Surface Water Ambient Monitoring Program

SWAMP Assement Repot for the Central Coast Region	2001-02

Central Coast Ambient Monitoring Program Hydrologic Unit Report for the 2001-02 Carmel River Watershed Rotation Area

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Water Boards

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1 Introduction

1.1 Addressing Priorities of the State

1.2 Overview of the Surface Water Ambient Monitoring Program in California

California Assembly Bill 982 (Water Code Section 13192; Statutes of 1999) required that the State Water Resources Control Board (SWRCB) assess and report on State water monitoring programs and prepare a proposal for a comprehensive surface water quality monitoring program. In the SWRCB Report to the Legislature from November 2000, entitled "Proposal for a comprehensive ambient surface water quality monitoring program", the SWRCB proposed to restructure the existing water quality monitoring programs into a new program, the Surface Water Ambient Monitoring Program (SWAMP). This new program is intended to provide comprehensive statewide environmental monitoring focused on information necessary to effectively manage the State's water resources. The program is designed to be consistent, cooperative, adaptable, scientifically sound, and to meet clear monitoring objectives. The program focuses on spatial and temporal trends in water quality statewide. It will facilitate reporting and categorizing of the State's water quality under Sections 305 (b) and 303 (d) of the Federal Clean Water Act. Specific program technical details can be found in the SWAMP Quality Assurance Management Plan (QAMP) (Puckett 2002).

Specifically, the statewide SWAMP is designed to meet four goals:

1. Create an ambient monitoring program that addresses all hydrologic units of the State.

2. Document ambient water quality conditions in potentially clean and polluted areas.

3. Identify specific water quality problems preventing the realization of beneficial uses of water in targeted watersheds.

4. Provide the data to evaluate the overall effectiveness of water quality regulatory programs in protecting beneficial uses of waters of the State.

1.3 Goals and Objectives of the Central Coast Ambient Monitoring Program

The Central Coast Regional Water Quality Control Board is responsible for water quality issues along the central coast of California. The region extends from southern San Mateo County in the north to northern Ventura County in the south, and includes Monterey, Santa Cruz, San Benito, San Luis Obispo, Santa Barbara and portions of Santa Clara counties. The Central Coast Ambient Monitoring Program is the Central Coast Regional Water Quality Control Board's ambient monitoring program, and a major portion of its funding comes from SWAMP**.** The goal of monitoring in the Central Coast region is to provide a screening level assessment of water quality in all hydrologic units, based on a variety of chemical, physical and biological indicators. Monitoring data is used to evaluate beneficial use support in the surface waters of the Region. Monitoring approaches include conventional water quality, water toxicity, sediment chemistry and toxicity, tissue chemistry, rapid bioassessment for benthic invertebrates, and habitat assessment. The Central Coast region uses a rotating basin approach where conventional water quality monitoring is conducted monthly at all sites, and at a subset of the sites other monitoring approaches are conducted annually or biannually. Coastal confluence sites, just above salt water influence, are monitored continuously, and serve for long-term trend monitoring and as "integrators" of upstream impacts.

It is the intent of the SWAMP program in the Central Coast Region to monitor and assess all the waters of the Region, using a weight-of-evidence approach. Data is intended for use in evaluating waterbodies for 305(b) reporting and 303(d) listing. General programmatic objectives of the monitoring program are to:

1. Determine the status and trends of surface, estuarine and coastal water quality and associated beneficial uses in the Central Coast Region
2. Coordinate with other data collection efforts
3. Provide information in easily accessible forms to support decision-making

The following specific monitoring objectives address questions posed in the SWAMP Monitoring Guidance related to beneficial use support. The monitoring approach and the water quality criteria that address these beneficial uses are discussed.

Is there evidence that it is unsafe to swim?
Beneficial Use: Water Contact Recreation (REC-1)
Objective(s): At sites throughout water bodies that are used for swimming, or that drain to areas used for swimming, screen for indications of bacterial contamination by determining percent of samples exceeding adopted water quality objectives and EPA mandated objectives. CCAMP data as well as data collected by local agencies and organizations will be used to assess shoreline and creek conditions.
Monitoring Approach: Monthly monitoring for indicator organisms (e.g. *E. coli*, fecal coliform, Enterococcus); compilation of data from other sources
Assessment Limitations: CCAMP currently samples for fecal and total coliform; assessments are typically based on these two parameters only. Sampling is conducted at a monthly interval only; Basin Plan criteria are typically based on percent exceedance within a 30-day period. The Basin Plan objective for geomean of fecal coliform is based on 5 samples in a 30-day period; monthly sampling is not conducive to calculating exceedances based on the 30 day objective, but is a useful measure of the magnitude of the problem.
Criteria:

- 10% of samples over 400 MPN/100 ml fecal coliform
- Geomean of fecal coliform over 200 MPN/100 ml
- 10% of samples over 235 MPN/100 ml *E. coli*

- 10% of samples over 104 MPN/100 ml Enterococcus (bays and estuaries only)

- Fecal to Total coliform ratio over 0 .1 when Total Coliform exceeds 1000 MPN/100 ml (bays and estuaries only)

Is there evidence that it is unsafe to drink the water?
Beneficial Use: Municipal and Domestic Water Supply (MUN)
Objective(s): At sites throughout water bodies that are sources of drinking water, determine percent of samples that exceed drinking water standards or adopted water quality objectives used to protect drinking water quality. Screen for presence of chemicals which may cause detrimental physiological response in humans using multi-species toxicity testing
Monitoring Approach: Monthly sampling for nitrate, general minerals and pH; annual or bi-annual multi-species toxicity testing and followup chemistry or toxicity identification evaluations where possible.
Assessment Limitations: CCAMP does not typically sample for metals or organic chemicals in water; assessment is based on conventional parameters and toxicity only.
Criteria:

- Nitrate (as N) over 10 mg/L
- pH under 6.5 or above 8.3
- Water toxicity effects significantly greater than reference tests and survival, growth, or reproduction less than 80% of control

Is there evidence that it is unsafe to eat fish and other aquatic resources?
Beneficial Uses: Commercial and Sport Fishing (COMM), Shellfish Harvesting (SHELL)
Objective(s): At sites located near the lower ends of streams and rivers, and in lakes, enclosed bays and estuaries, screen for chemical pollutants by determining the concentration of chemical contaminants in fish and shellfish samples, and assess whether samples exceed several critical threshold values of potential human impact (advisory or action levels).
Monitoring Approach: Annual fish and mussel tissue collection and chemical analysis
Assessment Limitations: CCAMP samples for an array of metals and organic chemicals commonly analyzed by the State Mussel Watch Program and the Toxic Substances Monitoring Program. This array does not include all currently applied pesticides, pharmaceuticals, and numerous other synthetic organic chemicals. Many chemicals do not have readily available human health criteria or advisory levels.
Criteria: Exceedance of Office of Environmental Health Hazard Assessment Criteria for fish and shellfish tissue and other relevant criteria and guidelines.

Is there evidence that aquatic life uses are not supported?
Beneficial Uses: Cold Freshwater Habitat (COLD); Preservation of Biological Habitats (BIOL); Warm Freshwater Habitat (WARM); Wildlife Habitat (WILD); Rare and Endangered Species (RARE); Spawning (SPAWN)
Objective(s): At sites along the main stem and at the lower ends of major tributaries of streams and rivers, screen for indications of water quality and sediment degradation for aquatic life and related uses, using several critical threshold values of toxicity,

biostimulation, benthic community condition, habitat condition, and physical and chemical condition.

Monitoring Approach: Spring synoptic sampling for sediment and water column toxicity, sediment chemistry, benthic invertebrate assemblages, and associated habitat quality. Toxicity Identification Evaluation and/or chemistry follow-through for toxic sites. Monthly conventional water quality monitoring for nutrients, dissolved oxygen, pH, turbidity, chlorophyll and water temperature. Pre-dawn or 24-hour continuous sampling for dissolved oxygen.

Assessment Limitations: CCAMP samples for an array of metals and organic chemicals commonly analyzed by the State Mussel Watch Program. This array does not include all currently applied pesticides, pharmaceuticals, and numerous other synthetic organic chemicals. Habitat sampling is conducted only in association with benthic invertebrate sampling and is not comprehensive. Sampling sites are located typically at the lower ends of major tributaries, streams and rivers within each Hydrologic Unit.

Critera:

- Sediment or water toxicity effects significantly greater than reference tests and survival, growth, or reproduction less than 80% of control
- Sediment concentrations of organic chemicals above detection limits
- Tissue concentrations of organic chemicals over established U.S. Fish and Wildlife and National Academy of Sciences guidelines for protection of aquatic life. Tissue concentrations for chemicals without guidelines above detection limits.
- Dissolved oxygen levels lower than 7.0 mg/L in cold water streams and 5.0 mg/l in warm water streams
- Median oxygen levels less than 85%.
- pH levels lower than 7.0 or above 8.5
- Unionized ammonia levels over 0.025 mg/L as N.
- Biostimulatory risk rank above scoring range of high quality sites, for a given stream stratum
- Index of Biotic Integrity below scoring range of high quality sites, for a given stream stratum

Is there evidence that agricultural uses are not supported?

Beneficial Use: Agricultural supply (AGR)

Objective(s): At sites throughout waterbodies that are used for agricultural purposes, determine percent of samples with concentrations of nutrients and salts above screening values or adopted water quality objectives used to protect agricultural uses.

Monitoring Approach: Monthly sampling for nutrients and salts

Assessment Limitations: CCAMP does not typically sample for all of the parameters identified in the Central Coast Water Quality Control Plan for protection of agricultural beneficial uses.

