CLEAN

Central Coast
Long-term Environmental
Assessment Network
REGIONAL MONITORING PROGRAM

Annual Report 2002 – 2003

January 31, 2004

Lead Agency:

City of Watsonville
P. O. Box 50000 • Watsonville • California • 95077-5000 • 831.728.6124

2002–2003 Annual Report

Central Coast Long-term Environmental Assessment Network

Submitted to:

California Regional Water Quality Control Board
Region 3
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401

Submitted by:

CCLEAN
P.O. Box 8346
Santa Cruz, CA 95061

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TABLE OF CONTENTS

List of Figures

List of Tables

CCLEAN
Central Coast Long-term Environmental Assessment Network
2002–2003 Annual Report

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 season 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.
- 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 season and wet season 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 season and wet season 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.
- Monthly sampling of 14 streams and rivers and two sites in Elkhorn Slough began in January 2002. 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, dissolved silica, total suspended solids and bacteria.
- A database template was developed that will allow seamless entry of CCLEAN data into the Regional Board’s CCAMP database.

Monitoring results from 2002-2003 provide the following findings:

- Analysis of 30-day effluent samples for POPs indicated that Santa Cruz, Watsonville, Monterey Regional Water Pollution Control Agency, and Carmel Area Wastewater District had very low concentrations of POPs, parts per trillion or less. Polynuclear aromatic hydrocarbons (PAHs) were present in greater concentrations than the other POPs, and the average PAH concentration ranged from 33.46 ng/L to 46.27 ng/L per discharger. None of the POP concentrations exceeded permit limits. Estimated annual loads per discharger of PAHs were all under a kilogram. Among the other POPs, hexachlorcyclohexanes (HCHs) and chlordanes had the next highest annual loads per discharger, which ranged from 2.5 g/yr to 24.1 g/yr and 0.8 g/yr to 6.5 g/yr, respectively. There were no consistent temporal patterns in the mean daily loads of POPs from effluent.

- Analysis of effluent grab samples for nutrients indicated similar concentrations among most dischargers for ammonia, but Carmel 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 8,105 kg/yr to 357,784 kg/yr. Estimated annual loads of nitrate nitrogen and urea nitrogen ranged from 13,514 kg/yr to 91,821 kg/yr and 260 kg/yr to 2,042 kg/yr, respectively.
- Receiving water monitoring for total coliform, fecal coliform and enterococcus bacteria revealed no spatial patterns indicative of wastewater effects. Nevertheless, one enterococcus sample of 300 MPN/100ml collected in May 2003 at station RW(F)-30 at Santa Cruz exceeded the proposed stricter water-contact recreation objective of no samples to exceed 104 MPN/100ml. In addition, samples from several stations at Watsonville exceeded the current shellfish harvesting objective of 230 MPN/100ml total coliform during the months of December and January.
- Analysis of POPs in mussels revealed a seasonal pattern for most POPs at most sites, with higher values in wet-season samples than in dry-season sample. There were high concentrations of dichlorodiphenyltrichloroethane (DDTs) and chlordanes at Laguna Creek and The Hook (e.g., higher than San Francisco Bay) and endosulfans in the dry-season sample from The Hook exceeded the 95^{th} percentile of the most contaminated samples analyzed by State Mussel Watch over a 20-year period. Moreover, mussels from every site exceeded at least one Maximum Tissue Residue Level (Rasmussen, 2000) for concentrations of POPs. There also were high concentrations of fecal coliform in various samples from Laguna Creek, The Hook, Fanshell Overlook and Carmel River Beach, which exceeded USFDA guidelines for fecal coliform in shellfish.
- Analysis of sediment samples for benthic infaunal revealed that the biota at all sites was dominated by annelids, followed by molluscs and arthropods. Moreover, 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. There were no temporal trends in benthos with most benthic groups and taxa varying little between years, although the bivalve *Axinopsida serricata* varied substantially between years at five sites. Sediment texture also was very similar between years at each site. Analysis of sediment samples for POPs revealed that every sample over the two years of sampling exceeded the NOAA Effect Range Low (ERL) guideline at which toxicity is typically measured in 10% of laboratory bioassays. Samples from two sites exceeded the average concentration of HCHs in San Francisco Bay sediments. Moreover, statistical analysis of a limited number of samples suggested that some POPs could be negatively affecting some infaunal groups. The densities of one species, the polychaete *Cossura pygodactylata*, exhibited especially strong negative effects of DDT (p = <0.0001, adjusted r^2 = 0.7158). Analysis of DDT isomers suggested the main historic sources of DDTs to Monterey Bay are near the apex of the bay.
- Analysis of monthly stream and river samples for nutrients indicated that the Salinas River had the highest mean concentrations of nitrate nitrogen and urea nitrogen. Analysis of stream and river samples for bacteria showed the highest concentrations of total coliform bacteria were found between Moore Creek and the Big Sur River, with low concentrations in Elkhorn

Slough. Geometric means for E. coli at Branciforte Creek, San Lorenzo River, Soquel Creek, Porter Gulch and Aptos Creek exceeded the water quality objective for water contact recreation in a proposed Basin Plan amendment recommended by Regional Board staff. Six of the streams and rivers had U.S. Geological Survey (USGS) flow gauges, which allowed estimation of annual loads. The Pajaro River had the highest annual loads of both nitrate and urea. The Pajaro River also had the highest annual load of total coliform bacteria, E. coli and enterococcus.

- Analysis of POPs in dry-season and wet-season 30-day samples from the San Lorenzo, Pajaro, Salinas and Carmel rivers indicated that the greatest mean daily load of most POPs occurred during the wet season. Moreover, in the 2003 wet season, loads of PAHs, DDTs, chlordanes, endosulfans and PCBs from the Pajaro River were 3–25 times greater than those from the river with the next highest load. The annual load of DDTs from the Pajaro River was 95% of the total annual load of 534 grams from all rivers. DDT isomers in the Pajaro River were consistent with sediment results indicating the historic source of DDTs near the apex of Monterey Bay. Combined loads from all four rivers greatly exceeded the combined loads from wastewater discharges for all POPs, except HCHs. The agricultural herbicide Dacthal was found in concentrations in the Pajaro and Salinas rivers that were more than 100 times greater than in either of the other rivers or any of the wastewater discharges. Dacthal concentrations in sediment and mussels also were consistent with highest loads occurring in the wet season and originating near the apex of the bay.

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, Duke Energy, 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

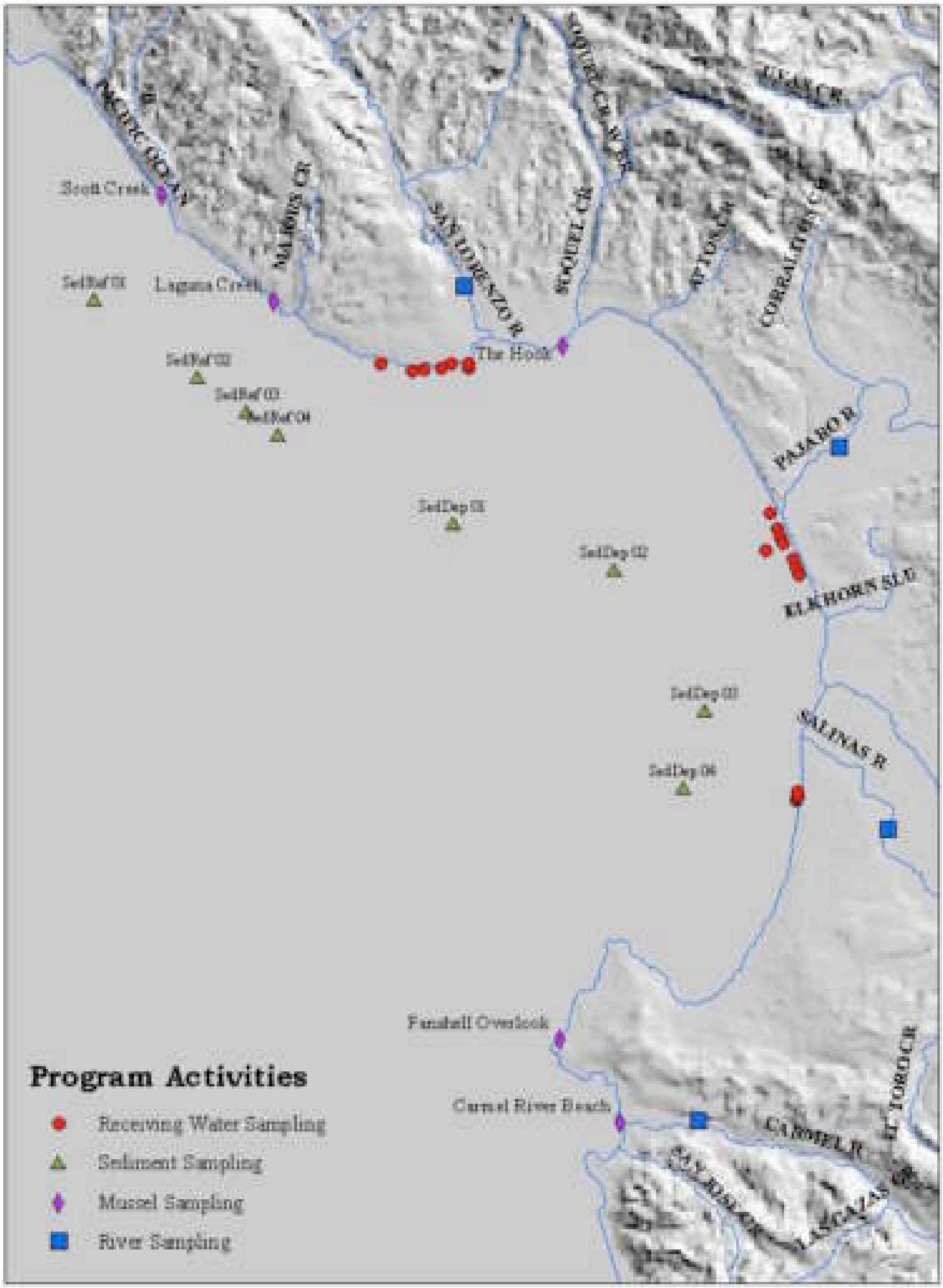

Figure 2.2.1. Locations of CCLEAN sampling sites for receiving water, sediment, mussels, and rivers (for POPs).

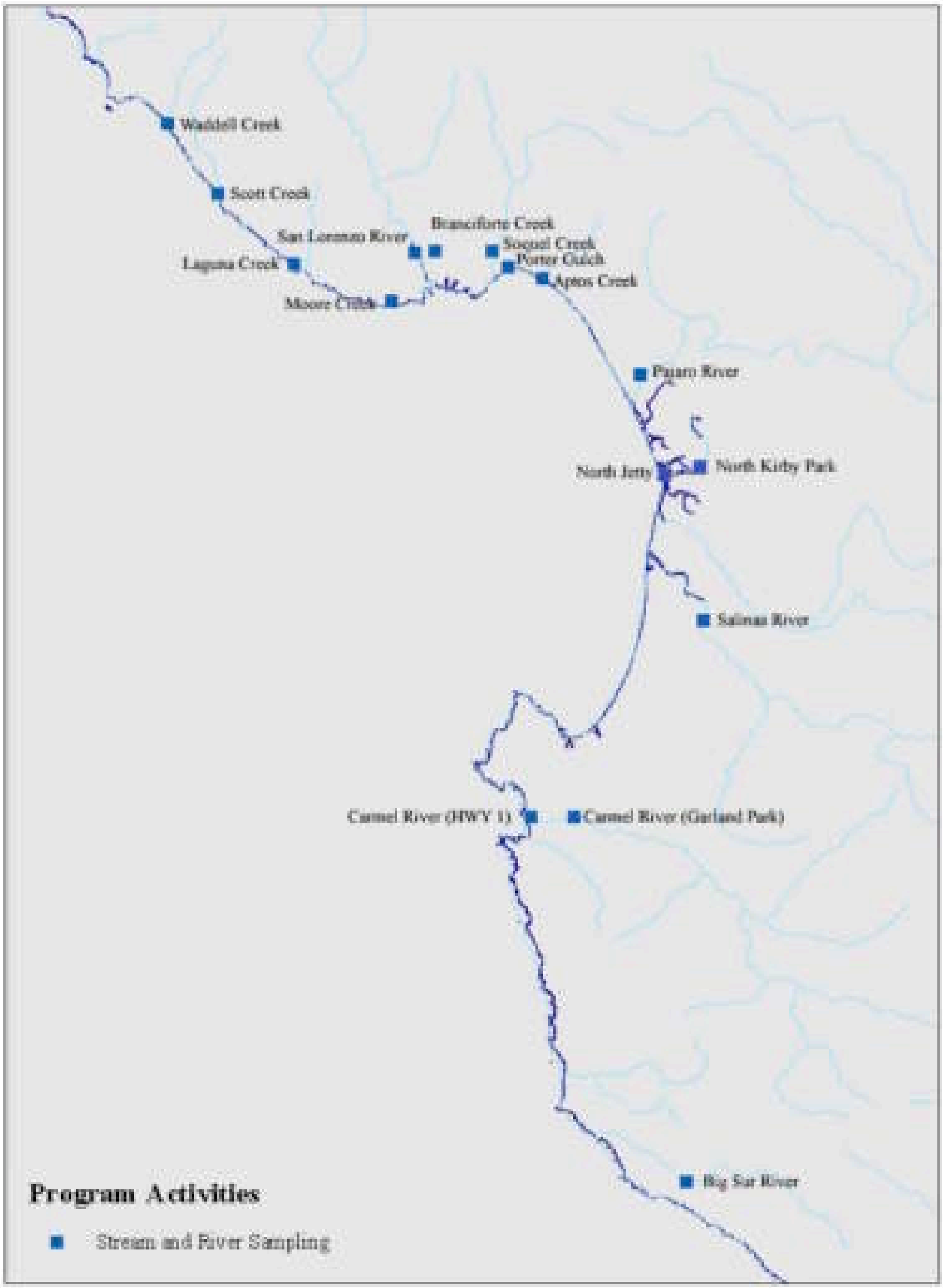

Figure 2.2.2. Locations of CCLEAN sampling sites for streams and rivers.

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 2002 through June 2003, the current status of monitoring, and findings. Technical components included are effluent sampling, mussel sampling, sediment sampling, monthly stream and river sampling and sampling of rivers for POPs. 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.

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 and dissolved silica in effluent	Monthly

3.1.1 Solid-Phase Extraction Sampling

3.1.1.1 Activities

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 averaging the daily loads from each sampling event (measured concentration x average daily flow during the sampling event) and multiplying by 365.

Dry-season effluent samples were collected with the ISCO equipment during the period September–November 2002 and wet-season effluent samples were collected during the period January–March 2003 (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, or nitrate, so estimates of loads for these nutrients from Santa Cruz assume that Scotts Valley's effluent has concentrations similar to Santa Cruz's.

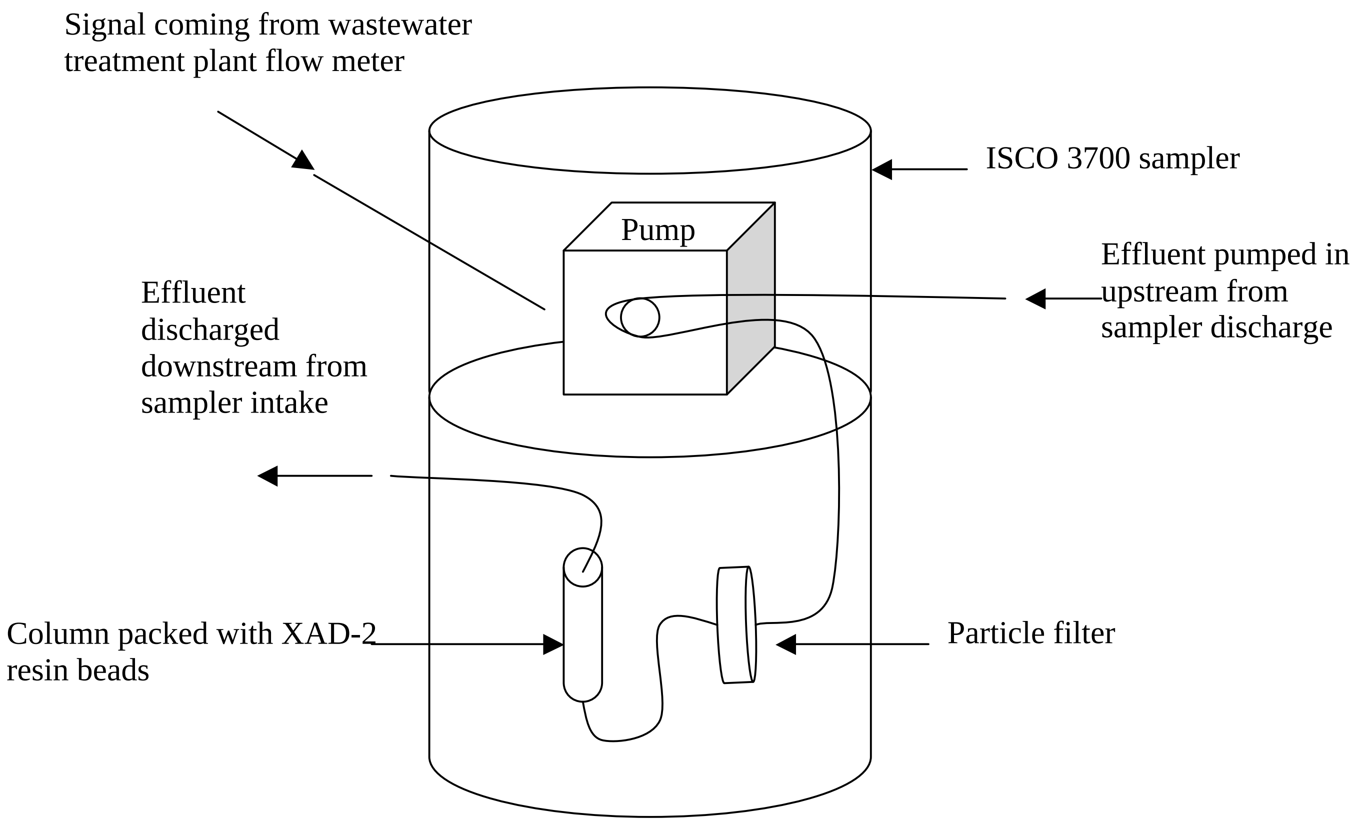

Figure 3.1.1. Configuration of ISCO samplers for CCLEAN effluent sampling.

Table 3.1.2. Dates and volumes of effluent samples, 2002–2003.

Season	River	Start Date	End Date	Number of Liters Sampled
Dry				
	Santa Cruz	September 30, 2002	November 6, 2002	183
	Watsonville	September 27, 2002	October 28, 2002	202
	Monterey Regional	September 26, 2002	October 23, 2002	202
	Carmel Area	September 26, 2002	November 1, 2002	199
Wet				
	Santa Cruz	January 29, 2003	March 10, 2003	201
	Watsonville	January 27, 2003	March 6, 2003	219
	Monterey Regional	January 27, 2003	March 6, 2003	270
	Carmel Area	January 27, 2003	March 6, 2003	244

3.1.1.2 Results

Concentrations of all POPs in effluent were very low in all samples, parts per trillion or less (Appendix B). Concentrations of POPs in the first equipment blank collected in September, 2001 were higher than those in the second equipment blank collected in February, 2002 probably because water of higher purity was pumped through the equipment in February. We suggest that the February equipment blank is a more accurate indicator of any potential contamination caused by the sampling equipment. Because these results are from a limited number of samples, differences among dischargers and sources discussed in the following sections should be considered preliminary.

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-PAHs	Biphenyl, Naphthalene, 1-methylnapthalene, 2-methylnapthalene, 2,6-dimethylnapthalene, 2,3,5-trimethylnapthalene, Acenaphthene, Acenaphthylene, Anthracene, Dibenzothiophene, Fluorene, Phenanthrene, 1-methylphenanthrene
High-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
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

Average effluent POP concentrations varied slightly among the four wastewater treatment plants (Table 3.1.4 and Appendix B). As in 2001-2002, Carmel and Watsonville had the first and second highest combined concentrations of PAHs, but there were very small differences among dischargers in the other POPs. Also consistent with 2001-2002, most of the effluents had higher concentrations of low-weight PAHs than high-weight PAHs. Exceptions to this pattern occurred for Carmel in both seasons and Monterey Regional in the wet season. The preponderance of low-weight PAHs in these samples suggests that petrogenic sources, such as leaking crankcase oil or other petroleum products, make the largest contribution to PAHs in most of the effluent samples.

The range of POP concentrations measured at the four wastewater treatment plants in the CCLEAN program were generally within the ranges for similar measurements 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, the Santa Cruz, Monterey Regional and Carmel samples were near or above the upper end of the range reported by SFEI. Chlordanes were generally similar in the CCLEAN samples and the SFEI samples and DDTs were higher in the wet-season sample from Watsonville than in the SFEI samples. PCBs in the CCLEAN samples were very similar to 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 fall 2001 (dry season) and winter 2002 (wet season).

	Concentration, ng/L						
Sample	Low-weight PAHs	High-weight PAHs	Chlordanes	HCHs	Endosulfans	PCBs	DDTs
Dry-season 2002							
Santa Cruz	37.212	10.024	0.192	2.267	0.469	0.174	0.150
Watsonville	47.968	4.614	0.328	0.849	0.565	0.184	0.221
Monterey Regional	20.749	13.297	0.418	1.804	0.256	0.159	0.186
Carmel	26.322	26.885	0.403	1.074	17.28	0.131	0.074
Equipment Blank	14.248	0.610	ND	0.033	ND	0.023	0.019
Wet-season 2003							
Santa Cruz	32.403	12.910	0.408	1.200	0.343	0.331	0.142
Watsonville	28.576	10.428	0.305	1.800	0.383	0.463	0.484
Monterey Regional	7.300	25.582	0.430	1.520	0.204	0.417	0.298
Carmel	16.806	21.357	0.501	1.510	0.199	0.195	0.113
Equipment Blank	13.046	1.157	ND	0.054	ND	0.048	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	13.25–16.35	0.19–0.41	0.14–0.15	0.17–0.33
Watsonville	11.35–11.95	0.31–0.33	0.22–0.48	0.18–0.46
Monterey Regional	12.82–20.68	0.42–0.43	0.19–0.30	0.16–0.42
Carmel	18.19–25.57	0.40–0.50	0.07–0.29	0.13–0.19
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	1010	2.65	19.55	2.19
Watsonville	748	1.955	14.45	1.615
Monterey	1284.8	3.358	24.82	2.774
Carmel	1070	2.81	20.74	2.32

There were no apparent seasonal patterns in wastewater loads of POPs. Mean daily loads showed no consistent pattern among seasons, except that similar patterns were evident among POPs at a given wastewater treatment facility (Figure 3.1.2). For example, the lowest mean daily loads for Santa Cruz occurred in the 2002 wet season and the lowest mean daily loads for Monterey Regional occurred in the 2002 dry season for each POP. Because of its lower discharge volume, Carmel generally had the smallest mean daily load of each POP in each sampling period, except for a high load of endosulfans in the 2002 dry season (Figure 3.1.2d).

Annual wastewater loads also 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 from Watsonville and loads of endosulfans from Carmel exhibiting 3-fold and 13-fold differences between years, respectively. The highest annual load of any wastewater POP was for PAHs, with 882 g per year from Watsonville in 2001-2002. Annual loads of HCHs were less than 51 g per discharger and the loads of chlordanes, endosulfans, PCBs and DDTs 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.

3.1.1.4 Recommendations

We recommend participation of CCLEAN contract laboratories in interlaboratory calibration exercises. There are various programs that coordinate such activities, including the Regional Monitoring Program in the San Francisco Bay area and the National Institute of Standards and Testing.

3.1.2 Grabs by Plant Personnel

3.1.2.1 Activities

Grabs by plant personnel are made monthly for analysis of urea and dissolved silica and weekly during POP sampling events for analysis of ammonia, nitrate, total suspended solids, temperature, conductivity, and pH (Table 3.1.1). 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

Replicate data for each wastewater treatment plant are found in Appendix B. Average concentrations of nutrients and total suspended solids indicated few differences among agencies, except that Carmel had substantially higher average concentrations of nitrate and urea (Table 3.1.7). The high average urea concentrations at Carmel were the result of two very high values measured on April 19, 2002 and May 10, 2002 (Appendix B). The only one of these constituents that has a permit limit is ammonia and all the agencies were well below their permit limits for median and daily maximum ammonia-N concentrations (Table 3.1.8).

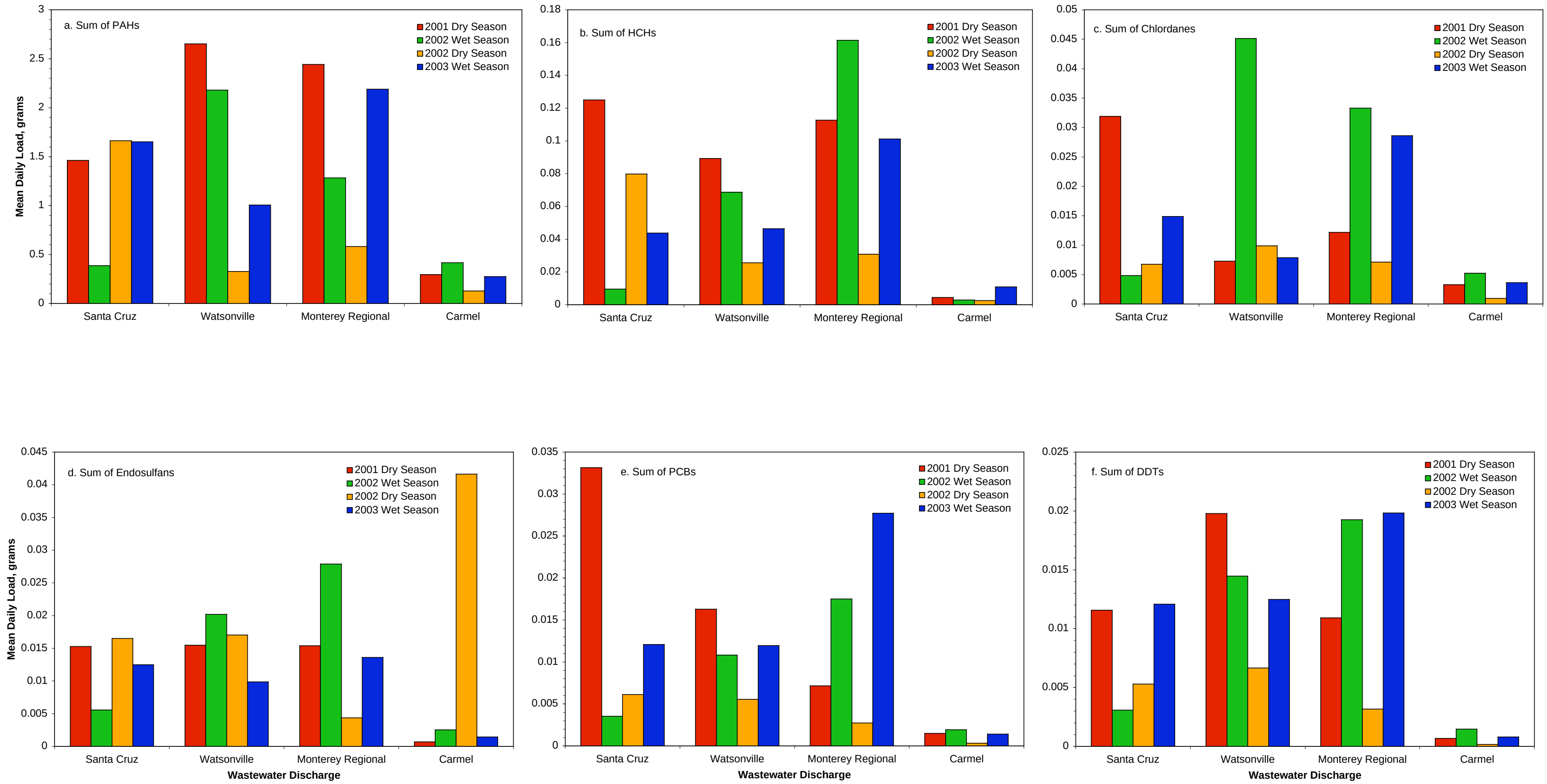

Figure 3.1.2. Mean daily loads of POPs in wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional and Carmel area wastewater treatment plants during dry-season and wet-season sampling in 2001–2002 and 2002–2003.

