JUNE 2003 *[FINAL DRAFT]*

Sacramento River Watershed Program

Annual Monitoring Report: 2001-2002

SACRAMENTO RIVER WATERSHED PROGRAM

Report Review Process

The review process and schedule for the 2001-2002 Annual Monitoring Report of the Sacramento River Watershed Program (SRWP) is outlined in the table below. This process includes internal reviews by the SRWP Monitoring, Toxics, and Public Outreach and Education Sub-Committees, and review by the all SRWP stakeholders and other interested public. The Public Draft report and the Final report will be available from the SRWP website,

http://www.sacriver.org.

Comments received for the Administrative Draft Annual Monitoring Report are available on the SRWP website. Comments received for the Public Draft Annual Monitoring Report were compiled and are responded to in Appendix E of this document.

SRWP Annual Monitoring Report (AMR) Review and Submittal Schedule

	Date	Review Milestones
✓	1-22-2003	AMR Administrative Draft submitted to Monitoring Sub-committee
✓	2-28-2003	Comments on Administrative Draft Due from Monitoring Sub-committee
✓	3-26-2003	Review and approve proposed responses to Monitoring Sub-committee comments at Monitoring Sub-committee meeting
✓	4-4-2003	Public draft released for stakeholder and peer review
✓	5-9-2003	Comments on Public Draft due from all reviewers
✓	5-28-2003	Review and approve proposed responses to Public Draft Comments at Monitoring Sub-committee meeting
✓	6-30-2002	Submit Final AMR to SRCSD, Monitoring Sub-committee, and USEPA

Acknowledgements

The Sacramento River Watershed Program Monitoring Program and the Annual Monitoring Report are products of the efforts of many people. A great deal of effort has been expended in field, laboratory, and office work to collect and analyze samples, to manage, summarize data, and to interpret the results of the Sacramento River Watershed Program monitoring effort. While the names of all of the individuals involved in the SRWP monitoring program are too numerous to list here, we would like to gratefully acknowledge the assistance of all of the participating members of the Monitoring Sub-Committee, the Toxics Sub-Committee, the Biological and Habitat Sub-Committee, and the Public Outreach and Education Sub-Committee. The members of these committees have provided invaluable assistance and advice in developing the monitoring program and in preparing and reviewing this document. We are also grateful for the efforts of the Peer Reviewers of this report. Their insightful comments and recommendations resulted in substantial improvements to this document.

In additional to the participating SRWP committee members, the following agencies and contractors have been instrumental in implementing the SRWP monitoring program.

U. S. Environmental Protection Agency

Sacramento Regional County Sanitation District

Central Valley Regional Water Quality Control Board

San Francisco Estuary Institute

California Department of Water Resources

U. S. Geological Survey

California Department of Fish and Game

University of California Aquatic Toxicology Laboratory

Moss Landing Marine Lab

Sierra Environmental Services

Sequoia Analytical Laboratories

BioVir Laboratories

Pacific EcoRisk

Larry Walker Associates

Acronyms and abbreviations Used in this Document

BMIs	Benthic Macroinvertebrates
CDFG	California Department of Fish and Game
CSBP	California Stream Bioassessment Procedure
CTR	California Toxics Rule
D/DB-P	Disinfection/Disinfection By-Product Rule
DDTs	Dichlorodiphenylethane compounds
DHS	California Department of Health Services
DOC	Dissolved Organic Carbon
DWR	California Department of Water Resources
EPT Index	Ephemera/Plecoptera/Tricoptera Index
FFGs	Functional Feeding Groups
FPOM	Fine Particulate Organic Matter
IBI	Index of Biotic Integrity
ICR	Information Collection Rule
MCLs	Maximum Contaminant Levels
μg/L	micrograms per liter
mg/L	milligrams per liter
MPN/100 mL	Most Probable Number of Bacteria per 100 mL
MWQI	Municipal Water Quality Investigations Program
NAWQA	National Water Quality Assessment Program
ng/L	nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
NTU	Nephelometric Turbidity units
PCBs	Polychlorinated Biphenyls
RWQCB	Regional Water Quality Control Board

SRCSD	Sacramento Regional County Sanitation District
TIE	Toxicity Identification Evaluation
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon

Executive Summary

What is in this Report?

This is the fourth Annual Monitoring Report for Sacramento River Watershed Program (SRWP). This document provides a review of the Sacramento River Watershed Program (SRWP) monitoring effort and the data generated by the SRWP and other collaborating water quality monitoring programs (USGS NAWQA, Sacramento River Coordinated Monitoring Program, City of Redding NPDES Monitoring, Department of Water Resources intensive tributary monitoring program). This report describes data collected from 1997–2001 by the SRWP and from varying periods for programs coordinating with the SRWP. These water chemistry, aquatic toxicity, fish tissue, and bioassessment data are used to evaluate the attainment of beneficial uses and potential impairment in surface waters of the Sacramento River watershed, to assess spatial and temporal distributions of a variety of important water quality characteristics, and to compare the relative contributions of different inputs to the Sacramento-San Joaquin Delta of selected parameters.

The categories of water quality data considered in this review are mercury (in water and fish tissue), drinking water parameters of concern, aquatic toxicity, and organochlorine pesticides and PCBs in fish tissue. Locations discussed in this executive summary are illustrated in Figure 1 (page 12) and in the individual sections of the Data Review beginning on page 15. The preliminary conclusions of this review of SRWP and other monitoring data are summarized below.

Mercury

- Mercury monitoring for 2001-2002 consisted of five total water column sampling events for with three of these events focused on Battle, Cottonwood, and Thomes Creek watersheds. One sample event was conducted for fish tissue.
- Mercury concentrations in fish tissue collected from 1997 to 2001 from the mainstem Sacramento River below Shasta Reservoir and major tributaries to this section of the river were higher than several of the human health-based and wildlife-based advisory and screening values. Frequent exceedances of the tissue-based water quality criterion for mercury recently developed by the USEPA (0.3 mg/kg) and adopted by the California Office of Health Hazard Assessment (OEHHA), and less frequent exceedance of the previous USEPA screening value of 0.6 mg/kg, indicate that there are human health concerns associated with consumption of some fish species from the lower Sacramento River watershed. The current water quality USEPA criterion of 0.3 mg/kg is based on a fish consumption rate of 17.5 g/day (equivalent to 4 quarter-pound servings per month). There is some disagreement whether the available data are adequate to warrant issuing fish consumption advisories, based on the fact that OEHHA has not issued advisories for these waters, while the Central Valley Regional Water Quality Control Board has recommended addition of a number of waterbodies to California’s 303(d) list based on the same available data. Interim Public Health Notices have also been issued by Placer, Yuba, and Nevada counties for eight Sierra

foothill waterbodies based on the same data used by the Regional Board. Although there is substantial uncertainty regarding the level of risk posed by these concentrations of mercury in fish, there is agreement that the risks are greatest for small children and pregnant women, and that the risks increase with greater consumption of fish. General consumption guidelines are provided by OEHHA on their web page (http://www.oehha.org), in addition to consumption advisories for specific waterbodies. Concerns over mercury in fish from the lower Sacramento River watershed are being addressed with continued monitoring being performed for 2002-2003 (Years 4 and 5). This shift in focus is in large part a result of coordination and consultation with OEHHA, which has been an active participant in the SRWP, and has provided the SRWP with guidance regarding data needs and study design for evaluation of human health risks related to fish consumption.

- Consumption-weighted average mercury concentrations[1] in tissues of fish collected from the Sacramento River mainstem from Keswick to the Delta, in smaller tributaries, and in three agricultural drains were equal to or lower than USEPA human health-based criterion of 0.3 mg/kg. However, in almost all trophic level 4 species collected throughout the watershed, average mercury concentrations were higher than the 0.3 mg/kg criterion, and were frequently two to three times higher than this criterion.
- Consumption-weighted average mercury concentrations in fish tissue collected from the lower American River and Feather River were higher than USEPA human health-based criterion of 0.3 mg/kg. Exceedance of the criterion indicates that there are potential risks to "average" human consumers associated with consumption of fish from these waterbodies.
- Total water column mercury concentrations in the Sacramento River from Keswick to River Mile 44 rarely exceeded the CTR mercury criterion of 50 ng/L(USEPA 2000). Total mercury concentrations exceeded the 50 ng/L limit in 30% of Cache Creek samples and 46% of samples from the upper Mill Creek watershed. The Feather and Yuba rivers are significant sources of mercury loads, but concentrations of total mercury and methylmercury were not elevated compared to the Sacramento River mainstem in 2000-2002. However, relatively high concentrations of mercury in fish from the lower Feather River and American River suggest that (1) these watersheds may have been significantly elevated sources of bioavailable methylmercury in previous years, or (2) factors other than methylmercury concentrations are significantly affecting bioaccumulation, or (3) that fish may be accumulating mercury from other locations. Spring Creek in the upper Sacramento River watershed, Battle Creek, Deer Creek, Big Chico Creek, and the American River did not appear to be major sources of total mercury—concentrations were low compared to the Sacramento River and were never observed to exceed the 50 ng/L CTR criterion at these sites. Preliminary results indicate that Cottonwood Creek and Thomes Creek

[1] The consumption-weighted average is an estimate of the average concentration of mercury for the total freshwater and estuarine fish consumed, and assumes that a combination of trophic level 3 and trophic level 4 fish are consumed. Details of this calculation are presented in the Mercury Data Summary, Section II.A of this document.

watersheds may be significant sources of mercury and methylmercury. With the exceptions of Mill Creek and Cache Creek, total mercury concentrations rarely exceeded the 50 ng/L CTR criterion at any site.

- Methylmercury concentrations in water column samples exceeded the Great Lakes human health-based criterion of 0.24 ng/L most frequently in samples from Arcade Creek (67% of samples) and from two agricultural drain sites (25% and 35% of samples). Methylmercury concentrations exceeded the Great Lakes wildlife-based criterion of 0.05 ng/L in nearly every sample collected from mainstem location below Hamilton City, and in all other tributaries and agricultural drains sampled.
- The Sacramento River watershed is the major source of total mercury to the Delta. This watershed contributes approximately 90% of the total mercury loads to the Delta. Within the Sacramento River watershed, the Cache Creek drainage is the single largest source area for total mercury (SRWP 2000, 2001). Major sources of total mercury loads to the Sacramento River watershed include runoff and erosion from historic gold mining sites, erosion of native soils, and natural mineral springs. Minor mercury sources include treated wastewater, urban runoff, historic mercury mines, and atmospheric mercury deposition from external sources.

Organophosphate, Carbamate, and Triazine Pesticides

- Pesticide monitoring for 2001-2002 consisted of six total water column sampling events.
- The results of SRWP and other monitoring programs continue to support the focus of the SRWP and of both state and federal regulatory agencies on the management of organophosphate pesticides in surface waters. Diazinon and chlorpyrifos appear to have the greatest potential for impacts on aquatic life uses, with other monitored pesticides appearing to have relatively low to minimal risk of impacts on aquatic life or human health. The potential impacts on beneficial uses from diazinon and chlorpyrifos are being addressed through the Water Quality Management Strategy developed by the Organophosphate Pesticide Focus Group (SRWP 2001), and by the TMDL being developed by the Central Valley Regional Water Quality Control Board.
- There are still few data available for the many minor tributaries to the Sacramento River watershed. For smaller tributary watersheds with a substantial proportion of agricultural land use (e.g. Big Chico Creek), there may be a significant potential for pesticides to occasionally reach concentrations of concern in surface waters. Although no pesticides were detected in the limited SRWP monitoring of several smaller tributary watersheds in 2000-2002, the available monitoring data are far too limited to make any reliable assessments regarding the potential impacts of pesticides for these and other tributaries. However, small tributaries with only a small proportion of their total drainage in agricultural land uses (e.g. Deer Creek and Mill Creek) are probably at relatively low risk of pesticide impacts on beneficial uses. Additional pesticide monitoring data (e.g. from DWR) should be evaluated for these watersheds when they become available, to better characterize the potential risks from pesticides in these watersheds, and additional monitoring should also be considered.

- The shift from use of organophosphate and carbamate pesticides for agricultural and other uses to other pesticides (including but not limited to pyrethroids and pyrethrins) indicates the need to increase monitoring for these pesticides. The University of California at Davis Department of Entomology is currently performing research to develop new sampling and analytical techniques to adequately identify and measure toxic concentrations of pyrethroid pesticides in water, sediment, and tissue. The SRWP is also collaborating with Dr. Don Weston (University of California Berkeley) to acquire funding for a study of the distribution and toxicity of sediment-associated pesticides in the Sacramento River watershed. The study is focused on pyrethroid pesticides, and Dr. Weston has demonstrated the ability to analyze pyrethroids (and other sediment-associated pesticides) at concentrations that cause toxicity in laboratory tests of sediment toxicity. Funding for this project is being pursued through the Pesticide Research and Identification of Source, and Mitigation (PRISM) Grant program administered by the State Water Resources Control Board.

Aquatic Toxicity

- Aquatic toxicity monitoring for 2001-2002 consisted of 6 sampling events. Only *Ceriodaphnia dubia* were tested during this monitoring period.
- Samples collected from Arcade Creek at Norwood Avenue (the only SRWP site with a predominantly urbanized watershed) continue to exhibit a higher frequency and severity of toxicity than all other tributaries and mainstem Sacramento River sites sampled. This pattern was also exhibited in limited sampling of two other locations in the Arcade Creek urban watershed in 2000-2001.
- The results of the 2001-2002 monitoring and of previous aquatic toxicity monitoring efforts have confirmed that significant toxicity to test organisms occurs in surface waters throughout the watershed. *Ceriodaphnia dubia* toxicity attributable to organophosphate pesticides in agricultural runoff and urban runoff has been definitively shown by SRWP monitoring and other studies. The widespread mortality observed in September 2001 was not associated with any known causes of toxicity, and suggests a need to continue to monitor for episodic toxicity during a wide range of hydrologic and weather conditions.
- Regularly scheduled monitoring conducted from 1998–2000 was valuable in beginning to evaluate the overall frequency and distribution of observed water column toxicity, and for identifying or confirming the causes of some of the observed toxicity. However, spatial and temporal coverage of the watershed by SRWP and other programs is far from comprehensive, and significant questions remain regarding the sources, severity, persistence, and ecological significance of periodic toxicity in surface waters of the Sacramento River watershed. It is clear that definitively addressing all of these questions will require monitoring and studies of much greater scope (and cost) than the current efforts by SRWP and other programs. To address some of these questions, the SRWP aquatic toxicity monitoring effort in 2000-2002 has focused primarily on monitoring specific episodic events (e.g. agricultural dormant spray season, runoff events, high flow events). This strategy resulted in observation of more frequent and severe toxicity in the Arcade Creek urban watershed, but did not result in a notably greater frequency of observed toxicity for

other locations. However, the 2000-2001 and 2001-2002 wet seasons both had below-average rainfall and fewer rainfall events may have affected the frequency (or magnitude) of episodic aquatic toxicity throughout the watershed. Additionally, interpretation of these two seasons of monitoring only a handful of episodic events must be cautious because the causes and timing of significant episodic toxicity events may differ greatly in different waterbodies, and the likelihood of missing a particular toxic event is high. Although even a single toxic event of sufficient severity has the potential to have significant adverse ecosystem impacts if key species are affected, there is currently insufficient evidence to either support or rule out such a hypothetical event. Episodic monitoring of aquatic toxicity was continued in the 2002-2003 monitoring season.

Drinking Water Parameters of Concern

Monitoring of drinking water parameters for 2001-2002 consisted of six total water column sampling events.

The Sacramento River and major tributaries provide water supplies for municipal, industrial and agricultural use in the Sacramento River Basin and downstream in the Sacramento-San Joaquin Delta. In addition, the Sacramento River is the primary source of flow to the Sacramento-San Joaquin Delta and the source of drinking water for an additional 20 million people in the Bay Area, Central Coast, and Southern California. The Sacramento River and its major tributaries are generally considered high quality drinking water sources. Although the quality of the Sacramento River is changed as it moves downstream and into the Delta, data collected to date for the best available indicators demonstrate that drinking water beneficial uses are substantially realized in the Sacramento River watershed. Water supply agencies treating Sacramento River and Delta water are currently able to meet drinking water standards and provide safe drinking water to millions of consumers throughout California. However, anticipated future drinking water regulations *may* require agencies treating Delta water to implement additional treatment (at increased costs). Drinking water parameters of potential concern included in the SRWP monitoring program include organic carbon, total dissolved solids, pathogens, turbidity, and nutrients. Organic carbon is of concern primarily due to its role in the creation of carcinogenic trihalomethanes (THMs) and other disinfection by-products during disinfection of source water. Total dissolved solids (TDS) can have an important effect on the taste and palatability of drinking water, and at very high levels, may cause health problems in sensitive individuals. The presence of high levels of TDS may also be objectionable to consumers owing to excessive scaling in water pipes and fixtures, heaters, boilers, and household appliances. TDS concentrations are also a factor limiting use of Delta waters for groundwater recharge, particularly in the Southern San Joaquin Valley. Pathogens such as *Cryptosporidium* and *Giardia* are of concern due to their potential to cause adverse human health effects. The primary concern associated with turbidity is its effect on disinfection processes, because high levels have been shown to protect microorganisms from the action of disinfectants and to increase the levels of chlorine and oxygen needed during treatment. Elevated nutrient concentrations may promote excessive algal growth and consequently contribute to taste and odor problems associated with some species of algae.

The mainstem Sacramento River, and major tributaries (the Yuba, Feather, and American rivers) consistently meet water quality goals and objectives for drinking water-related parameters. Based on the best available indicators, these results suggest that designated beneficial uses as sources of municipal and agricultural supply water and recreational uses are generally being achieved:

- There was a general trend for concentrations of several parameters (TDS, organic carbon, nutrients) to increase in the mainstem Sacramento River from the upper watershed to the lower watershed. This trend can generally be attributed to a combination of natural and anthropogenic sources, and is moderated by high quality Sierra tributary inflows.
- The Basin Plan limit for median fecal coliform numbers (200 MPN/100mL) was exceeded at only one site (Natomas East Main Drain), and the maximum limit for single samples (400 MPN/100 mL) was exceeded infrequently in the Sacramento River, the American River, and Cache Slough. Recommended USEPA and DHS single sample and geometric mean limits for total coliform are also infrequently exceeded at monitored locations. Recommended single sample Basin Plan limits for *E. coli* were exceeded at most locations monitored, but exceeded the geometric mean limit only at Natomas East Main Drain. Note that comparisons for *E. coli* are based on limited data biased towards episodic events expected to result in elevated bacteria counts.
- TOC concentrations measured in the Sacramento River at Colusa, Verona, and Freeport often exceed the Stage 1 Disinfectant/Disinfection By-Product (D/DBP) Rule treatment threshold of 2.0 mg/l. The 2.0 mg/L threshold is significant because exceedance of this threshold may require utilities to remove up to 35% percent of TOC in their source water. It is not clear that the observed concentrations of organic carbon will result in a requirement for municipal drinking water suppliers to remove *additional* TOC in source water. The Stage 1 D/DBP Rule does not require such treatment if certain treatment technology requirements used, or if other water quality requirements are met in influent or treated water. Additionally, treatment technologies currently in use by many utilities are already able to remove ≥35% of source water TOC from Sacramento River water. Even if additional TOC removal is necessary, this requirement would not limit the water supply use. Limited Specific UV Absorbance (SUVA) data suggest that average SUVA in Sacramento River surface waters are greater than D/DBP alternative criteria (2.0 L/mg-m) and would not provide relief from additional treatment requirements.
- Nitrate and nitrite appear to meet USEPA and DHS MCLs at all locations monitored in the Sacramento River watershed. Other nitrogen and phosphorus compounds monitored (ammonia, total nitrogen, dissolved orthophosphate) currently have no relevant regulatory thresholds for comparison. However, total nitrogen and total phosphorus concentrations may exceed expected ecoregional nutrient criteria under development by USEPA in many Sacramento River watershed surface waters.

The parameters of greatest concern for drinking water quality (TOC, TDS, nutrients, and pathogens) are still largely unregulated by the Regional Water Quality Control Board (RWQCB) and the Water Quality Control Plan (Basin Plan). The combination of existing and future land use changes, and the resulting increases in point source and nonpoint source discharges in the Sacramento River watershed, have the potential to increase loadings of these largely unregulated parameters of concern. The RWQCB is currently implementing a work plan for the development of an effective drinking water policy. This policy is expected to specifically address these parameters and establish water quality objectives for eventual inclusion in the Basin Plan.

PCBs and Organochlorine Pesticides in Fish Tissue

- Monitoring for PCBs and organochlorine pesticides in Fish Tissue 2001-2002 consisted of one sample event conducted in fall of 2001.
- Based on comparisons to screening values for organochlorine pesticides and PCBs in fish tissue, consumers who eat a variety of fish from different locations appear to be at relatively low risk from these compounds in fish tissue. However, potential risks increase for people selectively consuming a limited number of higher trophic level species (e.g. white catfish, largemouth bass, striped bass), and for individuals consuming more fish than the 21 g/day (about six quarter-pound servings per month) on which the screening values were based.
- Consumption-weighted average concentrations of DDTs and dieldrin in fish from agricultural drains, and of PCBs in fish from Delta locations exceeded USEPA screening values for these compounds. However, these results were dependent on very limited data for trophic level 3 species, and additional data are needed to adequately assess the potential risks for these waterbodies. Monitoring of organochlorine pesticides and PCBs in fish tissue has been continued in 2001-2002 to help address these questions.
- Evaluation of consumption-weighted average concentrations suggests the need to re-evaluate several of the waterbodies cited on the1998 303(d) for impairment due to organochlorine pesticides and PCBs. The results also support the Regional Board’s recommendation to remove the lower American River listing for Group A pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes including lindane, endosulfan, and toxaphene) from the updated 2002 303(d) list.
- Fish from smaller tributaries throughout the watershed tended to have lower concentrations of most organochlorines than other waterbodies evaluated (the Sacramento River mainstem, the Delta, the American and Feather rivers, and several agricultural drains). There was little evidence of other distinct spatial trends in organochlorine concentrations in fish tissue.

Bioassessment

The focus of the SRWP 2001-2002 bioassessment monitoring effort was shifted to developing a process for identifying reference conditions in the Sierra Nevada foothill region, in cooperation with the California State Water Resources Control Board and Department of Fish and Game. The Sierra foothill region was selected for the initial focus of this effort because this region is undergoing rapid development and urbanization. Identification of reference sites and conditions are critical for interpreting bioassessment monitoring results and for developing biocriteria. The process developed for identifying and selecting reference sites is expected to have application throughout the watershed and the state. No sampling and analysis of benthic macroinvertebrates was planned for 2001, but physical habitat assessments were performed at selected sites as part of the process of reference site identification.

The following bioassessment summary is from the 2000-2001 SRWP Annual Monitoring Report (SRWP 2002).

- Available data indicate that the beneficial uses evaluated by bioassessment monitoring (i.e. aquatic life uses and habitat) are achieved to a fairly high degree in the Sacramento River mainstem, major tributaries, and in all of the smaller tributaries assessed to date (Deer Creek, Big Chico Creek, Mill Creek, Butte Creek). However, because appropriate sampling techniques and reference conditions are in the process of being developed for assessing biological communities in non-wadable river systems, these results should not be considered conclusive (particularly for the mainstem Sacramento River).
- There was a strong correlation between elevation and physical habitat and aquatic life metrics. Lower elevation sites were more impacted by sedimentation and had much lower diversity and less complex community structure.
- The majority of sites evaluated had similar physical habitat characteristics and were considered to be in good to excellent condition. However, it is important to note that there are no comparable physical habitat measures for the non-wadable sites and that these appear to be the most physically impacted sites.
- Macroinvertebrate communities at most sites were described as complex with a wide range of taxa represented. Macroinvertebrate communities were dominated by sensitive taxa at almost all sites. Because reference conditions and biocriteria have not been developed for the Sacramento River watershed, it is not clear how the sampled stream and river reaches compare to other systems and ecoregions. However, the dataset for the complete 1997-2000 sampling effort provides a baseline of biological information that will contribute to developing an Index of Biotic Integrity (IBI) for the Sacramento River watershed, and the focus of future bioassessment efforts have shifted to developing a process for defining reference conditions for the watershed, beginning in the Sierra foothill ecoregion.

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1 Program Overview

1.1 Organization and Funding

The Sacramento River Watershed Program (SRWP) is an association of stakeholders in the Sacramento River watershed. These stakeholders include representatives of local municipalities and districts, state and federal agencies, agriculture, industry, landowners, environmental organizations, universities, technical consultants, and watershed conservancies. The SRWP was formed in 1996 and functions through a series of stakeholder meetings. In 2002, the SRWP elected a Board of Trustees and was incorporated as a not-for-profit California public benefit corporation.

Formation of the SRWP was facilitated by the Sacramento River Toxic Pollutant Control Program (SRTPCP), a locally initiated effort led by Sacramento County and the Sacramento Regional County Sanitation District (SRCSD). The SRTPCP is a watershed-based approach to the management of potentially toxic pollutants in surface waters of the Sacramento River watershed.

Funding for the SRTPCP is provided primarily by the federal government and is administered by USEPA Region IX. Local matching funds are provided by the Sacramento Regional County Sanitation District, and in-kind services are provided by several participating stakeholders. Additionally, significant public and private support of the program is being provided through the active participation of numerous representatives on the SRWP sub-committees. A portion of the SRTPCP funding was specifically designated to assist in the formation of the broader watershed program.

1.2 Program Goals and Objectives

The goal statement developed by the participating stakeholders for the SRWP in 1996 is as follows:

> ***SRWP Goal Statement****: "To ensure that current and potential uses of the watershed's resources are sustained, restored and, where possible, enhanced while promoting the long-term social and economic vitality of the region."*

One of the primary tasks of the SRTPCP and the SRWP is the design and implementation of a water quality monitoring program for the watershed. In early stakeholder meetings, a Monitoring Sub-committee was formed to lead the development of the water quality monitoring program.

1.2.1 Monitoring Program Goals

The Monitoring Sub-committee established the following long-term goal for the SRWP water quality monitoring program:

> *"In coordination with other sub-committees and the larger stakeholder group, develop a cost-efficient and well-coordinated long term monitoring program within the watershed to identify the causes, effects and extent of constituents of concern that affect the beneficial uses of water and to measure progress as control strategies are implemented."*

The SRWP water quality monitoring program is envisioned by the sub-committee to be a long-term (e.g. 20 year) effort that provides information to promote the understanding of conditions in surface waters of the watershed and to assess the health of these waters. The monitoring program changes annually as information is accumulated and new information needs are identified. It is projected that the water quality program will be integrated with other resource monitoring activities, including biological communities, habitat, and land use. More in-depth descriptions of the monitoring program are provided in the Phase 1 Monitoring Plan (LWA 1998a), and the Quality Assurance Project Plans for monitoring conducted from 1998 through 2002 (LWA1998b, 1999, 2000, and 2001).

The Monitoring Sub-committee established the following goal for the first year of the monitoring program, and retained this goal for the second year of monitoring:

> *"To assess conditions in the mainstem of the Sacramento River through the collection of baseline information, with an emphasis on examining the degree to which beneficial uses are attained or potentially impaired."*

The SRWP has made substantial progress towards meeting both the long-term and short-term goals for the monitoring program. The monitoring program developed by the SRWP through the stakeholder process is currently coordinating with a number of ongoing monitoring programs managed by federal, state, and regional public agencies. The collection and evaluation of baseline information for water quality parameters of interest to the SRWP is being accomplished directly through SRWP monitoring, and through cooperative data sharing with other monitoring programs conducted by the Department of Water Resources, the Central Valley Regional Water Quality Control Board, the U.S Geological Survey, the Sacramento River Coordinated Monitoring Program, and the City of Redding. Additionally, the program also compiles and reports water quality data generated prior to the initiation of SRWP monitoring in 1998. Evaluating the available information and identifying gaps in the data needed to assess the degree to which beneficial uses are achieved or potentially impaired in the watershed was (and continues to be) an integral part of the development of the monitoring program. The evaluation of water quality monitoring information documented herein is an extension of this ongoing process.

1.2.2 Objectives

The Monitoring Sub-committee also adopted long-term and short-term objectives. The long-term objectives include:

- Identification of available monitoring program elements that will provide information needed to understand the condition of surface waters of the watershed (i.e. to inventory the characteristics of the watershed).
- Identification of an approach for determining the relative health of the watershed (i.e. a means to assess and evaluate the meaning of the above information).

The short-term objectives developed by the sub-committee include:

- Identification of the monitoring goals and future uses for the data being collected, including: *water quality characterization, biological assessment, long-term trend analysis, and compliance with applicable water quality regulations*

- Identification of data needs and data quality objectives (i.e. to ensure that data collected will be useful, understandable, accessible, manageable, and scientifically valid).
- Coordination with other sub-committees of the SRWP (e.g. Toxics, Biological and Habitat, Education and Outreach).

1.3 Assessment of Beneficial Uses and Compliance with Water Quality Objectives

As stated above, the initial goal for the SWRP monitoring effort includes examining the degree to which beneficial uses are attained or potentially impaired. The existing and potential beneficial uses for the Sacramento River watershed are outlined in the water quality control plan (Basin Plan) for the Central Valley Region. The following are existing beneficial uses in the Sacramento River watershed, as defined in the Central Valley Region Basin Plan (CVRWQCB 1995):

- *municipal and domestic water supply*
- *agriculture (irrigation and stock watering)*
- *industry (process, service supply, power)*
- *contact recreation*
- *non-contact recreation*
- *freshwater habitat*
- *migration*
- *spawning*
- *wildlife habitat*
- *navigation*

Another purpose of the SRWP monitoring program is the comparison of observed ambient concentrations with adopted water quality objectives and criteria[2]. Numeric and narrative objectives have also been adopted in the Basin Plan (CVRWQCB 1995) for surface waters of the Sacramento River watershed for selected toxic pollutants in California. Water quality criteria for toxic pollutants are also included in the California Toxics Rule (CTR) (USEPA 2000). The CTR criteria are largely the same as the current USEPA recommended national ambient water quality criteria (USEPA 1999).

The Regional Water Quality Control Boards for the Central Valley and San Francisco Bay have developed lists of impaired waters which will not meet water quality objectives after implementation of technology-based controls for point sources and best management practices for non-point sources. These lists are required under Section 303(d) of the Clean Water Act. The portions of the lists that address the Sacramento River and its tributaries and the Sacramento-San Joaquin Delta are provided in individual data review sections. Management plans that establish Total Maximum Daily Loads (TMDLs) for listed pollutants must be prepared for all waters contained on the 303(d) lists, and the regulations state that TMDLs must lead to compliance with adopted water quality objectives.

[2] The SRWP's review and evaluation of designated uses and the criteria developed to protect these uses is consistent with the Water Quality Standards program mandated by the Clean Water Act, wherein a Standard for a water body is defined by four elements: designated uses of the water body, water quality criteria to protect the designated uses, an antidegradation policy, and general implementation policies.

1.4 Monitoring Program Description

The 2001-2002 SRWP monitoring program includes chemical, physical, biological and toxicological monitoring elements. The proposed program augments and coordinates with a number of other monitoring efforts that are ongoing in the watershed, including the USGS National Water Quality Assessment Program (NAWQA), the Sacramento Coordinated Water Quality Monitoring Program (CMP), and monitoring efforts by the Department of Water Resources (DWR), Department of Pesticide Regulation (DPR), City of Sacramento, and City of Redding.

The SRWP Monitoring Program was developed through an interest-based, coordinated approach. Managers of major water quality monitoring activities in the watershed were identified and invited to participate on the Monitoring Sub-committee. Numerous Sub-committee meetings were held to discuss and evaluate considerations in the development of the first year SRWP monitoring program. Existing monitoring programs were described and opportunities for coordination and integration were identified. Parameters of interest, candidate monitoring locations, monitoring frequency, sample collection methods, appropriate analytical methods, quality assurance/quality control, and program costs were evaluated by the Sub-committee.

