment and habitat assessment.

The Santa Barbara Hydrological Unit was sampled in 2001 and 2008. In 2006, due to limitations in budget and staff and the need to process the 303(d) listings, the schedule was modified and sampling did not occur.

CCAMP staff collected benthic macroinvertebrates (BMIs) following California Stream Bioassessment Protocols (Harrington 1999) in two consecutive spring seasons at each site. The data were then evaluated to answer the following questions posed in the SWAMP Monitoring Guidance related to beneficial use support:

- Is there evidence that it is unsafe to swim?
- Is there evidence that it is unsafe to drink the water?
- Is there evidence that it is unsafe to eat fish or other aquatic resources?
- Is there evidence that aquatic life uses are not supported?
- Is there evidence that water is unsafe for agricultural use?
- Is there evidence of impairment to aesthetics or other non-contact recreational uses?

7.2.3 Local Programs

City of Santa Barbara

The City of Santa Barbara has conducted an extensive water quality monitoring program in its creeks since May 2001. From 2001-2003, the City focused on gathering baseline data, primarily for bacterial pollution and habitat quality. The City conducted weekly sampling for indicator bacteria at over 30 sites in the Arroyo Burro, Laguna Channel, Mission, and Sycamore Creek watersheds. Spot samples were also collected for some chemical pollutants. In 2004, the City's water quality monitoring program was expanded to focus on chemical pollutants throughout the City, treatment/restoration project performance, and water quality during storm events.

The City currently conducts weekly and monthly sampling at key points in the watersheds and focuses on measuring indicator bacteria and habitat quality as part of its routine watershed assessment monitoring. The sampling program is designed to ask the following questions: Is overall water quality in our watersheds getting better over time? Are new hot spots emerging? Storm event sampling aims to determine which pollutants are a problem throughout each watershed and the effectiveness of reducing pollutants during storm events. The City attempts to sample two storms, including the "first flush" and one of the larger storms of the year. The sampling strategy is designed to ask: Which pollutants are seen at high levels during storm events? How do restoration/treatment projects impact water quality during storm events? How do these answers change during a storm hydrograph?

Santa Barbara County

In 1996, Santa Barbara County Environmental Health Services (EHS) began conducting weekly testing of 20 County beaches along the mainland for the indicator bacteria for which current State health standards exist: total coliform, fecal coliform, and enterococcus. This sampling program was launched in response to public concern about deteriorating ocean water quality and the need to protect public health. As part of the program, EHS announced their results in weekly press releases to several media sources and interested groups and compiled a database of the results to help understand trends and possible causes. However, in mid-2008 the Santa Barbara County Board of Supervisors eliminated funding for the sampling effort during the winter months (funding for testing from April through October is provided by the State) and EHS ceased conducting weekly sampling in late October 2008. Santa Barbara Channelkeeper took over the weekly sampling from November 2008 through May 2009. The County resumed weekly bacteria testing at a subset of County beaches in May 2009 and continued until the end of October, when Channelkeeper again took on the task during the months of November-March. Beginning in 2009, the County now provides funding for Santa Barbara Channelkeeper to conduct the weekly sampling during the months of November-March and resumes the sampling during the months of April-October (when the sampling is mandatory and State and federal funds are available to support it).

The Santa Barbara County Board of Supervisors established Project Clean Water (PCW) in 1998 to identify and implement solutions to creek and ocean water pollution. PCW's mission is to protect public health and enhance environmental quality in Santa Barbara County watersheds and beaches. One of the first County efforts under PCW was to begin characterizing water quality in the urban creeks in southern Santa Barbara County. The South Coast Watershed Characterization Study was prepared from monitoring data collected during the winter of 1998-99. Subsequent years saw increased funding for monitoring and PCW expanded the sampling to many more watersheds receiving urban runoff.

Due to funding cuts beginning in 2002, ambient creek monitoring was reduced and eventually eliminated from the PCW program. During the 2006 budget review process, a one-time allocation was provided to PCW by the Board of Supervisors to fund limited sampling. This sampling program targeted constituents of concern in 303(d) listed water quality limited streams receiving urban runoff, including the in Carpinteria area, the Goleta area, and Orcutt. Water monitoring by the County is now limited to annual spring-time monitoring of benthic macroinvertebrates (BMI) to help assess the long-term biological health of creeks.

Ventura County

In September 1998, the Ventura County Board of Supervisors directed the Environmental Health Division to develop a program to monitor the bacteriological quality of ocean water at Ventura County beaches. Over 50 beach locations along the 42-mile Ventura County coastline were sampled each week until 2007, when the number of beaches sampled was cut to ten due to a decrease in funding. As in Santa Barbara County, winter beach testing terminated in 2008 when County funding for this program was eliminated.

The Ventura Countywide Stormwater Quality Management Program conducts storm water monitoring each year as required by its municipal storm water permit. The monitoring program characterizes storm water discharges from monitoring sites representative of industrial, agricultural, and residential land uses; establishes the impact of storm water discharges on receiving waters by conducting monitoring of receiving water quality, mass emission, and bioassessment; identifies pollutant sources based on analysis of monitoring data, inspection of businesses, and investigation of illicit discharges; and defines storm water program effectiveness using data collected before and after implementation of pollution prevention programs (Ventura Countywide Stormwater Quality Management Program 2008).

Santa Barbara Channelkeeper’s Stream Team

Santa Barbara Channelkeeper's Stream Team program provides comprehensive and long-term monitoring of conditions in local watersheds. Ventura Stream Team began early in 2001 as a partnership between Santa Barbara Channelkeeper and the Ventura Chapter of the Surfrider Foundation. The Goleta Stream Team began in the summer of 2002 as a partnership between Channelkeeper and the Isla Vista Chapter of the Surfrider Foundation. Both have become programs managed by Channelkeeper. Channelkeeper is planning to launch a new Carpinteria Stream Team program in the summer of 2010 with sites in Carpinteria, Franklin, Santa Monica and Arroyo Paredon creeks as well as the Carpinteria Salt Marsh.

Stream Team has three basic goals: (1) to establish a baseline of information about stream conditions in the watershed; (2) to establish a trained volunteer monitoring base; and (3) to locate previously unidentified point sources of pollution.

Stream Team conducts monthly testing of the Ventura River, Goleta Slough and their major tributaries at designated sampling sites. At the beginning of each month, teams of volunteers measure physical and chemical parameters in the field using portable, hand-held instruments. Data collected includes on-site measurements of dissolved oxygen, turbidity, conductivity, pH, temperature and flow. Water samples, collected at each site, are processed in Channelkeeper's laboratory for three Public Health bacterial indicators using approved standard methodology (Colilert-18 and Enterolert-24, manufactured by Idexx Laboratories; US EPA, 2003). Additional samples are analyzed for nutrients through the cooperation of the Santa Barbara Coastal Long Term Ecological Research (SBC-LTER) Project at UCSB. The nutrient parameters measured are ammonium, nitrite plus nitrate, orthophosphate, total dissolved nitrogen and total dissolved phosphorus. Characteristics such as vegetation and observed aquatic life are also recorded at each site. Occasionally, tests for other ions and contaminants are conducted. Comprehensive reports describing the findings of both the Ventura and Goleta Stream Team monitoring programs can be found at http://www.stream-team.org.

8. Existing Water Quality Conditions

While there is a consensus among resource managers and the scientific community that water quality in the Sanctuary is generally good,[31] relatively little specific information about actual water quality conditions in the CINMS is currently available. The following section provides a brief summary of the water quality data that is available for waters in and near the Sanctuary.

8.1 CINMS and Santa Barbara Channel Waters

8.1.1 Geographical Patterns of Sediment Contamination

This section condenses the most recent available data from surveys of sediment chemistry and toxicity throughout the Southern California Bight (Bight) conducted in 1994, 1998, 2003 and 2008 by the Southern California Coastal Water Research Project (SCCWRP) (referred to hereinafter as Bight '94, '98, '03, and ’08 respectively) (Schiff & Gossett 1998, Noblet et al. 2003, Schiff et al. 2006).

Sampling sites for Bight '94 and '98 were distributed among 11 geographical strata: mainland shelf (5-30 m, 30-120 m, 120-200 m), upper mainland slope (200-500 m), lower slope and basin (500-1,000 m), embayments (marinas, ports, bays, harbors), estuaries (Los Angeles area estuaries, other estuaries), and large (>100 mgd) and small (<100 mgd) POTWs. Sites within the CINMS offshore from the Channel Islands (30-120 m) were added during Bight '03 (Figure 8.1).

In the Bight surveys, SCCWRP analyzed sediments for grain size, total organic carbon (TOC) and total nitrogen (TN), trace metals (antimony, arsenic, barium, cadmium, chromium, copper, lead, nickel, silver, selenium, and zinc), total PAH (sum of 24 individual compounds), total PCB (sum of 41 different congeners), total DDT, total chlordane (alpha and gamma isomers), and toxicity (amphipod survival tests). Results from Bight '94 and '98 related to geographical strata in or near the CINMS, and preliminary results of Bight '03 were previously summarized in Engle (2006). Selected results of the Bight '03 survey are summarized below.

The three ocean dredged material disposal sites closest to the CINMS (LA-1 off Port Hueneme [34°05'00"N, 119°14'00"W] - inactive; LA-2 off Los Angeles and Long Beach, [33°37'06"N, 118°17'24"W] - last used in 2001; and LA-3 off Newport Beach in Orange County [33°31'42"N, 117°54'48"W], interim site last used in 2006) were not evaluated as a separate stratum in the Bight surveys, but are described as a recommended focus of future Bight surveys (Schiff et al. 2006). Steinberger et al. (2000) examine the contribution of dredged material disposal to contaminant loads in the Bight. Interested readers may consult the US Army Corps of Engineers' Ocean Disposal Database (at http://el.erdc.usace.army.mil/odd/CE_Overall.htm) for records of activity at these sites. All of the active dredge disposal sites in the Bight are located in depths greater than 200 m, which reduces the extent to which contaminants from these sites will be advected out of their respective basins.

[31] See CINMS 2009 Condition Report at http://sanctuaries.noaa.gov/science/condition/cinms/download.html.

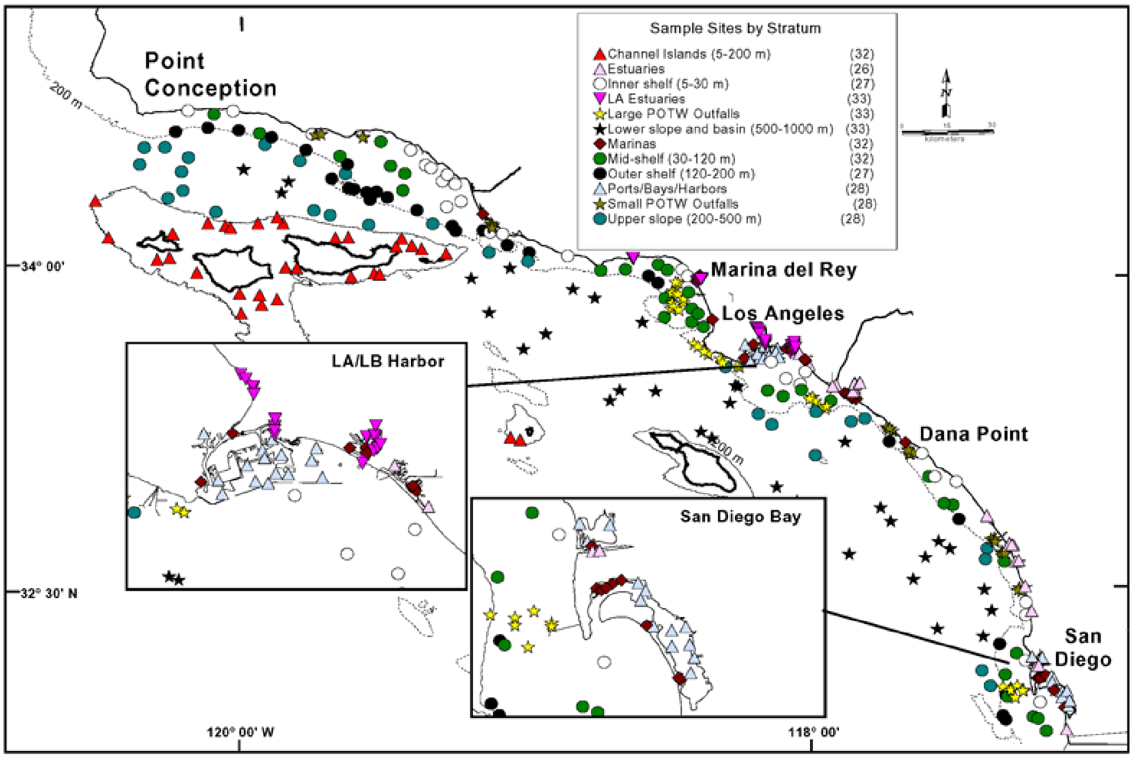

Figure 8.1
Sediment sampling sites for Bight 2003 (from Schiff et al. 2006).

Consistent spatial patterns in sediment contamination were observed during Bight '94, '98, and '03. Within the Bight as a whole, the highest concentrations of trace metals and several organic constituents have been observed in sediments from marinas, estuaries draining urbanized watersheds, and industrialized port facilities. When the areal extent of strata is considered in combination with concentrations of constituents in sediment, an average of 76% (range 70-87%) of the accumulated mass of constituents in the top two centimeters of sediment in the Bight is located at depths greater than 200 m (the mainland slope and basins).

Total DDT was the most widespread sediment contaminant detected, enriching 71% of Bight sediments. DDT was detected in sediments at the Channel Islands, and the mean for the islands (1.6 µg DDT/kg) was slightly higher than the mean for small POTWs in the Bight (1.2 µg DDT/kg). The shelf sediments off the Palos Verdes Peninsula and in Santa Monica Bay are the most significant source of total DDT and PCBs in the Bight (Figure 8.2 and Figure 8.3). This contamination stems primarily from the historic discharge of contaminated effluent through the ocean outfall of the Joint Water Pollution Control Plant (a Los Angeles County POTW on the peninsula), commonly referred to as the White's Point Outfall (Schiff & Gossett 1998). The history and current status of contamination stemming from this point source, related nearby sources (such as historic ocean dumping of DDT), and the consequences of bioaccumulation of DDT in marine birds and other biota, are summarized in Engle (2006).

Within the Santa Barbara Channel, spatial patterns of sediment contamination varied among analytes. For example, cadmium was more concentrated in deep water sediments of the Santa Barbara Channel and on the shelf surrounding the Channel Islands than it was in the mainland shelf from Santa Barbara to Point Mugu (Figure 8.4). The opposite pattern was observed for arsenic (Figure 8.5). More mercury was contained in the sediments on the mainland shelf than on the shelf surrounding the Channel Islands (Figure 8.6). PAH was more concentrated in sediment on the shelf surrounding the Channel Islands than it was in deeper waters of the Santa Barbara Channel (Figure 8.7). 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 (e.g., 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 crude oil platforms and/or the natural hydrocarbon seeps at the islands and in the Channel.

