CLEAN

Central Coast
Long-term Environmental
Assessment Network

REGIONAL MONITORING PROGRAM

Annual Report 2004–2005

January 31, 2006

Lead Agency:

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2004–2005 Annual Report

Central Coast Long-term Environmental Assessment Network

Submitted to:

California Regional Water Quality Control Board
Region 3
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January 31, 2006

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1.0 Executive Summary

Implementation of the CCLEAN monitoring program began on June 26, 2001, when the CCLEAN Steering Committee retained Applied Marine Sciences, Inc. (AMS) to provide technical direction for the program. Since that time, the following activities have been performed:

- A Quality Assurance Program Plan (QAPP) was written to guide sample analysis. This QAPP is performance-based and does not prescribe analytical methods for many analytes.
- A Request for Proposals to perform monitoring was issued on September 5, 2001 and on October 9, 2001 Kinnetic Laboratories Inc. (KLI) was selected for sampling effluent, rivers and mussels for persistent organic pollutants (POPs), and MEC Analytical Systems, Inc. (MEC) was selected for sampling sediment for POPs and benthic infauna. Both consultants teamed with Axys Analytical for analysis of POPs.
- Thirty-day flow-proportioned sampling of effluent from four wastewater treatment plants during the dry and wet season began in September and October 2001 and has continued since then.
- Weekly grabs of effluent have been collected during the 30-day flow-proportioned sampling for analysis of ammonia, nitrates, and total suspended solids.
- Monthly sampling of effluent at four wastewater treatment plants for analysis of urea and dissolved silica began in April to August 2001 (depending on the plant) and continues. Analysis of orthophosphate in these monthly grab samples began in 2003.
- Thirty-day flow-proportioned sampling of the San Lorenzo River, Pajaro River, Salinas River and Carmel River for analysis of POPs and nutrients during the dry and wet seasons began in October 2002 and has continued since then.
- Mussels have been collected from five sites for analysis of POPs and bacteria during the dry and wet seasons since February 2002.
- Annual sediment sampling for analysis of benthic infauna, POPs, total organic carbon and grain size began at eight sites on October 31, 2001. Duplicate samples were collected for analysis of benthic infauna in 2003.
- Monthly sampling of 14 streams and rivers and two sites in Elkhorn Slough began in January 2002. The two Elkhorn Slough sites were replaced in January 2004 with a site on Tembladero Slough. This sampling is conducted by the environmental health departments at the County of Santa Cruz and the County of Monterey for the analysis of urea and dissolved silica, total suspended solids, and bacteria. Ammonia and orthophosphate was added to the list of analytes in late 2003 or early 2004.
- Sampling of nearshore background water was begun in 2004 for the analysis of POPs, bacterial pathogen indicators, and nutrients.

- A database template was developed that will allow the seamless entry of CCLEAN data into the Regional Board's CCAMP database.

Monitoring results from 2004-2005 provide the following findings:

- Analysis of 30-day effluent samples for POP's demontrate that Santa Cruz, Watsonville, Monterey Regional Water Pollution Control Agency, and Carmel Area Wastewater Disctrict had very low concentrations of POP's, parts per trillion or less.
- Analysis of effluent grab samples for nutrients indicated similar concentrations among most dischargers for dissolved silica, but Santa Cruz and Monterey Regional had slightly higher concentrations of ammonia, Watsonville had higher concentrations of orthophosphate and Monterey Regional had slightly higher concentrations of total suspended solids (TSS). Santa Cruz and Monterey Regional had slightly higher concentrations of urea. Ammonia concentrations were well below permit limits for all dischargers. Estimated annual loads of ammonia nitrogen per discharger ranged from 12,114 kg/yr to 415,614 kg/yr. Estimated annual loads of nitrate nitrogen and urea nitrogen ranged from 11,927 kg/yr to 153,138 kg/yr and 162 kg/yr to 3946 kg/yr respectively. Estimated annual load of orthophosphate ranged from 7291 kg/yr to 142,389 kg/yr.
- Receiving water monitoring for total coliform, fecal coliform and enterococcus bacteria indicated that none of the existing or proposed objectives for pathogen indicators were exceeded in any sample during the 2004-2005 sampling period. Most of the highest concentrations for all of the sites coincided with the wet season, from December through March or April.
- Analysis of POP's in mussels revealed a seasonal pattern for most POP's at most sites, with higher values coinciding with wet season rather than dry season samples. At Laguna Creek and the Hook there were high concentrations of DDT's and chlordanes as well as dieldrin in the wet season samples. The Hook has exceeded the 95th percentile of the most contaminated samples analyzed by State Mussel Watch over a 20-year period for chlordanes, endosulfans and dieldrin. Every site had mussels that exceeded at least one Maximum Tissue Residue Level set by the State Water Resources Control board for concentrations of POP's. Mussels from Laguna Creek and Carmel River Beach had high levels of fecal coliform, which exceeded the USFDA guidelines for fecal coliform in shellfish. Analysis of mussel data from the National Status and Trends and State Mussel Watch programs suggest that concentrations of DDTs and dieldrin have not changed significantly over the last 20–30 years at sites removed from large agricultural sources of these legacy pesticides.
- Analysis of sediment samples for benthic infauna revealed that the biota was dominated by annelids, followed by arthropods and molluscs. Large declines in organism densities observed in 2003 had disappeared by October 2004 at most sites. The four depositional sites within Monterey Bay and the four reference sites outside Monterey Bay were similar within these site groups, as indicated by generally low coefficients of variation. Sediment texture was very similar between years at each site. Concentrations of DDTs in every sediment sample exceeded the NOAA Effect Range Low (ERL) guideline at which amphipod toxicity is typically measured in 10% of laboratory bioassays, and also exceeded the average concentration of DDTs in San Francisco Bay sediments in 2002. Concentrations of dieldrin exceeded the ERL in 16 out of 32 samples that have been analyzed. Moreover, statistical analysis of 32 samples suggested that POPs and river

discharges of suspended sediments could be negatively affecting several infaunal taxa. Analysis of historic data for sediment DDT concentrations near four CCLEAN sites indicated that only one site has experienced a significant decline in DDTs since 1969–1970.

- Analysis of monthly stream and river samples for nutrients indicated that Tembladero Slough had the highest mean concentrations of nitrate nitrogen, ammonia nitrogen and total suspended solids (TSS). The highest geometric means for total coliform were measured at the Salinas River and Tembladero Slough, exceeding the water quality objective for water contact recreation as defined by the EPA. This water quality objective also was exceeded for *E. coli* at Branciforte Creek, San Lorenzo River, Soquel Creek, Porter Gulch, Aptos Creek, Salinas River and Tembladero Slough. Six of the rivers and streams have USGS flow gages and another source provided flow data for Scott Creek, which allowed estimation of annual loads. The Pajaro River had the highest load of ammonia nitrogen and dissolved silica due to high flow in March. The Pajaro River had the highest loads for nitrate nitrogen, TSS, urea nitrogen, orthophosphate, total and fecal coliforms as well as enterococcus. The highest loads of bacteria and nutrients occurred during the wet season from December through mid-April.
- Analysis of POP's in 30-day samples during the dry and wet seasons from the San Lorenzo, Pajaro, Salinas and Carmel rivers indicated that all except the Carmel exceeded at least two California Toxics Rule criteria for POPs. The greatest mean daily loads of most POP's generally have occurred during the wet season. Combined loads of all rivers greatly exceeded the combined loads from wastewater dischargers for silica, TSS and nitrate nitrogen as well as all POP's. However, for ammonia nitrogen and orthophosphate, the combined load from rivers was less than the combined load from wastewater dischargers. Urea loads from rivers have been increasing and this year surpassed the combined load from wastewater dischargers. The Salinas River had extremely high flows during the 2005 wet season. The Pajaro and Salinas Rivers have the highest loads of most POP's, generally due to their higher flows. The Salinas River had the highest loads of PAH's and PCB's while the Pajaro River had the highest loads of DDT's and HCH's. Both the Pajaro and Salinas Rivers had similarly high levels for chlordanes and endosulfans.
- Analysis of satellite remote sensing data for chlorophyll and sediment plumes suggested that the nutrients discharged from the Pajaro and Salinas rivers could affect concentrations of sea surface chlorophyll. Additional analyses will be performed to more fully explore the relationship between river discharges and chlorophyll concentrations and evaluate whether there is a correlation between harmful algal blooms (HAB's) and river runoff and/or sediment plumes.
- Analysis of two nearshore background water quality sites (North and South Monterey Bay) during the wet season of 2004-2005 indicates that suspended solids and dissolved silicate were consistently detected in all samples at both sites, but urea, nitrate, ammonia and orthophosphate were rarely in any sample. The only pathogen indicator detected was total coliform, at or slightly above the detection limit. At least one site exceeded the Ocean Plan water quality objective for PCB's and dieldrin and the northern site equaled the water quality objective for DDT's.

2.0 INTRODUCTION

2.1 Background and Objectives

The CCLEAN monitoring program has been designed to fulfill several regulatory objectives. The Management Plan for the Monterey Bay National Marine Sanctuary includes a Memorandum of Agreement between eight federal, state, and regional agencies (including the Central Coast Regional Water Quality Control Board) to develop an ecosystem-based Water Quality Protection Program for the Sanctuary. The Regional Board has developed a framework for partial fulfillment of this Water Quality Protection Program called the Central Coast Ambient Monitoring Program (CCAMP). This multidisciplinary program includes sampling in watersheds that flow into coastal regions, in estuarine coastal confluences, and at coastal sites. The goal of CCAMP is to "collect, assess, and disseminate scientifically based water quality information to aid decision-makers and the public in maintaining, restoring, and enhancing water quality and associated beneficial uses." CCLEAN provides the initial nearshore component of CCAMP. It is being funded by the City of Santa Cruz, City of Watsonville, Moss Landing Power Plant, Monterey Regional Water Pollution Control Agency, and Carmel Area Wastewater District, under the direction of the Regional Board. CCLEAN satisfies the NPDES receiving water monitoring and reporting requirements of program participants.

Within the framework of CCAMP, the goal of the CCLEAN program is to assist stakeholders in maintaining, restoring, and enhancing nearshore water and sediment quality and associated beneficial uses in the Central Coast Region. The specific objectives of the program are as follows:

- Obtain high-quality data describing the status and long-term trends in the quality of nearshore waters, sediments, and associated beneficial uses.
- Determine whether nearshore waters and sediments are in compliance with the Ocean Plan.
- Determine sources of contaminants to nearshore waters.
- Provide legally defensible data on the effects of wastewater discharges in nearshore waters.
- Develop a long-term database on trends in the quality of nearshore waters, sediments and associated beneficial uses.
- Ensure that the nearshore component database is compatible with other regional monitoring efforts and regulatory requirements.
- Ensure that nearshore component data are presented in ways that are understandable and relevant to the needs of stakeholders.
- For CCLEAN to successfully achieve these objectives, a minimum of five years' data, and probably more, are necessary to determine the status and trends in the quality of nearshore waters, sediments, and associated beneficial uses.

2.2 Program Design

CCLEAN was designed with substantial input from stakeholders, including NPDES permittees, state and federal regulatory agencies, the Monterey Bay National Marine Sanctuary, the scientific community, and business and public interest groups. The program focuses on measuring possible water quality stressors for four receiving water beneficial uses that were prioritized by the stakeholders for protection. These beneficial uses are as follows:

- marine habitat,
- rare, threatened, or endangered species,
- water contact recreation, and
- wildlife habitat.

Discussions with stakeholders and reviews of reports and scientific publications indicated that there are possible impairments of these beneficial uses related to the following:

- elevated concentrations of POPs (e.g., petroleum hydrocarbons, chlorinated pesticides, polychlorinated biphenyls) in fish from the Monterey Submarine Canyon and sea otters,
- declines in sea otter populations, which may be related to diseases and/or high concentrations of POPs,
- bird and mammal deaths due to blooms of toxic phytoplankton,
- impacts to benthic habitats caused by deposition of suspended sediments in rivers, and
- beach closures due to high bacterial concentrations.

These beneficial use impairments may be caused by three possible water quality stressors, as follows:

- POPs in water and sediment,
- nutrients, and
- pathogens

Readers are referred to the Final Report for design of the CCLEAN program for a complete presentation of the scientific data and discussion of the rationale for each of the possible beneficial use impairments and related possible water quality stressors (Applied Marine Sciences, 2000).

CCLEAN is measuring inputs of these possible water quality stressors and effects in nearshore waters by sampling effluent, rivers and streams, mussels, sediments and benthic communities. Chemical analysis of samples is performed to detection requirements shown in Appendix A. Effluent for each municipal discharger and rivers are sampled for POPs, nutrients, and suspended sediments using automated equipment to obtain 30-day flow-proportioned samples in the dry season and in the wet season. Santa Cruz, Watsonville and Monterey Regional sample monthly along the 30-foot contour adjacent to their outfalls for bacteria. Sixteen shoreline sites near streams and rivers also are sampled monthly for nutrients, bacteria, and suspended sediments by personnel from the Department of Environmental Health for the counties of Santa Cruz and Monterey. Satellite imagery will be used to evaluate blooms of phytoplankton associated with discharges of high concentrations of nutrients. Mussels are sampled at five locations to fill geographic gaps in other ongoing programs to measure POPs and bacteria. Sediments are sampled for POPs and benthic organisms once a year at eight sites within the depositional band that has been identified by U.S. Geological Survey in Monterey Bay. The locations of sampling sites are shown in Figure 2.2.1 and Figure 2.2.2.

2.3 Program Implementation

The program participants selected the City of Watsonville to serve as the lead agency for financial and contractual matters. Through a Memorandum of Agreement, which was approved by the respective city councils and boards governing the participants, a formula was established to determine each participant's financial contribution to the program. This formula included an identical base amount paid by all participants, as well as a portion that varies according to total effluent discharged annually. As the relative volumes of discharged effluent vary in response to changes in population and patterns of wastewater reuse in each jurisdiction, the annual contribution of each participant may change over time.

On June 26, 2001, the CCLEAN participants contracted with Applied Marine Sciences, Inc. (AMS) to provide technical direction and oversight for the program. AMS answers directly to a Steering Committee that includes members from each program participant. AMS' general program responsibilities include the following:

- day-to-day management of the program,
- recommendation of consultants to perform technical components of the monitoring program,
- supervision of these consultants,
- final quality control checks and submittal of data to the Regional Board's database,
- data analysis and reporting,
- recommendation of changes to the Quality Assurance Program Plan and,
- recommendation of program modifications.

On September 5, 2001, a Request for Proposals was sent to 14 potential consultants to perform sampling and analysis required for the monitoring program. Proposals were received on September 28 and on October 9 two consultants were selected. Kinnetic Laboratories, Inc. (KLI) was chosen to collect and analyze the 30-day samples of effluent and river water and collect and analyze mussels. MEC Analytical Systems, Inc. (MEC) was chosen to collect and analyze sediment. KLI and MEC each teamed with Axys Analytical in British Columbia for analysis of POPs in water and sediment, respectively. Selection of KLI and MEC was contingent upon satisfactory analysis by Axys of a blind check sample, in accordance with the performance-based CCLEAN Quality Assurance Program Plan (Applied Marine Sciences, 2001). Sampling of effluent, sediment, mussels, and monthly sampling of streams and rivers was implemented in the first program year, from July 1, 2001, through June 30, 2002. Collection of thirty-day samples from rivers began in 2002-2003.

2.4 Report Contents

This report presents CCLEAN program activities that have occurred during the period from July 2004 through June 2005, the current status of monitoring, and findings. Technical components included are effluent sampling, mussel sampling, sediment sampling, monthly stream and river sampling, sampling of rivers for POPs and sampling of nearshore bay waters for background water quality. Data synthesis and interpretation are cumulative over the life of the program. Appendices to this report contain all data used as the basis for report tables and figures. POPs are presented as totals for different types of compounds, such as PAHs, DDTs, chlordanes, endosulfans, HCHs, and PCBs. Concentrations of individual analytes and results of QA/QC analyses will be submitted to the Regional Board's CCAMP database.

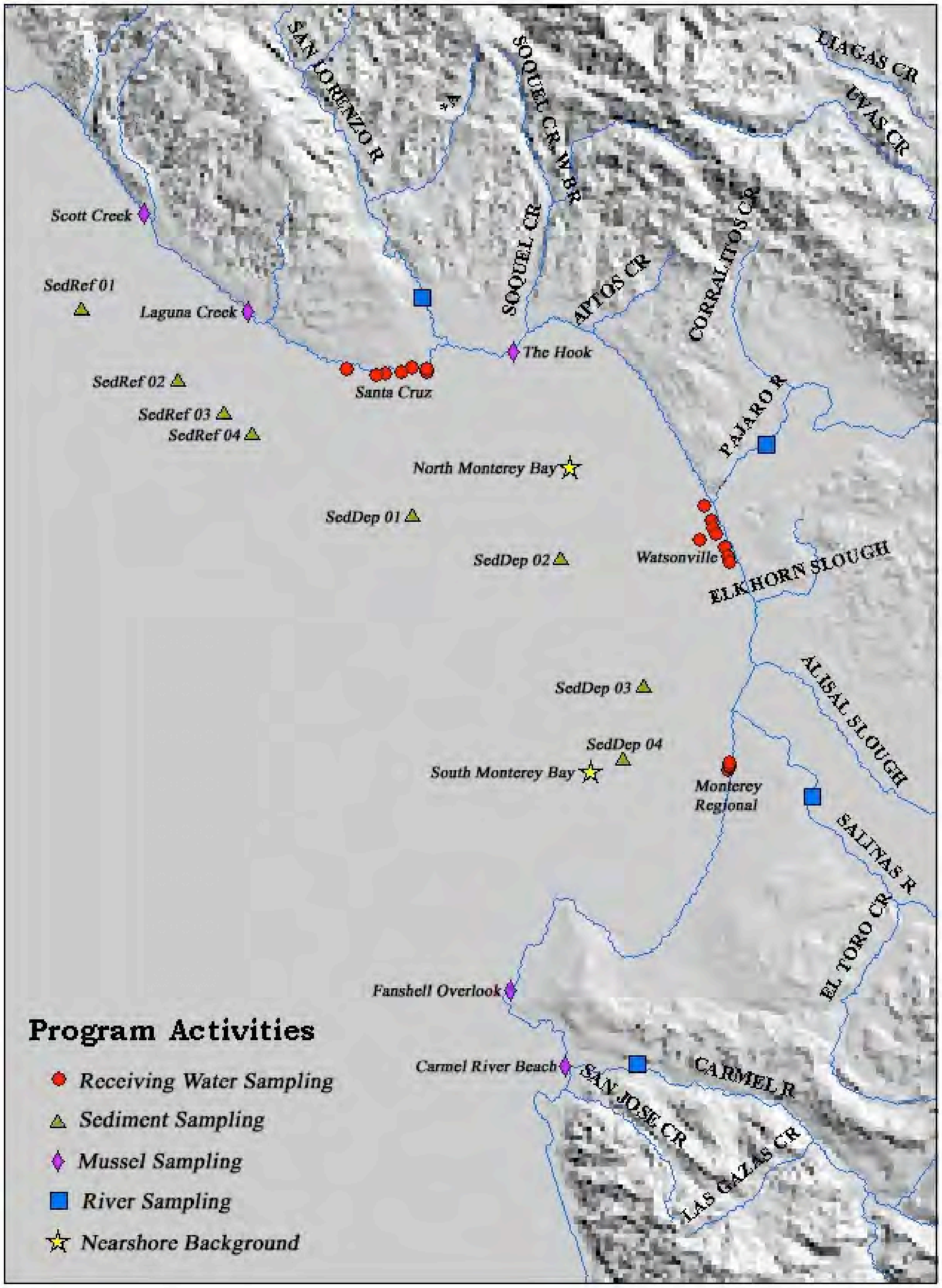


Figure 2.2.1. Locations of CCLEAN sampling sites for receiving water, sediment, mussels, and rivers (for POPs).

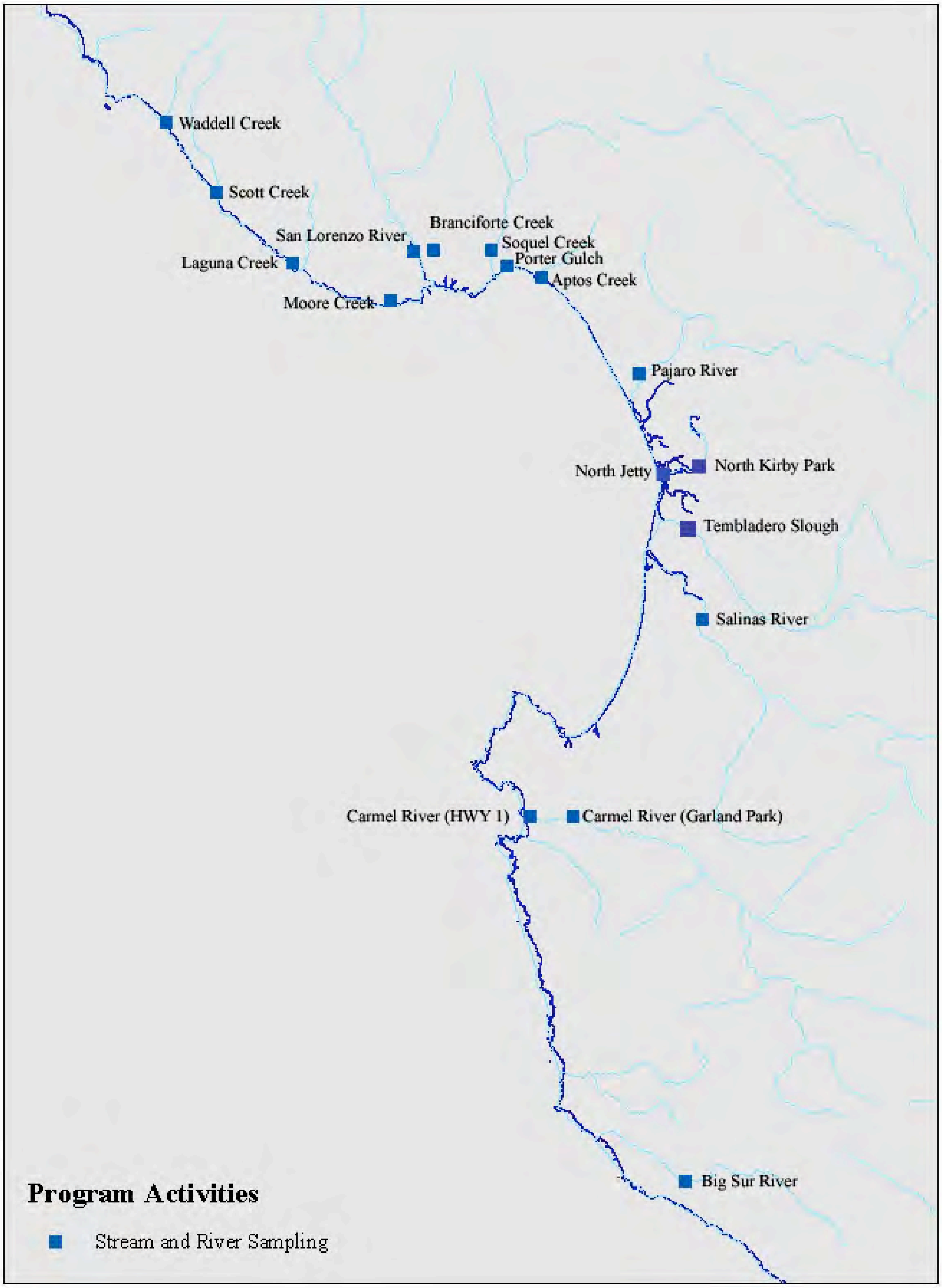


Figure 2.2.2. Locations of CCLEAN sampling sites for streams and rivers.

3.0 PROGRAM ACTIVITIES, RESULTS AND CURRENT STATUS

3.1 Effluent Sampling

Effluent sampling includes collection of 30-day flow-proportioned samples twice per year (i.e., in the wet season and in the dry season) for analysis of POPs and grab samples for analysis of nutrients and general water quality parameters (Table 3.1.1). Grab samples are collected by personnel of the program participants and analyzed in their laboratories. The objective of this program component is to measure potential sources and loads of POPs and nutrients to nearshore waters. The same sampling methods are being applied to four rivers (i.e., San Lorenzo, Pajaro, Salinas and Carmel).

Table 3.1.1. Effluent sampling parameters.

Parameters Sampled at Each Site	Frequency of Sampling
1) 30-day flow proportioned samples using automated pumping equipment, solid-phase-extraction techniques for POPs	Twice per year (wet season and dry season)
2) During 30-day period, weekly grab samples of effluent for ammonia and nitrate, total suspended solids, temperature, conductivity, and pH	
3) Grabs for urea, dissolved silica and orthophosphate in effluent	Monthly

3.1.1 Solid-Phase Extraction Sampling

3.1.1.1 Activities and Methods

The collection of 30-day flow-proportioned samples of effluent is accomplished by KLI using specialized equipment (Figure 3.1.1). Off-the-shelf equipment was obtained from suppliers and configured for each wastewater treatment plant. Programmable ISCO 3700 samplers were used to pump effluent through glass-fiber particle filters and Teflon™ columns packed with XAD-2 resin beads, which were obtained from Axys Environmental. All sampler tubing is composed of Teflon™, silicone (pump tubing) and stainless steel, which undergoes a thorough cleaning process prior to use. The samplers were programmed to pump 1 liter of effluent through the filter and column in response to electrical signals from the flow meter in each treatment plant. The estimated flow at each treatment plant was projected to ensure that the target volume of effluent would be pumped through the filter and column over an approximately 30-day period. Two hundred liters was used as the target volume to ensure the lowest possible detection limits for POPs. In the laboratory, the particle filter and the XAD-2 resin are extracted and the extracts are combined for a single analysis of total POPs. POPs are analyzed by Axys and ToxScan (for chlorpyrifos and diazinon). Beginning with the 2002-2003 samples, a silica/alumina column cleanup procedure was implemented to remove matrix interference for the measurement of oxychlordane. POP concentration in the effluent was determined by dividing the total amount of each POP by the volume of effluent sampled. The annual load of each constituent was estimated by calculating the average daily loads for each sampling event (measured concentration x average daily flow during the sampling event), averaging those two daily load estimates to produce an annual average daily load and multiplying that annual average by 365.

Dry-season effluent samples were collected with the ISCO equipment from June to August 2004 and wet-season effluent samples were collected from January to February 2005 (Table 3.1.2). An equipment blank sample was collected during both sampling periods by pumping ultra-pure water through the equipment. KLI produced the blank water by processing City of Santa Cruz potable water through a deionized water system consisting of a combination of pre-treatment carbon tank, two unibeds (consisting of a cation tank and an anion tank), and finally a single mixed bed tank for final polishing of the end product. This system provides deionized water of approximately 15-megohm resistance.

The City of Scotts Valley discharges effluent through the Santa Cruz outfall. Although it is difficult to ensure that effluent samples from the Santa Cruz treatment plant provide a well-mixed composite from both cities, the sampling point was situated as far downstream as possible to increase the likelihood that Scotts Valley's effluent is represented in samples and everywhere in this report where a contaminant concentration or load is ascribed to Santa Cruz those measurements also include Scotts Valley effluent. While Scotts Valley flow data have been incorporated into calculations of load estimates, Scotts Valley does not measure urea, dissolved silica, nitrate, or orthophosphate, so estimates of loads for these nutrients from Santa Cruz assume that Scotts Valley's effluent has concentrations similar to Santa Cruz's.

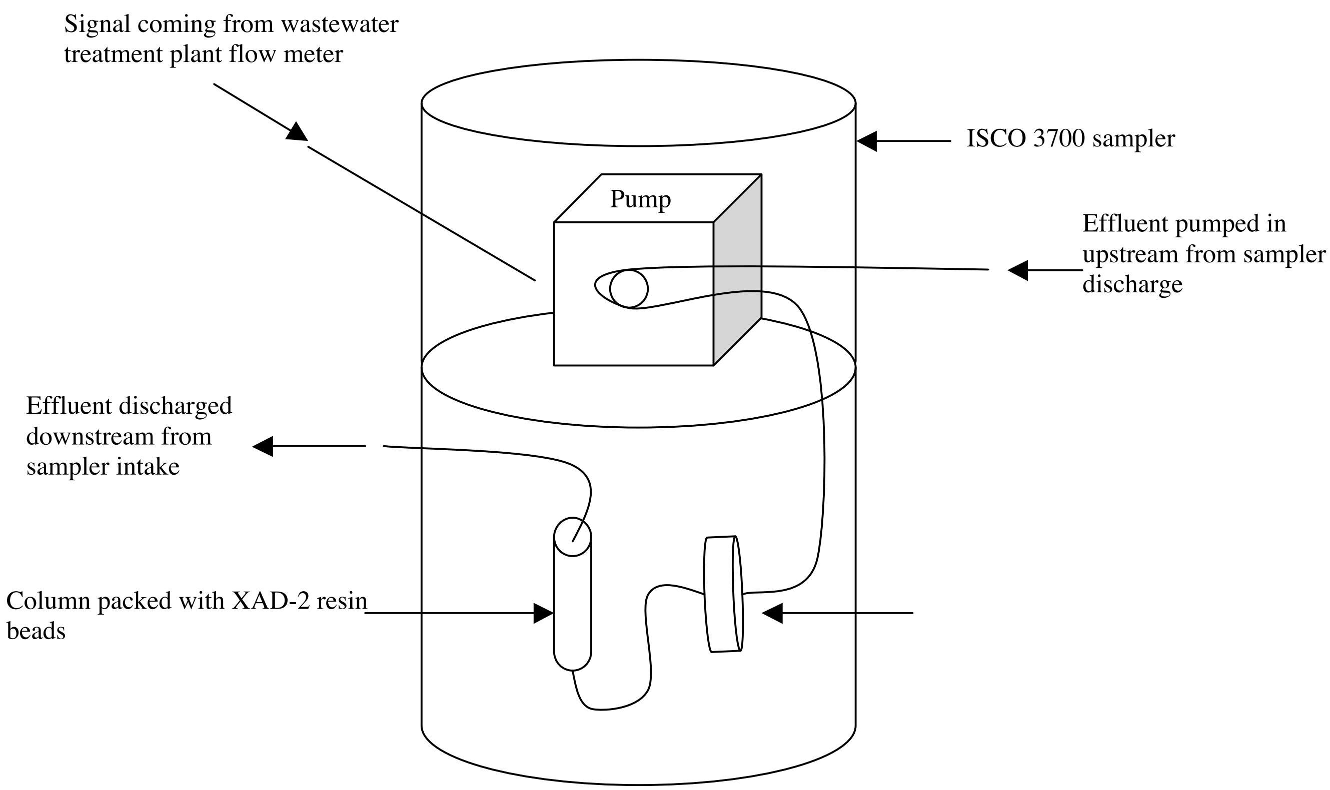


Figure 3.1.1. Configuration of ISCO samplers for CCLEAN effluent sampling.

Table 3.1.2. Dates and volumes of effluent samples, 2004–2005.

Season	Wastewater Discharge	Start Date	End Date	Number of Liters Sampled
Dry				
	Santa Cruz	June 23, 2004	August 4, 2004	204
	Watsonville	June 22, 2004	July22, 2004	204
	Monterey Regional	June 22, 2004	July 22, 2004	216
	Carmel Area	June 22, 2004	July 27, 2004	206
Wet				
	Santa Cruz	January 20, 2005	February 22, 2005	248
	Watsonville	January 19, 2005	February 21, 2005	243
	Monterey Regional	January 19, 2005	February 21, 2005	223
	Carmel Area	January 18, 2005	February 21, 2005	269

3.1.1.2 Results

Concentrations of all POPs in effluent were very low in all samples, parts per trillion or less (Appendix B). For discussion purposes, we sum the individual POP analytes into low-weight PAHs (two and three rings), high-weight PAHs (four, five and six rings), chlordanes, HCHs, endosulfans, PCBs, and DDTs (Table 3.1.3). Low-weight PAHs are often indicative of petrogenic sources, whereas high-weight PAHs are often indicative of pyrogenic sources (i.e., combustion products). Chlordanes, HCHs, endosulfans and DDTs are pesticides that have historically been applied to agricultural or residential uses. PCBs were historically used as coolants in large electrical transformers and as carriers in agricultural pesticides. This grouping convention is used in each section throughout this report.

Table 3.1.3. Individual analytes summed for POP groups.

POP Group	Analytes
Low-weight PAHs	Biphenyl, Naphthalene, 1-methylnapthalene, 2-methylnapthalene, 2,6-dimethylnapthalene, 2,3,5-trimethylnapthalene, Acenaphthene, Acenaphthylene, Anthracene, Dibenzothiophene, Fluorene, Phenanthrene, 1-methylphenanthrene
High-weight PAHs	Benz(a)anthracene, Chrysene, Fluoranthene, Pyrene, Benzo(a)pyrene, Benzo(e)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenz(a,h)anthracene, Perylene, Benzo(ghi)perylene, Indeno(1,2,3-cd)pyrene
Chlordanes	trans-Chlordane, cis-Chlordane, trans-Nonachlor, cis-Nonachlor, Oxychlordane, Heptachlor, Heptachlor epoxide
HCHs	alpha HCH, beta HCH, gamma HCH, delta HCH
Endosulfans	alpha-Endosulfan, beta-Endosulfan, Endosulfan Sulfate
PCBs	5, 8, 18, 20, 21, 28, 31, 33, 43, 44, 49, 52, 56, 60, 61, 66, 70, 73, 74, 76, 80, 86, 87, 89, 90, 93, 95, 97, 99, 101, 105, 106, 110, 111, 115, 116, 117, 118, 127, 128, 132, 138, 139, 141, 149, 151, 153, 156, 158, 160, 163, 164, 168, 170, 174, 177, 180, 181, 182, 183, 187, 190, 194, 195, 196, 201, 203
DDTs	o,p'-DDE, p,p'-DDE, o,p'-DDD, p,p'-DDD, o,p'-DDT, p,p'-DDT

High concentrations of low-weight PAHs were found in lab and equipment blanks. These high concentrations of low-weight PAHs were due to naphthalene and biphenyl. High concentrations of acenaphthene also were found in the 2004 dry season lab blank and the 2005 wet season equipment blank, 9.58 ng/L and 4.55 ng/L, respectively. Concentrations of naphthalene ranged from 1.05–2.09 ng/L in lab blanks and from 2.41–6.79 ng/L in equipment blanks. Biphenyl ranged from and 2.68–18.20 ng/L in lab blanks and from 1.68–6.63 ng/L in equipment blanks. The laboratory narrative report for the 2004 dry season lab blank indicated that an interference was observed in the lab blank with biphenyl and acenaphthene. Further work on a test batch did not produce improvement, suggesting that the biphenyl and acenaphthene data may be over reported for the 2004 dry season samples. Examination of the effluent data showed that concentrations of naphthalene ranged from 4.03–13.8 ng/L and it is possible that measured effluent concentrations were partly the result of contamination by either sampling equipment or the batch of XAD-2 resin that was in the sampling equipment and was extracted in the laboratory for the lab blank. Because concentrations of biphenyl and acenaphthene in effluent samples were generally below the concentrations reported for lab and equipment blanks (i.e., biphenyl in effluent ranged from 0.38–3.47 ng/L and acenaphthene in effluent ranged from 0.38–4.24 ng/L), and both exhibited consistent differences between wastewater discharges, it is less likely that effluent samples were contaminated for these two PAHs by the XAD-2 resin or sampling equipment.

Average concentrations of some effluent POPs varied among the four wastewater treatment plants (Table 3.1.4 and Appendix B). Monterey Regional had substantially lower concentrations of low-weight PAHs than any of the other wastewater discharges and Carmel had the highest concentrations of high-weight PAHs, especially in the 2004 dry season. The Carmel 2004 dry-season sample had much higher concentrations of HCHs that seen in any previous wastewater sample, which was due to the gamma isomer (76.5 ng/L).

The range of POP concentrations measured at the four wastewater treatment plants in the CCLEAN program were generally similar to those reported by the San Francisco Estuary Institute (San Francisco Estuary Institute, 2001) from four municipal treatment plants in the San Francisco Bay area (Table 3.1.5). The SFEI program measured only the PAHs specified by the Ocean Plan, which is a subset of the PAHs measured in the CCLEAN program using the same solid-phase extraction sampling methods. When only those common PAH analytes are considered, all the CCLEAN samples were near or above the range reported by SFEI. Chlordanes also were generally higher in the CCLEAN samples than the SFEI samples. DDTs at Watsonville, Monterey Regional and Carmel also were higher than in the SFEI samples. PCBs in the CCLEAN samples were within the ranges reported by SFEI. Effluent POPs in all the CCLEAN samples were, nevertheless, well below permit limits (Table 3.1.6).

Table 3.1.4. Concentrations of POPs in effluent from four wastewater discharges in the Monterey Bay area and equipment blanks collected in the summer 2004 (dry season) and winter 2005 (wet season).

	Concentration, ng/L							
Sample	Low-weight PAHs	High-weight PAHs	Chlordanes	HCHs	Endosulfans	PCBs	DDTs	Dieldrin
Dry-season 2004								
Santa Cruz	36.54	7.52	0.255	5.99	0.180	0.319	0.134	0.141
Watsonville	34.82	12.89	0.629	1.32	0.140	0.414	0.563	0.205
Monterey Regional	9.80	14.09	0.733	1.15	0.224	0.428	0.656	0.233
Carmel	36.55	47.14	1.16	76.61	0.228	0.578	0.461	0.385
Equipment Blank	7.72	1.06	ND	ND	ND	0.020	ND	ND
Lab Blank	31.72	0.525	ND	ND	ND	0.001	ND	ND
Wet-season 2005								
Santa Cruz	44.00	15.50	0.717	0.767	0.256	0.340	0.170	0.324
Watsonville	34.82	19.80	0.621	1.30	0.323	0.581	0.936	0.394
Monterey Regional	10.78	19.58	0.908	1.04	0.205	0.448	0.715	0.307
Carmel	29.06	23.63	0.904	0.504	0.303	0.234	0.285	0.885
Equipment Blank	22.85	1.22	0.006	0.029	ND	0.020	0.002	ND
Lab Blank	4.57	0.041	0.005	0.004	ND	0.001	ND	ND

Table 3.1.5. Comparison of POP ranges measured in effluent from CCLEAN dischargers and four dischargers in the San Francisco Bay area. PAH concentrations are based upon a subset of analytes measured in the CCLEAN program and which are those required by the Ocean Plan.

	Range of Measured Concentrations, ng/L			
Agency	PAHs	Chlordanes	DDTs	PCBs
Santa Cruz	17.39–20.11	0.24–0.60	0.13–0.17	0.29–0.30
Watsonville	14.30–17.65	0.54–0.59	0.56-0.94	0.36–0.50
Monterey Regional	12.24–16.32	0.68–0.78	0.66–0.72	0.38–0.39
Carmel	22.82–44.94	0.76–1.14	0.29–0.46	0.21–0.51
SFEI[a]	0.75–13.55	0.18–0.42	0.09–0.33	0.12–0.53

[a] = Data from San Francisco Estuary Institute (2001).

Table 3.1.6. Permit effluent limits for POP concentrations for each CCLEAN discharger.

	Permit Effluent Limits, ng/L			
Agency	PAHs	Chlordanes	DDTs	PCBs
Santa Cruz	1200	3.2	23.8	2.66
Watsonville	750	2	14	1.6
Monterey	1284.8	3.358	24.82	2.774
Carmel	1070	2.81	20.74	2.32

With the addition of 2004-2005 samples to the CCLEAN database, several seasonal patterns appeared in wastewater loads of POPs, although some were inconsistent among dischargers (Figure 3.1.2). Lowest mean daily loads of all POP groups from Santa Cruz occurred in the 2002 wet season and the lowest mean daily loads of all POP groups from Monterey Regional occurred in the 2004 dry season. The highest loads of HCHs, chlordanes, PCBs, DDTs and dieldrin from Monterey Regional occurred in the wet season within each sampling year. Because of its lower discharge volume, Carmel generally had the smallest mean daily load of each POP in each sampling period, except for high loads of HCHs in the 2004 dry season.

Although four years' data are insufficient to establish long-term trends, annual wastewater loads did not exhibit any temporal trends that were consistent among dischargers (Figure 3.1.3). Annual variation in POP loads was very high in some cases, with loads of PAHs, HCHs and dieldrin from Santa Cruz exhibiting 3.5-fold to 4-fold differences. Loads of chlordanes from Watsonville exhibited 9-fold differences, and loads of HCHs from Monterey Regional and Carmel exhibited 3.5-fold and 28-fold differences, respectively. endosulfans and chlordanes from Monterey Regional and loads of endosulfans from Carmel exhibiting 4-fold, 5-fold, 9-fold and 17-fold differences between years, respectively. The highest annual load of any wastewater POP was for PAHs, with 1278 g per year from Santa Cruz in 2003-2004. Annual loads of HCHs were less than 51 g per discharger, the loads of chlordanes were less than 30 g, and the loads of, PCBs, DDTs and dieldrin were less than 10 g for each discharger. Comparisons between POP loads from wastewater and rivers are discussed in Section 3.5.2.2.

3.1.1.3 Current Status

The sampling of POPs in wastewater effluent twice per year using flow-proportioned solid-phase sampling methods continues and has not encountered serious problems. We will continue to emphasize high quality in laboratory measurement of POPs at very low concentrations. Consideration is being given as to how measurement of emerging contaminants of concern, such as personal care products and endocrine disruptors, can be incorporated in the program. An interlaboratory comparison will be performed during the 2005-2006 program year.

3.1.1.4 Recommendations

Other than inclusion of emerging contaminants of concern, we have no recommendations.