Several possible monitoring approaches were discussed and evaluated during development of the proposed program design, including:

1. Mainstem river emphasis, with most parameters monitored.
2. More stations sampled with limited set of parameters monitored, with emphasis on parameters that are currently monitored by existing major programs.
3. More parameters monitored at fewer sites, with emphasis on existing major program sites.
4. Selected stations, parameters, and analytical methods chosen to facilitate an initial evaluation of beneficial use attainment in the watershed, with mainstem and major tributary emphasis.

Ultimately, the fourth approach was selected by the Monitoring Sub-committee as the starting point for the SWRP monitoring program and the best available means to achieving SRWP monitoring goals. The emphasis on the mainstem Sacramento River was favored to provide a foundation to which other programs and future additions to the SRWP Monitoring Program could be connected. This approach was chosen to provide best achievable information using conventional monitoring tools that would be most immediately useful in evaluating beneficial use attainment and potential impairment, and in the identification of management issues. Monitoring parameters and methods were selected to provide information that best addressed these issues. Sites were chosen to complement and augment ongoing monitoring, to provide information at the mouths of major tributaries, and to coincide with flow monitoring stations.

The SRWP monitoring program for 2001-2002 implemented several significant changes to the monitoring program, including modification of sampling locations, parameters, and sampling and analytical contractors. Note that changes made in the monitoring program were always prioritized by considering the goals of the program and the overall approach, even when those changes were required by decreases in the monitoring budget. The specific changes to the monitoring program are documented in the Quality Assurance Project Plans (QAPP) (SRWP 2001). The sites monitored, parameters measured, and sampling schedule for the SRWP monitoring program are discussed in the following sections.

1.4.1 Monitoring Sites

Site selection criteria were developed by the Monitoring Sub-committee to determine the monitoring locations for the SWRP monitoring program. Criteria used for the selection of sites included the following:

existing sampling station	*site access constraints*
flow gauging station	*sampling access constraints*
magnitude of streamflow	*available water quality data*
critical habitat area	*in existing watershed program*
predominant land use (e.g. agriculture, municipal, industrial, mining, etc.)	*potential water quality impairment, including 303(d) listed waterbodies*

After an initial screening using the criteria listed above, the selection was narrowed to include sites along the mainstem of the Sacramento River and at the mouths of major tributaries. Major tributaries were identified using existing streamflow data. Mainstem sites were selected to facilitate coordination with existing programs and to provide information below major reservoirs. Major tributaries were selected based on the magnitude of flow into the mainstem. The three major tributaries into Lake Shasta were included to capture these inputs and large tributary areas.

In addition to the mainstem monitoring, three smaller Sierra Nevada tributaries (Mill Creek, Big Chico Creek, and Deer Creek) were selected for special studies for 1998-2000 monitoring. The Sub-committee included these tributaries on a demonstration basis to encourage monitoring in these areas and to coordinate with the monitoring activities of the Department of Water Resources, Northern District.

For the 2001-2002 Monitoring year, locations were added for mercury monitoring in Cottonwood Creek watershed (three locations), Battle Creek watershed (three locations), Thomes Creek (three locations), Dry Creek (one site), and Little Chico Creek (one site) in 2001-2002. All of these locations were added to provide a better understanding of the mercury sources in the Sacramento River Watershed. Cottonwood Creek, Battle Creek, and Thomes Creek are relatively large tributary watersheds for which there are little or no mercury data, and Dry Creek and Little Chico Creek may be affected by significant historical mining operations in those watersheds.

Ceriodaphnia toxicity monitoring was performed at three new locations (the Pit River above Shasta, Cottonwood Creek at the mouth, and Cache Creek at Rumsey). The Pit River site was added because it is one of the major sources of flow in the watershed, and sporadic toxicity has been observed in the past. The Cottonwood Creek site was added because mining historically conducted in this watershed and CVRWQCB metals analyses data indicate a significant potential for aquatic toxicity. The Cache Creek site was added because it is on the 303(d) list for unknown toxicity.

Fish tissue monitoring was conducted at nine locations, compared to the 15 locations monitored in 2000-2001. The primary reason for the decrease in the number of locations is decreased available budget. The sites selected by the SRWP Fish Tissue Focus Group for monitoring include six previously monitored sites considered to be the highest priority for continued monitoring, and three new sites.

Overall, the 2001-2002 SRWP monitoring program included monitoring at 34 locations in the Sacramento River watershed. Seven of these sites are located on the mainstem of the Sacramento River, from the Sacramento River below Keswick Reservoir to the Sacramento River at River Mile 44. Five sites are located on major tributaries to the Sacramento River, two sites are located on major agricultural drains, and one site is located on an urban creek. The remaining 19 sites are located on smaller tributaries to the Sacramento River. The proposed sites cover over 300 miles of the Sacramento River system and represent a drainage area of over 23,000 square miles. Table 1 lists the sampling sites for the SWRP 2001-2002 monitoring program with a description of the location, type of site, and contributing land use percentages. The site locations are illustrated in Figure 1.

1.4.2 Monitoring Parameters

Specific individual parameters measured by the SRWP 2001-2002 monitoring effort are listed in Table 2.

For monitoring being performed in 2001-2002, analyses were added for ultraviolet absorbance at 254 nm (UVA_{254}), *E. coli* bacteria, and *Enterococcus* bacteria. Nitrogen and phosphorus compounds (ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, and dissolved orthophosphate) were monitored again in 2001-2002. These nutrient compounds were monitored in 1998-2000, but were not monitored during the 2000-2001 monitoring effort. Monitoring for these nutrient parameters was resumed primarily due to the expected implementation of national nutrient criteria by the U.S. Environmental Protection Agency, and was conducted at 12 sites.

The rationales for monitoring environmental parameters included in the SRWP monitoring program are discussed below.

1.4.2.1 Mercury, PCBs, and chlorinated pesticides in fish tissue

Mercury and certain organic contaminants (including DDT and PCBs) are readily accumulated directly from water or through the food web from low levels in water, resulting in concentrations in fish tissue which may be of concern to humans and wildlife. Monitoring levels of these pollutants in fish provides an effective way to assess potential human health hazards due to contamination of the Sacramento River system. Because fish accumulate contaminants throughout their life span and their habitat, measurements of contaminant concentrations in fish tissue provide an indication of average conditions over space and time. Fish tissue data can be useful in the determination of long term levels and trends of bioaccumulative contaminants (such as mercury, DDT and PCBs) in the watershed. This long-term data set can be used to measure the effectiveness of activities to control these pollutants.

1.4.2.2 Mercury in water

As stated above, low concentrations of mercury and methylmercury in water are of potential concern to human health. Several programs are currently planned or under way in the Sacramento River watershed to monitor mercury concentrations at various locations, including the Sacramento Coordinated Water Quality Program, the USGS National Water Quality Assessment for the Sacramento River, and CALFED. SRWP mercury monitoring supplements existing data, and planned and ongoing monitoring efforts, with information for eleven locations. Data obtained will be used to quantify ambient concentrations of mercury and methylmercury in surface waters of the Sacramento River watershed and to study whether these concentrations are causing or contributing to potential human health risks or otherwise adversely affecting beneficial uses.

1.4.2.3 Pesticides in water

Low concentrations of pesticides in water can affect the growth, reproduction and/or survival of sensitive aquatic species. The SRWP currently monitors organophosphate (OP), carbamate, and triazine pesticides. These classes of pesticides have been identified as being of potential concern to aquatic life in the Sacramento River system and are responsible for the presence of several Sacramento River watershed waterbodies on the 303(d) list of impaired waterbodies. Several programs are currently under way in the Sacramento River watershed to monitor pesticides at various locations in the Sacramento River watershed, including programs administered by the California Department of Pesticide Regulation (DPR), the California Regional Water Quality Control Board, and the USGS National Water Quality Assessment for the Sacramento River. SRWP pesticide monitoring will supplement the existing data with information for 10 additional locations. Specific pesticides analyses and locations for monitoring were selected on the basis of documented use of these pesticides upstream from the locations monitored, on pesticide-caused toxicity detected at these streams/rivers, and on inclusion for pesticides on the 303(d) list of impaired water bodies. Data obtained are used to quantify ambient concentrations of pesticides in surface waters of the Sacramento River watershed and to assess whether these concentrations are potentially adversely affecting uses. It should be noted that numerous other pesticides of potential concern to aquatic life and human health (including pyrethroids and legacy organochlorine pesticides) are not being monitored by the SRWP.

1.4.2.4 Toxicity in water

Ambient samples of water and sediment can be tested in the laboratory for toxicity to provide an indication of the conditions that exist in the natural environment. Standard test species and test procedures are used to provide reliable and comparable results. Toxicity is deemed to occur when test species are significantly affected by exposure to ambient water or sediment as compared to laboratory controls. Toxic effects measured for the SRWP in 2001-2002 include reduced reproduction and increased mortality of *Ceriodaphnia dubia*. Effects may occur rapidly over a period of hours to four days (acute toxicity) or may occur over a longer period (chronic toxicity). For the SRWP monitoring program, the results of toxicity testing are also used to trigger further investigations to determine the cause of observed toxicity. These toxicity identification investigations include the consideration of a number of factors, including contributing watershed characteristics, chemical characteristics of the water, biology, and additional toxicity testing wherein classes of toxicants are selectively removed or rendered non-toxic. Results from these weight-of-evidence investigations are useful in identifying potential water quality problems in the watershed. Sites for aquatic toxicity monitoring were selected to provide an overall survey of the distribution of toxicity in the watershed, and to coordinate with existing monitoring programs.

1.4.2.5 Pathogens and pathogen indicators

Pathogens are disease-producing organisms (protozoa, bacteria, and viruses) which adversely affect the quality of drinking water and/or may pose human health risks for water contact recreation. Two pathogens of particular concern are *Giardia lamblia* and *Cryptosporidium parvum*. Water treatment agencies are currently required to remove or inactivate at least 99.9% of *Giardia* and effective December 2001, are required to remove 99% of *Cryptosporidium* (Interim Enhanced Surface Water Treatment Rule, USEPA 1998). Although most facilities utilizing conventional or direct filtration remove at least 2 logs of *Cryptosporidium* (*ibid.)*, this organism is resistant to disinfection with chlorine, and high numbers of *Cryptosporidium* in source waters may require water supply agencies to switch to ozone or other disinfectants. Although some data exist for the Sacramento River near Redding and in the Sacramento River below Sacramento, data on the numbers of these pathogens are otherwise lacking for most of the Sacramento River system. Monitoring efforts by the Department of Water Resources, and the Metropolitan Water District of Southern California in the lower end of the watershed near Sacramento to assess numbers of *Cryptosporidium*, *Giardia*, and coliform organisms (indicators of fecal contamination) were completed in April, 1998, but no final report is expected to be released. The SRWP pathogen monitoring effort extended monitoring for these specific parameters to several additional upstream locations in the Sacramento River watershed. Coliform bacteria are monitored primarily as indicators of fecal contamination and the possible presence of enteric pathogens such as *Cryptosporidium* and *Giardia*. The USEPA recommends monitoring *Escherischia coli* and *Enterococci* as the preferred indicators of pathogen organisms. It was anticipated that SRWP data would be used primarily to determine the magnitude and extent of numbers of these pathogens in the mainstem of the river below major dams.

Monitoring for *Cryptosporidium* and *Giardia* was suspended for the 2001-2002 effort. Although the analytical method used to monitor *Giardia* and *Cryptosporidium* in 1999-2001 is much improved (compared to the ICR method used previously), there remains a high degree of uncertainty associated with data for these pathogens. The results of a recent DWR study (DiGiorgio *et al*. 2002) found that while recoveries of both organisms are acceptable under low turbidity conditions, recoveries of *Giardia* decrease unacceptably in higher turbidity waters. In addition, there are currently no regulatory limits or meaningful environmental benchmarks for surface waters for these pathogens. Due to SRWP budgetary constraints and to the uncertainties associated with the analytical method and interpretation of the results, monitoring of these pathogens was temporarily suspended by the SRWP. Monitoring may be resumed in subsequent years after further assessment of the results from monitoring conducted in 1999-2001. Monitoring of coliform indicator bacteria was continued in 2001-2002, including the addition of analyses for *Escherischia coli* and *Enterococci* bacteria.

1.4.2.6 Organic carbon in water

The organic content of water (measured as total and dissolved organic carbon) is a parameter important to drinking water suppliers. High concentrations of organic compounds in source waters contributes to the production of disinfection by-products (trihalomethanes and halo-acetic acids) as a result of conventional water treatment. Some of these by-products are carcinogenic and pose human health problems at relatively low concentrations. Additionally, the Stage 1 Disinfectants and Disinfection By-Product Rule (effective January 2002) requires drinking water systems serving at least 10,000 people to meet specified total organic carbon (TOC) removals dependant on source water TOC concentrations. For these reasons, baseline data on typical organic carbon concentrations and seasonal variability of those concentrations in the Sacramento River system are important to the assessment of drinking water uses. SRWP monitoring for organic carbon augments fairly extensive monitoring already being performed by the USGS NAWQA program, the City of Sacramento and the Department of Water Resources.

Some organic compounds commonly found in wastewaters and natural surface waters (lignin, humic and fulvic acids, and some aromatic compounds) strongly absorb ultraviolet radiation. Strong correlations have been demonstrated with organic carbon and precursors of trihalomethanes and other disinfection by-products (APHA *et al*. 1998). Ultraviolet absorbance at 254 nm (UVA_{254})is considered to be a useful surrogate measure for the ability of organic compounds to form these disinfection by-products.

1.4.2.7 General constituents (suspended and dissolved solids, turbidity, alkalinity, hardness, and nitrogen and phosphorus compounds) in water

These "conventional" water quality characteristics are important to the evaluation of the attainment of a variety of uses, including drinking water supply, recreation, aesthetics, aquatic habitat, and agricultural supply. Data for these parameters are available from a number of programs, including USGS NAWQA, the Sacramento Coordinating Monitoring Program and the Department of Water Resources. SRWP monitoring augments the ongoing data collection efforts for some of these constituents.

1.4.2.8 Benthic invertebrates and habitat characterization

Benthic invertebrates are the aquatic insects and other organisms that live along the bottom of streams, lakes, and other waterbodies. Procedures have been developed to standardize the assessment of biological habitat and benthic communities for use as a monitoring tool (Plafkin et al. 1989, CDFG 1996, DWR 1997). Ideally, information on invertebrate diversity, abundance, species richness, and other community metrics collected at specific sites is compared against expected conditions (or reference stream conditions) to evaluate the relative health of the biological community at that location. This information is used in combination with chemical concentration and toxicity data to assess ecosystem conditions at various locations. Different procedures are used depending on the characteristics of the stream (i.e. wadable versus non-wadable). This monitoring tool can be effectively used by citizen monitoring groups in smaller tributary watersheds. The Department of Water Resources and Department of Fish and Game are working actively with a number of tributary watershed groups to provide education and training regarding the assessment methods. Data from the SRWP monitoring program is intended to supplement and integrate results from projected tributary efforts.

The focus of the SRWP 2001-2002 bioassessment monitoring effort was shifted to developing a process for identifying reference conditions in the Sierra Nevada foothill region, in cooperation with the California State Water Resources Control Board and Department of Fish and Game. The Sierra foothill region was selected for the initial focus of this effort because this region is undergoing rapid development and urbanization. Identification of reference sites and conditions are critical for interpreting bioassessment monitoring results and for developing biocriteria. The process developed for identifying and selecting reference sites is expected to have application throughout the watershed and the state. No sampling and analysis of benthic macroinvertebrates was planned for 2001, but physical habitat assessments were performed at selected sites as part of the process of reference site identification.

1.4.3 Sampling Frequency and Schedule

The base monitoring frequency for 2001-2002 was reduced to six events per year (from nine events per year for 2000-2001, and 12 events in previous years). This change in frequency was made to accommodate a significant decrease in the SRWP monitoring budget for 2001-2002. In order to best satisfy the monitoring goals and priorities of the SRWP, some reductions in monitoring frequency were considered preferable to discontinuing monitoring for additional parameters or at existing monitoring locations. The basis for planning sample events was also changed to "episodic" (event-based) for all parameters in 2001-2002. This change was made to allow the program to focus on specific hydrological conditions and other events relevant to water quality (low and high flows, storm events, pesticide application seasons and events, spills, etc.).

Monitoring frequency varied by location and the parameter to be tested, as summarized below:

- Water quality monitoring for mercury, pesticides, pathogens, organic carbon, general constituents in water, and for aquatic toxicity sampling was "event-based", for a total of six sample events. These sample events were planned to coincide with a range of hydrological conditions and other events expected to significantly affect water quality (e.g. during seasonal pesticide applications, expected periods of agricultural or urban runoff, high and low flows), or conditions that match a previously observed pattern of toxicity or changes in concentrations of parameters. All data represent the results of a single grab sample per event per site (*i.e.*, no composite samples were collected), and analytical results for different parameters are essentially for the same sample (within the limitations of parameter-specific sampling requirements)
- Fish tissue sampling was conducted once annually (in the fall) for all sites monitored.

- Physical habitat assessment for bioassessment was conducted once annually for selected prospective reference sites.

The sample events were typically conducted over a period of three or four days. (Descriptions and dates for specific events are described later in the Data Review sections of this report.) A breakdown of sampling sites, sampling frequency, and parameters to be analyzed are provided in Table 3.

Table 1. SRWP 2001-2002 Monitoring Sites

			Percent Contributing Land Use				
Site description	Site ID[1]	Site Type	Rangeland	Forest	Agriculture	Urban, Residential	Other[2]
Sacramento River below Keswick	SRBKR	Mainstem	20	70	4.5	0.3	4.9
Sacramento River above Bend Bridge	SRABB	Mainstem	20	71	4.5	0.7	3.9
Sacramento River near Hamilton City	SRHAM	Mainstem	21	69	6.6	0.7	3.4
Sacramento River at Colusa	SRCOL	Mainstem	22	67	7.5	0.8	3.2
Sacramento River at Veterans Bridge	SRVET	Mainstem	18	62	16	1.1	3.0
Sacramento River at Freeport	SRFPT	Mainstem	18	62	15	1.8	3.4
Sacramento River at River Mile 44	SRRMF	Mainstem	18	62	15	1.9	3.4
Yuba River at Marysville	YRMRY	Major Trib	9.9	85	1.0	0.8	3.5
Feather River above Bear River	FRABR	Major Trib	—[3]	—	—	—	—
Feather River near Nicolaus	FRNIC	Major Trib	11	77	7.0	1.3	3.4
American River at J Street	ARJST	Major Trib	12	77	2.9	2.9	5.3
American River at Discovery Park	ARDPK	Major Trib	12	76	3.1	3.8	5.6
Pit River above Shasta	PRSHA	Tributary	22	67	5.8	0.2	4.7
MF Cottonwood Creek near Ono	CTMON	Tributary	—	—	—	—	—
NF Cottonwood Creek at McCauliffe Road	CTNON	Tributary	—	—	—	—	—
SF Cottonwood Creek at Anderson Canal	CTSCW	Tributary	—	—	—	—	—
Cottonwood Creek near Cottonwood	CTCTW	Tributary	35	61	2.8	0.5	0.2
NF Battle Creek at Manton Road	BANFA	Tributary	—	—	—	—	—
SF Battle Creek at Wildcat Road	BASFA	Tributary	—	—	—	—	—
Battle Creek below Coleman Fish Hatchery	BACTW	Tributary	9.0	89	0.5	0.3	0.8
Mill Creek at Mouth	MCMOU	Tributary	2.5	96	1.1	0.1	0.3
Thomes Creek at Paskenta	THPSK	Tributary	—	—	—	—	—
Thomes Creek at Henleyville	THAPK	Tributary	—	—	—	—	—
Thomes Creek at Rawson Rd Bridge	THRRB	Tributary	33	62	5.3	0.1	0.2
Deer Creek at Mouth	DCMOU	Tributary	4.5	93	2.3	0.0	0.1
Big Chico Creek at Mouth	CHMOU	Tributary	8.4	69	17	5.4	0.2
Dry Creek above Cherokee Canal	DRACC	Tributary	6.4	88	1.1	0.6	3.3
Little Chico Creek at Mouth	LCMOU	Tributary	19	66	8.9	6.1	0.5
Cache Creek near Rumsey	CCHRM	Tributary	37	47	7.4	2.1	6.5
Prospect Slough	PROSL	Tributary	—	—	—	—	—
Colusa Basin Drain above KL	COLDR	Ag Drain	18	17	64	1.4	0.2
Sacramento Slough	SACSL	Ag Drain	12	18	63	2.8	3.3
Arcade Creek at Norwood Ave.	ARCNW	Urban Creek	0.06	.003	14	84	2.1

(1) ### indicates multiple site IDs for this drainage.
(2) Includes water, wetlands, snowfields, shrub and brush tundra, and transitional areas
(3) "—" indicates land use percentages not calculated

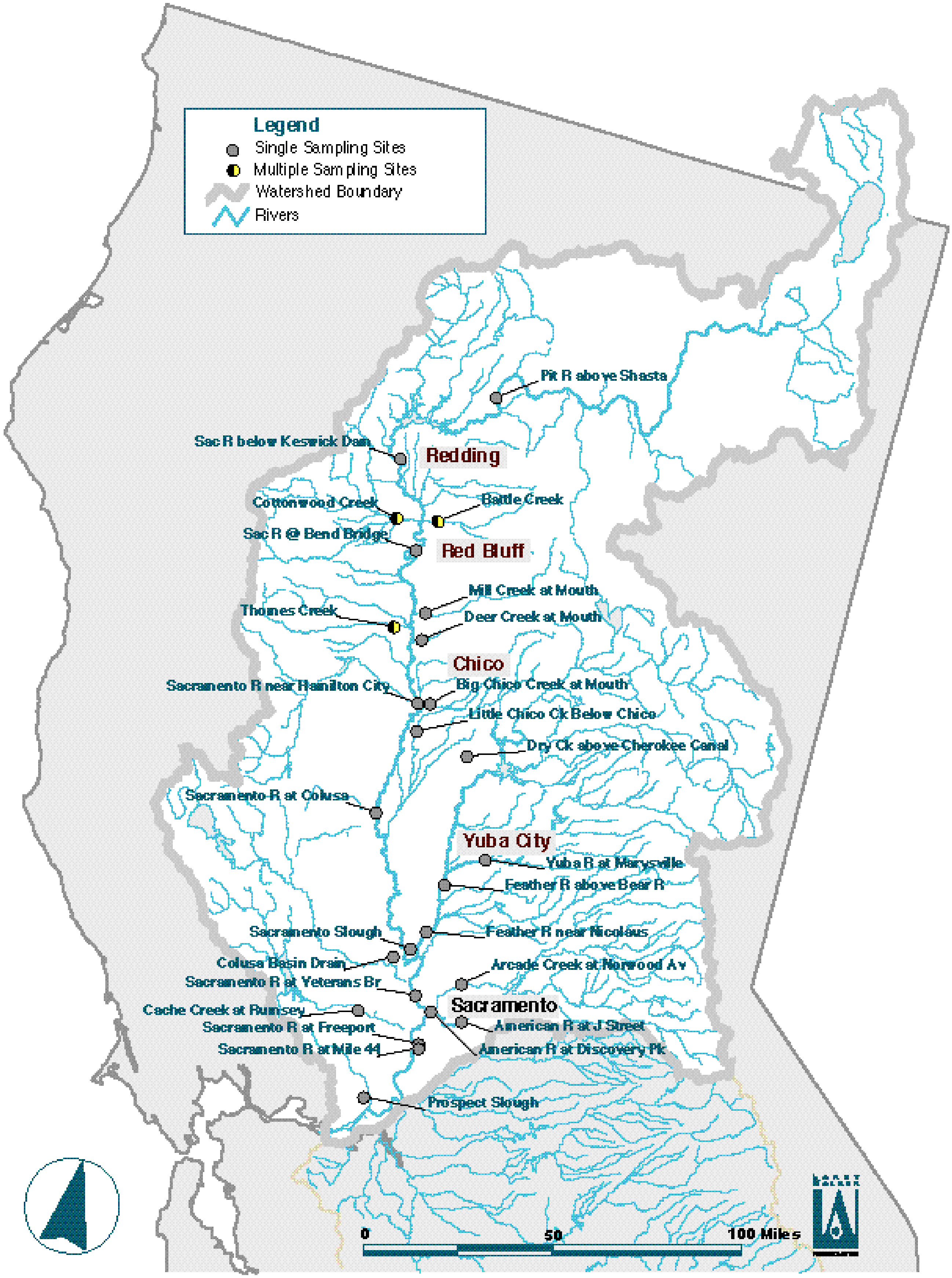

Figure 1. SRWP Monitoring Program Sampling Sites

Table 2. Parameters Measured for the SRWP 2001-2002 Monitoring Program

Chemical and Physical Water Quality Characteristics	
Mercury	*General Constituents*
Mercury, filtered and unfiltered	Alkalinity
Methylmercury, filtered and unfiltered	Hardness
	Total Suspended Solids
Nitrogen and Phosphorus Compounds	Total Dissolved Solids
Ammonia Nitrogen	Dissolved Organic Carbon
Nitrate and Nitrite Nitrogen	Total Organic Carbon
Total Kjeldahl Nitrogen	UVA_{254}
Dissolved Orthophosphate and Total Phosphorus	
	Field Parameters
Pesticides	Temperature
Organophosphate Pesticides	pH
Carbamate Pesticides	Dissolved Oxygen
Triazine Pesticides	Conductivity
Microbiological Water Quality Characteristics	
Escherischia coli	Total coliform bacteria
Enterococcus spp.	Fecal coliform bacteria
Aquatic Toxicity	
Ceriodaphnia reproduction	*Ceriodaphnia* mortality
Fish Tissue	**Bioassessment**
Mercury	*Physical Habitat*
Chlorinated pesticides	Selection of potential reference sites
PCBs	Measures of habitat quality
	Benthic Invertebrates
	Community abundance and diversity metrics

Table 3. Summary of Sampling Sites, Sampling Frequency, and Parameters.

	Chemical Characteristics															Aquatic Toxicity		Fish Tissue		Bioassess-ment(b)	
Monitoring Locations	**Hg and MeHg (unfiltered and unfiltered)**	**TSS**	**Hardness**	**Alkalinity**	**TOC**	**DOC**	**UVA 254**	**TDS**	**Nitrogen and Phosphorus compounds**	**OP pesticides**	**carbamate pesticides**	**triazines**	***E. coli***	***Enterococcus***	**Total, Fecal Coliforms**	**Ceriodaphnia**	**WC Tox Followup (a)**	**Mercury**	**PCBs & chlor. pest.**	**Benthic Invertebrates**	**Habitat Assessment**
Pit R. above Shasta			atox	atox												6 E	E			RB	
Sac. R. below Keswick	5 E	5 E	atox	atox				RED		DWR	DWR					6 E	E	2	2		
Cottonwood Ck at mouth	DWR	DWR	atox	atox						DWR	DWR					6 E	E				
Cottonwood Creek (3 sites)	12 E	12 E																			
Battle Creek (3 sites)	12 E	12 E																			
Sac. R. at Bend Br	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	DWR	DWR		6 E	6 E	6 E	6 E	E				
Mill Creek @ Los Molinos	DWR	DWR	DWR							3 E											
Deer Creek	DWR	DWR	DWR							3 E											
Thomes Creek (3 sites)	12 E	12 E																			
Dry Creek (trib to Little Chico Ck)	4 E	4 E																			
Little Chico Creek	4 E	4 E																			
Big Chico Creek at Mouth	DWR	DWR	DWR							3 E											
Sac. R. near Hamilton City	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E			6 E	6 E	6 E	6 E	E				
Sac. R. @ Colusa	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E			6 E	6 E	6 E	6 E	E				
Sac. Slough	4 E	4 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E	6 E		6 E	6 E	6 E	6 E	E				
Colusa Basin Dr	4 E	4 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E	6 E		6 E	6 E	6 E	6 E	E	2	3		
Yuba R. at Marysville	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E	6 E		6 E	6 E	6 E	6 E	E				
Feather R. between Yuba and Bear R.																		2	2		
Feather R. near Nicolaus	5 E	5 E	atox	atox	6 E	6 E	6 E	6 E	6 E	6 E		4 E	6 E	6 E	6 E	6 E	E	2	2		
Sac. R. at Veterans Br.	CMP	CMP	CMP	6	CMP	CMP	6	6	6	6 E		4 E	CMP	6	CMP						
Arcade Creek	4 E	4 E	atox	atox						6 E	6 E	6 E				6 E	E				
Natomas East Main Drain			DWR	DWR	DWR	DWR	DWR	DWR	6				6 E	6 E	6 E						
American R. at J St.																		2	2		
American R. at Discovery Pk	CMP	CMP	atox	atox	CMP	CMP	6	CMP	6	CMP			CMP	6	CMP	6 E	E	2	2		
Sac. R. at Freeport	CMP, GS	CMP	atox	atox	CMP	CMP	6	CMP	6	GS	GS	GS	CMP	6	CMP	6 E	E				
Sac. R. at RM44	CMP	CMP	CMP	6	CMP	CMP	6	CMP	6	CMP			CMP	6	CMP			4	4		
Cache Creek at Rumsey		CF	atox	atox	CF	CF	CF	CF								6 E	E	2	2		
Prospect Slough																		2	2		
Number Sites Monitored by SRWP	14	14	14	16	7	7	11	8	12	11	4	3	8	12	8	14	(a)	9	9	(b)	(b)
Number of Regular Analyses	86	86	0	12	42	42	66	48	72	57	24	14	48	72	48	84	(a)	20	21	(b)	(b)
Additional QC Analyses	12	9	0	0	12	12	12	6	12	12	12	12	6	6	6	12	(a)	2	2	(b)	(b)

Table Notes: Values indicate number of environmental samples collected annually. Additional samples are collected for Quality Assurance. Values appended with "E" indicate that monitoring will be "event-based". "atox" indicates parameter will be measured as part of aquatic toxicity monitoring effort. Ohter text entries indicate data or samples collected by primary coordinating programs: CMP = Sacramento River Coordinated Monitoring Program; GS = USGS; CF = CALFED; RB =Central Valley Regional Board; DWR = Dept of Water Resources; TEH = Tehama County RCD

(a) A fixed budget of $60,000 is allocated for Toxicity follow-up consisting of chemistry, TIE testing, and additional sampling that has no fixed frequency.

(b) Bioassessment monitoring includes physical habitat and biological assessments. Monitoring in 2001-2002 will consist primarily of identifying potential reference sites.

2 Data Review

The purpose of this data review is to present the results of monitoring performed by the SRWP and coordinating programs, and to present the conclusions of evaluation of these data. This review utilizes data compiled for the period 1994 through 2002, but focuses on SRWP monitoring conducted in 2001-2002. The primary data considered and presented for this review were generated by the following programs:

- The Sacramento River Watershed Program (SRWP) (http://www.sacriver.org)
- The Sacramento River Coordinated Monitoring Program (CMP) (LWA 2002),
- The City of Redding NPDES monitoring program,
- USGS National Assessment of Water Quality (NAWQA) for the Sacramento River (http://water.wr.usgs.gov/sac_nawqa/index.html),
- Department of Water Resources (Northern District) Intensive Tributary Monitoring Program (http://wwwdpla.water.ca.gov/nd/index.html),

The data from the coordinating programs are collected using similar sampling and analytical methods, and were therefore considered compatible with SRWP data. Data from these programs were pooled for subsequent evaluations, presentation of summary data (e.g. summary statistics), and plots of data, unless stated otherwise. For parameters with concentrations reported below analytical detection limits, summary statistics presented in this report were estimated using the robust method of Helsel and Cohn (1988), which uses probabilities adjusted for the proportion of data below detection to calculate unbiased estimates of the typical parametric statistics (mean, standard deviation, etc.). Additionally, selected results were also considered and evaluated from a number of other monitoring studies referenced in following data review sections.