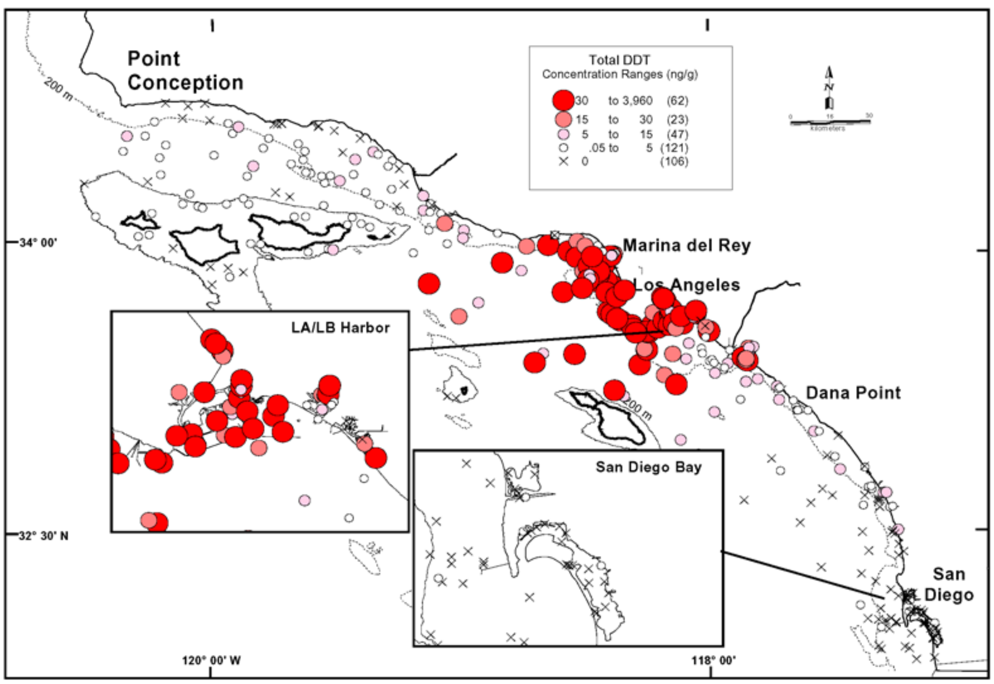

Figure 8.2
Concentration of total DDT in sediment sampled during Bight 2003 (from Schiff et al. 2006).

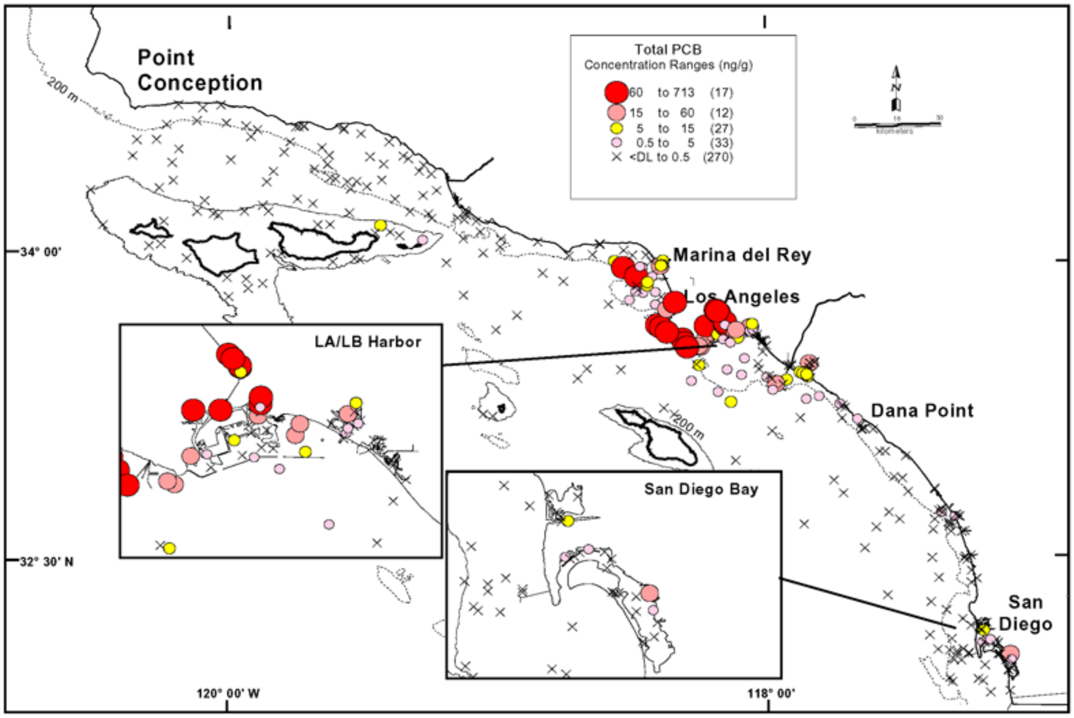

Figure 8.3
Concentration of total PCBs in sediment sampled during Bight 2003 (from Schiff et al. 2006).

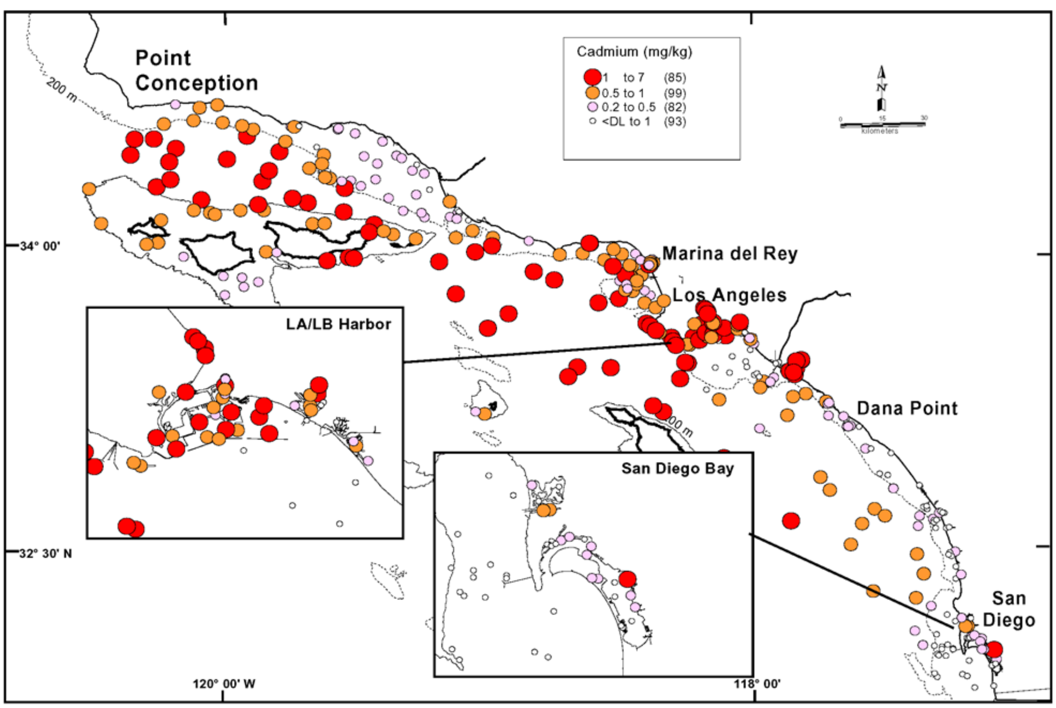

Figure 8.4
Concentration of cadmium in sediment sampled during Bight 2003 (from Schiff et al. 2006).

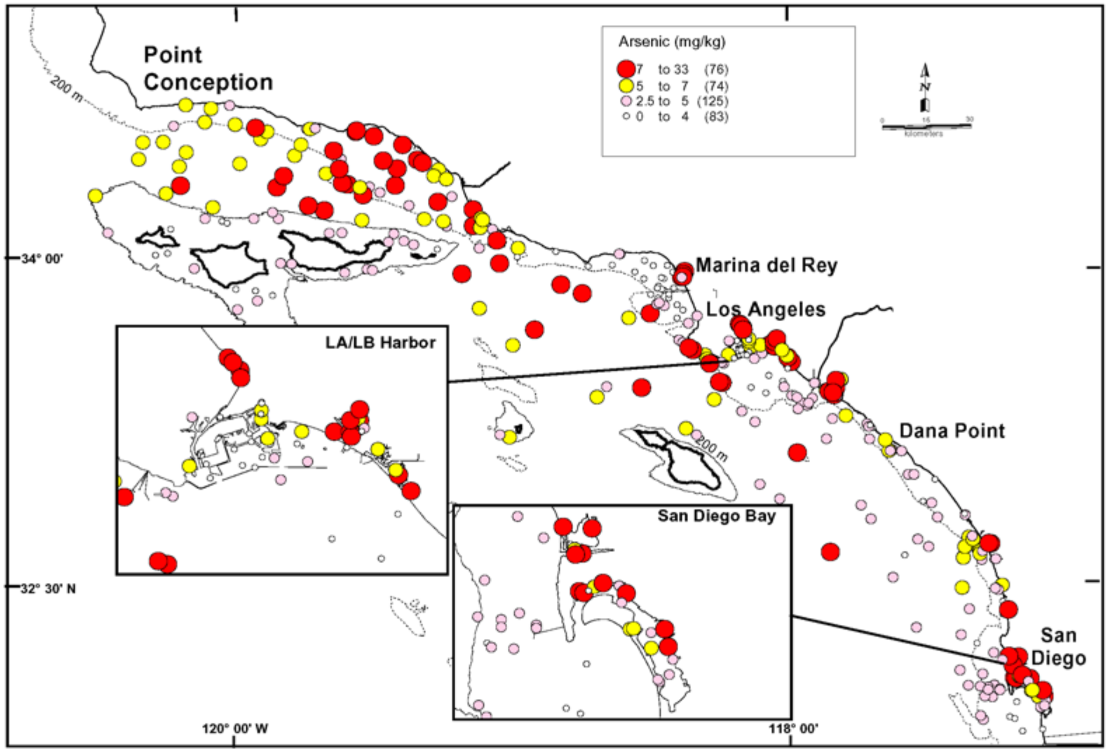

Figure 8.5
Concentration of arsenic in sediment sampled during Bight 2003 (from Schiff et al. 2006)

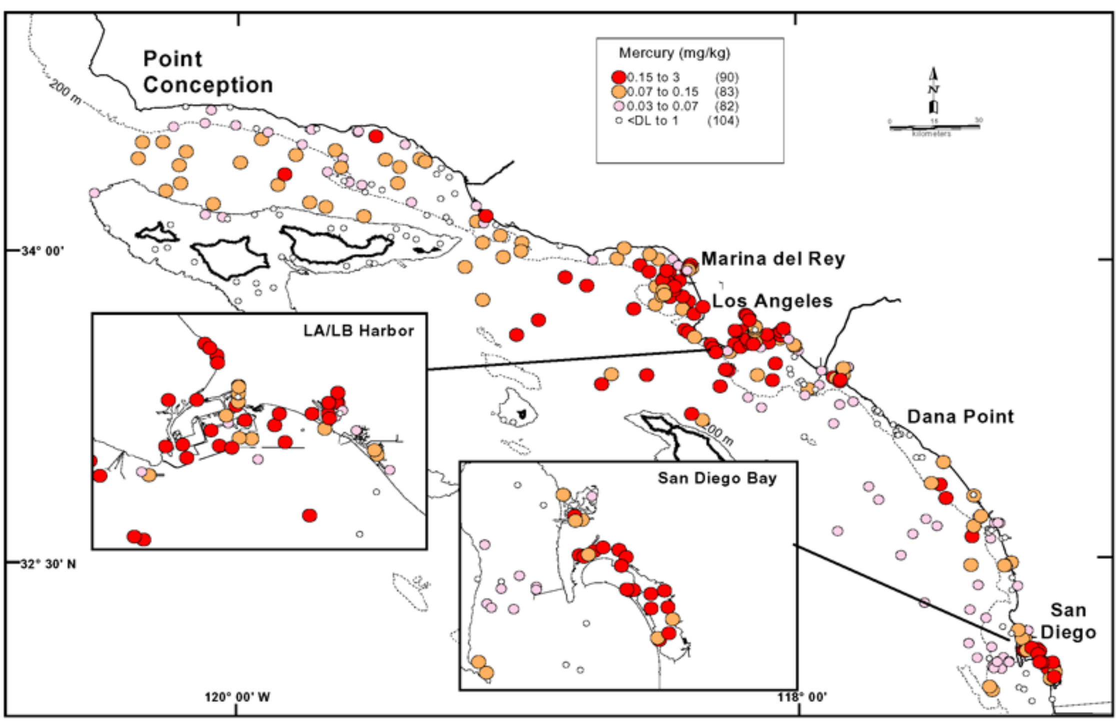

Figure 8.6
Concentration of mercury in sediment sampled during Bight 2003 (from Schiff et al. 2006).

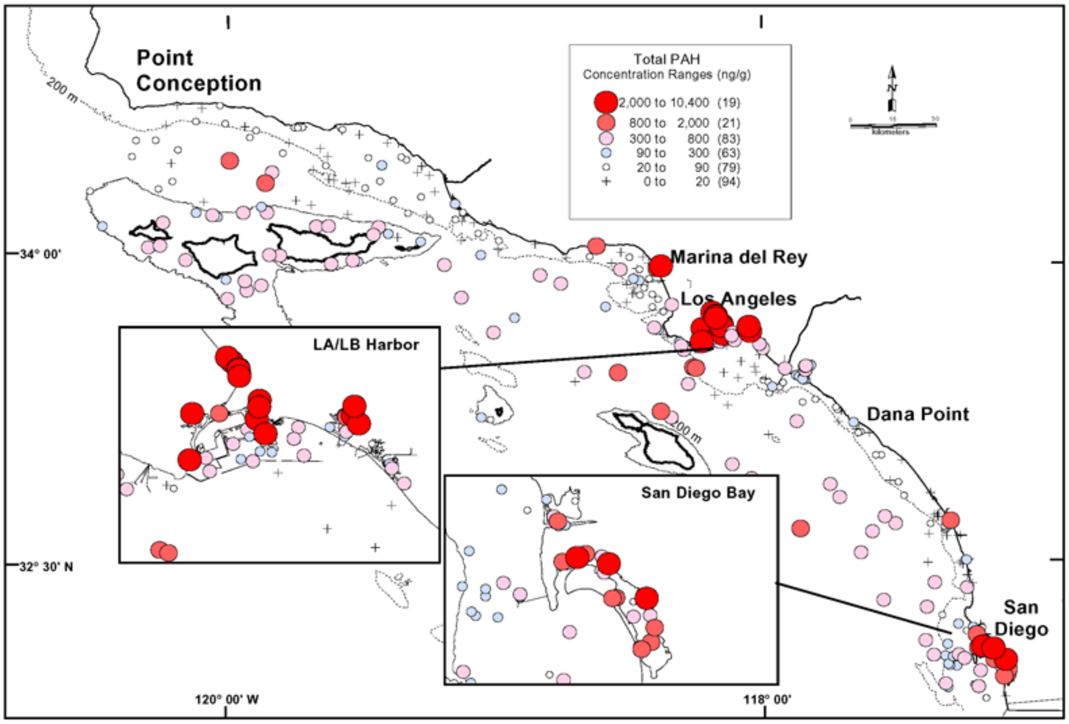

Figure 8.7
Concentration of total PAHs in sediment sampled during Bight 2003 (from Schiff et al. 2006).

8.1.2 Sediment Toxicity

Three approaches were used in Bight '03 to assess the potential toxicity of contaminated sediments. The first approach, developed by NOAA (Long et al. 1995), uses two concentration thresholds empirically derived based on relationships between observed biological responses and the measured concentrations of sediment contaminants. The effects range low (ERL) and the effects range median (ERM) correspond to the 10th and 50th percentiles of measured sediment characteristics, respectively, in a nationwide data set. Statistically speaking, concentrations below the ERL are found in sediments that are unlikely to have adverse effects on biota exposed to them. Concentrations above the ERM are found in sediments that are likely to result in adverse biological effects. In a second approach, a sediment quality guideline quotient (in this case, the ERMQ) was calculated as the mean quotient (C/ERM) of sediment concentration (C) and the ERM for several constituents to account for possible additive toxic effects. The third approach was direct toxicity evaluations measuring survival rates of amphipods in laboratory exposure tests (Bay et al. 2005).

Although sediment contaminants were widespread in the Bight, less than 1% of the Bight contained contaminants at concentrations presenting a high risk of acute toxicity[32] for benthic organisms (Figure 8.8). Only 1% of the Bight was at a moderate to high risk of adverse biological effects based on the mean effects range median quotient (ERMQ > 0.5). The greatest

[32] Acute is defined as sufficient to cause severe biological harm or death soon after a single exposure or dose.

risk was found in sediments of marinas, Los Angeles area estuaries, and large POTWs; these were the only strata whose mean ERMQ exceeded 0.5. The lowest risk was observed at the Channel Islands and near small POTWs. Where biological exceedances of ERLs and ERMs occurred, they were usually for total DDT (Figure 8.9). However, 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. Most Bight sediments, including those in the CINMS, had healthy benthic communities and were not acutely toxic based on amphipod survival tests (Figure 8.10).

