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Environmental Condition of Water, Sediment, and Tissue Quality in Central Coast Harbors

Under the Surface Water Ambient Monitoring Program Fiscal Year 2002 – 2003

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Under the Surface Waters Ambient Monitoring Program Fiscal Year 2002-2003

Prepared by
Marine Pollution Studies Laboratory
Moss Landing Marine Laboratories

For the
Central Coast Regional Water Quality Control Board
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401

Authors

Marco Sigala and Russell Fairey
Marine Pollution Studies Laboratory, Moss Landing Marine Laboratories

Mary Adams
Central Coast Regional Water Quality Control Board

With special thanks to:
Krista Kamer, Cassandra Lamerdin, Susan Mason, Lara Pranger, Mark Pranger, and Stacey Swenson
Marine Pollution Studies Laboratory, Moss Landing Marine Laboratories

Karen Worcester
Central Coast Regional Water Quality Control Board

Walt Nelson and Faith Cole
U.S. Environmental Protection Agency, Pacific Coastal Ecology Branch

Ananda Ranasinghe
Southern California Coastal Water Research Program

Dave Montagne
Los Angeles County Sanitation District

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EXECUTIVE SUMMARY

The environmental condition of six Central Coast harbors (Santa Cruz, Moss Landing, Monterey, Morro Bay, Port San Luis, and Santa Barbara) was assessed through sampling and analysis of a standard set of water, sediment, and tissue parameters. A survey approach was used to select stations with a probability-based, random design so that all six harbors could be assessed on an areal extent as one entity (i.e., all harbors) for water and sediment environmental condition. Thirty stations were selected in Morro Bay while six stations were chosen in each of the remaining five harbors. Tissue sampling was conducted at a subset of stations within each harbor. Tissue stations were selected a priori to provide spatial representation within each harbor. In addition to evaluating all harbors as one unit, individual harbors were assessed by comparing each station within a harbor to criteria, guidelines, and screening values when applicable. Water and sediment quality indices used in the Environmental Protection Agency's (EPA) National Coastal Condition assessment were also applied to the results to provide a ranking of good, fair, or poor to each site and to all harbors. The Water Quality Index is based on levels of dissolved oxygen, dissolved inorganic nitrogen, orthophosphate, chlorophyll, and water clarity while the Sediment Quality Index incorporates total organic carbon concentrations, sediment contamination based on sediment quality guideline exceedances, and toxicity to amphipods. Tissue samples were rated based on the percent of human health screening value exceedances for eight metal and organic analytes.

All Harbors

Overall water quality based on the areal extent of the six harbors was determined to be good in an estimated 84.5% of the harbor areas with only 1.3% rated poor. Poor rankings were mostly due to elevated total dissolved inorganic nitrogen (DIN) and poor water clarity levels, but orthophosphate and dissolved oxygen (DO) levels also played a role in the evaluations.

The majority (62.6%) of sediments in all harbors rated good with 15.6% classified as poor. At least one station in each harbor ranked poor. The primary sediment analytes of concern were chromium, total dichlorodiphenyltrichloroethane (DDTs), arsenic, and copper. Toxicity to amphipods (<80% mean-adjusted survival) was demonstrated from cumulative distribution frequency (CDF) calculations to occur in 12% of the Morro Bay sediment area and approximately 5% of the sediment area in the other five harbors.

Fish tissue analysis of flatfish (speckled sanddab, California halibut, and starry flounder) was conducted at 14 stations. Samples represented whole body burdens but were compared to edible fillet screening values, so exceedances could be overstated. A poor rating occurred in 25% of fish samples due to arsenic, total polychlorinated biphenyls

(PCBs) Aroclors, and total polycyclic aromatic hydrocarbons (PAHs) human health screening exceedances.

Bivalve mussels (*Mytilus californianus*) were deployed at 10 stations within the six harbors. About a third (31.3%) of the samples rated poor due to arsenic, total PAHs, total PCB Aroclors, and total DDTs screening value exceedances.

Sediment samples (0.1 m^2, 1.0 mm sieve) were collected at each station to characterize the benthic infaunal community. Mean species richness per station was 31.9 species per 0.1 m^2 with a median of 23.5 species per 0.1 m^2. Species diversity was highest in Monterey Harbor while Morro Bay had lower diversity on the whole. The majority of taxa were polychaetes, amphipods, and bivalves.

Fish community analysis was conducted at 14 stations throughout the six harbors, but eight of these stations were in Morro Bay. There were 22 distinct fish taxa caught with a total abundance of 508 individuals. Mean abundance was 31.8 fish per trawl with a mean of 4.1 fish species per trawl.

Santa Cruz Harbor
Water quality in Santa Cruz rated good at three of the six stations with no exceedances of available water quality criteria and guidelines. The other three sites, located in the back portion of the harbor, ranked fair due to DO, orthophosphate, and water clarity levels. These same three stations had DO concentrations below the Central Coast Regional Water Quality Control Board (RWQCB) criteria.

The stations falling in the back portion of Santa Cruz Harbor ranked poor according to the Sediment Quality Index while three stations in the front portion of the harbor ranked fair or good. More than half of the samples exceeded sediment quality guidelines for arsenic, copper, nickel, zinc, total chlordane, total DDTs, and total PCBs. Chlordane levels exceeded the more stringent Effects Range Median (ERM) sediment guideline at half of the stations in Santa Cruz Harbor.

Santa Cruz Harbor rated poor for fish and bivalve tissue in 37.5% of samples due to levels of arsenic, total PCB Aroclors, and total PAHs exceeding screening value guidelines. Among the harbors, fish tissue whole body samples from Santa Cruz Harbor had the highest concentrations of manganese, selenium, and total chlordanes. Bivalve mussels bioaccumulated the highest mean concentrations of aluminum, copper, zinc, total PCB Aroclors, total PAHs, and high molecular weight (HMW) PAHs compared to the other harbors.

Analytes of concern in Santa Cruz Harbor are reduced water DO levels and elevated concentrations of arsenic (sediment) and total PCBs (sediment and tissue). Chlordane levels were also elevated in sediment and exceeded human health screening values in resident fish populations.

Moss Landing Harbor

Of the six stations sampled in Moss Landing, three ranked good (50%), one ranked fair (16.7%), and two ranked poor (33.3%) for water quality. Two sites ranked poor for high total DIN, low water clarity, and high orthophosphate (at one station). These sites were located in the boat slip area in the southern part of the harbor near a well-known toxic hot spot.

Sediment quality in Moss Landing Harbor was a mix of poor and good with half of the six stations in each category. One station in the main channel ranked poor due to amphipod toxicity while two stations in the southern portion of the harbor ranked poor due to sediment contaminant levels and amphipod toxicity. The latter were the only stations in this study to receive a poor ranking for both sediment contaminants and amphipod toxicity, and they also received a poor ranking for water quality. Sediment contaminants of concern include total chlordanes, total DDTs, and total PCBs.

Bivalve tissue results rated poor in half of the samples, while fish tissue data resulted in a poor ranking at only 12.5% of the samples. Arsenic, total DDTs, total PCB Aroclors, and total PAHs screening values were exceeded in bivalve tissues while only total PCB Aroclors was exceeded in fish tissue samples. Bivalve mussels in Moss Landing bioaccumulated the highest mean concentrations of manganese, total chlordanes, total DDTs, and dieldrin compared to the other harbors.

Analytes of concern in Moss Landing Harbor are elevated water nutrient (nitrogen and orthophosphate) levels, total chlordanes (sediment), and total DDTs (sediment and tissue). Total PCB levels were also elevated in sediment and exceeded human health screening values in resident fish populations as well as transplanted bivalve mussels.

Monterey Harbor

All six stations in Monterey Harbor ranked good for overall water quality, although orthophosphate levels were rated fair.

No stations ranked good for sediment quality in Monterey Harbor with four ranked fair (66.7%) and two rated poor (33.3%). Two stations ranked poor because of sediment contaminant levels. They were located in the boat slip area and near the wharf. Sediments in Monterey Harbor exceeded the Effects Range Low (ERL) guideline for all 15 trace metal and organic analytes in at least one station. The more stringent ERM guidelines for copper, mercury, total PCBs, and HMW PAHs were exceeded in at least one station, suggesting expected toxic biologic effects.

Fish and bivalve tissue samples ranked poor in 37% of the samples due to arsenic, total PCB Aroclors, and total PAHs levels. The fish sample had the highest concentration of lead while bivalve mussels had the highest mean concentrations of lead and mercury compared to the other harbors.

Analytes of concern in Monterey Harbor in both sediment and tissue samples appear to be mercury and total PCBs. Concentrations of lead in resident fish populations and transplanted bivalve mussels are elevated compared to the other harbors, but lead does not appear to be a concern in sediment.

Morro Bay

Of the 30 stations sampled, no stations ranked poor and 25 stations ranked good (83.3%), 3 fair (10%), and 2 with not enough information to be ranked (6.7%). Three stations ranked fair due to low water clarity and elevated orthophosphate levels. Water quality criteria and guidelines were not exceeded for any water analyte.

Overall sediment quality in Morro Bay was good (66.7%) to fair (23.3%). Three stations (10%) located in the main portion of the harbor ranked poor due to amphipod toxicity. Copper exceeded the ERL sediment quality guideline at 36.7% of the stations suggesting potential toxic biological effects.

Tissue samples rated good at 87.5% of the stations with the only poor rating due to arsenic levels exceeding human health screening values in both fish and bivalve mussels. Compared to the other harbors, fish samples in Morro Bay had the highest mean concentrations of chromium, copper, mercury, nickel, silver, and zinc while bivalve mussels had the highest mean concentration of arsenic.

The analyte of greatest concern in Morro Bay appears to be copper since it exceeded sediment quality guidelines and was found in the highest concentration of resident fish populations compared to the other harbors.

Port San Luis

All six stations in Port San Luis ranked good for overall water quality, although orthophosphate levels were rated fair. Two stations had pH levels greater than the RWQCB criterion of 8.3, but no other criterion or guideline was exceeded.

Sediment quality in Port San Luis appears to be good (66.7%) with one station ranked fair (near the end of Harford pier) and one station ranked poor (near the Unocal pier). The poor ranking was due to high sediment contaminant levels of chromium and nickel. The station near the end of Harford pier had the highest Tributyltin (TBT) concentration in this study at 199 ng/g. Copper exceeded the ERL guideline at a third of the stations suggesting toxic biological effects.

One quarter of tissue samples in Port San Luis rated poor for contaminant levels. Fish exceeded screening value thresholds for total PCB Aroclors and total PAHs while bivalve mussels exceeded thresholds for arsenic and total PAHs. Fish tissue samples had the highest mean concentration of cadmium, total PCB Aroclors, HMW PAHs, and total PAHs compared to the other harbors while bivalve mussels bioaccumulated the highest mean concentrations of cadmium, selenium, and silver.

Analytes of concern in Port San Luis resident fish populations and transplanted bivalve mussels are total PAHs primarily due to elevated levels of naphthalene, phenanthrene, fluoranthene, and pyrene. Total PCBs in resident fish populations could also be an analyte of concern.

Santa Barbara Harbor

Water quality in Santa Barbara was a mixture of good (33.3%), fair (50%), and poor (16.7%). Fair and poor rankings were due to DO, orthophosphate, and water clarity levels. Santa Barbara was the only harbor with a station ranked poor for DO. Four stations had DO levels less than the RWQCB criteria of 5.0 mg/l with a measurement as low as 0.31 mg/l.

Sediment quality in Santa Barbara Harbor was poor for 83.3% of the stations with the one station that ranked good located in the open portion of the harbor near the entrance. Santa Barbara Harbor was the only harbor besides Moss Landing to have a station rank poor for both water and sediment quality parameters. Poor rankings were due to moderate levels of total organic carbon (TOC) and poor sediment contaminant levels. The ERM sediment quality guideline for total chlordane was exceeded at five Santa Barbara stations (83.3%) suggesting toxic biological effects. Other analytes at elevated levels in Santa Barbara were arsenic, copper, nickel, and total DDT. Toxicity to amphipods was not a major factor in the sediment rankings.

Tissue quality for fish and bivalve mussels rated poor in 25% of the stations for exceeding arsenic and total PAHs screening values. Fish samples had the highest concentrations of arsenic and low molecular weight (LMW) PAHs amongst the harbors.

Analytes of concern in Santa Barbara are low DO and elevated sediment total chlordanes levels.

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ACRONYMS AND UNITS

%R	Percent recovery
AMS	Applied Marine Sciences Lab
BPTCP	Bay Protection and Toxic Cleanup Program
CMC	California men's colony
CCAMP	Central Coast Ambient Monitoring Program
CDF	Cumulative distribution frequency
CEDEN	California Environmental Data Exchange Network
CRM	Certified reference material
CWA	Clean Water Act
DBT	Dibutyltin
DDTs	Dichlorodiphenyltrichloroethane
DFG-WPCL	Department of Fish and Game-Water Pollution Control Lab
DIN	Dissolved inorganic nitrogen
DO	Dissolved oxygen
EMAP	Environmental Monitoring and Assessment Program
ERL	Effects range low
ERM	Effects range median
EPA	United States Environmental Protection Agency
GPL	Gulf Breeze Lab, USEPA
GRTS	Generalized Random Tessellation Stratified
HMW	High molecular weight
LCM	Laboratory control material
LCS	Laboratory control spike
LMW	Low molecular weight
MDL	Method detection limit
MIS	Median International Standards
MLML-TM	Moss Landing Marine Labs-Trace Metals Lab
MPSL-DFG	Marine Pollution Studies Lab-Department of Fish and Game
MPSL-MLML	Marine Pollution Studies Lab at Moss Landing Marine Labs
MS	Matrix spike
MSD	Matrix spike duplicate
NOAA	National Oceanic and Atmospheric Administration
NSG	Not significant greater
NSL	Not significant lower
OEHHA	Office of Environmental Health Hazard Assessment
QA	Quality assurance
QAMP	Quality assurance management plan
QAPP	Quality assurance project plan
QC	Quality control
PAHs	Polycyclic aromatic hydrocarbons

PAR	Photosynthetically active radiation
PCBs	Polychlorinated biphenyls
PEL	Probable effects level
PG&E	Pacific Gas and Electric
RL	Reporting level
RHO	Reverse hierarchical ordering
RPD	Relative percent difference
RWQCB	Regional Water Quality Control Board
RWQCBCC	Central Coast Regional Water Quality Control Board
SD	Standard deviation
SDTP	Standardized data transfer protocols
SG	Significant greater
SL	Significant lower
SQGQ	Sediment quality guideline quotient
SQI	Sediment Quality Index
SQO	Sediment quality objective
SV	Screening value
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TBT	Tributyltin
TEL	Threshold effects level
TMDL	Total maximum daily load
TOC	Total organic carbon
TSS	Total suspended solids
WEMAP	Western Environmental Monitoring and Assessment Program
WQI	Water Quality Index

<u>Units</u>

m	meter
cm	centimeter
mm	millimeter
l	liter
ml	milliliter
g	gram
mg	milligram
µg	microgram
ng	nanogram
kg	kilogram
ppth	part per thousand
ppm	part per million (equal to 1 mg/kg, 1 µg/g, 1 mg/l)
ppb	part per billion (equal to 1 µg/kg, 1 ng/g, 1 µg/l)

1.0 Introduction

1.1 Scope

California is divided into nine Regional Water Quality Control Boards (RWQCBs). The Central Coast Board (RWQCBCC) extends from Gazos Creek watershed in San Mateo County in the north to Rincon Creek watershed in Santa Barbara County to the south and contains portions of the Monterey Bay National Marine Sanctuary. This coastal region is served by six active harbors: Santa Cruz, Moss Landing, Monterey, Morro Bay, Port San Luis, and Santa Barbara (Figure 1-1). Although individual harbors have been studied and monitored at various levels, this study represents an assessment of all harbors in a consistent manner.

This report includes analysis of water, sediment, and tissue samples collected in six Central Coast harbors in September 2003 and June 2004. Sampling was conducted by staff from the Marine Pollution Studies Laboratory at Moss Landing Marine Laboratories (MPSL-MLML) for the Central Coast Regional Water Quality Control Board's (RWQCBCC) Central Coast Ambient Monitoring Program (CCAMP). Sampling of five harbors in June 2004 at six randomly selected stations within each harbor boundary was funded through California's Surface Water Ambient Monitoring Program (SWAMP). It was designed to augment sampling in September 2003 funded by the Environmental Protection Agency's (EPA) Western Environmental Monitoring and Assessment Program (WEMAP) in Morro Bay. The Morro Bay study included thirty randomly selected stations within the Bay.

1.2 Geographic Setting and Background Information for each Harbor

Santa Cruz Small Craft Harbor

Santa Cruz Harbor is located in the heart of Santa Cruz, approximately 70 miles south of San Francisco (Figure 1-2). Construction was completed on the breakwater and 360 slips of the small craft harbor in 1964. An additional 455 slips were completed in the North Harbor extension in 1973 and currently the Harbor has space for 1,000 wet-berthed vessels with approximately 150 of those being commercial fishing boats. Leisure boating is the primary activity in this harbor with half of the boats being 'pleasure sailboats'. Tourism is a large part of the Harbor's economy as boating tours and the Harbor's concessions and grounds are popular destinations. Direct sales in the Harbor amount to approximately $17 million annually and the 'Port District', which includes ten major concessions and 30 smaller businesses, generates $45 million annually (check http://www.santacruzharbor.org for more information).

One watershed, Arana Gulch, covering approximately 3.5 square miles, drains to the Santa Cruz Small Craft Harbor. Arana Gulch originates in the foothills of the Santa Cruz Mountains at elevations up to 600 feet above sea level and flows out to the Pacific

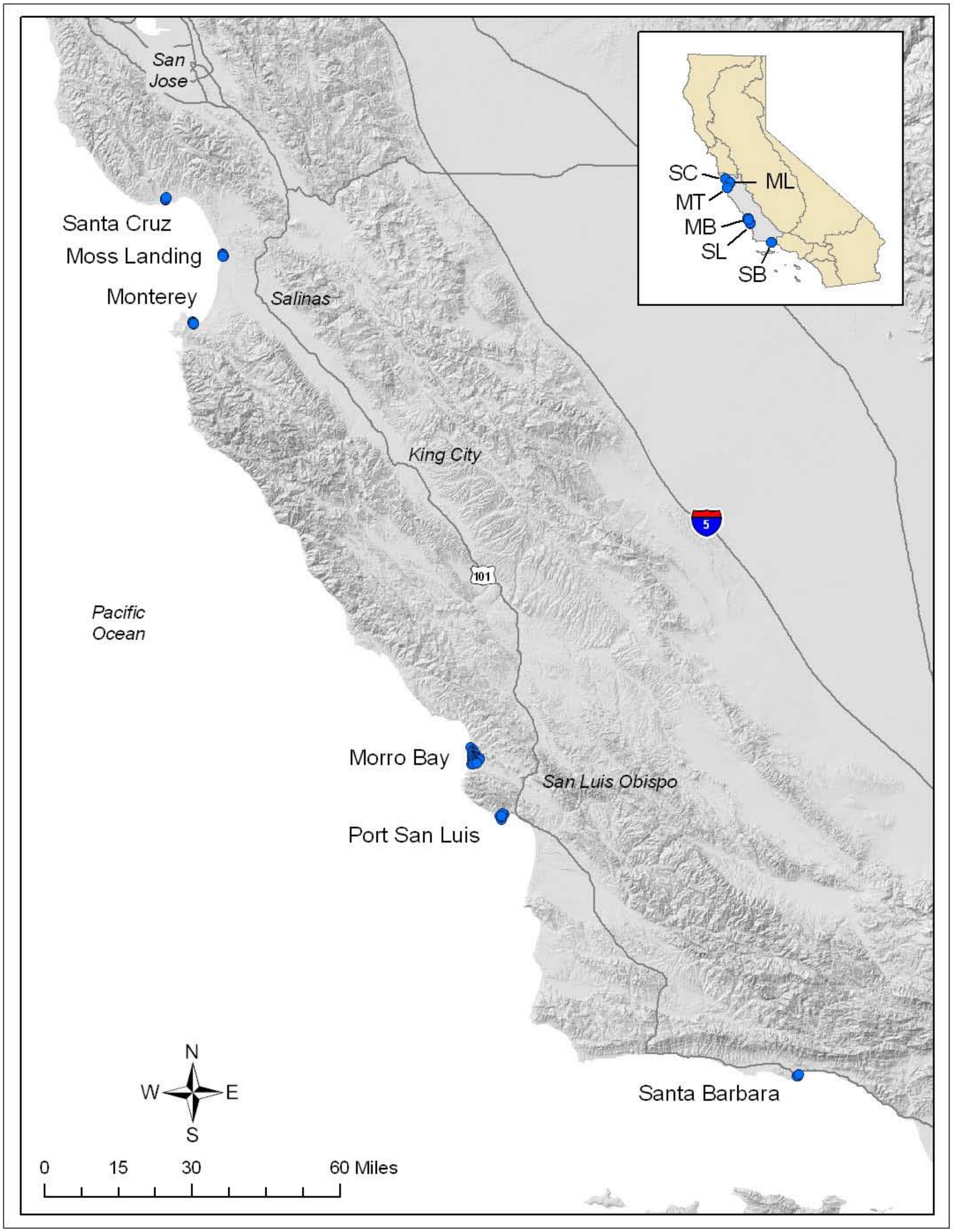


Figure 1-1. Location of the six central coast harbors within the Central Coast Regional Water Quality Control Board boundary.

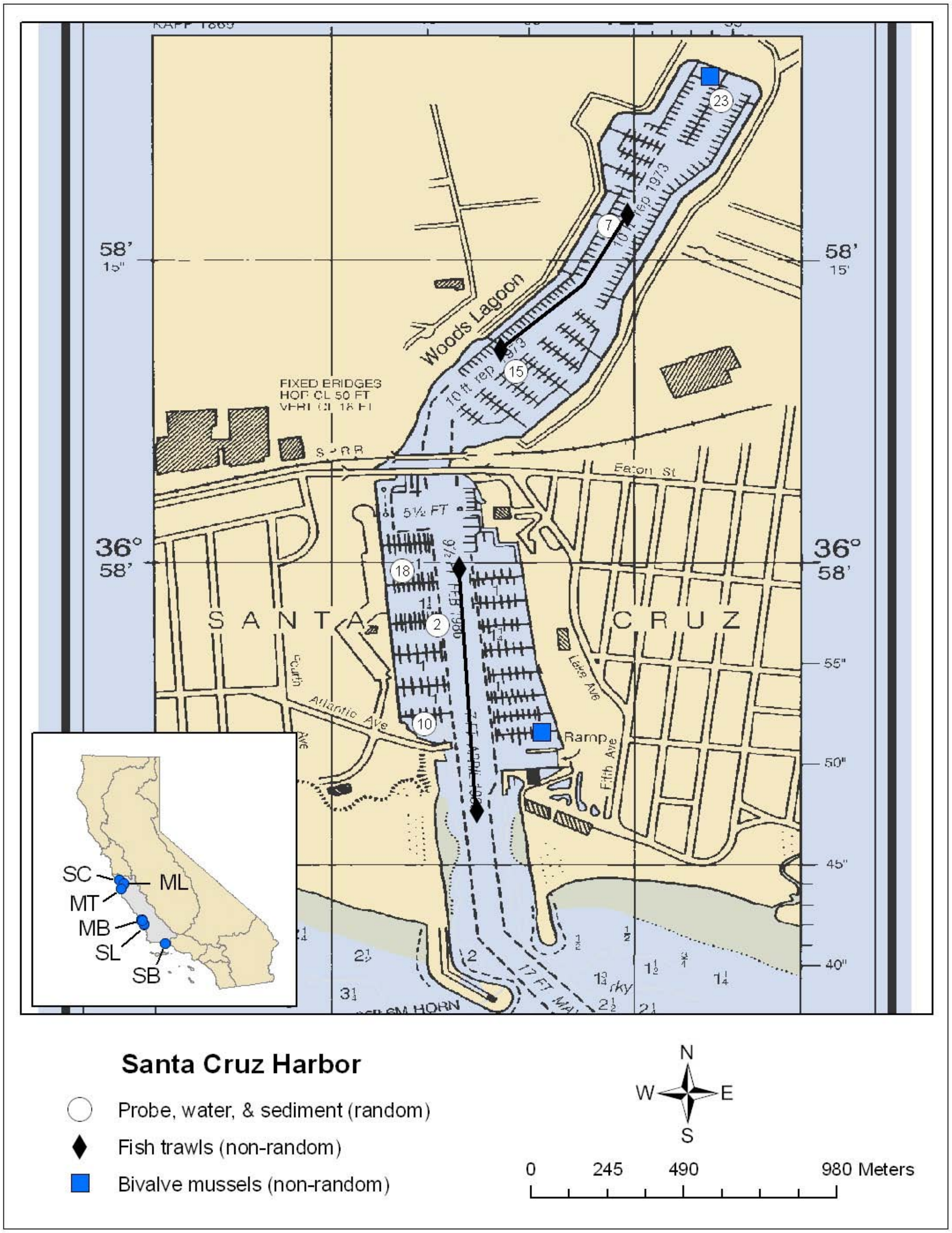


Figure 1-2. Santa Cruz Harbor station locations. Probe, water, and sediment stations represent probability-based, randomly selected locations (random). Tissue (fish and bivalve) stations were targeted (non-random). Fish trawls represent general trawl tracks.

Ocean at the Harbor. Historically, steelhead trout (*Oncorhynchus mykiss*) have spawned in the watershed. However, sedimentation and unnatural barriers have degraded the habitat, and currently there are multiple restoration efforts underway (Chartrand et al. 2002). Land uses in the upper watershed are primarily rural residential. In the lower elevations, land uses include orchards, areas designated as green space or open space, a golf course, and the urban areas of Santa Cruz.

In response to the Santa Cruz Harbor being dredged annually, sediment and tissue samples have correspondingly been tested. Although dredging reports submitted to the RWQCB by the Harbor District have not shown levels of organic chemicals above published guidelines, the Santa Cruz County Public Health and Environmental Health departments measured some metals, chlordane, and polycyclic aromatic hydrocarbons (PAHs) at concentrations considered to be above background levels with hydrogen sulfide levels detected above levels of concern. The Santa Cruz Harbor District has adopted a protocol that requires monitoring of hydrogen sulfide levels and modification of dredging operations if safe levels are exceeded (Santa Cruz County 2005). Bioaccumulation rates of metals and organic chemicals in sand crabs were not significantly different between pre- and post-dredging event samples (Kinnetic Labs 2005) and were similar to results from sand crab samples collected at other Santa Cruz County beaches outside of the influence of the harbor (Dugan et al. 2005).

Santa Cruz Harbor has also been sampled as part of larger regional and statewide monitoring efforts. In 1996, California mussels (*Mytilus californianus*) were transplanted to two sites in the Harbor and recollected after six weeks to examine bioaccumulated levels of metals and organic chemicals (SWRCB 2000). In 1998, the Bay Protection and Toxic Cleanup Program found elevated levels of sediment PCBs, PAHs, copper, and mercury at three sites (SWRCB 1998). Chlordane, an organochlorine (OC) pesticide banned from use in the 1970s, was the highest result detected in the study and was four times the Effects Range Median (ERM; Long et al. 1995) value at one of these sites. Although sediment was not toxic to the amphipod *Eohaustorius estuarius*, survival of the amphipod *Rhepoxynius abronius* was significantly lower, but the toxicity source was not determined.

Four times in the Harbor's history, anchovy kills resulting in the death of 1,000 or more fish have been documented due to low dissolved oxygen (DO) levels. To alleviate this issue the Harbor District aerates water in the back harbor using thirty aeration devices.

Moss Landing Harbor

Moss Landing is located at the eastern edge of Monterey Bay 25 miles south of Santa Cruz, 15 miles northeast of Monterey, and 95 miles south of San Francisco (Figure 1-3).

Moss Landing was named in 1866 after Captain Charles Moss, who was instrumental in the construction of the wharf establishing shipping facilities and a pier for commercial

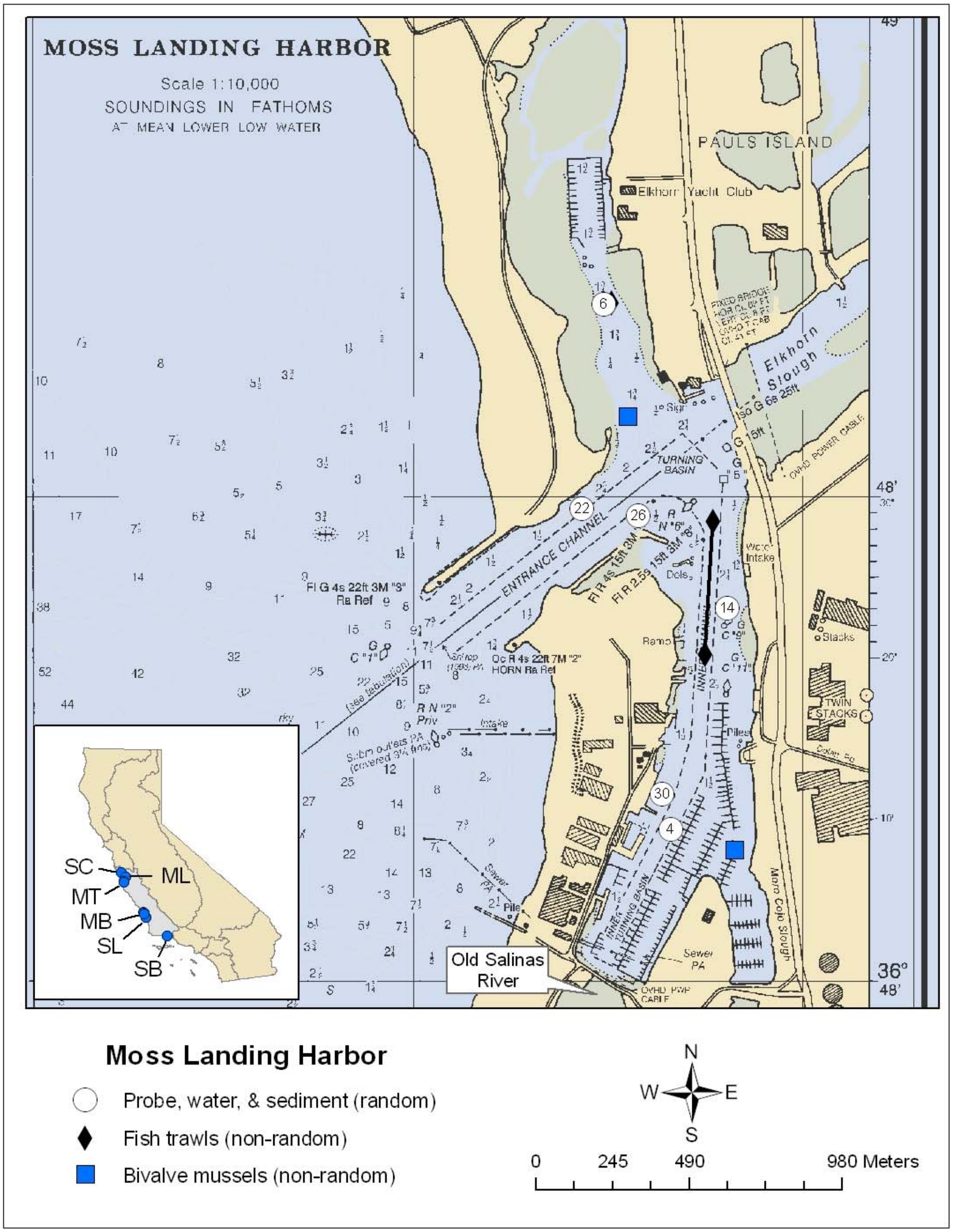


Figure 1-3. Moss Landing Harbor station locations. Probe, water, and sediment stations represent probability-based, randomly selected locations (random). Tissue (fish and bivalve) stations were targeted (non-random). Fish trawls represent general trawl tracks.

uses (Moss Landing Chamber of Commerce 2002). Commercial whaling was an important industry in Moss Landing between 1853 and 1927 until declining whale populations and foreign competition brought the industry to a halt (Lydon 2004). In the early 1900s, sardine fishing stimulated the small-scale fishing industry in Moss Landing resulting in the establishment of the Moss Landing Harbor District in 1947. Shortly thereafter the sardine fishery collapsed and fishermen were forced to change their focus to other fisheries.

Today, Moss Landing Harbor is one of the most important commercial fishing ports in California. The commercial fishing industry includes about 125 resident and 175 non-resident operations that employ well over 1,000 people. The direct economic value of commercial fishing at Moss Landing has been estimated at $18-25 million annually (Pomeroy and Dalton 2003) with more than 300 commercial vessels working out of this harbor (Weinstein 2002). Other important uses of the harbor are research institutions (Moss Landing Marine Laboratories and the Monterey Bay Aquarium Research Institute), tourism, and the natural gas power plant originally built by Pacific Gas and Electric (PG&E), which currently produces 2,560 MW of electricity annually for LS Power Generation LLC.

Moss Landing Harbor is connected to three coastal estuaries: Elkhorn Slough, Moro Cojo Slough, and Old Salinas River. The Harbor's watersheds support substantial agricultural activities as well as the cities of Salinas and Castroville. Elkhorn Slough is the second largest marine wetland in California (Robertson 2000) and drains to the Pacific Ocean through Moss Landing Harbor channel. This watershed drains parts of both Monterey and San Benito counties and includes the tributaries of Watsonville and Carneros Creeks. The watershed is more than 40,000 acres in size and includes salt marsh, coastal scrub, oak woodlands, rural residential areas, confined animal facilities, and row crop agriculture, particularly strawberries. The Slough became largely saline in 1946 when the Army Corps of Engineers opened the mouth of Elkhorn Slough to the Harbor channel; at this same time the outlet of the Salinas River was diverted from Moss Landing to its current alignment.

The Old Salinas River channel is the historic Salinas River channel. Prior to its diversion in 1946, the Salinas flowed to the Pacific Ocean at Moss Landing. Today, the Salinas River flows to the ocean seasonally several miles south of Moss Landing. The Old Salinas River conveys primarily agricultural return waters from a vestigial segment of the historic channel and is the receiving water for Tembladero Slough. Headwaters of Tembladero Slough are in the foothills east of the city of Salinas and include the watersheds of Alisal, Natividad, Gabilan, and Santa Rita creeks. Tembladero Slough is heavily influenced by agriculture and urban land uses. Several reaches of this watershed are listed on the CWA section 303(d) list of impaired waterbodies (Table 1-1) as a result of data collected by the Department of Fish and Game and CCAMP since 1988.

Table 1-1. Impaired segments as listed by CWA section 303(d) for Moss Landing Harbor Watersheds.

Waterbody	Pollutant/Stressor
Elkhorn Slough	Pathogens Pesticides Sedimentation
Moro Cojo Slough	Dissolved Oxygen Pesticides Sedimentation
Gabilan Creek	Fecal coliform
Alisal Creek	Fecal coliform Nitrate
Old Salinas River Estuary	Fecal coliform Depressed dissolved oxygen Nutrients Pesticides
Tembladero Slough	Fecal coliform Nutrients Pesticides

Moro Cojo Slough watershed covers approximately 17 square miles and drains to the Moss Landing Harbor south of Elkhorn Slough and north of the Salinas River watershed. Historically, Moro Cojo Slough was dominated by salt marsh habitats with small pockets of freshwater influence. Today, as a result of tidal control structures, the flow of saltwater is restricted into the slough. This has resulted in brackish conditions in the wet season and hyper-saline conditions in the dry season. Land uses in the watershed include row crop agriculture and confined animal facilities. In 1999 a 200-acre parcel was purchased by the Elkhorn Slough Foundation and is currently undergoing restoration (Habitat Management Group 1996). Historical data collected in the Slough was used to determine impairment of beneficial uses due to depressed DO, pesticides, and sedimentation (Table 1-1).

Moss Landing Harbor is currently listed on the CWA section 303(d) list of impaired waterbodies due to pathogens, pesticides, and sedimentation. Bay Protection and Toxic Cleanup Program (BPTCP) sampling showed significant toxic effects to the amphipod *Rhepoxynius abronius* and elevated levels of nickel (SWRCB 1998). Furthermore, mussels deployed as part of the State Mussel Watch Program had elevated total DDT concentrations, dieldrin, cadmium, and chromium relative to threshold values (SWRCB 2000). Resident fish collected from the harbor in 1987, 1988, and 1989 showed elevated levels of Tributyltin (TBT; SWRCB 1995a). Furthermore, sand crabs collected from Elkhorn Beach adjacent to the harbor mouth had the highest concentrations of PCBs in the region with elevated levels of arsenic, cadmium, chromium, copper, zinc, and the legacy pesticides DDT and oxychlordane (Dugan et al. 2005).

Water quality data in the vicinity of Moss Landing has been collected by volunteers for the Elkhorn Slough Foundation since 1988. Monitoring includes nutrients, pH, salinity, DO, and temperature. Similar data was also collected by CCAMP at one site in 1999. Bioaccumulation data has been collected by the California Department of Fish and Game's Mussel Watch Program since 1979. As a result of these data, Elkhorn Slough is on the Clean Water Act (CWA) section 303(d) list of impaired waterbodies for pathogens, pesticides, and sedimentation (Table 1-1).

In 1998, several stations within Elkhorn Slough were monitored for toxic effects and concentrations of chemicals and metals in sediment and water samples. These results are part of the BPTCP study conducted in the Central Coast Region (SWRCB 1998). Sediment samples had toxic effects to the amphipod *Rhepoxynius abronius* in 10 of 24 samples. Nine of these toxic results were from the back of the Slough at Andrews Pond and Egret Landing. The specific cause of toxicity was not determined.

Several stations were monitored for toxic effects and concentrations of chemicals and metals in sediment and water throughout Old Salinas River and Tembladero Slough as part of the BPTCP study (SWRCB 1998). The BPTCP study showed sediments of the Old Salinas River and lower reaches of Tembladero Slough contained elevated levels of chlordane and dieldrin greater than ERM sediment quality guideline values. Sediment samples were also toxic to both *R. abronius* and *Eohaustorius estuarius* in 4 of 5 samples collected at Sandholdt Bridge at the confluence of the Old Salinas River and the harbor. Samples were also collected in the Old Salinas and Tembladero Slough channels above their confluence at Monterey Dunes Way. Sediment samples from each of these sites also had dieldrin levels that exceeded the ERM guideline value and were toxic to *E. estuarius.*

Monterey Harbor

Monterey Harbor is located in the city of Monterey, north of Carmel and south of Moss Landing and Santa Cruz (Figure 1-4). The harbor, named for the Count of Monterey by Spanish mariner Sebastian Viscaino, has a long history beginning in the early 1600s as a trading port between the Philippines and Spain.

Monterey Harbor has undergone many changes beginning with the construction of the wharf in 1870 to handle the growth in passenger and freight services. The growing sardine industry prompted the expansion of the wharf and breakwater and, by 1920, the wharf was home to 20 fish outlets. The Municipal Wharf II was built in 1926 with further expansion and construction of a breakwater extension in 1934. With the collapse of the sardine industry in the 1950s, Fisherman's Wharf converted from commercial fishing warehouses and packing plants to tourist based industries. Today, Fisherman's Wharf

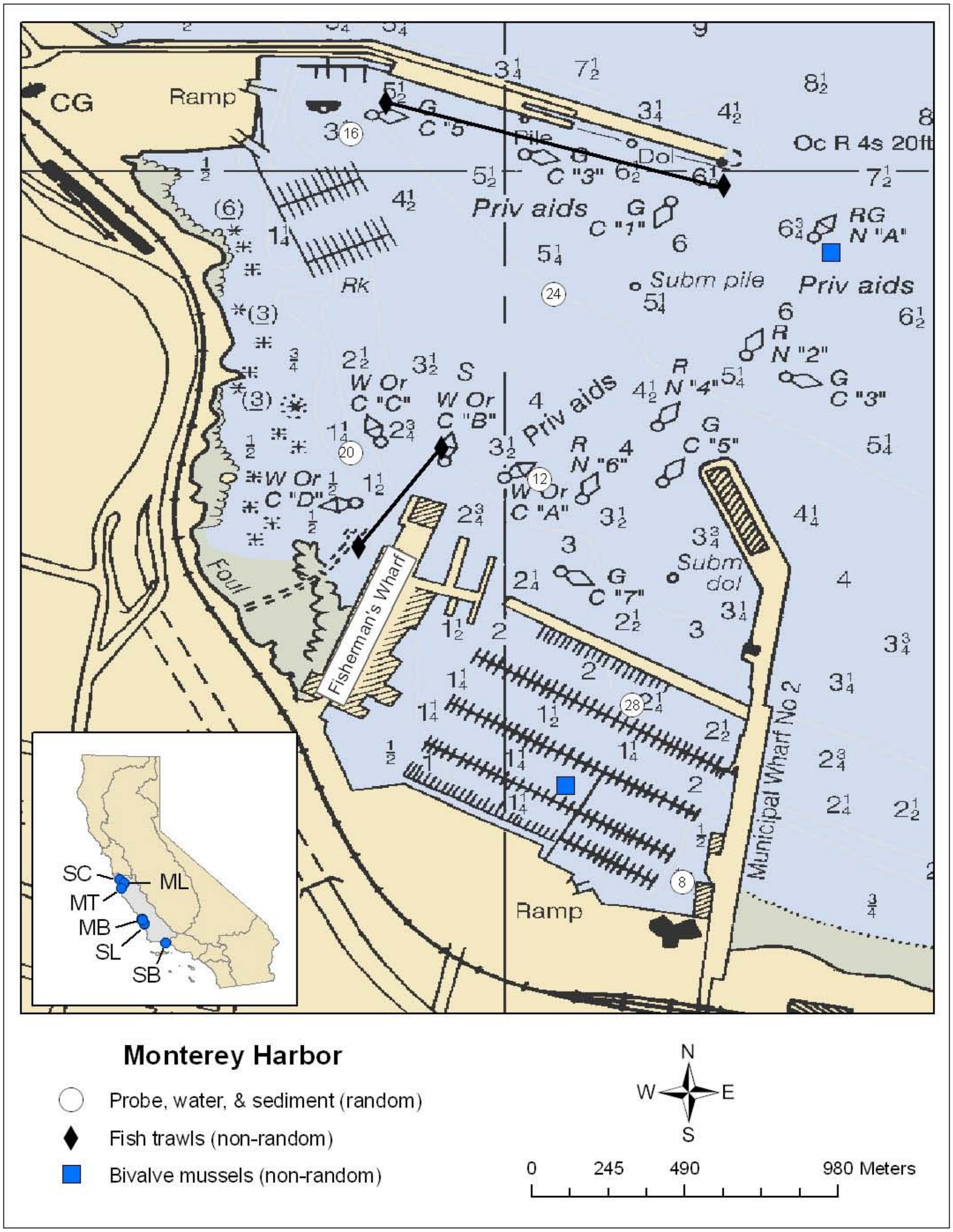


Figure 1-4. Monterey Harbor station locations. Probe, water, and sediment stations represent probability-based, randomly selected locations (random). Tissue (fish and bivalve) stations were targeted (non-random). Fish trawls represent general trawl tracks.

and Municipal Wharf II provide tourists with restaurants, shops, whale watching, deep-sea charters, a theater, aquarium, and abalone farm. Municipal Wharf II is also the center of the commercial wholesale fishing industry and houses several U.S. Coast Guard vessels.

The Municipal Marina currently has 413 slips for boats up to 50 feet in length and six locations where boats up to 75 feet long may tie up. In addition, there are approximately 150 privately owned mooring buoys in the outer harbor with twenty of these permitted live-aboard boats. In the summer there are additional temporary moorings allowed in the East Harbor. More details concerning the history and facilities in Monterey Harbor can be found at http://www.monterey.org/harbor/history.html.

There are no major watersheds flowing to the Monterey Harbor. Storm drains and surface runoff from the City of Monterey are the primary sources of runoff to the Harbor.

Monterey Harbor is currently on the CWA section 303(d) list for metals based on past elevated sediment and tissue lead concentrations. A slag pile with elevated levels of lead was discovered in the 1980s and attributed to slag that had been placed along the southern shore of the Harbor to stabilize railroad tracks that had run along the shore. This slag pile was cleaned up by the Union Pacific Railroad in the early 1990s. Follow-up monitoring indicated lead levels were still elevated but benthic communities were not negatively affected. Based on this information, the Central Coast RWQCB recommended removing Monterey Harbor from the CWA 303(d) list for impairment due to lead (RWQCBCC 2006a).

Morro Bay Harbor

Morro Bay is located on the Central Coast about 220 miles north of Los Angeles, 230 miles south of San Francisco, and about 15 miles northwest of San Luis Obispo (Figure 1-5). Morro Bay is a naturally enclosed bay originally protected by the sandspit and open to the Pacific Ocean on both sides of Morro Rock. Franklin Riley founded the port of Morro Bay in 1870 for export of dairy and ranch products. Riley was also instrumental in the construction of the wharf, which is known today as the Embarcadero. In 1933, the Army Corps of Engineers began construction on the large breakwater and road that now connects Morro Rock to the mainland next to Morro Creek. Morro Rock was one of the sources of material for this project and was quarried until 1969. Two artificial jetties have also been built on either side of the harbor entrance to further protect the harbor.

Since the 1920s, the town of Morro Bay has been a tourist-based economy, but commercial and sport fishing are also important industries. Abalone fishing quickly became successful in the 1940s, but stocks declined and commercial fishing switched to halibut, albacore, salmon, and rockfish. Oyster farming is conducted in the back portions of Morro Bay.

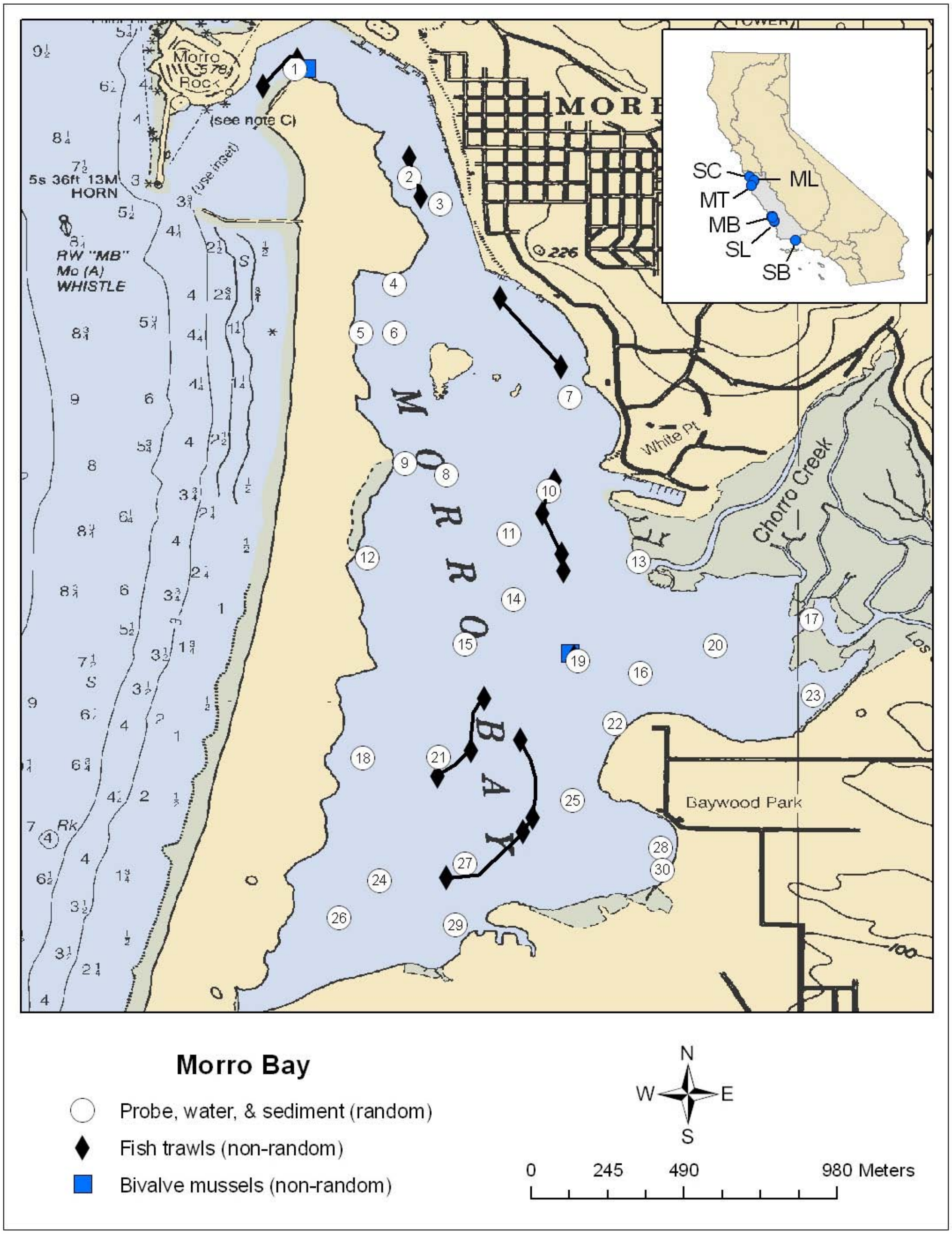


Figure 1-5. Morro Bay station locations. Probe, water, and sediment stations represent probability-based, randomly selected locations (random). Tissue (fish and bivalve) stations were targeted (non-random). Fish trawls represent general trawl tracks.

The U.S. Navy began training operations in Morro Bay in 1940. The base is now primarily occupied by the LS Power Generation LLC plant. The plant uses seawater from the bay to cool its turbines and discharges the warmed water outside of the harbor adjacent to Morro Rock. More information regarding Morro Bay can be found at http://en.wikipedia.org/wiki/Morro_Bay.

The Morro Bay watershed consists of the Chorro Creek and Los Osos Creek sub-watersheds. Chorro Creek drains a watershed of over 28,000 acres with its headwaters just northwest of San Luis Obispo. The California Men's Colony (CMC) wastewater treatment plant discharges tertiary treated wastewater to Chorro Creek. Los Osos Creek watershed drains approximately 18,000 acres. Land uses in the watershed include rangeland with areas of woodland, cropland, and urban land use.

Extensive monitoring in Chorro and Los Osos Creeks by RWQCBCC staff and volunteers at the Morro Bay National Estuary Program has identified several impairments associated with nutrients, DO, pathogens, and sedimentation in both Chorro and Los Osos Creeks. Recently, a total maximum daily load (TMDL) for nitrate, DO, and nuisance algal mass has been developed for Chorro Creek and identified the CMC as the primary source of nutrients, salts, and increased water temperature contributing to nuisance algal growth and depressed DO levels (RWQCBCC 2006b). The TMDL sets limits for salts, nutrients, and water temperature and calls for increasing canopy cover throughout the lower watershed.

Morro Bay was listed on the CWA section 303(d) list of impaired waterbodies for metals. However, as a result of TMDL monitoring in the Bay, it was determined that elevated metal concentrations were from natural sources and the Central Coast RWQCB recommended that Morro Bay be de-listed (RWQCBCC 2003).

Past studies in Morro Bay have found low levels of DDT metabolites, PCBs, PAHs, and TBT concentrations in sediments, but significant toxicity to the amphipod *Rhepoxynius abronius* in two of the five samples (SWRCB 1998). The source of toxicity was not determined. Tissue samples collected in 1988 and 1990 and analyzed for trace metals and TBT found concentrations of chromium and cadmium that exceeded Median International Standards (MIS) and TBT concentrations of 132 and 47.5 ng/g wet weight, respectively (SWRCB 2000).

An assessment of the Morro Bay National Estuary Program (NEP) including Morro Bay and the surrounding watersheds can be found in USEPA (2006). Data included in this study were used in the assessment. Current projects, accomplishments, and future goals of the Morro Bay NEP were also discussed.

Port San Luis

Port San Luis is located approximately 240 miles south of San Francisco, 15 miles southeast of Morro Bay, and 200 miles north of Los Angeles (Figure 1-6). The closest

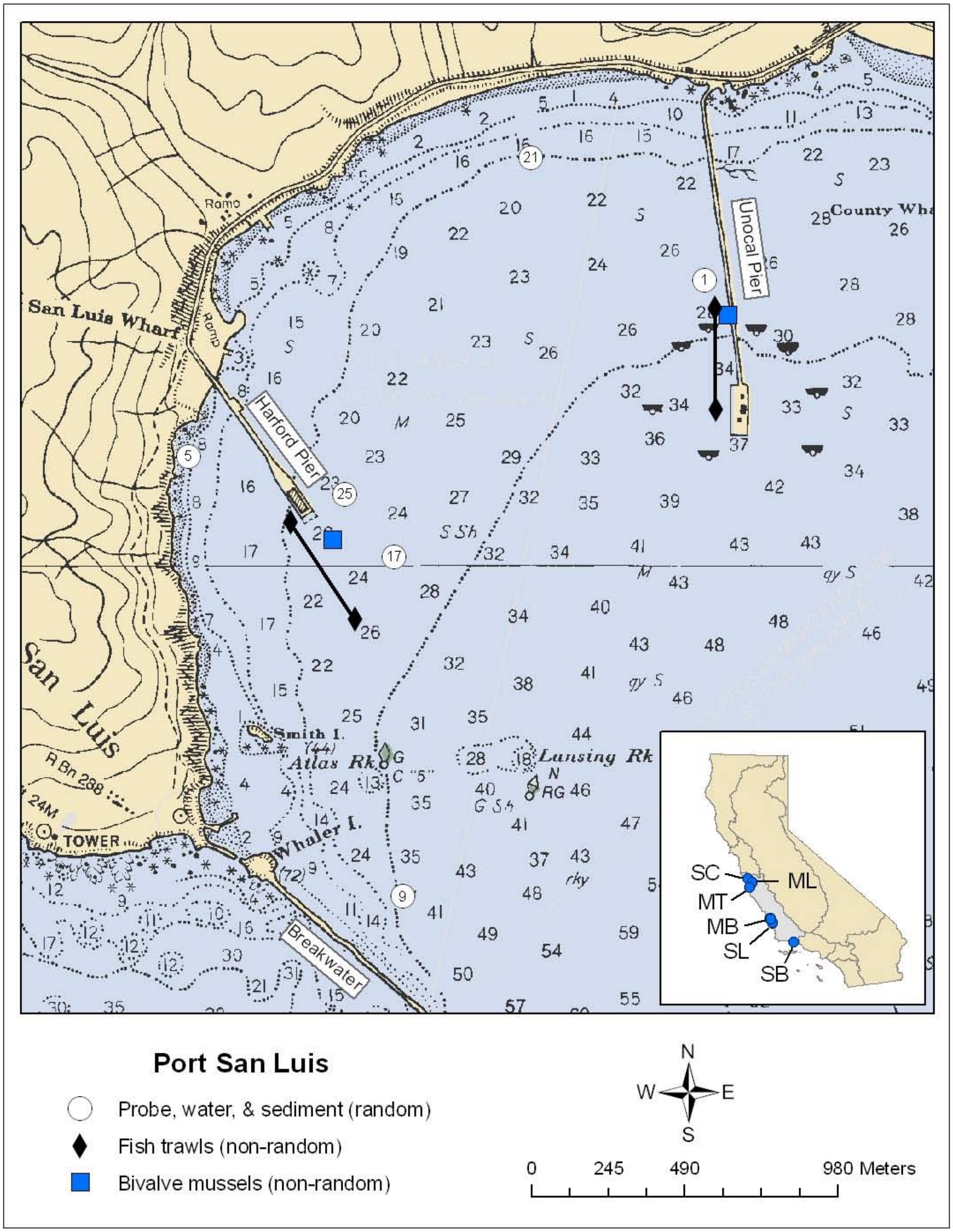


Figure 1-6. Port San Luis station locations. Probe, water, and sediment stations represent probability-based, randomly selected locations (random). Tissue (fish and bivalve) stations were targeted (non-random). Fish trawls represent general trawl tracks.

city is San Luis Obispo approximately 13 miles to the northeast. The harbor boundary as defined in this study consisted of the coastline between the Union Oil pipeline pier and the breakwater extending from Point San Luis, with the ocean boundary being a straight line between the tip of the pipeline pier and the tip of the breakwater.

Commercial activity in Port San Luis (then called Port Harford) was initiated in 1873 when the Harford Pier was built to serve the Pacific Coast Railway as a freight and passenger terminal between rail and ships. The port served as San Luis Obispo County's export site for dairy products, grain, cattle, and other farm and mineral products. Construction of the breakwater at the southwest edge of the harbor began in 1900. Harford Pier was expanded in 1906 to service Union Oil, the largest shipping company for oil on the West Coast, until 1942. The Harford Pier was in almost unusable condition when it was acquired by the Port San Luis Harbor District in 1965 and repaired to serve commercial and recreational users. In 1967, the Harbor District filled five acres of land adjacent to the pier which is still used for parking, boat haul out and repairs, and supports commercial businesses and day use recreation. A fish company and restaurant now resides in the old Pacific Coast Railway warehouse and other commercial and recreational businesses also lease space on the pier. Although the Harford Pier does service many commercial, sport, and recreational boats, there are no boat slips for commercial or recreational use within the harbor boundary. There are approximately 250 privately owned moorings, several guest moorings, and the harbor allows anchoring within its boundaries for short periods of time. The pier has two boat lifts open to the public.

In 1914, the railroad company constructed a second pier (Union Oil pipeline pier) on the northeast side of the harbor to transfer crude oil from Kern and Santa Barbara Counties to tankers. This pier also served as a receiving port for distribution to local markets. Storm waves destroyed the wooden pipeline pier in 1983. Unocal replaced the pier the following year with a concrete and steel pier that Unocal continued to use for oil shipping until 2001 when it donated the pier to Cal Poly State University for marine research and education.

San Luis Obispo Creek is the only major creek flowing to the ocean near Port San Luis, but the creek mouth is approximately 1/8 mile east of the Union Oil pipeline pier and outside the boundary of the harbor as defined for this study. Small creeks drain open space and trailer park land uses down the steep hillsides directly into the harbor area during storms. No data has been collected on these small creeks.

Tissue samples collected in past studies suggest bioaccumulation of metals and organics analytes relating to petrogenic sources such as crude and refined oil (PAHs) and industrial uses (PCBs). Sand crabs collected in 2000 and 2001 from the Old Port Beach within the harbor boundaries and at several locations along the beach adjacent to Avila Pier (outside of this study area) had elevated levels of PAHs, hexachlorobenzene (HCB), and PCBs (Dugan et al. 2005). Transplanted mussels from the Harford Pier and from outside of the breakwater had zinc, chromium, and cadmium concentrations that exceeded MIS thresholds in all samples (SWRCB 1995b). Furthermore, mussels transplanted to the Harford Pier in 1991 and 1992 had total PAH concentrations of 1,061 and 1,879 ng/g wet weight, respectively. These concentrations were much higher than the EPA human health screening value of 5.47 ng/g wet weight. Fluoranthene, phenanthrene and pyrene as a group consisted of 67% and 77% of the total PAHs concentrations in 1991 and 1992, respectively, and are components of creosote used to waterproof and protect wood pier pilings. Concentrations of PCBs were detected at levels below published screening values.

Santa Barbara Harbor

Santa Barbara Harbor is located in the heart of the city of Santa Barbara, approximately 100 miles north of Los Angeles (Figure 1-7). Local lumberman John P. Stearns built Stearns Wharf in 1872 to serve passenger and freight shipping and was expanded in 1877 to provide additional space for railroad car loading. Construction of the breakwater, which extends from Point Castillo at the south edge of the harbor to the sandspit in the northeast, was initiated in 1927. The era of shipping and transportation came to an end in the 1940s and today the wharf's primary economic stability is provided by tourist and marina services. The harbor has over 1,000 slips and 115 permanent moorings.

The Goleta Slough watershed drains approximately 47 square miles including the watersheds of Tecalotito (Glenn Annie), Los Carneros, San Pedro, San Jose, Maria Ygnacio, and Atascadero Creeks into Santa Barbara Harbor. Although land uses in each watershed vary, agriculture and urban uses dominate the majority of the watersheds. Sampling by the Goleta Stream Team found nitrate levels above the Basin Plan objective in Glenn Annie Creek and Los Carneros Creek, and they measured elevated coliform levels in all creeks (Leydecker and Grabowsky 2005). Data collected by CCAMP in 2001 supports these findings (http://www.ccamp.org/ca0/3/315/315m.htm).

The State Mussel Watch Program has not collected data in the harbor in the past ten years. However, two samples of California mussels were transplanted in Santa Barbara harbor in 1988. Cadmium, copper, and zinc concentrations exceeded MIS thresholds with TBT concentrations of 752 ng/g and 936 ng/g wet weight in the two samples. Organic chemicals were not analyzed.

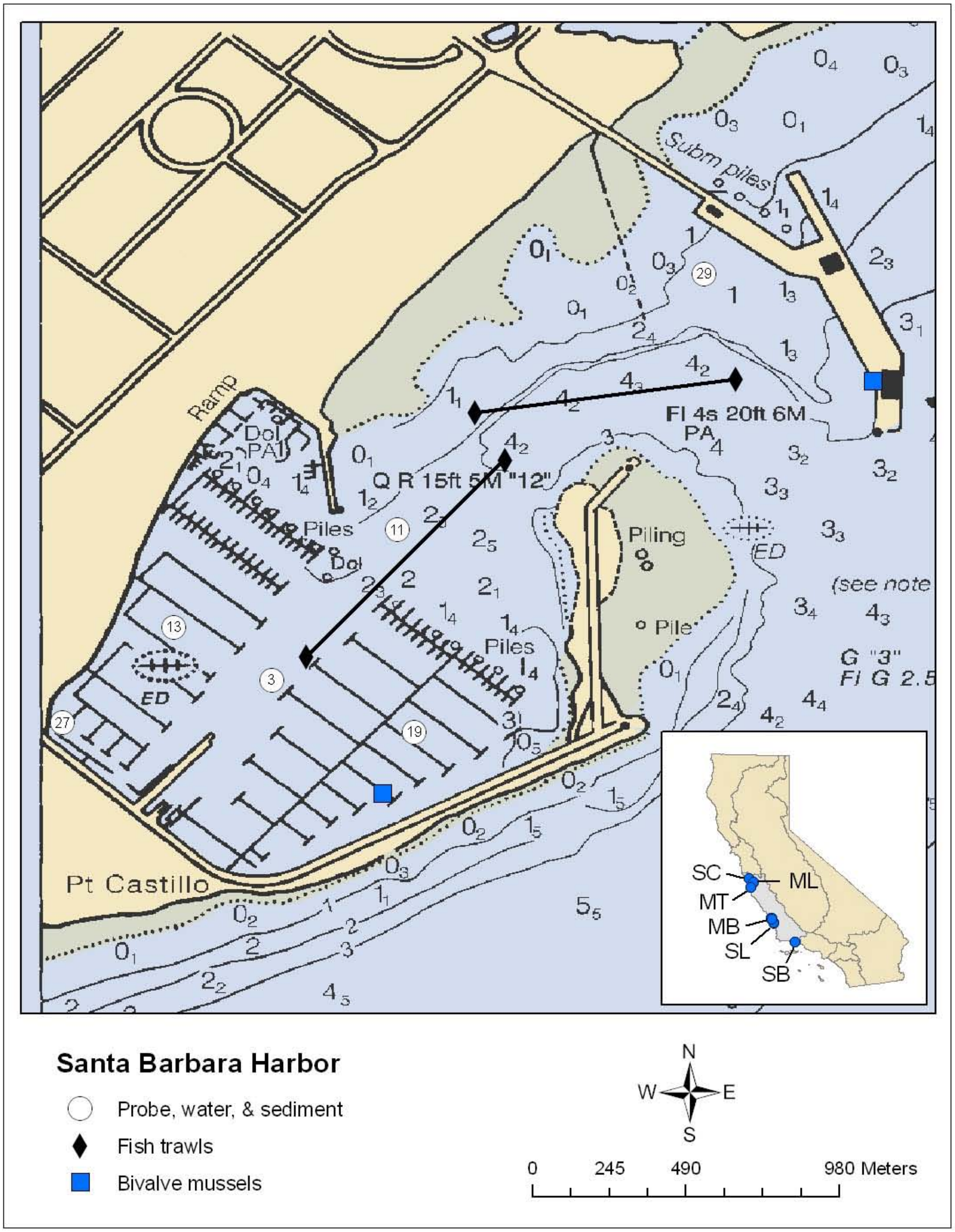


Figure 1-7. Santa Barbara Harbor station locations. Probe, water, and sediment stations represent probability-based, randomly selected locations (random). Tissue (fish and bivalve) stations were targeted (non-random). Fish trawls represent general trawl tracks.

2.0 Methods

2.1 Sampling Design

The sampling design followed the Environmental Monitoring and Assessment Program (EMAP) approach to evaluating the condition of ecological resources, which is described in reports such as Diaz-Ramos et al. (1996), Stevens (1997), Stevens and Olsen (1999) and is also presented in summaries provided on the internet at http://www.epa.gov/nheerl/arm/. EMAP employs a survey design approach to selecting samples so they provide valid estimates for the entire resource of interest based on probability-based, randomly selected samples rather than trying to perform a complete census of the resources.

This study brings together two EMAP-style studies. One study focused on five central coast harbors (Santa Barbara, Port San Luis, Monterey, Moss Landing, and Santa Cruz). The sampling frame boundaries of the harbors were developed by input from RWQCBCC, MPSL-MLML, and EPA staff. It is based on USGS 1:100,000 scale digital line graphs stored as a GIS data layer in an ARC/INFO program (Albers coverage). The same data layer was used for the EMAP Western Coastal Program in 1999, 2000, and 2004-6. Stations were selected using a Generalized Random Tessellation Stratified (GRTS) survey design for an areal resource with Reverse Hierarchical Ordering (RHO; Stevens 1997). No stratifications or panels were used in the design. A total of 30 stations were drawn with 6 falling within each harbor (multi-density category; Appendix A, Figures 1-2, 1-3, 1-4, 1-6, 1-7). An oversample of 30 stations was drawn to replace any primary stations not sampled due to factors such as inaccessible areas (e.g., station on land, permission denied) or safety concerns. Water column profiles, water, sediment, and fish samples were collected June 21-24, 2004. Mussels for bivalve accumulation were deployed at a subset (1-2) of stations that represented a spatial spread of each harbor (usually mouth and back of the harbor). Mussels were deployed in all six harbors February 17-19, 2004 and retrieved June 21-25, 2004. The second study was conducted in Morro Bay September 9-12, 2003 where 30 stations were sampled for water column profiles, water, and sediment, with a subset trawled for fish (Figure 1-5; Appendix A). EPA staff at the Gulf Breeze Laboratories in Florida developed the sampling frame for this study.