The review of data for parameters measured for the 2001-2002 SRWP monitoring effort is organized into the following general categories:

- Mercury in water and fish tissue
- Pesticides in water
- Aquatic toxicity
- Drinking water parameters of concern (organic carbon, dissolved and suspended solids, nutrients, pathogens)
- Organochlorine pesticides and PCBs in fish tissue
- Bioassessment

2.1 Process for Data Evaluation

Each evaluation is preceded by an overview of relevant monitoring information. The evaluations presented within each data review category were designed to address specific goals of the SRWP monitoring program. Monitoring data were evaluated for evidence that beneficial uses are attained or impaired, and if these evaluations indicated potential impairment due to a specific monitoring parameter, temporal and spatial trends in water quality were also evaluated and discussed. If the evaluations indicated that a particular parameter is probably not causing impairment, spatial and temporal trends were not evaluated for that parameter. Descriptions of the specific methods used to evaluate attainment of beneficial uses and spatial and temporal trends follow.

2.1.1 Evaluation of Attainment and Potential Impairment of Beneficial Uses

Comparisons with applicable water quality criteria, objectives, and other advisory criteria were performed as a preliminary evaluation of the degree to which beneficial uses of the Sacramento River watershed are attained or potentially impaired. Concentrations in water are compared to California Toxics Rule (CTR) criteria, USEPA Maximum Contaminant Levels (MCLs) for drinking water, and Central Valley Basin Plan objectives (which incorporate California Department of Health Services (DHS) Maximum Contaminant Levels (MCLs) for drinking water by reference). Concentrations of mercury and organic compounds in fish tissue were compared to various screening values developed by several different state and federal regulatory agencies. As a rule, these regulatory criteria and other limits define what are believed to be “safe levels”, rather than thresholds of adverse effects. Because these limits are conservative by design, individual exceedances are not necessarily predictive of actual impairments of beneficial uses. For the purpose of these evaluations, concentrations that exceed these regulatory limits in water or tissue are considered indicators of *potential* impairment of beneficial uses. Cases where concentrations clearly do not exceed regulatory limits indicate that beneficial uses are not being impaired by a specific constituent, but do not provide unequivocal evidence that a specific beneficial use is being fully attained. The results of these comparisons to regulatory criteria and other limits were also evaluated for consistency with the State Water Resources Control Board’s 303(d) list of waterbodies which the State considers to be impaired and not attaining beneficial uses. Note that the State Water Resources Control Board is currently developing a “listing policy” that will define how to determine impairment of beneficial uses, including data requirements, numbers of exceedances, and other information needed to qualify a waterbody for inclusion on the 303(d) list.

As discussed previously, water column monitoring frequency for 2001-2002 was reduced to six events per year (from nine events per year for 2000-2001, and 12 events in previous years). Additionally, the monitoring strategy was changed to “event-based” for all water column parameters in 2001-2002. Because the majority of monitoring events are selected to characterize hydrological events expected to result in higher than typical concentrations and loads of pollutants, this change in strategy will tend (over time) to bias the dataset towards “worst case” water quality conditions. For most monitoring locations with several years of monitoring data, this effect is offset for a while by the large majority of unbiased data in the data set. However, for locations monitored for the first time or with relatively short monitoring histories (e.g. many of the smaller tributaries monitored in 2001-2002), this bias can be substantial and immediate. There is no simple cure for this introduced bias. Statistical corrections may be possible in some cases, but they typically rely on fairly complex modeling or data-weighting methods. For the purpose of these assessments, no attempt is made to correct for the bias, other than to make the reader aware and to warn of its potential impact on the evaluations. Note that assessments based on fish tissue or bioassessment monitoring remain unbiased because they are not affected by these changes in water column monitoring strategy.

2.1.2 Spatial and Temporal Trends

For parameters determined to have the potential to impair beneficial uses, evaluations of spatial and temporal trends were also performed. Evaluation of these trends support the SRWP goal of collecting and evaluating water quality data for the purpose of characterizing baseline conditions in the watershed, and also provide information relevant to identifying sources of pollutants or causes of potential impairment. Due to the limitations of the data (e.g. only a few years of data for most parameters, different monitoring periods for different programs, high percentages of data below detection for some parameters and programs, and very few data for some sites and parameters), formal statistical analysis of the spatial and temporal trends would be resource-intensive and would provide little additional useful information for the SRWP. The discussions of general trends are qualitative and descriptive and are not characterized as statistically significant. Summary statistics and time series plots of chemical, physical, and microbiological water quality characteristics were also prepared and are provided in Appendix A and Appendix B, respectively. If appropriate for the specific data category, a semi-quantitative assessment was performed of the relative importance of the loads of selected pollutants to the Delta.

2.1.3 Statement of Data Quality

Data presented in this report have been reviewed and validated as required by the Quality Assurance Project Plan (SRWP 2001). In general, data collected by the SRWP and cooperating programs are adequate for the purposes intended and the evaluations presented in this review. A detailed review of data quality is presented in Appendix D of this report.

2.2 Mercury Data Summary

Monitoring results for the Sacramento River Watershed Program (SRWP) for the period June 1998 through June 2001 and for primary coordinating programs (USGS NAWQA, Sacramento River Coordinated Monitoring Program, City of Redding NPDES monitoring, and Department of Water Resources) are presented and summarized in this section. Data are compared to adopted water quality objectives and advisory criteria to evaluate attainment and potential impairment of beneficial uses in the watershed. Data are evaluated for spatial and temporal trends, and summary statistics are also provided in Appendix A. Qualitative comparisons of mass loads from the Sacramento River watershed and other major Delta inputs are used to evaluate the relative contributions of mercury to the San Francisco Bay – Sacramento/San Joaquin Delta system.

2.2.1 Background and Available Data Overview

The sources of data utilized for this report are summarized in Table 4. The monitoring locations for the primary data considered for this report (USGS NAWQA, Sacramento River Coordinated Monitoring Program, City of Redding NPDES monitoring, the California Department of Water Resources, and the Sacramento River Watershed Program) are illustrated in Figure 2.

Table 4. Mercury monitoring programs (water column and fish tissue) in the Sacramento River Watershed

Program	Monitoring Period(s)	Parameters	# of locations & geographic reference
SRWP	6/98–6/01 6/00–6/01	▪ Total Hg in water, ▪ Total Hg in fish tissue ▪ Methylmercury in water	3 water column sites: 2 upper watershed, and 1 in lower watershed; 13 fish tissue sites on Sacramento River and major tributaries
SRWP Special Study (USGS)	1/19/00, 2/20/00	▪ TSS, total Hg, and methylmercury in water	Sac. R. at bend Bridge and Woodson Bridge, Antelope Creek, Elder Creek, and Mill Creek
SRWP Special Study (CDFG)	3/01–6/01	▪ TSS, total Hg, and methylmercury in water	11 Sacramento River sites from Hamilton City to Colusa
SRWP Special Study (PER)	4/01	▪ TSS, total Hg, and methylmercury in water	3 sites in Mill Creek drainage
Sacramento River Mercury Control Planning Project (LWA 1997)	3/95–2/96	▪ Total and filtered Hg and MeHg, and TSS in water ▪ Hg and MeHg in benthic invertebrates and fish	7 water column sites on Sacramento River, Feather River, and Yuba River. MeHg at selected sites. 55 benthic invertebrate and 25 fish sites on Sierra tributaries to the Sacramento River.
Sacramento River CMP (SRCSD)	12/92–6/02	▪ Total and dissolved Hg in water	5 sites on Sacramento and American rivers in Sacramento metropolitan area
USGS Mercury Transport Study (Roth et al. 1998)	6/96–5/97	▪ Total, dissolved, and colloidal Hg in water	6 sites on Sacramento River and 7 sites on selected tributaries.
Sacramento River Basin NAWQA (USGS)	1996—2002	▪ Total Hg and MeHg in water ▪ Total Hg in sediments	12 Hg sites (5 MeHg sites), distributed throughout watershed 1996-98. 5 sites 1998-2002.
USGS (Domagalski 1998)	2/96–2/97	▪ Total Hg and MeHg in water ▪ Total Hg in sediments	11 water column and 17 sediment sites on the Sacramento River and major tributaries.
CVRWQCB (Slotton et al. 1997)	Spring, 1996	▪ Hg in benthic invertebrates.	38 sites in the Cache Creek watershed
CVRWQCB (Foe and Croyle 1998)	10/93–4/95, 1996-1998	▪ Total and dissolved Hg, and TSS in water	22 sites in major Delta tributaries, and 10 additional sites in Cache Ck watershed
City of Redding	1/98–5/01	▪ Total Hg in water	1 site at Sacramento River below Keswick Dam
SF Estuary Regional Monitoring Program	1989–1997	▪ Total and dissolved Hg in water ▪ Total Hg in fish tissue	18 Bay-Delta sites, including Sacramento River and San Joaquin River at the Delta terminus
Special Tributary Program (DWR)	6/98–5/00	▪ Total Hg in water ▪ Total Hg in fish tissue	13 water column sites and 8 fish tissue sites on Mill Creek, Big Chico Creek, and Deer Creek
CALFED Bay-Delta Hg Program	1999—2002	▪ Total Hg and MeHg in water, sediments, fish, clams, bird eggs, benthic invertebrates,	Locations throughout the Bay-Delta Estuary, and Cache Creek watershed. *Data not yet final for most projects.*

2.2.2 Attainment of Beneficial Uses and Potential Impairment

One of the SRWP monitoring program's primary goals is to assess the degree to which beneficial uses are attained or potentially impaired in surface waters of the watershed. For the purpose of these evaluations, mercury concentrations in water and fish tissue were compared to various regulatory criteria and screening or advisory thresholds. Concentrations that exceed these regulatory limits in water or tissue are considered indicators of *potential* impairment of beneficial uses, as described previously. Cases where concentrations clearly do not exceed regulatory limits indicate that beneficial uses are not being impaired by a specific constituent, but do not provide unequivocal evidence that a specific beneficial use is being fully attained. The results of these comparisons to regulatory criteria and other limits were also evaluated for consistency with the State Water Resources Control Board's 303(d) list of waterbodies which the State considers to be impaired and not attaining beneficial uses.

As discussed previously, monitoring frequency for 2001-2002 was reduced to six events per year (from nine events per year for 2000-2001, and 12 events in previous years). Additionally, the monitoring strategy was changed to "event-based" for all monitoring parameters in 2001-2002. Because the majority of monitoring events are selected to characterize hydrological events expected to result in higher than typical concentrations and loads of pollutants, this change in strategy will tend (over time) to bias the dataset towards "worst case" water quality conditions. For most monitoring locations with several years of monitoring data, this effect is offset by the large majority of unbiased data in the data set. However, for locations monitored for the first time (e.g. most of the smaller tributaries monitored in 2001-2002) or with relatively short monitoring histories, this bias can be substantial. There is no simple cure for this introduced bias. Statistical corrections may be possible in some cases, but they typically rely on fairly complex modeling or data-weighting methods. For the purpose of these assessments, no attempt is made to correct for the bias, other than to be aware and to warn the reader of its potential impact on the evaluations.

2.2.2.1 Water Column

2.2.2.1.1 Human Health Thresholds

Total mercury concentrations in water were compared with a variety of regulatory, screening, and advisory thresholds (Table 5). Adopted total mercury water quality objectives for the Sacramento River watershed include a human health-based water quality objective for drinking water of 2000 ng/L (the drinking water Maximum Contaminant Level or MCL) adopted in the Central Valley Basin Plan, and a human-health-based federal water quality criterion of 50 ng/L (30-day average) adopted in the May 2000 California Toxics Rule (CTR). The CTR criterion reflects the latest USEPA national water quality criterion for total mercury for protection of human health, which superceded the 1985 USEPA national criterion value of 12 ng/L. The CTR criterion does not reflect the approach used in the Great Lakes Initiative, where an objective of 3.1 ng/L was adopted based on use of field-derived bioaccumulation factors (BAFs). The fish consumption-based human health criteria for mercury are intended to protect sensitive individuals (pregnant women, unborn children, infants) and are based on different assumptions of fish consumption rates and bioaccumulation rates.

It should be noted that USEPA re-evaluated and revised its 304(a) national criterion for mercury in 2001 (USEPA 2001) and has promulgated the human health-based water quality criterion as a fish tissue-based criterion for methylmercury. New human health criteria based on USEPA's 304(a) revisions have not yet been proposed for California.

2.2.2.1.2 Wildlife Thresholds

No wildlife-based water quality objectives have been adopted for mercury in California and USEPA has not issued national wildlife-based advisory criteria for mercury in water. A wildlife-protective standard of 1.3 ng/L total mercury has been adopted for the Great Lakes area, based on criteria developed by USEPA. USEPA revised these Great Lakes values for protection of wildlife species in its Mercury Report to Congress (USEPA 1997), an advisory document. Total mercury criterion values presented in the Mercury Report to Congress ranged from 0.6 ng/L to 1.8 ng/L, with an average of 0.9□g/L for the species considered. The Mercury Report to Congress also identified a methylmercury criterion of 0.05 ng/L in water for protection of wildlife.

Table 5. Regulatory Standards and Other Threshold Values for Mercury in Water.

Basis for Limit	Concentration in water, ng/L	Form of Hg	Reference
Human Health	2000	Total	Maximum Contaminant Level (MCL) in drinking water (USEPA, 1996)
Human Health	50[2]	Total	Federal water quality criterion per California Toxics Rule (May 2000), Recommended National Water Quality Criteria (USEPA 1999)
Human Health	0.24 3.1	Methyl Total	Specific to Great Lakes, federal water quality criterion for Great Lakes (USEPA 1995)
Wildlife[1]	0.05 0.641 0.91	Methyl Dissolved Total	Mercury Report to Congress, Vol. VI (USEPA 1997)
Wildlife	1.3	Total	Specific to Great Lakes, federal water quality criterion for Great Lakes (USEPA 1995)

(1) Lowest average criterion, based on the average for all mammalian wildlife species studied in Mercury Report to Congress.
(2) This value represents a 30-day average not to be exceeded more than once in three years.

2.2.2.1.3 Comparison with Water Column Threshold Values

Because the mercury objective for protection of human health for drinking water exposure is orders of magnitude higher than fish consumption-based limits, the remaining discussion will focus only on the fish consumption-based values. The percentage of data meeting specific regulatory or advisory thresholds are presented in Table 6.

Total mercury concentrations in the Sacramento River (from Keswick to River Mile 44) and in the major tributaries were rarely observed to exceed the CTR criterion for mercury (0.3%, or 2 of 656 total samples in the Sacramento River, and in no samples from the American, Feather, and Yuba rivers). Mercury concentrations in Cache Creek exceeded the 50 ng/L limit in 30% of samples. Based on data collected by DWR and SRWP, mercury concentrations in the Mill Creek exceeded the 50 ng/L limit in 13% of samples collected from the mouth of the creek. Higher concentrations and percent exceedances (46%) were observed in waters of the upper Mill Creek watershed, where the influence from geothermal activity (hot springs) is greatest. DWR data for Deer Creek and Big Chico Creek indicate that the CTR criterion was met in every sample collected in the Deer Creek watershed, and in all but one sample (of 86) collected in the Big Chico Creek watershed. Mercury concentrations did not exceed the CTR criterion in any samples from the two agricultural drains monitored (Sacramento Slough and Colusa Basin Drain). Mercury concentrations did not exceed 50 ng/L in any samples collected in 2000-2001, and exceeded 50 ng/L in a single sample (Thomes Creek) in 2001-2002.

In comparison with total mercury advisory criteria in the range from 2–5 ng/L (as indicated by USEPA Region IX staff) for human health protection, or at 1.3 ng/L concentrations (as has been adopted in the Great Lakes for wildlife protection), ambient water column concentrations of total mercury frequently exceed these values at all sites tested throughout the Sacramento River watershed. In comparison with the 3.1 ng/L Great Lakes criterion for the protection of human health, the Sacramento River exceeded this criterion in only 23% of samples collected from Hamilton City upstream, while the 3.1 ng/L limit was exceeded in 85% of samples collected from the Sacramento River from Colusa to Greene's Landing. The 3.1 ng/L limit was exceeded in fewer than 10% of samples from the Deer Creek watershed, in 15% of samples from the Big Chico Creek watershed, and in nearly every sample (87%) from Mill Creek.

The Great Lakes Initiative adopted a human health-based methylmercury criterion of 0.24 ng/L. Methylmercury concentrations measured by SRWP and USGS at eight mainstem Sacramento River sites exceeded 0.24 ng/L in 9% of samples, and methylmercury concentrations in the two agricultural drain sites (Colusa Drain and Sacramento Slough, 1996-1998, 2001-2002) exceeded 0.24 ng/L in 25% and 35% of samples, respectively. Arcade Creek (an urban creek) exhibited the highest percentage of exceedances of the 0.24 ng/L limit (67%, 2000-02 data). Methylmercury concentrations in Cache Creek exceeded 0.24 ng/L in 9% of samples collected. In comparisons with the 0.05 ng/l wildlife-based methylmercury advisory criterion identified in the Mercury Report to Congress by USEPA, methylmercury concentrations exceeded the limit in approximately 81% of the total samples collected at all sites.

2.2.2.2 Fish Tissue

2.2.2.2.1 Threshold Values

Mercury concentrations in composite and individual fish tissue samples were compared with several different advisory thresholds and criteria for mercury in fish tissue (all expressed as wet weight) (Table 6). Human health-based limits range from 1.0 mg/kg (the Food and Drug Administration (FDA) Action Level applicable to commercially-caught fish), to 0.30 mg/kg (national ambient water quality criterion for protection of human health; USEPA 2001), to 0.14 mg/kg (SFRWQCB 1995). USEPA fish tissue advisory criteria for protection of wildlife in the Great Lakes, as revised in the 1997 Mercury Report to Congress, range from 0.68 mg/kg to 0.028 mg/kg. These criteria and screening values are risk-based advisory values against which tissue concentrations can be compared to determine whether more intensive monitoring, evaluation, or risk management (e.g. consumption advisories) are warranted. Note that these risk-based values are based on assumed fish consumption rates for humans (6.5 g/day to 30 g/day) or for wildlife species. For individuals or populations consuming more or less fish than assumed for a specific limit or screening value, the risk of adverse health effects is correspondingly increased or decreased. Additionally, each criterion or screening value is calculated from a reference dose (RfD) based on a daily intake level estimated not to cause adverse effects, and a safety factor to account for uncertainties in the reference dose. The current USEPA human health-based reference dose incorporates a safety factor of 10, and reference doses for birds and mammalian wildlife range from 2 to 10. The consumption rate and reference dose associated with each limit are specified in Table 7.

Table 6. Comparisons With USEPA Total Mercury Water Quality Criteria for Human Health: Percent of Data meeting Criteria (1996-2002)

	Location	Years monitored	Number of samples	% of data meeting USEPA criteria for protection of human health: 1997 USEPA 3.1 ng/L Great Lakes Standard	1985 USEPA 12 ng/L Criterion	1999 USEPA 50 ng/L Criterion(1)
Mainstem	Sacramento River below Keswick	1998–2002	56	93.2%	100.0%	100.0%
Mainstem	Sacramento River above Bend Bridge	1996–2002	51	66.3%	97.1%	100.0%
Mainstem	Sacramento River near Hamilton City	1999–2002	23	60.9%	95.3%	100.0%
Mainstem	Sacramento River at Colusa(2)	1996–2002	57	30.8%	84.0%	99.5%
Mainstem	Sacramento River at Verona(2)	1996–1998	28	11.3%	80.3%	100.0%
Mainstem	Sacramento River at Veterans Bridge(2)	1994–2002	123	6.8%	80.2%	100.0%
Mainstem	Sacramento River at Freeport(2)	1994–2002	174	14.3%	82.2%	100.0%
Mainstem	Sacramento River at River Mile 44(2)	1994–2002	118	13.7%	77.9%	99.7%
Mainstem	Sacramento River at Greene's Landing(2)	2000–2001	26	33.2%	97.6%	100.0%
Major Tribs	Yuba River at Marysville	1996–2002	50	47.7%	93.1%	100.0%
Major Tribs	Feather River near Nicolaus(2)	1996–2002	51	25.0%	87.3%	100.0%
Major Tribs	American River at Discovery Park(2)	1994–2002	120	63.5%	98.8%	100.0%
Tributaries	Spring Cr. PP Discharge to Keswick Res.	1998–2000	11	100.0%	100.0%	100.0%
Tributaries	MF Cottonwood Ck near Ono	2001–2002	2	100.0%	100.0%	100.0%
Tributaries	NF Cottonwood Ck at McCauliffe Rd	2001–2002	2	50%	100.0%	100.0%
Tributaries	SF Cottonwood Ck at Anderson Canal	2001–2002	2	100.0%	100.0%	100.0%
Tributaries	North Fork Battle Ck at Wildcat Road	2001–2002	2	100.0%	100.0%	100.0%
Tributaries	South Fork Battle Creek at Manton Road	2001–2002	2	100.0%	100.0%	100.0%
Tributaries	Battle Ck below Coleman Fish Hatchery	2001–2002	2	100.0%	100.0%	100.0%
Tributaries	Mill Creek at Highway 36	1998–2000	19	4.3%	20.2%	54.0%
Tributaries	Mill Creek at Black Rock	1998–2001	19	14.1%	46.2%	82.6%
Tributaries	Mill Creek at Highway 99	2001	4	1.6%	100.0%	100.0%
Tributaries	Mill Creek at Mouth	1998–2001	28	19.7%	54.6%	87.2%
Tributaries	Thomes Ck at Paskenta	2001–2002	2	50%	50%	100.0%
Tributaries	Thomes Ck at Henleyville	2002	1	0%	0%	0%
Tributaries	Thomes Ck at Rawson Rd Bridge	2002	1	0%	0%	100.0%

(Table continues on following page)

Table 6. Continued from previous page.

	Location	Years monitored	Number of samples	% of data meeting USEPA criteria for protection of human health: 1997 USEPA 3.1 ng/L Great Lakes Standard	1985 USEPA 12 ng/L Criterion	1999 USEPA 50 ng/L Criterion(1)
	Deer Creek below Childs Meadows	1998–2000	19	93.6%	100.0%	100.0%
	Deer Creek at Ponderosa Way	1998–1999	12	97.7%	100.0%	100.0%
	Deer Creek at Upper Diversion Dam	1998–2000	20	78.7%	100.0%	100.0%
	Deer Creek at Mouth	1998–2000	14	94.3%	100.0%	100.0%
	Big Chico Creek at Hwy 32	1998–2000	19	95.8%	100.0%	100.0%
	Big Chico Creek above Salmon Hole	1998–2000	16	88.5%	100.0%	100.0%
	Big Chico Creek at Chico (Rose Ave.)	1998–2000	19	92.0%	100.0%	100.0%
	Big Chico Creek above Mud Creek	1998–2000	21	78.1%	100.0%	100.0%
	Mud Creek above Big Chico Creek	1998–2000	11	58.5%	85.8%	97.6%
	Dry Creek above Cherokee Canal	2001–2002	3	28.2%	60.3%	100.0%
	Little Chico Creek below Chico	2002–2002	2	50%	50%	100.0%
	Cache Creek near Rumsey(2)	1996–1999	47	13.2%	37.7%	70.3%
	Cache Slough near Ryers Ferry(2)	1998–2000	11	5.2%	77.9%	100.0%
Ag Drain	Colusa Basin Drain above KL	1996–2002	49	6.8%	84.8%	100.0%
Ag Drain	Sacramento Slough(2)	1996–2002	46	3.4%	79.9%	100.0%
Ag Drain	Yolo Bypass near Woodland	1997–1998	10	0.1%	8.8%	69.9%
Urban Creek	Arcade Creek at Norwood Ave(2)	1996–2002	49	14.0%	70.2%	98.7%

(1) 50 ng/L is also the human health-based mercury objective adopted in the May 2000 California Toxics Rule

(2) Included on California 1998 303(d) list of impaired waterbodies, for mercury

2.2.2.2.2 Comparison with Fish Tissue Threshold Values

Fish tissue data from the SRWP monitoring effort at various locations were compared with fish tissue advisory values[3]. The concentrations of mercury accumulated in fish are known to be species specific, with predatory upper trophic level fish (e.g. Trophic Levels 3 and 4) having higher mercury concentrations. Additionally, concentrations of mercury are size- and age-dependent within a given species, with older, larger fish typically having higher mercury concentrations. (The process which produces these conditions is termed "biomagnification".) To control for these species-, age-, and size-dependent effects, SRWP fish tissue monitoring focused on mercury concentrations in individual fish and composite samples comprised of fish of similar legal catchable size. Where there were sufficient numbers of a particular species, tissue concentrations were plotted against length to illustrate this relationship (Figures 3 and 4, for largemouth bass and white catfish, respectively). Figure 5 presents data for individual samples for other species.

Average mercury concentrations are presented for each species and location in Table 8a. Average mercury concentrations are also summarized by waterbody type, species, and trophic level[4] in Table 8b, and the consumption-weighted average is provided for each waterbody type. The consumption-weighted average is an estimate of the average concentration of mercury for the total freshwater and estuarine fish consumed, and assumes that a combination of trophic level 3 and trophic level 4 fish are consumed. While the approach has not been adopted as official policy, USEPA Region 4 used this method for a TMDL developed for the Savannah River in Georgia, in which the consumption-weighted average was compared directly to the fish tissue-based water quality criterion for methylmercury (0.3 mg/kg) to evaluate whether a waterbody should be considered impaired (USEPA 2001b). The approach is also consistent with the development of the methylmercury criterion (USEPA 2001), which also assumes that fish consumed consist of a mix of different trophic level species. The consumption-weighted average mercury concentration is calculated as follows:

Consumption-Weighted Average = (57% x *Trophic Level 3 avg.*) + (43% x *Trophic Level 4 avg.*).

The percentages used for trophic levels 3 and 4 (TL3 and TL4) in this equation are based on assumptions used by USEPA in development of the methylmercury criterion, which assumed consumption of TL2, TL3, and TL4 species in proportions of 21.7%, 45.7%, and 32.6%, respectively (USEPA 2001). For the purpose of this analysis for the SRWP, it was assumed that no TL2 species were consumed and the TL2 percentage was apportioned equally between TL3 and TL4 species. It should be noted that the USEPA default consumption rates and TL3 and TL4 percentages may not be appropriate for

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[3] All SRWP fish tissue data presented are for edible fillets with skin off.

[4] "Trophic level" describes the position of a species in the food chain, determined by the number of energy-transfer steps to that level. Trophic level 3 fish consume primarily zooplankton and benthic invertebrates. Trophic level 4 fish preferentially consume trophic level 3 and lower trophic level fish species, as well as benthic invertebrates. Larger individuals of some primarily trophic level 3 species (e.g. trout) may be piscivorous and function at trophic level 4.

consumers in the Sacramento River watershed, and should ideally be adjusted based on site-specific consumption information. Fish consumption patterns for the Sacramento River watershed are currently being investigated by the Delta Tributaries Mercury Council of the SRWP. Additionally, although the consumption-weighted average should ideally be calculated separately for each waterbody, there were insufficient data to perform these calculations for each location and waterbody. However, species average concentrations were similar within each defined waterbody category, so grouping the locations within these broad waterbody categories appeared to provide characterizations that were also reasonable for the individual waterbodies.

Comparisons of tissue mercury concentrations to fish tissue advisory values are summarized below.

- A total of 15 fish species are represented in the data set, including seven trophic level 3 species and eight trophic level 4 species (Tables 8a and 8b). The average mercury concentrations for combined trophic level 3 species (0.10–0.19 mg/kg) were lower than the 0.3 mg/kg criterion for all waterbody categories sampled (Ag drains, tributaries, major tributaries, the Sacramento River from Keswick to the I Street Bridge, and Delta sites including Cache Slough and the Sacramento River at Mile 44 below I Street Bridge). Average mercury concentrations calculated individually for each of the seven trophic level 3 species (57 total samples) were also below 0.3 mg/kg for all locations and waterbody categories, with the exception of a single splittail sample (0.37 mg/kg) collected from Sacramento River at Mile 44.
- The average mercury concentrations for combined trophic level 4 species (0.30–0.88 mg/kg) were equal to or greater than the 0.3 mg/kg criterion for every waterbody category sampled. Average mercury concentrations calculated individually for each of the eight trophic level 4 species (208 total samples) were greater than 0.3 mg/kg for most locations and waterbody categories, with the following exceptions: Sacramento pikeminnow in the Sacramento River mainstem from Bend Bridge to River Mile 44, white catfish and crappie in Colusa Basin Drain, white catfish in Natomas East Main Drain and Putah Creek, and smallmouth bass in Chico Creek and Deer Creek all had average mercury concentrations lower than 0.3 mg/kg.
- Average mercury concentrations in fish tissue exceeded the USEPA criterion (0.3 mg/kg) in largemouth bass from all waterbody types and locations sampled, and average concentrations in white catfish exceeded the USEPA criterion in seven of nine sites sampled (Table 8, Figures 3 and 4). These two species were collected from lower Sacramento River and Delta sites, agricultural drains, and major and lesser tributaries from Keswick to Cache Slough.
- Most largemouth bass collected also exceeded the USEPA 1996 Screening Value (0.6 mg/kg), and a number of individual largemouth bass collected from the American River, Feather River, the Sacramento River at River Mile 44, and from Cache Slough exceeded the FDA Action Level of 1.0 mg/kg (Figure 4).
- All striped bass sampled (n = 8) exceeded the 0.3 mg/kg criterion (Figure 5). Striped bass exhibited the highest average mercury concentration (1.2 mg/kg) for any species sampled, and included the highest mercury concentration of any sample (3.5 mg/kg)

for a single large individual fish (~33 inches long) collected from the Feather River at Nicolaus.

- Consumption-weighted average mercury concentrations were highest (0.48 mg/kg) for the two major tributaries sampled (American River and Feather River), and also equaled the 0.3 mg/kg criterion for the two Delta locations sampled (0.30 mg/kg, Sacramento River at Mile 44 and Cache Slough). Consumption-weighted averages were lower than the 0.3 mg/kg criterion for smaller tributaries (0.20 mg/kg), the Sacramento River from Keswick to the "I" Street Bridge (0.25 mg/kg), and the two agricultural drains (0.28 mg/kg, Colusa Basin Drain and Sacramento Slough).

Table 7. Criteria and Screening Values for Mercury in Fish Tissue

Basis for limit	Criterion or Screening Value[1], mg/kg	RfD (µg/kg/day)	Body Weight (kg)	Consumption Rate (kg/day)	Reference
Human Health	1.0	0.47	60	0.0284	FDA Action Level[2] (vm.cfsan.fda.gov/~dms/)
	1.0	0.3	60	0.018	ATSDR 1999 (www.atsdr.cdc/gov/press/ma990419.html)
	0.6	0.06	60	0.065	USEPA Screening Value (USEPA 1995)
	0.33	0.1	60	0.018	Mercury Report to Congress, Vol. VI (USEPA 1997)
	0.14	0.06	70	0.030	SFRWQCB Screening Value (SFRWQCB 1995)
	0.23	0.1	70	0.030	OEHHA and SFEI Screening Value (OEHHA 1999, SFEI 1999)
	0.3	0.1	70	0.0175	Ambient Water Quality Criterion for Human Health (USEPA 2001)
Wildlife[4]	0.08 0.34	Hg criterion in trophic level 3 fish Hg criterion in trophic level 4 fish (See USEPA 1997 for calculations)			Mercury Report to Congress, Vol. VI (USEPA 1997)

(1) Expressed as mg/kg wet weight Values are calculated as (RfD x Body Weight) ÷ Consumption Rate.
(2) The FDA Action Level is intended to apply only to commercially caught fish, and not to locally-caught or sport fish.
(3) The USEPA 2001 criterion also assumes that a specific proportion of 3 trophic levels of fish are consumed—.0038 kg/day Trophic Level 2 (21.7%), .0080 mg/day Trophic Level 3 (45.7%), and .0057 kg/day Trophic Level 4 fish (32.6%).
(4) Lowest average criterion, based on the average for all mammalian wildlife species studied in Mercury Report to Congress.