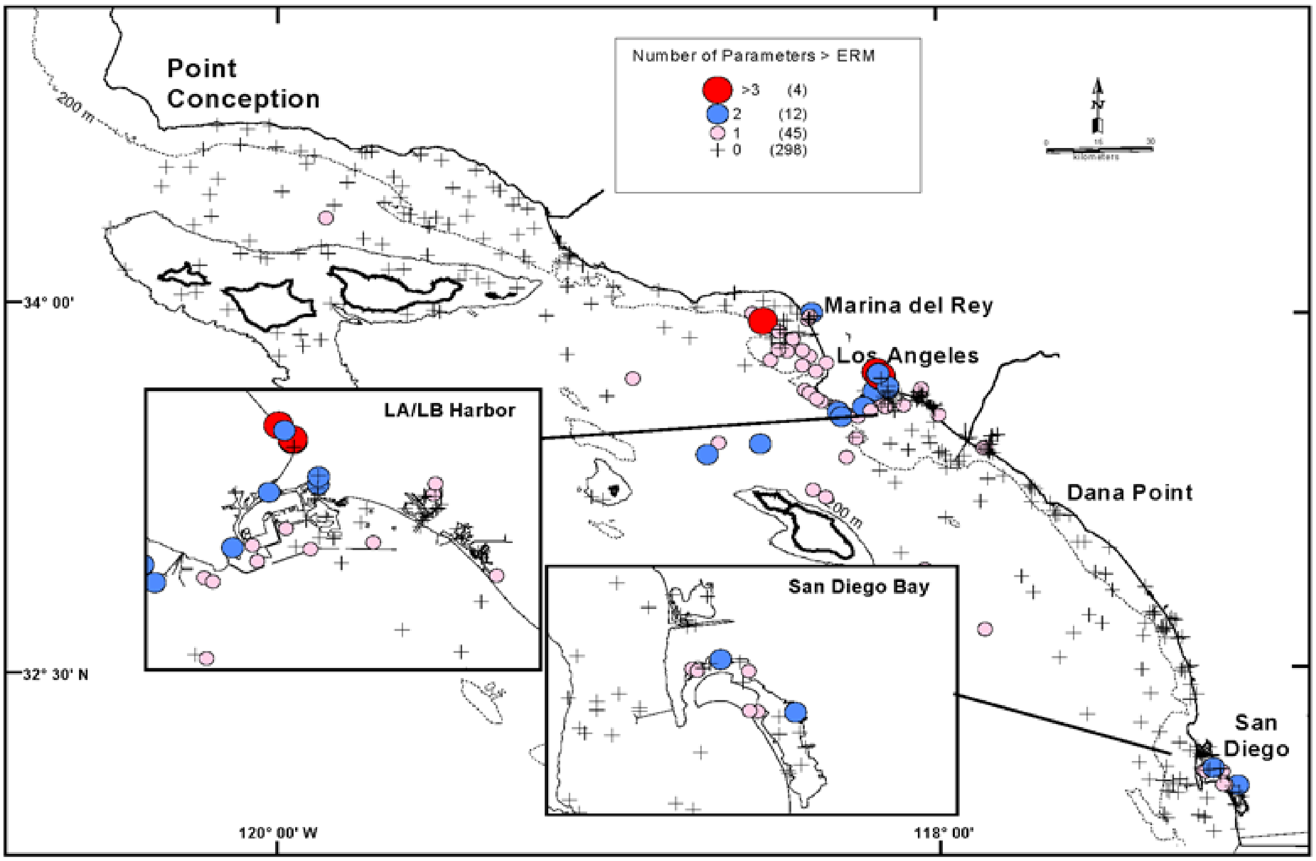

Figure 8.8
Number of constituents at Bight 2003 sediment sites for which the sediment concentrations exceeded the effects range median (ERM) (from Schiff et al. 2006).

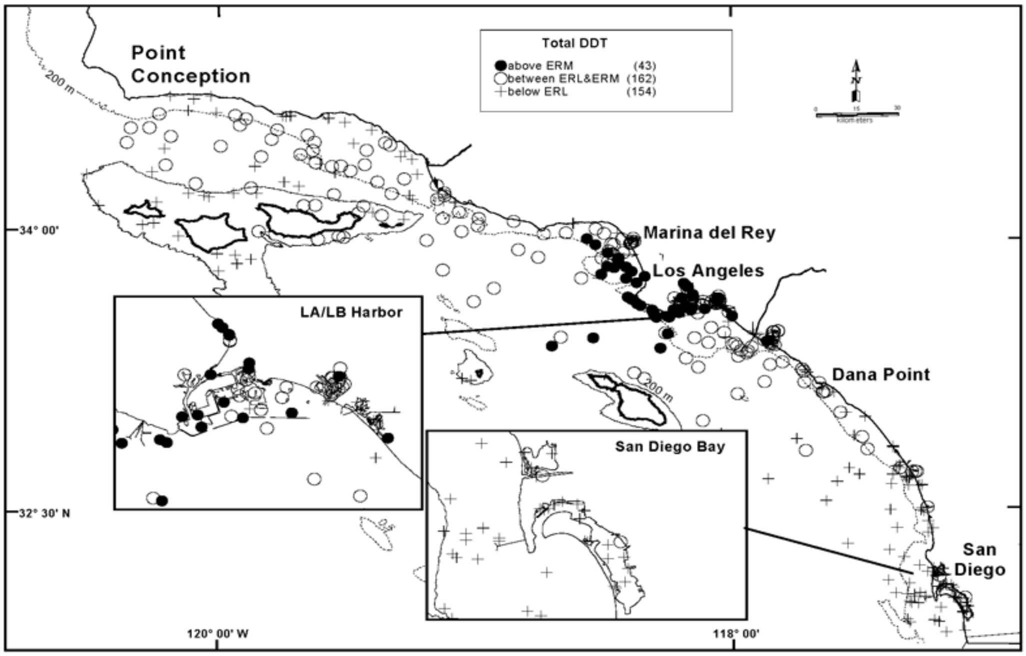

Figure 8.9
Ranking of Bight 2003 sediment sites according to whether total DDT concentrations in sediment exceeded the ERL and/or ERM (from Schiff et al. 2006).

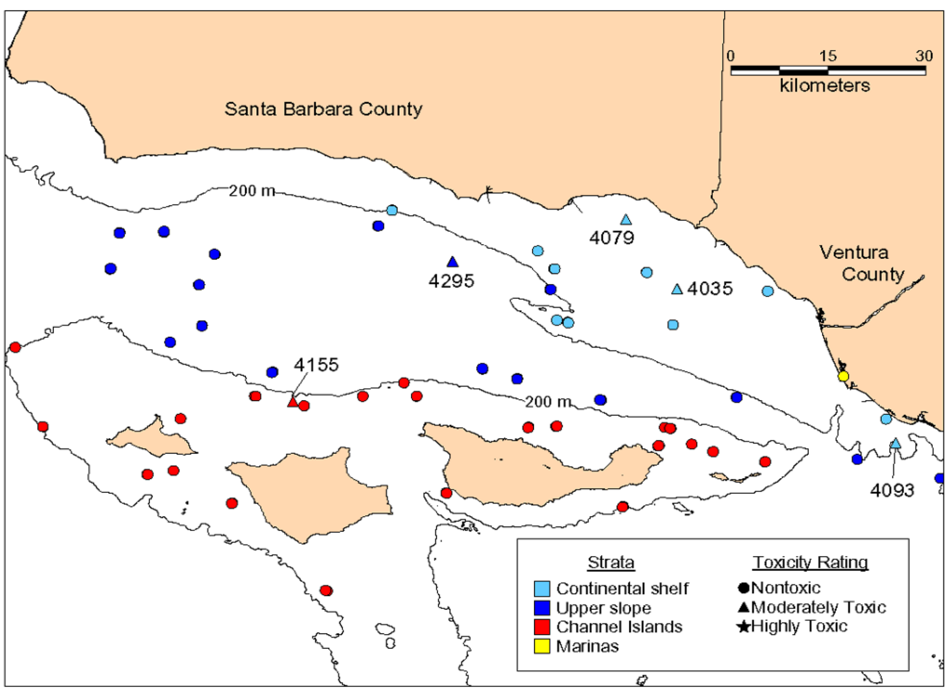

Figure 8.10
Bight 2003 sediment toxicity results for stations in the Santa Barbara Channel region. Results are from 10-day sediment exposure survival tests using the amphipod *Eohaustorius estuarius* (from Bay et al. 2005).

8.1.3 Concentrations of Pollutants in Sentinel Mussel Tissue

The concentration of contaminants in the water column may be so dilute that discrete water samples fall below laboratory analysis detection limits. Concentrations of pollutants found in filter-feeding mussels are an indicator of their existence in the water column, and analysis of marine animal tissue may currently be the best available tool for addressing the fate of priority contaminants such as DDT and PCBs. This section describes in detail a summary of all the Mussel Watch data available for the CINMS and adjacent waters.

Exceedance Criteria for Sentinel Mussel Data

An evaluation of mussel watch data for all stations from the CINMS, CINP and Catalina Island, including a presentation of available body burden data (tissue concentrations) through 2002 for most constituents (PCB congeners and PAH species were pooled, for simplicity) previously appeared in Engle (2006). For the purposes of this report, an Excel database was created which combines all available State and federal mussel watch data through 2004 for the stations listed in Table 7.4 (database available upon request). Despite the fact that many of the SMWP sites were only sampled a few times, and not in recent years, the database contains approximately 7,500 records for discrete measurements of individual constituents. The database includes measurements for mainland sites (which were not evaluated in Engle 2006), and includes one more year of data (2004) for the NOAA-MWP station on Santa Cruz Island. Although the database contains the records from the NOAA-MWP station on Catalina Island (Bird Rock), data from Catalina Island were not included in the evaluations described below.

It was not practical to present tissue concentrations from a database of this size. In order to put the available results into perspective, the data were screened using three different kinds of exceedance criteria: (1) Maximum Tissue Residue Levels (MRTLs from the SWRCB), (2) California-wide Elevated Data Levels (EDLs), calculated from CA-SMWP data, and (3) the 85th and 95th percentiles for all available data (through 2004) from NOAA-MWP sites in California.

Maximum Tissue Residue Levels (MTRLs)

MTRLs were developed by SWRCB staff using human health water quality objectives from the California Ocean Plan and from the California Toxic Rule (40 CFR Part 131) as established in the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SWRCB 2000). The water quality objectives are target concentrations of contaminants in ocean water, in ug/L, intended to protect people from consumption of fish, shellfish, and freshwater 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, and toxaphene. Application of MTRLs for this report required tissue concentrations based on wet weight, which were available from SMWP, but not from NOAA-MWP. All available SMWP data for stations in Table 7.4 were inspected for exceedances of the MTRLs for the organic compounds listed above; exceedances are reported in Table 8.1.

Elevated Data Levels (EDLs)

EDLs were 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 US 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 (EDL95) 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 SMWP data were evaluated using EDLs. For this report, data were compared to the EDLs derived from pooled statewide results from 1977-97, reported in Rasmussen (2000). EDLs were available for all of the organic compounds and trace elements listed in Table 7.3; exceedances are reported in Tables 8.1 and 8.2, respectively.

NOAA-MWP 85th and 95th Percentiles for California Sites

Previously, Engle (2006) screened mussel watch data from the Channel Islands National Park and Catalina Island using the national 50th and 85th percentiles calculated by O'Connor (2002) using NOAA-MWP data from 214 marine site means from 1990. For the present study, screening criteria were desired that would incorporate more recent data from the NOAA-MWP and which would reflect conditions in California, rather than in the nation as a whole. At our request, NOAA provided quantiles (25th, 50th, 75th, 85th, and 95th percentiles) for ranked data from all California sites using all available data through 2004. These percentiles were based on dry weight and were used to screen both SMWP and NOAA-MWP data. Results are reported in Table 8.3, using the same conventions described for the EDLs above ("markedly elevated" for concentrations above the 85th percentile, and "highly elevated" for concentrations above the 95th percentile).

Summary of Sentinel Mussel Results

Trace elements: When the CA-MWP exceedance criteria were used, copper and zinc were found to be highly elevated (>EDL95) in mussels at several of the mainland sites in the late 1980s. Except in one case (zinc, at Point Conception in 1989), all of these exceedances were from mussels in enclosed harbors. Interestingly, cadmium (an EPA priority metal) was highly elevated or markedly elevated at reasonably remote sites, including Gaviota and three of the Channel Islands, as well as in three mainland harbors. Mercury and lead, the other two EPA priority metals, were markedly elevated in mussels from Santa Barbara Harbor.

When the exceedance criteria developed using only NOAA-MWP site data are used, cadmium is again revealed (as recently as 2002-2004) as highly elevated (above the 95th percentile) in mussels from remote sites such as the Channel Islands and Point Conception, among other locations. Copper, zinc, and lead were highly elevated in mussels from enclosed harbors. Over time, mussels from Point Conception and Santa Cruz Island have had markedly or highly elevated levels of the greatest number of trace elements. Mussel data suggest that Gaviota, Goleta Slough, and Point Mugu are the sites least impacted by trace elements.

DDT: When exceedance criteria based on percentiles of ranked data are considered, all of the mainland coastal mussels with highly elevated levels of DDT were collected at harbors or marinas (Tables 8.1 and 8.3), in Mugu Lagoon (which is the receiving water for the highly polluted Calleguas Creek), or at Point Mugu. As was the case for trace metals, Point Conception appears to be more impacted by DDT than other sites on the open coast (in this case, Gaviota and Point Santa Barbara). In the late 1970s, mussels from San Miguel Island contained highly elevated levels of DDT, according to SMWP percentiles, and as recently as 1988, according to NOAA-MWP percentiles. Unfortunately, mussels were last collected from San Miguel Island in 1988, by NOAA. Santa Cruz Island, which has been more consistently sampled than San Miguel Island, was the source of mussels markedly elevated in 4,4'-DDE as recently as 1994 (Table 8.3). Engle (2006) proposed that pinnipeds and sea birds, which may feed on fish impaired by legacy pollutants at some distance from the islands before returning to island rookeries, may be serving as conduits for transfer of DDT to the nearshore waters of the islands. Jarvis et al. (2007) found that approximately 99% of commercially landed northern anchovy (*Engraulis mordax*) in the Southern California Bight contained enough DDT to exceed criteria for wildlife consumption; analogous values for Pacific sardine (*Sardinops sagax*), Pacific chub mackerel (*Scomber japonicus*), and California market squid (*Loligo opalescens*) were 86%, 33% and 0%, respectively.

When the MTRLs for open ocean waters are considered, DDT levels in mussels suggest that California Ocean Plan ocean water quality objectives for DDT were exceeded at every site in Table 7.4 at some point in recent decades (and as recently as 1994 in Mugu Lagoon) except for Gaviota, Goleta Slough, Santa Barbara Harbor, and the Channel Islands. When the MTRLs for bays and estuaries are considered, the Port Hueneme sites drop out of the list of implied DDT hot spots.

Other biocides: Regardless of the exceedance criteria employed, it is evident that other organic pesticides and their metabolites (many of them on the EPA Priority Chemical list) have been highly elevated in mussels in Goleta Slough, Carpinteria Marsh, Ventura Marina, Channel Islands Harbor, Port Hueneme, and Mugu Lagoon. The most widespread chemicals that have highly elevated levels in mussels (NOAA criteria) are alpha-hexachlorocyclohexane (alpha-HCH, or lindane), cis-nonachlor, trans-nonachlor, and endosulfan I. When the State MTRLs are considered, total chlordanes, toxaphene and dieldrin also appear to be of widespread influence. Tributyltin, a fungicide and marine anti-fouling agent which is now banned for use on most applications world-wide, was highly elevated in mussels from Santa Barbara Harbor, the Ventura Marina, and Port Hueneme in 1988. Sampling sites in Mugu Lagoon were linked to exceedances of NOAA's 95th percentiles for the greatest variety of organic pesticides. Point Mugu, Gaviota, Santa Barbara Harbor, Channel Islands Harbor (north), and three of the Channel Islands (Anacapa, Santa Barbara, and San Miguel) appear, based on mussel data, to be the least impacted by non-DDT pesticides of the sites examined - and less impacted than Point Conception and Santa Cruz Island.