2.2 Indicators

The condition of Central Coast harbors was evaluated using a standard set of core environmental parameters at all stations to help assess general physical and chemical habitat condition, condition of benthic faunal resources, and exposure to pollutants (i.e., amounts and types of pollutants; Table 2-1). A complete list of the analytes, analytical methods, method detection limits (MDLs), reporting levels (RLs), and units can be found in Appendix B. Demersal (fish) and sessile (mussels) faunal resources were monitored at a subset of stations within each harbor. These environmental indicators were similar to those used in previous EMAP estuarine sampling in California and other regions of the United States (Weisberg et al. 1992; Macauley et al. 1994, 1995; Strobel at al. 1994, 1995; Hyland et al. 1996, 1998; Nelson et al. 2005). Field procedures followed methods discussed in the EPA National Coastal Assessment Field Operations Manual (USEPA 2001b) and were accepted by SWAMP.

Table 2-1. Environmental indicators for the Central Coast Harbor survey. Number of samples includes field duplicates if applicable. * All harbors except Morro Bay. ** Morro Bay only. PAR = photosynthetically active radiation.

Matrix	Analyte	Stations (#)	Samples (#)
Water	Probe Measurements [depth, temperature, pH, dissolved oxygen (mg/l, %), specific conductivity (μS/cm), salinity (ppth), PAR (ambient, at depth)]	60	1478
	Dissolved Nutrients (ammonia as N, nitrate as N, nitrite as N, orthophosphate as P)	60	140
	Chlorophyll-a	60	140
	Total Suspended Solids (TSS)	60	140
Sediment	Grain size	60	64
	Total Organic Carbon (TOC)	60	64
	Trace Metals (Ag, Al, As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Se, Zn)	60	64
	Tributyltin (TBT) and Dibutyltin (DBT)*	30	32
	Trace Organics [Organochlorine (OC) pesticides, Organophosphate (OP) pesticides, PCBs, PAHs)	60	64
	Toxicity (Eohaustorius 10-day test)*	30	32
	Toxicity (Ampelisca 10-day test)**	30	32
	Benthic infaunal community	60	60
Tissue – Fish	Trace Metals (Ag, Al, As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Se, Zn)	14	28
	Tributyltin (TBT) and Dibutyltin (DBT)*	7	8
	Trace Organics (OC pesticides, OP pesticides, PCBs, PAHs)	14	28
Tissue – Mussels	Trace Metals (Ag, Al, As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Se, Zn)	10	11
	Tributyltin (TBT) and Dibutyltin (DBT)	10	11
	Trace Organics (OC pesticides, OP pesticides, PCBs, PAHs)	10	11

2.2.1 Water Measurements

2.2.1.1 Hydrographic Profile

Water column profiles were performed at each station to measure depth (m), temperature (°C), pH, DO (mg/l and % saturation), specific conductivity (µS/cm), salinity (ppth), and light attenuation using Photosynthetically Active Radiation (PAR). Methods and procedures followed those used for Western EMAP sampling, which followed guidance from the National Coastal Assessment Quality Assurance Project Plan (USEPA 2001a). These profiles, excluding PAR, were measured with a Hydrolab Datasonde 4a hand-held multiparameter water quality probe with a cable connection to a Hydrolab Surveyor 4a deck display. Prior to deployment, the Hydrolab instrument was suspended at the water surface for 2-3 minutes to allow for warm-up. If station depth was ≤2.0 m, discrete probe readings were taken at 0.5 m intervals if possible. If the station depth was >2.0 m, readings were taken at the surface (0.5 m) and every 1.0 m down to the near-bottom (0.5 m off-bottom). Measurements were recorded on the downcast and upcast, but only data from the downcast was reported in the database. The Hydrolab was calibrated each morning prior to sampling. The DO membrane was changed prior to the first sampling event.

Light attenuation measured as photosynthetically active radiation (PAR) was recorded with a hand-held Li-Cor LI1400 Data Logger with two Li-Cor spherical quantum sensors (LI-193SA). Two sensors were used to obtain simultaneous ambient and underwater readings. The ambient sensor was attached to the top of the boat, while the underwater sensor was attached to the Hydrolab unit. Underwater light readings were recorded at discrete depths concurrently with the Hydrolab probe measurements.

The depth of submerged light readings recorded near the surface varied among stations (0.1-1.5 m), especially at shallow sites where multiple measurements were taken. Percent light transmission was therefore adjusted to a 1 m depth to allow for inter-station comparisons (Nelson et al. 2005). The air and corresponding underwater (closest to 1 m depth) light measurements, together with the depth of the measurement, were used to compute the light extinction coefficient (k) using the relationship $k = (\ln(I_0) - \ln(I_d))/d$, where I_0 = in air measure of light, I_d = submerged light measurement, and d = depth of submerged light measurement. In cases where a 0.5 m and a 1.5 m light reading was available, the 1.5 m value was used because the reading was more representative of the conditions. The value of k that was computed was assumed to characterize the light attenuation at a depth of 1 m, and light at a depth of 1 m (I_{1m}) was then calculated as $I_{1m} = e^{(-kd)}$, where d = 1 m. Percent light transmission at 1 m was then computed as $(I_{1m} / I_0) * 100$.

Two indices were calculated to assess water quality stratification in the harbors (Nelson et al. 2005). The simple Stratification Index was calculated based on the simple difference between bottom and surface salinities. The second index ($\Delta\sigma_t$) was more complex comparing the difference between bottom and surface σ_t values, where σ_t is the density of a parcel of water with a given salinity and temperature relative to atmospheric pressure.

2.2.1.2 Water Quality Indicators

Water samples were collected with a Wildco 1.2 liter stainless steel Kemmerer sampler. In most cases, the water column was sampled at three depths: subsurface (0.5 m near-surface), mid-depth, and 0.5 m off-bottom. At depths ≤2.0 m, only subsurface (0.5 m near-surface) and 0.5 m off-bottom samples were collected. If the depth was too shallow for two measurements (<1.0 m), a mid-depth sample was collected.

At each depth, water was collected for dissolved nutrients (nitrate, nitrite, ammonia, orthophosphate), chlorophyll, and total suspended solids (TSS) analyses. After an initial purge of the Kemmerer, water was poured into a 250 ml polyethylene bottle for TSS analysis and put on wet ice in the field and stored at 4°C until analysis. Water was then poured into a clean, wide-mouth polycarbonate tub for nutrient and chlorophyll samples. A syringe-filtration system was used in which approximately 70-100 ml of water was filtered through a disposable syringe fitted with a polypropylene filtering system (0.7 micron filter) and collected in a polyethylene bottle for nutrient analysis. The filter was carefully removed with tweezers, folded into quarters, wrapped in aluminum foil, and then placed into a coin envelope. For chlorophyll analysis, the volume of water filtered was noted on the data sheet and coin envelope. Nutrient and chlorophyll samples were immediately put in a cooler containing dry ice until final storage in a -20°C freezer until analysis.

Unlike probe measurements, the analytical result of each water quality indicator was averaged over all depths (surface, mid-water, and bottom) to produce a mean water column value per station (Nelson et al. 2005). Prior to calculating the average, Morro Bay nutrient data was converted from μg/l to mg/l to be consistent with data from the other harbors and with the threshold values. Total dissolved inorganic nitrogen (DIN) was calculated by summing the average values of nitrate, nitrite, and ammonia at each station.

2.2.2 Sediment Measurements

Sediment for chemistry and toxicity analyses was collected with two side-by-side 0.05 m^2 modified Van-Veen grabs. The frame holding the two grabs was deployed from the side of the boat using a hydraulic winch. The top 2-3 centimeters of surficial sediment was collected from each grab with a pre-cleaned polyethylene scoop and poured into a pre-cleaned polycarbonate tub until approximately 6 liters (12 liters for stations with a field duplicate) of sediment was collected. The tub was stored on wet ice in the field until processing at the laboratory. The sediment within each tub was homogenized with a large polycarbonate stirring rod and then aliquots of sediment were distributed into pre-cleaned containers for the following analyses: grain size, total organic carbon (TOC), trace metals (Ag, Al, As, Cd, Cr, Cu, Mn, Ni, Pb, Zn, Se, Hg), TBT (not for Morro Bay samples), trace organics (OC and OP pesticides, PCBs, PAHs), and amphipod toxicity (10-day *Ampelisca abdita* bioassay for Morro Bay samples and 10-day *Eohaustorius estuarius* bioassay for the other harbors). Grain size for the Morro Bay samples was analyzed for % fines (silt/clay) only while the other harbors were analyzed for the full phi size class analysis. A % fines value was calculated from the phi analysis for comparison purposes across all harbors. Sediment trace organics were summed to calculate total chlordanes, total PCBs, low molecular weight (LMW) and high molecular weight (HMW) PAHs, total PAHs, total normalized PAHs, total DDTs, and total normalized DDTs (see Section 2.3.1).

2.2.3 Biotic Condition Indicators

2.2.3.1 Benthic Community Structure

The first sediment grab taken at each station was used for benthic infaunal samples. Standard EMAP protocol is to collect 0.1 m^2 surface area of sediment with a penetration depth of 10 cm and sieve the sediment through a 1.0 mm sieve. This procedure was followed in Morro Bay where a Van-Veen grab (0.1 m^2) was used to collect sediment. However, a special study was conducted within the other harbors to compare collection methods and size fractions because other programs in California use 0.05 m^2 grabs or cores (0.0071 m^2) and a 0.5 mm sieve fraction for analysis. For each sediment grab with the double Van-Veen, a box core (0.0071 m^2) was collected from one of the 0.05 m^2 grabs to create one sample (core). The residual portion of that grab was put into a separate container as a sample (residual). All 0.05 m^2 of sediment from the second grab represented a third sample (grab). These three samples were sieved in the field with 1.0 mm sieves and preserved with a 10% formalin/seawater solution. Samples were sieved into a 0.5 mm and 1.0 mm fraction 4-7 days later and preserved in 70% isopropyl alcohol for sorting and taxonomy. Three area measurements (0.0071 m^2, 0.05 m^2, and 0.1 m^2) and two size fractions (0.5 mm and 1.0 mm) were analyzed as part of the gear and sieve size special study, but the sample of interest for this study was the 0.1 m^2 1.0 mm fraction.

Benthic organisms were identified to the lowest taxonomic level. However, certain species were grouped into a higher taxonomic level consistent with the SWRCB Sediment Quality Objective (SQO) study. Some taxonomic identity was lost in this grouping, but it will allow future comparisons to SQO values providing another mechanism to evaluate benthic community in relation to sediment chemistry and toxicity.

2.2.3.2 Fish Community Structure

Fish community and abundance estimates within each harbor were obtained by trawling a 16-foot otter trawl (1.5 inch mesh body, 1.25 inch mesh cod end), moving at an approximate speed of 2-3 knots, through or near a station (Figures 1-2 through 1-7). A successful community trawl lasted approximately 10 minutes in duration. In most cases, trawling was the last field activity performed at each site to prevent disturbing conditions for the water and sediment sampling. In Morro Bay, trawling could not occur at each station due to water depth. Rather, trawling was conducted in channels near a station with a total number of trawls representing the major channels in the bay. In the other harbors, trawls were conducted at one or two stations within each harbor.

After the net was retrieved, contents were poured into a clean tub for sorting, identification, and measurement. Fish were sorted into groups and identified to genus and species. The total length of each fish was measured to the nearest centimeter with a tape measure. Anomalies, if present, were noted on the data sheet but not kept for histopathology studies. Flatfish in good health without reference to size class were targeted for contaminant analysis. If sufficient numbers of flatfish of a given species were caught to provide enough tissue for analysis, they were wrapped in aluminum foil and put into a bag for storage in a cooler containing dry ice. All other organisms were returned to the harbor.

Additional trawls were conducted for contaminant analysis if the first trawl (i.e., community trawl) did not provide sufficient tissue for chemistry analyses. In some cases, additional trawls were conducted in different areas to obtain sufficient tissue. Only species used for tissue analysis were measured. All other organisms were returned to the harbor.

2.2.3.3 Fish Contaminant Sampling

Flatfish were targeted for chemical analyses of whole-body tissue. All flatfish from each station were composited whole body and homogenized into one sample following the procedures in USEPA (2001b). Tissue was analyzed for trace metals (Ag, Al, As, Cd, Cr, Cu, Mn, Ni, Pb, Zn, Se, Hg), TBT and DBT (not for Morro Bay samples), trace organics (OC and OP pesticides, PCBs, PAHs), and lipids.

2.2.3.4 Bivalve Contaminant Sampling

Bivalve mussels were deployed at two stations in each harbor following California State Mussel Watch Protocols (SWRCB 2000; Figures 1-2 through 1-7). Within each harbor, two out of the six stations that represented the back and front or most seaward portion of the harbor were selected for mussel deployment. Two bags of mussels (one for trace metals and one for trace organics analyses) were transplanted February 17-19, 2004 at each station on structures or buoys closest to each station, mostly within 50-200 yards.

Mussels were retrieved June 21-25, 2004. The bag for metals analyses was placed in a plastic bag while the bag for organics analyses was wrapped in aluminum foil. Both items were placed in a cooler on wet ice until they could be placed in a -20°C freezer at the laboratory for storage.

Forty-five mussels were dissected and homogenized into a sample per station according to SWRCB (2000). Tissue samples were analyzed for trace metals (Ag, Al, Cd, Cr, Cu, Mn, Ni, Pb, Zn, Se, Hg), DBT, TBT, trace organics (OC and OP pesticides, PCBs, PAHs), and lipids.

2.3 Data Analysis

Analysis of data was conducted at two levels. The first level used the probabilistic design to provide a general description of indicator values in relation to their spatial extent across the sampling region (i.e., all harbors). This was accomplished by creating cumulative distribution functions (CDFs) with 95% confidence intervals. The second level compared indicator values to established guidelines, screening values, and criteria to assess the status of each harbor.

For calculation purposes, analyte concentrations falling below the method detection limit (MDL) were given a value of one half the lowest MDL for that particular analyte. While there are issues associated with this substitution (Helsel 2005), this report performs basic analyses (summations and mean calculations) rather than in-depth statistical analyses where this substitution can lead to misleading interpretations. For analytes with <15% non-detects (see Tables 4-2, 4-3, 4-10, 4-12-4-14), the Resource Conservation and Recovery Act deems substitution a satisfactory procedure (USEPA 1992, USEPA 2002). However, for particular analytes in this survey with low detection frequencies (e.g., chlorpyrifos, diazinon, TBT, DBT, and total chlordanes), calculated means and standard deviations clearly reflect this substitution bias and caution should be made in interpreting comparisons among stations. When making comparisons to water quality objectives, sediment quality guidelines, and tissue screening values for individual stations, the substitution bias was not considered an issue for all analytes, except sediment total DDTs and total PAHs for fish tissue, because the guidelines and objectives were higher than the calculated summation results. The bias, therefore, did not impact final conclusions.

Although area weights from the probabilistic design (see Section 2.3.2) can be used to calculate area-weighted means and standard deviations Diaz-Ramos et al. (1996), the means and standard deviations presented in this report represent un-weighted values based on total sample count.

2.3.1 Data Summations

The following summations were used for calculating total chlordanes, total PCBs, total PCB Aroclors, LMW PAHs, HMW PAHs, total PAHs, total normalized PAHs, total DDTs, total normalized DDTs, and the sediment quality objective SQGQ1. Summations were used for both sediment and tissue calculations except where noted in parentheses.

Total Chlordanes [sediment (Fairey et al. 2001) and tissue (USEPA 2000)] =
∑ [chlordane, cis-] [chlordane, trans-] [nonachlor, cis-] [nonachlor, trans-] [oxychlordane]

Total DDTs [sediment (Fairey et al. 2001) and tissue (USEPA 2000)] =
∑ [DDD(o,p')] [DDD(p,p')] [DDE(o,p')] [DDE(p,p')] [DDT(o,p')] [DDT(p,p')]

Total normalized DDTs [DDT_{OC}; sediment (Swartz et al. 1994)] = ∑ [nDDD(o,p')] [nDDD(p,p')] [nDDE(o,p')] [nDDE(p,p')] [nDDT(o,p')] [nDDT(p,p')]

where each DDT (nDDT) was normalized by total organic carbon (TOC) according to the formula:

DDT_{OC} µg/g = [(DDT ng/g) * (1000 µg/g)] * [100 / (% TOC)]

LMW PAHs [sediment (Long et al. 1995) and tissue (SWRCB 2000)] =
∑ [Acenapthene] [Acenapthylene] [Anthracene] [Biphenyl] [Dimethylnaphthalene, 2,6-] [Fluorene] [Methylnaphthalene, 1-] [Methylnaphthalene, 2-] [Methylphenanthrene, 1-] [Naphthalene] [Phenanthrene] [Trimethylnaphthalene, 2,3,5-]

HMW PAHs [sediment (Long et al. 1995) and tissue (SWRCB 2000)] =
∑ [Benz(a)anthracene] [Benzo(a)pyrene] [Benzo(b)fluoranthene] [Benzo(k)fluoranthene] [Benzo(g,h,i)perylene] [Benzo(e)pyrene] [Chrysene] [Dibenz(a,h)anthracene] [Fluoranthene] [Indeno(1,2,3-c,d)pyrene] [Perylene] [Pyrene]

Total PAHs [sediment (Long et al. 1995) and tissue (SWRCB 2000)] =
∑ [LMW PAHs] [HMW PAHs]

Total normalized PAHs [PAH_{OC}; sediment (Swartz 1999)] =
∑ [nAcenapthene] [nAcenapthylene] [nAnthracene] [nFluorene] [nNaphthalene] [nPhenanthrene] [nBenz(a)anthracene] [nBenzo(a)pyrene] [nBenzo(b)fluoranthene] [nBenzo(k)fluoranthene] [nChrysene] [nFluoranthene] [nPyrene]

where each PAH (nPAH) was normalized by total organic carbon (TOC) according to the formula:

PAH_{OC} µg/g = [(PAH ng/g) * (1000 µg/g)] * [100 / (% TOC)]

Total PCBs (sediment; Fairey et al. 2001) = 2 * (∑ [PCB008] [PCB018] [PCB028] [PCB044] [PCB052] [PCB066] [PCB101] [PCB105] [PCB118] [PCB128] [PCB138] [PCB153] [PCB170] [PCB180] [PCB187] [PCB195] [PCB206] [PCB209])

Total PCBs (tissue; USEPA 2000) = ∑ [PCB008] [PCB018] [PCB028] [PCB044] [PCB052] [PCB066] [PCB77] [PCB101] [PCB105] [PCB118] [PCB126] [PCB128] [PCB138] [PCB153] [PCB169] [PCB170] [PCB180] [PCB187]

Total PCB Aroclors (tissue; SWRCB 2000) =
∑ [Aroclor 1248] [Aroclor 1254] [Aroclor 1260]

SQGQ1 (sediment; Fairey et al. 2001) = (∑ [cadmium/4.21] [copper/270] [lead/112.18] [silver/1.77] [zinc/410] [total chlordane/6] [dieldrin/8] [total PAH_{OC}/1800] [total PCB/400])/9

2.3.2 Cumulative Distribution Functions (CDFs)

Cumulative distribution functions (CDFs) have been used extensively in other EMAP coastal studies to analyze data and to provide a spatial description of indicator values across the sample region (Summers et al. 1993, Strobel et al. 1994, Hyland et al. 1996, Nelson et al. 2005). A detailed description for calculating CDFs used in EMAP can be found in Diaz-Ramos et al. (1996). CDFs were calculated for most water and sediment analytes but not tissue analytes because of low sample size and the tissue stations were not selected based on the probabilistic design.

The Horvitz-Thompson ratio estimate of the CDF was given by the formula:

$$\hat{F}(x_k) = \frac{\sum_{i=1}^{n} \frac{1}{\pi_i} I(y_i \leq x_k)}{\hat{N}} \quad ; \quad \hat{N} = \sum_{i=1}^{n} \frac{1}{\pi_i}$$

$\hat{F}(x_k)$ = estimated CDF (proportion) for indicator value x_k

n = number of samples

y_i = the sample response for site i

x_k = the k th CDF response indicator

$$I(y_i \leq x_k) = \begin{cases} 1, y_i \leq x_k \\ 0, \mathit{otherwise} \end{cases}$$

π_i = selection probability for site i

$\hat{N}$ = the estimated population size

The selection probability for a site was the same for all stations within a harbor, but not across harbors.

The Horvitz-Thompson unbiased estimate of the variance for the ratio estimate was given by the formula:

$$\hat{V}\,[\hat{F}(x_k)] = \frac{\sum_{i=1}^{n} \frac{d_i^2}{\pi_i^2} + \sum_{i=1}^{n}\sum_{j \neq 1}^{n} d_i d_j \left(\frac{1}{\pi_i}\frac{1}{\pi_j} - \frac{1}{\pi_{ij}} \right)}{\hat{N}^2} \quad ;$$

$$\hat{N} = \sum_{i=1}^{n} \frac{1}{\pi_i}, \quad d_i = I(y_i \leq x_k) - \hat{F}(x_k), \quad d_j = I(y_j \leq x_k) - \hat{F}(x_k)$$

$\hat{F}(x_k)$ = estimated CDF (proportion) for indicator value x_k

$$I(y_i \leq x_k) = \begin{cases} 1, & y_i \leq x_k \\ 0, & otherwise \end{cases}$$

x_k = the kth indicator level of interest

y_i = value of indicator for the ith unit sampled

π_i = inclusion density evaluated at the location of the ith sample point

π_{ij} = joint inclusion density evaluated at the locations of the ith and jth sample points

n = number of units sampled

The joint inclusion probabilities were given by:

$$\pi_{ij} = \frac{(n-1) * \pi_i \pi_j}{n}$$

2.3.3 Comparison to Established Thresholds

Guidelines, screening values, and criteria used for specific water, sediment, and tissue analytes are listed in Appendix C. If guidelines, screening values, and criteria did not exist for an indicator, a value that helped summarize the data was chosen.

Results from water samples for each station were compared to objectives established in the California Ocean Plan (SWRCB 2001) and the Central Coast Regional Board Basin Plan objectives for municipal and domestic uses (RWQCBCC 1994). Values from select indicators were also compared to threshold values used in the U.S. Environmental Protection Agency's National Coastal Condition assessment to categorize each site as poor (low), fair (moderate), or high quality (Table 2-2; USEPA 2004). For example, station X would rate low (poor) for DO if the result was 1.5 mg/l and fair for chlorophyll a if the value was 6.0 µg/l. The five select indicators were then grouped into a Water Quality Index (WQI) rating (good, fair, or poor) for each station (Table 2-3). Continuing with the above example, station X would have a WQI rating of fair if DO rates poor and the other four indicators (DIN, orthophosphate, chlorophyll a, water clarity) rate fair.

Table 2-2. Indicators and threshold values used in the water and sediment quality assessments (USEPA 2004).

Matrix	Indicator	Poor (Low) Quality	Fair (Moderate) Quality	High Quality
Water	Dissolved Oxygen (DO)	<2 mg/l	2-5 mg/l	>5 mg/l
	Dissolved Inorganic Nitrogen (DIN)	>1.0 mg/l	0.5-1.0 mg/l	<0.5 mg/l
	OrthoPhosphate as P	>0.1 mg/l	0.01-0.1 mg/l	<0.01 mg/l
	Chlorophyll a	>20 µg/l	5.0-20 µg/l	<5.0 µg/l
	Water Clarity (% light transmission)	<10%	10-20%	>20%
Sediment	TOC	>5%	2-5%	<2%
	Sediment Contamination	Exceed >1 ERM (>2 ERM in Morro Bay)	Exceed ≥5 ERLs & 0 ERMs or 1 ERM in Morro Bay	Exceed <5 ERLs
	Amphipod Toxicity	<80% survival	-	≥80% survival

Table 2-3. Criteria for calculating the Water Quality Index rating by station as defined for select water indicators in Table 2-2 (USEPA 2004).

WQI Rating	Criteria
Good	A maximum of one indicator is fair, and no indicators are poor
Fair	One of the indicators is rated poor or two or more indicators are rated fair
Poor	Two or more of the five indicators are rated poor
Missing	Two components of the indicator are missing, and the available indicators do not suggest a fair or poor rating

Sediment chemical concentrations were compared to empirical sediment quality guidelines (SQGs) that can be used as screening tools to help predict when chemical conditions have an increased probability of toxicity and/or biological community impairment. One SQG is the Effects Range classification developed by NOAA (Long et al. 1995). The Effects Range Low (ERL) indicates the lower 10th percentile of ranked data where the chemical level was associated with a toxic biological effect, whereas the Effects Range Median (ERM) reflects the 50th percentile of ranked data and represents the level above which toxic biological effects are expected to occur. Effects are expected to occur occasionally when chemical concentrations fall between the ERL and ERM. A second SQG is the Threshold Effects Level (TEL) and the Probable Effects Level (PEL). These values were developed using chemical concentration data associated with both toxic biological effects and no observed effects (MacDonald 1992; MacDonald 1994a, 1994b; MacDonald et al. 1996, MacDonald et al. 2000). Values below a TEL suggest no adverse effects on benthic organisms whereas values above a PEL indicate more-frequent adverse effects. However, it is difficult to predict whether adverse effects would occur on benthic organisms if the values fall between a TEL and PEL (MacDonald et al. 2000). Neither of these methods is advocated over the use of the other in this report. Instead, both are used in the following analysis to create a weight of evidence that should help explain the relationships between observed chemical concentrations and the probability that a biological effect would be associated with that particular sediment chemical. Other sediment guidelines used were the consensus guidelines developed by Swartz (1999) for total PAHs and Swartz et al. (1994) for total DDTs normalized to total organic carbon content. Sediment chemical concentrations were compared with the sediment quality guideline quotient (SQGQ1) described in Fairey et al. (2001). SQGQ1 provides a means for evaluating complex chemical mixtures of trace metals and organics that incorporates both the magnitude and number of SQGs exceeded.

Select sediment indicators were also compared to threshold values used in EPA's National Coastal Condition assessment to categorize each site as poor (low), fair (moderate), or high quality (Table 2-2; USEPA 2004). Sediment contamination ratings were slightly modified from the National Coastal criteria due to the naturally enriched nickel concentrations in Morro Bay (see section 4.3.3). The three indicators were then grouped into a Sediment Quality Index rating (good, fair, or poor) for each station (Table 2-4).

Table 2-4. Criteria for determining the Sediment Quality Index rating by station as defined for select sediment indicators in Table 2-2 (USEPA 2004).

SQI Rating	Criteria
Good	None of the individual components are poor, and the sediment contaminants indicator is good
Fair	No measures are poor, and the sediment contaminants indicator is fair
Poor	One or more of the component indicators is poor

Tissue chemical concentrations were compared to California Office of Environmental Health Hazard Assessment (OEHHA; Brodberg and Pollock 1999) and EPA (USEPA 2000) human health consumption screening values. These thresholds are based on filet portions of fish rather than whole body tissues analyzed in this study, so exceedances could be overstated.

2.4 Data Management

Data from the five harbors is stored in the SWAMP database, a centralized database using standardized data transfer protocols (SDTP) for data exchange among program participants. The database is organized through a relational structure involving the use of multiple data tables linked through one or more common fields or primary keys. Field crews and laboratories were responsible for entering data into the appropriate tables or formats for data loading. Once in the database, data from the five harbors was validated and verified by a member of the SWAMP Database Management Team and then assessed by the SWAMP Quality Assurance (QA) Team. The data resides in the SWAMP database and will be available through the internet. Details of the SWAMP Information Management processes can be found at http://mpsl.mlml.calstate.edu/swamp.htm.

The Morro Bay data resides in the EPA database, which uses tables and primary keys as unique identifiers. Field crews and laboratories were responsible for entering data into the appropriate tables or formats for data loading. Once in the database, the EPA QA Officer assessed the data following the EMAP Quality Assurance Project Plan (QAPP; USEPA 2001a). The data is stored in the EPA database and is available by contacting the EPA office in Newport, Oregon. The data will also be accessible via the California Environmental Data Exchange Network (CEDEN) in conjunction with the SWAMP data.

3.0 Quality Assurance/Quality Control (QA/QC)

The quality assurance/quality control (QA/QC) portion of this study followed the guidelines set forth in the coastal Western EMAP program (USEPA 2001a) and in the SWAMP Quality Assurance Management Plan (QAMP; Puckett 2002). A performance-based approach was used to assess data quality which, depending on the analyte, included 1) field duplicates, 2) laboratory replicates, 3) laboratory method blanks, 4) laboratory matrix spike and matrix spike duplicates, and 5) Certified Reference Materials (CRMs), Laboratory Control Materials (LCMs), and/or Laboratory Control Spikes (LCSs). This approach provided a means to detect contamination, assess field and laboratory methodology, and evaluate precision and accuracy. The water and sediment data from Morro Bay was not validated and verified according to SWAMP protocols. Rather, the WEMAP QA Manager evaluated the data and provided a written summary evaluation.

Summary tables for QA/QC results are presented in multiple tables in Appendix F. Table 3-1, however, is duplicated from Appendix F, Table 1 in this section to present the percent recovery (%R) and relative percent difference (RPD) acceptance criteria for the various water analytes.

Table 3-1. Percent recovery (%R) and relative percent difference (RPD) acceptance criteria for different categories of analytes in water.

Analyte Category	% Surrogate Recovery Acceptance Criteria	% MS/MSD Recovery Acceptance Criteria	% CRM, LCM, & LCS Acceptance Criteria	RPD Criteria (MS/MSD, Laboratory Duplicate, Field Duplicate)
Conventional Constituents	NA	80-120	80-120	25
Trace Metals (Including Mercury)	NA	75-125	75-125	25
Trace Organics (PCBs, OC & OP pesticides)	50-150	50-150	50-150	25

3.1 Field Duplicates

To assess field homogeneity and field sampling procedures, field duplicates were collected at a rate of 5% for water, sediment, and tissue samples. Water duplicates were collected at four stations: CA03-0001 (surface, mid, and bottom depths), CA03-0025 (surface depth), 310SNLS25 (surface, mid, and bottom depths), and 309MTRY20 (surface and mid depths). At each depth, water from one Kemmerer grab provided sufficient water for the nutrient, chlorophyll, and TSS analyses. Sediment duplicates were taken at these same stations and consisted of homogenizing sediment from one

12-liter tub rather than the 6-liter tub used for all other samples. A tissue duplicate for fish chemistry and bivalve chemistry was taken at 310SNLS25. A tissue duplicate for fish chemistry was not analyzed in the Morro Bay study.

Field duplicate values were compared to field sample values using the relative percent difference (RPD), calculated as follows:

RPD = (|(Value1-Value2)|/(AVERAGE(Value1+Value2)))*100

where:
Value1=field sample value
Value2=duplicate sample value.

If Value1 or Value2 was less than three times the method detection limit (MDL), the RPD was not calculated because the values were too low to produce a statistically valid result. RPDs <25% were deemed acceptable as specified in the SWAMP QAMP (Puckett 2002). Field duplicates that did not meet quality control criteria are listed in Appendix F, Table 2. All other RPDs were acceptable.

3.2 Laboratory Replicates

Laboratory precision was assessed with laboratory replicates performed on at least one field sample per batch of 20 samples. There were insufficient duplicates for nitrite, nitrate+nitrite, and TBT with no duplicates run for chlorophyll (Appendix F, Table 3). Replicates were compared using the RPD (see Section 3.1; Value1=replicate 1 value, Value2=replicate 2 value). If the RPD was >25%, the data was considered non-compliant with the QAPP and qualified as 'estimated' (Appendix F, Table 4). If the RPD was ≤25%, the data was acceptable.

3.3 Laboratory Method Blanks

Laboratory method blanks were used to evaluate laboratory contamination during sample preparation and analysis. Blank samples undergo the same analytical procedure as samples with at least one blank analyzed per 20 samples. Acceptable data are those with values less than the MDL for that particular analyte.

For the Morro Bay samples, the laboratory blanks for tin in both sediment and tissue was of the same magnitude as the reported native samples. Therefore, tin will not be evaluated in this report. Two TBT batches did not have laboratory method blanks run (Appendix F, Table 5). Method blanks were detected in some ammonia, nitrate, nitrite, orthophosphate, and PCB analyses (Appendix F, Table 6).

3.4 Laboratory Matrix Spike and Matrix Spike Duplicates

A laboratory fortified sample matrix spike (MS) was used to evaluate the effect of the sample matrix on the recovery of the target analyte. Randomly selected field samples were spiked with known amounts of a target analyte. The percent recovery (%R) of the matrix spike was calculated as follows:

%R = ((MS result – Sample result)/(Expected value – Sample result)) * 100

The %R acceptance criteria vary according to analyte groups (Table 3-1).

This process was repeated on the same native samples to create a laboratory fortified sample matrix spike duplicate (MSD). MSDs were used to assess laboratory precision and accuracy. At least one MS/MSD pair was performed per 20 samples as required by the SWAMP QAMP (Puckett 2002) except for chlorophyll, TSS, grain size, and TOC.

MS/MSD RPDs were calculated as:

RPD = (|(Value1-Value2)|/(AVERAGE(Value1+Value2)))*100

where:
Value1=matrix spike value
Value2=matrix spike duplicate value.

Batches without MS or MSDs are listed in Appendix F, Table 7 with MS/MSD %Rs and RPDs that did not meet criteria in Appendix F, Table 8. The percent recoveries for sediment PAH samples were initially calculated incorrectly so the laboratory could not detect a problem with the MS and MSDs and, thus, could not correct the problem. The control chart indicates a matrix issue rather than a laboratory problem (i.e., the native samples were high and the laboratory did not spike high enough). Sediment PAH data were classified as ‘Estimated’ and should be regarded as having a high bias. Percent recoveries for all other analytes were calculated correctly.

3.5 Certified Reference Materials (CRMs), Laboratory Control Materials (LCMs), and Laboratory Control Spikes (LCSs)

Certified reference materials (CRMs), laboratory control materials (LCMs), and/or laboratory control spikes (LCSs) were used to assess the accuracy of a given analytical method compared to a known ‘true’ value. At least one CRM, LCM, or LCS was run per 20 samples as required by the SWAMP QAMP (Puckett 2002) except for 3 ammonia batches, 3 nitrite batches, 3 nitrate + phosphate batches, 4 TSS batches, and 1 TBT batch (Appendix F, Table 9). CRMs were not required for chlorophyll analyses. Certified reference material (CRM), LCM, and LCS that did not meet quality control acceptance criteria are listed in Appendix F, Table 10).

The SEPEX nutrient CRMs used for Morro Bay samples were not appropriate. In the case of ammonium, the CRM was more than two orders of magnitude greater than the expected value. With concentrations spiked so high, data readings at low levels could be questionable. However, the data was not rejected and was considered 'Estimated'. Data should be put into context with other nutrient data from Morro Bay.

3.6 Surrogate Spikes

Surrogate spikes are used to assess analyte loss during sample extraction and clean-up procedures and must be added to every field and QC sample prior to extraction. Whenever possible, isotopically-labeled analogs of the analytes should be used. However, there were some batches where surrogate spikes were not included (e.g., 2 TBT batches). Surrogate recoveries that did not meet quality control acceptance criteria are listed in Appendix F, Table 11.

3.7 Holding Times

There were 4,734 results in 14 batches classified as 'Estimated' due to holding time exceedances. These batches consisted of water nutrient [ammonia (3), nitrite (3), and nitrate and orthophosphate (3)], sediment organics [OC pesticides (1), PCBs (2), and PAHs (1)], and sediment toxicity (1) analyses. Although water nutrient samples were frozen, data was evaluated based on refrigerated (i.e., 4˚C) holding time criteria. Criteria for frozen water nutrient samples did not exist in the SWAMP QAMP (Puckett 2002). Nutrient samples were collected in June 2004 and stored frozen until analysis in September and October 2004. Sediment organics samples exceeded the 40 day holding time criteria between extraction and analysis by 7-30 days. Sediment toxicity samples were to be analyzed within 14 days of collection, but some Santa Barbara samples were analyzed 7 days after this time period. Although 'Estimated', data was considered usable for the intended purposes and for this report.

3.8 Toxicity Tests

There were minor deviations in water quality parameters or test conditions (conductivity, DO, temperature, light) in some replicates, and incoming sample temperature or holding times were exceeded in some cases. However, the data should be considered acceptable for their intended purpose.

3.9 QA/QC Summary

The Morro Bay data did not undergo the same verification process as the other five harbors and was not classified in the following terms. The WEMAP QA Manager deemed the Morro Bay data acceptable (B. Ozretich, personal communication).

Data that meet all SWAMP Measurement Quality Objectives (MQOs) as specified in the QAMP were classified as 'SWAMP-compliant' and considered usable without further evaluation. Data that failed to meet all program MQOs specified in the SWAMP QAMP, had analytes not covered in the SWAMP QAMP, or were insufficiently documented such that supplementary information was required for them to be used in reports were classified as 'Estimated' non-compliant with the SWAMP QAMP. 'Estimated' data batches were used in this report since they met project data quality objectives. Rejected data batches did not meet minimum requirements and/or had gross errors or omissions. Data were also classified as rejected when the reporting laboratory rejected the data.

There were 10,678 sample results, including grab samples, integrated samples, and field duplicates, of which 4,694 were classified as compliant and 5,984 were classified as Estimated. None of the results were classified as rejected. The summary of data classification on the reported dataset was as follows:

- All data presented in Appendix F, Table 6 was classified as SWAMP-compliant since the analytes detected in the laboratory blanks met the QAMP criteria.
- All surrogate spikes were added as required with the exception of samples analyzed for TBT by EPA Method 8323. Per DFG-WPCL, which performed the analyses, this method did not utilize surrogates and, therefore, the data was classified as SWAMP-compliant.
- All data presented in Appendix F, Tables 10 and 11 was classified as estimated due to surrogate recovery exceedances.
- All data presented in Appendix F, Tables 3, 5, 7, and 9 was classified as estimated due to insufficient QC samples performed.
- All data presented in Appendix F, Tables 2 and 4 was classified as estimated due to RPD exceedances.
- 4,734 results were classified as estimated due to holding time exceedances.
- 187 screening level results (PAH analytes that could not be quantified) were classified as estimated.

4.0 Results and Discussion

4.1 Hydrographic Profile

Probe measurements for temperature, salinity, pH, and dissolved oxygen were recorded at the surface for all 60 stations. However, bottom probe measurements were not recorded at 17 Morro Bay stations because the station depth was too shallow (depth ≤0.7 m) for multiple measurements. Specific issues relating to salinity and light readings are discussed in the corresponding section.

4.1.1 Water Temperature

Water temperatures in the harbors showed similar ranges near the bottom (12.7° C to 19.9° C) and the surface (12.8° C to 20.9° C) with the low and high values occurring in Morro Bay (Figure 4-1). All stations above 19° C were in Morro Bay, which was probably due to its shallow nature. Four of the six Santa Barbara stations had bottom temperatures above 16.9° C while the other northern harbors with the exception of Morro Bay had lower temperatures. Approximately 46% of the harbor areas had bottom temperatures less than 15° C (Figure 4-1).

The greatest temperature differences between the bottom and surface waters occurred in Santa Cruz (3.8° C), Santa Barbara (3.8° C), and Moss Landing Harbor (3.3° C; Figure 4-1). There were a few instances in Santa Cruz, Moss Landing, and Morro Bay where the difference in temperature was zero or the bottom temperatures were higher than the surface temperatures, but these differences were less than 0.4° C.

4.1.2 Salinity

An incorrect salinity standard was used at 15 of the 30 Morro Bay stations. A correction factor was calculated based on daily calibration records and a correct salinity calibration standard. The corrected salinities were reported in the database and are presented in this report.

Salinity in the harbors would be classified as euhaline since salinities were above 30 ppth and below 40 ppth (Figure 4-2). Bottom salinity (32.7-34.9 ppth) had a tighter range than surface salinity (31.6-35.1) with not much difference in Monterey, Port San Luis, and Santa Barbara harbors. Approximately 52% of the harbor areas had bottom salinities <34 ppth (Figure 4-2).

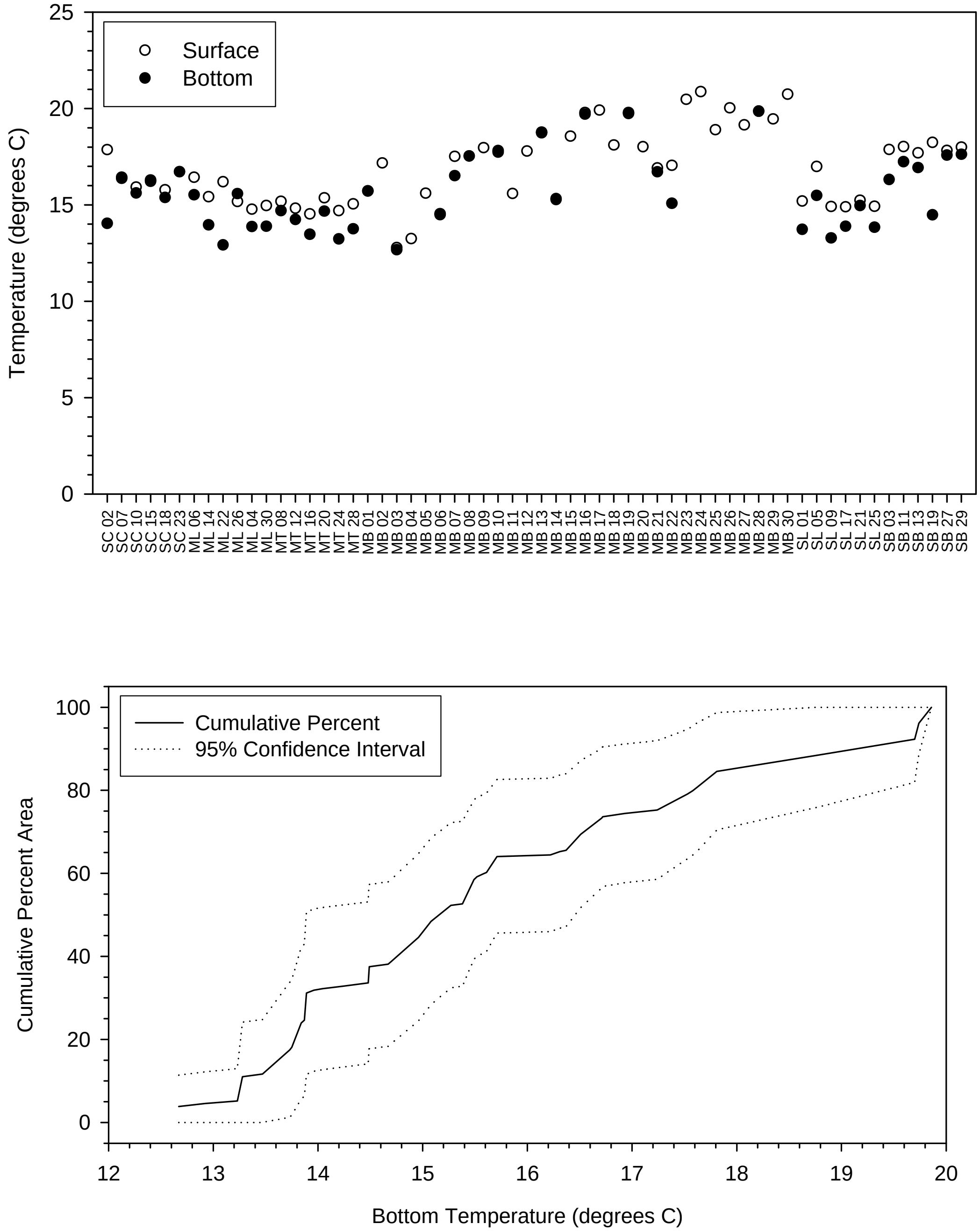
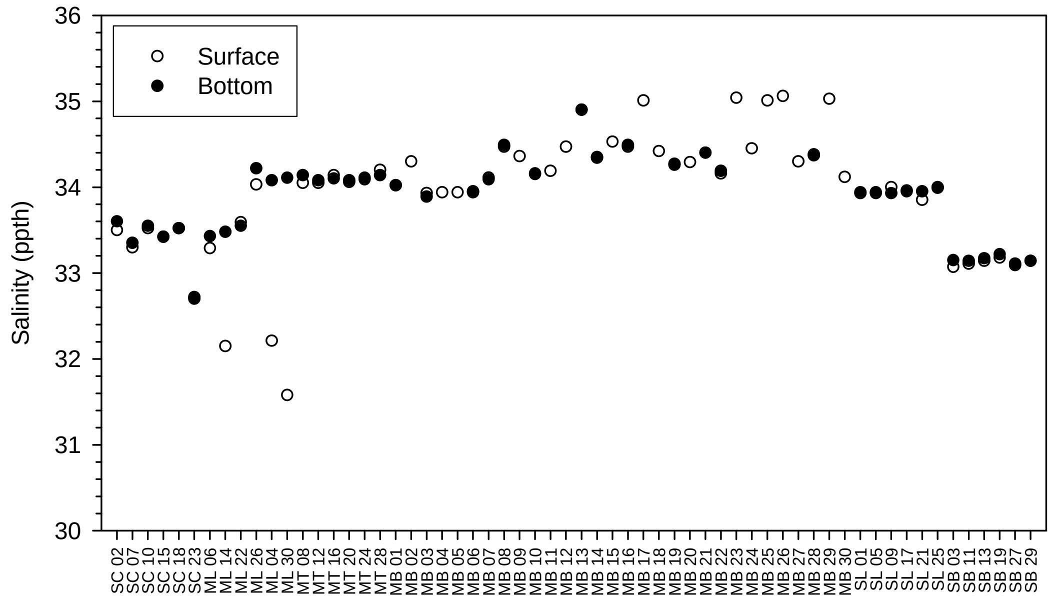


Figure 4-1. Water temperature values by station and by percent area. Stations indicate surface and, where applicable, bottom temperatures. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



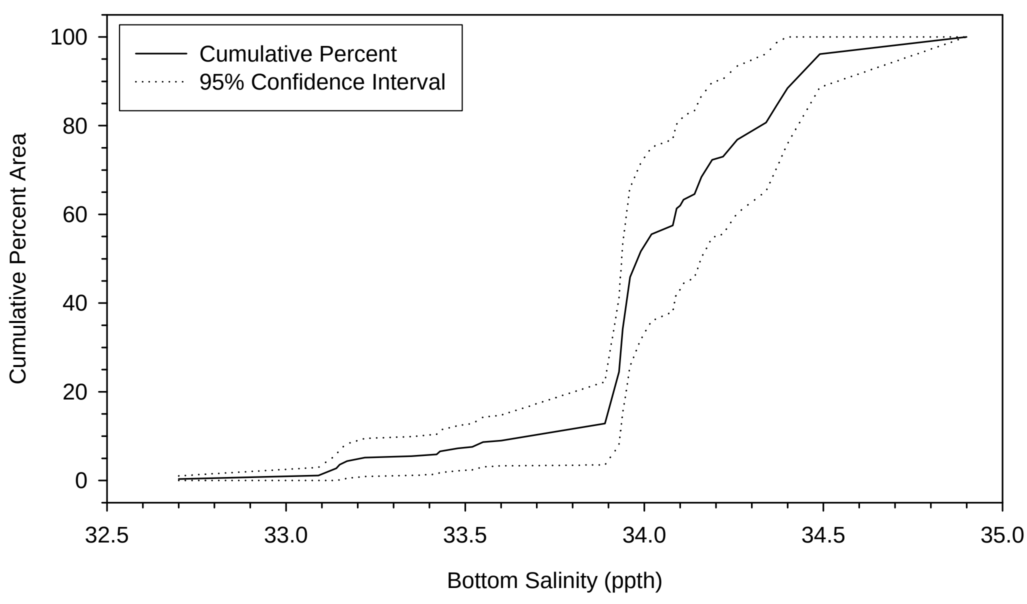


Figure 4-2. Water salinity values by station and by percent area. Stations indicate surface and, where applicable, bottom salinities. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

4.1.3 pH

The bottom and surface pH values were similar in the harbors except for Santa Barbara where four of the six stations had pH differences >0.3 (Figure 4-3). Fourteen stations (six Monterey, three Moss Landing, three Port San Luis, one Morro Bay, one Santa Barbara) had bottom pH values equal to or exceeding the Central Coast RWQCB Basin Plan criteria of 8.3 while 19 stations had surface pH values ≥8.3. The percentage of bottom waters in all harbors exceeding 8.3 was 9% (Figure 4-3). No stations had pH values below the lower criteria value of 7.0.

4.1.4 Dissolved Oxygen

Dissolved oxygen (DO) in bottom waters ranged from 0.3 mg/l in Santa Barbara to 10.0 mg/l in Morro Bay (Figure 4-4). The three low DO values in Santa Barbara occurred in the middle of the harbor (Figure 1-7). Surface DO values had a tighter range with a low of 4.6 mg/l in Moss Landing and a high of 9.9 mg/l in Morro Bay. The greatest difference in dissolved oxygen between the bottom and surface layers was recorded in Santa Barbara at 7.9 mg/l. Three of the remaining five Santa Barbara stations had DO differences greater than 3.3 mg/l, which most likely explains the wide range of pH values in Santa Barbara. DO differences at each station in the other harbors were less than 1.9 mg/l.

Seven stations (4 Santa Barbara, 3 Santa Cruz) had bottom DO values and four stations (2 Santa Cruz, 2 Moss Landing) had surface DO values that did not meet the Central Coast RWQCB Basin Plan criteria of DO levels not dropping below 5.0 mg/l at any time. According to EPA threshold values, three Santa Barbara stations would classify as poor quality (<2 mg/l) with a few stations in Santa Cruz, Moss Landing, and Santa Barbara deemed fair quality (<5 mg/l; Figure 4-4). Approximately 3% of the harbor areas had poor quality DO bottom concentrations with an additional 2% of fair quality (Figure 4-4). When comparing dissolved oxygen concentrations among stations, one should keep in mind DO changes seasonally, daily, and diurnally.

4.1.5 Light

The percent light transmission adjusted to 1 m depth ranged widely from 1.6% to 80.3% with both values occurring in Morro Bay (Figure 4-5). Other stations with a light transmission <10% (poor quality) occurred in Moss Landing and Santa Barbara. Approximately 7% of the harbor areas would be classified as poor quality with an additional 10% classified as moderate quality (Figure 4-5). Light (PAR) measurements were not recorded at four stations in Morro Bay (CA03-0303, -0304, -0305, and -0306) due to equipment failure.

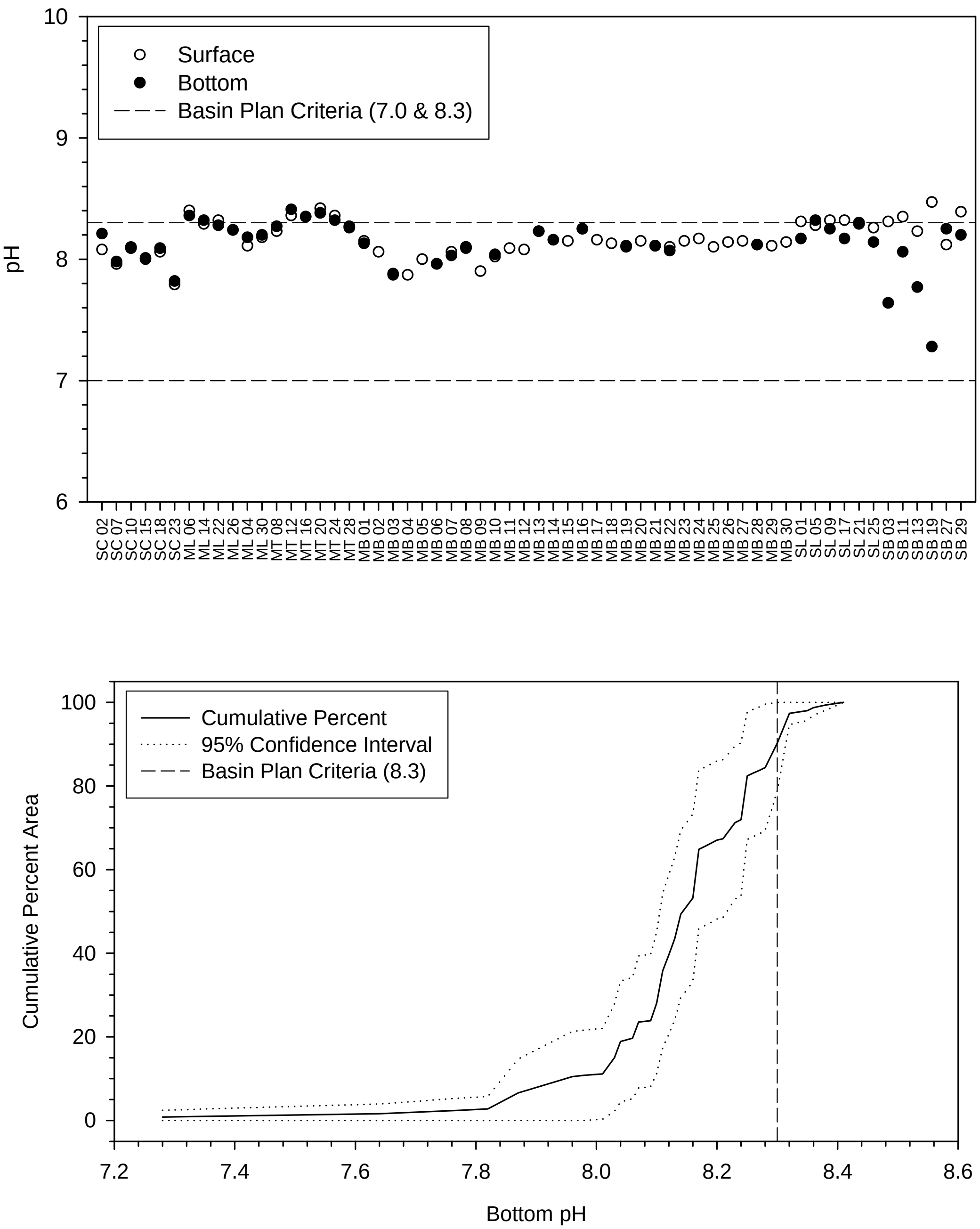


Figure 4-3. Water pH values by station and by percent area. Stations indicate surface and, where applicable, bottom pH. Percent areas were calculated by the cumulative distribution function (CDF). Criteria values represent Central Coast RWQCB Basin Plan values (RWQCBCC 1994). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

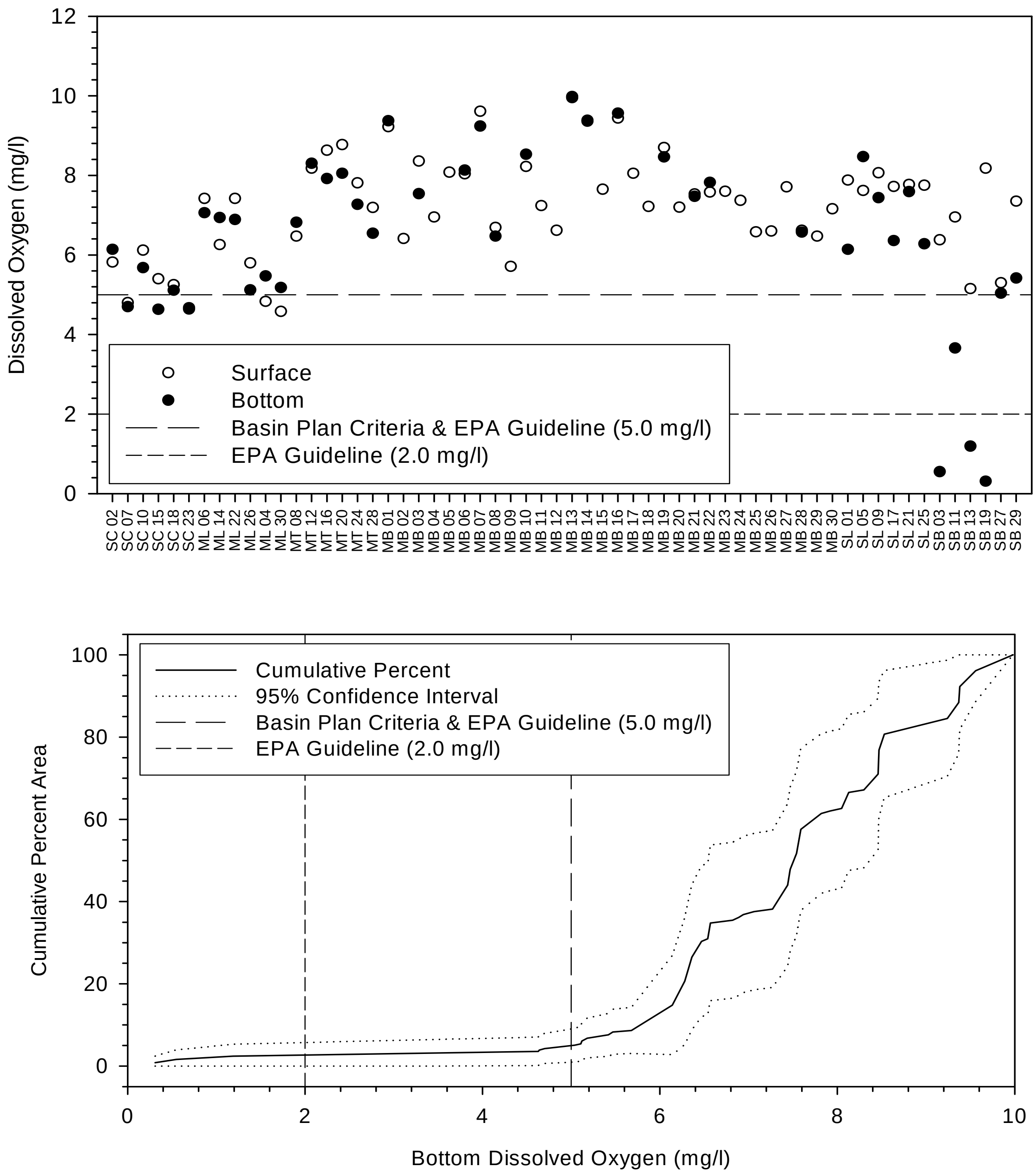
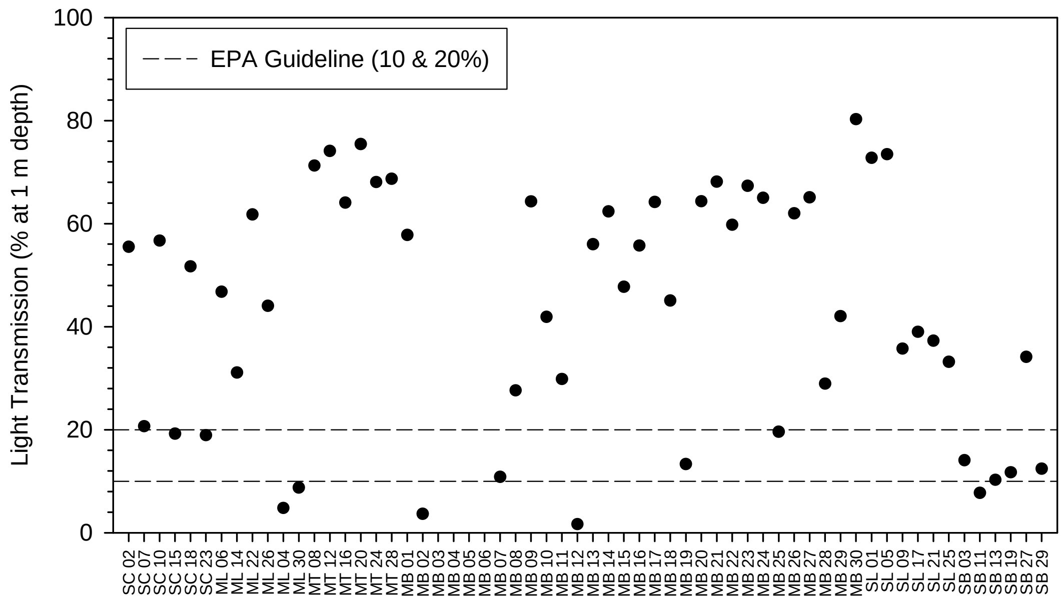


Figure 4-4. Water dissolved oxygen values by station and by percent area. Stations indicate surface and, where applicable, bottom dissolved oxygen. Percent areas were calculated by the cumulative distribution function (CDF). Assessment values represent Central Coast RWQCB Basin Plan criteria (5.0 mg/l; RWQCBCC 1994) and US EPA National Coastal Condition Assessment guidelines (2.0 and 5.0 mg/l; USEPA 2004). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



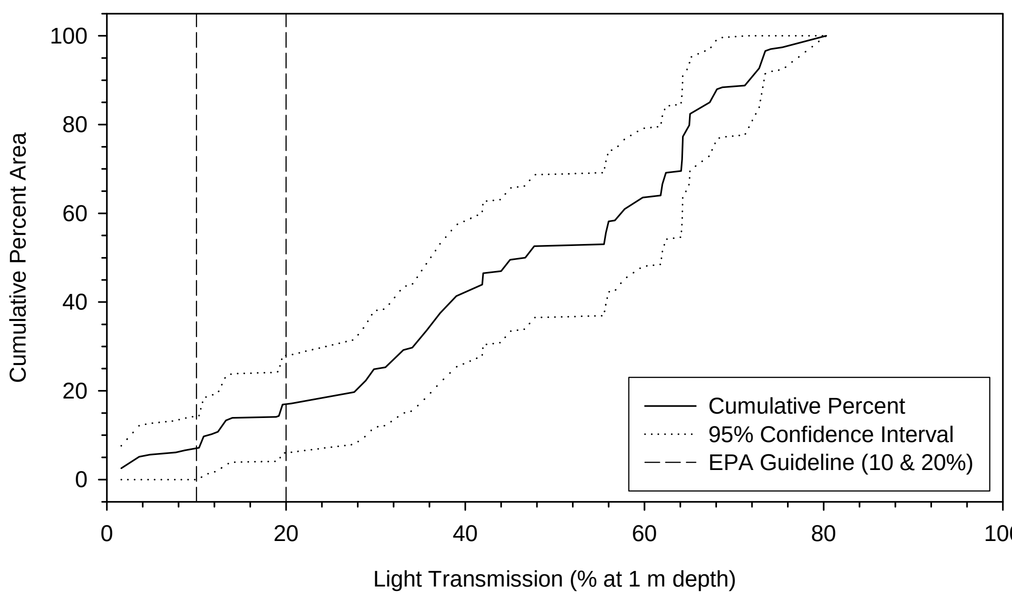


Figure 4-5. Percent light transmission values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent US EPA National Coastal Condition Assessment (USEPA 2004) guideline values. SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

4.1.6 Water Quality Stratification

The simple Stratification Index is based on the difference between surface and bottom salinities in which a positive value indicates bottom waters are more saline than surface waters (Nelson et al. 2005). The three highest Index values (>1.00) occurred in Moss Landing with all other values below 0.20 (Figure 4-6). Fourteen stations had negative values with the lowest value occurring in Port San Luis (-0.07). Approximately 44% of the harbor areas had positive Stratification Index values where the bottom salinity was greater than the surface salinity (Figure 4-6). For comparison, small estuaries in California reported Stratification Index values ranging from 0.2 to 0.7 while northern California rivers ranged from -0.1 to 5.2 with 97% of the northern California estuarine area having Index values ≤0.4 (Nelson et al. 2005).

The $\Delta\sigma_t$ stratification index is based on the differences between bottom and surface calculated densities of parcels of water. The lowest $\Delta\sigma_t$ value was -0.02 in Santa Cruz and the highest value, indicating strong stratification, was 2.18 in Moss Landing harbor (Figure 4-7). The latter is not surprising since that station also showed the greatest difference in surface and bottom salinities (2.53) as calculated in the Stratification Index and it had the lowest surface salinity of all stations (31.58 ppth). Less than 1% of the estuarine area had $\Delta\sigma_t$ values ≥2 (strong stratification) with about 52% of the harbors <0.15 (Figure 4-7). California small estuaries and northern California rivers showed $\Delta\sigma_t$ values ranging from -0.005 to 1.68 in the 1999 EMAP study (Nelson et al. 2005), indicating comparatively greater stratification ranges in Central Coast harbors.