Table 8a. Mercury in Fish Tissue, Average Species Concentrations by Location

Waterbody Type	Location	Species	Hg concentrations in fish tissue, mg/kg, wet weight		
			Count	Mean	Std. Dev.
Ag Drains	Colusa Basin Drain	Carp	3	0.151	0.040
		Crappie	1	0.080	•
		White Catfish	2	0.258	0.066
	Natomas East Main Drain	Largemouth Bass	3	0.645	0.041
		Striped Bass	1	0.808	•
		White Catfish	2	0.248	0.053
	Sacramento Slough	Largemouth Bass	3	0.480	0.034
		White Catfish	3	0.506	0.115
Delta (below I Street Bridge)	Cache Slough	Carp	1	0.107	•
		Crappie	1	0.315	•
		Largemouth Bass	18	0.708	0.290
		Sacramento Sucker	1	0.107	•
		White Catfish	21	0.497	0.193
	Sacramento R. at Mile 44	Bluegill	1	0.103	•
		Largemouth Bass	27	0.869	0.303
		Pike Minnow	2	0.147	0.046
		Sacramento Sucker	1	0.221	•
		Smallmouth Bass	1	0.570	•
		Striped Bass	1	0.343	•
		Sacramento Splittail	1	0.370	•
		White Catfish	30	0.404	0.240
Lower Sac. R. Mainstem	Sacramento R. above Bend Bridge	Pike Minnow	1	0.119	•
		Rainbow Trout	2	0.037	0.008
		Sacramento Sucker	1	0.103	•
	Sacramento R. at Colusa	Carp	1	0.186	•
		Pike Minnow	2	0.224	0.108
		Sacramento Sucker	1	0.059	•
		Striped Bass	1	0.303	•
	Sacramento R. at Veterans Br	Largemouth Bass	2	0.888	0.099
		Pike Minnow	1	0.251	•
		Sacramento Sucker	1	0.098	•
		White Catfish	2	0.384	0.239
	Sacramento R. below Keswick	Rainbow Trout	4	0.035	0.002
	Sacramento R. near Hamilton City	Pike Minnow	2	0.253	0.052
		Sacramento Sucker	1	0.030	•

Table continues on following page…

Table 8a. Mercury in Fish Tissue, Average Species Concentrations by Location

(Continued from previous page)

Waterbody Type	Location	Species	Hg concentrations in fish tissue, mg/kg, wet weight: Count	Mean	Std. Dev.
Major Tributaries	American R. at Discovery Park	Largemouth Bass	3	1.198	0.301
		Pike Minnow	2	0.419	0.002
		Redear Sunfish	2	0.191	0.157
		Sacramento Sucker	2	0.298	0.073
		White Catfish	2	0.393	0.185
	American R. at J Street	Largemouth Bass	1	0.659	•
		Pike Minnow	2	0.485	0.084
		Sacramento Sucker	2	0.092	0.010
	American R. at J Street	Sacramento Sucker	1	0.200	•
	Feather R. near Nicolaus	Bluegill	1	0.121	•
		Channel Catfish	1	0.729	•
		Largemouth Bass	29	0.812	0.496
		Pike Minnow	3	0.805	0.344
		Redear Sunfish	1	0.220	•
		Sacramento Sucker	1	0.280	•
		Striped Bass	5	1.595	1.172
		White Catfish	10	0.702	0.315
	Feather R. above Bear River	Redear Sunfish	1	0.100	•
		Sacramento Sucker	1	0.270	•
Tributaries	Big Chico Ck @ Hwy 32	Rainbow Trout	2	0.042	0.002
	Big Chico Ck @ Hwy 99	Riffle sculpin	1	0.146	•
		Smallmouth bass	1	0.231	•
	Big Chico Ck near mouth	Largemouth Bass	1	0.331	•
		Pike Minnow	1	0.484	•
	Clear Ck @ Hwy 273	Riffle sculpin	1	0.241	•
	Clear Ck @ Reading Bar	Rainbow Trout	1	0.046	•
		Riffle sculpin	1	0.160	•
	Clear Ck above Whiskeytown	Rainbow Trout	1	0.050	•
		Riffle sculpin	2	0.102	0.008
	Clear Creek at Mouth	Largemouth Bass	1	0.452	•
		Rainbow Trout	1	0.046	•
	Deer Ck @ Hwy 99	Riffle sculpin	1	0.082	•
		Smallmouth bass	1	0.075	•
	Deer Ck below Childs Meadow	Riffle sculpin	1	0.034	•
	McCloud R. above Shasta	Rainbow Trout	1	0.053	•
	Mill Ck at Black Rock	Riffle sculpin	1	0.327	•
	Mill Ck at Hwy 99	Riffle sculpin	1	0.279	•
	Pit R. above Shasta	Rainbow Trout	1	0.047	•
	Putah Creek	Bluegill	6	0.118	0.037
		Largemouth Bass	17	0.433	0.187
		Sacramento Sucker	1	0.185	•
		White Catfish	1	0.146	•
	Sacramento R. above Shasta	Rainbow Trout	2	0.060	0.004
	Upper Putah Creek	Brown Trout	1	0.056	•

Table 8b. Mercury in Fish Tissue, Summarized by Waterbody Type and Trophic Level

Waterbody Type	Species	Trophic Level(1)	Count	Hg concentrations in fish tissue, mg/kg, wet weight: Mean	Std. Dev.	Species-weighted trophic level averages(2)	Consumption-weighted Avg(3)
Ag drains (Sacramento Slough, Colusa Drain, Natomas East Main Drain)	Carp	3	3	0.15	0.04	0.15	0.28
	Crappie	4	1	0.08	•	0.45	
	Largemouth bass	4	6	0.56	0.096		
	Striped bass	4	1	0.81	•		
	White catfish	4	7	0.36	0.155		
Tributaries (Sac. R. above Shasta, Pit River, McCloud River, Clear Ck, Mill Ck, Deer Ck, Big Chico Ck, Putah Ck,)	Bluegill	3	6	0.12	0.037	0.11	0.20
	Brown trout	3	1	0.06	•		
	Rainbow trout	3	9	0.05	0.007		
	Riffle sculpin	3	9	0.16	0.098		
	Sacramento sucker	3	1	0.19	•		
	Largemouth bass	4	19	0.43	0.178	0.30	
	Pikeminnow	4	1	0.48	•		
	Smallmouth bass	4	2	0.15	0.11		
	White catfish	4	1	0.15	•		
Major tributaries (Feather River and American River)	Bluegill	3	1	0.12	•	0.17	0.48
	Redear sunfish	3	4	0.18	0.104		
	Sacramento sucker	3	7	0.22	0.098		
	Channel catfish	4	1	0.73	•	0.88	
	Largemouth bass	4	33	0.84	0.484		
	Pikeminnow	4	7	0.60	0.277		
	Striped bass	4	5	1.60	1.172		
	White catfish	4	12	0.65	0.314		
Lower Sac. R. Mainstem (Keswick to "I" Street Bridge)	Carp	3	1	0.19	•	0.10	0.25
	Rainbow trout	3	6	0.04	0.004		
	Sacramento sucker	3	4	0.07	0.034		
	Largemouth bass	4	2	0.89	0.099	0.45	
	Pikeminnow	4	6	0.22	0.074		
	Striped bass	4	1	0.30	•		
	White catfish	4	2	0.38	0.239		
Delta (Sac. River below "I" Street Bridge, and Cache Slough)	Bluegill	3	1	0.10	•	0.19	0.30
	Carp	3	1	0.11	•		
	Sacramento sucker	3	2	0.16	0.081		
	Sacramento splittail	3	1	0.37	•		
	Crappie	4	1	0.32	•	0.44	
	Largemouth bass	4	45	0.80	0.305		
	Pikeminnow	4	2	0.15	0.046		
	Smallmouth bass	4	1	0.57	•		
	Striped bass	4	1	0.34	•		
	White catfish	4	51	0.44	0.224		

(1) Trophic level 3 fish consume primarily zooplankton and benthic invertebrates. Trophic level 4 fish preferentially consume trophic level 3 and lower trophic level fish species, as well as benthic invertebrates. Larger individuals of some primarily trophic level 3 species (e.g. trout) may be piscivorous and function at trophic level 4.

(2) The average mercury concentration for each trophic level, calculated as the average of mercury concentrations for each species in the trophic level.

(3) The average mercury concentration for total freshwater and estuarine fish consumed, as described in the Total Maximum Daily Load (TMDL) for Total Mercury in Fish Tissue Residue in Lake Bennett (USEPA 2001b). The consumption-weighted average is calculated as follows: *Consumption-Weighted Average* = (56.6% x *Trophic Level 3 avg.*) + (43.4% x *Trophic Level 4 avg.*).

2.2.2.3 What do the results say about attainment of beneficial uses and potential impairment, and how does this compare with any relevant 303(d) listings for parameter and sites?

The beneficial uses at greatest potential risk from elevated mercury concentrations are wildlife protection and human health protection related to the consumption of fish, and therefore fish tissue concentrations are considered the best available indicator of potential impairment. An interim sport fish consumption advisory is currently in effect for the San Francisco Bay and Delta Region for elevated concentrations of mercury and other chemicals. Sport fish consumption advisories are also in effect for elevated mercury concentrations in fish in Clear Lake and Lake Berryessa, and more fish consumption advisories have been issued at the County Health Department level for foothill reservoirs on both sides of the watershed. The California Office of Environmental Health and Hazard Assessment (OEHHA) has also issued an interim advisory and consumption guidance for Black Butte Reservoir, in the Stony Creek Watershed. Based on these advisories (which recommend limiting consumption of specific sizes and species of fish), the local sportfishing beneficial use has been described by the Regional Board and SWRCB as impaired in the Bay, in the Delta, and in Clear Lake and Lake Berryessa.

A number of both mainstem and tributary reaches in the Sacramento River watershed are included for mercury on the California 1998 303(d) list (Table 9). The Central Valley Regional Water Quality Control Board (CVRWQCB) has also recommended the addition of ten new waterbodies for the 2002 update to the 303(d) list (CVRWQCB 2003), including Black Butte Reservoir and five reservoirs in the Sierra Nevada foothills. It should be noted that the CVRWQCB used a more conservative approach to determine impairment than used by USEPA to develop the methylmercury criterion or the Savannah River TMDL (USEPA 2001, 2001b). The CVRWQCB compared average concentrations only in trophic level 4 species with the 0.3 mg/kg USEPA criterion, and considered trophic level 3 species only when there were “limited” data for trophic level 4 fish. With only one exception, all of the current and recommended 303(d) listings for mercury are based on elevated concentrations of mercury in fish tissue, and mining activity (resource extraction) is cited as the major source of mercury.

With the exception of Cache Creek, the waterbodies included on the 303(d) list had a fairly high frequency of compliance with the CTR criterion of 50 ng/L (97-100%) and the USEPA 1985 criterion of 12 ng/L (>70%) for total mercury concentrations in water. Conversely, with the exceptions of the Sacramento River at Hamilton City and the American River at Discovery Park, 303(d)-listed waterbodies had very low rates of compliance (less than 25%) with the Great Lakes 3.1 ng/L human health objective for mercury in water. Fish tissue data indicated that concentrations of mercury in trophic level 4 species (particularly largemouth bass, white catfish, and striped bass) frequently exceed screening values at a number of locations in the lower watershed. Based on comparisons of consumption-weighted average tissue mercury concentrations to the recently-adopted 0.3 mg/kg USEPA criterion, SRWP fish tissue data generally support the need for fish consumption advisories already in effect for the lower American River, the lower Feather River, and Sacramento Slough, and indicate that advisories should be evaluated for two additional agricultural drains (Colusa Basin Drain and Natomas East

Main Drain). These same data also indicate that potential health risks are lower for the Sacramento River mainstem from Keswick to River Mile 44 (which is technically in the Delta) and for most smaller tributaries throughout the watershed, for consumers of a mix of trophic level 3 and 4 fish. Potential health risks are of course higher for individuals consuming higher than average amounts of fish, or for those consuming primarily trophic level 4 species (especially largemouth bass, white catfish, or striped bass[5]). However, because the USEPA criterion for methylmercury includes substantial margins of safety, moderate differences in the rates of consumption and percentages of TL3 and TL4 species would not result in greatly increased risks. Potential risks will also vary for specific waterbodies within each waterbody category, but these differences are expected to be relatively small since mercury concentrations were generally similar in fish from the different locations monitored within each category.

Based in part on SRWP fish tissue data, the CVRWQCB's recommended update to the 2002 303(d) list includes a recommendation to change the upstream limit of the mercury-impaired reach of the mainstem Sacramento River from Red Bluff to Knight's Landing and to reduce the total mercury-impaired length from 30 to 16 miles of river. Based on guidance from OEHHA, the available fish tissue data from the SRWP are not yet sufficient to support additional consumption advice from OEHHA in the Sacramento River watershed. However, SRWP fish tissue data for the lower Sacramento River watershed and the recommended addition of ten waterbodies to the 303(d) list for mercury in fish tissue by the Regional Board clearly indicate a need to further evaluate potential human health and wildlife concerns in these waterbodies. The SRWP is continuing to investigate these concerns with fish tissue monitoring performed in the fall of 2002. Agencies participating in the SRWP are also applying for grant funds to perform more extensive fish tissue monitoring in the Sacramento River watershed for this purpose.

[5] The current fish consumption advisory for San Francisco Bay and Delta waterways is specifically for mercury concentrations in striped bass.

Table 9. Waterbodies Listed For Mercury On the California 1998 303(d) List or Recommended for Addition or Revision for the 2002 303(d) List

Waterbody	Listed Source of Mercury	**2.2.2.4** Area Affected		Fish Advisory	303(d) List
Delta Waterways	Resource Extraction	480000	Acres	Yes	1998
Berryessa Lake	Resource Extraction	20700 (19083[3])	Acres	Yes	1998
Clear Lake	Resource Extraction	43000 (40070[3])	Acres	Yes	1998
Davis Creek Reservoir	Resource Extraction	290 (163[3])	Acres	No	1998
Marsh Creek Reservoir	Resource Extraction	375	Acres	No	1998
American River, Lower	Resource Extraction	23 (27[3])	Miles	No	1998
Cache Creek	Resource Extraction	35 (96[3])	Miles	No	1998
Feather River, Lower	Resource Extraction	60 (42[3])	Miles	No	1998
Harley Gulch	Resource Extraction	8 (6[3])	Miles	No	1998
Humbug Creek	Resource Extraction	9 (2.2[3])	Miles	No	1998
James Creek	Resource Extraction	6	Miles	No	1998
Sacramento River (Knight's Landing To Delta[3])	Resource Extraction	30 (16[3])	Miles	No	1998
Sacramento Slough	Source Unknown	1 (1.7[3])	Miles	No	1998
Sulfur Creek	Resource Extraction	7 (14[3])	Miles	No	1998
Bear Creek	Resource Extraction	15	Miles	No	2002[(3)]
Upper Bear River	Resource Extraction	10	Miles	IPHN[(1)]	2002[(3)]
Black Butte Reservoir	Resource Extraction	4,500	Acres	Yes[(2)]	2002[(3)]
Camp Far West Reservoir	Resource Extraction	1,945	Acres	IPHN[(1)]	2002[(3)]
Lake Combie	Resource Extraction	362	Acres	IPHN[(1)]	2002[(3)]
Lake Englebright	Resource Extraction	754	Acres	IPHN[(1)]	2002[(3)]
Little Deer Creek	Resource Extraction	4	Miles	IPHN[(1)]	2002[(3)]
Lower Putah Creek	Resource Extraction	28	Miles	No	2002[(3)]
Rollins Reservoir	Resource Extraction	774	Acres	IPHN[(1)]	2002[(3)]
Scotts Flat Reservoir	Resource Extraction	660	Acres	IPHN[(1)]	2002[(3)]

(1) Interim Public Health Notification issued by Placer, Nevada, and Yuba counties.
(2) Draft Advisory issued by OEHHA, 2000.
(3) Recommended revision or addition for California 303(d) 2002 list update by the Central Valley Regional Board (CVRWQCB 2003)

2.2.3 Spatial Distributions & Patterns

This evaluation is based primarily on water quality data for the 2000-2002 monitoring period. The complete data set and specific monitoring periods for each location are summarized in Appendix A (Summary Statistics). Fish tissue data reviewed in this section are also presented in Appendix A.

2.2.3.1 Water Column

Water column total mercury concentrations in the mainstem Sacramento River generally increased with distance downstream from the Keswick Reservoir discharge (Figure 6). A significant proportion of the increase occurred between Keswick and Colusa, with approximately a four-fold increase in median concentrations (from 0.7 ng/L to 2.7 ng/L) measured for the 2000-2002 monitoring period. Median total mercury concentrations in the mainstem below Colusa increased more moderately to the Sacramento below the confluence with the Feather River (by about 50%), and decreased slightly below the American River confluence. In the Sacramento River below the American River confluence, there was no apparent trend in total mercury concentrations (Sacramento River at Freeport, River Mile 44, and Greene's Landing).

Total mercury concentrations at the mouth of the Feather River system were midway between those in the Sacramento River at Colusa and Veterans Bridge. Concentrations in the Yuba and American rivers were much lower than either the Sacramento or Feather rivers. Total mercury concentrations in Arcade Creek, and the two agricultural drains monitored were substantially higher than concentrations anywhere in the mainstem Sacramento River. Concentrations in Mill Creek were substantially higher than the observed in the Sacramento River upstream from the confluence. SRWP special studies conducted in 2000 by USGS (Domagalski 2000) and in 2001 by Pacific Ecorisk to identify potential sources of the observed increase in mercury between Red Bluff and Colusa confirmed that Mill Creek was a significant source of mercury during some storm events. The USGS study concluded that there were also other significant sources of mercury in this stretch of the river. It was determined that Elder Creek (on the West side of the valley) and Antelope Creek (on the East side of the valley) were probably not significant sources. Thomes Creek was identified as a potentially significant source of mercury by this study. A single SRWP monitoring event collected in 2001-2002 under relatively high flow conditions indicates that Thomes Creek can contribute a substantial proportion of the total mercury load in the Sacramento River above Hamilton City. Battle Creek and Cottonwood Creek were also monitored in 2001-2002 (n=2 events). Although data are limited, these results suggest that Cottonwood Creek may be responsible for a substantial proportion of the increase in mercury concentrations observed in the Sacramento River between Keswick and Bend Bridge. Mercury concentrations in Battle Creek were very low for the events monitored (similar to concentrations typical for the Sacramento River below Keswick). As noted above, data are still very limited for these three tributary watersheds and the relative importance of loads from these watersheds should be confirmed through additional monitoring in 2002-2003.

Total methylmercury concentrations measured in the mainstem Sacramento River by SRWP in 2000-2002 exhibit a similar spatial distribution pattern to that for total mercury (compare Figures 6 and 7). Median unfiltered methylmercury concentrations in the mainstem Sacramento River also exhibited a dramatic (more than six-fold) increase from less than 0.02 ng/L below Keswick to .12 ng/L at Veterans Bridge. An interesting deviation from the pattern observed for total mercury was observed in the Sacramento River below the American River confluence. A similar decrease was observed below the American River confluence for the Sacramento River at Freeport, but methylmercury concentrations appeared to increase substantially at River Mile 44, and then decrease again at Greene's Landing to below concentrations at Freeport. While the influence of the Sacramento Regional Wastewater Treatment Plant below Freeport may explain some of the increase in methylmercury at River Mile 44, there is no obvious explanation for the observed decrease at Greene's Landing in 2000-2001 (Greene's Landing was not monitored by SRWP in 2001-2002).

Methylmercury data for the tributaries to the Sacramento River exhibit patterns that differ somewhat from total mercury concentrations. Because methylmercury is a non-conservative pollutant (i.e. mass is not necessarily conserved in the form of methylmercury due to methylation and demethylation processes), source assessments based on apparent differences in concentration must be made with caution. However, it is interesting to note that nearly all of the increase observed in Sacramento River mainstem methylmercury concentrations occurs before confluences with the major tributaries. Additionally, methylmercury concentrations observed in the Feather and Yuba Rivers were not high enough to account for increases below the confluence with the Feather River. Methylmercury concentrations in the Yuba and Feather River were similar to those in the Sacramento River above the confluence with the Feather River, while concentrations in the lower American River were still well below concentrations above its confluence with the Sacramento River. In Cottonwood Creek, Battle Creek, Mill Creek and Thomes Creek watersheds (for the few events sampled), there were two notable patterns: (1) methylmercury concentrations increased substantially towards the lower reaches of each watershed, and (2) concentrations were higher in the mouths of these tributaries than in the Sacramento River at each confluence. Methylmercury concentrations were also higher in Sacramento Slough, Colusa Basin Drain, and Arcade Creek (concentrations approximately 50% to more than 100% those measured in the mainstem). Although the flows from these sources are relatively small compared to the mainstem, cumulatively, these sources may account for a substantial proportion of the increase in mainstem methylmercury concentrations and loads. However, increases observed in mainstream methylmercury concentrations are likely at least partially due to methylation of instream mercury sources in the Sacramento River.

2.2.3.2 Fish Tissue

Fish tissue samples (typically consisting of composites of five fish each) were collected from 29 locations ranging from the Sacramento River above Lake Shasta to Cache Slough (near Rio Vista) in the Delta (Figure 5). Fish were collected during the months of September and October from 1997 to 2001. A total of 15 fish species have been sampled, including seven trophic level 3 species and eight trophic level 4 species. It should be noted that mercury concentrations in fish tissue are dependent not only on water column concentrations of bioavailable mercury, but also on the productivity of the waterbody (e.g. oligotrophic vs. eutrophic) and the trophic level, feeding patterns, and age of the fish. For this reason, mercury concentrations in trophic level 3 species (e.g. rainbow trout), should not be directly compared with concentrations in trophic level 4 species (e.g. largemouth bass) as a means of inferring spatial differences in levels of bioavailable mercury. Examination of the average tissue mercury concentrations for each trophic level (Table 8) provides a less biased view of regional patterns in fish tissue concentrations.

Spatial patterns in average mercury concentrations for each trophic level are generally similar to the patterns discussed previously for consumption-weighted averages. The average tissue mercury concentration for trophic level 4 species was highest for the two major tributaries (Feather River and American River), and concentrations in trophic levels 3 and 4 were lowest in smaller tributaries. Average tissue mercury concentrations in trophic level 3 species were generally similar in agricultural drains, major tributaries, and the two Delta locations. Average tissue mercury concentrations in trophic level 4 species were highest in the major tributaries and were lower by about a factor of two in the lower Sacramento River mainstem (from Keswick to the "I" Street Bridge), the two Delta sites (Sacramento River at Mile 44 and Cache Slough), and in the two agricultural drains (Colusa Basin Drain and Sacramento Slough).

This pattern in fish tissue concentrations exhibits at least one interesting contrast with the spatial pattern observed for the water column mercury and methylmercury concentrations—in 2000-2002 mercury and methylmercury concentrations in the Feather and American rivers were generally lower than or similar to concentrations observed in the mainstem, while average fish tissue mercury concentrations were approximately twice as high in the two tributary locations as in the mainstem Sacramento River. Because the mercury concentrations in fish tissue integrate bioavailable mercury concentrations in water over a period of several years, these results suggest two possibilities: (1) that the pattern observed in water column concentrations of total mercury and methylmercury in 2000-2002 may not be representative of typical conditions over a longer period, or (2) that variation in water column concentrations of total mercury and methylmercury are not the single most important factor controlling fish tissue mercury concentrations. Although most of the fish species sampled were selected because they are not highly migratory, a third hypothesis that can not be ruled out based on these results is that the fish or their prey accumulated high mercury concentrations from locations other than where they were caught.

2.2.4 Temporal Distribution & Patterns

Unfiltered total mercury concentrations in the water column exhibit strong seasonal patterns in the mainstem Sacramento River and major tributaries. Concentrations of total mercury typically peak following early wet season precipitation and with increased river flows of the early wet season (typically in November-December), and then decrease steadily through the remainder of the year. In general, this pattern is consistent with the seasonal mobilization of fine-grained particulates in river sediments and runoff deposited during the dry season and during lower stream flows. Mercury tends to adsorb to fine grained sediments, leading to the close correlation between sediment transport and mercury transport phenomena. This pattern appears to be consistent at all the mainstem Sacramento River sites monitored between Redding and River Mile 44, and in the major tributaries in the lower watershed (the Feather River, Yuba River, and American River). This pattern is less distinct for total mercury concentrations in the agricultural drainage-dominated Colusa Basin Drain and Sacramento Slough.

Methylmercury concentrations exhibited less distinct and more variable seasonal patterns throughout the watershed in 2000-2002 (Figure 8). At most locations, water column concentrations of unfiltered methylmercury exhibited only a moderate increase during the early wet seasons (Fall 2000 and 2001). The most consistent temporal trend observed in the 2000-2002 data was the two- to five-fold increase in methylmercury that was observed for all three major tributary locations, but most dramatically for the Feather and Yuba rivers. This did not coincide with a comparable increase in methylmercury concentrations in the lower Sacramento river mainstem, which exhibited an early wet season peak in the fall of 2002, but no notable increase during the spring of 2001. Longer-term patterns in methylmercury concentrations in the Sacramento River at Freeport exhibit a slightly more consistent pattern of increased concentrations in the early wet season with peaks often occurring from January through March, followed by a steep decline through October (Figure 9). Probable causes of temporal variations in Sacramento River methylmercury include seasonal mobilization of total mercury, increased methylation due to seasonal water temperature changes, or increased inflows of methylmercury from tributaries. Continuing methylmercury monitoring by the SRWP monitoring program and several CALFED-funded projects are expected to provide additional information to address this question.

Seasonal variation in unfiltered methylmercury concentrations are illustrated in Figure 8 for selected SRWP locations monitored 2000-2002. Longer-term patterns in seasonal variation in unfiltered total mercury and methylmercury concentrations are illustrated for the Sacramento River at Freeport in Figure 9 for 1996 through 2002. Time series plots of water column mercury and methylmercury concentrations are also presented in Appendix B of this report.

2.2.5 Mass Load Comparisons

Evaluations of mass load sources within the Sacramento River watershed and from other major Delta tributaries are currently being performed as part of the Strategic Plan being developed by the Delta Tributaries Mercury Council (DTMC) for management of mercury in the Delta and Sacramento River. This information is vital to development of pollutant management strategies and Total Maximum Daily Loads (TMDLs). It should be noted that mass loads are not direct indicators of water quality or predictors of instantaneous concentrations of mercury in water or in fish tissue.

The results of previous assessments of mass load contributions to the Delta (SRWP 2000, 2001) highlighted the dominance of the Sacramento River watershed with respect to total riverine flows and mercury inputs to the Delta—approximately 90% of estimated total average total mercury loads are from the Sacramento River and Yolo Bypass. In years with relatively high annual flows, such as 1998, loads from the Yolo Bypass and the

Cache Creek watershed are estimated to exceed the loads from the rest of the Sacramento River watershed. Within the Cache Creek watershed, mercury loads from the Superfund mine site at Clear Lake do not appear to contribute a significant proportion of the total mercury loads from the Cache Creek watershed. Evidence compiled by the Delta Tributaries Mercury Council from their Strategic Plan for Mercury in the Sacramento River Watershed (www.sacriver.org/subcommittees/dtmc/documents.html) indicate that erosion of native soils with naturally-elevated mercury concentrations is the predominant source of mercury loads from the highly erosive Cache Creek drainage, which have been estimated to be greater than 200 kg in wet years. On average, only about 5 kg of mercury is estimated to be discharged from Clear Lake annually (CVRWQCB 2001). Although the available data for the San Joaquin River and the Mokelumne River are still very limited, the low annual flows (in comparison to the Sacramento River flows) and moderate mercury concentrations in these rivers suggest that these inputs are responsible for a relatively low percentage of total mercury inputs to the Delta (less than 10% for the San Joaquin River and Mokelumne River, combined). These estimates are intended only to provide a semi-quantitative comparison of the relative magnitude of the major Delta inputs, and are not intended to be definitive estimates of actual loads. Because these estimates are based on limited data and long-term average flows, they do not fully account for the seasonal spikes in mass loadings that typically occur during peak streamflow events, and may therefore underestimate total mercury loads to the Delta. It should also be noted that estimates of mass loads of *total* mercury provide little direct information regarding causes of excessive mercury bioaccumulation in the Delta, primarily because total mercury concentrations are not closely related to concentrations of bioavailable mercury.

As part of the Strategic Plan for mercury controls (DTMC and SRWP 2002), the DTMC has analyzed a variety of data sources in addition to mercury concentration and flow data to develop load models for the Sacramento River watershed. The DTMC has evaluated land use characteristics, density of mercury and gold mines, and several other measures of factors useful in relating load estimates for specific sources and tributary watersheds to loads in the Sacramento River mainstem. The goal of this process is to estimate known background loads and source loads, and to compute discrete contributions from controllable sources. Results of the DTMC evaluations indicate that total mercury loads double (approximately) in the mainstem between Hamilton City and Colusa, and double again between Colusa and the Sacramento River below the confluence with the Feather River. The largest increase in methylmercury load in the mainstem Sacramento River is estimated to occur between Hamilton City and Veterans Bridge, increasing the load approximately six-fold in this reach. The Feather River is estimated to represent approximately one-fifth of the methylmercury load at Veterans Bridge. The results of the DTMC evaluations don't indicate any single outstanding source of mercury or methylmercury loads to the Sacramento River, but instead suggest that loads in mainstem increase throughout the river's length. This assessment is consistent with the patterns described for spatial variability of total mercury and methylmercury water column concentrations. Major sources of total mercury loads include erosion of native soils, and geothermal springs, which appear to represent significant proportions of the total loads, in addition to the major anthropogenic source (runoff and erosion from historic gold mine sites). Other minor sources of mercury mass loads include treated municipal and industrial wastewater, atmospheric deposition, historic mercury mines, and urban runoff. The Strategic Plan estimates that a substantial proportion (up to 39%) may be from sources as yet unknown.

2.2.6 Conclusions and Recommendations

Mercury concentrations in fish tissue collected from 1997 to 2001 from the mainstem Sacramento River below Shasta Reservoir and major tributaries to this section of the river were higher than several of the human health-based and wildlife-based advisory and screening values. Frequent exceedances of the tissue-based water quality criterion for mercury recently developed by the USEPA (0.3 mg/kg) and adopted by the California Office of Health Hazard Assessment (OEHHA), and less frequent exceedance of the previous USEPA screening value of 0.6 mg/kg, indicate that there are human health concerns associated with consumption of some fish species from the lower Sacramento River watershed. The current water quality USEPA criterion of 0.3 mg/kg is based on a fish consumption rate of 17.5 g/day (equivalent to 4 quarter-pound servings per month). There is some disagreement whether the available data are adequate to warrant issuing fish consumption advisories, based on the fact that OEHHA has not issued advisories for these waters, while the Central Valley Regional Water Quality Control Board has recommended addition of a number of waterbodies to California's 303(d) list based on the same available data. Interim Public Health Notices have also been issued by Placer, Yuba, and Nevada counties for eight Sierra foothill waterbodies based on the same data used by the Regional Board. Although there is substantial uncertainty regarding the level of risk posed by these concentrations of mercury in fish, there is agreement that the risks are greatest for small children and pregnant women, and that the risks increase with greater consumption of fish. General consumption guidelines are provided by OEHHA on their web page (http://www.oehha.org), in addition to consumption advisories for specific waterbodies. Concerns over mercury in fish from the lower Sacramento River watershed are being addressed with continued monitoring being performed for 2002-2003 (Years 4 and 5). This shift in focus is in large part a result of coordination and consultation with OEHHA, which has been an active participant in the SRWP, and has provided the SRWP with guidance regarding data needs and study design for evaluation of human health risks related to fish consumption.