PAHs: Among the classes of contaminants examined, levels of PAH in mussels resulted in the least widespread exceedances. Based on mussel data, Port Hueneme was a hotspot for PAH contamination when the sites there were sampled in the mid-1980s. With the exception of phenanthrene, the PAH compounds that caused the exceedances in Port Hueneme mussels were higher molecular weight PAHs (four to six rings), which suggest they were pyrogenic in nature (combustion byproducts), rather than petrogenic. Four PAH compounds (two of which are lower weight compounds with two rings) were markedly or highly elevated in mussels at Point Conception at various times since 1989 - naphthalene as recently as 2004. The remoteness of this site makes it tempting to consider natural hydrocarbon emissions, such as oil and gas seeps, or oil extraction facilities, as potential sources of PAHs there. Point Santa Barbara and Santa Barbara Harbor were the other two sites with several "hits" for PAH, again for different compounds than observed in mussels from Port Hueneme.

PCBs: Before 1971, Monsanto Corporation sold PCBs with a variety of chlorine percentages under the trade name Arochlor, followed by a four-digit code, such as "1242." The last two digits of the trade name code referred to the average percentage of chlorine atoms in the PCB. The CA-SMWP calculated MTRLs and EDLs for "total Arochlor PCB," which they define as the sum of three types of Arochlor: PCB1248, 1254 and 1260. One of the more striking results from the mussel sentinel data is the consistency with which total Arochlor PCB was the sole analyte producing exceedances of MTRLs or EDLs for most of the Channel Islands (Table 8.1). Exceedances for Arochlor PCBs, based on MTRLs and EDLs, were also widespread in mussel data from mainland sites.

These results contrast with those resulting from application of the NOAA exceedance criteria. With the exception of four cases from Santa Cruz in the late 1980s, PCBs in mussels from the Channel Islands did not exceed NOAA's statewide 85th or 95th percentiles. Overall, of the 26 individual PCB congeners measured in mussels from the Channel region (see Table 8.4), fourteen congeners were detected at markedly or highly elevated levels in mussels from at least one site in the study area over the course of the two mussel watch programs. Mussel data from Point Conception, Port Hueneme, and Santa Cruz Island show the strongest evidence of PCB contamination in the late 1980s.

Table 8.1

Exceedances of synthetic organic contaminants measured by the California State Mussel Watch Program (CA-SMWP) in mussels from coastal sites between Point Conception and Point Mugu and at Channel Islands National Park. Exceedance criteria (Maximum Tissue Residue Levels [MTRLs] and Elevated Data Levels [EDLs] are based on wet weight (ppb) and were not available for all of the organic constituents measured in the program. All dates for which organic data were available from the CA-SMWP are listed for each site. EDLs were different for resident (R) and transplanted (T) mussels.

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	MTRL[a] open ocean	MTRL[b] bays & estuaries	EDL85[c]	EDL95[d]
Point Conception	450	07/25/1977	R	total PCB	----	----	----
		12/01/1977	R	total PCB	----	----	----
		08/03/1978	R	----	----	----	----
		11/30/1978	R	total DDT[e]	----	o,p DDT	----
		01/04/1991	R	total chlordane total Arochlor PCB[f]	----	----	----
		11/04/1997	R	total Arochlor PCB	----	oxadiazon	oxadiazon
Gaviota	455	01/26/1988	T	----	----	----	----
		03/21/1989	T	total chlordane Dieldrin	----	----	----
Goleta Slough 1	460	12/18/1988	T	total Arochlor PCB total Chlordane Dieldrin	total Chlordane Dieldrin	Dacthal Diazinon	Diazinon
Santa Barbara Harbor	470	1/26/1988	T	-----	-----	----	----
		12/18/1988	T	-----	-----	----	----
Carpinteria Marsh	475	1/26/1988	T	total Chlordane total DDT	Dieldrin	Endosulfan I total Endosulfan	-----
		12/18/1988	T	total Chlordane total DDT total Arochlor PCB	total Arochlor PCB Dieldrin	Endosulfan I Endosulfan sulfate total Endosulfan Chlorpyrifos	Chlorpyrifos
		3/30/1999	T	total Chlordane total DDT total Arochlor PCB	Dieldrin p,p DDE	Chlorpyrifos Endosulfan I, II Endosulfan sulfate total Endosulfan Heptachlor epoxide Oxadiazon	Oxadiazon

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	MTRL[a] open ocean	MTRL[b] bays & estuaries	EDL85[c]	EDL95[d]
Ventura Marina	485	1/25/1988	T	total DDT	total Chlordane p,p DDE Dieldrin total Arochlor PCB	Alpha-Chlordene p,p DDMS o,p DDT p,p DDT Endosulfan I total endosulfan Heptachlor total Arochlor PCB	Alpha-Chlordene Heptachlor total Arochlor PCB
Channel Island Harbor	505.0	11/11/1980		total DDT	total Chlordane p,p DDE dieldrin total Arochlor PCB	Chlorbenside Beta HCH	Beta HCH
		02/08/1982		total DDT	total Chlordane p,p DDE toxaphene total Arochlor PCB	Chlorbenside Transchlordane Transnonachlor Oxychlordane total chlordane o,p DDD p,p DDD p,p DDE o,p DDT p,p DDT total DDT Endosulfan I total Endosulfan Toxaphene Arochlor 1254 (a PCB) total Arochlor PCB	Chlorbenside Transnonochlor Oxychlordane total chlordane o,p DDD p,p DDD o,p DDT p,p DDT Toxaphene Arochlor 1254 (a PCB) total Arochlor PCB
Channel Island Harbor-North	505.2	12/31/1986	T	total DDT	p,p DDE dieldrin total Arochlor PCB	Cis nonachlor p,p DDE o,p DDT p,p DDT total DDT Endosulfan I total Endosulfan	p,p DDE
Port Hueneme	506.0	5/13/1980		total chlordane total DDT	p,p DDE dieldrin total Arochlor PCB	o,p DDT p,p DDT Hexachlorobenzene Arochlor 1254 total Arochlor PCB	

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	MTRL[a] open ocean	MTRL[b] bays & estuaries	EDL85[c]	EDL95[d]
		11/11/1980		total chlordane total DDT	dieldrin total Arochlor PCB	Endosulfan I total Endosulfan alpha HCH gamma HCH Arochlor 1254 total Arochlor PCB	gamma HCH
		2/8/1982		total chlordane total DDT	p,p DDE toxaphene total Arochlor PCB	Cis-chlordane Trans-chlordane Trans-nonachlor oxychlordane o,p DDD p,p DDD p,p DDE p,p,DDMS o,p DDT p,p DDT total DDT Endosulfan I total Endosulfan Heptachlor Toxaphene Arochlor 1254 total Arochlor PCB	Trans-nonachlor oxychlordane o,p DDD p,p DDD o,p DDT p,p DDT Heptachlor Toxaphene Arochlor 1254 total Arochlor PCB
Port Hueneme/Wharf B	506.1	12/30/1985	T	total chlordane total DDT	dieldrin total Arochlor PCB	p,p DDMU Endosulfan total endosulfan alpha-HCH Arochlor 1254 (PCB) total Arochlor PCB Tributyltin	p,p DDMU Tributyltin
		12/31/1986	T		total Arochlor PCBs	Arochlor 1254 (PCB) total Arochlor PCB Tributyltin	Arochlor 1254 (PCB) total Arochlor PCB Tributyltin
		1/25/1988	T	total chlordane total DDT	p,p DDD dieldrin total Arochlor PCB	p,p DDD o,p DDE heptachlor Arochlor 1254 (PCB) total Arochlor PCB	Heptachlor total Arochlor PCB
		12/18/1988	T		total Arochlor PCB	Arochlor 1254 (PCB) total Arochlor PCB	

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	MTRL[a] open ocean	MTRL[b] bays & estuaries	EDL85[c]	EDL95[d]
Port Hueneme/Wharf 1	506.2	12/30/1985	T	total chlordane total DDT	total Arochlor PCB	cis-nonachlor p,p DDMU endosulfan I total endosulfan arochlor 1254 (PCB) total Arochlor PCB	
		12/31/1986	T	total DDT	total chlordane dieldrin total Arochlor PCB	o,p DDD p,p DDD o,p DDE p,p DDT alpha HCH arochlor 1254 (PCB) total Arochlor PCB	
		1/25/1988	T	total chlordane total DDT	total Arochlor PCB		
		12/18/1988	T		total Arochlor PCB	arochlor 1254 (PCB) total Arochlor PCB	
Port Hueneme Entrance	506.3	1/25/1988	T	total chlordane total DDT	dieldrin total Arochlor PCB	alpha chlordene	
Point Mugu	507.0	7/24/1977	R	total DDT	total Arochlor PCB		
		12/2/1977	R	total DDT	total Arochlor PCB	arochlor 1254 (PCB) total Arochlor PCB	
		8/4/1978	R	total DDT	total Arochlor PCB	arochlor 1254 (PCB) total Arochlor PCB	o,p DDD p,p DDD p,p DDT
		11/16/1978	R			o,p DDT	
Mugu Lagoon/ L Street	507.1	12/31/1986	T	total DDT	total chlordane p,p DDE dieldrin toxaphene total Arochlor PCB	cis-chlordane trans-nonachlor o,p DDD p,p DDD o,p DDT dieldrin endosulfan II endosulfan sulate	oxychlordane chlorpyrifos dacthal p,p DDE total DDT endosulfan I total endosulfan endrin

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	MTRL[a] open ocean	MTRL[b] bays & estuaries	EDL85[c]	EDL95[d]
		12/28/1990	T	total DDT	total chlordane p,p DDE dieldrin toxaphene total Arochlor PCB	cis-nonachlor o,p DDD p,p DDD p,p DDE p,p DDMU total DDT endosulfan I endosulfan II	dacthal endosulfan sulfate total endosulfan
Mugu Lagoon/ Laguna Rd.	507.2	12/30/1985	T	total DDT dieldrin	total chlordane p,p DDD p,p DDE toxaphene total Arochlor PCB	cis-chlordane cis-nonachlor oxychlordane total chlordane o,p DDD p,p DDD p,p DDMU o,p DDT p,p DDT total endosulfan heptachlorepoxide	dacthal p,p DDE endosulfan I gamma HCH toxaphene
		12/31/1986	T	total DDT	total chlordane p,p DDD p,p DDE p,p DDT dieldrin toxaphene total Arochlor PCB	alpha chlordene gamma chlodene dacthal p,p DDD p,p DDT endosulfan II endosulfan sulfate	cis-chlordane trans-chlordane trans-nonachlor total chlordane o,p DDD p,p DDE o,p DDT total DDT endosulfan I total endosulfan endrin toxaphene
		12/28/1990	T	total chlordane total DDT	p,p DDE dieldrin toxaphene total Arochlor PCB	dacthal p,p DDE total DDT endosulfan II endosulfan sulfate total endosulfan toxaphene	total chlordane

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	MTRL[a] open ocean	MTRL[b] bays & estuaries	EDL85[c]	EDL95[d]
Mugu Lagoon/Calleguas	507.3	12/30/1985	T	total DDT	total chlordane p,p DDE p,p DDT dieldrin toxaphene total Arochlor PCB	alpha-chlordene o,p DDD p,p DDD o,p DDE p,p DDMU dieldrin endosulfan II endosulfan sulfate	cis-chlordane gamma-chlordane trans-chlordane trans-nonachlor oxy-chlordane total chlordane chlorpyrifos dacthal p,p DDE o,p DDT p,p DDT total DDT endosulfan I total endosulfan endrin heptachlorepoxide hexachlorobenzene toxaphene
		12/31/1986	T	total DDT	total chlordane p,p DDE p,p DDT dieldrin toxaphene total Arochlor PCB	alpha-chlordene trans-nonachlor total chlordane p,p DDE p,p DDD o,p DDT dieldrin	cis-chlordane gamma-chlordane dacthal o,p DDD p,p DDE p,p DDT total DDT endosulfan I endosulfan II endosulfan sulfate total endosulfan endrin hexachlorobenzene toxaphene

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	MTRL[a] open ocean	MTRL[b] bays & estuaries	EDL85[c]	EDL95[d]
		12/18/1988	T	total DDT	total chlordane p,p DDE p,p DDD dieldrin toxaphene total Arochlor PCB	gamma-chlordane cis-nonachlor p,p DDMU p,p DDMU p,p DDT dieldrin endosulfan I endosulfan sulfate endrin gamma-HCH	alpha-chlordene cis-chlordane trans-nonachlor oxy-chlordane total chlordane chlorpyrifos dacthal o,p DDD p,p DDD o,p DDE p,p DDE o,p DDT total DDT endosulfan I endosulfan II total endosulfan ethion heptachlorepoxide hexachlorobenzene toxaphene
		12/28/1990	T	total DDT	total chlordane p,p DDE dieldrin toxaphene total Arochlor PCB	alpha-chlordene cis-nonachlor trans-nonachlor oxy-chlordane total chlordane dacthal o,p DDD p,p DDD p,p DDMU p,p DDT total DDT	gamma-chlordane p,p DDE p,p DDMU endosulfan II endosulfan sulfate total endosulfan hexachlorobenzene toxaphene
		2/8/1994	T	total DDT	total chlordane p,p DDE p,p DDD p,p DDT dieldrin toxaphene total Arochlor PCB	alpha-chlordene cis-chlordane gamma-chlordane trans-nonachlor oxy-chlordane total chlordane p,p DDD o,p DDE endrin Arochlor 1260 (PCB)	cis-nonachlor chlorpyrifos dacthal o,p DDD p,p DDE o,p DDT p,p DDT total DDT heptachlorepoxide toxaphene
San Miguel/West	500	8/1977	R		total Arochlor (PCB)	total Arochlor PCB	total DDT total Arochlor PCB

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	MTRL[a] open ocean	MTRL[b] bays & estuaries	EDL85[c]	EDL95[d]
		12/1977	R		total Arochlor PCB	total DDT total PCB	total Arochlor PCB
		8/1978	R		total Arochlor PCB	total DDT total PCB	total DDT total PCB
		11/1978	R		total Arochlor PCB	total DDT total PCB	total Arochlor PCB
San Miguel/East	501	7/1977	R		total Arochlor PCB	total Arochlor PCB	------
		12/1977	R	total Arochlor PCB		total Arochlor PCB	------
		8/1978	R	total Arochlor PCB		total Arochlor PCB	------
		11/1978	R	total Arochlor PCB		total Arochlor PCB	------
Santa Cruz Island	502	8/1977	R	total Arochlor PCB		total Arochlor PCB	------
		12/1977	R	total Arochlor PCB		total Arochlor PCB	------
		8/1978	R	total Arochlor PCB		total Arochlor PCB	------
		12/1978	R	total Arochlor PCB		total Arochlor PCB	------
Anacapa Island	503	8/1977	R			total Arochlor PCB	------
		12/1977	R	total Arochlor PCB		total Arochlor PCB	------
		8/1978	R	total Arochlor PCB		total Arochlor PCB	------
		11/1978	R	total Arochlor PCB		total Arochlor PCB	------
		5/1980	T			total chlordane	------
		11/1980	T		total Arochlor PCB	total Arochlor PCB	alpha-HCH
Santa Barbara Island	504	7/1977	R	total Arochlor PCB		total Arochlor PCB	------
		12/1977	R	total Arochlor PCB		total Arochlor PCB	------
		8/1978	R	total Arochlor PCB		total Arochlor PCB	------
		12/1978	R	total Arochlor PCB		total Arochlor PCB	------

[a] Maximum Tissue Residue Level for mussels in ocean waters (see text)

[b] Maximum Tissue Residue Level for mussels in enclosed bays or estuaries (see text)

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

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

[e] Total DDT is calculated by the CA-SWMP as ∑[o,p-DDD, p,p-DDD, o,p-DDE, p,p-DDE, o,p-DDT, p,p-DDT, p,p-DDMS, p,p-DDMU]

[f] Total Arochlor PCB is defined by the CA-SWMP as∑[PCB 1248, PCB 12 54, PCB1260], the four-letter codes refer to three subcategories of the PCB manufactured by Monsanto under the Arochlor brand name. There are 209 possible congeners of biphenyls; NOAA-MWP includes a larger suite of PCBs in its total PCB derivative.