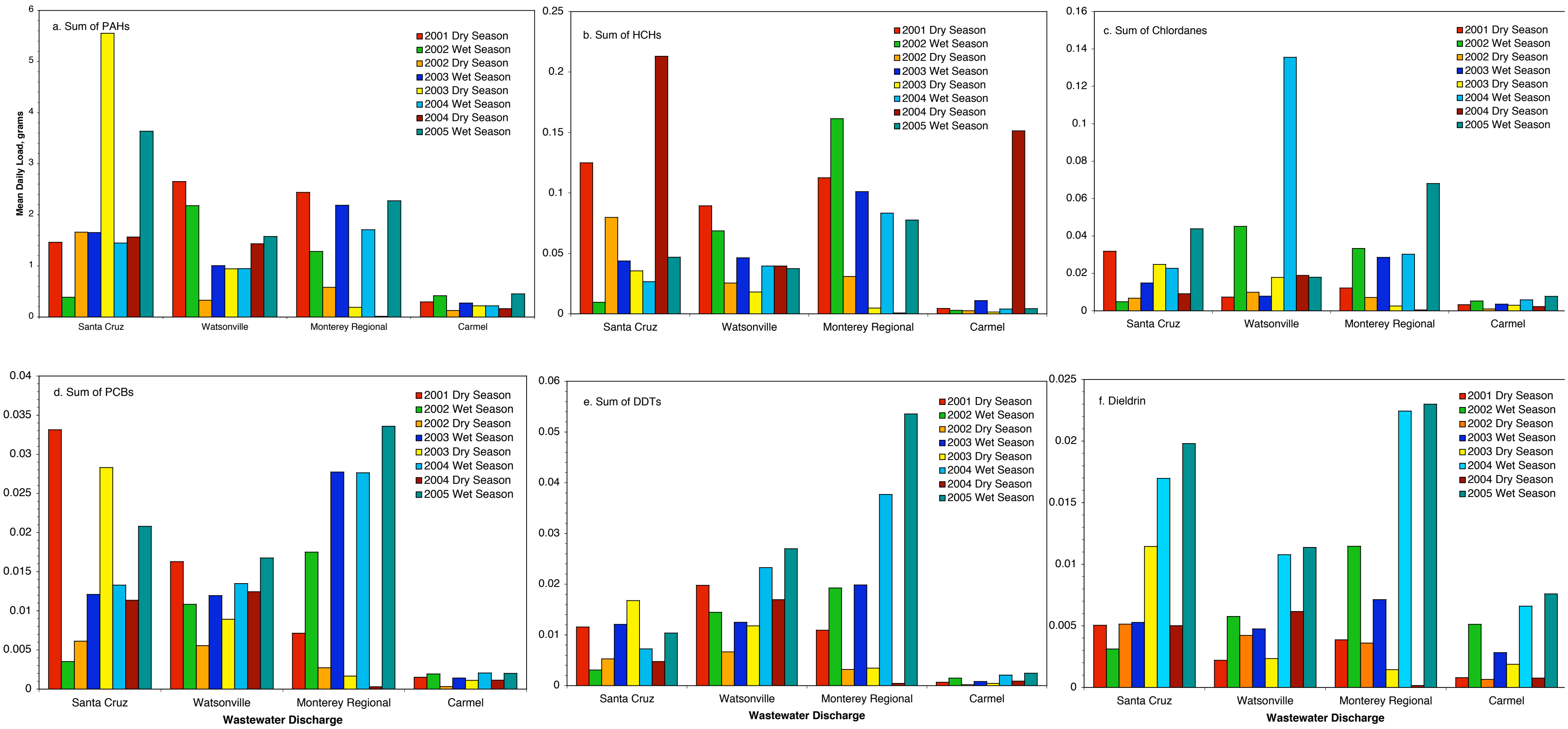


Figure 3.1.2. Mean daily loads of POPs in wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional and Carmel Area wastewater treatment plants during dry-season and wet-season sampling in 2001–2002, 2002–2003, 2003-2004 and 2004-2005.

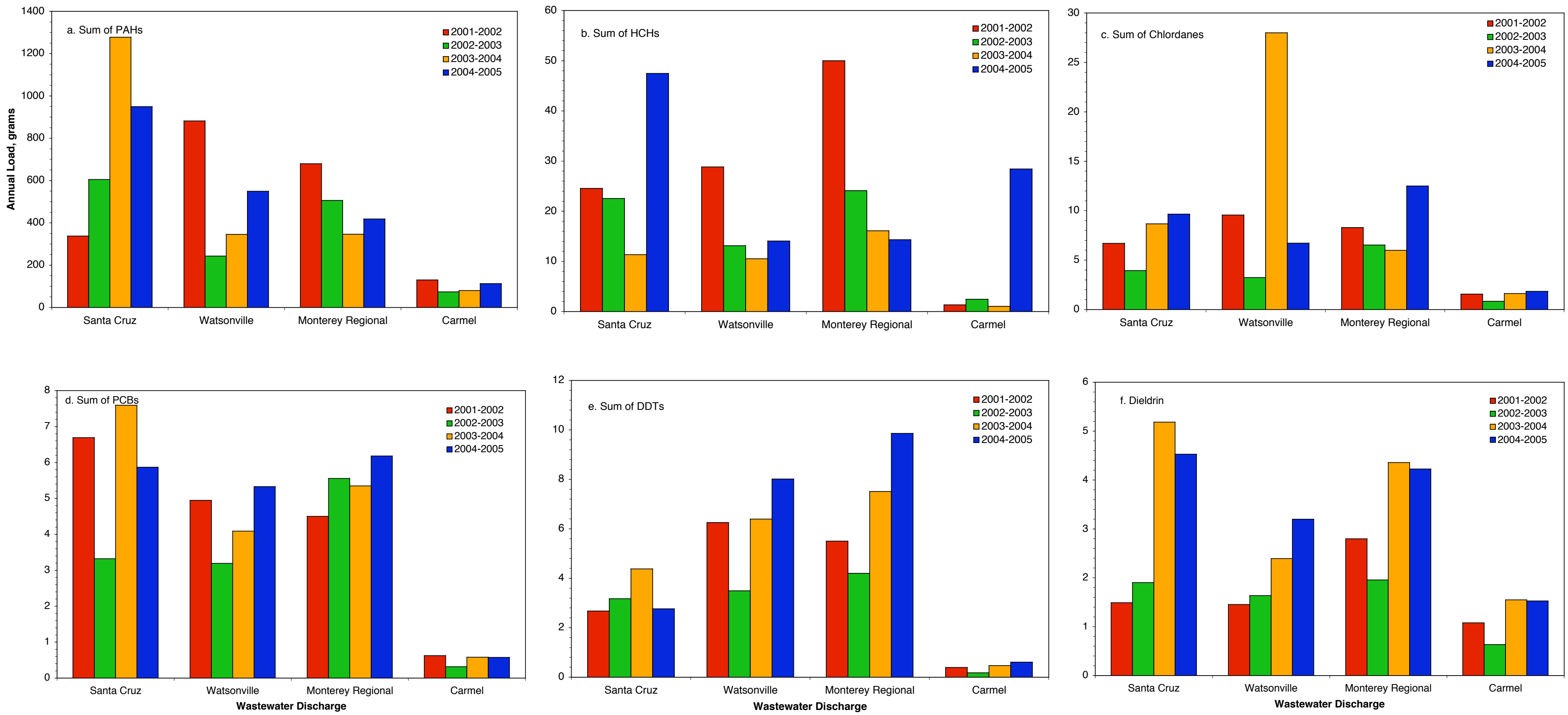


Figure 3.1.3. Annual loads of POPs in wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional and Carmel Area wastewater treatment plants during 2001–2002, 2002–2003, 2003-2004 and 2004-2005.

3.1.2 Grabs by Plant Personnel

3.1.2.1 Activities

Grabs by plant personnel are made monthly for analysis of urea, dissolved silica and orthophosphate and weekly during POP sampling events for analysis of ammonia, nitrate, total suspended solids, temperature, conductivity, and pH (Table 3.1.2). Annual loads of these constituents are estimated by calculating the load on each sampling date (flow multiplied by concentration), then multiplying the average load among all samples by 365. All analyses are performed by the laboratories in the respective treatment plants, except that the urea samples for Santa Cruz, Watsonville and Monterey Regional are analyzed in the Watsonville laboratory and the urea samples from Carmel are analyzed by Monterey Bay Analytical Services.

3.1.2.2 Results

Average concentrations of nutrients and total suspended solids indicated few differences among agencies, except that Santa Cruz and Monterey Regional had higher average concentrations of ammonia, Watsonville had a higher average concentration of orthophosphate, and Monterey Regional had higher average TSS (Appendix B and Table 3.1.7). Ammonia and TSS have permit limits and all the agencies were well below their permit limits for median and daily maximum ammonia-N concentrations and mean and daily maximum TSS concentrations (Table 3.1.8).

Table 3.1.7. Average concentration of nutrients and total suspended solids in effluent from four wastewater treatment facilities in the Monterey Bay area from July 2004 through June 2005.

Agency	Ammonia-N	Nitrate-N	Urea-N	Dissolved silica	Ortho-PO_4	TSS
Santa Cruz	21.2	9.2	0.22	31.9	7.0	3.9
Watsonville	15.0	7.1	0.11	37.8	19.5	7.5
Monterey Regional	30.9	0.9	0.27	44	1.7	12
Carmel	16.4	8.5	0.07	28.8	3.5	8.3

Table 3.1.8. Actual measurements made from July 2004 through June 2005 compared with permit limitations for effluent ammonia-N and total suspended solids (TSS) concentration (mg/L) for each wastewater treatment plant.

Analyte Agency	Measured	Permit Limit	Measured	Permit Limit
Ammonia	Median		Daily Maximum	
Santa Cruz	19.9	69.0	28.8	276.0
Watsonville	16.2	51.0	23.4	200.0
Monterey Regional	31.7	87.6	34.2	350.4
Carmel	1.5	73.2	37.8	292.8
TSS	Mean		Daily Maximum	
Santa Cruz	3.9	30	8	90
Watsonville	7.5	30	10.4	90
Monterey Regional	12	30	16	90
Carmel	8.3	30	25	90

As with the POP measurements, effluent flow volumes were used to calculate the load of nutrients and total suspended solids discharged by each wastewater treatment plant, and these displayed large differences between discharges but no temporal trends (Appendix B and Figure 3.1.4). Carmel consistently had the lowest loads of nutrients and total suspended solids, except that the tertiary treatment at Monterey Regional resulted in very low loads of nitrate. Comparisons between nutrient loads from wastewater and rivers are discussed in Section 3.5.2.1.

3.1.2.3 Current Status

Collection and analysis of monthly grabs and weekly grabs during POP sampling are being performed on schedule and without problems. The logistical arrangements between Watsonville and Santa Cruz and Monterey Regional for analysis of urea also are functioning smoothly.
The CCLEAN nutrient data from effluent, streams and rivers is of interest to the oceanographic community.

3.1.2.4 Recommendations

As with the POP measurements, we suggest consideration of future interlaboratory calibrations for measurements of nutrients, especially urea and dissolved silica as soon as the program budget can support it. While we suspect no problems with any of the analyses, urea is performed to oceanographic standards (Goeyens et al., 1998; Kudela & Cochlan, 2000; Mulvenna & Savidge, 1992) and analysis of check samples by both laboratories is prudent.

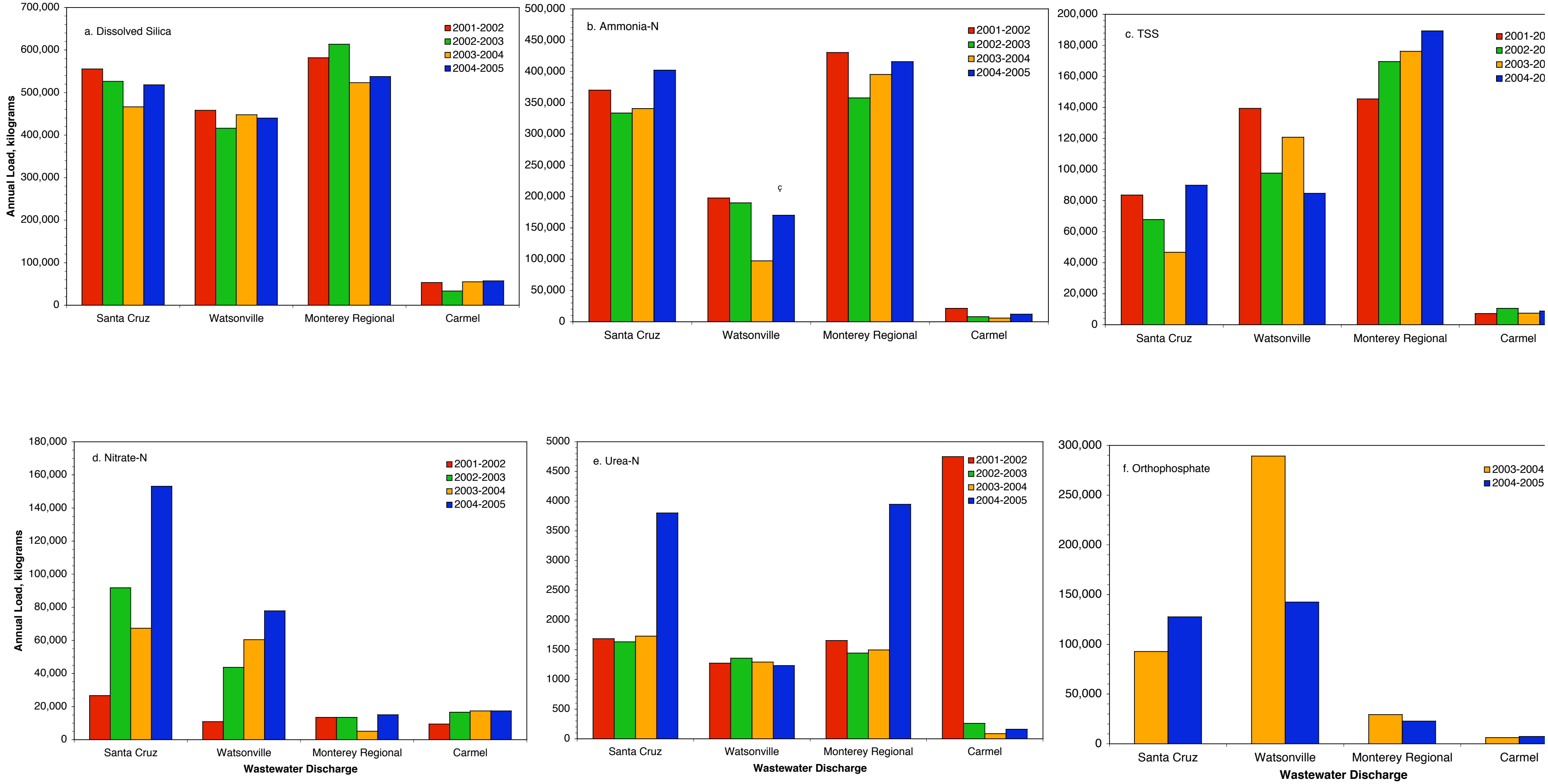


Figure 3.1.4. Annual loads of nutrients and total suspended solids in wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional and Carmel Area wastewater treatment plants during 2001–2002, 2002–2003, 2003-2004 and 2004-2005.

3.2 Receiving Water Sampling

3.2.1 Activities and Methods

Receiving water sampling consists of monthly sampling for pathogen indicators at stations along the 30-ft contour near the wastewater discharges of Santa Cruz, Watsonville, and Monterey Regional counties continued from July 2004 though June 2005 (Appendix B). Water samples were analyzed for total coliform, fecal coliform, and *Enterococcus* bacteria.

Sample collections are made by plant personnel from Santa Cruz, Watsonville, Monterey Regional and/or their consultants, and analyzed in the respective treatment plant laboratories. The locations of receiving water monitoring sites for each agency are described in Table 3.2.1.

Table 3.2.1. Locations of receiving water monitoring sites for each CCLEAN discharger.

Agency	Site	Location
Santa Cruz	RW(A)	Point Santa Cruz
	RW(C)	Old outfall
	RW(E)	610 m upcoast of old outfall
	RW(F)	Natural Bridges
	RW(G)	Terrace Point
	RW(H)	1180 m upcoast of Terrace Point
	RW(I)	2080 m upcoast of Terrace Point
Watsonville	A	2000 m north of outfall
	B	1500 m north of outfall
	C	300 m north of outfall
	D	Adjacent to outfall
	E	300 m south of outfall
	F	1500 m south of outfall
	G	2000 m south of outfall
	ZID	Edge of Zone of Initial Dilution
Monterey Regional	A	900 ft north of outfall
	B	Adjacent to outfall
	C	900 ft south of outfall
	D	1800 ft south of outfall

3.2.2 Results

Concentrations of pathogen indicators were generally low in the receiving waters during 2004–2005. All measurements for all sites and agencies were below 900 MPN/100mL, 300 MPN/100mL, and 80 MPN/100mL for total coliform, fecal coliform and *Enterococcus*, respectively, for the period July 1st, 2004 to June 30th, 2005 (Figures 3.2.1, 3.2.2, 3.2.3). Except for one measurement of *Enterococcus* at Santa Cruz on May 21, 2003 of 300 MPN/100mL, all measurements for all sites and agencies have been below 900 MPN/100mL, 300 MPN/100mL, and 80 MPN/100mL for total coliform, fecal coliform and *Enterococcus*, respectively, for the entire length of this program (Figures 3.2.4, 3.2.5, 3.2.6). None of the existing or proposed objectives for pathogen indicators were exceeded in any sample during the 2004-2005 sampling period (Table 3.2.2).

Most of the highest concentrations for each site coincided with the wet season, from December through March or April. During October of 2004 there was a large pulse in total and fecal coliform at Santa Cruz of 250 and 35 MPN/100mL respectively (Figure 3.2.1 b). In January of 2005 there was a large peak in total and fecal coliform at Watsonville of 900 and 300 MPN/100mL respectively (Figure 3.2.2 a, b). In Monterey the largest concentrations of bacteria for the 2004-2005 period was during December and April reaching 125, 30 and 80 MPN/100mL for total coliform, fecal coliform, and *Enterococcus* respectively (Figure 3.2.3 a, b & c).

Measurements at the Watsonville discharge are especially confounded by storm runoff due to its proximity to the plume of the Pajaro River. At Santa Cruz site RW(A), near Point Santa Cruz, there were much higher levels of total and fecal coliform than the other sites during October 2004 (Figures 3.2.1a and 3.2.1b). At Watsonville site G, just north of the ZID (zone of initial dilution), there were higher levels of total and fecal coliform than the other sites during January 2005 (Figures 3.2.2a and 3.2.2b). At Monterey site A, 900 ft north of the outfall, there higher levels of total and fecal coliform than the other sites during October and December of 2004 (Figures 3.2.3a and 3.2.3b) and elevated *Enterococcus* at site B, adjacent to the outfall, during September and December 2004 (Figure 3.2.3c). It should be noted that the City of Santa Cruz lowered the detection limit for total coliform, fecal coliform and *Enterococcus* from 20 MPN/100mL to 2 MPN/100mL in April 2003. The decision to lower the detection limit was based upon the need to have comparable data among the dischargers.

This is the fourth year of the project and overall the trend seems to be that the bacteria levels detected mirror the rainfall or episodic storm events perhaps with a time delay in some areas due to differing patterns of drainage from some watersheds. Background levels are consistently low throughout the summer and early fall, however, during the winter and spring there are pulses of higher bacteria levels coinciding with increased storm runoff. The higher levels could be due to increases in runoff from agricultural lands and animal wastes which enter into the storm and sewer drains. There is also evidence that leaking or malfunctioning onsite septic systems are an source of nutrient pollution into local watersheds and runoff (see Section 3.5.2.2), and may be contributing nearshore bacteria, as well.

Table 3.2.2. Comparison of existing and proposed water quality objectives for bacteria concentrations in the Central Coast Region.

Beneficial Use	Indicator	Existing Objective	Proposed Objective
Marine Water Contact Recreation	Total Coliform	All stations <1,000/100mL <20% samples/30 days from a given station >1,000/100mL no sample >10,000/100mL	Geometric mean <1,000/100mL no samples >10,000/100mL no samples >1,000 if fecal-to-total ratio >0.1
	Fecal Coliform	Geometric mean <200/100mL <10% of all samples >400/100mL	Geometric mean <200/100mL no samples >400/100mL
	Enterococcus	None	Geometric mean <35/100mL no samples >104/100mL

3.2.3 Current Status

Monthly receiving water sampling will be continued by each agency and no changes to this program element are expected.

3.2.4 Recommendations

We currently have no recommendations regarding this program element.

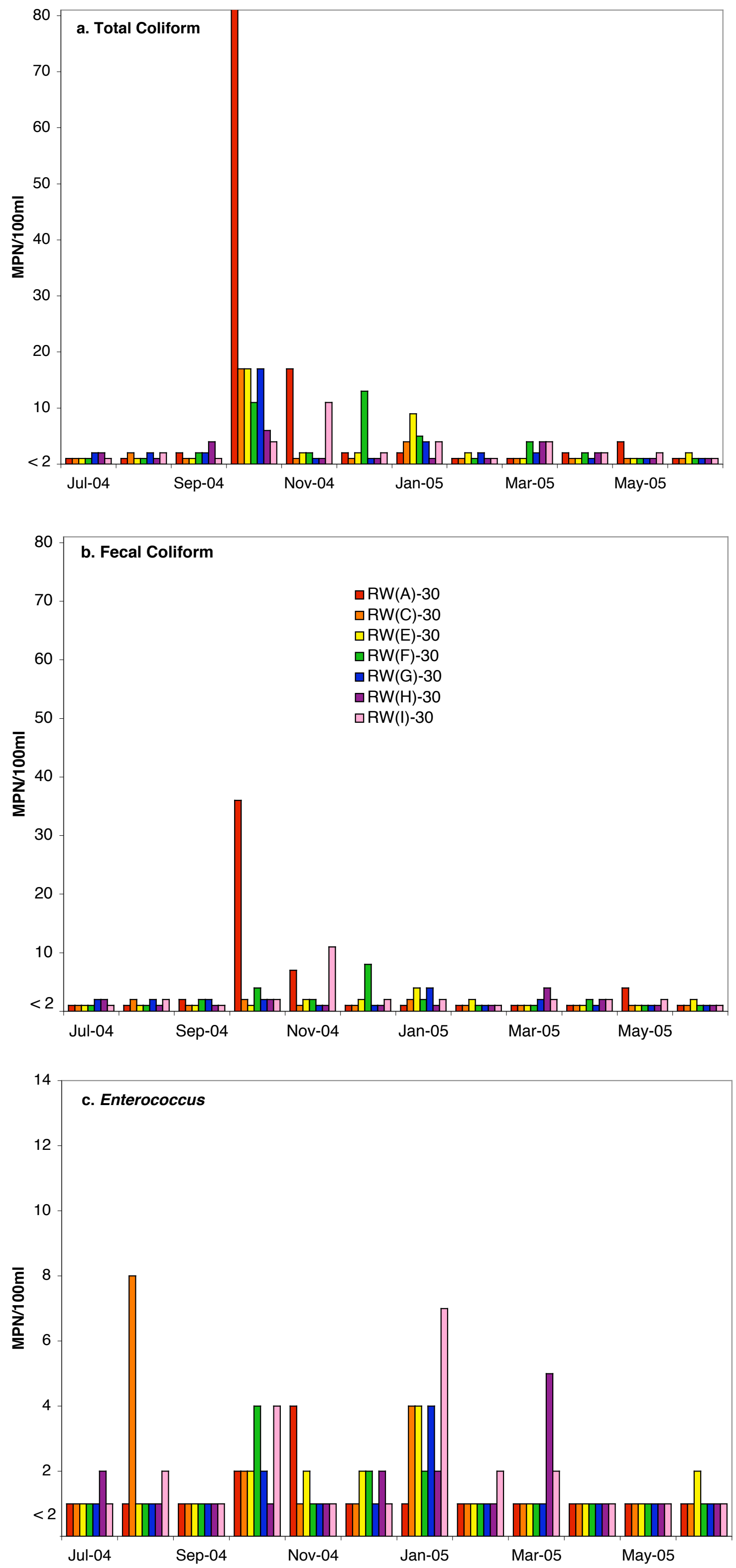


Figure 3.2.1. Most probable number of pathogen indicators at receiving water monitoring site near the Santa Cruz wastewater discharge during 2004–2005. Site RW(G) is closest to the discharge.

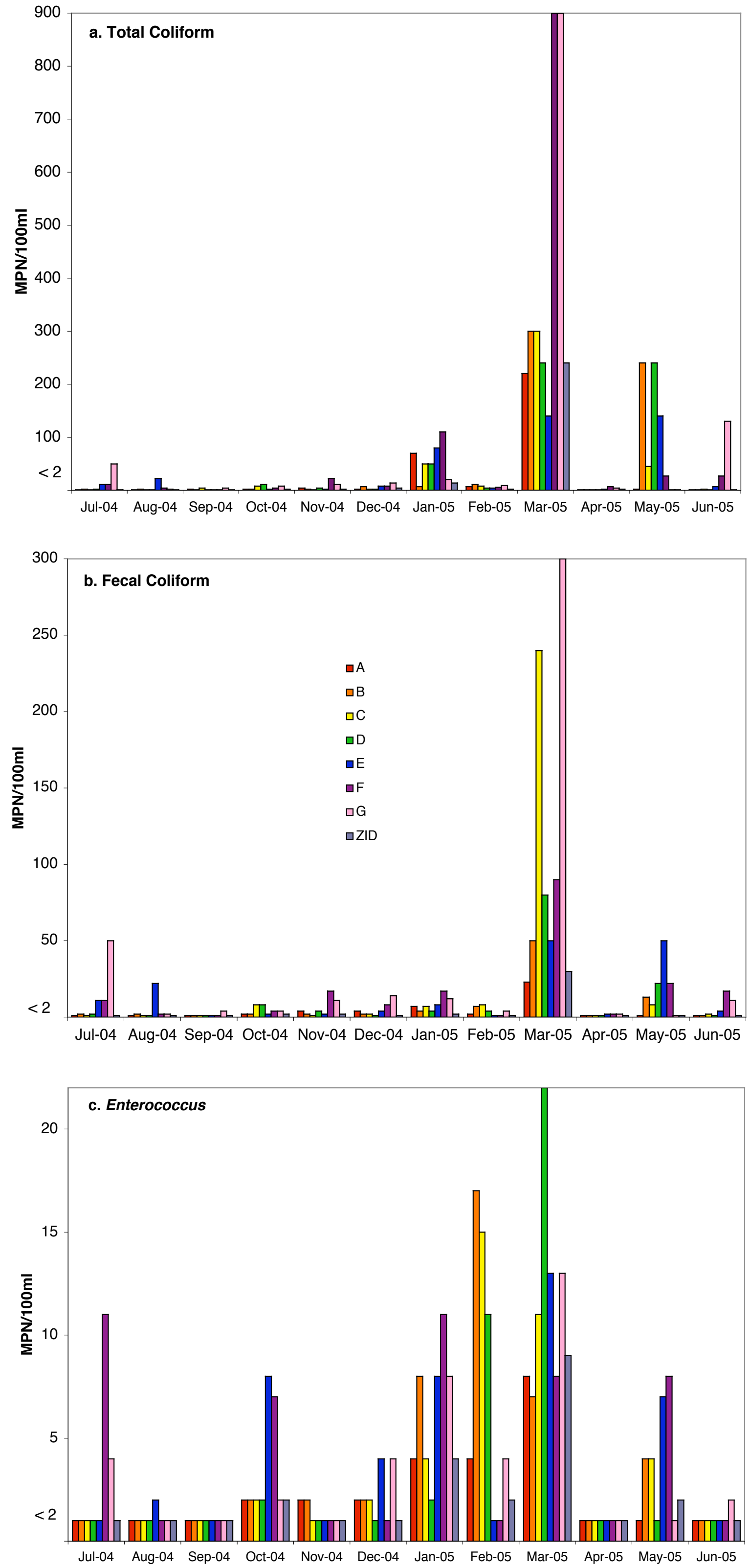


Figure 3.2.2. Most probable number of pathogen indicators at receiving water monitoring site near the Watsonville wastewater discharge during 2004–2005. Sites D & ZID are closest to the discharge.

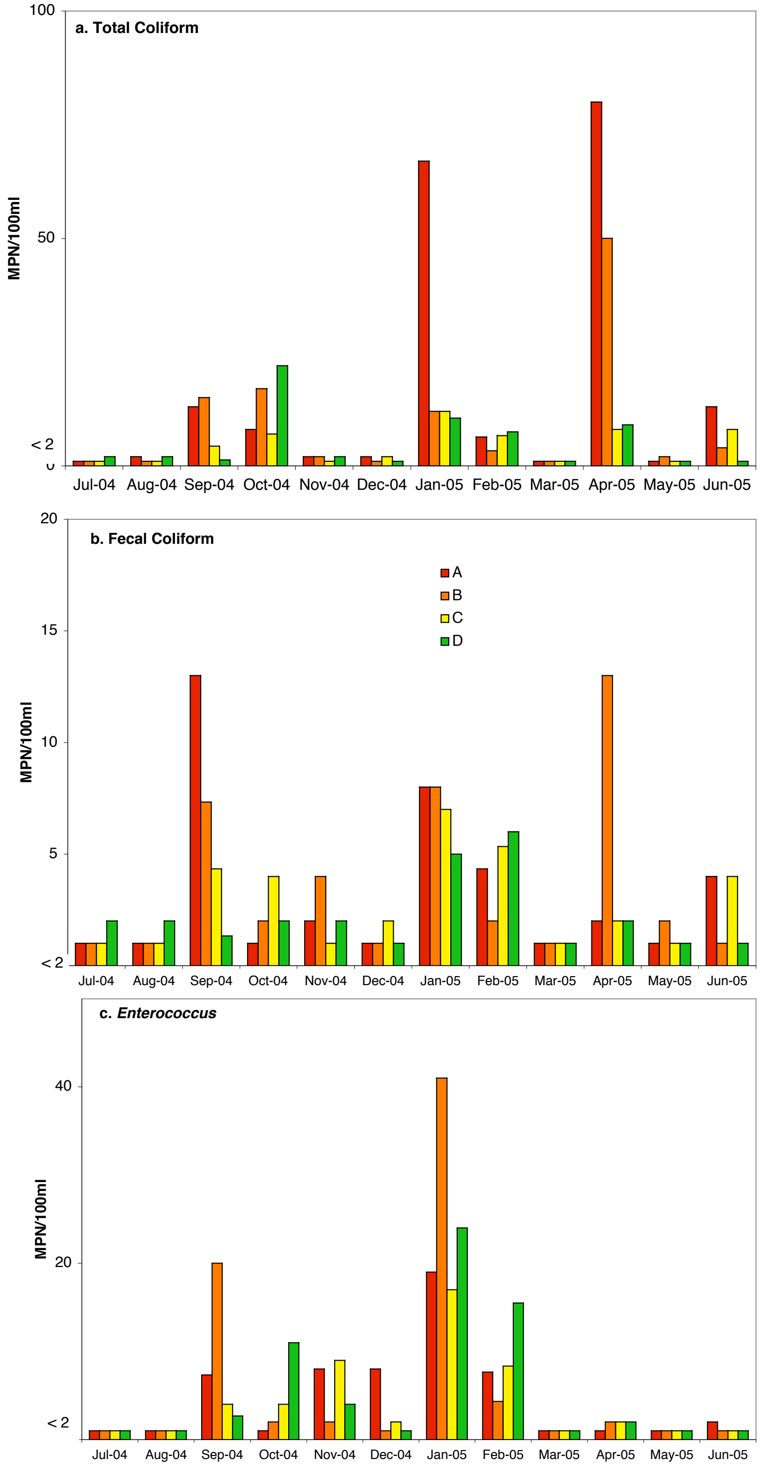


Figure 3.2.3. Most probable number of pathogen indicators at receiving water monitoring sites near the Monterey Regional discharge during 2004–2005. Site B is closest to the discharge.

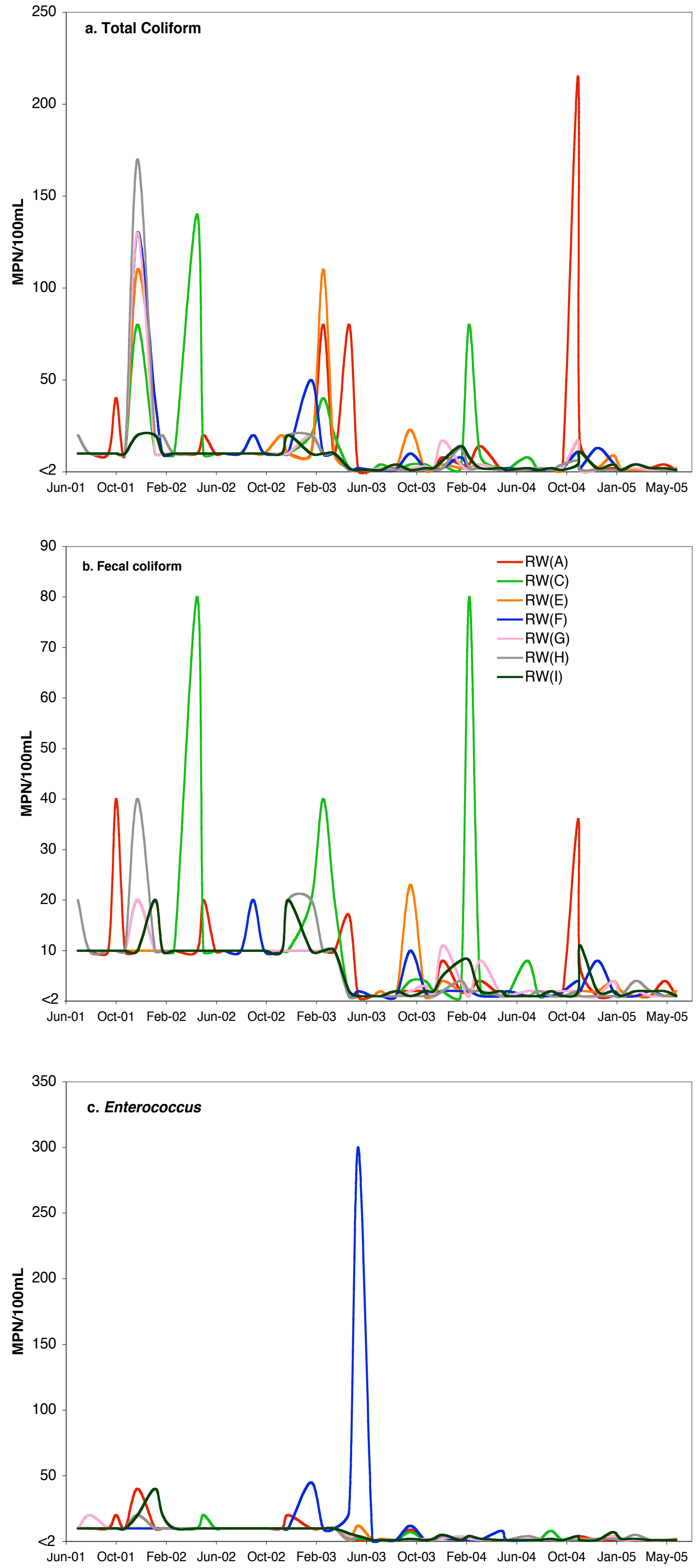


Figure 3.2.4. Most probable numbers of pathogen indicator bacteria at water monitoring sites near the Santa Cruz wastewater discharge from July 2001 to June 2005. Site RW(G) is closest to the discharge.

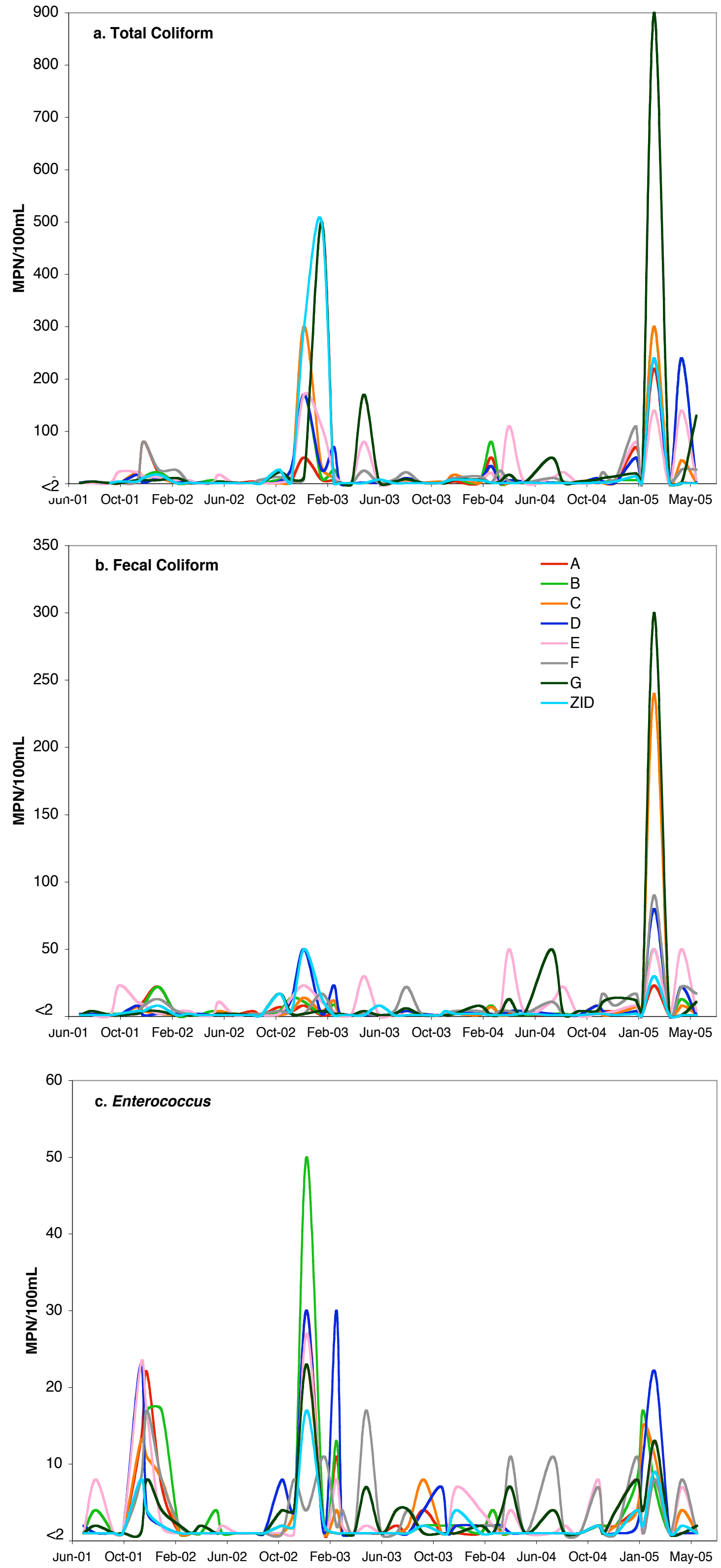


Figure 3.2.5. Most probable number of pathogen indicator bacteria at water monitoring sites near the Watsonville wastewater discharge from July 2001 to June 2005. Site D & ZID are closest to the discharge.

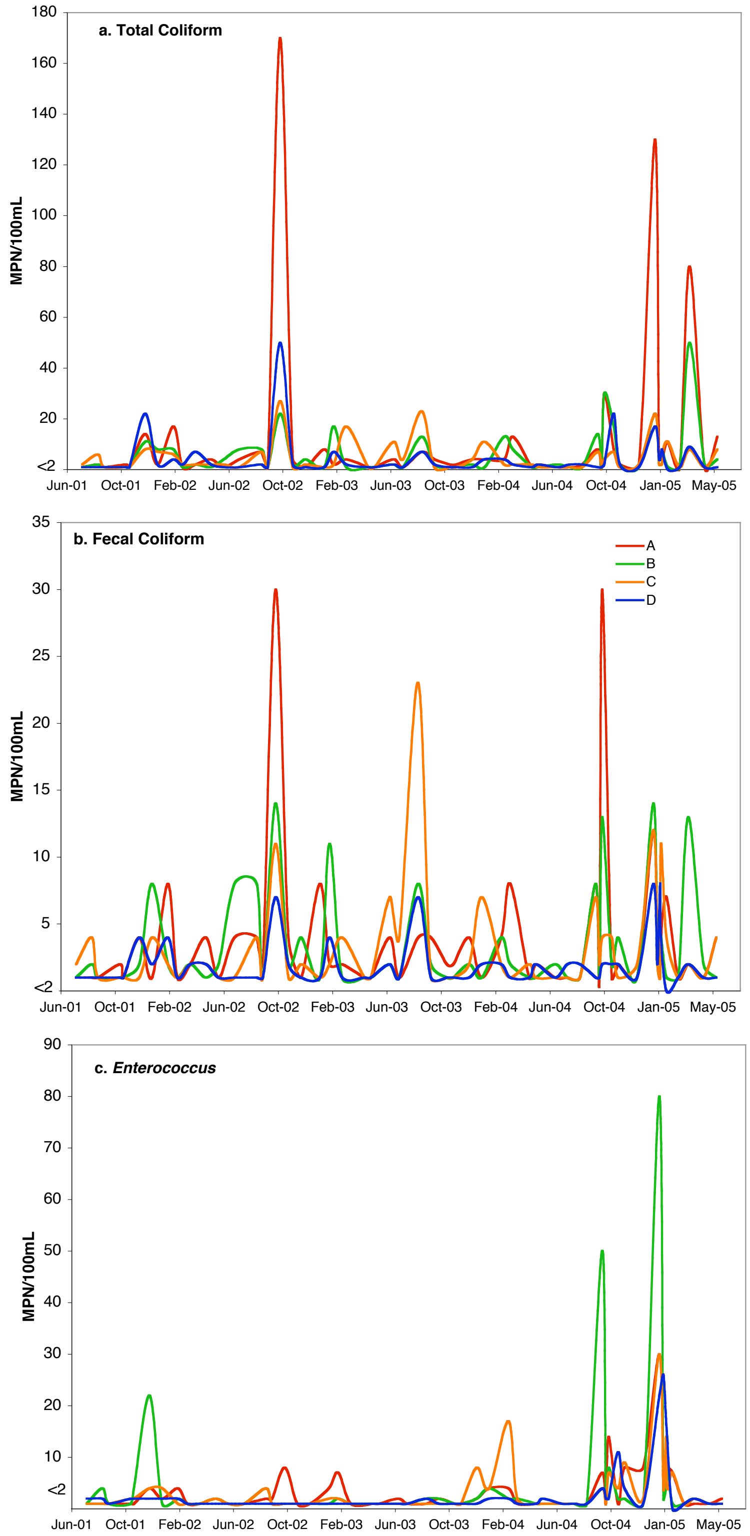


Figure 3.2.6. Most probable number of pathogen indicator bacteria at water monitoring sites near the Monterey Regional wastewater discharge form July 2001 through June 2005. Site B is closest to the discharge.

3.3 Mussel Sampling

Mussel sampling consists of collecting mussels from five sites twice a year, during the wet season and dry season, for analysis of POPs and bacteria. The objective of this program element is to determine the extent to which POPs, and pathogens might be incorporated into components of the food web that are consumed by humans and sea otters. Mussel sampling is being performed by KLI, with POP analyses analyzed by Axys and Analytical Resources, Inc. and bacteria analyzed by Biovir.

3.3.1 Activities and Methods

The sites shown in Table 3.3.1 were sampled by KLI in August 2004 (dry season) and February 2005 (wet season). Approximately 30 mussels were collected from each site for both POP analyses and bacteria analyses. Field duplicates were collected at Laguna Creek in August 2004 and February 2005 to analyze the effects of within-site variation in the mussel population and analytical processes on variation in analytical results.

Table 3.3.1. Site names and coordinates for CCLEAN mussel sampling locations.

Site Name	Latitude	Longitude
Scott Creek	37.042°	122.234°
Laguna Creek	36.984°	122.159°
The Hook	36.959°	121.965°
Fanshell Overlook	36.584°	121.972°
Carmel River Beach	36.539°	121.932°

3.3.2 Results

Mussels at Scott Creek, Laguna Creek, Fanshell Overlook, and Carmel River Beach generally have been similar in their concentrations of PAHs, chlordanes, and PCBs (Appendix D, Figure 3.3.1), except that PCBs were much higher at Carmel River Beach in August 2004 than at any other time or site. DDT concentrations also have been similar among Scott Creek, Fanshell Overlook, and Carmel River Beach sites. Mussels at The Hook generally have had higher POP concentrations than those from the other four CCLEAN sites, although the differences were less apparent in the dry season samples (October 2002, August 2003 and August 2004) than in the wet season samples (February 2002, February 2003, March 2004 and February 2005) (Figure 3.3.1).