4.2 Water Quality Indicators

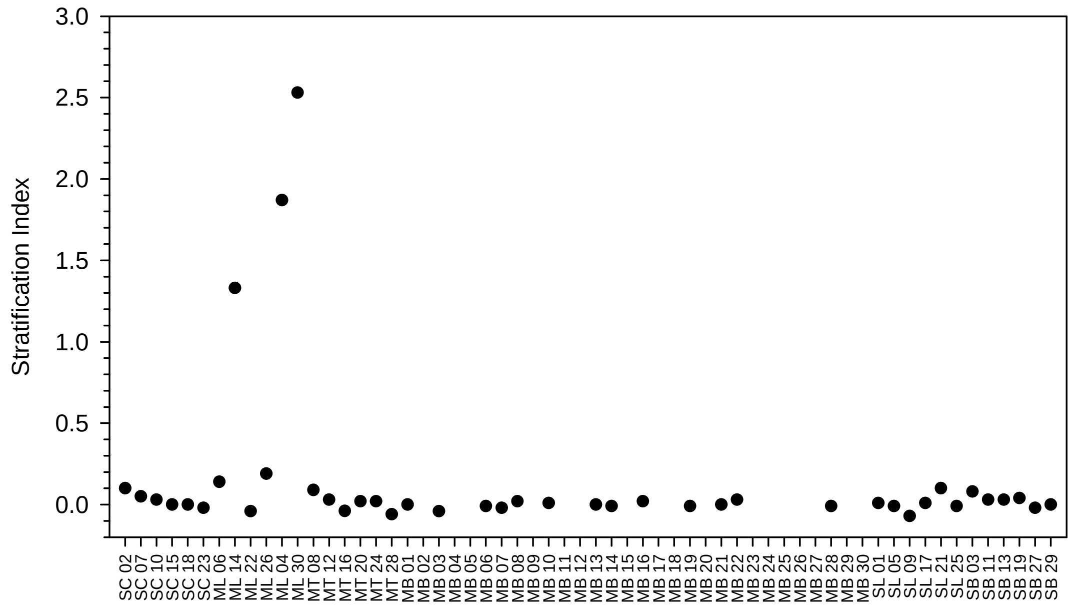
4.2.1 Chlorophyll a

The lowest chlorophyll values were found in Monterey (0.24 and 0.28 μg/l), while the highest values were found in Morro Bay, Moss Landing, and Santa Barbara (Figure 4-8). About 82% of the harbor areas had average chlorophyll concentrations <2.00 μg/l (Figure 4-8). All Central Coast harbor stations met the National Coastal Condition report's high quality threshold (<5 μg/l; USEPA 2004) and would less likely show eutrophic conditions (Bricker et al. 1999).

4.2.2 Nutrients

Nitrate as N

The two highest average dissolved nitrate values occurred in Moss Landing Harbor (3.055 and 2.513 mg/l; Figure 4-9). All other stations were below 0.830 mg/l with the lowest values occurring in Santa Barbara (all stations <0.009 mg/l). Two stations in Monterey Harbor were also below this level (0.004 and 0.005 mg/l). Approximately 91% of the harbor areas had average dissolved nitrate concentrations <0.1 mg/l (Figure 4-9).



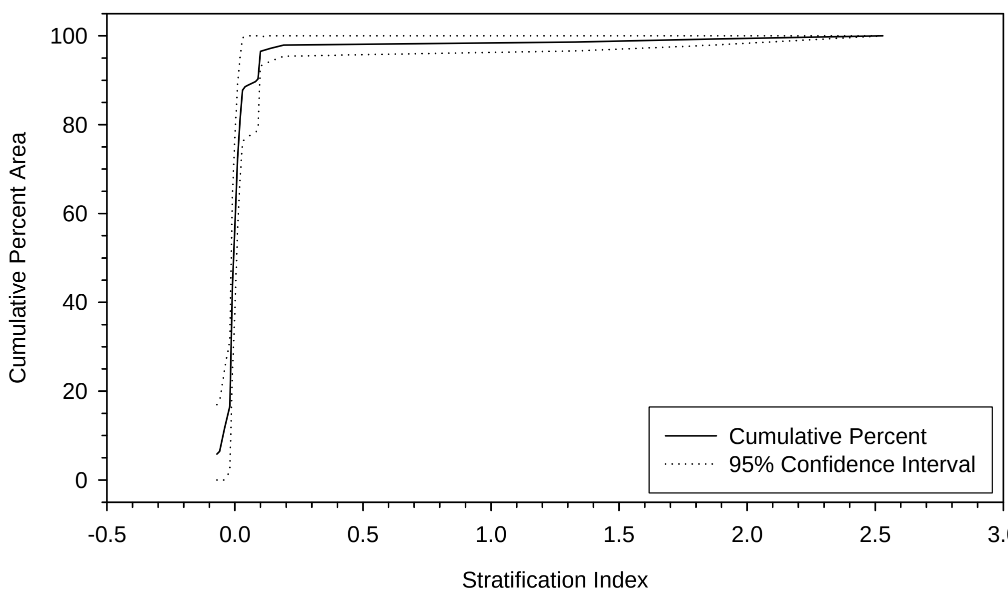


Figure 4-6. Stratification Index values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

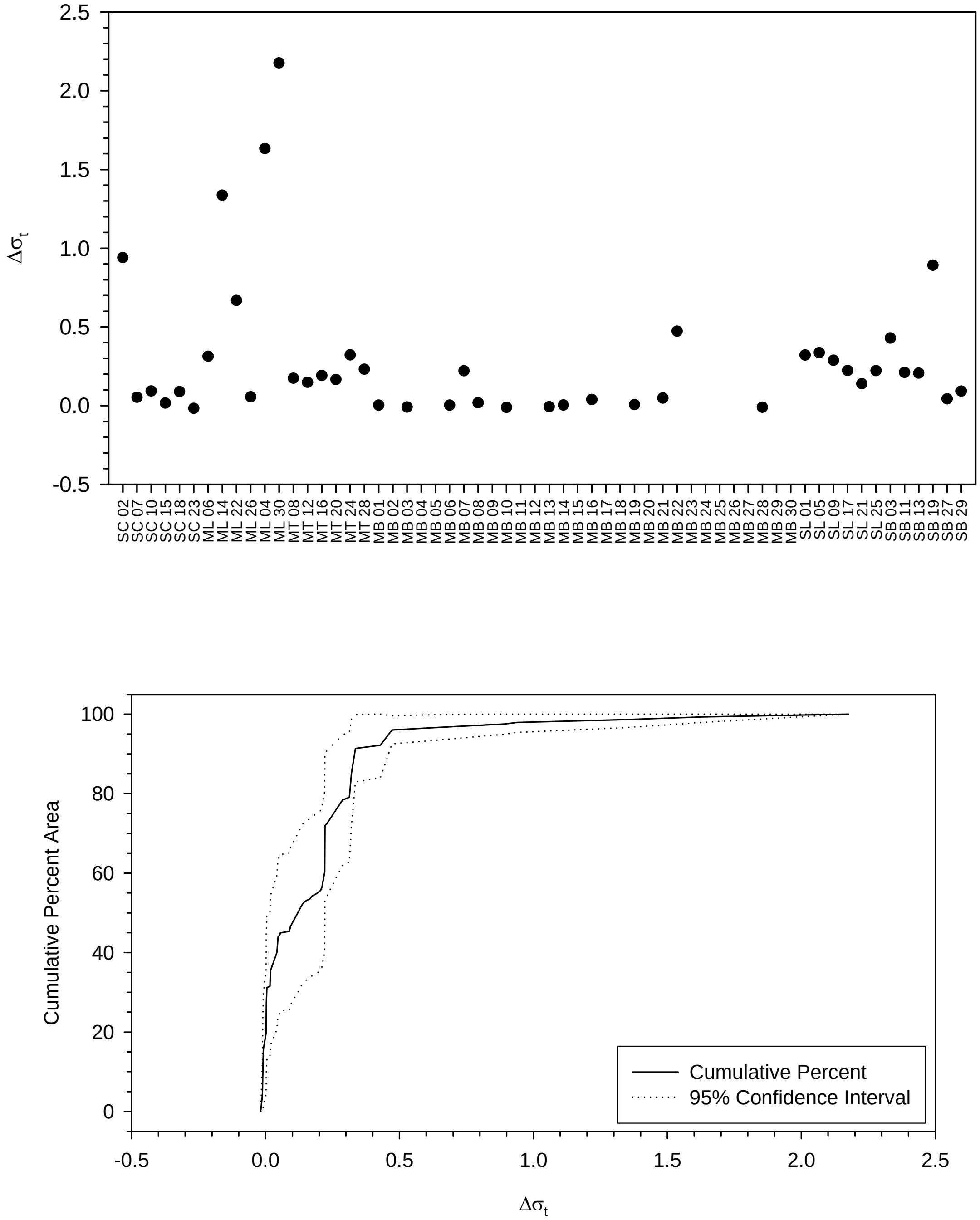
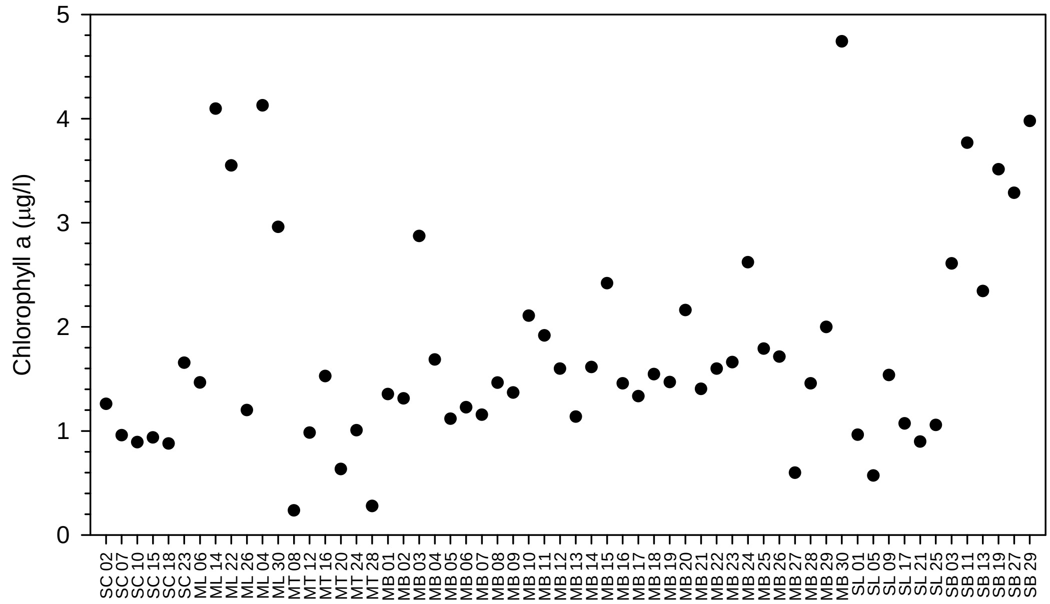


Figure 4-7. The Δσt stratification index values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



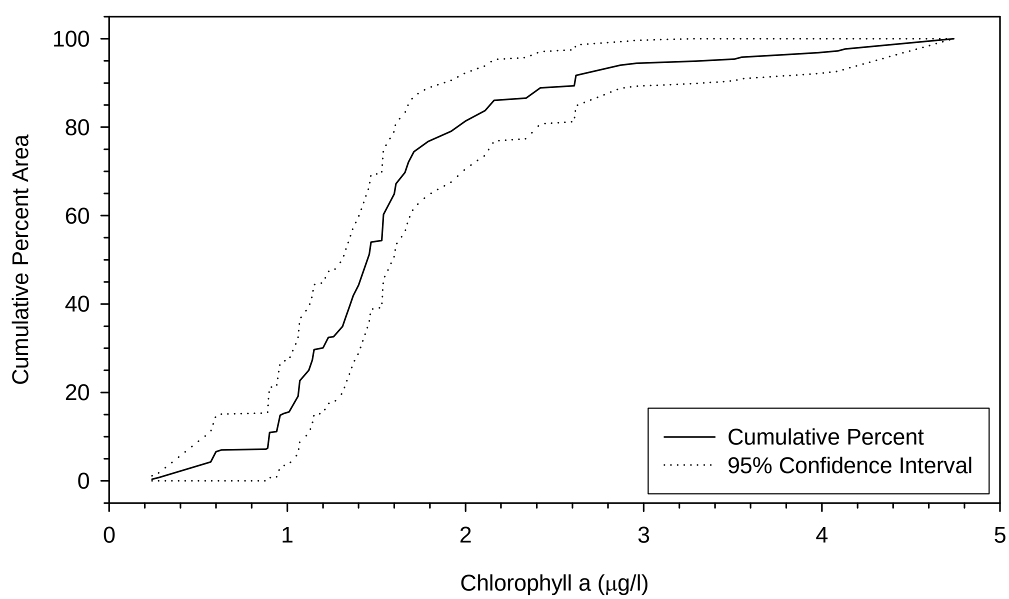
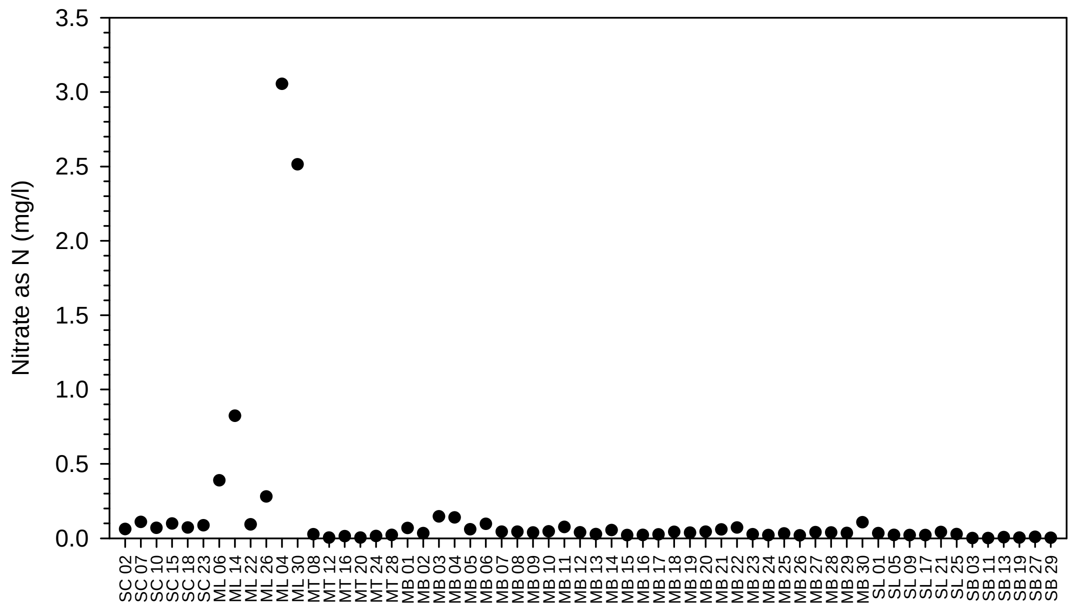


Figure 4-8. Water chlorophyll a values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



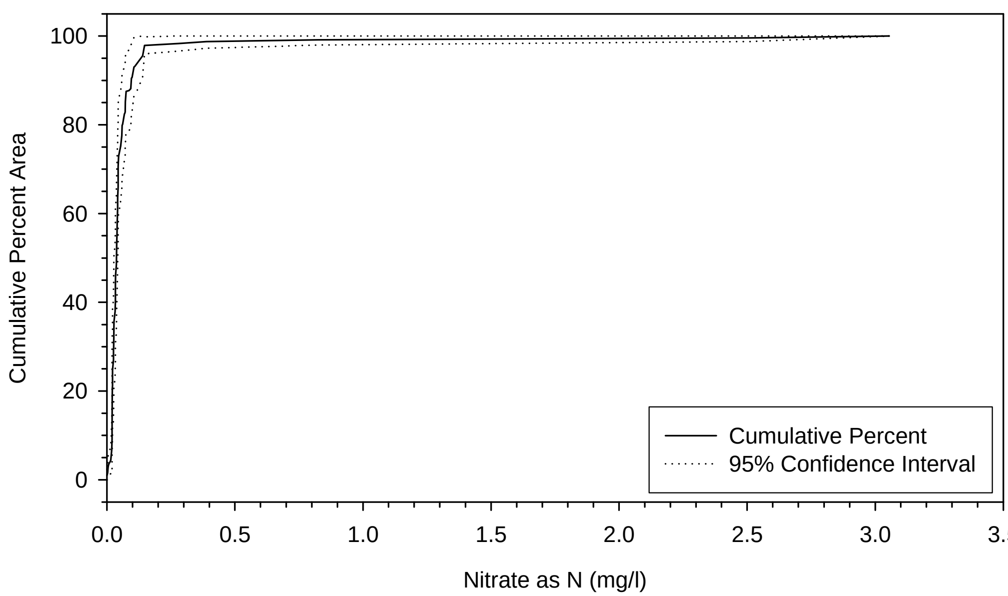


Figure 4-9. Water nitrate values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

Nitrite as N
The highest average dissolved nitrite levels were in Moss Landing Harbor (0.0256 and 0.0235 mg/l) with the remaining values below 0.0135 mg/l (Figure 4-10). Dissolved nitrite was lowest at two stations in Morro Bay (0.0002 and 0.0004 mg/l), but five of the six Santa Barbara stations had the next lowest values ranging between 0.0006 and 0.0008 mg/l. Moss Landing had the greatest range of nitrite levels with a fair amount of variability in Morro Bay. Seventy-four percent of the harbors had dissolved nitrite values <0.0050 mg/l (Figure 4-10).

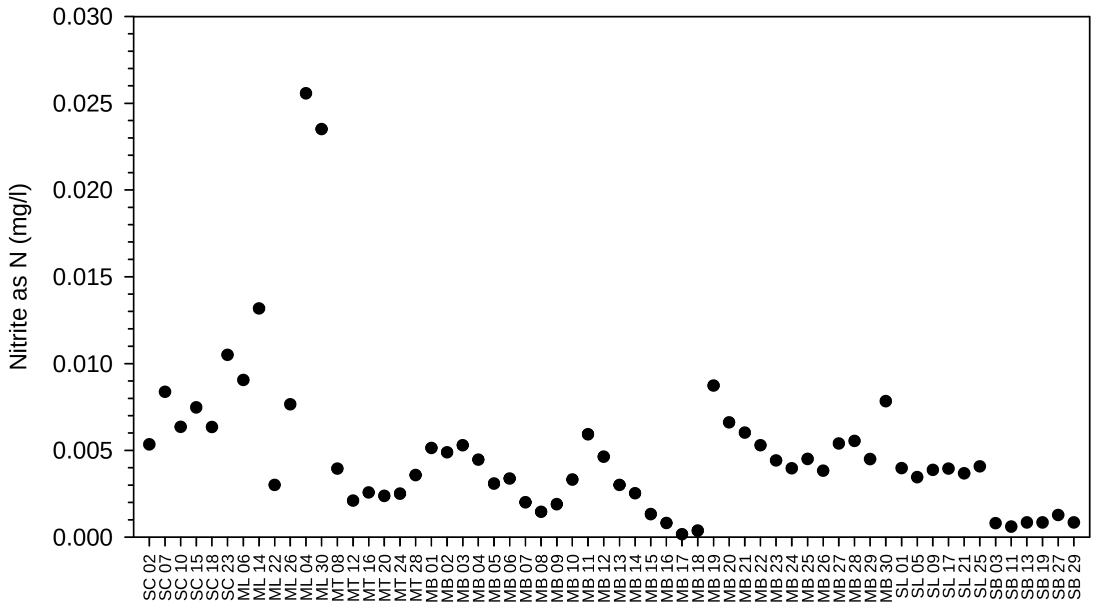
Ammonia as N
Dissolved ammonia was relatively high in Santa Cruz with the four highest values reported (0.1273-0.1365 mg/l; Figure 4-11). One Santa Barbara station and two Moss Landing stations also had elevated values. The lowest ammonia values occurred in Santa Barbara Harbor (0.0029 mg/l) along with a station in Moss Landing. The percent area of harbor waters with dissolved ammonia concentrations <0.04 mg/l was 61% (Figure 4-11).

Dissolved Inorganic Nitrogen
Total dissolved inorganic nitrogen (DIN) was calculated by summing the average dissolved nitrate, nitrite, and ammonia concentrations at each station. The highest DIN values occurred in Moss Landing (3.181 and 2.650 mg/l), which classifies these stations as poor quality (>1.0 mg/l; Figure 4-12). These stations had the highest dissolved nitrate and nitrite concentrations. One additional total DIN result from Moss Landing exceeded the USEPA threshold value for fair water quality and measured 0.876 mg/l. All other stations (approximately 98% of the harbor areas) were below 0.5 mg/l (the threshold value for high quality water) with the two lowest DIN concentrations in Santa Barbara (0.005 and 0.029 mg/l; Figure 4-W12).

OrthoPhosphate as P
Dissolved orthophosphate ranged from 0.0097 to 0.1324 mg/l, with the lowest and highest values occurring in Santa Barbara Harbor (Figure 4-13). Station 309MSLG04 in Moss Landing Harbor also had a relatively high dissolved orthophosphate concentration at 0.1037 mg/l with all other stations below 0.0800 mg/l. Morro Bay and, to some extent, Port San Luis had relatively consistent orthophosphate concentrations across stations. Less than 1% of the harbor areas were poor quality (>0.1 mg/l) with the remaining areas rated as fair quality (0.01-0.1 mg/l; Figure 4-13).

4.2.3 Total Suspended Solids

Total suspended solids (TSS) ranged widely in the harbors with the highest value in Morro Bay (67.28 mg/l) and the lowest value in Monterey (4.83 mg/l; Figure 4-14). Some groupings of high and low TSS values occurred in Santa Cruz and Moss Landing harbors which were most likely related to location and tidal flow. The high stations in



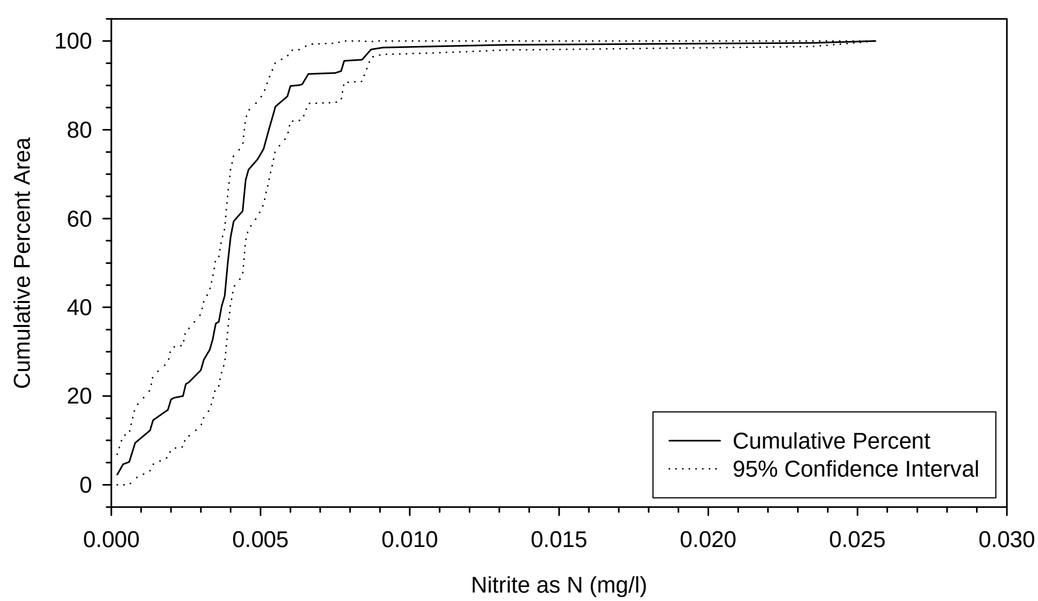
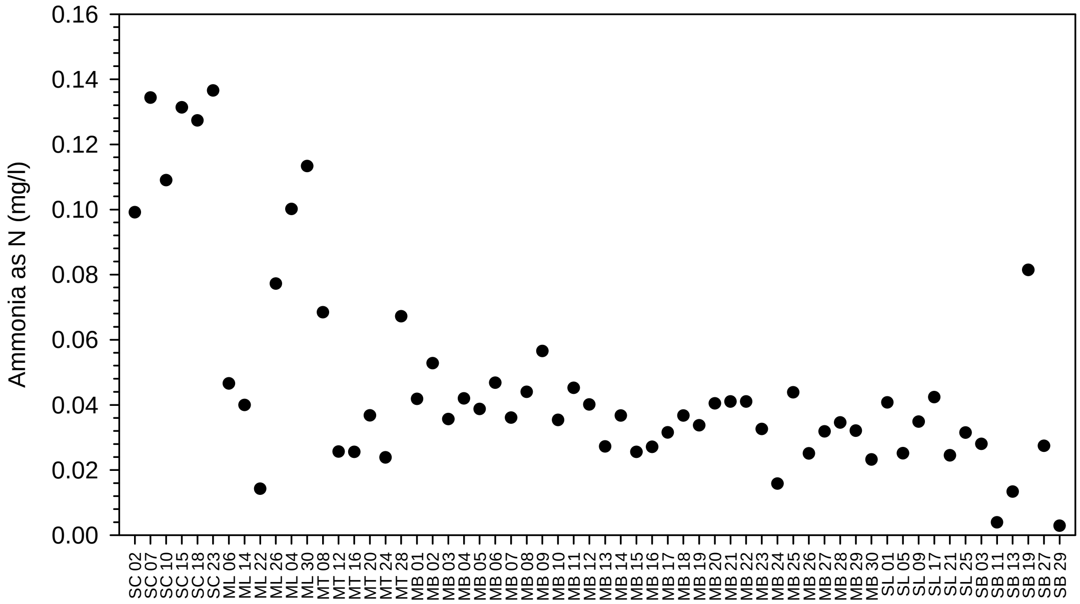


Figure 4-10. Water nitrite values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



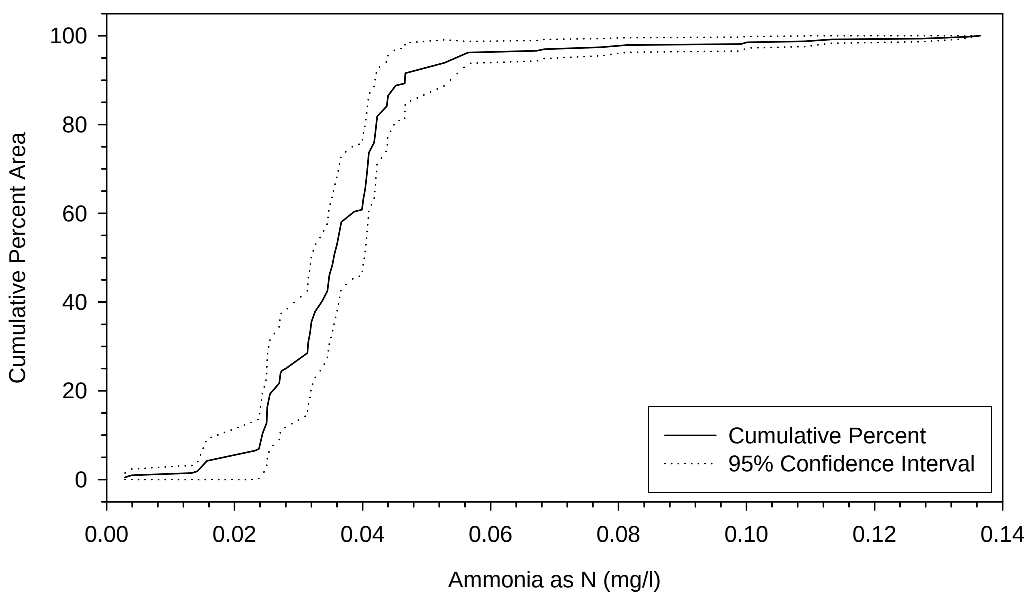
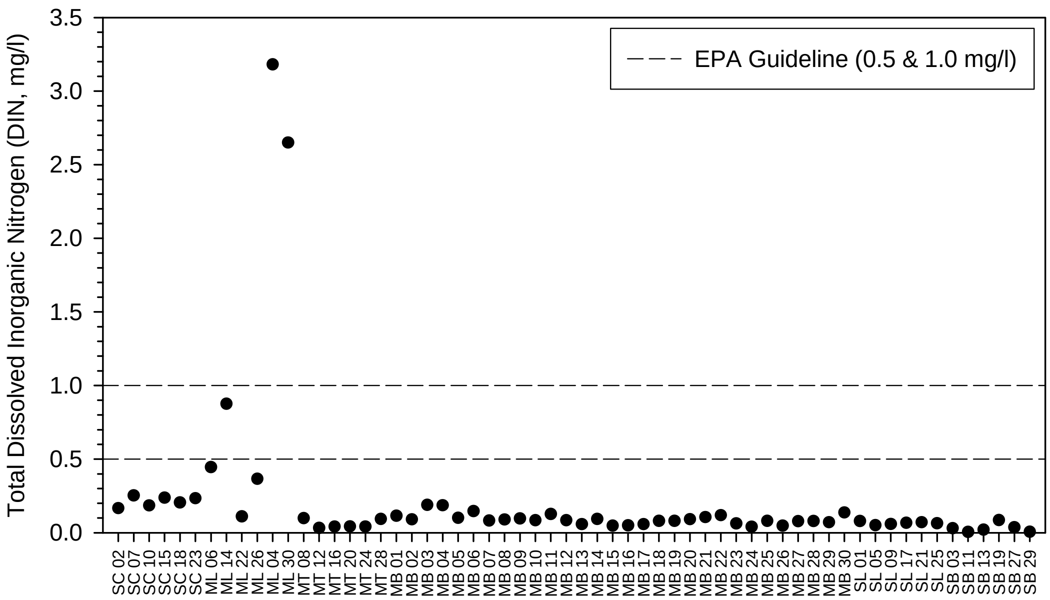


Figure 4-11. Water ammonia values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



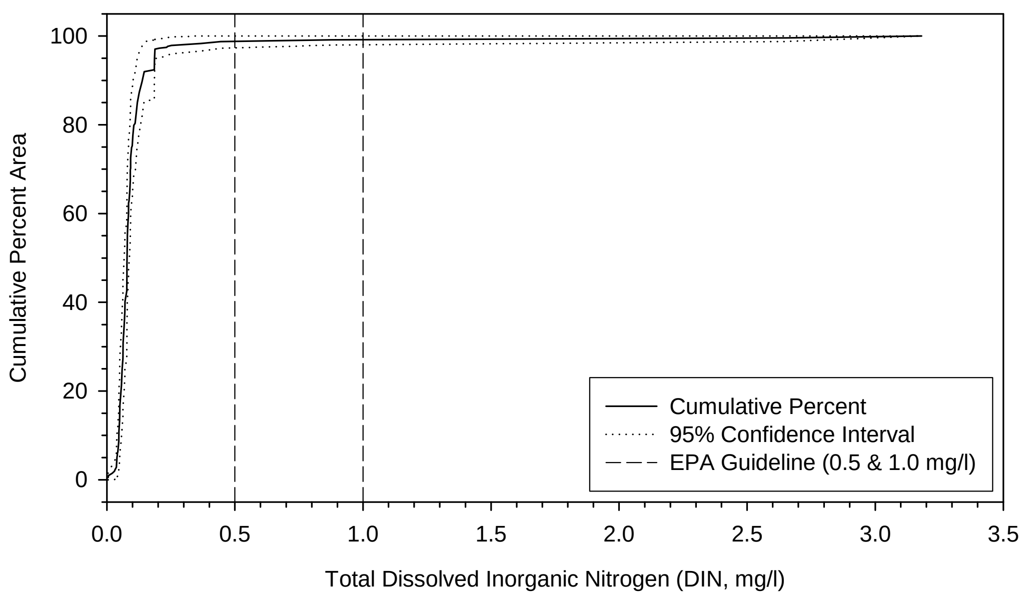


Figure 4-12. Water total dissolved inorganic nitrogen values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent US EPA National Coastal Condition Assessment (USEPA 2004) guideline values. SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

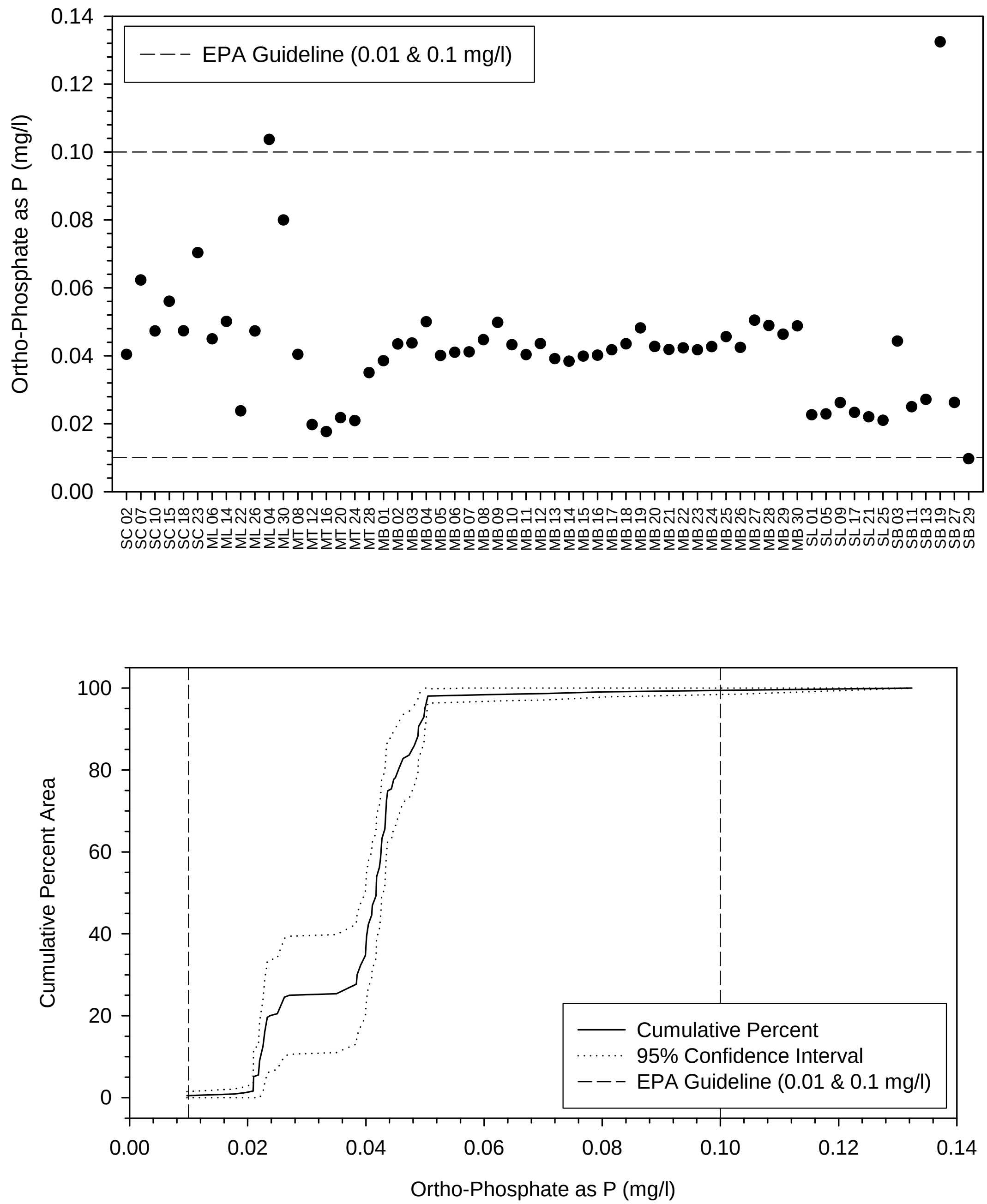
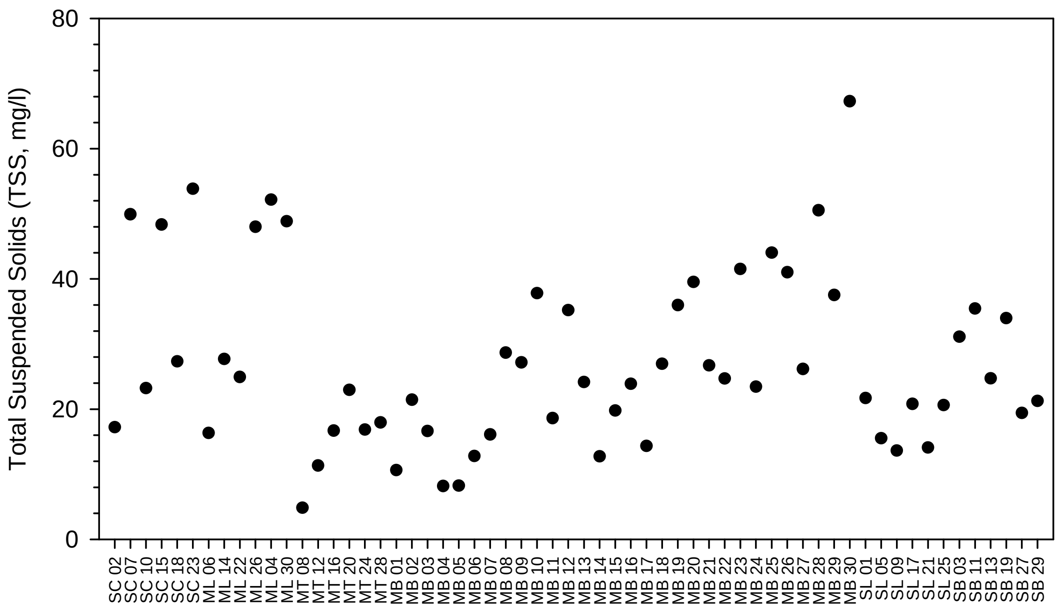


Figure 4-13. Water orthophosphate values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent US EPA National Coastal Condition Assessment (USEPA 2004) guideline values. SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



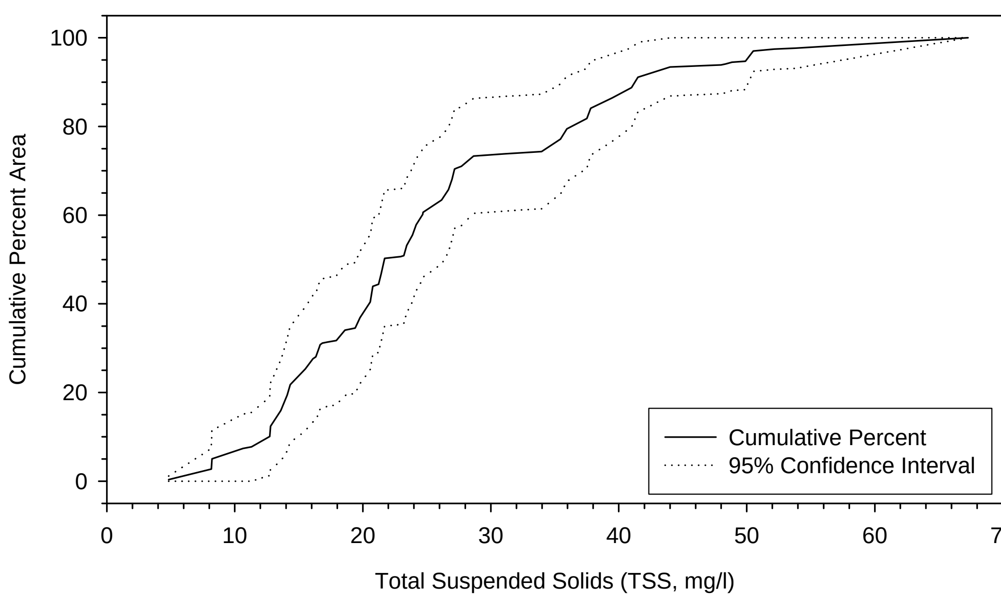


Figure 4-14. Water total suspended solids (TSS) values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

Santa Cruz occurred in the back of the harbor with sampling occurring at a negative low tide as it began to flood, while the low values were at stations near the mouth of the harbor that were sampled as the tide was flooding (Figure 1-2). Moss Landing did not group according to station location because a high and a low station were close to each other in the mouth (Figure 1-3); however, the Moss Landing high stations were sampled on a flood tide while the low values were collected on an ebbing tide near slack water. TSS was <30 mg/l at 74% of the harbor waters (Figure 4-14).

4.2.4 Summary

Water Quality Index

Dissolved oxygen, total dissolved inorganic nitrogen (DIN), orthophosphate as P, chlorophyll a, and water clarity (% light transmission) were used to create a water quality index value (good, fair, poor, or missing) for each station (Table 2-3). Forty-five (75%) of the stations, including all six stations from Monterey and Port San Luis, were classified as good (Figure 4-15). The three poor stations (5%) were in Moss Landing (n=2) and Santa Barbara (n=1). Poor classifications in Moss Landing were due to elevated DIN, poor water clarity, and high orthophosphate concentrations at station 309MSLG04. The Santa Barbara station rated poor because of low dissolved oxygen and high orthophosphate concentrations. When looking at ratings by the percentage of overall harbor areas, a slightly better picture was painted with 84.5% of the harbor areas rated good with only 1.3% rated poor (Figure 4-15).

4.3 Sediment Quality Indicators

4.3.1 Grain Size

The % fines (silt/clay) composition helps to define sediment as sands (<20% silt/clay), intermediate muddy sand (20-80%), and muds (>80% silt/clay; Nelson et al. 2005). Percent fines ranged widely from muds to sands across and within harbors (Figure 4-16). The lowest % fines value occurred in Morro Bay (1.27%) while the highest value occurred in Moss Landing (98.28%). Approximately 46% of the harbors were classified as sands (<20% silt/clay) and 20% as muds (>80% silt/clay; Figure 4-16).

At five of the six harbors (excluding Morro Bay), the full range of clays, silts, sands, and pebbles were characterized (Table 4-1). Station 310SNLS21 in San Luis had the lowest values for four of the seven silt/clay classes, but station 310SNLS05 had the lowest total silt/clay composition at 4.79% compared to the other harbors excluding Morro Bay. Station 315SBRB19 in Santa Barbara had the most number of high values for silts and clays (n=3), but 309MSLG04 in Moss Landing had the highest total silt/clay value at 98.28%. Not surprisingly, station 310SNLS05 with the lowest silt/clay composition had the highest sand composition (95.06%), while station 309MSLG04 had the lowest composition of sand (1.72%). Station 306MSLG22 in Moss Landing Harbor had the

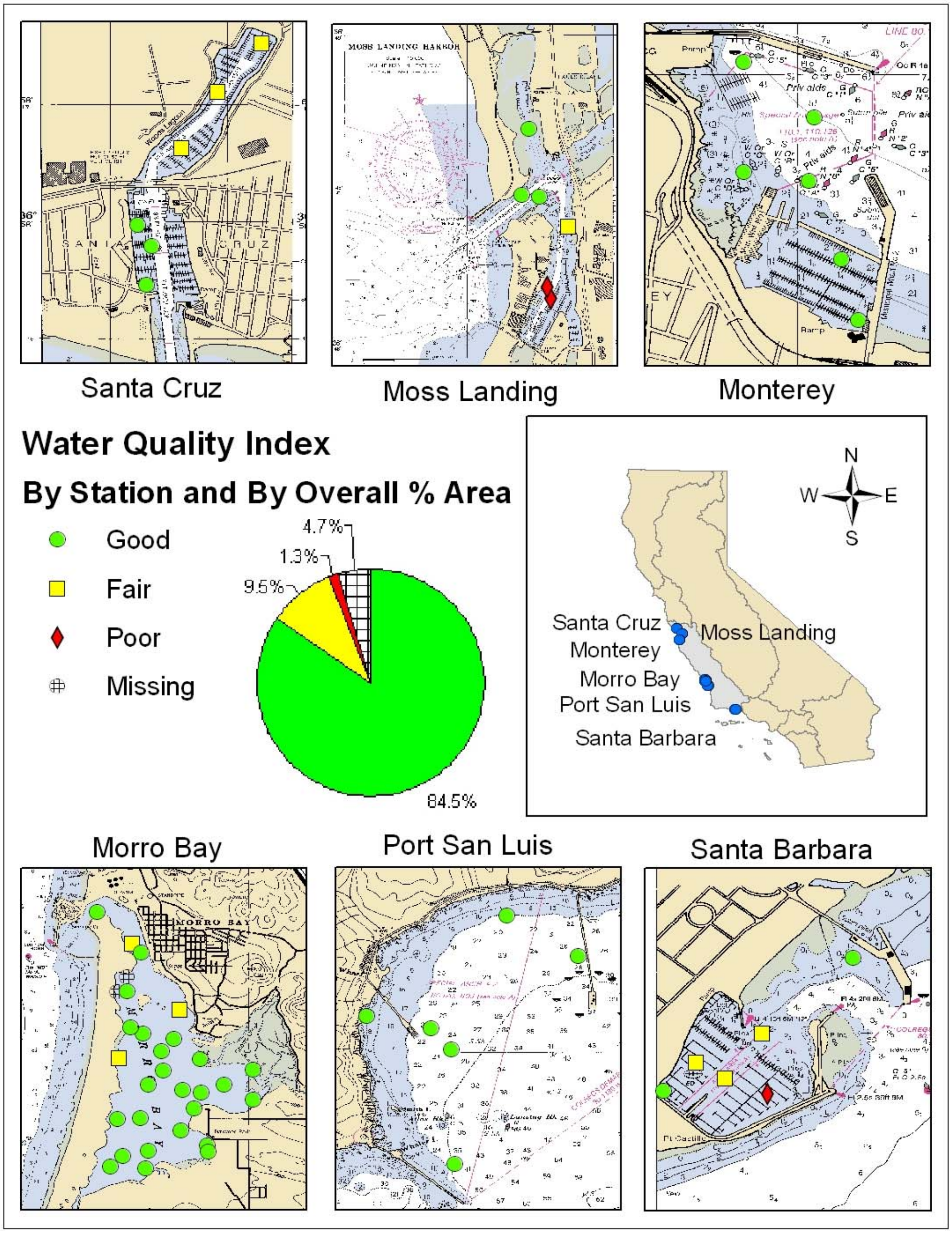
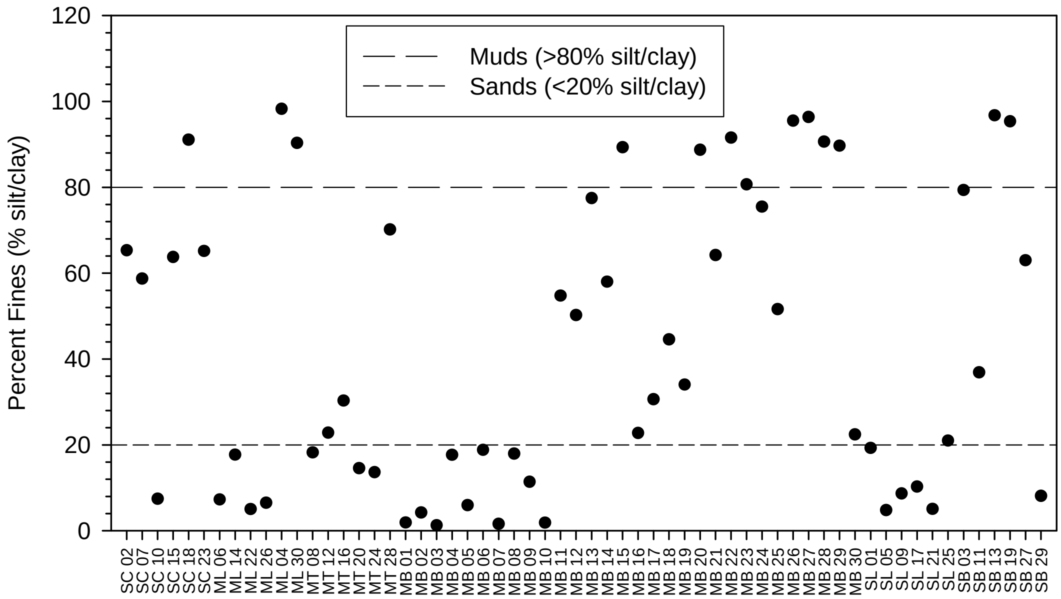


Figure 4-15. Water Quality Index values by station and by percent area. Overall rankings (good, fair, poor) were based on individual rankings for total dissolved inorganic nitrogen (DIN), orthophosphate as P, chlorophyll a, and water clarity (% light transmission; USEPA 2004). Index values by percent area, as calculated by the cumulative distribution function (CDF), are illustrated in the pie chart.



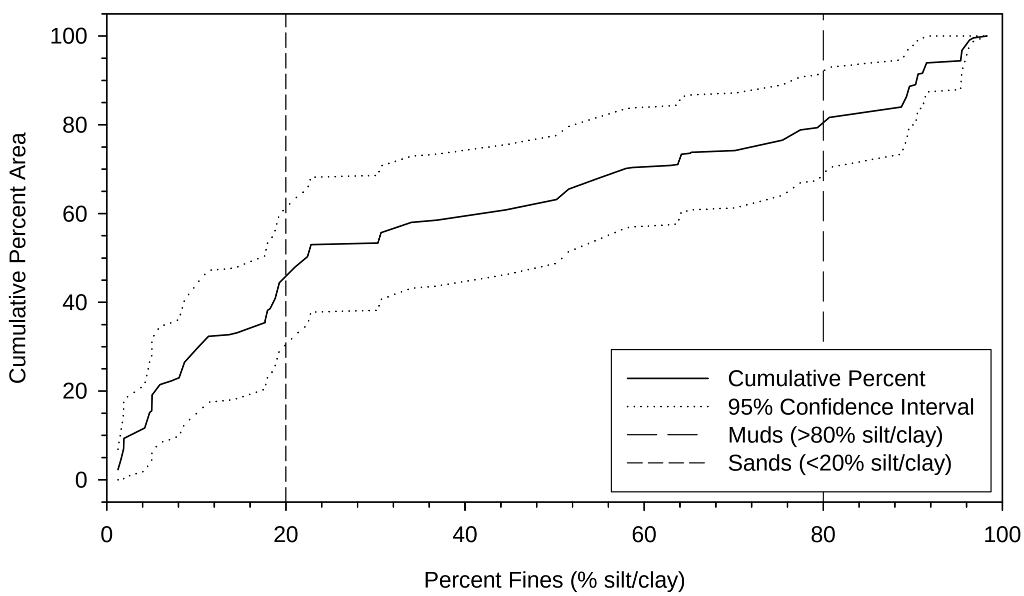


Figure 4-16. Sediment percent fines (% silt/clay) grain size values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines indicate general classifications (muds and sands) by silt/clay composition. SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

highest percentage of pebbles (23.40%) with the majority of stations not having pebbles greater than the size of a granule (phi=-1).

4.3.2 Total Organic Carbon (TOC)

The concentration of organic carbon plays an important role in controlling the bioavailability of non-ionic organic compounds in sediments (DiToro et al. 1991, Swartz 1999). Total organic carbon (TOC) varied in the harbors, but remained low in Port San Luis and high in five of the six Santa Barbara stations (Figure 4-17). TOC concentrations in Morro Bay tended to increase from stations near the mouth to the back portions of the Bay (Figures 1-5 and 4-17). The highest TOC value was recorded in Monterey (4.47%) with the next highest values occurring in Santa Barbara (3.68%) and Morro Bay (3.59%). All stations were rated as fair to high quality with 72% of the harbor areas falling in the high quality category (<2% TOC; Figure 4-17). The lowest values were recorded in Morro Bay with the lowest value less than the detectable level (i.e., <MDL).

Table 4-1. Summary data for grain size by size classes. Numbers below each size class represents the corresponding phi size.

Size Class	Clay			Silt				Sand					Pebbles				
	Clay	Clay	Clay	V. Fine	Fine	Medium	Coarse	V. Fine	Fine	Medium	Coarse	V. Coarse	Granule	Small	Medium	Large	V. Large
Station	>10	10	9	8	7	6	5	4	3	2	1	0	-1	-2	-3	-4	<-5
304SCRZ02	16.08	2.66	2.8	3.75	7.24	11.59	21.17	20	10.29	2.97	0.8	0.54	0.11	0	0	0	0
304SCRZ07	15.2	9.52	4.07	5.15	8.75	9.06	6.94	6.8	11.31	16.52	4.66	1.51	0.5	0	0	0	0
304SCRZ10	2.82	0.52	0.38	0.5	0.79	0.94	1.49	7.26	72.07	12.05	0.53	0.18	0.07	0.41	0	0	0
304SCRZ15	19.19	4.44	4.8	4.84	7.13	8.72	14.63	20.87	9.15	2.51	1.64	0.96	0.19	0.93	0	0	0
304SCRZ18	32.94	6.15	6.76	8.49	12.16	13.18	11.4	5.37	2.73	0.25	0.19	0.12	0.26	0	0	0	0
304SCRZ23	25.88	4.09	4.48	6.34	9.48	7.79	7.07	19.18	13.39	1.69	0.43	0.18	0	0	0	0	0
306MSLG06	3.06	0.21	0.46	0.48	0.48	0.67	1.9	8.32	21.89	47.2	10.51	3.58	1.24	0	0	0	0
306MSLG14	7.33	0.92	1.06	1.22	1.31	1.47	4.38	42.42	19.6	14.01	5.39	0.88	0	0	0	0	0
306MSLG22	2.34	0	0.39	0.45	0.55	0.5	0.79	6.79	19.67	15.52	16.08	13.51	9.75	9.64	4.01	0	0
306MSLG26	2.95	0.38	0.53	0.51	0.51	0.59	1.05	21.33	64.01	5.55	2.11	0.49	0	0	0	0	0
309MSLG04	52.3	6.84	8.29	8.55	9.24	6.53	6.53	1.31	0.23	0.15	0.03	0	0	0	0	0	0
309MSLG30	48.45	8.85	8.64	7.67	7.06	5.15	4.49	1.33	1.38	2.55	1.7	1.05	1.68	0	0	0	0
309MTRY08	6.38	0.36	0.75	1.12	1.2	3.19	5.24	18.97	56.25	5.22	0.59	0.46	0.27	0	0	0	0
309MTRY12	6.83	0.37	0.7	1.3	1.2	3.31	9.1	8.92	49.09	17.45	1.45	0.27	0	0	0	0	0
309MTRY16	10.51	1.07	1.77	1.93	2.51	4.38	8.12	21.03	43.48	3.89	0.89	0.27	0.16	0	0	0	0
309MTRY20	5.02	0.42	0.44	0.79	0.78	1.59	5.49	22.81	56.45	5.48	0.65	0.06	0	0	0	0	0
309MTRY24	5.02	0.15	0.75	0.66	0.93	2.01	4.12	8.85	60.89	15.43	1.06	0.14	0	0	0	0	0
309MTRY28	21.3	3.79	5.92	5.36	6.45	9.81	17.53	8.6	16.49	3.19	1.1	0.46	0	0	0	0	0
310SNLS01	4.18	0.62	0.48	0.85	1.21	2.3	9.64	54.28	18.75	5.39	1.26	0.5	0.54	0	0	0	0
310SNLS05	1.91	0.12	0.09	0.34	0.35	0.56	1.42	54.91	33.99	5.61	0.44	0.11	0.16	0	0	0	0
310SNLS09	2.48	0.17	0.45	0.39	0.69	1.11	3.39	27.64	55.33	7.35	0.64	0.11	0.25	0	0	0	0
310SNLS17	2.74	0.19	0.28	0.52	0.69	1.26	4.58	36.21	40.17	10.19	1.96	0.86	0.36	0	0	0	0
310SNLS21	1.77	0.22	0.1	0.22	0.35	0.49	1.92	70.4	17.05	6.37	0.81	0.16	0.13	0	0	0	0
310SNLS25	4.09	0.52	0.47	0.77	1.23	2.49	11.43	45.03	28.36	4.36	0.99	0.13	0.13	0	0	0	0
315SBRB03	19.37	4.32	5.44	9.19	13.8	14.74	12.49	13.03	6.08	0.4	0.34	0.4	0.41	0	0	0	0
315SBRB11	10.1	2.13	2.34	3.23	4.18	6.26	8.63	25.99	29.6	2.98	1.27	1.09	2.18	0	0	0	0
315SBRB13	29.59	7.1	9.23	14.51	17.06	13.31	5.95	1.04	0.51	0.34	0.48	0.62	0.27	0	0	0	0
315SBRB19	23.98	7.24	9.94	14.56	16.62	15.5	7.51	3	0.76	0.29	0.33	0.19	0.08	0	0	0	0
315SBRB27	22	6.02	6.42	6.41	8.28	7.55	6.3	10.26	21.78	2.98	0.81	0.94	0.25	0	0	0	0
315SBRB29	1.3	0.48	0.09	0.36	0.71	1.6	3.55	27.81	61.84	1.54	0.31	0.25	0.17	0	0	0	0

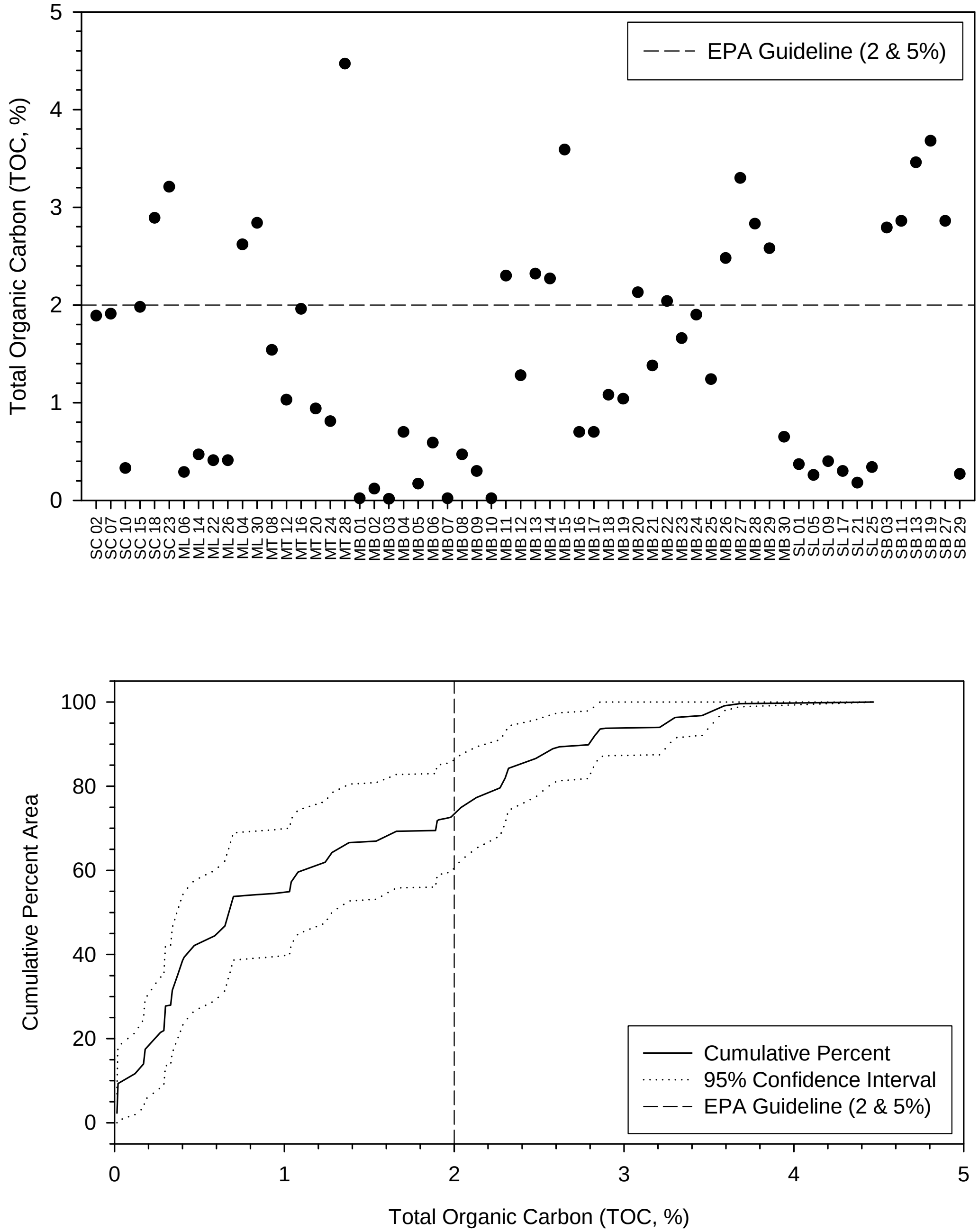


Figure 4-17. Sediment total organic carbon (TOC) values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed line represents US EPA National Coastal Condition Assessment guideline values (USEPA 2004). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

4.3.3 Trace Metals

Twelve trace metals (aluminum, arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver, and zinc) were analyzed from sediment in all harbors. The minimum and maximum values, mean and standard deviation, and detection frequencies are presented in Table 4-2. Eight of the twelve analytes were detected at all 60 stations. The lowest detection frequency occurred for cadmium where it was detected at 86.7% of the stations. The results for each station for nine analytes were compared to the Effects Range Low (ERL), Effects Range Median (ERM), Threshold Effects Level (TEL), and Probable Effects Level (PEL) with the number of exceedances per analyte listed in Table 4-2. A discussion of these sediment quality guidelines can be found in section 2.3.3 Comparison to Established Thresholds. Guideline values for ERLs, ERMs, TELs, and PELs can be found in Appendix C.

Table 4-2. Sediment trace metals summary data per analyte. Minimum (Min), maximum (Max), mean (Mean) and standard deviation (SD) values in mg/kg dry weight, percent frequency of detection (result >MDL; n=60 stations), and number of Effects Range Low (ERL), Effects Range Median (ERM), Threshold Effects Level (TEL), and Probable Effects Level (PEL) exceedances are presented for each analyte. Non-detect results were given values equal to ½ MDL for summation purposes. Dash indicates a guideline was not established.

Analyte	Min (mg/kg)	Max (mg/kg)	Mean (mg/kg)	SD	Detection Frequency (%)	>ERL (%)	>ERM (%)	>TEL (%)	>PEL (%)
Aluminum	1,890	44,669	21,228	9,391	100	-	-	-	-
Arsenic	0.2	17.3	7.6	3.36	98.3	38	0	47	0
Cadmium	0.06	1.62	0.55	0.38	86.7	7	0	32	0
Chromium	23.7	426	132	92	100	58	2	83	33
Copper	4	483	59	79	100	52	2	67	15
Lead	3.6	113	17.6	19.0	100	7	0	17	2
Manganese	96.4	695	272	130	100	-	-	-	-
Mercury	0.003	1.28	0.129	0.216	96.7	15	3	23	3
Nickel	13.8	458	116.8	129.1	100	87	47	92	50
Selenium	0.025	1.6	0.63	0.45	95	-	-	-	-
Silver	0.05	1.13	0.27	0.190	100	2	0	2	0
Zinc	14.2	400	80.0	65.7	100	13	0	20	2

Aluminum

Aluminum was detected at all stations with sediment concentrations ranging from 1,890 mg/kg in Morro Bay to 44,669 mg/kg in Port San Luis (Figure 4-18). Station 309MTRY16 in Monterey had the second highest aluminum concentration at 41,895 mg/kg. The mean concentration was 21,228 mg/kg with 22% of the harbor areas having a value above 20,000 mg/kg (Figure 4-18). Sediment quality guidelines have not been developed for aluminum.

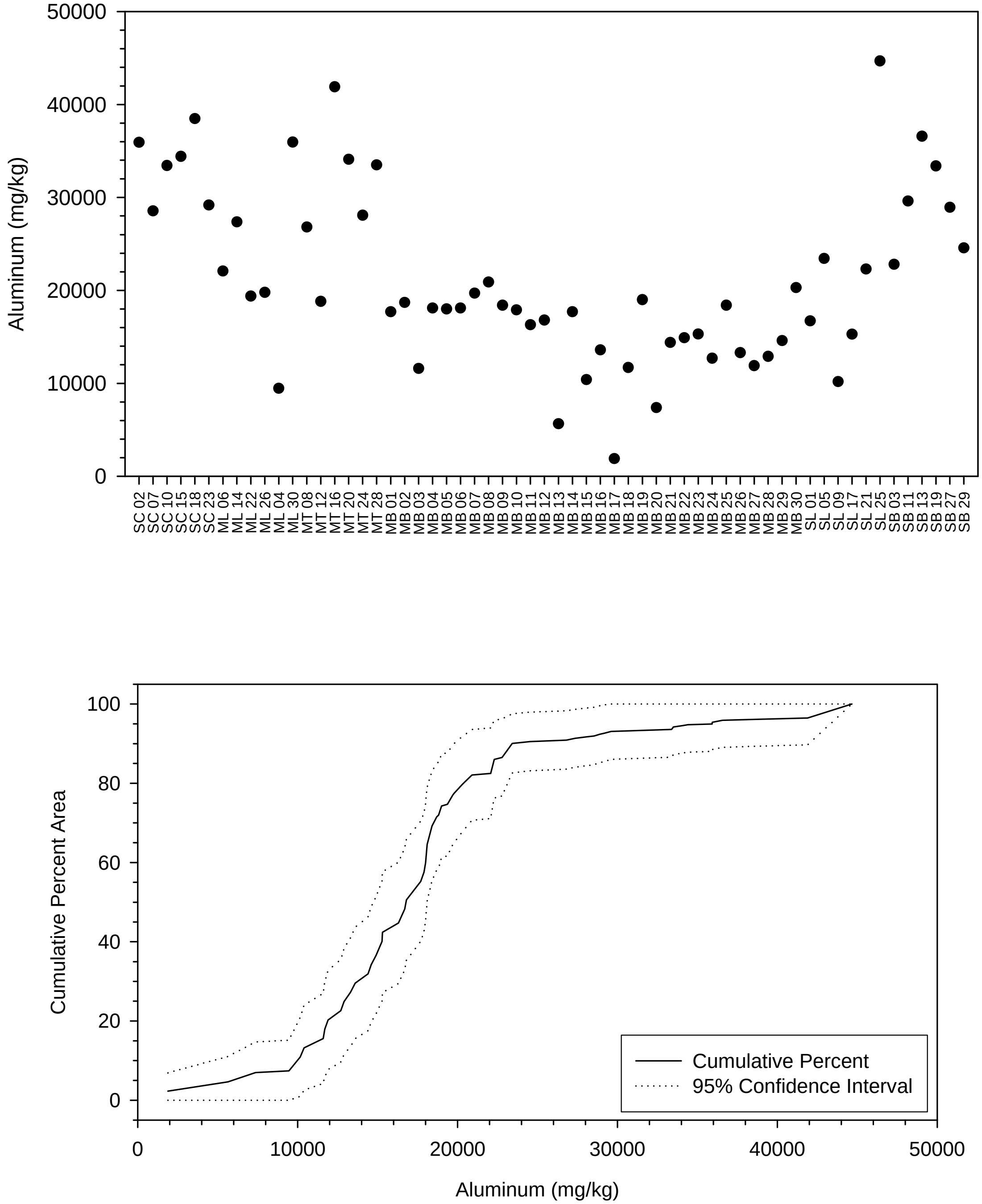
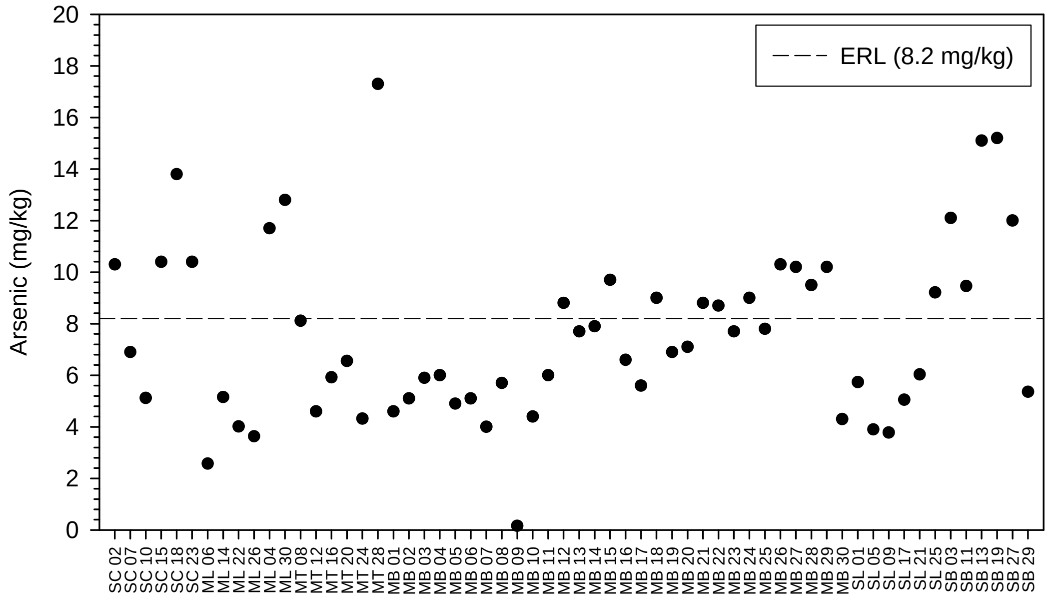


Figure 4-18. Sediment aluminum values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

Arsenic
Arsenic is a metalloid often contained in paint pigments, wood treatments, and pesticides (USEPA 2001c). While marine paint and coating compounds made with arsenic are no longer used because of their toxicity, it is still used in CCA (chromated copper arsenate) treated wood in docks and pilings and may still be present on older boats. Arsenic concentrations exceeded the ERL (8.2 mg/kg) at 38% of the stations and the TEL (7.24 mg/kg) at 47% of the stations (Table 4-2, Figure 4-19). The highest value occurred in Monterey (17.3 mg/kg) with the next two highest values in Santa Barbara (15.1 and 15.2 mg/kg). The range of arsenic concentrations in Port San Luis was much tighter than the other harbors. The mean concentration of arsenic was 7.6 mg/kg with 31% of the waters predicted to exceed the ERL (Figure 4-19). All harbors had at least one sample concentration above the ERL. The lowest arsenic value was found in Morro Bay where it was not detected.