Table 8.2
Exceedances for trace elements measured by the California State Mussel Watch Program (CA-SMWP) in mussels from coastal sites between Point Conception and Point Mugu and at Channel Islands National Park. All dates for which trace element data were available from the CA-SMWP are listed for each site. Exceedance criteria (Elevated Data Levels [EDL]) are based on wet weight (ppb), and were different for resident (R) and transplanted (T) mussels (see text).

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	EDL85[a]	EDL95[b]
Coastal Sites					
Point Conception	450	07/25/1977	R	----	----
		12/01/1977	R	----	----
		08/03/1978	R	Ag	----
		11/30/1978	R	Ag	----
		3/20/1989	R	Ag, Cr	Zn
		12/22/1989	R	----	----
		01/04/1991	R	Cr, Zn	----
		11/04/1997	R	Cr	----
Gaviota	455	01/26/1988	T	----	----
		03/21/1989	T	----	Cd
		12/22/1989		----	----
Goleta Slough 1	460	12/18/1988	T	----	----
Santa Barbara Harbor	470	1/26/1988	T	Pb	Cu, Zn
		12/18/1988	T	Cd, Hg	Cu, Zn
Carpinteria Marsh	475	3/30/1999	T	Al, Cr, Mn, Se	----
Ventura Marina	485	1/25/1988	T	----	Cu, Zn
Channel Island Harbor	505.0	5/21/1980	T	Cd	----
		11/11/1980	T	----	----
Channel Island Harbor-North	505.2	12/31/1986	T	----	----
Port Hueneme	506.0	5/13/1980	T	Cd	----
		11/11/1980	T	----	----
Port Hueneme/Wharf B	506.1	1/25/1988	T	----	Cu, Zn
Port Hueneme/Wharf 1	506.2	12/31/1986	T	Cu, Zn	----
		1/25/1988	T	----	----
Port Hueneme Entrance	506.3	1/25/1988	T	----	----
Point Mugu	507.0	7/24/1977	R	Ag	----
		12/2/1977	R	----	----

CA-SMWP station	Station #	Sample Date (mm/dd/yyyy)	Type	EDL85[a]	EDL95[b]
		8/4/1978	R	----	----
		11/16/1978	R	----	----
Mugu Lagoon/L Street	507.1	12/31/1986	T	Mn	----
Mugu Lagoon/Laguna Rd		12/31/1986	T	Hg	----
Mugu Lagoon/Calleguas	507.3	12/31/1986	T	----	----
		12/18/1988	T	----	----
		2/8/1994	T	Al	----
Channel Islands Sites					
San Miguel/West	500	8/1977	R	Hg	------
		12/1977	R	Hg	------
		8/1978	R	Cd	------
		11/1978	R	Hg	------
San Miguel/East	501	7/1977	R	Cd	------
		12/1977	R	Cd	------
		8/1978	R	------	------
		11/1978	R	------	------
Santa Cruz Island	502	8/1977	R	------	------
		12/1977	R	------	------
		8/1978	R	------	------
		12/1978	R	------	------
		3/1981	R	Cd	Cd
Anacapa Island	503	8/1977	R	Ag	------
		12/1977	R	------	------
		8/1978	R	Ag, Pb	------
		11/1978	R	Ag	------
		12/1979	R	------	------
		5/1980	T	Cd	Cd
		11/1980	T	Cd	Cd
Santa Barbara Island	504	7/1977	R	Cd	------
		12/1977	R	------	------
		8/1978	R	------	------
		12/1978	R	Cd	Cd

[a]EDL85: 85th percentile for statewide CA-SMWP samples from 1977-1997.
[b]EDL95: 95th percentile for statewide CA-SMWP samples from 1977-1997.

Table 8.3
Exceedances for trace elements, synthetic organics, PAH, and PCB concentrations (dry weight) in sentinel mussels from the Santa Barbara Channel area, based on the 85th (yellow fill) and 95th (orange fill) percentiles for all available statewide (California) data from the NOAA-MWP (1986-2004). CA-MWP data for constituents measured by both programs was screened using the NOAA percentiles, although CA-MWP data were not part of the data set from which the percentiles were calculated. The *most recent* year during which an 85th or 95th percentile was exceeded by the available data is indicated (19*XX*, or 20*XX*); many of the CA-MWP sites have not been sampled since the late 1970s (islands) or the late 1980s (some coastal sites). Constituents for which the statewide 85th or 95th percentiles were never exceeded by the available data are not listed.

	COAST, HARBORS, SLOUGHS, LAGOONS North ← → South														CHANNEL ISLANDS			
Constituent	Point Conception - all sites	Gaviota	Pt. Santa Barbara	Goleta Slough 1	Santa Barbara Harbor	Carpinteria Marsh	Ventura Marina	Channel Island Harbor	Channel Island Harbor No.	Port Hueneme	Port Hueneme Wharfs 1 and B	Port Hueneme Entrance	Point Mugu	Mugu Lagoon - all sties	San Miguel Island - all sites	Santa Cruz Island- all sites	Anacapa Island	Santa Barbara Island
Trace Elements																		
Aluminum	98		98			99												
Antimony	87		86													86		
	87		87													87		
Arsenic	87		00													04		
	86														88	96		
Cadmium	04				88	99	88		86	80	88	88			88	04	79	
	89	89			88			80		80					78	02	80	88
Chromium	98		98													98		
	97					99												
Copper											88							
	77				88		88				88	88						
Iron																98		
Lead	77				88		88				88	88					79	
Mercury	89				88		88	80	86	80	88			86			80	
	78														88			88
Nickel	97					99												
Selenium	88					99										88		
	88													86				
Silver	02		00										78			78	79	77
																	78	
Zinc	91		00													04	79	
	89			88	88		88	86				88				02		
Synthetic Organics																		
2,4'-DDD	78							86		80	85		77					

	COAST, HARBORS, SLOUGHS, LAGOONS North ← → South														CHANNEL ISLANDS			
Constituent	Point Conception - all sites	Gaviota	Pt. Santa Barbara	Goleta Slough 1	Santa Barbara Harbor	Carpinteria Marsh	Ventura Marina	Channel Island Harbor	Channel Island Harbor No.	Port Hueneme	Port Hueneme Wharfs 1 and B	Port Hueneme Entrance	Point Mugu	Mugu Lagoon - all sties	San Miguel Island - all sites	Santa Cruz Island- all sites	Anacapa Island	Santa Barbara Island
							88		82	82	88		78	90				
2,4'-DDE	02							82		80	88	88		90		87		
							88	86		80	88			90				
2,4'-DDT										80	88		78	90				
							88	82		82		88		94				
4,4'-DDD						88						88						
							88	82		82	88		78	94				
4,4'-DDE	90			88		99					88	88	77			94		
								82		82	88		78	94	88			
4,4'-DDT	86					99					85		77			86		
						99	88	86		82	88	88	78	94				
aldrin	96		96													88		
	87																	
alpha-HCH	91	89	00			88		82		80	85			90				
								80		82	86			85				
beta-HCH			00					80								04		
delta-HCH																96		
gamma-HCH	91									80						90		
	91																	
chlorpyrifos			96															
						99								94				
cis-nonachlor												88						
				88			88	86			85			94				
trans-nonachlor								82		82	88			90				
				88			88							94				
monobutyltin	98																	
dibutyltin	98		93															
tributyltin					88		88				88	88						
dieldrin				88				80										
endosulfan I				88				82		82	88			90				
						99	88			80	85	88		90				
endosulfan II																96		
						99								90				
endosulfan sulfate																04		
						99		86						90				
endrin			96											94		94		
heptachlor-epoxide														88				
														94		86		

	COAST, HARBORS, SLOUGHS, LAGOONS North ← → South														CHANNEL ISLANDS			
Constituent	Point Conception - all sites	Gaviota	Pt. Santa Barbara	Goleta Slough 1	Santa Barbara Harbor	Carpinteria Marsh	Ventura Marina	Channel Island Harbor	Channel Island Harbor No.	Port Hueneme	Port Hueneme Wharfs 1 and B	Port Hueneme Entrance	Point Mugu	Mugu Lagoon - all sties	San Miguel Island - all sites	Santa Cruz Island- all sites	Anacapa Island	Santa Barbara Island
hexachlorobenzene	00 86													88 90		86		
mirex	89 89																	
oxychlordane				88				80 86		82				94				
pentachlorobenzene			00															
PAHs																		
1-methylnaphthalene						99												
2-methylnaphthalene	89																	
naphthalene	04 89		89													04		
C2-chrysenes					02													
C3-chrysenes					98 02													
C4-chrysenes	98		98															
C2-dibenzothiophenes					02													
C3-dibenzothiophenes			02															
dibenzo[a,h]anthracene	91																	
benzo[a]anthracene											86							
benzo[a]pyrene											86							
benzo[e]pyrene											88							
indeno[1,2,3-c,d]pyrene											86							
pyrene											88	88						
benzo[b]fluoranthene											88	88						
fluoranthene											88	88						
perylene			02			99												
phenanthrene											88							

Constituent	COAST, HARBORS, SLOUGHS, LAGOONS North ←													→ South	CHANNEL ISLANDS			
	Point Conception - all sites	Gaviota	Pt. Santa Barbara	Goleta Slough 1	Santa Barbara Harbor	Carpinteria Marsh	Ventura Marina	Channel Island Harbor	Channel Island Harbor No.	Port Hueneme	Port Hueneme Wharfs 1 and B	Port Hueneme Entrance	Point Mugu	Mugu Lagoon - all sties	San Miguel Island - all sites	Santa Cruz Island- all sites	Anacapa Island	Santa Barbara Island
PCBs																		
PCB 8/5	89		96															
PCB 44							88				88	88						
PCB 52							88				88	88						
PCB 66							88				88	88						
PCB 105											88							
PCB 118							88				88							
PCB 128											88	88						
PCB 138											88	88						
PCB 170/190	89		94															
PCB 180											88	88						
PCB 187											88	88						
PCB 195/208	89															86		
PCB 206	88		89															
PCB 209	88 89		89													88		
dichlorobiphenyls	86 86															86 86		
trichlorobiphenyls	86																	
octachlorobiphenyls																87 86		
nonachlorobiphenyls	86																	

Table 8.4

Polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) measured by the NOAA-MWP and the CA-SWMP in sentinel mussels from the Santa Barbara Channel area. Constituents on the EPA's list of Priority Chemicals are labeled (PC).

	NOAA-MWP	CA-SWMP		NOAA-MWP	CA-SWMP
PAHs			**PAHs (cont.)**		
anthracene (PC)	X		C1-phenanthrenes/anthracenes	X	
anathracene		X	C2-phenanthrenes/anthracenes	X	
benzo [a] anthracene (PC)	X	X	C3-phenanthrenes/anthracenes	X	
dibenzo[a,h]anthracene (PC)	X	X	C4-phenanthrenes/anthracenes	X	
biphenyl	X	X	1-methylphenanthrene	X	X
chrysene (PC)	X	X	pyrene (PC)	X	X
C1-chrysenes	X		benzo [a] pyrene (PC)	X	X
C2-chrysenes	X		benzo [e] pyrene	X	X
C3-chrysenes	X		indeno [1,2,3-c,d] pyrene (PC)	X	X
C4-chrysenes	X		1,2,3,4-tetrachlorobenzene	X	
C1-dibenzothiophenes	X		1,2,4,5-tetrachlorobenzene	X	
C2-dibenzothiophenes	X				
C3-dibenzothiophenes	X		**PCB congeners** (PC)		
dibenzothiophene	X		PCB 1248		X
C1-fluoranthenes/pyrenes	X		PCB 1254		X
C2-fluoranthenes/pyrenes	X		PCB 1260		X
C3-fluoranthenes/pyrenes	X		PCB 8/5	X	
fluoranthene (PC)	X	X	PCB 8		X
benzo [b] fluoranthene (PC)	X	X	PCB 18	X	X
benzo [k] fluoranthene (PC)	X	X	PCB 28	X	X
fluorene (PC)	X	X	PCB 44	X	X
C1-fluorenes	X		PCB 52	X	X
C2-fluorenes	X		PCB 66	X	X
naphthalene (PC)	X	X	PCB 101/90	X	
C1-naphthalenes	X		PCB 101		X
C2-naphthalenes	X		PCB 105	X	X
C3-naphthalenes	X		PCB 118	X	X
C4-naphthalenes	X		PCB 128	X	X
1-methylnaphthalene	X	X	PCB 138	X	X
2-methylnaphthalene	X	X	PCB 153		X
2,6-dimethylnaphthalene	X	X	PCB 152/132/168	X	
2,3,5-trimethylnaphthalene		X	PCB 170		X
1,6,7 trimethylnaphthalene	X		PCB 170/190	X	
acenaphthene	X	X	PCB 180	X	X
acenaphthylene	X	X	PCB 187	X	X
perylene	X	X	PCB 195		X
benzo [g,h,I] perylene (PC)	X	X	PCB 195/208	X	
phenanthrene (PC)	X	X	PCB 206	X	X
			PCB 209	X	
			di-, tri-, tetra-. hexa-, hepta-, octo-, and nonachlorobiphenyls	X	

PBDE: Polybrominated Diphenyl Ethers (PBDEs) are widespread throughout the coastal environment. Sentinel mussel tissue concentrations at seven sites closest to the CINMS are presented in Table 8.5. Nationally, the majority of tissue measurements above detection limits had concentrations between 1 and 270 ppb lipid weight and were categorized as medium, and this held for southern California as well. The three sites closest to CINMS all increased from 1996, with Santa Cruz Island showing the least change. Catalina Island, which had been the fourth lowest in 1996, declined and became the lowest. Anaheim Bay, located in an industrialized area that includes a military base, had the highest measurement in the nation (8,202 pbb lipid weight). The highest sediment measurements observed were taken from a highly urbanized location, Marina del Rey, CA (88 ppb dry weight). The toxicity and ecosystem effects of PBDEs on marine biota and on human health have not been well studied, but it appears likely that this contaminant is the next PCB, at least in consideration of its persistence in the environment.

Table 8.5

Santa Barbara Channel Sentinel mussel tissue PBDE concentrations

		Tissues 1996		Tissues 200x		Sediment 200x
Site	**Station name**	**Lipid**	**Dry**	**Lipid**	**Dry**	**Dry**
PCPC	Point Conception	0	0.0	33	2.7	-
SBSB	Point Santa Barbara	62	3.2	96	7.0	-
SCFP	Santa Cruz Island Fraser Point	22	2.6	34	2.1	-
PDPD	Point Dume	236	13.7	130	9.8	0.2
MDSJ	Marina del Rey	**404**	**37.6**	**855**	**75.2**	**87.8**
ABWJ	Anaheim Bay	**1112**	**93.4**	**8,202**	**840.8**	0.5
SCBR	South Catalina Island	63	3.1	21	1.4	**-**

Concentrations Lipid = ppb lipid weight, Dry = ppb dry weight, 200x = 2004 through 2007. Dashes mean no samples taken. **Bold** data are considered 'high', the remainder are 'medium' with the exception of Point Conception which was 'low'. Data from Kimbrough et al. 2009.