Comparison of CCLEAN mussel data with data from other regional sampling programs helps to put Monterey Bay POP concentrations into perspective. Bodega Head is a collection site for clean mussels used as background comparisons and for transplanting in the Regional Monitoring Program for Trace Substances in San Francisco Bay and the State Mussel Watch program. Concentrations of POPs at the CCLEAN sites generally were higher than those at Bodega Head within the same sampling season (data made available by the San Francisco Estuary Institute). In particular, all CCLEAN sites had higher PAH, DDT and chlordane concentrations than did Bodega Head (Figure 3.3.1a, Figure 3.3.1b and 3.3.1c) and dieldrin at Laguna Creek and The Hook also were substantially greater than those at Bodega Head (Figure 3.3.1e). In contrast, Bodega Head mussels had higher PCB concentrations than those at the CCLEAN sites. San Francisco Bay is a highly urbanized estuary that receives the outflow from every major river in the Central Valley of California and San Francisco Bay has been listed as impaired for legacy pesticides, such as DDTs, chlordanes and dieldrin. Comparison of CCLEAN sites with a more contaminated location in San Francisco Bay (Yerba Buena Island) showed that mussels from Laguna Creek and The Hook generally had similar or greater concentrations of DDTs, chlordanes and dieldrin than those from Yerba Buena Island within the same season. Consequently, mussels from several CCLEAN sites have had POP concentrations higher than those from an open coast site considered to be relatively clean and, in some cases, comparable to those from a contaminated, urbanized embayment.

Other studies have shown that POP concentrations in bivalves can vary according to the size of the organism (Gilek *et al.*, 1996) with higher concentrations being found in smaller individuals. Shell length was examined to see if differences among sites could help explain the consistently high POP concentrations at The Hook. Average shell lengths at The Hook ranged from 53.98 mm to 60.79 mm and were comparable to those at other sites (Figure 3.3.2), so high POP concentrations at that site remain enigmatic.

Temporal patterns of POP concentrations in mussels suggest seasonal differences. Most POPs had higher concentrations in CCLEAN mussels from February 2002, February 2003, March 2004 and February 2005 than in those from October 2002, August 2003 and August 2004 (Figure 3.3.1). Although these POPs are lipophilic and their dry-weight concentrations may vary according to physiological cycles related to lipid accumulation (e.g., gametes have high lipid content), there were no differences among sampling periods in the lipid content of the mussels that were consistent with the seasonal patterns in POP concentrations (Appendix D, Figure 3.3.3). Consequently, the temporal pattern exhibited by the three sampling periods suggests differences in the ambient concentrations experienced by the mussels. The relatively higher POP concentrations during wet season sampling periods in February 2002, February 2003, March 2004 and February 2005 suggest high winter stream and river flows and runoff from land might be sources of higher ambient concentrations and especially this past seasons abnormally high flow during the spring of 2004-2005 (refer to Figure 3.5.5b in Rivers and Stream section).

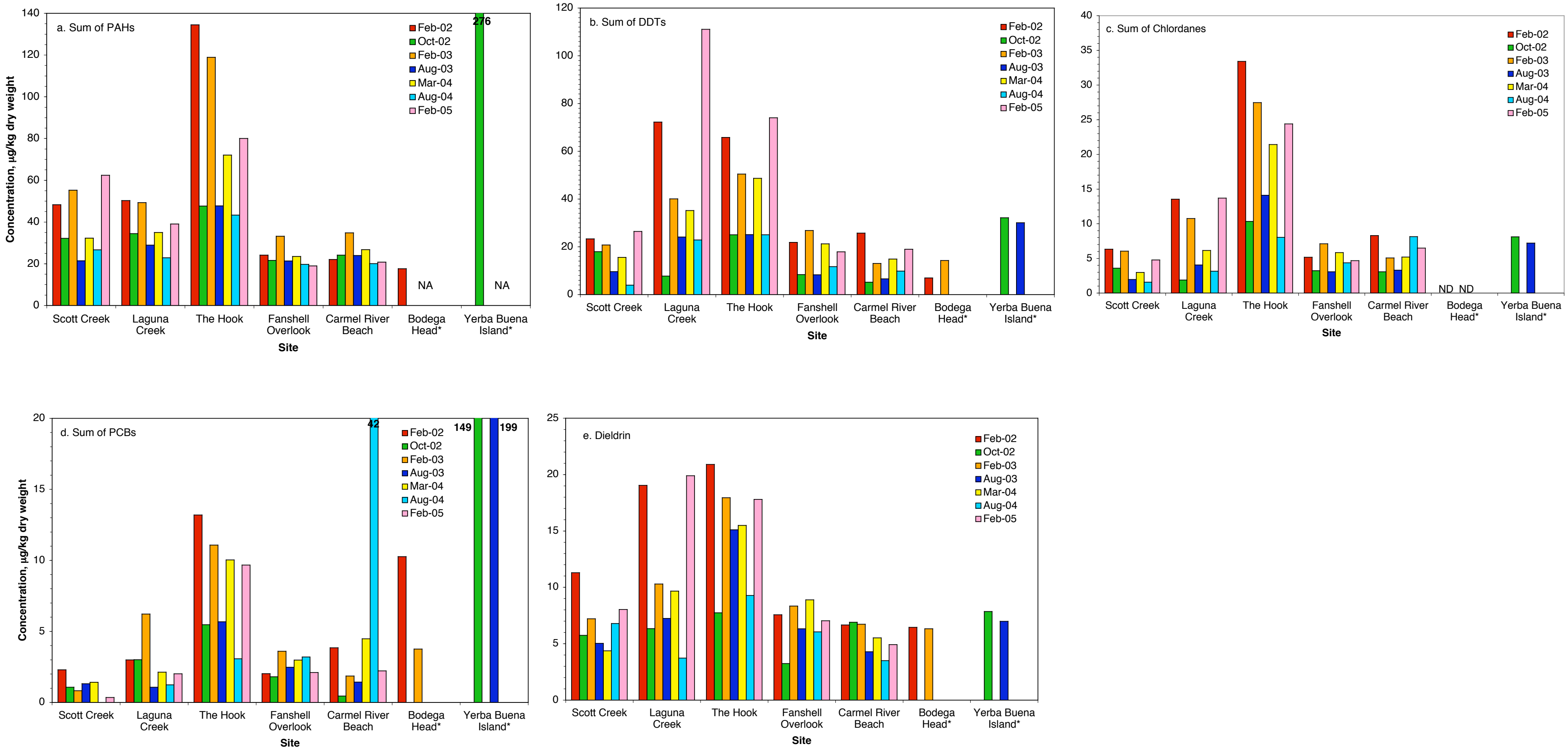


Figure 3.3.1. Dry-weight concentrations of PAHs, DDTs, chlordanes, PCBs and dieldrin in mussel tissues from five CCLEAN sites sampled in February 2002, October 2002, February 2003, August 2003, March 2004, August 2004 and February 2005. Laguna Creek (February 2002 and October 2002), The Hook (February 2003), Fanshell Overlook (August 2003), Carmel River Beach (March 2004), Laguna Creek (August 2004), and Laguna Creek (February 2005) values are the means of two field duplicates. NA = Not analyzed; ND = Not detected; * = Bodega Head was sampled in May 2002 and May 2003, and Yerba Buena Island was sampled in September 2002 and September 2003 as part of the Regional Monitoring Program for Trace Substances in San Francisco Bay.

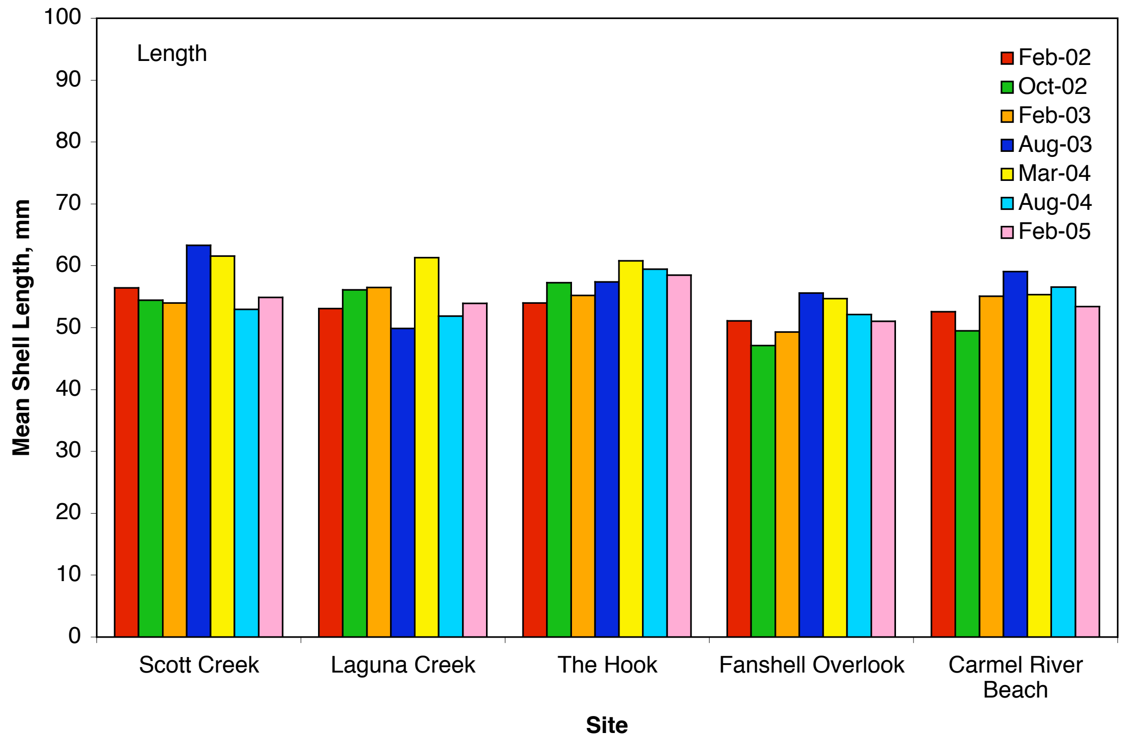


Figure 3.3.2. Mean shell length in mussels from five CCLEAN sites analyzed for POP concentrations

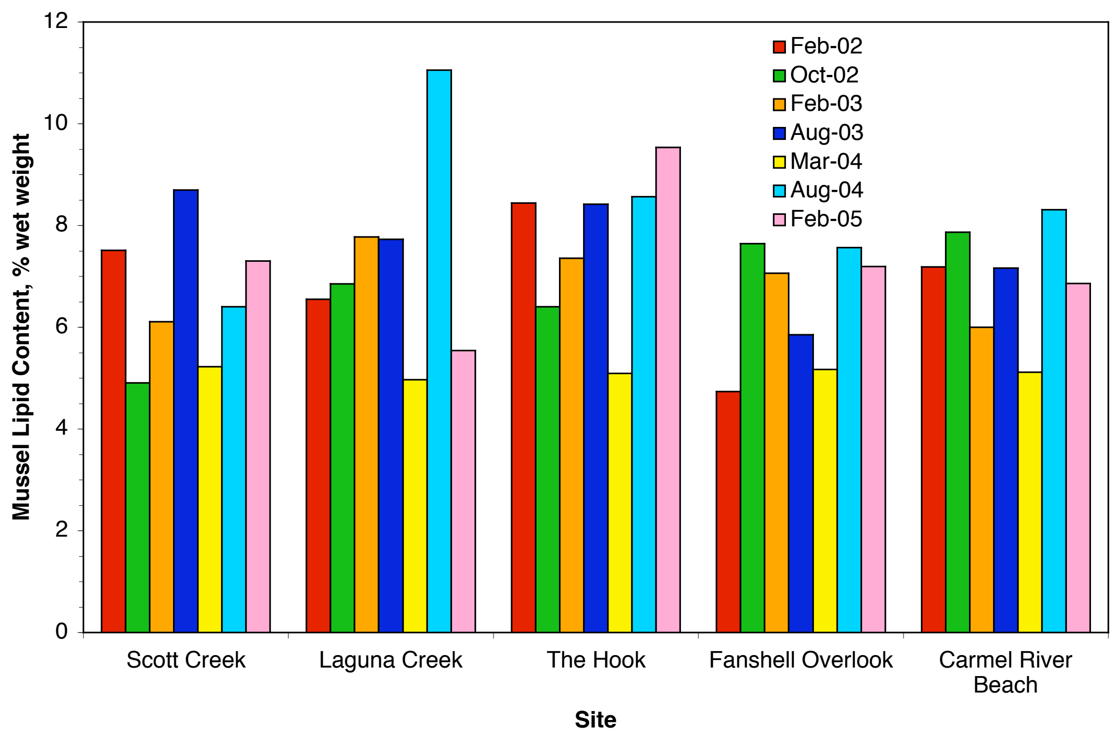


Figure 3.3.3. Lipid content in CCLEAN mussel samples as a percent of wet weight.

There are several applicable screening values and guidelines that can be used to evaluate the POP concentrations in mussel tissues in a larger context (Table 3.3.2). The State Water Resources Control Board (SWRCB) has published Maximum Tissue Residue Levels (MTRLs) (Rasmussen, 2000) that were developed from water quality objectives in the 1997 California Ocean Plan (State Water Resources Control Board, 1997) and bioconcentration factors recommended by the U.S. Environmental Protection Agency (USEPA, 1991). As stated by Rasmussen (2000), "The MTRLs are used as alert levels or guidelines indicating water bodies with potential human health concerns and are an assessment tool and not compliance or enforcement criteria." The State Mussel Watch has ranked tissue concentrations measured over a 20-year period and designated concentrations corresponding to elevated data levels (EDL) for the 85^{th} and 95^{th} percentiles of all measurements (Rasmussen, 2000). The EDL 85 indicates a concentration that is markedly elevated from the median of all measurements and the EDL 95 indicates a concentration that is highly elevated from the median of all measurements. The U.S. Food and Drug administration (USFDA) has set upper limits for contaminants in fish and shellfish to protect the health of consumers (U.S. Food & Drug Administration Center for Food Safety & Applied Nutrition, 2001). The USEPA has set screening values for fish or shellfish taken by both recreational and subsistence fishers (US Environmental Protection Agency, 2000). These screening values are based upon the toxicity of different POPs and assume an average fisher body weight of 70 kg with consumption of 17.5 g/day by recreational fishers and 142.4 g/day by subsistence fishers. These screening values indicate potential public health concerns and exceedances should receive intensive site-specific monitoring and evaluation of human health risk. The California Office of Environmental Health Hazard Assessment (OEHHA) has determined screening values (Brodberg & Pollock, 1999) using the same methods as used by USEPA, except that they assumed a consumption rate of 21 g/day of fish or shellfish. All of these alert levels and guidelines are based on wet-weight concentrations.

Table 3.3.2. Screening values and guidelines for tissue concentrations of POPs (wet weight).

Analyte	SWRCB MTRL	CA SMW EDL 85	CA SMW EDL 95	US FDA Shellfish	US EPA REC	US EPA SUB	CA OEHHA
Dieldrin	0.2	1.6	2.5	300	2.5	0.3	2
Total PCBs	0.6	15.1	35.2	2000	20	2.4	20
Total Chlordanes	0.32	4.4	7.2	300	114	14	30
Total DDTs	9.1	48.8	129	5000	117	14.4	100
Total Endosulfans		0.3	1.2		24000	295	20000
Total PAHs	0.26						

As reported in previous years, mussels from all five sites exceeded at least one alert level for concentrations of POPs (Figure 3.3.4). The MTRL for Ocean Plan PAHs (a subset of the PAHs measured by CCLEAN) has been consistently exceeded in all samples (Figure 3.3.4a). The MTRL for DDTs was exceeded at Laguna Creek and at The Hook in February 2002 and 2005 and the USEPA DDT screening value for subsistence fishers was nearly equaled at Laguna

Creek and the Hook in February 2002 and 2005 and exceeded at Laguna Creek in February 2005 (Figure 3.3.4b). The MTRL for Ocean Plan chlordanes (a subset of the chlordanes measured by CCLEAN) also has consistently been exceeded in all samples, and the SMW EDL 85 for this POP was exceeded at The Hook in February 2002, 2003, and 2005 (Figure 3.3.4c). The MTRL for Ocean Plan PCBs (a subset of the PCBs measured by CCLEAN) has been exceeded in every sample from The Hook except the most recent dry season sampling in August 2004 (Figure 3.3.4d). Carmel River Beach also exceeded the PCB MTRL, with a value of 6.7 μg/Kg. The SMW EDL 85 for endosulfans was exceeded at every site at least once and The Hook exceeded the SMW EDL 95 in October 2002 (Figure 3.3.5e). The chlorinated pesticide dieldrin exceeded the SWRCB MTRL in all mussel samples, exceeded the SMW EDL 85 at Scott Creek, Laguna Creek and The Hook in February 2002, at Laguna Creek and The Hook in February 2003 and 2005 and March 2004 and at The Hook in August 2003. This POP also exceeded the OEHHA screening value at Laguna Creek in February 2002 and 2005 and at The Hook in February 2002, February 2003, August 2003, March 2004 and February 2005, as well as the SMW EDL 95 and the USEPA recreational fishing screening value at Laguna Creek in February 2002 and February 2005 and at The Hook in February 2002, February 2003, March 2004 and February 2005 (Figure 3.3.4f).

The exceedences of these screening values and guidelines indicate that contamination of nearshore shellfish in the Monterey Bay area may be of concern for human and wildlife health. Moreover, exceedences of SMW EDLs for DDTs, Ocean Plan chlordanes, endosulfans and dieldrin show that some CCLEAN mussel samples are among the most contaminated 5-15% of samples analyzed by SMW over a 20-year period. These results suggest, at the least, that people should limit their consumption of mussels. The exceedence of the USEPA subsistence fisher screening value for dieldrin especially raises concerns for the health of humans and wildlife, such as sea otters, that may consume large quantities of mussels and other bivalves.

Other data sources were examined to determine whether there are long-term trends in mussel POP concentrations in the Monterey Bay area. The State Mussel Watch (SMW) program and the National Status and Trends (NS&T) program have data for several sites in Monterey Bay beginning in 1977 and 1986, respectively. We picked two locations at the margins of Monterey Bay distant from large sources of agricultural discharges, Pacific Grove and Santa Cruz. For Pacific Grove, SMW data from Pacific Grove and NS&T data form Lovers Point were combined due to their proximity. For Santa Cruz, NS&T data from Point Santa Cruz were used. DDTs and dieldrin were picked for this analysis as examples of chlorinated pesticides because the CCLEAN data have shown exceedences of a number of alert levels. There were slight upward and downward trends in DDTs at Santa Cruz and Pacific Grove, respectively, but neither was statistically significant (Figure 3.3.5a). There also were upward trends in dieldrin at both locations, but neither was statistically significant (Figure 3.3.5b). These results suggest that background concentrations of these two legacy pesticides in mussels have not changed in Monterey Bay over the past 20–30 years.

Concentrations of bacteria in mussels varied among sites and times, but did not exhibit consistent seasonal patterns (Appendix D, Figure 3.3.6). Mussels from Scott Creek generally had the lowest concentrations of the three pathogen indicators that were measured, except for February 2005, when it, Laguna Creek and Carmel River Beach had high total coliform concentrations. The highest concentration of total coliform was measured at Carmel River Beach in February 2005, the highest concentration of fecal coliform was measured at Laguna Creek in February 2005 and the highest concentration of *Enterococcus* was measured at Fanshell Overlook in February 2003 (Figure 3.3.6). Nevertheless, The Hook had the highest geometric mean concentration of enterococcus over all sampling periods, whereas Fanshell Overlook and Carmel River Beach had the highest geometric mean concentrations of total and fecal coliform, respectively (Table 3.3.3). Mussels from Laguna Creek, The Hook, Fanshell Overlook, and Carmel River Beach also exceeded the USFDA guidelines for concentrations of fecal coliform of 330 MPN/100g (U.S. Food & Drug Administration Center for Food Safety & Applied Nutrition, 2001) at various times (Figure 3.3.6b). Although these guidelines are intended to protect human health, susceptible mammals that ate these mussels also could have been at risk from exposure to pathogens of fecal origin.

3.3.3 Current Status

Mussel sampling continues as in previous years. As with effluent sampling, consideration is being given as to how measurement of emerging contaminants of concern, such as personal care products and endocrine disruptors, can be incorporated in the program.

3.3.4 Recommendations

CCLEAN should continue a willingness to collaborate with tissue monitoring being proposed by the Regional Board's CCAMP program. CCAMP is investigating the use of sand crabs for tissue monitoring and use of these organisms would substantially expand the shoreline that could be covered by tissue monitoring. Moreover, further investigations of the sources and pathways of POPs into mussels should be considered, especially at The Hook.

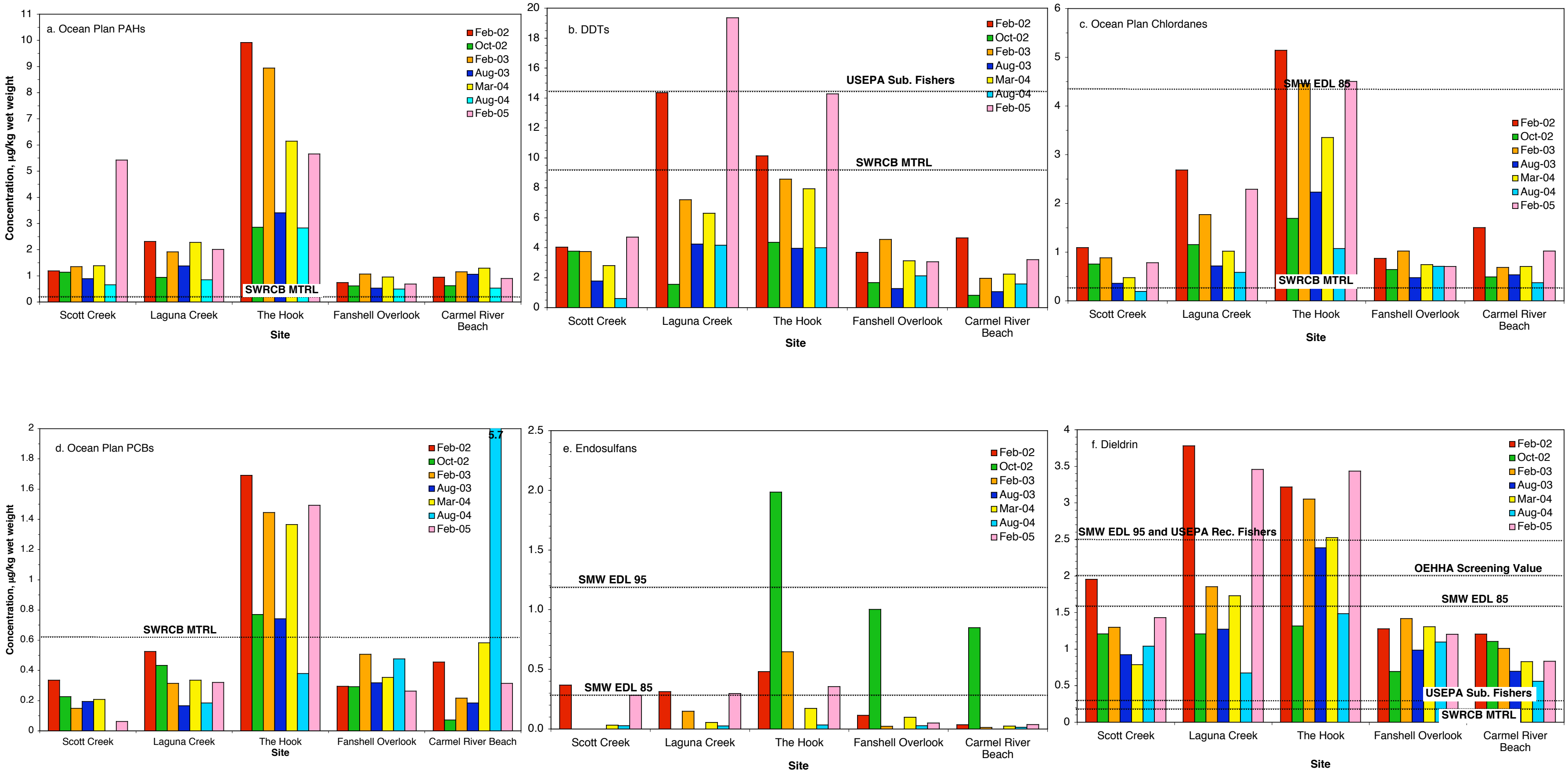


Figure 3.3.4. Wet-weight tissues concentrations of Ocean Plan PAHs, DDTs, chlordanes, PCBs, endosulfans and dieldrin in mussels from five CCLEAN sites compared with various screening values and guidelines. Mussels were collected in February 2002, October 2002, February 2003, August 2003, March 2004, August 2004 and February 2005.

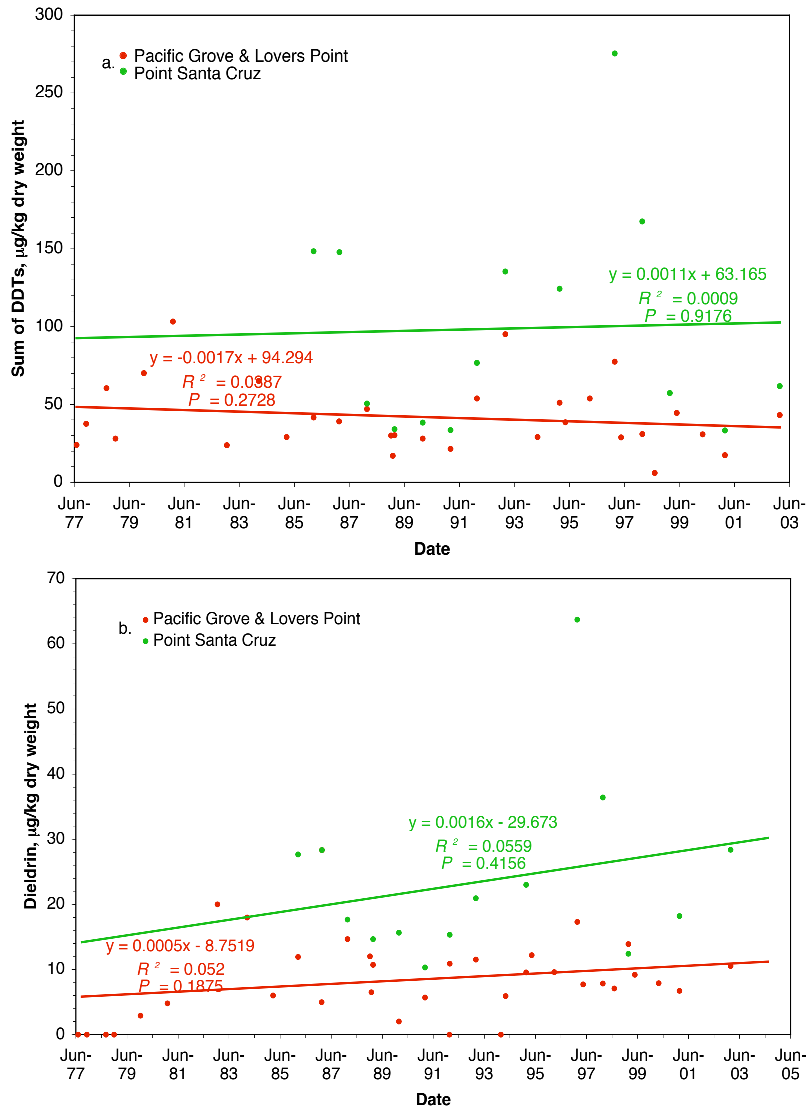


Figure 3.3.5. Concentrations of the sum of DDT's and dieldrin at Pacific Grove and Lovers Point, and Point Santa Cruz. Data from National Status and Trends Mussel Watch Program.

Table 3.3.3. Geometric mean concentrations of bacteria in mussels from five CCLEAN sites. Number of samples equals 7 (February 2002, October 2002, February 2003, August 2003, March 2004, August 2004, February 2005), non-detected results reported as half the detection limit (i.e., 10 MPN/100 g).

Site	Total Coliform	Fecal Coliform	Enterococcus
Scott Creek	116	40	77
Laguna Creek	135	69	146
The Hook	218	73	235
Fanshell Overlook	337	111	123
Carmel River Beach	251	118	122

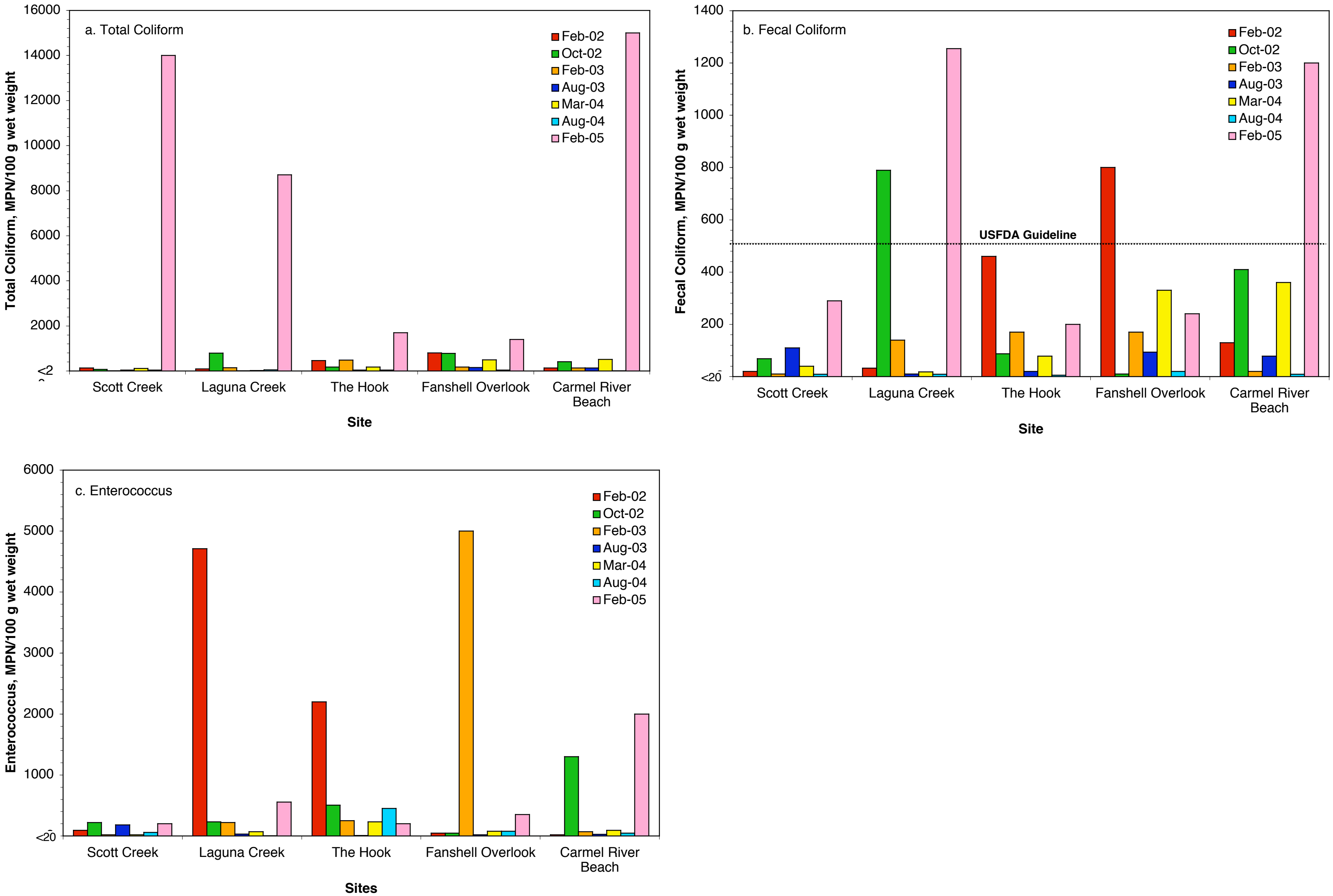


Figure 3.3.6. Concentrations of bacteria in mussels from five CCLEAN sites in the Monterey Bay area. Data were collected in February 2002, October 2002, February 2003, August 2003, March 2004, August 2004 and February 2005.

3.4 Sediment Sampling

The objectives of this program component are to measure concentrations of POPs in sediments where the sediments are most likely to be deposited after washing off the land and out of rivers, and the effects of POPs on macrobenthos. Site coordinates and depths are shown in Table 3.4.1. Sediment sampling is conducted by MEC, with support from other consultants. Benthic infauna are analyzed by ABA Consultants, POPs are analyzed by Axys and Analytical Resource, Inc. (chlorpyrifos and diazinon), and total organic carbon (TOC) and grain size are analyzed by MEC.

Table 3.4.1. Names and locations of CCLEAN sediment sampling sites.

Site Name	Depth, m	Latitude (N)	Longitude (W)
SedRef 01	81.7	36° 59.155’	122° 16.800’
SedRef 02	80.7	36° 56.615’	122° 12.610’
SedRef 03	81.3	36° 55.490’	122° 10.640’
SedRef 04	81.9	36° 54.745’	122° 09.370’
SedDep 01	80.9	36° 51.800’	122° 02.366’
SedDep 02	80.0	36° 50.245’	121° 55.910’
SedDep 03	80.0	36° 45.670’	121° 52.290’
SedDep 04	80.0	36° 43.145’	121° 53.225’

Sediment samples are collected annually from eight sites along the 80-m contour in Monterey Bay. The 80-m contour is where the U.S. Geological Survey (USGS) has identified the thickest layer of Holocene sediments around Monterey Bay, which represents the area where sediments washing off the land and out of the rivers have been deposited (Figure 3.4.1). Sampling sites were located in this area because it is where contaminants adsorbed to sediment particles are most likely to be deposited and where possible contaminant effects on benthic infauna most likely would be observed. Sites were categorized according to their location, with a reference grouping of sites located outside of the Bay northwest of Santa Cruz between Terrace Point and El Jarro Point and a depositional grouping of sites located within Monterey Bay from Santa Cruz to just south of the Salinas River. Sediment transport studies by USGS have show that fine-grain sediments from land and from the San Lorenzo, Pajaro and Salinas rivers are transported northwestward in Monterey Bay and are deposited along the 80-m contour (Eittreim et al., 2002). Consequently, sediments at the reference sites likely include less recent riverine and terrigenous sediments originating within Monterey Bay than do sediments at the depositional sites.

3.4.1 Activities and Methods

Annual sediment sampling was conducted on October 12, 2004. Samples were collected with a 0.1-m^2 Smith-McIntyre grab sampler. Normally, two samples are collected at each station, one for analysis of benthic infauna and one for analysis of TOC, sediment grain size and concentrations of POPs in the top 2 cm of sediment. Infauna samples were sieved through a 0.5-mm screen and the organisms were identified to the lowest practical taxon. Data for 2004 are presented in Appendix E and interpretations in the following section include cumulative results over all four years.

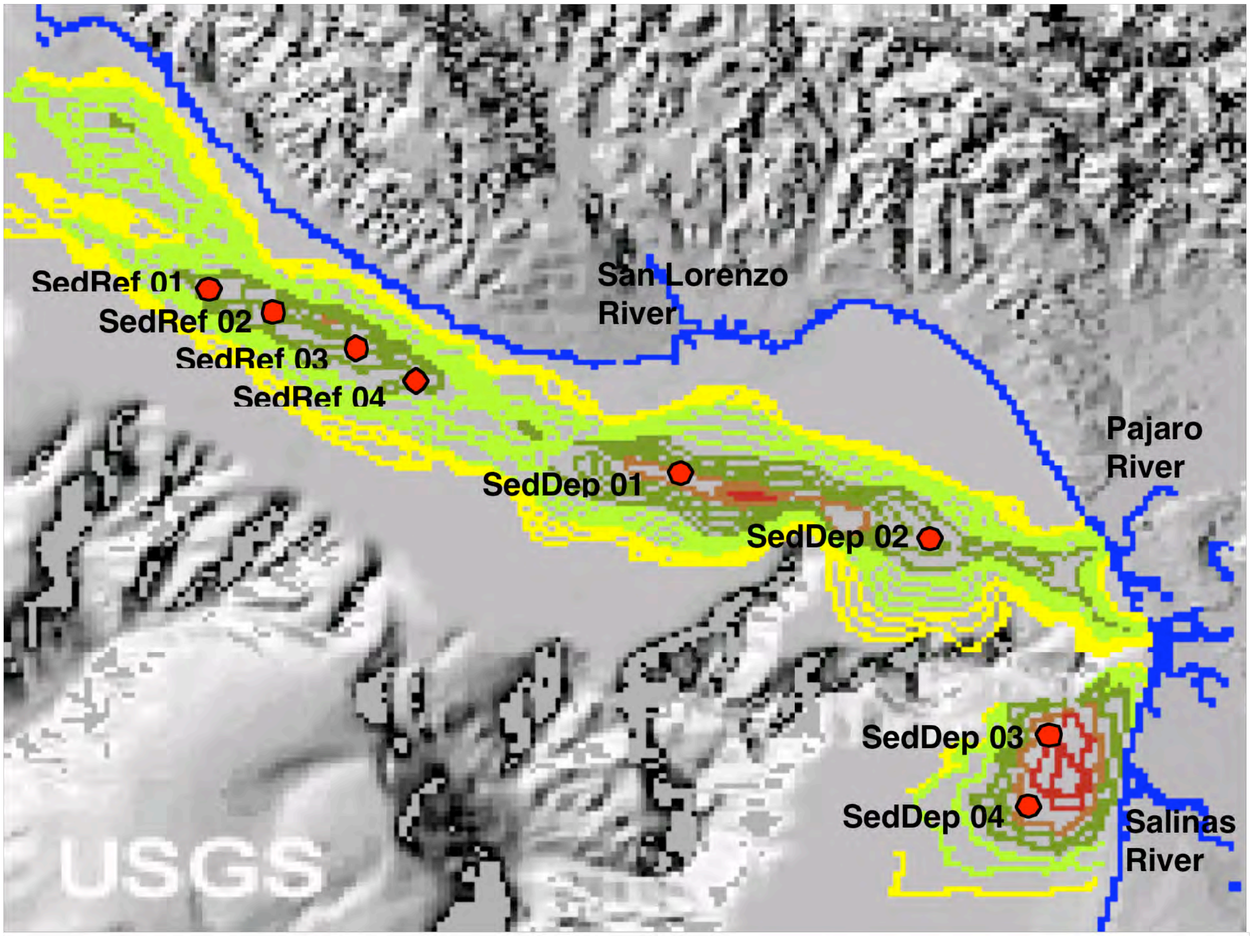


Figure 3.4.1. Location of CCLEAN sediment sampling sites relative to the thickness of Holocene sediments measured by USGS, as indicated by the contour colors; yellow is thinnest, red is thickest (Wong et al., 1999).

3.4.2 Results

Macrobenthos was dominated by annelids (exclusive of oligochaetes) at all sites, followed by arthropods in the Reference group and molluscs in both groups (Table 3.4.2), Moreover, 16 of the 28 taxa that were among the 12 most abundant in any year and site category were annelids, six were molluscs and three were arthropods (Appendix E). The three remaining taxa were an echinoderm, a nemertean and a cidarian.

Table 3.4.2. Mean, standard deviation and coefficients of variation calculated among all sites within CCLEAN site categories for macrobenthos, sediment quality and POPs in October 2004.

	Reference Sites			Deposition Sites		
Parameter	Mean	S.D.[a]	C.V.[b]	Mean	S.D.[a]	C.V.[b]
Biota Summaries, #/0.10m^2						
Total Abundance	1421.5	69.4	4.9	1037.3	394.2	38.0
Total Taxa	131.5	7.9	6.0	117.3	13.6	11.6
Annelida Abundance	985.0	58.3	5.9	678.0	279.5	41.2
Annelida Taxa	76.8	5.8	7.6	62.0	8.8	14.1
Arthropoda Abundance	136.3	18.3	13.4	98.3	65.1	66.3
Arthropoda Taxa	28.0	2.7	9.7	28.3	5.5	19.5
Mollusca Abundance	128.0	42.8	33.4	125.3	91.0	72.6
Mollusca Taxa	20.0	2.4	12.2	20.3	3.9	19.5
Echinoderm Abundance	67.5	25.5	37.8	83.0	9.3	11.3
Echinoderm Taxa	2.5	1.3	51.6	2.0	0.0	0.0
Misc. Abundance	104.8	34.0	32.5	52.8	32.6	61.7
Misc. Taxa	4.3	1.5	35.3	4.8	1.7	36.0
Sediment Quality, %						
Clay (<4μm)	10.7	2.8	25.7	17.2	2.3	13.1
Silt (4-63μm)	67.1	24.5	36.6	78.4	4.9	6.2
Sand (63μm-2mm)	22.1	27.2	123.0	4.3	2.8	64.4
Gravel/Shell (>2mm)	0.002	0.002	115.5	0.024	0.047	200.0
TOC	0.73	0.12	16.27	0.85	0.04	4.51
POPs, μg/Kg dry weight						
Low-Weight PAHs	36.7	11.4	31.2	63.5	14.6	23.0
High-Weight PAHs	48.7	12.3	25.6	62.2	19.0	30.5
Total PAHs	84.8	23.4	27.6	125.7	32.9	26.1
Total PCBs	0.47	0.12	26.3	0.30	0.14	45.5
Total DDTs	4.8	1.0	21.9	4.7	1.3	28.5
Total Chlordanes	0.10	0.11	102.7	0.06	0.04	70.9
Total HCHs	0.17	0.33	200.0	0	0	0
Dieldrin	0.02	0.03	200.0	0.05	0.01	18.4

[a] = Standard Deviation
[b] = Coefficient of Variation

As previously reported (CCLEAN, 2004), sites within each category had similar densities of biota groups, as indicated by generally low coefficients of variation (Table 3.4.2). Arthropods and mollusks were the most variable within the depositional sites, with coefficients of variation around 70%. There also was general similarity between site categories for densities of biota groups, except that mean densities of most categories of animals were higher at the reference sites, except for echinoderms.

There were substantial increases in total densities of benthic organisms in 2004 at all sites, compared to 2003, except SedDep 02 (Figure 3.4.2). Most of this increase occurred for annelids, whose 2004 densities ranged from 1.8 to 5.4 times greater than in 2003. The increased densities of total annelids from 2003 to 2004 were reflected in similar increases for several common annelids (Figure 3.4.3). Densities of *Mediomastus* spp. indet. *Cossura pygodactylata* and *Nephtys cornuta* all increased substantially from 2003 to 2004, except for C. *pygodactylata* at SedDep 02 (Figure 3.4.3c). Densities of other common taxa, such as the bivalve *Axinopsida serricata* and the ophiuroid *Amphiodia* spp. did not change substantially between 2003 and 2004 (Figures 3.4.3b and 3.4.3d).