Cadmium
Cadmium compounds are used in the metal plating and battery industry and as stabilizing agents in many polyvinyl chloride (PVC) products. Cadmium is a component of petrol, diesel fuel, and lubricating oils. Cadmium is also highly persistent in the environment and will concentrate or bioaccumulate in aquatic animals. Fifteen of the lowest nineteen cadmium values (<0.30 mg/kg) were found in Morro Bay with eight of these stations below detection limits (Figure 4-20). The highest concentration of cadmium occurred in Santa Barbara (1.62 mg/kg). Cadmium concentrations greater than the ERL (1.2 mg/kg) were found at 4 stations (7%; 2 Monterey, 1 Moss Landing, 1 Santa Barbara) while 19 stations (32%) had values greater than the PEL (0.676 mg/kg; Table 4-2). The mean concentration of cadmium was 0.55 mg/kg with only about 2% of the sediments having concentrations >ERL (Figure 4-20).

Chromium
Chromium compounds are used for chrome plating (e.g., protective coatings for equipment accessories), as dyes, as inorganic paint pigments, and as fungicides and wood preservatives in docks and pilings. Chromium may be oxidized and leached from stainless steel into a water-soluble form. Chromium has been used in various capacities in marinas and by boaters and can wash from parking lots, service roads, and launch ramps into surface waters with rainfall (USEPA 2001c). Chromium is also prevalent in serpentine soils. The ERM (370 mg/kg) was exceeded for chromium at station 310SNLS01 (426 mg/kg) and almost exceeded at 310SNLS21 (359 mg/kg) in Port San Luis (Figure 4-21). The ERL (81 mg/kg) was exceeded at 58% of the stations with 27 exceedances occurring in Morro Bay where high natural levels of chromium occur (RWQCBCC 2003; Table 4-2). The TEL (52.3 mg/kg) was exceeded at 83% of the stations with 33% of the stations having values >PEL (160.4 mg/kg). The mean chromium concentration was 132 mg/kg, which was greater than the ERL and TEL and could reflect the naturally high concentrations in Morro Bay. Seventy-six percent of the harbor areas exceeded the ERL and 3% exceeded the ERM (Figure 4-21). Chromium



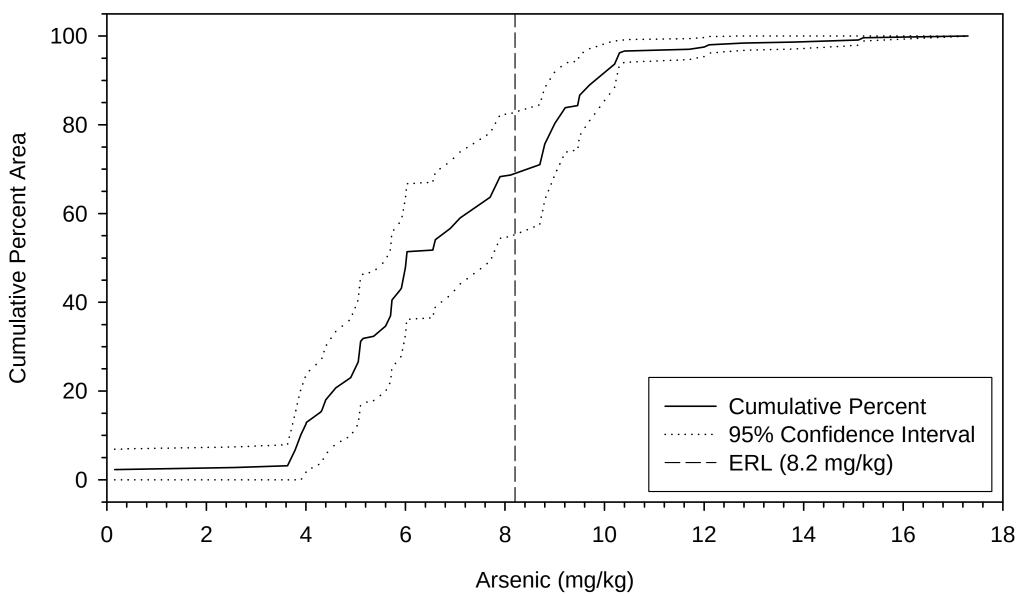
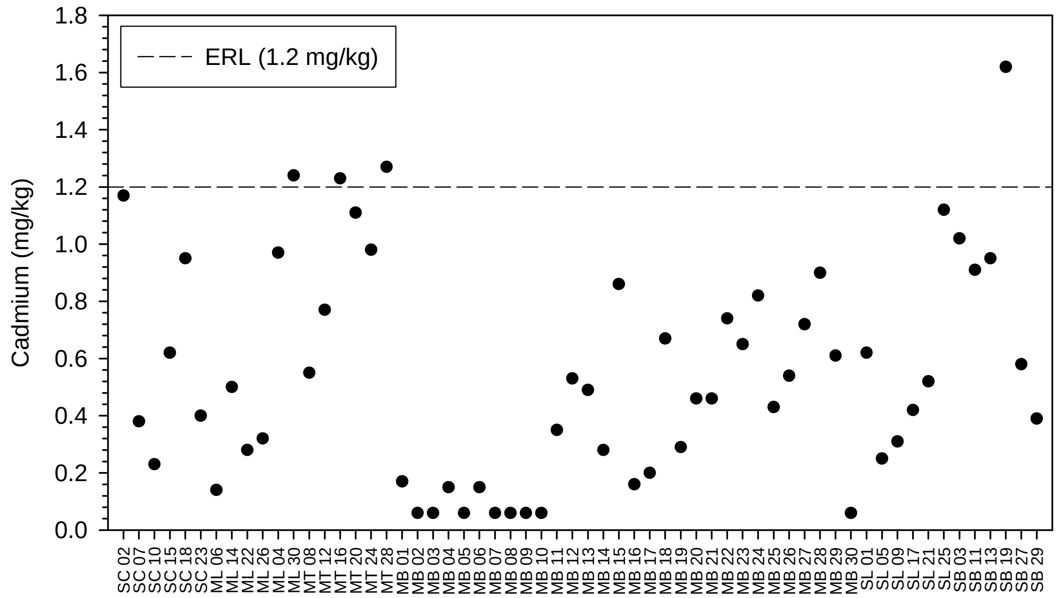


Figure 4-19. Sediment arsenic values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed line represents the Effects Range Low (ERL) guideline value associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



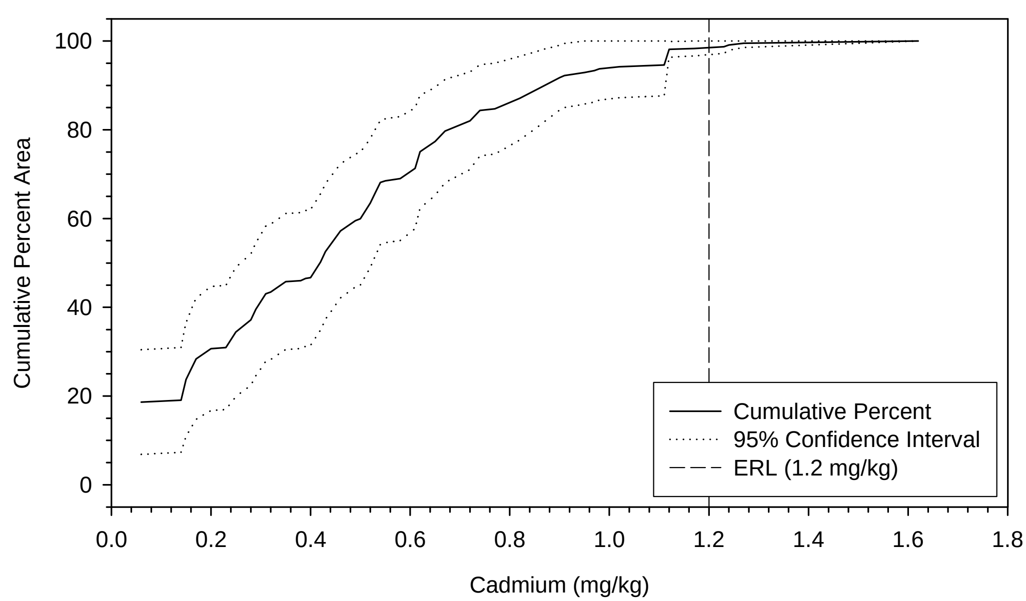
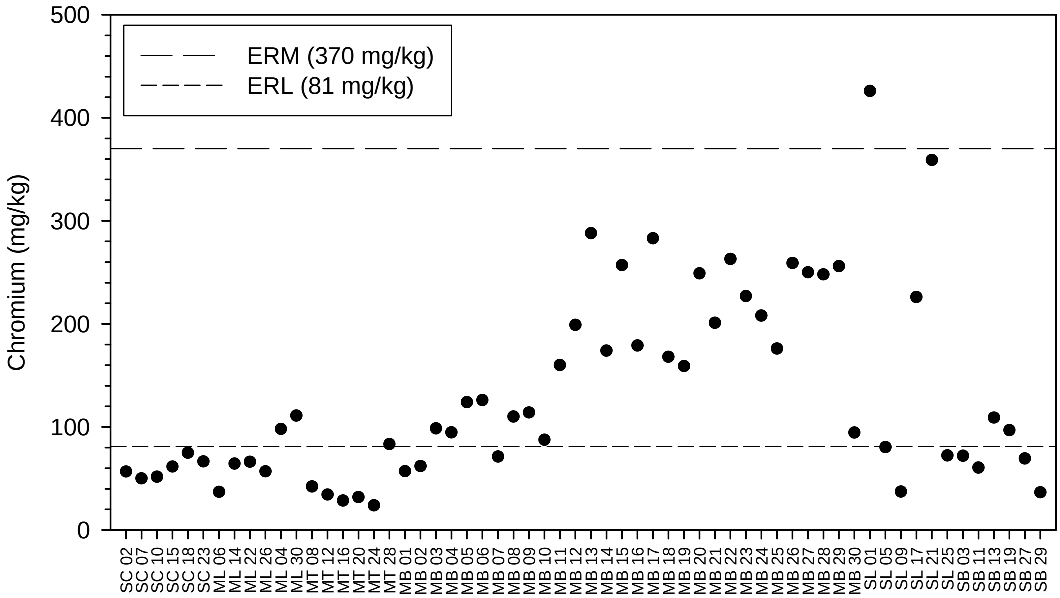


Figure 4-20. Sediment cadmium values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed line represents the Effects Range Low (ERL) guideline value associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



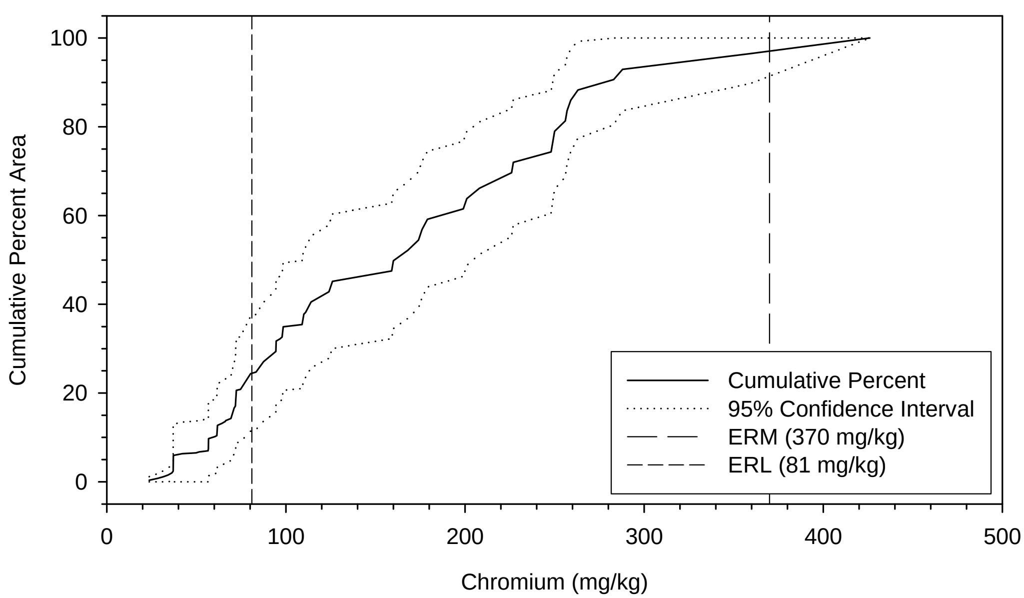


Figure 4-21. Sediment chromium values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

was low in Monterey Harbor considering the lowest four values occurred at the six stations (<0.80 mg/kg; Figure 4-21).

Copper

Copper is a broad-spectrum biocide that may be associated with acute and chronic toxicity, reduction in growth, and a wide variety of sub-lethal effects (Spear and Pearce 1979). Marina-related sources of copper include anti-fouling paints and wood preservatives in docks and pilings. The highest concentration of copper was found in Monterey (483 mg/kg), which exceeded the ERM (270 mg/kg) suggesting toxic biological effects. This value was more than double the next highest three values which were in Santa Barbara (220-234 mg/kg; Figure 4-22). The ERL (34 mg/kg) and TEL (18.7 mg/kg) were exceeded in all harbors at 52% of the stations with the PEL (108.2 mg/kg) exceeded in Santa Cruz (n=3), Monterey (n=2), and Santa Barbara (n=4) harbors (Table 4-2). The mean sediment copper concentration was 59 mg/kg with 38% of the copper concentrations >ERL and <1% exceeding the ERM (Figure 4-22). The six lowest copper concentrations occurred in Morro Bay.

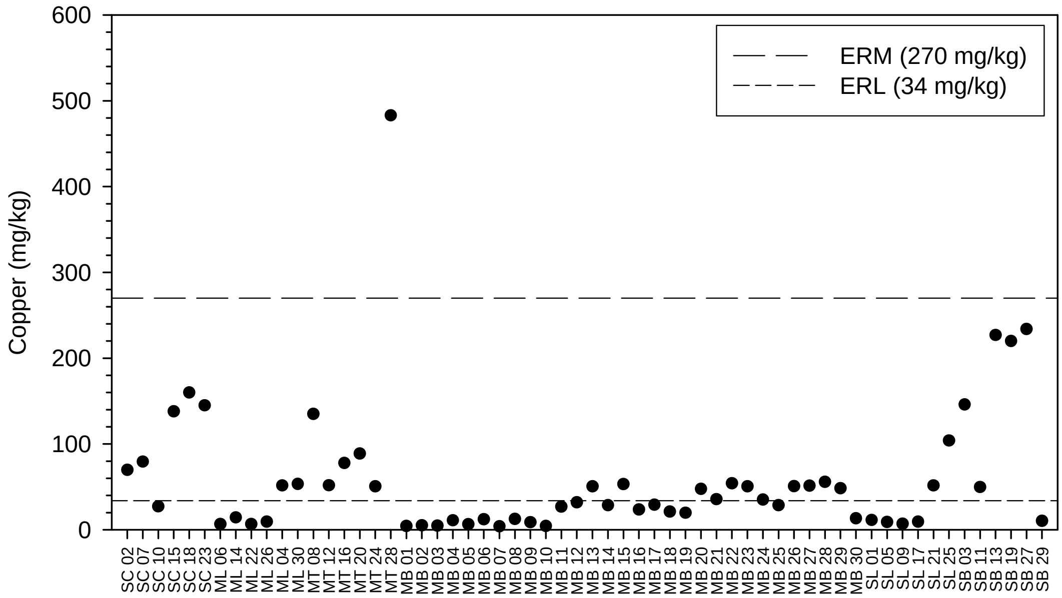
Lead

Lead is poisonous in all forms, is cumulative, and the toxic effects are many and severe. Marina and boating-related sources of lead compounds can include sailboat keels, marine paints, and lead acid batteries. Lead can be discharged into the marina environment from leaching of sailboat keels (Hinkey 2001), and corrosion of fittings and lead acid batteries (Washington State Department of Ecology 2001). A lead slag pile was cleaned up in the early 1990s in Monterey Harbor. Follow up monitoring indicated lead levels were still elevated but benthic communities in the harbor were not negatively affected. Based on this information, the RWQCBCC has recommended removing Monterey Harbor from the CWA 303(d) list for impairment due to lead (RWQCBCC 2006a).

Monterey and Santa Barbara harbors had the highest levels of lead with 7% of the stations exceeding the ERL (46.7 mg/kg), 17% exceeding the TEL (30.24 mg/kg), and 2% exceeding the PEL (112.18 mg/kg; Table 4-2; Figure 4-23). Of the four stations with values greater than the ERL, three were from Monterey (including the highest value) and one was from Santa Barbara Harbor. The mean concentration of lead was 17.6 mg/kg. Only 2% of the harbor areas had concentrations greater than the ERL (Figure 4-23).

Manganese

Five of the six lowest manganese concentrations (≤125 mg/kg) including the lowest value occurred in Monterey (Table 4-2; Figure 4-24). The fifteen highest concentrations occurred in Morro Bay (>360 mg/kg) with the highest value at station CA03-0317 (695 mg/kg). The mean sediment manganese concentration was 272 mg/kg with 93% of the harbor areas having concentrations less than 500 mg/kg (Figure 4-24). Sediment quality guidelines do not exist for manganese.



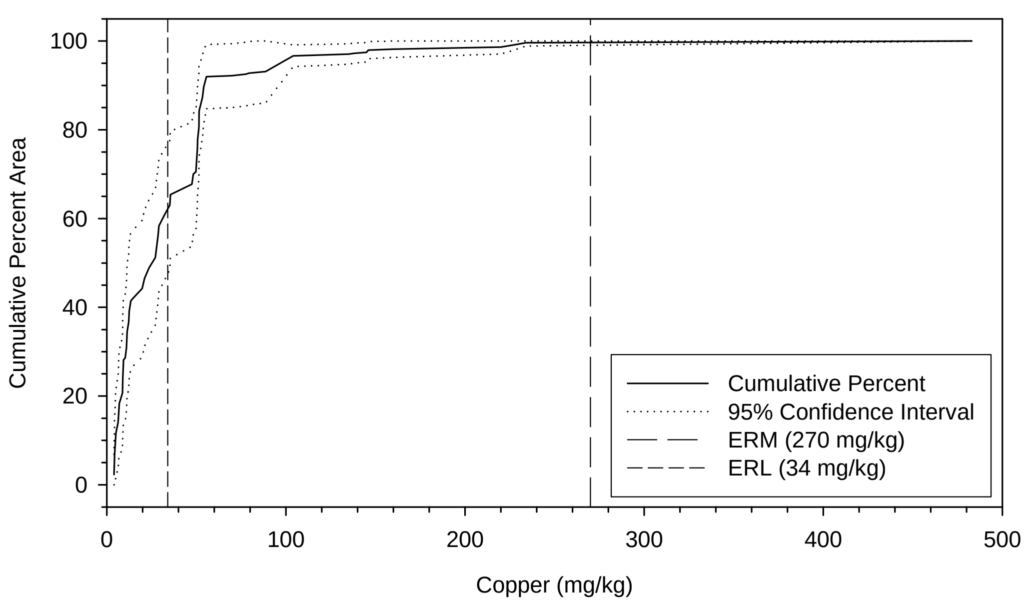
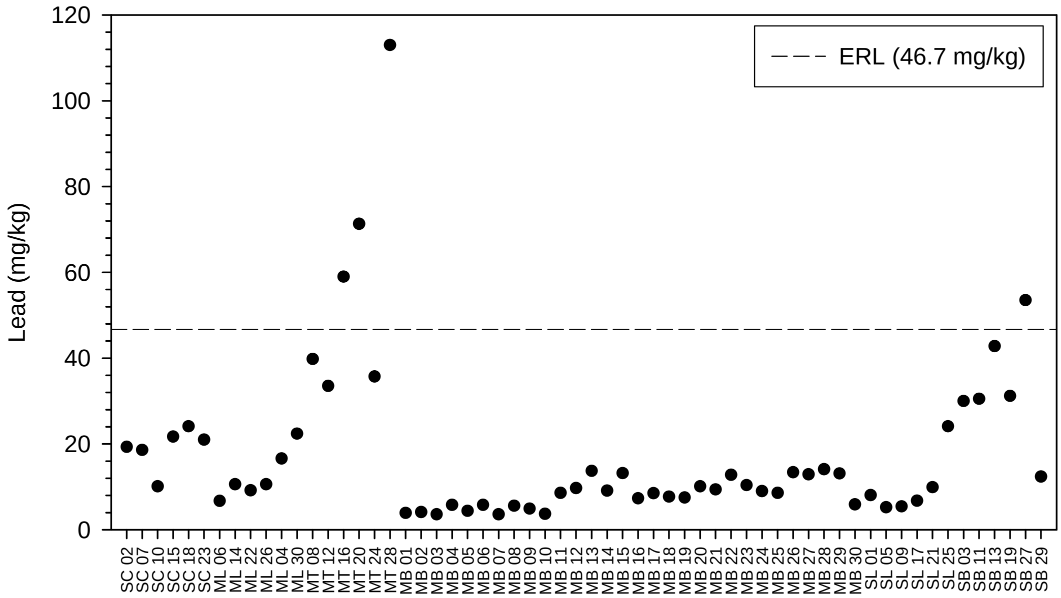


Figure 4-22. Sediment copper values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



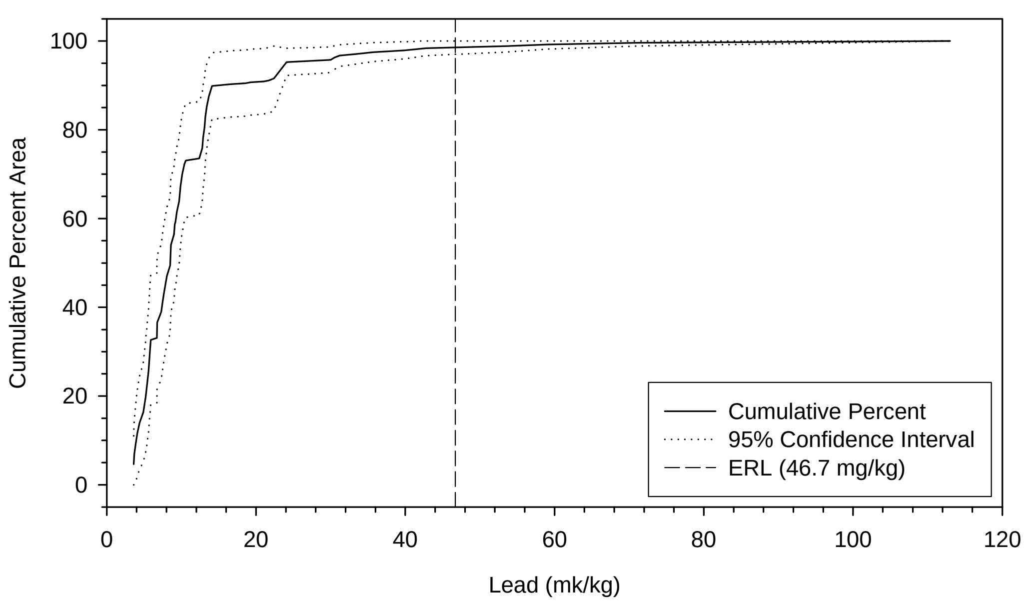
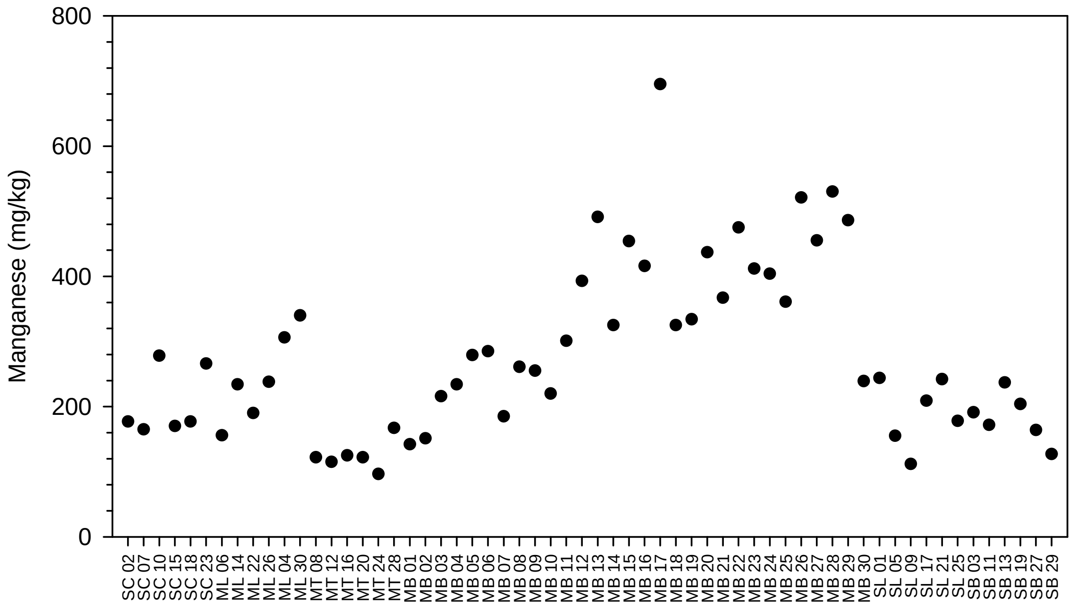


Figure 4-23. Sediment lead values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed line represents the Effects Range Low (ERL) guideline value associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



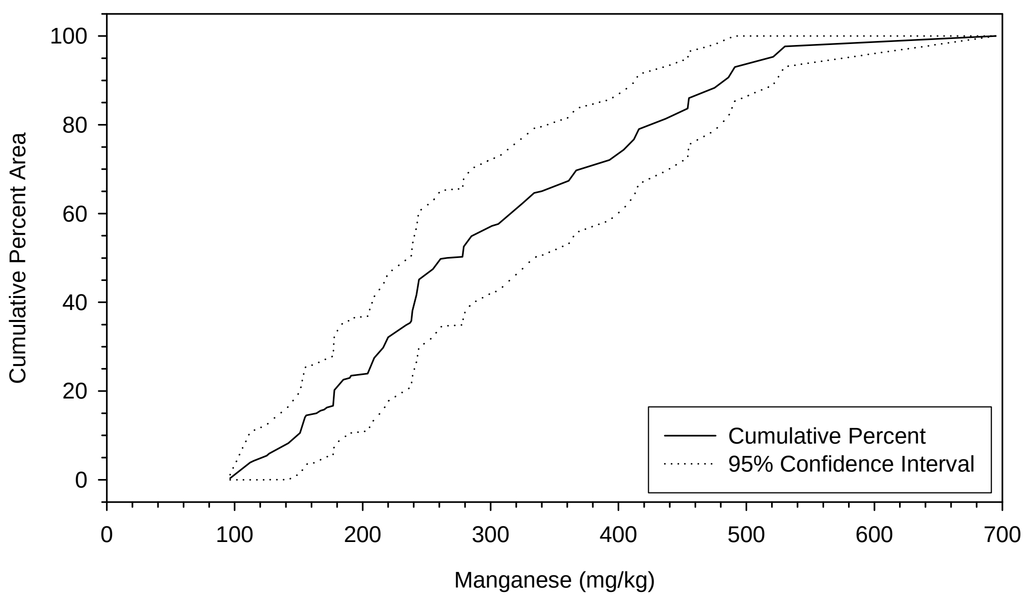


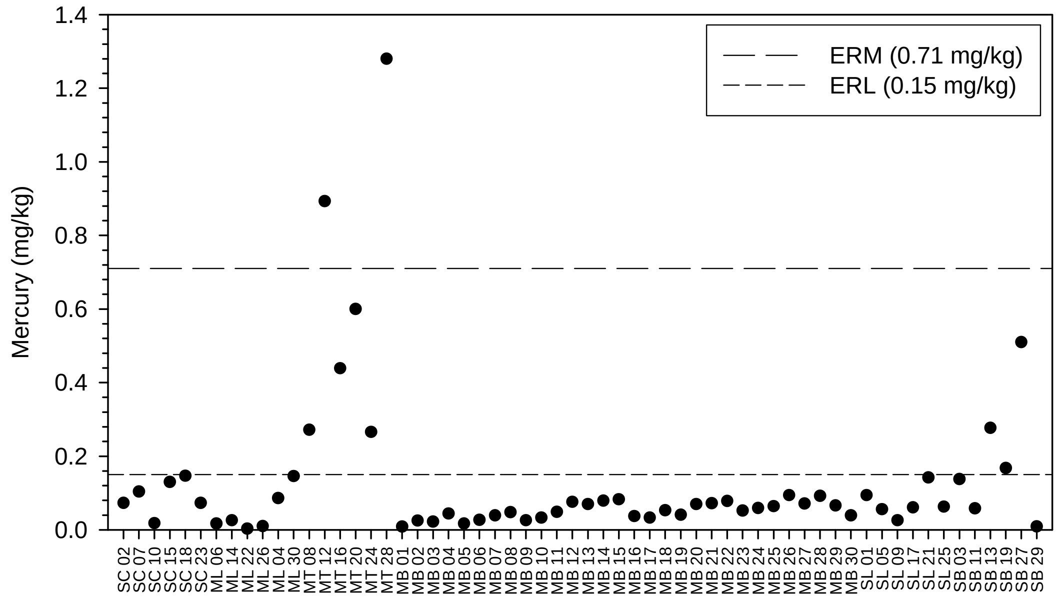
Figure 4-24. Sediment manganese values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

Mercury
The highest sediment concentrations of mercury, which exceeded the ERM (0.71 mg/kg) and PEL (0.70 mg/kg), were recorded in Monterey (1.28 and 0.89 mg/kg; Figure 4-25). The probability of adverse biological impacts is high in Monterey at these levels. The ERL (0.15 mg/kg) was exceeded at 15% of the stations with the TEL (0.13 mg/kg) exceeded at 23% of the stations (Figure 4-25). The mean concentration of mercury in the harbor sediments was 0.129 mg/kg with approximately 4% area of the sediments >ERL and only 1% area >ERM (Figure 4-25). To reiterate, all six samples from Monterey Harbor exceeded the ERL, two (309MTRY12 and 309MTRY28) of which exceeded the ERM. Sediment mercury concentrations were not detected at station 306MSLG22 in Moss Landing and station CA03-0301 in Morro Bay.

Nickel
Of the twelve metals analyzed, nickel had the highest percentage of ERL (20.9 mg/kg), ERM (51.6 mg/kg), TEL (15.9 mg/kg), and PEL (42.8 mg/kg) exceedances (Table 4-2). The highest 20 values were from Morro Bay ranging from 86.9 to 458 mg/kg (Figure 4-26). Nickel is a naturally abundant crustal element along the West Coast (Lauenstein et al. 2000) and in Morro Bay (RWQCBCC 2003). The ERM value for nickel has a low reliability (Long et al. 1995) suggesting comparisons with sediment quality guidelines should be made cautiously. The three lowest concentrations of nickel were in Monterey. The mean nickel concentration was 116.8 mg/kg with 97% of the sediments exceeding the ERL and 58% the ERM (Figure 4-26).

Selenium
The highest concentrations of selenium were found at 13 Morro Bay stations with the highest value occurring at station CA03-0327 (Figure 4-27). Santa Barbara and one station in Monterey also had relatively high selenium concentrations. Selenium was not detected at three stations (2 Moss Landing, 1 Morro Bay). The mean selenium concentration in all harbor sediments was 0.63 mg/kg with about 69% percent of the harbor areas having selenium concentrations less than 1.0 mg/kg (Figure 4-27). Sediment quality guidelines do not exist for selenium.

Silver
Eighteen Morro Bay stations had the lowest concentrations of silver (Figure 4-28). The highest concentration of silver was found in Monterey (1.13 mg/kg), which more than doubled the next three highest concentrations (0.55-0.61 mg/kg) which occurred in Santa Barbara. The ERL (1.00 mg/kg) and TEL (0.73 mg/kg) were only exceeded at the high station in Monterey. The mean silver concentration in the harbor sediments was 0.27 mg/kg with <1% of the harbor sediment areas exceeding the ERL (Table 4-2; Figure 4-28).



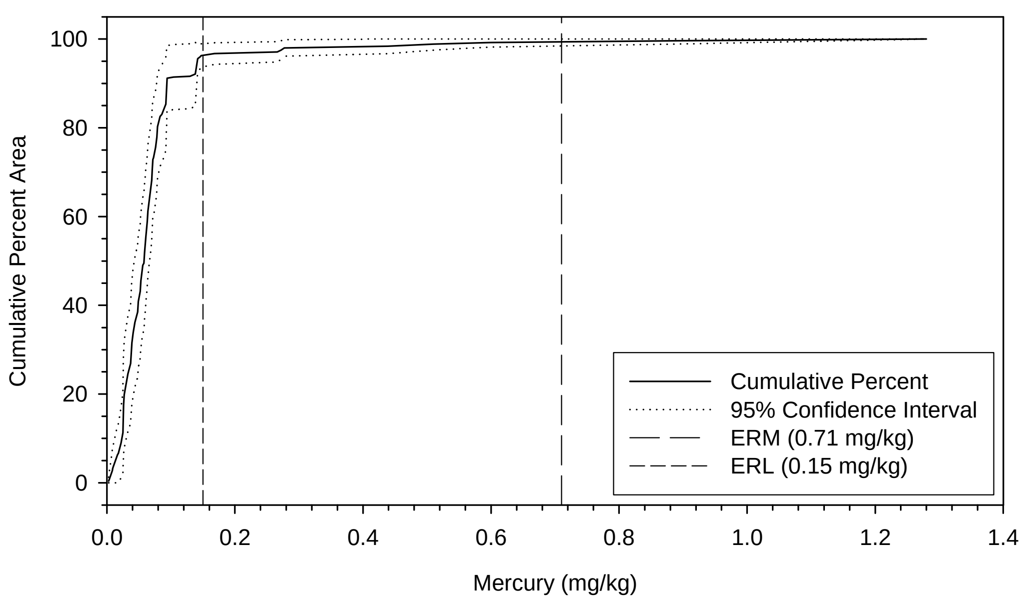
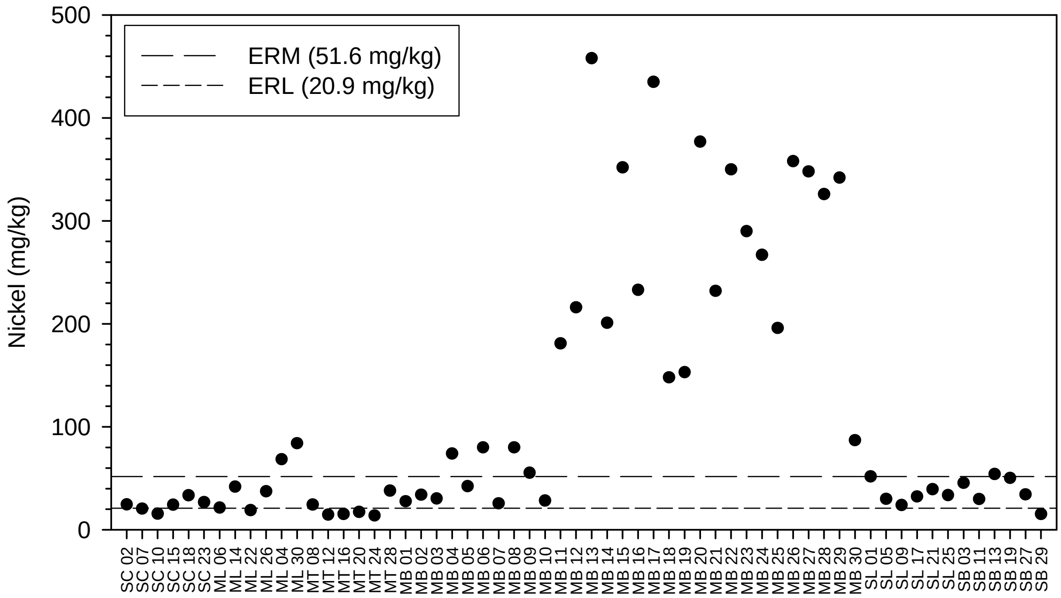


Figure 4-25. Sediment mercury values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



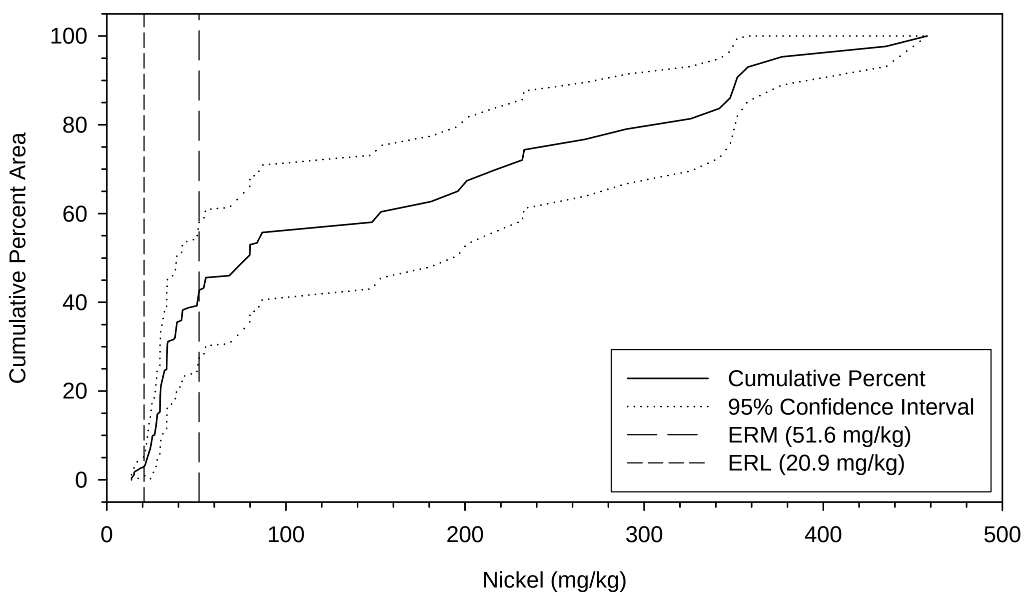


Figure 4-26. Sediment nickel values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

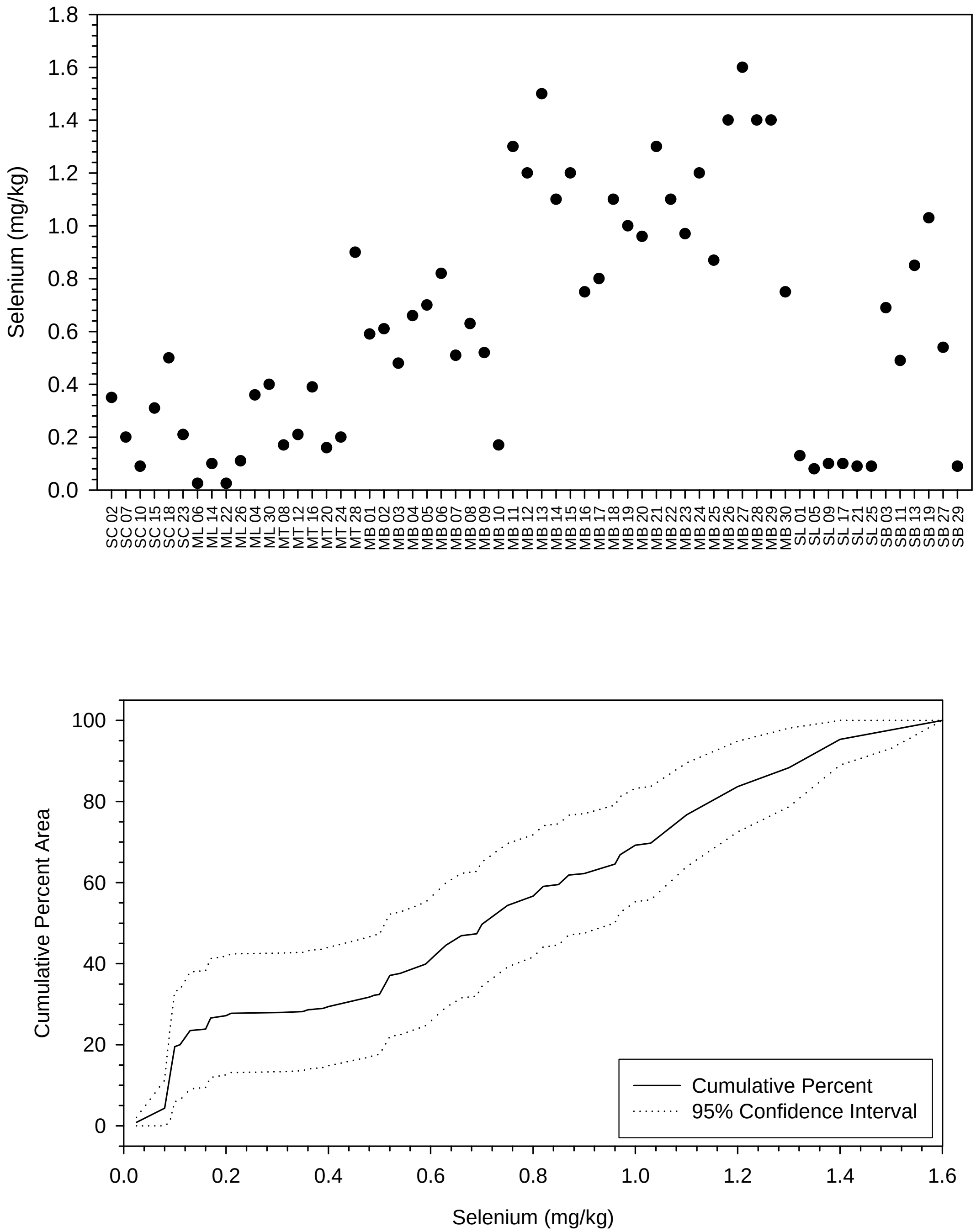
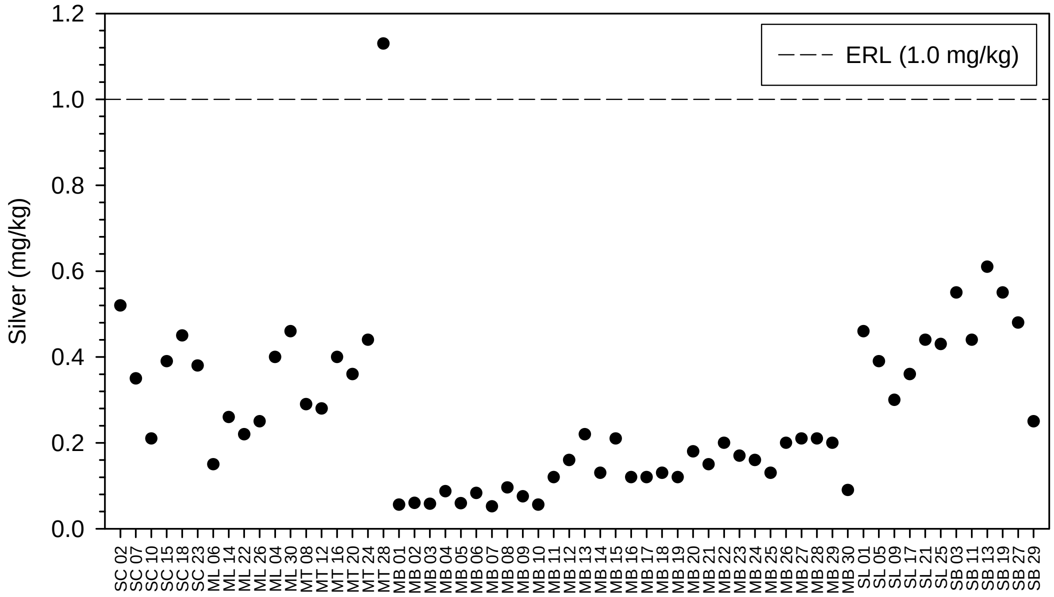


Figure 4-27. Sediment selenium values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



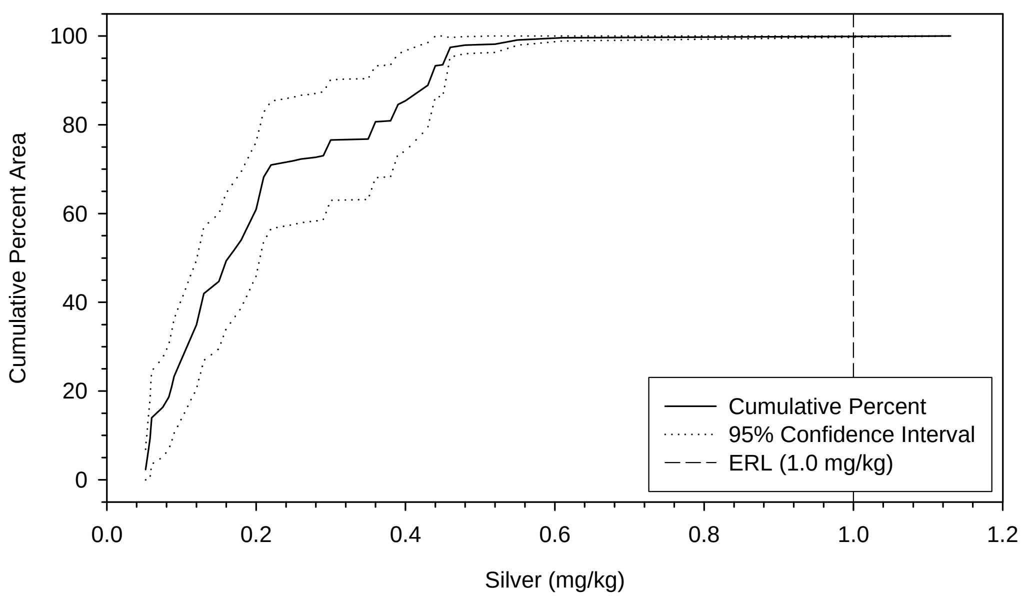


Figure 4-28. Sediment silver values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed line represents the Effects Range Low (ERL) guideline value associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

Zinc

Zinc anodes are commonly used as anti-corrodants for metal hulls, engine parts, and boat propeller shafts (USEPA 2001c). Zinc is also contained in boat anti-fouling paints (Hinkey 2001), motor oil, and tires, and is a common constituent of urban runoff or runoff from marina parking lots (USEPA 2001c). Zinc is a component of the wood preservative ACZA, which is used in marine pilings, docks, and piers. Generally, zinc and its salts have high acute and chronic toxicity (particularly zinc chromate) to aquatic life and zinc chromate is listed as a potential carcinogen.

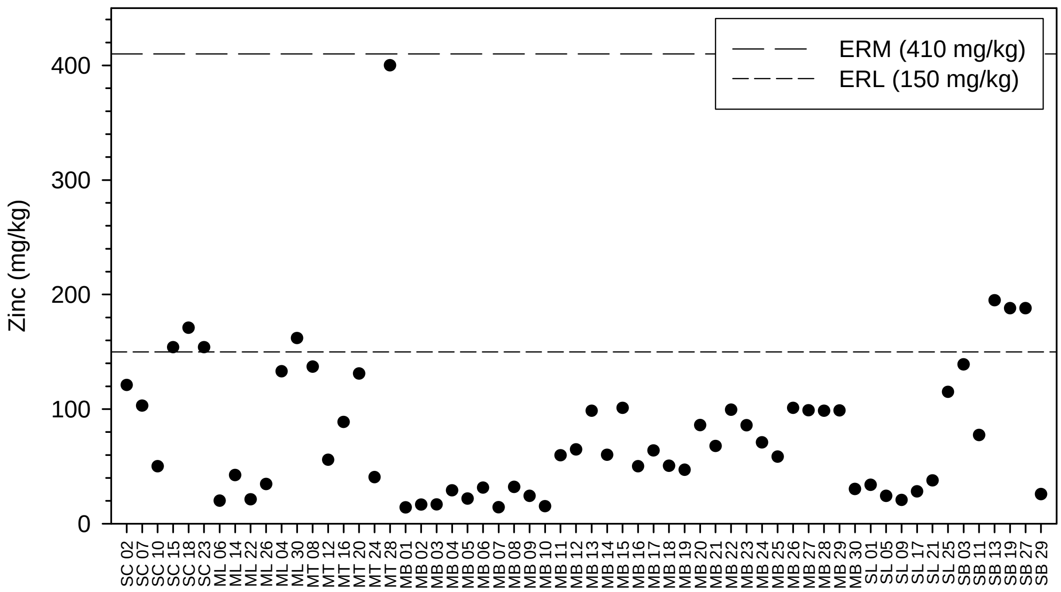
Zinc was found in the highest concentration in Monterey (400 mg/kg) adjacent to the boat slip area at the municipal wharf (station 309MTRY28; Figure 1-4). This result exceeded the PEL (271 mg/kg) and was close to exceeding the ERM (410 mg/kg; Figure 4-29). This value was more than double the three next highest values, which occurred in Santa Barbara (188-195 mg/kg). The ERL (150 mg/kg) was exceeded at 13% of the stations (3 Santa Cruz, 1 Moss Landing, 1 Monterey, and 3 Santa Barbara) with 20% of the stations exceeding the TEL (124 mg/kg; Table 4-2). The mean zinc concentration was 80 mg/kg with 3% of the harbor area sediments exceeding the ERL (Figure 4-29). The five lowest zinc values were found in Morro Bay and were all below 20 mg/kg.

4.3.4 Trace Organics

Sediment trace organics [OC and OP pesticides, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs)] were analyzed at all 60 stations, but specific analytes were not consistent across harbors since different labs conducted the analyses (Appendix B). Furthermore, chlorpyrifos, diazinon, TBT and DBT were analyzed in all harbors but Morro Bay. Analyte concentrations falling below the MDL were given a value of one half the lowest MDL for that particular analyte. Summary data (minimum, maximum, mean, standard deviation, detection frequency) and number of ERL, ERM, TEL, and PEL exceedances are presented for the organic analytes of interest in Table 4-3. The summations for each group are provided in section 2.3.1.

Total Chlordane

Total chlordane was calculated for all harbors; however, Morro Bay samples were analyzed for only two (chlordane, cis- and nonachlor, trans-) of the five analytes so the total chlordane value was under-represented in this harbor. NOAA (1990) showed these two analytes as principal components comprising roughly 26% of technical chlordane. At least one of the five analytes in the chlordane summation was detected at 16 of the 60 harbor stations (26.7%) with the highest value occurring in Santa Cruz (Table 4-3; Figure 4-30). The ERL (2.00 ng/g) and TEL (2.26 ng/g) were exceeded at 27% of the stations with the ERM (6.00 ng/g) and PEL (4.79 ng/g) exceeded at 17% and 18% of the stations, respectively. The ten stations with values >ERM were in Santa



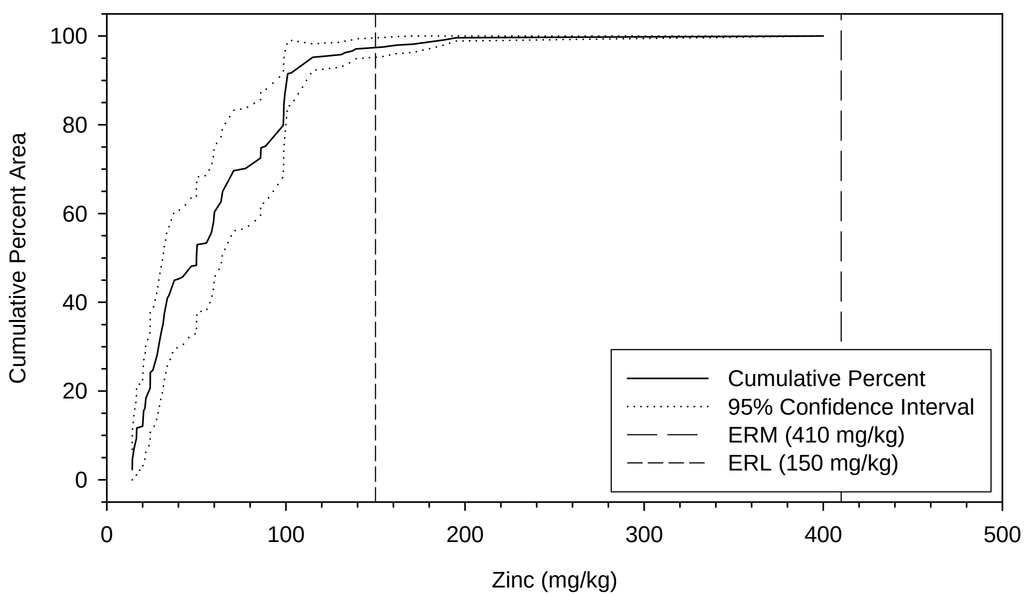


Figure 4-29. Sediment zinc values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

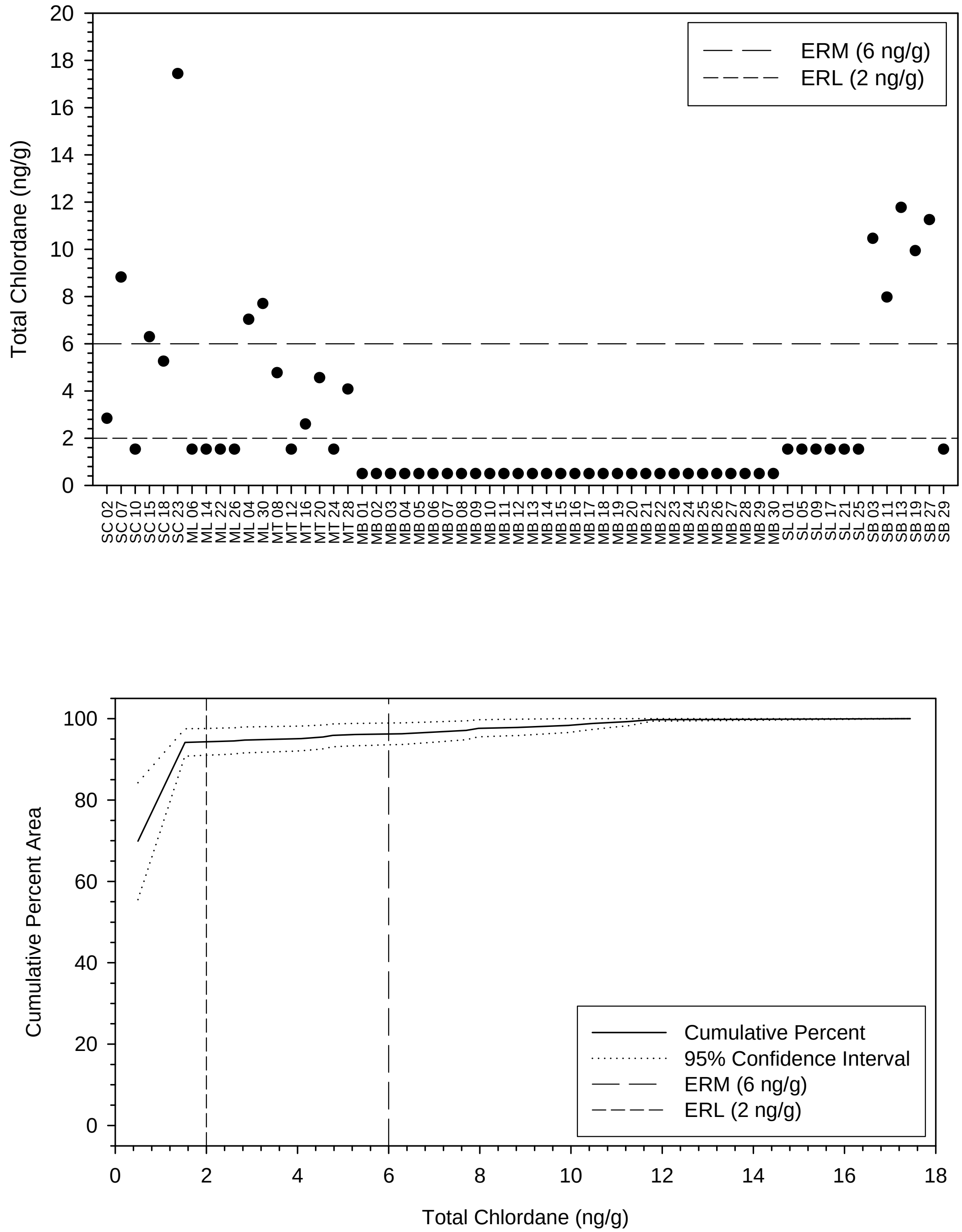


Figure 4-30. Sediment total chlordane values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

Table 4-3. Sediment organics summary data per analyte. Minimum (Min), maximum (Max), mean (Mean) and standard deviation (SD) values in ng/g dry weight, percent frequency of detection (result >MDL), and number of Effects Range Low (ERL), Effects Range Median (ERM), Threshold Effects Level (TEL), and Probable Effects Level (PEL) exceedances are presented for each analyte. Dash indicates sediment quality guidelines are not established. Total chlordane values for Morro Bay samples contain only two of five analytes recommended for summation. HMW PAHs and Total PAHs do not include Benzo(e)pyrene and Perylene for Morro Bay samples. Values for chlorpyrifos, diazinon, DBT, and TBT are based on 30 stations whereas the other analytes are based on 60 stations.

Analyte	Min (ng/g)	Max (ng/g)	Mean (ng/g)	SD	Detection Frequency (%)	>ERL (%)	>ERM (%)	>TEL (%)	>PEL (%)
Total Chlordane	0.50	17.44	2.65	3.65	26.7	27	17	27	18
Total DDTs	1.50	263.0	15.18	45.50	86.7	87	3	53	2
Total PCBs	2.02	197.89	23.00	28.22	53.3	25	2	27	2
LMW PAHs	5.06	2,330.1	206.4	403.7	68.3	12	0	12	2
HMW PAHs	10.41	11,283.0	916	2016	58.3	13	2	28	2
Total PAHs	15.49	13,613.11	1,122	2,416	70	12	0	15	0
Chlorpyrifos	0.47	14.30	1.10	2.668	6.7	-	-	-	-
Diazinon	4.28	4.28	4.28	0	0	-	-	-	-
Dibutyltin (DBT)	25	25	25	0	0	-	-	-	-
Tributyltin (TBT)	12.5	199	18.7	34.1	3.3	-	-	-	-

Barbara (n=5), Santa Cruz (n=3), and Moss Landing (n=2), suggesting toxic biological effects at these stations (Figure 4-30). None of the analytes were detected at station 315SBRB29 in Santa Barbara and all 30 of the Morro Bay stations. The mean concentration of total chlordane was 2.65 ng/g, which was higher than the ERL and TEL. Ninety-four percent of the harbor sediments were below the ERL with only approximately 4% exceeding the ERM (Figure 4-30).

Total DDTs

DDT metabolites were detected at 52 of the 60 stations (86.7%). The two highest concentrations of sediment total DDT were found in Moss Landing at stations 309MSLG30 (263.0 ng/g) and 309MSLG04 (247.3 ng/g) where there were DDE (p,p') concentrations of 151 ng/g and 152 ng/g, respectively. The remaining stations had values <32 ng/g with an overall total DDT mean of 15.18 ng/g (Table 4-3; Figure 4-31). The ERL (1.58 ng/g) was a little higher than the summed DDTs with values equal to one

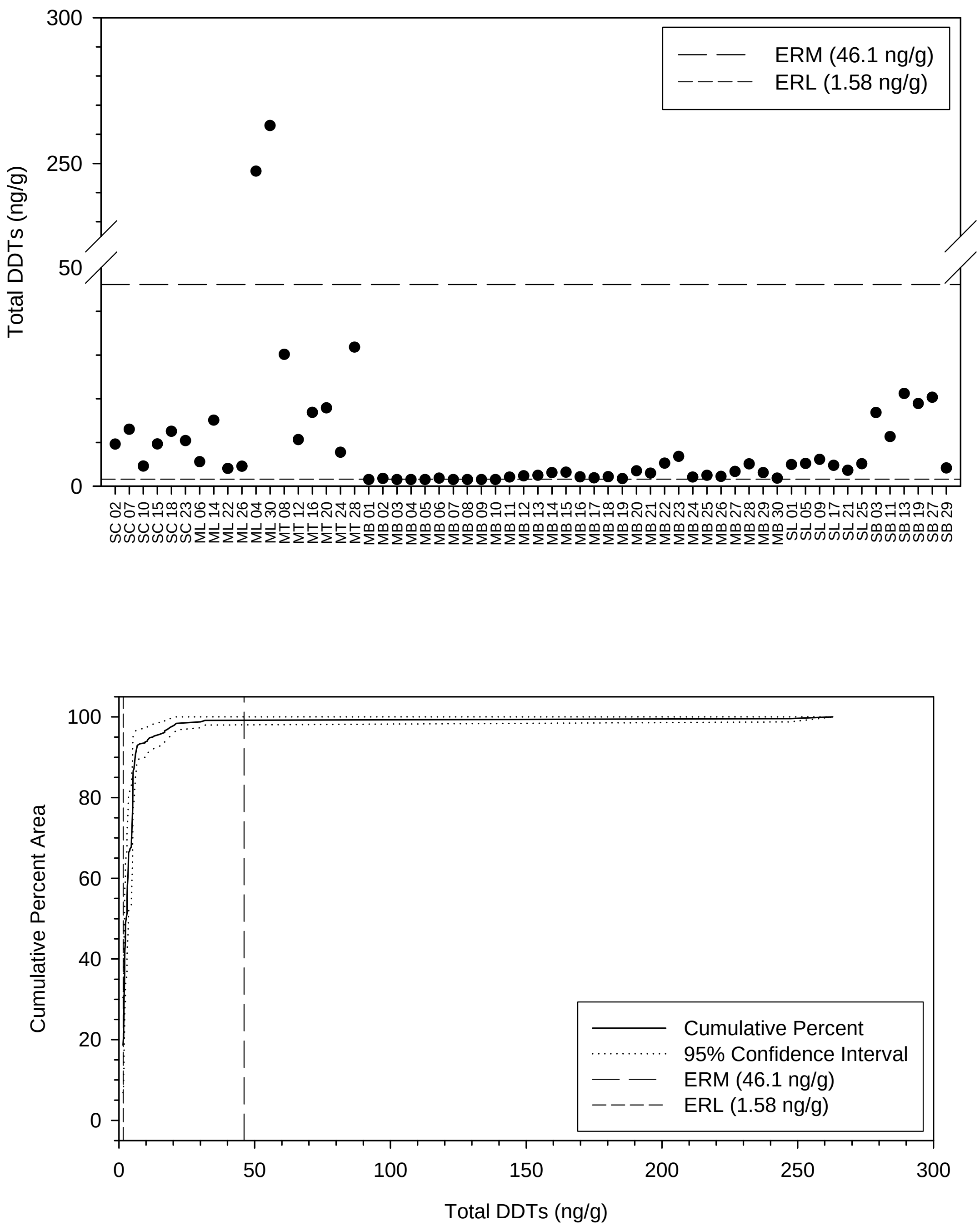


Figure 4-31. Sediment total DDTs values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

half the lowest MDL (1.50 ng/g), so all stations where DDTs were detected exceeded the ERL (n=52). Thirty-two stations (53%) exceeded the TEL (3.89 ng/g). The ERM (46.1 ng/g) and PEL (51.7 ng/g) were exceeded at the two Moss Landing stations. Overall, 1% of the harbor sediments exceeded the ERM (Figure 4-31).