Contaminants higher up the food chain: Total DDT concentrations in pelagic forage fishes and squid in the Southern California Bight have decreased over the past 25 years. Similarly, total PCB concentrations have also decreased for the same species examined. Bioaccumulation appears to be widespread within multiple species; sardines, anchovies, and mackerel accumulated measurable total DDT and total PCB throughout virtually all of the landings in the

Bight. Moreover, the accumulation of total DDT, based upon wildlife risk screening values (Ridgway et al. 2000, as presented in Jarvis et al. 2007), was at levels that represented a potential risk to higher order predators such as marine birds and mammals even though levels have declined over the past two decades. There are at least three factors that could possibly control the bioaccumulation of total DDT and total PCB in pelagic forage species of the Southern California Bight. One factor could be equilibrium partitioning between the concentrations in the water column and lipid reservoirs in the fish (Zeng et al. 2005). A strong correlation was observed between tissue concentrations and fish lipid content during the present study. Species with the greatest lipid content (anchovy and sardine) contained the highest contaminant concentrations.

A study in 2002 by researchers from UC Santa Cruz examined pesticide residues in sea lions throughout central and southern California (Le Boeuf et al 2002). They found that DDT levels in the blubber of California sea lions decreased by over one order of magnitude from 1970 to 2000. Although there has been a noticeable decrease in DDT in California sea lion blubber, concentrations remain high compared to other marine mammals around the world. PCB concentrations are as high or higher than those known to induce effects at a physiological level. This is a cause for concern for the animals as well as for humans that feed on contaminated fishes in the area. Despite relatively high concentrations of DDT and PCBs, there was little evidence from the study that population growth or the health of individual California sea lions had been compromised (Le Boeuf et al 2002). However, more recent research looking at synergistic effects between exposure to organochlorides and domoic acid at different developmental life stages (including neonatal) is finding that the former compounds the effects of the latter (Tiedeken and Ramsdell 2009).

Bald eagles introduced to and currently nesting on Santa Catalina Island continue to exhibit reproductive injuries caused by ongoing exposures to DDTs and PCBs. Mean concentrations of p,p′-DDE measured in bald eagle nestling plasma samples in 2003 exceeded published criteria for effects on bald eagle reproduction at Santa Catalina Island and Barkley Sound, more than 30 years since heavy usage restrictions were imposed (Cesh et al. 2008).

8.1.4 Storm Water Plumes

Figure 8.11 shows surface water salinity from five sites near the CINMS (three within the Santa Barbara Channel and two south of Santa Rosa Island) from 2000 through 2006. Lowered surface salinity may indicate freshwater plumes emanated from mainland runoff. Although salinity is surely the best plume tracer, it can only be readily measured in situ, which limits the timing and locations of observations. This limitation, coupled with the inclement weather and sea states typically surrounding major rain events, begs for future identification and tracking of plumes with remotely sensed imagery. Runoff, in addition to being fresh, may also include a host of pollutants affecting water quality. Low salinity readings were found during the winter of 2005, with the lowest levels measured at the three in-channel sampling locations (East Channel, Mid-Channel and Mugu). The winter of 2004/05 included 25-50 year rain events, but the timing of those storms to that of the CalCOFI cruise was incidental. This data could be an indication that these areas may be affected by heavy storm runoff from the Santa Clara and Ventura Rivers, especially as the sampling stations on the ocean side of Santa Rosa were not low (as one might expect from heavy island runoff). However, without sampling occurring before, during and after such rain events, it could be easy to miss any effects as the plumes dissipate after a few days. Researchers have also found that major plume events in southern California are typically associated with upwelling wind conditions which help drive the plumes to the south and east rather than continuing offshore. Due to the multiple day upwelling wind conditions that commonly follow discharge events, plumes were observed to flow from their respective river mouths to down-coast waters at rates of 20-40 km d-1 (Warrick et al. 2007). However, these processes are extremely dynamic, and the distance a plume extends depends at least in part upon wind speed and discharge volume.

Storm sampling during Bight ‘03 examined the relationships between salinity (an indication of a river plume), levels of indicator bacteria, and ocean color (from remote sensing via satellite), with mixed results. The total accuracy of plume detection in terms of surface salinity was not high (68% on average), seemingly because of an imperfect correlation between plume salinity and ocean color. The accuracy of plume detection in terms of indicator bacteria exceedances was even lower (64% on average), resulting from low correlation between ocean color and bacterial contamination (Nezlin et al. 2008).

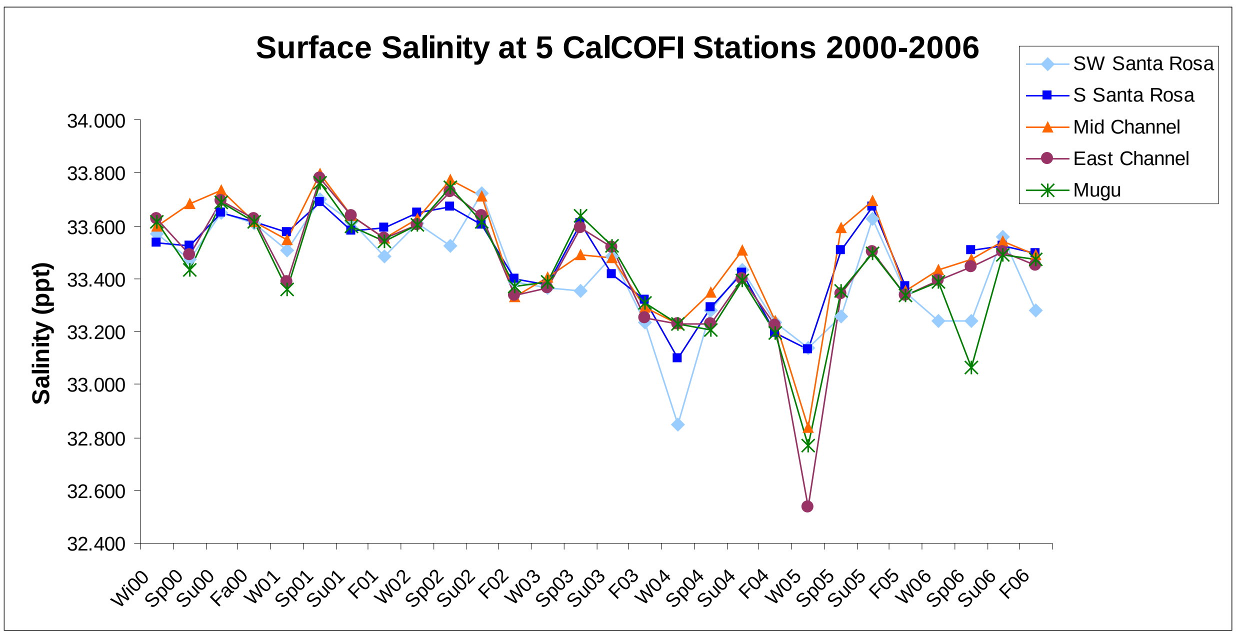

Figure 8.11
Surface water salinity from five sites near CINMS.

Information about storm water plumes produced by terrestrial runoff from the mainland coast of the Santa Barbara Channel and the coasts of the Channel Islands was previously summarized by Engle (2006). Information evaluated included remotely sensed images of surface sediment plumes (Advanced Very High Resolution Radiometer [AVHRR] and Sea-viewing Wide-Field-of-View sensor [SeaWiFS]; see Otero & Siegel 2004, Warrick et al. 2004, Nezlin et al. 2005); salinity/depth profiles from CalCOFI surveys, the SBC-LTER, and UCSB’s Plumes ‘n Blooms project; and toxicity data for storm water plumes in the Santa Monica Bay (Bay et al. 2003). Some of the conclusions reached in Engle (2006) are as follows:

- Most suspended sediment (and by inference, terrestrial runoff) enters the Santa Barbara Channel in storm water plumes generated by the Ventura River, Santa Clara River and Calleguas Creek.

- On average, February is the month when sediment plumes penetrate furthest offshore into the Santa Barbara Channel.

- Over 90% of the sediment load in Santa Clara River storm plumes is lost from the water column within approximately 1 km of the river mouth.

- Almost every year, at least one runoff event produces a jet of freshened water from the Santa Clara River that extends 10 km into the Santa Barbara Channel.

- Fine suspended sediment from runoff forms plumes covering more than 20% of the surface of the Santa Barbara Channel about once per year, but 10-year storms are required to produce plumes extending as far as 30 km in the offshore direction.

- Storms must exceed 2.5 cm (rainfall depth) before sediment plumes spread west along the mainland coast from Ventura County to Santa Barbara Point (just west of Santa Barbara Harbor).

- Surface salinity anomalies suggest that 25- to 50-year rain events may be necessary before mainland runoff is sufficient in volume to reduce salinity across the Channel all the way to the Channel Islands.

- Toxicity was present in Ballona Creek storm water plumes in the Santa Monica Bay when plume water contained at least 10% creek water. This level of freshwater content would correspond to a decrease in salinity in Santa Barbara Channel seawater from ~33 psu (average ambient surface salinity) to ~30 psu. This degree of freshening was not observed except very close to the mainland shore in any of the Channel data inspected by Engle (2006).

A study conducted by Otero and Siegel (2004) from 1997-2001 used satellite ocean-color and sea-surface temperature imagery to assess the occurrence, extent and duration of surface sediment plumes from discharged stormwaters and phytoplankton blooms in the Santa Barbara Channel. They found that storm events are rarely intense enough for sediment plumes to reach the islands.

Bight '08 surveys found that although storm water runoff plumes could be large, the spatial extent of the contaminant plume was far less than that of the turbidity plume. Unfortunately, this means that remote sensing of color may not be the best way to predict contaminant load. The direction and extent of travel of the plume depends in part on winds that follow the rain event. Offshore winds can help to pull surface water offshore, but if these winds are not strong, along-shore currents may move the plumes downcoast. At least during the Bight '08 survey period, tracked storm plumes tended to follow the coast rather than extend offshore towards the islands.

Anthropogenic nutrient loadings and their contribution to toxic plankton blooms will continue to be examined by the Bight and Plumes 'n Blooms programs, among others.

8.1.5 Other Water Quality Indicators

Indicator bacteria at anchorages

Santa Barbara Channelkeeper's snapshot surveys of indictor bacteria at island anchorages between 2005 and 2007 generally found that levels were non-detectable or very low at most sites, with a few exceptions. All samples fell below the State standards for body contact recreation. Total coliform was detected in a quarter of the samples, although all fell below the State single sample standard of 10,000 colonies per 100 ml.[33] The highest levels were found at an elephant seal haulout at Santa Rosa Island (Keyhole). As all levels were low, these results are not of concern.

E.coli was detected in 16% of samples. The highest by far was from a sample at Keyhole off Santa Rosa Island, but even these levels were below State standards. Enterococci were found in 12% of the samples, but also at very low levels. The highest detection came from Del Mar Cove, a small cove near the west end of Santa Cruz Island, with 52 MPN/100ml. No marine mammals were seen in the vicinity and there were no other clues as to what could have contributed to this level of enterococci.

This effort was designed to provide a snapshot of bacteria levels to begin to determine if bacterial contamination might be occurring at popular anchorages, and was not meant to be an exhaustive study. Because most sites are fairly open and exposed to currents and wave action, they may experience enough natural flushing such that sewage discharges, if they are in fact occurring, are undetectable. However, due to the limited number of samples and a very limited number of samples representing high-use conditions, the results should not be considered conclusive.

Contaminants from offshore oil platforms

In an effort to assess whether fishes living around oil and gas platforms tend to be more heavily contaminated than those from natural sites, a study was conducted in 2005-2006 to examine element concentrations in three species of fishes living around platforms and natural sites. The study involved the collection of 18 kelp bass (*Paralabrax clathratus*), 80 kelp rockfish (*Sebastes atrovirens*), and 98 Pacific sanddab (*Citharichthys sordidus*) from five offshore oil platforms and ten natural areas for whole-body analysis of 63 elements. The natural areas, which served as reference sites, were assumed to be relatively uninfluenced by contaminants originating from platforms. Statistical comparisons of 21 metals indicated that none consistently exhibited higher concentrations at oil platforms than at natural areas.

Other studies have examined toxicity of produced water and/or its constituents to species found in the Santa Barbara Channel and found reduced larval settlement in red abalone, reduced

[33] The unit of measure is the "most probable number" of "colony forming units," abbreviated as "MPN" in 100 milliliters (ml) of sample.

survivorship in coral, growth and functional impairments in mussels, and reduced colonization by kelp.[34]

Constituents of Emerging Concern

Bay et al. (2008) investigated the exposure and effects of emerging contaminants on the hornyhead turbot (*Pleuronichthys verticalis*), a common flatfish in the coastal waters of southern California. Biological effects were measured at multiple levels (gene expression, hormones, reproduction, and population characteristics) and compared to chemical concentrations in effluent, water, sediment, and fish tissue. A wide variety of personal care products (e.g., tranquilizers, antibiotics, fragrances, and anti-inflammatory agents), flame retardants and industrial compounds were present in wastewater, receiving water, and fish liver samples. Several indicators of endocrine disruption were detected in fish from the same locations. Continuing investigations suggested that fish at wastewater outfalls may be more sensitive to DNA damage (Rempel-Hester 2009).

Harmful Algal Blooms

As summarized in the CINMS 2009 Condition Report, there has been an apparent increase in *Pseudo-nitzschia* blooms since 2001. The blooms appear to be increasing in intensity and length of season each year. There have been extensive marine animal mortality events attributable to domoic acid in recent years (CINMS 2009).

8.2 Existing Conditions: Coastal Waters and Watersheds

Information about the quality of water (chemistry and toxicity) entering the Santa Barbara Channel from coastal streams and rivers is generated by several entities:

- The surface water ambient monitoring programs of the Central Coast Regional Water Quality Control Board (Region 3) and Los Angeles Regional Water Quality Control Board (Regions 4).[35]

- Monitoring of selected storm water drains and stream sites (the latter, mass emission stations) by the municipal storm water monitoring programs of Santa Barbara and Ventura counties.[36]

- Citizen monitoring groups:
    - Santa Barbara Channelkeeper's (SBCK) Goleta Stream Team and Ventura Stream Team[37]
    - Friends of the Santa Clara River[38]

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[34] See Polgar et al, p. 34.
[35] http://www.waterboards.ca.gov/swamp/regionalreports.html#rb4; http://www.ccamp.org/ccamp/ccamp.htm
[36] http://www.waterboards.ca.gov/centralcoast/stormwater/municipal/phase_2/santa_barbara_co/santa-barbaraco-swmp.pdf; http://www.vcstormwater.org/
[37] http://www.sbck.org/index.php?option=com_content&task=view&id=18&Itemid=19; http://www.sbck.org/index.php?option=com_content&task=view&id=19&Itemid=18

- Ventura Coastkeeper Calleguas Creek watershed monitoring program[39]

- University of California's Santa Barbara Coastal Long Term Ecological Research Project[40]

- Monitoring of receiving water quality by NPDES permittees discharging to river segments

- Monitoring of agricultural runoff required by the Irrigated Agricultural Waiver Program[41]

- Monitoring conducted as part of implementation programs for Total Maximum Daily Loads (TMDLs)

Intermittent basic water quality data (nitrogen and phosphorus, total dissolved solids, pH, dissolved oxygen, etc.) are available from the lower reaches of the majority of the streams in the region with coastal outlets; longer term and more comprehensive sampling has occurred in several streams, including measurements of metals and synthetic organic compounds in water, sediments, and/or tissue, and toxicity tests using water or sediments. Inferences about water quality in coastal outflows can be made from sediment chemistry and/or toxicity data from the lower reaches or estuaries of coastal rivers, and bioaccumulation of contaminants in tissues (of fish or invertebrates) residing at coastal confluences. Among the sources for these data are State and Federal mussel watch programs (discussed earlier in this report), and the SWRCB's Bay Protection and Toxic Cleanup Program (BPTCP). Mugu Lagoon (eastern and western arms, main lagoon, and tidal prism) was classified by the BPTCP in 1999 as a high priority candidate toxic hot spot (LARWQCB 1999). As of this writing, none of the other estuaries or lagoons along the Santa Barbara Channel mainland coast had been classified as "areas of concern" or "candidate toxic hot spots" by the BPTCP (LARWQCB 1999, CCRWQCB 1998).[42]

Over the years, a variety of monitoring data (water, sediment, and tissue) have revealed exceedances of water quality objectives for specific water bodies established in Region 4's Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties and Region 3's Basin Plan for the Central Coast. These exceedances have resulted in the inclusion of many coastal stream reaches on the biannual statewide Clean Water Act 303(d) List of Water Quality Limited Segments, the most recent of which was produced in 2006.[43] 303(d) listings do not reflect the full range of pollutants that are detectable in the water, sediments or aquatic organisms of area streams and estuaries, because not all of the pollutants have occurred in high enough concentrations in monitoring data, or frequently enough, to trigger 303(d) listings. Also, new listings (for new stream reaches, or new pollutants or stressors) are anticipated by the Regional Boards for the 2008 303(d) list (expected to be released in 2010) for many of the streams

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[38] http://www.fscr.org/html/activities.html
[39] http://www.wishtoyo.org/ventura-coastkeeper.html
[40] http://sbc.lternet.edu/research/a1.html
[41] http://www.swrcb.ca.gov/agwaivers/index.html
[42] McGrath Lake, which is at the coast but not connected to the ocean, is considered by the BPTCP as a toxic hot spot owing to sediment concentrations of DDT, chlordane, dieldrin, toxaphene and endosulfan.
[43] Available at http://www.waterboards.ca.gov/tmdl/303d_lists2006approved.html

discussed herein. Nevertheless, the 2006 303(d) listings for the lowest reaches (closest to the ocean) and estuaries/lagoons of coastal rivers provide a reasonable view of the range of pollutants potentially entering the Santa Barbara Channel during terrestrial runoff.