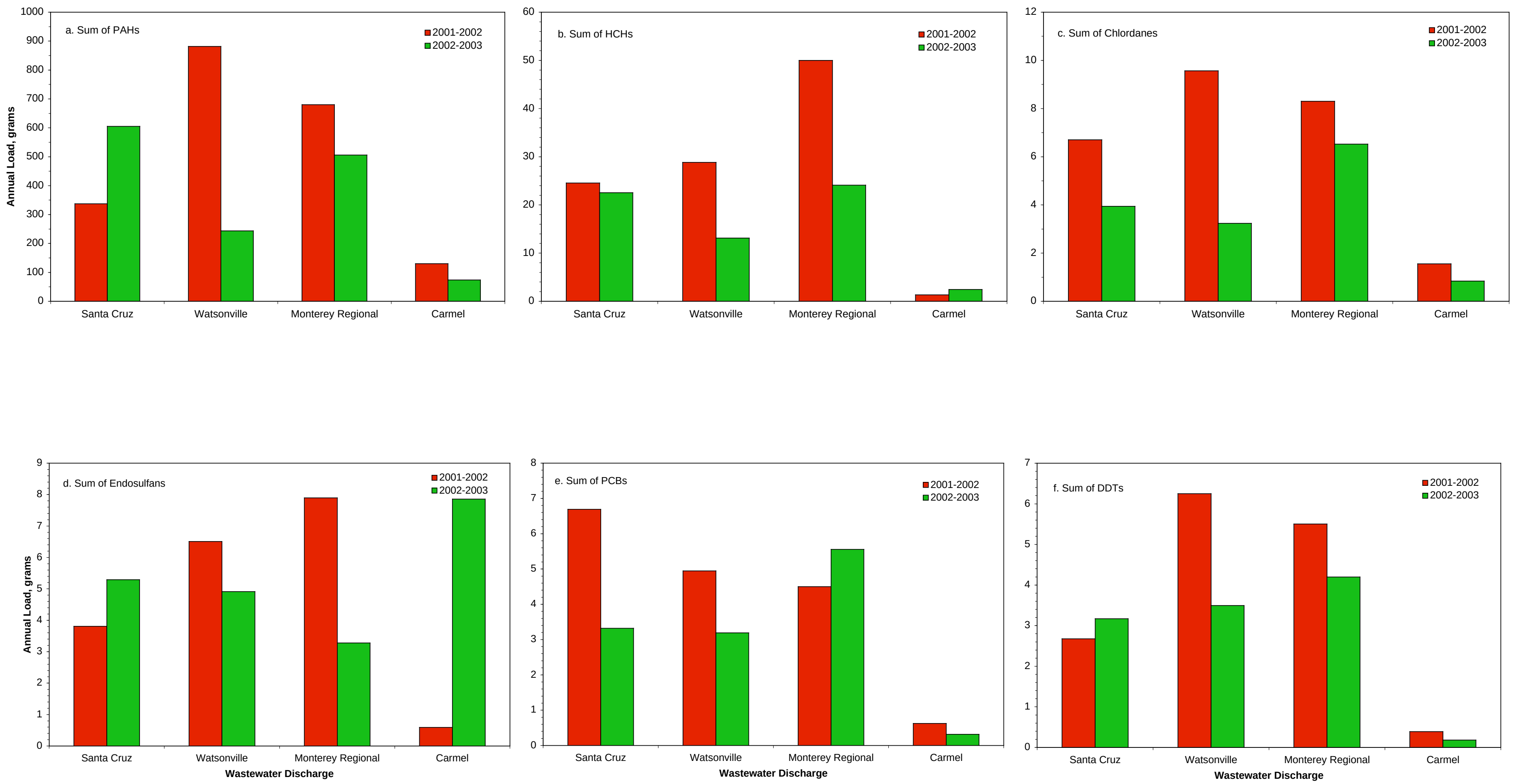

Figure 3.1.3. Annual loads of POPs in wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional and Carmel area wastewater treatment plants during 2001–2002 and 2002–2003.

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

	Average Concentration, mg/l				
Agency	Ammonia-N	Nitrate-N	Urea-N	Dissolved silica	TSS
Santa Cruz	24.4	6.8	0.11	36.9	7.02
Watsonville	18.08	4.24	0.19	39.56	9.56
Monterey Regional	28.6	1.1	0.11	47.6	13.1
Carmel	12.5	5.3	0.34	35.2	4.2

Table 3.1.8. Actual measurements compared with permit limitations for effluent ammonia-N concentration (mg/L) for each wastewater treatment plant.

	Median		Daily Maximum	
Agency	Measured	Permit Limit	Measured	Permit Limit
Santa Cruz	25.0	69.0	27.3	276.0
Watsonville	17.3	51.0	40.3	204.0
Monterey Regional	28.6	87.6	34.7	350.4
Carmel	13.6	73.2	32.3	292.8

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 (Appendix B and Figure 3.1.4). Estimated loads of ammonia-N ranged from 430,366 kg/year from Monterey Regional in the 2001-2002 sampling year Regional to 8,105 kg/year from Carmel in the 2002-2003 sampling year (Figure 3.1.4a). Estimated loads of nitrate-N ranged from 91,821 kg/year at Santa Cruz in 2002-2003 to 9,452 kg/year at Carmel in 2001-2002. Estimated loads of urea-N ranged from 4,748 kg/year from Carmel in 2001-2002 to 260 kg/year from the same treatment plant in 2002-2003. Unlike nitrogen sources, dissolved silica does not contribute to blooms of phytoplankton but must be present in sufficient quantities, relative to nitrogen, to prevent blooms of noxious dinoflagellates. Estimated loads of dissolved silica ranged from 613,668 kg/year from Monterey Regional in 2002-2003 to 33,590 kg/year from Carmel in 2002-2003. Estimated loads of total suspended solids ranged from 169,615 kg/year from Monterey Regional in 2001-2002 to 7,153 kg/year from Carmel in 2001-2002. Comparisons between nutrient loads from wastewater and rivers are discussed in Section 3.5.2.1.

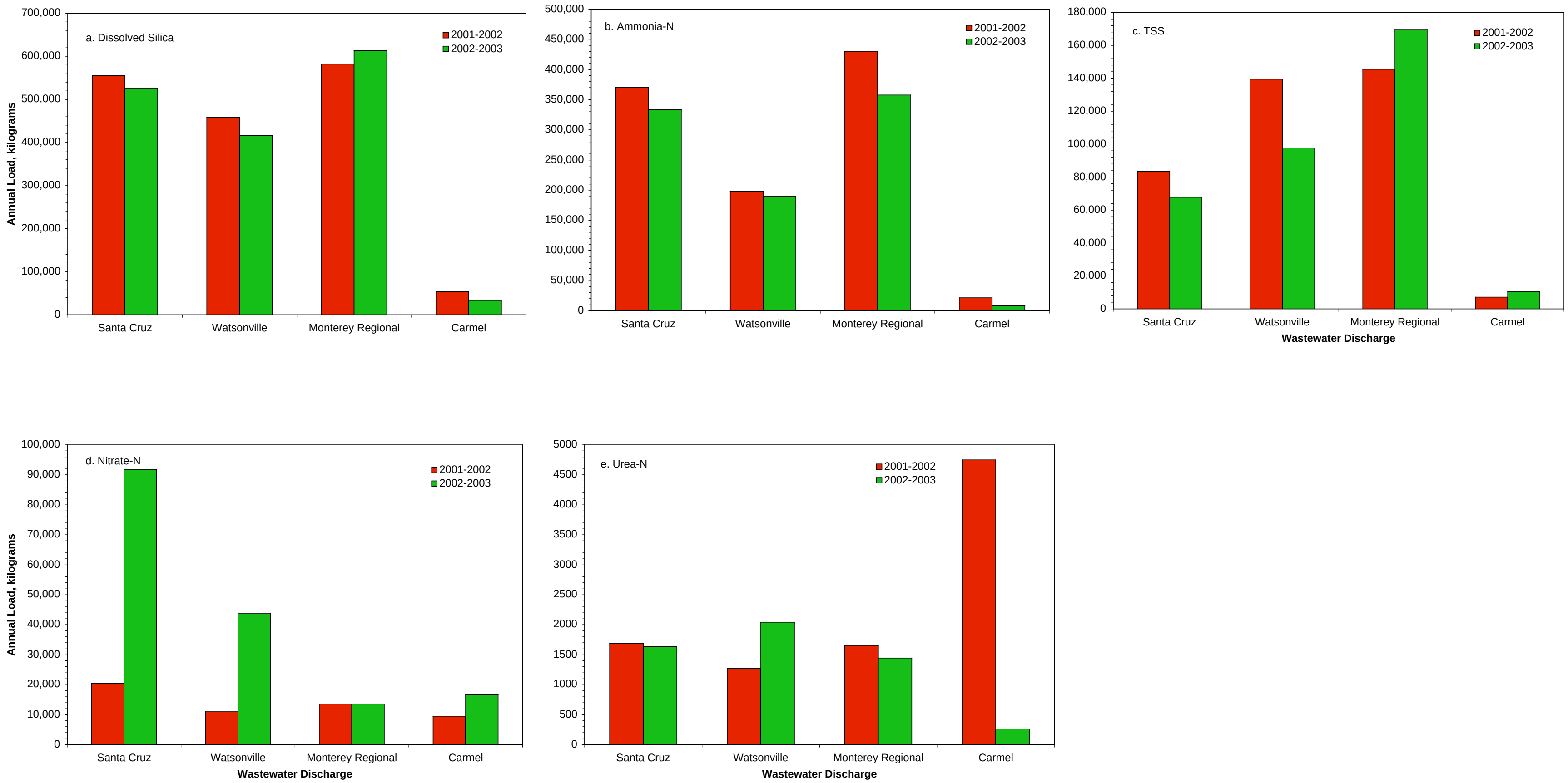

Figure 3.1.4. Annual loads of nutrients and total suspended solids in wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional and Carmel area wastewater treatment plants during 2001–2002 and 2002–2003.

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. Beginning in the 2003-2004 sampling year, grab samples have been collected for analysis of orthophosphate in wastewater.

The CCLEAN nutrient data from effluent, streams and rivers is of interest to the oceanographic community. We are aware of no other coastal monitoring program that is measuring urea and we have recently received requests for these data from researchers at University of California, Santa Cruz. As one of the objectives of CCLEAN is to ensure that our data are compatible with other regional monitoring efforts, we view such interest by the scientific community as a positive sign that the program can contribute to the base of knowledge necessary to understand environmental dynamics in Monterey Bay nearshore waters.

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. 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.

3.2 Receiving Water Sampling

3.2.1 Activities

Receiving water sampling, which consists of monthly sampling for pathogen indicators at stations along the 30-foot contour near the wastewater discharges of Santa Cruz, Watsonville and Monterey Regional, continued from July 2002 through June 2003. Measurements were made for total coliform, fecal coliform, and enterococcus bacteria. Carmel is required to sample beach sites if their effluent concentration of total coliform exceeds 2,400 MPN/100L three or more times in a 30-day period, which did not occur during the period of July 2002 through June 2003. Collections were made by treatment plant personnel from Santa Cruz, Watsonville and Monterey Regional, or their consultants, and analyzed in the respective treatment plant laboratories. 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 north of outfall

3.2.2 Results

Receiving water concentrations of bacteria pathogen indicators were generally low (Appendix C and figures 3.2.1, 3.2.2, and 3.2.3). None of the measurements for any of the agencies exceeded the existing water-contact recreation objective of 1,000 MPN/100ml total coliform and 400 MPN/100ml fecal coliform. However, the enterococcus sample of 300 MPN/100ml collected in May 2003 at station RW(F)-30 at Santa Cruz exceeded the proposed stricter water-contact recreation objective of no samples to exceed 104 MPN/100ml (Table 3.2.2). In addition, samples from several stations at Watsonville exceeded the current shellfish harvesting objective of 230 MPN/100ml total coliform during the months of December and January.

Sampling stations at Santa Cruz had highest total and fecal coliform counts in February, and greater than detection limit values in September and April as well as in the winter months. It should be noted that in April 2003 the City of Santa Cruz lowered the detection limit for total coliform, fecal coliform and enterococcus from 20 MPN/100ml to 2 MPN/100ml. Although the individual NPDES permit under which the City of Santa Cruz was discharging had set 20 MPN/100ml as acceptable, the decision to go to the lower reporting limit was based upon the desire to achieve comparability of data between the dischargers.

Watsonville stations had the highest total and fecal coliform counts from October through February, with additional peaks in sample values in May. Sampling sites for Monterey had peak values of total and fecal coliform in October. Measurements at the Watsonville discharge, especially, probably are confounded by storm runoff, as wastewater plant personnel have observed that the plume of the Pajaro River often crosses the wastewater discharge during storm events. Moreover, rainfall data (California Department of Water Resources, 2004) indicate that the highest concentrations of bacteria at the Watsonville sites were measured during periods with higher rainfall (Figure 3.2.4). None of the sites closest to any of the discharges were systematically higher than more distant sites, which could indicate the discharge as a source.

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	<1,000/100ml <20% 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

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

3.2.4 Recommendations

We currently have no recommendations regarding this program element.

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 ToxScan and bacteria analyzed by Biovir.

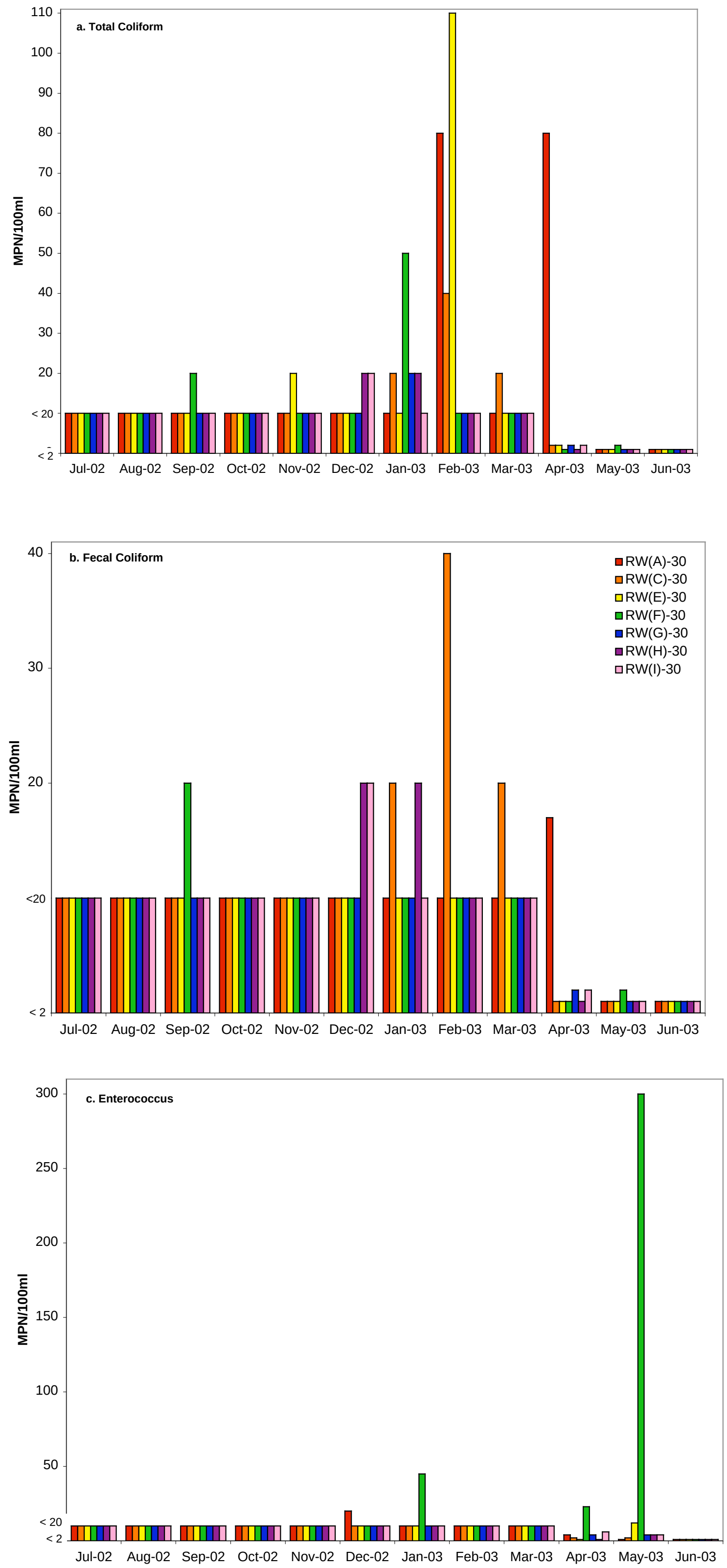

Figure 3.2.1. Concentrations of pathogen indicators at receiving water monitoring sites near the Santa Cruz wastewater discharge. Site RW (G) is closest to the discharge.

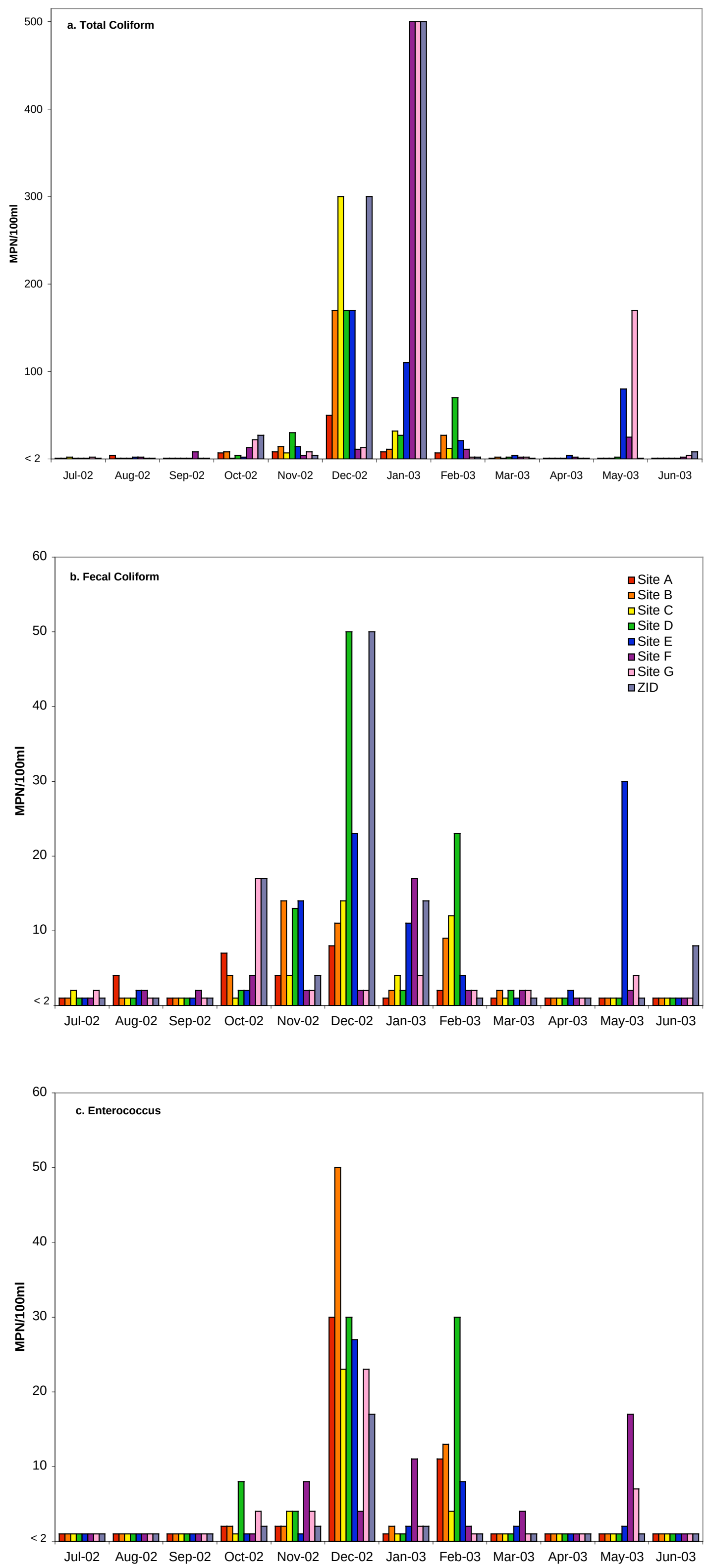

Figure 3.2.2. Concentrations of pathogen indicators at receiving water monitoring sites near the Watsonville wastewater discharge. Sites D and ZID are closest to the discharge.

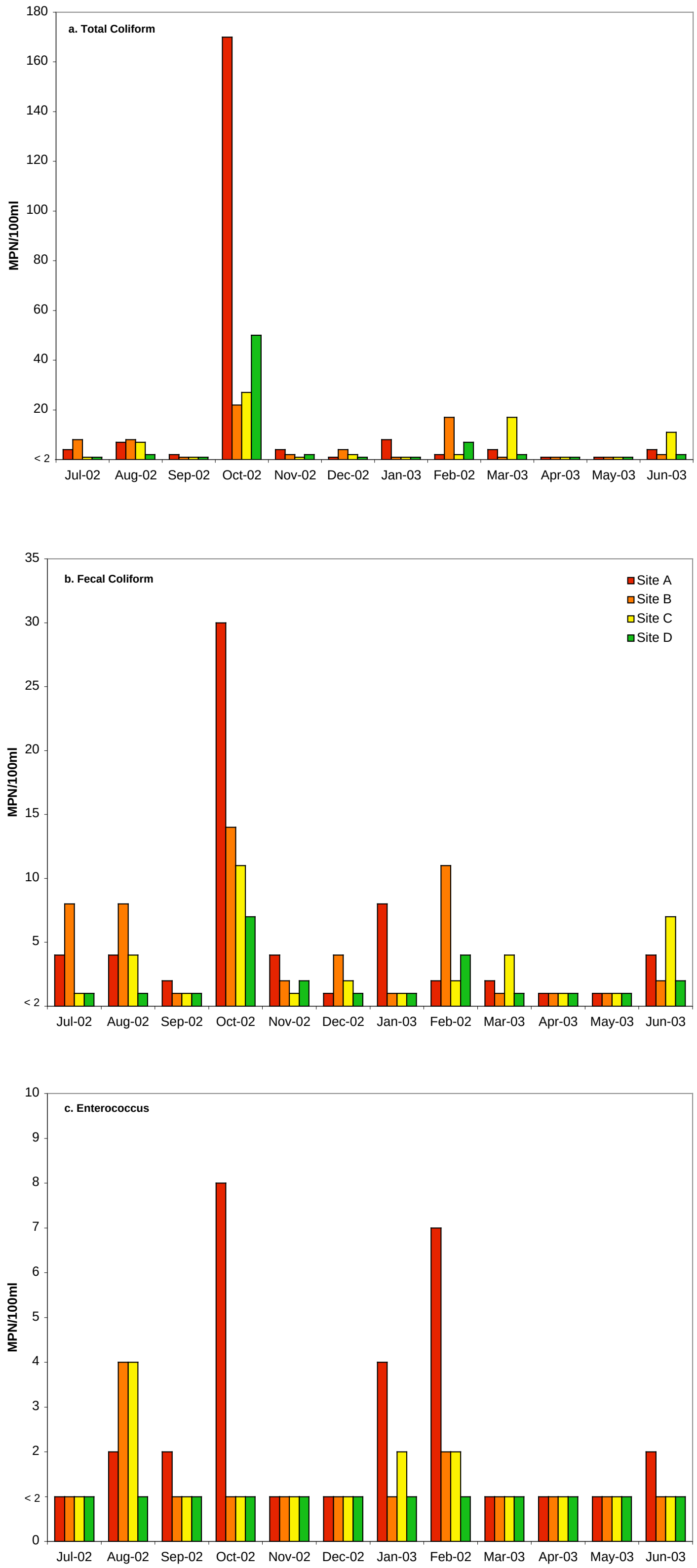

Figure 3.2.3. Concentrations of pathogen indicators at receiving water monitoring sites near the Monterey Regional wastewater discharge. Site B is closest to the discharge.

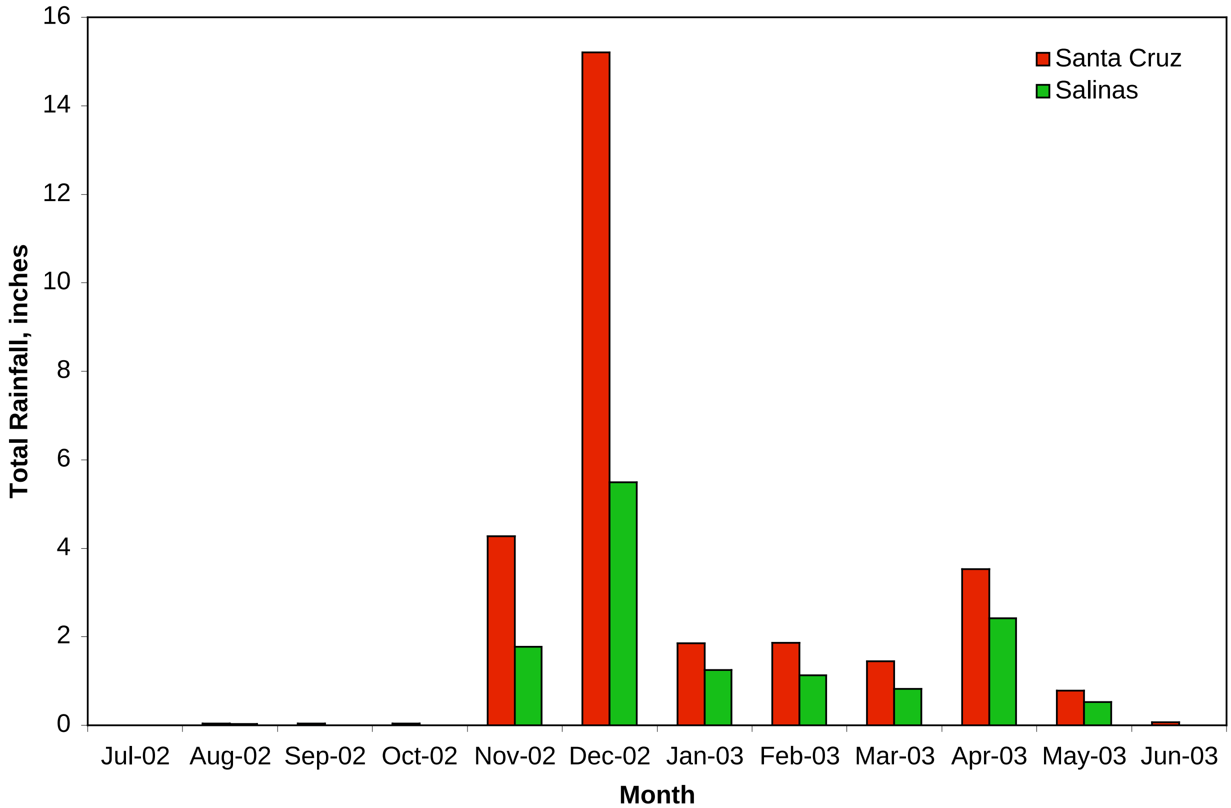

Figure 3.2.4. Total monthly rainfall in Santa Cruz and Salinas from July 2002 through June 2003.

3.3.1 Activities

The sites shown in Table 3.3.1 were sampled by KLI on October 8, 2002 (dry season) and February 27, 2003 (wet season). Approximately 30 mussels were collected from each site for both POP analyses and bacteria analyses. Field duplicates were collected at Laguna Creek to analyze variation in the mussel population at a given site.

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

As was reported in the CCLEAN Annual Report for 2001-2002, mussels at Scott Creek, Fanshell Overlook, and Carmel River Beach were similar in their concentrations of POPs (Appendix D, Figure 3.3.1). Moreover, concentrations of POPs at these sites generally were similar to those in mussels at Bodega Head (data made available by the San Francisco Estuary Institute), although all CCLEAN sites had higher DDT and chlordane concentrations than did Bodega Head (Figure 3.3.1b and 3.3.1c). Bodega Head is a collection site for clean mussels used as background comparisons and for transplanting in the Regional Monitoring Program for Trace Contaminants in San Francisco Bay and the State Mussel Watch program.

Mussels at Laguna Creek and The Hook had higher POP concentrations than the other three CCLEAN sites, although the differences were less apparent in October 2002 than in either February 2002 or February 2003 (Figure 3.3.1). The Hook had much higher concentrations of PAHs and chlordanes than any of the other CCLEAN sites and Bodega Head, while Laguna Creek had similar concentrations of DDTs to those at The Hook. Moreover, mussels at both Laguna Creek and The Hook had concentrations of DDTs that were much higher than those measured at Yerba Buena Island in San Francisco Bay in September 2001 (Figure 3.3.1b) and The Hook also had much higher chlordane concentrations than Yerba Buena Island (Figure 3.3.1c). San Francisco Bay has been placed on the 303(d) list for legacy pesticides, which include DDTs and chlordanes.