Other conclusions of this review of mercury monitoring data can be summarized as follows:

- Consumption-weighted average mercury concentrations in tissues of fish collected from the Sacramento River mainstem from Keswick to the Delta, in smaller tributaries, and in three agricultural drains were equal to or lower than USEPA human health-based criterion of 0.3 mg/kg. However, in almost all trophic level 4 species collected throughout the watershed, average mercury concentrations were higher than the 0.3 mg/kg criterion, and were frequently two to three times higher than this criterion.
- Consumption-weighted average mercury concentrations in fish tissue collected from the lower American River and Feather River were higher than USEPA human health-based criterion of 0.3 mg/kg. Exceedance of the criterion indicates that there are

potential risks to “average” human consumers associated with consumption of fish from these waterbodies.

- Total water column mercury concentrations in the Sacramento River from Keswick to River Mile 44 rarely exceeded the CTR mercury criterion of 50 ng/L(USEPA 2000). Total mercury concentrations exceeded the 50 ng/L limit in 30% of Cache Creek samples and 46% of samples from the upper Mill Creek watershed. The Feather and Yuba rivers are significant sources of mercury loads, but concentrations of total mercury and methylmercury were not elevated compared to the Sacramento River mainstem in 2000-2002. However, relatively high concentrations of mercury in fish from the lower Feather River and American River suggest that (1) these watersheds may have been significantly elevated sources of bioavailable methylmercury in previous years, or (2) factors other than methylmercury concentrations are significantly affecting bioaccumulation, or (3) that fish may be accumulating mercury from other locations. Spring Creek in the upper Sacramento River watershed, Battle Creek, Deer Creek, Big Chico Creek, and the American River did not appear to be major sources of total mercury—concentrations were low compared to the Sacramento River and were never observed to exceed the 50 ng/L CTR criterion at these sites. Preliminary results indicate that Cottonwood Creek and Thomes Creek watersheds may be significant sources of mercury and methylmercury. With the exceptions of Mill Creek and Cache Creek, total mercury concentrations rarely exceeded the 50 ng/L CTR criterion at any site.
- Methylmercury concentrations in water column samples exceeded the Great Lakes human health-based criterion of 0.24 ng/L most frequently in samples from Arcade Creek (67% of samples) and from two agricultural drain sites (25% and 35% of samples). Methylmercury concentrations exceeded the Great Lakes wildlife-based criterion of 0.05 ng/L in nearly every sample collected from mainstem location below Hamilton City, and in all other tributaries and agricultural drains sampled.
- The Sacramento River watershed is the major source of total mercury to the Delta. This watershed contributes approximately 90% of the total mercury loads to the Delta. Within the Sacramento River watershed, the Cache Creek drainage is the single largest source area for total mercury. Major sources of total mercury loads to the Sacramento River watershed include runoff and erosion from historic gold mining sites, erosion of native soils, and natural mineral springs. Minor mercury sources include treated wastewater, urban runoff, historic mercury mines, and atmospheric mercury deposition from external sources.

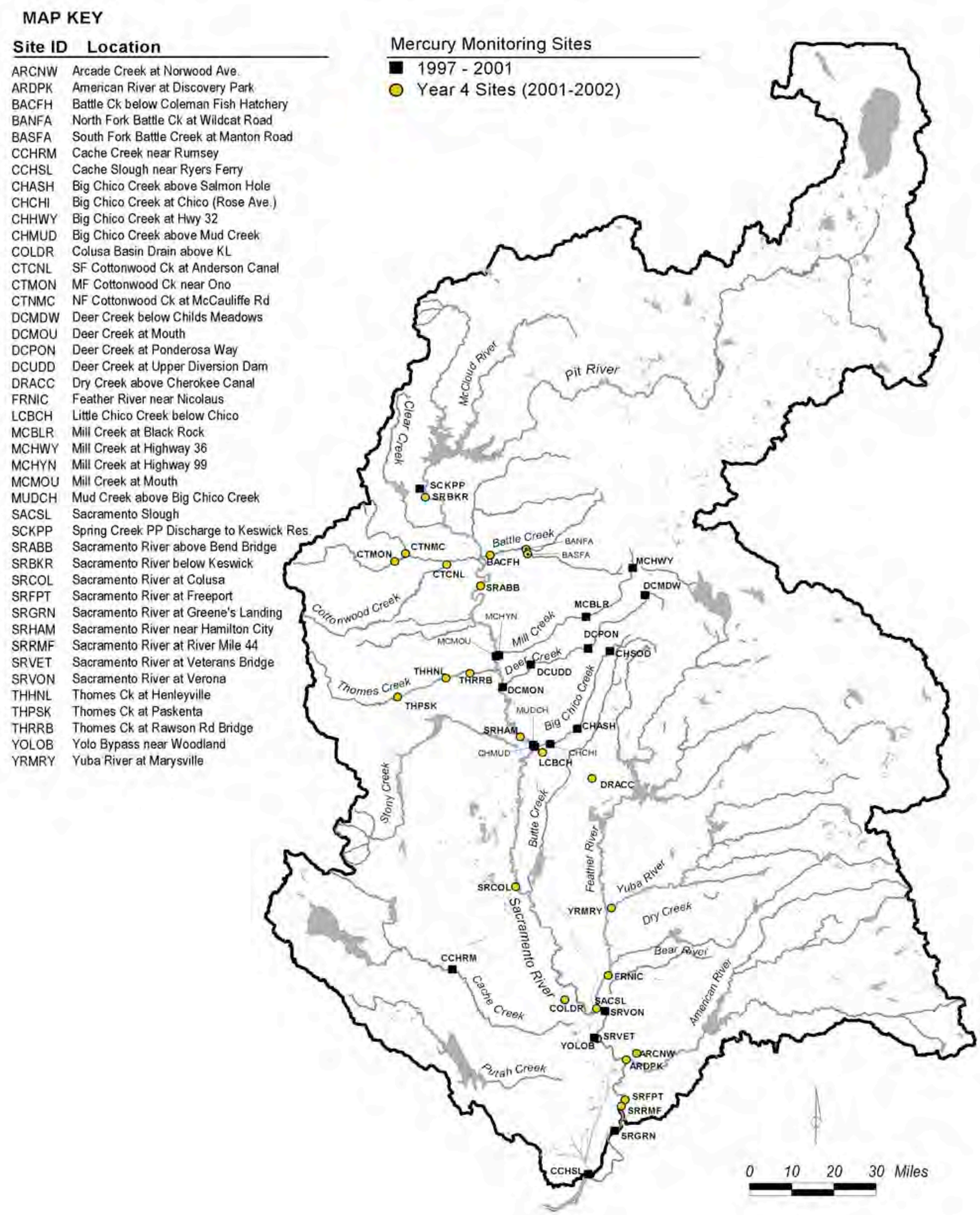

Figure 2. Mercury Monitoring Sites for the Sacramento River Watershed Program: USGS NAWQA, City of Redding, Sacramento River CMP, and SRWP

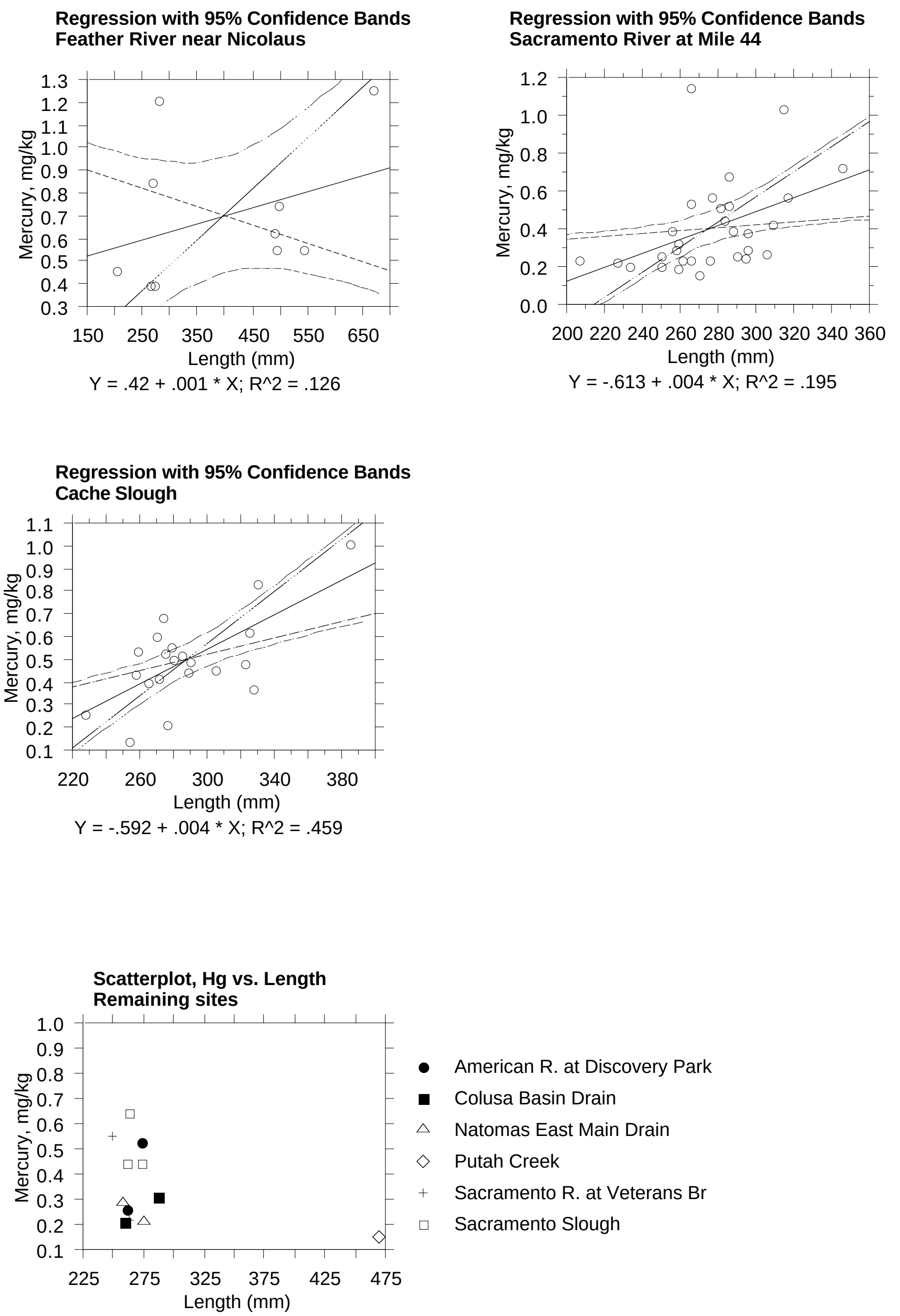

Figure 3. Mercury in White Catfish in the Sacramento River Watershed: SRWP Data, 1997-2000

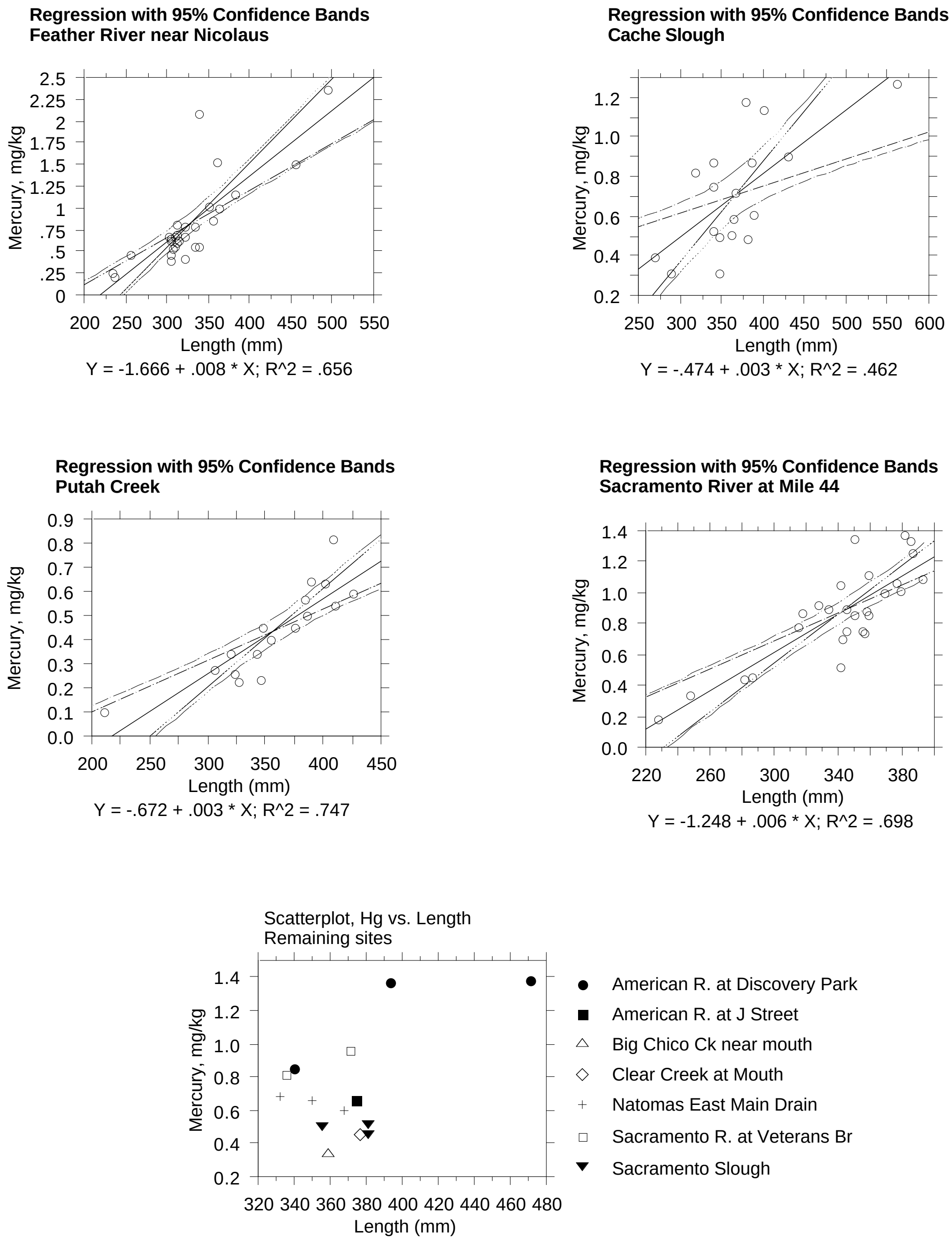

Figure 4. Mercury in Largemouth Bass in the Sacramento River Watershed: SRWP Data, 1997-2001

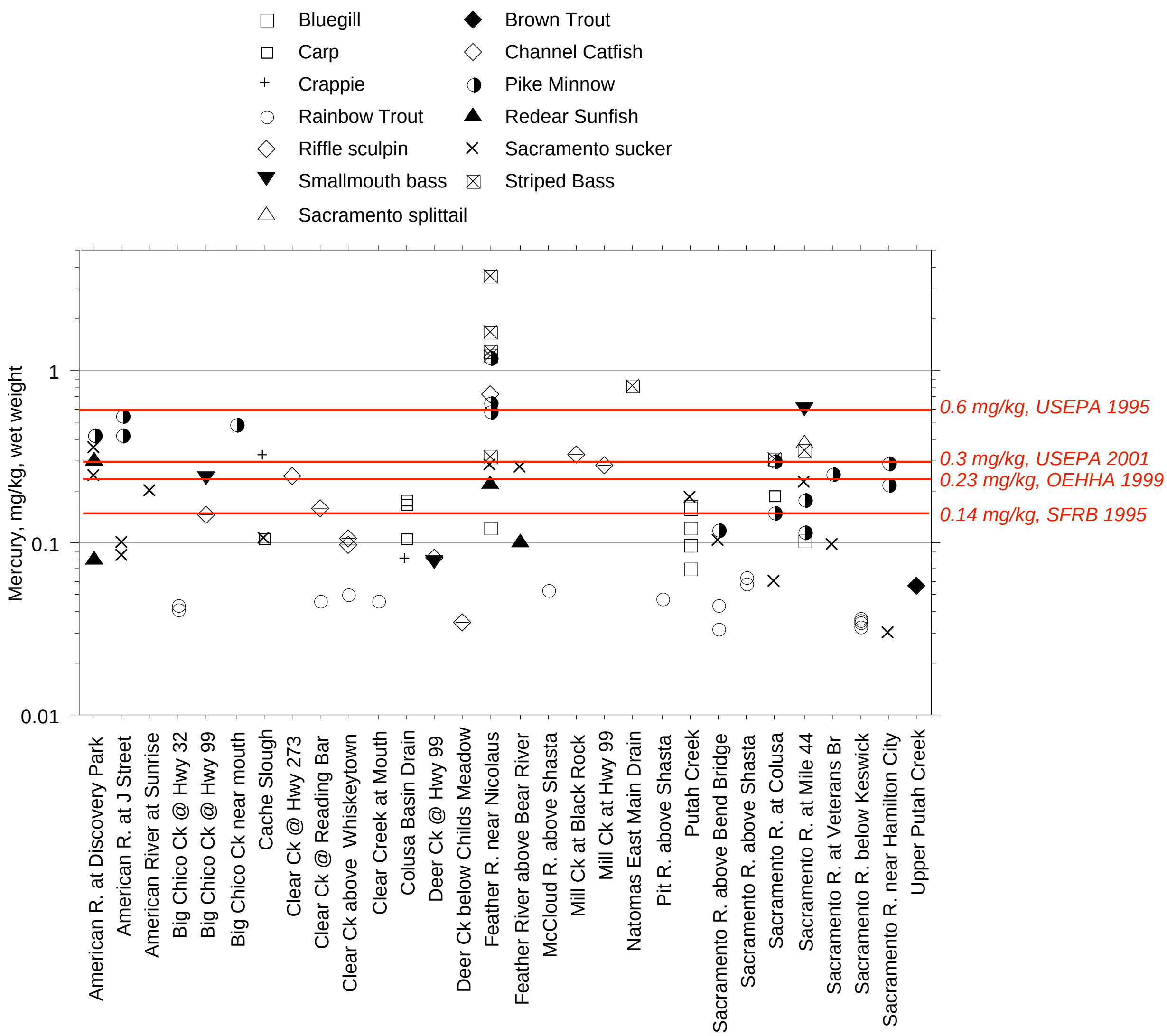

Figure 5. Mercury in Other Fish Species in the Sacramento River Watershed: SRWP Data, 1997–2001, and DWR Data, 1999

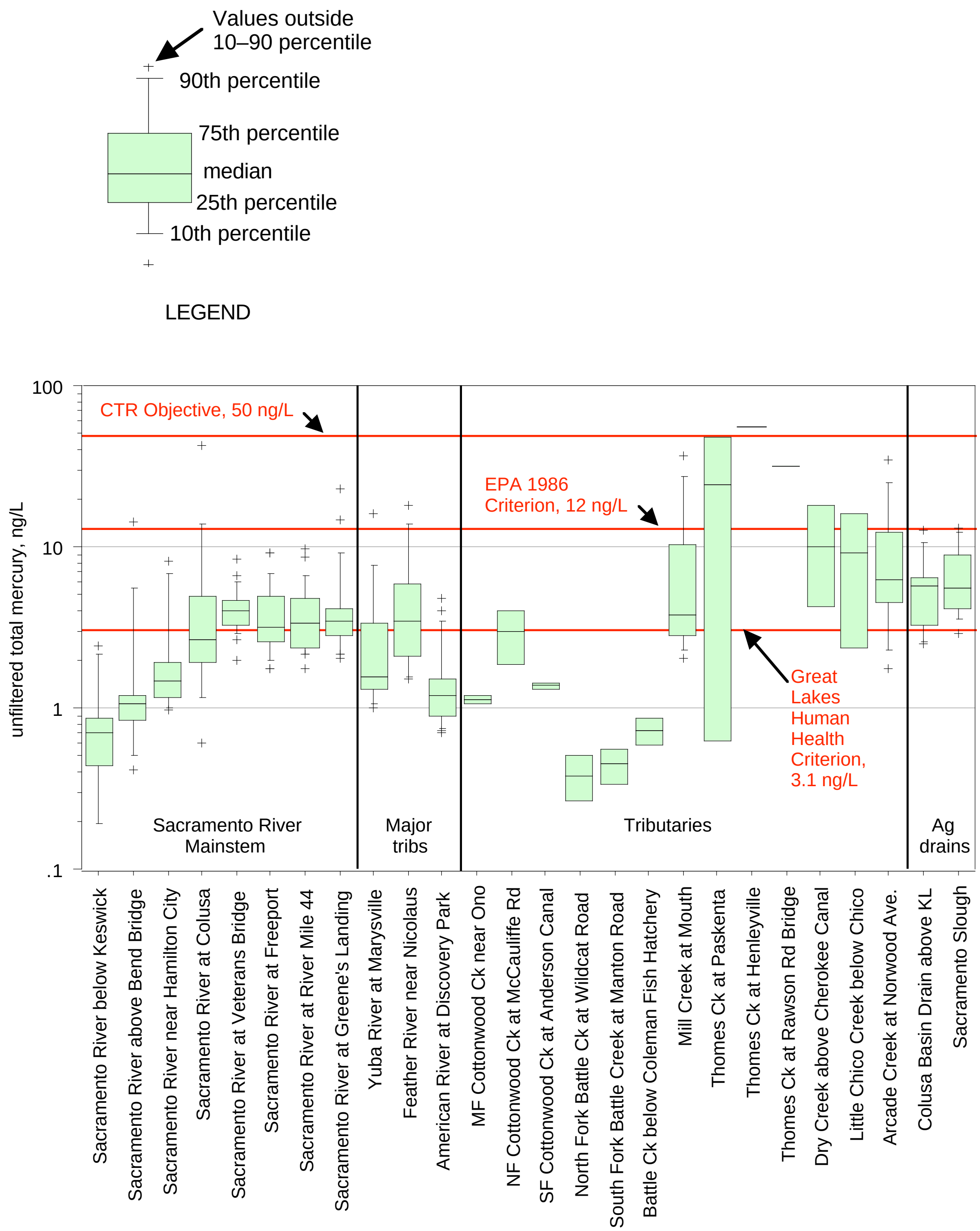

Figure 6. Mercury in the Sacramento River Watershed, Unfiltered Total Mercury Concentrations in Water, 2001-2002 data

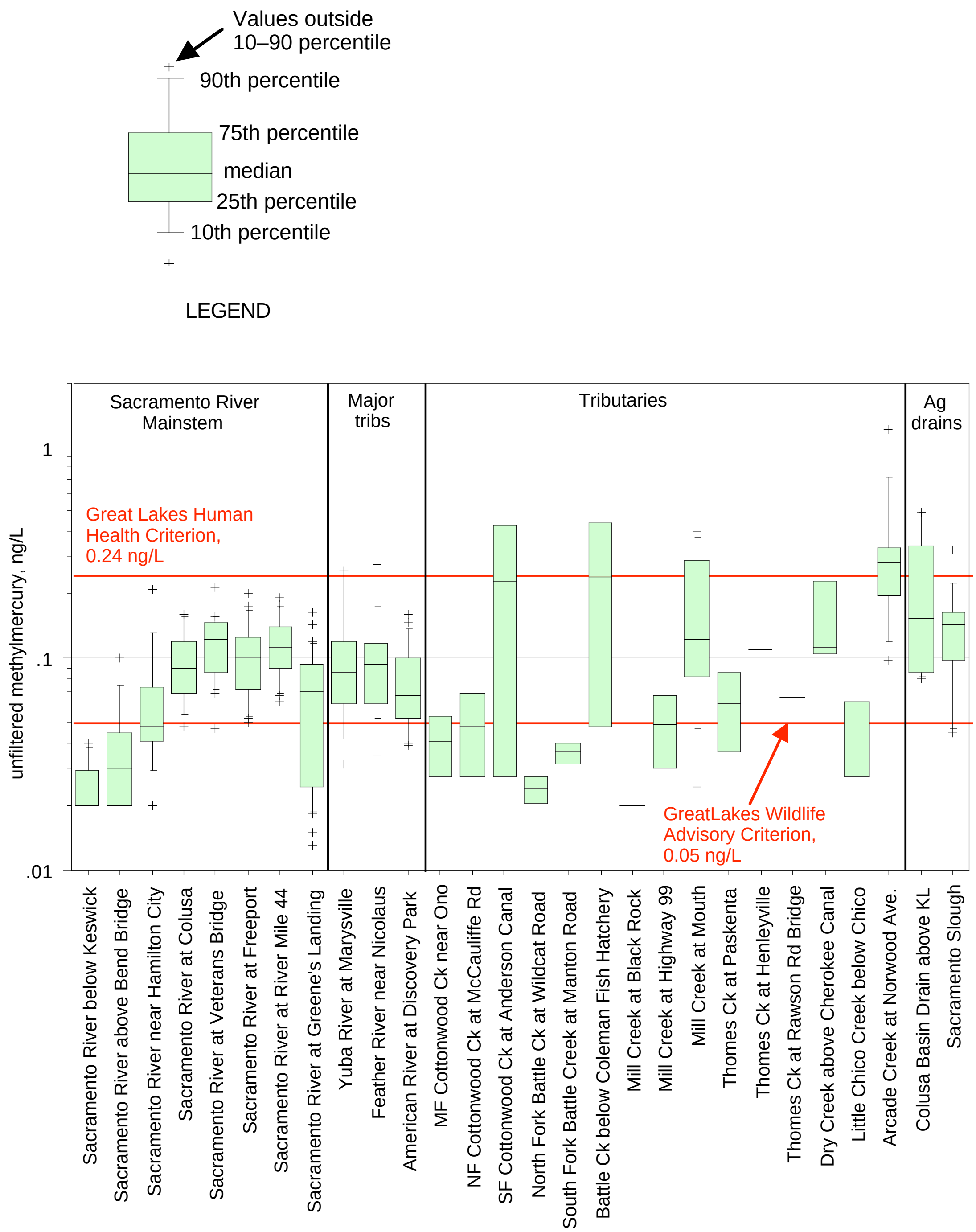

Figure 7. Methylmercury in the Sacramento River Watershed: Unfiltered Methylmercury Concentrations in Water (SRWP data, 2001-2002)

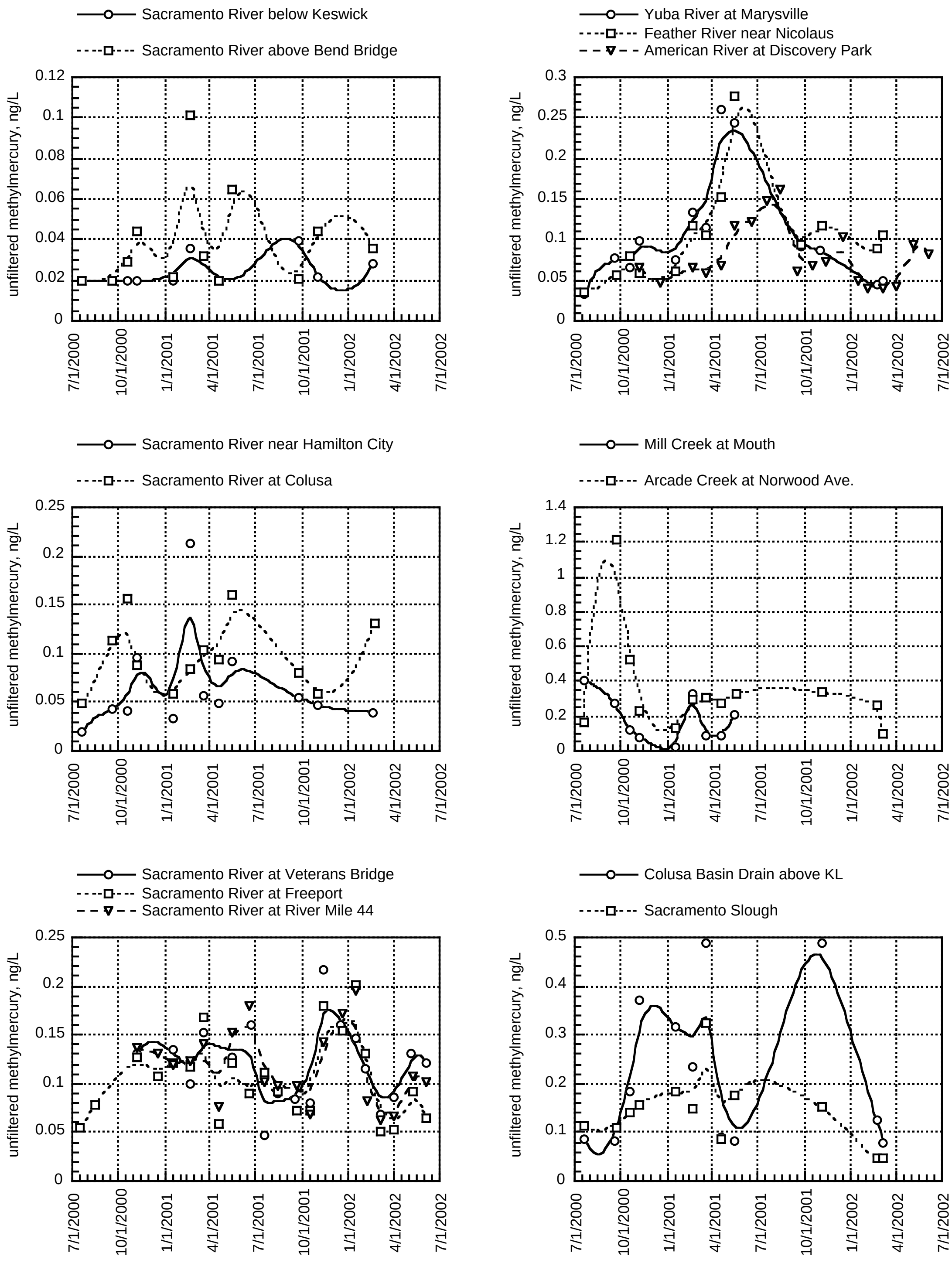

Figure 8. Unfiltered Methylmercury Concentration Time Series, 2001-2002 Data
Smoothed line fits are shown to illustrate general temporal trends observed in 2000-2002 SRWP, USGS, and CMP monitoring data.

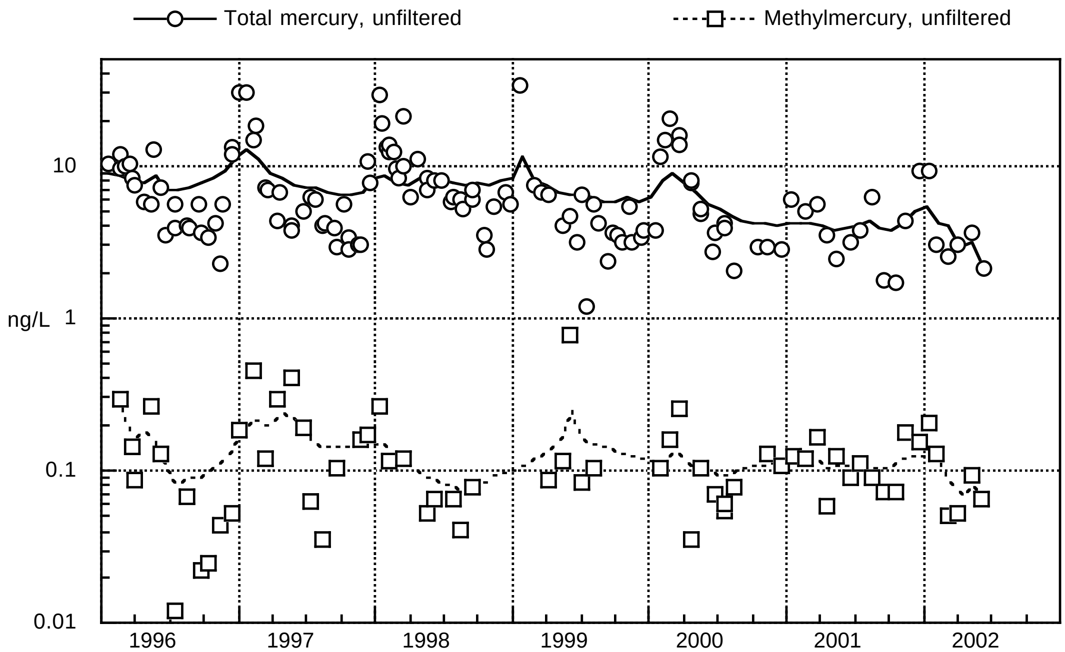

Figure 9. Unfiltered Total Mercury and Methyl Mercury in Water: Sacramento River at Freeport (USGS NAWQA data, 1996-2002, and Sacramento River CMP data, 1996-2001)

2.3 Pesticide Data Summary

Monitoring results for the Sacramento River Watershed Program (SRWP) and for primary coordinating programs (USGS NAWQA, Sacramento River Coordinated Monitoring Program, and Department of Water Resources) are presented and summarized in this section. Data were compared to relevant water quality objectives and toxicity thresholds to evaluate attainment of beneficial uses and potential impairment of these uses in surface waters of the watershed. It should be noted that these evaluations are limited to the pesticides monitored by SRWP, and do not include many other pesticides that have potential to affect beneficial uses. Data were evaluated for spatial and temporal trends if evidence of potential impairment was found. Summary statistics for pesticides detected in 1999-2002 SRWP monitoring are provided in Appendix A.