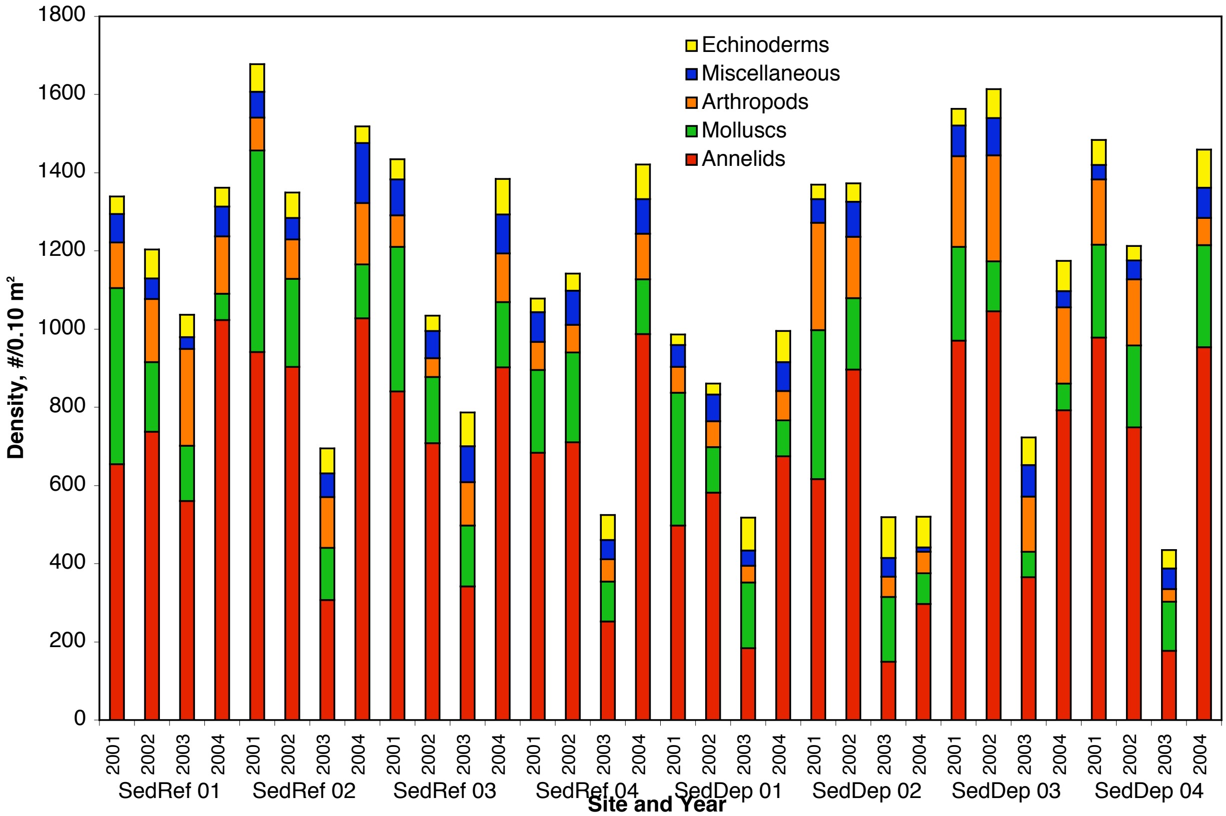


Figure 3.4.2. Total densities of biota phyla at eight CCLEAN sites in 2001, 2002, 2003 and 2004. Densities for 2003 are the mean of two replicates per site.

An analysis of variance (ANOVA) for differences in densities among years revealed interannual variation was highly significant (p<0.005) for some taxa (Table 3.4.3). We used a lower probability to reject the null hypothesis because a high number of ANOVAs were performed (i.e., 27; one for each of the taxa in Appendix E) and the conventional significance level p<0.05 could confer significance on 5% of test results due to chance alone. Among the 16 taxa that exhibited highly significant differences among years, all but six had significantly lower densities in 2003 than in 2001. These included seven polychaetes, a bivalve, a gastropod and nemerteans.

The other six taxa included two polychaetes, two bivalves, an anthozoan, and a crustacean. The edwardsiid anemones, in particular, increased markedly in 2003 and remained high in 2004 at most sites (Figure 3.4.4).

Table 3.4.3. Highly significant (p <0.005) ANOVA results for differences among years in densities of benthic taxa. Densities for 2003 are the mean of two replicates per site. Data were log transformed (natural log).

Taxon	Group	Adjusted r^2	p	Tukey HSD[a]
Axinopsida serricata	Bivalvia	0.4814	<0.0001	2001>2002=2003=2004
Cossura pygodactylata	Polychaeta	0.5490	<0.0001	2001=2002=2004>2003
Cylichna alba	Gastropoda	0.4414	0.0002	2001>2002=2003=2004
Edwardsiid	Anthozoa	0.4244	0.0003	2003=2004>2002=2001
Ennucula tenuis	Bivalvia	0.4038	0.0005	2003=2001=2004>2002
Macoma spp.	Bivalvia	0.6035	<0.0001	2004=2001=2003>2002
Mediomastus ambiseta	Polychaeta	0.8389	<0.0001	2002=2001>2004=2003
Mediomastus californiensis	Polychaeta	0.5425	<0.0001	2004=2002, 2002=2001, 2002>2003, 2004>2001>2003
Mediomastus spp. indet.	Polychaeta	0.6347	<0.0001	2004=2001=2002>2003
Nemertea	Nemertea	0.4265	0.0003	2002=2001=2004>2003
Nephtys cornuta	Polychaeta	0.4963	<0.0001	2004=2001=2002>2003
Pholoe glabra	Polychaeta	0.5647	<0.0001	2001=2002>2003=2004
Pinnixia spp.	Crustacea	0.3360	0.0022	2004=2003, 2003=2002, 2002=2001, 2004>2002, 2003>2001
Prionospio jubata	Polychaeta	0.6548	<0.0001	2003=2004>2001=2002
Prionospio lighti	Polychaeta	0.3205	0.0030	2004=2001=2002, 2001=2002=2003, 2004>2003
Prionospio steenstrupi	Polychaeta	0.3492	0.0017	2001=2002, 2002=2004, 2004=2003, 2001>2004, 2002>2003

[a] = Results for Tukey HSD *a posteriori* test to partition differences among years. Highest mean density is on the left and lowest mean density is on the right.

Unlike the macrobenthos, sediment texture did not change over time, although there were differences among sites. Sediment texture was dominated by silt at all sites except for SedRef 01, which had a higher percentage of sand than silt (Appendix E), and mean percentages of clay and silt-sized particles were slightly higher in the depositional group (Table 3.4.2), There was substantially more sand in the sediments among the reference group and sand and gravel percentages also varied the most within site categories, with coefficients of variation ranging from 134.5 to 60.9 and from 200 to 141.5, respectively. Sediment texture did not vary substantially across years. The percentages of each sediment size fraction were consistent among years at all sites (Figure 3.4.5).

Sediment total organic carbon (TOC) also was stable over time, but it varied among sites (Figure 3.4.6, Table 3.4.2 and Appendix E). Sediment TOC was slightly higher and less variable among the depositional sites than among the reference sites. Higher variation within the reference category (Table 3.4.2) was due to lower TOC in the sandier sediments at SedRef 01 than at the other three reference sites (Figure 3.4.6 and Appendix E).

As in previous years, sediment POPs were dominated by PAHs across both site categories with PAHs occurring in higher concentrations in the depositional category (Table 3.4.2). High molecular weight PAHs predominated at every site except SedDep 03 (Appendix E). There also were slightly higher dieldrin concentrations in the depositional category than in the reference category. Conversely, the reference category had slightly higher mean concentrations of PCBs, chlordanes and HCHs than did the depositional category (Table 3.4.2 and Appendix E).

The sediment concentrations of some POPs have been stable during the past four years, while others have varied substantially (Figure 3.4.7). PAHs and DDTs were generally similar among years at all sites (Figures 3.4.7a and 3.4.7b). Conversely, PCBs, chlordanes, HCHs and dieldrin varied among years (Figures 3.4.7c, 3.4.7d, 3.4.7e4.4.7f) although ANOVA determined that only PCBs and dieldrin differed significantly among years (Table 3.4.4). In both cases, 2003 concentrations were significantly lower than at least one other year.

Although high variability and small sample size make it difficult to detect long-term trends, historic data suggest that there is no evidence of a declining trend in sediment concentrations of DDTs at some locations in Monterey Bay since its legal use in the United States was banned in 1972. Some samples collected in 1970–1973 and 1995 by two studies (Phillips *et al*., 1975; Stephenson *et al*., 1997) came from sites close to SedDep 01, SedDep 02, SedDep 03 and SedDep 04 (Figure 3.4.8). While there were generally lower concentrations of DDTs in 2001–2003 than in 1970–1973 (Figure 3.4.9), SedDep 04 was the only station that exhibited a statistically significant decline over time (Table 4.4.5), whereas stations SedDep 02 and SedDep 03 had their highest concentrations of DDTs in 1995. These high 1995 values may be due partly to differences between studies in analytical methods and/or sampling locations, although they may indicate true temporal variation. For example, very intense storms occurring in January and March 1995 may have washed legacy DDT-laden sediments off agricultural fields, causing high DDT concentrations at SedDep 02 and SedDep 03 when samples were collected in April of that year.

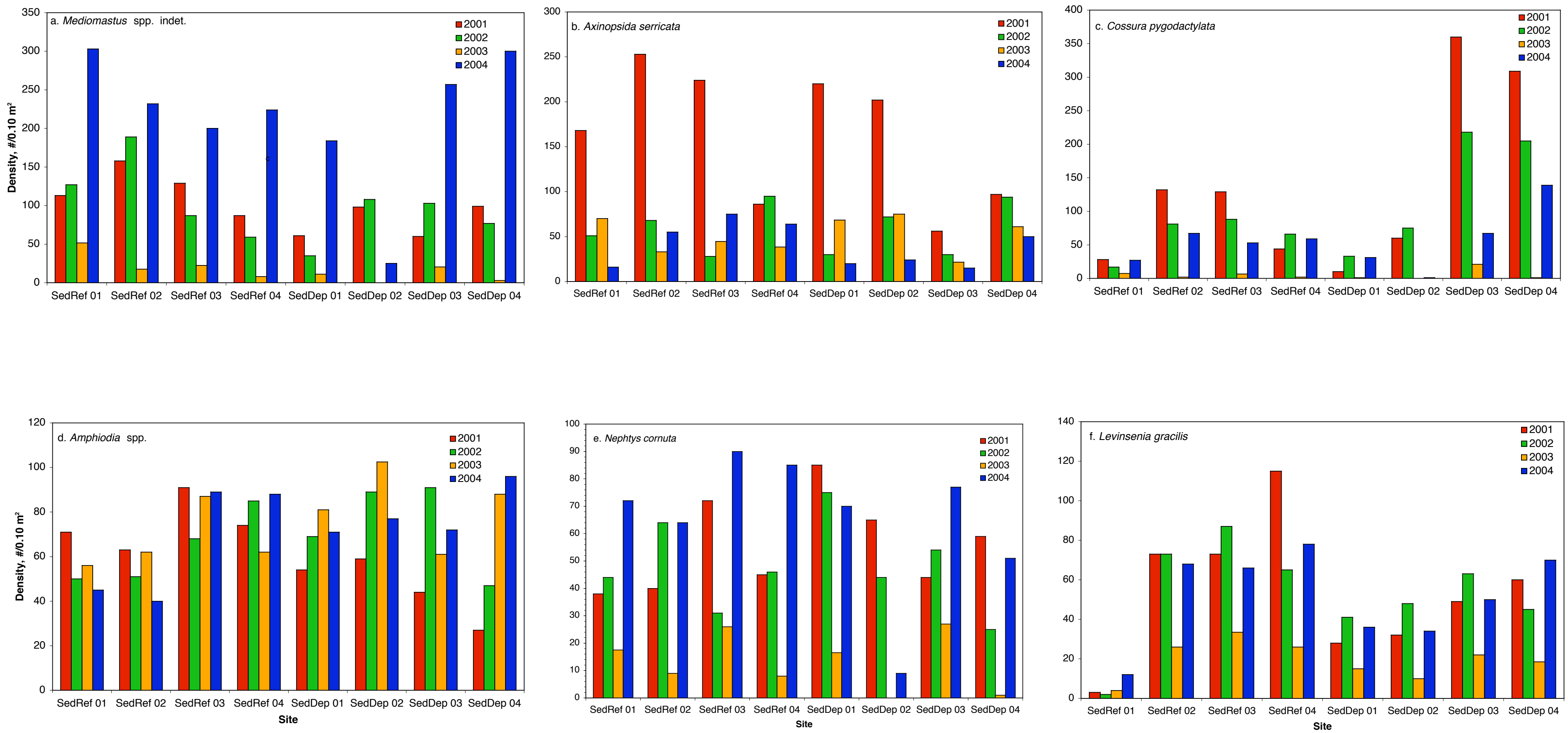


Figure 3.4.3. Densities of the six most abundant benthic taxa across both site categories in 2001, 2002, 2003 and 2004. Densities for 2003 are the mean of two replicates per site.

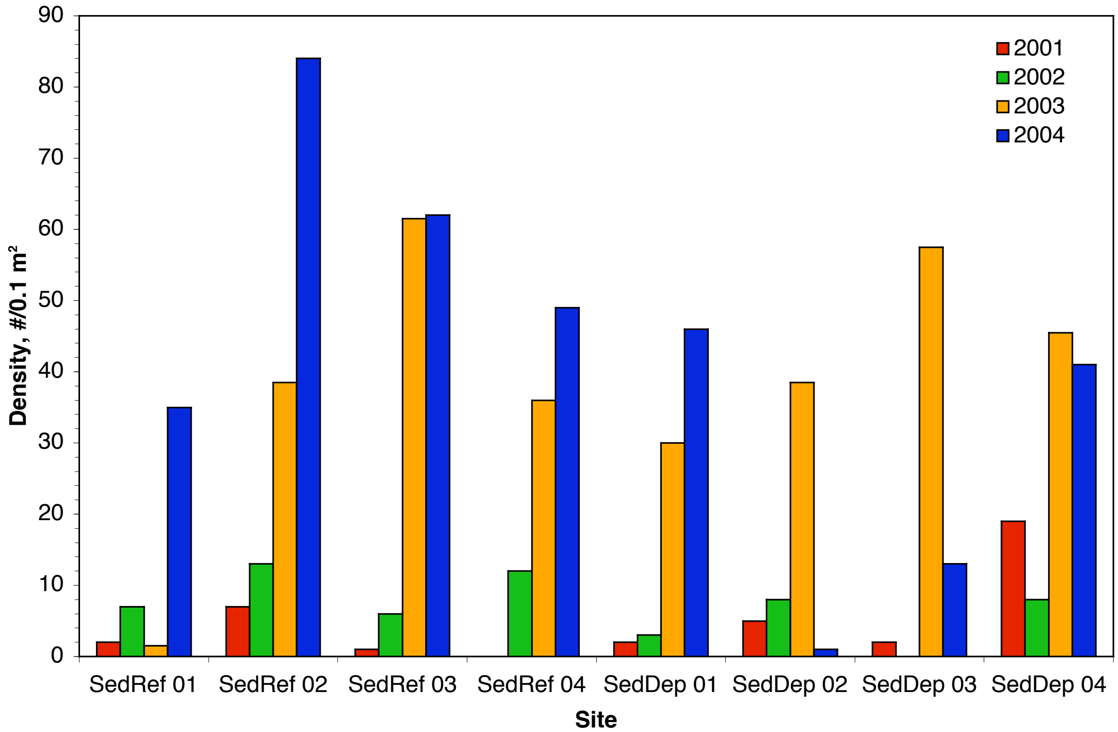


Figure 3.4.4. Densities of Edwardsiid anthozoans in samples collected at eight CCLEAN sites in 2001, 2002, 2003 and 2004. Densities for 2003 are the mean of two replicates per site.

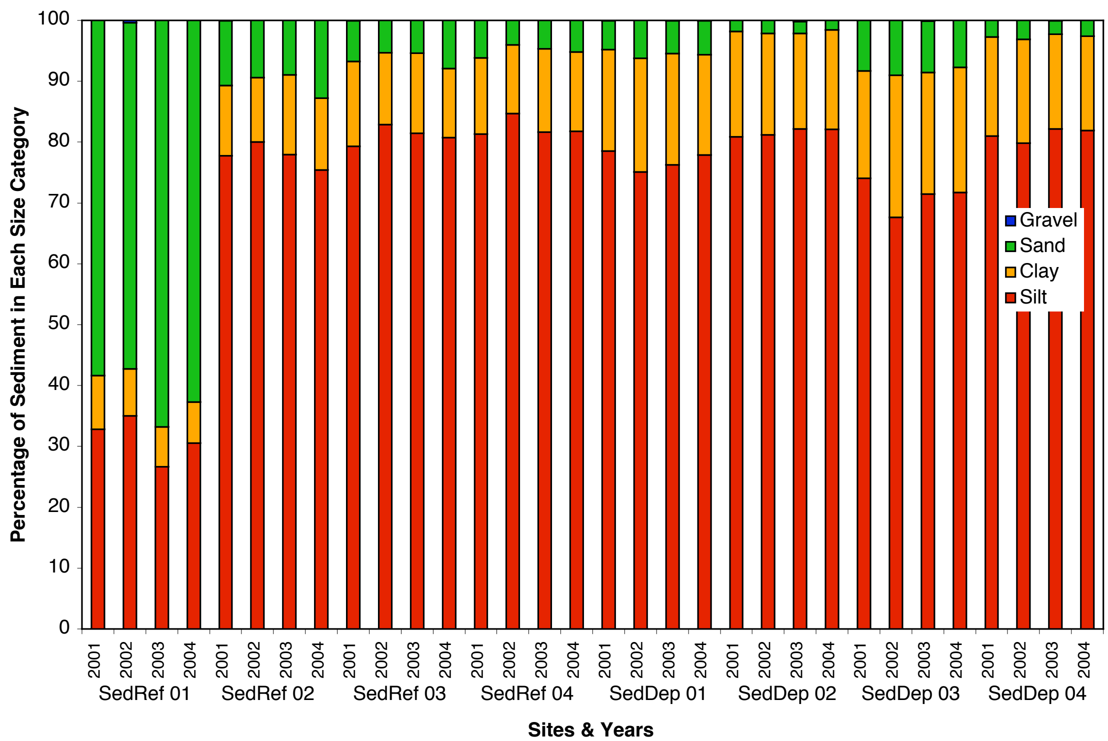


Figure 3.4.5. Percentages of silt, clay, sand and gravel in sediments collected at eight CCLEAN sites in 2001, 2002, 2003 and 2004.

The sediment concentrations of DDTs measured at CCLEAN sites from 2001–2004 consistently exceeded 2002 averages for San Francisco Bay, as well as a NOAA sediment guideline (Figure 3.4.7b). Since 2001, the average annual concentrations of DDTs among all CCLEAN sites have ranged from 2.3 to 2.6 and 3.2 to 3.7 times higher than the 2002 average for San Francisco Bay and the NOAA ERL, respectively. The NOAA ERL (Effects Range Low) indicated in Figure 3.4.7b refers to sediment guidelines developed by the U.S. National Oceanic and Atmospheric Administration based upon the incidence of acute toxicity to amphipods that has been observed in laboratory tests (Long *et al*., 2001; Long *et al*., 2000; Long *et al*., 1995). The Effects Range Low describes the 10th percentile of concentrations that have exhibited toxicity to amphipods. Below the ERL, toxic effects on amphipods are rarely observed, whereas exceeding the ERL to above the ERM (Effects Range Median) leads to increased incidence of acute toxicity. None of the other POPs approached NOAA ERLs or ERMs (Table 3.4.6).

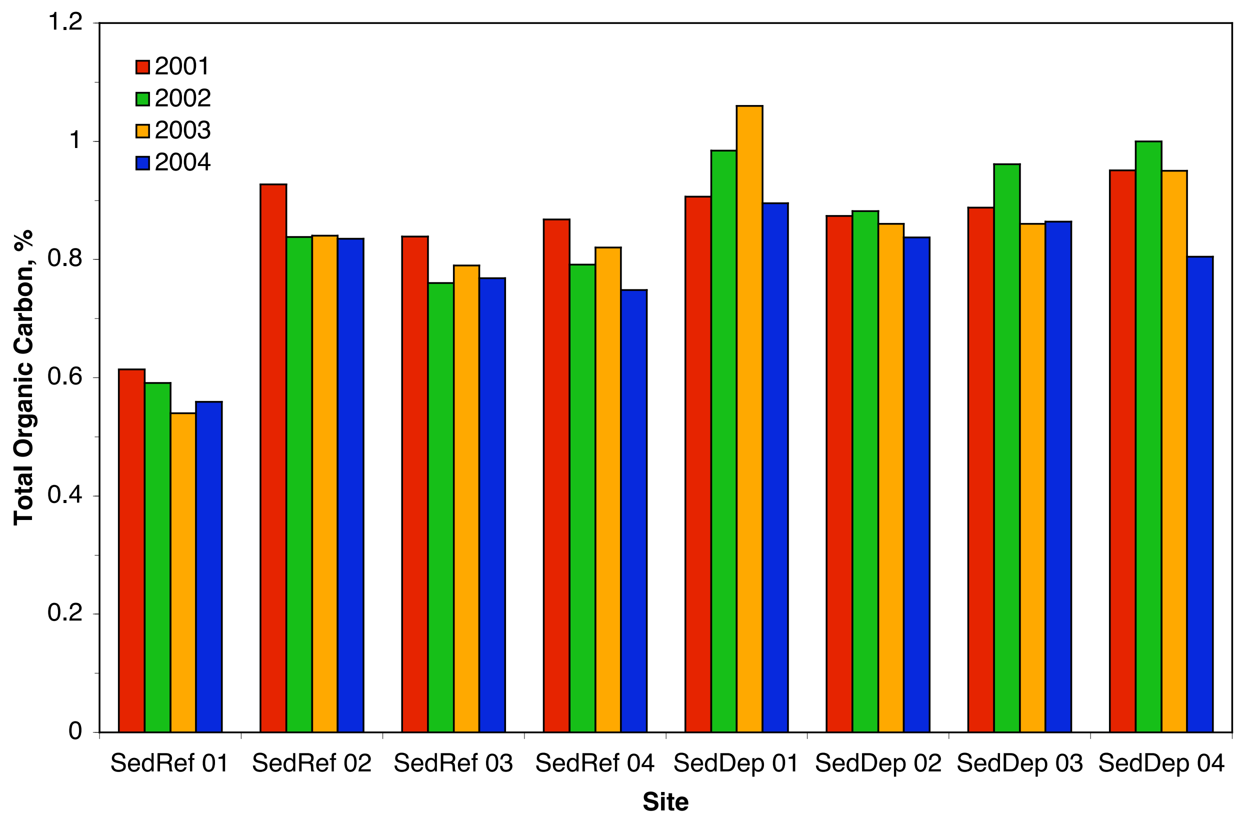


Figure 3.4.6. TOC in sediments collected at eight CCLEAN sites in 2001, 2002, 2003 and 2004.

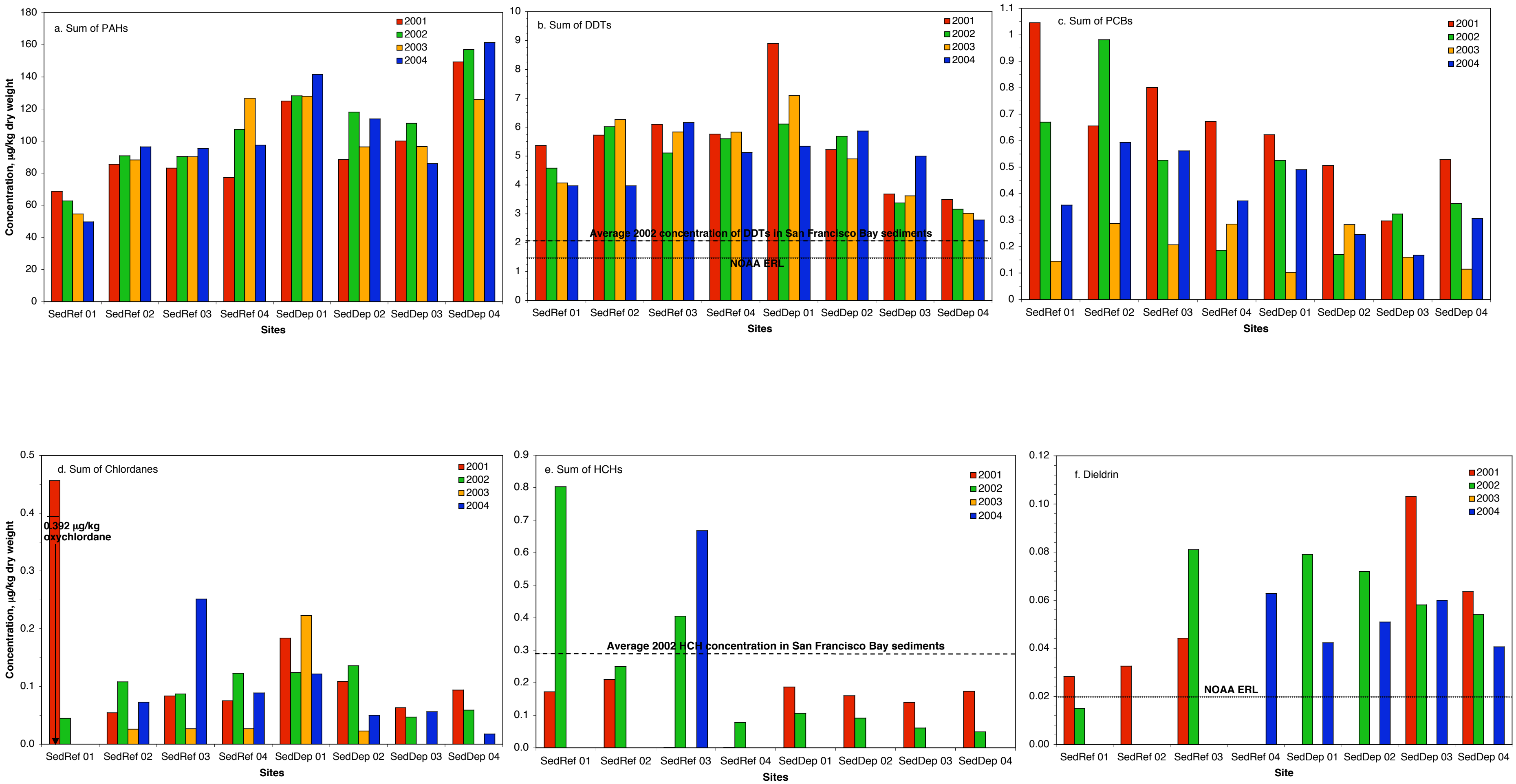


Figure 3.4.7. POPs in sediments collected from eight CCLEAN sites in 2001, 2002, 2003 and 2004. NOAA ERL (Effects Range Low) refers to sediment guidelines developed by the U.S. National Oceanic and Atmospheric Administration based upon the incidence of acute toxicity to amphipods that has been observed in laboratory tests (Long *et al*., 2001; Long *et al*., 2000; Long *et al*., 1995)

Table 3.4.4. ANOVA results for differences among years in sediment concentrations of five groups of POPs and dieldrin. Concentrations were log transformed (natural log).

POP analyte	Adjusted r^2	p	Tukey HSD[a]
PAHs	-0.0861	0.9087	2002=2003=2004=2001
DDTs	-0.0682	0.7965	2001=2003=2002=2004
PCBs	0.4367	0.0002	2001=2002=2004>2003
Chlordanes	0.0793	0.1541	2001=2002=2004=2003
HCHs	0.1339	0.0721	2002=2001=2004=2003
Dieldrin	0.2064	0.0235	2002=2001=2004, 2001=2004=2003, 2002>2003

[a] = Results for Tukey HSD a posteriori test to partition differences among years. Highest mean density is on the left and lowest mean density is on the right.

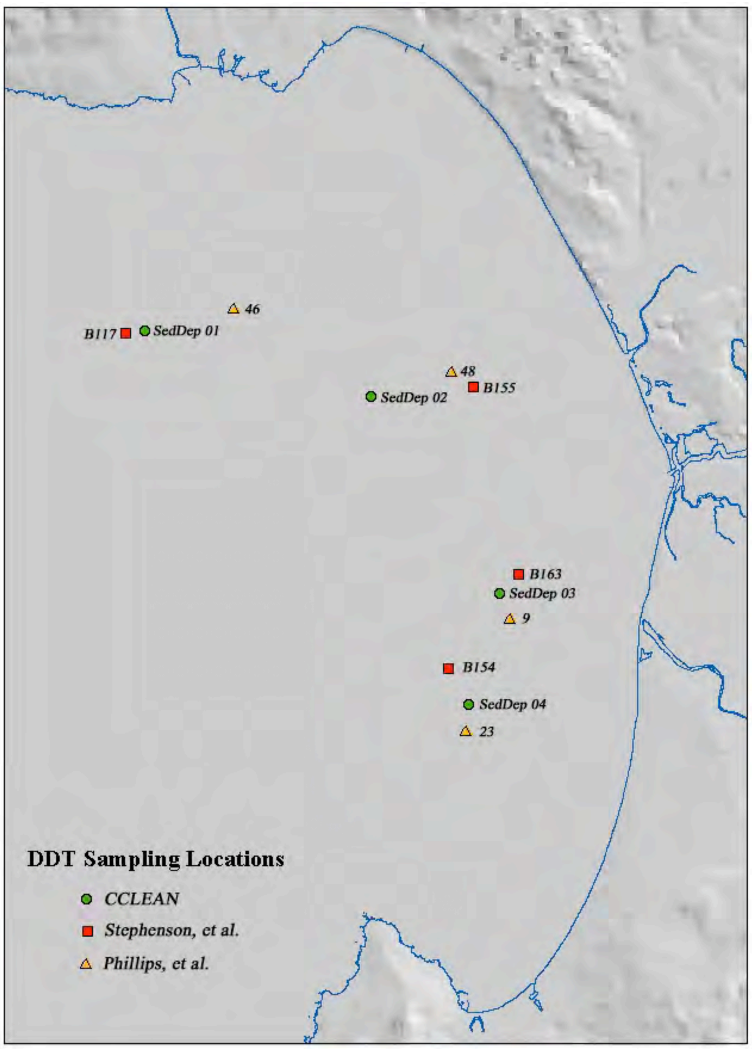


Figure 3.4.8. Locations of samples collected near CCLEAN sites by Phillips, et al in 1970–1973 and Stephenson, et al in 1995.

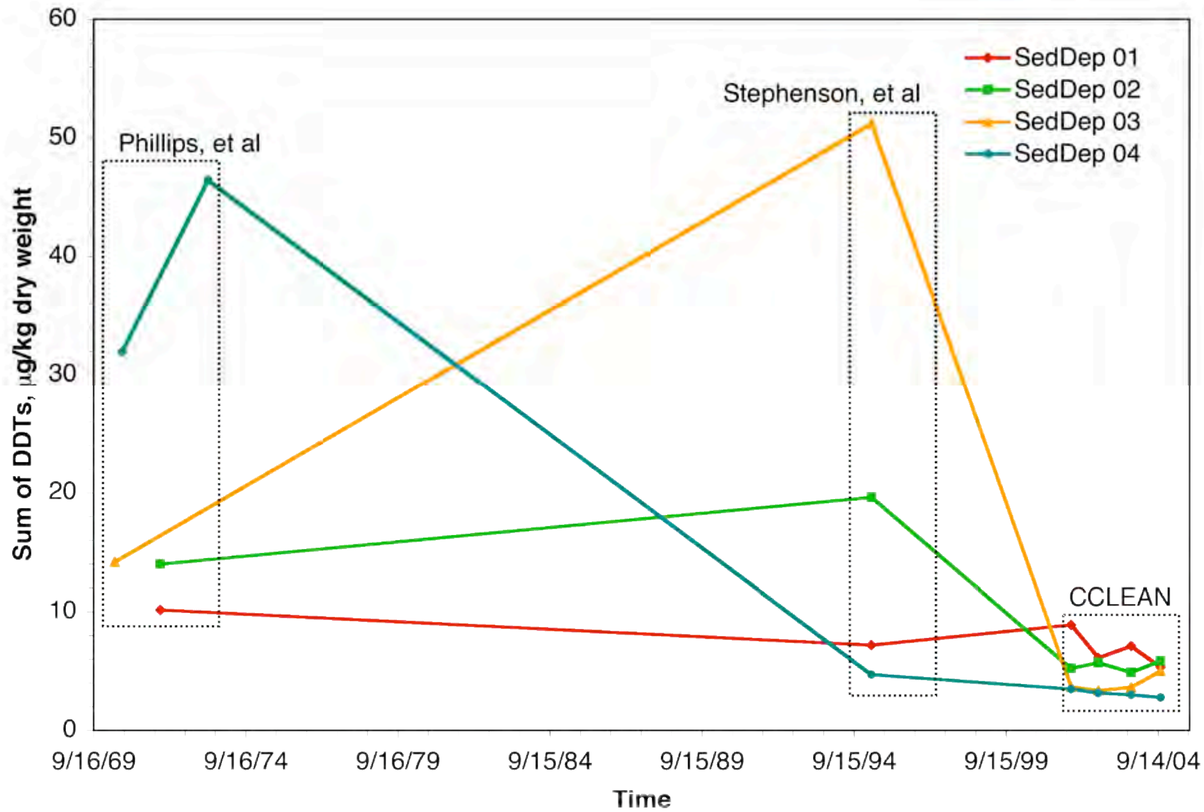


Figure 3.4.9. Temporal variation in DDT concentrations near four CCLEAN sites. Non-CCLEAN data are from Phillips, et al (1975) and Stephenson, et al (1997).

Table 3.4.5. Results of regression analysis to determine trends over time in sediment DDT concentrations near four CCLEAN sites. Data were log transformed (natural log).

Site	Adjusted r^2	p
SedDep 01	0.3016	0.1972
SedDep 02	0.1619	0.2752
SedDep 03	-0.1811	0.5781
SedDep 04	0.8996	0.0025

Table 3.4.6. NOAA ERL and ERM values (µg/kg dry weight) for sediment POPs.

POP	ERL	ERM
LPAHs	552	3,160
HPAHs	1700	9,600
DDTs	1.58	46.1
Chlordanes	0.5	6
Dieldrin	0.02	8
PCBs	22.7	180

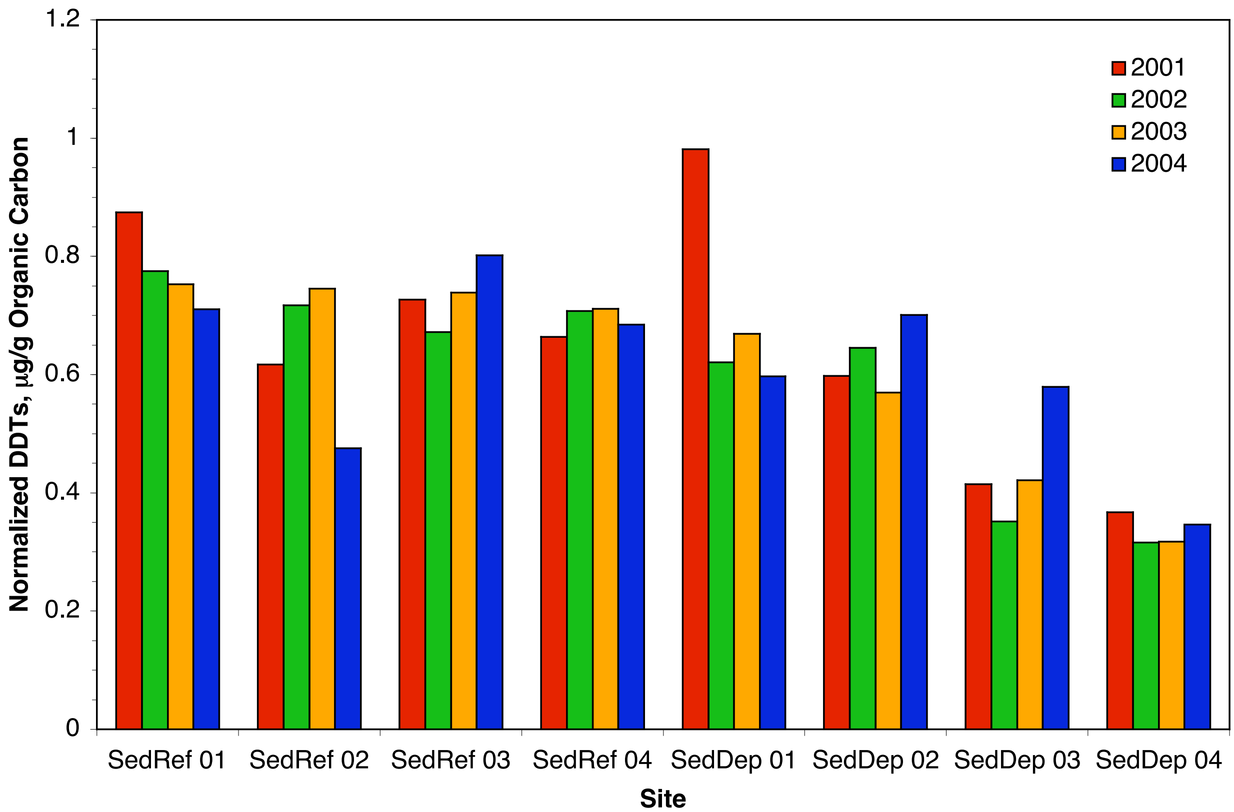


Figure 3.4.10. Sediment concentration of DDTs normalized to total organic carbon at eight CCLEAN sites in 2001, 2002, 2003 and 2004.

Although sediments at CCLEAN sites appear to not exceed toxicity thresholds for DDT or NOAA sediment guidelines for other POPs, the sediment data and other ancillary data were analyzed to determine whether combinations of POPs, sediment parameters or other factors might have subtle effects on the densities of benthic taxa. Sediment TOC and texture are well known for their effects on macrobenthos and mixtures of contaminants can have synergistic effects that are not observed with single chemicals. For this analysis we estimated the combined toxicity of low-weight and high-weight PAHs, DDTs, chlordanes, dieldrin and PCBs by adding the percentage of the ERM concentration (Table 3.4.6) measured for each of these POPs in each sample, which is called the ERM quotient. Moreover, because the Salinas, Pajaro and San Lorenzo rivers appear to be important sources of many POPs to Monterey Bay and also discharge POPs other than those measured by CCLEAN that could affect macrobenthos (e.g., synthetic pyrethroid pesticides, which adhere strongly to sediment particles), as well as other materials (e.g., nutrients, organic carbon, etc.) total estimated loads of suspended sediments discharged from these rivers in the 12 months prior to sediment sampling also were included in this analysis. Assuming that the site-specific effects of TSS discharged from each river vary according to the distance from the river to each site, the independent variables for riverine TSS loads consisted of the annual TSS load from the river divided by the distance from that river to each site.

Stepwise linear regressions were performed using sediment TOC, percent fines (silt + clay), ERM quotient, and the total kilograms of suspended sediments discharged from each of the three rivers in 2001, 2002, 2003 and 2004 (divided by the distance from each river to each site) as the independent variables and the densities of the 28 most abundant taxa as the dependent variables. All data were log transformed (natural log). As for the ANOVA results for differences in organism densities among years, only results in which $p<0.005$ were considered to be significant.

Twenty-two of the 28 most abundant taxa, two taxonomic groups and total abundance had highly significant regressions (Table 3.4.7). Six taxa (i.e., *Aricida (Allia) ramosa*, *Cossura pygodactylata*, *Ennucula tenuis*, *Levinsenia gracilis*, *Macoma* spp., and Nemertea), total Annelida and total abundance suggested negative effects of the ERM quotient. *Rochefortia tumida* was the only taxon that was positively associated with the ERM quotient. TOC or percent fines had significant relationships with nine taxa. Thirteen taxa, total Annelida, total Mollusca and total abundance suggested negative effects of suspended sediments discharged from the Salinas River, while seven taxa and total mollusca suggested negative effects of suspended sediments discharged by the Pajaro River and five taxa suggested negative effects suspended sediments discharged by the San Lorenzo River. Two, four and three taxa, were positively associated with the load of suspended sediments discharged from the Salinas, Pajaro and San Lorenzo rivers, respectively.

Additional statistical procedures were performed to help determine which of the significant independent variables had the strongest associations with each taxon or group and, therefore, accounted for most of the variation in the taxon or group. Partial correlations, which are the correlations between pairs of variables with all other variables held constant, were calculated for each taxon or group and its significant independent variables, as determined by the linear regressions. In all but four cases, *Decamastus gracilis*, *Eculymeninae* sp. 2, *Levinsenia gracilis*, and *Rochefortia tumida*, suspended sediments from one of the three rivers was the most important variable (Table 3.4.8). Suspended sediment from the Salinas River was the most important variable in 14 cases and in 12 of these cases it was negatively associated with the taxon or group. Either the Pajaro River or San Lorenzo River were the most important variables for seven taxa and five of these relationships were positive. Sediment fines were the most important variables for three taxa. Suspended sediment from the Pajaro River was the second-most important variable for six taxa and total Mollusca, and in five of these cases the relationship was negative. Suspended sediment form the Salinas River was the second-most important variable for four taxa and all were negative relationships. Sediment fines or TOC were the second-most important variable for three taxa. ERM quotient was the second-most important variable for four taxa, total Annelida and total Mollusca.

A chi-square test was performed to determine whether the effects of the TSS discharges from the rivers differed from what would be expected if the effects were related only to the loads of TSS. This test attempts to determine whether the TSS loads from some rivers might exert disproportionate negative effects on benthic organisms if, for example, the sediments from some rivers are more toxic than those from other rivers. Of the fourteen cases in which negative TSS effects were the most important independent variables for benthic organisms (Table 3.4.8), the Salinas River had 12, the Pajaro River had two, and the San Lorenzo River had none. These observed frequencies differed significantly from frequencies that would be expected if the effects were related solely to the load of TSS (Table 3.4.9), suggesting that TSS from the Salinas River exerts a disproportionate negative effect on benthic organisms at the eight CCLEAN sediment sites.

While these regression and partial correlation results do not establish causality between the independent variables and dependent variables, they do suggest suspended sediment from the rivers, primarily the Salinas River, may be having negative effects on benthic organisms along the 80-meter contour. Moreover, *Aricidia (Allia) ramosa*, *Cossura pygodactylata, Ennucula tenuis* and Nemertea, total Annelida and total Mollusca may be negatively affected by the cumulative concentrations of POPs.

These statistical analyses are not comprehensive for the possible effects of pesticides and other organic chemicals on macrobenthos. There are other pesticides, such synthetic pyrethroids, and other organic chemicals, such as the flame retardants polybrominated biphenyl ethers (PBDEs), that we have not measured and their potential effects on macrobenthos in Monterey Bay are yet to be examined. Moreover, organism densities are affected by multiple other factors that were not included in the analyses, such as temperature, oxygen concentration and interspecific interactions. Nevertheless, the regression analyses and partial correlations continue to suggest human activities on land could be affecting biological communities in Monterey Bay.

3.4.3 Current Status

The annual sediment sampling will continue with the routine analysis of two replicates for benthic organisms.

3.4.4 Recommendation

We have no recommendations for this program element.

Table 3.4.7. Highly significant results ($p < 0.005$) of stepwise multiple regressions for the effects of TOC, fines (silt + clay), ERM quotient, and the annual loads of TSS from the San Lorenzo, Pajaro and Salinas rivers (adjusted for the distance of each site from each river) on infaunal densities (number per $0.1m^2$) in 32 sediment samples collected over four years. Densities for 2003 are the mean of two replicates per site. All data were log transformed (natural log).