Because organic carbon determines the bioavailability of total DDTs, results were normalized to TOC content (see section 2.3.1) and compared to the consensus guideline of 100 µg/g OC (Swartz et al. 1994). No stations had normalized total DDT concentrations that exceeded the guideline with approximately 89.4% of the harbor sediment areas with concentrations <2 µg/g OC (Figure 4-32). The two highest values occurred in Moss Landing. The other high concentrations in Morro Bay reflect low TOC concentrations artificially inflating the low total DDT concentrations.

PCBs

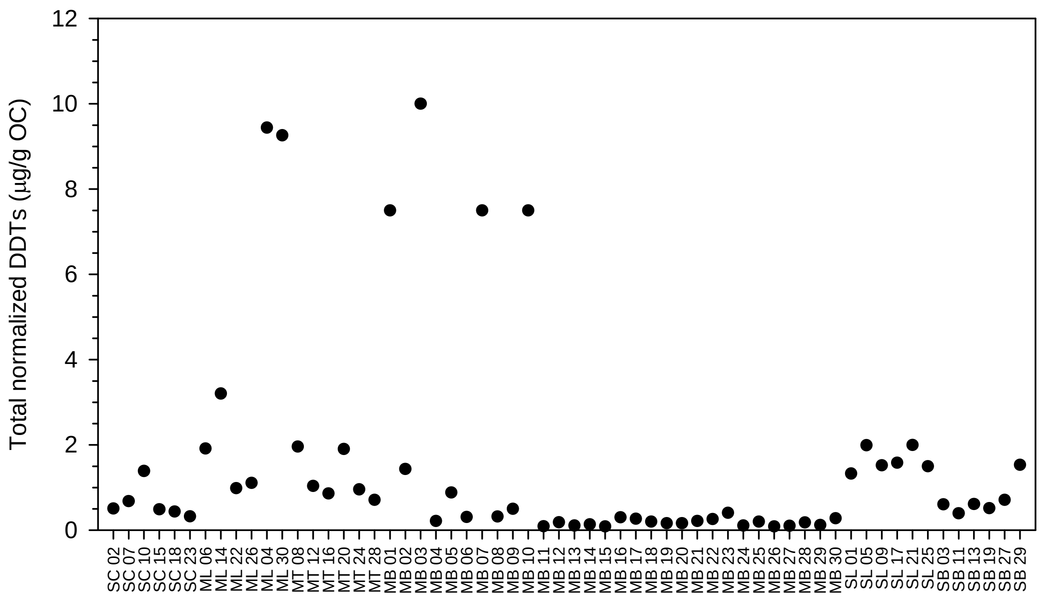
Polychlorinated biphenyls (PCBs) are base/neutral compounds formed by direct chlorination of biphenyl. Eighteen of the possible 209 PCB congeners were summed for comparison purposes (see Section 2.2.1). These congeners were detected at 32 stations (53.3%) with 27 non-detectable levels occurring in Morro Bay. Total PCB concentrations were highest in Monterey (197.89 ng/g) and Santa Barbara (116.22 ng/g; Figure 4-33). The high value in Monterey exceeded the ERM (180 ng/g) and PEL (188.79 ng/g) with ERL (22.7 ng/g) and TEL (21.55 ng/g) exceedances at 25% and 27%, respectively, of the stations (Table 4-3; Figure 4-33). The average concentration of total PCBs (23.00 ng/g) was slightly higher than the ERL. Six percent of the harbors sediment area exceeded the ERL with <1% exceeding the ERM (Figure 4-33).

PAHs

Polycyclic aromatic hydrocarbons (PAHs) are base/neutral organic compounds that are components of crude and refined petroleum products and are also products of incomplete combustion of organic materials. Due to their similar modes of toxic action and often complex mixture in sediments, PAHs were grouped into low molecular weight (LMW), high molecular weight (HMW), and total PAH summations for reporting.

Twelve low molecular weight PAHs (LMW PAHs) were detected at 41 stations (68.3%) with a mean value of 206.4 ng/g (Table 4-3). The 19 stations where LMW PAHs were not detected occurred in Morro Bay. All six Monterey stations and one Santa Barbara station had LMW PAH summations >760 ng/g, which exceeded the ERL (552 ng/g) and TEL (312 ng/g) suggesting some association with toxic biological effects (Figure 4-34). The highest LMW PAH summation occurred in Monterey at station 309MTRY08 (2,330.11 ng/g) exceeding the PEL (1,442 ng/g) but not the ERM (3,160 ng/g). Approximately 3% of the sediment areas in the six harbors exceeded the ERL (Figure 4-34).

Twelve high molecular weight PAHs (HMW PAHs) were detected at 35 stations (all non-detects in Morro Bay) with a mean value of 916 ng/g (Table 4-3). The highest value



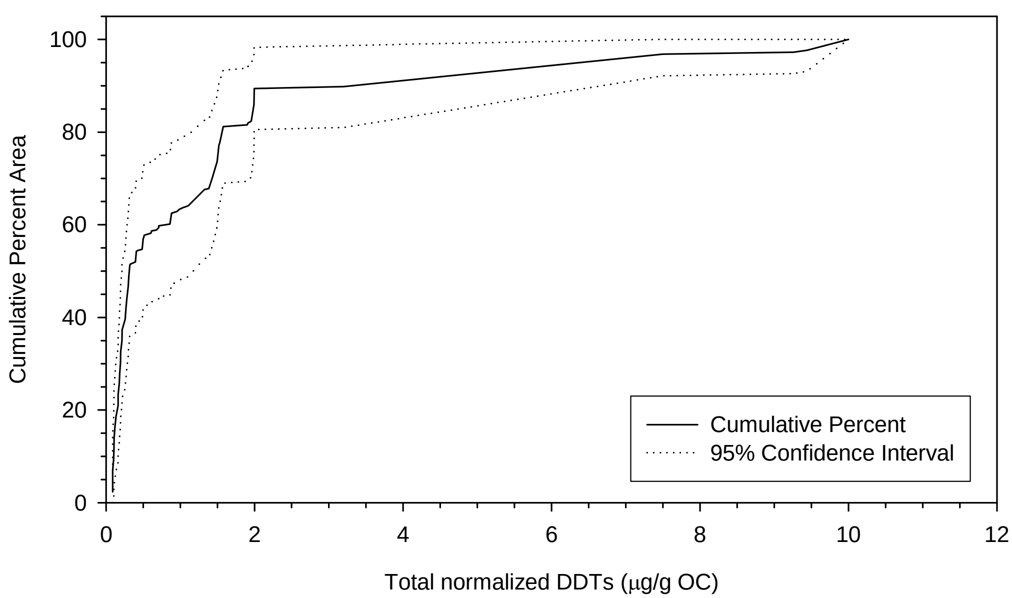


Figure 4-32. Sediment total normalized DDTs values by station and by percent area. Values were normalized to total organic carbon (TOC) content. Percent areas were calculated by the cumulative distribution function (CDF). No value exceeded the consensus guideline of 100 µg/g OC (Swartz et al. 1994). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

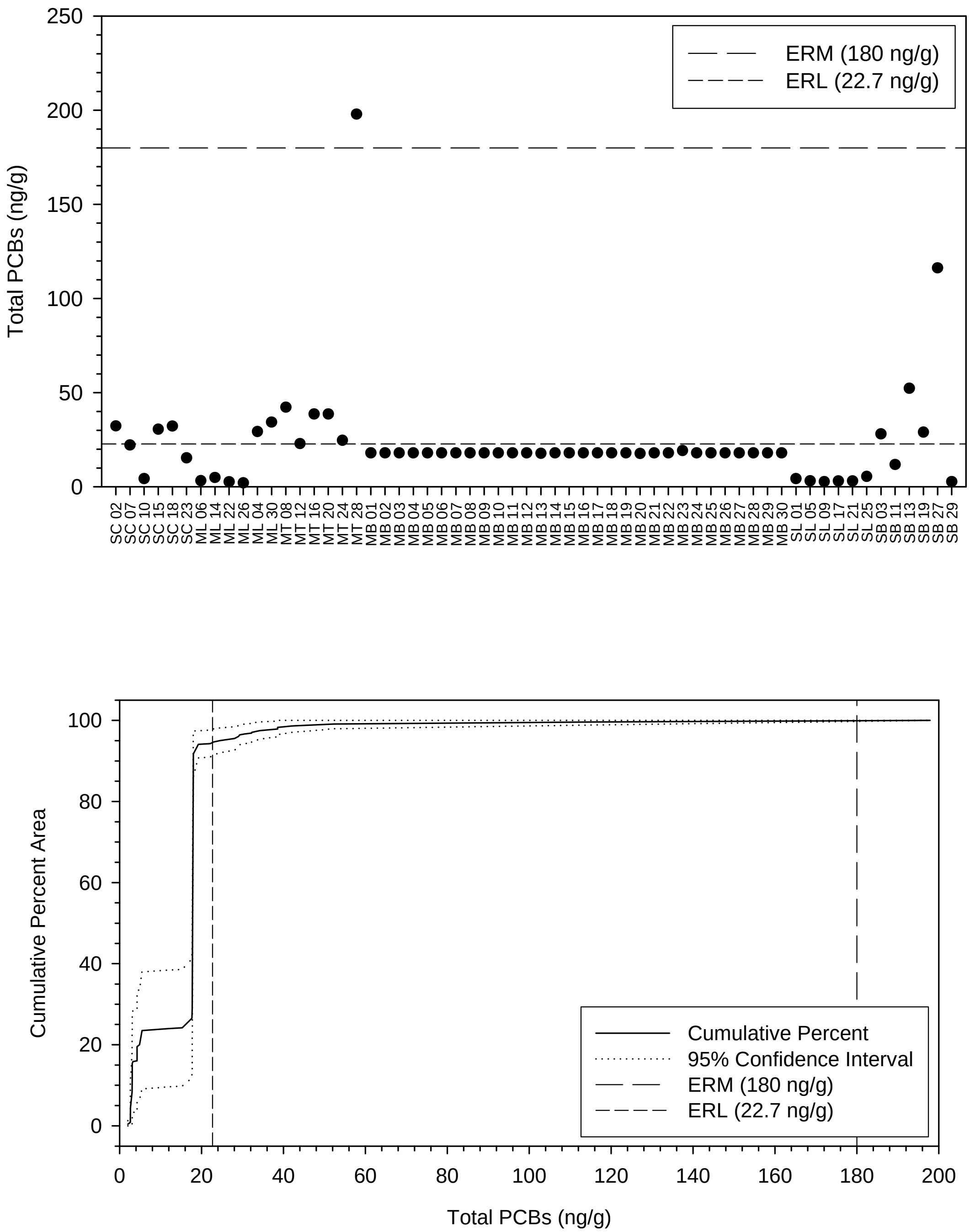
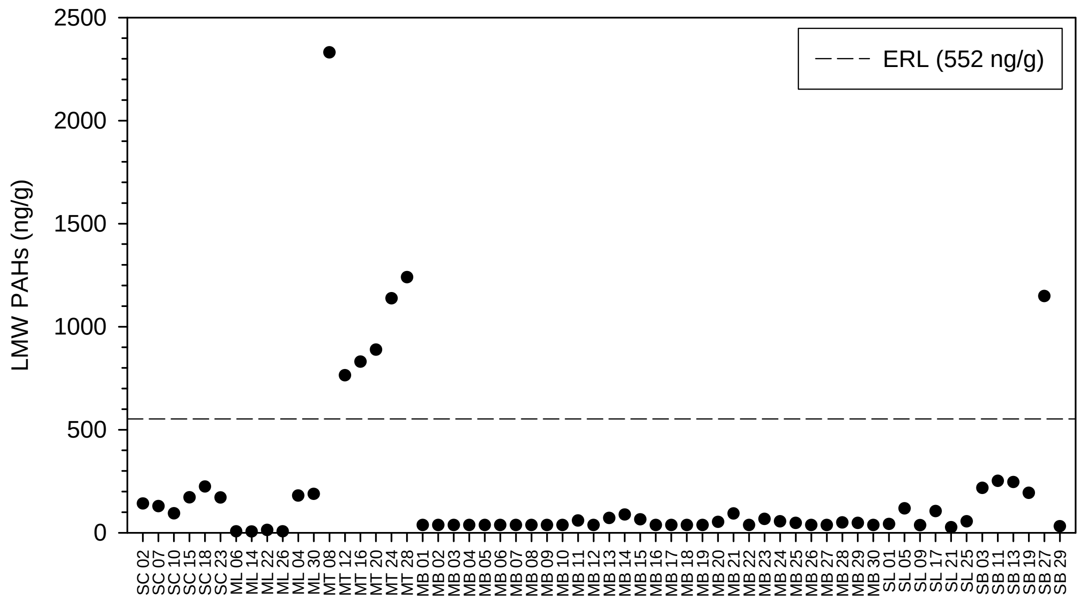


Figure 4-33. Sediment total PCB values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



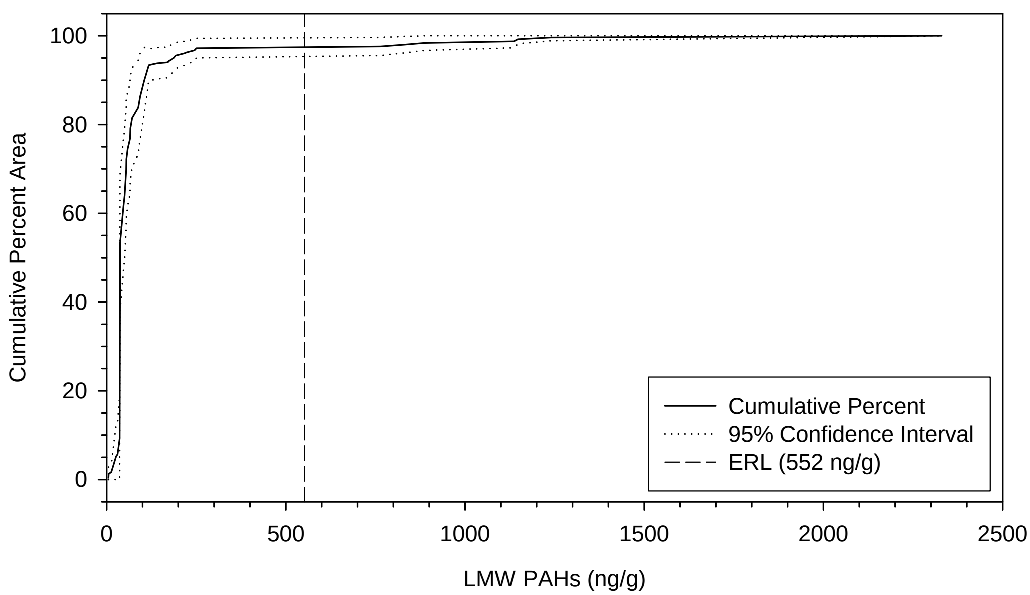


Figure 4-34. Sediment low molecular weight (LMW) PAH values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed line represents the Effects Range Low (ERL) guideline value associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

was recorded in Monterey (11,283 ng/g), which exceeded the ERM (9,600 ng/g) and PEL (6,676.14 ng/g; Figure 4-35). This value more than doubled the five other stations in Monterey and two stations in Santa Barbara that exceeded the ERL (1,700 ng/g) and PEL (655 ng/g; Figure 4-35). About 3% of the harbor sediments exceeded the ERL with <1% greater than the ERM. Benzo(e)pyrene and Perylene were not analyzed in the Morro Bay samples so the sum of HMW PAHs for these stations were artificially low and could explain the many non-detects and low values in Morro Bay.

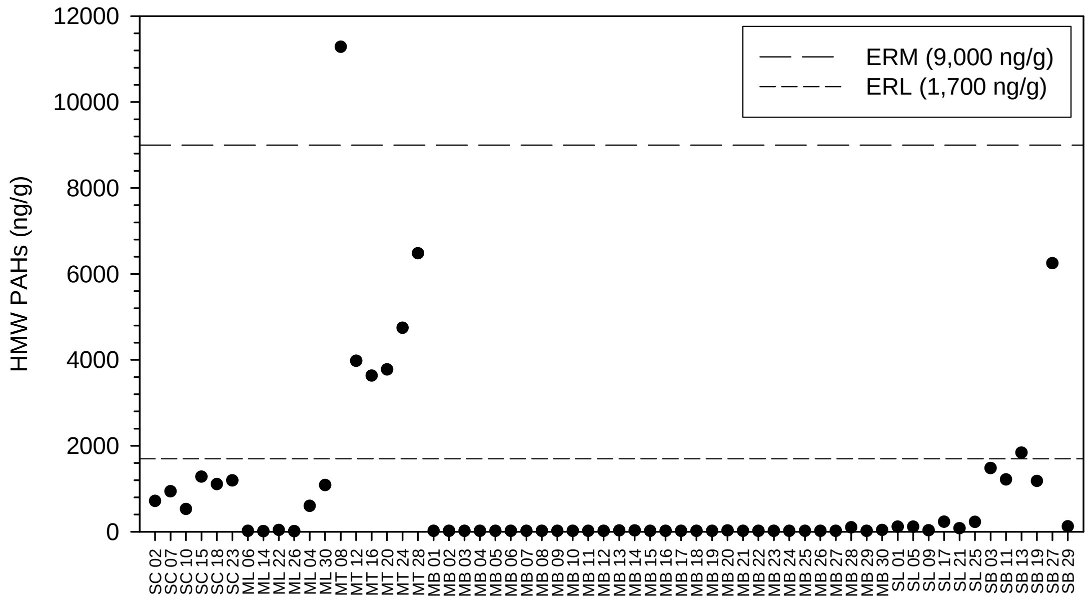
Total PAHs were calculated by summing the concentrations of LMW and HMW PAHs. The average concentration of total PAHs was 1,122 ng/g with the highest concentration recorded in Monterey (Table 4-3). The ERL (4,022 ng/g) was exceeded at 12% of the stations while the TEL (1684.06 ng/g) was exceeded at 15% of the stations (Figure 4-36). The ERM (44,792 ng/g) and PEL (16,770.54 ng/g) were not exceeded at any station. The percent of harbor areas exceeding the ERL and expecting to show some association with toxic biological effects was 3% (Figure 4-36). Benzo(e)pyrene and Perylene were not analyzed in the Morro Bay samples so the sum of total PAHs for these stations were artificially low.

Swartz (1999) developed a consensus guideline for total PAHs normalized to organic carbon because of the important role of organic carbon in determining PAH partitioning and bioavailability. The summation involves only 13 of the 24 PAHs used in the summation for total PAHs with each analyte normalized to percent TOC content (see section 2.3.1). No stations had normalized total PAH concentrations that exceeded the consensus guideline of 1,800 µg/g OC with approximately 88% of the harbors with concentrations <100 µg/g OC (Figure 4-37). The higher values occurred in Monterey (n=6), Santa Barbara (n=1), and Santa Cruz (n=1). It is interesting that Morro Bay had four relatively high normalized concentrations when this harbor had consistently low PAH values (Figures 4-36 and 4-37). This result is probably an artifact of low TOC concentrations at those stations (Figure 4-17).

Additional Analytes

Chlorpyrifos was detected at stations 309MSLG04 (14.3 ng/g) and 309MSLG30 (5.68 ng/g) in Moss Landing Harbor. The remaining 28 stations did not have detectable levels of chlorpyrifos. Diazinon was not detected at any of the 30 stations. Chlorpyrifos and diazinon were not measured in Morro Bay.

Dibutyltin (DBT) and Tributyltin (TBT) were only detected at one station. Station 310SNLS25 in Port San Luis Harbor had a TBT value of 199 ng/g. A sediment field duplicate was collected at this station, which had a TBT concentration of 95.3 ng/g. One possible reason why there were so few detections was the reporting limits (RL) were high for DBT (100 ng/g) and TBT (50 ng/g; Appendix B). TBT and DBT were not analyzed in Morro Bay.



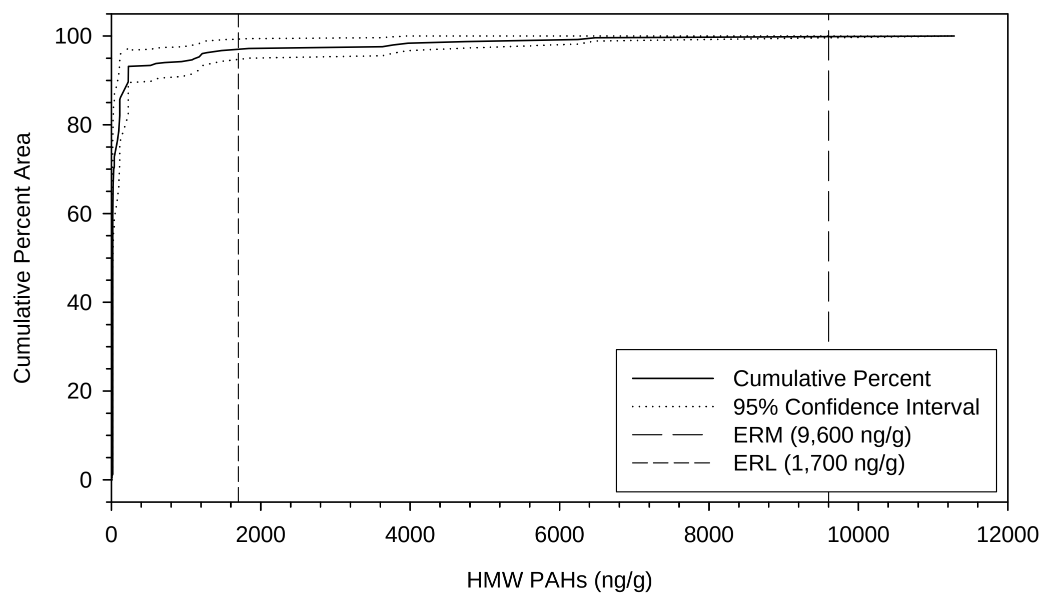
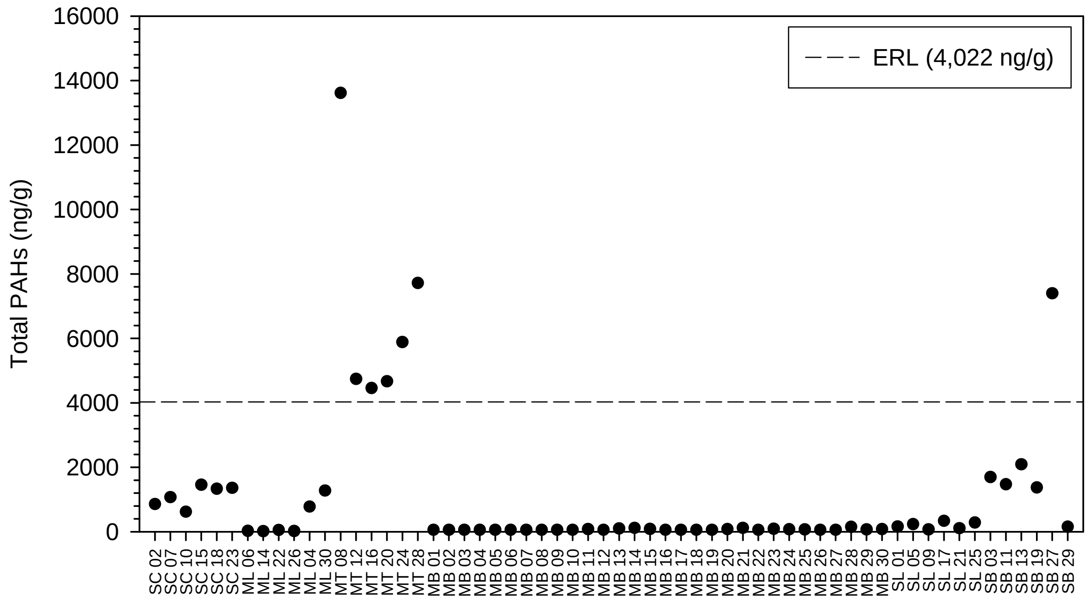


Figure 4-35. Sediment high molecular weight (HMW) PAH values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.



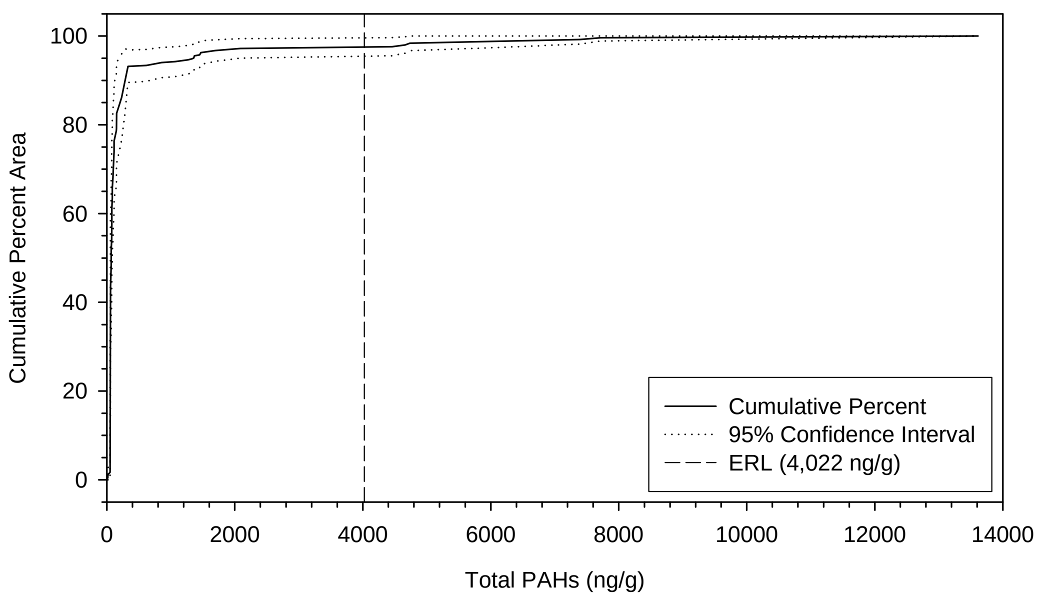


Figure 4-36. Sediment total PAH values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Dashed lines represent Effects Range Low (ERL) and Effects Range Median (ERM) guideline values associated with potential toxic biological events (Long et al. 1995). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

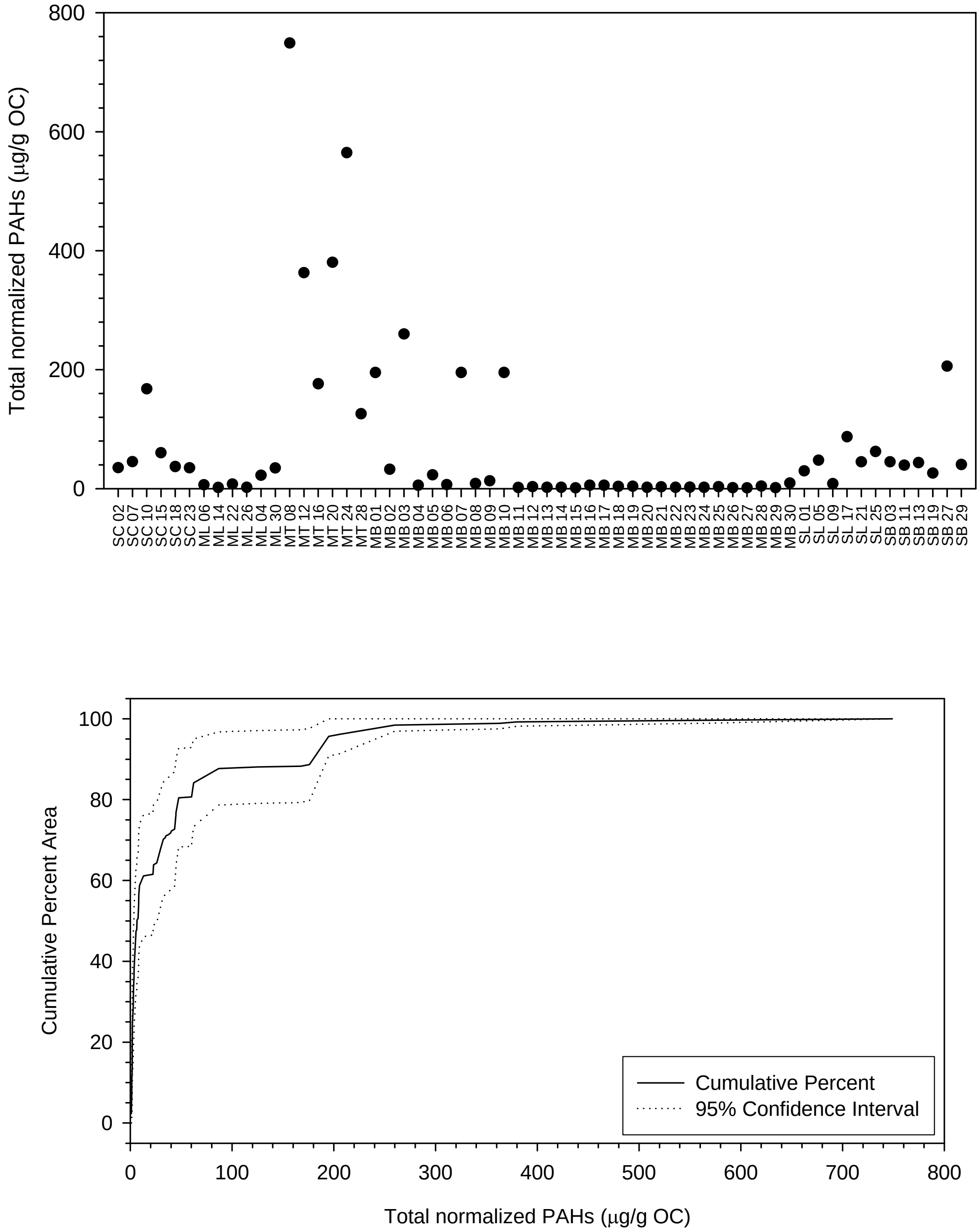


Figure 4-37. Sediment total normalized PAH values by station and by percent area. Values were normalized to total organic carbon (TOC) content. Percent areas were calculated by the cumulative distribution function (CDF). No value exceeded the Swartz (1999) consensus guideline of 1,800 µg/g OC. SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

4.3.5 Toxicity

Sediment toxicity tests for Morro Bay samples used protocols for the amphipod *Ampelisca abdita* whereas the other five harbors used protocols for the amphipod *Eohaustorius estuarius*. The results were not combined and, thus, each species is presented separately. In both cases, the results were deemed acceptable for analysis because mean amphipod survival in the control tests were >90% and survival in any single control replicate was >80%. A station was classified as one of three codes indicating a significant toxicity effect if either the mean percent survival was <80% and/or the percent survival for the station was significantly different from the control percent survival based on a one-tailed paired T-test with a p-value <0.05. That is, a station was coded SL (Significant Lower) if percent survival was <80% and there was a significant difference from the control (p<0.05). SG (Significant Greater; >80% survival, p<0.05) and NSL (Not Significant Lower; <80% survival, p>0.05) were the other two codes indicating a significant toxicity effect. NSG (Not Significant Greater; >80% survival, p>0.05) indicated no toxicity. The mean percent survival at each station was adjusted according to the mean percent survival in the control replicates so a station could have a percent survival >100%.

Significant toxicity effects to *Eohaustorius estuarius* was demonstrated in Moss Landing at stations 309MSLG04 (SL; survival=7%, p=0.000) and 309MSLG30 (SL; survival=11%, p=0.000; Figure 4-38). These two stations are located in Moss Landing Harbor near the confluence with the Old Salinas River (Figure 1-3). Station 309MSLG22 in Moss Landing had a mean-corrected survival of 78%, but it was not significantly different from the controls (p=0.167) most likely due to the high variability (standard deviation=43%) in the sample. On the other hand, station 304SCRZ18 in Santa Cruz and 315SBRB11 in Santa Barbara had percent survival values significantly different than their controls (p<0.05), but the mean adjusted percent survivals were above 80% (97% and 94%, respectively). This result is most likely an artifact of low variability in the control samples rather than an actual toxicity effect. Approximately 5% of the five harbor areas were expected to show significant toxicity effects to *E. estuarius* (i.e., mean adjusted percent survival <80%; Figure 4-38).

Significant toxicity to *Ampelisca abdita* occurred in Morro Bay at stations CA03-0304 (SL; survival=11.7%, p=0.000), CA03-0311 (SL; survival=78.7%, p=0.004), and CA03-0315 (SL; survival=62.6%, p=0.007; Figure 4-39). Fourteen other stations in Morro Bay showed a significantly different percent survival (p<0.05), but the mean adjusted percent survival was >80%. This discrepancy was probably due to the low variability in sample replicates and, thus, the results should be viewed in the context of percent survival and probably does not reflect a true toxicity effect. Approximately 12% of Morro Bay sediments were expected to demonstrate significant toxicity to *A. abdita* (i.e., mean adjusted percent survival <80%; Figure 4-39).

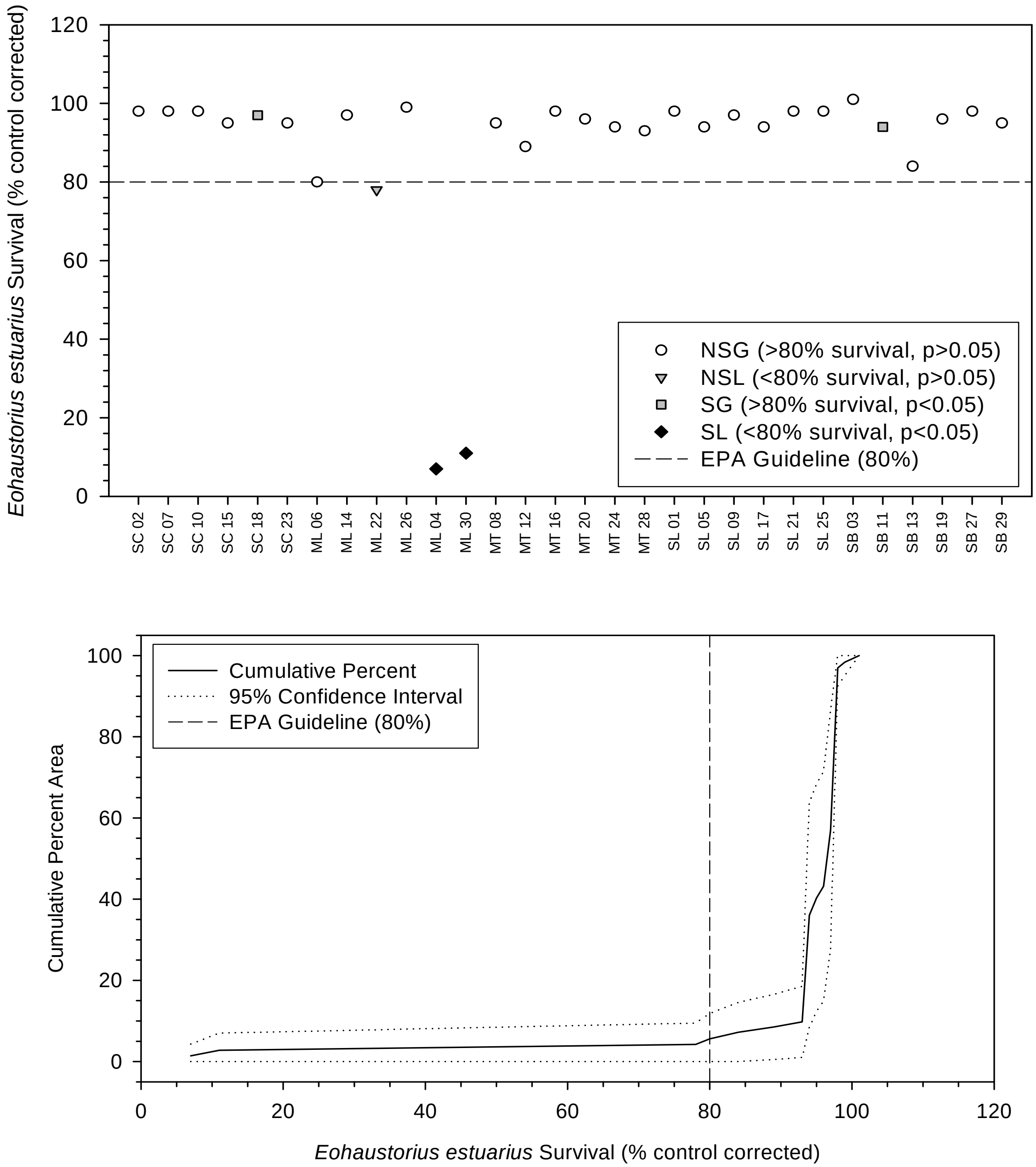


Figure 4-38. Amphipod (*Eohaustorius estuarius*) survival in sediment toxicity tests by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Codes are used in the Surface Ambient Monitoring Program (SWAMP) to represent various levels of toxicity with 80% survival indicating the guideline used in the US EPA National Coastal Condition Assessment (USEPA 2004). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

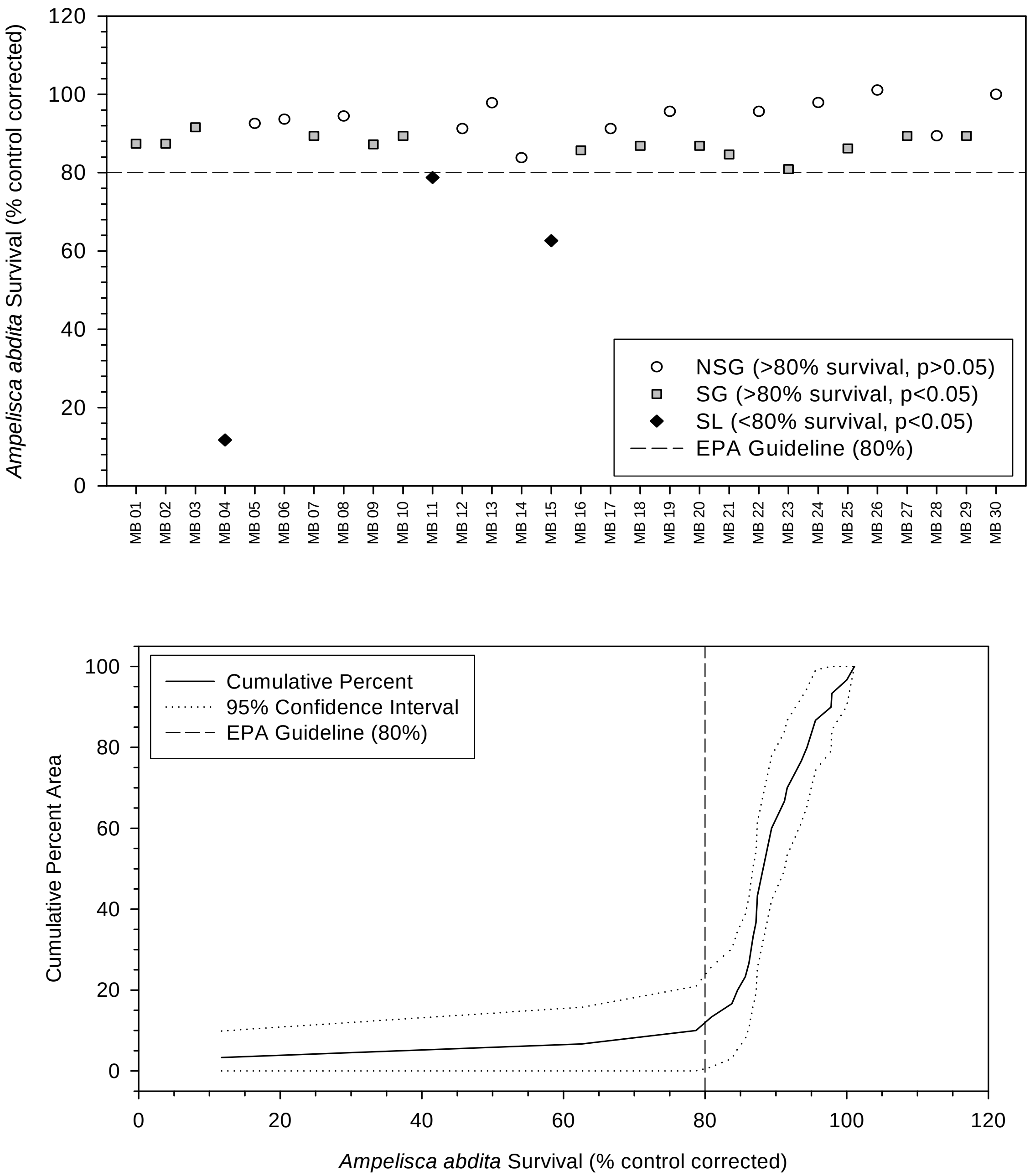


Figure 4-39. Amphipod (*Ampelisca abdita*) survival in sediment toxicity tests by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). Codes are used in the Surface Ambient Monitoring Program (SWAMP) to represent various levels of toxicity with 80% survival indicating the guideline used in the US EPA National Coastal Condition Assessment (USEPA 2004). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

4.3.6 Summary

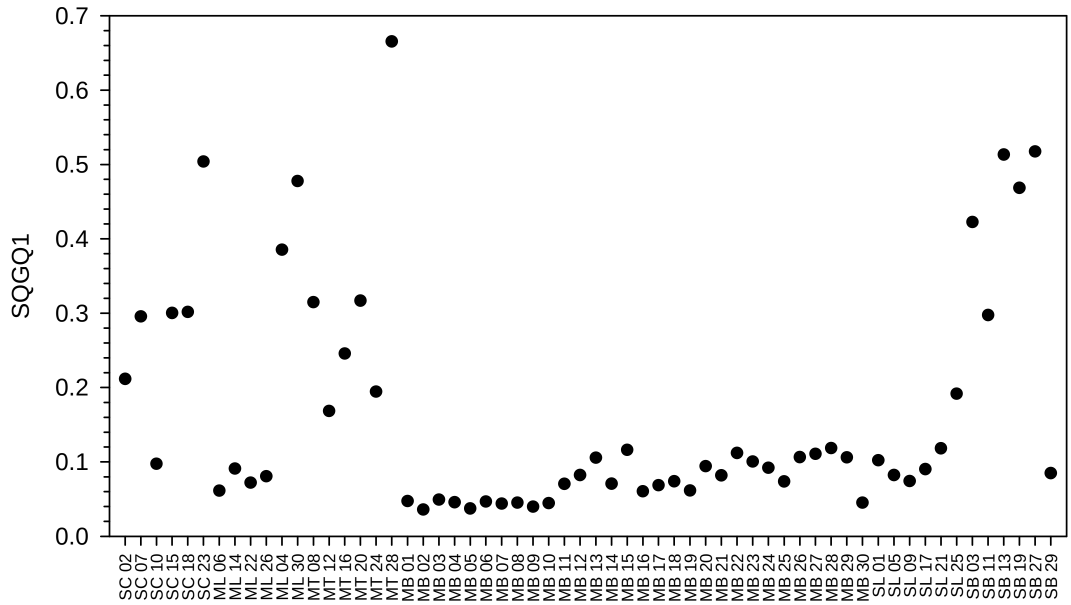
Sediment Quality Guidelines

The mean sediment quality guideline quotient (SQGQ1) described in Fairey et al. (2001) provides a means for evaluating complex chemical mixtures of trace metals and organics that incorporates both the magnitude and number of SQGs exceeded. The SQGQs were then compared to acute sediment toxicity to assess the probability of toxicity across the range of SQGQ values. The study determined that elevated SQG levels were strongly associated with sediment toxicity. The highest SQGQ1 value in this study was 0.67 in Monterey (Figure 4-40). Only six other stations (4 Santa Barbara, 1 Santa Cruz, 1 Moss Landing) had SQGQ1 values >0.40 with 42 stations having values <0.15. The majority (about 90%) of sediment area in all harbors had SQGQ1 values <0.12 (Figure 4-40).

Summary by Station

The number of ERL and ERM exceedances for 9 metal and 6 organic analytes were plotted in each harbor to examine distribution patterns (Figure 4-41). Medium to high levels of ERL and/or ERM exceedances occurred in the back portion of the harbor in Santa Cruz, heavy boat and industrial traffic section of Moss Landing, and heavy traffic and boat slip portions of Monterey and Santa Barbara harbors. The greater number of ERL and ERM exceedances in Morro Bay occurred in the middle and back portions of the bay where runoff and sediment accumulation are most likely the main factors. The area near the Unocal pier in Port San Luis showed higher ERL and ERM exceedances compared to other areas in the Port, which could represent historic practices, but overall exceedances was lower than the other harbors.

To get an idea of stations with potential sediment contamination issues, the number of metal ERL and ERM exceedances, organic ERL and ERM exceedances, and SQGQ1 value for each station were tabulated. Stations falling in the top 10 values for each guideline were noted to see if the same stations kept recurring. Ten stations from Santa Cruz (n=2), Moss Landing (n=2), Monterey (n=2), and Santa Barbara (n=4) demonstrated the greatest frequency of exceeding guidelines or having a higher SQGQ1 value (Table 4-4). No stations from Morro Bay and Port San Luis made the top ten including the three stations in Morro Bay where associated toxic affects occurred (Figure 4-39). Station 309MTRY28 in Monterey had the highest SQGQ1 value and exceeded the ERL for all 15 metals and organics analytes and the ERM for 3 analytes (copper, mercury, total PCBs). It is interesting to note, though, that there was no significant toxicity effect with a 93% mean-corrected survival at this station. Two stations with significant toxicity effects were in Moss Landing with these stations also showing a relatively high number of ERL and ERM (nickel, total DDTs, total chlordane) exceedances for metals and organics (Table 4-4). Of the top ten stations, four of Santa Barbara’s six stations made the list exceeding the ERM for total chlordane and nickel (station 315SBRB13 only) and having SQGQ1 values >0.40. Station 309MTRY08 in Monterey had the highest concentrations of PAHs (LMW, HMW, total, and normalized



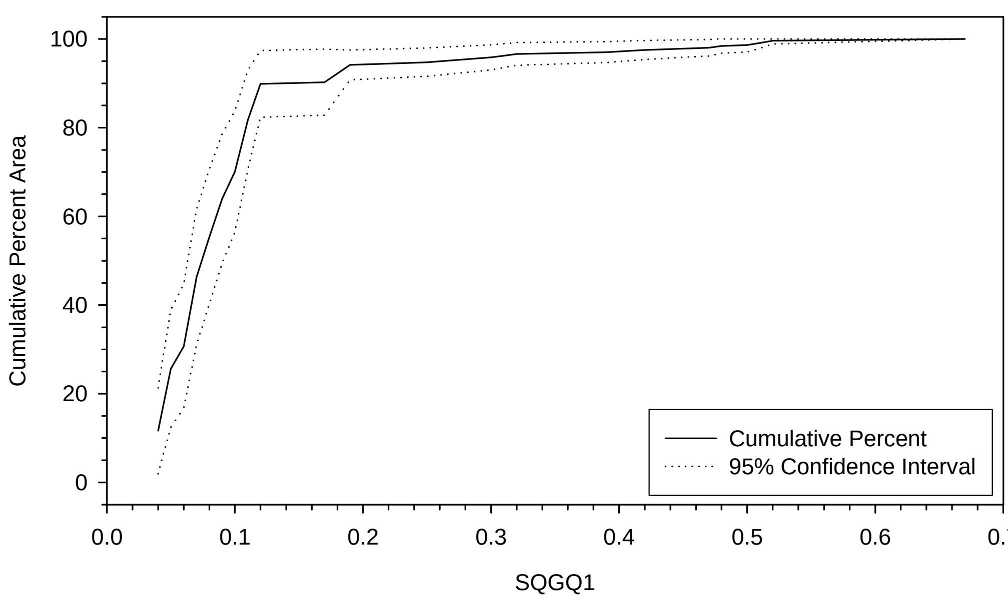


Figure 4-40. Mean sediment quality guideline quotient (SQGQ1) values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

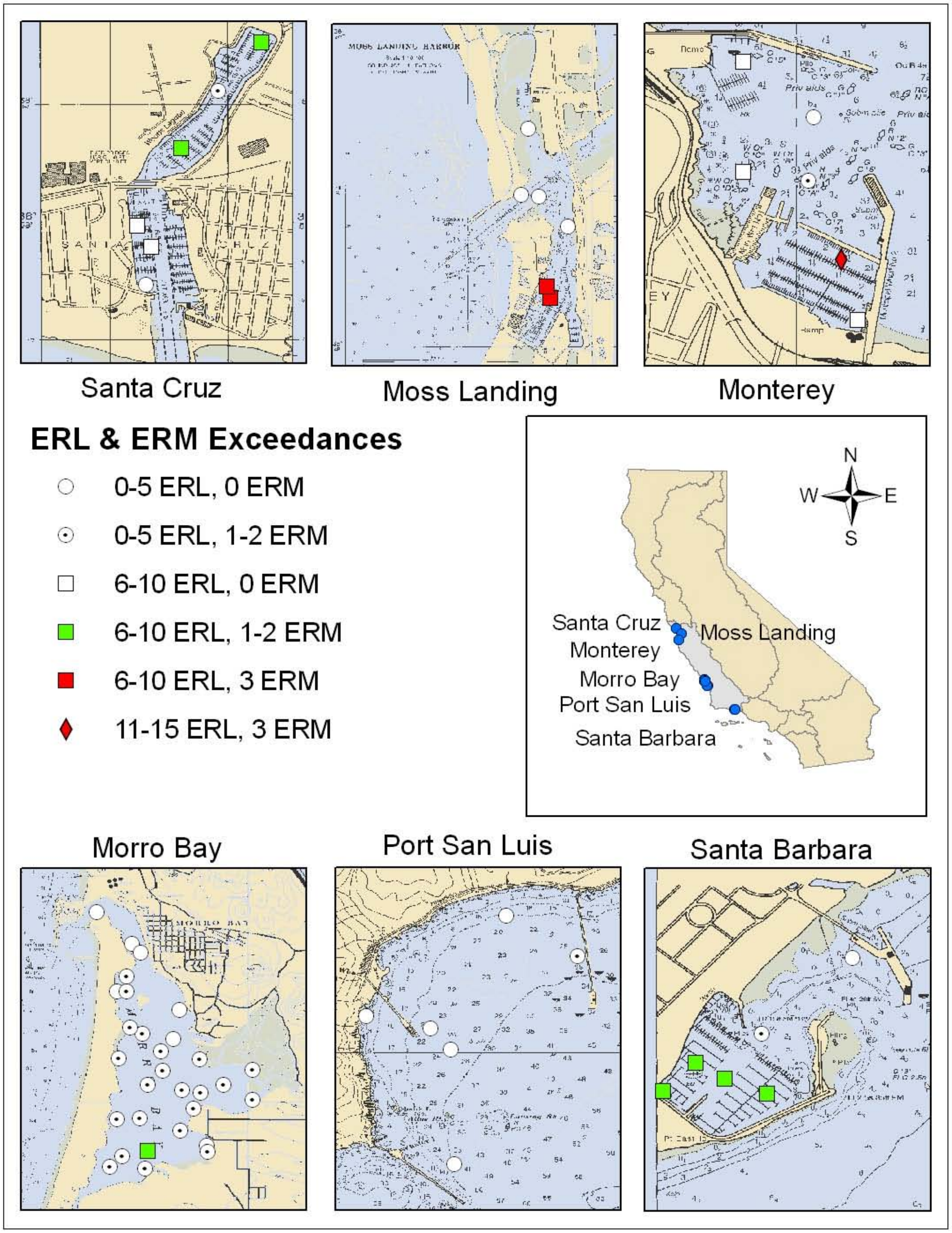


Figure 4-41. Number of Effects Range Low (ERL) and Effects Range Median (ERM) exceedances for 9 metal and 6 organic analytes plotted by station in each harbor.

total) exceeding the ERM for HMW PAHs. This could be a result of incomplete combustion of petroleum products since this station is close to the boat launch and could be a warm-up area for boaters (Figure 1-4). One other station to note is 310SNLS25 in Port San Luis where the high value of Tributyltin (TBT) occurred.

Table 4-4. Sediment summary statistics for select harbor stations. Number of ERL and ERM exceedances are presented for trace metal and organic analytes along with the SQGQ1 value. Frequency (Freq.) represents the number of times a particular station was in the top ten values for each criterion. Toxicity indicates whether a station showed a toxic effect (SL=toxic for survival and statistical significance, NSG=no toxicity) with the mean-corrected percent survival shown in parentheses.

			Metals		Organics			Toxicity
Station	Station Name	Freq.	>ERL	>ERM	>ERL	>ERM	SQGQ1	(% survival)
304SCRZ15	Santa Cruz Harbor 15	3/5	4	0	3	1	0.30	NSG (95)
304SCRZ23	Santa Cruz Harbor 23	3/5	4	0	2	1	0.50	NSG (95)
309MSLG04	Moss Landing Harbor 4	5/5	4	1	3	2	0.39	SL (7)
309MSLG30	Moss Landing Harbor 30	5/5	6	1	3	2	0.48	SL (11)
309MTRY08	Monterey Harbor 8	3/5	3	0	6	1	0.31	NSG (95)
309MTRY28	Monterey Harbor 28	5/5	9	2	6	1	0.67	NSG (93)
315SBRB03	Santa Barbara Harbor 3	3/5	3	0	3	1	0.42	NSG (101)
315SBRB13	Santa Barbara Harbor 13	5/5	6	1	4	1	0.51	NSG (84)
315SBRB19	Santa Barbara Harbor 19	4/5	7	0	3	1	0.47	NSG (96)
315SBRB27	Santa Barbara Harbor 27	4/5	6	0	6	1	0.52	NSG (98)

Summary by Harbor

To single out specific analytes of concern, ERL and ERM sediment quality guideline values were examined among harbors and for all harbors combined as a percent of the total area calculated by the CDFs and as a percent of the total stations sampled in a harbor (Table 4-5). Sediment contamination across all harbors leading to expected toxic biological effects (i.e., >ERM) was low (<5%) except for nickel (58%). As discussed earlier, though, nickel is a naturally occurring metal along the West coast with a questionable ERM. In 76% and 80% of the sediment area across all harbors, chromium and total DDT concentrations, respectively, exceeded the ERL and toxic biological effects are expected to occur. However, total DDT summations for non-detects (1.50 ng/g) was close to the ERL (1.58 ng/g) and better detection limits should be used in future studies. Elevated arsenic and copper concentrations could also result in toxic biological effects in >30% of the harbor sediment areas. For all harbors combined, the percent of stations with ERL and ERM guideline exceedances for a given

Table 4-5. Sediment summary statistics of percent ERL and ERM exceedances for select trace metal and organic analytes for all harbors combined and by individual harbor. For all harbors combined, values represent the area-weighted percentage as calculated by the cumulative distribution frequency (CDF) of a given analyte exceeding ERL and ERM guideline values. Values in parentheses represent the percentage of stations exceeding ERL and ERM guidelines values for a given analyte with the percentage calculated based on the stations sampled. Analytes not included in this table did not have ERL and ERM exceedances or a sediment quality guideline was not established.

	All Harbors (n=60)		Santa Cruz (n=6)		Moss Landing (n=6)		Monterey (n=6)		Morro Bay (n=30)		Port San Luis (n=6)		Santa Barbara (n=6)	
Analyte	>ERL %	>ERM %	>ERL %	>ERM %	>ERL %	>ERM %	>ERL %	>ERM %	>ERL %	>ERM %	>ERL %	>ERM %	>ERL %	>ERM %
Arsenic	32 (38.3)	0 (0)	66.7	0.0	33.3	0.0	16.7	0.0	33.3	0.0	16.7	0.0	83.3	0.0
Cadmium	2 (6.7)	0 (0)	0.0	0.0	16.7	0.0	33.3	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Chromium	76 (58.3)	3 (1.7)	0.0	0.0	33.3	0.0	16.7	0.0	90.0	0.0	50.0	16.7	33.3	0.0
Copper	38 (51.7)	<1 (1.7)	83.3	0.0	33.3	0.0	100.0	16.7	36.7	0.0	33.3	0.0	83.3	0.0
Lead	2 (6.7)	0 (0)	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
Mercury	4 (15)	1 (3.3)	0.0	0.0	0.0	0.0	100.0	33.3	0.0	0.0	0.0	0.0	50.0	0.0
Nickel	97 (86.7)	58 (46.7)	66.7	0.0	83.3	33.3	33.3	0.0	100.0	80.0	100.0	16.7	83.3	16.7
Silver	<1 (1.7)	0 (0)	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Zinc	3 (13.3)	0 (0)	50.0	0.0	16.7	0.0	16.7	0.0	0.0	0.0	0.0	0.0	50.0	0.0
Total Chlordane	6 (26.7)	4 (16.7)	83.3	50.0	33.3	33.3	66.7	0.0	0.0	0.0	0.0	0.0	83.3	83.3
Total DDT	80 (86.7)	1 (3.3)	100.0	0.0	100.0	33.3	100.0	0.0	73.3	0.0	100.0	0.0	100.0	0.0
Total PCBs	6 (25)	<1 (1.7)	50.0	0.0	33.3	0.0	100.0	16.7	0.0	0.0	0.0	0.0	66.7	0.0
LMW PAHs	3 (11.7)	0 (0)	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0
HMW PAHs	3 (13.3)	<1 (1.7)	0.0	0.0	0.0	0.0	100.0	16.7	0.0	0.0	0.0	0.0	33.3	0.0
Total PAHs	3 (11.7)	0 (0)	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0

analyte were similar to the percentage calculated by CDFs for some analytes (e.g., arsenic, silver, total DDTs) but not others (e.g., copper, nickel, total chlordanes).

In Santa Cruz, total chlordane should be the main analyte of concern with five ERL and three ERM exceedances at the six stations (Table 4-5). Total DDTs, arsenic, total PCBs, and copper should also be monitored. Moss Landing Harbor had two ERM exceedances (33.3%) occurring for nickel, total chlordane, and total DDT with an additional six analytes exceeding the ERL in at least one station. Monterey Harbor exceeded the ERL for all 15 analytes in at least one station. The ERM for copper, mercury, total PCBs, and HMW PAHs was exceeded in at least one station with all six stations >ERL. Low molecular weight (LMW) PAHs should also be of concern in Monterey since the six stations comprised the highest seven values and more than doubled the values in other harbors. At the 30 stations in Morro Bay, chromium, nickel, and total DDT appear to be analytes of concern, but chromium and nickel occur in naturally high concentrations and the detection level of total DDT was near the ERL. It is interesting that concentrations of TOC, arsenic, cadmium, chromium, nickel, zinc, and silver tended to increase from stations near the mouth to the back portions of Morro Bay. However, this pattern was not seen with the other metal analytes or any organics analytes. Copper exceeded the ERL at 36.7% of the stations and is probably the analyte to watch in Morro Bay. It appears sediment contamination issues are minor in Port San Luis since the exceedances were for naturally high occurring elements (nickel and chromium). Copper should be monitored since a third of the stations had ERL exceedances. The ERM for total chlordane was exceeded at five Santa Barbara stations (83.3%) suggesting toxic biological effects across the harbor. Other analytes of interest in Santa Barbara are arsenic, copper, nickel, total chlordane, and total DDT since the ERL was exceeded at ≥5 stations (Table 4-5).

Sediment Quality Index

Sediment total organic carbon (TOC), contamination (based on ERL and ERM exceedances), and amphipod toxicity were compared to threshold values to determine a Sediment Quality Index rating for each station (Table 2-4). Each harbor had at least one station rated poor (28.3%) with these stations falling in the heavier used areas of the harbors (Figure 4-42). About half (n=29) of the stations rated good, but the majority of these stations were in Morro Bay. Looking at the overall condition of the harbors, 62.6% of the sediment areas rated good with 15.6% of the areas classified poor (Figure 4-42). Most of the stations rated poor either due to sediment contaminants or toxicity to amphipods. Only stations 309MSLG04 and 306MSLG26 in Moss Landing rated poor for both sediment contaminants and toxicity.

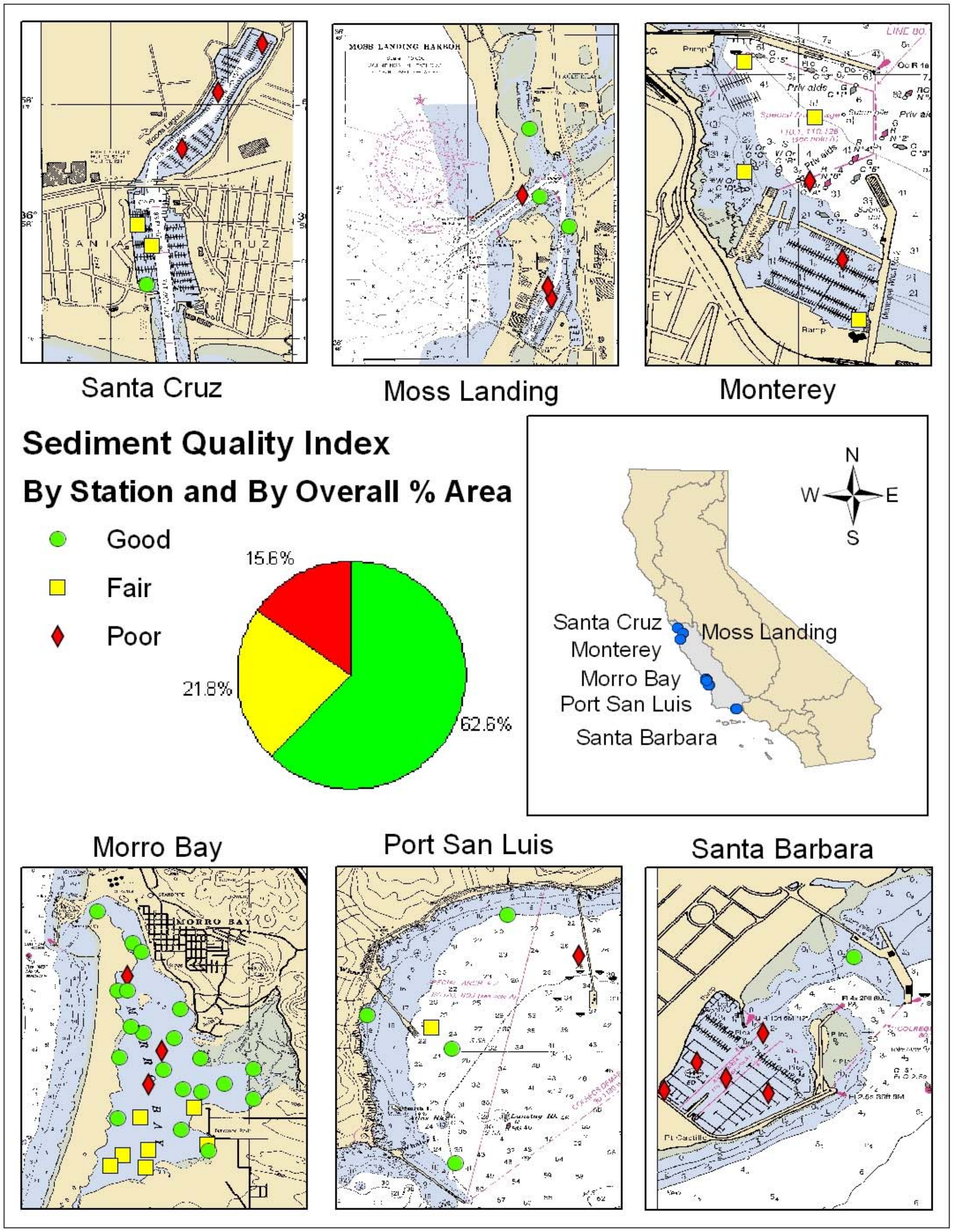


Figure 4-42. Sediment Quality Index values by station and by percent area. Overall rankings (good, fair, poor) were based on individual rankings for TOC, contamination (based on ERL and ERM exceedances), and toxicity (USEPA 2004). Index values by percent area, as calculated by the cumulative distribution function (CDF), are illustrated in the pie chart.

4.4 Biotic Condition Indicators

4.4.1 Benthic Community

Sixty (30 in Morro Bay) benthic infaunal samples (0.1 m^2 area, 1.0 mm sieve fraction) were collected in Central Coast harbors. Taxonomic identifications were made to the lowest possible level, but some taxa were grouped into higher levels to match the SWRCB Sediment Quality Objective (SQO) study. A total of 459 unique taxonomic identifications were found. However, taxa that were classified as colonial, not infaunal, or as falling within a questionable group in the SQO study were not included in the data analysis (n=93).

Infaunal Species Richness and Diversity

Species richness per 0.1 m^2 ranged from a low of 6 taxa in Morro Bay to 113 taxa in Monterey (Table 4-6; Figure 4-43). Five of the harbors had stations with relatively high species richness values, but all 30 Morro Bay stations had <40 species per 0.1 m^2. The mean and median values were 31.9 and 23.5 species per 0.1 m^2, respectively (Table 4-6). Seventy-five percent of the harbor sediments had species counts <31 species per 0.1 m^2 with 90% having species counts ≤54 species per 0.1 m^2 (Figure 4-43).