2.3.1 Background and Available Data Overview

The sources of data utilized for this report are summarized in Table 10a. The majority of non-SRWP data discussed in this report were obtained from the Department of Pesticide Regulation Surface Water Database (July 15, 2000). The monitoring locations for the primary data considered for this report (USGS NAWQA, California, the Sacramento River Coordinated Monitoring Program, California Department of Pesticide Regulation, and the Sacramento River Watershed Program) are illustrated in Figure 10.

The majority of the pesticide monitoring performed in surface waters of the Sacramento River watershed has been focused on pesticides used in rice cultivation and orchard dormant spray applications, and pesticides commonly found in urban runoff. Of these, the SRWP monitoring program has focused primarily on organophosphate and carbamate pesticides, with triazine pesticides also monitored at selected locations (Table 10a). "Legacy" organochlorine pesticides (including DDT, aldrin, dieldrin, endrin, heptachlors, chlordanes, endosulfans, toxaphene, and hexachlorocyclohexanes) were not monitored in water. All samples were collected as instantaneous grab samples.

As discussed previously in this document, SRWP monitoring for pesticides was performed on an episodic basis in 2001-2002. A total of 5 events, including three wet weather episodic events (of four planned events) and two dry weather events, were monitored at 11 locations. Wet weather episodic events included the first significant watershed-wide storm event of the 2001-2002 wet season (late October 2001), the organophosphate pesticide dormant spray application period (mid-February 2002), and a late wet season rainfall event (March 2001). One dry weather "episodic" event was scheduled to coincide with late dry season low flows, and one with the highest probability for detecting rice herbicides[6] (mid-May 2002). These events are summarized in Table 10b. The number of detections and total number of samples analyzed at each site are summarized in Table 10c for pesticides detected in SRWP 2001-2002 monitoring.

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[6] Several local water agencies (City of Sacramento, county of Sacramento Department of Water Resources, City of West Sacramento, and East Bay Municipal Utility district) coordinated to sponsor supplemental analyses for molinate and thiobencarb at five SRWP sampling sites during this event.

Table 10a. Pesticide monitoring programs in the Sacramento River Watershed

Program	Monitoring Period(s)	Parameters	# of locations & geographic reference
SRWP	6/99–5/01	▪ Organophosphate, carbamate, and triazine pesticides in water	6 sites: 3 Sac. River sites (OPs), 2 Ag. Drain sites (OPs, carbamates), and 1 urban runoff-dominated site (all parameters)
Sacramento River CMP (SRCSD)	12/92–12/01	▪ Diazinon and chlorpyrifos in water	5 sites on Sacramento and American rivers in Sacramento metropolitan area
Sacramento River Basin NAWQA (USGS)	2/96–4/98	▪ Wide range of pesticides, including OPs, carbamates,	5 sites: 1 Sac. River site, 2 Ag. Drainage dominated sites, 1 urban runoff-dominated site, and Yolo Bypass
USGS (Domagalski 1998)	5/98–9/00	▪ Wide range of pesticides, including OPs, carbamates,	Continuation of NAQWA monitoring at Sac. River at Freeport
Department of Pesticide Regulation (DPR)	1996–2001 (wet season episodic sampling)	▪ Organophosphate, carbamate, and triazine pesticides in water	3 sites: Sacramento River at Veterans Bridge (Alamar) and Sutter Bypass near Karnak, and Wadsworth cnal
DPR	1995–2001	▪ Rice Pesticides	3 sites: Sacramento River at Village Marina, Butte Slough, and Colusa Basin Drain
DPR (Spurlock 2002)	1991-2001	▪ Chlorpyrifos, diazinon ▪ Acute Toxicity	Meta-analysis of 32 surface water and dormant spray studies
CVRWQCB	1/94–3/94	▪ Organophosphate, carbamate, and triazine pesticides in water	21 sites: Sacramento River, Feather River, Yuba River, and multiple ag. drainage-affected sites
Sacramento NPDES Stormwater Monitoring Program	1990–2000	▪ Organophosphate and carbamate pesticides in water	13 Sacramento area urban runoff and river sites
SF Estuary Regional Monitoring Program	1989–1998	▪ Pesticides in water	18 Bay-Delta sites, including Sacramento River and San Joaquin River at the Delta terminus
Special Tributary Program (DWR)	6/98–5/00	▪ Pesticides in water	13 water column sites on Mill Creek, Big Chico Creek, and Deer Creek
Offstream Storage Study (DWR)	1999 to 2001	▪ Pesticides in water	42 sites: 7 Sac. River sites and 32 tributary sites between Keswick and Colusa, and 3 reservoir sites. *Data not available*

Table 10b. SRWP Pesticide Monitoring, 2001-2002: Events and locations.

Events		Locations and Pesticides Monitored[1]										
Dates	Description	Mill Creek	Deer Creek	Big Chico Creek	Sac. R at Hamilton City	Sac. R. at Colusa	Sacramento Slough	Colusa Basin Drain	Yuba River at Marysville	Feather R. near Nicolaus	Sac. R. at Veterans Br.	Arcade Creek at Norwood Av
Sept 23-26, ‘01	Late dry season, low flows	—	—	—	o	o	o/c	o/c	o/c	o	o	o/c/t
Oct 31-Nov 6, ‘01	First significant storm event of the wet season (e.g. “first flush”)	—	—	—	o	o	o/c	o/c	o/c	o/t	o/t	o/c/t
Feb 17-23, ‘02	Rainfall event following OP pesticide dormant spray application	o	o	o	o	o	o/c	o/c	o/c	o/t	o/t	o/c/t
Mar 7-8, ‘02	Late wet season storm event	o	o	o	o	o	o/c	o/c	o/c	o/t	o/t	o/c/t
May 14-16, ‘02	Rice pesticide application and discharge season (dry weather “episodic” event)	—	—	—	o	o/r	o/c/r	o/c/r	o/c/r	o/r	o/r	o/c/t/r

(1) “o” = organophosphate pesticides by EPA Method 8141a
“c” = carbamate pesticides by EPA Method 8321
“t” = triazine pesticides by EPA Method 619
‘r” = molinate and thiobencarb by EPA 507
“—“ indicates site not monitored for the event

Table 10c. Number of detections and total samples for pesticides detected in SRWP monitoring, 2001-2002.

		Locations and numbers of detections/total samples[1]										
Method	Analyte	Mill Creek	Deer Creek	Big Chico Creek	Sac R. at Hamilton City	Sac R. at Colusa	Sacramento Slough	Colusa Basin Drain	Yuba river at Marysville	Feather River near Nicolaus	Sac. River at Veterans Br.	Arcade Creek at Norwood Av
EPA 8141a	Diazinon	0/2	0/2	0/2	0/4	0/4	0/5	1/5	0/5	0/5	0/5	5/5
EPA 8141a	Prometon	0/2	0/2	0/2	0/4	0/4	0/5	0/5	0/5	0/5	0/5	1/5
EPA 8141a	Prowl	0/2	0/2	0/2	1/4	0/4	0/5	0/5	0/5	0/5	0/5	0/5
EPA 8321a	Carbaryl	—	—	—	—	—	0/5	0/5	0/4	—	—	1/5
EPA 8321a	Diuron	—	—	—	—	—	1/5	1/5	0/4	—	—	1/5
EPA 507	Molinate	—	—	—	—	0/1	1/1	1/1	—	0/1	0/1	—
EPA 507	Thiobencarb	—	—	—	—	0/1	0/1	1/1	—	0/1	0/1	—

(1) Number of samples in which pesticide was detected vs. the total number of samples analyzed

2.3.2 Attainment of Beneficial Uses and Potential Impairment

Pesticides monitored by the SRWP include organophosphate and phenoxyurea pesticides, carbamate pesticides, and triazine pesticides (analyzed by USEPA methods 8141, 8321, and 619, respectively). In addition, the rice herbicides molinate and thiobencarb were monitored at six locations for a single event using EPA method 507 (in coordination with the City of Sacramento). Individual pesticides and their respective reporting limits are presented in Table 11. Seven of these pesticides were detected in SRWP monitoring in 2001-2002. An additional nine pesticides detected in 1999-2001 monitoring, but not detected in 2001-2002 (aldicarb, bromacil, carbofuran, chlorpyrifos, EPTC, malathion, methomyl, propazine, and tebuthiuron), have been discussed in the 1999-2000 and 2000-2001 Annual Monitoring Reports and are not evaluated again in this document. The concentrations of pesticide detected in 2001-2002 were compared with a variety of regulatory and toxicity thresholds (Table 12) to evaluate potential risks to human health and aquatic life. The regulatory thresholds considered include USEPA aquatic life criteria, USEPA's Maximum Contaminant Levels (MCL) for drinking water, reference doses for drinking water from USEPA's IRIS database, and minimum toxic thresholds from USEPA's Office of Pesticide Programs (OPP) Ecotoxicity database. Also considered were recommended aquatic life criteria developed by the California Department of Fish and Game for diazinon and chlorpyrifos (CDFG 2000). There are no criteria in the adopted California Toxics Rule for any of the pesticides detected in SRWP monitoring. Of the pesticides detected in SRWP monitoring, only chlorpyrifos, diazinon, and malathion have aquatic life criteria developed using USEPA methodology. Of the pesticides detected in 2001-2002, only molinate and thiobencarb have Drinking Water MCLs. No relevant regulatory limits are available for other detected pesticides (carbaryl, diuron, prometon, and prowl). The results of these comparisons provide some perspective regarding potential impacts on beneficial uses. However, these results do not provide definitive or conclusive information regarding such impacts.

2.3.2.1 Comparisons with water quality criteria and toxicity thresholds

Carbaryl was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (1.7 μg/L, LC_{50} for crustacean species), either in SRWP monitoring or data reported in DPR's Surface Water Database.

Diazinon was detected at greater than DFG's recommended Continuous Concentration Criterion (CCC) of 0.050 μg/L in six of nine samples collected from Arcade Creek in 2000-2001. Aquatic toxicity testing at this site indicates that metabolically activated toxicants are often the cause of significant mortality and/or reproductive toxicity frequently observed at this site—a pattern that is consistent with diazinon toxicity. Although diazinon was not detected at greater than the recommended CCC at any other SRWP-monitored site, data in the DPR Surface Water database indicate that diazinon concentrations have commonly exceeded this value at nearly every location monitored, including the Sacramento River mainstem, and major and minor tributaries. The greatest magnitude and most frequent exceedances of the recommended CCC have been observed in the numerous waterways most directly affected by agricultural drainage or urban runoff. Based on the data in the DPR Surface Water database, diazinon concentrations in agricultural drainage-dominated waterways commonly exceed 0.2 μg/L, the lowest LC_{50} (for crustacea) recorded in the USEPA's OPP Ecotoxicity database. Although it appears that this concentration is not frequently exceeded in the Sacramento River or major tributaries, other studies have documented cases of significant reproductive effects and mortality to *Ceriodaphnia dubia* due to diazinon, or have observed diazinon concentrations high enough to cause toxicity (Foe and Sheipline 1993, Larsen *et al.* 1998a and b, Holmes *et al.* 1998). Concentrations many times higher than DFG's recommended CCC and other toxicity thresholds have been documented in urban creeks and agricultural drains by numerous researchers and monitoring programs (Ogle and Cooke 2000).

Diuron was not detected in 2001-2002 at concentrations greater than the minimum toxicity threshold in USEPA's OPP Ecotoxicity Database (2.4 μg/L, aquatic plant species EC_{50}), but has been detected at concentrations greater than this threshold in Arcade Creek in 1999-2000. Data reported in DPR's Surface Water Database indicate that this threshold was exceeded occasionally in agricultural drainage, urban runoff, and urban creeks, sometimes by more than an order of magnitude. It was not exceeded in any samples reported for the Sacramento River.

Molinate was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (220 μg/L, aquatic plant species EC_{50}), either in SRWP monitoring or data reported in DPR's Surface Water Database. The concentration detected in Colusa Basin Drain (12 μg/L) was about half of the USEPA MCL for molinate (20 μg/L) and approached the IRIS RfD (14 μg/L). Concentrations exceeding the MCL and the RfD have often been reported in USEPA's OPP Ecotoxicity Database for two agricultural drains (Colusa Basin Drain and Butte Slough), but not for Sacramento River mainstem or the Feather River sites.

Thiobencarb was detected in Colusa Basin Drain (2.1 μg/L) at a concentration exceeding the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (2 μg/L, crustacean species LOEC). The concentration detected did not exceed the primary health-based MCL of 70 μg/L, but did exceed the secondary taste and odor-based MCL of 1 μg/L. In DPR's Surface Water Database, thiobencarb has been reported to exceed this toxicity threshold frequently in two agricultural drains (Colusa Basin Drain and Butte Slough), but never in the Sacramento River mainstem or the Feather River sites.

Prometon was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (98 μg/L, aquatic plant species EC_{50}), either in SRWP monitoring or data reported in DPR's Surface Water Database.

Prowl (pendimethalin) was not detected at concentrations exceeding or approaching the lowest toxic threshold reported in USEPA's OPP Ecotoxicity Database (5.2 μg/L, aquatic plant species EC_{50}), either in SRWP monitoring or data reported in DPR's Surface Water Database.

No pesticides were detected at concentrations exceeding drinking water reference doses (RfD) reported in USEPA's IRIS database.

Table 11. Pesticides monitored by the Sacramento River Watershed Program.

Analyte	RL, µg/L[1]	Analyte	RL, µg/L[1]
Organophosphate pesticides by EPA Method 8141a			
Azinphosmethyl	1.0	Fenthion	0.10
Bolstar	0.10	Malathion	0.10
Chlorpyrifos	0.05	Merphos	0.10
Coumaphos	0.20	Mevinphos	0.70
Def	0.10	Naled	0.50
Demeton-S	0.20	Parathion, ethyl	0.10
Diazinon	0.05	Parathion, methyl	0.10
Dichlorovos	0.20	Phorate	0.10
Dimethoate	0.10	Prowl	0.10
Disulfoton	0.10	Ronnel	0.10
EPN	0.10	Stirophos	0.10
EPTC	0.10	Tokuthion	0.10
Ethion	0.10	Trichloronate	0.10
Ethoprop	0.10	Trifluralin	0.10
Fensulfotion	0.50		
Carbamate pesticides by EPA Method 8321			
Aldicarb	0.8	Linuron	0.8
Aminocarb	0.8	Methiocarb	0.8
Barban	7.0	Methomyl	7.0
Benomyl (Carbendazim)	0.8	Mexacarbate	0.8
Bromacil	0.8	Monuron	0.8
Carbaryl	0.14	Neburon	0.8
Carbofuran	0.14	Oxamyl	7.0
Chloropropham	7.0	Propachlor	7.0
Chloroxuron	0.8	Propoxur	0.8
Diuron	0.8	Siduron	0.8
Fenuron	0.8	Tebuthiuron	0.8
Fluometuron	0.8		
Triazine pesticides by EPA Method 619			
Ametryn	0.5	Propazine	0.5
Atraton	0.5	Simetryn	0.5
Atrazine	0.5	Simazine	0.5
Cyanazine	0.5	Terbuthylazine	0.5
Prometon	0.5	Terbutryn	0.5
Prometryn	0.5		
EPA Method 507			
Molinate	0.5	Thiobencarb	0.5

(1) Reporting Limit

Table 12. Advisory Criteria and Other Threshold Values for Pesticides Detected in SRWP Monitoring (2001–2002).

Pesticide	Aquatic Life Criterion (Units = µg/L)	MCL	IRIS RFd	Minimum Toxicity Thresholds [1] (threshold type, taxonomic class)
Carbaryl	—	—	700	1.5 (minimum LC_{50}, crustacea)
Diazinon	0.05 [2]	—	—	0.2 (minimum LC_{50}, crustacea)
Diuron	—	—	14	2.4 (minimum EC_{50}, aquatic plants)
Molinate	—	20	14	220 (minimum EC_{50}, aquatic plants)
Prometon	—	—	100	98 (minimum EC_{50}, aquatic plants)
Prowl (pendimethalin)	—	—	280	5.2 (minimum EC_{50}, aquatic plants) 9.8 (LOEC, crustacea)
Thiobencarb	—	70	70	17 (minimum EC_{50}, aquatic plants) 2 (LOEC, crustacea)

(1) From USEPA's Environmental Fate and Effects Division Office of Pesticide Programs Pesticide Ecotoxicity Database (USEPA 2000)
(2) CDFG recommended criterion continuous concentration (CCC). Note that this value is incorrectly rounded to one significant digit by CDFG, and should be expressed as 0.053 µg/L, according to USEPA procedures for calculating aquatic life criteria.

2.3.2.2 What do these results say about attainment of beneficial uses and potential impairment, and how does this compare with any relevant 303(d) listings for parameter and sites?

Waterbodies in the Sacramento River watershed that are included on the California 1998 303(d) list due to elevated pesticide concentrations are presented in Table 13. Table 13 also summarizes waterbodies recommended for addition to the 2002 303(d) list by the Regional Water Quality Control Board.

As stated previously, it should be noted that comparisons with advisory criteria and toxicity thresholds do not provide conclusive evidence of attainment or impairment of beneficial uses. However, for the purpose of these evaluations, repeated significant exceedances of these values are considered as an indication of potential impairment of beneficial uses. In general, regulatory agency advisory criteria (e.g. USEPA aquatic life criteria or drinking water MCLs) are given the most weight in these evaluations. However, because most of the pesticides detected do not have any adopted regulatory limits, detected concentrations were compared to available toxicity threshold data as a coarse screen for potential impairment of beneficial uses. These were considered the best available indicators of potential impairment. As previously noted, these evaluations are limited to the pesticides monitored by SRWP, and do not include many other pesticides that have the potential to affect beneficial uses.

The beneficial uses at greatest potential risk from elevated pesticide concentrations in surface water are "Cold Freshwater and Estuarine Habitat", "Commercial and Sport Fishing", and "Municipal and Domestic Water Supply" (as defined in the Central Valley Region Basin Plan, CVRWQCB 1995). The most direct effects are likely to be on aquatic plants and crustacea, taxonomic groups which include the species most sensitive to the most widely used insecticides and herbicides. Based on data from the SRWP and other monitoring efforts, there may be significant potential for localized impacts on these beneficial uses due to elevated concentrations of some pesticides in some surface waters of the Sacramento River watershed. Based on findings of elevated concentrations and documented toxicity in surface waters ranging from small urban creeks and agricultural drains to the Sacramento River mainstem and Delta waterways, diazinon appears to pose the greatest and most extensive risks. The Central Valley Regional Board has concluded that beneficial uses are impaired by diazinon, and has cited diazinon as the primary reason for including numerous waterbodies on the 1998 303(d) list and recommended 2002 update of the 303(d) list of impaired waterbodies (Table 13). Direct effects of elevated diazinon concentrations are likely to be limited to sensitive zooplankton species. These invertebrate species are also important food sources for higher trophic level organisms in the ecosystem, and reduction of zooplankton populations during critical periods could also impact populations of higher trophic level organisms (e.g. fish) (Ogle and Cooke 2000).

Although less frequently detected at toxic concentrations in the mainstem Sacramento River, elevated chlorpyrifos concentrations appear to pose similar risks. Because of its toxic mode of action is the same as diazinon, chlorpyrifos will also contribute to organophosphate toxicity even at concentrations below its single-chemical toxicity threshold (Bailey *et al.* 1996). The available pesticide concentration data agree well with the California 303(d) list of impaired waterbodies. Chlorpyrifos and diazinon are responsible for the greatest number of the individual listings on the California 303(d) List of impaired waterbodies, with diazinon alone responsible for the listing of 30 Sacramento River miles and 60 Feather River miles (reduced in the 2002 303(d) list update to 16 and 42 river miles, respectively), 48,000 acres in the Delta, and 265,000 acres in the San Francisco Bay Estuary. Diazinon is also responsible for numerous listings in urban creeks in the Sacramento metropolitan area, as well as in other urban area in California. Diazinon is also cited as a cause of impairment for all five new waterbodies recommended for addition to the 2002 303(d) list (CVRWQCB 2003) for pesticide impairment. Based on a weight of evidence approach, it appears clear that these two organophosphate pesticides have a high potential for impairment of aquatic life and related beneficial uses in surface waters of the Sacramento River watershed. It should be noted that a Department of Pesticide Regulation meta-analysis of data from 32 surface water and dormant spray application studies (Spurlock 2002) found that the use and frequency of detections and the maximum concentrations of both of these pesticides has decreased substantially over the period studied (1991-2001), suggesting that risks to beneficial uses may be decreasing as well.

There appears to be some potential for localized impacts on aquatic life in specific waters in the watershed due to occasionally elevated concentrations of malathion and carbofuran, primarily in waterways dominated by agricultural drainage. As with diazinon and chlorpyrifos, direct toxic effects of these insecticides are likely to be limited to sensitive aquatic invertebrate species. There appears to be little risk of beneficial use impairment from these pesticides in the Sacramento River and larger tributaries, however. The available data appear to support the single 303(d) listing for malathion in the Sacramento River watershed (Colusa Basin Drain), although the number of detections and potential impacts of both carbofuran and malathion have been substantially reduced in recent years by changes in rice farming practices. There are no 303(d) listings in the Sacramento River watershed due specifically to carbofuran.

There appears to be some potential for localized impacts on aquatic life due to occasionally elevated concentrations of diuron, primarily in urban creeks and waterways dominated by agricultural drainage. There appears to be little risk of beneficial use impairment in the Sacramento River and larger tributaries from this herbicide. Direct toxic effects of this pesticide are probably limited to sensitive aquatic plant species. There are no 303(d) listings due specifically to diuron.

For the locations monitored, there appears to be little to no significant potential for impairment of aquatic life uses due to elevated concentrations of other pesticides monitored by the SRWP. Although the potential certainly exists for impairment due to synergistic effects from exposure to multiple pesticides, based on the available data there is yet little evidence of this phenomenon at the locations monitored, with the specific exception of organophosphate pesticides (discussed previously). Beneficial uses related to human health concerns (drinking water supply, and contact and non-contact recreational use) do not appear to be at risk from any of the pesticides monitored by the SRWP.

Table 13. Waterbodies in the Sacramento River watershed listed for pesticides on the California 1998 303(d) List or recommended for addition to the 303(d) List

Pesticide	**Waterbody**	**Area Affected**	**Cited Sources**
Chlorpyrifos	Delta Waterways[(2)]	48,000 Acres	Agriculture; Urban Runoff
	Arcade Creek	10 Miles	Urban Runoff
	Elder Creek[(3)]	10 Miles	Urban Runoff
	Chicken Ranch Slough[(3)]	5 Miles	Urban Runoff
	Strong Ranch Slough[(3)]	5 Miles	Urban Runoff
Diazinon	Delta Waterways[(2)]	48,000 Acres	Agriculture; Urban Runoff
	Feather River, Lower[(2)]	60 Miles	Agriculture; Urban Runoff
	Sac. R. (Red Bluff To Delta)[(2)]	30 Miles	Agriculture
	Morrison Creek[(3)]	20 Miles	Agriculture; Urban Runoff
	Arcade Creek	10 Miles	Agriculture; Urban Runoff
	Elder Creek[(3)]	10 Miles	Agriculture; Urban Runoff
	Chicken Ranch Slough[(3)]	5 Miles	Agriculture; Urban Runoff
	Strong Ranch Slough[(3)]	5 Miles	Agriculture; Urban Runoff
	Natomas E. Main Drain[(2)]	5 Miles	Agriculture; Urban Runoff
	Elk Grove Creek[(3)]	5 Miles	Agriculture
	Sacramento Slough[(3)]	1 Miles	Agriculture; Urban Runoff
	SF Bay/Delta Estuary	265,460 Acres	Nonpoint Source
Group A Pesticides (aldrin, dieldrin, endrin, heptachlor, heptachlor epoxide, chlordanes, endosulfans, toxaphene, and hexachlorocyclohexanes)	Delta Waterways[(2)]	48,000 Acres	Agriculture
	Colusa Drain[(2)]	70 Miles	Agriculture
	Feather River, Lower[(2)]	60 Miles	Agriculture
	American River, Lower[(1)]	23 Miles	Urban Runoff
Malathion, Methyl Parathion	Colusa Drain[(2)]	70 Miles	Agriculture
DDT	Delta Waterways[(2)]	48,000 Acres	Agriculture
Dieldrin, Chlordane	SF Bay/Delta Estuary	292,520 Acres	Nonpoint Source
	Recommended additions to the 2002 303(d) List		
Azinphos-methyl, diazinon, molinate	Colusa Drain	49 Miles	Agriculture
Diazinon	Lower Bear River	21 Miles	Agriculture
Diazinon	Jack Slough	14 Miles	Agriculture
Diazinon, Molinate	Butte Slough	8.9 Miles	Agriculture
Diazinon	Sutter Bypass	19 Miles	Agriculture

(1) Recommended for removal from 303(d) list in 2002 (CVRWQCB 2003)
(2) Area Affected was reduced in 2002 update (CVRWQCB 2003)
(3) Area Affected was increased in 2002 update (CVRWQCB 2003)

2.3.3 Spatial Distributions & Patterns

Spatial distributions and patterns of detection were evaluated for pesticides determined to have a reasonable potential to cause impairment of beneficial uses (chlorpyrifos, diazinon, malathion, and diuron). As with other pollutants, the ability to evaluate spatial distribution patterns is highly dependent on the sites selected for monitoring. SRWP monitoring was performed at sites selected to complement monitoring performed by USGS NAWQA and the Department of Pesticide Regulation. Most of the data available are from monitoring performed in water bodies dominated by agricultural drainage or urban runoff, and for the mainstem Sacramento River. There are relatively few data available for the major tributaries to the Sacramento River (Feather River, Yuba River, and American River), and even fewer currently available for the greater number of minor tributaries to the Sacramento River. Within these limitations, there are still a number of general patterns discernible in the available data.

2.3.3.1 General patterns

As expected, the frequency of detection and maximum concentrations detected are generally highest in waterbodies dominated by agricultural drainage or urban runoff, and lowest in the mainstem Sacramento River and tributaries.

In the Sacramento River, the frequency of detection and maximum values are generally lower upstream of the major agricultural production areas in the watershed. As an example, in SRWP monitoring, no organophosphate pesticides were detected in any samples collected from the Sacramento River near Hamilton City and Colusa sites, or from several smaller tributaries (Mill Creek, Deer Creek, and Big Chico Creek), which are above the region of the most intensive agricultural use of organophosphate pesticides for dormant spray applications. No pesticides were detected in 14 samples from the Feather River or the 5 samples from the Yuba River collected in 2000-2002, and there were few detections in the lower American River.

In SRWP monitoring, the greatest number of different pesticides (nine of 16 pesticides detected, 1999-2002) and the most frequent detections were observed at Arcade Creek. This pattern is consistent with results of USGS NAWQA monitoring performed 1996-1998.

2.3.3.2 Organophosphate pesticides

Organophosphate pesticides have been monitored at 14 locations by the SRWP. Of the 29 pesticides analyzed in the organophosphate pesticide scan (EPA Method 8141), five were detected in SRWP monitoring conducted 1999-2002. These were chlorpyrifos, diazinon, EPTC, malathion, and prowl.

Diazinon is a widely used organophosphate insecticide. Its pattern of detection reflects its use in a variety of agricultural and urban/residential settings. In SRWP monitoring, it was the most frequently detected organophosphate pesticide, detected at six of 14 sites monitored (Colusa Basin Drain, Sacramento Slough, Sacramento River at Veteran Bridge, Arcade Creek, American River, and the Sacramento River at Freeport). Of these SRWP sites, diazinon was detected most frequently (22 of 26 samples) in Arcade Creek, an urban creek affected by both urban runoff and aerial deposition from nearby agricultural areas. In studies contained in the DPR Surface Water database, diazinon was frequently detected (and concentrations were highest) in both urban runoff and waterways dominated by agricultural runoff. Diazinon was less frequently detected in the Sacramento River mainstem and tributaries monitored. Reporting limits for most of the data ranged from 0.002 μg/L for the USGS NAWQA program, to 0.01-0.05 μg/L for most of the other studies in the DPR Surface Water database.

In the ten studies contained in the DPR Surface Water database, chlorpyrifos was most frequently detected in urban runoff, never detected in the Sacramento River mainstem, and was rarely detected in other water bodies. Chlorpyrifos was detected in two SRWP samples (on each from Arcade Creek and Colusa Basin Drain). The Sacramento river Coordinated Monitoring Program has detected chlorpyrifos only twice (at less than .01 μg/L) in 148 reported samples from three Sacramento River mainstem sites. Reporting limits for most of the data ranged from 0.004 μg/L for the USGS NAWQA program, to 0.03-0.05 μg/L for most of the other studies in the DPR Surface Water database.

Malathion was detected in only two SRWP samples, from Sacramento Slough and Colusa Basin Drain. In studies contained in the DPR Surface Water database, malathion was most frequently detected in waterways dominated by agricultural drainage, and it has been less frequently detected in urban runoff and urban creeks. Malathion was not reported at detectable concentrations for any of the hundreds of results reported for the Sacramento River in the DPR Surface Water database. Reporting limits for most of the data ranged from 0.005 μg/L for the USGS NAWQA program, to 0.03-0.1 μg/L for most of the other studies in the DPR Surface Water database.

2.3.3.3 Carbamate pesticides

Carbamate pesticides were monitored at eight locations by the SRWP (one urban creek, two agricultural drainage dominated waterways, the Yuba and American rivers, and three Sacramento River sites). Pesticides analyzed in the carbamate pesticide scan (EPA Method 8321) includes both herbicides and insecticides, seven of which have been detected in SRWP monitoring conducted in 1999-2002. Of the pesticides detected, only diuron appears to have a significant potential to impair beneficial uses, and potential impacts from diuron appear limited to urban creeks and agricultural drains.

Diuron is an herbicide commonly used for weed control on public rights of way and for landscape maintenance, with significant amounts also used for alfalfa and citrus crops. In SRWP monitoring, diuron was detected in Arcade Creek, Colusa Basin Drain and Sacramento Slough, and the Sacramento River at Freeport. In DPR's Surface Water database, diuron was commonly detected at nearly every location monitored, including the Sacramento River mainstem, urban creeks, urban runoff, and in many waterways dominated by agricultural drainage. The highest concentrations were reported in smaller agricultural drains. Concentrations approaching toxic levels were not reported in the mainstem and major tributaries. Reporting limits for most of these studies ranged from 0.003–0.07 μg/L.

2.3.3.4 Triazine pesticides

Triazine pesticides were monitored by the SRWP in Arcade Creek, the Feather River, and the Sacramento River at Veterans Bridge. Of the pesticides analyzed in the triazine pesticide scan (EPA Method 619), only prometon and propazine have been detected in SRWP monitoring conducted 1999-2001. Neither of these two pesticides were considered to have significant potential for beneficial use impairment.