Criteria:

- pH below 6.5 or above 8.3
- Electrical conductivity over 3000 for salinity
- Sodium absorbtion ratio over 9.0

- Chloride over 106 mg/L
- Boron over 2.0 mg/L
- Sodium over 69 mg/L
- Ammonium over 30 mg/L
- Nitrate over 30 mg/L as N

Is there evidence that aesthetic and other non-contact recreational uses are not supported?
Beneficial Use: Non-Contact Water Recreation (REC-2)
Objective(s): At sites throughout waterbodies that are used for non-contact recreation, screen for indications of bacterial contamination by determining the percent of samples exceeding adopted water quality objectives and assess aesthetic condition for protection of non-contact water recreation
Monitoring Approach: Monthly sampling for pathogen indicator organisms (E. coli, total and fecal coliforms); monthly qualitative assessment of % algal cover, presence of scum, odor, trash, etc.
Assessment Limitations: CCAMP does not currently conduct a formal assessment for trash.
Criteria:

- pH under 6.5 or over 8.3
- 10% of samples over 4000 MPN/100 ml fecal coliform
- Dry weather turbidity persistently over 10 NTU
- Algal cover persistently over 25%
- Scum, odor, trash, oil films present

1.4 Overview of the Central Coast Ambient Monitoring Program Approach

The CCAMP mission statement is to collect, assess and disseminate water quality information to aide decision makers and the public in maintaining, restoring and enhancing water quality and associated beneficial uses in the Central Coast Region. The CCAMP monitoring strategy calls for dividing the Region into five watershed rotation areas and conducting synoptic, tributary based sampling each year in one of the areas. Approximately thirty sites are monitored in each watershed rotation area. Over a five-year period all of the Hydrologic Units in the Region are monitored and evaluated. In addition to the rotational approach, thirty-one of the Region's coastal creeks and rivers are monitored continuously just upstream of their confluence with the Pacific Ocean.

The CCAMP strategy of establishing and maintaining permanent long term monitoring sites provides a framework for trend analysis and detection of emergent water quality problems and maintenance of high quality waters. CCAMP uses a variety of monitoring approaches to characterize status and trends of coastal watersheds, including conventional water quality analysis, benthic invertebrate bioassessment, analysis of tissue and sediment for organic chemicals and metals, and toxicity evaluation.

In order to develop a broad picture of the overall health of waters in the Central Coast Region, a similar monitoring approach is applied in each watershed area. This provides compatibility across the Region and allows for prioritization of problems across a relatively large spatial scale. However, additional watershed specific knowledge is incorporated into the study design, so that questions which are narrower in focus can also be addressed. For example, in watersheds where Total Maximum Daily Load assessments are being undertaken, other program funds can be applied to support additional monitoring for TMDL development. Special studies are undertaken as funding and staffing permits to further focus monitoring on questions of interest in individual watersheds.

Watershed characterization involves three major components: acquisition and evaluation of existing data, monitoring of surface water and habitat quality, and developing a watershed assessment based on findings.

Evaluation of existing sources of data

Existing sources of data are evaluated for pollutants of concern, historic trends, data gaps, etc. These include Department of Health Services, USGS, Department of Fish and Game, Department of Pesticide Regulation, Toxic Substances Monitoring Program, STORET, NPDES discharge data, and other sources. Data from County, City, and other selected programs are also acquired. Selected data is compiled into the CCAMP data base format and used along with data collected by CCAMP to evaluate standard exceedances, pollutant levels which warrant attention, beneficial use impairment, and other pertinent information. Basic GIS data layers, where available, describing land use, geology, soils, discharge locations, etc. are used in analysis and display of data, to further understanding of probable sources and causes of identified problems.

Monitoring approaches

Table 2.4a indicates the relationship between monitoring types and beneficial uses recognized in the Central Coast Basin Plan. Monitoring approaches currently employed by CCAMP are shown in bold. It is intended that the program become more comprehensive as funding allows for additional monitoring approaches, but the current suite of monitoring activities addresses all beneficial uses to some degree. Virtually all major rivers and streams and their immediate tributaries in Region 3 are designated for cold water fisheries, commercial and sport fishing, contact and non-contact recreation, groundwater recharge, municipal and domestic supply, spawning, and migration beneficial uses. Many also support threatened and endangered species and biological habitats of special significance. Because these important beneficial uses tend to be universal in the Region and require most stringent water quality objectives, the CCAMP suite of indicators targets these beneficial uses particularly, and is intended to be applied uniformly at all sites.

Table 2.4a. Relationship between beneficial uses and monitoring activities.
X - monitoring approaches currently employed by CCAMP
+ - monitoring approaches not currently employed by CCAMP

	CWQ	Sed Chemistry	H2O Chemistry	Tissue Chemistry	Rapid Bioassessment	Toxicity	Geomorphology	Habitat	Remote Sensing	Flow	Sedimentation
Municipal & Domestic	X		+	X					+	X	
Estuarine Habitat	X	X	+	X	X	X	+	+	+	X	+
Marine Habitat	X	X	+	X	X	X	+	+	+		+
Wildlife Habitat	X	X	+	X	X	X	+	+	+	X	+
Biological Habitat of Special Significance	X	X	+	X	X	X	+	+	+	X	+
Rare & Endangered Species	X	X	+	X	X	X	+	+	+	X	+
Fish Migration	X	X	+	X	X	X	+	+	+	X	+
Fish Spawning	X	X	+	X	X	X	+	X	+	X	X
Shellfishing	X			X							
ASBS	X	X	+	X	X	X	+	+	+	X	+
Agricultural Supply	X	X	+			X				X	
Industrial Process Supply	X		+			X					
Industrial Service Supply	X								+		+
Groundwater Recharge	X		+			X	+		+	X	
Fresh Water Replenishment	X		+			X	+		+	X	
Navigation	X	X				X	+		+	X	+
Hydroelectric Power Generation	X						+		+	X	
Water Contact Recreation	X										
NonContact Recreation	X										
Commercial and Sport Fishing	X	X	+	X	X	X	+	+	+	X	
Aquaculture	X	X	+	X		X					
Warm Water Habitat	X	X	+	X	X	X	+	+	+	X	+
Coldwater Habitat	X	X	+	X	X	X	+	+	+	X	+

1.5 Scope of the Report

This report provides a data summary for watershed monitoring completed during fiscal years 1 and 2 (00-01 and 01-02) of the SWAMP Program. This includes CCAMP watershed rotation monitoring of the Carmel River Hydrologic Unit (307) between January 2002 and March 2003 as well as coastal confluences monitoring at one site in this Hydrologic Unit since April of 2001. The 2002 rotation area included Carmel River and one tributary, Tularcitos Creek in Monterey County. The report provides an analysis of beneficial use support and determination of impairment for monitored waterbodies.

2 Carmel River Hydrologic Unit Description

The Carmel River watershed is located in Monterey County just south of Monterey Bay, between the Santa Lucia mountains to the South and the Sierra del Salinas to the North and East. The river flows northwest through Carmel Valley to Carmel River lagoon and the Pacific Ocean near Carmel. The watershed drains approximately 199,570 acres (Cal Water v. 2.2) (Table 3.1a). The largest tributary to the Carmel River is Tularcitos Creek.

Steelhead trout (*Oncorhynchus mykiss*) are common in the Carmel River. There are currently no segments of the River or its tributaries that are identified as impaired on the CWA 303(d) list of impaired waters.

There are two major impoundments along the watercourse, Los Padres Dam and San Clemente Dam. The Carmel Valley has a mixture of urban areas, including Carmel Village and the City of Carmel by the Sea, rural residential, agriculture, rangeland and recreational areas. The Carmel River between San Clemente Dam and Los Padres Dam flows through woodland and grassland, primarily used for rangeland and rural residential purposes. The upper reaches of the Carmel River, above the Los Padres Dam, flow through the Los Padres National Forest.

Five sites, four on the mainstem and one on Tuarcitos Creek, were monitored by CCAMP during the 2002 sampling year. In addition, one site at highway has been monitored monthly since April 2001.

Table 3.1a. Santa Lucia watershed acreage estimated using Cal Water shape file (v 2.2)

Waterbody Name	**Watershed Acreage**
Carmel River	163,648
Tularcitos Creek	35,976

3 Sampling Design

Watershed rotation area monitoring sites are placed at safe access locations along the main stem of each major creek and river, typically upstream of each major tributary input, and also at the lower end of each major tributary. Sampling locations frequently are located at public bridge crossings because of all-weather public access. Care is taken to ensure that samples are not influenced by the bridge structure itself. Approximately thirty sites are allocated within the sampling area, in addition long-term coastal confluence sites are monitored continuously at thirty three creek mouths throughout the Region.

The CCAMP program design includes monthly monitoring for conventional water quality (CWQ) at all selected sites. At a subset of sites, generally selected based on hydrogeomorphological considerations or local issues of concern, other monitoring approaches are applied. These include sediment chemistry and toxicity, fish and freshwater clam tissue chemistry, benthic macroinvertebrate assessment and habitat assessment.

4 Methods

4.1 Conventional Water Quality

CCAMP staff collects monthly grab samples and field measurements for conventional parameters at all watershed rotation area and coastal confluence sites. Sampling is conducted following the protocols outlined in CCAMP Standard Operating Procedures (CCAMP 2000).

Field measurements are taken using a multi-analyte Hydrolab DS4a. Measured values are stored in a Surveyor 4a and subsequently downloaded. Data are also recorded on field data sheets, and are used to verify electronically recorded values. Probes are lowered to approximately two-thirds of the water's depth and allowed to equilibrate for at least one minute prior to recording measurements. Field measurements include dissolved oxygen, pH, conductivity, salinity, water temperature, chlorophyll a, and turbidity.

Samples are collected for laboratory analysis at the Central Coast Region's contract laboratory, BC Laboratories in Bakersfield, California. The laboratory analyzes samples for the following parameters: nitrate as N, nitrite as N, total ammonia, total phosphate as P, ortho-phosphate as P, dissolved solids, suspended solids, boron, calcium, chloride, magnesium, sodium, total and fecal coliform. Pre-cleaned 1-L plastic bottles are used to collect samples for nutrients, salts, dissolved and suspended solids analyses. Sterile and sealed 120ml plastic bottles containing sodium thiosulfate preservative are used to collect total and fecal coliform samples. Once collected, samples are stored in ice chests at 4º C until they are transferred to the contract laboratory. Proper chain of custody documentation is maintained for all samples as described in the SWAMP QAMP (Puckett 2002).

During the summer months (July-September) CCAMP staff collect pre-dawn dissolved oxygen measurements. Prior to 2002 CCAMP staff visited each site between 3 a.m. and 30 minutes before sunrise to collect in-situ dissolved oxygen measurements using the Hydrolab DS4a. Beginning in the summer of 2002 CCAMP staff deploy a Hydrolab mini-sonde at each site for 24 hours. The mini-sonde measures dissolved oxygen and pH every 30 minutes. Each mini-sonde is programmed to warm up for two minutes with a circulator to allow the dissolved oxygen to equilibrate. Measurements are stored internally and downloaded following mini-sonde retrieval. Instruments are secured inside ABS pipes and cabled to stationary objects.