Taxon	Adjusted r^2	p	Equation
Aricidia (Allia) ramosa	0.3574	0.0006	y = 4.25 – 0.42 Salinas TSS – 1.61 ERM Quotient
Axinopsida serricata	0.4694	<0.0001	y = 0.53 San Lorenzo TSS – 0.18 Salinas TSS – 0.16
Cossura pygodactylata	0.5677	<0.0001	y = 1.34 Fines – 2.64 ERM Quotient – 0.66 Salinas TSS – 0.19
Cylichna alba	0.6014	<0.0001	y = 8.90 – 0.19 Salinas TSS – 0.42 Pajaro TSS
Decamastus gracilis	0.7461	<0.0001	y = 21.30 – 3.66 Fines - 0.33 San Lorenzo TSS
Eculymeninae sp. 2	0.4310	0.0003	y = 1.52 + 1.22 Fines – 0.22 San Lorenzo TSS – 0.15 Pajaro TSS
Edwardsiid	0.2500	0.0021	y = 0.30 Salinas TSS– 0.77
Ennucula tenuis	0.4265	0.0001	y = 0.55 San Lorenzo TSS - 0.97 ERM Quotient – 6.79
Euphilomedes carcharodonta	0.5369	<0.0001	y = 14.60 – 3.64 TOC – 0.62 San Lorenzo TSS – 0.54 Pajaro TSS
Levinsenia gracilis	0.7599	<0.0001	y = 2.79 Fines – 1.19 ERM Quotient – 0.23 Salinas TSS – 8.56
Macoma sp.	0.6541	<0.0001	y = 1.37 San Lorenzo TSS + 0.55 Pajaro TSS – 1.47 ERM Quotient – 1.88 TOC – 23.80
Maldaninae spp.	0.2579	0.0018	y = 1.58 + 0.15 Pajaro TSS
Mediomastus ambiseta	0.7724	<0.0001	y = 25.19 + 4.33 TOC – 0.85 San Lorenzo TSS – 0.59 Pajaro TSS– 0.53 Salinas TSS
Mediomastus californiensis	0.4964	<0.0001	y = 0.004 + 0.36 Pajaro TSS – 0.21 Salinas TSS
Mediomastus spp. indet.	0.5487	<0.0001	y = 4.54 + 0.29 Pajaro TSS– 0.34 Salinas TSS
Nemertea	0.5626	<0.0001	y = 4.56 – 0.83 ERM Quotient – 0.26 Salinas TSS
Nephthys cornuta	0.4257	<0.0001	y = 6.81 – 0.30 Salinas TSS
Pholoe glabra	0.2632	0.0045	y = 6.62 – 0.15 Pajaro TSS – 0.13 Salinas TSS
Prionospio jubata	0.5776	<0.0001	y = 0.38 Salinas TSS – 3.95 TOC – 3.77
Prionospio lighti	0.2220	0.0038	y = 5.41 – 0.26 Salinas TSS
Prionospio steenstrupi	0.7365	<0.0001	y = 12.03 –1.01 Fines – 0.18 Pajaro TSS– 0.30 Salinas TSS
Rochefortia tumida	0.4373	0.0002	y = 16.61 + 1.49 ERM Quotient – 0.57 San Lorenzo TSS – 0.35 Pajaro TSS
Total Annelida	0.6297	<0.0001	y = 7.51 – 0.78 ERM Quotient – 0.23 Salinas TSS
Total Mollusca	0.5200	<0.0001	y = 8.64 – 0.18 Pajaro TSS – 0.13 Salinas TSS
Total Abundance	0.5571	<0.0001	y = 7.76 – 0.47 ERM Quotient – 0.15 Salinas TSS

Table 3.4.8. The first and second most influential independent variables for each taxon or group with a highly significant (p <0.005), as indicated by their respective partial correlations.

	#1 Independent Variable		#2 Independent Variable	
Taxon	Variable	Partial Correlation	Variable	Partial Correlation
Aricidia (Allia) ramosa	Salinas TSS	-0.6311	ERM Quotient	-0.3797
Axinopsida serricata	San Lorenzo TSS	0.6550	Salinas TSS	-0.5989
Cossura pygodactylata	Salinas TSS	-0.7782	ERM Quotient	-0.5460
Cylichna alba	Pajaro TSS	-0.7572	Salinas TSS	-0.5889
Decamastus gracilis	Fines	-0.8576	San Lorenzo TSS	0.4114
Eculymeninae sp. 2	Fines	0.6909	Pajaro TSS	-0.4293
Edwardsiid	Salinas TSS	0.5237	NA[1]	-
Ennucula tenuis	San Lorenzo TSS	0.6436	ERM Quotient	-0.4434
Euphilomedes carcharodonta	Pajaro TSS	-0.6285	TOC	-0.5777
Levinsenia gracilis	Fines	0.8737	Salinas TSS	-0.6938
Macoma sp.	San Lorenzo TSS	0.8103	Pajaro TSS	0.7140
Maldaninae spp.	Pajaro TSS	0.5309	NA[1]	-
Mediomastus ambiseta	Salinas TSS	-0.8354	Pajaro TSS	-0.6784
Mediomastus californiensis	Pajaro TSS	0.6061	Salinas TSS	-0.5328
Mediomastus spp. indet.	Salinas TSS	-0.6847	Pajaro TSS	0.4937
Nemertea	Salinas TSS	-0.7652	ERM Quotient	-0.4445
Nephtys cornuta	Salinas TSS	-0.6665	NA[1]	-
Pholoe glabra	Salinas TSS	-0.4853	Pajaro TSS	-0.4085
Prionospio jubata	Salinas TSS	0.7276	TOC	-0.6045
Prionospio lighti	Salinas TSS	-0.4971	NA[1]	-
Prionospio steenstrupi	Salinas TSS	-0.8282	Fines	-0.5415
Rochefortia tumida	ERM Quotient	0.5724	Pajaro TSS	-0.5584
Total Annelida	Salinas TSS	-0.8062	ERM Quotient	-0.5106
Total Mollusca	Salinas TSS	-0.6524	Pajaro TSS	-0.6266
Total Abundance	Salinas TSS	-0.7609	ERM Quotient	-0.4262

[1] = Only one significant independent variable.

Table 3.4.9. Results of Chi-square (χ^2) test for differences between observed and predicted frequencies of negative effects of total suspended sediment loads from the Salinas, Pajaro and San Lorenzo rivers being the most important independent variable affecting benthic taxa. Predicted frequencies are based upon the proportions of total TSS loads from each river during 2001–2004.

	Observed Frequencies	Expected Frequencies	Deviation	Deviation^2/ Expected
Salinas TSS negative	12	6.55	5.45	4.53
Pajaro TSS negative	2	5.36	-3.36	2.11
San Lorenzo TSS negative	0	2.09	-2.09	2.09
Sum	14	14		8.73
χ^2, 2 degrees of freedom, $p = 0.025$				7.38

3.5 Rivers and Streams

Monthly sampling of water from 17 coastal sites in Monterey and Santa Cruz Counties for analysis of nutrients, total suspended solids and bacteria continued in 2004-2005 (Appendix F1). The objective of this sampling is to determine sources and loads of discharged nutrients, suspended sediments and bacteria to near-shore waters from the rivers and streams that flow into the Monterey Bay National Marine Sanctuary (MBNMS).

Wet season and dry season sampling is also conducted at San Lorenzo, Pajaro, Salinas, and Carmel Rivers for analysis of persistent organic pollutants (POPs). The objective of this sampling is to determine the loads of POPs into the near-shore waters from the four major rivers.

3.5.1 Activities and Methods

For most of the sites the samples are collected by the Environmental Health Department for Santa Cruz and Monterey counties, at regular monthly intervals when possible. Tembladero Slough is sampled in a cooperative effort with the Elkhorn Slough National Estuarine Research Reserve. All samples are analyzed for urea (urea-N), nitrate (NO_3-N), dissolved silica (SiO_2), ammonia (NH_3-N), orthophosphate (O-PO_4), total suspended solids (TSS), and total coliform, *E. coli*, and *Enterococcus* bacteria. Measurements of ammonia and orthophosphate began in the 2003-2004 sampling year.

Annual loads for all measurements are estimated for sites that have flow data available. USGS stream gage data are available for San Lorenzo River, Soquel Creek, Pajaro River, Salinas River, Carmel River and Big Sur River. Flow data for Scott Creek were obtained from US Fish and Wildlife Service. Each annual load is estimated by calculating the daily load for each grab sampling date (flow multiplied by grab sample concentration), calculating the mean for all daily loads for the site, and multiplying the mean by 365 for an annual load. These calculations are estimates, based on individual grab samples, and therefore they are likely to underestimate actual loads because high loads associated with episodic storm events may not be sampled.

Sampling for POPs is performed by KLI with the same methods and frequency as for the effluent sampling (see Section 3.5.1). Sampling is performed twice per year, during the dry season and the wet season (Table 3.5.1). Each sample is collected over an approximately 30-day period using solid-phase extraction methods. At all rivers except the Carmel River, annual loads are estimated by averaging the daily loads from each sampling event (measured concentration multiplied by average daily stream flow during the sampling event) and multiplying that average by 365. At the Carmel River, a general absence of dry-season samples requires a different approach, in which the average daily load obtained during wet-season sampling is multiplied by the total number of days during the year with recorded flow. Stream flow data are obtained from USGS stream gages**.**

For this year's load calculations, the CCLEAN database was combined with that of the Central Coast Regional Water Quality Control Board, Central Coast Ambient Monitoring Program (CCAMP). Although this report is focused on the 2004-2005 sampling season the increased number of data points (*n*) allowed by use of the CCAMP database was used to recalculate loads for the entire timeline of the project. At the time of this writing, CCAMP data were available only through October 2004. The *n* values used to calculate the loads using both the CCLEAN and CCAMP databases are shown in Table 3.5.2.

Table 3.5.1. Dates and volumes of river POP samples, 2004–2005.

Season	River	Start Date	End Date	Number of Liters Sampled
Dry				
	San Lorenzo	June 23, 2004	August 2, 2004	206
	Pajaro	June 23, 2004	August 27, 2004	211
	Salinas	June 22, 2004	August 2, 2004	213
	Carmel	DRY	DRY	None
Wet				
	San Lorenzo	January 24, 2005	February 24, 2005	394
	Pajaro	January 20, 2005	February 24, 2005	582
	Salinas	January 19, 2005	February 24, 2005	186
	Carmel	January 19, 2005	February 21, 2005	199

3.5.2 Results

3.5.2.1 Monthly Sampling

In 2004–2005, average concentrations of NO_3 (nitrate) and NH_3 (ammonia) and total suspended sediments followed a consistent spatial pattern. Tembladero Slough, Salinas River and Pajaro River ranked first, second and third highest in concentrations of all three analytes. Tembladero Slough had an annual average of 29.48 mg/L nitrate and 0.21 mg/L ammonia for all grab samples (Table 4.5.3 for all concentration data). The Salinas River had an annual average of 7.26 mg/L nitrate and 0.10 mg/L ammonia for all samples and the Pajaro River was 3.63 mg/L nitrate and 0.07 mg/L ammonia. Total suspended sediment concentrations at Tembladero Slough, Salinas River and Pajaro River averaged 37.43, 26.43 and 58.44 mg/L, respectively.

Annual averages of other nutrients, such as urea and orthophosphate, did not display consistent spatial patterns during 2004–2005. Urea concentrations were highest at Pajaro River (48.67 ug/L), followed by Tembladero Slough (40.33 ug/L) and Moore Creek (40.00 ug/L). The concentration of orthophosphate was highest at Moore Creek, followed by Tembladero Slough, followed by Branciforte Creek at 0.68, 0.55 and 0.42 mg/L, respectively. Concentrations of dissolved silica were highest at Branciforte Creek, Porter Gulch and Aptos Creek at 41.85, 40.36 and 36.03 mg/L respectively (Table 4.5.3).

Spatial patterns of average concentrations of total coliform, *E. coli* and *Enterococcus* also differed. Total coliform bacteria in 2004–2005 at Tembladero Slough, Salinas River and San Lorenzo River were at 23155, 13039 and 6494 MPN/100mL, respectively (Table 4.5.3). Concentrations of *E. coli* at the San Lorenzo River, Aptos Creek and Tembladero Slough 526, 418 and 325 MPN/100mL, respectively. Average concentrations of *Enterococcus* at the Salinas River, Porter Gulch, Tembladero Slough and San Lorenzo River were 32, 31, 25 and 24 MPN/100mL respectively. Recently, it has been proposed that the State Board incorporate the U.S. EPA's bacterial indicator criteria recommendation into the State's water quality standards. For *E. coli* the geometric mean is 126/100mL and for *Enterococcus* it is 33 MPN/100mL. The recommended criteria also sets a single sample maximum (SSM) value for different designated beach areas based on degree of water contact recreation and frequency of use from 235 MPN/100mL and 61 MPN/100mL for *E. coli* and *Enterococcus*, respectively, at high-use areas, to 575 MPN/100mL and 151 MPN/100mL for *E. coli* and *Enterococcus*, respectively, at low-use areas. All samples that exceeded the limit were highlighted in red in the Table 4.5.3 and the raw data Appendix F1.

Annual maximum flow was somewhat higher for the 2004-2005 sampling year than the 2003-2004 sampling period, resulting in higher loads for some analytes this year than in the previous year (Figure 3.5.1 a, b). Overall there were large differences between years that seem to be related to annual rainfall patterns. There are clear seasonal patterns to when the loads occur, which also mirror seasonal rainfall patterns (Figure 3.5.5, 3.5.6). The load of total suspended solids, TSS, was greatest at the Pajaro River followed by the San Lorenzo River in February 2005 (Figure 3.5.2a). Dissolved silica, SiO_2, loads reached peak levels between January and May 2005 and the Pajaro was again the highest with the San Lorenzo the next highest (Figure 3.5.2 b). Nutrient loads were high for the Pajaro River. Nitrate, NO_3, load was highest at the Pajaro from

January to April 2005; however, there was an even larger pulse at the Salinas River in May 2005 (Figure 3.5.2d). Ammonia, NH_3, loads peaked in February 2005 at the Pajaro River. The Carmel River had high levels in March 2005 and Scott Creek had high levels in January 2005 (Figure 3.5.3e). Urea loads were particularly high in 2004-2005 potentially due to the increased maximum flow from the previous year. The highest levels of urea were at the Pajaro River and then the Carmel and San Lorenzo River (Figure 3.5.2c). Orthophosphate loads were much higher this year than last for the Pajaro especially but overall the San Lorenzo River has consistently elevated loads over all the years (Figure 3.5.4f, Figure 3.5.3f). Although the concentrations at Branciforte and Moore Creek are higher, the flow at San Lorenzo is greater such that its load of orthophosphate is higher than the other two creeks (Table 3.5.4).

Bacteria loads were highest in the wet season, consistent with rainfall patterns. Total coliform load was highest in the Pajaro and San Lorenzo Rivers from January to April 2005 (Figure 3.5.4 a). Similar patterns are seen for *E. coli* and *Enterococcus* loads with the Pajaro and San Lorenzo Rivers again having the highest levels (Figure 3.5.4 b, c). These results suggest effects of storm runoff from terrestrial sources, such as agricultural drainage and animal wastes.

Unfortunately the Salinas River had no samples taken from December 2004 to March 2005 and therefore the majority of the rainfall for the entire season was missed. Loads for the Salinas River were therefore potentially grossly underestimated due to this lack of sampling during the wet season. Due to equipment malfunction of the nitrate probe the POP sampling had to revert to nutrient grab samples for estimates of nitrate concentration. Due to the lack of data for the Salinas River we used the grab samples from the POP sampling's nitrate concentration in the load calculations for the Salinas River from Jan 2005 to May 2005. Due to the extremely high flow during this time the load estimate for the Salinas River nitrate is ~30% larger than the Pajaro River load for the 2004-2005 sampling year.

Only a few analytes exhibited increased loads in 2004-2005 at certain sites. Dissolved silica had higher loads at all sites in 2004-2005 than in previous years (Figure 3.5.2 b). Some nutrients also exhibited increases in 2004-2005. Nitrate loads were higher for the Salinas River (including the estimated load from the grab data obtained during POP sampling) (Figure 3.5.2 d) and ammonia loads were higher for Scott Creek, Pajaro River and Carmel River (Figure 3.5.3 e). Lastly urea was higher this year for the San Lorenzo, Pajaro, Carmel and Big Sur rivers (Figure 3.5.2 c).

Table 3.5.2. Number of data points from CCLEAN and CCAMP used to calculate loads.

	CCLEAN	CCAMP
	Year	**Year**
Site	**2004-2005**	**2004-2005**
Scott Creek	12	2
San Lorenzo River	12	3
Soquel Creek	12	3
Pajaro River	12	3
Salinas River	7	3
Carmel River	6	0
Big Sur River	8	3
	2003-2004	**2003-2004**
Scott Creek	12	4
San Lorenzo River	12	4
Soquel Creek	10	4
Pajaro River	12	1
Salinas River	10	4
Carmel River	7	3
Big Sur River	13	4
	2002-2003	**2002-2003**
Scott Creek	9	7
San Lorenzo River	9	7
Soquel Creek	9	8
Pajaro River	9	5
Salinas River	11	8
Carmel River	5	2
Big Sur River	12	7
	2001-2002	**2001-2002**
Scott Creek	4	5
San Lorenzo River	6	12
Soquel Creek	6	12
Pajaro River	7	12
Salinas River	6	9
Carmel River	6	8
Big Sur River	6	13
	2000-2001	**2000-2001**
Scott Creek		0
San Lorenzo River		0
Soquel Creek		0
Pajaro River		3
Salinas River		12
Carmel River		0
Big Sur River		0

Table 3.5.3. Mean concentration of nutrients, total suspended solids (TSS), and geometric mean concentrations of indicator bacteria at CCLEAN stream and river sampling sites from July 2004-to June 2005. Non-detect values were treated as 0 for nutrients and TSS and as one half of the detection limit of 10 MPN/100mL for bacteria. Values in red text for NO_3-N exceeded the U.S. EPA proposed water quality objective of 10 mg/L. Values in red text for total coliform and *E. coli*. exceeded the geometric mean water quality objective of 10,000 MPN/100mL single sample maximum for total coliform and 126 MPN/100mL for *E. coli*, as proposed in the Basin Plan Amendment for Water Contact Recreation.

Site	NO3-N (mg/L)	NH3-N (mg/L)	SiO2 (mg/L)	TSS (mg/L)	Urea-N (ug/L)	O-PO4 (mg/L)	Total Coliform (MPN/100mL)	E. coli (MPN/100mL)	Enterococcus (MPN/100mL)
Waddell Creek @ HWY 1	0.19	0.01	23.40	11.32	20.83	0.08	1114	56	8
Scott Creek @ HWY 1	0.09	0.02	27.22	4.11	11.42	0.10	1040	71	8
Laguna Creek @Mouth	0.19	0.01	26.87	5.40	17.83	0.16	1547	74	11
Moore Creek @ Mouth	1.12	0.03	18.93	20.70	40.00	0.68	4109	71	13
Branciforte Creek @ Isabel	0.18	0.01	41.85	3.58	35.92	0.42	2134	226	22
San Lorenzo River@ Laurel St.	0.36	0.02	28.79	9.20	14.50	0.20	6494	526	24
Soquel Creek@ RR Bridge	0.26	0.03	31.64	10.00	6.17	0.14	2882	283	14
Porter Gulch @ Mouth	0.79	0.01	40.36	9.26	36.83	0.24	4137	290	31
Aptos Creek @ Winfield Dr.	0.31	0.06	36.03	14.01	4.25	0.31	3518	418	21
Pajaro River @ Thurwachter Rd.	3.63	0.07	17.10	37.43	48.67	0.17	3993	84	8
Salinas River@Davis Road	7.26	0.10	7.51	26.43	29.86	0.26	13039	268	32
Tembladero Slough @ Preston St.	29.48	0.21	17.78	58.44	40.33	0.55	23155	325	25
Carmel River @ Garland Park	0.24	0.02	23.87	3.20	19.60	0.03	2110	43	17
Big Sur @ Andrew Molera	0.11	0.01	22.40	0.38	22.00	0.02	1082	41	7
Carmel River @ HWY 1	0.34	0.03	22.78	1.50	55.83	0.01	1178	12	7

Table 3.5.4. Estimated annual loads of nutrients, TSS, and bacteria discharged into near-shore waters from July 2004 to June 2005.

Site	NO_3-N (kg/yr)	NH_3-N (kg/year)	SiO_2 (kg/year)	TSS (kg/year)	Urea-N (kg/year)	Ortho-PO_4 (kg/year)	Total Coliform (millions/year)	*E. coli.* (millions/year)	Enterococcus (millions/year)
Scott Creek	6.08E+03	1.29E+03	1.50E+06	5.35E+05	6.37E+02	8.12E+08	2.38E+07	8.05E+06	3.42E+03
San Lorenzo River	2.83E+04	2.92E+02	3.89E+06	2.02E+06	2.01E+03	6.47E+09	4.29E+08	4.94E+07	2.32E+04
Soquel Creek	5.36E+03	7.19E+02	9.53E+05	9.93E+05	2.44E+01	7.40E+08	7.85E+07	1.12E+07	3.26E+03
Pajaro River	2.71E+05	4.69E+03	3.80E+06	4.01E+07	5.04E+03	1.19E+10	6.27E+08	1.23E+08	8.94E+04
Salinas River	2.14E+05	1.07E+03	5.93E+05	2.29E+06	6.59E+02	2.54E+09	2.07E+07	1.64E+06	5.21E+03
Carmel River	3.41E+04	3.78E+03	2.25E+06	2.46E+05	2.05E+03	1.32E+08	1.53E+06	8.80E+05	8.76E+02
Big Sur River	1.55E+04	7.04E+02	2.27E+06	6.27E+04	1.72E+03	6.61E+08	4.16E+07	7.48E+06	7.92E+02

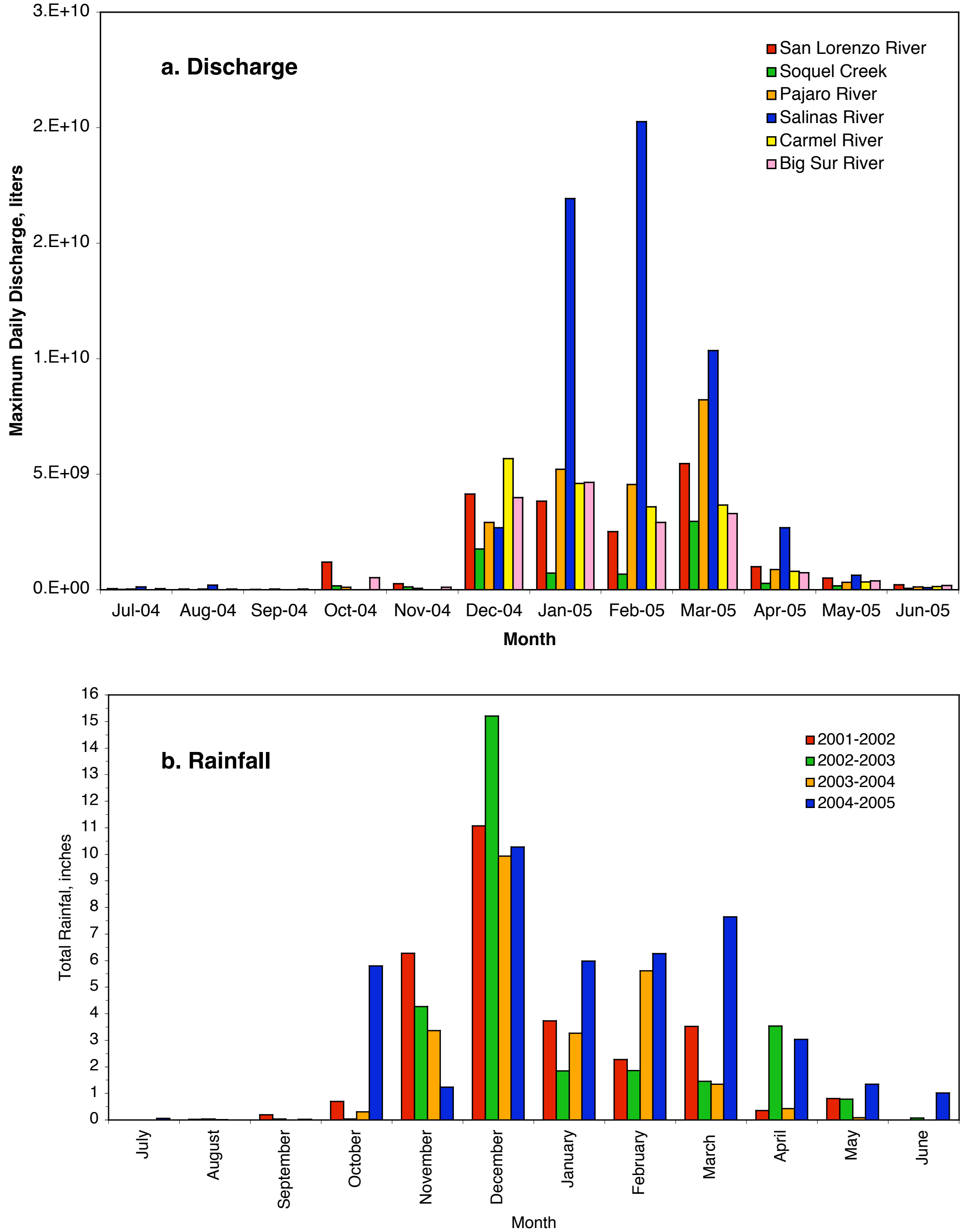


Figure 3.5.1. Maximum daily discharge in liters for the six streams which have stream gauges monitored by USGS for July 2004 to June 2005. Total rainfall in inches over the 4 years of CCLEAN sampling for Santa Cruz.

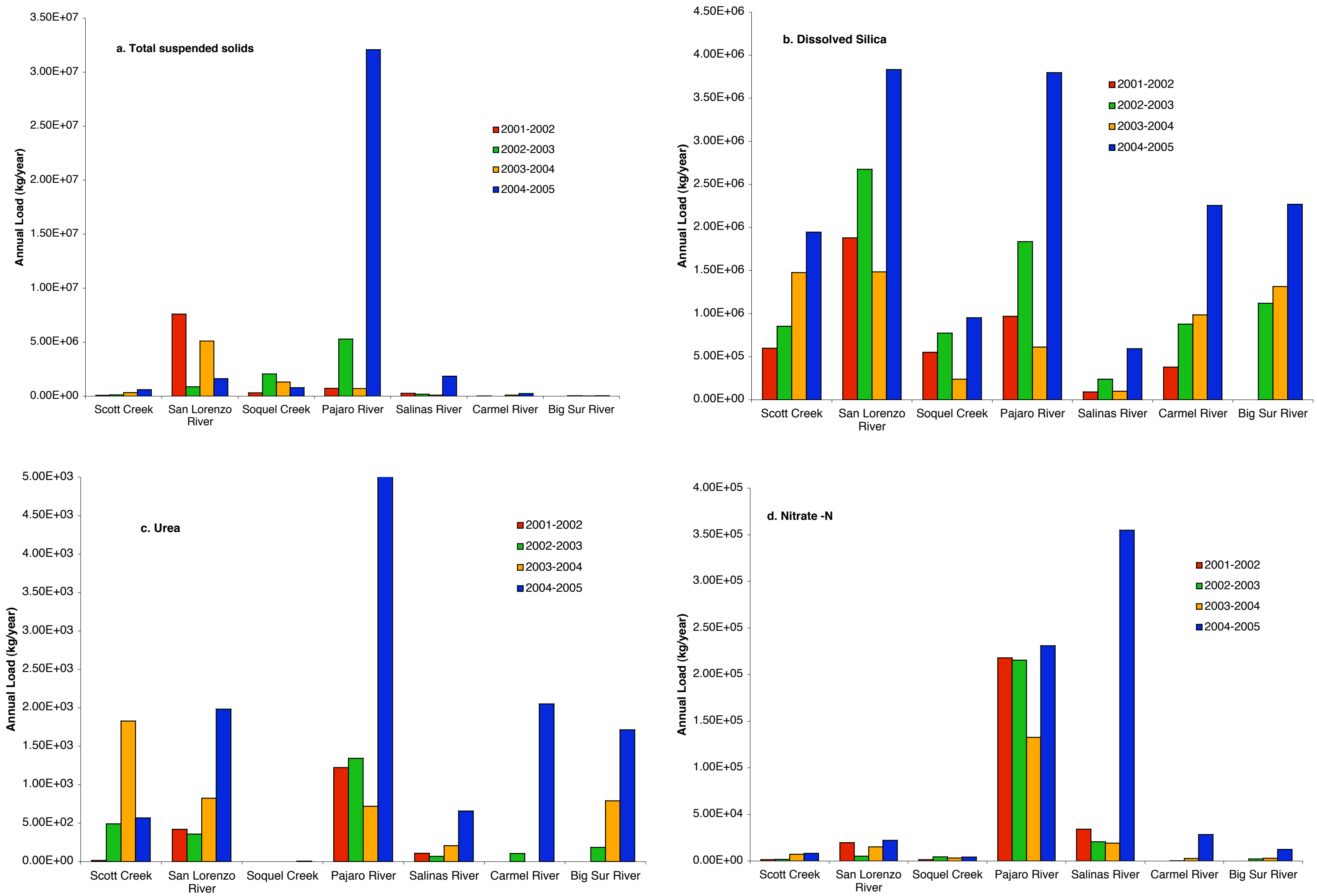
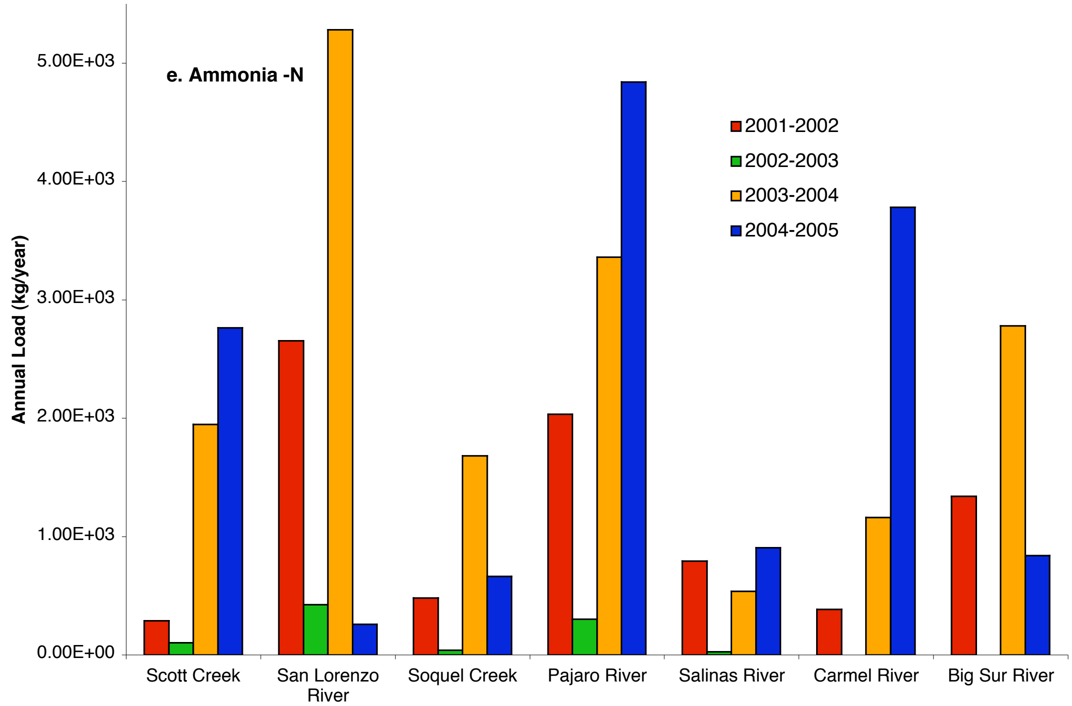


Figure 3.5.2. Annual loads of total suspended solids, dissolved silica, urea and nitrate into near shore waters from 7 streams and rivers during the 2001-2002, 2002-2003, 2003-2004, and 2004-2005 sampling seasons.



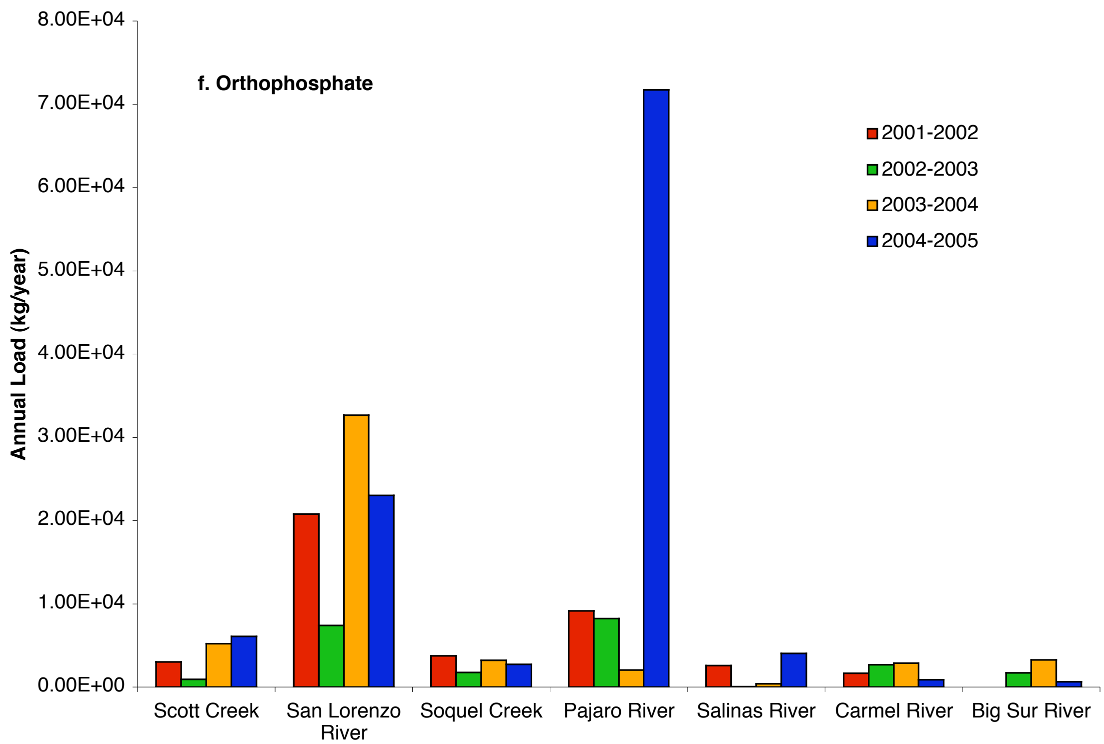


Figure 3.5.3. Annual loads of ammonia and orthophosphate into near shore waters from 7 streams and rivers during the 2001-2002, 2002-2003, 2003-2004, and 2004-2005 sampling seasons.

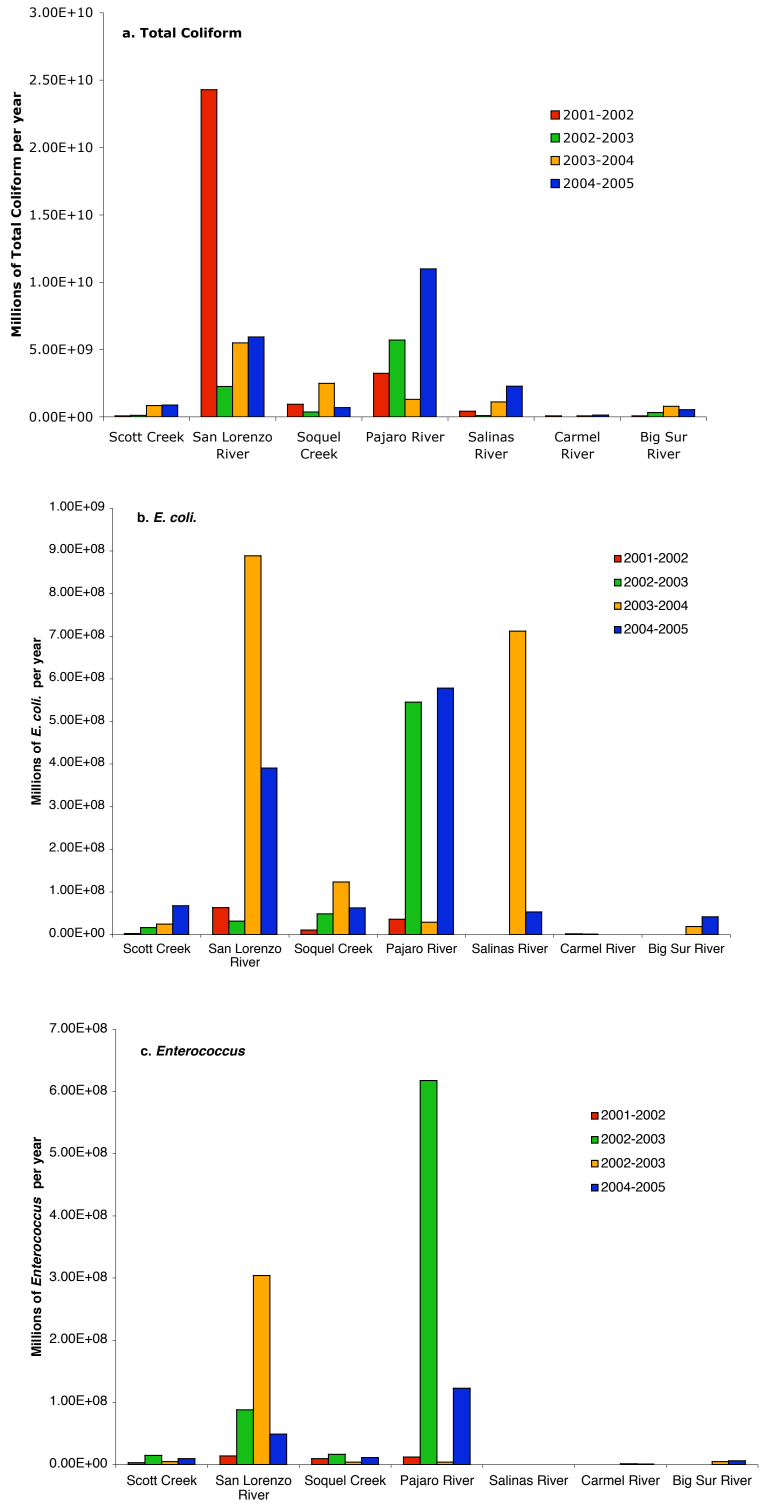


Figure 3.5.4. Comparisons of estimated loads of indicator bacteria into nearshore waters during 2001-2002, 2002-2003, 2003-2004, and 2004-2005 sampling seasons, including CCAMP data.

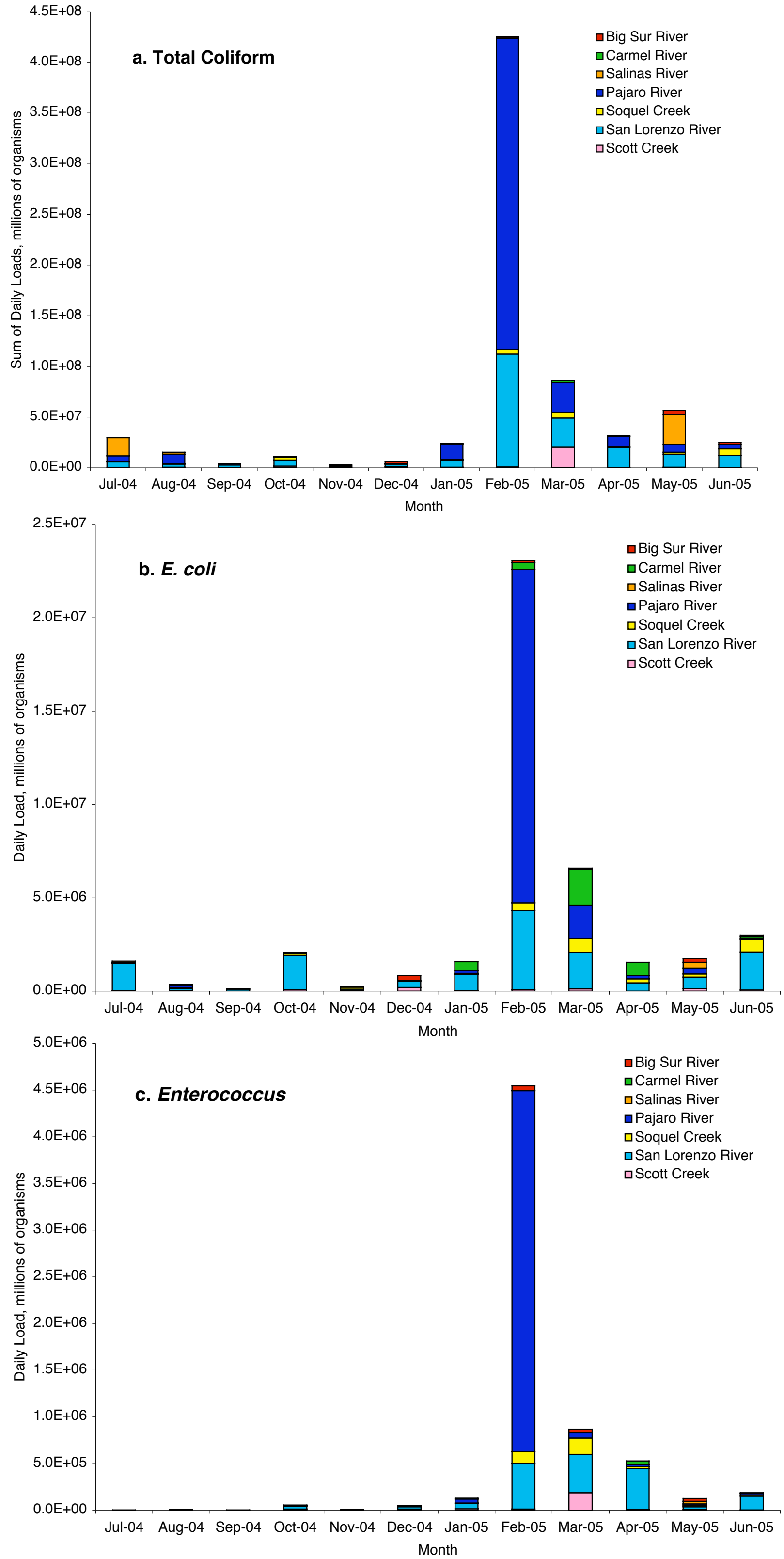


Figure 3.5.5. Sums of daily loads of indicator bacteria estimated from samples collected on monthly sampling dates at each of 7 streams and rivers.