Other studies have shown that POP concentrations in bivalves can vary according to the size of the organism (Gilek, Bjoerk & Naef, 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 57.24 mm and were comparable to those at other sites (Figure 3.3.2), so high POP concentrations at that site remain enigmatic.

Most POPs had higher concentrations in CCLEAN mussels from February 2002 and February 2003 than in those from October 2002 (Figure 3.3.1), especially the sites with the highest concentrations. This pattern suggests seasonal differences in POP bioaccumulation. While 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 large differences among sampling periods in the lipid content of the mussels (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. Although three samples are not conclusive, the higher concentrations in February 2002 and February 2003 suggest storm runoff might be a source of higher ambient concentrations.

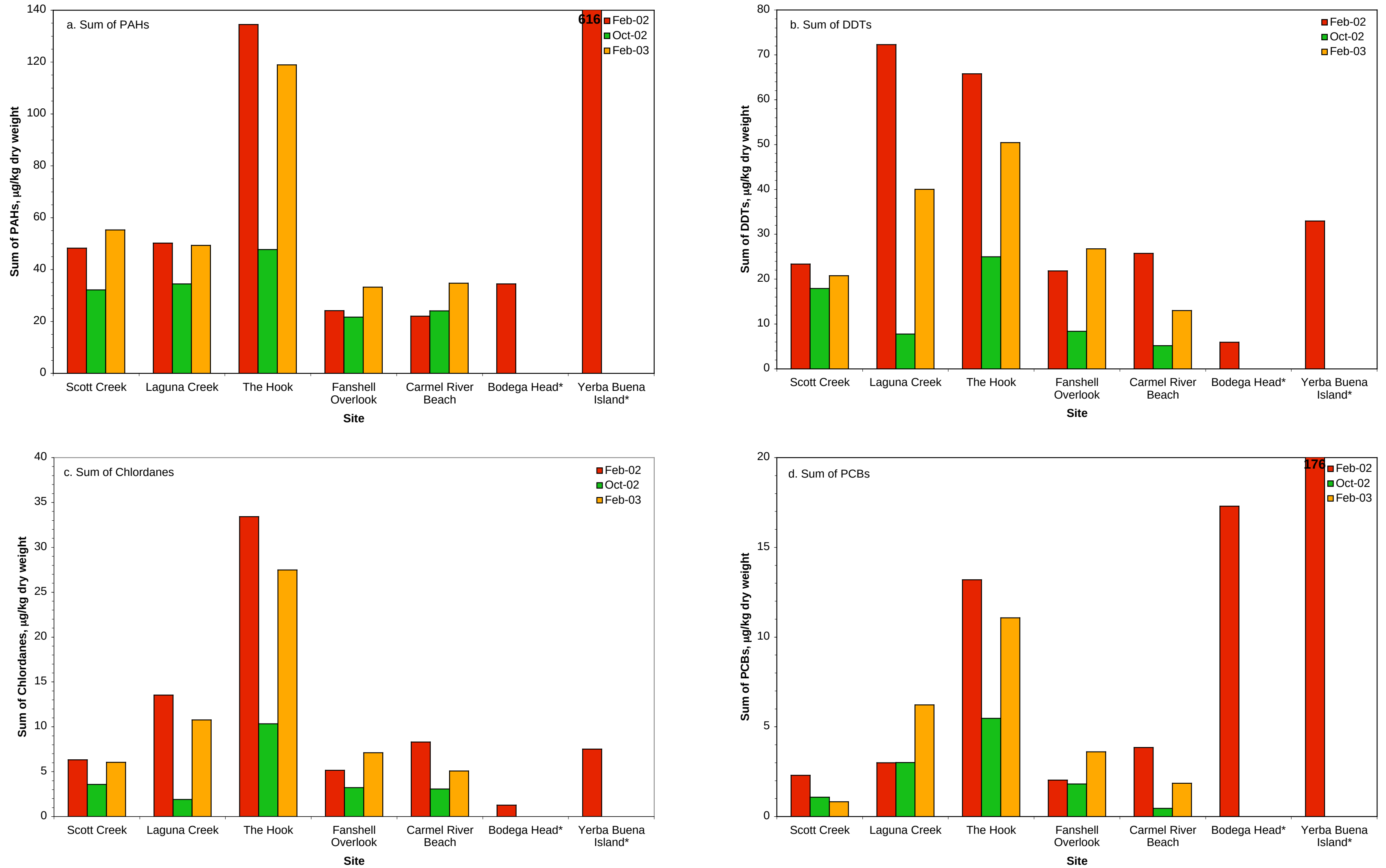

Figure 3.3.1. Concentrations of four major groups of POPs in mussel tissues from five CCLEAN sites sampled in February 2002, October 2002 and February 2003. Laguna Creek values are the means of two field duplicates. * = Bodega Head and Yerba Buena Island were sampled in May and September 2001, respectively, as part of the Regional Monitoring Program for Trace Contaminants in San Francisco Bay.

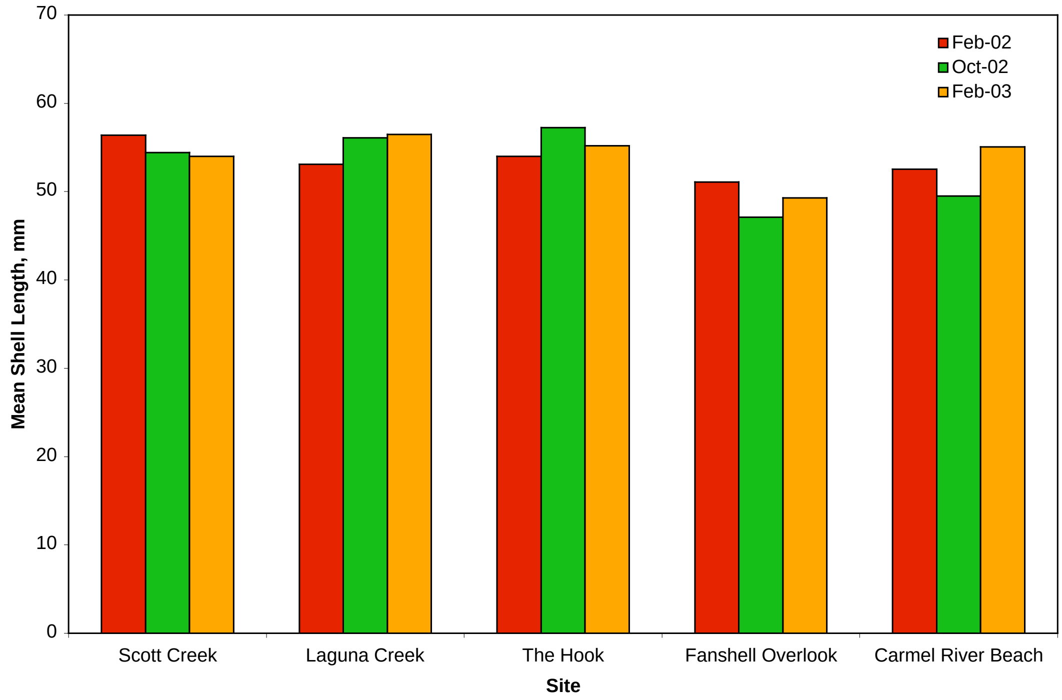

Figure 3.3.2. Mean shell length in mussels from five CCLEAN sites analyzed for POP concentrations.

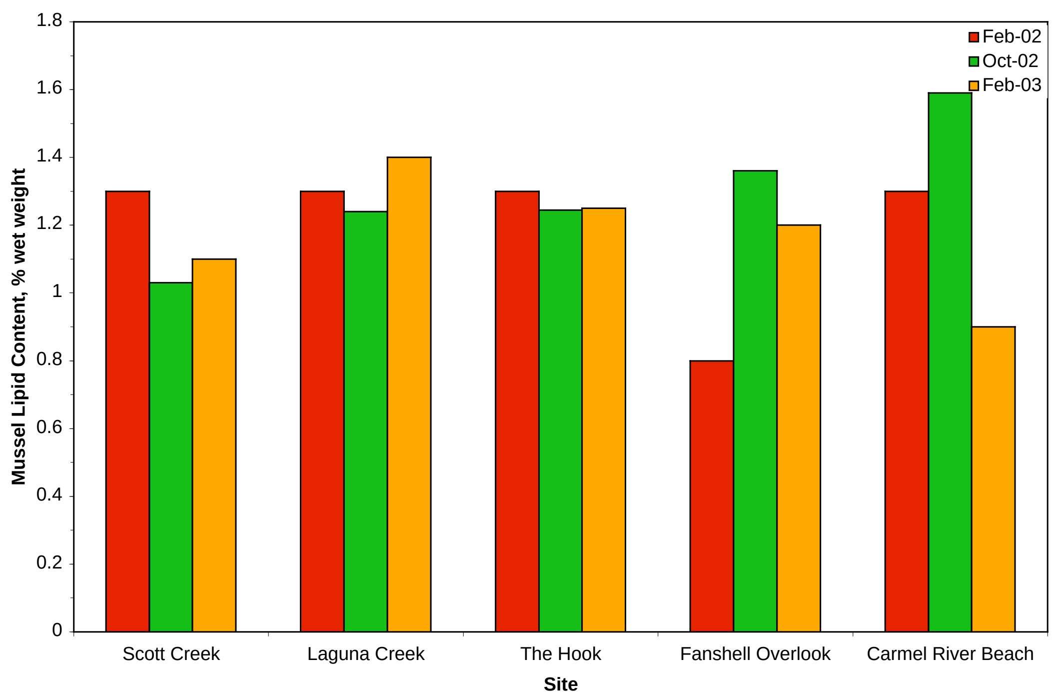

Figure 3.3.3. Lipid content in CCLEAN mussel samples as a percent of wet weight.

There are several applicable alert levels and guidelines that can be used to view the POP concentrations in mussel tissues in a larger context. 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 also has ranked tissue concentrations measured over a 20-year period and designated concentrations corresponding to elevated data levels (EDL) for the 85th and 95th 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. Both the MTRLs and the EDLs are based on wet-weight concentrations.

As reported in the CCLEAN 2001-2002 Annual Report, mussels from all five sites exceeded at least one alert level for concentrations of POPs (Figure 3.3.4). The MTRLs for Ocean Plan PAHs (a subset of the PAHs measured by CCLEAN) was exceeded in all samples (Figure 3.3.4a). The MTRL for DDTs was exceeded at Laguna Creek and at The Hook in February 2002 (Figure 3.3.4b). The MTRL for Ocean Plan chlordanes (a subset of the chlordanes measured by CCLEAN) was exceeded in all samples, and the SMW EDL 85 for this POP was exceeded at The Hook in February 2002 and in February 2003 (Figure 3.3.4c). The MTRL for PCBs was exceeded in every sample from The Hook, in the February 2002 samples from Carmel River Beach and in the February 2003 samples from Fanshell Overlook (Figure 3.3.4d). There is no MTRL for endosulfans and, although these chlorinated pesticides were found in low concentrations when compared to the other POPs, every site exceeded the SMW EDL 85 at least once and The Hook exceeded the SMW EDL 85 in every sample and the SMW EDL 95 in October 2002 (Figure 3.3.4e).

The exceedences of MTRLs indicate that nearshore waters in the Monterey Bay area have potential human health concerns. Moreover, for DDTs, Ocean Plan chlordanes and endosulfans, exceedences of SMW EDLs 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 that people should limit their consumption of mussels and they also raise concerns for wildlife that may consume large quantities of mussels.

Concentrations of bacteria in mussels varied among sites and times (Appendix D, Figure 3.3.5). Mussels from Scott Creek generally had the lowest concentrations of the three bacteria that were measured. Fanshell Overlook had the highest measured concentrations of each bacterium, with total coliform and fecal coliform being highest in February 2002 and enterococcus being highest in February 2003. Nevertheless, Laguna Creek had the highest mean concentration of enterococcus over the three sampling periods, while Fanshell Overlook had the highest mean concentrations of total and fecal coliform (Table 3.3.2). 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) in either February or October 2002 (Figure 3.3.5b). While these guidelines are intended to protect human health, susceptible mammals that ate these mussels could have been at risk from exposure to pathogens of fecal origin.

Table 3.3.2. Mean concentrations of bacteria in mussels from five CCLEAN sites. Number of samples equals 3 (February 2002, October 2002, February 2003).

Site	Total Coliform	Fecal Coliform	Enterococcus
Scott Creek	66	29	111
Laguna Creek	339	321	1720
The Hook	375	239	985
Fanshell Overlook	583	323	1697
Carmel River Beach	223	187	463

Analysis of field duplicates from The Hook indicated very little variation within sites for most measurements (Appendix D). Relative percent differences (i.e., the difference between two measurements divided by the mean of the two and multiplied by 100) varied from approximately 3 to 14 for most POPs, except for endosulfans and HCHs, which were not detected or detected at very low concentrations in one of the replicates in one or both of the sampling periods. There were relatively larger relative percent differences between replicates in the concentration of bacteria (40–117), which is consistent with the results reported in the CCLEAN 2001-2002 Annual Report.

3.3.3 Current Status

Collections and analysis of mussels from the five CCLEAN sites have been performed in August 2003 and another sampling is scheduled for February 2004. Results from these two sets of samples will be reported in the Annual Report for 2003-2004.

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.

We also recommend collaboration with the Regional Monitoring Program for Trace Contaminants in San Francisco Bay to ascertain whether the relatively low concentrations of PCBs measured in the CCLEAN program, compared to Bodega Head, indicate analytical differences or a strong influence of outflow from San Francisco Bay on Bodega Head.

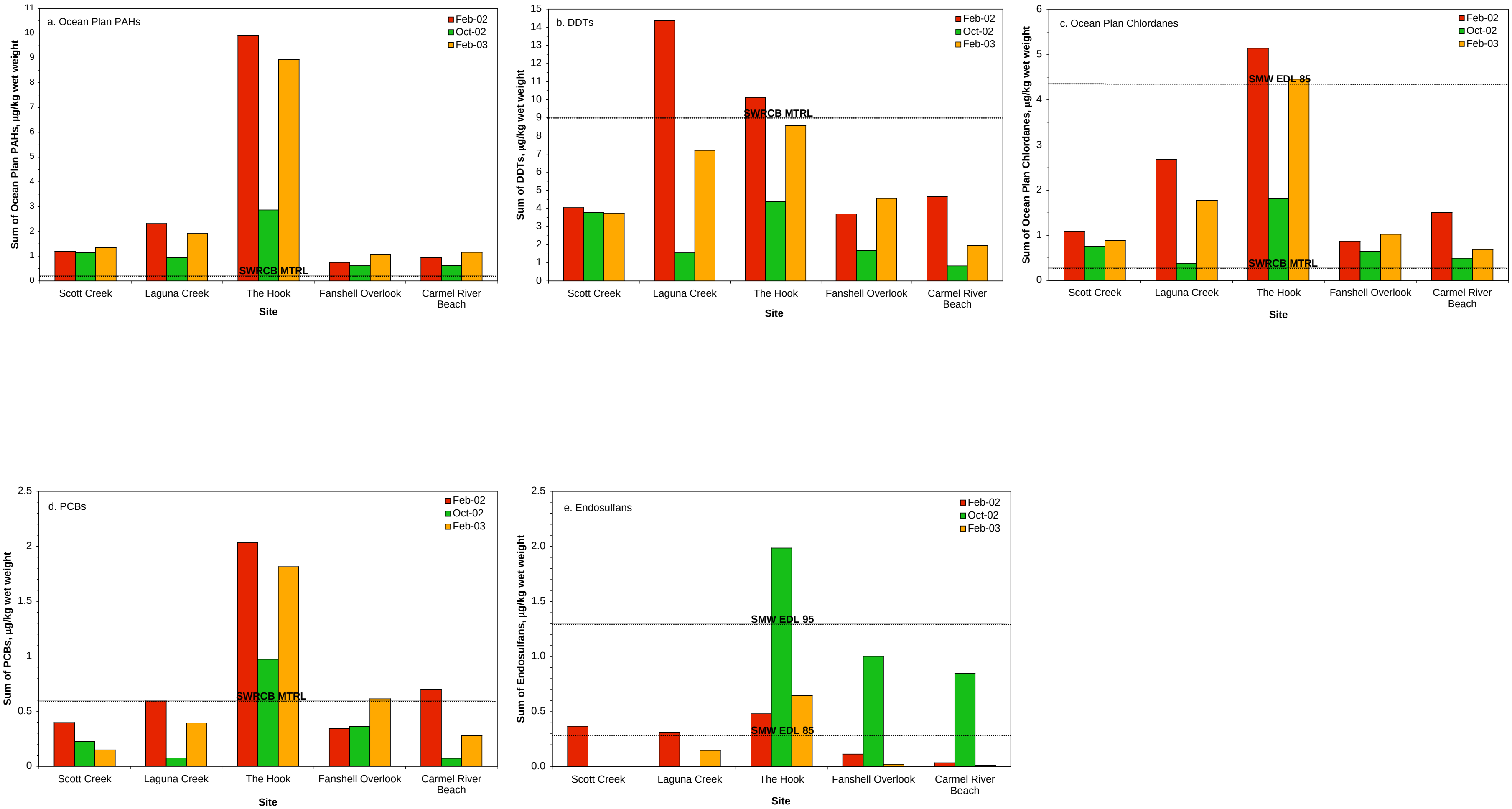

Figure 3.3.4. Wet-weight tissues concentrations of Ocean Plan PAHs, DDTs, chlordanes, PCBs and endosulfans in mussels from five CCLEAN sites compared with State Water Resources Control Board Maximum Tissue Residue Levels or State Mussel Watch EDL 85 (85th percentile) and EDL 95 (95th percentile) concentrations for resident California mussels (dashed lines). Mussels collected in February 2002, October 2002 and February 2003.

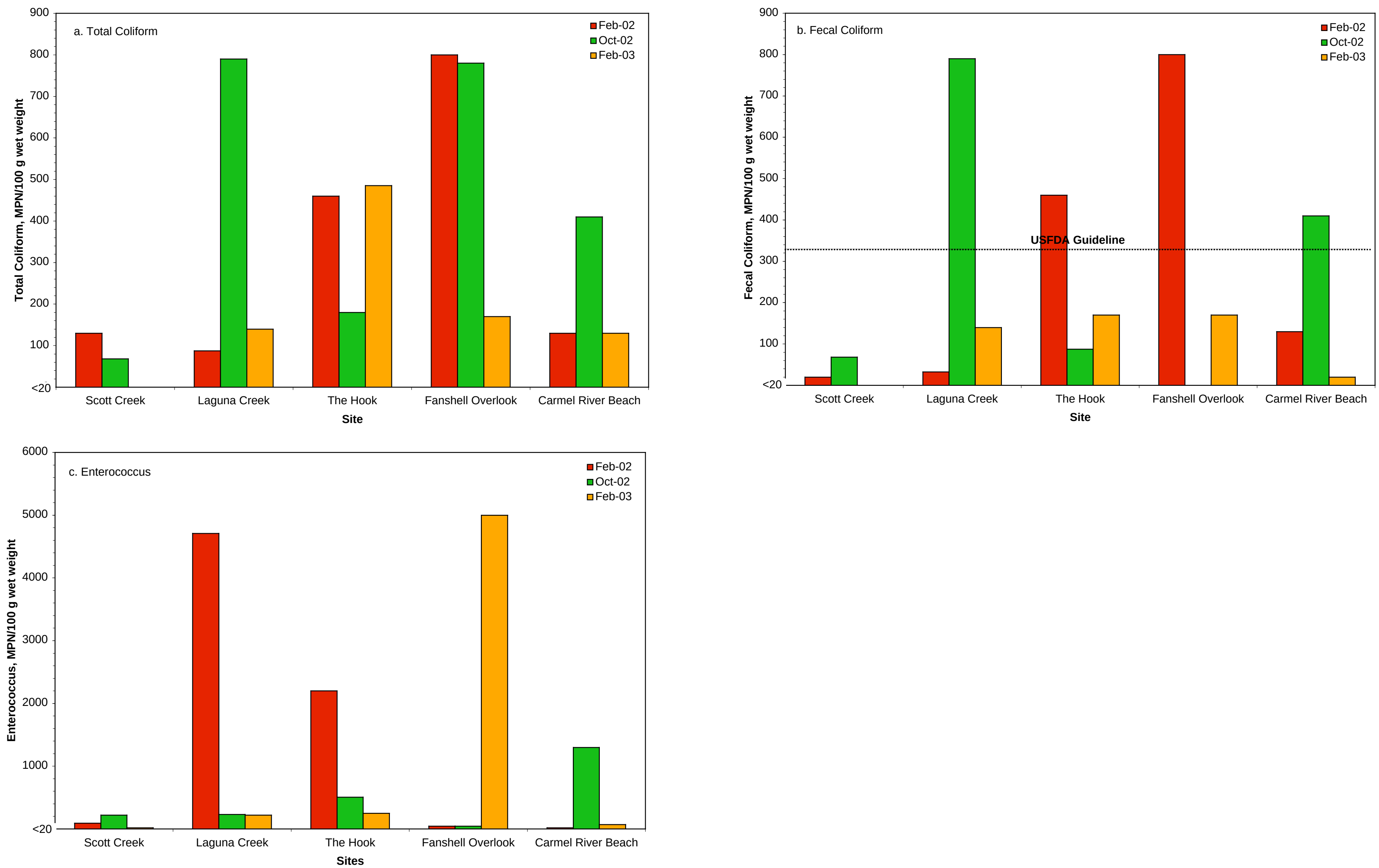

Figure 3.3.5. Concentrations of bacteria in mussels from five CCLEAN sites in the Monterey Bay area. Data were collected in February 2002, October 2002 and February 2003.

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 benthic infauna. 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 being analyzed by MEC.

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

Site Name	Depth, m	Latitude	Longitude
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 being located outside of the Bay northwest of Santa Cruz between Terrace Point and El Jarro Point and a depositional grouping of sites being 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 in Monterey Bay than do sediments at the depositional sites.

3.4.1 Activities

Annual sediment sampling was conducted on September 24, 2002. Samples were collected with a 0.1-m^2 Smith-McIntyre grab sampler. Two samples were taken at each station, one for analysis of benthic infauna and one for analysis of TOC, sediment grain size and concentrations of POPs. Data for 2002 are presented in Appendix E and interpretations in the following section include cumulative results over both years.

3.4.2 Results

Sediment biota was dominated by annelids at all sites, followed by molluscs and arthropods (Table 3.4.2), Moreover, nine of the 16 taxa that were among the 10 most abundant in either year and site category were annelids and three were molluscs (Appendix E).

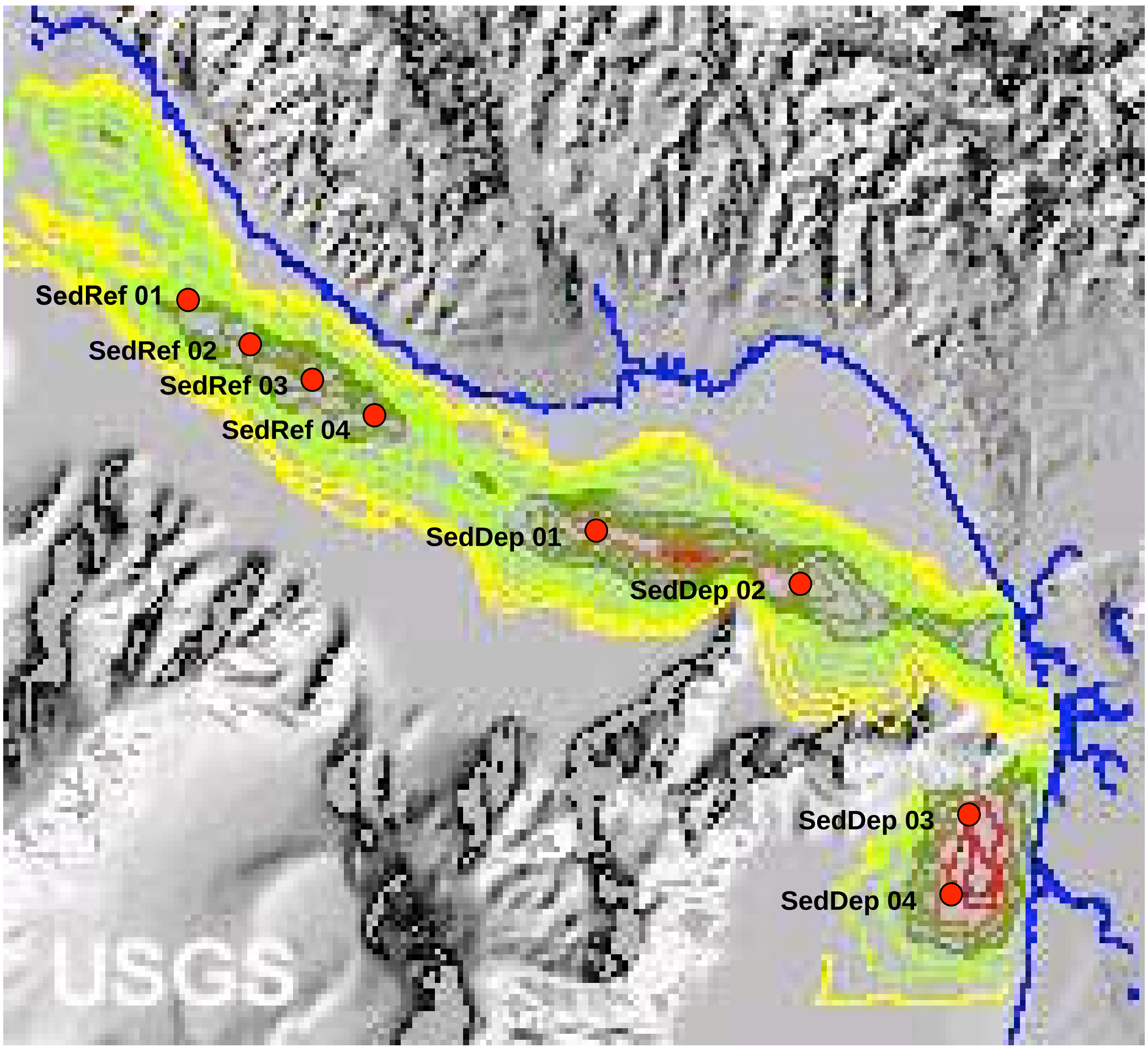

Figure 3.4.1. Location of CCLEAN sediment sampling sites relative to the thickness of Holocene sediments measured by USGS, as indicated by the contour colors; yellow is thinnest, red is thickest (Wong et al., 1999).

As we previously reported (CCLEAN, 2003), sites within each category had similar densities of biota groups, as indicated by generally low coefficients of variation (Table 3.4.2). Arthropods were the most variable within each site category, with coefficients of variation over 50%. Site categories also were similar for densities of biota groups, except that mean densities of arthropods were higher at the deposition sites and mean densities of molluscs were higher at the reference sites.

Table 3.4.2. Mean, standard deviation and coefficients of variation within CCLEAN site categories for sediment biota, sediment quality and POPs in October 2002.

	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	1182.25	131.50	11.12	1265.25	315.90	24.97
Total Taxa	122.50	14.48	11.82	121.75	14.59	11.98
Annelida Abundance	764.75	93.08	12.17	818.50	198.90	24.30
Annelida Taxa	72.75	6.40	8.79	70.50	9.11	12.92
Arthropoda Abundance	95.00	48.87	51.45	166.00	84.31	50.79
Arthropoda Taxa	25.00	6.06	24.22	25.75	11.41	44.32
Mollusca Abundance	201.00	30.84	15.35	158.50	44.35	27.98
Mollusca Taxa	17.50	2.89	16.50	19.75	2.36	11.96
Echinoderm Abundance	66.00	15.71	23.80	75.75	21.09	27.85
Echinoderm Taxa	2.75	0.50	18.18	2.00	0.82	40.82
Misc. Abundance	68.25	16.48	24.15	53.75	20.69	38.50
Misc. Taxa	4.50	1.29	28.69	3.50	0.58	16.50
Sediment Quality, %						
Clay (<4µm)	10.35	1.82	17.58	18.95	3.08	16.27
Silt (4-63µm)	70.65	23.83	33.73	75.93	6.13	8.07
Sand (63µm-2mm)	18.89	25.40	134.46	5.12	3.12	60.88
Gravel/Shell (>2mm)	0.10	0.21	200.00	0.004	0.01	141.42
TOC	0.75	0.11	14.44	0.96	0.05	5.47
POPs, µg/Kg dry weight						
Low-Weight PAHs	33.30	9.01	27.05	56.23	8.04	14.29
High-Weight PAHs	54.52	9.84	18.05	72.42	17.39	24.01
Total PAHs	87.82	18.48	21.05	128.65	20.24	15.73
Total PCBs	0.59	0.29	48.37	0.35	0.13	36.61
Total DDTs	5.57	0.75	13.49	6.79	1.13	16.66
Total Chlordanes	0.080	0.034	42.36	0.102	0.045	43.97
Total HCHs	0.486	0.310	63.71	0.086	0.026	30.59

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

There were no temporal trends in benthos with most benthic groups and taxa varying little between years. Total annelids, arthropods, miscellaneous biota and echinoderms generally were similar between years at each site, while molluscs exhibited greater variation between years at some sites (Figure 3.4.2). Five of the six most abundant taxa across both site categories and years also were similar between years at most sites (Figure 3.4.3). The polychaetes *Cossura pygodactylata* (Figure 3.4.3a), *Pholoe glabra* (Figure 3.4.4e) and *Levinsenia gracilis* (Figure 3.4.3f) and the echinoderm *Amphiodia* sp. (Figure 3.4.3d) varied between years at one or two sites, while the bivalve *Axinopsida serricata* (Figure 3.4.3b) varied substantially at five sites. The indeterminate species of the polychaete *Mediomastus* was very similar between years at all sites (Figure 3.4.3b).