Tables 8.6 and 8.7 list the mobile contaminants (including toxicity from unknown constituents) that have exceeded water quality standards at, or just upstream from, the coastal outlets of watersheds draining into the Santa Barbara Channel. A non-exhaustive list of entities which have been monitoring water or sediment quality in the pertinent stream reaches or estuaries is provided. Monitoring data from all of these programs was not consulted to create the table; the contaminant list was developed using the 2006 303(d) lists for Regions 3 and 4 and the online data provided by the Central Coast Ambient Monitoring Program (the latter as of March 2008). The tables suggest that water exported from several coastal estuaries (Devereux Slough, Goleta Slough, Carpinteria Salt Marsh, Santa Clara River estuary and Mugu Lagoon) are more likely to contain pesticides, heavy metals, PAHs, and/or PCBs than discharges from coastal streams lacking estuaries. Notable exceptions are Bell Creek and Mission Creek in the Santa Barbara area, in which water or sediment quality has exceeded criteria for total DDT, p,p'-DDE (Bell Creek) and several non-DDT legacy pesticides (Mission Creek). However, the water draining from several other low-order streams with direct ocean discharges has been found to be toxic to minnows or amphipods. For many coastal streams, fecal and/or coliform bacteria are the only reported constituents exceeding water quality criteria. Nitrate/nitrogen concentrations exceed applicable water quality criteria in several coastal confluences. Of the larger coastal watersheds, the Ventura River watershed exports the cleanest water; trash is the only mobile contaminant that has caused a 303(d) listing in river segments closest to the ocean, although the lower reaches of the river are listed for excessive algal growth, which may be linked to elevated nutrient levels.

Table 8.6
Reports of elevated levels of mobile contaminants in monitored streams, rivers and estuaries which drain directly into the Pacific Ocean between Point Conception and the mouth of the Ventura River. Harbors and marinas are not included.

Water Body	Monitoring Efforts	Pollutants or stressors responsible for 2006 303(d) listings	Other constituents producing at least one exceedance (water/ sediment/ tissue/ survival tests) as reported in the Central Coast Ambient Monitoring Program online database (as of February 2008), or in recent CCAMP monitoring reports (1)
Gaviota Creek	CCAMP - WQ/WTX/SED SBC-LTER State Parks	boron	fecal coliform unionized ammonia water toxicity (minnows, amphipods)
Canada del Capitan	CCAMP - WQ/WTX SBC-LTER State Parks	----	----
Canada del Refugio	CCAMP - WQ/WTX SBC-LTER State Parks	----	fecal & total coliform total dissolved solids water toxicity (minnows)
Dos Pueblos Creek	CCAMP - WQ/WTX	----	total coliform
Tecolote Creek	CCAMP - WQ/WTX	----	fecal & total coliform
Bell Creek	CCAMP - WQ/WTX/SED	nitrate	boron fecal & total coliform total dissolved solids water toxicity (minnows) total DDT, p,p'-DDE
Devereux Slough	CCAMP - WQ/WTX	----	boron fecal & total coliform total dissolved solids dieldrin total chlordane

Water Body	Monitoring Efforts	Pollutants or stressors responsible for 2006 303(d) listings	Other constituents producing at least one exceedance (water/ sediment/ tissue/ survival tests) as reported in the Central Coast Ambient Monitoring Program online database (as of February 2008), or in recent CCAMP monitoring reports (1)
Goleta Slough (2)	CCAMP-CC SBCK SBPCW (3)	pathogens priority organics	nickel in sediment synthetic organics in sediment 4,4'-DDD alpha-chlordane in sediment lindane in sediment
Arroyo Burro Creek	CCAMP- WQ/WTX CCAMP-CC SBC-LTER	pathogens (4)	fecal coliform water toxicity (minnows, amphipods)
Mission Creek	CCAMP-WQ/WTX/SED CCAMP-CC SBC-LTER	pathogens toxicity	fecal coliform alpha-chlordane in sediment total-chlordane in sediment lindane in sediment aldrin dieldrin (tissue) water toxicity (amphipods)
Sycamore Creek	CCAMP- WQ/WTX	----	boron fecal & total coliform water toxicity (amphipods)
Montecito Creek	CCAMP- WQ/WTX	----	fecal & total coliform
San Ysidro Creek	CCAMP- WQ/WTX	----	fecal & total coliform
Romero Creek	CCAMP- WQ/WTX	----	fecal & total coliform
Toro Creek	CCAMP- WQ/WTX	----	fecal & total coliform
Arroyo Paredon	CCAMP- WQ/WTX SBPCW (2006) (5)	----	boron nitrate (6) fecal & total coliform water toxicity (water fleas) total chlordane in sediment phosphate (USEPA recommended criteria)

Water Body	Monitoring Efforts	Pollutants or stressors responsible for 2006 303(d) listings	Other constituents producing at least one exceedance (water/ sediment/ tissue/ survival tests) as reported in the Central Coast Ambient Monitoring Program online database (as of February 2008), or in recent CCAMP monitoring reports (1)
Carpinteria Salt Marsh (5, 7)	CCAMP-CC State Parks SBPCW (2006)	nutrients priority organics	arsenic (tissue) cadmium (sediment & tissue) cis-chlordane (tissue) total chlordane (tissue) trans-chlordane (tissue) total DDT (tissue) dieldrin (tissue) total PAH (tissue)
Carpinteria Creek	CCAMP-WQ/WTX/SED SBC-LTER	pathogens	nitrate boron fecal & total coliform water toxicity (water fleas, minnows, amphipods) pore water ammonia
Rincon Creek	CCAMP-WQ/WTX/SED SBC-LTER	toxicity boron	water toxicity (minnows & amphipods) pore water ammonia

CCAMP - WQ/WTX/SED: Central Coast Ambient Monitoring Program - Conventional Water Quality (WQ), Water Toxicity (WTX), and Sediment Chemistry (SED)
CCAMP-CC: Central Coast Ambient Monitoring Program - Coastal Confluences Sampling Program (periodic sediment chemistry surveys)
State Parks: California State Parks staff and volunteers monitor for dissolved oxygen, nutrients and benthic invertebrates
SBCK: Santa Barbara Channelkeeper's Goleta Stream Team citizen monitoring program.
SBC-LTER: Santa Barbara Coastal Long Term Ecological Research project
SBPCW: Santa Barbara County Project Clean Water (storm water monitoring program)
VCSMP: Ventura Countywide Stormwater Monitoring Program

(1) Screening criteria used by CCAMP include Basin Plan or California Ocean Plan water quality objectives (beneficial use dependent); sediment toxicity critieria such as survival rates for amphipods, Probable Effects Levels, Threshold Effects Levels (TEL), NOAA Effects Range- Median and -Low (ERM, ERL); water toxicity criteria such as survival rates for fathead minnow larvae, amphipods, or water fleas; and body burden criteria for fish and bivalves such as US Fish & Wildlife and National Academy of Sciences guidelines for protection of aquatic life, and Maximum Tissue Residue Levels (MRTLs). For details, the reader is directed to the online database and CCAMP reports available at http://www.ccamp.org. Reports consulted for the table were the Central Coast Ambient Monitoring Program's June 2007 Hydrologic Unit Report for the 2001-02 South Coast Watershed Rotation Area; SWAMP Assessment Report for the Central Coast Region, 2001-2002, and the Central Coast Ambient Monitoring Program's 1998 Coastal Confluences Sediment Chemistry Assessment.

(2) Goleta Slough was delisted for metals and sediments based on SWRCB staff recommendations in the SWRCB Staff Report Supporting the 2006 Section 303(d) List (http://www.waterboards.ca.gov/tmdl/303d_lists2006staffrpts.html). Glen Annie Creek, a tributary of Goleta Slough, is listed for nitrate, and will be proposed for listing for toxicity, salts and coliforms in 2008. Other tributaries of Goleta Slough (Los Carneros, San Jose, and Atascadero Creeks) will be proposed for listing for coliforms in 2008.
(3) The Santa Barbara County storm water monitoring program (Project Clean Water) has, with variable frequency, measured bacteria, glyphosphate (aka Round-up), demeton, diazinon, chlorpyrifos, malathion, parathion, metals, nutrients, oil and grease in storm runoff at sites in San Jose Creek and Atascadero Creek (both tributary to the slough). These results are not incorporated in the table, but are available at http://www.sbprojectcleanwater.org/water_quality_monitoring.html.
(4) Arroyo Burro Creek has been recommended for delisting for pathogens in the SWRCB Staff Reports Supporting the 2006 Section 303(d) List (http://www.waterboards.ca.gov/tmdl/303d_lists2006staffrpts.html), on the basis that the original listing in 1998 was prompted by beach closures, and the contention that Arroyo Burro Beach, rather than the Creek, should have been listed for pathogens.
(5) As of March 2008, the Santa Barbara County storm water monitoring program (Project Clean Water) was scheduled to measure bacteria, glyphosphate (aka Round-up), demeton, diazinon, chlorpyrifos, malathion, parathion, metals, nutrients, oil and grease in storm runoff at sites in Santa Monica and Franklin Creeks (both tributary to the Carpinteria Marsh), and in Arroyo Paredon Creek.
(6) Arroyo Paredon Creek flows primarily through rural residential and greenhouse areas. The groundwater in this watershed is known to have extremely elevated levels of nitrate and a sump pump discharges groundwater to the creek at the Highway 101 bridge.
(7) Carpinteria Salt Marsh was delisted in 2006 for sediments/silt based on SWRCB staff recommendations. A tributary to Carpinteria Salt Marsh (Franklin Creek) is listed for nitrate, and along with Santa Monica Creek (also tributary to the marsh), may be added to the 303(d) list for coliforms in 2009.

Table 8.7
Reports of elevated levels of mobile contaminants in monitored streams, rivers and estuaries which drain directly into the Pacific Ocean from the Ventura River to Point Mugu. Only the lowest reaches of rivers (those closest to ocean outlets) are included. Harbors and marinas are not included.

Water Body	Monitoring Efforts	Pollutants/stressors responsible for 2006 303(d) listings for segments requiring TMDLs, or being addressed by TMDLs
Ventura River Estuary and Reach 1	VCSQMP-mass emission monitoring SBCK OVSD-receiving water monitoring	**Listed as requiring TMDLs** trash (1)
Santa Clara Estuary and Reach 1 (to 101 bridge)	VCSQMP-mass emission monitoring SWAMP (FY00/01) UCSB LTER VCWWTP	**Listed as requiring TMDLs** chemA (2) coliform toxaphene toxicity
Calleguas Creek Reach 1 (Mugu Lagoon)	SWAMP (FY00/01) Ventura Coastkeeper	**Listed as needing TMDLs** endosulfan **Listed as Being Addressed by EPA approved TMDLs** chlordane copper DDT dieldrin mercury nickel nitrogen PCBs toxicity (sediment) toxaphene zinc
Calleguas Creek Reach 2 (estuary to Potrero Rd.)	VCQSMP-mass emission monitoring Ventura Coastkeeper SWAMP (FY00/01)	**Listed as needing TMDLs** chemA (tissue) (3) endosulfan (tissue) (3) fecal coliform sediment/silt (3) **Listed as Being Addressed by EPA approved TMDLs** ammonia chlordane (tissue) copper DDT (water, tissue, sediment) dieldrin nitrogen PCBs toxicity (sediment) toxaphene

OVSD: Ojai Valley Sanitary District's receiving water monitoring program

VCWWTP: Ventura County Wastewater Treatment Plant's receiving water monitoring program
SBCK: Santa Barbara Channelkeeper's Ventura River Stream Team citizen monitoring program.
VCSQMP: Ventura Countywide Storm water Quality Management Program

(1) A trash TMDL for the Ventura River Estuary was approved by the State Water Resources Control Board in December 2007.
(2) chemA: refers to the sum of the following legacy pesticides and lubricants: aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, HCH (including lindane)
(3) These pollutants/stressors were moved by the USEPA from the 2006 "Being Approved" List to the 303(d) List pending completion and USEPA approval of a TMDL. However, a TMDL for Calleguas Creek OC Pesticides & PCBs became in effect on March 24, 2006, which covers all reaches of Calleguas Creek and its estuary (Mugu Lagoon).

Table 8.8 summarizes the impaired waterbodies draining to the Santa Barbara Channel in both Santa Barbara and Ventura counties.

Table 8.8
Impaired water bodies discharging to the Santa Barbara Channel near the CINMS
(from California's 2006 Clean Water Act Section 303(d) List of Water Quality Limited Segments).