Quality Assurance

Hydrolab probes (both the DS4a and the mini-sonde) are calibrated prior to and following each sampling event. Probes are calibrated using laboratory certified standards for pH, conductivity and turbidity, and are air calibrated for dissolved oxygen. Chlorophyll *a* is calibrated using a manufacturer supplied "calibration cube". Calibration data is recorded in an Excel spreadsheet and is used to evaluate instrument performance. The SWAMP QAMP has defined +/- 20% difference as the maximum allowable variation between the calibration standard and post calibration measurement of the standard (Puckett 2002, Appendix C).

A blind field duplicate sample is collected once per sampling trip, resulting in 10% total field duplicates. Duplicates samples, two bottles filled side by side, are labeled with a unique site tag to remain anonymous to the contract laboratory. Data from duplicates is compared to original samples and evaluated using the SWAMP maximum for relative percent difference of 25% (Puckett 2002, Appendix C).

The quality control measures employed by the contract laboratory are also evaluated using SWAMP criteria. These measures include but are not limited to matrix spike recovery, calibration control samples, blanks and lab duplicates.

CCAMP Biostimulatory Risk Index

CCAMP has developed a "Biostimulatory Risk Index" to serve as a screening tool to evaluate sites for risk of problems associated with eutrophication. A more complete description of the index and its use is found in Appendix A; however, it is briefly summarized in this section.

The Biostimulatory Risk Index is a combination of several different measures, or "metrics" of stimuli (nutrient concentrations) and responders (pH, dissolved oxygen, algal and plant cover, water column chlorophyll concentrations), which have been percentile ranked and combined to form a single value. CCAMP collects data on a number of parameters that serve as measures of biostimulation or response. The index is intended to characterize both in-situ monitoring site response to biostimulatory substances and the capacity of monitoring site water quality parameters to induce adverse biostimulatory responses in downstream areas. Some measures, such as nutrient and chlorophyll concentrations, serve as metrics based on magnitude alone (where higher concentrations are considered “worse” than lower concentrations and are ranked accordingly). Others are more complex, particularly “double-ended” parameters such as dissolved oxygen and pH. For example, both supersaturated and depressed concentrations of dissolved oxygen can be indicative of eutrophication. For such parameters the departure of the measurement from the Regional median value is used to calculate the metric (where a larger departure ranks worse than a smaller departure). Various forms of plant cover are stimulated by nutrients and can create nuisance conditions. The Index utilizes the maximum value from three qualitative estimates of percent cover for rooted plants, filamentous algae and periphyton, to calculate a plant cover metric.

4.2 Rapid Bioassessment

CCAMP staff collect benthic macroinvertebrates (BMIs) following California Stream Bioassessment Protocols (Harrington 1999 as cited in Puckett 2000, Appendix G) in two consecutive spring seasons at each site. All BMI samples are processed and identified to the lowest possible taxon at the Department of Fish and Game Aquatic Bioassessment Laboratory (DFG-ABL).

Samples are collected during base-flow conditions. Sampling reaches are always selected in association with conventional water quality monitoring sites. When riffle habitat is present, a reach of stream containing riffles is selected for sampling. Riffles are typically the most taxonomically diverse microhabitats within streams, and are targeted for BMI sample collection. Three riffles within each stream reach are randomly selected for sampling. At each riffle, a transect location is randomly chosen from all possible meter marks along the upper third of the riffle. Three samples are collected along the transect, which is perpendicular to the direction of flow, using a D-shaped kick net. A 1x2 foot area of substrate upstream of the kick-net is disturbed for 1 minute at each site. The three samples from each transect are composited into a single sample. Each sample is preserved in 95% ethanol until analyzed.

When riffle habitat is not present, a representative 100m reach is measured out and three transect locations are chosen randomly from the 100 possible meter marks in the reach. At each transect location the two margins and thalweg are sampled by disturbing a 1 x 2-foot portion of substrate upstream of the kick-net to approximately 4-6 inches in depth. The three site collections per transect are composited to create one sample that is sieved to 0.5 mm and preserved in 95% ethanol. All samples are stored at the Central Coast Regional Board until they are transferred with the appropriate chain of custody forms to the DFG laboratory at Rancho Cordova for identification.

At the laboratory, BMI samples are randomly sub-sampled and sorted to obtain 300 individuals per sample. These individuals are stored in an ethanol-glycerin solution, identified to genus or the lowest possible taxonomic unit, and enumerated. Metrics calculated from individual count data include abundance, taxa richness and composition, taxa tolerant or intolerant of impaired conditions, and relative dominance of functional feeding groups. All organisms identified and included in the individual taxa list for each site are labeled with scientific name, date and location collected, and are returned to CCAMP for archiving.

Physical and habitat characteristics are estimated at each site based on visual observations, which score the following habitat parameters on a 1-20 scale: epifaunal substrate, embeddedness, velocity/depth regimes, sediment deposition, channel flow, channel alteration, riffle frequency, bank vegetation, bank stability, and riparian zone width. Field samplers are trained by CDFG staff to conduct this assessment, and scores are intercalibrated for consistency prior to start of sampling.

5.2.1 CCAMP Index of Biotic Integrity

The CCAMP Index of Biotic Integrity (CCAMP-IBI) is a sum of several ranked metric scores, including taxonomic richness, number of Ephemeroptera taxa, number of Trichoptera taxa, number of Plecoptera taxa, percentage of intolerant individuals (with tolerance scores of 0, 1, or 2), percentage of tolerant individuals (with tolerance scores of 8, 9 or 10), percent dominant taxon, and percent predators. This index includes all metrics utilized by Karr and Chu (1999) in their Index of Biotic Integrity, with the exception of "clinger taxa count" and "long-lived taxa count". The CCAMP program has been utilizing this index for a number of years for evaluating benthic invertebrate data in the Central Coast. In the past year, a Southern California Index of Biotic Integrity has been developed (Ode et al. 2005), which has incorporated data from the Central Coast Region and more southerly regions. This index includes percent collect-gatherer + collector-filterer, percent non-insect taxa, percent tolerant taxa, *Coleoptera* richness, predator richness, percent intolerant individuals, and EPT richness. Metrics selected for the Southern California IBI were screened using several selection criteria, including range of scoring, responsiveness to disturbance, and minimal inter-correlation. We have evaluated the performance of the CCAMP IBI against the Southern California IBI and find that they are relatively well correlated (R^2=0.72) (Figure 5.2.1a). In the future, we will incorporate the Southern California IBI into the analysis of our benthic data.

CCAMP-IBI scores range from 0 to 10. Sites in the lowest quartile of all CCAMP bioassessment data score below approximately 3.0, as a site average. Sites in the highest quartile score above 6.0. We have examined these quartile break points relative to other indices of water quality and this is discussed in more detain in Appendix B.

4.3 Water Toxicity

Sampling for toxicity to fathead minnow larvae (*Pimephales promelas*) and water fleas (*Ceriodaphnia dubia*) is conducted at a subset of watershed rotation area sites by CCAMP staff. Samples are collected in four 1-gallon amber glass bottles and are maintained at 4° C until delivery to the laboratory within 48 hours. Toxicity testing is performed at the University of California Davis Marine Pollution Studies Laboratory at Granite Canyon (UCD-GC). All tests are conducted for seven days, at 25ºC according to US EPA (1994) protocols. Water quality parameters including conductivity, hardness, alkalinity, pH, dissolved oxygen, and ammonia are measured at the beginning of each test. Test solutions are renewed daily; dissolved oxygen and pH are measured on the old solution and replacement solution. Temperature is monitored continuously by a temperature probe in an additional test solution placed in the controlled temperature room. Details of toxicity testing methods can be found in the SWAMP QAMP (Puckett 2002, Appendix F).

Larvae of the fathead minnow are purchased from an organism supplier and received on test initiation day (less than 24 hours old). Ten fish are randomly distributed to ten test containers containing 250 mL of sample. Test containers are checked daily, and the number of living fish recorded; immobile fish that do not respond to a stimulus are considered dead. Survival and growth endpoints (as dry weight) were recorded for each test container at the end of seven days.

Water flea neonate individuals (<24 h old) are introduced singly into small cups containing 15 mL sample. Each sample includes ten replicates. Survival and reproduction are monitored daily in each replicate. Survival and reproduction endpoints (number of neonates and broods) were recorded for each test container at the end of seven days.

Samples are also tested for chlorpyrifos and diazinon using Enzyme-Linked Immunosorbent Assay (ELISA). All ELISA analyses are performed at UCD-GC with kits from Strategic Diagnostics Inc. (Newark, DE). The lowest detectable doses are 30 ng/L for diazinon and 50 ng/L for chlorpyrifos (Sullivan and Goh 2000).

<u>Quality Assurance</u>

Field duplicate samples are tested to estimate the variability in results associated with sampling and laboratory procedures. All toxicity tests include both positive and negative controls. Positive controls tests are conducted monthly at the laboratory and concurrently with test samples. These controls consist of a dilution series of copper (from cupric chloride) to determine the LC_{50} values for *C. dubia*. Reference toxicant test are conducted to determine whether organism response is within prescribed limits and control chart variations are noted in interoperations of the data. Negative controls consist of laboratory dilutions of water adjusted with sea water to the lowest and highest conductivity observed in the test samples. Data acceptability for 7 day chronic toxicity testing for *C. dubia* is determined by the following criteria: control samples have greater than 80% survival, surviving females average 15 neonates and at least 60% of the surviving females have at least 3 broods (see the UCD-GC SOP document included in Puckett 2002 for more detailed QAQC information).

To verify accuracy of the ELISA method, an external standard is quantified with each batch. Accuracy of these measurements is considered acceptable if the measured value is within 20% of the known concentration. In addition, 5% of the samples measured using the ELISA method are also measured using an EPA analytical method for comparison. The measurement is considered acceptable if the relative percent difference between the results using the two methods is less than 50%. The SWAMP QAPP allows the program manager to determine control limits for external QA assessments (Puckett 2002).