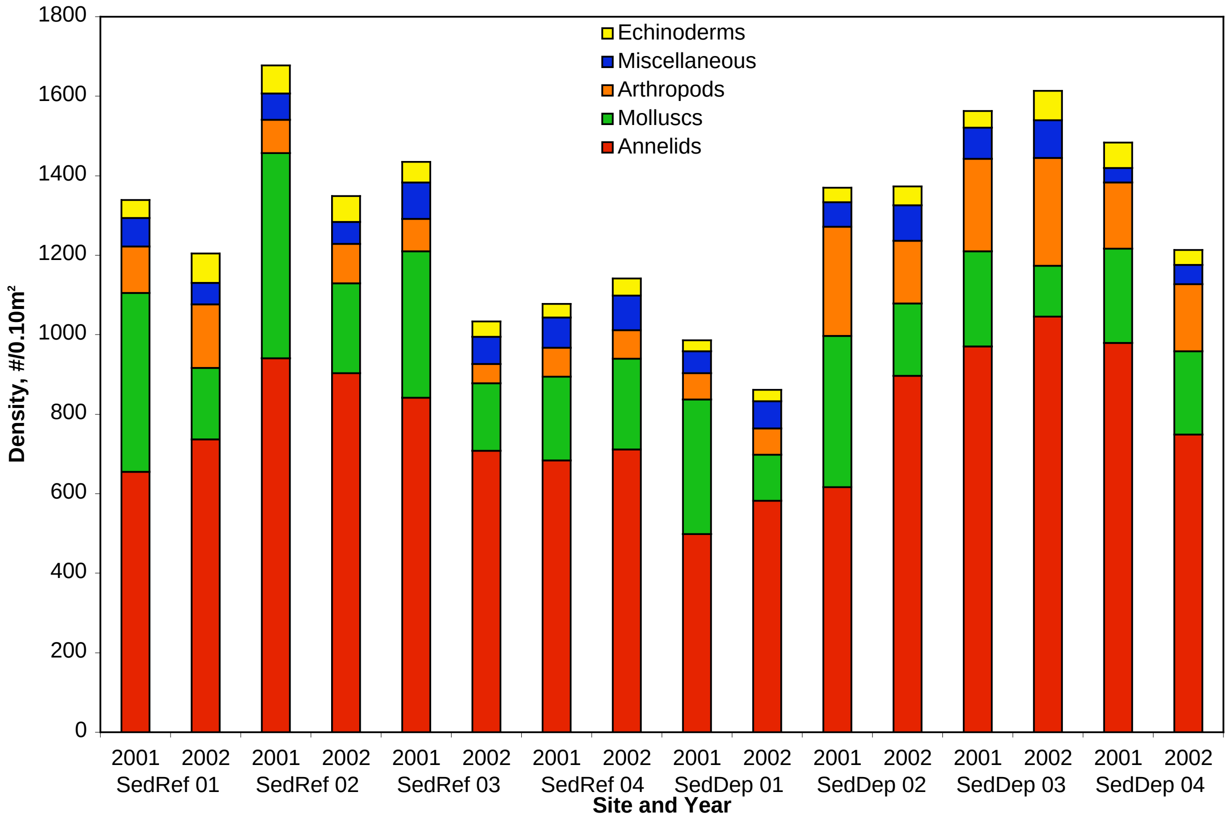

Figure 3.4.2. Total densities of biota groups at eight CCLEAN sites in 2001 and 2002.

Sediment texture was dominated by silt at all sites except for SedRef 01, which had higher a percentage of sand than silt (Appendix E), and mean percentages of silt-sized particles were similar between site categories (Table 3.4.2). There was slightly more sand and gravel 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 60.88 to 134.46 and from 141.42 to

200, respectively. Sediment texture did not vary substantially across years. The percentages of each sediment size fraction were consistent between years at all sites (Figure 3.4.4).

Sediment total organic carbon (TOC) was slightly higher and less variable among the depositional sites than among the reference sites (Table 3.4.2 and Appendix E). Higher variation within the reference category was due to lower TOC at SedRef 01 that at the other three reference sites (Appendix E). As with the sediment texture parameters, there was very little variation in TOC between years at any site (Figure 3.4.5).

Sediment POPs were dominated by PAHs across both site categories with high-molecular weight PAHs having higher concentrations than low-molecular weight PAHs at every site except SedDep 03 (Table 3.4.2 and Appendix E). The depositional sites had slightly higher mean concentrations of PAHs, DDTs, and chlordanes than did the reference sites, whereas the reference sites had slightly higher mean concentrations of PCBs and HCHs than did the depositional sites.

There were no temporal trends in POPs. PAHs, DDTs and chlordanes were very similar between years at all sites, except for a very high oxychlordane contribution to total chlordanes at SedRef 01 in 2001 (Figure 3.4.6). PCBs and HCHs were more variable between years but, from 2001 to 2002, some sites increased and some sites decreased.

The sediment concentrations of two POPs measured at CCLEAN sites in 2002 exceeded 2002 averages in San Francisco Bay and some NOAA sediment guidelines. DDT concentrations consistently exceeded averages for San Francisco Bay (Figure 3.4.6c) and some 2002 HCHs also exceeded averages for San Francisco Bay (Figure 3.4.6e). In particular, the 2002 concentrations of DDTs at CCLEAN sites were 2.9 to 4.6 times higher than the average for San Francisco Bay. The NOAA ERL (Effects Range Low) indicated in Figure 3.4.6c refers to sediment guidelines developed by the U.S. National Oceanic and Atmospheric Administration based upon the incidence of acute toxicity that has been observed in laboratory tests (Long, Hong & Severn, 2001; Long et al., 2000; Long et al., 1995). The Effects Range Low describes the 10^{th} percentile of concentrations that have exhibited toxicity. Below the ERL, toxic effects are rarely observed, whereas exceeding the ERL leads to increased incidence of acute toxicity. All of the CCLEAN sites exceeded by 3–6 times the ERL for DDTs, but the ERLs were not exceeded for any of the other POPs (Table 3.4.3).

Because DDT can bind tightly to organic matter in sediments, some investigators prefer to infer toxic effects of DDT from concentrations normalized to organic carbon (Swartz et al., 1994). Swartz et al. have suggested that the threshold for ecotoxicological effects of DDT in sediments on amphipods is approximately 100 mg ΣDDT/g OC, which is substantially above DDT concentrations normalized to organic carbon in CCLEAN samples (Figure 3.4.7)

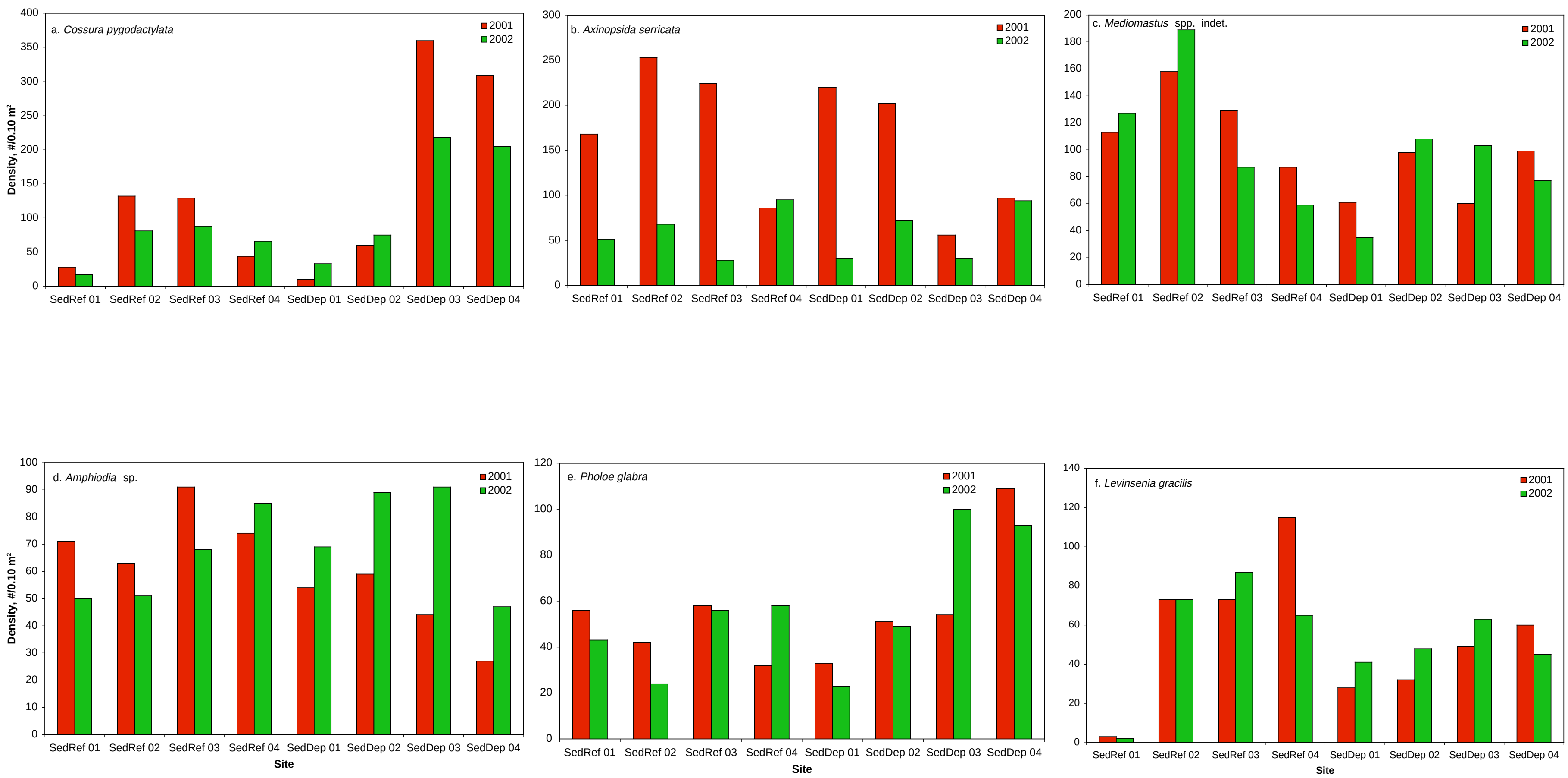

Figure 3.4.3. Densities of the six most abundant benthic species across both site categories in 2001 and 2002.

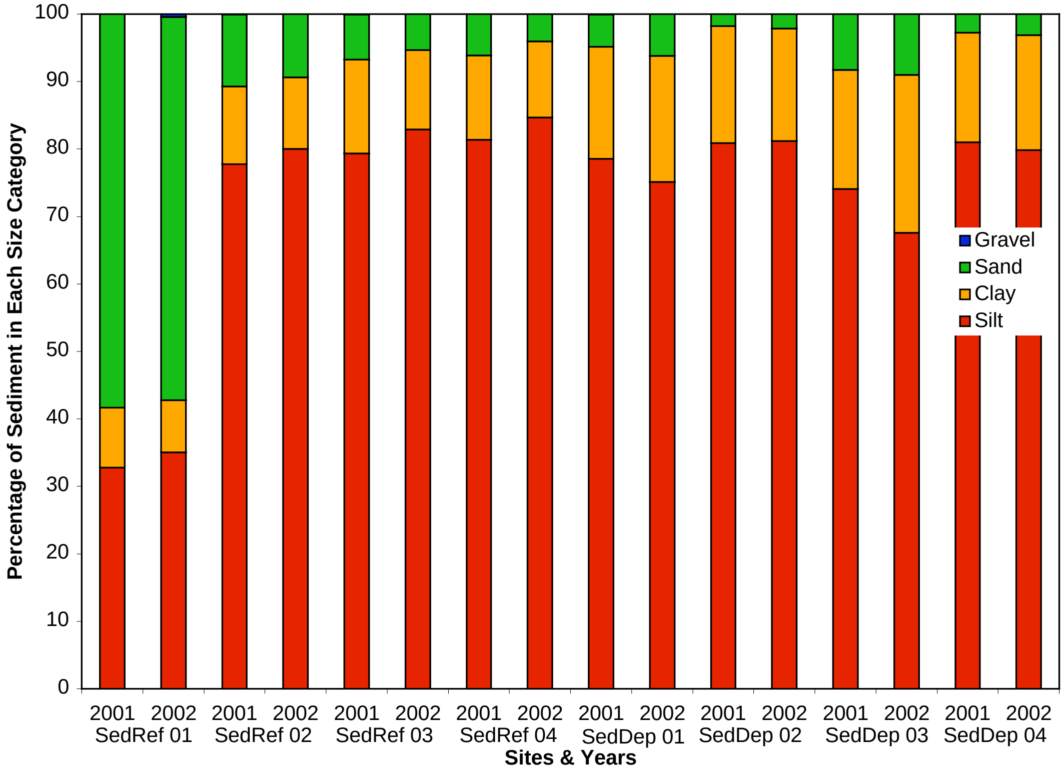

Figure 3.4.4. Percentages of silt, clay, sand and gravel in sediments collected at eight CCLEAN sites in 2001 and 2002.

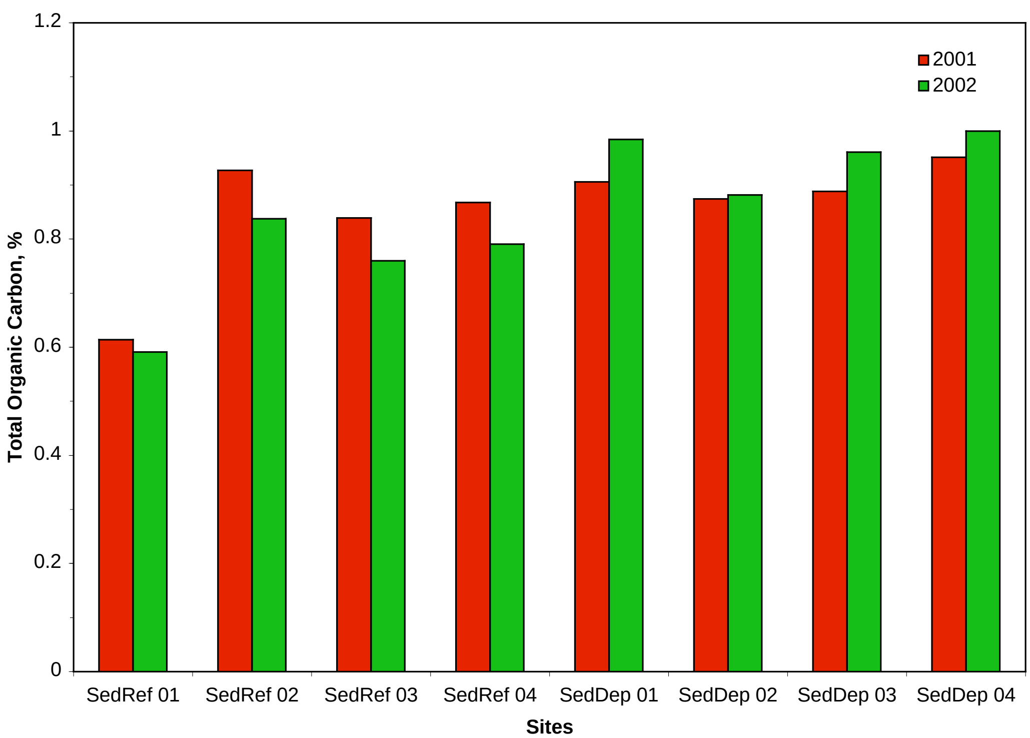

Figure 3.4.5. TOC in sediments collected at eight CCLEAN sites in 2001 and 2002.

Table 3.4.3. NOAA ERL values (μg/kg dry weight) for sediment POPs.

POP	ERL
LPAHs	552
HPAHs	1700
DDTs	1.58
PCBs	22.7

Although sediments at CCLEAN sites appear to not exceed toxicity thresholds for DDT or NOAA sediment guidelines for other POPs, the sediment data were analyzed to determine whether sediment parameters might have subtle effects on the densities of benthic taxa. Stepwise linear regressions were performed using sediment TOC, percent fines (silt + clay) and POPs normalized to organic carbon as the independent variables and the densities of the 16 most abundant taxa as the dependent variables (Table 3.4.4). Ten of the 16 most abundant taxa and two taxonomic groups had significant regressions, with five taxa (i.e., *Cossura pygodactylata*, *Pholoe glabra*, *Protomedeia articulata*, Nemertea and *Scoletoma tetraura*) and both groups (i.e., Annelida and Echinodermata) indicating negative effects of POPs. Three taxa were positively associated with POPs (i.e., *Levinsenia gracilis*, Maldaninae spp. juv. and *Prionospio steenstrupi*). TOC and percent fines affected five taxa and the two groups either separately or in combination with POPs. While 16 samples is not a large enough number to definitively ascribe biological effects of sediment POPs, the results of the regression analysis suggest that many of the benthic taxa may be affected by POPs.

One species, the polychaete *Cossura pygodactylata*, exhibited especially strong negative effects of DDT (Table 3.4.4; $p = <0.0001$, adjusted $r^2 = 0.7158$). A bivariate plot of organism density versus normalized DDT concentrations reveals that this negative relationship was consistent in both site categories and years (Figure 3.4.8).

The locations of DDT sources can be inferred by examining the contribution of individual isomers to total DDTs. Although some DDE was applied to agricultural fields as an insecticide, applications consisted mostly of DDT, which degrades over time into DDD and DDE. Irrespective of total DDT concentrations in sediments, the greatest percentage of total DDTs was contributed by DDT at the four depositional sites, especially site SedDep 03 and SedDep 04 offshore the Salinas River (Figure 3.4.9). These results suggest the main historic sources of DDTs to Monterey Bay are near the apex of the bay.

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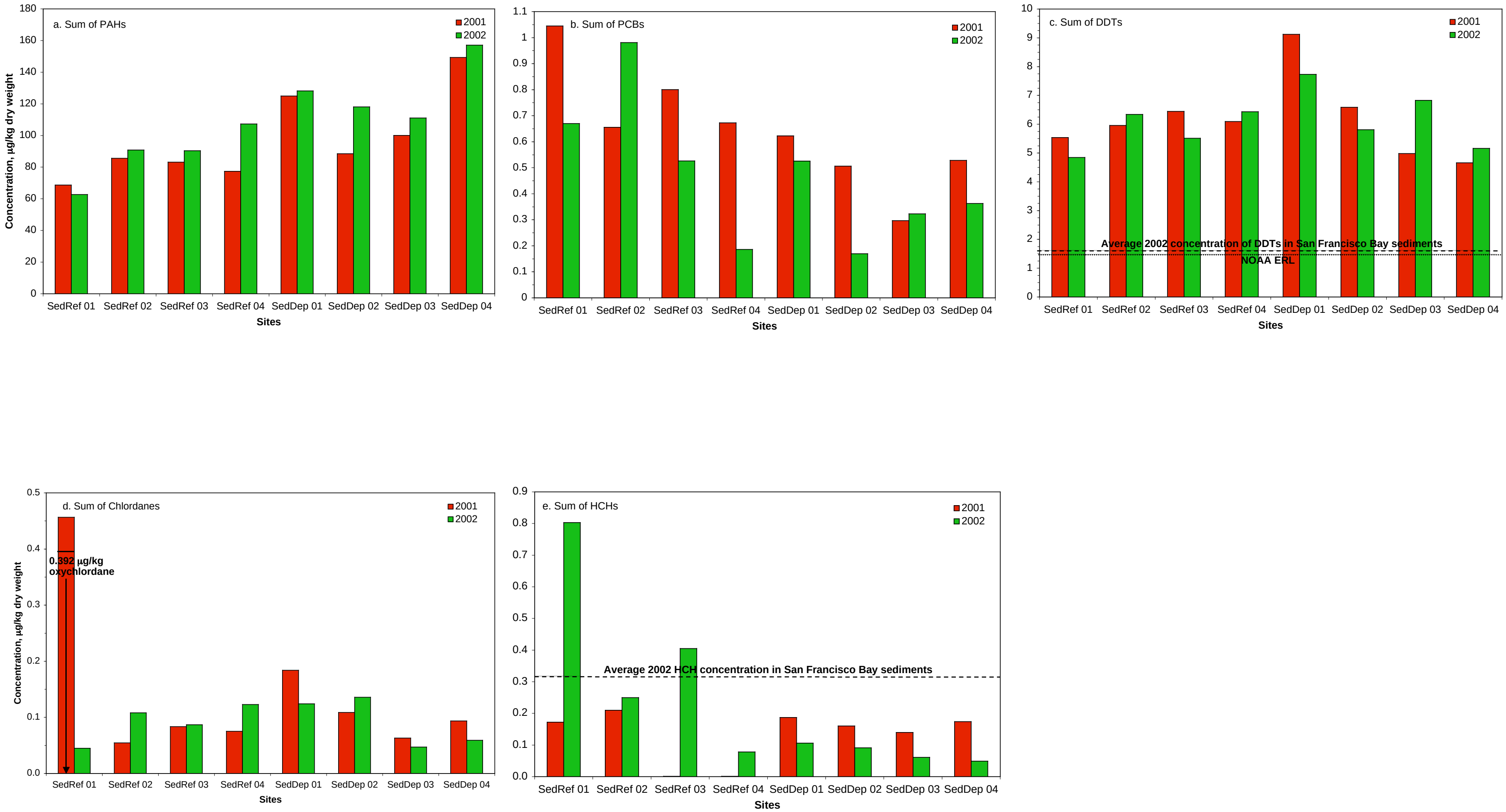

Figure 3.4.6. POPs in sediments collected from eight CCLEAN sites in 2001 and 2002.

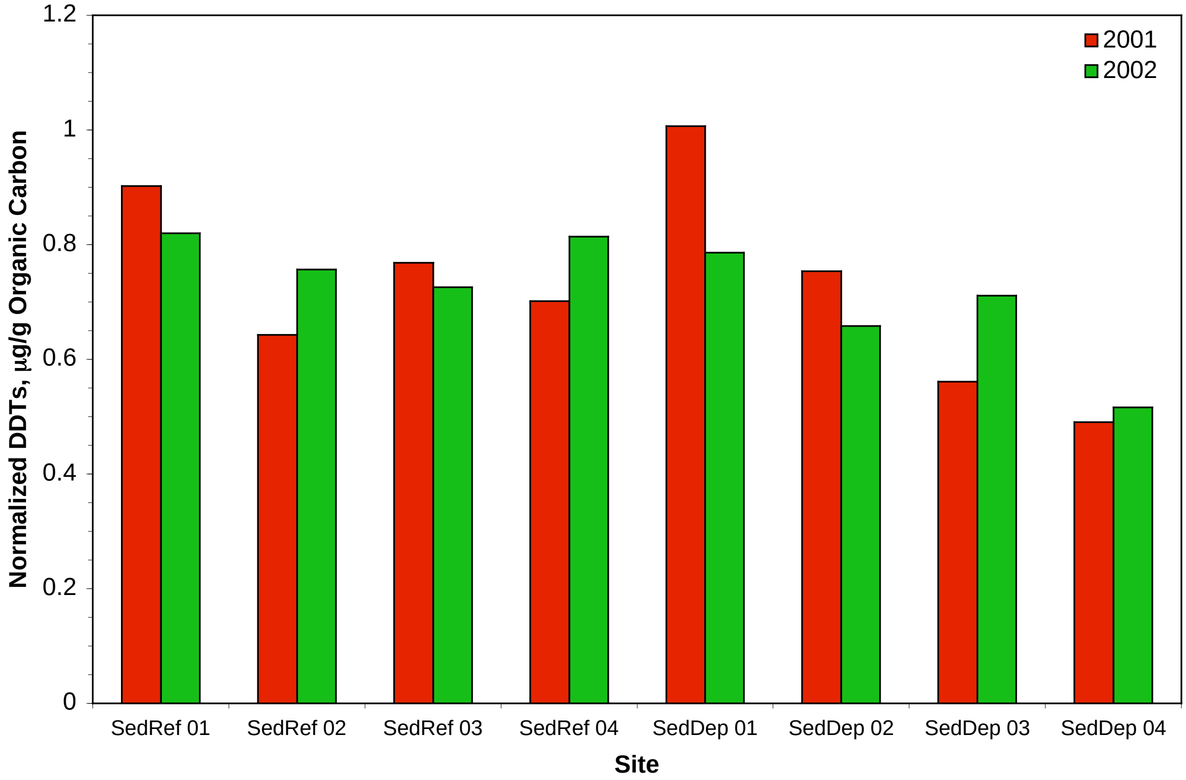

Figure 3.4.7. Sediment concentration of DDTs normalized to total organic carbon at eight CCLEAN sites in 2001 and 2002.

Table 3.4.4. Results of stepwise multiple regressions for the effects of TOC, fines (silt + clay), PAHs, DDTs, PCBs, chlordanes, and HCHs on infaunal densities (number per $0.1m^2$) in 16 sediment samples collected over two years. All POP concentrations were normalized to organic carbon and all data were log transformed.

Taxon	*P*	Adjusted r^2	Equation
Cossura pygodactylata	<0.0001	0.7158	y = -11.11 DDT + 4.50
Pholoe glabra	0.0375	0.2220	y = -3.04 DDT + 2.42
Levinsenia gracilis	<0.0001	0.8482	y = 3.81 Fines – 5.78
Nephthys cornuta	0.0227	0.3555	y = 2.89 TOC + 3.06 DDT + 0.20
Protomedeia articulata	0.0103	0.3411	y = -28.89 PCB + 1.94
Rochefortia tumida	0.0278	0.2509	y = -5.23 TOC + 2.95
Nemertea	0.0547	0.2622	y = -0.922 Fines – 13.42 Chlordanes + 3.41
Maldaninae spp. Juv.	0.0360	0.3080	y = 1.59 fines + 5.29 DDT – 3.09
Scoletoma tetraura	0.0123	0.4133	y = -1.77 PAH – 10.82 PCB + 3.69
Prionospio steenstrupi	0.0023	0.4622	y = 16.03 PCB + 0.65
Total Annelida	0.0043	0.4131	y = -1.82 DDT + 3.31
Total Echinodermata	0.0103	0.5518	y = -3.77 TOC – 0.86 PAH – 5.43 PCB – 6.55 HCH + 4.01

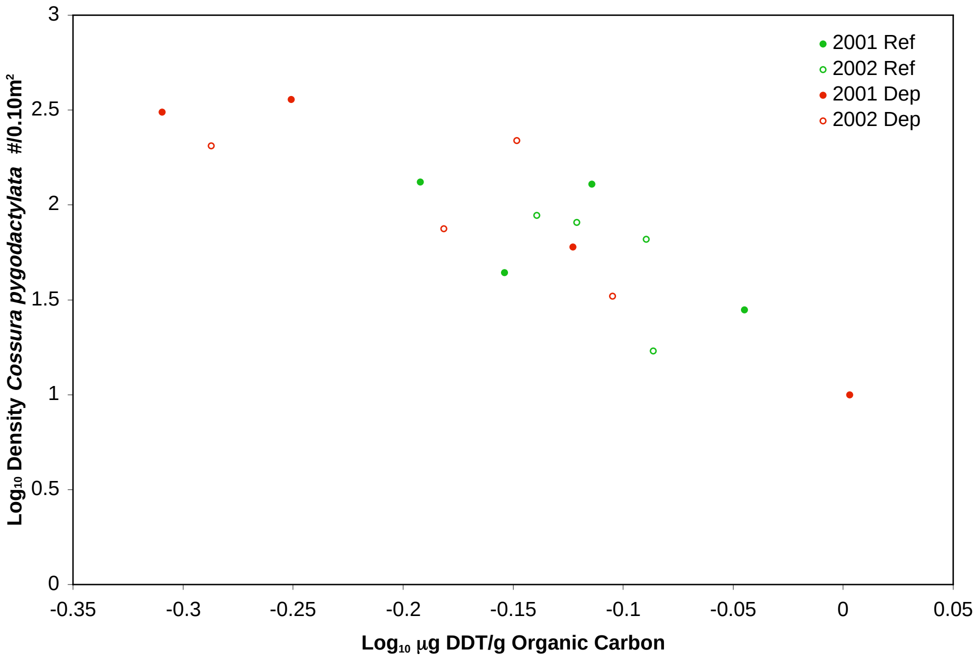

Figure 3.4.8. Bivariate plot showing the relationship between DDT concentration normalized to organic carbon and the density of the polychaete *Cossura pygodactylata*.