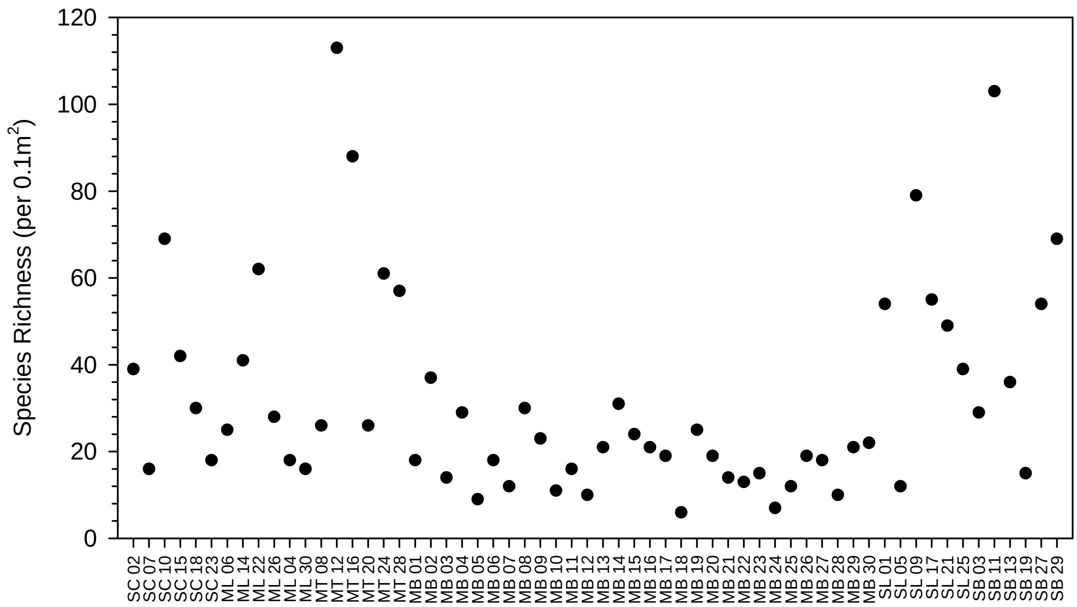
Another measure of species diversity is the Shannon-Wiener index (H'). This index follows information theory and measures the uncertainty in predicting the next species collected in a sample (Krebs 1994). A larger value of H' indicates greater uncertainty and, thus, greater species diversity. Mean and median H' in the harbors were about the same (Table 4-6). The greatest diversity (3.36) occurred in Monterey, which also had the highest species richness (Figure 4-44). The lowest diversity (0.87) occurred in Port San Luis. Station 304SCRZ10 in Santa Cruz was the only other station with an H' value greater than 3.00. Unlike species richness, Morro Bay samples had a wider range of diversity index values, similar to that of the other harbors (Figure 4-44). Approximately 27% of the harbors had H' values <1.50 with 83% having H' values <2.50 (Figure 4-44).

Table 4-6. Summary of benthic infaunal indices for Central Coast harbor stations (n=60). All values are per 0.1 m^2.

	Mean	SD	Median	Range
Benthic Species Richness	31.9	23.7	23.5	6 – 113
Benthic H'	2.00	0.59	2.04	0.87 – 3.36
Benthic Abundance	1,190.9	1,644.5	644	41 – 9,594

Infaunal Abundance and Taxonomic Composition

Benthic infaunal abundance averaged 1,190.9 individuals per 0.1 m^2 (Table 4-6). The median value, though, was much lower at 644 individuals per 0.1 m^2. The three highest abundances were found in Santa Barbara with other high values in Monterey (n=2),



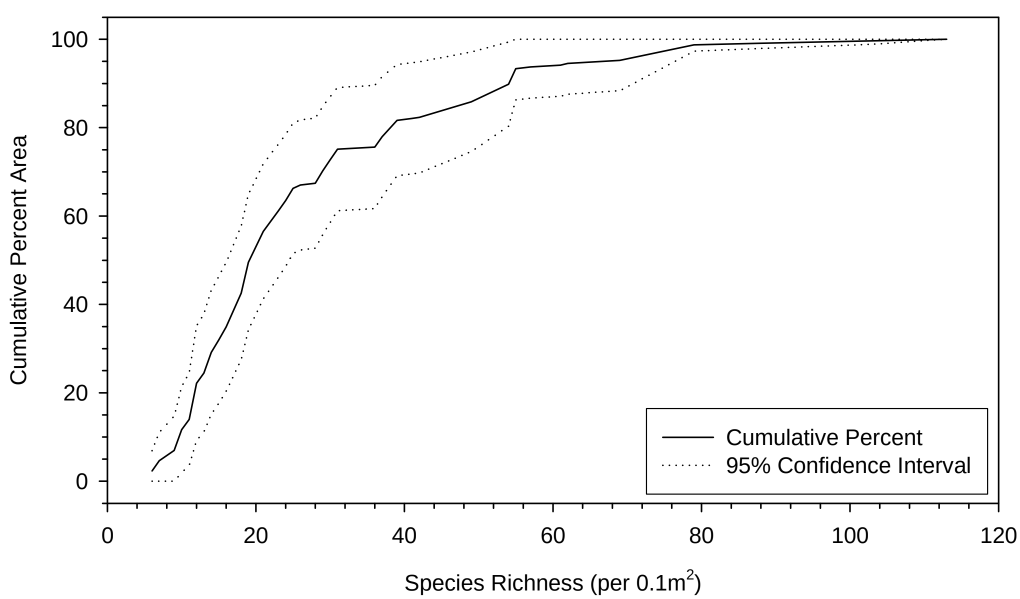


Figure 4-43. Benthic infaunal species richness per 0.1 m^2 values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

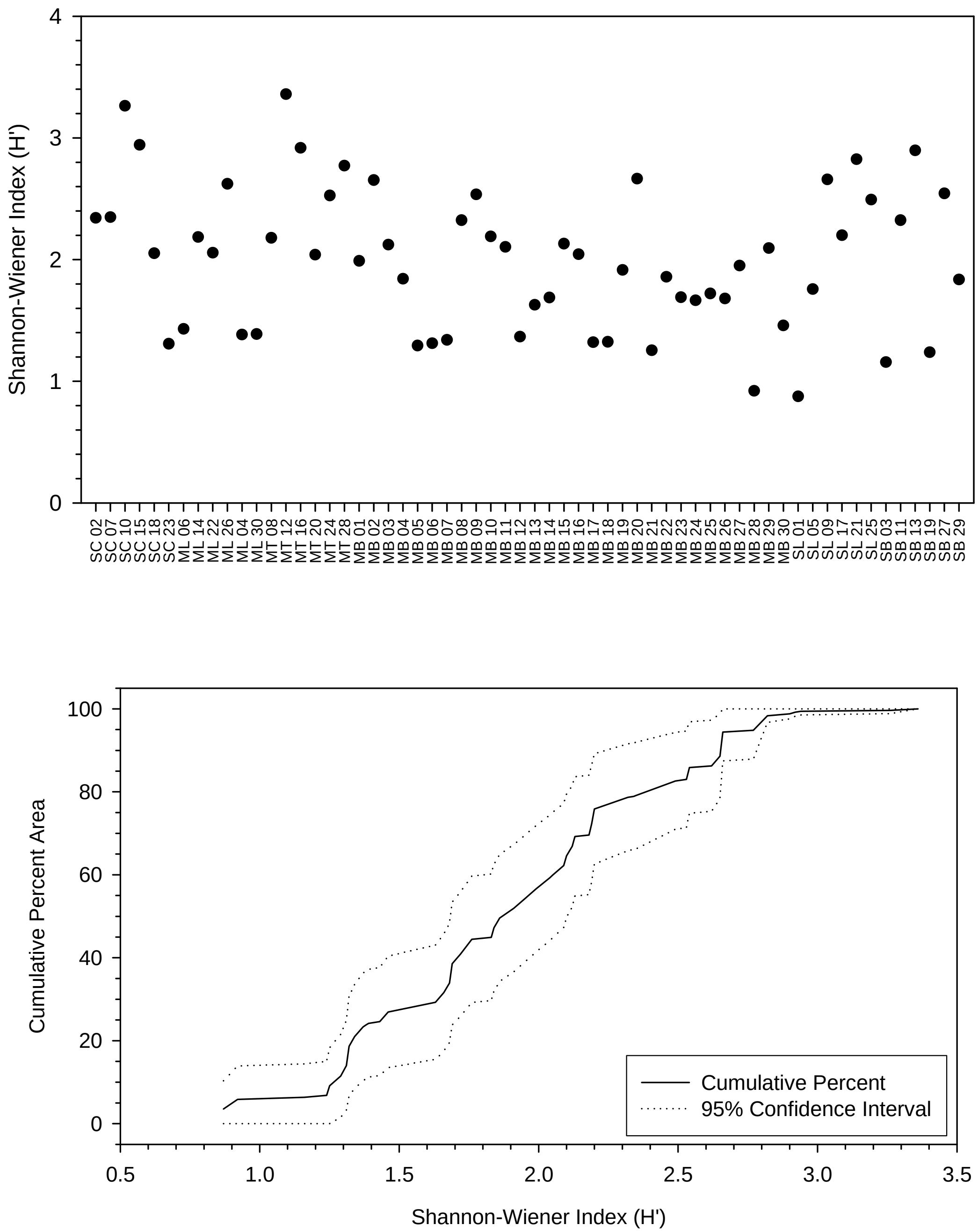
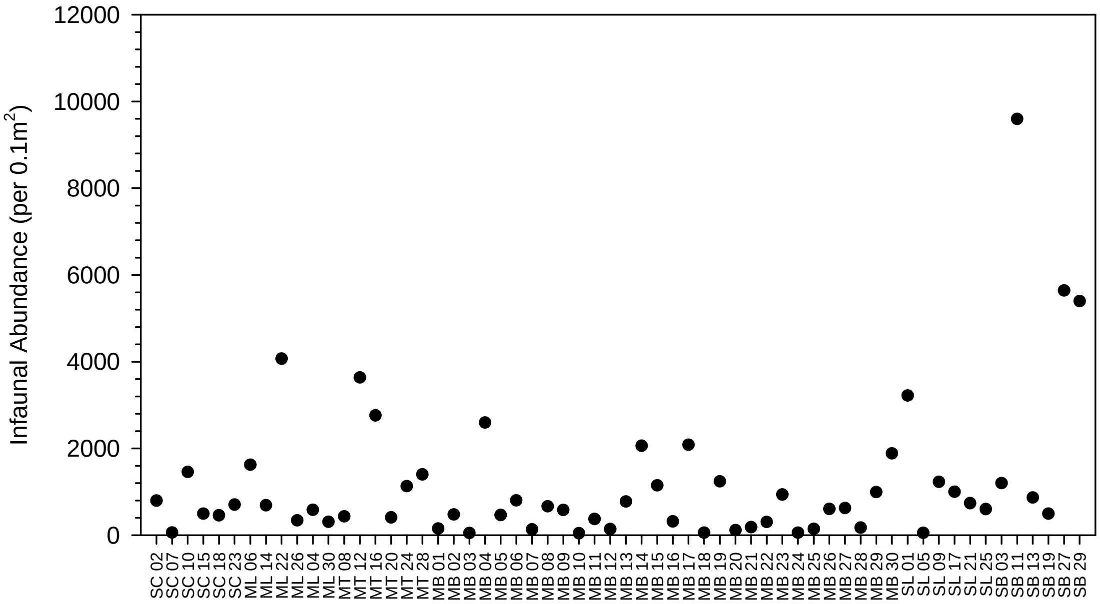


Figure 4-44. Shannon-Wiener Index (H') values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

Port San Luis (n=1), and Moss Landing (n=1; Figure 4-45). The lowest abundances including the minimum (n=41) were generally found in Morro Bay (Figure 4-45). Half of the harbor sediments had infaunal abundances less than 600 individuals per 0.1 m^2 with about 90% of the sediments having less than 2,060 individuals per 0.1 m^2 (Figure 4-45).

Fifty-nine taxa had mean abundances greater than 20 individuals per 0.1 m^2 (Table 4-7). The majority of these taxa were polychaetes (n=20), amphipods (n=20), and bivalves (n=6). The polychaete *Phyllochaetopterus prolifica* had the highest mean abundance, but it only occurred in 3% of the samples (Table 4-7). The pycnogonid *Anoropallene palpida* had the second highest mean abundance, but it was only found at one station (315SBRB29 in Santa Barbara). The bivalve *Nutricola confusa* was found at a third of the stations and was the fourth most abundant taxa (2,799 individuals at 315SBRB29 in Santa Barbara and 2,792 individuals at 310SNLS01 in Port San Luis). The polychaete *Mediomastus* sp. occurred most frequently (72%) and had the greatest abundance of all the taxa, which occurred at station 315SBRB11 in Santa Barbara (Table 4-7). Four other polychaetes, an oligochaete, a bivalve, and a tanaid also occurred in ≥45% of the samples.

Of the 59 taxa in Table 4-7, six species (*Pseudopolydora paucibranchiata, Nippoleucon hinumensis, Streblospio benedicti*, *Pontogeneia rostrata*, *Monocorophium uenoi*, *Grandidierella japonica*) are introduced (non-native to California) while eight species are classified as cryptogenic or not demonstrably native or introduced (*Aphelochaeta monilaris, Protolaeospira eximia, Leptochelia dubia, Exogone lourei, Caprella californica*, *Platynereis bicanaliculata, Amphipholis squamata*, *Scoletoma tetraura* Cmplx; CANOD 2007). *G. japonica* and *S. benedicti* were found in 43% and 28%, respectively, of the samples while *P. paucibranchiata* was found in 20% of the samples (Table 4-7). *P. rostrata* was found at stations CA03-0314 and CA03-0315 in Morro Bay (Figure 1-5). Of the six introduced species, *P. paucibranchiata* had the highest mean abundance (280.3 individuals per 0.1 m^2) followed by *N. hinumensis* at 101.5 individuals per 0.1 m^2.



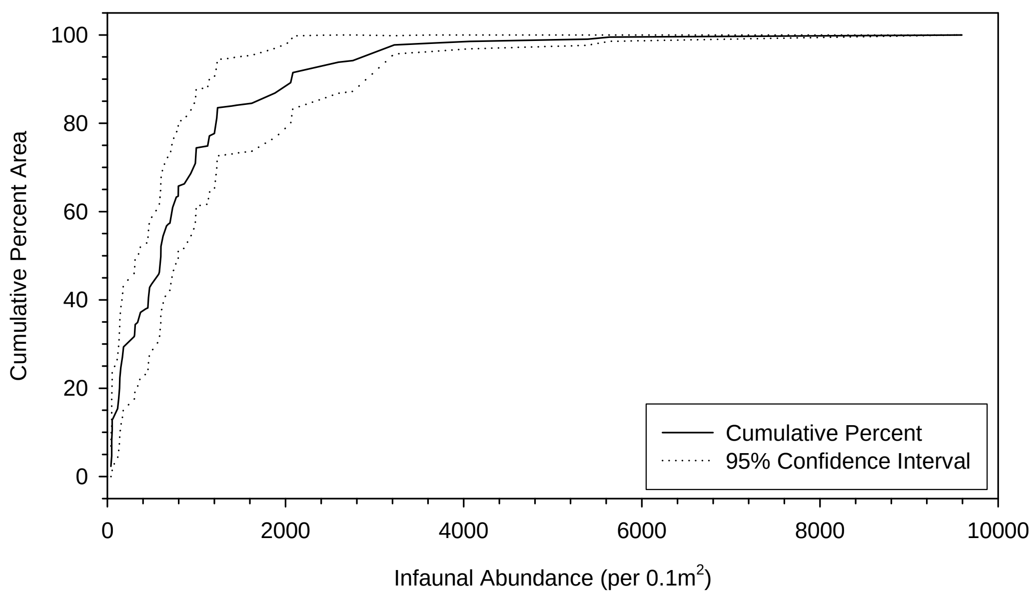


Figure 4-45. Benthic infaunal abundance per 0.1 m^2 values by station and by percent area. Percent areas were calculated by the cumulative distribution function (CDF). SC=Santa Cruz, ML=Moss Landing, MB=Morro Bay, SL=Port San Luis, SB=Santa Barbara.

Table 4-7. Taxonomic grouping, abundance, and frequency of occurrence of the numerically dominant benthic infaunal species. Numerically dominant taxa were defined as taxa with a mean abundance >20 individuals per 0.1 m^2.

Taxa	Group	Mean	SD	Min	Max	Frequency (%)
Phyllochaetopterus prolifica	Polychaeta	678.5	955.30	3	1354	3
Anoropallene palpida	Pycnogonida	595.0	-	595	595	2
Americorophium stimpsoni	Amphipoda	526.5	741.76	2	1051	3
Nutricola confusa	Bivalvia	479.5	843.79	1	2799	33
Aphelochaeta monilaris	Polychaeta	285.3	378.24	2	953	10
Pseudopolydora paucibranchiata	Polychaeta	280.3	539.98	1	1424	20
Cossura sp A	Polychaeta	209.5	271.24	1	571	7
Paracorophium sp	Amphipoda	207.3	293.82	1	1041	37
Mediomastus sp	Polychaeta	156.5	535.40	1	3456	72
Mayerella acanthopoda	Amphipoda	156.0	176.43	1	348	5
Protolaeospira eximia	Polychaeta	128.0	-	128	128	2
Oligochaeta	Oligochaeta	127.0	226.70	1	1187	70
Armandia brevis	Polychaeta	119.5	335.19	1	1827	48
Leptochelia dubia	Tanaidacea	114.1	237.79	1	1080	57
Nippoleucon hinumensis	Cumacea	101.5	199.67	1	401	7
Nutricola ovalis	Bivalvia	92.2	174.02	1	808	45
Synaptotanais notabilis	Tanaidacea	88.9	196.74	1	606	15
Mactrotoma californica	Bivalvia	82.3	106.65	5	204	5
Exogone lourei	Polychaeta	76.9	149.48	1	810	53
Petaloclymene pacifica	Polychaeta	76.3	137.34	1	282	7
Heterophoxus oculatus group	Amphipoda	70.4	74.77	1	243	30
Sphaerosyllis californiensis	Polychaeta	65.6	140.69	1	429	15
Streblospio benedicti	Polychaeta	62.0	80.68	1	205	28
Capitella capitata Cmplx	Polychaeta	61.0	208.84	1	1109	47
Chaetozone hedgpethi	Polychaeta	52.2	48.99	4	132	10
Chaetozone sp N 1	Polychaeta	50.6	37.81	2	127	18
Alvania compacta	Gastropoda	44.7	59.91	1	159	10
Pontogeneia rostrata	Amphipoda	43.5	30.41	22	65	3
Dipolydora sp	Polychaeta	39.3	60.19	1	151	22
Chone mollis	Polychaeta	38.3	70.70	1	194	12
Lepidepecreum sarlhi	Amphipoda	37.1	46.62	2	128	12
Monocorophium uenoi	Amphipoda	36.4	58.40	1	152	13
Caprella californica	Amphipoda	36.3	80.30	1	325	27
Tritella tenuissima	Amphipoda	36.0	33.94	12	60	3
Euphilomedes carcharodonta	Ostracoda	34.0	70.38	1	327	40
Oxyurostylis pacifica	Cumacea	32.7	36.12	1	72	5
Tritella pilimana	Amphipoda	32.0	-	32	32	2
Allorchestes angusta	Amphipoda	31.9	49.92	1	148	25
Rhepoxynius homocuspidatus	Amphipoda	31.3	53.58	1	138	10
Edotia sublittoralis	Isopoda	29.3	54.50	2	111	7
Rhepoxynius sp A	Amphipoda	29.0	39.60	1	57	3
Platynereis bicanaliculata	Polychaeta	28.8	56.83	1	205	32
Gammaropsis thompsoni	Amphipoda	28.3	35.88	1	77	10
Notomastus sp	Polychaeta	26.6	55.56	1	271	45

Taxa	Group	Mean	SD	Min	Max	Frequency (%)
Postasterope barnesi	Ostracoda	26.4	44.15	1	118	18
Dorvillea (Schistomeringos) sp	Polychaeta	26.0	39.00	1	131	18
Photis brevipes	Amphipoda	26.0	44.57	1	143	23
Amphipholis squamata	Ophiuroid	25.3	30.11	1	59	5
Pododesmus macrochisma	Bivalvia	25.0	-	25	25	2
Aoroides spinosa	Amphipoda	24.5	18.45	4	45	7
Grandidierella japonica	Amphipoda	24.0	34.84	1	158	43
Atylus tridens	Amphipoda	24.0	32.53	1	47	3
Tellina meropsis	Bivalvia	23.2	26.69	1	77	17
Aoroides intermedia	Amphipoda	22.5	23.33	6	39	3
Acteocina inculta	Gastropoda	22.3	40.05	1	117	25
Simomactra sp	Bivalvia	22.0	27.40	1	53	5
Scoletoma tetraura Cmplx	Polychaeta	20.5	22.92	1	65	22
Alia carinata	Gastropoda	20.4	51.30	1	157	15
Eohaustorius barnardi	Amphipoda	20.0	-	20	20	2

4.4.2 Fish Community

Trawling was conducted at sixteen stations within the six harbors with eight of the stations in Morro Bay (Figures 1-2 through 1-7). Only one station was trawled in Moss Landing and Santa Barbara harbors due to the size of the harbors. Two stations each were trawled in Santa Cruz, Monterey, and Port San Luis. No fish were caught in the standard trawl for community analysis at two stations (304SCRZ02 in Santa Cruz and 309MTRY24 in Monterey). Of the fourteen stations where a standard trawl was successful in catching fish, there were 22 distinct fish taxa caught with a total abundance of 508 individuals. The mean number of fish species per trawl was 4.1 taxa with an average abundance of 31.8 individuals (Table 4-8). The highest number of species in a trawl (n=11) was collected in Morro Bay at station CA03-0310. The highest fish abundance was caught in Moss Landing at station 306MSLG26 (n=130) with the second highest fish abundance captured at station CA03-0307 in Morro Bay (n=76). Speckled sanddab (*Citharichthys stigmaeus*) was the most numerically dominant fish species with the highest number of individuals per trawl, greatest relative abundance, and highest frequency of occurrence in the trawls (Table 4-8). At station 306MSLG26 in Moss Landing, approximately 100 juvenile rockfish (*Sebastes* spp.) were caught. This number inflated the summary statistics for this taxa and caution should be used when comparing to other species across harbors. Of the ten numerically dominant fish species, surfperch comprised three species [white (*Phanerodon furcatus)*, black (*Embiotoca jacksoni)*, and shiner (*Cymatogaster aggregata*)] while two flatfish species were captured [speckled sanddab and starry flounder (*Platichthys stellatus)*; Table 4-8]. Some of the species caught of interest that were not numerically dominant were lingcod (*Ophiodon elongatus*), California halibut (*Paralichthys californicus*), Dover sole (*Microstomus pacificus*), and three additional surfperch species (pile, walleye, and barred).

Table 4-8. Summary statistics for the ten numerically dominant fish species captured in Central Coast harbors (n=16 stations). Mean per trawl represents the mean total abundance of fish captured per trawl, mean number of fish species per trawl, or mean number of specific fish species per trawl. Max is the maximum number of a fish species captured in one trawl. Relative abundance is the percentage of total abundance for a given species. Frequency represents the number (percent in parentheses) of trawls in which each species was captured. SD = standard deviation. NA = not applicable.

Parameter/ Species	Common Name	Mean per trawl	SD	Max per trawl	Relative Abundance (%)	Frequency (% Frequency)
Total Abundance	NA	31.8	32.78	130	100	NA
Total Species	NA	4.1	2.77	11	NA	14 (87.5)
Citharichthys stigmaeus	Speckled sanddab	14.5	19.82	71	45.7	11 (68.8)
Sebastes sp.	Rockfish (juvenile)	6.3	NA	100	19.7	1 (6.3)
Leptocottus armatus	Staghorn sculpin	4.3	5.46	15	13.4	10 (62.5)
Platyrhinoidis triseriata	Thornback	1.4	2.87	11	4.5	5 (31.3)
Phanerodon furcatus	White surfperch	0.8	2.26	9	2.6	4 (25.0)
Syngnathus leptorhynchus	Bay pipefish	0.8	2.24	9	2.4	4 (25.0)
Sebastes auriculatus	Brown rockfish	0.8	2.74	11	2.4	2 (12.5)
Cymatogaster aggregata	Shiner surfperch	0.6	1.20	4	2.0	5 (31.3)
Embiotoca jacksoni	Black surfperch	0.4	1.21	4	1.4	2 (12.5)
Platichthys stellatus	Starry flounder	0.4	1.02	4	1.2	3 (18.8)

4.4.3 Fish Contaminant Indicators

Speckled sanddab, California halibut, and starry flounder were caught in all six harbors at a total of 14 stations and were analyzed for trace metals and organics (Table 4-9). Fish were analyzed whole body with two composites per station for each fish species in Morro Bay and one composite per fish species in the other harbors. When applicable, data from composites were combined for each station. Data was reported in wet weight and compared to California Office of Environmental Health Hazard Assessment (OEHHA; Brodberg and Pollock 1999) and United States Environmental Protection Agency (USEPA 2000) screening values for human health consumption. Since these screening values were developed for tissue fillet samples, comparisons to results in this study should be made cautiously keeping in mind that exceedances could be overstated due to expected higher concentrations in whole body samples.

Speckled sanddab was caught in all six harbors and ranged in size from 9-14 cm (Table 4-9). One to three California halibut per station were analyzed in Morro Bay only and represented a larger size class (24-56 cm). Two distinct size classes of starry flounder were caught in Santa Cruz (16-22 cm) and Morro Bay (36-47 cm).

Table 4-9. Summary of fish used by harbor and by station in tissue contaminant analyses. Sample size (N) and size range (cm) are presented for each fish species. Asterisk (*) indicates the station where a field duplicate was collected.

Harbor	Station	Fish	N	Size Range (cm)
Santa Cruz	304SCRZ02	Speckled Sanddab	36	9-14
	304SCRZ07	Starry Flounder	7	16-22
Moss Landing	306MSLG26	Speckled Sanddab	39	6-12
Monterey	309MTRY12	Speckled Sanddab	18	10-13
Morro Bay	CA03-0301	Speckled Sanddab	31	8-11
	CA03-0302	Speckled Sanddab	22	7-11
	CA03-0307	Speckled Sanddab	71	8-13
	CA03-0310	California Halibut	1	39
	CA03-0310	Speckled Sanddab	17	8-12
	CA03-0319	Speckled Sanddab	4	9-10
	CA03-0321	California Halibut	3	24-56
	CA03-0321	Starry Flounder	3	36-47
	CA03-0325	California Halibut	3	44-49
	CA03-0325	Speckled Sanddab	21	8-12
Port San Luis	310SNLS01	Speckled Sanddab	20	6-12
	310SNLS25*	Speckled Sanddab	44	8-19
Santa Barbara	315SBRB11	Speckled Sanddab	9	4-5

4.4.3.1 Trace Metals

Summary information (minimum, maximum, mean, standard deviation, detection frequency) and number of OEHHA and EPA exceedances for fish tissue samples are presented in Table 4-10 for each trace metal analyte. These values were based on calculations for each of the 14 stations including multiple composites if applicable. Data were reported in mg/kg wet weight. Summary information by harbor and by fish species is listed in Appendix D. Manganese was not analyzed in the Morro Bay samples.

Nine of the twelve metal analytes were detected in at least one of the composites per station except for silver which was not detected at any station (Table 4-10). OEHHA and EPA screening values (SV) exist for arsenic, cadmium, mercury, and selenium (see Appendix C). Fish tissue concentrations of arsenic exceeded the OEHHA SV (1.0 mg/kg) at 7 stations (Santa Cruz, Monterey, Santa Barbara, 4 Morro Bay), while the higher EPA SV (1.2 mg/kg) was exceeded at one Morro Bay station (1.27 mg/kg; CA03-0310) and in Santa Barbara (1.51 mg/kg). The three other analytes with screening values were all well below threshold values. Overall, fish tissue metals concentrations were relatively low with the exception of arsenic (Table 4-10). Aluminum concentrations may have been elevated in this study since it is standard EMAP protocol to store fish in aluminum foil prior to analysis.

Table 4-10. Fish tissue trace metals summary data per analyte. Sample size (N), minimum (Min), maximum (Max), mean (Mean) and standard deviation (SD) values in mg/kg wet weight, percent frequency of detection (result >MDL), and number of OEHHA and EPA exceedances are presented for each analyte. Non-detect results were given values equal to ½ MDL for summation purposes. Detection frequency was based on at least one detection in a sample per station. Asterisk (*) indicates results were all non-detects and were not reported. Dash (-) indicates screening values were not established.

Analyte	N	Min (mg/kg)	Max (mg/kg)	Mean (mg/kg)	SD	Detection Frequency (%)	OEHHA (#)	EPA (#)
Aluminum	14	15.6	74.0	36.3	15.4	100	-	-
Arsenic	14	0.54	1.51	0.99	0.23	100	7	2
Cadmium	14	0.01	0.19	0.05	0.047	100	0	0
Chromium	14	0.12	0.72	0.33	0.19	100	-	-
Copper	14	0.52	1.35	0.82	0.22	100	-	-
Lead	14	0.03	0.22	0.09	0.050	100	-	-
Manganese	7	0.50	3.71	1.67	1.03	100	-	-
Mercury	14	0.005	0.102	0.047	0.030	92.9	0	0
Nickel	14	0.01	0.42	0.12	0.139	57.1	-	-
Selenium	14	0.33	0.62	0.42	0.075	100	0	0
Silver	14	*	*	*	*	0	-	-
Zinc	14	10.1	15.7	13.3	1.7	100	-	-

Comparing tissue contamination within the harbors, Morro Bay had the highest metals concentrations for chromium, copper, mercury, nickel, silver, and zinc (Table 4-11; Appendix D). Santa Cruz (manganese and selenium), Moss Landing (aluminum), Monterey (lead), Port San Luis (cadmium), and Santa Barbara (arsenic) also had at least one metal analyte with the highest mean concentration among the harbors.

Of the three fish species, speckled sanddab had the highest concentrations of aluminum, cadmium, chromium, lead, manganese, and nickel (Appendix D). California halibut had the highest concentrations of mercury and zinc, while starry flounder had the greatest values of arsenic, copper, and selenium among the fish species.

Table 4-11. Summary by harbor of important tissue metal and organic analytes. Highest tissue mean concentration (H) and exceedances (E) of at least one human health consumption screening value for a given analyte by tissue type (F=fish, B=bivalve) are shown for each analyte. h = Morro Bay had the highest mean concentrations of PAHs but the analytes were all non-detects.

Group	Analyte[1]	Tissue Type	Santa Cruz	Moss Landing[2]	Monterey	Morro Bay	Port San Luis	Santa Barbara
Rank	Poor (%)	F	37.5	12.5	37.5	12.5	25	25
	Poor (%)	B	37.5	50	37.5	12.5	25	25
Trace Metals	Aluminum	F		H				
		B	H					
	ARSENIC	F	E		E	E		EH
		B	E	E	E	EH	E	E
	CADMIUM	F					H	
		B					H	
	Chromium	F				H		
		B				H		
	Copper	F				H		
		B	H					
	Lead	F			H			
		B			H			
	Manganese	F	H					
		B		H				
	MERCURY	F				H		
		B			H			
	Nickel	F				H		
		B				H		
	SELENIUM	F	H					
		B					H	
	Silver	F				H		
		B					H	
	Zinc	F				H		
		B	H					
Trace Organics	TOTAL CHLORDANE	F	H					
		B		H				
	TOTAL DDTs	F		H				
		B		EH				
	TOTAL PCB AROCLORS	F	E	E	E		EH	
		B	EH	E	E			
	LMW PAHs	F				h		H
		B	H					
	HMW PAHs	F				h	H	
		B	H					
	TOTAL PAHs	F	E		E	h	EH	E
		B	EH	E	E	E	E	E

[1] All capital letters indicate OEHHA and/or EPA human health consumption guidelines exist for that analyte except for LMW and HMW PAHs
[2] Also exceeded screening values for Dieldrin and was close to the threshold for Toxaphene

4.4.3.2 Trace Organics

Summary information (minimum, maximum, mean, standard deviation, detection frequency) and number of OEHHA and EPA screening value exceedances are presented in Table 4-12 for eleven trace organic analytes. These values were based on summations, where applicable, for each of the 14 stations including multiple composites if applicable. Data was reported in ng/g wet weight. Total chlordane values for Morro Bay only included Chlordane, cis- and Nonachlor, trans-. PCB congeners only and not Aroclors were analyzed in Morro Bay so the total PCB calculation is based on the sum of 18 congeners (minus congener 169) recommended by USEPA (2000). The summation for high molecular weight (HMW) PAHs and total PAHs for Morro Bay did not include Benzo(e)pyrene and Perylene. The summation for total PAHs where all 24 analytes were non-detects had a value of 66.76 ng/g in Morro Bay and 5.83 ng/g in the other harbors. These values were greater than the EPA screening value (5.47 ng/g) and were not included in calculating the number of exceedances. Summary information by harbor and by fish species are listed in Appendix D.

At least one of the PCB Aroclors and one of the DDT metabolites were detected in all samples. The remaining 9 analytes were detected in less than half of the samples with chlorpyrifos, diazinon, DBT, and TBT not detected at any station. Total PCB Aroclors in five harbors exceeded the OEHHA and EPA threshold values of 20 ng/g at 6 of the 7 stations (not Santa Barbara). However, the 7 Morro Bay stations where PCB congeners were summed did not have any exceedances. Total PAHs where at least one of the PAH analytes was detected exceeded the EPA screening value of 5.47 ng/g at four stations (Santa Cruz, Monterey, Port San Luis, Santa Barbara). Other tissue contaminants with OEHHA and EPA screening values (e.g., dieldrin, hexachlorobenzene, toxaphene, see Appendix C) did not exceed the thresholds.

Morro Bay (n=9) and Port San Luis (n=4) had the greatest number of analytes with the highest mean concentration, but the Morro Bay results reflect high detection limits artificially increasing the summations rather than actual known concentrations (Table 4-11; Appendix B). PAH concentrations in Port San Luis (HMW and total) and Santa Barbara (LMW) had the second highest concentrations of PAHs behind Morro Bay, but they were relatively low (<11 ng/g; Appendix D). Of the two fish samples analyzed in Port San Luis, one sample had non-detects for PAHs while the other sample had detected values of naphthalene, phenanthrene, fluoranthene, and pyrene. Santa Cruz had a higher concentration of total Chlordane (8.12 ng/g) compared to the other harbors (<3.75 ng/g). Total DDTs in Moss Landing (60.90 ng/g) had more than double the concentrations found in the other harbors, while Port San Luis (120.2 ng/g) and Monterey (102.7 ng/g) showed the same trend for total PCB Aroclors (other harbors <41 ng/g; Appendix D).

In general, tissue organic concentrations did not differ among fish species (Appendix D). The one noticeable difference occurred for total DDTs where the concentration in starry flounder (32.40 ng/g) was double that in speckled sanddab (14.64 ng/g) and higher than California halibut (24.24 ng/g). HMW, LMW, and total PAHs were highest in California halibut, but this result was based on the high detection limit. Speckled sanddab had the highest concentrations of total PCB Aroclors and total chlordane.

Table 4-12. Fish tissue trace organics summary data per analyte. Sample size (N), minimum (Min), maximum (Max), mean (Mean) and standard deviation (SD) values in ng/g wet weight, percent frequency of detection (result >MDL), and number of OEHHA and EPA exceedances are presented for each analyte. Non-detect results were given values equal to ½ MDL for summation purposes. Detection frequency was based on at least one analyte detection in a sample per station. Asterisk (*) indicates results were all non-detects and were not reported. Dash (-) indicates screening values were not established.

Analyte	N	Min (ng/g)	Max (ng/g)	Mean (ng/g)	SD	Detection Frequency (%)	OEHHA (#)	EPA (#)
Total Chlordane	14	0.01	12.93	1.93	3.43	21.4	0	-
Total DDTs	14	2.18	60.90	17.74	16.78	100	0	0
Total PCB Aroclors	7	17.7	198.7	33.4	56.0	100	6	6
Total PCBs	7	0.9	8.0	2.9	2.9	42.9	0	0
LMW PAHs	14	2.92	27.61	15.55	12.51	28.6	-	-
HMW PAHs	14	2.92	39.15	21.27	18.57	7.1	-	-
Total PAHs	14	5.83	66.76	36.83	31.08	28.6	-	4
Chlorpyrifos	7	*	*	*	*	0	0	-
Diazinon	7	*	*	*	*	0	0	-
Dibutyltin (DBT)	7	*	*	*	*	0	-	-
Tributyltin (TBT)	7	*	*	*	*	0	-	0

4.4.3.3 Fish Contaminant Summary

Harbors were rated good or poor for fish tissue samples depending on the number of screening value exceedances for the eight analytes with screening values (Table 4-11). For example, fish samples from Santa Cruz exceeded screening values for arsenic, total PCB Aroclors, and total PAHs for a rating of 37.5% poor. Monterey also rated poor for 37.5% of the samples due to arsenic, total PCB Aroclors, and total PAH exceedances. The other harbors rated poor in <25% of fish tissue samples.

4.4.4 Bivalve Contaminant Indicators

Bivalve mussels (*Mytilus californianus*) were deployed at two stations in each harbor. However, bags were missing upon retrieval at two stations (304SCRZ23 in Santa Cruz and 310MORO19 in Morro Bay) and the analyses were based on 10 stations. Furthermore, the bag containing bivalves at station 310MORO01 in Morro Bay was partially buried in the sand and a number of individuals were dead upon retrieval.

4.4.4.1 Trace Metals

Three replicate bivalve mussel samples were created for metals analysis, but the results were averaged within a station and reported as wet weight for comparisons to California OEHHA (Brodberg and Pollock 1999) and EPA (USEPA 2000) screening values. Summary bivalve tissue data (minimum, maximum, mean, standard deviation, detection frequency, and number of OEHHA and EPA screening value exceedances) are presented in Table 4-13.

Table 4-13. Bivalve mussel tissue trace metals summary data per analyte. Sample size (N), minimum (Min), maximum (Max), mean (Mean) and standard deviation (SD) values in mg/kg wet weight, percent frequency of detection (result >MDL), and number of OEHHA and EPA exceedances are presented for each analyte. Non-detect results were given values equal to ½ MDL for summation purposes. Dash (-) indicates screening values were not established.

Analyte	N	Min (mg/kg)	Max (mg/kg)	Mean (mg/kg)	SD	Detection Frequency (%)	OEHHA (#)	EPA (#)
Aluminum	10	4.3	156.4	53.5	53.6	100	-	-
Arsenic	10	1.46	2.41	1.92	0.37	100	10	10
Cadmium	10	0.49	2.75	1.41	0.755	100	0	0
Chromium	10	0.19	0.52	0.35	0.11	100	-	-
Copper	10	1.45	16.19	4.95	5.82	100	-	-
Lead	10	0.08	1.15	0.35	0.333	100	-	-
Manganese	10	0.59	2.59	1.11	0.62	100	-	-
Mercury	10	0.005	0.035	0.016	0.008	90	0	0
Nickel	10	0.15	0.65	0.29	0.149	100	-	-
Selenium	10	0.37	0.65	0.54	0.089	100	0	0
Silver	10	0.003	0.06	0.01	0.020	50	-	-
Zinc	10	14.9	90.5	35.7	24.9	100	-	-

All metal analytes were detected in all bivalve samples, except for mercury (90%) and silver (50%). Screening values exist for only four analytes and were not exceeded for cadmium, mercury, and selenium. The arsenic screening values (OEHHA=1.0 mg/kg;

EPA=1.2 mg/kg) were exceeded in all harbors for all 10 samples with an overall mean value of 1.92 mg/kg (Table 4-13). The highest value of arsenic was in Morro Bay (2.41 mg/kg) while the lowest concentration was in Monterey (1.46 mg/kg). Aluminum had a large range with a somewhat low mean (Table 4-13). The high mean concentrations were in Santa Cruz (129.3 mg/kg) and Moss Landing (118.3 mg/kg) with the other harbors <40 mg/kg. Copper levels in bivalve tissues ranged from 1.45 to 16.19 mg/kg with an overall mean of 4.95 mg/kg. The highest copper concentration was in Monterey (16.19 mg/kg), but the other Monterey station only had a concentration of 1.82 mg/kg dropping the mean down to 9.00 mg/kg. The one station from Santa Cruz had the highest mean copper concentration at 15.19 mg/kg. Moss Landing, Morro Bay, Port San Luis, and Santa Barbara had concentrations <3.75 mg/kg (Appendix E). Zinc varied across the harbors with a range of 14.9 to 90.5 mg/kg and a mean of 35.7 mg/kg. Santa Cruz (61.8 mg/kg) and Monterey (55.5 mg/kg) had the highest mean concentrations among the harbors with the lowest concentrations found in Morro Bay (16.2 mg/kg) and Port San Luis (16.0). To summarize, Santa Cruz (aluminum, copper, zinc), Moss Landing (manganese), Monterey (lead, mercury), Morro Bay (arsenic, chromium, nickel), and Port San Luis (cadmium, selenium, silver) had at least one of the highest mean concentration of an analyte in bivalve tissues while Santa Barbara had none (Table 4-11).

4.4.4.2 Trace Organics

Summary information (minimum, maximum, mean, standard deviation, detection frequency) and number of OEHHA and EPA exceedances are presented in Table 4-14 for ten trace organic analytes. These values were based on summations, where applicable, for each of the 10 stations. Summary information by harbor and by fish species is listed in Appendix E.

Human health consumption screening values (SVs) exist for total chlordane, total DDTs, total PCB Aroclors, and total PAHs. Total chlordane did not have any exceedances and was only detected in 40% of the samples (Table 4-14). Total DDTs had a wide range of concentrations (5.39-245.38 ng/g) but a low mean (32.45 ng/g). The high value was found at station 309MSLG04 in Moss Landing, which exceeded the OEHHA and EPA SVs and exceeded the second highest value by nine times (306MSLG26 in Moss Landing = 27.04 ng/g). All other stations were <11 ng/g (Appendix E). Three stations (304SCRZ10 in Santa Cruz, 309MSLG04 in Moss Landing, 309MTRY24 in Monterey) exceeded the OEHHA and EPA total PCB Aroclors screening value of 20 ng/g. The high value was in Moss Landing (48.7 ng/g), but the highest mean concentration was in Santa Cruz (37.2 ng/g). Total PAHs exceeded the EPA SV of 5.47 ng/g in all 10 samples. The high concentrations were in Santa Cruz (108.84 ng/g) and Monterey (49.12 ng/g) compared to the other harbors (<23 ng/g; Appendix E). LMW PAHs were detected in all 10 samples with the highest individual concentration in Monterey (36.31 ng/g). Santa Cruz had the highest mean concentration of LMW PAHs (31.55 ng/g) compared to the other harbors (<24 ng/g; Appendix E). HMW PAHs ranged widely across the harbors, but the mean was low (Table 4-14). Santa Cruz had the highest concentration (77.29 ng/g) more than tripling Monterey (25.66 ng/g) and the other harbors (<8 ng/g). Chlorpyrifos, diazinon, DBT, and TBT were not detected in any samples. Other tissue analytes with OEHHA and EPA screening values (Appendix C) were compared to the data. Dieldrin (OEHHA=2.0 ng/g, EPA=2.5 ng/g) was exceeded at stations 309MSLG04 (18.6 ng/g) and 306MSLG26 (5.2 ng/g) in Moss Landing. Toxaphene (OEHHA=30 ng/g, EPA=36.3 ng/g) was not exceeded in any sample, but station 309MSLG04 (28.8 ng/g) in Moss Landing was close to the threshold. The rest of the samples were non-detects. To summarize, Santa Cruz had the highest mean concentrations of total PCB Aroclors, LMW PAHs, HMW PAHs, and total PAHs while Moss Landing had the highest mean concentrations of total chlordane, total DDTs, dieldrin, and toxaphene (Table 4-11).

Table 4-14. Bivalve mussel tissue organics summary data per analyte. Sample size (N), minimum (Min), maximum (Max), mean (Mean) and standard deviation (SD) values in ng/g wet weight, percent frequency of detection (result >MDL), and number of OEHHA and EPA exceedances are presented for each analyte. Non-detect results were given values equal to ½ MDL for summation purposes. Asterisk (*) indicates results were all non-detects and are not reported. Dash (-) indicates screening values were not established.

Analyte	N	Min (ng/g)	Max (ng/g)	Mean (ng/g)	SD	Detection Frequency (%)	OEHHA (#)	EPA (#)
Total Chlordane	10	1.33	7.30	2.36	1.95	40	0	-
Total DDTs	10	5.39	245.38	32.45	75.11	100	1	1
Total PCB Aroclors	10	8.4	48.7	20.2	13.4	80	3	3
LMW PAHs	10	5.41	36.31	15.58	10.57	100	-	-
HMW PAHs	10	2.92	77.29	16.56	25.17	80	-	-
Total PAHs	10	8.32	108.84	32.14	34.81	100	-	10
Chlorpyrifos	10	*	*	*	*	0	-	-
Diazinon	10	*	*	*	*	0	-	-
Dibutyltin (DBT)	10	*	*	*	*	0	-	-
Tributyltin (TBT)	10	*	*	*	*	0	-	-

4.4.4.3 Bivalve Contaminant Summary

Harbors were rated good or poor for bivalve mussel tissue samples depending on the number of screening value exceedances for the eight analytes with screening values

(Table 4-11). For example, bivalve samples from Santa Cruz exceeded screening values for arsenic, total PCB Aroclors, and total PAHs for a rating of 37.5% poor. Moss Landing rated poor in 50% of the bivalve tissue samples while Monterey, Port San Luis, and Santa Barbara rated poor in <37.5% of the samples. These four harbors exceeded screening values for arsenic and total PAHs with total PCB Aroclors exceeded in Moss Landing and Monterey and total DDTs exceeded in Moss Landing. Morro Bay had the lowest poor rating with screening value exceedances in only 12.5% of the samples.

5.0 Summary

5.1 All Harbors

Water Quality Indicators

Overall water quality was determined to be good in an estimated 84.5% of the harbor areas with only 1.3% poor (Table 5-1). The water quality ranking of individual stations showed 75% good and 5% poor. The poor rankings were mostly due to elevated total dissolved inorganic nitrogen (DIN) and poor water clarity levels, but orthophosphate and dissolved oxygen (DO) levels also played a role in the evaluations. Comparing to established RWQCB Basin Plan criteria, 9% of the harbor bottom waters had pH levels ≥8.3 and 5% of bottom waters had DO levels <5.0 mg/l, which exceeded the corresponding criteria. Chlorophyll and nitrate levels in all harbor waters did not exceed guideline thresholds.

Sediment Quality Indicators

The majority (62.6%) of sediments in the harbor areas were rated good with 15.6% classified as poor (Table 5-1). About half of the individual stations (48.3%) fell in the good category, but most of these stations were in Morro Bay where half of all stations were sampled. About 28% of the stations, with at least one station in each harbor, ranked poor primarily due to sediment contaminant levels and toxicity to amphipods. The sediment composition of harbor areas mostly fell into the category of sands (46%; <20% silt/clay) or muds (20%; >80% silt/clay) with 72% of the areas deemed high quality for total organic carbon (TOC). Overall, sediment contaminant levels indicating expected toxic biological effects (i.e., >ERM) were low (<5%) with the primary analytes of concern being chromium, total DDTs, arsenic, and copper. Toxicity to amphipods (<80% mean-adjusted survival) was estimated from cumulative distribution frequency (CDF) calculations to occur in 12% of the Morro Bay sediment area and approximately 5% of the sediment areas in the other five harbors. The value for Morro Bay could represent a statistical artifact rather than an actual toxic event, though.

Tissue Quality Indicators

Fish tissue analysis of flatfish (speckled sanddab, California halibut, and starry flounder) was conducted at 14 stations throughout the harbors. The samples represented whole body composites but were compared to screening value thresholds based on fillet composites so exceedances could be overstated. One quarter of the stations rated poor for fish tissue quality (Table 5-1). Human health screening values for arsenic, total PCB Aroclors, and total PAHs were exceeded, but fish tissue screening values were not exceeded for cadmium, mercury, selenium, total chlordane, total DDTs, total PCB congeners, chlorpyrifos, diazinon, and TBT. Comparing the harbors, Morro Bay had the highest mean concentrations for chromium, copper, mercury, nickel, silver, zinc, and PAHs (HMW, LMW, total), but the latter was an artifact of high detection limits. Santa Cruz (manganese, selenium, total chlordane), Moss Landing (aluminum, total DDTs), Monterey (lead), Port San Luis (cadmium, total PCB Aroclors, HMW and Total PAHs), and Santa Barbara (arsenic, LMW PAHs) also had at least one of the highest trace metal or organic concentrations in fish tissue.

Bivalve mussels (*Mytilus californianus*) were deployed at 10 stations within the six harbors. Bivalve tissue quality rated poor at 31.3% of the stations (Table 5-1). The screening value for arsenic was exceeded in all 10 samples, but the guidelines for cadmium, mercury, and selenium were not exceeded in any sample. Screening values were exceeded for total PAHs (all 10 samples), total PCB Aroclors (3 samples), and total DDTs (1 sample), but the total chlordane threshold was not exceeded. Chlorpyrifos, diazinon, DBT, and TBT were not detected in any samples. Two samples in Moss Landing Harbor exceeded the screening value for dieldrin and one sample was close to exceeding the threshold for toxaphene. Santa Cruz (aluminum, copper, zinc), Moss Landing (manganese), Monterey (lead, mercury), Morro Bay (arsenic, chromium, nickel), and Port San Luis (cadmium, selenium, silver) had at least one of the highest mean concentration of an analyte while Santa Barbara had none. For the six trace organic analytes that were detected in bivalve mussel tissues, Santa Cruz had the highest mean concentrations of total PCB Aroclors, LMW PAHs, HMW PAHs, and total PAHs while Moss Landing had the highest mean concentrations of total chlordane and total DDTs.

Community Quality Indicators

Sediment samples (0.1 m^2, 1.0 mm sieve) were collected at each station to characterize the benthic infaunal community. The mean species richness per station was 31.9 species per 0.1 m^2 with a median of 23.5 species per 0.1 m^2. Species diversity was highest in Monterey Harbor while Morro Bay had lower diversity on the whole compared to the other harbors. About 75% of the harbor sediments were expected to have species richness <31 species per 0.1 m^2. Species abundance was highest in Santa Barbara (3 stations), Monterey (2 stations), Moss Landing (1 station), and Port San Luis (1 station) with an overall mean of 1,190.9 and median of 644 individuals per 0.1 m^2. Morro Bay had lower abundances compared to the other harbors. The majority of taxa were polychaetes, amphipods, and bivalves with the polychaete *Mediomastus* sp. occurring most frequently and having the greatest abundance at a station.

Fish community analysis was conducted at 14 stations throughout the six harbors, but eight of these stations were in Morro Bay. There were 22 distinct fish taxa caught with a total abundance of 508 individuals. The mean abundance was 31.8 fish per trawl with a mean of 4.1 fish species per trawl. The highest number of species in a trawl was collected in Morro Bay (n=11) while the greatest fish abundance was caught in Moss Landing (n=130). Speckled sanddab was the most numerically dominant fish species with the highest number of individuals per trawl, greatest relative abundance, and highest frequency of occurrence in the trawls. Surfperch (white, black, shiner), flatfish (speckled sanddab, starry flounder), and staghorn sculpin were some of the numerically dominant fish species.

5.2 Santa Cruz Harbor

Water Quality Indicators

Water quality in Santa Cruz Harbor rated good at three of the six stations with no exceedances of available water quality criteria and guidelines (Table 5-1). The other three sites, located in the back portion of the harbor, ranked fair due to dissolved oxygen (DO), orthophosphate, and water clarity levels. These same three stations had bottom DO and two of the three had surface DO concentrations below the Central Coast RWQCB criteria. Although all six stations were determined to be high quality for total dissolved inorganic nitrogen (DIN), four stations had the highest ammonia concentrations of all stations with the other two stations in the top eight.

Sediment Quality Indicators

The stations falling in the back portion of Santa Cruz Harbor ranked poor according to the sediment quality index while the three stations in the front portion of the harbor ranked fair or good. Sediment chemistry data showed elevated levels of several metals and organics analytes. More than 50% of the samples exceeded ERL guidelines for arsenic, copper, nickel, zinc, total chlordane, total DDTs, and total PCBs. Chlordane levels exceeded the more stringent ERM guideline at half of the stations in Santa Cruz Harbor. Toxicity effects were seen at only one station, but this result probably reflected a statistical artifact of low variability in the control samples rather than an actual toxicity effect.

Tissue Quality Indicators

Santa Cruz Harbor rated poor for both fish and bivalve tissue samples in 37.5% of the stations (Table 5-1). Fish tissue (speckled sanddab and starry flounder) whole body samples from Santa Cruz Harbor had the highest concentrations of manganese and selenium. Arsenic levels exceeded the OEHHA screening value for tissue fillet samples at one of the two stations. In general fish tissue metal concentrations were relatively low for most metals. Total PCB Aroclors exceeded the OEHHA and EPA threshold values of 20 ng/g at both stations. Total PAHs where at least one of the PAH analytes was detected exceeded the EPA screening value at the station in the back portion of the harbor. The highest concentration of total chlordanes (8.12 ng/g) was found in Santa Cruz, which more than doubled the levels found in the other harbors (<3.75ng/g).

Santa Cruz had the highest mean aluminum concentration (129.3 mg/kg) in bivalve tissue when compared to the other harbors (<40 mg/kg). Santa Cruz also had the highest mean concentrations of copper and zinc, and it exceeded the arsenic guideline. It also had the highest mean concentration of total PCB Aroclors, with the bivalve tissue station near the mouth of the harbor exceeding both the OEHHA and EPA screening values. Compared to the other harbors, bivalve mussels bioaccumulated relatively higher amounts of PAHs. Total PAHs exceeded the screening value at the station near the mouth of the harbor having the highest concentration in the study (108.84 ng/g). LMW PAHs were detected at both stations with values doubling the concentration of the other harbors except Monterey. Furthermore, Santa Cruz had the highest concentration of HMW PAHs, more than tripling the concentrations in Monterey and more than six times the amount found in the remaining harbors.

Community Quality Indicators
Most of the species richness values for Santa Cruz Harbor were between 20 and 40 taxa per $0.1m^2$ with the highest value around 70 taxa. Compared to the other harbors in this study, species richness was similar to Moss Landing and slightly higher or comparable to Morro Bay. Species diversity scores as measured by the Shannon-Wiener index as well as infaunal abundance were not distinctly different from the other harbors in the study.

Analytes of Concern
Analytes of concern in Santa Cruz Harbor are reduced water DO levels and elevated concentrations of arsenic (sediment) and total PCBs (sediment and tissue; Table 5-2). Chlordane levels were also elevated in sediment and exceeded human health screening values in resident fish populations.

5.3 Moss Landing Harbor

Water Quality Indicators
Of the six stations sampled in Moss Landing, three ranked good (50%), one ranked fair (16.7%), and two ranked poor (33.3%) for water quality (Table 5-1). The two sites ranked poor for high total dissolved inorganic nitrogen, low water clarity, and high orthophosphate (one station) levels. These sites were located in the boat slip area in the southern part of the harbor near the confluence with a well-documented toxic hot spot in the Old Salinas River. Although bottom dissolved oxygen (DO) levels were not below the Central Coast Basin Plan criteria (5.0 mg/l), two of the six stations had surface DO levels below this criteria. Two stations also had bottom pH values exceeding the criteria of 8.3. Moss Landing harbor showed the greatest water column stratification compared to the other harbors. Also in this harbor two stations had elevated nutrient levels. Chlorophyll levels did not exceed 5.0 µg/l in any sample from Moss landing; however, low DO levels in surface samples may indicate some concern for eutrophic conditions.

Sediment Quality Indicators
Sediment quality in Moss Landing Harbor was a mix of poor and good with half of the six stations in each category (Table 5-1). One station in the main channel ranked poor due to amphipod toxicity while two stations in the southern portion of the harbor ranked poor due to sediment contaminant levels and amphipod toxicity. The latter were the only stations in this study to receive a poor ranking for both sediment contaminants and amphipod toxicity, and they received a poor ranking for water quality. Sediment contaminants of concern in Moss Landing include total chlordanes, total DDTs, and total

PCBs. Elevated concentrations of nickel were found, but this is probably due to naturally high levels from the serpentine soils found along the Central coast.

Tissue Quality Indicators
Fish tissue quality rated poor for 12.5% of the samples (Table 5-1). In general fish tissue metal concentrations were relatively low for most metals. The one sample of speckled sanddab caught and analyzed from Moss Landing Harbor had the highest mean concentration of aluminum, which may have been elevated due to sample storage protocols. OEHHA and EPA threshold values for total PCB Aroclors were exceeded, but the screening value for total DDTs was not exceeded even though the concentration more than doubled the levels of the other harbors.

Bivalve mussel tissue quality rated poor in half of the samples based on the number of screening value exceedances for eight analytes (Table 5-1). Bivalve mussels bioaccumulated the highest mean concentrations of manganese, total chlordanes, total DDTs, and dieldrin along with the second highest concentration of aluminum compared to the other harbors. Both samples exceeded the threshold screening values for arsenic, total PAHs, and dieldrin. Furthermore, the bivalve station deployed in the back portion of the harbor in the boat slip area exceeded screening values for total DDTs and total PCB Aroclors and was close to exceeding the threshold for toxaphene.

Community Quality Indicators
Most of the species richness values for the Moss Landing Harbor were between 20 and 40 taxa per $0.1m^2$ with the highest value around 65 taxa. The data from this harbor exhibited a very similar pattern to that of Santa Cruz. Species diversity scores as measured by the Shannon-Wiener Index as well as benthic infaunal abundance were not distinctly different between the other harbors in the study.

Moss Landing Harbor had the highest fish abundance (n=130) in a single trawl of all the harbors.

Analytes of Concern
Analytes of concern in Moss Landing Harbor are elevated water nutrient (nitrogen and orthophosphate) levels, total chlordanes (sediment), and total DDTs (sediment and tissue; Table 5-2). Total PCB levels were also elevated in sediment and exceeded human health screening values in resident fish populations as well as transplanted bivalve mussels.

5.4 Monterey Harbor

Water Quality Indicators
Overall water quality in Monterey Harbor appears to be in good condition since all six stations ranked good (Table 5-1). These sites, though, ranked fair for orthophosphate

levels. Water measured at the bottom of four stations had pH levels exceeding the RWQCB criteria of 8.3.

Sediment Quality Indicators
No stations ranked good for sediment quality in Monterey Harbor with four ranked fair (66.7%) and two rated poor (33.3%; Table 5-1). Two stations ranked poor because of sediment contaminant levels, and they were located in the boat slip area and near the wharf. Sediments in Monterey Harbor exceeded the ERL sediment guideline for all 15 trace metal and organic analytes in at least one station. The more stringent ERM guideline for copper, mercury, total PCBs, and HMW PAHs was exceeded in at least one station suggesting expected toxic biologic effects. Significant toxicity to amphipods, however, was not seen in the samples. One of the poor stations in Monterey Harbor also had the highest total organic carbon (TOC) content in the study, which plays an important role in controlling the bioavailability of non-ionic organic compounds in sediments.

Tissue Quality Indicators
Fish and bivalve mussel tissue quality rated poor in 37.5% of the Monterey stations (Table 5-1). The one sample of speckled sanddab caught and analyzed from Monterey Harbor had the highest mean concentration of lead and the second highest mean concentration of total PCB Aroclors, more than doubling the other harbors besides Port San Luis. The OEHHA and EPA human health screening values were exceeded for arsenic (OEHHA only), total PCB Aroclors, and total PAHs.

Bivalve mussels deployed in Monterey Harbor had the highest mean concentrations of lead and mercury and the second highest mean levels of copper, zinc, total PAHs, LMW PAHs, and HMW PAHs. Human health screening values were exceeded for arsenic and total PAHs at both stations, although the arsenic concentration was the lowest amongst the harbors. The concentration of total PCB Aroclors exceeded the guideline at the station near the mouth of the harbor.

Community Quality Indicators
Species richness values in Monterey Harbor showed a wide range of values from about 25 to the highest in the study at about 115 taxa per $0.1m^2$. This range was similar to the results in Santa Barbara Harbor. Species diversity scores as measured by the Shannon-Wiener Index also tended to be relatively higher than other harbors. Benthic infaunal abundance was not distinctly different between the other harbors.

Analytes of Concern
Analytes of concern in Monterey Harbor in both sediment and tissue samples appear to be mercury and total PCBs (Table 5-2). Concentrations of lead in resident fish populations and transplanted bivalve mussels are elevated compared to the other harbors, but lead does not appear to be a concern in sediment.

5.5 Morro Bay Harbor

Water Quality Indicators

Of the 30 stations sampled, no stations ranked poor with 25 stations ranked good (83.3%), 3 fair (10%), and 2 with not enough information to be ranked (6.7%; Table 5-1). The 3 stations ranked fair due to low water clarity and elevated orthophosphate levels. Water quality criteria and guidelines were not exceeded for any water analyte.

Sediment Quality Indicators

Overall sediment quality in Morro Bay was good (66.7%) to fair (23.3%; Table 5-1). Three stations (10%) located in the main portion of the harbor ranked poor due to amphipod toxicity. Although sediment concentrations of chromium and nickel were elevated, this was probably due to natural sources from serpentine soils common in this watershed. Total DDTs levels exceeded the ERL guideline in 73% of the samples, but this was most likely an artifact because the summation of detection levels was near the ERL guideline value. Copper exceeded the ERL threshold at 36.7% of the stations suggesting potential associations with toxic biological effects. Concentrations of TOC, arsenic, cadmium, chromium, nickel, zinc, and silver tended to increase from stations near the mouth to the back portions of Morro Bay. However, this pattern was not seen with the other metal analytes or any organics analytes.

Tissue Quality Indicators

Tissue quality in Morro Bay rated poor for 12.5% of the stations for both fish and bivalve mussel tissue samples (Table 5-1). Fish caught and analyzed whole body from Morro Bay Harbor had the highest mean concentrations of chromium, copper, mercury, nickel, silver, and zinc. However, the level of arsenic in the fish tissue was the only analyte that exceeded the OEHHA human health screening value for tissue fillet samples at four stations with one station exceeding the stricter EPA screening value. The fish tissue samples in Morro Bay Harbor had the highest concentrations of HMW, LMW, and total PAHs, but this result is misleading because all analytes were not detected in the samples. The detection limits at the laboratory were higher than the other harbors so the summations were correspondingly higher.

Both the OEHHA and EPA screening values for arsenic were exceeded for all samples in the study, but Morro Bay had the highest mean concentration among all the harbors at 2.41 mg/kg. Morro Bay also had elevated levels of chromium and nickel, representative of the naturally high levels in the watershed.

Community Quality Indicators

Morro Bay had the lowest species richness amongst the harbors but showed some comparability with Santa Cruz and Moss Landing. Species diversity as measured by the Shannon-Wiener index was similar to the other harbors but remained in the lower end of the range. Infaunal abundance was low except for three stations where abundance was greater than 2,000 individuals per $0.1m^2$.

In contrast to the benthic infaunal data, Morro Bay had the highest number of fish species (n=11) and the second highest fish abundance (n=76) caught in a trawl compared to the other five harbors.

Analytes of Concern
The analyte of greatest concern in Morro Bay appears to be copper since it exceeded sediment quality guidelines and was found in the highest concentration of resident fish populations compared to the other harbors (Table 5-2).

5.6 Port San Luis Harbor

Water Quality Indicators
All six stations ranked good for water quality (Table 5-1), although the orthophosphate levels were rated fair. Two stations had bottom pH levels greater than the RWQCB criteria of 8.3, but no other criteria or guideline was exceeded.

Sediment Quality Indicators
Sediment quality in Port San Luis appears to be good (66.7%) with one station ranked fair (near the end of Harford pier) and one station ranked poor (near the Unocal pier; Table 5-1). The poor ranking was due to high sediment contaminant levels of chromium and nickel. Total organic carbon (TOC) content levels were low. The station near the end of Harford pier had the highest Tributyltin (TBT) concentration in this study at 199 ng/g. Elevated levels of nickel and chromium were measured, but this was probably due to naturally high levels from the serpentine soils. Total DDTs also exceeded the ERL guideline in all samples, but this most likely reflected an artifact of detection limits and the ERL value. Copper exceeded the ERL threshold at a third of the stations suggesting potential associations with toxic biological effects.

Tissue Quality Indicators
Tissue quality for bivalve mussels and fish rated poor at 25% of the stations in Port San Luis (Table 5-1). Fish tissue samples collected in Port San Luis had the highest mean concentration of cadmium, total PCB Aroclors, HMW PAHs, and total PAHs, with human health screening values exceeded for the latter two analytes. However, screening values for total PAHs were exceeded in one sample due to levels of naphthalene, phenanthrene, fluoranthene, and pyrene while the other sample showed non-detects for all analytes. Port San Luis (120.2 ng/g), along with Monterey Harbor (102.7 ng/g), had more than double the concentration of total PCB Aroclors than the other harbors (<41 ng/g).

Bivalve mussels bioaccumulated the highest mean concentrations of cadmium, selenium, and silver. The levels of arsenic and total PAHs exceeded established screening values with levels of naphthalene, phenanthrene, and fluoranthene elevating the total PAH results.

Community Quality Indicators
Benthic infaunal species richness, diversity (Shannon-Wiener Index), and abundance in Port San Luis indicated a wide range amongst the six stations and similar to the other harbors.

Analytes of Concern
Analytes of concern in Port San Luis resident fish populations and transplanted bivalve mussels are total PAHs primarily due to elevated levels of naphthalene, phenanthrene, fluoranthene, and pyrene (Table 5-2). Total PCBs in resident fish populations could also be an analyte of concern.

5.7 Santa Barbara Harbor

Water Quality Indicators
Water quality in Santa Barbara Harbor was a mixture of good (33.3%), fair (50%), and poor (16.7%; Table 5-1). The fair and poor rankings were due to a combination of moderate to low quality dissolved oxygen (DO), orthophosphate, and water clarity levels. In fact, Santa Barbara was the only harbor with a station ranked poor for DO and four stations had bottom DO levels less than the RWQCB criteria of 5.0 mg/l with a measurement as low as 0.31 mg/l.

Sediment Quality Indicators
Sediment quality in Santa Barbara Harbor was poor for 83.3% of the stations (Table 5-1). Santa Barbara Harbor was the only harbor besides Moss Landing to have a station rank poor for both water and sediment quality indicators. The one station that ranked good was located in the open portion of the harbor near the entrance. The poor rankings were due to moderate levels of TOC and poor sediment contaminant levels. The ERM sediment quality guideline for total chlordane was exceeded at five Santa Barbara stations (83.3%) suggesting toxic biological effects across the harbor. Other analytes of interest in Santa Barbara are arsenic, copper, nickel, total chlordane, and total DDT since the ERL guideline was exceeded at ≥5 stations. Toxicity to amphipods was not a major factor in the sediment rankings.