4.4 Sediment Chemistry and Toxicity

Bed sediment samples are collected by Marine Pollution Studies Laboratory (MPSL-DFG) staff at a subset of watershed rotation area sites. Sampling targets fine-grained sediments within the wetted creek channel. A pre-cleaned Teflon™ scoop is used to collect the top 2 cm of sediment from five or more sub-sites into a pre-cleaned glass composite jar. After an adequate amount of sediment is collected, it is homogenized thoroughly and aliquoted into pre-cleaned, pre-labeled sample jars (glass or polyethylene, as appropriate) for organic chemical, metal or toxicological analysis. Once collected, samples are stored at 4°C and shipped with appropriate chain-of-custody and handling procedures to the analytical laboratories (MPSL-DFG, Rancho Cordova-DFG and UCD-GC). Field data sheets are completed for each sampling event to document conditions and sampling notes. Details on sediment sampling are described in the bed sediment procedures outlined in the SWAMP QAMP (Puckett 2002, Appendix D).

Analysis for metal concentrations in sediment samples is conducted at MPSL at Moss Landing. Organic chemical, polynuclear aromatic hydrocarbons, total organic carbon, and grain size analyses are conducted at the DFG laboratory at Rancho Cordova. Analysis and QC procedures used by these laboratories are outlined in the SWAMP QAMP (Puckett 2002).

Toxicity and ELISA analyses are conducted at UCD-GC. Ten-day sediment toxicity testing using *Hyalella azteca* (EPA 2000) is conducted using eight 100-mL replicates, each with 10 *Hyalella* individuals. Water quality parameters, including conductivity, hardness, alkalinity, pH, dissolved oxygen, and ammonia are measured in overlying water from one replicate of each sample at the beginning and end of each test. Dissolved oxygen is measured daily in one replicate of each sample. Temperature is monitored continuously by placing a probe in an additional test solution in the controlled temperature room. Endpoints recorded after ten days are survival and growth (as dry weight).

<u>Quality Assurance</u>

Sediment toxicity QA procedures such as field duplicates, and positive and negative controls are similar to those discussed in the section on water toxicity. See Puckett (2002) for a complete discussion on QAQC procedures. In sediment toxicity tests the positive control test consists of a dilution series of cadmium (from cadmium chloride). The negative control for *Hyalella* consists of reference sediment subjected to the same well-water renewals as the samples.

4.5 Tissue Bioaccumulation

Resident fish and transplanted freshwater clams (*Corbicula fluminea*) are used to assess bioaccumulation of organic chemicals and metals in streams and lakes throughout the watershed rotation areas.

MPSL-DFG staff performs deployment, collection and preparation of fresh water clams at a subset of watershed rotation sites. Clams are collected from Big Break Lake near the Sacramento River Delta, and tested for contamination prior to deployment. Clams are deployed for one month in anchored polypropylene mesh bags, approximately 15 cm above the streambed. Approximately 25 to 50 clams, 20 to 30 mm in diameter, are deployed at each site for each analysis (organics and metals). After a month-long deployment, clams are collected and sent to the laboratory for analysis. Clams intended for metals analysis are transported in plastic bags; clams intended for organic analysis are bagged in aluminum, then plastic. All sample handling is performed with methods designed to minimize contamination. Details of clam collection, handling, deployment and retrieval can be found in the SWAMP QAMP (Puckett 2002, Appendix D).

Fish sampling in reservoirs and at watershed rotation area sites is conducted by the DFG-ABL through the Toxic Substances Monitoring Program (TSMP). Two to four composite samples containing four fish each are collected for each species. Within each composite the smallest fish is at least 75% the length of the largest fish. Larger, older fish are targeted. When the target species is a food fish, the minimum size is set at the legal angling size or practical eating size for that species.

Fish collection techniques used include boat and backpack electrofishing, gill netting and seine netting. Fish species and length are recorded. Fish are sacrificed and wrapped in aluminum foil or Teflon®. The heads and tails of fish larger than the wrapping material are removed prior to wrapping (gut contents are kept intact). Fish are kept on dry ice in the field, and then frozen at -20º C prior to analysis. Details of fish sampling methods used in the TSMP can be found in the CDFG-MPSL Standard Operating Procedure document, Method 102 (CDFG-MPSL 2001).

5 Carmel River Hydrologic Unit Assessment

In this section, the Carmel River Hydrologic Unit is evaluated according to questions posed in the SWAMP report to the Legislature (2000). It is only possible to address these questions in terms of analytes actually evaluated, for the given sampling period and sampling frequency. For example, from the standpoint of assessing whether water is of adequate quality to drink, only a few of the many chemicals with drinking water standards have been evaluated. However, when violations of standards and criteria are found, they support conclusions of water quality impairment.

5.1.1 Summary of monitoring

Table 6.1a. Specific monitoring activities conducted at sites in the Carmel River Hydrologic Unit (HU307). **CWQ** - Conventional Water Quality; **BMI** - Benthic Macroinvertebrate Assessment; **Sed Chem & Tox** - Sediment Chemistry and Toxicity; **Tissue Chem** - Tissue Chemistry analysis.

Site Tag	Monitoring Site	CWQ	BMI	Sed Chem & Tox	Tissue Chem
307CML	Carmel River at Highway 1	X	X	X	
307CMD	Carmel River at Schulte Road	X			
307CMU	Carmel River at Esquiline Road	X	X		
307CMN	Carmel River at Nasson Community Park	X			
307TUL	Tularcitos Creek at Carmel Valley Road	X			
307-00-01	Carmel River Lagoon				X

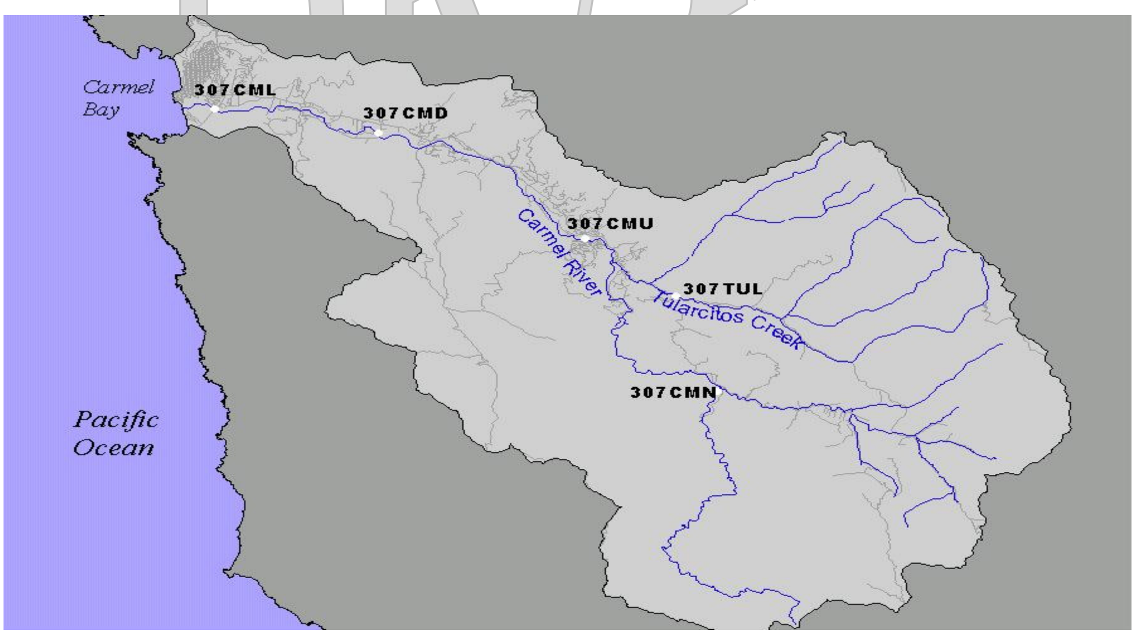

Figure 6.1a. CCAMP monitoring sites in the Carmel River Hydrologic Unit.

Table 6.1b. Findings related to monitoring questions for sites in the Carmel River Hydrologic Unit (HU307). **Yes** - evidence that a problem exists, **No** - no evidence that a problem exists, **S** – some evidence that a problem may exist, **NA** - not assessed

Site Tag	**Monitoring site**	**Unsafe to Swim?**	**Unsafe to drink?**	**Are aquatic life uses impaired?**	**Unsafe to eat fish?**	**Are agriculture uses impaired?**	**Aesthetics or non-contact recreation?**
307CML	Carmel River at Highway 1	No	No	Yes	NA	No	No
307CMD	Carmel River at Schulte Road	No	No	No	NA	No	No
307CMU	Carmel River at Esquiline Road	No	No	S	NA	No	No
307CMN	Carmel River at Nasson Community Park	No	No	No	NA	No	No
307TUL	Tularcitos Creek at Carmel Valley Road	Yes	No	S	NA	No	Yes

5.1.2 Is there evidence that it is unsafe to swim?

Fecal coliform levels were low throughout the Carmel River, with only one excursion over the criterion for water body contact, at the Highway 1 site (307CML). In contrast, at the Tularcitos Creek site (307TUL), 50% of all samples violated the 400 MPN criterion. The geomean at this site was 544 MPN/100 ml, well over the 200 MPN criterion.

5.1.3 Is there evidence that it is unsafe to drink the water?

Nitrate levels in the Carmel River watershed never exceeded the drinking water standard in any samples, and the highest level measured, at the Tularcitos Creek site, (307TUL) was 0.53 mg/L as N.

pH occasionally exceeded the upper limit for drinking water at Esquiline Road (307CMU) (7%) and Nason Road (307CMN) (3%). Excursions were minimal, with a maximum value of 8.37.

Water toxicity tests were conducted at the Coastal Confluence site at Highway 1 (307CML). No toxicity responses (survival, growth or reproduction) were observed in tests conducted on fathead minnows, *Pimephales promelas*, or water fleas, *Ceriodaphnia dubia*.