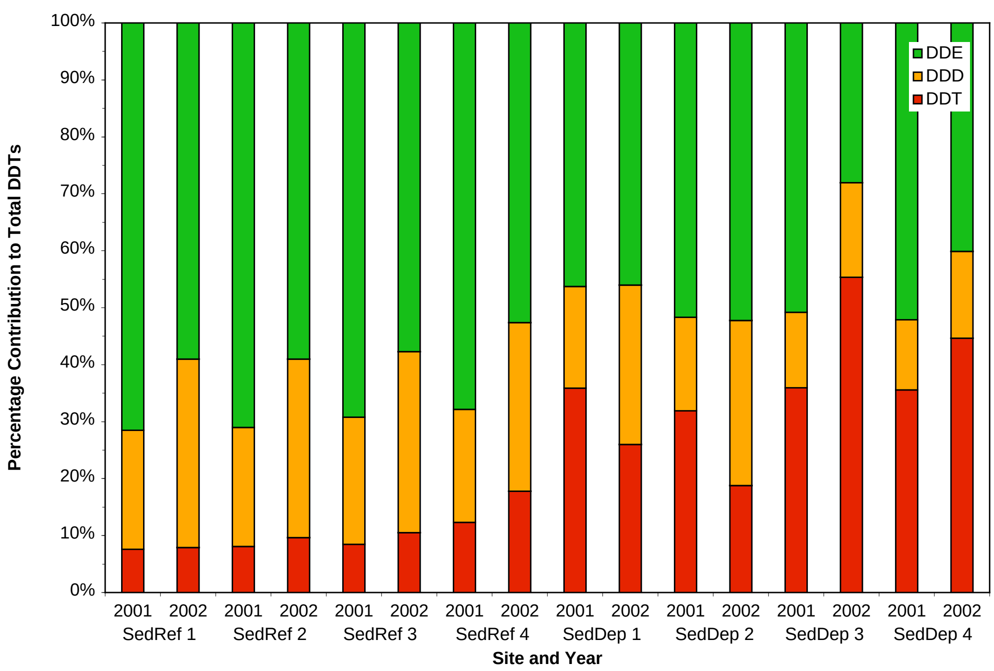

Figure 3.4.9. Percentage of total DDTs contributed by each of three isomers in sediments from eight CCLEAN sites sampled in 2001 and 2002.

3.4.3 Current Status

The third sediment sampling was conducted on October 21, 2003. The results from this effort will be reported in the 2003-2004 Annual Report. During this sampling, two replicates were collected from each site for analysis of benthic fauna to assess within-site variation. Data from these duplicate samples will be analyzed before a second year of duplicate samples is authorized.

3.4.4 Recommendations

We currently have no recommendations for the sediment sampling component.

3.5 Stream and River Sampling

Monthly sampling of 16 coastal sites in Monterey and Santa Cruz Counties of analysis of nutrients, total suspended solids and bacteria continued in 2002-2003. Site descriptions are presented in Table 3.5.1. The objective of this sampling is to determine sources and loads of discharged nutrients, suspended sediments and bacteria to near-shore waters.

Beginning in October 2002, sampling was begun at San Lorenzo River, Pajaro River, Salinas River and Carmel River for analysis of POPs. The objective of this sampling is to determine the loads of POPs into nearshore waters from the four major rivers.

3.5.1 Activities

Samples continue to be collected by the environmental Health Departments for Santa Cruz and Monterey Counties, usually at regular monthly intervals. Samples are analyzed for urea (urea-N), nitrate (NO_3-N), dissolved silica (SiO_2), total suspended solids, and total coliform, *E. coli*, and *Enterococcus* bacteria. Annual loads for all analyzed constituents are estimated for sites that have USGS stream gauge data available. These loads are estimated by calculating daily load for each grab sampling date (flow multiplied by grab sample concentration), calculating the mean for all daily loads estimated for the site, and multiplying the mean daily load by 365. As stated in last year's report, it must be recognized that our estimated loads, which are derived from grab samples, are likely underestimates 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 3.1). Sampling is performed twice per year, during the dry season and during the wet season (Table 3.5.2). Each sample is collected over an approximately 30-day period using solid-phase extraction methods. The annual load of each constituent was 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. Stream flow data were obtained from USGS stream gauges. Flow was reported for Carmel River on only 190 days during the July 2002 – June 2003 period, so the wet-season average daily load was multiplied by 190 to estimate annual loads from this river. POPs were analyzed by Axys and ToxScan (for chlorpyrifos and diazinon).

3.5.2 Results

3.5.2.1 Monthly Sampling

Results for mean grab sample concentrations for nutrients, total suspended solids, and geometric mean concentrations for bacteria from July 2002 through June 2003 are summarized in Table 3.5.3. A summary of all available data is provided in Appendix F-1. Total coliform results exceeding 24191 MPN/100mL were included in the analysis, but it should be noted that they are above the upper detection limit. Highlighted values for *E. coli* exceed the geometric mean water quality objective of 126 MPN/100mL, as proposed in the Basin Plan Amendment for Water Contact Recreation.

Table 3.5.1. Stream and river sites being sampled by Santa Cruz and Monterey counties for CCLEAN.

Sampler	Site Name	Site Location
Santa Cruz County	Waddell Creek	at Hwy 1
Santa Cruz County	Scott Creek	at Hwy 1
Santa Cruz County	Laguna Creek	at mouth
Santa Cruz County	Moore Creek	at mouth
Santa Cruz County	San Lorenzo River	at Laurel Street Bridge
Santa Cruz County	Branciforte Creek	at Isbel Drive
Santa Cruz County	Porter Gulch	at New Brighton Beach
Santa Cruz County	Soquel Creek	under RR trestle
Santa Cruz County	Aptos Creek	at Winfield Street
Santa Cruz County	Pajaro River	at Thurwacher Bridge
Monterey County	Elkhorn Slough	at Kirby Park
Monterey County	Elkhorn Slough	at North Jetty
Monterey County	Salinas River	Salinas River at Davis Road
Monterey County	Carmel River	at Garland Park
Monterey County	Carmel River	at Hwy 1
Monterey County	Big Sur River	at Andrew Molera State Park downstream of Hwy 1

Table 3.5.2. Dates and volumes of river POP samples, 2002–2003.

Season	River	Start Date	End Date	Number of Liters Sampled
Dry				
	San Lorenzo	October 3, 2002	November 1, 2002	369
	Pajaro	October 3, 2002	November 1, 2002	294
	Salinas	October 5, 2002	November 5, 2002	72
	Carmel	Not Sampled (no flow)	-	-
Wet				
	San Lorenzo	January 27, 2003	May 15, 2003	392
	Pajaro	January 29, 2003	May 14, 2003	79
	Salinas	January 27, 2003	May 14, 2003	61
	Carmel	January 24, 2003	May 14, 2003	181

Estimated annual loads of all nutrients, TSS, and bacteria for sites with available USGS flow data were generally greatest from the Pajaro River (Table 3.5.4).

The 2002-2003 sampling season had higher loads of total coliform, *E. coli,* and *Enterococcus* than the 2001-2002 sampling season at all sites, with the Pajaro River showing the most marked increase in the annual load of these indicator organisms (Figure 3.5.1). Total suspended solids, urea and nitrate loads also were greater for all sampling sites in the 2002-2003 sampling season, with the exception of the San Lorenzo River, where the estimated annual loads of silica and urea decreased (Figure 3.5.2). Estimated annual loads of nitrate decreased for the 2003-2003 sampling season at all sites except for Soquel Creek, which showed a slight increase in annual loads.

The 2002-2003 loads of bacteria, total suspended solids and nutrients varied by sampling date and location (Figure 3.5.3 and Figure 3.5.4). Summations of daily loads on the sampling dates for each of the six streams and rivers with flow data were much higher in December 2002 and generally higher is the wet season, consistent with rainfall patterns (see Figure 3.2.4). Moreover, in December, the Pajaro River had the highest load of every analyte, except dissolved silica (Figure 3.5.4b).

These six streams and rivers contributed higher annual loads of some constituents to nearshore waters than did the four wastewater discharges (Figure 3.5.5). The combined loads of dissolved silica, total suspended solids and nitrate from San Lorenzo River, Soquel Creek, Pajaro River, Salinas River, Carmel River and Big Sur River were 3–33 times higher than those from wastewater discharges in 2001-2002 and 2002-2003 (Figure 3.5.5a–c). Conversely, the load of urea was greater from wastewater than from rivers (Figure 3.5.5d). Measurement of ammonia in rivers and streams began in 2003-2004 and this nutrient will be added to the comparison of loads in next year’s report.

Table 3.5.3. Mean concentrations of nutrients and total suspended solids (TSS), and geometric mean concentrations of bacteria at CCLEAN stream and river sampling sites from June 2002 through July 2003. Non-detect values treated as "0" for nutrients and TSS (due to differing detection limits for Santa Cruz and Monterey Counties) and as one half the detection limit of 10 MPN/100mL for bacteria. Highlighted values for E. coli exceed the geometric mean water quality objective of 126 MPN/100mL, as proposed in the Basin Plan Amendment for Water Contact Recreation.

Site	NO_3-N (mg/L)	SiO_2 (mg/L)	Urea-N (µg/L)	TSS (mg/L)	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Waddell Creek @ HWY 1	0.10	23.52	7.26	5.48	382	26	9
Scott Creek @ HWY 1	0.07	25.98	8.04	5.60	388	47	9
Laguna Creek @ Mouth	0.12	22.58	11.61	17.84	864	53	11
Moore Creek @ Mouth	0.32	18.59	13.07	14.40	3130	41	15
Branciforte Creek @ Isabel Dr.	0.41	37.41	4.25	8.14	1358	151	16
San Lorenzo River @ Laurel St.	0.18	25.16	2.23	4.64	1766	133	16
Soquel Creek @ RR Bridge	0.14	28.97	6.84	27.16	1147	172	14
Porter Gulch @ Mouth	1.36	36.29	8.71	271.64	2187	222	15
Aptos Creek @ Winfield Dr.	0.26	34.29	2.23	136.26	1418	222	36
Pajaro River @ Thurwachter Rd.	2.07	20.42	10.06	18.68	2832	83	15
Elkhorn Slough @ Kirby Park	0.25	1.39	15.25	13.94	48	10	8
Elkhorn Slough @ N. Jetty	0.75	0.71	6.92	4.50	85	13	7
Salinas River @ Davis Rd.	51.92	8.60	20.25	14.00	6994	85	15
Carmel River @ Garland Park	ND	22.71	10.08	ND	1551	45	29
Big Sur River @ Andrew Molera	ND	21.72	2.75	ND	1023	19	11
Carmel River @ HWY 1	ND	21.98	3.20	ND	683	15	9

Table 3.5.4. Estimated Annual Loads of Nutrients, TSS, and bacteria discharged into near-shore waters from July 2002 to June 2003.

NO3-N (kg/year)		Urea-N (kg/year)		SiO2 (kg/year)		TSS (kg/Year)	
Site	**Load**	**Site**	**Load**	**Site**	**Load**	**Site**	**Load**
Pajaro River	3.04E+05	Pajaro River	1.12E+03	San Lorenzo River	2.67E+06	Pajaro River	6.54E+06
Salinas River	1.41E+05	Soquel Creek	1.90E+02	Pajaro River	1.90E+06	Soquel Creek	3.33E+06
Soquel Creek	8.01E+03	Big Sur River	1.80E+02	Carmel River	1.40E+06	San Lorenzo River	1.32E+06
San Lorenzo River	5.21E+03	San Lorenzo River	1.42E+02	Big Sur River	1.09E+06	Salinas River	2.60E+05
Big Sur River	0	Carmel River	1.00E+02	Soquel Creek	7.59E+05	Big Sur River	0
Carmel River	0	Salinas River	7.16E+01	Salinas River	2.50E+05	Carmel River	0

Total Coliform (Millions/year)		E. Coli (Millions/year)		Enterococcus (Millions/year)	
Site	**Load**	**Site**	**Load**	**Site**	**Load**
Pajaro River	8.52E+09	Pajaro River	6.37E+08	Pajaro River	5.79E+08
San Lorenzo River	3.66E+09	San Lorenzo River	2.77E+08	San Lorenzo River	8.74E+07
Salinas River	7.53E+08	Soquel Creek	9.83E+07	Carmel River	1.75E+07
Carmel River	7.26E+08	Carmel River	1.34E+07	Soquel Creek	1.60E+07
Soquel Creek	6.00E+08	Big Sur River	8.78E+06	Salinas River	5.98E+06
Big Sur River	4.22E+08	Salinas River	7.02E+06	Big Sur River	5.41E+06

3.5.2.2 POP Sampling

Dry-season and wet-season sampling captured seasonal differences in river flow regimes (Figure 3.5.6). Although no flow occurred in the Carmel River during the 2002 dry season, dry-season flow at each of the other rivers was below the annual median and 2003 wet season flow was substantially above the median.

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 3.5.7).

PAHs, DDTs, chlordanes, endosulfans and PCBs all had higher mean daily loads in the wet season than in the dry season (Figure 3.5.7a–e), consistent with the pattern for bacteria, total suspended solids and nutrients (Figure 3.5.3 and Figure 3.5.4). Conversely, there were higher daily loads of HCHs, which had the lowest overall loads of any of these POP groups, in the dry season from each of the three rivers that had dry-season flow (figure 3.5.7f). Wet-season loads of PAHs, DDTs, chlordanes, endosulfans and PCBs were much higher from the Pajaro River than from any of the other rivers. In the 2003 wet season, loads of PAHs, DDTs, chlordanes, endosulfans and PCBs from the Pajaro River were 3–25 times greater than those from the river with the next highest load, which also was similar to the pattern for bacteria, total suspended solids and nutrients.

Load estimates from these four rivers are subject to at least two sources of uncertainty. First, there are beach berms that impound 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 beach berm is in place. In this case, the estimated loads would be higher than actual loads. A second source of uncertainty might bias the load estimate downward from actual loads. The wet-season 2003 sampling was planned for a time with expected rainfall and associated river flows. It did not, however, capture the first major storm-related flow of the season when concentrations of POPs probably would be highest.

Regardless of uncertainties in the estimated loads of POPs from rivers, combined loads from all four rivers during the 2002-2003 project year greatly exceeded the combined loads from wastewater discharges for most POPs (Figure 3.5.8). Loads of PAHs, DDTs, Chlordanes, Endosulfans and PCBs were 4, 54, 3, 2 and 1.4 times higher, respectively, from rivers than from wastewater (Figure 3.5.8a-e). Conversely, the annual load of HCHs from wastewater was more than 100 times greater than that from rivers (Figure 3.5.8f).

As indicated by Figure 3.5.7, the Pajaro River contributed 58–95% of the total annual river load for each of the POP groups. In particular, the load of DDTs from the Pajaro River deserves further examination. The loads of total DDTs from San Lorenzo, Pajaro and Salinas rivers all contained DDT as a major component (Figure 3.5.9), which suggests that each of these watersheds contain soil contaminated with undegraded legacy DDT. Moreover, the load of DDT from the Pajaro River was 174 grams, accounting for 96% of the DDT load from rivers. Because DDT was not detected in any of the wastewater discharges, although both DDD and DDE were, the Pajaro River likely was the primary source of DDT to Monterey Bay in the 2002-2003 sampling year. This observation is consistent with the higher percentages of DDT in total DDTs in sediments near the apex of Monterey Bay than in those farther to the west (Figure 3.4.9).

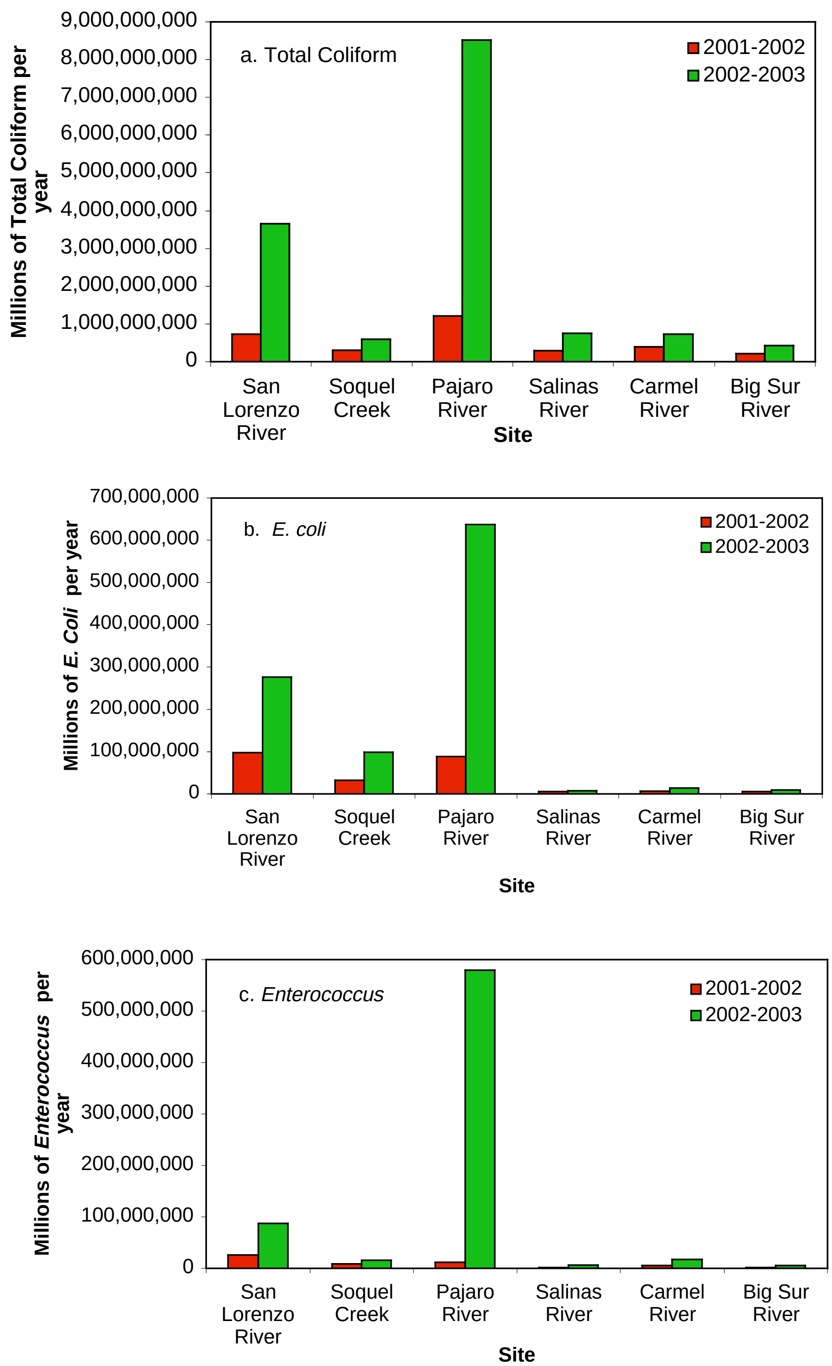

Figure 3.5.1. Annual loads of bacteria to nearshore waters from six streams or rivers during the 2001-2002 and 2002-2003 sampling seasons.

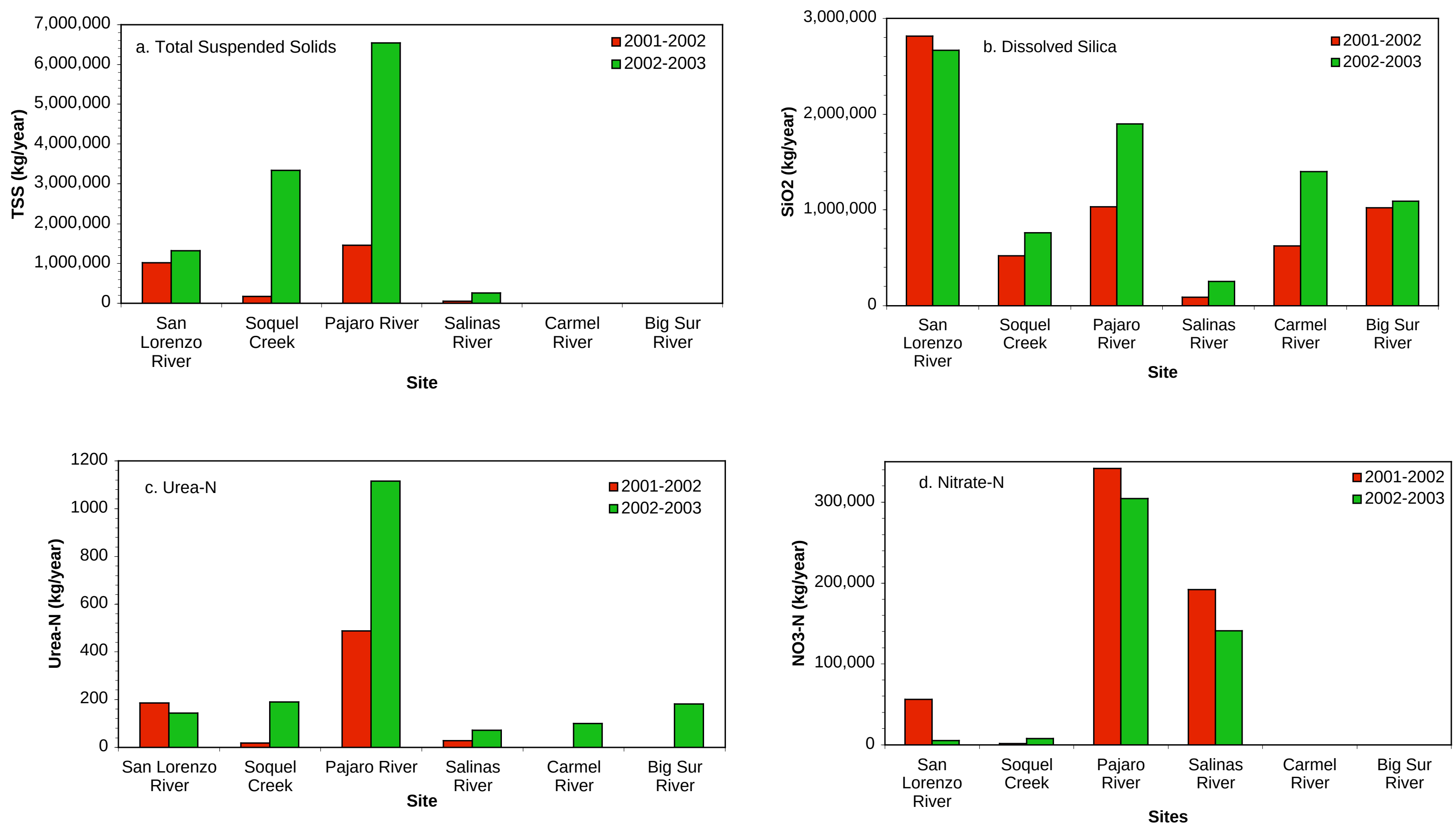

Figure 3.5.2. Annual loads of total suspended solids, dissolved silica, urea and nitrate into near-shore waters from six streams and rivers during the 2001-2002 and 2002-2003 sampling seasons.

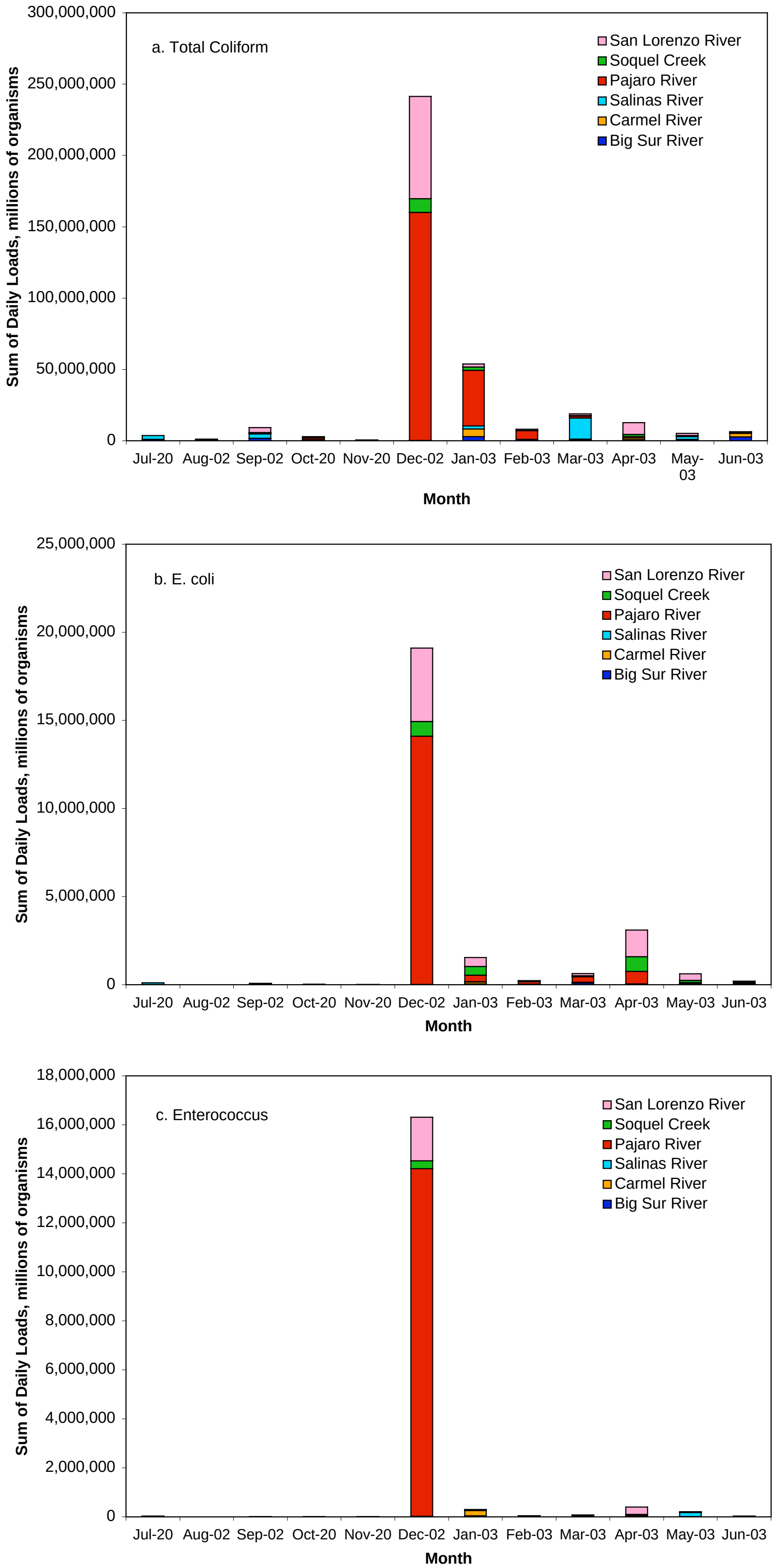

Figure 3.5.3. Sums of daily loads of bacteria estimated from samples collected on monthly sampling dates at each of six streams and rivers.