Stream/Waterbody	Impairment	Potential Source(s)
	Santa Barbara County	
Arroyo Burro Creek	Pathogens	Urban Runoff, Nonpoint Source
Arroyo Paredon	Boron Nitrate Toxicity	Unknown (all)
Carpinteria Creek	Pathogens	Agriculture, Land Disposal, Septage Disposal
Carpinteria Marsh	Nutrients Organic Enrichment/ Low Dissolved Oxygen Priority Organics	Agriculture (nutrients and organic enrichment/low DO) Urban Runoff
Goleta Slough	Pathogens Priority Organics	Urban Runoff Nonpoint Source
Mission Creek	Pathogens	Urban Runoff, Transient Encampments
Pacific Ocean at Arroyo Burro Beach	Total Coliform	Unknown
Pacific Ocean at Carpinteria State Beach	Fecal Coliform Total Coliform	Unknown Unknown
Pacific Ocean at East Beach (Mouth of Mission Creek)	Fecal Coliform	Agriculture, Urban Runoff, Natural Sources, Nonpoint Source, Unknown Nonpoint Source
	Total Coliform	Agriculture, Urban Runoff, Natural Sources, Nonpoint Source, Unknown Nonpoint Source
Pacific Ocean at East Beach (Mouth of Sycamore Creek)	Total Coliform	Unknown
Pacific Ocean at Gaviota Beach	Total Coliform	Unknown
Pacific Ocean at Goleta Beach	Indicator Bacteria	Unknown
Pacific Ocean at Hammonds Beach	Fecal Coliform	Unknown
Pacific Ocean at Haskells Beach	Indicator Bacteria	Unknown
Pacific Ocean at Hope Ranch Beach	Fecal Coliform	Unknown
Pacific Ocean at Jalama Beach	Fecal Coliform	Agriculture, Pasture Grazing, Natural Sources, Nonpoint Source
	Total Coliform	Agriculture, Pasture Grazing, Natural Sources, Nonpoint Source

Pacific Ocean at Leadbetter Beach	Indicator Bacteria	Unknown
Pacific Ocean at Pt. Rincon	Fecal Coliform Total Coliform	Unknown Unknown
Pacific Ocean at Refugio Beach	Total Coliform	Unknown
Rincon Creek	Boron Toxicity	Unknown Unknown
Santa Ynez River (below City of Lompoc to ocean)	Nitrate as Nitrate Salinity/TDS/Chlorides Sedimentation/Siltation	Unknown Agriculture Agriculture, Urban Runoff, Resource Extraction
Ventura County		
Calleguas Creek	Endosulfan (tissue) ChemA (tissue) Chloride Fecal Coliform Sedimentation/Siltation Boron Sulfates Total Dissolved Solids Trash	Nonpoint Source Nonpoint Source Nonpoint/Point Source Nonpoint/Point Source Agriculture, Natural Sources Nonpoint Source Nonpoint Source Nonpoint Source Nonpoint Source
Channel Islands Harbor	Lead (sediment) Zinc (sediment)	Nonpoint Source Nonpoint Source
Channel Islands Harbor Beach	Indicator Bacteria	Nonpoint/Point Source
Hobie Beach (Channel Islands Harbor)	Indicator Bacteria	Nonpoint/Point Source
Ormond Beach	Indicator Bacteria	Unknown
Port Hueneme Harbor (Back Basins)	DDT (tissue) PCBs (tissue)	Nonpoint Source Nonpoint Source
Port Hueneme Pier	PCBs (tissue)	Nonpoint Source
Rio de Santa Clara/Oxnard Drain No.3	ChemA (tissue) Chlordane (tissue) DDT (tissue) Nitrogen PCBs (tissue) Sediment Toxicity Toxaphene (tissue)	Nonpoint Source Nonpoint Source Nonpoint Source Nonpoint Source Nonpoint Source Nonpoint Source Nonpoint Source
San Buenaventura Beach	Indicator Bacteria	Unknown
Santa Clara River	ChemA (tissue) Coliform Bacteria Toxaphene Toxicity Total Dissolved Solids Chlorpyrifos Diazinon Boron Sulfates	Unknown Nonpoint Source Nonpoint Source Unknown Nonpoint/Point Source Unknown Unknown Unknown Unknown
Ventura Harbor: Ventura Keys	Indicator Bacteria	Nonpoint Source
Ventura Marina Jetties	DDT PCBs	Unknown Unknown
Ventura River	Algae Eutrophic Total Coliform Trash Pumping Water Diversion	Nonpoint/Point Source Nonpoint/Point Source Nonpoint Source Nonpoint/Point Source Nonpoint Source Nonpoint Source

8.3 Comparison between Point and Nonpoint Source Loading

A comparison of pollutant loadings from point and nonpoint sources has not been published for the Santa Barbara Channel, but SCCWRP's Regional Monitoring surveys have worked towards addressing this topic for the larger Bight.

Four large POTWs each discharge over 100 million gallons per day into the Southern California Bight: the Hyperion Treatment Plant, operated by the City of Los Angeles; the Joint Water Pollution Control Plant, operated by the Los Angeles County Sanitation Districts; Treatment Plant No. 2, operated by the Orange County Sanitation District; and the Point Loma Wastewater Treatment Plant, operated by the City of San Diego. These four facilities have historically been the largest contributors of contaminants to the Bight. The degree to which contaminants found in the Channel originate from these outfalls is unknown, but the evidence presented by DDT found in sentinel mussels at the Northern Channel Islands proves that it is possible.

Owing to improved treatment, source control and pretreatment, cumulative pollutant loads from POTWs declined by up to several orders of magnitude during the 25 years prior to 1996. 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). However, changes in wastewater treatment practices have played an important role in improving effluent quality. Largely as a result of reductions in concentrations of pollutants from POTWs in the Bight, suspended solids and biological oxygen demand (BOD) decreased by 50%, heavy metals decreased by 90%, and chlorinated hydrocarbons decreased by 99% in discharges to the ocean between 1971 and 1996. From 1971 to 2000, annual emissions of all metals analyzed decreased between 22% (selenium) and 98% (cadmium), with a median reduction of 88%. Total DDT and PCB each decreased by three orders of magnitude between 1971 and 2000 to near or below detectable levels (Lyon and Stein 2008).

As wastewater treatment improves, the relative contribution of pollutant loads from other sources increases. Schiff et al. (2000) compared pollutant loadings from the late 1990s for different types of point sources in the Southern California Bight (Table 8.9). The study indicated that urban runoff into the Bight contributes significantly more suspended solids, nitrate, phosphate, chromium, copper, lead, nickel, and zinc than discharges from small and large POTWs combined. Note that POTWs provided 100% of nitrite-N, and the ratio of discharged nitrate/nitrite may depend upon the treatment process. Also, an analysis of more recent data from the greater Los Angeles area indicated that point sources deliver higher annual loadings of copper to the coastal ocean than runoff from urban watersheds (wet and dry weather combined) (Stein et al. 2007). Out of the point source contributors, oil platform discharges provided nearly 12% of the total load for lead. By far, power plant discharges contributed the main source of mercury - 85% of the total load. Using effluent monitoring data, A. Leydecker (unpublished data) estimated that dissolved inorganic nitrogen inputs from the ocean outfalls of POTWs in Santa Barbara County exceeded the combined nitrate export from eight coastal streams by a factor of two to three in WYs 2001 and 2003, and by a factor of approximately ten in WY 2002. Although power generating stations accounted for 86% by volume of the point source discharges to the Bight, their in-plant waste is not an important source of contaminants (Raco-Rands 1995). The in-plant flow of the power generating stations accounted for 0.04% of treated effluent flow and <0.001 to 7% of the mass emissions of individual constituents discharged to the Southern California Bight, with most contributions being less than 1%. The highest percent contributions by the plants were in copper and lead, but they still made up less than 10% of the input of these individual constituents to the Bight.

Table 8.9

Total mass emissions of selected pollutants from several sources to the coastal ocean in the Southern California Bight. Adapted from Schiff et al. 2000.

Constituent	Total Load	Percent of 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)	9,224	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)	5,880	-	99.00	1.00	-	-	-
Phosphate (mt)	4,702	61.68	38.32	-	-	-	-
Total P (mt)	1,841	-	100.0	-	-	-	-
Cyanide (kg)	8,026	-	80.99	18.71	«0.01	«0.01	0.30
Arsenic (kg)	5,723	-	87.37	6.67	4.11	1.00	0.86
Cadmium (kg)	2,085	-	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)	9,212	-	84.67	8.48	6.85	«0.01	«0.01
Silver (kg)	6,031	«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	2,900	-	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	-	-	-	-	-	-

More recent examination of the estimated annual mass emissions from major sources to the Bight have indicated that by 2000, large POTWs, dredged material and storm water runoff were the largest contributors (Lyon and Stein 2008). By this estimation, 70% of lead inputs into the Bight came from dredged and dumped material, followed by 27% from storm water runoff.

Sixty percent of chromium and 54% of mercury also came from dredged material. In contrast, power generating stations, industrial facilities and oil platforms contributed less than 1% of most constituents (Lyon and Stein 2008).

Contaminated sediments are found throughout the Southern California Bight but are not equally distributed (SCCWRP 2007). A disproportionate amount occur on the mainland slopes and basins, within embayments and in proximity to large POTWs in Los Angeles and San Diego. The lowest risk of adverse biological effects from this contamination was observed around the Channel Islands. DDT was prevalent in pelagic forage fish tissue in the Bight. Contamination above Canadian screening values protective of wildlife consumers of fish (seabirds and marine mammals) was restricted primarily to DDT. Virtually none of the landings exceeded screening values for PCBs. Tissue concentrations of DDT were generally highest in the central Bight, the location with the highest sediment concentrations (Allen et al. 2007).

9. Conclusions

According to the United Nations, the most serious problems facing the global marine environment include alterations and destruction of habitats, changes in sediment flows due to hydrological changes, climate change, declines in fish stocks and other renewable resources, effects of sewage and chemical pollution, and eutrophication (Mora 2004, UNEP/RSP 2006). Within the Southern California Bight, and more locally in the Santa Barbara Channel, all of these issues exist to some degree, but vary spatially, temporally, and when compared to other parts of the world. The level of contamination is often relative to a background level found at suitable reference sites. Often, a lack of information prevents assessment to any degree.

Surveys of the available data suggest that water quality in the CINMS is relatively good. The CINMS 2009 Condition Report concludes that stressors on water quality in the Sanctuary may preclude full development of living resources assemblages and habitats but are not likely to cause substantial or persistent declines (CINMS 2009a). Sampling conducted by SCCWRP typically demonstrates that water quality in and around the CINMS is higher than at most other sites in the Southern California Bight, suggesting that water quality impacts from regional anthropogenic point and nonpoint source pollutant discharges are significantly mitigated by distance from the mainland and have probably declined over several decades due to improved regulation and management. Although sizeable sediment plumes from mainland rivers are visible from satellite images during and after major storm events, these events are rarely intense enough for the plumes to reach the islands. Limited bacteria sampling at popular Channel Island anchorages in 2005-2007 found that levels of fecal indicator bacteria were undetected or extremely low at most sites.

While DDT, cadmium, PAHs and other contaminants are present in sediments at and around the Channel Islands, their concentrations present the lowest risk of acute toxicity of all sites sampled in the Bight ’03 surveys. Monitoring of pollutants concentrations in sentinel mussels in the late 1970s showed elevated levels of trace elements (mercury, cadmium, lead and silver), PCB, PBDE, DDT and other synthetic organics at some island sites, but again these levels were generally lower than at most other sites in the Southern California Bight.

Despite these findings, the conclusion that water quality in the CINMS is good is based on limited data and, as other reports have recommended, the Sanctuary should take a proactive approach to addressing existing and potential threats to water quality in order to maintain and protect the integrity of CINMS resources. Existing threats include pollution from offshore oil and gas production facilities, storm water plumes from the mainland, large vessels such as cruise ships and cargo vessels, smaller recreational vessels, invasive species, dredged materials, marine debris, and harmful algal blooms. Emerging or potential threats include new energy production projects in the Santa Barbara Channel, pharmaceuticals and personal care products discharged in sewage effluent, open ocean aquaculture, and ocean acidification. It is likely that pollution from many of these sources will increase over current levels, which could threaten Sanctuary resources.

As summarized in this report, there are a plethora of laws, management programs and research and monitoring efforts at the federal, State and local levels to address the water quality issues that affect or could affect Sanctuary resources. The CINMS has already sketched out a roadmap for a water quality protection program to address these existing and emerging threats, as evidenced by its commitment to implementing the Water Quality Action Plan outlined in the revised Management Plan. The strategies laid out in the action plan address the need for the CINMS to support and conduct monitoring for pollutants, identify sources of pollutants, prioritize Sanctuary water quality threats, work closely with existing and new partners and water quality authorities, and develop and implement priority corrective actions and Sanctuary programs to address water quality concerns.

This report aims to help focus the direction of this action plan by presenting the research and monitoring efforts that have characterized various water quality conditions in the Sanctuary region and summarizing information on the numerous authorities and management programs pertaining to water quality in the Sanctuary region.

The next step is for Sanctuary managers to use this information to help prioritize water quality threats to Sanctuary resources, and to identify needs and opportunities to coordinate and/or develop partnerships with existing authorities and other interested groups concerned with improving water quality in the Sanctuary. This should include formulating research and monitoring priorities geared towards addressing the most important existing and emerging threats to water quality in the Sanctuary, forming and strengthening partnerships with other entities working to address these threats, and helping to coordinate and improve enforcement of existing water quality protection laws and regulations. It should also include an assessment of the need for and feasibility of implementing additional water quality management strategies using existing resources and programs, and the need for any additional resources to develop a Sanctuary water quality management program. These tasks may best be carried out by the formation of a new Water Quality Working Group on the Sanctuary Advisory Council. We will not repeat the recommendations put forward in the *Water Quality Needs Assessment* or *Assessment of Coastal Watershed Resources and Watershed Conditions* reports, but simply note that these provide an excellent foundation on which such a Working Group could build its work plan.

The Monterey Bay National Marine Sanctuary (MBNMS) Water Quality Protection Program provides an excellent model, and CINMS staff and the SAC should refer to this program and consult with the staff and Advisory Council of the MBNMS in developing its own such program. The MBNMS program has identified the various water quality issues and problems in the Sanctuary and is now working to develop and implement plans with specific strategies and actions that address these problems. Strategies include public education, technical assistance, management practices, research and monitoring, and regulations and enforcement where necessary. The program has developed seven multi-stakeholder action plans to prevent pollution and facilitate water quality improvements in the areas of urban runoff, regional monitoring, marinas and boating, agriculture and rural lands, beach closures, cruise ships, and wetlands.

With regard to monitoring, since data on water quality in the CINMS are temporally and spatially limited, it is important for the Sanctuary to clearly identify water quality monitoring needs and develop a monitoring plan for Sanctuary waters based on identified priorities and gaps in research and data. An ideal plan would include regular monitoring within CINMS waters for bacteria, marine debris, toxicity, metals, nutrients, and hydrocarbons as well as standard parameters such as salinity, temperature, dissolved oxygen, chlorophyll and currents. To address some of the more prominent threats to Sanctuary water quality that have already been identified, such a plan could also include targeted monitoring of contaminant concentrations around oil platforms near the Sanctuary; monitoring of indicator bacteria at island anchorages and nearshore island locations frequented by day-use recreationists and overnight campers at high-use times; coordinated research efforts to assess the composition, dynamics and fate of storm water plumes from the mainland, particularly the Ventura and Santa Clara Rivers, on water quality in the CINMS; and coordination of various groups conducting research in or otherwise regularly using Sanctuary waters on a comprehensive Sanctuary marine debris collection and tracking program, among others.

The CINMS should look to the MBNMS' Water Quality Data Synthesis, Assessment and Management (SAM) Project as a model when developing its own monitoring plan. The SAM Project involves water quality monitoring coordination, data management, and data analysis to address fundamental issues surrounding the sources, status and trends of non-point source pollution in coastal watersheds and nearshore marine systems. Water quality and other spatial data sets have been collated into a database/GIS system that serves as a model for ongoing data integration and access in the region and is used as a tool for addressing research questions to improve knowledge of pollution problems and the effectiveness of pollution mitigation efforts.

In addition to more comprehensive and targeted water quality monitoring, there is a pressing need for better enforcement of the multitude of laws and regulations that govern water quality in the CINMS at the federal, State and local levels. The CINMS should focus in particular on enforcement of its new discharge prohibition regulation, which will require coordination with the USCG, DFG and other agencies with enforcement capabilities and a field presence in CINMS waters, as well as with the Sanctuary Education Team and other entities with a role in educating Sanctuary users to raise awareness and ensure compliance with the regulation. Another area that merits particular focus by the CINMS is continued and strengthened monitoring of vessel operations in Sanctuary waters, given the increase in vessel traffic that is projected to occur in Sanctuary waters in the coming years.

Finally, it is essential that Sanctuary managers keep abreast of emerging issues that could impact Sanctuary resources in the future, including climate change and ocean acidification, open ocean aquaculture, contaminants of emerging concern, and offshore energy projects, as well as emerging technologies and scientific methods to study their effects on aquatic life. The SAC's Working Groups will continue to play an important role in this capacity.

As one of only 13 marine sanctuaries nation-wide, the CINMS requires stringent protection. Given that the CINMS' mission is to conserve, protect and enhance the biodiversity, ecological integrity and cultural legacy of marine resources surrounding the Channel Islands for current and future generations, the CINMS must take a proactive approach to water quality protection planning with the ultimate goal of sustaining high water quality in the Sanctuary and surrounding waters. This presents many challenges in light of the fact that most of the sources that could potentially impair Sanctuary water quality lie beyond the boundary of the CINMS. However, as outlined in this report, there are numerous agencies and organizations involved in monitoring and protecting water quality in and around the CINMS, so coordination with and among these other entities to identify gaps and increase partnerships to address research, monitoring, protection and enforcement capabilities will be key in the CINMS' efforts to develop and implement a successful water quality protection plan. With this and previous reports, the Water Quality Action Plan laid out in the Management Plan, strong relationships with other relevant agencies and organizations, and a dedicated and highly competent staff and SAC, the CINMS is well-positioned to succeed in preserving the high quality of the CINMS' water resources for present and future generations.

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