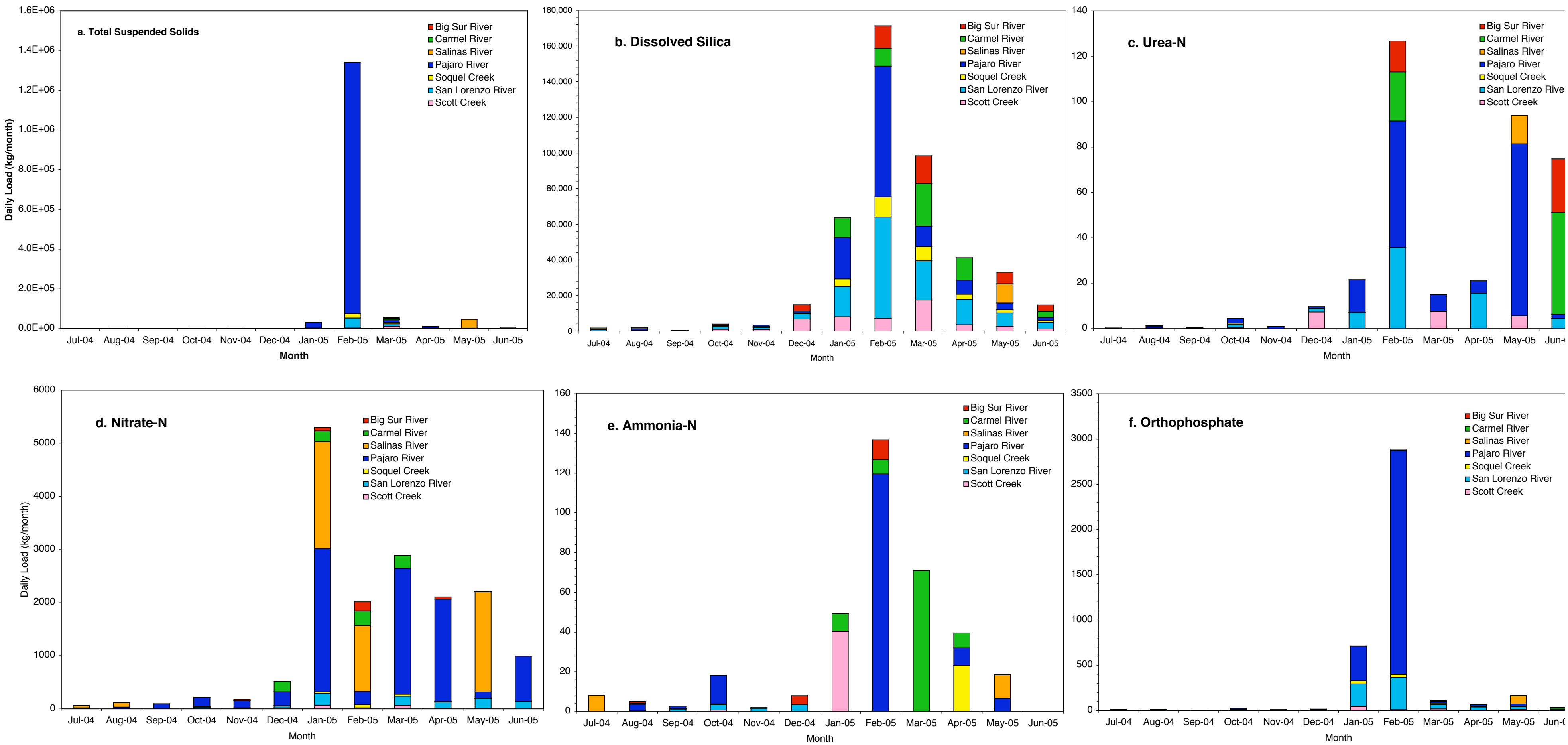


Figure 3.5.6. Sums of daily loads of TSS, dissolved silica, nitrate, ammonia & orthophosphate estimated from samples collected on monthly sampling dates at each of 7 streams and rivers.

3.5.2.2 POP Sampling

Every river, except the Carmel, exceeded criteria for at least two POPs in the California Toxics Rule (CTR), which was promulgated by the USEPA (Federal Register / Vol. 65, No. 97 / Thursday, May 18, 2000 / Rules and Regulations) to limit the concentrations of toxic materials in California's inland waters. The Pajaro and Salinas rivers exceeded CTR criteria for several chlorinated pesticides, the San Lorenzo River exceeded criteria for chlordane and PCBs, and the Salinas River also exceeded the PCB criterion (Table 3.5.1). None of the rivers exceeded criteria for any of the PAHs.

Table 3.5.1. Actual measurements of selected POPs made in four rivers from July 2004 through June 2005 compared with the most stringent CTR criteria (µg/L). Red text indicates exceedences of the CTR criteria.

	Maximum 2004–2005 30-day Average Concentration Measured				
Analyte	San Lorenzo	Pajaro	Salinas	Carmel	CTR[1]
4,4'-DDT	0.000176	0.00489	0.00110	0.000039	0.00059
4,4'-DDE	0.000218	0.00570	0.00364	0.000042	0.00059
4,4'-DDD	0.000058	0.00204	0.000576	0.000007	0.00083
Dieldrin	0.000078	0.00102	0.000431	0.000015	0.00014
Chlordane	0.000716	0.000725	0.000438	0.000069	0.00057
PCBs	0.000277	0.000112	0.000397	0.000129	0.00017
Benzo(a)anthracene	0.00171	0.000881	0.00161	0.000129	0.0044
Benzo(a)pyrene	0.00223	0.000788	0.00100	0.000134	0.0044
Benzo(b)fluoranthene	0.00251	0.00152	0.00290	0.000188	0.0044
Benzo(k)fluoranthene	0.00184	0.000795	0.000838	0.000124	0.0044
Chrysene	0.00326	0.00204	0.00385	0.00033	0.0044

[1] = CTR criteria for consumption of water and organisms

The combined loads of some constituents to nearshore waters from streams and rivers were greater than those from the four wastewater discharges (Figure 3.5.7). The combined loads of dissolved silica from San Lorenzo River, Soquel Creek, Pajaro River, Salinas River, Carmel River and Big Sur River were 3.7–11.5 greater than from wastewater discharges in 2001-2002, 2002-2003, 2003-2004 and 2004-2005 (Figure 3.5.7a). Combined loads of suspended sediments from rivers and streams were 7.2–10.8 times those from wastewater and combined loads of nitrate from rivers and streams were 2.5–9.8 times those from wastewater during the same period. The rivers and streams also exceeded the wastewater discharges in the combined load of urea. Conversely, the combined loads of ammonia and orthophosphate from the wastewater discharges were 34–57 and 2.7–6.2 times greater than those from rivers and streams (Figure 3.5.7e-f).

Dry-season and wet-season sampling captured seasonal differences in river flow regimes (Figure 3.5.8). Flows during the 2004 dry season sampling period were below the annual mean and flows during the 2005 wet season sampling period were substantially above the annual mean for each river. Moreover, mean daily discharges from the rivers during POP sampling events (Figure 3.5.9) reflect spatial and temporal patterns in river discharges (Figure 3.5.10).

Mean daily loads of POPs from the San Lorenzo, Pajaro, Salinas and Carmel rivers were substantially different between seasons and among rivers (Appendix F-2 and Figure 3.5.11). PAHs, DDTs, dieldrin, chlordane, PCBs and HCHs all had consistently higher mean daily loads in the wet season than in the dry season and the Carmel River had consistently lower loads than the other rivers. Wet-season loads of DDTs and dieldrin were much higher from the Pajaro and Salinas rivers than from either of the other two rivers, whereas PAHs, chlordanes and HCHs had comparable loads from the San Lorenzo, Pajaro and Salinas rivers. During high-flow years (2004 wet season and 2005 wet season, see Figure 3.5.10) daily loads of PCBs were much higher from the Salinas River than from the other rivers.

Load estimates from these four rivers are subject to several sources of uncertainty. First, sand seasonally piles up on beaches, impounding lagoons during much of the year at all four rivers. These load estimates are based upon flow measurements that are made upstream of the river mouth and the measured flow may not actually discharge to the ocean if the river is impounded by sand. In this case, the estimated loads would be higher than actual loads. Second, although the 2005 wet season sampling event was during a period of high river flows, it did not capture the first major storm-related flow of the season when concentrations of POPs probably would be highest. Third, the particle filters for the 2004 wet season samples probably contained more sediment than would be the case had the inlet of the sample tubing at each site remained in the water column, instead of becoming buried by mobilized sediment. Because our budget does not allow for analysis of separate particulate and dissolved sample phases, the upward bias in POP concentrations caused by excess sediment cannot be corrected. Nevertheless, this later bias probably is small because the large sediment particles that buried the sample intake carry proportionally smaller concentrations of POPs than do smaller particles that remain suspended in the water.

Regardless of uncertainties in the estimated loads of POPs from rivers, combined loads from all four rivers during the 2004-2005 project year exceeded the combined loads from wastewater discharges for all POPs by a substantial amount, especially during years with high river discharges (Figure 4.5.10). The annual loads of PAHs, DDTs, dieldrin, chlordanes and PCBs from rivers in 2003–2004 and 2004–2005 have exceeded respective loads from wastewater by minimum of 11.5 times (PAHs in 2003–2004) to maximum of 707 times (DDTs in 2003–2004). Among the POPs reported here, only loads of HCHs from wastewater were close to those from rivers, and in 2002–2003, wastewater loads exceeded those of rivers.

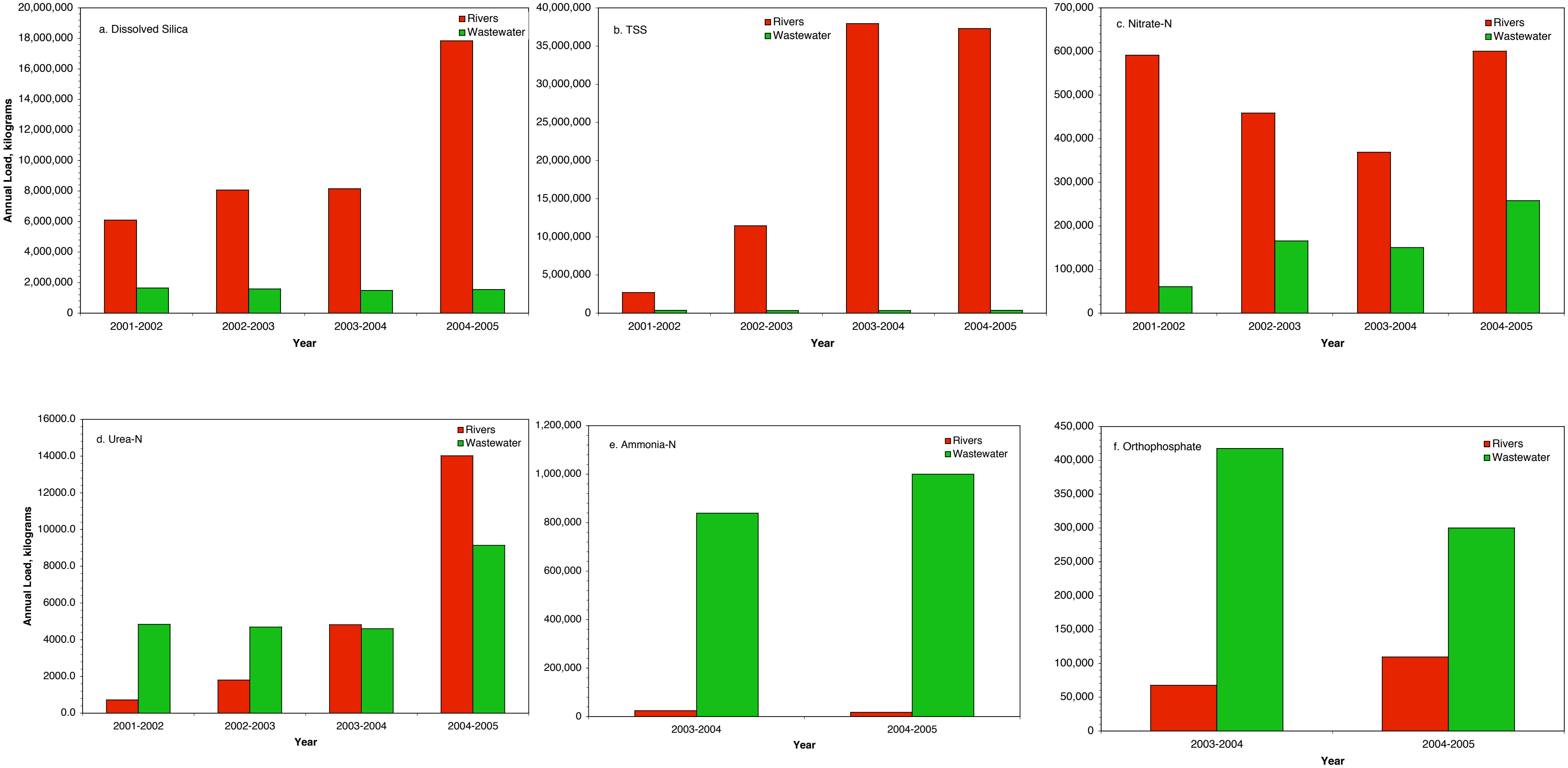


Figure 3.5.7. Comparisons of combined annuals loads of nutrients from gauged rivers [Scott Creek (added in 2003-2004), San Lorenzo River, Soquel Creek, Pajaro River, Salinas River, Carmel River and Big Sur River] and wastewater (City of Santa Cruz, City of Watsonville, Monterey Regional Water Pollution Control Agency and Carmel Area Wastewater District.

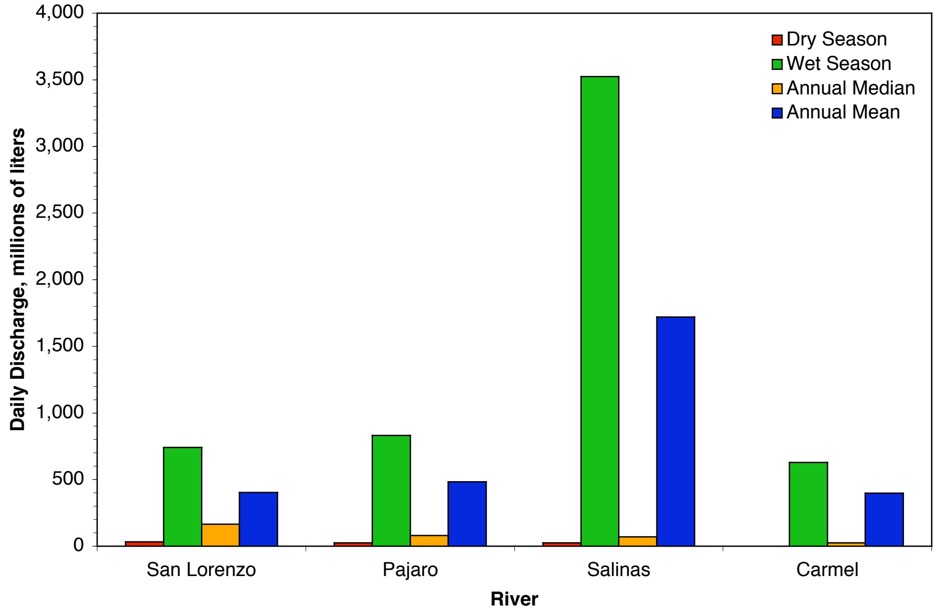


Figure 3.5.8. Mean daily discharges from the four rivers during 2004 dry-season and 2005 wet-season sampling, compared with the annual median and annual mean.

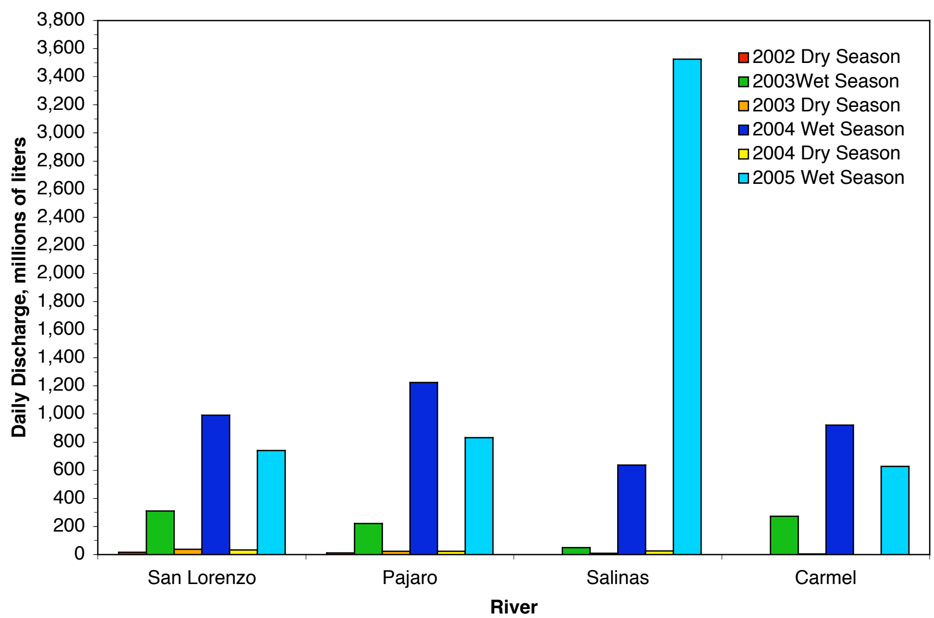


Figure 3.5.9. Mean daily discharges from the San Lorenzo, Pajaro, Salinas and Carmel rivers during 30-day dry-season and wet-season sampling periods in 2002-2003, 2003-2004 and 2004-2005.

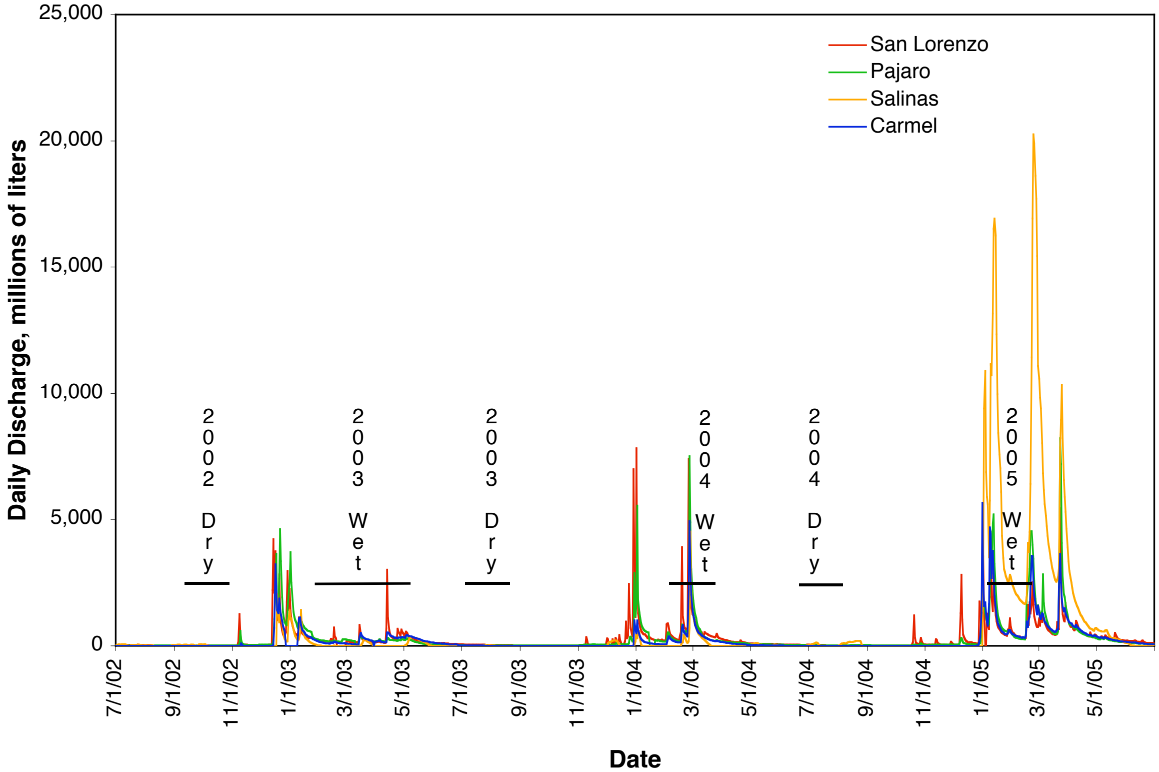


Figure 3.5.10. Thirty-day POP sampling events compared with daily discharges from four rivers.

3.5.2.3 Effects of River Nutrients on Monterey Bay Chlorophyll

An important objective of the CCLEAN program is the assessment of whether discharges from land are affecting the water quality and ecosystems of the Monterey Bay area. An analysis was performed to determine whether the waters adjacent to two discharges, Scott Creek and the Pajaro River, have higher sea-surface chlorophyll concentrations than nearby reference locations.

Recently researchers have used satellite remote sensing data to extract variables such as chlorophyll a (chlorophyll) and sea surface temperature (SST) as well as view real time plumes of sediment from land to sea. Stanford researchers were able to correlate agricultural runoff with seasonal blooms in the Gulf of California's Yaqui Valley using Sea-viewing Wide Field-of-view Sensor (SeaWiFS) images and a record of irrigation events in the valley (Beman, 2005). Another study started by the Institute for Computational Earth System Science (ICESS) in Santa Barbara was called "Plumes and Blooms" and analyzed relationships between sediment plumes covering the Santa Barbara Channel from terrestrial runoff and developing plankton blooms during the 1997-1998 El Nino (Otero, 2004). The frequency and intensity of Harmful Algal Blooms (HABs) has increased along the California coast in recent years and some researchers believe the general increase in frequency of these events is related to pollution in runoff from terrestrial inputs (Kemp, 2005). In this study we hope to evaluate whether the Monterey Bay and its rivers and streams can be evaluated in a similar way to try to understand and potentially predict patterns of HABs.

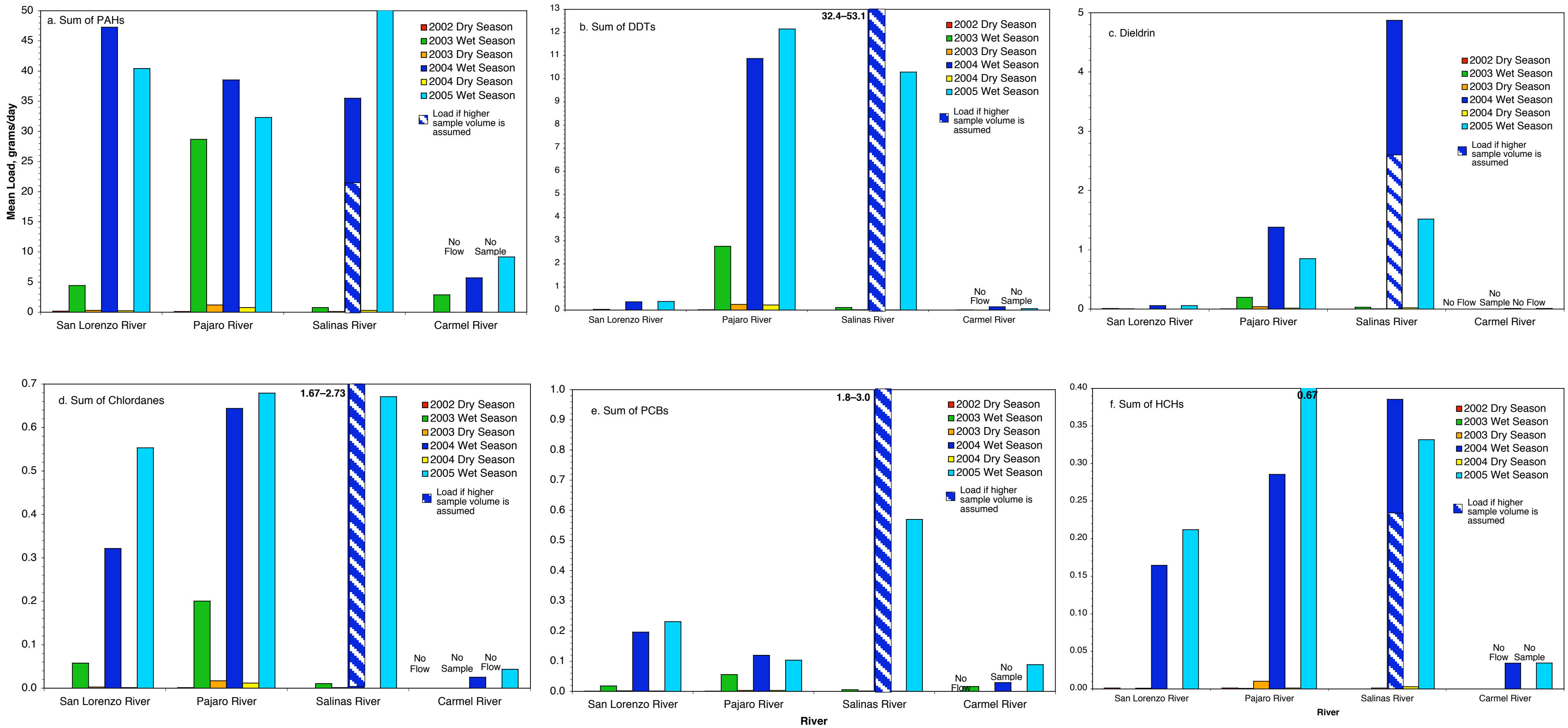


Figure 3.5.11. Mean dry season and wet season daily loads of POPs from the San Lorenzo, Pajaro, Salinas and Carmel rivers in 2002–2003, 2003–2004 and 2004-2005.

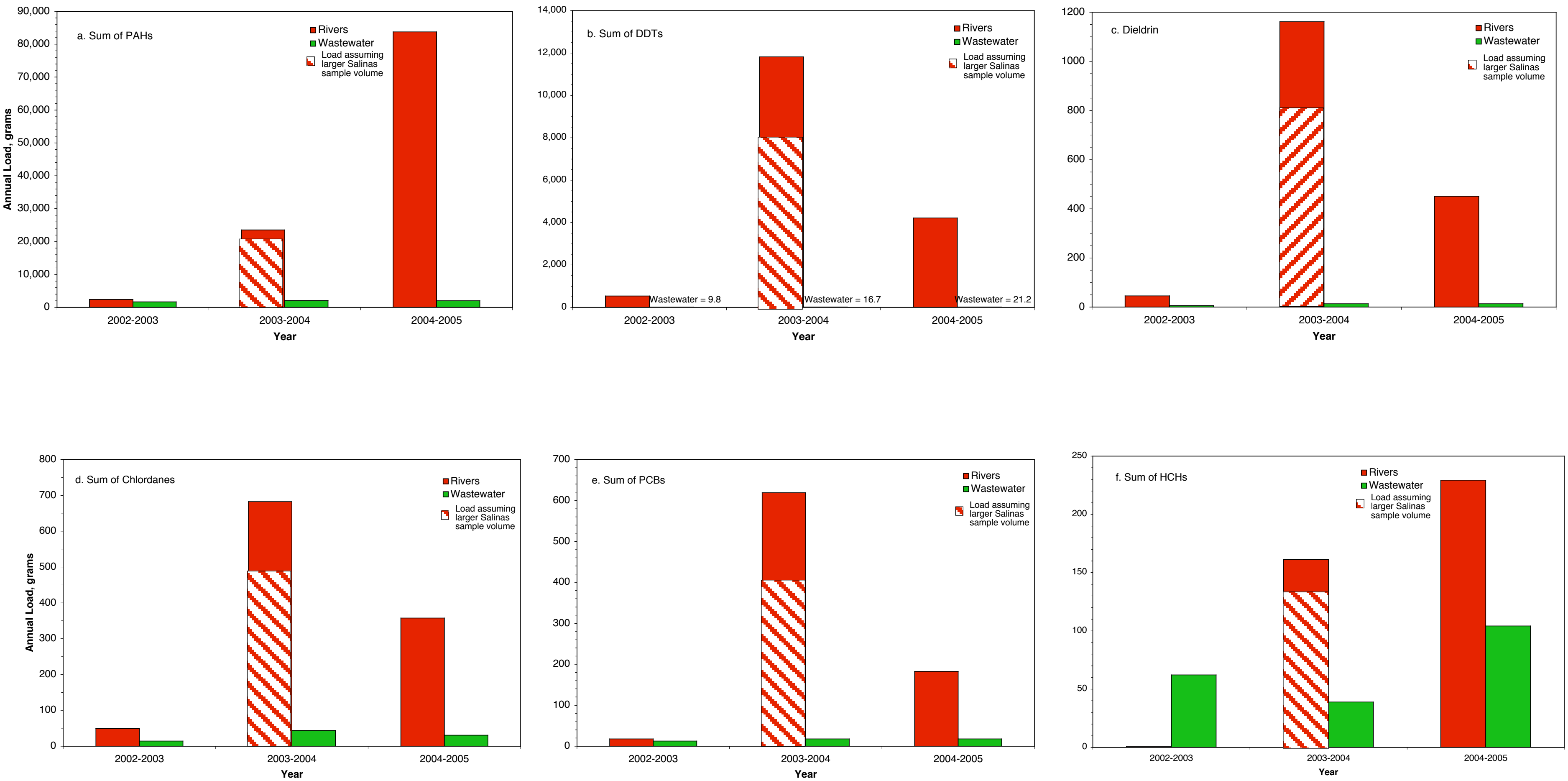


Figure 3.5.12. Comparisons of combined annual loads of POPs from the San Lorenzo, Pajaro, Salinas and Carmel rivers and wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional Water Pollution Control Agency and Carmel Area Wastewater District.

Satellite images obtained from NASA called SeaWiFS, or Sea-viewing Wide Field-of-view Sensor, can yield satellite remote sensed chlorophyll measurements. We attempted to correlate these remotely sensed data with discharge from rivers and streams to determine if any input signal from the rivers can be seen to increase chlorophyll levels beyond background or control levels, or an area that is not influenced by river or stream discharge. The satellite values of chlorophyll are based on the spectroradiometer sensor, which measures water-leaving radiance, L_W, that which is not absorbed by the ocean, in specific bands or wavelengths of the visible spectrum. One major difficulty is separating out the scattering in the atmosphere caused by such things as particulates and aerosols from other signals such as chlorophyll. The benefit of course is global coverage at a 1km resolution. Our problem was finding SeaWiFS images where Monterey Bay is not completely or partially covered with clouds or coastal fog. During storm events when discharge would be highest, available data is sparse.

3.5.2.3.1 Activities and Methods

Using latitude and longitude as a means to repeat exact transects on each SeaWiFS image, values for chlorophyll at approximately 5, 1-km^2 pixels were extracted from the images for an area offshore from Scott Creek and the area adjacent to the Pajaro and Salinas River discharge. These sites were chosen to represent a range of nutrient loads from streams and rivers into Monterey Bay (see Table 3.5.3). The Pajaro River contributed the highest loads of nitrate, urea and orthophosphate, and the second highest load of ammonia, while the Salinas River contributed the second, third, and fourth highest loads of nitrate, orthophosphate, urea and ammonia, respectively, from gauged sources measured by CCLEAN in 2004-2005. Scott Creek contributed the sixth highest loads of nitrate and urea, the third highest load of ammonia, and the fourth highest load of orthophosphate. Similar transects approximately equal distances from shore in an area that was removed from each respective discharge also were sampled for chlorophyll values. The differences in sea surface chlorophyll between each discharge and its respective reference were analyzed using a paired *t*-test in which the values for all five pixels in each transect were averaged to represent the chlorophyll concentration on that date. All means were log-transformed prior to the *t*-test. We also requested normalized water-leaving radiance data (L_{wN}) from MODIS at 551nm. Researchers have used this in a similar study trying to relate sediment plumes from streams and rivers to elevated plankton levels or blooms (Otero, 2004). They used the L_{wN} data as a proxy for suspended sediments. However only four days had readable data that correlated with the chlorophyll data we had clear images for.

3.5.2.3.2 Results

Based on the data for both near-stream and reference sites, the paired t-test results for sea surface chlorophyll showed that while the Scott Creek site did not significantly differ from its reference site ($p<0.167$), the Pajaro River site was significantly higher than its reference site ($p< 0.0079$). ANOVA showed that the Pajaro River site had significantly more chlorophyll than the Scott Creek site (Table 3.5.5). Table 3.5.6 are the mean values of the Scott Creek and Pajaro River transects of the SeaWiFs chlorophyll image. Although the normalized water-leaving radiance at 551nm had only four days that matched up with our chlorophyll data, we attempted to make correlations between the chlorophyll values and the L_{wN}. There was no significant correlation for the Pajaro River data but the Scott Creek data show a significant correlation (Figure 3.5.13, r^2 = 0.2147, p = 0.0026).

Table 3.5.5. Table of ANOVA results for differences between Scott Creek and Pajaro River transects of *chl* values from SeaWiFs images.

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Region	1	11.05	11.05	44.24	<0.0001
Error	78	19.48	0.2498		

Table 3.5.6. Table of mean values for chlorophyll a and normalized water leaving radiance at 551 nm for Scott Creek and Pajaro River sites and their controls.

Date	Scott Creek	Scott reference	Pajaro River	Pajaro reference
Chlorophyll				
12/27/03	1.0624	0.8413	1.2107	0.6724
1/3/04	1.3342	1.1704	3.9524	0.7837
1/5/04	0.7245	1.1704	3.0390	1.8772
1/22/04	1.5729	0.8975	2.4044	1.6060
2/8/04	1.5930	1.6246	4.5410	4.6044
2/9/04	2.3924	1.9978	5.9674	4.4146
2/10/04	3.1014	2.1512	5.9674	5.5724
2/11/04	2.6382	3.1958	6.5748	4.1306
3/9/04	4.2360	4.3048	17.952	9.0492
3/15/04	1.5636	1.5934	3.1898	3.7216
3/23/04	3.3192	2.7420	0.7041	0.61202
Normalized water leaving radiance 551nm				
1/3-5/04	0.2548	0.2430	1.4520	0.5344
2/9/04	0.4802	0.9792	0.4802	0.5884
2/10/04	0.6650	0.7522	0.3764	0.6246
3/15/04	0.4752	0.6554	0.4688	0.4418

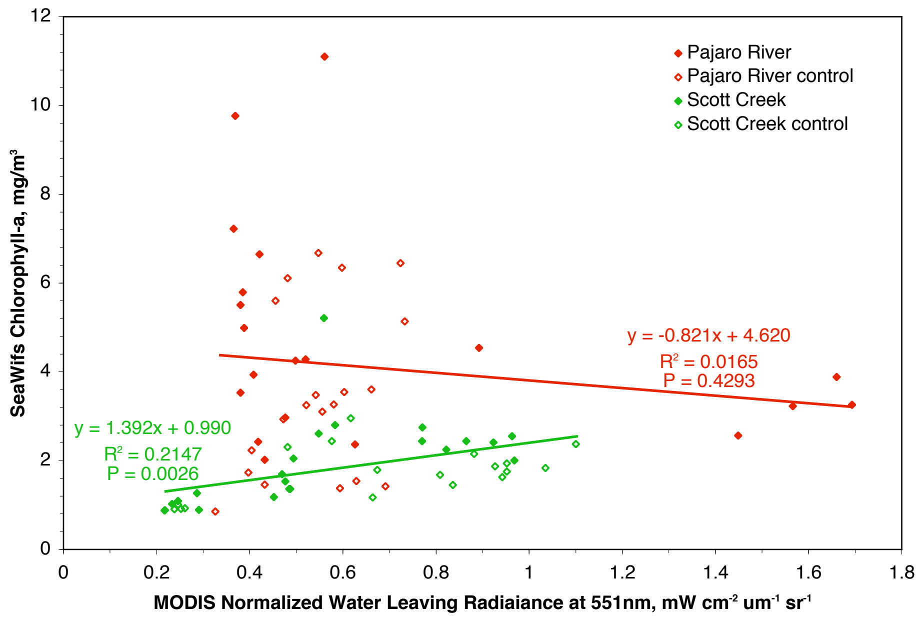


Figure 3.5.13. Correlation showing relationships of chlorophyll values to normalized water leaving radiance at 551nm (a proxy for suspended sediment) for both Scott Creek and Pajaro River.

3.5.3 Current Status

The CCLEAN monthly sampling of rivers and streams for nutrients and bacteria has been incorporated into the Regional Board's CCAMP program for 2006–2007. While this change will reduce the number of sites sampled to 10, it is a cost-effective collaboration with an existing program that will provide uniformly high data quality. Moreover, CCAMP measures stream flow on each sampling date, so we will be able to estimate loads from each of the streams, rather than the subset for which we have been able to obtain gage data. As part of the cumulative report for the first five years of the CCLEAN program, we will use stream flow models developed by the Regional Board to estimate flows and loads from all of the streams sampled since CCLEAN began.

A limited analysis of 2004 SeaWiFS data has suggested effects of river discharges on sea surface chlorophyll concentrations. Dr. Kudela currently is analyzing satellite sea surface chlorophyll data for Monterey Bay to determine the areas of the bay that are most likely to be affected by river discharges. This effort involves statistical procedures to determine what areas are correlated with river discharges at various time lags. This information can then be used to focus the area covered by our analyses, which will be expanded to include more years of data to more fully assess whether nutrient discharges from the rivers are associated with algal blooms.

3.5.4 Recommendations

The cumulative report for the first five years of CCLEAN should include a full analysis of whether discharges of nutrients from rivers and streams affect algal blooms, especially those that are harmful. CCLEAN will continue to collaborate with colleagues at University of California at Santa Cruz's Center for Integrated Technologies, Dr. Kudela and Dr. Peter Miller about the best ways to calibrate, process and analyze the satellite sea surface chlorophyll data.

3.6 Nearshore Background Water Quality

Beginning with the 2004 wet season, CCLEAN implemented measurements of POPs, pathogen indicators and nutrients at two locations in Monterey Bay. The objective of this work is to determine the status and trends in the quality of nearshore background waters in the Monterey Bay area, with an emphasis on POPs and nutrients.

3.6.1 Activities and Methods

Buoys were fabricated for deployment by KLI (Figure 3.6.1) at a site in northern Monterey Bay and at a site in southern Monterey Bay (Figure 2.2.1). Deployments lasted for 30 days between February 20 and March 21, 2004 and between June 24 and July 26, 2004. Each deployment sampled 200 liters at each site. The buoys were configured so that near-surface water was pumped across the same particle filters and columns packed with XAD-2 resin as used in the wastewater and river sampling efforts to collect POPs. Duplicate grabs were collected at buoy deployment and buoy retrieval for analysis of total coliform, fecal coliform, enterococcus, ammonia, nitrate, urea, orthophosphate, dissolved silica, and total suspended solids. The City of Santa Cruz laboratory analyzed orthophosphate, the City of Watsonville analyzed total coliform, fecal coliform, enterococcus, TSS, urea and ammonia, and Monterey Bay Analytical analyzed dissolved silica and nitrate. Axys Analytical analyzed POPs. This sampling was conducted on the same cycle as sampling of rivers and wastewater for POPs. Data from the dry season deployment in 2004 were not available for this report and they will be reported in the next annual report.

3.6.2 Results

Very few conventional water quality constituents or pathogen indicators were detected in the marine waters at North Monterey Bay and South Monterey Bay (Appendix G). Suspended solids and dissolved silicate were consistently detected in all samples at both sites, but urea, nitrate, ammonia and orthophosphate were rarely detected in any sample. The only pathogen indicator detected was total coliform, at or slightly above the detection limit, at South Monterey Bay on February 20 and at both sites on July 26. Results from duplicate field samples were generally very similar, except for an differences in TSS, with relative percent differences as high as 37–41) at South Monterey Bay on February 20 and June 24.

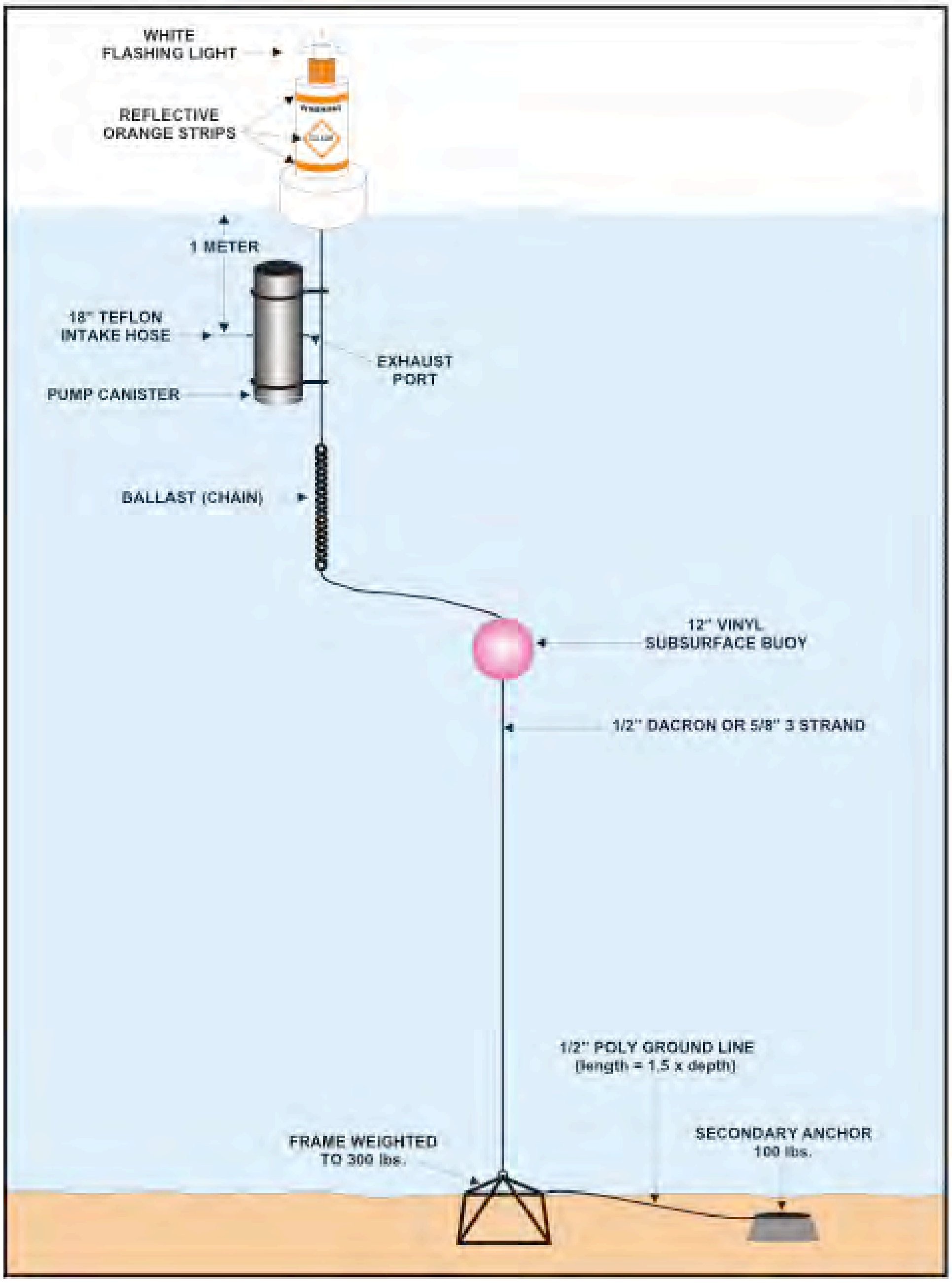


Figure 3.6.1. Moorings deployed to measure nearshore background water quality.

All the major groups of POPs were detected at both background sites, with some at surprisingly high concentrations (Appendix G and Figure 3.6.2), especially in the wet-season samples. Concentrations of POPs were generally similar between the two Monterey Bay sites, except for higher concentrations of DDTs, endosulfans and dieldrin at North Monterey Bay than at South Monterey Bay. The most recently available data from the Regional Monitoring Program for Trace Substances indicate higher dry-season concentrations of PAHs (Figure 3.6.2a), DDTs (Figure 3.6.2c), PCBs (Figure 3.6.2d), endosulfans (Figure 3.6.2e) and dieldrin (Figure 3.6.2f) in the San Francisco Bay than at either Monterey Bay sites, whereas HCHs (Figure 3.6.1b) were greater in Monterey Bay.

A comparison of regulatory water quality objectives with concentrations of POPs measured at North Monterey Bay and South Monterey Bay offers some surprising results. Table B of the California Ocean Plan (State Water Resources Control Board, 2001) specifies water quality objectives for the protection of marine aquatic life and human health. CCLEAN includes some analytes in the POP groups it reports (i.e., for PAHs, PCBs and chlordanes) that are not included in those groups, as they are defined in the Ocean Plan. When only those analytes that are included in the Ocean Plan definitions are analyzed, the Ocean Plan 30-day average water quality objectives for the protection of human health from carcinogens were exceeded or equaled by three POPs in Monterey Bay samples in March 2004 (Figure 3.6.3). The concentrations of PCB in the equipment blanks for March July 2004 (see Table 3.1.4) were a substantial fraction of the concentrations measured in the Monterey Bay samples, but even after the Monterey Bay samples were corrected for these equipment blank values, the South Monterey Bay site exceeded the water quality objective in March 2004 (Figure 3.6.3.a). Dieldrin exceeded the water quality objective at North Monterey Bay (Figure 3.6.3b), consistent with its high concentrations in mussels at The Hook and Laguna Creek (Figure 3.3.4). The concentration of DDTs at the North Monterey Bay site was as high as the water quality objective in March 2004 (Figure 3.6.3c).