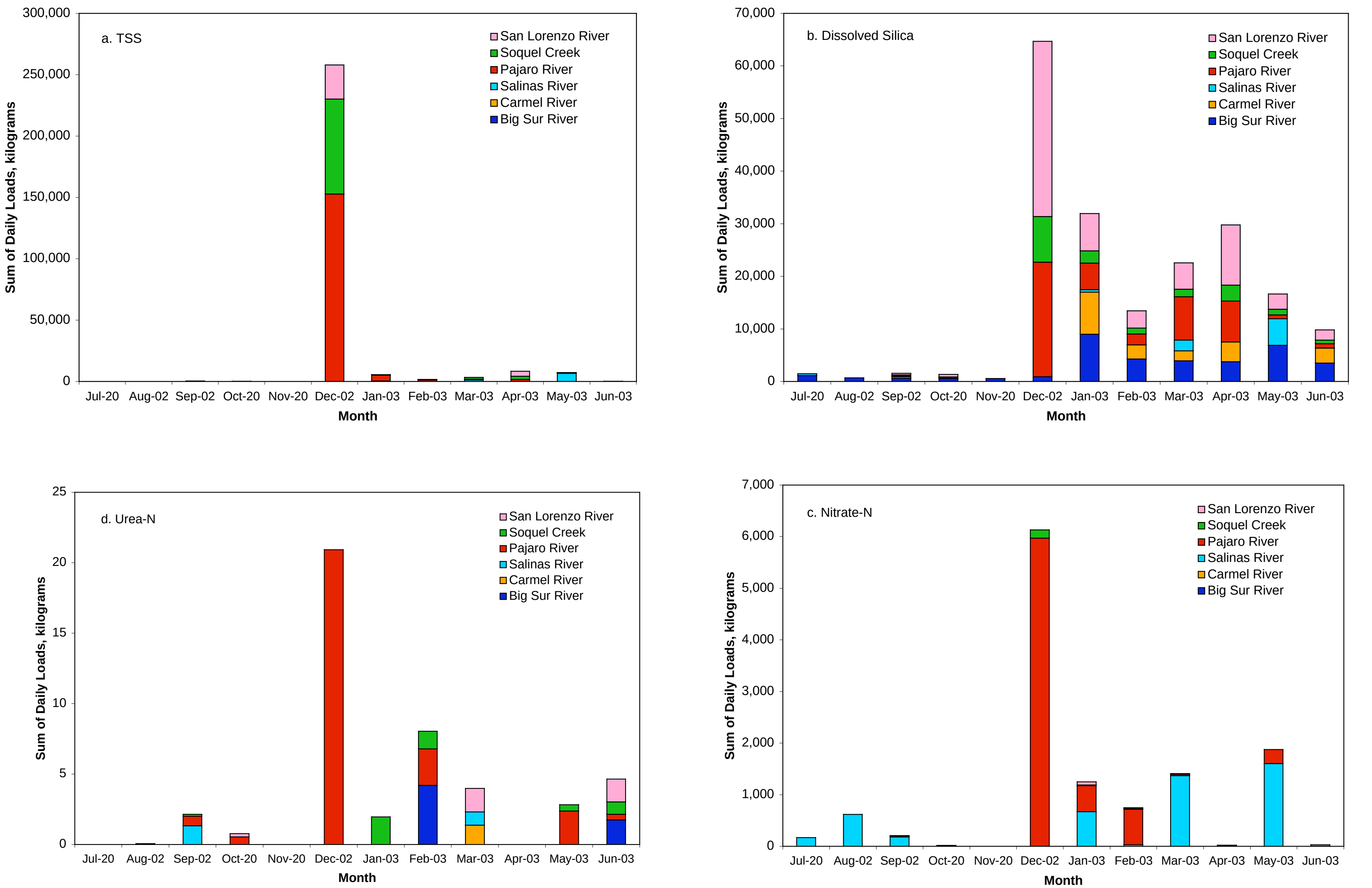

Figure 3.5.4. Sums of daily loads of total suspended solids and nutrients estimated from samples collected on monthly sampling dates at each of six streams and rivers.

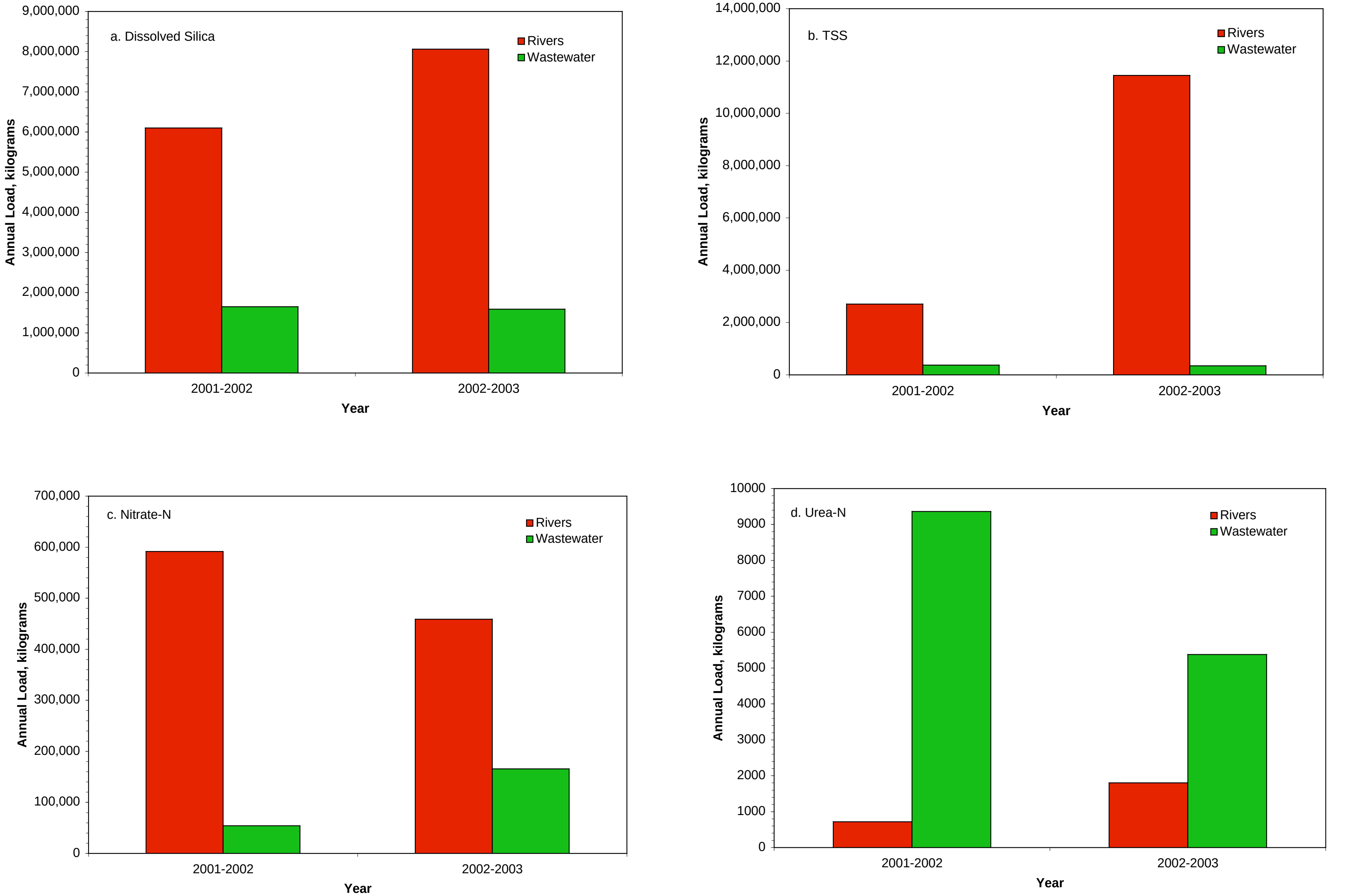

Figure 3.5.5. Comparisons of combined annuals loads of nutrients from gauged rivers (San Lorenzo River, Soquel Creek, Pajaro River, Salinas River, Carmel River and Big Sur River) and wastewater (City of Santa Cruz, City of Watsonville, Monterey Regional Water Pollution Control Agency and Carmel Area Wastewater District).

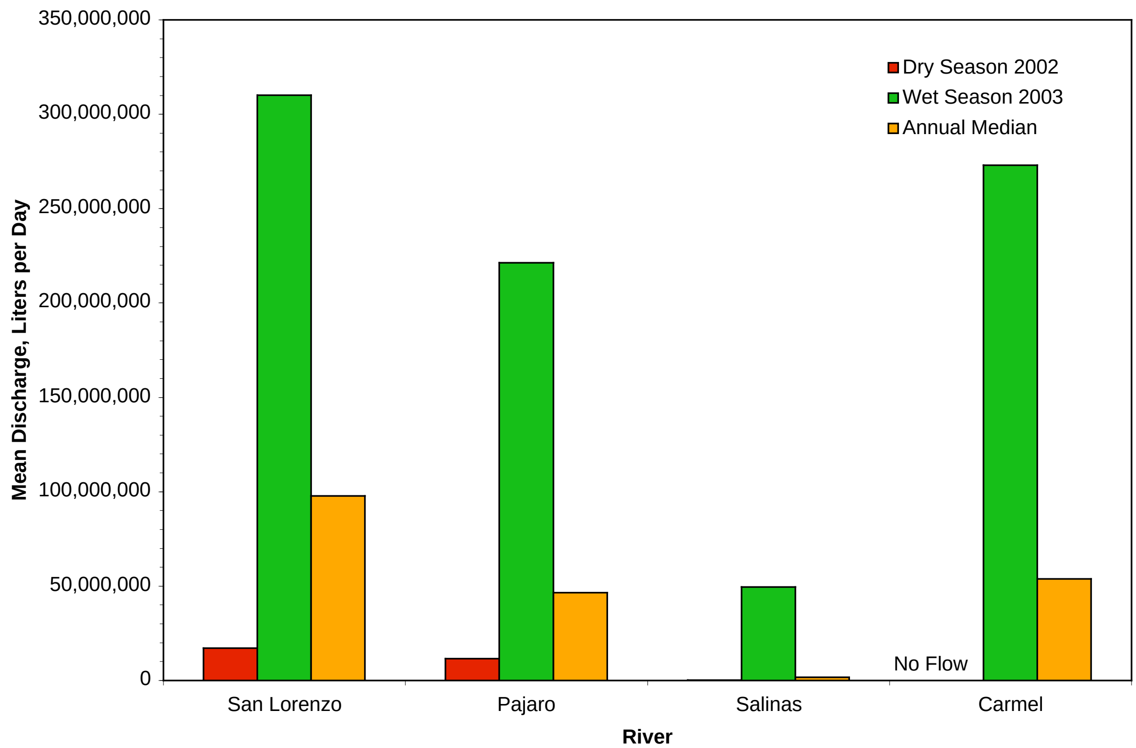

Figure 3.5.6. Mean daily discharges from the San Lorenzo, Pajaro, Salinas and Carmel rivers during 2002 dry-season and 2003 wet-season sampling, compared with the annual median.

Dacthal is another POP for which rivers were the main source to nearshore waters. In the 2003 wet season, this agricultural herbicide was found in high concentrations in the Pajaro and Salinas rivers, 6.16 ng/L and 26 ng/L, respectively, which was more than 100 times greater than the concentrations in either the San Lorenzo or Carmel rivers (Appendix F-2). Due to differences in flow, the Pajaro and Salinas rivers had very similar mean daily loads in the 2003 wet season (Figure 3.5.10). Although Dacthal also was detected in wastewater effluent (Appendix B), the annual load from rivers far exceeded that from wastewater (Figure 3.5.11).

Dacthal also was similar to other POPs in its distributions in sediments and mussels (Figure 3.5.12). In 2001, the highest sediment concentrations of Dacthal were measured at the two sites nearest the Salinas and Pajaro rivers, with decreasing concentrations to the northwest (Figure 3.5.12a). In 2002, Dacthal was found in sediments at only two sites in Monterey Bay. In mussels, Dacthal was detected only in wet-season samples and the high concentration at Scott Creek suggests there are other local sources that are not included in the river samples (Figure 3.5.12b).

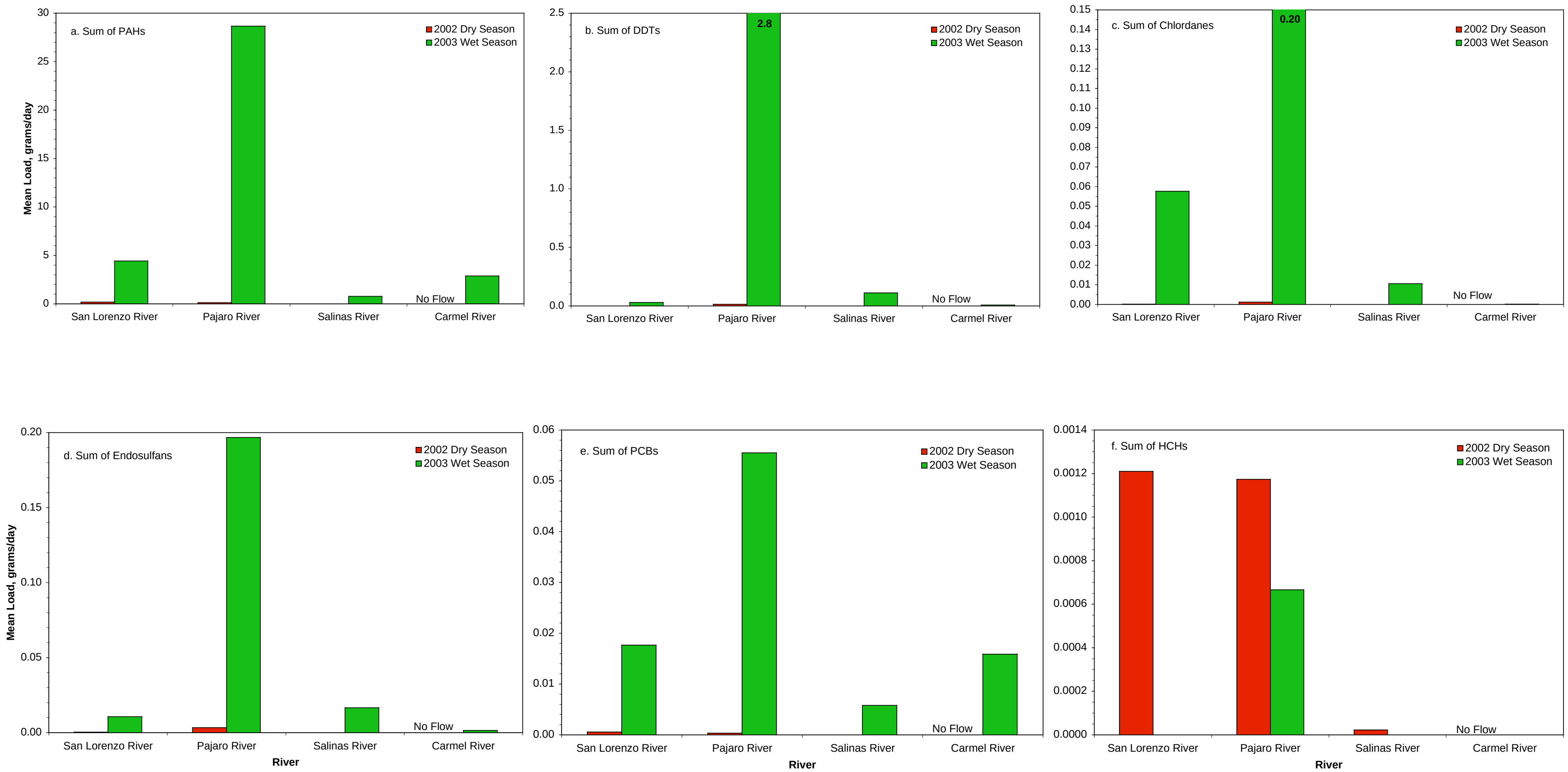

Figure 3.5.7. Mean daily loads of POPs from the San Lorenzo, Pajaro, Salinas and Carmel rivers during the 2002 dry season and the 2003 wet season.

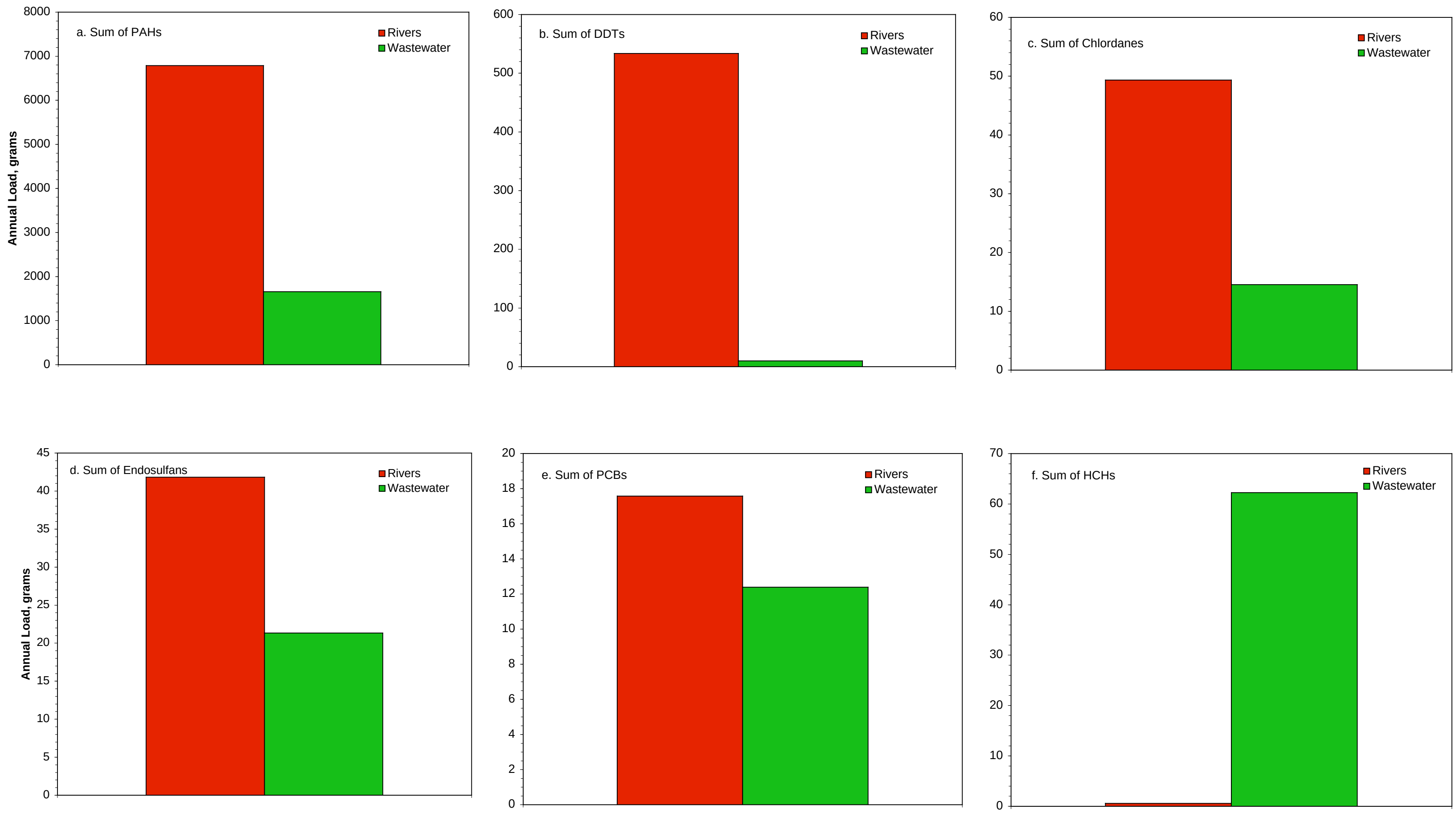

Figure 3.5.8. Comparisons of combined annuals loads (July 2002 through June 2003) of POPs from the San Lorenzo, Pajaro, Salinas and Carmel rivers and wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional Water Pollution Control Agency and Carmel Area Wastewater District.

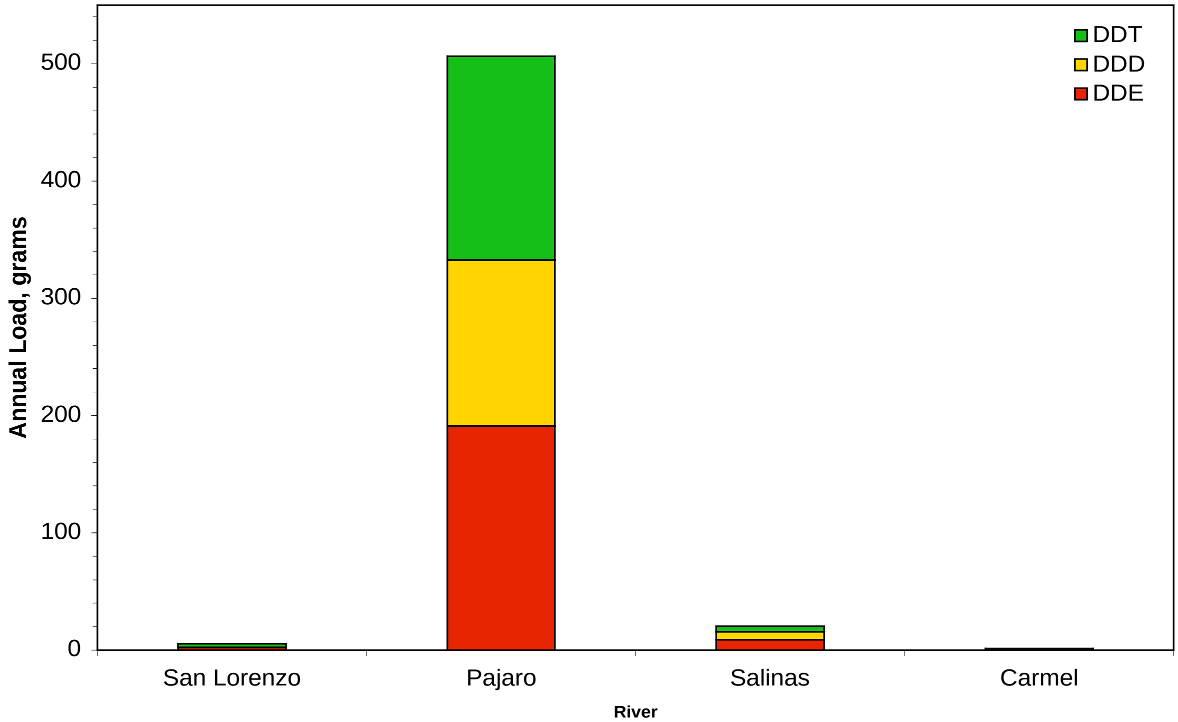

Figure 3.5.9. Estimated annual loads of DDT isomers to nearshore waters from four rivers between July 2002 and June 2003.

As the only POP with higher loads from wastewater than from rivers, HCHs also deserve additional discussion. Chemical production of this pesticide results in four primary isomers, α, β, δ and γ. γ-HCH (lindane) is the only isomer with insecticidal properties, and various purification steps are intended to reduce the amounts of the other isomers. The loads of HCHs from wastewater discharges in 2002-2003 ranged from 94–100% γ-HCH. Production of γ-HCH ceased in the USA in 1976, but it continues to be imported for use in treatment of agricultural seeds, production of other chemical products and for use in prescription shampoos and ointments for the treatment of lice (head and pubic) and scabies (Agency for Toxic Substances and Disease Registry, 2003) and was contained in over-the-counter shampoos . Some medications containing γ-HCH are available over the counter in Canada. These medications typically contain 1% γ-HCH. The much higher loads of γ-HCH in wastewater than in rivers is consistent with the source being shampoos and ointments for the treatment of lice and scabies. Moreover, an annual load of 60 g from wastewater suggests approximately 6,000 g of shampoo and ointment are used per year in the greater Monterey Bay area. Pyrethroids have replaced γ-HCH as the pesticide of choice for the treatment of lice and if the source of γ-HCH is such shampoos and ointments, the loads of HCHs should decline in the future.

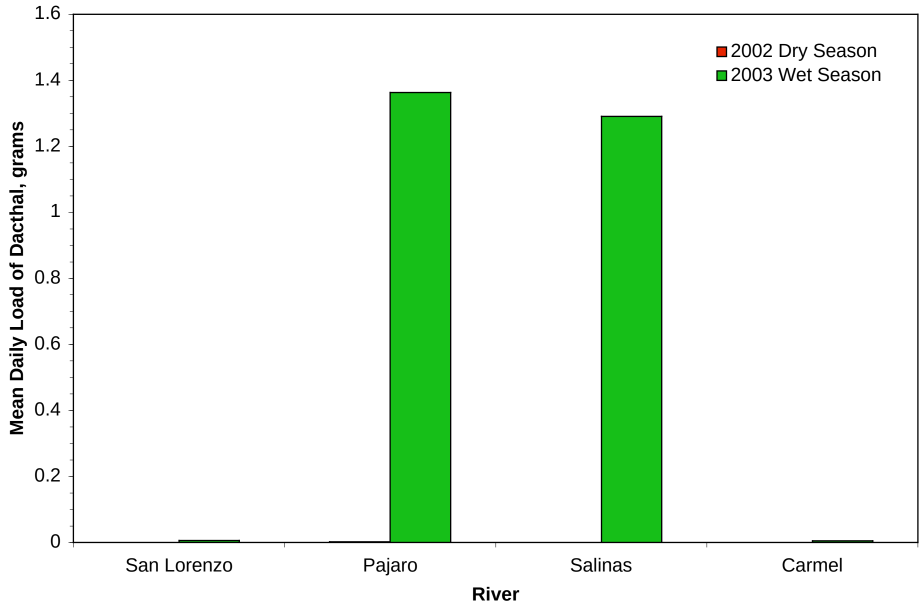

Figure 3.5.10. Mean daily loads of Dacthal from the San Lorenzo, Pajaro, Salinas and Carmel rivers during the 2002 dry season and the 2003 wet season.

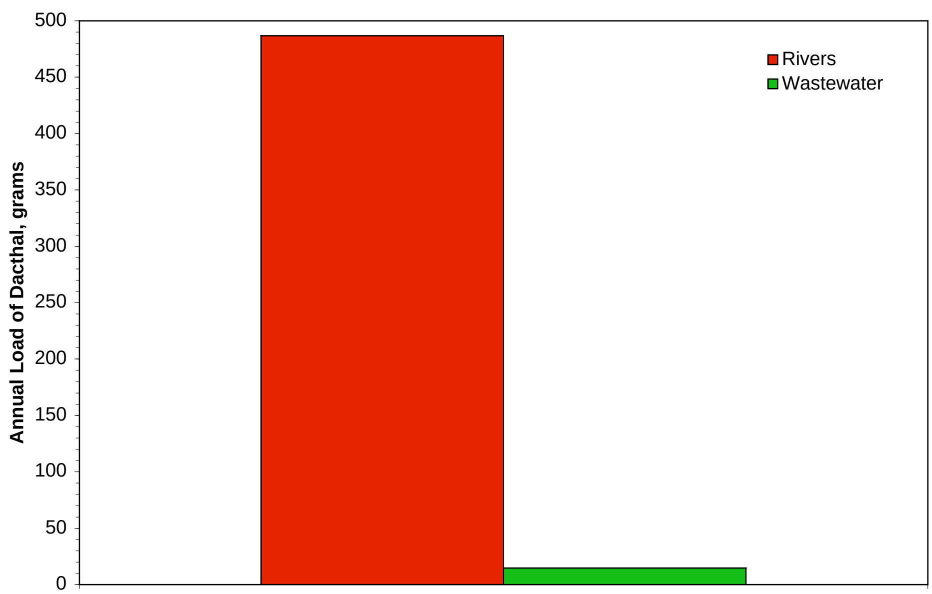

Figure 3.5.11. Comparisons of combined annual loads (July 2002 through June 2003) of Dacthal from the San Lorenzo, Pajaro, Salinas and Carmel rivers and wastewater from the City of Santa Cruz, City of Watsonville, Monterey Regional Water Pollution Control Agency and Carmel Area Wastewater District.

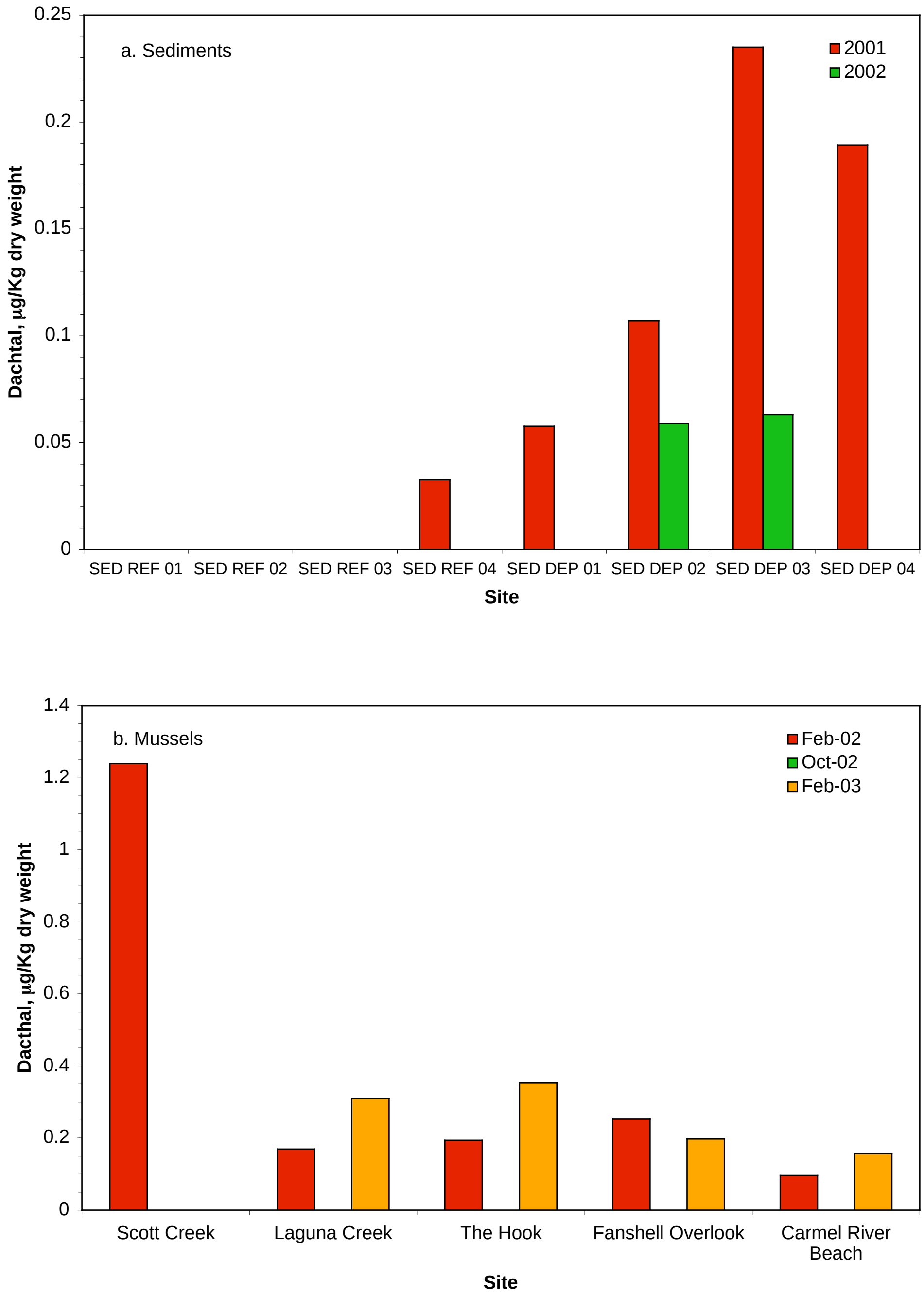

Figure 3.5.12. Concentrations of Dacthal in sediments and mussels at CCLEAN sites during the 2001-2002 and 2002-2003 sampling years.