Tissue Quality Indicators
Tissue quality for fish and bivalve mussels in Santa Barbara rated poor in 25% of the stations (Table 5-1). The concentration of arsenic was the highest in the study and exceeded the human health screening value. The one fish sample in Santa Barbara also had the highest levels of LMW PAHs and exceeded the total PAHs screening value. A positive note is that the concentration of total PCB Aroclors did not exceed the

screening value, which could not be said for samples collected in Santa Cruz, Moss Landing, Monterey, and Port San Luis.

Bivalve tissue samples bioaccumulated relatively low levels of metals and organics during the deployment period in Santa Barbara. Tissue concentrations of arsenic and total PAHs exceeded screening value thresholds. Compared to the other harbors, though, none of the analytes in Santa Barbara were found in the highest mean concentrations.

Community Quality Indicators
Species richness values were nearly evenly distributed across the spectrum for Santa Barbara Harbor, ranging from about 15 to almost 110 taxa per $0.1m^2$. Species diversity as measured by the Shannon-Wiener Index showed a similar pattern. The three highest benthic infaunal abundance values (5,394 - 9,594 individuals per $0.1\ m^2$) in the study were measured in Santa Barbara Harbor with the other three stations falling in the middle of the range.

Analytes of Concern
Analytes of concern in Santa Barbara are low DO and elevated sediment total chlordanes levels (Table 5-2).

Table 5-1. Summary rankings for water, sediment, and tissue condition for all harbors and by individual harbors. Water and sediment condition rankings by percent area and by percent of stations are based on US EPA Water Quality and Sediment Quality Index values (see Section 2.3.3). Fish and bivalve tissue rankings for Poor are based on the percent of trace metal and organic analytes (n=8) where at least one human health consumption guideline was exceeded. Dash indicates value was not applicable.

		Water		Sediment		Tissue	
	Value	Area (%)	Station (%)	Area (%)	Station (%)	Fish (%)	Bivalves (%)
All Harbors	Good	84.5	75	62.6	48.3	75	68.7
	Fair	9.5	16.7	21.8	23.3	-	-
	Poor	1.3	5	15.6	28.3	25	31.3
Santa Cruz	Good	-	50	-	16.7	62.5	62.5
	Fair	-	50	-	33.3	-	-
	Poor	-	0	-	50	37.5	37.5
Moss Landing	Good	-	50	-	50	87.5	50
	Fair	-	16.7	-	0	-	-
	Poor	-	33.3	-	50	12.5	50
Monterey	Good	-	100	-	0	62.5	62.5
	Fair	-	0	-	66.7	-	-
	Poor	-	0	-	33.3	37.5	37.5
Morro Bay	Good	-	83.3	-	66.7	87.5	87.5
	Fair	-	10	-	23.3	-	-
	Poor	-	0	-	10	12.5	12.5
Port San Luis	Good	-	100	-	66.7	75	75
	Fair	-	0	-	16.7	-	-
	Poor	-	0	-	16.7	25	25
Santa Barbara	Good	-	33.3	-	16.7	75	75
	Fair	-	50	-	0	-	-
	Poor	-	16.7	-	83.3	25	25

Table 5-2. Analytes of concern for each harbor by matrix type (water, sediment, and tissue). Dash indicates a chemical of concern was not applicable.

	Water	Sediment	Tissue
Santa Cruz	dissolved oxygen	total PCBs total chlordanes arsenic	total PCBs total chlordanes
Moss Landing	nitrogen ortho-phosphate	total PCBs total DDTs total chlordanes	total PCBs total DDTs
Monterey	-	mercury total PCBs	mercury total PCBs lead
Morro Bay	-	copper	copper
Port San Luis	-	-	total PAHs total PCBs
Santa Barbara	dissolved oxygen	total chlordanes	

6.0 Limitations

As with most studies, there were limitations associated with this one. The main limitations stemmed from piecing together two studies into one assessment. Although the basic design principles were the same between Morro Bay and the other five harbors, the number of stations within a harbor was not consistent. The stations were also sampled in different years (2003 and 2004). Comparing data was difficult due to different analyte lists and detection limits (including range of detection limits) between the two studies. Improved (i.e., lower) detection limits for sediment DDTs, Dibutyltin (DBT), Tributyltin (TBT), and tissue PAHs would have helped in discerning differences between the harbors and making comparisons to sediment quality guidelines and human health screening values. Finally, tissue samples were not collected at all stations so the results could not be summarized statistically for the harbor areas.

7.0 References

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow. 1999. National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries. NOAA, National Ocean Service, Special Projects Office and the National Centers for Coastal Ocean Science. Silver Spring, MD: 71 pp.

Brodberg, P.K. and G.A. Pollock. 1999. Prevalence of selected target chemical contaminants in sport fish from two California lakes: Public health designed screening study. Sacramento, CA: Pesticide and Environmental Toxicology Section, Office of Environmental Health Hazard Assessment. California Environmental Protection Agency.

California Aquatic Non-Native Organism Database (CANOD). 2007. California Aquatic Non-Native Organism Database managed by the California Department of Fish and Game Office of Spill Prevention and Response. Available online at: http://www.dfg.ca.gov/ospr/organizational/scientific/exotic/MISMP.htm (accessed June 2007)

Chartrand, S., Hecht, B. Alley, D. and Danzig, T. 2002. Arana Gulch Watershed Enhancement Plan – Phase I: Steelhead and Sediment Assessments, Santa Cruz County, California. Prepared for Arana Gulch Watershed Alliance.

Diaz-Ramos, S., D.L. Stevens, Jr., and A.R. Olsen. 1996. EMAP Statistics Methods Manual. EPA/620/R-96/002. Corvallis, OR: U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory.

DiToro, D.M., C.S. Zarba, D.J. Hansen, W.J. Berry, R.C. Swartz, C.E. Cowan, S.P. Pavlou, H.E. Allen, N.A. Thomas, and P.R. Paquin. 1991. Technical basis for establishing sediment quality criteria for nonionic organic chemicals using equilibrium partitioning. Environmental Toxicology and Chemistry 10:1541-1583.

Dugan, J.E., G. Ichikawa, M. Stephenson, D. Crane, J. McCall and K. Regalado. 2005. Monitoring of Coastal Contaminants using Sand Crabs. Prepared for Central Coast Regional Water Quality Control Board.

Fairey, R., E.R. Long, C.A. Roberts, B.S. Anderson, B.M. Phillips, J.W. Hunt, H.R. Puckett, and C.J. Wilson. 2001. An evaluation of methods for calculating mean sediment quality guideline quotients as indicators of contamination and acute toxicity to amphipods by chemical mixtures. Environmental Toxicology and Chemistry 20:2276-2286.

Habitat Management Group. 1996. Moro Cojo Slough Management and Enhancement Plan. Final Report. Prepared for the Monterey County Planning and Building Inspection Department and State Coastal Conservancy.

Helsel, D.R. 2005. Nondetects and Data Analysis: Statistics for censored environmental data. Wiley, New York, 250 p.

Hinkey, L.M. 2001. A baseline assessment of environmental conditions and the potential for Polycyclic Aromatic Hydrocarbons (PAHs) biodegradation in marina waters and sediments. PhD Thesis in Marine Sciences (Chemical Oceanography), University of Puerto Rico, Mayaguez Campus.

Hyland, J.L., T.J. Herrlinger, T.R. Snoots, A.H. Ring-wood, R.F. Van Dolah, C.T. Hackney, G.A. Nelson, J.S. Rosen, and S.A. Kokkinakis. 1996. Environmental Quality of Estuaries of the Carolinian Province: 1994. Annual Statistical Summary for the 1994 EMAP- Estuaries Demonstration Project in the Carolinian Province. NOAA Technical Memorandum NOS ORCA 97. NOAA/NOS, Office of Ocean Resources Conservation and Assessment, Silver Spring, MD. 102 p.

Hyland, J.L., L. Balthis, C.T. Hackney, G. McRae, A.H. Ringwood, T.R. Snoots, R.F. Van Dolah, and T.L. Wade. 1998. Environmental quality of estuaries of the Carolinian Province: 1995. Annual statistical summary for the 1995 EMAP-Estuaries Demonstration Project in the Carolinian Province. NOAA Technical Memorandum NOS ORCA 123 NOAA/NOS, Office of Ocean Resources Conservation and Assessment, Silver Spring, MD. 143 p.

Kinnetic Laboratories Incorporated (Kinnetic Labs). 2005. Report to Brian Foss, Santa Cruz Port Director. Unpublished.

Krebs, C.J. 1994. Ecology: The experimental analysis of distribution and abundance, Fourth edition. HarperCollins College Publishers, New York, NY. 801p.

Lauenstein, G.G., E.A. Crecelius, and A.Y. Cantillo. 2000. Baseline metal concentrations of the U.S. West Coast and their use in evaluating sediment contamination. Presented at 21st Ann. Soc. Environ. Toxicology and Chemistry meeting, November 12-15, 2000, Nashville, Tennessee.

Leydecker. A and L.A. Grabowsky. 2005. Goleta Stream Team 2002 – 2005. A review of the findings of Santa Barbara Channelkeeper’s Goleta Stream Team June 2002 – June 2005. Santa Barbara Channelkeeper. Unpublished.

Long, E.R., D.L. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects Within Ranges of Chemical Concentration in Marine and Estuarine Sediments. Environmental Management 19:81-97.

Lydon, S. 2004. The Moss landing Whaling Station:1919-1926. Available Online at http://www.sandylydon.com/html/sec5.html (accessed June 2007)

Macauley, J.M., J.K. Summers, P.T. Heitmuller, V.D. Engle, G.T. Brooks, M. Babikow, and A.M. Adams. 1994. Annual Statistical Summary: EMAP - Estuaries Louisiana Province - 1992. U.S. EPA Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL. EPA/620/R-94/002. 82 p. plus Appendix A.

Macauley, J.M., J.K. Summers, V.D. Engle, P.T. Heitmuller, and A.M. Adams. 1995. Annual Statistical Summary: EMAP - Estuaries Louisiana Province -1993. U.S. EPA Office of Research and Development, Environmental Research Laboratory, Gulf Breeze, FL. EPA/620/R-96/003. 95 p.

MacDonald, D.D. 1992. Development of an integrated approach to the assessment of sediment quality in Florida. Prepared for the Florida Department of Environmental Regulation. MacDonald Environmental Services, Ltd. Ladysmith, British Columbia. 114 pp.

MacDonald, D.D. 1994a. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Volume 1- Development and Evaluation of Sediment Quality Assessment Guidelines. Prepared for the Florida Department of Environmental Regulation. MacDonald Environmental Services, Ltd. Ladysmith, British Columbia. 126 pp.

MacDonald, D.D. 1994b. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Volume 2- Application of the Sediment Quality Assessment Guidelines. Prepared for the Florida Department of Environmental Regulation. MacDonald Environmental Services, Ltd. Ladysmith, British Columbia. 52 pp.

MacDonald, D.D., R.S. Carr, F.D. Calder, E.R. Long, and C.G. Ingersoll. 1996. Development and Evaluation of Sediment Quality Guidelines for Florida Coastal Waters. Ecotoxicology 5:253-278.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Archives of Environmental Contamination and Toxicology 39:20-31.

Moss Landing Chamber of Commerce. 2002. Available online at http://www.mosslandingchamber.com/index.html (accessed June 2007)

National Oceanic and Atmospheric Association (NOAA). 1990. Chlordane in the marine environment of the United States: Review and results from the National status and trends program. Office of Oceanography and Marine Assessment, National Ocean Service, National Oceanic and Atmospheric Association, U.S. Department of Commerce. NOAA Technical Memorandum NOS OMA 55.

Nelson, W.G., H. Lee II, and J.O. Lamberson. 2005. Condition of Estuaries of California for 1999: A Statistical Summary. Office of Research and Development, National Health and Environmental Effects Research Laboratory, EPA 620/R-05-004.

Pomeroy, C. and M. Dalton. 2003. Socioeconomics of the Moss Landing commercial fishery: Report to the Monterey County Office of Economic Development. http://www.psmfc.org/efin/docs/otherpublications/ML_Cmcl_Fishing_Ind_Report.pdf (accessed June 2007)

Puckett, M. 2002. Quality Assurance Management Plan for the State of California's Surface Water Ambient Monitoring Program. California Department of Fish and Game. Monterey, CA.

Regional Water Quality Control Board, Central Coast (RWQCBCC). 1994. Central Coast Region Water Quality Control Plan (Basin Plan). State of California, Central Coast Regional Water Quality Control Board, San Luis Obispo, CA.

Regional Water Quality Control Board, Central Coast (RWQCBCC). 2003. Project Report: Recommendation to delist Morro Bay, San Luis Obispo County, California for metals from the 303d list. State of California, Central Coast Regional Water Quality Control Board, San Luis Obispo, CA, 30 p.

Regional Water Quality Control Board, Central Coast (RWQCBCC). 2006a. Justification for Delisting Monterey Harbor for Lead, Monterey County, California. State of California, Central Coast Regional Water Quality Control Board, San Luis Obispo, CA.

Regional Water Quality Control Board, Central Coast (RWQCBCC). 2006b. Total maximum daily load for nutrients and dissolved oxygen in Chorro Creek, San Luis Obispo County, California. Central Coast Regional Water Quality Control Board, San Luis Obispo, CA.

Robertson, D. 2000. Elkhorn Slough and Moss Landing. http://www.montereybay.com/creagrus/elkhornslough.html (accessed June 2007)

Santa Cruz County Environmental Health Services (Santa Cruz County). 2005. Updated Assessment of Potential Health Risk Associated with harbor Dredging. Unpublished.

Spear, P.A. and R.C. Pearce. 1979. Copper in the aquatic environment: Chemistry, distribution, and toxicology. NRCC Report Number 16454. National Research Council of Canada. Ottawa, Canada. 227 pp.

State Water Resources Control Board (SWRCB). 1995a. Toxic Substances Monitoring Program Data Report. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, CA.

State Water Resources Control Board (SWRCB). 1995b. State Mussel Watch Program 1987-1993 Data Report. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, CA.

State Water Resources Control Board (SWRCB). 1998. Chemical and biological measures of sediment quality in the Central Coast Region. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, CA.

State Water Resources Control Board (SWRCB). 2000. State Mussel Watch Program 1995-1997 Data Report. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, CA.

State Water Resources Control Board (SWRCB). 2001. California Ocean Plan, Water Quality Control Plan, Ocean Waters of California. State Water Resources Control Board, California Environmental Protection Agency, Sacramento, CA.

Stevens, D.L. Jr. 1997. Variable density grid-based sampling designs for continuous spatial populations. Environmetrics 8:167-195.

Stevens, D.l., Jr. and A.R. Olsen. 1999. Spatially restricted surveys over time for aquatic resources. Journal of Agricultural, Biological and Environmental Statistics 4:415-428.

Strobel, C.J., S.J. Benyi, D.J. Keith, H.W. Buffum, and E.A. Petrocelli. 1994. Statistical summary: EMAP - Estuaries Virginian Province - 1992. U.S. EPA Office of Research and Development, Environmental Research Laboratory, Narragansett, RI. EPA/620/R-94/019. 63 p. plus Appendices A–C.

Strobel, C.J., H.W. Buffum, S.J. Benyi, E.A. Petrocelli, D.R. Reifsteck, and D.J. Keith. 1995. Statistical summary: EMAP - Estuaries Virginian Province - 1990 to 1993. U.S. EPA National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division, Narragansett, R.I. EPA/620/R-94/026. 72 p. plus Appendices A–C.

Summers J.K., J.M. Macauley, J.M. Brooks, T.L. Wade, W.H. Benson, J.M. O'Neal. 1993. Contaminant levels in sediments and biota in Gulf of Mexico estuaries [abstract]. In: Gulf Estuarine Research Society Annual Meeting; 1993 Apr 1-4; Mobile, AL.

Swartz, R.C., F.A. Cole, J.O. Lamberson, S.P. Ferraro, D.W. Schults, W.A. DeBen, H. Lee II, R.J. Ozretich. 1994. Sediment toxicity, contamination and amphipod abundance at a DDT- and dieldrin-contaminated site in San Francisco Bay. Environmental Toxicology and Chemistry 13:949-962.

Swartz, R.C. 1999. Consensus sediment quality guidelines for polycyclic aromatic hydrocarbon mixtures. Environmental Toxicology and Chemistry 18:780-787.

U.S. Environmental Protection Agency (USEPA). 1992. Statistical analysis of ground-water monitoring data at RCRA Facilities: Addendum to interim final guidance. United States Environmental Protection Agency, Office of Solid Waste. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 2000. Guidance for assessing chemical contaminant data for use in fish advisories. Volume 1: Fish sampling and analysis. Third edition. EPA-823-B-00-007. U.S. Environmental Protection Agency, Office of Water. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 2001a. Environmental Monitoring and Assessment Program (EMAP): National Coastal Assessment Quality Assurance Project Plan 2001-2004. United States Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA/620/R-01/002.

U.S. Environmental Protection Agency (USEPA). 2001b. National Coastal Assessment: Field Operations Manual. U. S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, FL. EPA 620/R-01/003. pp72.

U.S. Environmental Protection Agency (USEPA). 2001c. National Management Measures Guidance to Control Nonpoint Source Pollution from Marinas and Recreational Boating. Nonpoint Source Control Branch, Office of Wetlands, Oceans and Watersheds, Office of Water, U.S. Environmental Protection Agency. November 2001.

U.S. Environmental Protection Agency (USEPA). 2002. RCRA waste sampling draft technical guidance. EPA-530-D-02-002. U.S. Environmental Protection Agency, Office of Solid Waste. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 2004. National Coastal Condition Report II. EPA-620/R-03/002. Office of Research and Development and Office of Water, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 2006. National Estuary Program Coastal Condition Report. EPA-842/B-06/001. Office of Research and Development and Office of Water, Washington, D.C. Also available online at http://www.epa.gov/owow/oceans/nepccr/index.html (accessed June 2007).

Washington State Department of Ecology. 2001. Concentrations of Selected Chemicals in Sediments from Harbors in the San Juan Islands. Publication No. 01-03-007.

Weinstein, A. 2002. Site characterization: Human influences: socioeconomic uses: harbors. Available online at http://bonita.mbnms.nos.noaa.gov/ (accessed June 2007).

Weisberg, S.B., J.B. Frithsen, A.F. Holland, J.F. Paul, K.J. Scott, J.K. Summers, H.T. Wilson, R. Valente, D.G. Heimbuch, J. Gerritsen, S.C. Schimmel, and R.W. Latimer. 1992. EMAP - Estuaries Virginian Province 1990 demonstration project report. U.S. EPA Environmental Research Laboratory, Narragansett, R.I. EPA/600/R-92/100.

8.0 Appendices

8.1 Appendix A

Appendix A. Central Coast Harbor station coordinates. Coordinates are separated by type of sampling [water/probe/sediment, bivalve, trawl (start), and trawl (end)] and were recorded using the NAD83 datum. Trawl points represent general track lines and not necessarily all conducted trawls.

		Water/Probe/Sediment		Bivalve		Trawl (start)		Trawl (end)	
Harbor	StationCode	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)
Santa Cruz	304SCRZ02	36.96577	-122.00274			36.96372	-122.00220	36.96656	-122.00244
Santa Cruz	304SCRZ07	36.97129	-122.00037			36.96958	-122.00187	36.97144	-122.00011
Santa Cruz	304SCRZ10	36.96440	-122.00292	36.97334	-121.99898				
Santa Cruz	304SCRZ15	36.96927	-122.00166						
Santa Cruz	304SCRZ18	36.96652	-122.00323						
Santa Cruz	304SCRZ23	36.97301	-121.99882	36.96428	-122.00130				
Moss Landing	306MSLG06	36.81163	-121.78758						
Moss Landing	306MSLG14	36.80638	-121.78493						
Moss Landing	306MSLG22	36.80810	-121.78806						
Moss Landing	306MSLG26	36.80798	-121.78685	36.80967	-121.78708	36.80853	-121.78555	36.81165	-121.78742
Moss Landing	306MSLG26					36.80729	-121.78532	36.81031	-121.78667
Moss Landing	309MSLG04	36.80256	-121.78614	36.80220	-121.78478				
Moss Landing	309MSLG30	36.80317	-121.78634						
Monterey	309MTRY08	36.60209	-121.89009						
Monterey	309MTRY12	36.60564	-121.89135			36.60823	-121.88940	36.60896	-121.89270
Monterey	309MTRY12					36.60589	-121.89231	36.60512	-121.89294
Monterey	309MTRY16	36.60868	-121.89301						
Monterey	309MTRY20	36.60587	-121.89301						
Monterey	309MTRY24	36.60727	-121.89122	36.60763	-121.88879				
Monterey	309MTRY28	36.60365	-121.89053	36.60294	-121.89112				
Morro Bay	310M0RO01			35.36933	-120.86143				
Morro Bay	310M0RO19			35.33599	-120.84643				
Morro Bay	CA03-0301	35.36922	-120.86211			35.36988	-120.86193	35.36835	-120.86392
Morro Bay	CA03-0302	35.36323	-120.85554			35.36207	-120.85492	35.36429	-120.85554
Morro Bay	CA03-0303	35.36162	-120.85381						
Morro Bay	CA03-0304	35.35698	-120.85644						

		Water/Probe/Sediment		Bivalve		Trawl (start)		Trawl (end)	
Harbor	StationCode	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)
Morro Bay	CA03-0305	35.35425	-120.85835						
Morro Bay	CA03-0306	35.35426	-120.85644						
Morro Bay	CA03-0307	35.35069	-120.84643			35.35237	-120.84692	35.35629	-120.8504
Morro Bay	CA03-0308	35.34616	-120.85345						
Morro Bay	CA03-0309	35.34727	-120.85582						
Morro Bay	CA03-0310	35.34514	-120.8476			35.34591	-120.84729	35.34403	-120.84795
Morro Bay	CA03-0311	35.34281	-120.84988						
Morro Bay	CA03-0312	35.34148	-120.85797						
Morro Bay	CA03-0313	35.34139	-120.84252						
Morro Bay	CA03-0314	35.33908	-120.84962						
Morro Bay	CA03-0315	35.33646	-120.85239						
Morro Bay	CA03-0316	35.33489	-120.84241						
Morro Bay	CA03-0317	35.33929	-120.83263						
Morro Bay	CA03-0318	35.33002	-120.85823						
Morro Bay	CA03-0319	35.33554	-120.84596			35.33613	-120.84605	35.34171	-120.84686
Morro Bay	CA03-0320	35.33642	-120.83813						
Morro Bay	CA03-0321	35.33012	-120.85388			35.32906	-120.85397	35.33051	-120.85205
Morro Bay	CA03-0321					35.33076	-120.8521	35.33349	-120.8513
Morro Bay	CA03-0322	35.33197	-120.84383						
Morro Bay	CA03-0323	35.33361	-120.83253						
Morro Bay	CA03-0324	35.32301	-120.85729			35.32328	-120.85345	35.32587	-120.84908
Morro Bay	CA03-0325	35.32771	-120.84626			35.32678	-120.84857	35.33247	-120.84917
Morro Bay	CA03-0326	35.32086	-120.85957						
Morro Bay	CA03-0327	35.32398	-120.85242						
Morro Bay	CA03-0328	35.32493	-120.84122						
Morro Bay	CA03-0329	35.32064	-120.85294						
Morro Bay	CA03-0330	35.32381	-120.84113						
Port San Luis	310SNLS01	35.17342	-120.74192	35.17258	-120.74126	35.17039	-120.74160	35.17277	-120.74162
Port San Luis	310SNLS05	35.16927	-120.75675						
Port San Luis	310SNLS09	35.15888	-120.75059						
Port San Luis	310SNLS17	35.16690	-120.75084						
Port San Luis	310SNLS21	35.17631	-120.74691						
Port San Luis	310SNLS25	35.16837	-120.75227	35.16729	-120.75262	35.16544	-120.75195	35.16772	-120.75381
Santa Barbara	315SBRB03	34.40534	-119.69165						
Santa Barbara	315SBRB11	34.40699	-119.69028			34.40776	-119.68910	34.40560	-119.69128
Santa Barbara	315SBRB11					34.40875	-119.68800	34.40831	-119.68912

		Water/Probe/Sediment		Bivalve		Trawl (start)		Trawl (end)	
Harbor	StationCode	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)	Latitude (DD)	Longitude (DD)
Santa Barbara	315SBRB13	34.40592	-119.69273						
Santa Barbara	315SBRB19	34.40477	-119.69010	34.40409	-119.69044				
Santa Barbara	315SBRB27	34.40487	-119.69395						
Santa Barbara	315SBRB29	34.40980	-119.68692	34.40862	-119.68507				

8.2 Appendix B

Appendix B. List of analytical methods, laboratory, MDLs, RLs, and units for each analyte analyzed in water, sediment, and tissue samples for Morro Bay and the other five harbors. In some cases, the range of MDLs and RLs are provided for a given analyte. Units for sediment are in dry weight. Tissue units are in wet weight and represent fish and bivalve mussel analyses. -99 indicates value not reported or not applicable.

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Water	Conventional	Ammonia as N	TAAII	GPL	0.4844	7	ug/l	SM 4500-NH3 DM	MLML-TM	0.0001-0.0006	0.0022-0.0028	mg/l
Water	Conventional	Chlorophyll a	TDF700	GPL	0.145676	-99	ug/L	EPA 445.0M	MPSL-DFG	0.045	0.045	µg/L
Water	Conventional	Nitrate + Nitrite as N						MBARI TRNo90-2	MLML-TM	0.001	0.005-0.008	mg/l
Water	Conventional	Nitrate as N	TAAII	GPL	1.246	53.2	ug/l	MBARI TRNo90-2	MLML-TM	0.001	0.005-0.008	mg/l
Water	Conventional	Nitrite as N	TAAII	GPL	0.13258	1.4	ug/l	SM 4500-NO2 BM	MLML-TM	0.000028-0.00003	0.0004-0.0007	mg/l
Water	Conventional	OrthoPhosphate as P	TAAII	GPL	0.7471	8.37	ug/l	MBARI TRNo90-2	MLML-TM	0.0006-0.0012	0.0022-0.0042	mg/l
Water	Conventional	Total Suspended Solids	SM2040D	MLML	1	1	mg/l	SM 2540 D	MPSL-DFG	5	5	mg/l
Sediment	Conventional	Total Organic Carbon	SEDMT-TC	GPL	0.03	-99	%	EPA 9060	AMS	0.01	0.01	%
Sediment	Grain Size	Fine-Plumb,Clay Phi>10						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Fine-Plumb,Clay Phi10						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Fine-Plumb,Clay Phi9						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Fine-Plumb,Coarse Silt						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Fine-Plumb,Fine Silt						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Fine-Plumb,Medium Silt						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Fine-Plumb,V. Fine Silt						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Fines,Percent	Wet Sieve	GPL	-99	-99	%					
Sediment	Grain Size	Granule-Plumb						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Pebble-Plumb,Large						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Pebble-Plumb,Medium						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Pebble-Plumb,Small						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Pebble-Plumb,V. Large						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Sand-Plumb,Coarse						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Sand-Plumb,Fine						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Sand-Plumb,Medium						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Sand-Plumb,V. Coarse						Plumb	AMS	0.01	0.01	%
Sediment	Grain Size	Sand-Plumb,V. Fine						Plumb	AMS	0.01	0.01	%
Sediment	Organics-	Dibutyltin						EPA	DFG-	50	100	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
	Biocide							8323M	WPCL			
Sediment	Organics-Biocide	Tributyltin						EPA 8323M	DFG-WPCL	25	50	ng/g
Sediment	Organics-PAHs	Acenaphthene	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Acenaphthene-d10(Surrogate)						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	%
Sediment	Organics-PAHs	Acenaphthylene	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Anthracene	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Anthracene-D10(Surrogate)	SW8270C	GPL	1	1	%					
Sediment	Organics-PAHs	Benz(a)anthracene	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Benz(a)anthracene-d12(Surrogate)						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	%
Sediment	Organics-PAHs	Benzo(a)pyrene	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Benzo(b)fluoranthene	SW8270C	GPL	2-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Benzo(e)pyrene						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Benzo(g,h,i)perylene	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Benzo(g,h,I)perylene-d12(Surrogate)						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	%
Sediment	Organics-PAHs	Benzo(k)fluoranthene	SW8270C	GPL	2-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Biphenyl	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Biphenyl-d10(Surrogate)						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	%
Sediment	Organics-PAHs	Chrysene	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Chrysenes, C1 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Chrysenes, C2 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Chrysenes, C3 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Dibenz(a,h)anthracene	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Dibenzothiophene	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-	Dibenzothiophenes, C1 -						EPA	DFG-	0.564-	0.564-	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
	PAHs							8270M	WPCL	1.13	1.13	
Sediment	Organics-PAHs	Dibenzothiophenes, C2 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Dibenzothiophenes, C3 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Dimethylnaphthalene, 2,6-	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Dimethylphenanthrene, 3,6-						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Fluoranthene	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Fluoranthene/Pyrenes, C1 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Fluorene	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Fluorene-D10(Surrogate)	SW8270C	GPL	1	1	%					
Sediment	Organics-PAHs	Fluorenes, C1 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Fluorenes, C2 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Fluorenes, C3 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Indeno(1,2,3-c,d)pyrene	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Methyldibenzothiophene, 4-						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Methylfluoranthene, 2-						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Methylfluorene, 1-						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Methylnaphthalene, 1-	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Methylnaphthalene, 2-	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Methylphenanthrene, 1-	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Naphthalene	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Naphthalene-d8(Surrogate)						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	%
Sediment	Organics-PAHs	Naphthalenes, C1 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Naphthalenes, C2 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-	Naphthalenes, C3 -						EPA	DFG-	0.564-	0.564-	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
	PAHs							8270M	WPCL	1.13	1.13	
Sediment	Organics-PAHs	Naphthalenes, C4 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Perylene						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Perylene-d12(Surrogate)						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	%
Sediment	Organics-PAHs	Phenanthrene	SW8270C	GPL	0-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Phenanthrene/Anthracene, C1 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Phenanthrene/Anthracene, C2 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Phenanthrene/Anthracene, C3 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Phenanthrene/Anthracene, C4 -						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Phenanthrene-d10(Surrogate)						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	%
Sediment	Organics-PAHs	Pyrene	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PAHs	Pyrene-d10(Surrogate)						EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	%
Sediment	Organics-PAHs	Trimethylnaphthalene, 2,3,5-	SW8270C	GPL	1-10	10	ng/g	EPA 8270M	DFG-WPCL	0.564-1.13	0.564-1.13	ng/g
Sediment	Organics-PCBs	PCB 008	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 018	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 027						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 028	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 029						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 031						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 033						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 044	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 049						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 052	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-	PCB 056						EPA	DFG-	0.112-	0.225-	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
	PCBs							8082M	WPCL	0.226	0.452	
Sediment	Organics-PCBs	PCB 060						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 066	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 070						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 074						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 077	SW8082A	GPL	0	1	ng/g					
Sediment	Organics-PCBs	PCB 087						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 095						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 097						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 099						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 101	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 105	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 110	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 114						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 118	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 126	SW8082A	GPL	0	1	ng/g					
Sediment	Organics-PCBs	PCB 128	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 137						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 138	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 141						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 149						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 151						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 153	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-	PCB 156						EPA	DFG-	0.112-	0.225-	ng/g

Matrix	Group	Analyte	Morro Bay Method	Lab[1]	MDL	RL	Unit	Other Five Harbors Method	Lab[1]	MDL	RL	Unit
	PCBs							8082M	WPCL	0.226	0.452	
Sediment	Organics-PCBs	PCB 157						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 158						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 170	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 174						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 177						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 180	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 183						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 187	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 189						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 194						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 195	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 200						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 201						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 203						EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 206	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB 207(Surrogate)						EPA 8081AM, EPA 8082M	DFG-WPCL	-88	-88	%
Sediment	Organics-PCBs	PCB 209	SW8082A	GPL	0	1	ng/g	EPA 8082M	DFG-WPCL	0.112-0.226	0.225-0.452	ng/g
Sediment	Organics-PCBs	PCB AROCLOR 1248						Newman, et al., 1988	DFG-WPCL	11-23	28-58	ng/g
Sediment	Organics-PCBs	PCB AROCLOR 1254						Newman, et al., 1988	DFG-WPCL	4-9	11-23	ng/g
Sediment	Organics-PCBs	PCB AROCLOR 1260						Newman, et al., 1988	DFG-WPCL	4-9	11-23	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Sediment	Organics-Pesticides	Aldrin	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.292-0.588	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Chlordane, cis-	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.804-1.62	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Chlordane, trans-						EPA 8081AM	DFG-WPCL	0.453-0.913	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Chlordene, alpha-						EPA 8081AM	DFG-WPCL	0.31-0.624	0.561-1.13	ng/g
Sediment	Organics-Pesticides	Chlordene, gamma-						EPA 8081AM	DFG-WPCL	0.287-0.579	0.561-1.13	ng/g
Sediment	Organics-Pesticides	Chlorpyrifos						EPA 8081AM	DFG-WPCL	0.938-1.89	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Dacthal						EPA 8081AM	DFG-WPCL	0.799-3.57	1.27-4	ng/g
Sediment	Organics-Pesticides	DBCE(Surrogate)						EPA 8081AM	DFG-WPCL	-88	-88	%
Sediment	Organics-Pesticides	DCBP(p,p')						EPA 8081AM	DFG-WPCL	1.01-4.52	1.27-4.52	ng/g
Sediment	Organics-Pesticides	DDD(o,p')	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.862-1.74	1.12-2.26	ng/g
Sediment	Organics-Pesticides	DDD(p,p')	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	1.01-2.03	1.12-2.26	ng/g
Sediment	Organics-Pesticides	DDD*(p,p')(Surrogate)						EPA 8081AM	DFG-WPCL	-88	-88	%
Sediment	Organics-Pesticides	DDE(o,p')	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.754-1.52	2.25-4.52	ng/g
Sediment	Organics-Pesticides	DDE(p,p')	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.647-1.3	2.25-4.52	ng/g
Sediment	Organics-Pesticides	DDMU(p,p')						EPA 8081AM	DFG-WPCL	1.35-2.72	3.37-6.78	ng/g
Sediment	Organics-Pesticides	DDT(o,p')	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	1.14-2.3	3.37-6.78	ng/g
Sediment	Organics-Pesticides	DDT(p,p')	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	2.77-5.59	5.61-11.3	ng/g
Sediment	Organics-Pesticides	Diazinon						EPA 8081AM	DFG-WPCL	8.55-38.2	25.3-80	ng/g
Sediment	Organics-Pesticides	Dibromooctafluorobiphenyl(Surrogate)						EPA 8081AM	DFG-WPCL	-88	-88	%
Sediment	Organics-Pesticides	Dieldrin	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.531-2.37	0.63-2.37	ng/g
Sediment	Organics-Pesticides	Endosulfan I	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	1.37-6.1	2.53-8	ng/g
Sediment	Organics-Pesticides	Endosulfan II	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	1.37-6.1	2.53-8	ng/g
Sediment	Organics-Pesticides	Endosulfan sulfate	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	1.37-6.1	2.53-8	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Sediment	Organics-Pesticides	Endrin	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	1.19-5.31	2.53-8	ng/g
Sediment	Organics-Pesticides	HCH, alpha						EPA 8081AM	DFG-WPCL	0.534-1.08	0.561-1.13	ng/g
Sediment	Organics-Pesticides	HCH, beta						EPA 8081AM	DFG-WPCL	0.691-1.39	1.12-2.26	ng/g
Sediment	Organics-Pesticides	HCH, delta						EPA 8081AM	DFG-WPCL	0.404-0.814	2.25-4.52	ng/g
Sediment	Organics-Pesticides	HCH, gamma	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.382-0.768	0.561-1.13	ng/g
Sediment	Organics-Pesticides	Heptachlor	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.579-1.17	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Heptachlor epoxide	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.566-1.14	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Hexachlorobenzene	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.121-0.244	0.337-0.678	ng/g
Sediment	Organics-Pesticides	Methoxychlor						EPA 8081AM	DFG-WPCL	1.66-3.34	3.37-6.78	ng/g
Sediment	Organics-Pesticides	Mirex	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	1.06-2.13	1.68-3.39	ng/g
Sediment	Organics-Pesticides	Nonachlor, cis-						EPA 8081AM	DFG-WPCL	1.1-2.21	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Nonachlor, trans-	SW8081A	GPL	0	0-0.5	ng/g	EPA 8081AM	DFG-WPCL	0.436-0.877	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Oxadiazon						EPA 8081AM	DFG-WPCL	1.18-5.29	1.27-5.29	ng/g
Sediment	Organics-Pesticides	Oxychlordane						EPA 8081AM	DFG-WPCL	0.413-0.832	1.12-2.26	ng/g
Sediment	Organics-Pesticides	Parathion, Ethyl						EPA 8081AM	DFG-WPCL	1.06-4.75	2.53-8	ng/g
Sediment	Organics-Pesticides	Parathion, Methyl						EPA 8081AM	DFG-WPCL	1.92-8.59	5.1-16	ng/g
Sediment	Organics-Pesticides	Tedion						EPA 8081AM	DFG-WPCL	0.931-4.16	2.53-8	ng/g
Sediment	Organics-Pesticides	Tetrachloro-m-xylene(Surrogate)	SW8081A, SW8082A	GPL	1	1	%					
Sediment	Organics-Pesticides	Toxaphene	SW8081A	GPL	12	50	ng/g	EPA 8081AM	DFG-WPCL	8.98-18.1	22.5-45.2	ng/g
Sediment	Semi-VOAs	Terphenyl,p-(Surrogate)	SW8270C	GPL	1	1	%					
Sediment	Trace Metals	Aluminum	ICPMS	GPL	6.7	100	ug/g	EPA 200.8	MPSL-DFG	125	400	mg/kg
Sediment	Trace Metals	Antimony	ICPMS	GPL	0.17	1	ug/g					
Sediment	Trace Metals	Arsenic	ICPMS	GPL	0.32	5	ug/g	EPA 200.8	MPSL-DFG	1.8	5	mg/kg
Sediment	Trace Metals	Cadmium	ICPMS	GPL	0.12	0.5	ug/g	EPA 200.8	MPSL-DFG	0.02	0.05	mg/kg

Matrix	Group	Analyte	Morro Bay Method	Morro Bay Lab[1]	Morro Bay MDL	Morro Bay RL	Morro Bay Unit	Other Five Harbors Method	Other Five Harbors Lab[1]	Other Five Harbors MDL	Other Five Harbors RL	Other Five Harbors Unit
Sediment	Trace Metals	Chromium	ICPMS	GPL	0.18	2	ug/g	EPA 200.8	MPSL-DFG	0.7	2	mg/kg
Sediment	Trace Metals	Copper	ICPMS	GPL	0.26	2	ug/g	EPA 200.8	MPSL-DFG	1.5	5	mg/kg
Sediment	Trace Metals	Iron	ICPMS	GPL	6.7	50	ug/g					
Sediment	Trace Metals	Lead	ICPMS	GPL	0.22	1	ug/g	EPA 200.8	MPSL-DFG	0.4	1	mg/kg
Sediment	Trace Metals	Manganese	ICPMS	GPL	0.11	1	ug/g	EPA 200.8	MPSL-DFG	0.5	2	mg/kg
Sediment	Trace Metals	Mercury	CVAA & ICPMS	GPL	0.017	0.033	ug/g	DFG SOP 103	MPSL-DFG	0.006	0.017	mg/kg
Sediment	Trace Metals	Nickel	ICPMS	GPL	0.13	1	ug/g	EPA 200.8	MPSL-DFG	0.4	1	mg/kg
Sediment	Trace Metals	Selenium	ICPMS	GPL	0.34	5	ug/g	EPA 7742M	DFG-WPCL	0.05	0.2	mg/kg
Sediment	Trace Metals	Silver	ICPMS	GPL	0.011	0.3	ug/g	EPA 200.8	MPSL-DFG	0.07	0.2	mg/kg
Sediment	Trace Metals	Tin	ICPMS	GPL	0.57	2.5	ug/g					
Sediment	Trace Metals	Zinc	ICPMS	GPL	0.3	2	ug/g	EPA 200.8	MPSL-DFG	2	6	mg/kg
Tissue	Organics-Biocide	Dibutyltin						EPA 8323M	DFG-WPCL	20-94	40-188	ng/g
Tissue	Organics-Biocide	Tributyltin						EPA 8323M	DFG-WPCL	10-47	20-94	ng/g
Tissue	Organics-PAHs	Acenaphthene	SW8270C	GPL	5.4-12	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Acenaphthene-d10(Surrogate)						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Acenaphthylene	SW8270C/ SW8081A	GPL	0.01-8.9	1-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Anthracene	SW8270C	GPL	3.4-7.6	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Anthracene-D10(Surrogate)	SW8270C	GPL	1	1	%					
Tissue	Organics-PAHs	Benz(a)anthracene	SW8270C	GPL	4.2-9.3	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Benz(a)anthracene-D12(Surrogate)	SW8270C	GPL	4-8.9	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Benzo(a)pyrene	SW8270C	GPL	12-26	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Benzo(b)fluoranthene	SW8270C	GPL	12-26	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Benzo(e)pyrene						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Benzo(g,h,i)perylene	SW8270C	GPL	13-29	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Tissue	Organics-PAHs	Benzo(g,h,i)perylene-D12(Surrogate)						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Benzo(k)fluoranthene	SW8270C	GPL	9.3-21	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Biphenyl	SW8270C	GPL	4.8-11	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Biphenyl-D10(Surrogate)						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Chrysene	SW8270C	GPL	4.3	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Chrysenes, C1 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Chrysenes, C2 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Chrysenes, C3 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Dibenz(a,h)anthracene	SW8270C	GPL	4.2	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Dibenzothiophene	SW8270C	GPL	4.1	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Dibenzothiophenes, C1 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Dibenzothiophenes, C2 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Dibenzothiophenes, C3 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Dimethylnaphthalene, 2,6-	SW8270C	GPL	3	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Dimethylphenanthrene, 3,6-						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Fluoranthene	SW8270C	GPL	7	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Fluoranthene/Pyrenes, C1 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Fluorene	SW8270C	GPL	4.9	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Fluorene-D10(Surrogate)	SW8270C	GPL	1	1	%					
Tissue	Organics-PAHs	Fluorenes, C1 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Fluorenes, C2 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Fluorenes, C3 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Indeno(1,2,3-c,d)pyrene	SW8270C	GPL	4.7	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g

Matrix	Group	Analyte	Morro Bay					Other Five Harbors				
			Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Tissue	Organics-PAHs	Methyldibenzothiophene, 4-						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Methylfluoranthene, 2-						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Methylfluorene, 1-						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Methylnaphthalene, 1-	SW8270C	GPL	4.3-9.6	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Methylnaphthalene, 2-	SW8270C	GPL	6.2-14	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Methylphenanthrene, 1-	SW8270C	GPL	3.9-8.7	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Naphthalene	SW8270C	GPL	5.4-12	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Naphthalene-d8(Surrogate)						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Naphthalenes, C1 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Naphthalenes, C2 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Naphthalenes, C3 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Naphthalenes, C4 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Perylene						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Perylene-d12(Surrogate)						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Phenanthrene	EPA3540C	GPL	8.3-18	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Phenanthrene/Anthracene, C1 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Phenanthrene/Anthracene, C2 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Phenanthrene/Anthracene, C3 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Phenanthrene/Anthracene, C4 -						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Phenanthrene-d10(Surrogate)	SW8270C	GPL	8.3-18	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Pyrene	SW8270C	GPL	7.6-17	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Pyrene-d10(Surrogate)						EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g
Tissue	Organics-PAHs	Trimethylnaphthalene, 2,3,5-	SW8270C	GPL	5.6-12	20-44	ng/g	EPA 8270M	DFG-WPCL	0.486-7.896	0.486-7.896	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Tissue	Organics-PCBs	Lipid						EPA 8082	DFG-WPCL	-88	-88	%
Tissue	Organics-PCBs	PCB 008	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 018	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 027						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 028	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 029						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 031						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 033						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 044	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 049						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 052	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 056						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 060						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 066	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 070						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 074						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 077	SW8082A	GPL	0.1-0.22	2-4.4	ng/g					
Tissue	Organics-PCBs	PCB 087						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 095						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 097						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 099	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 101	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 105	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Tissue	Organics-PCBs	PCB 110						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 114	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 118	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 128	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 137						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 138	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 141						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 149						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 151						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 153	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 156						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 157						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 158						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 170	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 174						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 177						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 180	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 183						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 187	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 189						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 194						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 195	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 200						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Tissue	Organics-PCBs	PCB 201						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 203						EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 206	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB 207(Surrogate)						EPA 8082	DFG-WPCL	-88	-88	%
Tissue	Organics-PCBs	PCB 209	SW8082A	GPL	0.1-0.22	2-4.4	ng/g	EPA 8082	DFG-WPCL	0.093-1.606	0.186-3.215	ng/g
Tissue	Organics-PCBs	PCB AROCLOR 1248						EPA 8082	DFG-WPCL	9.3-160.6	23.3-402.3	ng/g
Tissue	Organics-PCBs	PCB AROCLOR 1254						EPA 8082	DFG-WPCL	3.72-64.30	9.3-160.55	ng/g
Tissue	Organics-PCBs	PCB AROCLOR 1260						EPA 8082	DFG-WPCL	3.72-64.30	9.3-160.55	ng/g
Tissue	Organics-Pesticides	Aldrin	SW8081A	GPL	0.01-0.02	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.242-4.174	0.93-16.06	ng/g
Tissue	Organics-Pesticides	Chlordane, cis-	SW8081A	GPL	0.01-0.02	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.666-11.506	0.93-16.06	ng/g
Tissue	Organics-Pesticides	Chlordane, trans-						EPA 8081A	DFG-WPCL	0.376-6.486	0.93-16.06	ng/g
Tissue	Organics-Pesticides	Chlordene, alpha-						EPA 8081A	DFG-WPCL	0.257-4.437	0.465-8.028	ng/g
Tissue	Organics-Pesticides	Chlordene, gamma-						EPA 8081A	DFG-WPCL	0.257-4.437	0.465-8.028	ng/g
Tissue	Organics-Pesticides	Chlorpyrifos						EPA 8081A	DFG-WPCL	0.777-13.423	0.93-16.06	ng/g
Tissue	Organics-Pesticides	Dacthal						EPA 8081A	DFG-WPCL	0.58-10.15	0.93-16.06	ng/g
Tissue	Organics-Pesticides	DBCE(Surrogate)						EPA 8081A	DFG-WPCL	-88	-88	%
Tissue	Organics-Pesticides	DCBP(p,p')						EPA 8081A	DFG-WPCL	0.744-12.84	0.93-16.06	ng/g
Tissue	Organics-Pesticides	DDD(o,p')	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.714-12.33	0.93-16.06	ng/g
Tissue	Organics-Pesticides	DDD(p,p')	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.837-14.46	0.93-16.06	ng/g
Tissue	Organics-Pesticides	DDD*(p,p')(Surrogate)						EPA 8081A	DFG-WPCL	-88	-88	%
Tissue	Organics-Pesticides	DDE(o,p')	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.625-10.79	1.86-32.15	ng/g
Tissue	Organics-Pesticides	DDE(p,p')	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.536-9.25	1.86-32.15	ng/g
Tissue	Organics-Pesticides	DDMU(p,p')						EPA 8081A	DFG-WPCL	1.12-19.36	2.79-48.13	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Tissue	Organics-Pesticides	DDT(o,p')	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.945-16.32	2.79-48.13	ng/g
Tissue	Organics-Pesticides	DDT(p,p')	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	2.3-39.67	4.65-80.28	ng/g
Tissue	Organics-Pesticides	Diazinon						EPA 8081A	DFG-WPCL	6.29-108.48	18.6-321.48	ng/g
Tissue	Organics-Pesticides	Dibromooctafluorobiphenyl(Surrogate)						EPA 8081A	DFG-WPCL	-88	-88	%
Tissue	Organics-Pesticides	Dieldrin	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.391-6.749	0.465-8.028	ng/g
Tissue	Organics-Pesticides	Endosulfan I	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	1-17.35	1.86-32.15	ng/g
Tissue	Organics-Pesticides	Endosulfan II	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	1-17.35	1.86-32.15	ng/g
Tissue	Organics-Pesticides	Endosulfan sulfate	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	1-17.35	1.86-32.15	ng/g
Tissue	Organics-Pesticides	Endrin	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.874-15.096	1.86-32.15	ng/g
Tissue	Organics-Pesticides	HCH, alpha						EPA 8081A	DFG-WPCL	0.443-7.652	0.465-8.028	ng/g
Tissue	Organics-Pesticides	HCH, beta						EPA 8081A	DFG-WPCL	0.573-9.89	0.93-16.06	ng/g
Tissue	Organics-Pesticides	HCH, delta						EPA 8081A	DFG-WPCL	0.335-5.79	1.86-32.15	ng/g
Tissue	Organics-Pesticides	HCH, gamma	SW8081A	GPL	0.01-0.02	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.316-5.45	0.465-8.03	ng/g
Tissue	Organics-Pesticides	Heptachlor	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.48-8.291	0.93-16.055	ng/g
Tissue	Organics-Pesticides	Heptachlor epoxide	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.469-8.103	0.93-16.055	ng/g
Tissue	Organics-Pesticides	Hexachlorobenzene	SW8081A	GPL	0.01	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.1-1.735	0.279-4.813	ng/g
Tissue	Organics-Pesticides	Methoxychlor						EPA 8081A	DFG-WPCL	1.38-23.688	2.79-48.128	ng/g
Tissue	Organics-Pesticides	Mirex	SW8081A	GPL	0.01-0.02	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.878-15.153	1.4-24.064	ng/g
Tissue	Organics-Pesticides	Nonachlor, cis-						EPA 8081A	DFG-WPCL	0.911-15.736	0.93-16.055	ng/g
Tissue	Organics-Pesticides	Nonachlor, trans-	SW8081A	GPL	0.01-0.02	1-2.2	ng/g	EPA 8081A	DFG-WPCL	0.361-6.223	0.93-16.055	ng/g
Tissue	Organics-Pesticides	Oxadiazon						EPA 8081A	DFG-WPCL	0.87-15.04	0.93-16.055	ng/g
Tissue	Organics-Pesticides	Oxychlordane						EPA 8081A	DFG-WPCL	0.342-5.903	0.93-16.055	ng/g
Tissue	Organics-Pesticides	Parathion, Ethyl						EPA 8081A	DFG-WPCL	0.781-13.498	1.86-32.148	ng/g

			Morro Bay					Other Five Harbors				
Matrix	Group	Analyte	Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
Tissue	Organics-Pesticides	Parathion, Methyl						EPA 8081A	DFG-WPCL	1.41-24.44	3.72-64.296	ng/g
Tissue	Organics-Pesticides	Tedion						EPA 8081A	DFG-WPCL	0.684-11.825	1.86-32.148	ng/g
Tissue	Organics-Pesticides	Tetrachloro-m-xylene(Surrogate)	SW8081A, SW8082A	GPL	1	1	%					
Tissue	Organics-Pesticides	Toxaphene	SW8081A	GPL	0.01-0.02	50-110	ng/g	EPA 8081A	DFG-WPCL	7.44-128.404	18.6-321.48	ng/g
Tissue	Semi-VOAs	Terphenyl,p-(Surrogate)	SW8270C	GPL	1	1	%					
Tissue	Trace Metals	Aluminum	ICPMS	GPL	0.31-0.46	6.9-10.4	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	1.67-18.8	5-56.4	mg/kg
Tissue	Trace Metals	Arsenic	ICPMS	GPL	0.093-0.14	0.69-1	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.017-0.188	0.05-0.564	mg/kg
Tissue	Trace Metals	Cadmium	ICPMS	GPL	0.01-0.016	0.21-0.31	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.002-0.019	0.005-0.056	mg/kg
Tissue	Trace Metals	Chromium	ICPMS	GPL	0.028	0.17-0.26	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.05-0.564	0.167-1.88	mg/kg
Tissue	Trace Metals	Copper	ICPMS	GPL	0.048	0.34-0.52	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.033-0.376	0.083-0.94	mg/kg
Tissue	Trace Metals	Iron	ICPMS	GPL	0.86-1.3	5.2-7.8	ug/g					
Tissue	Trace Metals	Lead	ICPMS	GPL	0.028-0.042	0.34-0.52	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.005-0.056	0.017-0.188	mg/kg
Tissue	Trace Metals	Manganese	ICPMS	GPL	0.014-0.35	0.17-1.9	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.017-0.188	0.05-0.564	mg/kg
Tissue	Trace Metals	Mercury	ICPMS	GPL	0.0081-0.0099	0.016-0.02	ug/g	DFG SOP 103	MPSL-DFG	0.01-0.073	0.03-0.220	mg/kg
Tissue	Trace Metals	Nickel	ICPMS	GPL	0.045-0.067	0.34-0.52	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.017-0.188	0.05-0.564	mg/kg
Tissue	Trace Metals	Selenium	ICPMS	GPL	0.093-0.14	0.69-1	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.033-0.376	0.1-1.128	mg/kg
Tissue	Trace Metals	Silver	ICPMS	GPL	0.03-0.09	0.1-0.3	ug/g	EPA 200.8 & 200.8M	MPSL-DFG	0.005-0.056	0.017-0.188	mg/kg
Tissue	Trace Metals	Tin	ICPMS	GPL	0.1-0.16	0.86-1.3	ug/g					
Tissue	Trace Metals	Zinc	ICPMS	GPL	0.32-0.48	1.7-	ug/g	EPA	MPSL-	0.333-	1-11.28	mg/kg

Matrix	Group	Analyte	Morro Bay					Other Five Harbors				
			Method	Lab[1]	MDL	RL	Unit	Method	Lab[1]	MDL	RL	Unit
						2.6		200.8 & 200.8M	DFG	3.76		

[1] Lab Codes: AMS – Applied Marine Sciences in League City, TX; DFG-WPCL – California Department of Fish and Game's Water Pollution Control Laboratory in Rancho Cordova, CA; GPL – Gulf Breeze Laboratory in Gulf Breeze, FL; MLML or MPSL-DFG – Moss Landing Marine Laboratories' Department of Fish and Game Lab in Moss Landing, CA; MLML-TM – Moss Landing Marine Laboratories' Trace Metals Lab in Moss Landing, CA.

8.3 Appendix C

Appendix C. List of criteria and thresholds for specific analytes analyzed in water, sediment, and tissue samples. Water samples were compared to the Ocean Plan (SWRCB 2001) and Central Coast Basin Plan (RWQCBCC 1994). Sediment samples were compared to the Effects Range Low (ERL), Effects Range Median (ERM), Threshold Effects Level (TEL), and Probable Effects Level sediment quality guidelines (PEL; Long et al. 1995, MacDonald et al. 1996). Tissue samples were compared to California Office of Environmental Health Hazard Assessment (OEHHA; Brodberg and Pollock 1999) and U.S. Environmental Protection Agency (USEPA 2000) human health consumption guidelines (wet weight values).

	Water			Sediment					Tissue (Fish and Shellfish)		
Analyte	Units	Ocean Plan	Basin Plan	Units	ERL	ERM	TEL	PEL	Units	OEHHA	EPA
Acenaphthene	ug/l			ng/g	16	500	6.71	88.9	ng/g		
Acenaphthylene	ug/l	0.0088		ng/g	44	640	5.87	127.89	ng/g		
Aldrin	ug/l	0.000022		ng/g					ng/g		
Aluminum	mg/l		1	mg/kg					mg/kg		
Anthracene	ug/l	0.0088		ng/g	85.3	1,100	46.85	245	ng/g		
Arsenic	mg/l	0.006	0.05	mg/kg	8.2	70	7.24	41.6	mg/kg	1.0	1.2
Benz(a)anthracene	ug/l			ng/g	261	1,600	74.83	692.53	ng/g		
Benzo(a)pyrene	ug/l	0.0088		ng/g	430	1,600	88.81	763.22	ng/g		
Cadmium	mg/l	0.001	0.01	mg/kg	1.2	9.6	0.676	4.21	mg/kg	3.0	4.0
Chlordane, cis-	ug/l	0.000023		ng/g					ng/g		
Chlordane, Total	ug/l	0.000023	0.1	ng/g	2	6	2.26	4.79	ng/g	30	
Chlordane, trans-	ug/l	0.000023		ng/g					ng/g		
Chlorpyrifos	ug/l			ng/g					ng/g	10,000	1,200
Chromium	mg/l	190	0.05	mg/kg	81	370	52.3	160.4	mg/kg		
Chrysene	ug/l	0.0088		ng/g	384	2,800	107.71	845.98	ng/g		
Copper	mg/l	0.003		mg/kg	34	270	18.7	108.2	mg/kg		
DDD(o,p')	ug/l	0.00017		ng/g					ng/g		
DDD(p,p')	ug/l	0.00017		ng/g					ng/g		
DDD*(p,p)(Surrogate)	ug/l	0.00017		ng/g					ng/g		
DDE(o,p')	ug/l	0.00017		ng/g					ng/g		
DDE(p,p')	ug/l	0.00017		ng/g	2.2	27	2.07	374.17	ng/g		
DDMU(p,p')	ug/l	0.00017		ng/g					ng/g		
DDT(o,p')	ug/l	0.00017		ng/g					ng/g		
DDT(p,p')	ug/l	0.00017		ng/g			1.19	4.77	ng/g		
DDT, Total	ug/l	0.00017		ng/g	1.58	46.1	3.89	51.7	ng/g	100	117

	Water			Sediment					Tissue (Fish and Shellfish)		
Analyte	Units	Ocean Plan	Basin Plan	Units	ERL	ERM	TEL	PEL	Units	OEHHA	EPA
Diazinon	ug/l			ng/g					ng/g	300	2800
Dibenz(a,h)anthracene	ug/l	0.0088		ng/g	63.4	260	6.22	134.61	ng/g		
Dieldrin	ug/l	0.00004		ng/g	0.02	8	0.715	4.3	ng/g	2.0	2.5
Endosulfan I	ug/l	0.009		ng/g					ng/g		
Endosulfan II	ug/l	0.009		ng/g					ng/g		
Endosulfan sulfate	ug/l	0.009		ng/g					ng/g		
Endrin	ug/l	0.002	0.2	ng/g	0.02	45			ng/g	1,000	1,200
Fluoranthene	ug/l	15		ng/g	600	5,100	112.82	1,493.54	ng/g		
Fluorene	ug/l	0.0088		ng/g	19	540	21.17	144.35	ng/g		
HCH, alpha	ug/l	0.004		ng/g					ng/g		
HCH, beta	ug/l	0.004		ng/g					ng/g		
HCH, delta	ug/l	0.004		ng/g					ng/g		
HCH, gamma	ug/l	0.004		ng/g					ng/g	30	30.7
Heptachlor	ug/l	0.0072	0.01	ng/g					ng/g		
Heptachlor epoxide	ug/l	0.004	0.01	ng/g					ng/g	4.0	4.39
Hexachlorobenzene	ug/l	0.00021		ng/g					ng/g	20	25
Indeno(1,2,3-c,d)pyrene	ug/l	0.0088		ng/g					ng/g		
Lead	mg/l	0.002		mg/kg	46.7	218	30.24	112.18	mg/kg		
Mercury	ug/l	0.04	2	mg/kg	0.15	0.71	0.13	0.7	mg/kg	0.3	0.4
Methoxychlor	ug/l		100	ng/g					ng/g		
Methylnaphthalene, 2-	ug/l			ng/g	70	670	20.21	201.28	ng/g		
Mirex	ug/l			ng/g					ng/g		800
Naphthalene	ug/l			ng/g	160	2,100	34.57	390.64	ng/g		
Nickel	mg/l	0.005		mg/kg	20.9	51.6	15.9	42.8	mg/kg		
Nitrate as N	mg/l		10	mg/kg					mg/kg		
Nonachlor, cis-	ug/l	0.000023		ng/g					ng/g		
Oxychlordane	ug/l	0.000023		ng/g					ng/g		
Oxygen, Dissolved	mg/l		5.0								
PAH, Total	ug/l	0.0088		ng/g	4,022	44,792	1,684.06	1,6770.54	ng/g		5.47
PCB Arochlor 1248	ug/l	0.000019		ng/g					ng/g		
PCB Arochlor 1254	ug/l	0.000019		ng/g					ng/g		
PCB Arochlor 1260	ug/l	0.000019		ng/g					ng/g		
PCB, Total	ug/l	0.000019		ng/g	22.7	180	21.55	188.79	ng/g	20	20
PCB, Total Aroclors	ug/l	0.000019		ng/g					ng/g	20	20
pH	pH units	0.006	<7.0 >8.3	pH units							

	Water			Sediment					Tissue (Fish and Shellfish)		
Analyte	Units	Ocean Plan	Basin Plan	Units	ERL	ERM	TEL	PEL	Units	OEHHA	EPA
Phenanthrene	ug/l	0.0088		ng/g	240	1,500	86.68	543.53	ng/g		
Pyrene	ug/l	0.0088		ng/g	665	2,600	152.66	1,397.6	ng/g		
Selenium	mg/l	0.015	0.01	mg/kg					mg/kg	20	20
Silver	mg/l	0.0007	0.05	mg/kg	1	3.7	0.733	1.77	mg/kg		
Toxaphene	ug/l	0.00021	5	ng/g					ng/g	30	36.3
Tributyltin	ug/l	0.0014		ng/g					ng/g		1,200
Zinc	mg/l			mg/kg	150	410	124	271	mg/kg		

8.4 Appendix D

Appendix D. Fish tissue summary information by harbor and by fish species. Minimum (Min), maximum (Max), mean (Mean), and standard deviation (SD) values are presented for each trace metals and trace organic analyte. Non-detect results were given values equal to ½ MDL for summation purposes. Data represents wet weight values.