5.1.4 Is there evidence that it is unsafe to eat the fish?

Three-spined stickleback (*Gasterosteus aculeatus*) were collected in the Carmel River lagoon in August 2001 and October 1999 by California Department of Fish and Game staff working with the Toxic Substances Monitoring Program. In both the 1999 and 2001 samples, tissue analysis for organic chemicals resulted in detection of low levels of DDE and trans-nonachlor, a form of chlordane. No other organic chemicals were detected in either sample. Concentrations of most metals were below Median International Standards (MIS). However, in the 1999 sample zinc measured 72 ppm, exceeding the MIS value of 45 ppm. In the 2001 sample zinc concentrations were 38 and 41 ppm (in split sample analysis), approaching the MIS value. Sediment analysis at the Highway 1 site (307CML, the site nearest the lagoon) did not have elevated zinc. Anthropogenic sources of zinc in this watershed are unknown and should be the subject of further investigation. Zinc is common in stormwater runoff from highways, as it is commonly found in brake linings and batteries. It is also a component of galvanized metal.

5.1.5 Is there evidence that aquatic life uses are not supported?

No violations of the ammonia objective (0.025) or the pH objective (<7, >8.5) for aquatic life were observed.

Slightly depressed oxygen levels, below the cold water standard (7.0 mg/L), were recorded at the Esquiline Road site (307CMU) during summer time 24-hour monitoring and in one mid day sample. Several measurements appeared somewhat supersaturated at the Schulte Road site (307CMD) (up to 127%). Both the Esquiline Road (307CMU) and Nason Road (307CMN) sites had relatively high percent cover by macroalgae. Levels of ortho-phosphate were elevated at the Tularcitos site (307TUL), averaging 0.185 mg/L and consistently over 0.1 mg/L. At this site a bag of fertilizer was observed in the creek on April 4, 2002. The CCAMP Biostimulatory Risk Index score was not particularly elevated at the Tularcitos Creek site (307TUL) at 0.219; the site showed little evidence of eutrophication, but is at risk for causing downstream impacts because of elevated levels of phosphate. In general there is little evidence that eutrophication is a problem in the Carmel watershed. All sites on the main stem of the Carmel River had low Index scores, with the highest being 0.103 at Highway 1 (307CML). This range of values is not considered to indicate elevated risk for eutrophication. None of the sites scored anywhere close to 0.40, the level at which impairment generally is observed.

Benthic invertebrate community assemblages collected and identified from two sites on the main stem show that relative to other sites in the Region biological integrity is fair. The CCAMP Index of Biotic Integrity averaged 3.7 at Highway 1 (307CML) and 4.0 at Esquiline Road (307CMU). Elsewhere in the Region scores reach as high as 7.7 (at the Big Sur River). Samples were dominated by several species of fly larvae, mosquito larvae, and ostracods. Sand dominated the substrate at the Highway 1 site (307CML), likely significantly influencing biotic integrity. This site had one of the poorest scores in the Region for sediment impact. It is not clear why CCAMP IBI scores were as low as they were at Esquiline Road; habitat appeared to be in good condition, and sediment impact scores here were very high (good). Very few intolerant species were found at this site.

Toxicity testing was conducted at the Highway 1 site (307CML). No toxicity responses (survival, growth or reproduction) were observed in water tests conducted on fathead minnows, *Pimephales promelas*, or water fleas, *Ceriodaphnia dubia*. However, adverse biological effects were observed in the sediment toxicity test using amphipods, *Hyalella azteca*. Growth of the test organisms was significantly reduced relative to the control. The substrate at this site is primarily composed of sand with few fines (Figure 6.1b). The sediment sample was made up of 79.9% sand, 13.1% silt and 1.48% Total Organic Carbon.

Figure 6.1b. Photographs of the Highway 1 site (307CML) in April and June 2002.

Sediment collected from the Highway 1 site (307CML) was analyzed for metals and organic chemical content. Aluminum concentrations at this site were measured at 88,000 mg/Kg. Also of note: the chromium concentration at this site was 44.2 mg/Kg, exceeding the Florida TEL value. Several organic chemicals were detected (see Table 6.1c). However, only total DDT exceeded published criteria values.

Table 6.1c. Organic chemicals detected in the sediment sample collected at 307CML in March 2002, with available criteria for reference.

Site Tag	Chlordane, Total	DDD(p,p')	DDE(p,p')	DDT, Total	Dieldrin	Nonachlor, trans	Total PCB
307CML	1.46	4.86	2.56	7.42	1.32	1.17	14.362
ERM marine	6			46.1	8		
Florida PEL	8.9			4450	6.67		
Florida TEL	4.5			6.89	2.85		

5.1.6 Is there evidence that agricultural uses are not supported?

pH exceeded the upper limit for agricultural use at Esquiline Road (307CMU) (7%) and Nason Road (307CMN) (3%). Excursions were minimal, with a maximum value of 8.37, and are not considered to be a source of concern for agriculture. At all sites in the watershed pH, conductivity, salts and nutrients were not evaluated above criteria.

5.1.7 Is there evidence that aesthetic and non-contact recreation uses are not supported?

Generally the Carmel River appears to be in good aesthetic condition. Dry season turbidity remained low at all sites. Fecal coliform levels never exceeded the non-contact recreation criterion of 4000 MPN/100 ml on the main stem of the River. The Tularcitos site did have 12% exceedance of this criterion. It also at times had a large amount of nuisance algal mats floating on the water surface. Though other sites had high percent periphyton cover at times, they never reached quantities that were considered a nuisance.

5.1.8 Discussion

In general, CCAMP data indicated good water quality in this watershed. In addition to the data discussed in previous paragraphs, there were additional noteworthy data:

The site-specific objective for total dissolved solids (200 mg/L) was exceeded multiple times at all sites. The appropriateness of this objective should be evaluated.

Historic bioaccumulation data from the Carmel River lagoon includes a single fish tissue sample from 1991. That sample showed slightly elevated levels of p'p'DDE. Two fresh water clam samples taken from the lagoon from 1984 and 1989 were evaluated for metals. Freshwater clams from San Clemente Reservoir were analyzed for metals in 1982. Available criteria for metals (Median International Standards) were not exceeded in any of these samples. Sand crabs from Carmel River area beaches were collected and analyzed for metals, petroleum products and synthetic organic chemicals by DFG and UCSB staff in 2001. This data showed the presence of PAHs and synthetic organic chemicals; however, concentrations were below established criteria.

Pathogen indicators are monitored by the Monterey County beach water quality at Carmel City Beach. There are very few exceedances of water quality criteria for pathogen indicators at this location.

5.1.9 Conclusion

In spite of the generally excellent water quality in the Carmel River watershed, CCAMP monitoring activities did document levels of fecal coliform, total dissolved solids, pH and organic chemicals in sediment that do not meet Basin Plan water quality criteria (Regional Water Quality Control Board 1994) or generally accepted sediment screening criteria. In addition, the single sediment sample tested for toxicity to the amphipod *Hyallela azteca* resulted in significantly reduced growth of the test organisms relative to the control sample. Neither the Carmel River nor Tularcitos Creek are currently identified as having impaired beneficial uses on the 303(d) list. However, CCAMP monitoring data suggests that Tularcitos Creek should be considered for listing on the 303(d) list for impairment of beneficial uses due to elevated fecal coliform levels. To address these issues the following Regional board actions are recommended:

- Basin Planning
    - Evaluate existing site-specific Basin Plan objectives for total dissolved solids for appropriateness.
    - Evaluate appropriateness of Basin Plan objectives for pH.

    - Review and revise beneficial use designations for each waterbody in the Hydrologic Unit.
- Nonpoint Source Management
    - Identify and manage nutrient sources. Priority for this action should be phosphate sources in the Tularcitos Creek watershed.
    - Identify and manage fecal coliform sources in the Tularcitos Creek watershed.
- Follow up Monitoring
    - Sediment chemistry and toxicity monitoring is recommended in the lower reaches of the Carmel River to determine if toxicity is persistent and to determine if detected organic chemicals are its source.

6 Quality Assurance

Evaluating field data

Field equipment is calibrated according to manufacturers specifications (Hydrolab Inc, 2002) prior to and following each sampling event. Field data is qualified with a flag and disabled from use in data calculations and determination of beneficial use impairment if the following is true:

- Post calibration measurements differ from the calibration standard values by more than 20% as identified in the SWAMP Quality Assurance Management Plan (QAMP) (Puckett 2002, Appendix C).

Evaluating laboratory data

Data is qualified with a flag if it meets one of the following criteria:

- Analyte of interest is not detected (non-detect), the minimum detection limit (MDL) and/or practical quantifiable limit (PQL) is higher than the SWAMP target reporting limit (TRL), and the MDL does not exceed levels of concern or Basin Plan objectives.
- The result is between the MDL and the PQL and these values are below the appropriate water quality criterion.
- The difference between the results from a blind field duplicate and an original sample exceeds the allowable relative percent difference (RPD) defined in the SWAMP QAMP (Puckett 2002, Appendix C). The maximum RPD for conventional parameters, synthetic organics and metals is 25%.
- Blind field duplicates for coliforms exceed the 95% confidence interval values.
- Holding time requirements are not met.

Data is qualified with a flag and disabled from use in calculations and determination of beneficial use impairment if it meets one of the following criteria.

- Analyte of interest is not detected (non-detect), MDL and/or PQL is higher than the SWAMP target reporting limit (TRL), and the non-detect value is near or exceeding a criterion.
- The surrogate spike recovery levels exceed the allowable range of acceptance as identified by the contract laboratory's quality assurance program (BC Labs, 2002). The acceptable levels vary between analytes.
- Matrix spike recovery values exceed the allowable recovery (percent recovery) as defined in the SWAMP QAMP (Puckett 2002, Appendix C). The maximum variation in percent recovery for conventional parameters and metal in sediment is 25%. For synthetic organics in sediment the required recovery is at least 50%.
- The batch precision violates the precision requirements defined in the SWAMP QAMP (Puckett 2002, Appendix C). These requirements are 80-120% precision for conventional parameters and 50-150% precision for organic chemicals in sediment and tissue.
- The method blank results exceed the MDL.
- The relative percent difference (RPD) between the blind field duplicate result and the original sample exceeds the allowable defined in the SWAMP QAMP

(Puckett 2002, Appendix C) and the difference between the two results is greater than twice the analyte's SWAMP TRL.

All data was evaluated relative to the SWAMP QA criteria. A summary of the flags attached to the final data are listed in Table 7a. Flags that have been accepted are included in the database as qualifiers. These data are used by CCAMP in analyses but can be excluded by other users such as TMDL staff. Data, which are rejected because they are outside of the QA criteria defined in the SWAMP QAMP, are disabled from all analyses.