Pesticides detected in SRWP 2000-2001 monitoring are listed in Table 14, along with their primary uses and pounds reported applied in 2001 in the Sacramento River watershed. Summary statistics for pesticides detected in SRWP monitoring (1999-2001) are presented in Appendix A.

2.3.4 Temporal Distribution & Patterns

Most of the available monitoring data are focused on the periods of greatest use of particular pesticides or categories of pesticides (e.g. rice pesticide monitoring in late spring and organophosphate pesticide monitoring during the dormant spray application season). Although the episodic monitoring conducted by the SRWP from 2000-2002 is intended to monitor conditions most likely to result in pesticide detections, pesticides were infrequently detected at any location other than Arcade Creek. It should be noted that these two years of monitoring represents at most two samples for each specific type of episodic "event", and therefore no definitive conclusions regarding temporal patterns can be reached based solely on SRWP monitoring. Additionally, this focused approach to monitoring provides relatively little information about other periods or seasons. However, in combination with the available data from other programs, these results generally confirm that the pattern of detections and greatest concentrations reflects patterns of pesticide use. Specific examples include:

- The highest concentrations of diazinon were detected in the months of January and February throughout the watershed. This period coincides with the dormant spray application season.
- The highest concentrations of carbofuran, malathion, and molinate have been observed in May and June, coincident with the release of water from rice fields.
- The percent detections reported for carbofuran in DPR's Surface Water Database decreased from approximately 85% in 1994, to 0% in 2000, and carbofuran was not detected in SRWP 2000-2001 monitoring. A similar pattern was observed for malathion. These decreases correspond to changes made by the rice farming industry to pesticide application practices and in holding times for irrigation water after pesticide application. Granular formulations of carbofuran were also banned in 1994 to protect wildlife.

Overall use of cholinesterase-inhibiting organophosphate and carbamate insecticides has declined over the last several years (DPR 2000a, Spurlock 2002). In contrast, over the same period, the total number of acres planted in fruit and vegetable crops and the total pounds of all varieties of pesticides applied has increased in California (DPR 2000a). This suggests that there may be a general shift from organophosphate and carbamate insecticides to other categories of pesticides, possibly in response to economic pressures, patterns of pest pressures, and pesticide resistance. It has been suggested that pyrethroid pesticides are increasingly being used in place of organophosphate and carbamate pesticides for many crops, and the Department of Pesticide Regulation documented an increase in the number of pyrethroid applications from 1991 to 1996 and a corresponding decrease in the number of organophosphate pesticide applications during this period (DPR 1999). Although reported applications of the five pyrethroids accounting for 93% of the total pyrethroid use in California in 1999 (bifenthrin, cyfluthrin, cypermethrin, esfenvalerate, and permethrin) appeared to have stabilized in counties in the Sacramento River watershed, with no substantial increases from 1995 to 2000 (based on published pesticide use reports from DPR), reported use of bifenthrin, cyfluthrin, and cypermethrin all increased in 2001. Pesticides other than pyrethroids may also be replacing organophosphate and carbamate pesticides in agricultural applications. Pyrethroids are also replacing organophosphate pesticides since their ban in popular retail pesticide products. Other means of pest control, including biopesticides (e.g. bacteria, naturally-occurring compounds, and pheromones), reduced-risk pesticides, and non-chemical pest management practices have also increased dramatically since 1995 (*ibid*.). Given the extremely low toxicity thresholds of some of these pesticides (e.g. pyrethrins and pyrethroids, Table 15), the lack of monitoring data has been recognized as significant information gap. In response to this need, the University of California Department of Entomology is currently developing new analytical and monitoring methods for monitoring pyrethroid pesticides, and USGS has also been funded by CALFED to develop analytical methods.

The Department of Pesticide Regulation has also documented an increase in the number of detections of thiobencarb in Colusa Basin Drain (1994-2000) and the number of exceedances of the performance goal of 1.5 μg/L and the USEPA criterion of 6.2 μg/L (Newhart 2000). The increasing number and magnitude of detected concentrations are due in part to the increased use of thiobencarb. Increased use of this rice pesticide is attributed to an increase in acreage planted in rice in Glenn and Colusa counties, the geographical spread of rice weeds, and the development of herbicide resistance in rice weeds.

There were generally insufficient detected SRWP pesticide data to generate meaningful time series plots.

2.3.5 Mass Load Comparisons

Average mass loads of pesticides to the Delta can not be reliably estimated from the available data, due primarily to relatively infrequent monitoring and even less frequent detection of pesticides in most waterbodies monitored.

2.3.6 Conclusions and Recommendations

Conclusions of this review of pesticide monitoring data can be summarized as follows:

- The results of SRWP and other monitoring programs continue to support the focus of the SRWP and of both state and federal regulatory agencies on the management of organophosphate pesticides in surface waters. Diazinon and chlorpyrifos appear to have the greatest potential for impacts on aquatic life uses, with other monitored pesticides appearing to have relatively low to minimal risk of impacts on aquatic life or human health. The potential impacts on beneficial uses from diazinon and chlorpyrifos are being addressed through the Water Quality Management Strategy developed by the Organophosphate Pesticide Focus Group (SRWP 2001), and by the TMDL being developed by the Central Valley Regional Water Quality Control Board.
- There are still few data available for the many minor tributaries to the Sacramento River watershed. For smaller tributary watersheds with a substantial proportion of agricultural land use (e.g. Big Chico Creek), there may be a significant potential for pesticides to occasionally reach concentrations of concern in surface waters. Although no pesticides were detected in the limited SRWP monitoring of several smaller tributary watersheds in 2000-2002, the available monitoring data are far too limited to make any reliable assessments regarding the potential impacts of pesticides for these and other tributaries. However, small tributaries with only a small proportion of their total drainage in agricultural land uses (e.g. Deer Creek and Mill Creek) are probably at relatively low risk of pesticide impacts on beneficial uses. Additional pesticide monitoring data (e.g. from DWR) should be evaluated for these watersheds when they become available, to better characterize the potential risks from pesticides in these watersheds, and additional monitoring should also be considered.
- The shift from use of organophosphate and carbamate pesticides for agricultural and other uses to other pesticides (including but not limited to pyrethroids and pyrethrins) indicates the need to increase monitoring for these pesticides. The University of California at Davis Department of Entomology is currently performing research to develop new sampling and analytical techniques to adequately identify and measure toxic concentrations of pyrethroid pesticides in water, sediment, and tissue. The SRWP is also collaborating with Dr. Don Weston (University of California Berkeley) to acquire funding for a study of the distribution and toxicity of sediment-associated pesticides in the Sacramento River watershed. The study is focused on pyrethroid pesticides, and Dr. Weston has demonstrated the ability to analyze pyrethroids (and other sediment-associated pesticides) at concentrations that cause toxicity in laboratory tests of sediment toxicity. Funding for this project is being pursued through the Pesticide Research and Identification of Source, and Mitigation (PRISM) Grant program administered by the State Water Resources Control Board.

Table 14. Most frequently monitored pesticides (DPR Surface Water Database, July 2000) and pesticides detected in SRWP Monitoring, 2000-2002: Major uses and total watershed applications.

Pesticide	Use category	Top uses in Sac. River watershed[1] (lbs applied x 1,000)	Total use reported for Sac. River watershed[1] (lbs x 1000) 1999	2000	2001	Detection by SRWP 2001-02[4]
Atrazine	Herbicide	Corn (4.6), sudan grass (4.3), forest trees (1.8), sorghum (0.078)	18	14	11	ND
Bromacil	Herbicide	Rights of way (4.9), citrus (0.086), landscape maintenance (0.043), nuts (0.023), structural pest control[3] (0.0016)	4.6	5.4	5.0	ND
Carbaryl	Insecticide	Rice (7.5), stonefruit[2] (6.6), melons (4.9), tomatoes (2.1) corn (1.8), apples (0.68), almonds (0.66), grapes (0.42),	37	58	27	Detected
Carbofuran	Insecticide	Alfalfa (2.9), cotton (2.2)	33	19	5.1	ND
Chlorpyrifos	Insecticide	Walnuts (62), pest control[3] (27), Alfalfa (13), almonds (12), cotton (4.6), stonefruit[2] (1.9), landscape maintenance (1.5), pears (1.1)	156	136	127	ND
Diazinon	Insecticide	Stonefruit[2] (30), pest control[3] (14), almonds (8.6), tomatoes (4.9), pears (4.3), walnuts (3.7), landscape maintenance (1.4)	99	93	68	Detected
Diuron	Herbicide	Rights of way (45), alfalfa (17), walnuts (9.2), landscape maintenance (2.3), grapes (1.8), olives (1.7)	96	112	79	Detected
EPTC	Herbicide	Safflower (5.7), alfalfa (4.4), beans (4.3), tomatoes (1.9), clover (0.7)	39	34	18	ND
Fonofos	Insecticide	None reported in Sacramento River watershed	0.68	0.20	0	NM
Malathion	Insecticide	Pest control[3] (22), walnut (16), Alfalfa (14), rice (1.9), landscape maintenance (1.2)	47	27	58	ND
Methomyl	Insecticide	Melons (4.5), tomatoes (4.0), beans (2.7), cucumbers (2..2), alfalfa (2.0), Sudan grass (1.6), corn (1.2), squash (0.7)	30	29	21	ND
Methyl parathion	Insecticide	Walnut (10.8), corn (0.1) pears (.005), apples (.005)	39	10	11	ND
Molinate	Herbicide	Rice (673)	851	951	673	Detected
Prometon	Herbicide	Rights of way (.00075)	0	2.5	.0075	Detected
Pendimethalin (Prowl)	Herbicide	Rice (4.5), walnuts (3.4), landscape maintenance (2.8), cotton (2.4), rights of way (1.9), sunflowers (1.8), almonds (1.6), beans (1.4), onions (0.8)	21	23	22	Detected
Simazine	Herbicide	Walnut (11), grapes (7.5), almonds (4.1), pears (2.6), olives (1.7), rights of way (0.29), pest control[3] (0.16)	29	40	27	ND
Thiobencarb	Herbicide	Rice (618)	703	993	619	Detected

(1) Total pounds of active ingredient applications reported in 2001 for major agricultural counties in Sacramento River watershed (Butte, Sutter, Colusa, Yolo, Yuba, Glenn, Sacramento, and Tehama) (DPR 2002). The DPR Pesticide Use database available for this report was characterized as "preliminary" by DPR.

(2) apricot, nectarines, peaches, plums, prunes

(3) public health and structural pest control

(4) Indicates whether detected in 2001-02 monitoring. "ND" = Not Detected, "NM" = Not Monitored

Table 15. Total Pounds Applied (1999 - 2001) and Toxicity Threshold Values for the Five Pyrethroid Pesticides Most-Used in the Sacramento River Watershed

	Total use reported for Sacramento River watershed[1], lbs x 1000				
Pesticide	1999	2000	2001	IRIS Rfd, µg/L	Minimum Toxicity Thresholds, µg/L (threshold type, taxonomic class)[2]
Bifenthrin	2.0	2.2	2.7	—[3]	0.004 (EC_{50}, crustacea)
Cyfluthrin	1.1	1.5	2.7	180	250,000 (LC_{50}, aves)
Cypermethrin	14.1	14.5	23.7	70	0.0047 (LC_{50}, crustacea) 0.0006 (LOEC, crustacea)
Esfenvalerate	6.8	5.6	5.8	—	0.15 (EC_{50}, crustacea) 0.07 (LC_{50}, fishes)
Permethrin	25.2	23.4	17.0	350	0.018 (minimum EC_{50}, crustacea)

(1) Total pounds of active ingredient applications reported for major agricultural counties in Sacramento River watershed (Butte, Sutter, Colusa, Yolo, Yuba, Glenn, Sacramento, and Tehama)
(2) From U.S. EPA's Environmental Fate and Effects Division of the Office of Pesticide Programs Pesticide Ecotoxicity Database, (USEPA 2000).
(3) "—" indicates no value reported.

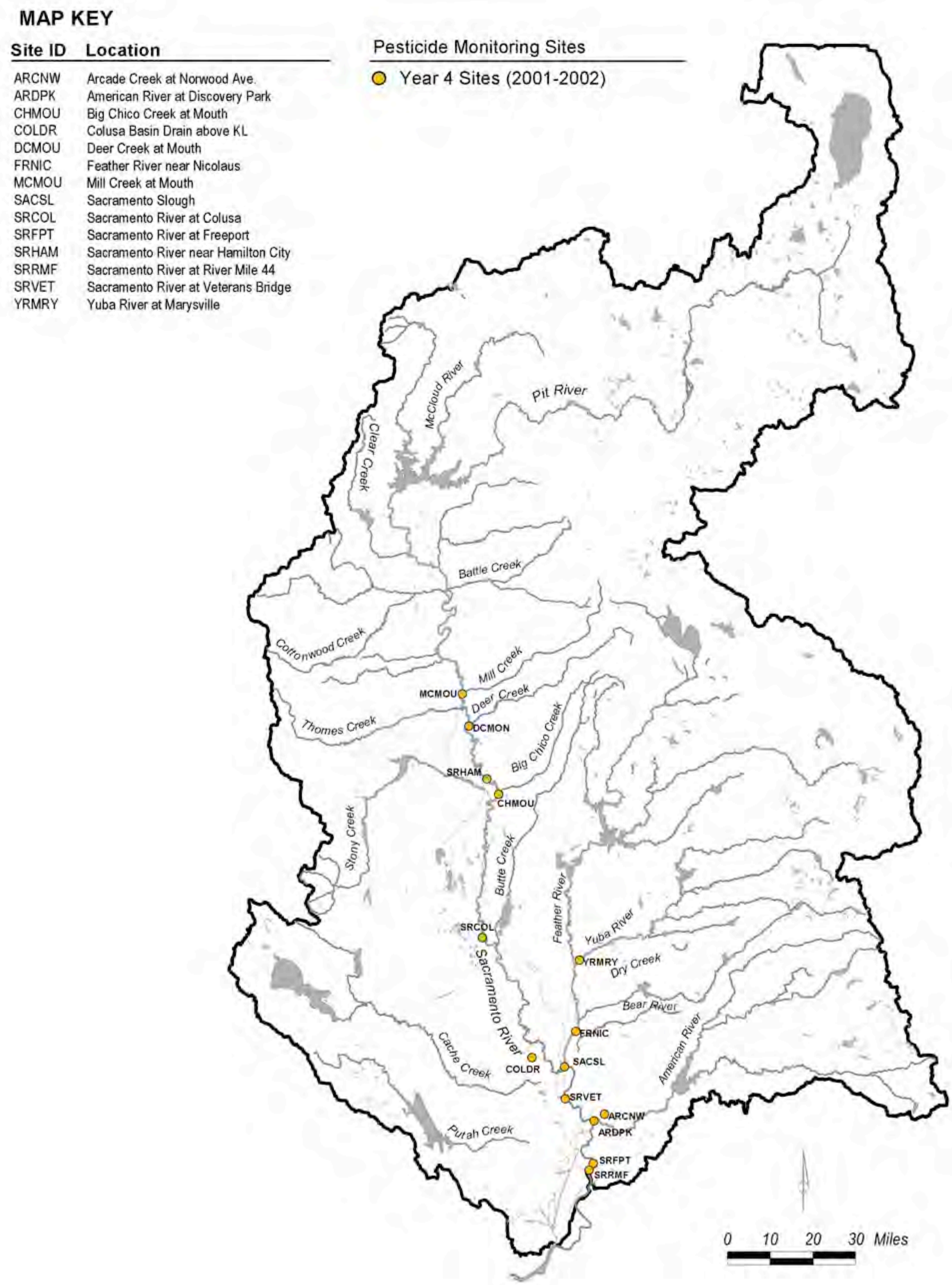

Figure 10. Pesticide Monitoring for the Sacramento River Watershed Program, 2001–2002 Monitoring Locations

2.4 Aquatic Toxicity

2.4.1 Background and Overview of Available Data

Aquatic toxicity monitoring in the mainstem Sacramento River and its tributaries was undertaken by the SRWP to characterize the spatial and temporal distribution of toxicity in surface waters of the watershed, and to identify potential sources and causes of toxicity. Laboratory toxicity tests were performed using USEPA procedures and the standard freshwater test organism, *Ceriodaphnia dubia* (water flea), seven-day reproduction and survival test to assess water quality. Tests using the fathead minnow (*Pimephales*) and the algae *Selenastrum capricornutum* were performed in previous monitoring years and are not reported in this document. Determination of significant toxicity for each test endpoint was accomplished using hypothesis testing statistical procedures described in the method documents for the specific tests[7] (USEPA 1994). Toxicity Identification Evaluations (TIEs) (USEPA 1991, 1992, 1993) were performed on selected samples to attempt to identify the toxicants responsible for repeated adverse effects in toxicity tests. The toxicity monitoring program (implemented in 1996 and continuing to present) was designed to assess the success of implemented pollution control programs (e.g. for rice pesticides), as well as to identify toxicity concerns in the study area.

Aquatic toxicity monitoring conducted in 2001–2002 was performed at 14 locations throughout the watershed. Sites monitored for aquatic toxicity monitoring were selected to provide an overall survey of the distribution of toxicity in the watershed and to coordinate with existing monitoring programs, and were located on the Pit River, the Sacramento mainstem, three major tributaries, two agricultural drainage-dominated sites, and one urban runoff-dominated site. In previous years, monitoring was also performed on eight smaller tributaries (Sacramento River above Shasta, McCloud River, Mill Creek, Deer Creek, Big Chico Creek, Clear Creek, and Butte Creek). The locations of the 2001-2002 monitoring sites are illustrated in Figure 11.

A total of 5 events, including three wet weather episodic events (of four planned events) and two dry weather events, were monitored at the 14 locations. Wet weather episodic events included the first significant watershed-wide storm event of the 2001-2002 wet season (late October 2001), the organophosphate pesticide dormant spray application period (mid-February 2002), and a late wet season rainfall event (March 2001). One dry weather "episodic" event was scheduled to coincide with late dry season low flows, and one with the highest probability for detecting rice herbicides (mid-May 2002). (Note: These events are also summarized in Table 10b in the previous section.)

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[7] Although the hypothesis testing procedures described in the USEPA 1994 document refer specifically to testing for differences between several treatments and a control, the methods are equally applicable to testing for differences between ambient water samples and a control. The specific statistical methods used for a particular sample depend on the results of each test and include both parametric t-tests and non-parametric equivalents.

A summary of a number of other relevant studies of aquatic toxicity in the Sacramento River watershed is provided in Table 16 (and are also summarized in more detail in de Vlaming *et al.* 2000). The critical results of these studies may be briefly summarized as follows:

Foe 1998—This study identified diazinon as the responsible toxicant in each of ten samples (out of 33) exhibiting toxicity from Orestimba Creek, San Joaquin River at Vernalis, and Sacramento Slough. Samples from the Sacramento River at Greene's Landing were not toxic to *Ceriodaphnia* (three samples, January 1997). Samples were collected following precipitation events of 0.5 inches or more.

DPR (Nordmark et al. 1998-2000, Gill 2002)—This five-year study by the Department of Pesticide Regulation is focused on the occurrence of toxicity attributable to detections of dormant-spray pesticides in a small agricultural drainage (Wadsworth Canal), the Sutter Bypass, and in the Sacramento River. Preliminary results reported from this ongoing study indicate that significant chronic toxicity was rarely observed in samples from the Sacramento River (one sample in 1998-99 monitoring, and one sample in 1999-00 monitoring). At the Sutter Bypass location, only acute toxicity to *Ceriodaphnia* was monitored, and no significant toxicity was observed (1996-1998). Acute toxicity monitoring was changed to the Wadsworth Canal location for 1998-99 monitoring, and multiple occurrences of acute toxicity to Ceriodaphnia were observed in 1998-99 and 1999-00 monitoring. The authors stated that occurrences of acute toxicity generally corresponded with diazinon concentrations of approximately 0.2 μg/L. Diazinon and methidathion were the most commonly detected pesticides, with occasional detections of carbaryl, diuron, simazine, bromacil, and hexazinone also reported. The highest concentrations and most frequent detections were reported for Wadsworth Canal. Results from monitoring in winter 2000-2001 were not available in time for inclusion in this report.

SFEI 1998—The Regional Monitoring Program for Trace Substances aquatic toxicity results for the Sacramento River: one of two samples caused significant toxicity to *Mysidopsis bahia* (shrimp), zero of two samples caused significant toxicity to *Mytilus edulis* (mussel) larvae.

DPR 1998—Studies performed by the Department of Pesticide Regulation have concluded that aquatic toxicity attributed to pesticides in rice field drainage has been greatly reduced, due to changes in farming practices and extended holding times for applied pesticides.

CVRWQCB 2000—Sacramento River Watershed Program aquatic toxicity data for 1998-1999 have also been compiled and reported in a separate report prepared by the Central Valley Regional Water Quality Control Board.

Table 16. Selected Aquatic Toxicity Monitoring Programs in the Sacramento River Watershed

Program	Monitoring Period and (frequency)	Parameters	# of sampling locations & geographic reference
SRWP	8/96–5/00 (monthly); 7/00–5/02 (episodic)	▪ 7-day *Ceriodaphnia* toxicity tests ▪ 4-day *Selenastrum* toxicity tests ▪ 7-day *Pimephales* toxicity tests ▪ Toxicity Identification Evaluations	21 sampling sites throughout the Sacramento River watershed (*Selenastrum* testing limited to 3 sites after 5/98; *Pimephales* testing discontinued after 5/99)
Regional Board/CalFed	6/99–5/00 (monthly)	▪ 7-day *Pimephales* toxicity tests	24 sampling sites throughout the Sacramento River watershed
CUWA	2/98–3/99 (monthly)	▪ *Pimephales* toxicity tests with SRWP samples split with UCD Aquatic Toxicology Lab	6 SRWP sites: 5 mainstem Sacramento River sites and one Feather River site
DWR Special Tributary Monitoring	6/98–5/00 (monthly)	▪ 7-day *Ceriodaphnia* and 10-day*Pimephales* toxicity tests ▪ Toxicity Identification Evaluations	27 (*Cerio.*) sampling sites in Sac River tributaries (Clear Ck, Mill Ck, Deer Ck, Big Chico Ck)
SF Bay Regional Monitoring Program (SFEI 1997)	1994–1997 (episodic storm events)	▪ 48-hour *Mytilus* and *Crassostrea* toxicity tests, and 7-day *Mysidopsis bahia* toxicity tests ▪ Dissolved and particulate diazinon and chlorpyrifos in water	10-13 Bay-Delta sampling sites, including the Sacramento River and San Joaquin River at the Delta terminus
CVRWQCB (Foe *et al*. 1998)	1996 and 1997 wet seasons	▪ 7-day *Ceriodaphnia* toxicity tests ▪ Toxicity Identification Evaluations ▪ Dormant-spray pesticides in water	4 sampling sites: Sac Slough and Sac River at Greene's Landing; Orestimba Ck, and San Joaquin River at Vernalis
DPR (Nordmark *et al*. 1998-00)	1996–00, weekly during dormant spray season	▪ 96-hour and 7-day *Ceriodaphnia* toxicity tests ▪ Dormant-spray pesticides, herbicides in water	2 Sutter Bypass sampling sites, Wadsworth Canal, 1 sampling site at Sacramento River at Bryte *or* Alamar
DPR (Spurlock 2002)	1991-2001	▪ Chlorpyrifos, diazinon ▪ Acute Toxicity	Meta-analysis of 32 surface water and dormant spray studies
Rice Pesticide Monitoring (DPR 1995-98)	1995-1999 (episodic discharge events)	▪ 96-hour *Ceriodaphnia* toxicity tests ▪ Rice pesticides in water	4 sampling sites: Colusa Basin Drain, Butte Slough, and Sacramento River at Village Marina and near Bryte
CVRWQCB, CALFED	9/00–8/01	▪ 4-day *Selenastrum* toxicity tests	8 sites in the Sacramento River watershed *(data not available for review)*

2.4.2 Attainment of Beneficial Uses and Potential Impairment

Comparisons with water quality criteria and 303(d) listings: What do the data say about attainment of beneficial uses and potential impairment? Toxicity to aquatic organisms in surface waters outside designated mixing zones[8] is prohibited by the Basin Plan's enforceable narrative water quality objective:

> *"All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Water Board."*

The results of SRWP monitoring and other studies have documented that water collected from different streams and rivers throughout the watershed have episodically caused toxicity to zooplankton, fish larvae, and algal test organisms (*Ceriodaphnia*, *Pimephale*s, and *Selenastrum*, respectively). The magnitude of statistically significant effects observed on test organisms ranged from small decreases in growth or reproduction to 100% mortality of the test organisms. However, whether such observed toxicity to test organisms indicates non-attainment of specific designated beneficial uses remains open to interpretation. Observed toxicity to test organisms may be of ecological significance, e.g. if it translates to significant decreases in instream populations of resident species. Although the link between significant effects in laboratory toxicity tests and ecosystem impairment has not been definitively established, some studies have established that there is a statistically significant relationship between laboratory results and ecosystem effects, most clearly for highly toxic point source discharges (de Vlaming *et al*. 2000). For the purpose of the evaluations performed herein, it is assumed that toxicity to test organisms is an indication of potential impairment to aquatic species and ecosystems.

As stated previously, toxicity in surface waters is prohibited by the Basin Plan, and violations of this prohibition have resulted in waterbodies being included on the 303(d) List of impaired waterbodies. A number of sites have been included on California's 1998 303(d) list of impaired waterbodies for toxicity of unknown cause and for organophosphate pesticides (Table 17), which have been identified as causes of observed toxicity in the watershed. The observed toxicity attributed to diazinon and chlorpyrifos in Arcade Creek samples is consistent with the 303(d) listings of this and several other waterbodies for toxicity due to these pesticides. The Sacramento River mainstem from Shasta to the Delta, the lower Feather River, and the American River are all listed for toxicity of unknown causes(s), and some samples from each of these reaches were toxic to test organisms in previous monitoring years. The causes of observed toxicity at these

[8] The Central Valley Basin Plan states that mixing zones *may* be allowed and that objectives *may* not apply within designated mixing zones, but will apply at the edge of designated mixing zones (CVRWQCB 1995). If granted, mixing zones are generally designated in NPDES permits for specific point source discharges. None of the locations monitored by the SRWP are within designated mixing zones.

locations has not yet been determined. The Toxicity Focus Group of the SRWP has developed a strategy to address toxicity of unknown causes and has applied for funding from CALFED to begin implementing the strategy.

Table 17. Waterbodies cited for unknown toxicity and organophosphate pesticides on California 1998 303(d) list or Recommended for Addition to the 2002 303(d) List

Waterbody	Cause for Listing	Source	Area Affected	Units
1998 303(d)-listed waterbodies				
Delta Waterways(2)	Unknown Toxicity(1)	Source Unknown	48,000	Acres
Delta Waterways(2)	Chlorpyrifos, Diazinon	Agriculture, Urban Runoff	48,000	Acres
American River, Lower(3)	Unknown Toxicity	Source Unknown	23	Miles
Arcade Creek	Chlorpyrifos, Diazinon	Agriculture, Urban Runoff	10	Miles
Cache Creek(3)	Unknown Toxicity	Source Unknown	35	Miles
Chicken Ranch Slough(3)	Chlorpyrifos, Diazinon	Agriculture, Urban Runoff	5	Miles
Colusa Basin Drain(2)	Unknown Toxicity	Agriculture	70	Miles
Elder Creek(3)	Chlorpyrifos	Urban Runoff	10	Miles
Elder Creek(3)	Diazinon	Agriculture, Urban Runoff	10	Miles
Elk Grove Creek(3)	Diazinon	Agriculture, Urban Runoff	5	Miles
Feather River, Lower(2)	Unknown Toxicity	Source Unknown	60	Miles
Feather River, Lower(2)	Diazinon	Agriculture, Urban Runoff	60	Miles
Morrison Creek(3)	Diazinon	Agriculture, Urban Runoff	20	Miles
Natomas East Main Drain(2)	Diazinon	Agriculture, Urban Runoff	5	Miles
Sacramento River (Red Bluff to Delta(2))	Unknown Toxicity	Source Unknown	185	Miles
Sacramento River (Red Bluff to Delta(2))	Diazinon	Agriculture	30	Miles
Sacramento River (Shasta Dam To Red Bluff(2))	Unknown Toxicity	Source Unknown	50	Miles
Sacramento Slough(3)	Diazinon	Agriculture, Urban Runoff	1	Miles
Strong Ranch Slough(3)	Diazinon	Agriculture, Urban Runoff	5	Miles
Waterbodies recommended for addition to the 2002 303(d) List				
Lower Bear River	Diazinon	Agriculture	21	Miles
Jack Slough	Diazinon	Agriculture	14	Miles
Butte Slough	Diazinon, Molinate	Agriculture	8.9	Miles
Sutter Bypass	Diazinon	Agriculture	19	Miles

(1) "Unknown Toxicity" is the term used in the 303(d) List to indicate toxicity of unknown cause(s).
(2) Area Affected was reduced in 2002 update (CVRWQCB 2003)
(3) Area Affected was increased in 2002 update (CVRWQCB 2003)

2.4.3 Spatial and Temporal Patterns

Toxicity testing results from 2001–2002 monitoring are summarized in Tables 18 and 19. It should be noted that the spatial and temporal coverage of the watershed by SRWP and other monitoring efforts are not adequate to completely characterize and evaluate the incidence and significance of aquatic toxicity throughout the watershed. However, the results available so far have demonstrated some consistent temporal and spatial patterns discussed below.

Results from the 2001–2002 survey confirmed some patterns of toxicity observed in previous surveys, and presented unexpected results in other cases. The results of 2001–2002 aquatic toxicity monitoring can be summarized as follows:

2.4.3.1 Mortality

- Thirteen of 62 samples collected (21%) caused significant mortality[9] to *Ceriodaphnia*. Nine of the 13 samples causing mortality were collected during the dry season event collected in September 2001. Mortality was widespread in the watershed for this event, with only Colusa Basin Drain and Sacramento River at Freeport exhibiting no significant toxicity. During this event, mortality generally decreased or was less extreme toward the southern part of the watershed, e.g. periods to exhibit 100% mortality became longer, and mortality was lower or not significant for lower watershed samples (with the exception of Arcade Creek). There was no obvious environmental cause for the observed widespread toxicity, although the spatial pattern suggests a possible atmospheric source. None of the seven samples that were re-tested exhibited significant mortality, and only two (Sacramento River at Hamilton City and Colusa) exhibited significant reductions in reproduction. The remaining four samples causing mortality for other events were collected from one mainstem Sacramento River site (one event), one American River site (one event), and from Arcade Creek (two events).
- Arcade Creek was the only site that exhibited significant mortality or reproductive toxicity for the seasonal first flush rainfall event collected in October.
- Significant mortality was observed in only one sample from the two agricultural drainage-dominated sites (Colusa Basin Drain and Sacramento Slough) in monitoring conducted 2001-2002. No significant mortality was observed in the previous monitoring periods (1999-2001). Monitoring performed prior to 1996 reported 100% *Ceriodaphnia* mortality in samples collected from these sites during the spring, when rice field runoff was present in surface waters (Connor *et al.* 1993). The long-term decrease in toxicity at these locations is attributed largely to the effectiveness of changes in pesticide application practices and longer holding times implemented by the rice farming industry for rice flood water to allow for degradation of pesticides.
- Three of five samples collected in 2001-2002 from Arcade Creek at Norwood Avenue caused severe mortality (100%) to *Ceriodaphnia*. Five Arcade Creek samples were

[9] Significant mortality is defined as ≥20% mortality that is significantly different from controls at a 95% statistical confidence level.

treated with piperonyl butoxide (PBO), which prevents metabolic activation of organophosphate pesticides. PBO eliminated mortality in the three samples that caused significant mortality, indicating that some or all of the toxicity was due to a metabolically activated toxicant such as diazinon or chlorpyrifos. PBO treatments caused significant reproductive toxicity in the two non-toxic Arcade Creek samples.