Group	Harbor/Fish Species	Analyte	Unit	Min	Max	Mean	SD
Trace Metals	Santa Cruz	Aluminum	mg/kg	18.5	49.2	33.9	21.7
	Moss Landing	Aluminum	mg/kg	74.0	74.0	74.0	
	Monterey	Aluminum	mg/kg	21.2	21.2	21.2	
	Morro Bay	Aluminum	mg/kg	15.6	45.7	34.1	9.5
	Port San Luis	Aluminum	mg/kg	32.2	51.1	41.7	13.4
	Santa Barbara	Aluminum	mg/kg	23.8	23.8	23.8	
	Santa Cruz	Arsenic	mg/kg	0.54	1.14	0.84	0.43
	Moss Landing	Arsenic	mg/kg	0.83	0.83	0.83	
	Monterey	Arsenic	mg/kg	1.04	1.04	1.04	
	Morro Bay	Arsenic	mg/kg	0.78	1.27	1.02	0.15
	Port San Luis	Arsenic	mg/kg	0.87	0.87	0.87	0.00
	Santa Barbara	Arsenic	mg/kg	1.51	1.51	1.51	
	Santa Cruz	Cadmium	mg/kg	0.009	0.009	0.009	0.000
	Moss Landing	Cadmium	mg/kg	0.038	0.038	0.038	
	Monterey	Cadmium	mg/kg	0.024	0.024	0.024	
	Morro Bay	Cadmium	mg/kg	0.019	0.086	0.041	0.023
	Port San Luis	Cadmium	mg/kg	0.063	0.192	0.128	0.091
	Santa Barbara	Cadmium	mg/kg	0.014	0.014	0.014	
	Santa Cruz	Chromium	mg/kg	0.14	0.16	0.15	0.02
	Moss Landing	Chromium	mg/kg	0.27	0.27	0.27	
	Monterey	Chromium	mg/kg	0.13	0.13	0.13	
	Morro Bay	Chromium	mg/kg	0.31	0.72	0.48	0.14
	Port San Luis	Chromium	mg/kg	0.17	0.27	0.22	0.07
	Santa Barbara	Chromium	mg/kg	0.12	0.12	0.12	
	Santa Cruz	Copper	mg/kg	0.58	0.69	0.63	0.08
	Moss Landing	Copper	mg/kg	0.63	0.63	0.63	
	Monterey	Copper	mg/kg	0.76	0.76	0.76	
	Morro Bay	Copper	mg/kg	0.82	1.35	1.00	0.17
	Port San Luis	Copper	mg/kg	0.52	0.67	0.59	0.11
	Santa Barbara	Copper	mg/kg	0.67	0.67	0.67	
	Santa Cruz	Lead	mg/kg	0.029	0.035	0.032	0.004
	Moss Landing	Lead	mg/kg	0.048	0.048	0.048	
	Monterey	Lead	mg/kg	0.218	0.218	0.218	
	Morro Bay	Lead	mg/kg	0.075	0.125	0.102	0.021
	Port San Luis	Lead	mg/kg	0.063	0.077	0.070	0.010
	Santa Barbara	Lead	mg/kg	0.033	0.033	0.033	
	Santa Cruz	Manganese	mg/kg	1.02	3.71	2.37	1.90
	Moss Landing	Manganese	mg/kg	2.01	2.01	2.01	

Group	Harbor/Fish Species	Analyte	Unit	Min	Max	Mean	SD
	Monterey	Manganese	mg/kg	0.50	0.50	0.50	
	Port San Luis	Manganese	mg/kg	1.29	1.83	1.56	0.38
	Santa Barbara	Manganese	mg/kg	1.36	1.36	1.36	
	Santa Cruz	Mercury	mg/kg	0.005	0.027	0.016	0.016
	Moss Landing	Mercury	mg/kg	0.011	0.011	0.011	
	Monterey	Mercury	mg/kg	0.033	0.033	0.033	
	Morro Bay	Mercury	mg/kg	0.030	0.102	0.068	0.027
	Port San Luis	Mercury	mg/kg	0.019	0.037	0.028	0.013
	Santa Barbara	Mercury	mg/kg	0.053	0.053	0.053	
	Santa Cruz	Nickel	mg/kg	0.009	0.009	0.009	0.000
	Moss Landing	Nickel	mg/kg	0.120	0.120	0.120	
	Monterey	Nickel	mg/kg	0.009	0.009	0.009	
	Morro Bay	Nickel	mg/kg	0.023	0.416	0.203	0.155
	Port San Luis	Nickel	mg/kg	0.041	0.071	0.056	0.021
	Santa Barbara	Nickel	mg/kg	0.009	0.009	0.009	
	Santa Cruz	Selenium	mg/kg	0.418	0.616	0.517	0.140
	Moss Landing	Selenium	mg/kg	0.432	0.432	0.432	
	Monterey	Selenium	mg/kg	0.332	0.332	0.332	
	Morro Bay	Selenium	mg/kg	0.360	0.470	0.437	0.037
	Port San Luis	Selenium	mg/kg	0.344	0.352	0.348	0.006
	Santa Barbara	Selenium	mg/kg	0.338	0.338	0.338	
	Santa Cruz	Silver	mg/kg	0.003	0.003	0.003	0.000
	Moss Landing	Silver	mg/kg	0.003	0.003	0.003	
	Monterey	Silver	mg/kg	0.003	0.003	0.003	
	Morro Bay	Silver	mg/kg	0.015	0.015	0.015	0.000
	Port San Luis	Silver	mg/kg	0.003	0.003	0.003	0.000
	Santa Barbara	Silver	mg/kg	0.003	0.003	0.003	
	Santa Cruz	Zinc	mg/kg	11.9	15.7	13.8	2.7
	Moss Landing	Zinc	mg/kg	11.4	11.4	11.4	
	Monterey	Zinc	mg/kg	13.0	13.0	13.0	
	Morro Bay	Zinc	mg/kg	13.2	15.5	14.4	0.7
	Port San Luis	Zinc	mg/kg	11.1	12.4	11.8	0.9
	Santa Barbara	Zinc	mg/kg	10.1	10.1	10.1	
	California Halibut	Aluminum	mg/kg	2.9	6.4	4.3	1.8
	Speckled Sanddab	Aluminum	mg/kg	18.5	85.0	43.1	22.1
	Starry Flounder	Aluminum	mg/kg	27.6	49.2	38.4	15.3
	California Halibut	Arsenic	mg/kg	0.86	1.10	0.96	0.12
	Speckled Sanddab	Arsenic	mg/kg	0.54	1.51	1.01	0.27
	Starry Flounder	Arsenic	mg/kg	1.03	1.14	1.08	0.08
	California Halibut	Cadmium	mg/kg	0.010	0.014	0.012	0.002
	Speckled Sanddab	Cadmium	mg/kg	0.009	0.192	0.053	0.048
	Starry Flounder	Cadmium	mg/kg	0.009	0.027	0.018	0.012
	California Halibut	Chromium	mg/kg	0.22	0.36	0.26	0.08
	Speckled Sanddab	Chromium	mg/kg	0.12	0.86	0.38	0.25
	Starry Flounder	Chromium	mg/kg	0.16	0.40	0.28	0.17
	California Halibut	Copper	mg/kg	0.52	0.73	0.61	0.11
	Speckled Sanddab	Copper	mg/kg	0.52	1.35	0.86	0.25

Group	Harbor/Fish Species	Analyte	Unit	Min	Max	Mean	SD
	Starry Flounder	Copper	mg/kg	0.58	1.55	1.06	0.68
	California Halibut	Lead	mg/kg	0.062	0.096	0.078	0.017
	Speckled Sanddab	Lead	mg/kg	0.029	0.218	0.095	0.053
	Starry Flounder	Lead	mg/kg	0.035	0.085	0.060	0.035
	Speckled Sanddab	Manganese	mg/kg	0.50	3.71	1.78	1.08
	Starry Flounder	Manganese	mg/kg	1.02	1.02	1.02	
	California Halibut	Mercury	mg/kg	0.068	0.101	0.085	0.017
	Speckled Sanddab	Mercury	mg/kg	0.011	0.120	0.048	0.030
	Starry Flounder	Mercury	mg/kg	0.005	0.088	0.047	0.059
	California Halibut	Nickel	mg/kg	0.023	0.023	0.023	0.000
	Speckled Sanddab	Nickel	mg/kg	0.009	0.810	0.190	0.275
	Starry Flounder	Nickel	mg/kg	0.009	0.221	0.115	0.150
	California Halibut	Selenium	mg/kg	0.410	0.470	0.440	0.030
	Speckled Sanddab	Selenium	mg/kg	0.332	0.616	0.415	0.080
	Starry Flounder	Selenium	mg/kg	0.418	0.525	0.472	0.076
	California Halibut	Silver	mg/kg	0.015	0.015	0.015	0.000
	Speckled Sanddab	Silver	mg/kg	0.003	0.015	0.009	0.007
	Starry Flounder	Silver	mg/kg	0.003	0.015	0.009	0.009
	California Halibut	Zinc	mg/kg	13.4	16.0	14.3	1.4
	Speckled Sanddab	Zinc	mg/kg	10.1	15.7	13.3	1.8
	Starry Flounder	Zinc	mg/kg	11.9	15.2	13.6	2.3
Trace Organics	Santa Cruz	Total Chlordane	ng/g	3.31	12.93	8.12	6.80
	Moss Landing	Total Chlordane	ng/g	2.20	2.20	2.20	
	Monterey	Total Chlordane	ng/g	3.72	3.72	3.72	
	Morro Bay	Total Chlordane	ng/g	0.01	0.01	0.01	0.00
	Port San Luis	Total Chlordane	ng/g	1.33	1.33	1.33	0.00
	Santa Barbara	Total Chlordane	ng/g	2.15	2.15	2.15	
	Santa Cruz	Chlorpyrifos	ng/g	0.389	0.389	0.389	0.000
	Moss Landing	Chlorpyrifos	ng/g	0.389	0.389	0.389	
	Monterey	Chlorpyrifos	ng/g	0.389	0.389	0.389	
	Morro Bay	Chlorpyrifos	ng/g	NA	NA	NA	NA
	Port San Luis	Chlorpyrifos	ng/g	0.389	0.389	0.389	0.000
	Santa Barbara	Chlorpyrifos	ng/g	0.389	0.389	0.389	
	Santa Cruz	Total DDT	ng/g	13.67	25.46	19.57	8.34
	Moss Landing	Total DDT	ng/g	60.90	60.90	60.90	
	Monterey	Total DDT	ng/g	27.05	27.05	27.05	
	Morro Bay	Total DDT	ng/g	2.18	40.75	10.94	13.84
	Port San Luis	Total DDT	ng/g	13.21	23.91	18.56	7.57
	Santa Barbara	Total DDT	ng/g	7.59	7.59	7.59	
	Santa Cruz	Diazinon	ng/g	3.15	3.15	3.15	0.00
	Moss Landing	Diazinon	ng/g	3.15	3.15	3.15	
	Monterey	Diazinon	ng/g	3.15	3.15	3.15	
	Morro Bay	Diazinon	ng/g	NA	NA	NA	NA
	Port San Luis	Diazinon	ng/g	3.15	3.15	3.15	0.00
	Santa Barbara	Diazinon	ng/g	3.15	3.15	3.15	
	Santa Cruz	Dibutyltin	ng/g	10.0	10.0	10.0	0.0
	Moss Landing	Dibutyltin	ng/g	10.0	10.0	10.0	

Group	Harbor/Fish Species	Analyte	Unit	Min	Max	Mean	SD
	Monterey	Dibutyltin	ng/g	10.0	10.0	10.0	
	Morro Bay	Dibutyltin	ng/g	NA	NA	NA	NA
	Port San Luis	Dibutyltin	ng/g	10.0	10.0	10.0	0.0
	Santa Barbara	Dibutyltin	ng/g	10.0	10.0	10.0	
	Santa Cruz	HMW PAHs	ng/g	2.92	2.92	2.92	0.00
	Moss Landing	HMW PAHs	ng/g	2.92	2.92	2.92	
	Monterey	HMW PAHs	ng/g	2.92	2.92	2.92	
	Morro Bay	HMW PAHs	ng/g	39.15	39.15	39.15	0.00
	Port San Luis	HMW PAHs	ng/g	2.92	6.26	4.59	2.36
	Santa Barbara	HMW PAHs	ng/g	2.92	2.92	2.92	
	Santa Cruz	LMW PAHs	ng/g	2.92	3.56	3.24	0.46
	Moss Landing	LMW PAHs	ng/g	2.92	2.92	2.92	
	Monterey	LMW PAHs	ng/g	3.47	3.47	3.47	
	Morro Bay	LMW PAHs	ng/g	27.61	27.61	27.61	0.00
	Port San Luis	LMW PAHs	ng/g	2.92	4.27	3.59	0.96
	Santa Barbara	LMW PAHs	ng/g	4.48	4.48	4.48	
	Santa Cruz	Total PAHs	ng/g	5.83	6.48	6.16	0.46
	Moss Landing	Total PAHs	ng/g	5.83	5.83	5.83	
	Monterey	Total PAHs	ng/g	6.39	6.39	6.39	
	Morro Bay	Total PAHs	ng/g	66.76	66.76	66.76	0.00
	Port San Luis	Total PAHs	ng/g	5.83	10.53	8.18	3.32
	Santa Barbara	Total PAHs	ng/g	7.40	7.40	7.40	
	Santa Cruz	Total PCB Aroclors	ng/g	27.7	53.7	40.7	18.4
	Moss Landing	Total PCB Aroclors	ng/g	25.7	25.7	25.7	
	Monterey	Total PCB Aroclors	ng/g	102.7	102.7	102.7	
	Morro Bay	Total PCB Aroclors	ng/g	NA	NA	NA	NA
	Port San Luis	Total PCB Aroclors	ng/g	41.7	198.7	120.2	111.0
	Santa Barbara	Total PCB Aroclors	ng/g	17.7	17.7	17.7	
	Morro Bay	Total PCBs	ng/g	0.9	8.0	2.9	2.9
	Santa Cruz	Tributyltin	ng/g	5.0	5.0	5.0	0.0
	Moss Landing	Tributyltin	ng/g	5.0	5.0	5.0	
	Monterey	Tributyltin	ng/g	5.0	5.0	5.0	
	Morro Bay	Tributyltin	ng/g	NA	NA	NA	NA
	Port San Luis	Tributyltin	ng/g	5.0	5.0	5.0	0.0
	Santa Barbara	Tributyltin	ng/g	5.0	5.0	5.0	
	California Halibut	Total Chlordane	ng/g	0.01	0.01	0.01	0.00
	Speckled Sanddab	Total Chlordane	ng/g	0.01	12.93	1.98	3.66
	Starry Flounder	Total Chlordane	ng/g	0.01	3.31	1.66	2.34
	California Halibut	Chlorpyrifos	ng/g	NA	NA	NA	NA
	Speckled Sanddab	Chlorpyrifos	ng/g	0.389	0.389	0.389	0.000
	Starry Flounder	Chlorpyrifos	ng/g	0.389	0.389	0.389	
	California Halibut	Total DDT	ng/g	19.56	30.36	24.24	5.54
	Speckled Sanddab	Total DDT	ng/g	2.18	60.90	14.64	17.52
	Starry Flounder	Total DDT	ng/g	13.67	51.13	32.40	26.49
	California Halibut	Diazinon	ng/g	NA	NA	NA	NA
	Speckled Sanddab	Diazinon	ng/g	3.15	3.15	3.15	0.00
	Starry Flounder	Diazinon	ng/g	3.15	3.15	3.15	

Group	Harbor/Fish Species	Analyte	Unit	Min	Max	Mean	SD
	California Halibut	Dibutyltin	ng/g	NA	NA	NA	NA
	Speckled Sanddab	Dibutyltin	ng/g	10.0	10.0	10.0	0.0
	Starry Flounder	Dibutyltin	ng/g	10.0	10.0	10.0	
	California Halibut	HMW PAHs	ng/g	39.15	39.15	39.15	0.00
	Speckled Sanddab	HMW PAHs	ng/g	2.92	39.15	21.31	18.65
	Starry Flounder	HMW PAHs	ng/g	2.92	39.15	21.03	25.62
	California Halibut	LMW PAHs	ng/g	27.61	27.61	27.61	0.00
	Speckled Sanddab	LMW PAHs	ng/g	2.92	27.61	15.55	12.60
	Starry Flounder	LMW PAHs	ng/g	3.56	27.61	15.58	17.00
	California Halibut	Total PAHs	ng/g	66.76	66.76	66.76	0.00
	Speckled Sanddab	Total PAHs	ng/g	5.83	66.76	36.86	31.25
	Starry Flounder	Total PAHs	ng/g	6.48	66.76	36.62	42.62
	California Halibut	Total PCB Aroclors	ng/g	NA	NA	NA	NA
	Speckled Sanddab	Total PCB Aroclors	ng/g	17.7	198.7	36.7	59.9
	Starry Flounder	Total PCB Aroclors	ng/g	17.7	27.7	13.8	19.6
	California Halibut	Total PCBs	ng/g	5.1	10.7	7.3	3.0
	Speckled Sanddab	Total PCBs	ng/g	0.85	0.85	0.85	0.00
	Starry Flounder	Total PCBs	ng/g	9.8	9.8	9.8	
	California Halibut	Tributyltin	ng/g	NA	NA	NA	NA
	Speckled Sanddab	Tributyltin	ng/g	5.0	5.0	5.0	0.0
	Starry Flounder	Tributyltin	ng/g	5.0	5.0	5.0	

8.5 Appendix E

Appendix E. Bivalve mussel tissue summary information by harbor. Minimum (Min), maximum (Max), mean (Mean), and standard deviation (SD) values are presented for each trace metals and trace organic analyte. Non-detect results were given values equal to ½ MDL for summation purposes. Data represents wet weight values.

Group	Harbor/Fish Species	Analyte	Unit	Min	Max	Mean	SD
Trace Metals	Santa Cruz Harbor	Aluminum	mg/kg	129.3	129.3	129.3	
	Moss Landing Harbor	Aluminum	mg/kg	80.3	156.4	118.3	53.8
	Monterey Harbor	Aluminum	mg/kg	4.3	68.5	36.4	45.4
	Morro Bay Harbor	Aluminum	mg/kg	32.5	32.5	32.5	
	Port San Luis	Aluminum	mg/kg	13.1	22.1	17.6	6.3
	Santa Barbara Harbor	Aluminum	mg/kg	12.0	16.9	14.5	3.5
	Santa Cruz Harbor	Arsenic	mg/kg	1.63	1.63	1.63	
	Moss Landing Harbor	Arsenic	mg/kg	1.63	1.69	1.66	0.04
	Monterey Harbor	Arsenic	mg/kg	1.46	2.38	1.92	0.65
	Morro Bay Harbor	Arsenic	mg/kg	2.41	2.41	2.41	
	Port San Luis	Arsenic	mg/kg	2.09	2.29	2.19	0.15
	Santa Barbara Harbor	Arsenic	mg/kg	1.54	2.04	1.79	0.36
	Santa Cruz Harbor	Cadmium	mg/kg	0.734	0.734	0.734	
	Moss Landing Harbor	Cadmium	mg/kg	1.004	2.232	1.618	0.869
	Monterey Harbor	Cadmium	mg/kg	0.630	2.749	1.690	1.499
	Morro Bay Harbor	Cadmium	mg/kg	1.762	1.762	1.762	
	Port San Luis	Cadmium	mg/kg	1.755	1.772	1.763	0.012
	Santa Barbara Harbor	Cadmium	mg/kg	0.493	0.950	0.721	0.323
	Santa Cruz Harbor	Chromium	mg/kg	0.43	0.43	0.43	
	Moss Landing Harbor	Chromium	mg/kg	0.37	0.49	0.43	0.09
	Monterey Harbor	Chromium	mg/kg	0.19	0.52	0.35	0.23
	Morro Bay Harbor	Chromium	mg/kg	0.45	0.45	0.45	
	Port San Luis	Chromium	mg/kg	0.27	0.29	0.28	0.01
	Santa Barbara Harbor	Chromium	mg/kg	0.25	0.27	0.26	0.02
	Santa Cruz Harbor	Copper	mg/kg	15.19	15.19	15.19	
	Moss Landing Harbor	Copper	mg/kg	1.62	2.45	2.03	0.59
	Monterey Harbor	Copper	mg/kg	1.82	16.19	9.00	10.16
	Morro Bay Harbor	Copper	mg/kg	1.45	1.45	1.45	
	Port San Luis	Copper	mg/kg	1.58	1.78	1.68	0.14
	Santa Barbara Harbor	Copper	mg/kg	1.56	5.90	3.73	3.07
	Santa Cruz Harbor	Lead	mg/kg	0.356	0.356	0.356	
	Moss Landing Harbor	Lead	mg/kg	0.168	0.187	0.177	0.014
	Monterey Harbor	Lead	mg/kg	0.725	1.146	0.936	0.298
	Morro Bay Harbor	Lead	mg/kg	0.081	0.081	0.081	
	Port San Luis	Lead	mg/kg	0.168	0.208	0.188	0.029
	Santa Barbara Harbor	Lead	mg/kg	0.210	0.214	0.212	0.002
	Santa Cruz Harbor	Manganese	mg/kg	1.52	1.52	1.52	
	Moss Landing Harbor	Manganese	mg/kg	1.53	2.59	2.06	0.75

Group	Harbor/Fish Species	Analyte	Unit	Min	Max	Mean	SD
	Monterey Harbor	Manganese	mg/kg	0.59	0.64	0.61	0.03
	Morro Bay Harbor	Manganese	mg/kg	1.02	1.02	1.02	
	Port San Luis	Manganese	mg/kg	0.80	0.97	0.89	0.12
	Santa Barbara Harbor	Manganese	mg/kg	0.72	0.75	0.73	0.02
	Santa Cruz Harbor	Mercury	mg/kg	0.020	0.020	0.020	
	Moss Landing Harbor	Mercury	mg/kg	0.005	0.016	0.011	0.008
	Monterey Harbor	Mercury	mg/kg	0.012	0.035	0.023	0.017
	Morro Bay Harbor	Mercury	mg/kg	0.012	0.012	0.012	
	Port San Luis	Mercury	mg/kg	0.012	0.021	0.016	0.006
	Santa Barbara Harbor	Mercury	mg/kg	0.008	0.015	0.012	0.005
	Santa Cruz Harbor	Nickel	mg/kg	0.265	0.265	0.265	
	Moss Landing Harbor	Nickel	mg/kg	0.351	0.405	0.378	0.039
	Monterey Harbor	Nickel	mg/kg	0.162	0.256	0.209	0.066
	Morro Bay Harbor	Nickel	mg/kg	0.647	0.647	0.647	
	Port San Luis	Nickel	mg/kg	0.190	0.216	0.203	0.018
	Santa Barbara Harbor	Nickel	mg/kg	0.148	0.264	0.206	0.081
	Santa Cruz Harbor	Selenium	mg/kg	0.443	0.443	0.443	
	Moss Landing Harbor	Selenium	mg/kg	0.524	0.652	0.588	0.091
	Monterey Harbor	Selenium	mg/kg	0.510	0.599	0.554	0.063
	Morro Bay Harbor	Selenium	mg/kg	0.598	0.598	0.598	
	Port San Luis	Selenium	mg/kg	0.589	0.610	0.600	0.015
	Santa Barbara Harbor	Selenium	mg/kg	0.370	0.463	0.416	0.065
	Santa Cruz Harbor	Silver	mg/kg	0.004	0.004	0.004	
	Moss Landing Harbor	Silver	mg/kg	0.003	0.003	0.003	0.000
	Monterey Harbor	Silver	mg/kg	0.003	0.007	0.005	0.003
	Morro Bay Harbor	Silver	mg/kg	0.010	0.010	0.010	
	Port San Luis	Silver	mg/kg	0.041	0.059	0.050	0.013
	Santa Barbara Harbor	Silver	mg/kg	0.003	0.003	0.003	0.000
	Santa Cruz Harbor	Zinc	mg/kg	61.8	61.8	61.8	
	Moss Landing Harbor	Zinc	mg/kg	23.8	36.4	30.1	8.9
	Monterey Harbor	Zinc	mg/kg	20.4	90.5	55.5	49.6
	Morro Bay Harbor	Zinc	mg/kg	16.2	16.2	16.2	
	Port San Luis	Zinc	mg/kg	14.9	17.1	16.0	1.6
	Santa Barbara Harbor	Zinc	mg/kg	24.6	51.4	38.0	18.9
Trace Organics	Santa Cruz	Total Chlordane	ng/g	4.20	4.20	4.20	
	Moss Landing	Total Chlordane	ng/g	1.98	7.30	4.64	3.76
	Monterey	Total Chlordane	ng/g	1.33	1.33	1.33	0.00
	Morro Bay	Total Chlordane	ng/g	1.33	1.33	1.33	
	Port San Luis	Total Chlordane	ng/g	1.33	1.33	1.33	0.00
	Santa Barbara	Total Chlordane	ng/g	1.33	2.18	1.76	0.61
	Santa Cruz	Total DDT	ng/g	10.26	10.26	10.26	
	Moss Landing	Total DDT	ng/g	27.04	245.38	136.21	154.39
	Monterey	Total DDT	ng/g	5.71	5.96	5.83	0.18
	Morro Bay	Total DDT	ng/g	6.25	6.25	6.25	
	Port San Luis	Total DDT	ng/g	6.46	6.52	6.49	0.05
	Santa Barbara	Total DDT	ng/g	5.39	5.50	5.45	0.08
	Santa Cruz	LMW PAHs	ng/g	31.55	31.55	31.55	

Group	Harbor/Fish Species	Analyte	Unit	Min	Max	Mean	SD
	Moss Landing	LMW PAHs	ng/g	9.79	18.73	14.26	6.32
	Monterey	LMW PAHs	ng/g	10.61	36.31	23.46	18.18
	Morro Bay	LMW PAHs	ng/g	5.41	5.41	5.41	
	Port San Luis	LMW PAHs	ng/g	5.90	8.29	7.10	1.69
	Santa Barbara	LMW PAHs	ng/g	14.56	14.64	14.60	0.05
	Santa Cruz	HMW PAHs	ng/g	77.29	77.29	77.29	
	Moss Landing	HMW PAHs	ng/g	3.84	12.11	7.98	5.84
	Monterey	HMW PAHs	ng/g	4.51	46.81	25.66	29.91
	Morro Bay	HMW PAHs	ng/g	2.92	2.92	2.92	
	Port San Luis	HMW PAHs	ng/g	2.92	4.13	3.52	0.86
	Santa Barbara	HMW PAHs	ng/g	5.16	5.91	5.53	0.53
	Santa Cruz	Total PAHs	ng/g	108.84	108.84	108.84	
	Moss Landing	Total PAHs	ng/g	13.63	30.84	22.24	12.17
	Monterey	Total PAHs	ng/g	15.11	83.12	49.12	48.09
	Morro Bay	Total PAHs	ng/g	8.32	8.32	8.32	
	Port San Luis	Total PAHs	ng/g	8.82	12.42	10.62	2.55
	Santa Barbara	Total PAHs	ng/g	19.80	20.47	20.13	0.48
	Santa Cruz	Total PCB Aroclors	ng/g	37.2	37.2	37.2	
	Moss Landing	Total PCB Aroclors	ng/g	13.8	48.7	31.2	24.6
	Monterey	Total PCB Aroclors	ng/g	16.3	27.5	21.9	7.9
	Morro Bay	Total PCB Aroclors	ng/g	8.4	8.4	8.4	
	Port San Luis	Total PCB Aroclors	ng/g	12.5	12.6	12.5	0.0
	Santa Barbara	Total PCB Aroclors	ng/g	8.4	16.5	12.4	5.7
	Santa Cruz Harbor	Chlorpyrifos	ng/g	0.39	0.39	0.39	
	Moss Landing Harbor	Chlorpyrifos	ng/g	0.39	0.39	0.39	0.00
	Monterey Harbor	Chlorpyrifos	ng/g	0.39	0.39	0.39	0.00
	Morro Bay Harbor	Chlorpyrifos	ng/g	0.39	0.39	0.39	
	Port San Luis	Chlorpyrifos	ng/g	0.39	0.39	0.39	0.00
	Santa Barbara Harbor	Chlorpyrifos	ng/g	0.39	0.39	0.39	0.00
	Santa Cruz Harbor	Diazinon	ng/g	3.15	3.15	3.15	
	Moss Landing Harbor	Diazinon	ng/g	3.15	3.15	3.15	0.00
	Monterey Harbor	Diazinon	ng/g	3.15	3.15	3.15	0.00
	Morro Bay Harbor	Diazinon	ng/g	3.15	3.15	3.15	
	Port San Luis	Diazinon	ng/g	3.15	3.15	3.15	0.00
	Santa Barbara Harbor	Diazinon	ng/g	3.15	3.15	3.15	0.00
	Santa Cruz Harbor	Dibutyltin	ng/g	10.0	10.0	10.0	
	Moss Landing Harbor	Dibutyltin	ng/g	10.0	10.0	10.0	0.0
	Monterey Harbor	Dibutyltin	ng/g	10.0	10.0	10.0	0.0
	Morro Bay Harbor	Dibutyltin	ng/g	10.0	10.0	10.0	
	Port San Luis	Dibutyltin	ng/g	10.0	10.0	10.0	0.0
	Santa Barbara Harbor	Dibutyltin	ng/g	10.0	10.0	10.0	0.0
	Santa Cruz Harbor	Tributyltin	ng/g	5.0	5.0	5.0	
	Moss Landing Harbor	Tributyltin	ng/g	5.0	5.0	5.0	0.0
	Monterey Harbor	Tributyltin	ng/g	5.0	5.0	5.0	0.0
	Morro Bay Harbor	Tributyltin	ng/g	5.0	5.0	5.0	
	Port San Luis	Tributyltin	ng/g	5.0	5.0	5.0	0.0
	Santa Barbara Harbor	Tributyltin	ng/g	5.0	5.0	5.0	0.0

8.6 Appendix F

Appendix F. Summary Quality Assurance/Quality Control (QA/QC) tables for Section 3.0. QA/QC data applies to the five harbors sampled under SWAMP and the bivalve mussel tissue collected in Morro Bay.

Table 1. Percent recovery (%R) and relative percent difference (RPD) acceptance criteria for different categories of analytes in water**.**

Analyte Category	% Surrogate Recovery Acceptance Criteria	% MS/MSD Recovery Acceptance Criteria	% CRM, LCM, & LCS Acceptance Criteria	RPD Criteria (MS/MSD, Laboratory Duplicate, Field Duplicate)
Conventional Constituents	NA	80-120	80-120	25
Trace Metals (Including Mercury)	NA	75-125	75-125	25
Trace Organics (PCBs, OC & OP pesticides)	50-150	50-150	50-150	25

Table 2. Field duplicate samples that did not meet quality control acceptance criteria.

Analyte	Station Code	Date	Field Sample	Field Duplicate	Units	RPD	Laboratory
Acenaphthene	309MTRY20	24/Jun/2004	14.6	10.3	ng/g	34.54	DFG-WPCL
Benzo(g,h,i)perylene	309MTRY20	24/Jun/2004	254	194	ng/g	26.79	DFG-WPCL
Biphenyl	309MTRY20	24/Jun/2004	5.76	3.97	ng/g	36.79	DFG-WPCL
DDD(o,p')	309MTRY20	24/Jun/2004	1.86	1.37	ng/g	30.34	DFG-WPCL
Dibenzothiophene	309MTRY20	24/Jun/2004	28.7	21.7	ng/g	27.78	DFG-WPCL
Dibenzothiophenes, C1-	309MTRY20	24/Jun/2004	84.6	64.3	ng/g	27.27	DFG-WPCL
Dimethylphenanthrene, 3,6-	309MTRY20	24/Jun/2004	30.3	23.2	ng/g	26.54	DFG-WPCL
Fluoranthene/Pyrenes, C1-	309MTRY20	24/Jun/2004	916	664	ng/g	31.90	DFG-WPCL
Fluorene	309MTRY20	24/Jun/2004	70	51.8	ng/g	29.89	DFG-WPCL
Fluorenes, C1-	309MTRY20	24/Jun/2004	133	96	ng/g	32.31	DFG-WPCL
Fluorenes, C2-	309MTRY20	24/Jun/2004	117	57	ng/g	68.97	DFG-WPCL
Fluorenes, C3-	309MTRY20	24/Jun/2004	39.1	24.2	ng/g	47.08	DFG-WPCL
Methyldibenzothiophene, 4-	309MTRY20	24/Jun/2004	32.2	24.2	ng/g	28.37	DFG-WPCL
Methylfluorene, 1-	309MTRY20	24/Jun/2004	44.7	30.9	ng/g	36.51	DFG-WPCL
Methylnaphthalene, 1-	309MTRY20	24/Jun/2004	14.4	9.94	ng/g	36.65	DFG-WPCL
Methylnaphthalene, 2-	309MTRY20	24/Jun/2004	20.4	13	ng/g	44.31	DFG-WPCL
Naphthalene	309MTRY20	24/Jun/2004	36.5	18.6	ng/g	64.97	DFG-WPCL
Naphthalenes, C1-	309MTRY20	24/Jun/2004	35.7	23.5	ng/g	41.22	DFG-WPCL
Naphthalenes, C2-	309MTRY20	24/Jun/2004	96.9	68.6	ng/g	34.20	DFG-WPCL
Naphthalenes, C4-	309MTRY20	24/Jun/2004	61.4	46.8	ng/g	26.99	DFG-WPCL
Nitrate as N	309MTRY20	24/Jun/2004	0.002	0.002	mg/l	0.00	MLML-TM
Nitrate as N	309MTRY20	24/Jun/2004	0.004	0.002	mg/l	66.67	MLML-TM
PCB 027	309MTRY20	24/Jun/2004	-0.145	0.28	ng/g	629.63	DFG-WPCL
PCB 052	309MTRY20	24/Jun/2004	1.03	1.63	ng/g	45.11	DFG-WPCL
PCB 087	309MTRY20	24/Jun/2004	0.837	1.38	ng/g	48.99	DFG-WPCL
PCB 095	309MTRY20	24/Jun/2004	1.24	2.1	ng/g	51.50	DFG-WPCL
PCB 097	309MTRY20	24/Jun/2004	0.7	1.01	ng/g	36.26	DFG-WPCL
PCB 099	309MTRY20	24/Jun/2004	0.968	1.39	ng/g	35.79	DFG-WPCL
PCB 101	309MTRY20	24/Jun/2004	2.14	3.24	ng/g	40.89	DFG-WPCL
PCB 105	309MTRY20	24/Jun/2004	1.02	1.33	ng/g	26.38	DFG-WPCL

Analyte	Station Code	Date	Field Sample	Field Duplicate	Units	RPD	Laboratory
PCB 110	309MTRY20	24/Jun/2004	2.61	3.93	ng/g	40.37	DFG-WPCL
PCB 118	309MTRY20	24/Jun/2004	2.41	3.47	ng/g	36.05	MPSL-DFG
PCB 128	309MTRY20	24/Jun/2004	0.604	0.809	ng/g	29.02	MPSL-DFG
PCB 137	309MTRY20	24/Jun/2004	-0.145	0.188	ng/g	1548.84	MPSL-DFG
PCB 138	309MTRY20	24/Jun/2004	3.43	4.6	ng/g	29.14	DFG-WPCL
PCB 141	309MTRY20	24/Jun/2004	0.345	0.524	ng/g	41.20	DFG-WPCL
PCB 156	309MTRY20	24/Jun/2004	0.268	0.438	ng/g	48.16	DFG-WPCL
PCB 158	309MTRY20	24/Jun/2004	0.258	0.39	ng/g	40.74	DFG-WPCL
PCB Aroclor 1254	309MTRY20	24/Jun/2004	32	47	ng/g	37.97	DFG-WPCL
Phenanthrene	309MTRY20	24/Jun/2004	393	304	ng/g	25.54	DFG-WPCL
Phenanthrene/Anthracene, C1-	309MTRY20	24/Jun/2004	540	374	ng/g	36.32	DFG-WPCL
Phenanthrene/Anthracene, C2-	309MTRY20	24/Jun/2004	403	274	ng/g	38.11	DFG-WPCL
Total Suspended Solids	309MTRY20	24/Jun/2004	12.5	-5	mg/l	466.67	MLML_TM
Total Suspended Solids	309MTRY20	24/Jun/2004	17.33	12.25	mg/l	34.35	MLML-TM
Trimethylnaphthalene, 2,3,5-	309MTRY20	24/Jun/2004	23.7	8.16	ng/g	97.55	DFG-WPCL
Acenaphthene	310SNLS25	22/Jun/2004	1.82	4.64	ng/g	87.31	DFG-WPCL
Ammonia as N	310SNLS25	22/Jun/2004	0.0213	0.016	mg/l	28.42	MLML_TM
Anthracene	310SNLS25	22/Jun/2004	8.85	15.4	ng/g	54.02	DFG-WPCL
Benz(a)anthracene	310SNLS25	22/Jun/2004	17.3	26.2	ng/g	40.92	DFG-WPCL
Benzo(a)pyrene	310SNLS25	22/Jun/2004	18.4	29	ng/g	44.73	DFG-WPCL
Benzo(b)fluoranthene	310SNLS25	22/Jun/2004	30.6	41.5	ng/g	30.24	DFG-WPCL
Benzo(e)pyrene	310SNLS25	22/Jun/2004	14.4	20.4	ng/g	34.48	DFG-WPCL
Benzo(g,h,i)perylene	310SNLS25	22/Jun/2004	13.5	17.4	ng/g	25.24	DFG-WPCL
Benzo(k)fluoranthene	310SNLS25	22/Jun/2004	11	16.9	ng/g	42.29	DFG-WPCL
Chlorophyll a	310SNLS25	22/Jun/2004	0.639	1.21	µg/L	61.76	MPSL-DFG
Chrysenes, C1-	310SNLS25	22/Jun/2004	7.27	9.71	ng/g	28.74	DFG-WPCL
Dibenz(a,h)anthracene	310SNLS25	22/Jun/2004	3.78	7.26	ng/g	63.04	DFG-WPCL
Dibenzothiophene	310SNLS25	22/Jun/2004	1.45	2.49	ng/g	52.79	DFG-WPCL
Dibenzothiophenes, C1-	310SNLS25	22/Jun/2004	2.06	3.67	ng/g	56.20	DFG-WPCL
Dimethylphenanthrene, 3,6-	310SNLS25	22/Jun/2004	-0.671	1.64	ng/g	476.99	DFG-WPCL
Fluoranthene	310SNLS25	22/Jun/2004	41.5	61.7	ng/g	39.15	DFG-WPCL

Analyte	Station Code	Date	Field Sample	Field Duplicate	Units	RPD	Laboratory
Fluoranthene/Pyrenes, C1-	310SNLS25	22/Jun/2004	41.7	55.4	ng/g	28.22	DFG-WPCL
Fluorene	310SNLS25	22/Jun/2004	4.16	6.5	ng/g	43.90	DFG-WPCL
Fluorenes, C3-	310SNLS25	22/Jun/2004	2.32	3.51	ng/g	40.82	DFG-WPCL
Indeno(1,2,3-c,d)pyrene	310SNLS25	22/Jun/2004	13.8	27.8	ng/g	67.31	DFG-WPCL
Methylfluoranthene, 2-	310SNLS25	22/Jun/2004	4.7	6.32	ng/g	29.40	DFG-WPCL
Methylnaphthalene, 1-	310SNLS25	22/Jun/2004	2.95	3.02	ng/g	2.35	DFG-WPCL
Methylphenanthrene, 1-	310SNLS25	22/Jun/2004	3.57	5.83	ng/g	48.09	DFG-WPCL
PCB 028	310SNLS25	22/Jun/2004	-0.134	0.209	ng/g	914.67	DFG-WPCL
PCB 031	310SNLS25	22/Jun/2004	-0.134	0.181	ng/g	1340.43	DFG-WPCL
PCB 033	310SNLS25	22/Jun/2004	-0.134	0.155	ng/g	2752.38	DFG-WPCL
PCB 049	310SNLS25	22/Jun/2004	0.161	0.215	ng/g	28.72	DFG-WPCL
PCB 206	310SNLS25	22/Jun/2004	-0.134	0.149	ng/g	3773.33	DFG-WPCL
PCB Aroclor 1260	310SNLS25	22/Jun/2004	5	-5	ng/g	200.00	DFG-WPCL
Perylene	310SNLS25	22/Jun/2004	7.4	9.95	ng/g	29.39	DFG-WPCL
Phenanthrene	310SNLS25	22/Jun/2004	19.5	38.6	ng/g	65.75	DFG-WPCL
Phenanthrene/Anthracene, C1-	310SNLS25	22/Jun/2004	17.9	29.8	ng/g	49.90	DFG-WPCL
Phenanthrene/Anthracene, C3-	310SNLS25	22/Jun/2004	6.12	8.61	ng/g	33.81	DFG-WPCL
Pyrene	310SNLS25	22/Jun/2004	37.1	55.3	ng/g	39.39	DFG-WPCL
Total Suspended Solids	310SNLS25	22/Jun/2004	23.13	13.59	mg/l	51.96	MLML_TM
Total Suspended Solids	310SNLS25	22/Jun/2004	34.16	13.21	mg/l	88.45	MLML_TM
Tributyltin	310SNLS25	22/Jun/2004	199	95.3	ng/g	70.47	DFG-WPCL
Sand-Plumb	315SBRB03	22/Jun/2004	0.2	0.4	%	66.67	AMS
Sand-Plumb	315SBRB03	22/Jun/2004	0.57	0.4	%	35.05	AMS
PCB 028	310SNLS25(Fish)	22/Jun/2004	0.37	0.27	ng/g	31	DFG-WPCL
PCB 031	310SNLS25(Fish)	22/Jun/2004	0.189	0.139	ng/g	30	DFG-WPCL
PCB 060	310SNLS25(Fish)	22/Jun/2004	0.207	0.156	ng/g	28	DFG-WPCL
PCB 066	310SNLS25(Fish)	22/Jun/2004	0.721	0.55	ng/g	27	DFG-WPCL
PCB 074	310SNLS25(Fish)	22/Jun/2004	0.378	0.275	ng/g	31	DFG-WPCL

Table 3. Batches for which laboratory duplicate samples were not run.

Analyte	Batch ID	Notes	Laboratory
Chlorophyll a	CHL071604	QAO: no DUP	MPSL-DFG

Table 4. Laboratory duplicate samples that did not meet quality control acceptance criteria.

Analyte	Station Code	Parent Value	Duplicate Value	Units	RPD	Laboratory	Batch ID
Acenaphthene	310SNLS25	4.64	2.06	ng/g	77	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Aluminum	304SCRZ10	456	332	mg/kg	31.4	MPSL-DFG	MPSL_2005Dig15_T_TM
Aluminum	309MTRY28	18.4	13.8	mg/kg	28.4	MPSL-DFG	MPSL_2005Dig04_T_TM
Anthracene	310SNLS25	15.4	8.7	ng/g	56	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Anthracene	310SNLS21	2.11	1.47	ng/g	36	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Benz(a)anthracene	310SNLS25	26.2	19.3	ng/g	30	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Benz(a)anthracene	310SNLS21	4.41	1.72	ng/g	88	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Benzo(a)pyrene	310SNLS25	29	21.4	ng/g	30	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Benzo(a)pyrene	310SNLS21	5.57	3.24	ng/g	53	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Benzo(e)pyrene	310SNLS21	4.44	2.79	ng/g	46	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Benzo(g,h,i)perylene	310SNLS21	3.75	1.97	ng/g	62	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Chrysene	310SNLS25	20.8	14.6	ng/g	35	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Chrysene	310SNLS21	3.33	0.99	ng/g	110	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Chrysenes, C1-	310SNLS25	9.71	6.81	ng/g	35	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Chrysenes, C1-	310SNLS21	3.13	2.41	ng/g	26	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Dibenz(a,h)anthracene	310SNLS25	7.26	4.72	ng/g	42	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Dibenzothiophene	310SNLS25	2.49	1.44	ng/g	53	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Dibenzothiophenes, C1-	310SNLS25	3.67	2.55	ng/g	36	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Dimethylphenanthrene, 3,6-	310SNLS25	1.64	1.17	ng/g	33	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Fluoranthene	310SNLS25	61.7	43.2	ng/g	35	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Fluoranthene	310SNLS21	12.7	6.84	ng/g	60	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Fluoranthene/Pyrenes, C1-	310SNLS25	55.4	39	ng/g	35	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Fluorene	310SNLS25	6.5	4.11	ng/g	45	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Fluorenes, C2-	310SNLS25	5.66	4.33	ng/g	27	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Fluorenes, C3-	310SNLS25	3.51	2.22	ng/g	45	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Indeno(1,2,3-c,d)pyrene	310SNLS25	27.8	18.4	ng/g	41	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Indeno(1,2,3-c,d)pyrene	310SNLS21	3.27	1.69	ng/g	64	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Mercury	306MSLG26	-0.039	0.058	mg/kg	200	MPSL-DFG	MPSL_2005Dig05_T_Hg
Methylfluoranthene, 2-	310SNLS25	6.32	4.44	ng/g	35	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Methylfluoranthene, 2-	310SNLS21	1.41	-0.659	ng/g	550	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Methylfluorene, 1-	310SNLS21	-0.649	1.8	ng/g	430	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH

Analyte	Station Code	Parent Value	Duplicate Value	Units	RPD	Laboratory	Batch ID
Methylphenanthrene, 1-	310SNLS25	5.83	3.95	ng/g	38	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
PCB 028	310SNLS25	0.209	-0.132	ng/g	200	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 028	315SBRB29	-0.478	0.53	ng/g	200	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 031	310SNLS25	0.181	-0.132	ng/g	200	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 031	315SBRB29	1.05	0.653	ng/g	31	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 033	310SNLS25	0.155	-0.132	ng/g	200	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 049	310SNLS25	0.215	-0.132	ng/g	200	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 052	310SNLS25	0.319	0.197	ng/g	47.3	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 066	310SNLS25	0.335	0.254	ng/g	27.5	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 070	310SNLS25	0.379	0.275	ng/g	31.8	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 070	315SBRB29	0.881	1.21	ng/g	50	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 074	315SBRB29	-0.478	0.561	ng/g	200	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 087	310SNLS25	0.182	-0.132	ng/g	200	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 095	310SNLS25	0.254	0.145	ng/g	54.6	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 095	310SNLS21	0.145	0.195	ng/g	29.41	DFG-WPCL	WPCL_L-280-04_BS327_KR_S_PCB
PCB 099	310SNLS25	0.164	-0.132	ng/g	200	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 101	310SNLS25	0.388	0.221	ng/g	54.8	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 105	310SNLS25	0.194	0.137	ng/g	34.4	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 110	310SNLS25	0.521	0.351	ng/g	38.99	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 118	310SNLS25	0.427	0.314	ng/g	30.5	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 138	310SNLS21	0.158	0.206	ng/g	26.37	DFG-WPCL	WPCL_L-280-04_BS327_KR_S_PCB
PCB 149	310SNLS25	0.192	0.14	ng/g	31.3	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 151	315SBRB29	-0.478	0.528	ng/g	200	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 157	315SBRB29	0.543	-0.482	ng/g	200	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 157	304SCRZ07	-0.095	0.102	ng/g	200	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 200	315SBRB29	-0.478	0.673	ng/g	200	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 206	310SNLS25	0.149	-0.132	ng/g	200	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB Aroclor 1254	315SBRB29	-19.1	24	ng/g	200	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
Phenanthrene	310SNLS25	38.6	21.3	ng/g	58	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Phenanthrene	310SNLS21	8.87	4.39	ng/g	68	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Phenanthrene/Anthracene, C1-	310SNLS25	29.8	19.1	ng/g	44	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Phenanthrene/Anthracene, C1-	310SNLS21	9.45	6.81	ng/g	32	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH

Analyte	Station Code	Parent Value	Duplicate Value	Units	RPD	Laboratory	Batch ID
Phenanthrene/Anthracene, C3-	310SNLS25	8.61	6.19	ng/g	33	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Phenanthrene/Anthracene, C3-	310SNLS21	2.96	1.64	ng/g	57	DFG-WPCL	WPCL_L-280-04_BS329_S_PAH
Pyrene	310SNLS25	55.3	40.7	ng/g	30	DFG-WPCL	WPCL_L-280-04_BS328_S_PAH
Sand-Plumb	304SCRZ23	0.18	0.28	%	43.48	AMS	070704-03
Selenium	306MSLG26	3.09	3.98	mg/kg	25.3	MPSL-DFG	MPSL_2005Dig05_T_TM
Selenium	310SNLS17	0.1	0.07	mg/kg	35.29	DFG-WPCL	072704-Se

Table 5. Batches for which laboratory blanks were not run.

Analyte	Batch ID	Notes	Laboratory
Tributyltin	L-280-04-TBT_2	QAO: no blank	DFG-WPCL
Tributyltin	L321-322-04_TBT	QAO: no blank for extraction date 8/16	DFG-WPCL

Table 6. Laboratory method blanks in which analytes were detected.

Analyte	Result	Units	MDL	RL	Detected	Analysis Date	Method Name	Laboratory	Batch ID
Ammonia as N	0.0005	mg/l	0.0002	0.0022	DNQ	17/Sep/2004	SM 4500-NH3 DM	MLML_TM	091704-NH3
Ammonia as N	0.0003	mg/l	0.0002	0.0022	DNQ	17/Sep/2004	SM 4500-NH3 DM	MLML_TM	091704-NH3
Ammonia as N	0.0004	mg/l	0.0001	0.0028	DNQ	27/Sep/2004	SM 4500-NH3 DM	MLML_TM	092704-NH3
Ammonia as N	0.0004	mg/l	0.0001	0.0028	DNQ	27/Sep/2004	SM 4500-NH3 DM	MLML_TM	092704-NH3
Ammonia as N	0.0008	mg/l	0.0006	0.0022	DNQ	05/Oct/2004	SM 4500-NH3 DM	MLML_TM	100504-NH3
Ammonia as N	0.0007	mg/l	0.0006	0.0022	DNQ	05/Oct/2004	SM 4500-NH3 DM	MLML_TM	100504-NH3
Nitrate as N	0.001	mg/l	0.001	0.006	DNQ	20/Sep/2004	MBARI TRNo90-2	MLML_TM	092004-NO3+PO4
Nitrate as N	0.002	mg/l	0.001	0.005	DNQ	06/Oct/2004	MBARI TRNo90-2	MLML_TM	100604-NO3+PO4
Nitrate as N	0.001	mg/l	0.001	0.005	DNQ	06/Oct/2004	MBARI TRNo90-2	MLML_TM	100604-NO3+PO4
Nitrite as N	0.0001	mg/l	0.00003	0.0004	DNQ	17/Sep/2004	SM 4500-NO2 BM	MLML_TM	091704-NO2
Nitrite as N	0.0002	mg/l	0.00003	0.0004	DNQ	17/Sep/2004	SM 4500-NO2 BM	MLML_TM	091704-NO2
Nitrite as N	0.0001	mg/l	0.00003	0.0006	DNQ	27/Sep/2004	SM 4500-NO2 BM	MLML_TM	092704-NO2
Nitrite as N	0.0001	mg/l	0.00003	0.0006	DNQ	27/Sep/2004	SM 4500-NO2 BM	MLML_TM	092704-NO2
Nitrite as N	0.0001	mg/l	0.000028	0.0007	DNQ	05/Oct/2004	SM 4500-NO2 BM	MLML_TM	100504-NO2
Nitrite as N	0.0001	mg/l	0.000028	0.0007	DNQ	05/Oct/2004	SM 4500-NO2 BM	MLML_TM	100504-NO2
OrthoPhosphate as P	0.0009	mg/l	0.0009	0.0022	DNQ	28/Sep/2004	MBARI TRNo90-2	MLML_TM	092804-NO3+PO4
OrthoPhosphate as P	0.0014	mg/l	0.0006	0.0022	DNQ	06/Oct/2004	MBARI TRNo90-2	MLML_TM	100604-NO3+PO4
OrthoPhosphate as P	0.0006	mg/l	0.0006	0.0022	DNQ	06/Oct/2004	MBARI TRNo90-2	MLML_TM	100604-NO3+PO4
PCB 052	0.204	ng/g	0.159	0.318	DNQ	11/Jan/2005	EPA 8082M	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 052	0.645	ng/g	0.538	1.08	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 052	0.156	ng/g	0.098	0.195	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 066	0.604	ng/g	0.538	1.08	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 066	0.105	ng/g	0.098	0.195	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 070	0.16	ng/g	0.159	0.318	DNQ	11/Jan/2005	EPA 8082M	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 070	0.157	ng/g	0.098	0.195	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 095	0.645	ng/g	0.538	1.08	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 095	0.126	ng/g	0.098	0.195	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 101	0.78	ng/g	0.538	1.08	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-

Analyte	Result	Units	MDL	RL	Detected	Analysis Date	Method Name	Laboratory	Batch ID
									04_BS320_KR_T_PCB
PCB 101	0.175	ng/g	0.098	0.195	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 105	0.798	ng/g	0.538	1.08	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 105	0.121	ng/g	0.098	0.195	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 110	0.267	ng/g	0.159	0.318	DNQ	11/Jan/2005	EPA 8082M	DFG-WPCL	WPCL_L-280-04_BS326_KR_S_PCB
PCB 110	0.187	ng/g	0.159	0.318	DNQ	11/Jan/2005	EPA 8082M	DFG-WPCL	WPCL_L-280-04_BS327_KR_S_PCB
PCB 110	1.61	ng/g	0.538	1.08		25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 110	0.251	ng/g	0.098	0.195		25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 118	1.26	ng/g	0.538	1.08		25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 118	0.218	ng/g	0.098	0.195		25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB 138	0.83	ng/g	0.538	1.08	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-321-04_BS320_KR_T_PCB
PCB 138	0.14	ng/g	0.098	0.195	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB
PCB Aroclor 1260	5	ng/g	3.9	9.75	DNQ	25/Oct/2004	EPA 8082M	DFG-WPCL	WPCL_L-322-04_BS322_KR_T_PCB

Table 7. Batches for which matrix spikes (MS) or matrix spike duplicates (MSD) were not run.

Analyte	Batch ID	Notes	Laboratory
Mercury	MPSL_2005Dig04_T_Hg	QAO: no MS/MSD	MPSL-DFG
Mercury	MPSL_2005Dig05_T_Hg	QAO: no MS/MSD	MPSL-DFG
Mercury	MPSL_2005 Dig 24_T_Hg	QAO: no MS/MSD	MPSL-DFG
Mercury	MPSL_2005THgDig43_T_Hg	QAO: no MS/MSD	MPSL-DFG
Nitrate as N	092004-NO3+PO4	MS/D was analyzed on Nitrate + Nitrite and was not calculated for Nitrate alone	MLML-TM
Nitrate as N	092804-NO3+PO4	MS/D was analyzed on Nitrate + Nitrite and was not calculated for Nitrate alone	MLML-TM
Nitrate as N	100604-NO3+PO4	MS/D was analyzed on Nitrate + Nitrite and was not calculated for Nitrate alone	MLML-TM
Trace Metals	MPSL_2005Dig24_T_TM	QAO: no MS/MSD	MPSL-DFG
Trace Metals	MPSL_2005Dig15_T_TM	QAO: no MS/MSD	MPSL-DFG
Tributyltin	L321-322-04_TBT	QAO: no MS/MSD for extraction date 8/5	DFG-WPCL

Table 8. Matrix spikes (MS), matrix spike duplicates (MSD), percent recoveries (%R), and relative percent differences (RPD) that did not meet specified criteria. Boldface type indicates values that did not meet quality control criteria**.**

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Acenapthylene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	117.70	**260.13**	**37.65**	DFG-WPCL
Aluminum	306MSLG26	23/Jun/2004	MPSL_2005Dig19_T_TM	**133**	**132**	4.01	MPSL-DFG
Anthracene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**6.25**	**176.47**	**186.31**	DFG-WPCL
Anthracene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	134.94	**155.02**	13.85	DFG-WPCL
Benzo(a)anthracene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	52.94	**325.00**	**143.87**	DFG-WPCL
Benzo(a)anthracene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	114.18	**157.46**	**31.87**	DFG-WPCL
Benzo(a)pyrene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**-300.00**	**536.36**	**707.69**	DFG-WPCL
Benzo(a)pyrene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	120.30	**191.79**	**45.81**	DFG-WPCL
Benzo(b)fluoranthene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**240.00**	**516.67**	**73.13**	DFG-WPCL
Benzo(b)fluoranthene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	121.97	**209.77**	**52.94**	DFG-WPCL
Benzo(e)pyrene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**188.24**	**394.74**	**70.84**	DFG-WPCL
Benzo(e)pyrene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	98.51	147.76	**40.00**	DFG-WPCL
Benzo(g,h,i)perylene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**352.94**	**647.37**	**58.87**	DFG-WPCL
Benzo(g,h,i)perylene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	108.96	**166.42**	**41.73**	DFG-WPCL
Benzo(k)fluoranthene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**168.75**	**335.29**	**66.08**	DFG-WPCL
Benzo(k)fluoranthene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	106.72	141.79	**28.23**	DFG-WPCL
Chlordane, cis-	306MSLG26	23/Jun/2004	WPCL_L-322-04_BS322_KR_T_OCH	54	71	**27**	DFG-WPCL
Chrysene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**341.18**	**547.37**	**46.41**	DFG-WPCL
Chrysene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	88.06	**154.48**	**54.77**	DFG-WPCL
DDE(p,p')	306MSLG26	23/Jun/2004	WPCL_L-322-04_BS322_KR_T_OCH	114	66	**53**	DFG-WPCL
Dibenz(a,h)anthracene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	91.89	**258.82**	**95.19**	DFG-WPCL
Dibenzothiophenes, C1-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	108.72	**152.90**	**33.77**	DFG-WPCL
Dimethylphenanthrene, 3,6-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**237.50**	**661.29**	**94.30**	DFG-WPCL
Endrin	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS327_KR_S_OCH	**151.02**	149.53	0.99	DFG-WPCL
Endrin	306MSLG26	23/Jun/2004	WPCL_L-322-04_BS322_KR_T_OCH	147	**151**	3	DFG-WPCL
Fluoranthene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**1096.00**	**1503.03**	**31.32**	DFG-WPCL
Fluoranthene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**201.52**	**281.34**	**33.06**	DFG-WPCL
Fluoranthene/Pyrenes, C1-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**174.66**	**296.03**	**51.57**	DFG-WPCL
Fluoranthene/Pyrenes, C1-	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	131.82	**152.63**	14.63	DFG-WPCL
Fluorene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**260.00**	**456.25**	**54.80**	DFG-WPCL

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Fluorene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**153.18**	147.62	3.69	DFG-WPCL
Fluorenes, C1-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**-23.53**	**265.00**	**238.98**	DFG-WPCL
Fluorenes, C1-	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**183.70**	**175.37**	**4.64**	DFG-WPCL
HCH, delta	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS327_KR_S_OCH	**47.50**	52.72	10.41	DFG-WPCL
Indeno(1,2,3-c,d)pyrene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	120.15	**197.01**	**48.47**	DFG-WPCL
Methylfluoranthene, 2-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS329_S_PAH	100.00	**198.17**	**65.85**	DFG-WPCL
Methylfluorene, 1-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**-1.34**	**-0.67**	**66.67**	DFG-WPCL
Methylfluorene, 1-	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**163.06**	**157.12**	3.71	DFG-WPCL
Methylnapthalene, 2-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**220.57**	**237.32**	7.32	DFG-WPCL
Methylphenanthrene, 1-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**178.67**	**310.26**	**53.83**	DFG-WPCL
Naphthalene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**323.53**	**500.00**	**42.86**	DFG-WPCL
Naphthalenes, C1-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	82.43	**175.16**	**71.99**	DFG-WPCL
Naphthalenes, C2-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**352.63**	**754.78**	**72.63**	DFG-WPCL
Naphthalenes, C2-	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**152.99**	136.57	**11.34**	DFG-WPCL
Naphthalenes, C3-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**333.33**	**756.00**	**77.60**	DFG-WPCL
Naphthalenes, C3-	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**228.98**	**194.85**	16.11	DFG-WPCL
Parathion, Methyl	306MSLG26	23/Jun/2004	WPCL_L-322-04_BS322_KR_T_OCH	122	**154**	23	DFG-WPCL
PCB 018	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	125.00	78.67	**45.49**	DFG-WPCL
PCB 028	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	90.24	68.33	**27.64**	DFG-WPCL
PCB 044	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	**159.35**	75.27	**71.67**	DFG-WPCL
PCB 049	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	123.74	74.73	**49.40**	DFG-WPCL
PCB 052	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	129.68	63.19	**68.95**	DFG-WPCL
PCB 056	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	101.36	76.45	**28.01**	DFG-WPCL
PCB 066	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	111.72	75.00	**39.34**	DFG-WPCL
PCB 070	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	131.39	65.47	**66.97**	DFG-WPCL
PCB 074	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	101.72	78.93	**25.23**	DFG-WPCL
PCB 087	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	89.75	64.04	**33.42**	DFG-WPCL
PCB 095	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	93.57	52.02	**57.07**	DFG-WPCL
PCB 099	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	91.19	68.67	**28.18**	DFG-WPCL
PCB 101	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	73.30	**41.77**	**38.32**	DFG-WPCL
PCB 110	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	96.90	50.84	**62.35**	DFG-WPCL
PCB 118	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	81.93	54.99	**39.36**	DFG-WPCL

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
PCB 138	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	82.92	54.48	**41.40**	DFG-WPCL
PCB 149	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	99.70	70.06	**34.92**	DFG-WPCL
PCB 151	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	124.35	95.45	**26.30**	DFG-WPCL
PCB 153	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS326_KR_S_PCB	98.48	69.02	**35.17**	DFG-WPCL
Perylene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**515.79**	**672.73**	**26.41**	DFG-WPCL
Phenanthrene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**296.00**	**709.38**	**82.23**	DFG-WPCL
Phenanthrene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**173.68**	**202.99**	**15.56**	DFG-WPCL
Phenanthrene/Anthracene, C1-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**145.48**	**166.41**	13.41	DFG-WPCL
Phenanthrene/Anthracene, C1-	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**206.02**	**179.70**	13.65	DFG-WPCL
Phenanthrene/Anthracene, C2-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**28.18**	**-17.76**	**200.00**	DFG-WPCL
Phenanthrene/Anthracene, C2-	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**192.54**	**152.99**	22.89	DFG-WPCL
Pyrene	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	56.25	**-85.71**	**200.00**	DFG-WPCL
Pyrene	310SNLS25	22/Jun/2004	WPCL_L-280-04_BS329_S_PAH	**185.61**	**231.34**	21.94	DFG-WPCL
Tedion	306MSLG26	23/Jun/2004	WPCL_L-322-04_BS322_KR_T_OCH	150	**151**	1	DFG-WPCL
Trimethylnaphthalene, 2,3,5-	309MTRY20	24/Jun/2004	WPCL_L-280-04_BS328_S_PAH	**180.30**	**217.24**	18.59	DFG-WPCL

Table 9. Batches for which certified reference material (CRM), laboratory control material (LCM), or laboratory control spike (LCS) samples were not run.

Analyte	Batch ID	Notes	Laboratory
Ammonia as N	091704-NH3	No CRM	MLML-TM
Ammonia as N	092704-NH3	No CRM	MLML-TM
Ammonia as N	100504-NH3	No CRM	MLML-TM
Nitrite as N	091704-NO2	No CRM	MLML-TM
Nitrite as N	092704-NO2	No CRM	MLML-TM
Nitrite as N	100504-NO2	No CRM	MLML-TM
Nitrate as N	092004-NO3+PO4	No CRM	MLML-TM
Nitrate as N	092804-NO3+PO4	No CRM	MLML-TM
Nitrate as N	100604-NO3+PO4	No CRM	MLML-TM
Orthophosphate	092004-NO3+PO4	No CRM	MLML-TM
Orthophosphate	092804-NO3+PO4	No CRM	MLML-TM
Orthophosphate	100604-NO3+PO4	No CRM	MLML-TM
Total Suspended Solids	TSS062304	QAO: no CRM	MPSL-DFG
Total Suspended Solids	TSS062404	QAO: no CRM	MPSL-DFG
Total Suspended Solids	TSS062504	QAO: no CRM	MPSL-DFG
Total Suspended Solids	TSS062804	QAO: no CRM	MPSL-DFG
Tributyltin	L32-322-04-TBT	QAO: no LCS	DFG-WPCL

Table 10. Certified reference material (CRM), laboratory control material (LCM), and laboratory control spike (LCS) samples that did not meet quality control acceptance criteria.

Analyte	Sample Type	Batch ID	% Recovery	Laboratory
Anthracene	CRM	WPCL_L-280-04_BS328_S_PAH	52.1	DFG-WPCL
Benz(a)anthracene	CRM	WPCL_L-280-04_BS328_S_PAH	44	DFG-WPCL
Benz(a)anthracene	CRM	WPCL_L-280-04_BS329_S_PAH	51	DFG-WPCL
Benz(a)anthracene	CRM	WPCL_L-322-04_T_PAH	58.5	DFG-WPCL
Benzo(a)pyrene	CRM	WPCL_L-280-04_BS328_S_PAH	54.3	DFG-WPCL
Benzo(a)pyrene	CRM	WPCL_L-280-04_BS329_S_PAH	58.8	DFG-WPCL
Benzo(a)pyrene	CRM	WPCL_L-322-04_T_PAH	47.5	DFG-WPCL
Benzo(e)pyrene	CRM	WPCL_L-280-04_BS328_S_PAH	57.7	DFG-WPCL
Benzo(e)pyrene	CRM	WPCL_L-280-04_BS329_S_PAH	64.1	DFG-WPCL
Benzo(k)fluoranthene	CRM	WPCL_L-280-04_BS328_S_PAH	53.7	DFG-WPCL
Benzo(k)fluoranthene	CRM	WPCL_L-280-04_BS329_S_PAH	63.2	DFG-WPCL
Chrysene	CRM	WPCL_L-280-04_BS329_S_PAH	49	DFG-WPCL
Chrysene	CRM	WPCL_L-280-04_BS328_S_PAH	41.2	DFG-WPCL
DDD(o,p')	CRM	WPCL_L-321-04_BS320_KR_T_OCH	155	DFG-WPCL
DDT(o,p')	CRM	WPCL_L-321-04_BS320_KR_T_OCH	-55.1	DFG-WPCL
DDT(p,p')	CRM	WPCL_L-321-04_BS320_KR_T_OCH	-320	DFG-WPCL
Dibenz(a,h)anthracene	CRM	WPCL_L-322-04_T_PAH	-34.5	DFG-WPCL
Endosulfan II	LCS	WPCL_L-280-04_BS327_KR_S_OCH	45	DFG-WPCL
Endosulfan II	LCS	WPCL_L-322-04_BS322_KR_T_OCH	0	DFG-WPCL
Endrin	LCS	WPCL_L-321-04_BS320_KR_T_OCH	163	DFG-WPCL
Endrin	LCS	WPCL_L-322-04_BS322_KR_T_OCH	151	DFG-WPCL
Fluorenes, C1-	LCS	WPCL_L-280-04_BS328_S_PAH	154	DFG-WPCL
HCH, delta	LCS	WPCL_L-321-04_BS320_KR_T_OCH	44	DFG-WPCL
Methylfluorene, 1-	LCS	WPCL_L-280-04_BS328_S_PAH	154	DFG-WPCL
Oxychlordane	CRM	WPCL_L-321-04_BS320_KR_T_OCH	-86.4	DFG-WPCL
PCB 031	CRM	WPCL_L-321-04_BS320_KR_T_PCB	26.5	DFG-WPCL
Perylene	CRM	WPCL_L-280-04_BS328_S_PAH	45.8	DFG-WPCL
Perylene	CRM	WPCL_L-280-04_BS329_S_PAH	47.4	DFG-WPCL

Analyte	Sample Type	Batch ID	% Recovery	Laboratory
Perylene	CRM	WPCL_L-322-04_T_PAH	-13.9	DFG-WPCL
Phenanthrene	CRM	WPCL_L-280-04_BS328_S_PAH	64.8	DFG-WPCL
Pyrene	CRM	WPCL_L-280-04_BS328_S_PAH	64.7	DFG-WPCL
Pyrene	CRM	WPCL_L-322-04_T_PAH	66.8	DFG-WPCL
Silver	CRM	2004Dig46	151	MPSL-DFG
Silver	CRM	MPSL_2005Dig05_T_TM	171	MPSL-DFG
Silver	CRM	MPSL_2005Dig04_T_TM	285	MPSL-DFG
Zinc	CRM	2004Dig47	74.4	MPSL-DFG

Table 11. Surrogate recoveries that did not meet quality control acceptance criteria.

Surrogate	Station Code	Batch ID	% Recovery	Laboratory
PCB 207(Surrogate)	310SNLS25	WPCL_L-280-04_BS327_KR_S_PCB	151	DFG-WPCL
PCB 207(Surrogate)	LCS	WPCL_L-322-04_BS322_KR_T_PCB	157	DFG-WPCL
DBCE(Surrogate)	CRM	WPCL_L-280-04_BS327_KR_S_OCH	190	DFG-WPCL
Dibromooctafluorobiphenyl(Surrogate)	CRM	WPCL_L-280-04_BS327_KR_S_OCH	151	DFG-WPCL
Benzo(g,h,I)perylene-d12(Surrogate)	LabBlank	WPCL_L-280-04_BS329_S_PAH	28	DFG-WPCL
Benzo(g,h,I)perylene-d12(Surrogate)	LabBlank	WPCL_L-280-04_BS328_S_PAH	31	DFG-WPCL
Perylene-d12(Surrogate)	LabBlank	WPCL_L-280-04_BS328_S_PAH	46	DFG-WPCL
Benzo(g,h,I)perylene-d12(Surrogate)	LCS	WPCL_L-280-04_BS329_S_PAH	43	DFG-WPCL
Benzo(g,h,I)perylene-d12(Surrogate)	LCS	WPCL_L-280-04_BS328_S_PAH	43	DFG-WPCL