CCAMP field and laboratory data was evaluated using the SWAMP QAMP and CCAMP acceptability criteria outlined above. The contract laboratory submitted electronic QA/QC data for all results discussed in this report. They submitted data for 61 samples, each with 20 analytes, and attached flags to a number of sample analytes. These flags were reevaluated using the SWAMP measurement quality objectives (MQOs) where appropriate.

SWAMP acceptability criteria were generally less strict than that of the contract laboratory. Therefore, several of the data were flagged by the contract laboratory and remained flagged in the CCAMP database but are acceptable for use in some data analyses using SWAMP criteria. Data that did not meet SWAMP acceptability criteria were flagged with the appropriate code and the term "reject". Rejected data was not included in any of the analyses discussed in this document.

There were a total of 174 flags generated during QA analysis of data collected from the Carmel River Hydrologic Unit. Flags include those generated by the Region 3 contract laboratory such as matrix spike and continuing calibration exceedances as well as field duplicate analysis and field equipment calibration data analysis. Of these174 flags 13 were outside the MQOs identified in the SWAMP QAMP (Puckett 2002). Rejected data are maintained in the database with a flag identifying the data as disabled. These data are not used in any assessments.

<u>Field Duplicates</u>
Blind field duplicate results were compared to original sample data. Data pairs were compared in terms of relative percent difference and determined to be unacceptable if the difference between duplicate pairs exceeded the analyte's specific MQOs and was greater than twice the TRL, as defined in the SWAMP QAMP (Puckett 2002). For each blind field duplicate pair, there are several different analytes.

Ten blind field duplicate samples pairs were collected, each with 20 analytes analyzed by the contract laboratory. We identified five sample analytes or less than 1% of the total data set that did not meet the QA criteria defined above. All five field duplicate samples failed both the SWAMP MQO and the "twice the TRL" criteria.

The contract lab also analyzed blind field duplicate samples for total and fecal coliform on 10 occasions. Because analysis of these data is not discussed in the SWAMP QAMP, we compared the duplicate result to the original sample using the 95% confidence interval table from Standard Methods (1999) for multiple tube dilutions. For these data, there were no exceedances of the abovementioned criteria.

MDLs / PQLs

Comparison of reported MDLs and PQLs relative to the target values defined in the SWAMP QAMP (Puckett 2002) can result in several flags including the following: result between MDL and PQL, MDL above TRL and PQL above TRL. Additional qualifying flags related to MDL and PQL results include the following: elevated MDL/PQL due to matrix interference and elevated MDL/PQL due to sample dilution. For data discussed in this report a total of 61 samples, each with 20 analytes, were screened. We identified no sample analytes that had MDLs or PQLs elevated above the SWAMP TRL. We compared reported MDL/PQL and the appropriate analytes' water quality criteria to determine if elevated MDL/PQL will result in non-detect values of concern. In this dataset there are 39 sample analytes with results between the MDL and PQL values. However, none of these are elevated above levels of concern and therefore were not rejected.

Matrix Spikes

The contract laboratory identified a total of nine sample analytes for which there was a matrix spike recovery problem (being outside of the laboratory's quality control (QC) criteria. Reevaluation of these data using the SWAMP MQOs resulted in the rejection of only two sample analytes and the acceptance, with a qualifying flag, of seven sample analytes.

Method Blanks

No method blank flags were reported by the contract laboratory.

Precision

Sample and batch precision flags were not reported for any sample analytes by the contract laboratory.

Field Data

Field data collected using a Hydrolab DS4a were evaluated using Calibration records. First data are evaluated to determine if measurements are outside of the Calibration Range. In the Carmel Watershed 61 field measurements were recorded, each consisting of conductivity, pH, dissolved oxygen, water temperature, salinity and Chlorophyll a. Seven conductivity measurements were above the upper calibration range and qualified with flags. Calibration records were also used to identify accuracy of the probes by comparing pre and post calibration data to identify drift. Four pH measurements have been disqualified because of calibration drift. Each of these measurements was collected in December of 2002.

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Appendix A. CCAMP Biostimulatory Risk Index

Introduction

Nutrients, such as nitrate, ammonia and phosphate, are often found at elevated concentrations in waterbodies of the Central Coast Region, and elsewhere in the State of California. Some nutrients have numeric objectives associated with particular beneficial uses. Specifically, to protect for municipal and domestic water supply, nitrate as N cannot exceed 10 mg/L. To protect against general toxicity, ammonia concentrations cannot exceed 0.025 mg/L. However, there are no numeric objectives that protect surface waters from the biostimulatory effects of excessive nutrients. Eutrophication results from a complex interaction of multiple nutrients, sunlight, substrate, water velocity, and other factors. It is difficult to identify specific nitrate or phosphate concentrations that represent thresholds over which problems will certainly occur. Consequently, the Central Coast Basin Plan narrative objective for biostimulatory substances is as follows:

> "Waters shall not contain bio-stimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses."

Understanding how to manage surface waters for biostimulation is complex, as interactions and effects of excessive nutrients are not always readily apparent. For example, a site that has excessive concentrations of phytoplankton or other algae may not display elevated concentrations of dissolved nutrients, as the nutrients may have already been taken up by plant material. This interplay of chemical, physical, and biological factors complicates assessment of overall water quality.

The Central Coast Ambient Monitoring Program has developed a "Biostimulatory Risk Index" to serve as a screening tool to simultaneously consider factors which serve as stimuli (nutrients), in parallel with those which act as responders (algal and plant cover, pH, dissolved oxygen and water column chlorophyll concentrations). The index is intended to characterize both in-situ monitoring site response to biostimulatory substances and the capacity of monitoring site water quality parameters to induce adverse biostimulatory responses in downstream areas. The index currently has no provision for addressing nutrient-poor waters, nor waters impacted by toxic effects associated with several of its components.

The Biostimulatory Risk Index is a combination of several different measures, or "metrics" of stimuli or response, which have then been ranked and combined to form a single value. The Central Coast Ambient Monitoring Program collects data on a number of parameters that are used in developing the preliminary Index, and serve as metrics. Some of these measures, such as nitrate concentration, may serve as metrics based on magnitude alone (where higher concentrations are considered "worse" than lower concentrations and are ranked accordingly). Others are more complex, particularly "double-ended" parameters such as dissolved oxygen and pH. For example, both supersaturated and depressed concentrations of dissolved oxygen can be indicative of eutrophication. Thus, one possible indicator of dissolved oxygen impairment is the departure of the measurement from the median value (where a larger departure ranks worse than a smaller departure).

Biostimulatory Risk Index Development

Index development included testing of a number of metrics that reflect various measures of nutrient stimulus and response. Candidate components included ranked concentrations of individual nutrient forms (such as unionized ammonia, orthophosphate, etc.), measures of dissolved solids, turbidity, various characterizations of percent vegetative cover and other measures. A subset of these candidates was selected for use.

Selected Components

- Chemical composite
  - Nitrate as N
  - Nitrite as N
  - Ammonia as N
  - Ortho-Phosphate as P
- Oxygen Saturation
- pH
- Chlorophyll *a*
- Plant Cover composite
  - Algal cover
  - Algal cover filamentous
  - Algal cover periphyton
  - Instream plant cover

Five metrics were developed and were calculated as follows:

1) c = Chemical composite metric = Sample percentile rank of summed concentrations (mg/L) of NO2-N + NO3-N + NH3-N + (PO4-P * 10)

This metric assumes that dissolved nutrients of various forms can all contribute to biostimulation, either at the site or downstream from it, and that they can be summed to represent overall nutrient availability, once adjustments have been made for the typical uptake ratio of phosphorus to nitrogen in plant tissue (1:10).

2) p = pH metric = Sample percentile rank departure from median of entire CCAMP dataset (8.2)

This metric reflects fluctuations in pH levels in response to photosynthetic and respiration activity by plants. Photosynthetic activity uses up carbon dioxide, causing bicarbonate ions to dissociate to create more CO2 and OH^-; this process increases alkalinity. The opposite is true during respiration and decay. This process assumes that pH that diverges widely from the median can be a measure of excessive plant activity, either as photosynthesis or respiration, and thus an indicator of biostimulation.

3) o = Oxygen metric = Sample percentile rank departure from median of entire CCAMP dataset for percent saturation (92.6)

The assumption driving this metric is that both depressed and supersaturated oxygen levels are indications of biostimulation. Samples taken in association with significant amounts of aquatic plant and algae growth may be supersaturated in late afternoon, and depressed in pre-dawn samples. Oxygen levels may remain depressed throughout the day when plant decay is prevalent. Percent saturation is used instead of dissolved oxygen concentration because it takes into account the confounding effects of water temperature and salinity.

4) a = Chlorophyll *a* component = Sample percentile rank of water column concentration of chlorophyll *a* (ug/L)

This metric assumes that higher concentrations of water column chlorophyll *a* are indications of phytoplankton abundance and hence of biostimulatory activity.

5) f = Flora component = Sample percentile rank of the maximum of one of the following: (Filamentous, Periphyton, or total Algal cover, instream plant cover)

This metric assumes that various forms of plant and algal cover represent uptake of nutrients from the stream system and hence indicate biostimulatory activity. Light availability, substrate and other factors affect which form of plant predominates; therefore this metric calculates rank based on the maximum value of the various forms quantified. This metric is not weighted highly because the quantified values are extremely subjective in nature and are highly variable.

Metrics are weighted and summed for each sampling event at each site, as follows:

$$a = 2^{(f1*c \; + \; f2*p \; + \; f3*o + f4*a \; + \; f5*f)}$$

Where:

f1=chemical composite weight = 6
f2= pH weight = 7
f3=oxygen weight = 5
f4=chlorophyll *a* weight = 9
f5=flora weight = 1

The mean percentile rank of ‘a’ for each site is utilized as the Biostimulatory Index for that site.

CCAMP staff evaluated performance of the index using data from the entire Region. Weighting factors f1, f2, f3, f4, and f5 were initially determined by confining the database under consideration to several hydrologic units well known to staff, and setting weighting factors to values that ranked sites in a sequence that was consistent with staff knowledge of the sites. Performance of the index was then examined in other hydrologic units not used to develop the weighting factors, using different staff, knowledgeable of site and waterbody characteristics in the new set of hydrologic units. Through iterative adjustment of weighting factors, index performance was tested until all staff agreed that site rankings best reflected overall staff knowledge of the sites.