3.6.3 Current Status

Sampling of nearshore background water will continue.

3.6.4 Recommendations

We recommend the implementation of a continuous evaluation of detection limits for conventional constituents.

3.7 Special Projects

3.7.1 Measuring POPs in Sea Otters

CCLEAN was awarded a grant from Proposition 13 funding through the Coastal Nonpoint Source Program to measure POPs in sea otters. This cooperative effort includes the California Department of Fish and Game Marine Wildlife Veterinary Care and Research Center. The grant amount is $426,616. The funding will allow analysis of tissues from dead otters that have received detailed necropsies to determine cause of death, general health, presence of disease, age, sex, and organ weights. This project will allow us to determine the role of POPs in sea otter mortality, with greater certainty that has been possible with the low numbers of cases previously examined (Kannan et al., 1998; Nakata et al., 1998). The grant start date was June 1, 2004. The CCLEAN QAPP was revised to conform to SWAMP format and content and the California Department of Fish and Game sea otter necropsy database has been updated to include pathology results that were not available at the time of the necropsy. This project involves analysis of liver tissue from 230 sea otters for POPs and evaluation of the role of POPs in sea otter mortality. The draft Final Report will be completed by March 31, 2007.

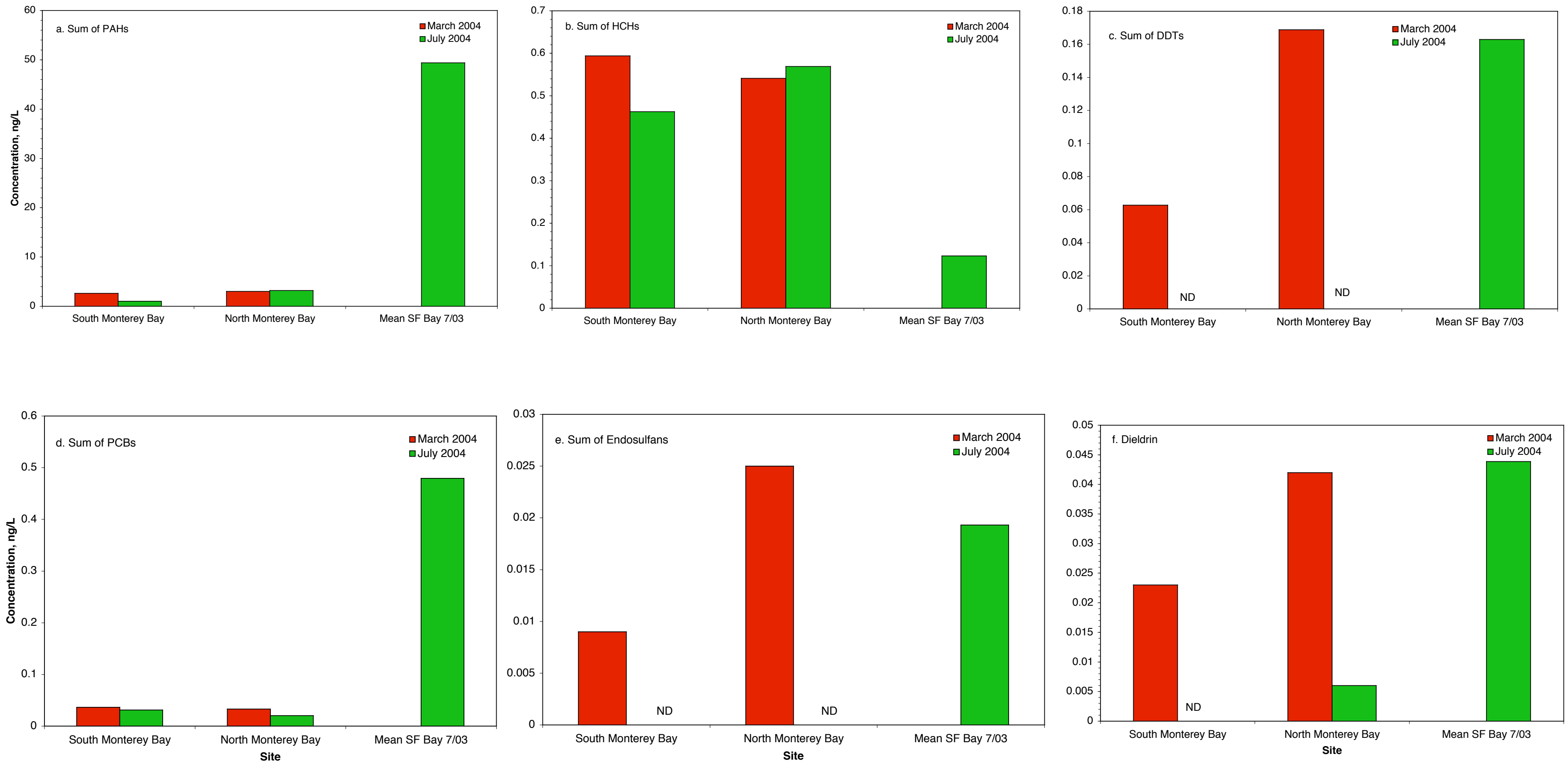


Figure 3.6.2. Concentrations of POPs at two CCLEAN marine background sites in Monterey Bay during the 2004 wet and dry season. Data from the Regional Monitoring Program for Trace Substances for the mean of San Francisco Bay sites in July 2002 are shown for reference.

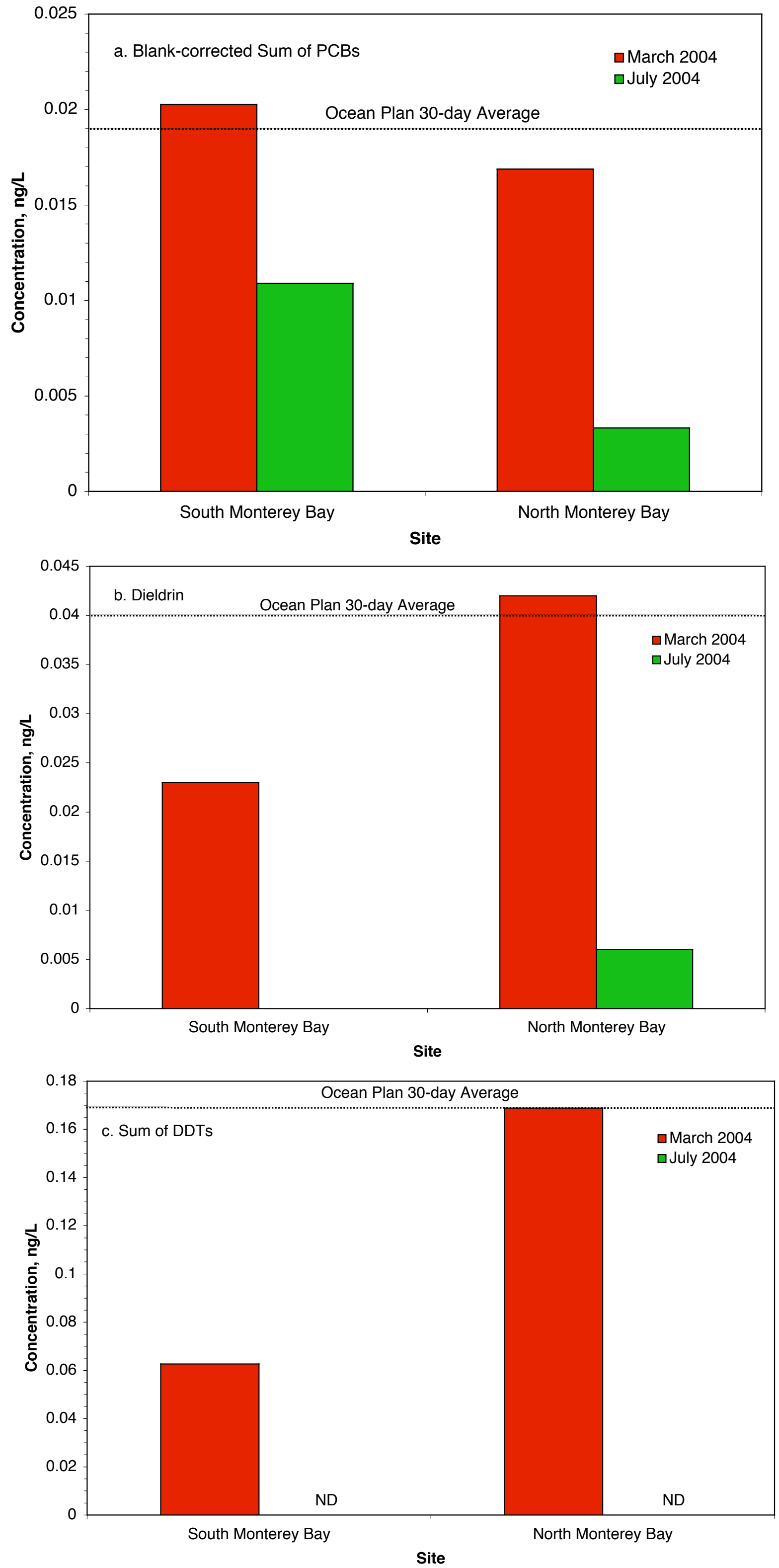


Figure 3.6.3. Comparison of POPs measured in the 2004 wet and dry season at two Monterey Bay sites with 30-day average water quality objectives in Table B of the California Ocean Plan.

3.7.2 Monitoring and Mitigation of Fecal Pathogens

CCLEAN was recently awarded a Prop 50 Ocean Protection grant to study sources and mitigation of fecal pathogens from coastal sources. This program will involve monthly sampling for the conventional pathogen indicator bacteria (total coliform, fecal coliform, and *Enterococcus*) for comparison with actual concentrations of bacterial (*Campylobacter* spp., *Escherichia coli* O157, *Salmonella* spp., and *Vibrio* spp.) and protozoal (*Cryptosporidium* and *Giardia* spp.) pathogens. Paired water and shellfish samples from six sites, as well as sewage influent and effluent from four sites, will be tested quarterly. Controlled laboratory models will be used to test the efficacy of various management practices for using wetlands to reduce fecal pathogens in nonpoint source runoff and a natural wetland will be sampled to evaluate the efficacy of natural wetlands for reducing fecal pathogen levels along the California coast. These results will help prioritize watersheds for implementation of management actions and technology transfer from the laboratory. Field wetland measurements will be used to inform resource managers about the best ways to prevent fecal pathogens from entering coastal waters.

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5.0 Appendices

Appendix A. Chemical analytes and target method detection limits for the CCLEAN program.

Matrix	Parameter & Analyte	Target MDL	Units
Water	**Nutrients**		
	Ammonia	0.01	mg/L
	Nitrate	0.1	mg/L
	Urea	0.1	mg/L
	Silicate	0.1	mg/L
	Orthophosphate	0.03	mg/L
	Conventional		
	Total Suspended Solids	1	mg/L
	Temperature	0.1	° C
	Conductivity	0.01	mS/cm
	pH	0.1	units
	Persistent Organic Pollutants		
	PAHs		
	1-Methylnaphthalene	50	pg/L
	2,3,5-Trimethylnaphthalene	50	pg/L
	2,6-Dimethylnaphthalene	50	pg/L
	2-Methylnaphthalene	50	pg/L
	Biphenyl	50	pg/L
	Naphthalene	50	pg/L
	1-Methylphenanthrene	50	pg/L
	Acenaphthene	50	pg/L
	Acenaphthylene	50	pg/L
	Anthracene	50	pg/L
	Fluorene	50	pg/L
	Phenanthrene	50	pg/L
	Benz(a)anthracene	50	pg/L
	Chrysene	50	pg/L
	Fluoranthene	50	pg/L
	Pyrene	50	pg/L
	Benzo(a)pyrene	50	pg/L
	Benzo(b)fluoranthene	50	pg/L
	Benzo(e)pyrene	50	pg/L
	Benzo(k)fluoranthene	50	pg/L
	Dibenz(a,h)anthracene	50	pg/L
	Perylene	50	pg/L
	Benzo(ghi)perylene	50	pg/L
	Indeno(1,2,3-cd)pyrene	50	pg/L
	Dibenzothiophene	50	pg/L
	C1-Chrysenes	50	pg/L
	C2-Chrysenes	50	pg/L

Matrix	Parameter & Analyte	Target MDL	Units
Water	**Persistent Organic Pollutants**		
	PAHs		
	C3-Chrysenes	50	pg/L
	C4-Chrysenes	50	pg/L
	C1-Dibenzothiophenes	50	pg/L
	C2-Dibenzothiophenes	50	pg/L
	C3-Dibenzothiophenes	50	pg/L
	C1-Fluoranthene/Pyrenes	50	pg/L
	C1-Fluorenes	50	pg/L
	C2-Fluorenes	50	pg/L
	C3-Fluorenes	50	pg/L
	C1-Naphthalenes	50	pg/L
	C2-Naphthalenes	50	pg/L
	C3-Naphthalenes	50	pg/L
	C4-Naphthalenes	50	pg/L
	C1 Phenanthrene/Anthracenes	50	pg/L
	C2-Phenanthrene/Anthracenes	50	pg/L
	C3-Phenanthrene/Anthracenes	50	pg/L
	C4-Phenanthrene/Anthracenes	50	pg/L
	Pesticides		
	Cyclopentadienes		
	Aldrin	50	pg/L
	Dieldrin	50	pg/L
	Endrin	50	pg/L
	Chlordanes		
	alpha-Chlordane	50	pg/L
	cis-Nonachlor	50	pg/L
	gamma-Chlordane	50	pg/L
	Heptachlor	50	pg/L
	Heptachlor Epoxide	50	pg/L
	Oxychlordane	50	pg/L
	trans-Nonachlor	50	pg/L
	DDTs		
	o,p'-DDD	50	pg/L
	o,p'-DDE	50	pg/L
	o,p'-DDT	50	pg/L
	p,p'-DDD	50	pg/L
	p,p'-DDE	50	pg/L
	p,p'-DDT	50	pg/L
	HCH		
	alpha-HCH	50	pg/L
	beta-HCH	50	pg/L
	delta-HCH	50	pg/L

Matrix	Parameter & Analyte	Target MDL	Units
Water	**Persistent Organic Pollutants**		
	Pesticides		
	gamma-HCH	50	pg/L
	Other		
	Chlorpyrifos	50	pg/L
	Dacthal	50	pg/L
	Diazinon	50	pg/L
	Endosulfan I	50	pg/L
	Endosulfan II	50	pg/L
	Endosulfan Sulfate	50	pg/L
	Mirex	50	pg/L
	Pesticides		
	Oxadiazon	50	pg/L
	Hexachlorobenzene	50	pg/L
	PCB congeners		
	8, 18, 28, 31, 33, 44, 49, 52,56, 60, 66, 70, 74, 87,95, 97, 99, 101, 105, 110,118, 128, 132, 138,141, 149, 151, 153, 156,158, 170, 174, 177,180, 183, 187, 194, 195,201, 203	5	pg/L
Sediment	**Conventional**		
	Total Organic Carbon	0.1	%
	Species Indentifications	Lowest possible	Taxon
	Grain Size		
	Clay (<4μm)	1	%
	Silt (4μm-63μm)	1	%
	Sand (63μm-2mm)	1	%
	Gravel+Shell (>2mm)	1	%
	Persistent Organic Pollutants[a]		
	PAHs		
	1-Methylnaphthalene	5	μg/kg
	2,3,5-Trimethylnaphthalene	5	μg/kg
	2,6-Dimethylnaphthalene	5	μg/kg
	2-Methylnaphthalene	5	μg/kg
	Biphenyl	5	μg/kg
	Naphthalene	5	μg/kg
	1-Methylphenanthrene	5	μg/kg
	Acenaphthene	5	μg/kg
	Acenaphthylene	5	μg/kg
	Anthracene	5	μg/kg
	Fluorene	5	μg/kg
	Phenanthrene	5	μg/kg
	Benz(a)anthracene	5	μg/kg
	Chrysene	5	μg/kg

Matrix	Parameter & Analyte	Target MDL	Units
Sediment	**Persistent Organic Pollutants**[a]		
	PAHs		
	Fluoranthene	5	µg/kg
	Pyrene	5	µg/kg
	Benzo(a)pyrene	5	µg/kg
	Benzo(b)fluoranthene	5	µg/kg
	Benzo(e)pyrene	5	µg/kg
	Benzo(k)fluoranthene	5	µg/kg
	Dibenz(a,h)anthracene	5	µg/kg
	Perylene	5	µg/kg
	Benzo(ghi)perylene	5	µg/kg
	Indeno(1,2,3-cd)pyrene	5	µg/kg
	Dibenzothiophene	5	µg/kg
	C1-Chrysenes	5	µg/kg
	C2-Chrysenes	5	µg/kg
	C3-Chrysenes	5	µg/kg
	C4-Chrysenes	5	µg/kg
	C1-Dibenzothiophenes	5	µg/kg
	C2-Dibenzothiophenes	5	µg/kg
	C3-Dibenzothiophenes	5	µg/kg
	C1-Fluoranthene/Pyrenes	5	µg/kg
	C1-Fluorenes	5	µg/kg
	C2-Fluorenes	5	µg/kg
	C3-Fluorenes	5	µg/kg
	C1-Naphthalenes	5	µg/kg
	C2-Naphthalenes	5	µg/kg
	C3-Naphthalenes	5	µg/kg
	C4-Naphthalenes	5	µg/kg
	C1 Phenanthrene/Anthracenes	5	µg/kg
	C2-Phenanthrene/Anthracenes	5	µg/kg
	C3-Phenanthrene/Anthracenes	5	µg/kg
	C4-Phenanthrene/Anthracenes	5	µg/kg
	Cyclopentadienes		
	Aldrin	1	µg/kg
	Dieldrin	1	µg/kg
	Endrin	1	µg/kg
	Chlordanes		
	alpha-Chlordane	1	µg/kg
	cis-Nonachlor	1	µg/kg
	gamma-Chlordane	1	µg/kg
	Heptachlor	1	µg/kg
	Heptachlor Epoxide	1	µg/kg

Matrix	Parameter & Analyte	Target MDL	Units
Sediment	**Persistent Organic Pollutants[a]**		
	Pesticides		
	Chlordanes		
	Oxychlordane	1	µg/kg
	trans-Nonachlor	1	µg/kg
	Indeno(1,2,3-cd)pyrene	5	µg/kg
	DDTs		
	o,p'-DDD	1	µg/kg
	o,p'-DDE	1	µg/kg
	o,p'-DDT	1	µg/kg
	p,p'-DDD	1	µg/kg
	p,p'-DDE	1	µg/kg
	p,p'-DDT	1	µg/kg
	HCH		
	alpha-HCH	1	µg/kg
	beta-HCH	1	µg/kg
	delta-HCH	1	µg/kg
	gamma-HCH	1	µg/kg
	Other		
	Chlorpyrifos	1	µg/kg
	Dacthal	1	µg/kg
	Diazinon	1	µg/kg
	Endosulfan I	1	µg/kg
	Endosulfan II	1	µg/kg
	Endosulfan Sulfate	1	µg/kg
	Mirex	1	µg/kg
	Oxadiazon	1	µg/kg
	Hexachlorobenzene	1	µg/kg
Sediment	**Persistent Organic Pollutants[a]**		
	PCB congeners		
	8, 18, 28, 31, 33, 44, 49, 52,56, 60, 66, 70, 74, 87,95, 97, 99, 101, 105, 110,118, 128, 132, 138,141, 149, 151, 153, 156,158, 170, 174, 177,180, 183, 187, 194, 195,201, 203	1	µg/kg
Tissues	**Conventional**		
	Moisture	0.1	%
	Lipid	0.1	%
	Persistent Organic Pollutants[a]		
	PAHs		
	1-Methylnaphthalene	5	µg/kg
	2,3,5-Trimethylnaphthalene	5	µg/kg
	2,6-Dimethylnaphthalene	5	µg/kg

Matrix	Parameter & Analyte	Target MDL	Units
Tissues	**PAHs**		
	2-Methylnaphthalene	5	µg/kg
	Biphenyl	5	µg/kg
	Naphthalene	5	µg/kg
	1-Methylphenanthrene	5	µg/kg
	Acenaphthene	5	µg/kg
	Acenaphthylene	5	µg/kg
	Anthracene	5	µg/kg
	Fluorene	5	µg/kg
	Phenanthrene	5	µg/kg
	Benz(a)anthracene	5	µg/kg
	Chrysene	5	µg/kg
	Fluoranthene	5	µg/kg
	Pyrene	5	µg/kg
	Benzo(a)pyrene	5	µg/kg
	Benzo(b)fluoranthene	5	µg/kg
	Benzo(e)pyrene	5	µg/kg
	Benzo(k)fluoranthene	5	µg/kg
	Dibenz(a,h)anthracene	5	µg/kg
	Perylene	5	µg/kg
	Benzo(ghi)perylene	5	µg/kg
	Indeno(1,2,3-cd)pyrene	5	µg/kg
	Dibenzothiophene	5	µg/kg
	C1-Chrysenes	5	µg/kg
	C2-Chrysenes	5	µg/kg
	C3-Chrysenes	5	µg/kg
	C4-Chrysenes	5	µg/kg
	C1-Dibenzothiophenes	5	µg/kg
	C2-Dibenzothiophenes	5	µg/kg
	C3-Dibenzothiophenes	5	µg/kg
	C1-Fluoranthene/Pyrenes	5	µg/kg
	C1-Fluorenes	5	µg/kg
	C2-Fluorenes	5	µg/kg
	C3-Fluorenes	5	µg/kg
	C1-Naphthalenes	5	µg/kg
	C2-Naphthalenes	5	µg/kg
	C3-Naphthalenes	5	µg/kg
	C4-Naphthalenes	5	µg/kg
	C1 Phenanthrene/Anthracenes	5	µg/kg
	C2-Phenanthrene/Anthracenes	5	µg/kg

Matrix	Parameter & Analyte	Target MDL	Units
Tissues	**Persistent Organic Pollutants**[a]		
	PAHs		
	C3-Phenanthrene/Anthracenes	5	µg/kg
	C4-Phenanthrene/Anthracenes	5	µg/kg
	Pesticides		
	Cyclopentadienes		
	Aldrin	1	µg/kg
	Dieldrin	1	µg/kg
	Endrin	1	µg/kg
	Chlordanes		
	alpha-Chlordane	1	µg/kg
	cis-Nonachlor	1	µg/kg
	gamma-Chlordane	1	µg/kg
	Heptachlor	1	µg/kg
	Heptachlor Epoxide	1	µg/kg
	Chlordanes		
	Oxychlordane	1	µg/kg
	trans-Nonachlor	1	µg/kg
	DDTs		
	o,p'-DDD	1	µg/kg
	o,p'-DDE	1	µg/kg
	o,p'-DDT	1	µg/kg
	p,p'-DDD	1	µg/kg
	p,p'-DDE	1	µg/kg
	p,p'-DDT	1	µg/kg
	HCH		
	alpha-HCH	1	µg/kg
	beta-HCH	1	µg/kg
	delta-HCH	1	µg/kg
	gamma-HCH	1	µg/kg
	Other		
	Chlorpyrifos	1	µg/kg
	Dacthal	1	µg/kg
	Diazinon	1	µg/kg
	Endosulfan I	1	µg/kg
	Endosulfan II	1	µg/kg
	Endosulfan Sulfate	1	µg/kg
	Mirex	1	µg/kg
	Oxadiazon	1	µg/kg
	Hexachlorobenzene	1	µg/kg

Matrix	Parameter & Analyte	Target MDL	Units
Tissues	**Persistent Organic Pollutants**[a]		
	PCB congeners 8, 18, 28, 31, 33, 44, 49, 52,56, 60, 66, 70, 74, 87,95, 97, 99, 101, 105, 110,118, 128, 132, 138,141, 149, 151, 153, 156,158, 170, 174, 177,180, 183, 187, 194, 195,201, 203	1	µg/kg
Sea Otters	**Butyl tins**	1	
	Dibutyl tin	20	µg/kg, wet weight
	Tributyl tin	10	µg/kg, wet weight

[a] = Sediment and mussel tissue persistent organic pollutants are reported on a dry-weight basis.
Note: Organochlorines analyzed by GC-ECD will be determined using two columns of differing polarity (e.g., DB-5 and DB-17) in order to separate co-eluting congeners and reduce the influence of interferences.

Appendix B. CCLEAN effluent data for the period July 2004 through June 2005.

Agency	Date	SC Flow, MGD	SV Flow, MGD	Flow, MLD	Urea-N Conc, mg/l	Urea-N Load, kg/day	Silicate Conc, mg/l	Silicate Load, kg/day	TSS, SV Conc, mg/l	TSS, SV Load, kg/day	TSS, SC Conc, mg/l	TSS, SC Load, kg/day	Ammonia-N, SV Conc, mg/l	Ammonia-N, SV Load, kg/day	Ammonia-N, SC Conc, mg/l	Ammonia-N, SC Load, kg/day	Nitrate-N Conc, mg/l	Nitrate-N Load, kg/day	Orthophosphate-P Conc, mg/l	Orthophosphate-P Load, kg/day	Cond. mS/cm	pH	Temp.
Santa Cruz																							
	7/4/04	7.43	0.855	31.359					7	5.985	5	156.794	0.14	1.040	16.4	514.283	15.8	495.468			1.28	7.25	25
	7/6/04	7.45	0.853	31.427	0.199	6.254	39	1225.647															
	7/12/04	7.66	0.891	32.366					5	4.455	4	129.462	0.14	1.072	19.2	621.418	11.8	381.913			1.23	7.41	24
	7/20/04	10.07	0.778	41.060															7.680	315.338			
	7/21/04	8.52	0.915	35.711					4	3.660	3	107.134	0.14	1.193	23.4	835.649	11.5				1.53	7.4	26
	8/2/04	9.39	0.848	38.751					11	9.328	3	116.252	0.14	1.315	20.5	794.392	9.8	379.758	7.350	284.819	1.24	7.42	25
	8/3/04	9.36	0.782	38.387	0.249	9.558	40	1535.499													1.29	7.17	25
	9/7/04	10	0.766	40.749	0.260	10.595	36	1466.975											6.850	279.133	1.34	7.21	26
	10/5/04	9.2	0.885	38.172	0.278	10.612	32	1221.495											7.530	287.433			
	11/1/04	8.2	1.033	34.947	0.333	11.637	38	1327.982															
	11/8/04	8.6	1.252	37.290															6.950	259.164			
	12/6/04	11.35	1.195	47.483	0.168	7.977																	
	12/14/04	9.5	1.101	40.125			36	1444.492															
	1/4/05	19.3	1.295	77.952															6.200	483.303			
	1/12/05	14.9	1.326	61.415	0.250	15.354	0.007	0.424															
	1/25/05	11.47	1.024	47.290					20	20.480	3	141.869	1.10	12.617	28.8	1361.946	3.5	165.514			1.24	7.38	19
	2/1/05	9.76	1.101	41.109			33	1356.593											8.650	355.592			
	2/3/05	9.67	0.95	40.197					12	11.400	3	120.590	0.78	7.543	24.2	972.760	8.5	341.672			1.16	7.26	18
	2/6/05	10.91	0.98	45.004					12	11.760	3	135.011	0.78	8.510	21.1	949.577	9.6	432.035			1.14	7.2	19
	2/15/05	31.09	1.343	122.759					30	40.290	8	982.071	0.78	24.250	23.6	2897.110	6.3	773.381			1.26	7.11	19
	2/22/05	17.4	1.173	70.299	0.208	14.622																	
	2/23/05	15.88	1.149	64.455					24	27.576	3	193.364	0.78	12.386	13.9	895.921	6	386.729			1.14	7.19	18
	3/1/05	19.67	1.064	78.478															6.480	508.539			
	3/2/05	15.1	1.286	62.021	0.164	10.171	31	1922.651															
	4/1/05	13.91	1.086	56.760															7.03	399.022			
	4/4/05	14.7	0.983	59.360	0.130	7.717	33	1958.885															
	5/3/05	14.96	0.553	58.717															6.280	368.741			
	5/4/05	15.1	0.972	60.833			33	2007.473															
	5/25/05	11.8	0.902	48.077	0.204	9.808																	
	6/6/05	12.20	0.731	48.944	0.218	10.670	32	1566.203											6.25	305.899			
Santa Cruz																							
Mean		12.485	1.002	51.050	0.222	10.415	31.917	1419.527	13.889	14.993	3.889	231.394	0.531	7.770	21.233	1093.673	9.200	419.559	7.023	349.726	1.259	7.273	22.182
Total Load, kg/year		4557.025	365.876	18633.180		3801.33		518127.2		5472.323		84458.92	0.140	2835.89	19.9	399190.6		153138.96		127649.86			

Santa Cruz	Total PAHs		LPAHs		HPAHs		Chlordanes		DDTs		HCHs		Endosulfans		PCBs		Dacthal		DDE		DDD		DDT		Diedrin	
POPs	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day
2004 Dry Season	44.061	1.568	36.539	1.300	7.5216	0.268	0.2552	0.009	0.1336	0.005	5.9899	0.213	0.1801	0.006	0.318882	0.011	0.154	0.005	0.0765	0.003	0.0413	0.001	0.0158	0.001	0.141	0.005
2005 Wet Season	59.495	3.636	44	2.689	15.495	0.947	0.717	0.044	0.170	0.010	0.767	0.047	0.256	0.016	0.340459	0.021	0.112	0.007	0.077	0.005	0.053	0.003	0.04	0.002	0.324	0.020
Mean	51.78	2.60	40.270	1.994	11.508	0.607	0.486	0.026	0.152	0.008	3.378	0.130	0.218	0.011	0.330	0.016	0.133	0.006	0.077	0.004	0.047	0.002	0.028	0.002	0.233	0.012
Total Load, g/year		949.62		727.970		221.648		9.653		2.763		47.448		4.024		5.868		2.249		1.355		0.859		0.549		4.529

Agency	Date	Flow, MGD	Flow, MLD	Urea-N Conc, mg/l	Urea-N Load, kg/day	Silicate Conc, mg/l	Silicate Load, kg/day	TSS Conc, mg/l	TSS Load, kg/day	Ammonia-N Conc, mg/l	Ammonia-N Load, kg/day	Nitrate-N Conc, mg/l	Nitrate-N Load, kg/day	Orthophosphate-P Conc, mg/l	Orthophosphate-P Load, kg/day	Cond. mS/cm	pH	Temp.
Watsonville																		
	6/23/04	8.08	30.583					9.2	281.362							1.477	7.1	22.8
	6/24/05	8.3	31.416							12.4	389.552	12.1	380.128				6.5	24.3
	6/29/05	7.48	28.312					6.4	181.196							1.433	6.9	23.0
	6/30/05	7.33	27.744					4.4	122.074								6.9	22.7
	7/1/05	7.4	28.009							6.5	182.059	14.5	406.131			1.408	7.1	22.2
	7/5/05	6.57	24.867					6.8	169.099								7.5	22.6
	7/6/05	7.62	28.842					6.4	184.587								7.1	21.6
	7.8/05	8.2	31.037							8.9	276.229	8.7	270.022			1.339	7.1	21.9
	7/12/04	8.7	32.930			42.5	1399.50375	12	395.154								6.9	24.1
	7/13/05	8.44	31.945					9.6	306.676								7.1	23.7
	7/15/05	9.26	35.049							19	665.933	1.8	63.088			1.443	7.0	24.1
	7/19/05	8.88	33.611					7.2	241.998								6.3	24.1
	7/20/05	8.37	31.680					10.4	329.477								6.5	24.6
	7/22/05	9.24	34.973							20.2	706.463	1	34.973				6.6	24.3
	7/28/04	7.43	28.123											14.0	393.716			
	7/29/04	8.67	32.816	0.133	4.374													
	8/20/04	8.04	30.431	0.139	4.226													
	8/23/04	8.3	31.416			42.2	1325.7341							4.4	138.228			
	9/15/04	7.63	28.880			38.9	1123.414495											
	9/29/04	7.18	27.176	0.119	3.242													
	9/30/04	6.95	26.306											25.0	657.644			
	10/1/04	7.4	28.009			38.3	1072.7447											
	10/26/04	9.32	35.276											12.0	423.314			
	10/28/04	7.8	29.523	0.118	3.494													
	11/12/04	7.78	29.447			37.9	1116.05267											
	11/30/04	7.53	28.501	0.132	3.759									13.0	370.514			
	12/1/04	8.12	30.734			43.9	1349.23138											
	12/16/04	7.51	28.425	0.120	3.418													
	12/22/04	7.26	27.479											13.0	357.228			
	1/13/05	8.77	33.194			35.7	1185.041865											
	1/18/05	8.34	31.567					5.6	176.775								6.6	18.8
	1/19/05	8.09	30.621					8.4	257.213								6.8	18.8
	1/21/05	8.01	30.318							12.4	375.941	6.3	191.002			1356	6.8	19.8
	1/25/05	8.38	31.718					7.2	228.372								6.7	20.0
	1/26/05	8.35	31.605					5.6	176.987								6.7	20.3
	1/27/05	8.39	31.756	0.118	3.744													
	1/28/05	8.09	30.621							19.4	594.041	7.5	229.655	25.2		14.27	6.8	20
	2/1/05	7.31	27.668					10.4	287.751								6.7	19
	2/2/05	7.50	28.388			38.7	1098.59625	6.8	193.035								6.7	18.6
	2/4/05	7.50	28.388							13	369.038	9.4	266.843			1120	6.7	19.5
	2/8/05	7.44	28.160					6.9	194.307								6.7	19.2
	2/9/05	7.27	27.517					6.0	165.102								6.7	19.2
	2/10/05	7.36	27.858											68.0				
	2/11/05	7.23	27.366							23.4	640.354	2.8	76.624			1388	6.7	20.1
	2/15/05	11.48	43.452					8.0	347.614								6.6	19.3
	2/16/05	9.38	35.503					4.8	170.416								6.5	18.1
	2/18/05	9.13	34.557													1199		
	2/23/05	8.06	30.507	0.078	2.388													
	3/22/05	15.08	57.078			29.6	1689.50288							14.0				
	3/29/05	8.72	33.005	0.085	2.799													
	5/5/05	8.23	31.151			32.6	1015.50793											
	5/19/05	8.24	31.188											17.0				
	5/25/05	7.83	29.637	0.103	3.038													
	6/21/05	7.15	27.063	0.100	2.699													
	6/27/05	6.28	23.770											9.0				
	6/28/05	6.56	24.830			35.7	886.41672											
Watsonville																		
Mean		8.12	30.75	0.11	3.38	37.82	1205.61	7.48	232.06	15.02	466.62	7.12	213.16	19.51	390.11	508.44	6.80	21.31
Total Load, kg/year		2965.36	11223.904		1233.730		440048.869		84702.897	16.2	170317.472		77804.418		142389.177			

Watsonville	Total PAHs		LPAHs		HPAHs		Chlordanes		DDTs		HCHs		Endosulfans		PCBs		Dacthal		DDE		DDD		DDT		Diedrin	
POPs	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day
2004 Dry Season	47.708	1.436	34.821	1.048	12.887	0.388	0.629	0.019	0.563	0.017	1.315	0.040	0.140	0.004	0.414	0.012	0.915	0.028	0.435	0.013	0.1277	0.004	0	0.000	0.205	0.006
2005 Wet Season	54.618	1.575	34.816	1.004	19.802	0.571	0.621	0.018	0.936	0.027	1.298	0.037	0.323	0.009	0.581	0.017	1.37	0.040	0.441	0.013	0.442	0.013	0.053	0.002	0.394	0.011
Mean	51.163	1.505	34.819	1.026	16.345	0.479	0.625	0.018	0.749	0.022	1.307	0.039	0.231	0.007	0.497	0.015	1.143	0.034	0.438	0.013	0.285	0.008	0.027	0.001	0.300	0.009
Total Load, g/year		549.489		374.488		175.001		6.723		8.017		14.056		2.467		5.327		12.236		4.710		3.028		0.279		3.200

				Urea-N		Silicate		TSS		Ammonia-N		Nitrate-N		Orthophosphate-P		Cond.	pH	Temp.
Agency	Date	Flow, MGD	Flow, MLD	Conc, mg/l	Load, kg/day	Conc, mg/l	Load, kg/day	Conc, mg/l	Load, kg/day	Conc, mg/l	Load, kg/day	Conc, mg/l	Load, kg/day	Conc, mg/l	Load, kg/day	mS/cm		
Monterey Regional																		
	6/15/04	0.3	1.136	0.320	0.363	44	49.96					0.76	0.863					
	6/23/04	0	0.000					12	0.000	34.2	0.000	0.22	0.000			1706	7.4	24.4
	6/28/04	0	0.000					10	0.000	31.4	0.000	0.22	0.000	1.78	0.000	1568	7.3	24.4
	7/8/04	0	0.000					12	0.000	33.6	0.000	0.22	0.000					
	7/12/04	0	0.000					11	0.000	31.4	0.000					1558	7.3	24.4
	7/14/04	0	0.000	0.310	0.000	44	0.00											
	7/18/04	0.4	1.514							28.6	43.300							
	7/19/04	0.1	0.379					10	3.785			0.22	0.083			1517	7.3	25.6
	7/21/04	0	0.000							31.9	0.000							
	8/19/04	0	0.000	0.190	0.000	47	0.00											
	8/24/04	0	0.000									0.22	0.000	0.50	0.000			
	9/3/05	0	0.000			46	0.00											
	9/14/05	2.9	10.977									0.22	2.415	1.64	18.001			
	9/29/05	0	0.000	0.190	0.000													
	10/4/04	8	30.280			46	1392.88											
	10/7/04	1.7	6.435											2.67	17.180			
	10/27/04	20.6	77.971	0.350	27.290									2.30	179.333			
	11/4/04	20	75.700			45	3406.50											
	11/8/04	19.5	73.808	0.230	16.976													
	11/12/04	20.1	76.079									0.22	16.737	2.35	178.784			
	12/2/04	18.6	70.401			42	2956.84											
	12/15/04	18.8	71.158	0.320	22.771													
	12/29/04	19.9	75.322									1	75.322	1.35	101.684			
	1/11/05	23.7	89.705									0.22	19.735	1.29	115.719			
	1/14/05	19.9	75.322	0.330	24.856													
	1/19/05	20.1	76.079					15	1141.178	31.4	2388.865					1709	7.3	21.1
	1/20/05	20	75.700			44	3330.80											
	1/24/05	20	75.700					13	984.100	26.9	2036.330					1441	7.2	20.6
	1/27/05	19.7	74.565									0.22	16.404	0.50	37.282			
	2/2/05	19.46	73.656					16	1178.498	30.2	2224.414					1598	7.5	19.4
	2/4/05	19.2	72.672									0.57	41.423	0.50	36.336			
	2/8/05	19.28	72.975							33	2408.168							
	2/9/05	19.22	72.748													1575	7.2	21.1
	2/10/05	19.39	73.391									0.22	16.146	0.50	36.696			
	2/14/05	19.8	74.943					12	899.316	29.7	2225.807					1446	7.4	21.1
	2/16/05	22.61	85.579									2.97	254.169	0.50	42.789			
	2/22/05	21.59	81.718	0.280	22.881	40	3268.73	12	980.618	28.6	2337.139					1342	7.1	21.1
	3/9/05	20.8	78.728			41	3227.85											
	3/16/05	20	75.700									2.15	162.755	0.50	37.850			
	3/28/05	23.2	87.812	0.280	24.587													
	4/12/05	20.7	78.350									1.65	129.277	2.40	188.039			
	4/21/05	0.5	1.893	0.250	0.473													
	5/11/05	0.1	0.379			43	16.28											
	5/12/05	0.1	0.379									0.8	0.303	2.00	0.757			
	5/25/05	0	0.000	0.260	0.000													
	6/2/05	0.3	1.136									4.32	4.905	6.00	6.813			
	6/8/05	0.2	0.757			44	33.31											
	6/20/05	0.41	1.552	0.230	0.357													
Monterey Regional																		
Mean		10.858	41.096	0.272	10.812	44	1473.595	12	518.749	30.9	1138.669	0.91	41.141	1.67	62.329	1546	7.3	22.3
Total Load, kg/year		3962.988	14999.908		3946.326		537862.221		189343.527	31.65	415614.067		15016.448		22750.090			

Monterey	Total PAHs		LPAHs		HPAHs		Chlordanes		DDTs		HCHs		Endosulfans		PCBs		Dacthal		DDE		DDD		DDT		Diedrin	
POPs	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day
2004 Dry Season	23.884	0.016	9.799	0.007	14.085	0.010	0.733	0.000	0.656	0.000	1.151	0.001	0.224	0.000	0.428	0.000	2.14	0.001	0.343	0.000	0.247	0.000	0.0663	0.000	0.233	0.000
2005 Wet Season	30.359	2.274	10.784	0.808	19.575	1.467	0.908	0.068	0.715	0.054	1.036	0.078	0.205	0.015	0.448	0.034	1.22	0.091	0.287	0.022	0.358	0.027	0.07	0.005	0.307	0.023
Mean	27.122	1.145	10.292	0.407	16.830	0.738	0.820	0.034	0.686	0.027	1.094	0.039	0.214	0.008	0.438	0.017	1.680	0.046	0.315	0.011	0.303	0.013	0.068	0.003	0.270	0.012
Total Load, g/year		418.026		148.652		269.375		12.505		9.857		14.307		2.830		6.181		16.944		3.966		4.925		0.965		4.226

Agency	Date	Flow, MGD	Flow, MLD	Urea-N Conc, mg/l	Urea-N Load, kg/day	Silicate Conc, mg/l	Silicate Load, kg/day
Carmel Area							
	6/25/04	**0.602**	2.279				
	7/2/04	**0.324**	1.226				
	7/9/04	**0.333**	1.260				
	7/12/04	**0.171**	0.647	0.035		29.5	
	7/16/04	**0.292**	1.105				
	7/23/04	**0.318**	1.204				
	7/25/04	**1.903**	7.203				
	8/2/04	0.233	0.882	0.046	0.041	29.7	26.193
	8/26/04	0.245	0.927				
	9/3/04	0.302	1.143	0.084	0.096	29.8	34.063
	10/5/04	1.651	6.249	0.057	0.356	28.3	176.848
	10/18/04	2.059	7.793				
	11/1/04	1.508	5.708				
	11/8/04	1.594	6.033	0.053	0.320	29.9	180.395
	12/6/04	1.500	5.678	0.048	0.273	33	187.358
	12/13/04	1.512	5.723				
	1/7/05	2.621	9.920	0.042	0.417	34.8	345.233
	1/11/05	3.883	14.697				
	1/28/05	**2.111**	7.990				
	2/3/05	**1.784**	6.752				
	2/9/05	**1.899**	7.188	0.350	2.516	29.3	210.600
	2/10/05	**1.943**	7.354				
	2/16/05	**3.230**	12.226				
	2/25/05	**2.637**	9.981				
	3/8/05	2.473	9.360	0.050	0.468	28.8	269.577
	3/24/05	3.385	12.812				
	3/28/05	1.461	5.530			23.9	132.164
	4/4/05	2.481	9.391				
	4/7/05	2.105	7.967				
	4/14/05	1.998	7.562	0.037	0.280	28.1	212.504
	4/21/05	0.323	1.223				
	4/25/05	1.944	7.358			25.4	186.894
	4/28/05	1.839	6.961				
	5/4/05	0.374	1.416				
	5/11/05	0.389	1.472	0.039	0.057	28.2	41.521
	6/9/05	0.626	2.369				
	6/30/05	0.401	1.518	0.050	0.076	24.8	37.641
Carmel Area							
Mean		1.5	5.6	0.07	0.4	28.8	157.0
Total Load, kg/year		537.181	2033.231		162.543		57304.743

Date	TSS Conc, mg/l	TSS Load, kg/day	Ammonia-N Conc, mg/l	Ammonia-N Load, kg/day	Nitrate-N Conc, mg/l	Nitrate-N Load, kg/day
6/25/04	**14.8**	33.723	**36.4**	82.940	**0.7**	1.595
7/2/04	**25**	30.659	**26.9**	32.989	**2.4**	2.943
7/9/04	**16**	20.166	**20.7**	26.090	**26.9**	33.905
7/16/04	**7.2**	7.958	**37.8**	41.777	**1.2**	1.326
7/23/04	**4.2**	5.055	**36.7**	44.173	**0.7**	0.843
1/28/05	**2.8**	22.372	**1.2**	9.588	**14.3**	114.259
2/3/05	**4**	27.010	**0.1**	0.675	**14.8**	99.936
2/10/05	**2**	14.709	**2.3**	16.915	**12.3**	90.457
2/16/05	**4**	48.902	**0.3**	3.668	**5.6**	68.463
2/25/05	**3**	29.943	**1.7**	16.968	**6.2**	61.882
Mean	8.3	24.0	16.4	27.6	8.5	47.6
Total Load, kg/year		8778.127	1.5	10066.081 27588.384		17359.760

Date	Orthophosphate-P Conc, mg/l	Orthophosphate-P Load, kg/day	Cond. mS/cm	pH	Temp.
6/25/04	**2.30**	2.821	1.45	**7.2**	21.7
7/2/04			2.1	**7.3**	21.7
7/9/04			1.45	**7.2**	21.8
7/16/04			1.63	**7.3**	22.6
7/23/04			1.59	**7.2**	22.5
7/25/04	3.80	27.371			
8/26/04	3.75	3.477			
9/3/04	3.80	4.344			
10/18/04	3.86	30.082			
11/1/04	4.36	24.886			
12/13/04	3.24	18.542			
1/11/05	1.68	24.691			
1/28/05			1.18	**6.7**	17.8
2/3/05	3.30	22.283	0.99	**6.7**	18.4
2/10/05			1.07	**6.9**	18.4
2/16/05			1.03	**6.7**	18.2
2/25/05	2.71	27.049	1.10	**6.7**	17.6
3/24/05	2.62	33.568			
4/4/05	3.04	28.547			
4/7/05	5.80	46.211			
4/21/05	3.90	4.768			
4/28/05	3.60	25.058			
5/4/05	4.03	5.705			
6/9/05	4.30	10.188			
Mean	3.5	20.0	1.4	7.0	20.1
Total Load, kg/year		7291.235			

Carmel	Total PAHs		LPAHs		HPAHs		Chlordanes		DDTs		HCHs		Endosulfans		PCBs		Dacthal		DDE		DDD		DDT		Diedrin	
POPs	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day	Conc, ng/L	Load, g/day
2004 Dry Season	83.692	0.165	36.554	0.072	47.138	0.093	1.160	0.0023	0.461	0.0009	76.606	0.151	0.228	0.0005	0.578	0.0011	0.23	0.0005	0.257	0.0005	0.2039	0.0004	0	0.0000	0.385	0.0008
2005 Wet Season	52.690	0.452	29.056	0.249	23.634	0.203	0.904	0.0078	0.285	0.0024	0.504	0.0043	0.303	0.0026	0.234	0.0020	0.134	0.0011	0.126	0.0011	0.073	0.0006	0.086	0.0007	0.885	0.0076
Mean	68.191	0.309	32.805	0.161	35.386	0.148	1.032	0.005	0.373	0.0017	38.555	0.078	0.266	0.002	0.406	0.0016	0.182	0.0008	0.192	0.0008	0.138	0.0005	0.043	0.0004	0.635	0.0042
Total Load, g/year		112.700		58.688		54.012		1.834		0.613		28.412		0.557		0.5754		0.2928		0.2900		0.1879		0.1347		1.5249

Appendix C. Results of receiving water bacteria sampling by Santa Cruz, Watsonville and Monterey Regional Water Pollution Control Agency conducted from July 2004 through June 2005.