3.5.3 Current Status

Since June of 2003, several changes to sampling sites have been made. Because of the difficulty of estimating loads from Elkhorn Slough, the two sampling sites there have been dropped and a site at Tembledero Slough has been added. Sampling of this site is performed in a cooperative effort with Elkhorn Slough National Estuarine Research Reserve. In December of 2003, staff gauges were installed and calibrated at Branciforte Creek, Laguna Creek, and Tembledero Slough. Existing gauges at Aptos Creek and Waddell Creek were calibrated. Also, contact information was obtained for researchers who may share historic flow data for Waddell Creek and Scott Creek. Permission has been obtained from California State Parks to install a staff gauge in Natural Bridges State Park on Moore Creek, near its entrance to the Pacific, and at Porter/Tannery Gulch at New Brighton Beach. In addition, UC Berkeley graduate students studying GIS have created a prototype stream flow model for CCLEAN. Efforts to improve the accuracy of the model continue.

Beginning in the 2003-2004 sampling year, stream samples are being analyzed for ammonia and orthophosphate. As with wastewater sampling, addition of these nutrients will allow a more complete evaluation of the potential effects of these nutrient loads on blooms of harmful algae.

3.5.4 Recommendations

Installation of staff gauges at all stream sampling sites will improve our ability to estimate loads only if rating data can be collected over a range of flows. A cooperative effort with the Regional Board has been implemented to collect these data and should be continued. As with the effluent grab sampling, we recommend conducting an interlaboratory calibration exercise for analysis of nutrients, especially urea and dissolved silica.

3.6 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 has a start date of June 1, 2004.

3.7 Measuring Background Water Quality in Monterey Bay

Beginning with the 2004 wet season, CCLEAN will implement 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 ambient waters in the Monterey Bay area, with an emphasis on POPs and nutrients. Buoys will be deployed by KLI at site in northern Monterey Bay and at a site in southern Monterey Bay for 30-days periods in the wet season and in the dry season. Near-surface water will be pumped across the same particle filters and XAD-2 resin to sample POPs. Duplicate grabs will be collected at buoy deployment and retrieval for analysis of total coliform, fecal coliform, enterococcus, ammonia, nitrate, urea, orthophosphate, dissolved silica, and total suspended solids. This sampling will be conducted on the same cycle as sampling of rivers and wastewater for POPs.

Data from the first year of this program component will be analyzed before a second year of buoy deployments is authorized. If concentrations of POPs, nutrients and pathogen indicators are consistently low or not detected in these background samples, the sampling locations might be shifted or the resources for this sampling could be redirected.

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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
	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

Matrix	Parameter & Analyte	Target MDL	Units
Water	**Persistent Organic Pollutants**		
	PAHs		
	C2-Chrysenes	50	pg/L
	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

Matrix	Parameter & Analyte	Target MDL	Units
Water	**Persistent Organic Pollutants**		
	Pesticides		
	HCH		
	alpha-HCH	50	pg/L
	beta-HCH	50	pg/L
	delta-HCH	50	pg/L
	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

Matrix	Parameter & Analyte	Target MDL	Units
Sediment	**Persistent Organic Pollutants**[a]		
	PAHs		
	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
	C3-Phenanthrene/Anthracenes	5	μg/kg
	C4-Phenanthrene/Anthracenes	5	μg/kg

Matrix	Parameter & Analyte	Target MDL	Units
Sediment	**Persistent Organic Pollutants[a]**		
	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
	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

Matrix	Parameter & Analyte	Target MDL	Units
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
Mussel 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
	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

Matrix	Parameter & Analyte	Target MDL	Units
Mussel Tissues	**Persistent Organic Pollutants[a]**		
	PAHs		
	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
	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

Matrix	Parameter & Analyte	Target MDL	Units
Mussel Tissues	**Persistent Organic Pollutants**[a]		
	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
	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

[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 2002 through June 2003.

					Urea-N		Silicate		TSS, SV		TSS, SC		Ammonia-N, SV		Ammonia-N, SC		Nitrate-N		Cond.	pH	Temp.
Agency	Date	SC Flow, MGD	SV 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	Conc, mg/l	Load, kg/day	mS/cm		
Santa Cruz																					
	7/3/02	7.57	0.899	32.055	0.14	4.481	40	1282.207	4.5	4.046			0.03	0.022							
	8/12/02	9.52	1.070	40.083	0.11	4.520	40	1603.326	2	2.140			1.90	2.033							
	9/18/02	8.71	0.807	36.022	0.16	5.926	41	1476.896	5	4.035			2.20	1.775							
	9/28/02	10.02	0.944	41.499					5	4.720			2.20	2.077	25.0	1037.469	4.5	185.914	1.69	7.4	24
	9/30/02	8.93	0.974	37.487					5	4.870	3.0	112.460	2.20	2.143							
	10/1/02	8.29	0.898	34.777	0.07	2.301	40	1391.063	7	6.286			0.30	0.269							
	10/6/02	9.50	0.902	39.372					4	3.608			0.30	0.271	22.1	870.112	4.1	159.455	1.76	7.2	25
	10/8/02	8.40	0.779	34.743					4	3.116	3.0	104.228	0.30	0.234							
	10/14/02	9.10	1.010	38.266					3	3.030			0.30	0.303	26.5	1014.058	3.8	145.412	1.59	7.2	24
	10/16/02	7.70		29.145							4.0	116.578									
	10/22/02	7.70	0.797	32.161					3	2.391			0.30	0.239	27.3	877.999	5.0	159.198	1.7	7.28	23
	11/3/02	9.10	0.924	37.941					7	6.468			0.45	0.416	25.0	948.521	2.3	87.264	1.55	7.25	
	11/5/02	8.00	0.802	33.316					7	5.614	6.0	199.893	0.45	0.361							
	11/18/02	11.80	0.848	47.873	0.08	3.592	41	1962.780	22	18.656			0.45	0.382							
	12/1/02	10.60	0.841	43.304	0.23	9.868	39	1688.863	5	4.205			0.50	0.421							
	1/7/03	11.70	1.021	48.149	0.07	3.545	34	1637.065	7	7.147			0.60	0.613							
	02/03/03	8.40	1.053	35.780					11	11.583	3.0	107.339	6.20	6.529	20.3	726.326	6.2	221.834	1.26	7.1	19
	2/11/03	7.30	0.885	30.980	0.10	3.219	41	1270.189	8	7.080			6.20	5.487							
	02/12/03	9.60	1.041	40.276					8	8.328	8.0	322.209	6.20	6.454	24.3	978.711	9.0	362.486	1.4	7.16	19
	02/19/03	8.60	0.965	36.204					9	8.685	6.0	217.221	6.20	5.983	25.2	912.329	11.0	398.239	1.39	7.07	19
	02/24/03	9.00	0.934	37.600					8	7.472	6.0	225.601	6.20	5.791	23.0	864.804	9.2	345.922		7.06	20
	03/02/03	9.50	1.011	39.784	0.15	6.118	33	1312.876	11	11.121			10.00	10.110							
	03/04/03	8.40	0.744	34.610					11	8.184	6.0	207.660	10.00	7.440	25.5	882.556	13.0	449.931	1.41	7.14	19
	04/01/03	9.60	1.005	40.140	0.10	3.984	23	923.218	10	10.050			0.60	0.603							
	05/01/03	9.30	1.057	39.201	0.11	4.165	33	1293.641	3	3.171			0.30	0.317							
	06/01/03	9.30	0.903	38.618	0.05	1.944	38	1467.497	6	5.418			0.14	0.126							
Santa Cruz																					
Mean		9.063	0.925	37.669	0.11	4.472	36.9	1442.469	7.020	6.457	5.0	179.243	2.58	2.416	24.4	911.289	6.8	251.565	1.53	7.19	21.3
Total Load, kg/year		3308.023	337.464	13749.043		1632.258		526501.020		2356.783		65423.805	0.600	881.808	25.0	332620.311		91821.342			

Santa Cruz	Total PAHs		LPAHs		HPAHs		Chlordanes		DDTs		HCHs		Endosulfans		PCBs		Dacthal	
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
2002 Dry Season	47.236	1.663	37.212	1.310	10.024	0.353	0.192	0.007	0.150	0.005	2.267	0.080	0.469	0.017	0.174	0.006	0	0.000
2003 Wet Season	45.313	1.652	32.403	1.181	12.910	0.471	0.408	0.015	0.142	0.005	1.200	0.044	0.343	0.012	0.331	0.012	0.0858	0.003
Mean	46.274	1.657	34.808	1.246	11.467	0.412	0.300	0.011	0.146	0.005	1.733	0.062	0.406	0.014	0.253	0.009	0.043	0.002
Total Load, g/year		604.970		454.673		150.297		3.944		1.908		22.546		5.292		3.322		0.571

				Urea-N		Silicate		TSS		Ammonia-N		Nitrate-N		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	mS/cm		
Watsonville																
	7/22/02	7.01	26.533			40	1061.314									
	7/29/02	7.54	28.539	0.065	1.862											
	8/12/02	7.02	26.571			47.1	1251.48									
	8/29/02	7.62	28.842	0.165	4.758											
	9/17/02	8.23	31.151			44	1370.6242									
	9/27/02	8.05	30.469							40.3	1227.911				7.2	23.3
	9/30/02	7.20	27.252	0.196	5.346										7.2	22.9
	10/1/02	7.69	29.107					7.6	221.211						7.1	22.9
	10/2/02	7.96	30.129					8.4	253.080						7.2	22.4
	10/3/02	8.04	30.431											1.868	7.1	22.2
	10/4/02	7.49	28.350							26.5	751.266				7.1	22.8
	10/8/02	8.41	31.832					6.8	216.457						7.0	23.0
	10/9/02	7.63	28.880					12	346.555						7.0	23.6
	10/10/02	8.34	31.567											1.971	7.0	23.4
	10/11/02	7.76	29.372							20.8	610.929	8.10	237.910		7.0	23.6
	10/15/02	7.96	30.129					10.4	313.337						7.0	22.6
	10/16/02	8.19	30.999					11.6	359.590						7.0	22.6
	10/17/02	8.18	30.961											1.634	7.0	22.6
	10/18/02	8.16	30.886							12.3	379.893	11.20	345.919		7.0	22.6
	10/21/02	8.06	30.507	0.077	2.360					16.4	500.316	4.60	140.333		7.0	22.3
	10/22/02	8.61	32.589					6.4	208.569						7.1	22.0
	10/23/02	7.77	29.409					4.8	141.165						7.0	21.9
	10/24/02	7.98	30.204											1.898	7.0	21.6
	10/25/02	7.86	29.750							22.1	657.477				7.0	21.3
	10/29/02	7.97	30.166			36.7	1107.1087			18.1	546.013					
	11/12/02	7.07	26.760			34.1	912.5143					0.95	25.422			
	11/21/04	7.11	26.911	0.099	2.659											
	12/19/02	9.12	34.519	0.231	7.979	33.7	1163.297									
	1/28/03	6.67	25.246	0.146	3.686			7.2	181.771					1.613	7.0	19.2
	1/29/03	6.37	24.110					8.2	197.706						7.1	18.6
	1/31/03	6.56	24.830							3	74.489	6.10	151.461			
	2/4/03	6.47	24.489					11.4	279.174						7.1	18.7
	2/5/03	6.40	24.224					14.4	348.826					1.474	7.1	18.5
	2/7/03	6.19	23.429							8.78	205.708	3.40	79.659		7.1	18.8
	2/11/03	6.22	23.543					11.6	273.095						7.1	18.8
	2/12/03	6.51	24.640			38	936.3333	12.4	305.540					1.635	7.3	18.5
	2/13/03	6.29	23.808	0.287	6.833											
	2/14/03	6.28	23.770							18.2	432.610	0.90	21.393		7.2	19.3
	2/18/03	6.75	25.549					5.2	132.854						7.1	18.2
	2/19/03	6.83	25.852					8	206.812					1.564	7.1	19.2
	2/21/03	7.29	27.593							13.1	361.464	1.50	41.389		7.1	19.5
	2/25/03	7.02	26.571					6.4	170.052						7.1	19.6
	2/26/03	7.34	27.782					10	277.819					1.685	7.0	19.7
	2/28/03	7.69	29.107							11.8	343.458	4.00	116.427		7.0	19.1
	3/4/03	7.93	30.015			36.4	1092.5478	8.8	264.132							
	3/5/03	7.81	29.561					7.6	224.662							
	3/7/03	6.87	26.003							16.3	423.848	5.10	132.615		7.1	19.7
	3/26/03	7.99	30.242	0.316	9.557											
	4/9/03	8.00	30.280			40.3	1220.284			25.4	769.112					
	4/29/03	8.44	31.945	0.279	8.913			21.4	683.632							
	5/8/03	7.73	29.258			40.1	1173.2478	9.6	280.877							
	5/28/03	8.20	31.037	0.282	8.752							0.79	24.519	1.7		
	6/12/03	7.38	27.933			44.7	1248.6185									
	6/27/03	6.79	25.700	0.172	4.420											
Watsonville																
Mean		7.482	28.321	0.193	5.594	39.555	1139.761	9.555	267.587	18.077	520.321	4.24	119.731	1.704	7.1	21.0
Total Load, kg/year		2731.079	10337.133		2041.694		416012.720		97669.296	17.3	189917.176		43701.969			

Watsonville	Total PAHs		LPAHs		HPAHs		Chlordanes		DDTs		HCHs		Endosulfans		PCBs		Dacthal	
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
2002 Dry Season	52.582	1.585	47.968	1.446	4.614	0.139	0.328	0.010	0.221	0.007	0.849	0.026	0.565	0.017	0.184	0.006	0.196	0.006
2003 Wet Season	39.004	1.006	28.576	0.737	10.428	0.269	0.305	0.008	0.484	0.012	1.800	0.046	0.383	0.010	0.463	0.012	0.192	0.005
Mean	45.793	1.295	38.272	1.091	7.521	0.204	0.316	0.009	0.353	0.010	1.324	0.036	0.474	0.013	0.324	0.009	0.194	0.005
Total Load, g/year		472.849		398.393		74.456		3.238		3.495		13.139		4.911		3.192		1.982

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	Cond. mS/cm	pH	Temp.
Monterey Regional																
	7/11/02	3.10	11.734					13	152.536	29.1	341.445				7.4	25.0
	7/17/02	1.90	7.192					13	93.490			3	21.575		7.4	25.0
	7/24/02	2.20	8.327			42	349.73	9	74.943						7.4	23.9
	7/30/02	1.50	5.678	0.117	0.661			11	62.453						7.4	26.1
	8/5/97	1.80	6.813			49	333.84	11	74.943	25.2	171.688				7.4	26.1
	8/15/97	2.10	7.949	0.112	0.889			12	95.382			6	47.691		7.3	26.1
	8/20/02	1.20	4.542			43	195.31	14	63.588						7.3	25.6
	8/28/02	0.90	3.407	0.158	0.540			14	47.691						7.3	26.1
	9/5/02	1.40	5.299					16	84.784			0.5	2.650		7.4	26.1
	9/17/02	0.70	2.650					12	31.794	28.3	74.981				7.4	25.6
	9/25/02	0.50	1.893			49	92.73	10	18.925						7.3	25.6
	9/30/02	2.30	8.706	0.158	1.379			10	87.055						7.5	25.0
	10/1/02	0.20	0.757					11	8.327	31.6	23.921	0.22	0.167		7.5	25.0
	10/8/02	8.00	30.280					10	302.800	28.6	866.008				7.4	26.1
	10/9/02	4.40	16.654					12	199.848			0.45	7.494		7.4	25.0
	10/17/02	5.50	20.818					11	228.993	28	582.890	0.1	2.082			
	10/22/02	6.70	25.360	0.051	1.300	47.5	1204.58	13	329.674						7.3	25.0
	10/24/97	5.00	18.925					12	227.100	28.6	541.255	0.22	4.164		7.2	
	10/30/02	8.00	30.280					18	545.040						7.3	25.0
	10/31/02	9.20	34.822					17	591.974	24.1	839.210	0.45	15.670		7.3	25.0
	11/12/02	21.40	80.999	0.070	5.662	53	4292.95	11	890.989						7.4	24.4
	11/19/02	21.30	80.621					14	1128.687	28.3	2281.560				7.3	22.8
	11/20/02	21.10	79.864					15	1197.953			1.13	90.246		7.2	22.8
	12/6/02	20.30	76.836									3.4	261.241		7.3	22.2
	12/19/02	23.90	90.462	0.070	6.323	45	4070.77	17	1537.846						7.3	21.7
	12/20/02	23.90	90.462							22.4	2026.338				7.3	20.6
	1/6/03	20.70	78.350			49	3839.13	16	1253.592						7.3	21.7
	1/8/03	20.50	77.593					17	1319.073			0.5	38.796		7.3	21.7
	1/9/03	20.60	77.971	0.102	7.957			20	1559.420						7.4	22.2
	1/13/03	21.40	80.999					21	1700.979	25.8	2089.774				7.3	21.1
	2/6/03	20.70	78.350	0.135	10.588	44	3447.38					0.5	39.175		7.4	21.1
	2/14/03	20.20	76.457							28.6	2186.670				7.4	
	2/19/03	20.70	78.350					9	705.146			0.5	39.175		7.4	21.1
	2/20/03	21.00	79.485					13	1033.305	30.2	2400.447				7.4	22.2
	2/27/98	13.60	51.476					10	514.760	33	1698.708	0.5	25.738		7.4	21.7
	3/6/03	9.30	35.201					12	422.406	34.7	1221.457	0.5	17.600		7.3	21.7
	3/7/03	4.90	18.547			48	890.23								7.4	22.2
	3/8/03	4.30	16.276	0.172	2.806											
	4/2/03	0.42	1.590							30.2	48.009				7.4	21.7
	4/4/03	10.60	40.121									0.5	20.061		7.3	22.8
	4/16/03	0.80	3.028			47	142.32	14	42.392						7.4	22.8
	4/24/03	11.80	44.663	0.149	6.660			14	625.282						7.3	22.2
	5/21/03	7.40	28.009	0.098	2.741	47	1316.42	9	252.081						7.3	25.0
	5/23/03	1.20	4.542							25.2	114.458				7.4	23.9
	5/30/03	16.20	61.317									0.5	30.659		7.5	23.9
	6/5/03	1.10	4.164					12	49.962	32.5	135.314				7.3	25.0
	6/11/03	0.90	3.407	0.091		55		13	44.285						7.4	24.4
	6/18/98	1.20	4.542					13	59.046			0.5	2.271		7.3	25.0
Monterey Regional																
Mean		9.334	35.328	0.114	3.959	47.6	1681.281	13.1	464.698	28.6	980.230	1.1	37.025		7.3	24.7
Total Load, kg/year		3406.819	12894.809		1445.010		613667.649		169614.914	28.6	357783.814		13514.154			

Monterey	Total PAHs		LPAHs		HPAHs		Chlordanes		DDTs		HCHs		Endosulfans		PCBs		Dacthal	
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
2002 Dry Season	34.046	0.582	20.749	0.355	13.297	0.227	0.418	0.007	0.186	0.003	1.804	0.031	0.256	0.004	0.159	0.003	0.466	0.008
2003 Wet Season	32.882	2.188	7.300	0.486	25.582	1.703	0.430	0.029	0.298	0.020	1.520	0.101	0.204	0.014	0.417	0.028	0.872	0.058
Mean	33.464	1.385	14.024	0.420	19.440	0.965	0.424	0.018	0.242	0.012	1.662	0.066	0.230	0.009	0.288	0.015	0.669	0.033
Total Load, g/year		505.601		153.398		352.203		6.525		4.200		24.091		3.281		5.556		12.045

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	Cond. mS/cm	pH	Temp.
Carmel Area																
	7/6/02	0.367	1.389	0.900	1.250	34.7	48.202									
	8/1/02	0.248	0.939	0.680	0.638	41.6	39.049									
	9/26/02	0.307	1.162	0.640	0.744	32.6	37.881									
	9/27/02	0.499	1.889					5.6		15.0		3.9		1.43	7	21.7
	10/4/02	0.346	1.310	0.470	0.616	39.8	52.122	4.8		13.6		5.6		1.36	7.1	21.3
	10/11/02	0.293	1.109					3.6		16.9		5.1		1.43	7.1	21.7
	10/18/02	1.696	6.419					2		22.4		3.0		1.44	7.2	22.2
	10/25/02	0.225	0.852					2		25.9		2.2		1.59	6.9	20.6
	11/1/02	0.759	2.873					5.8	16.662	32.3	92.792	1.5	4.309	1.61	7.1	19.7
	11/4/02	0.869	3.289	0.670	2.204	26.6	87.492									
	12/6/02	1.208	4.572	0.400	1.829	35.5	162.316									
	1/28/03	1.832	6.934	0.057	0.395	32.2	223.279									
	1/31/03	1.903	7.203					9.6	69.147	0.9	6.483	12.3	88.595	1.32	6.6	19.2
	2/7/03	2.002	7.578	0.063	0.477	32.6	247.029	4.6		8.6		5.6		1.28	6.9	18.1
	2/14/03	1.810	6.851					4	27.403	0.1	0.685	6.7	45.901	1.22	6.7	18.9
	2/21/03	1.872	7.086					2.8	19.839	0.1	0.709	6.6	46.764	1.14	6.6	18.5
	2/28/03	1.955	7.400					1.6	11.839	1.4	10.360	5.7	42.178	1.15	6.5	18.3
	3/21/03	0.269	1.018	0.049	0.050	39.8	40.523									
	4/10/03	0.464	1.756	0.055	0.097	39.3	69.020									
	5/12/03	0.585	2.214	0.080	0.177	26.7	59.120									
	6/11/03	0.245	0.927	0.064	0.059	41.3	38.299									
Carmel Area																
Mean		1.234	4.669	0.344	0.711	35.2	92.028	4.2	28.978	12.5	22.206	5.3	45.550	1.36	6.9	20.02
Total Load, kg/year		450.228	1704.111		259.635		33590.065		10577.121	13.6	8105.020		16625.576			

Carmel POPs	Total PAHs Conc, ng/L	Total PAHs Load, g/day	LPAHs Conc, ng/L	LPAHs Load, g/day	HPAHs Conc, ng/L	HPAHs Load, g/day	Chlordanes Conc, ng/L	Chlordanes Load, g/day	DDTs Conc, ng/L	DDTs Load, g/day	HCHs Conc, ng/L	HCHs Load, g/day	Endosulfans Conc, ng/L	Endosulfans Load, g/day	PCBs Conc, ng/L	PCBs Load, g/day	Dacthal Conc, ng/L	Dacthal Load, g/day
2002 Dry Season	53.207	0.128	26.322	0.063	53.207	0.128	0.403	0.001	0.074	0.0002	1.074	0.003	17.280	0.042	0.131	0.0003	0.222	0.0005
2003 Wet Season	38.163	0.276	16.806	0.121	21.357	0.154	0.501	0.004	0.113	0.001	1.510	0.011	0.199	0.001	0.195	0.0014	0.048	0.0003
Mean	45.685	0.202	21.564	0.092	37.282	0.141	0.452	0.002	0.093	0.000	1.292	0.007	8.740	0.022	0.163	0.0009	0.135	0.0004
Total Load, g/year		73.696		33.725		51.541		0.838		0.181		2.463		7.858		0.3154		0.1609

Equipment Blank

Date	Total PAHs, ng/L	Low-weight PAHs, ng/L	High-weight PAHs, ng/L	Chlordanes, ng/L	DDTs, ng/L	HCHs, ng/L	Endosulfans, ng/L	PCBs, ng/L	Dacthal, ng/L
September 2002	14.857	14.248	0.610	ND	0.019	0.033	ND	0.023	ND
Januayr 2003	14.203	13.046	1.157	ND	ND	0.054	ND	0.048	0.007

Appendix C. Results of receiving water bacteria sampling by Santa Cruz, Watsonville and Monterey Regional Water Pollution Control Agency conducted from July, 2002 through June, 2003.

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

	Date												
Site	7/2/02	8/13/02	9/11/02	10/8/02	11/19/02	12/4/02	1/28/03	2/26/03	3/25/03	4/29/03	5/21/03	6/24/03	Median
Total Coliform													
RW(A)-30	<20	<20	<20	<20	<20	<20	<20	80	<20	80	<2	<2	<20
RW(C)-30	<20	<20	<20	<20	<20	<20	20	40	20	2	<2	<2	<20
RW(E)-30	<20	<20	<20	<20	20	<20	<20	110	<20	2	<2	<2	<20
RW(F)-30	<20	<20	20	<20	<20	<20	50	<20	<20	<2	2	<2	<20
RW(G)-30	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**20**	**<20**	**<20**	**2**	**<2**	**<2**	**<20**
RW(H)-30	<20	<20	<20	<20	<20	20	20	<20	<20	<2	<2	<2	<20
RW(I)-30	<20	<20	<20	<20	<20	20	<20	<20	<20	2	<2	<2	<20
Fecal Coliform													
RW(A)-30	<20	<20	<20	<20	<20	<20	<20	<20	<20	17	<2	<2	<20
RW(C)-30	<20	<20	<20	<20	<20	<20	20	40	20	<2	<2	<2	<20
RW(E)-30	<20	<20	<20	<20	<20	<20	<20	<20	<20	<2	<2	<2	<20
RW(F)-30	<20	<20	20	<20	<20	<20	<20	<20	<20	<2	2	<2	<20
RW(G)-30	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**2**	**<2**	**<2**	**<20**
RW(H)-30	<20	<20	<20	<20	<20	20	20	<20	<20	<2	<2	<2	<20
RW(I)-30	<20	<20	<20	<20	<20	20	<20	<20	<20	2	<2	<2	<20
Enterococcus													
RW(A)-30	<20	<20	<20	<20	<20	20	<20	<20	<20	4	<2	<2	<20
RW(C)-30	<20	<20	<20	<20	<20	<20	<20	<20	<20	2	2	<2	<20
RW(E)-30	<20	<20	<20	<20	<20	<20	<20	<20	<20	<2	12	<2	<20
RW(F)-30	<20	<20	<20	<20	<20	<20	45	<20	<20	23	300	<2	<20
RW(G)-30	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**<20**	**4**	**4**	**<2**	**<20**
RW(H)-30	<20	<20	<20	<20	<20	<20	<20	<20	<20	<2	4	<2	<20
RW(I)-30	<20	<20	<20	<20	<20	<20	<20	<20	<20	6	4	<2	<20

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

	Date												
Site	07/08/02	08/19/02	09/09/02	10/21/02	11/18/02	12/17/02	1/27/03	2/24/03	3/10/03	4/7/03	5/5/03	6/9/03	Median
Total Coliform													
A	<2	4	<2	7	8	50	8	7	<2	<2	<2	<2	2
B	<2	<2	<2	8	14	170	11	27	2	<2	<2	<2	1
C	2	<2	<2	<2	7	300	32	12	<2	<2	<2	<2	<2
D	**<2**	**<2**	**<2**	**4**	**30**	**170**	**27**	**70**	**2**	**<2**	**2**	**<2**	**<2**
E	<2	2	<2	2	14	170	110	21	4	4	80	<2	4
F	<2	2	8	13	4	11	500	11	2	2	25	2	6
G	2	<2	<2	22	8	13	500	2	2	<2	170	4	3
ZID	**<2**	**<2**	**<2**	**27**	**4**	**300**	**500**	**2**	**<2**	**<2**	**<2**	**8**	**1**
Fecal Coliform													
A	<2	4	<2	7	4	8	<2	2	<2	<2	<2	<2	<2
B	<2	<2	<2	4	14	11	2	9	2	<2	<2	<2	1
C	2	<2	<2	<2	4	14	4	12	<2	<2	<2	<2	<2
D	**<2**	**<2**	**<2**	**2**	**13**	**50**	**2**	**23**	**2**	**<2**	**<2**	**<2**	**1**
E	<2	2	<2	2	14	23	11	4	<2	2	30	<2	2
F	<2	2	2	4	2	2	17	2	2	<2	2	<2	2
G	2	<2	<2	17	2	2	4	2	2	<2	4	<2	2
ZID	**<2**	**<2**	**<2**	**17**	**4**	**50**	**14**	**<2**	**<2**	**<2**	**<2**	**8**	**<2**
Enterococcus													
A	<2	<2	<2	2	2	30	<2	11	<2	<2	<2	<2	<2
B	<2	<2	<2	2	2	50	2	13	<2	<2	<2	<2	<2
C	<2	<2	<2	<2	4	23	<2	4	<2	<2	<2	<2	<2
D	**<2**	**<2**	**<2**	**8**	**4**	**30**	**<2**	**30**	**<2**	**<2**	**<2**	**<2**	**<2**
E	<2	<2	<2	<2	<2	27	2	8	2	<2	2	<2	<2
F	<2	<2	<2	<2	8	4	11	2	4	<2	17	<2	1
G	<2	<2	<2	4	4	23	2	<2	<2	<2	7	<2	<2
ZID	**<2**	**<2**	**<2**	**2**	**2**	**17**	**2**	**<2**	**<2**	**<2**	**<2**	**<2**	**<2**

Table C-3. Bacteria sampling data for Monterey Regional. Sites with bold-face type are closest to point of discharge.