Staff evaluated the final site ranking for evidence of threshold values at which sites begin to show overall impairment or cause downstream problems. Staff agreed that above an average index score of 0.40, sites begin to commonly show signs of impairment, including algal blooms, widely ranging dissolved oxygen concentrations, and elevated nutrient concentrations. We are using this value as a threshold for screening monitoring data for biostimulatory risk. Figure A.1. shows the mean and range of nitrate concentrations at sites scored for biostimulatory risk. Sites whose scores fall below the threshold of 0.40 virtually never exceed the drinking water standard for nitrate. 89% of these samples have site nitrate averages under 1.0 mg/L-N. Also, sites with a risk score of 0.40 or greater never have benthic invertebrate community index scores in the highest quartile (over 6.0) (Figure A.2.).

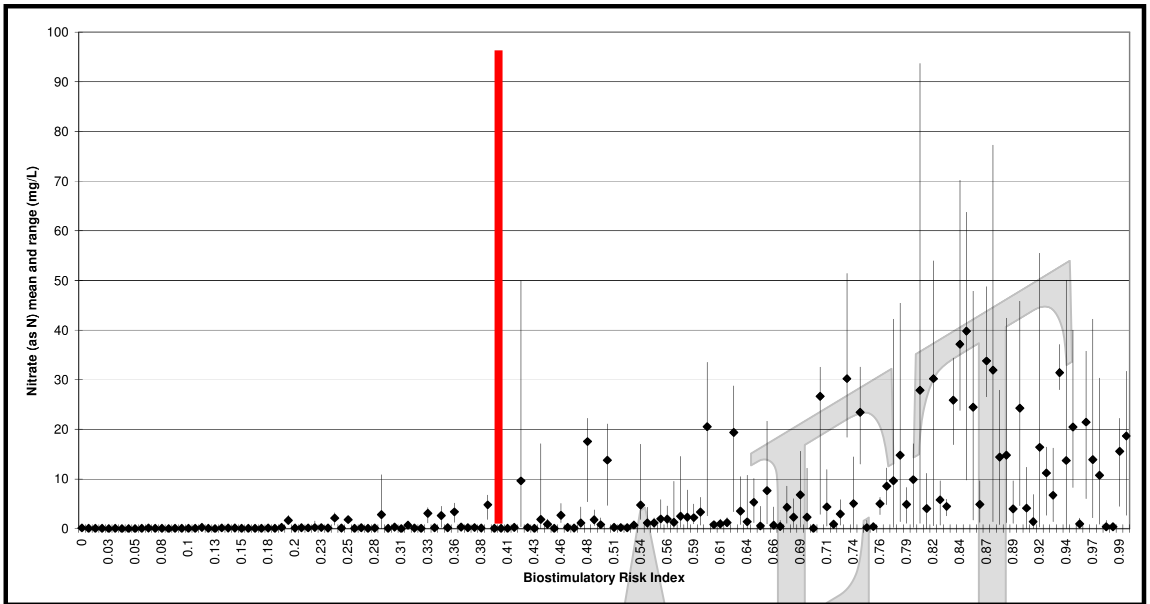


Figure A.1. Range and mean of Nitrate-N concentrations (mg/L) at sites scored for biostimulatory risk in the Central Coast Region. Biostimulatory risk threshold (0.40) indicated by red line.

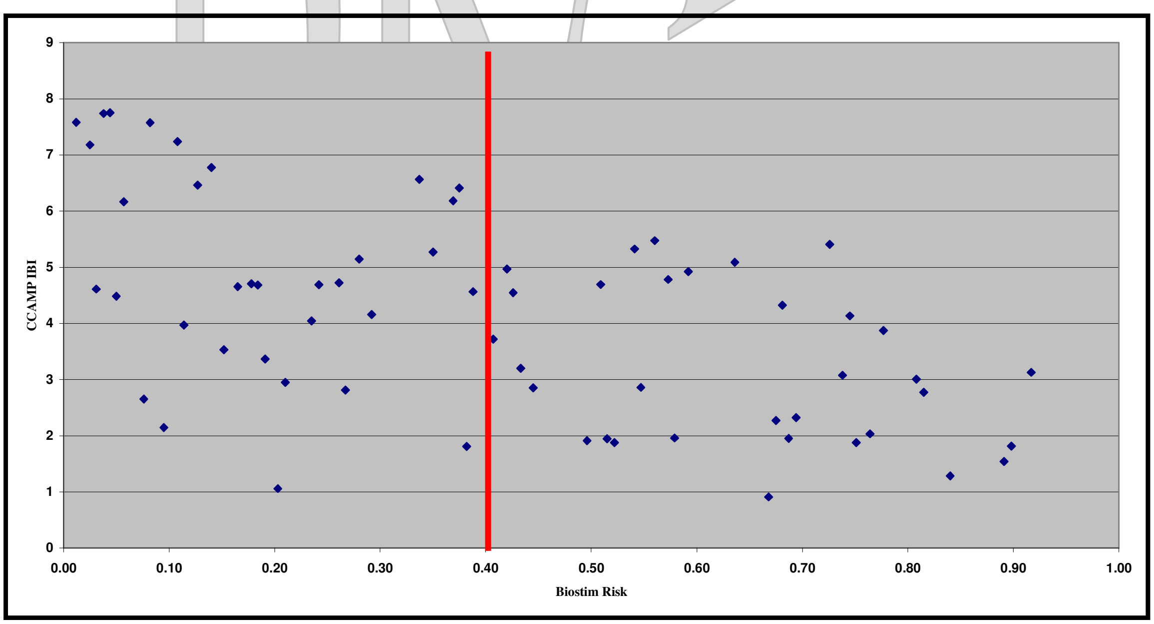


Figure A.2. Scatter plot of CCAMP-IBI scores against the Biostimulatory Risk Index for CCAMP sites. Biostimulatory risk threshold (0.40) indicated by red line.

Index development assumptions

The Bioassessment Risk Index is not based on bio-chemical process modeling. The only component of the index that deals with plant uptake of nutrients is the chemical composite component that assumes that phosphate concentration impacts occur at levels 10 times lower than nitrogenous compounds. The factor of ten was selected based on the typical ratio of these two nutrients in plant tissue. Freshwater systems tend to be limited by phosphorus. If the N:P ration is above 10:1 N:P a system will likely experience an algal bloom, the severity of which will be dictated by the amount of available phosphorus. (Schindler 1978 and Jaworski 1981). Examination of the data indicates that nitrogen is rarely the limiting nutrient in streams and rivers that exhibit problems with bio-stimulatory substances on the Central Coast of California. For this reason we selected a multiplier on the high end of literature values.

Since the Index is intended for use in moving water, it does not rely upon the assumption that effects will be located at the same place or time as causes.

Ranking of nutrient concentrations assumes that oligotropic conditions do not exist in the Central Coast Region and that a straight ranking of nutrient concentration from low to high reflects conditions moving from "good" (i.e. low concentrations) to "bad" (i.e. high concentrations). We have not documented conditions which appeared to be nutrient-poor in this Region.

The Index does not rely upon mass loading calculations (e.g. total pounds of a stressor delivered to a monitoring site). Biostimulatory impacts in stream and river systems are more related to concentrations found within a given reach than to nutrient loads moving through the reach. For example, during storm events very large quantities of nutrients move rapidly through river and stream systems with little or no impact on the streams and rivers. The true impacts of these nutrients are not manifest until they reach a 'terminal water body' such as a lake or the near shore ocean.

Biostimulatory Risk in the Central Coast Region

Figure A.3. shows the quartile rank of BioStim scores for all sites monitored by the Central Coast Ambient Monitoring Program. In general, Biostimulatory Risk Index scores are highest in areas of the Central Coast Region already known to suffer from very high levels of nutrients. Most of these areas are associated with intensive irrigated agricultural activity. Sites in the upper quartile of ranked scores are primarily in watersheds that have already been 303(d) listed as impaired by nutrients. Many are smaller tributaries that enter impaired rivers, such as Quail Creek (tributary to Salinas River), Little Oso Flaco Creek (tributary to Oso Flaco Creek), Main Street Canal, Orcutt-Solomon Creek and Blosser Channel (tributary to Santa Maria River), and Salsipuedes and Llagas Creeks (tributary to Pajaro River). Many of these tributaries have exceptionally high concentrations of nutrients and serve as major nutrients sources to the main stem systems. For example, Quail Creek concentrations have ranged as high as 94.7 mg/L for nitrate (as N) and 2.8 mg/L for orthophosphate (as P). Other waterbodies scoring in the top quartile are slow moving terminal waterbodies, such as Tembladero Slough, Moro Cojo Slough, and the Old Salinas River. These types of systems tend to have relatively high scores for pH, oxygen, and chlorophyll *a*, in addition to chemistry. Though much less common, some chemical scores are driven more by elevated phosphate concentrations than by nitrate. These include San Antonio and Carneros Creek sites. Santa Ynez River, Chorro Creek and San Luis Obispo Creek also have relatively high phosphate levels downstream of their respective wastewater treatment plant discharges. A few waterbodies not currently 303(d) listed for nutrients also scored in the top quartile. These include Franklin Creek, Arroyo Paradon Creek, Los Berros Creek and San Antonio Creek. They will be considered for 303(d) listing in the next listing cycle.

Waterbodies which fall in the lowest risk quartile include all of the Carmel River watershed, all creeks in the Santa Lucia Hydrologic Unit (along the Big Sur coast), most creeks in northern San Luis Obispo County (excluding San Simeon Creek), and small creeks in relatively undisturbed watersheds, such as Scott Creek (Santa Cruz County), Toro Creek, Old Creek above the reservoir, and Coon Creek (San Luis Obispo County), and El Capitan Creek and Gaviota Creek (Santa Barbara County). Several waterbodies which do not score in the lowest quartile overall have upper watershed sites with scores in the lowest quartile. These include San Luis Obispo Creek, Santa Ynez River, and San Simeon Creeks above their respective wastewater treatment plants.