Table C-1. Bacteria sampling data for Santa Cruz. Sites with bold face type are closest to point of dischrge.

Santa Cruz	**Date**												
Station	7/27/04	8/25/04	9/22/04	10/29/04	11/2/04	12/14/04	1/21/05	2/9/05	3/15/05	4/20/05	5/24/05	6/21/05	Median
Total Coliform													
RW(A)-30	< 2	< 2	2	215	17	2	2	< 2	< 2	2	4	< 2	2
RW(C)-30	< 2	2	< 2	17	< 2	< 2	4	< 2	< 2	< 2	< 2	< 2	< 2
RW(E)-30	< 2	< 2	< 2	17	2	2	9	2	< 2	< 2	< 2	2	< 2
RW(F)-30	< 2	< 2	2	11	2	13	5	< 2	4	2	< 2	< 2	2
RW(G)-30	**2**	**2**	**2**	**17**	**< 2**	**< 2**	**4**	**2**	**2**	**< 2**	**< 2**	**< 2**	**2**
RW(H)-30	2	< 2	4	6	< 2	< 2	< 2	< 2	4	2	< 2	< 2	< 2
RW(I)-30	< 2	2	< 2	4	11	2	4	< 2	4	2	2	< 2	2
Fecal Coliform													
RW(A)-30	< 2	< 2	2	36	7	< 2	< 2	< 2	< 2	< 2	4	< 2	< 2
RW(C)-30	< 2	2	< 2	2	< 2	< 2	2	< 2	< 2	< 2	< 2	< 2	< 2
RW(E)-30	< 2	< 2	< 2	< 2	2	2	4	2	< 2	< 2	< 2	2	< 2
RW(F)-30	< 2	< 2	2	4	2	8	2	< 2	< 2	2	< 2	< 2	< 2
RW(G)-30	**2**	**2**	**2**	**2**	**< 2**	**< 2**	**4**	**< 2**	**2**	**< 2**	**< 2**	**< 2**	**< 2**
RW(H)-30	2	< 2	< 2	2	< 2	< 2	< 2	< 2	4	2	< 2	< 2	< 2
RW(I)-30	< 2	2	< 2	2	11	2	2	< 2	2	2	2	< 2	2
Enterococcus													
RW(A)-30	< 2	< 2	< 2	2	4	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
RW(C)-30	< 2	8	< 2	2	< 2	< 2	4	< 2	< 2	< 2	< 2	< 2	< 2
RW(E)-30	< 2	< 2	< 2	2	2	2	4	< 2	< 2	< 2	< 2	2	< 2
RW(F)-30	< 2	< 2	< 2	4	< 2	2	2	< 2	< 2	< 2	< 2	< 2	< 2
RW(G)-30	**< 2**	**< 2**	**< 2**	**2**	**< 2**	**< 2**	**4**	**< 2**	**< 2**	**< 2**	**< 2**	**< 2**	**< 2**
RW(H)-30	2	< 2	< 2	< 2	< 2	2	2	< 2	5	< 2	< 2	< 2	< 2
RW(I)-30	< 2	2	< 2	4	< 2	< 2	7	2	2	< 2	< 2	< 2	< 2

Table C-2. Bacteria sampling data for Watsonville. Sites with bold face type are closest to point of discharge.

Watsonville	**Date**												
Site	7/13/08	8/10/08	9/14/08	10/26/08	11/9/08	12/7/08	01/25/09	02/08/09	3/8/09	4/12/09	05/10/09	06/14/09	Median
Total Coliform													
A	<2	<2	2	2	4	2	70	7	220	<2	2	<2	2
B	2	2	<2	2	2	7	7	11	300	<2	240	<2	2
C	<2	<2	4	8	<2	2	50	8	300	<2	45	2	3
D	**2**	**<2**	**<2**	**11**	**4**	**2**	**50**	**4**	**240**	**<2**	**240**	**<2**	**3**
E	11	22	<2	2	2	8	80	4	140	2	140	7	7.5
F	11	4	<2	4	22	8	110	6	900	7	27	27	9.5
G	50	2	4	8	11	14	20	9	900	4	<2	130	10
ZID	**<1**	**<2**	**<2**	**2**	**2**	**4**	**14**	**2**	**240**	**2**	**<2**	**<2**	**2**
Fecal Coliform													
A	<2	<2	<2	2	4	4	7	2	23	<2	<2	<2	<2
B	2	2	<2	2	2	2	4	7	50	<2	13	<2	2
C	<2	<2	<2	8	<2	2	7	8	240	<2	8	2	2
D	**2**	**<2**	**<2**	**8**	**4**	**<2**	**4**	**4**	**80**	**<2**	**22**	**<2**	**3**
E	11	22	<2	2	2	4	8	<2	50	2	50	4	4
F	11	2	<2	4	17	8	17	<2	90	2	22	17	9.5
G	50	2	4	4	11	14	12	4	300	2	<2	11	7.5
ZID	**<2**	**<2**	**<2**	**2**	**2**	**<2**	**2**	**<2**	**30**	**<2**	**<2**	**<2**	**<2**
Enterococcus													
A	<2	<2	<2	2	2	2	4	4	8	<2	<2	<2	<2
B	<2	<2	<2	2	2	2	8	17	7	<2	4	<2	2
C	<2	<2	<2	2	<2	2	4	15	11	<2	4	<2	<2
D	**<2**	**<2**	**<2**	**2**	**<2**	**<2**	**2**	**11**	**22**	**<2**	**<2**	**<2**	**<2**
E	<2	2	<2	8	<2	4	8	<2	13	<2	7	<2	<2
F	11	<2	<2	7	<2	<2	11	<2	8	<2	8	<2	<2
G	4	<2	<2	2	<2	4	8	4	13	<2	<2	2	2
ZID	**<2**	**<2**	**<2**	**2**	**<2**	**<2**	**4**	**2**	**9**	**<2**	**2**	**<2**	**<2**

Table C-2. Bacteria sampling data for Monterey Regional. Sites with bold face type are closest to the point of discharge.

Monterey Regional	**Date**																	
Station	7/13/08	8/10/08	9/14/08	9/22/08	9/28/08	10/19/08	11/2/08	12/14/08	1/19/09	1/28/09	2/3/09	2/5/09	2/17/09	3/15/09	4/6/09	5/10/09	6/7/09	Median
Total Coliform																		
A	<2	2	8	<2	30	8	2	2	130	4	4	4	11	<2	80	<2	4	4
B	**<2**	**<2**	**14**	**<2**	**30**	**17**	**2**	**<2**	**22**	**2**	**2**	**7**	**<2**	**<2**	**50**	**2**	**2**	**2**
C	<2	<2	7	2	4	7	<2	2	22	2	2	7	11	<2	8	<2	2	2
D	2	2	<2	<2	2	22	2	<2	17	4	8	7		<2	9	<2	2	2
Fecal Coliform																		
A	<2	<2	8	<2	30	<2	2	<2	12	4	2	4	7	<2	2	<2	2	2
B	**<2**	**<2**	**8**	**<2**	**13**	**2**	**4**	**<2**	**14**	**2**	**<2**	**4**	**<2**	**<2**	**13**	**2**	**2**	**2**
C	<2	<2	7	2	4	4	<2	2	12	2	<2	11	4	<2	2	<2	2	2
D	2	2	<2	<2	2	2	2	<2	8	2	8	4		<2	2	<2	2	2
Enterococcus																		
A	<2	<2	7	<2	14	<2	8	8	30	8	8	8	7	<2	<2	<2	7	7
B	**<2**	**<2**	**50**	**2**	**8**	**2**	**2**	**<2**	**80**	**2**	**4**	**8**	**<2**	**<2**	**2**	**<2**	**2**	**2**
C	<2	<2	4	<2	7	4	9	2	30	4	14	4	7	<2	2	<2	4	4
D	<2	<2	4	2	2	11	4	<2	22	26	17	14		<2	2	<2	2	2

Table C-2. Bacteria sampling data for Carmel Area Wastewater District. Sites with bold face type are closest to the effluent.

Carmel

	Total Coliform		*Fecal Coliform*	
DATE	**K-4**	**K-5**	**K-4**	**K-5**
7/2/04	11	**49**	11	**22**
7/14/04	17	**4**	17	**4**
7/21/04	49	**49**	49	**49**
7/28/04	2	**49**	2	**49**
8/2/04		**140**		**140**
8/3/04		**5**		**2**
8/4/04	2	**8**	2	**2**
8/5/04		**2**		**2**
8/6/04		**2**		**2**
8/7/04		**2**		**2**
8/9/04		**2**		**2**
8/10/04		**5**		**5**
8/11/04	2	**8**	2	**2**
8/12/04		**4**		**4**
8/13/04		**2**		**2**
8/16/04		**79**		**79**
8/17/04		**5**		**5**
8/18/04	7	**5**	7	**2**
8/19/04		**23**		**23**
8/20/04		**46**		**46**
8/23/04		**2**		**2**
8/24/04		**30**		**30**
8/25/04	2	**2**	2	**2**
8/26/04		**13**		**8**
8/27/04		**2**		**2**
8/30/04		**5**		**5**
8/31/04		**33**		**33**
9/1/04	2	**17**	2	**17**
9/2/04		**49**		**49**
9/3/04		**2**		**2**
9/4/04		**5**		**5**
9/6/04		**2**		**2**
9/7/04		**5**		**5**
9/8/04	2	**4**	2	**2**
9/9/04		**11**		**11**
9/10/04		**2**		**2**
9/13/04		**2**		**2**
9/14/04		**2**		**2**
9/15/04	5	**2**	5	**2**
9/16/04		**2**		**2**
9/17/04		**23**		**23**
9/20/04		**2**		**2**
9/21/04		**33**		**2**
9/22/04	2	**2**	2	**2**
9/23/04		**40**		**26**
9/24/04		**2**		**2**
9/27/04		**5**		**5**
9/28/04		**33**		**11**
9/29/04	2	**5**	2	**5**
9/30/04		**8**		**8**
10/1/04		**5**		**5**
10/2/04		**70**		**70**
10/4/04		**13**		**13**
10/5/04		**2**		**2**
10/6/04	2	**7**	2	**7**
10/7/04		**2**		**2**
10/8/04		**2**		**2**
10/11/04		**5**		**2**
10/12/04		**2**		**2**
10/13/04	2	**5**	2	**5**
10/14/04		**2**		**2**
10/15/04		**2**		**2**
10/18/04		**11**		**2**
10/19/04		**33**		**23**
10/20/04	240	**2400**	7	**1600**
10/21/04		**22**		**2**
10/22/04		**2**		**2**
10/25/04		**2**		**2**
10/26/04		**2**		**2**
10/27/04	220	**11**	14	**7**
10/28/04		**7**		**4**
10/29/04		**2**		**2**
11/1/04		**2**		**2**
11/2/04		**2**		**2**
11/3/04	2	**2**	2	**2**
11/4/04		**2**		**2**
11/5/04		**2**		**2**
11/6/04		**2**		**2**
11/8/04		**5**		**2**
11/9/04		**2**		**2**
11/10/04	8	**2**	5	**2**
11/11/04		**4**		**2**
11/12/04		**5**		**5**

Appendix D. CCLEAN mussel data for August 2004 (dry season) and February 2005 (wet season).

Bacterial concentrations noted with an asterisk (*) were below the method detection limit, and are reported as helf of the detection limit value.

Sum of analyte concentrations, ug/Kg, dry weight

Augist 4-6, 2004	Total PAHs	Low-weight PAHs	High-weight PAHs	DDT's	Chlordanes	PCB's	Endosulfans	HCH's	Dacthal
Scott Creek	26.7193	22.6	4.1	4.0	1.6	0.0	0.179	0	0.045
Laguna Creek Rep 1	21.4485	18.0	3.5	21.4	2.4	1.1	0.127	0	0.035
Laguna Creek Rep 2	21.0857	17.1488	3.9369	24.334	3.922	1.364	0.154	0	0.0557
The Hook	43.3306	31.4551	11.8755	25.008	8.045	3.078	0.212	0	0.0951
Fanshell Overlook	19.7245	18.3828	1.3417	11.71	4.356	3.197	0.154	2.48	0.0255
Carmel River Beach	20.1101	18.4623	1.6478	9.876	8.135	41.597	0.09	0	0.0518
RPD for replicates	0.85	2.33	6.12	6.50	24.13	10.18	9.61	--	23.09
February 22, 2005									
Scott Creek	62.4334	27.0162	35.4172	26.415	4.793	0.351	1.587	0	1.24
Laguna Creek Rep 1	38.8909	29.2997	9.5912	104.13	12.577	1.849	1.387	1.58	1.61
Laguna Creek Rep 2	39.1906	29.7643	9.4263	118.01	14.813	2.181	2.058	0	2
The Hook	80.0483	63.7006	16.3477	74	24.4	9.674	1.84	0	4.46
Fanshell Overlook	18.9609	16.9741	1.9868	17.924	4.67	2.109	0.297	0	0.217
Carmel River Beach	20.7931	17.4329	3.3602	18.98	6.49	2.217	0.217	0	0.186
RPD for replicates	0.38	0.79	0.87	6.25	8.16	8.24	19.48	100	10.80

Bacterial Concentrations, MPN/100mL wet weight

Bacteria	Total Coliform	Fecal Coliform	Enterococcus
August 2004			
Scott Creek	45	9	56
Laguna Creek	48	9	5
The Hook	45	5	450
Fanshell Overlook	45	20	78
Carmel River Beach	9	9	45
February 2005			
Scott Creek	14000	290	200
Laguna Creek	8700	1255	555
The Hook	1700	200	200
Fanshell Overlook	1400	240	350
Carmel River Beach	15000	1200	2000

Appendix E. CCLEAN 2004 data for sediment benthos and chemistry.

Benthos

Species	Phylum	Group	SedRef01	SedRef02	SedRef03	SedRef04	SedDep01	SedDep02	SedDep03	SedDep04
Mediomastus spp. indet.	Annelida	Polychaeta	303	232	200	224	184	25	257	300
Axinopsida serricata	Mollusca	Bivalvia	16	55	75	64	20	24	15	50
Cossura pygodactylata	Annelida	Polychaeta	27	67	53	59	31	1	67	139
Amphiodia sp.	Echinodermata	Ophiuroidea	45	40	89	88	71	77	72	96
Nephtys cornuta	Annelida	Polychaeta	72	64	90	85	70	9	77	51
Levinsenia gracilis	Annelida	Polychaeta	12	68	66	78	36	34	50	70
Pholoe glabra	Annelida	Polychaeta	14	7	20	17	25	14	17	19
Maldaninae	Annelida	Polychaeta	45	53	34	54	26	33	64	22
Rochefortia tumida	Mollusca	Bivalvia	6	11	14	23	25	2	8	27
Nemertea	Nemertea	Nemertea	38	69	32	39	23	9	27	32
Scoletoma tetraura complex	Annelida	Polychaeta	17	18	15	23	28	38	14	28
Protomedeia articulata	Arthropoda	Gammaridea	0	0	0	1	1	6	5	10
Edwardsiid	Cnidaria	Anthozoa	35	84	62	49	46	1	13	41
Aricidea (Allia) ramosa	Annelida	Polychaeta	28	48	32	41	0	0	14	19
Prionospio lighti	Annelida	Polychaeta	30	93	68	54	59	0	46	41
Spiophanes berkeleyorum	Annelida	Polychaeta	9	15	14	20	18	9	10	16
Mediomastus ambiseta	Annelida	Polychaeta	0	0	0	1	0	0	0	0
Euclymeninae sp. 2	Annelida	Polychaeta	2	20	16	11	16	6	13	14
Scaphopoda	Mollusca	Scaphopoda	8	8	16	5	2	8	1	35
Euphilomedes carcharodonta	Arthropoda	Ostracoda	13	0	4	11	6	0	0	1
Prionospio steenstrupi	Annelida	Polychaeta	13	5	3	7	5	3	2	5
Cylichna alba	Mollusca	Gastropoda	7	3	7	6	0	0	0	4
Pinnixa spp.	Arthropoda	Decapoda	18	62	46	30	6	6	3	1
Mediomastus californiensis	Annelida	Polychaeta	15	17	35	33	10	2	8	37
Decamastus gracilis	Annelida	Polychaeta	61	12	8	8	0	2	1	1
Macoma sp.	Mollusca	Bivalvia	8	14	6	10	8	8	12	36
Prionospio jubata	Annelida	Polychaeta	34	9	15	16	3	0	6	7
Ennucula tenuis	Mollusca	Bivalvia	5	3	0	2	3	11	3	6

	SedRef01	SedRef02	SedRef03	SedRef04	SedDep01	SedDep02	SedDep03	SedDep04
Total Abundance	1362	1519	1384	1421	995	520	1175	1459
Total Taxa	137	139	122	128	130	98	120	121
Annelida Abundance	1023	1028	902	987	669	297	792	954
Annelida Taxa	78	83	69	77	71	50	63	64
Anthropoda Abundance	147	156	125	117	75	54	195	69
Anthropoda Taxa	32	27	26	27	33	23	33	24
Mollusca Abundance	67	138	167	140	92	79	69	261
Mollusca Taxa	17	23	20	20	17	19	19	26
Echinoderm Abundance	48	43	91	88	79	78	78	97
Echinoderm Taxa	4	3	2	1	2	2	2	2
Misc. Abundance	77	154	99	89	80	12	41	78
Misc. Taxa	6	3	5	3	7	4	3	5

Sediment Quality and Chemistry

Analyte	SedRef 01	SedRef 02	SedRef 03	SedRef 04	SedDep 01	SedDep 02	SedDep 03	SedDep 04
Clay (<4mm), %	6.73	11.80	11.38	13.03	16.49	16.30	20.56	15.54
Silt (4-63 mm), %	30.53	75.40	80.72	81.79	77.87	82.13	71.73	81.88
Fines (Silt + Clay), %	37.27	87.20	92.11	94.82	94.36	98.43	92.29	97.42
Sand (63 mm-2mm), %	62.73	12.80	7.89	5.18	5.55	1.57	7.72	2.59
Gravel/Shell (>2mm), %	0.004	0.004	0.000	0.000	0.09	0.000	0.000	0.000
TOC, %	0.56	0.84	0.77	0.75	0.90	0.84	0.86	0.81
Low molecular weight PAHs, µg/Kg dry wt	19.92	40.38	40.86	45.70	68.96	54.25	49.25	81.37
High molecular weight PAHs, µg/Kg dry wt	29.81	55.99	54.65	51.84	72.52	59.60	36.76	80.05
Sum PAHs, µg/Kg dry wt	49.74	96.37	95.51	97.54	141.48	113.85	86.01	161.42
PCBs, µg/Kg dry wt	0.357	0.594	0.561	0.373	0.491	0.246	0.168	0.306
DDT, µg/Kg dry wt	0.075	0.152	0.173	0.191	0.339	0.500	0.220	0.194
DDD, µg/Kg dry wt	0.934	1.443	1.413	1.487	1.549	1.099	0.560	0.452
DDE, µg/Kg dry wt	2.96	4.56	3.54	3.66	3.98	3.40	2.01	2.13
Sum of DDTs, µg/Kg dry wt	3.97	6.16	5.12	5.34	5.87	5.00	2.79	2.77
Chlordanes, µg/Kg dry wt	0	0.073	0.252	0.089	0.122	0.050	0.057	0.018
HCHs, µg/Kg dry wt	0	0	0.668	0	0	0	0	0
Dacthal, µg/Kg dry wt	0	0	0	0	0	0	0	0
Dieldrin, µg/Kg dry wt	0	0	0	0.063	0.042	0.051	0.060	0.041

Appendix F. Data for CCLEAN river and stream samples from July 2004 through June 2005.
Sites are arranged from North to South. A value of "0" for nutrients and TSS indicates non-detectable concentration and is analyzed as "0". A value of 5 MPN/100mL for all bacteria indicates a concentration below the lower detection limit and is anlyzed as 5 MPN/100mL, which is one half the detection limit.

Location	Date	Flow, if available	NO_3-N ppm	NH_3-N ppm	SiO_2 (mg/L)	Urea-N ug/L (ppb)	Ortho-PO_4 mg/L	TSS ppm	Total Coliform (MPN/100 mL)	E. Coli (MPN/100 mL)	Enterococcus (MPN/100mL)
WaddellCreek @ HWY 1	7/26/04	NA	0	0	21.8	0	0.015	50.6	4884	31	5
	8/30/04	NA	1.032	0.03	18.9	0	0.12	14.4	25000	135	20
	9/29/04	NA	0.045	0.02	22.2	0	0.18	2.1	5794	173	5
	10/25/04	NA	0	0	22.5	0	0.04	0	459	72	10
	11/22/04	NA	0.367	0.02	21.8	0	0.06	21.8	199	10	5
	12/6/04	NA	0.574	0.02	19.9	0	0.03	0.4	586	52	5
	1/19/05	NA	0.084	0	24.7	0	0.09	4.6	488	41	10
	2/22/05	NA	0.001	0	22.3	0	0.05	13.5	327	31	5
	3/21/05	NA	0.072	0	26.4	0	0.04	26.4	650	31	5
	4/18/05	NA	0.073	0.02	28.2	0	0.09	1.2	1782	379	52
	5/16/05	NA	0.048	0	26	0	0.16	0.8	959	41	5
	6/20/05	NA	0	0	26.1	0	0.07	0	547	63	10
Scott Creek@ HWY 1	7/26/04	1.5	0.041	0	28	0	0.015	2.7	3654	512	5
	8/30/04	0.8	0.168	0.03	28.3	0	0.24	0	25000	1274	5
	9/29/04	0.6	0	0.03	26.7	0	0.31	2.9	496	63	20
	10/25/04	17.0	0.077	0.02	26.8	0	0.04	0	3654	187	30
	11/22/04	13.8	0.169	0.03	26.5	0	0.05	0.4	991	86	5
	12/6/04	110.1	0.07	0	25.1	0	0.015	0	426	74	5
	1/19/05	122.1	0.229	0.135	27.3	0	0.16	8	175	5	5
	2/22/05	106.5	0.074	0	27.5	0	0.04	10.5	336	30	5
	3/21/05	256.1	0.102	0	28	0	0.03	18.8	3255	20	30
	4/18/05	52.5	0.097	0	28.1	0	0.04	3.1	275	5	5
	5/16/05	39.8	0.071	0	27.2	0	0.16	2.5	624	146	10
	6/20/05	18.4	0.017	0	27.1	0	0.07	0.4	697	146	10

Location	Date	Flow, if available	NO_3-N ppm	NH_3-N ppm	SiO_2 (mg/L)	Urea-N ug/L (ppb)	Ortho-PO_4 mg/L	TSS ppm	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Laguna Creek @Mouth	7/26/04	NA	0.191	0	20.1	0	0.015	3.2	25000	5	5
	8/30/04	NA	0.13	0.02	29	0	0.31	29	2909	74	20
	9/29/04	NA	0	0	27.8	0	0.36	0	5794	1153	278
	10/25/04	NA	0.124	0.03	28.2	0	0.05	0.4	4160	121	51
	11/22/04	NA	0.501	0.03	27	0	0.07	0	1162	10	5
	12/6/04	NA	0.325	0.02	26.5	0	0.015	6.3	2613	565	5
	1/19/05	NA	0.29	0	16.7	0	0.45	0.4	428	74	5
	2/22/05	NA	0.172	0	29.8	0	0.45	20	644	52	5
	3/21/05	NA	0.137	0	29.1	0	0.03	4.3	480	85	5
	4/18/05	NA	0.126	0	29.3	0	0.05	0	197	5	5
	5/16/05	NA	0.12	0	29	0	0.06	1.2	1178	199	31
	6/20/05	NA	0.122	0	29.9	0	0.05	0	1153	298	5
Moore Creek @ Mouth	7/26/04	NA	0	0	26.4	0	1.99	26.4	25000	5	5
	8/30/04	NA	0.222	0.03	6.8	0	3.22	45.1	25000	97	20
	9/29/04	NA	0	0.05	3	0	1.3	71.4	19863	5	5
	10/25/04	NA	2.443	0.02	11.7	0	0.05	19.2	958	60	30
	11/22/04	NA	5.331	0.02	14.3	0	0.04	6.7	2392	41	31
	12/6/04	NA	2.144	0	15.9	0	0.015	6.5	830	74	5
	1/19/05	NA	0.308	0	30.3	0	0.45	6.2	1274	135	5
	2/22/05	NA	0.246	0.06	30.1	0	0.31	24.6	2382	496	74
	3/21/05	NA	0.548	0.08	28.7	0	0.11	9.4	3130	435	30
	4/18/05	NA	0.49	0	28.7	0	0.47	10.2	530	41	5
	5/16/05	NA	0.892	0.05	21.6	0	0.21	8.2	9804	354	41
	6/20/05	NA	0.82	0	9.6	0	0.03	14.5	19863	85	5

Location	Date	Flow, if available	NO_3-N ppm	NH_3-N ppm	SiO_2 (mg/L)	Urea-N ug/L (ppb)	Ortho-PO_4 mg/L	TSS ppm	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Branciforte Creek @ Isabel	7/26/04	NA	0.128	0	36.9	0	0.49	1.2	4106	820	119
	8/30/04	NA	0.067	0.02	36.7	0	0.8	0	3255	155	20
	9/29/04	NA	0	0.02	32.2	0	0.71	0	4352	697	5
	10/25/04	NA	0.235	0	35.5	0	0.4	2.8	2142	216	41
	11/22/04	NA	0	0	39.5	0	0.3	0	1086	63	5
	12/6/04	NA	0.149	0	38.1	0	0.13	0.4	650	74	5
	1/19/05	NA	0.542	0	49.7	0	0.58	0.8	645	63	10
	2/22/05	NA	0.005	0	50.9	0	0.43	15.4	1850	187	41
	3/21/05	NA	0.324	0.02	52.3	0	0.44	13.2	4611	341	143
	4/18/05	NA	0.389	0	49.5	0	0.38	6.8	2282	262	31
	5/16/05	NA	0.227	0	42.7	0	0.18	1.1	3255	557	97
	6/20/05	NA	0.141	0	38.2	0	0.23	1.2	2481	336	5
San Lorenzo River @ Laurel St.	7/26/04	9.3	0.373	0	27.8	0	0.32	5.5	25000	6488	10
	8/30/04	5.0	0.125	0.03	27.7	0	0.58	0.8	25000	1046	20
	9/29/04	4.6	0.085	0.11	25.5	0	0.08	4.9	25000	960	20
	10/25/04	23.0	0.528	0.05	25.4	0	0.16	14.9	11199	3255	51
	11/22/04	17.0	0.186	0.04	27.4	0	0.16	16.5	2046	185	5
	12/6/04	48.0	0.306	0.03	25.4	0	0.08	2.1	2142	272	20
	1/19/05	223.0	0.408	0	30.9	0	0.45	0.4	1334	161	10
	2/22/05	662.0	0	0	35.1	0	0.22	30.8	6867	262	30
	3/21/05	271.0	0.266	0	33.1	0	0.07	17.1	4352	295	62
	4/18/05	183.0	0.265	0	31.7	0	0.08	1.1	4352	97	98
	5/16/05	108.0	0.73	0	28.5	0	0.11	2.3	4884	231	10
	6/20/05	55.0	1.008	0	27	0	0.06	14	8664	1515	108

Location	Date	Flow, if available	NO_3-N ppm	NH_3-N ppm	SiO_2 (mg/L)	Urea-N ug/L (ppb)	Ortho-PO_4 mg/L	TSS ppm	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Soquel Creek@ RR Bridge	7/26/04	2.9	0.088	0	36.5	0	0.09	0	2909	278	5
	8/30/04	1.9	0.1	0	38	0	0.42	0.4	10462	249	5
	9/29/04	1.2	0	0.02	33.4	0	0.32	0	1050	146	5
	10/25/04	4.7	1.423	0.02	31.7	0	0.16	7.3	19863	959	73
	11/22/04	5.9	0.33	0.02	35.2	0	0.04	0.4	9208	776	5
	12/6/04	5.4	0.429	0	31.8	0	0.05	8.4	1782	422	5
	1/19/05	65.0	0.193	0	27.3	0	0.22	3.2	341	31	5
	2/22/05	171.0	0.15	0	27	0	0.08	52.4	1081	98	30
	3/21/05	112.0	0.134	0	28.9	0	0.07	30.2	1918	275	63
	4/18/05	41.0	0.1	0.23	29.5	0	0.07	17	884	211	20
	5/16/05	25.0	0.044	0	29.1	0	0.07	0	2909	272	31
	6/20/05	16.0	0.135	0	31.3	0	0.04	0.7	17329	1726	31
Porter Gulch @ Mouth	7/26/04	NA	0.877	0	44.8	0	0.17	0.8	17329	278	40
	8/30/04	NA	2.025	0.03	44.6	0	0.67	5.4	12033	160	41
	9/29/04	NA	0.433	0.06	61.6	0	0.82	16.1	24192	8164	1785
	10/25/04	NA	1.415	0	40.2	0	0.17	0	1785	62	20
	11/22/04	NA	1.375	0	41.3	0	0.05	0	2613	907	10
	12/6/04	NA	1.142	0	38.7	0	0.07	0	884	95	63
	1/19/05	NA	0.262	0	34.6	0	0.28	15.2	1354	228	10
	2/22/05	NA	0.195	0	28.6	0	0.17	63.1	4106	110	5
	3/21/05	NA	0.2	0	36.8	0	0.09	5.7	3282	231	5
	4/18/05	NA	0.294	0	36.1	0	0.1	2.5	4352	419	63
	5/16/05	NA	0.484	0	36.9	0	0.21	1.5	4160	314	10
	6/20/05	NA	0.758	0.02	40.1	0	0.11	0.8	3654	240	131

Location	Date	Flow, if available	NO_3-N ppm	NH_3-N ppm	SiO_2 (mg/L)	Urea-N ug/L (ppb)	Ortho-PO_4 mg/L	TSS ppm	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Aptos Creek @ Winfield Dr.	7/26/04	NA	0.144	0	36.7	0	0.4	9.3	25000	7701	5
	8/30/04	NA	0.136	0.04	37.9	0	0.66	0.4	12033	1607	301
	9/29/04	NA	0	0	32.6	0	0.64	4.3	6131	683	31
	10/25/04	NA	0.201	0.02	36.9	0	0.28	3.2	8664	857	41
	11/22/04	NA	0.666	0.51	37	0	0.35	9.6	9208	1935	10
	12/6/04	NA	0.488	0.03	36.1	0	0.29	36.8	1658	395	85
	1/19/05	NA	0.25	0.04	34.8	0	0.42	8.8	431	20	5
	2/22/05	NA	1.075	0	32.7	0	0.23	40	1956	98	10
	3/21/05	NA	0.397	0	35.2	0	0.11	25.5	3448	413	63
	4/18/05	NA	0.102	0.02	36.7	0	0.1	4.2	703	52	5
	5/16/05	NA	0.122	0	37.4	0	0.09	6.8	2481	323	5
	6/20/05	NA	0.131	0	38.4	0	0.17	19.2	2909	379	63
Pajaro River@ Thurwachter Rd.	7/26/04	9.3	0.417	0	6.6	0	0.015	0.4	25000	74	5
	8/30/04	15.0	0.812	0.09	16.5	0	0.04	7.2	25000	426	5
	9/29/04	5.9	6.46	0.1	4	0	0.16	28	7270	86	5
	10/25/04	11.0	6.163	0.53	18	0	0.48	1.6	2613	175	5
	11/22/04	19.0	2.992	0	19.1	0	0.03	3.9	932	31	5
	12/6/04	23.0	4.632	0	19.8	0	0.04	0.4	521	10	5
	1/19/05	347.0	3.176	0	27.3	0	0.45	31.6	1782	20	5
	2/22/05	1630.0	0.062	0.03	18.4	0	0.62	317.3	7701	448	97
	3/21/05	234.0	4.142	0	20	0	0.03	22.7	5172	309	10
	4/18/05	183.0	4.298	0.02	17.7	0	0.04	21.6	2247	41	5
	5/16/05	89.0	0.528	0.03	18.1	0	0.11	7.3	3654	146	5
	6/20/05	35.0	9.927	0	19.7	0	0.06	7.2	4884	51	20

Location	Date	Flow, if available	NO_3-N ppm	NH_3-N ppm	SiO_2 (mg/L)	Urea-N ug/L (ppb)	Ortho-PO_4 mg/L	TSS ppm	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Salinas River @ Davis Road	7/6/04	37.0	0.452	0.09	6.6	0	0.04	0	19863	776	5
	8/2/04	4.3	8.129	0.05	2.12	10	0.07	30	15531	41	10
	9/7/04	0.0	4.968	0.16	6.5	24	0.129	27	6488	98	183
	10/5/04	0.0	27.549	0.04	10.2	51	0.087	15	11199	1201	5
	11/2/04	0.0	6.323	0.18	7.74	67	0.085	11	24192	110	85
	12/7/04	0.0	0.226	0.17	1.4	36	0.241	29	24192	4611	1935
	5/4/05	244.0	3.161	0.02	18	21	0.16	73	4884	52	5
Tembladero Slough @ Preston St.	7/19/04	NA	39.968	0.09	19.8	28	0.5	42	24192	259	30
	8/23/04	NA	35.904	0.19	26.4	39	0.61	60	19863	120	10
	9/27/04	NA	28.678	0.22	19.6	43	0.202	57	24192	359	5
	11/16/04	NA	20.323	0.14	19.3	29	0.411	78	24192	282	5
	1/31/05	NA	25.742	0.15	17.2	29	0.539	48	24192	327	143
	3/21/05	NA	15.581	0.24	0.1	84	0.33	79	24192	1076	428
	4/25/05	NA	34.549	0.65	18.1	45	0.63	49	24192	504	20
	5/24/05	NA	16.033		20.6	36	1.18	64	24192	249	95
	6/27/05	NA	48.549	0	18.9	30	0.558	49	19863	288	5
Carmel River @ HWY 1	1/25/05	183.0	0	0.02	24.7	0	0.005	0	1054	20	20
	2/9/05	145.0	0	0.02	28.2	61	0.005	0	1014	5	5
	3/9/05	363.0	0	0.08	26.8	0	0.005	9	2187	10	5
	4/6/05	307.0	0	0	25.6	0	0.005	0	1233	31	10
	4/18/05	206.0	0	0.03	11.4	0		0	959	10	10
	6/1/05	67.0	0		20	274	0.07	0	620	10	5

Location	Date	Flow, if available	NO_3-N ppm	NH_3-N ppm	SiO_2 (mg/L)	Urea-N ug/L (ppb)	Ortho-PO_4 mg/L	TSS ppm	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Carmel River @ Garland Park	8/3/04	NA	0	0.07	23	0	0.1	30	8664	96	20
	10/5/04	NA	0	0.05	20.6	10	0.06	0	2602	262	74
	11/3/04	NA	0	0	23.3	0	0.059	0	1669	63	74
	12/15/04	NA	0	0.04	23.2	0	0.005	0	1191	41	30
	1/25/05	NA	0	0	23.9	0	0.005	0	1054	31	31
	2/9/05	NA	0	0	26	0	0.005	0	663	10	5
	3/9/05	NA	0	0.03	27.2	0	0.005	2	759	20	5
	4/6/05	NA	0	0	26.4	0	0.005	0	598	20	10
	5/11/05	NA	0	0.02	22.9	0	0.005	0	2359	52	20
	6/1/05	NA	0		22.2	186	0.005	0	1539	52	5
Big Sur @ Andrew Molera	8/3/04	13.0	0	0.03	22.2	11	0.05	0	1956	122	5
	10/6/04	12.0	0	0	20.3	0	0.041	1	1211	20	10
	12/15/04	60.0	0	0.03	23.5	0	0.005	0	1334	173	5
	2/2/05	206.0	0	0.02	25.2	27	0.005	0	272	20	10
	3/9/05	275.0	0	0	23.5	0	0.005	2	5	5	5
	5/3/05	120.0	0	0	20.9	0	0.005	0	601	63	10
	5/11/05	123.0	0	0	22.3	0	0.005	0	2142	74	10
	6/7/05	70.0	0	0	21.3	138	0.029	0	1137	41	5

Appendix G. Data for nearshore background water quality for 2004 wet season and dry season samples.

Wet Season 2004 Background Water Quality - Nutrients, all units mg/L

Date	Site	Replicate	Total Coliform	Fecal Coliform	Enterococcus	TSS	SiO_2	Urea	NO_3	NH_3	Ortho-P
2/20/04	North Monterey Bay	1	<10	<10	<10	28.6	0.38	<0.02	<1	<0.02	<0.03
2/20/04	North Monterey Bay	2	<10	<10	<10	28.4	0.4	<0.02	<1	<0.02	<0.03
2/20/04	South Monterey Bay	1	10	<10	<10	22.6	0.4	<0.02	<1	<0.02	<0.03
2/20/04	South Monterey Bay	2	20	<10	<10	34.4	0.4	<0.02	<1	<0.02	<0.03
3/30/04	North Monterey Bay	1	<10	<10	<10	7.4	0.17	<0.02	<1	<0.02	<0.03
3/30/04	North Monterey Bay	2	<10	<10	<10	6.9	0.18	<0.02	<1	<0.02	<0.03
3/30/04	South Monterey Bay	1	<10	<10	<10	8.7	0.25	<0.02	<1	<0.02	<0.03
3/30/04	South Monterey Bay	2	<10	<10	<10	11.3	0.19	<0.02	<1	0.02	<0.03

Dry Season 2004 Background Water Quality - Nutrients, all units mg/L

Date	Site	Replicate	Total Coliform	Fecal Coliform	Enterococcus	TSS	SiO_2	Urea	NO_3	NH_3	Ortho-P
6/24/04	North Monterey Bay	1	<10	<10	<10	9.2	0.17	<0.01	0.5	0.04	0.03
6/24/04	North Monterey Bay	2	<10	<10	<10	11.6	0.14	<0.01	<0.5	0.04	0.02
6/24/04	South Monterey Bay	1	<10	<10	<10	8.8	0.17	0.017	<0.5	0.04	0.02
6/24/04	South Monterey Bay	2	<10	<10	<10	12.8	0.17	<0.01	<0.5	0.03	0.03
7/26/04	North Monterey Bay	1	10	<10	<10	9.9	0.815	<0.02	<1	<0.02	0.04
7/26/04	North Monterey Bay	2	<10	<10	<10	9.3	0.843	<0.02	<1	<0.02	0.04
7/26/04	South Monterey Bay	1	10	<10	<10	6.9	0.656	<0.02	0.71	<0.02	0.04
7/26/04	South Monterey Bay	2	659	<10	<10	6.7	0.704	<0.02	<1	<0.02	0.04

2004 Background Water Quality - POPs, all units ng/L

Wet Season, March

	Lo-PAHs	Hi-PAHs	HCHs	DDE	DDD	DDT	PCBs	Endosulfans	Chlordanes	Dacthal	Dieldrin
North Monterey Bay	4.963	1.811	0.541	0.0740	0.0408	0.0540	0.0332	0.025	0.0176	0.500	0.0420
South Monterey Bay	5.210	1.467	0.594	0.0414	0.0071	0.0142	0.0364	0.009	0.0149	0.256	0.0230

Dry Season, July

	Lo-PAHs	Hi-PAHs	HCHs	DDE	DDD	DDT	PCBs	Endosulfans	Chlordanes	Dacthal	Dieldrin
North Monterey Bay	9.798	1.748	0.569	0	0	0	0.0204	0	0	0.127	0.0060
South Monterey Bay	5.966	0.319	0.462	0	0	0	0.0312	0	0	0.028	0