	Date												
Site	7/8/02	8/26/02	9/9/02	10/7/02	11/4/02	12/2/02	1/13/03	2/3/02	3/3/03	4/21/03	5/5/03	6/16/03	Median
Total Coliform													
A	4	7	2	170	4	<2	8	2	4	<2	<2	4	4
B	**8**	**8**	**<2**	**22**	**2**	**4**	**<2**	**17**	**<2**	**<2**	**<2**	**2**	**2**
C	<2	7	<2	27	<2	2	<2	2	17	<2	<2	11	1
D	<2	2	<2	50	2	<2	<2	7	2	<2	<2	2	1
Fecal Coliform													
A	4	4	2	30	4	<2	8	2	2	<2	<2	4	3
B	**8**	**8**	**<2**	**14**	**2**	**4**	**<2**	**11**	**<2**	**<2**	**<2**	**2**	**2**
C	<2	4	<2	11	<2	2	<2	2	4	<2	<2	7	1
D	<2	<2	<2	7	2	<2	<2	4	<2	<2	<2	2	<2
Enterococcus													
A	<2	2	2	8	<2	<2	4	7	<2	<2	<2	2	1
B	**<2**	**4**	**<2**	**<2**	**<2**	**<2**	**<2**	**2**	**<2**	**<2**	**<2**	**<2**	**<2**
C	<2	4	<2	<2	<2	<2	2	2	<2	<2	<2	<2	<2
D	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

Appendix D. CCLEAN mussel data for October 2002 (dry season) and February 2003 (wet season).

	Sum of Analyte Concentrations, µg/Kg, dry weight								
October 8, 2002	Total PAHs	Low-weight PAHs	High-weight PAHs	DDTs	Chlordanes	PCBs	Endosulfans	HCHs	Dacthal
Scott Creek	32.19	28.47	3.72	17.96	3.59	1.08	0	3.5	ND
Laguna Creek	34.45	30.95	3.50	7.79	1.89	0.38	0	1.27	ND
The Hook rep 1	48.53	39.06	9.47	26.78	9.96	5.48	1.97	0	ND
The Hook rep 2	46.88	36.10	10.78	23.22	10.71	5.64	11.1	0.69	ND
Fanshell Overlook	21.65	20.70	0.95	8.37	3.22	1.81	1.00	3.47	ND
Carmel River Beach	24.10	22.55	1.55	5.18	3.07	0.45	0.85	1.06	ND
RPD for replicates	3.44	7.86	8.83	14.23	7.25	2.95	4.41	200	-
February 27, 2003									
Scott Creek	55.25	42.44	12.81	20.78	6.04	0.83	0	0	0
Laguna Creek	49.32	37.94	11.39	40.05	10.76	2.19	0.83	0	0.31
The Hook rep 1	124.90	91.84	33.07	53.96	26.49	11.07	0.17	0.95	0.408
The Hook rep 2	112.92	82.66	30.26	46.92	28.45	10.26	6.61	0	0.297
Fanshell Overlook	33.20	30.64	2.56	26.78	7.11	3.60	0.02	0	0.198
Carmel River Beach	34.79	31.38	3.41	13.03	5.08	1.86	0.01	0	0.157
RPD for replicates	10.07	10.51	8.87	13.96	7.14	7.62	147.44	200	31.49

			Bacterial Concentrations, MPN/100g wet weight		
October 8, 2002	% Lipid, wet weight	% Moisture	Total Coliform	Fecal Coliform	Enterococcus
Scott Creek	1.03	79	68	68	220
Laguna Creek	1.24	80	790	790	230
The Hook rep 1	1.16	83	230	45	220
The Hook rep 2	1.33	82	130	130	790
Fanshell Overlook	1.36	80	780	<20	45
Carmel River Beach	1.59	84	410	410	1300
RPD for replicates	13.65	1.21	55.56	97.14	113
February 27, 2003					
Scott Creek	1.1	82	<20	<20	20
Laguna Creek rep 1	1.4	82	140	140	220
The Hook rep 1	1.2	83	170	70	300
The Hook rep 2	1.3	83	800	270	200
Fanshell Overlook	1.2	83	170	170	5000
Carmel River Beach	0.9	85	130	20	70
RPD for replicates	8.00	0	109	117	40

Appendix E. CCLEAN 2002 data for sediment benthos and chemistry.

Biota (2002 data for all species that were among the 10 most abundant in any year in either site category; species are ranked according to overall densities across all sites in both years)

Species	Phylum	Group	SedRef 01	SedRef 02	SedRef 03	SedRef 04	SedDep 01	SedDep 02	SedDep 03	SedDep 04
Cossura pygodactylata	Annelida	Polychaeta	17	81	88	66	33	75	218	205
Axinopsida serricata	Mollusca	Bivalvia	51	68	28	95	30	72	30	94
Mediomastus spp. indet.	Annelida	Polychaeta	127	189	87	59	35	108	103	77
Amphiodia sp.	Echinodermata	Ophiuroidea	50	51	68	85	69	89	91	47
Pholoe glabra	Annelida	Polychaeta	43	24	56	58	23	49	100	93
Levinsenia gracilis	Annelida	Polychaeta	2	73	87	65	41	48	63	45
Nephtys cornuta	Annelida	Polychaeta	44	64	31	46	75	44	54	25
Protomedeia articulata	Arthropoda	Gammaridea	5	3	2	5	9	109	49	59
Rochefortia tumida	Mollusca	Bivalvia	71	82	88	73	20	39	33	23
Nemertea	Nemertea	Nemertea	61	47	31	31	23	37	71	25
Scoletoma tetraura	Annelida	Polychaeta	17	28	19	20	18	54	48	13
Mediomastus ambiseta	Annelida	Polychaeta	43	57	21	40	30	56	40	17
Maldaninae spp. juv.	Annelida	Polychaeta	5	33	24	25	41	61	30	15
Prionospio steenstrupi	Annelida	Polychaeta	27	15	14	8	10	3	6	13
Cylichna alba	Mollusca	Gastropoda	4	10	8	6	2	6	3	11
		Total Abundance	1204	1349	1034	1142	861	1373	1614	1213
		Total Taxa	141	127	112	110	109	127	140	111
		Annelida Abundance	737	903	708	711	582	897	1046	749
		Annelida Taxa	82	72	69	68	68	80	75	59
		Anthropoda Abundance	161	100	48	71	66	157	272	169
		Anthropoda Taxa	33	26	19	22	17	17	41	28
		Amphipod Abundance	47	32	13	23	23	124	156	88
		Amphipods - Protomedeia	42	29	11	18	14	15	107	29
		Mollusca Abundance	179	226	170	229	116	182	127	209
		Mollusca Taxa	17	21	18	14	20	23	18	18
		Echinoderm Abundance	53	55	69	87	69	90	95	49
		Echinoderm Taxa	3	3	2	3	1	2	3	2
		Misc. Abundance	86	77	49	61	31	58	80	46
		Misc. Taxa	6	5	4	3	3	4	3	4

Appendix E. CCLEAN 2002 data for sediment benthos and chemistry (continued).

Sediment Quality

Analyte	SedRef 01	SedRef 02	SedRef 03	SedRef 04	SedDep 01	SedDep 02	SedDep 03	SedDep 04
Clay (<4µm), %	7.718	10.623	11.793	11.271	18.685	16.682	23.383	17.040
Silt (4-63 µm), %	35.023	80.001	82.895	84.693	75.112	81.173	67.610	79.827
Fines (Silt + Clay), %	42.741	90.624	94.688	95.964	93.797	97.855	90.993	96.867
Sand (63 µm-2mm), %	56.843	9.376	5.313	4.036	6.203	2.132	9.003	3.133
Gravel/Shell (>2mm), %	0.416	0.000	0.000	0.000	0.000	0.012	0.004	0.000
TOC, %	0.591	0.838	0.760	0.791	0.984	0.882	0.961	1.000

Chemistry

Analyte	SedRef 01	SedRef 02	SedRef 03	SedRef 04	SedDep 01	SedDep 02	SedDep 03	SedDep 04
Low molecular weight PAHs, µg/Kg dry wt	21.114	32.786	37.013	42.29	57.486	44.692	59.623	63.128
High molecular weight PAHs, µg/Kg dry wt	41.617	58.073	53.368	65.017	70.755	73.43	51.4893	93.99
Sum PAHs, µg/Kg dry wt	62.731	90.859	90.381	107.307	128.241	118.122	111.1123	157.118
PCBs, µg/Kg dry wt	0.670	0.981	0.526	0.186	0.525	0.170	0.323	0.363
DDT, µg/Kg dry wt	0.382	0.613	0.581	1.143	2.010	1.090	3.8580	2.306
DDD, µg/Kg dry wt	1.604	1.985	1.752	1.906	2.165	1.682	1.133	0.785
DDE, µg/Kg dry wt	2.858	3.744	3.183	3.387	3.556	3.035	1.917	2.071
Sum of DDTs, µg/Kg dry wt	4.844	6.342	5.516	6.436	7.731	5.807	6.830	5.162
Chlordanes, µg/Kg dry wt	0.045	0.108	0.087	0.123	0.124	0.136	0.047	0.059
HCHs, µg/Kg dry wt	0.803	0.25	0.405	0.078	0.106	0.091	0.061	0.049
Dacthal, µg/Kg dry wt	ND	ND	ND	ND	ND	0.059	0.063	ND

Appendix F-1. Data for CCLEAN stream and river samples from July 2002 through June 2003.

Sites are arranged from North to South. A value of "0" for nutrients and TSS indicates a 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 analyzed as 5 MPN/100mL, which is one half the detection limit.

Location	Date	Flow, if available (cfs)	NO_3-N (mg/L)	SiO_2 (mg/L)	Urea-N (µg/L)	TSS (mg/L)	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Waddell Creek @ HWY 1	09/23/02	NA	0.279	19.4	78	0.8	1333	5	5
	10/29/02	NA	0	22.5	14	1.8	5794	10	52
	12/19/02	NA	0.203	25.1	0	36.1	459	63	63
	01/29/03	NA	0.182	23.2	0	0	238	10	10
	03/12/03	NA	0.07	22.1	25	0	160	5	5
	03/26/03	NA	0	29.4	23	0	169	84	5
	04/30/03	NA	0	21.7	0	1.5	134	110	5
	05/28/03	NA	0.079	24	0	3.6	269	84	5
	06/25/03	NA	0.076	24.3	0	5.5	211	41	5
Scott Creek @ HWY 1	09/23/02	NA	0	27.2	27	5.2	350	20	5
	10/29/02	NA	0	27.7	23	0.4	487	84	5
	12/19/02	NA	0.213	24.9	0	22.4	842	134	20
	01/29/03	NA	0.182	25.9	0	0	1301	145	183
	03/12/03	NA	0.091	24.9	15	6.5	474	5	5
	03/26/03	NA	0.019	30.9	22	4.4	253	84	5
	04/30/03	NA	0	23.7	16	3.5	143	10	5
	05/28/03	NA	0.069	23.9	38	8	168	86	10
	06/25/03	NA	0.077	24.7	14	0	373	96	5
Laguna Creek @ Mouth	09/23/02	NA	0.285	15.1	38	0	2359	10	5
	10/29/02	NA	0	16.4	0	4.6	441	10	5
	12/19/02	NA	0.191	25.4	0	4.6	748	74	30
	01/29/03	NA	0.408	29.1	0	98.4	379	20	5
	03/12/03	NA	0	22.6	48	5.9	783	31	10
	03/26/03	NA	0.044	33.1	0	0	411	31	5
	04/30/03	NA	0	17.1	65	4.5	1284	464	10
	05/28/03	NA	0.113	26.3	31	36.4	958	465	171
	06/25/03	NA	0	18.1	42	6.2	2310	109	5

Appendix F-1. Data for CCLEAN stream and river samples from July 2002 through June 2003 (continued).

Location	Date	Flow, if available (cfs)	NO_3-N (mg/L)	SiO_2 (mg/L)	Urea-N (µg/L)	TSS (mg/L)	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Moore Creek @ HWY 1	09/23/02	NA	0	5.5	32	23.1	24192	5	5
	10/29/02	NA	0.989	4.9	20	17.4	25000	5	5
	12/19/02	NA	1.066	23.7	20	55.6	6488	1036	2733
	01/29/03	NA	0.407	29.9	10	0	464	41	5
	03/12/03	NA	0	23	20	7.1	871	10	5
	03/26/03	NA	0	26.8	51	0.4	1153	20	5
	04/30/03	NA	0	7.5	56	7.5	6294	292	30
	05/28/03	NA	0.378	27.2	14	14.9	728	285	30
	06/25/03	NA	0	18.8	29	3.6	3441	20	5
Branciforte Creek @ Isabel Dr.	09/23/02	NA	0.236	34.9	28	1.2	2755	368	5
	10/29/02	NA	0.099	36.6	0	10.4	1989	432	20
	12/19/02	NA	1.102	44.5	0	12.4	4106	249	231
	01/28/03	NA	0.94	44.7	0	4.3	413	52	10
	03/12/03	NA	0.096	23.2	12	23.2	318	20	5
	03/26/03	NA	0.617	37.1	0	2.2	959	173	5
	04/30/03	NA	0.299	44.6	0	16.1	2723	228	135
	05/28/03	NA	0.247	37.5	15	2.3	985	171	5
	06/25/03	NA	0.073	33.6	27	1.2	2063	148	20
San Lorenzo River @ Laurel St.	9/23/02	6	0.367	23.2	0	1.2	24191	169	30
	10/29/02	7.3	0.461	26.3	13	7.1	4325	110	5
	12/19/02	536	0	25.4	0	21.2	5475	318	135
	1/28/03	101	0.238	28.7	0	0	836	203	10
	3/12/03	58	0.106	23	0	0.8	480	20	10
	3/26/03	68	0.077	30.1	10	0.4	754	74	5
	4/30/03	195	0	24	0	8.6	1725	318	63
	5/28/03	55	0	21.5	0	1.3	1071	275	20
	6/25/03	33	0.348	24.2	20	1.2	521	85	5

Appendix F-1. Data for CCLEAN stream and river samples from July 2002 through June 2003 (continued).

Location	Date	Flow, if available (cfs)	NO_3-N (mg/L)	SiO_2 (mg/L)	Urea-N (µg/L)	TSS (mg/L)	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Soquel Creek @ RR Bridge	09/23/02	2	0	34.4	28	2.8	1046	61	10
	10/29/02	2.4	0.21	40.1	0	0	919	41	5
	12/19/02	182	0.354	19.54	0	173.8	2143	187	74
	01/28/03	32	0.169	29.5	25	4.3	3076	637	10
	03/12/03	16	0.375	28.4	32	9	676	98	10
	03/27/03	19	0.038	30.9	0	32.6	780	110	20
	04/30/03	49	0.075	25.3	0	21.5	1281	693	31
	05/28/03	17	0	25.5	11	0.4	839	272	10
	06/25/03	10	0	27.08	36	0	959	216	10
Porter Gulch @ mouth	09/23/02	NA	2.335	43.4	40	2.8	12996	11198	61
	10/29/02	NA	1.162	46.7	0	17	3255	169	5
	12/19/02	NA	0.593	32.1	0	2368.1	1842	185	121
	01/28/03	NA	0.417	32	16	4.8	422	20	5
	03/12/03	NA	0.68	32.6	52	3.2	1119	185	10
	03/27/03	NA	0.327	37.1	0	11.1	1063	285	5
	04/30/03	NA	0.405	30.9	36	1.6	3130	422	41
	05/28/03	NA	1.001	33.1	24	28.2	11153	135	5
	06/25/03	NA	5.36	38.7	0	8	839	63	20
Aptos Creek @ Winfield Dr.	09/23/02	NA	0.312	37.2	0	1.8	1616	262	5
	10/29/02	NA	0.423	36.2	21	0.8	1336	84	10
	12/19/02	NA	0.208	30.1	0	609.2	2224	108	120
	01/28/03	NA	0.231	35.3	0	2.4	1467	464	132
	03/12/03	NA	0.197	34.6	12	1.2	723	85	20
	03/27/03	NA	0.187	37.3	0	1.2	798	132	5
	04/30/03	NA	0.083	31.6	0	603.8	1664	1050	759
	05/28/03	NA	0.201	32.4	0	3.9	789	213	52
	06/25/03	NA	0.507	33.9	10	2	4352	481	31

Appendix F-1. Data for CCLEAN stream and river samples from July 2002 through June 2003 (continued).

Location	Date	Flow, if available (cfs)	NO_3-N (mg/L)	SiO_2 (mg/L)	Urea-N (µg/L)	TSS (mg/L)	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Pajaro River @ Thurwachter	09/23/02	5	1.607	13.7	56	2.8	6867	5	5
	10/29/02	5.4	0.512	7.1	41	3.1	8664	10	10
	12/19/02	503	4.853	17.7	17	124.1	12997	1145	1153
	01/28/03	113	1.833	18.4	0	17.6	14136	134	5
	03/12/03	75.5	3.724	11.3	14	6.7	3255	74	5
	03/26/03	91	0.115	37	0	2.2	545	145	5
	04/30/03	101	0.049	31.5	0	6.8	336	288	20
	05/28/03	19	5.86	15.9	51	4.8	1076	108	10
	06/25/03	11	0.101	31.2	15	0	1674	74	20
Elkhorn Slough@N. Kirby Park	7/25/02	NA	0	1.26	16	13	63	10	10
	8/28/02	NA	0	2.3	24	21	74	5	10
	9/26/02	NA	0	2.4	20	14.3	161	10	20
	10/29/02	NA	1	1.42	30	12	20	5	5
	11/5/02	NA	0	0.39	0	9	175	10	10
	12/11/02	NA	2	1.11	11	7	108	2	5
	1/29/03	NA	0	0.79	20	7	122	98	20
	2/6/03	NA	0	1.02	19	7	142	72	5
	3/27/03	NA	0	2.19	0	16	10	5	5
	4/15/03	NA	0	0.31	31	10	31	5	5
	5/12/03	NA	0	2.14	12	38	20	20	10
	6/18/03	NA	0	1.3	0	13	5	5	10

Appendix F-1. Data for CCLEAN stream and river samples from July 2002 through June 2003 (continued).

Location	Date	Flow, if available (cfs)	NO_3-N (mg/L)	SiO_2 (mg/L)	Urea-N (µg/L)	TSS (mg/L)	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Elkhorn Slough @ N. Jetty	7/25/02	NA	0	0.23	0	0	5	5	5
	8/28/02	NA	0	0.41	0	8	41	5	5
	9/26/02	NA	0	0.25	0	6	86	10	10
	10/29/02	NA	4	0.84	12.00	0	31	10	5
	11/5/02	NA	1	0.36	0	0	74	20	31
	12/11/02	NA	4	0.56	0	5	1119	31	5
	1/29/03	NA	0	0.5	10.00	8	74	31	10
	2/6/03	NA	0	0.71	12.00	0	160	31	5
	3/27/03	NA	0	1.22	20.00	10	73	10	5
	4/15/03	NA	0	0.1	14.00	0	20	5	5
	5/12/03	NA	0	3.06	15.00	11	5475	62	20
	6/18/03	NA	0	0.31	0	6	31	5	5
Salinas River @ Davis Road	7/25/02	17	4	8.26	0	0	6488	211	52
	8/28/02	1.8	140	3.3	15.00	0	5475	10	5
	9/26/02	15	5	8.1	36.00	6	8164	63	10
	10/29/02	0	148	0	10.00	11	15531	265	5
	11/5/02	0	160	3.2	13.00	10	10462	199	5
	12/11/02	0	23	4.85	52.00	28	24192	12997	6867
	1/29/03	13	21	13.8	0	9	6488	63	10
	2/6/03	0.74	17	8.16	10.00	7	1956	10	5
	3/27/03	35	16	23.7	11.00	15	17329	41	5
	4/15/03	0.05	15	5.4	50.00	24	24192	158	5
	5/12/03	131	5	15.8	0	21	583	20	51
	6/18/03	0	69	8.6	46.00	37	3873	20	5

Appendix F-1. Data for CCLEAN stream and river samples from July 2002 through June 2003 (continued).

Location	Date	Flow, if available (cfs)	NO_3-N (mg/L)	SiO_2 (mg/L)	Urea-N (µg/L)	TSS (mg/L)	Total Coliform (MPN/100mL)	E. Coli (MPN/100mL)	Enterococcus (MPN/100mL)
Carmel River @ Garland Park	7/2/02	NA	0	19.1	0	0	3076	41	10
	8/6/02	NA	0	38.9	38.00	0	1850	63	51
	9/3/02	NA	0	20.8	0	0	1956	31	85
	10/8/02	NA	0	20.6	25.00	0	1968	218	41
	11/5/02	NA	0	20.7	0	0	1455	52	20
	12/3/02	NA	0	14.7	0	0	2613	61	74
	1/7/03	NA	0	17.9	44.00	0	933	62	122
	2/4/03	NA	0	17.9	0	0	1650	10	265
	3/4/03	NA	0	22.3	14.00	0	754	5	5
	4/8/03	NA	0	25.1	0	0	960	216	20
	5/6/03	NA	0	27.1	0	0	1169	41	5
	6/3/03	NA	0	27.4	0	0	1785	41	10
Big Sur @ Andrew Molera	7/2/02	18	0	25.8	0	0	2063	30	20
	8/8/02	13	0	21.9	0	0	2613	10	5
	9/3/02	12	0	20.4	0	0	6131	63	5
	10/8/02	12	0	18.6	0	0	2909	20	20
	11/5/02	13	0	18.3	0	0	2098	63	52
	12/3/02	25	0	14.7	0	0	294	20	30
	1/7/03	185	0	19.9	0	0	631	10	10
	2/4/03	90	0	19.4	19.00	0	410	5	5
	3/4/03	73	0	22.1	0	0	185	52	20
	4/8/03	58	0	26.5	0	0	571	10	5
	5/7/03	112	0	25.1	0	0	369	5	5
	6/3/03	51	0	27.9	14.00	0	2187	31	10
Carmel River @ HWY 1	1/7/03	209.5	0	15.6	0	0	1050	20	41
	2/4/03	49	0	22.3	0	0	88	20	5
	3/4/03	35	0	22.1	16.00	0	985	5	5
	4/8/03	63	0	24.4	0	0	749	20	5
	6/3/03	46	0	25.5	0	0	2187	20	10

Appendix F-2. Data for CCLEAN river POP samples from July 2002 through June 2003.

Sites are arranged from North to South. A value of "0" indicates a non-detectable concentration and is analyzed as "0".

San Lorenzo River

	Average Flow	Lo-PAHs		HiPAHs		Total PAHs		Chlordanes		DDE		DDD		DDT		Total DDTs		HCHs		Endosulfans		PCBs		Dacthal	
	L/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day
Dry Season	17,166,898.08	9.640	0.165	1.061	0.018	10.701	0.184	0.008	0.00014	0.013	0.00022	0	0	0	0	0.013	0.00022	0.071	0.001	0.019	0.00033	0.033	0.001	0.0139	0.000
Wet Season	310,098,952.15	7.045	2.185	7.212	2.236	14.257	4.421	0.186	0.058	0.043	0.013	0	0	0.054	0.017	0.097	0.030	0	0	0.034	0.011	0.057	0.018	0.0198	0.006
Annual Mean	250,842,202.45	8.343	1.175	4.137	1.127	12.479	2.302	0.097	0.029	0.028	0.007	0	0	0.027	0.008	0.055	0.015	0.035	0.001	0.027	0.005	0.045	0.009	0.017	0.003
Annual Load, g			428.922		411.473		840.396		10.541		2.457		0		3.045		5.502		0.221		1.996		3.326		1.164

Pajaro River

	Average Flow	Low-PAHs		Hi-PAHs		Total PAHs		Chlordanes		DDE		DDD		DDT		Total DDTs		HCHs		Endosulfans		PCBs		Dacthal	
	L/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day
Dry Season	11,490,812.06	10.566	0.121	1.292	0.015	11.858	0.136	0.101	0.001	0.384	0.004	0.789	0.009	0.063	0.001	1.236	0.014	0.102	0.001	0.289	0.003	0.028	0.0003	0.14	0.0016
Wet Season	221,261,890.02	36.905	8.166	92.630	20.495	129.535	28.661	0.906	0.201	4.713	1.043	3.460	0.766	4.303	0.952	12.476	2.760	0.003	0.001	0.889	0.197	0.251	0.055	6.16	1.363
Annual Mean	245,608,453.83	23.736	4.144	46.961	10.255	70.697	14.399	0.504	0.101	2.548	0.524	2.125	0.387	2.183	0.476	6.856	1.387	0.053	0.001	0.589	0.100	0.139	0.028	3.150	0.682
Annual Load, g			1512.392		3743.136		5255.529		36.813		191.117		141.370		173.889		506.375		0.336		36.508		10.185		249.036

Appendix F-2. Data for CCLEAN river POP samples from July 2002 through June 2003 (continued).

Salinas River

	Average Flow	Lo-PAHs		HiPAHs		Total PAHs		Chlordanes		DDE		DDD		DDT		Total DDTs		HCHs		Endosulfans		PCBs		Dacthal	
	L/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day
Dry Season	195,727.10	19.172	0.004	2.751	0.001	21.923	0.004	0	0	0.150	0.000029	0.133	0.000026	0	0	0.283	0.000055	0.115	0.000022	0.175	0.000034	0.034	0.000007	0.778	0.000152
Wet Season	49,625,442.18	11.367	0.564	4.250	0.211	15.617	0.775	0.214	0.011	0.994	0.049	0.719	0.036	0.535	0.027	2.248	0.112	0	0	0.334	0.017	0.117	0.006	26	1.290
Annual Mean	92,527,367.07	15.270	0.284	3.501	0.106	18.770	0.390	0.107	0.005	0.572	0.025	0.426	0.018	0.268	0.013	1.265	0.056	0.057	0.000	0.255	0.008	0.075	0.003	13.389	0.645
Annual Load, g			103.632		38.592		142.223		1.934		9.008		6.516		4.845		20.369		0.004		3.031		1.057		235.501

Carmel River

	Average Flow	Lo-PAHs		Hi-PAHs		Total PAHs		Chlordanes		DDE		DDD		DDT		Total DDTs		HCHs		Endosulfans		PCBs		Dacthal	
	L/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day	ng/L	g/day
Dry Season	None																								
Wet Season	272,909,335.05	6.702	1.829	3.855	1.052	10.558	2.881	0.001	0.00019	0.026	0.007	0	0	0	0	0.026	0.007	0	0	0.006	0.002	0.058	0.016	0.0194	0.005
Annual Mean	157,281,644.59																								
Annual Load, g			347.538		199.898		547.436		0.037		1.327		0		0		1.327		0		0.291		3.014		1.006