Several of the creeks that score in the lowest quartile are dry in the summer, so scoring is calculated only from wet weather samples, which do not typically represent the worst case conditions relative to biostimulation. These include Montecito and San Ysidro Creeks in Santa Barbara County, both of which are channelized drainages passing through urban and agricultural land uses, and Villa Creek in San Luis Obispo County, which supports upstream irrigated agriculture.

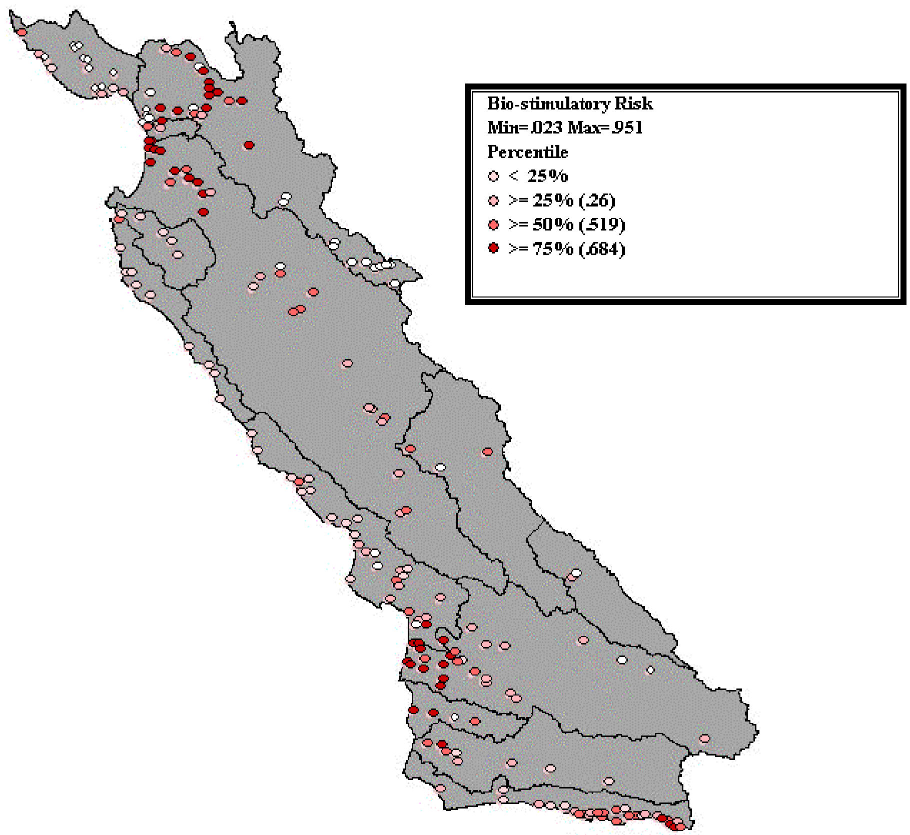


Figure A.3. Biostimulatory Risk Index scores for all sites monitored by CCAMP in the Central Coast Region between January 1998 and July 2005. Site scores are shown in quartiles, with sites ranked in the 75th quartile and above having the highest risk for eutrophic conditions.

Biostimulatory Risk Index and Waterbody Impairment

RWQCB staff have evaluated sites rankings alongside water quality and habitat data and subjectively made a determination of the Index score for creeks beginning to show “impairment”. 0.40 was selected, as a site average. Sites in this range begin to show somewhat elevated nutrient concentrations, occasional algal blooms, and depressed dissolved oxygen concentrations.

Appendix B. CCAMP Index of Biotic Integrity

The CCAMP Index of Biotic Integrity (CCAMP-IBI) is a sum of several ranked metric scores, including taxonomic richness, number of Ephemeroptera taxa, number of Trichoptera taxa, number of Plecoptera taxa, percentage of intolerant individuals (with tolerance scores of 0, 1, or 2), percentage of tolerant individuals (with tolerance scores of 8, 9 or 10), percent dominant taxon, and percent predators. This index includes all metrics utilized by Karr and Chu (1999) in their Index of Biotic Integrity, with the exception of "clinger taxa count" and "long-lived taxa count". The CCAMP program has been utilizing this index for a number of years for evaluating benthic invertebrate data in the Central Coast.

CCAMP-IBI scores range from 0 to 10. Sites in the lowest quartile of all CCAMP bioassessment data score below approximately 3.0, as a site average. Sites in the highest quartile score above 6.0. We have examined these quartile break points relative to other indices of water quality as shown in the following figures.

Figure B.1. shows that at 60% of all sites in the lowest quartile, multiple measures of toxicity were present; only 20% of these sites had no evidence of toxicity. At sites in the highest quartile, 60% were free of toxicity and the remaining sites showed only a single indication of toxicity (such as reduced growth or reproduction).

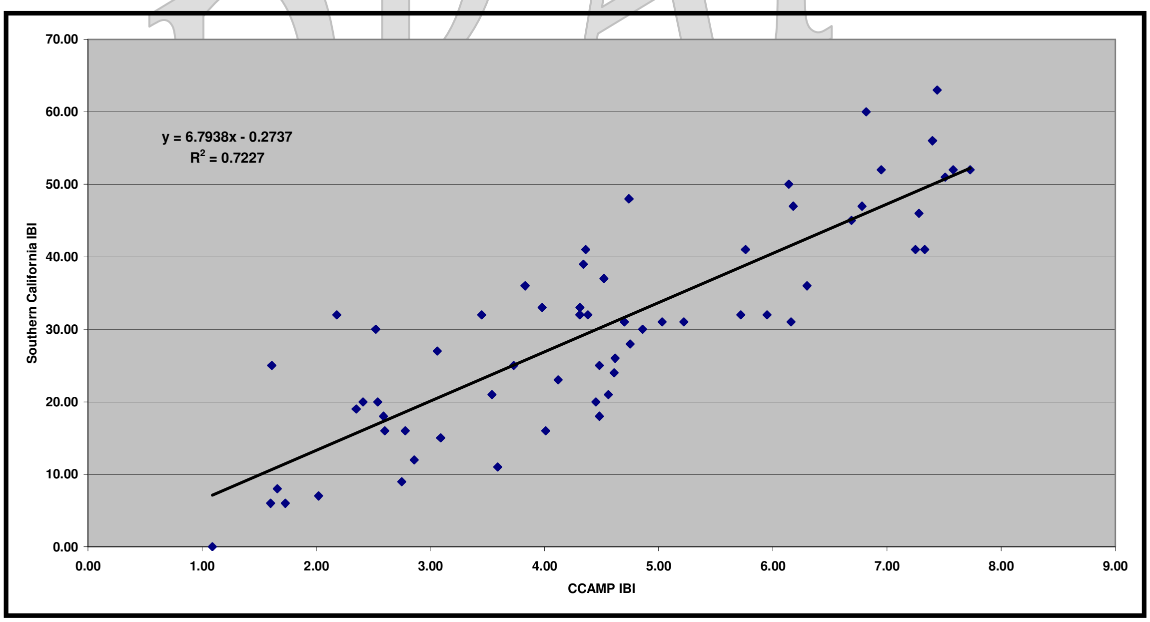
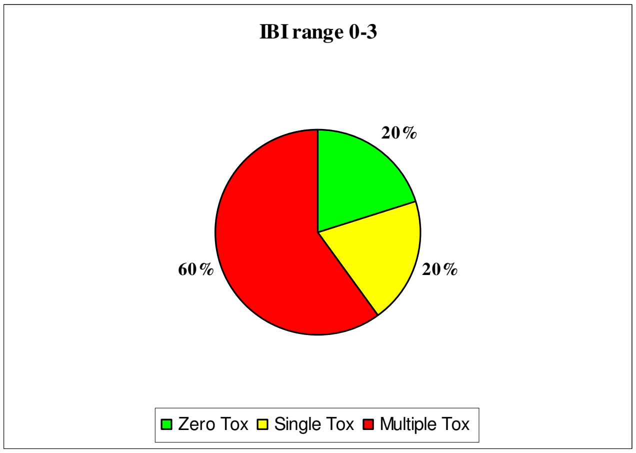
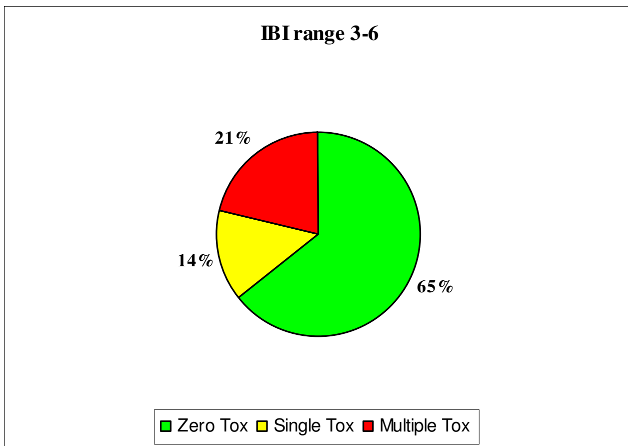
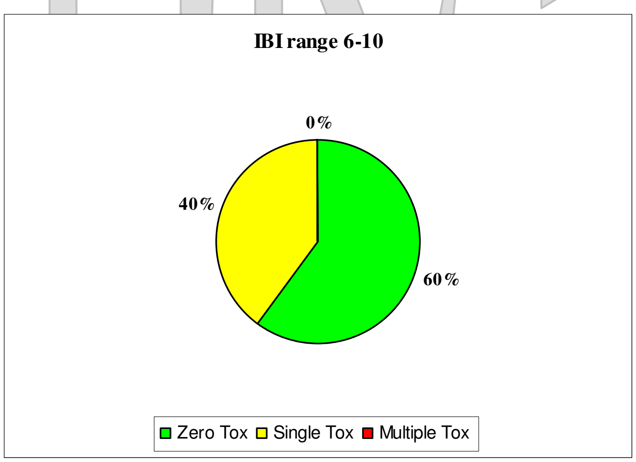


Figure B.2. Regression of Southern California Index of Biotic Integrity scores against Central Coast Ambient Monitoring Program Index of Biotic Integrity scores for the Central Coast Region.



Lowest IBI quartile scores





Highest IBI quartile scores

Figure B.3. Percent of sites showing zero toxicity, a single toxic result or multiple toxic results, according to CCAMP-IBI quartile scores.