2.4.3.2 Reproductive toxicity

- Significant adverse reproductive effects to *Ceriodaphnia* have been observed at nearly every location monitored in the Sacramento River watershed during the past four years. In 2001–2002 monitoring, 7 of 21 samples (33%) collected from five Sacramento River mainstem sites from Redding to Freeport caused significant decreases in reproduction. Four of 15 samples (27%) collected from the major tributary sites (American River, Yuba River, and Feather River) also caused adverse reproductive effects. Twelve of the 13 total samples causing reproductive toxicity were collected during the dormant spray application event and the rice field discharge event, although several sites exhibiting toxicity were outside of the areas expected to be impacted by these sources. In all of these cases, the specific causes of observed reproductive toxicity have not been determined. In 2001-2002 monitoring, one of five samples from Colusa Basin Drain and one of five samples from Sacramento Slough caused significant adverse reproductive effects.
- In the three toxic and two non-toxic Arcade Creek samples treated with PBO, the treatment removed all significant mortality, but appeared to cause reproductive toxicity.

The watershed-wide pattern of reproductive toxicity to *Ceriodaphnia* observed in the months of January and February of 1997-2000 and not observed in 2001, seemed to re-appear in February 2002. This period typically coincides with seasonal high flows and application of dormant-spray pesticide applications. However, 2000-2001 was a relatively low rainfall year in the watershed with below-normal precipitation in January and February, and normal seasonal high flows did not occur in the Sacramento River mainstem or in the major tributaries. Although higher in 2001-2002, rainfall and river flows were still below-average for the year. Although there were no strong seasonal patterns observed in the incidence of significant toxicity to *Ceriodaphnia* in 1998-2002 monitoring (Figures 12 and 13), the results of the SRWP and other monitoring programs support the conclusion that significant adverse effects on test organisms (at most locations) tend to be associated with episodic events. The episodic events most commonly associated with observed toxicity are the application and subsequent runoff of dormant-spray pesticides from agricultural areas, and seasonal hydrologic events such as first-flush storms in areas affected by urban runoff. However, in 2001-2002 monitoring, the most severe and widespread toxicity was observed during a scheduled dry season event not associated with any known hydrological or weather event. This result highlights the pitfalls of monitoring focused solely on known episodic events.

2.4.4 Conclusions and Recommendations

Samples collected from Arcade Creek at Norwood Avenue continue to exhibit a higher frequency and severity of toxicity than all other tributaries and mainstem Sacramento

River sites sampled. This pattern was also exhibited in limited sampling of two other locations in the Arcade Creek urban watershed in 2000-2001.

The results of the 2001-2002 monitoring and of previous aquatic toxicity monitoring efforts have confirmed that significant toxicity to test organisms occurs in surface waters throughout the watershed. *Ceriodaphnia dubia* toxicity attributable to organophosphate pesticides in agricultural runoff and urban runoff has been definitively shown by SRWP monitoring and other studies. The widespread mortality observed in September 2001 was not associated with any known causes of toxicity, and suggests a need to continue to monitor for episodic toxicity during a wide range of hydrologic and weather conditions.

Regularly scheduled monitoring conducted from 1998–2000 was valuable in beginning to evaluate the overall frequency and distribution of observed water column toxicity, and for identifying or confirming the causes of some of the observed toxicity. However, spatial and temporal coverage of the watershed by SRWP and other programs is far from comprehensive, and significant questions remain regarding the sources, severity, persistence, and ecological significance of periodic toxicity in surface waters of the Sacramento River watershed. It is clear that definitively addressing all of these questions will require monitoring and studies of much greater scope (and cost) than the current efforts by SRWP and other programs. To address some of these questions, the SRWP aquatic toxicity monitoring effort in 2000-2002 has focused primarily on monitoring specific episodic events (e.g. agricultural dormant spray season, runoff events, high flow events). This strategy resulted in observation of more frequent and severe toxicity in the Arcade Creek urban watershed, but did not result in a notably greater frequency of observed toxicity for other locations. However, the 2000-2001 and 2001-2002 wet seasons both had below-average rainfall and fewer rainfall events may have affected the frequency (or magnitude) of episodic aquatic toxicity throughout the watershed. Additionally, interpretation of these two seasons of monitoring only a handful of episodic events must be cautious because the causes and timing of significant episodic toxicity events may differ greatly in different waterbodies, and the likelihood of missing a particular toxic event is high. Although even a single toxic event of sufficient severity has the potential to have significant adverse ecosystem impacts if key species are affected, there is currently insufficient evidence to either support or rule out such a hypothetical event. Episodic monitoring of aquatic toxicity was continued in the 2002-2003 monitoring season.

Table 18. Summary of 2000-2001 Aquatic Toxicity Monitoring Survey Results: Samples Exhibiting Significant Toxicity to *Ceriodaphnia dubia*

		Samples Exhibiting Significant Toxicity(1)			
	total samples collected	Significant reduction in reproduction		Significant Mortality (>20%)	
Monitoring Location	n	n	%	n	%
Pit River above Shasta	4	1	25%	1	25%
Sacramento River below Keswick Reservoir	4	1	25%	1	25%
Sacramento River above Bend Bridge	4	1	25%	2	50%
Cottonwood Creek at Main Street	3	0	0%	1	33%
Sacramento River near Hamilton City	4	1	25%	1	25%
Sacramento River at Colusa	4	2	50%	1	25%
Sacramento Slough	5	1	20%	1	20%
Colusa Basin Drain	5	1	20%	0	0%
Yuba River near Marysville	5	1	20%	1	20%
Feather River at Nicolaus	5	2	40%	1	20%
American River at Discovery Park	5	2	40%	0	0%
Sacramento River at Freeport	5	2	40%	0	0%
Arcade Creek at Norwood Avenue	5	0	0%	3	60%
Cache Creek near Runsey	4	0	0%	0	0%
	62	15	24%	13	21%

(1) Significant toxicity is defined as increased mortality and/or decreased reproduction that is significantly different from controls at a 95% statistical confidence level.

Table 19. SRWP 2000–2001 Toxicity Test Results, Reproduction and Mortality in *Ceriodaphnia*

Site	Late Dry Season, Low Flows 9/23-9/26 2001	Seasonal "First Flush" Storm 10/31-11/6 2001	Significant Rainfall of >0.5 inches, OP Pesticide Application Period 2/17-2/23 2002	Significant Rainfall of >0.5 inches within 24 hours 3/7-3/8 2002	Rice Field Discharge Period; Late Wet Season 5/14-5/16 2002
	Toxicity Testing endpoints[(2)]: Reproduction (average neonates/adult) *% Mortality (Days to 100% Mortality)* Event Types and Dates:				
Laboratory Control[(1)]	20.4-48.1 *0-10*	22.8-39.9 *0-20*	20.4-39 *0-10*	0-32 *0-10*	19.4-26.5 *0-10*
Pit River above Shasta	0.0 *100 (1)*	55.1 *20*	28.7 *0*		23.7 *0*
Sacramento River below Keswick	0.0 *100 (1)*	30.6 *10*	31.9 *10*		15.0 *20*
Sacramento River above Bend Bridge	0.0 *100 (1)*	29.0 *10*	8.0 *10*		11.2 *40*
Cottonwood Creek at Main Street	4.1 *90*	23.9 *30*			23.8 *0*
Sacramento River near Hamilton City	13.5 *100 (6)*	30.2 *0*	20.7 *0*		16.6 *22*
Sacramento River at Colusa	8.6 *100 (6)*	29.0 *10*	22.7 *0*		13.1 *20*
Sacramento Slough	9.8 *50*	28.7 *10*	19.1 *10*	27.6 *0*	23.5 *10*
Colusa Basin Drain	23.9 *10*	33.6 *10*	37.7 *10*	4.9 *50*	15.7 *20*
Yuba River near Marysville	14.9 *40*	27.2 *0*	21.0 *10*	18.7 *20*	24.3 *20*
Feather River near Nicolaus	16.3 *0*	33.0 *10*	25.9 *0*	1.7 *90*	13.8 *10*
American River at Discovery Park	22.2 *0*	31.8 *10*	26.9 *0*	20.9 *0*	15.2 *20*
Sacramento River at Freeport	32.6 *20*	27.9 *10*	17.9 *10*	5.7 *40*	12.1 *20*
Arcade Creek at Norwood Avenue	0.0 *100 (3)*	0.0 *100 (3)*	33.2 *10*	0.0 *100 (6)*	24.9 *10*
Arcade Ck at Norwwod + 100 ppb PBO	0.0 *0*	7.9 *0*	9.0 *0*	6.4 *0*	7.7 *0*
Arcade Ck at Norwwod + 200 ppb PBO		2.9 *0*			
Cache Creek near Rumsey	31.3 *10*	20.7 *10*	26.5 *0*		22.2 *10*

Table Notes:
(1) The laboratory controls met all EPA criteria for test acceptability.
Ceriodaphnia tests for different locations were set up on separate days. Range of data for separate controls is shown.
(2) Outlined cells indicate a significant reduction in reproduction or increase in mortality (>20%) compared to the laboratory control.
The reproduction endpoint was analyzed with Dunnett's test and the mortality endpoint was analyzed with Fisher's exact test (p<.05).
(3) Piperonyl butoxide (PBO) prevents toxic action of metabolically activated organophosphate pesticides.

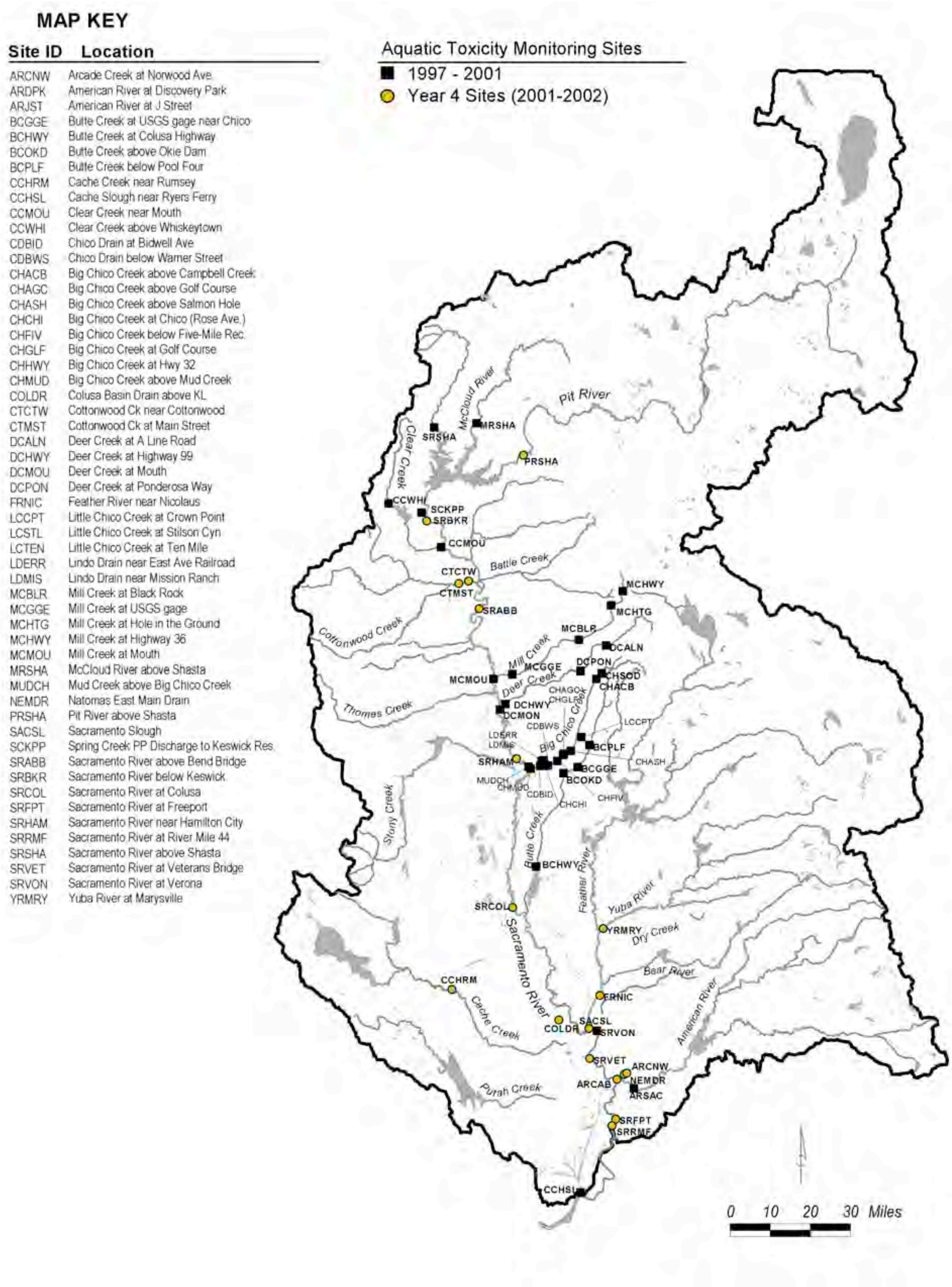


Figure 11. Aquatic Toxicity Monitoring for the Sacramento River Watershed Program, 1997-2002 Monitoring Locations

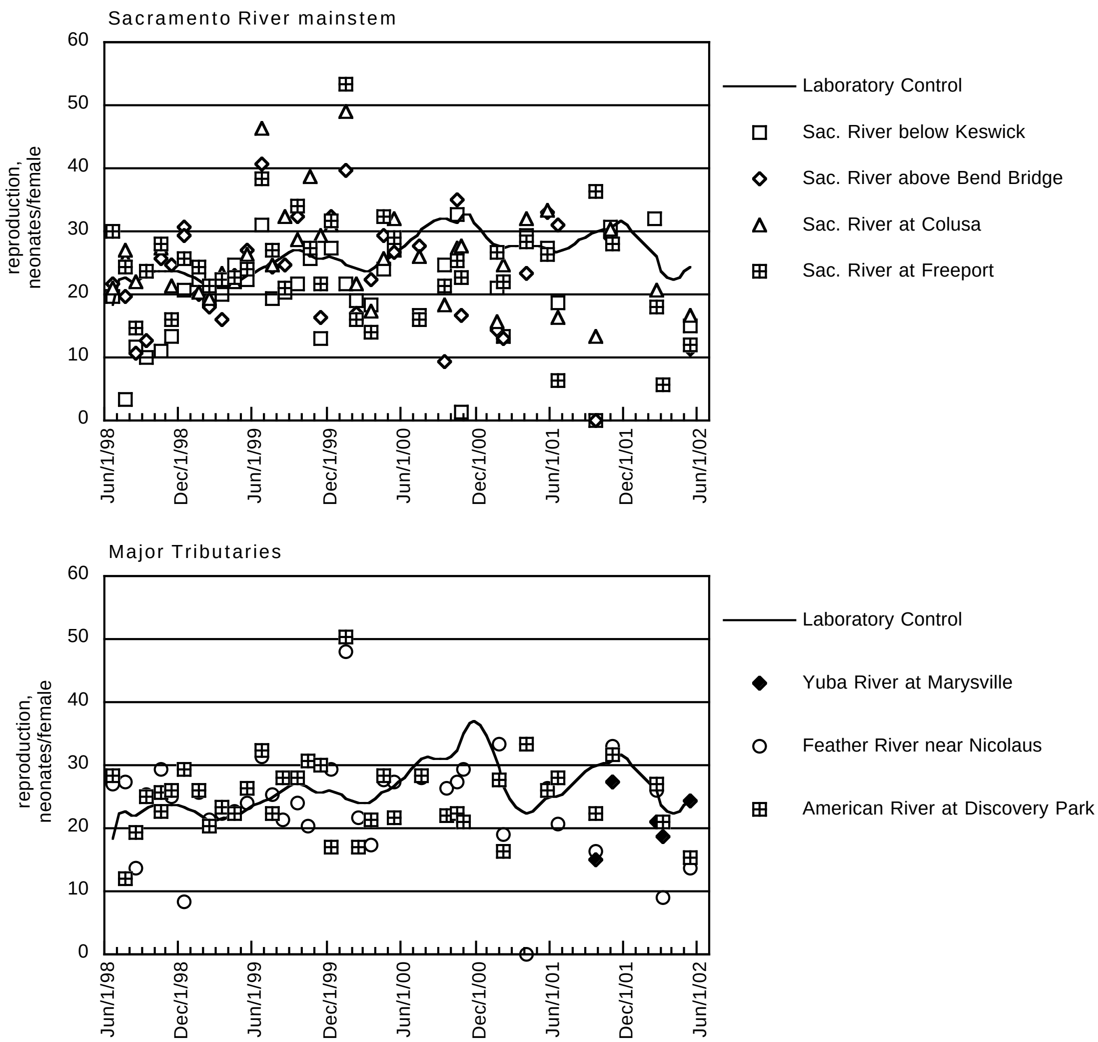


Figure 12. *Ceriodaphnia* reproduction in samples from the mainstem Sacramento River and major tributaries

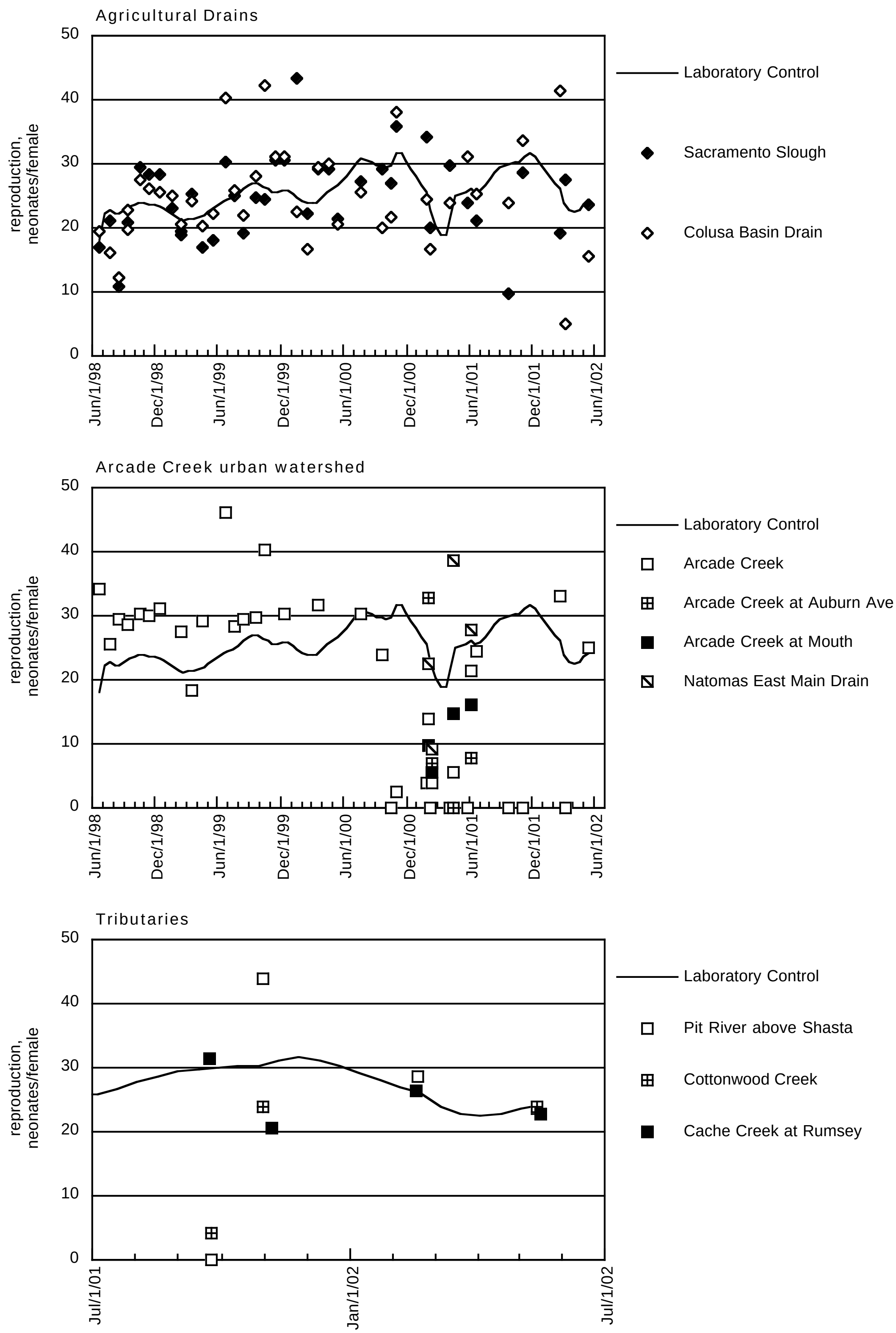


Figure 13. *Ceriodaphnia* reproduction in samples from agricultural drains, the Arcade Creek urban watershed, and other tributaries

2.5 Drinking Water Parameters of Concern

2.5.1 Background and Available Data Overview

For the purposes of this analysis, drinking water parameters are grouped into four categories: total dissolved solids, organic carbon and ultraviolet absorbance, nitrogen and phosphorus compounds, and bacterial pathogen indicators. Minerals, *Cryptosporidium* and *Giardia*, and taste effects of some rice pesticides are also considered parameters relevant to drinking water beneficial uses, but were not monitored in 2001-2002. The parameters included within each category are discussed below in terms of their attainment of beneficial uses, and spatial and temporal distributions, if additional evaluation was warranted. For selected parameters, relative contribution to mass loads within the Sacramento-San Joaquin Delta are also discussed. General spatial distribution patterns, when considered, are described in terms of mean or median concentrations, as appropriate. Summary statistics for all parameters discussed are provided in Appendix A.

The sources of data utilized for this report are summarized in Table 20. The monitoring locations for the primary data considered for this report (USGS NAWQA, Sacramento River Coordinated Monitoring Program, City of Redding NPDES monitoring, the California Department of Water Resources, and the Sacramento River Watershed Program) are illustrated in Figure 14.

Table 20. Selected Drinking Water Monitoring Programs in the Sacramento River Watershed

Program	Monitoring Period(s)	Parameters	# of sampling locations & geographic reference
NAWQA (USGS)	2/96–4/98 (through 2002 for Sacramento River at Freeport)	▪ Total Dissolved Solids in water ▪ Total and Dissolved Organic Carbon in water ▪ Nutrients in water: nitrite as N; nitrate as N; ammonia as N organic nitrogen as N; dissolved orthophosphate as P; total phosphorus as P ▪ General Minerals in water: total alkalinity; sodium; chloride; sulfate; calcium; dissolved magnesium, manganese, potassium, iron, silica as SiO_2	12 sampling sites distributed throughout the Sacramento River watershed
SRWP	6/98–6/02	▪ Total Dissolved Solids in water ▪ Organic carbon and UVA_{254} in water ▪ Nutrients in water: nitrite as N nitrate as N; ammonia as N dissolved orthophosphate as P total phosphorus as P ▪ General Minerals in water: Total Alkalinity; Sodium; Chloride; Sulfate; Calcium; Total Magnesium, Manganese, Potassium, Iron ▪ Total and Fecal Coliform and E. coli in water ▪ *Giardia* and *Cryptosporidium* in water	12 sampling sites on Sacramento River and major tributaries
MWQIP (DWR)	3/86–3/98 (1/96–3/98 considered for present analysis)	▪ Total Dissolved Solids in water ▪ Dissolved Organic Carbon in water ▪ Nutrients in water: Nitrate as N; Ammonia as N ▪ General Minerals in water: Total Alkalinity; Sodium; Chloride; Sulfate; Calcium; Dissolved Magnesium, Potassium ▪ Fecal Coliform in water	19 sampling sites distributed throughout the Sacramento-San Joaquin Delta (5 sites considered for present analysis)
CMP (SRCSD)	12/92–6/02 (10/96–6/02 considered for present analysis)	▪ Total Dissolved Solids in water ▪ Organic carbon and UVA_{254} in water ▪ Nutrients in water: nitrite as N nitrate as N; ammonia as N dissolved orthophosphate as P total phosphorus as P ▪ Total and Fecal Coliform and E. coli in water ▪ *Giardia* and *Cryptosporidium* in water	5 sites on Sacramento and American rivers in Sacramento metropolitan area
City of Redding	1/98–5/01	▪ Total Dissolved Solids in water	1 site at Sacramento River below Keswick Dam

2.5.2 Attainment of Beneficial Uses and Potential Impairment

2.5.2.1 Comparisons with Relevant Water Quality Objectives

The Central Valley Basin Plan has adopted by reference California Title 22 of the California Code of Regulations Maximum Contaminant Levels (MCLs) for drinking water, as Basin Plan objectives. Specifically, the Basin Plan states:

> *"At a minimum, water designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the following provisions of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan: Tables 64431-A (Inorganic Chemicals) and 64431-B."*

Note that these drinking water MCLs are originally intended to apply to finished tap water, rather than to untreated sources of drinking water. Comparisons of surface water characteristics with MCLs clearly indicate that there is no impairment due to a specific parameter when the MCL for that parameter is not exceeded. Exceedances of MCLs in untreated source water indicate that there is some potential for increased treatment costs or for exceedances of the MCL in the treated drinking water, but are not definitive evidence that the use is impaired. For the purpose of these evaluations, it is assumed that waters that comply with MCLs are achieving the designated use as sources of drinking water, and that exceedance of MCLs indicate potential impairment of this use.

Existing applicable water quality objectives and goals for the parameters included within three drinking water categories (TDS, TOC and DOC, and pathogens) are listed in Table 22. Median concentrations of selected drinking water-related parameters monitored in 2000-2001 are presented in Table 23. The results of comparisons with these numeric thresholds can be summarized as follows:

- Total dissolved solids (TDS) concentrations in surface waters monitored in the Sacramento River watershed were observed to exceed DHS and USEPA's Secondary Drinking Water Standard Maximum Contaminant Level (MCL) of 500 mg/L once in Sacramento Slough and twice in Colusa Basin Drain. Long-term median concentrations were well below the 500 mg/L MCL at both sites. TDS concentrations were not observed to exceed the 500 mg/L MCL at any other sites.
- Total organic carbon concentrations were compared to the 2.0 mg/L TOC treatment threshold included in the Stage 1 Disinfectants/Disinfection By-products (D/DBP) Rule. This regulation is designed to limit precursors to disinfection byproducts such as trihalomethanes, which are human carcinogens. In cases where the running annual average TOC in source water (measured at water treatment plant intakes) is 2.0–4.0 mg/L, water utilities may be required to remove up to 35% of the TOC (depending on source water alkalinity) unless they meet other specific quality or treatment technology requirements[10]. If the running average source water TOC is greater than

[10] Utilities would not have to meet these removal requirements if they meet one of several possible conditions, including: (1) average TOC in their treated water less than 2.0 mg/L; (2) average levels of haloacetic acids and trihalomethanes below 30 μg/L and 40 μg/L, respectively, or a clear commitment to

4.0 mg/L, water utilities may be required to remove up to 45% of the TOC in their influent. Total organic carbon concentrations occasionally exceeded the D/DBP goal at all sites evaluated (Table 22). TOC concentrations measured in Sacramento Slough and the Colusa Basin Drain exceeded the 2 mg/L D/DBP treatment threshold in almost every sample analyzed, and exceeded the 4.0 mg/L threshold in more than 50% of samples collected. The percentage of TOC concentrations in the mainstem Sacramento River exceeding the 2 mg/L D/DBP threshold value increased in a downstream direction from Keswick to Veterans Bridge. The Yuba, Feather, and American rivers also occasionally have TOC concentrations above the relevant drinking water quality threshold value, with percent exceedances ranging from 15% (in the Yuba River at Marysville) to 50% (in the Feather River near Nicolaus). Long-term average TOC concentrations were greater than 2.0 mg/L at most locations monitored, with the exception of the Yuba River, the American River, the Sacramento River above Bend Bridge, and several smaller tributaries.

Included in the D/DBP Rule is a provision that utilities would not have to meet these removal requirements if the average Specific UV Absorbance (SUVA) is less than 2.0 L/mg-m in source water <u>or</u> treated water. SUVA is defined as the ratio of ultraviolet absorbance at 254 nm to the dissolved organic carbon concentration (UVA_{254}/DOC), and is used as a measure of the ability of organic carbon to react with disinfectants and form trihalomethanes and other disinfection by-products. UVA_{254} has only been measured in 5 events 2001-2002 by the SRWP, and in several more events by the Sacramento Coordinated Monitoring Program. However, these preliminary results indicate that average SUVA is greater than the 2.0 L/mg-m D/DBP threshold in Sacramento River watershed surface waters monitored for this parameter (the Sacramento River mainstem and three major tributaries, and the two agricultural drains).

- Fecal coliform numbers were evaluated in comparison to the Basin Plan water quality objective of 200 Most Probable Number (MPN) per 100 milliliters (ml) as a geometric mean value and a maximum value of 400 MPN/100 ml. Long-term geometric mean fecal coliform numbers exceeded the 200 MPN/100 ml objective only at Natomas East Main Drain, which also exceeded the 400 MPN/100 ml objective in 13 of 34 samples collected from 2000-2002. Maximum fecal coliform numbers were observed to exceed the 400 MPN/100 ml objective in the Sacramento River (in 17 of 238 total samples from the mainstem), in the American River (in 6 of 66 samples), in the Yuba River (1 of 5 samples), and Feather River (1 of 9 samples), and in Cache Slough (in 3 of 12 samples).

Total and fecal coliform data are also relevant to another important beneficial use, contact recreation. Although USEPA has identified as a priority the transition to using *E. coli* and *Enterococcus* bacteria (instead of total and fecal coliform bacteria) as indicators of microbial contamination (Action Plan for Beaches and Recreational Waters; EPA/600/R-98/079, March 1999), in this same document, USEPA reaffirmed commitment to the limits established in the 1986 criteria document (*Ambient Water*

implement treatment to meet these levels by June 2005; or (3) average Specific UV Absorbance (SUVA) less than 2.0 L/mg-m in source water <u>or</u> treated water.

Criteria for Bacteria—1986), which include specific limits for total and fecal coliform bacteria. The 1986 criteria document is also referenced in USEPA's *National Recommended Water Quality Criteria* (USEPA 1999). The California Department of Health Services (DHS) *Guidance for Freshwater Beaches* (Draft, February 11, 2000) recommends limits and testing for total and fecal coliform bacteria, as well as *E. coli* or *Enterococcus*. The non-regulatory DHS *Guidance* also cites the numbers of bacteria at which closing and posting beaches is recommended. These recommended limits are identical to the limits cited by USEPA in the 1986 criteria document (*Ambient Water Criteria for Bacteria—1986*). In 2002, CVRWQCB Staff recommended adopting the recommended limits for *E. coli* in the Basin Plan for the Central Valley (CVRWQCB 2002).

For the purpose of evaluating achievement and potential impairment of contact recreational uses, total and fecal coliform and *E. coli* data were compared to the limits recommended by CVRWQCB staff, USEPA, and DHS. The recommended limits for total coliform are 1,000 MPN/100 mL as a 5-sample 30-day geometric mean and 10,000 MPN/100 mL as a single sample maximum. The single sample limit for total coliform bacteria was exceeded in four of 66 samples collected from the American River at Discovery Park, and in one of 68 samples from the Sacramento River at Veterans Bridge. The long-term geometric mean was below the 1,000 MPN/100 mL limit at all locations monitored. The limits for fecal coliform bacteria are essentially the same values adopted in the Central Valley Basin Plan (200 MPN/100 mL as a geometric mean and 400 MPN/100 mL as a single sample maximum). Comparisons to fecal coliform limits are provided in previous paragraphs.

The recommended limits for *E. coli* are 126 MPN/100 mL as a 5-sample 30-day geometric mean and 235 MPN/100 mL as a single sample maximum. The single sample limit for *E. coli* was exceeded at nearly every site, but the long-term geometric means exceeded the 126 MPN/100 mL recommended objective only at Natomas East Main Drain. It should be noted that SRWP began monitoring *E. coli* in 2001-2002 and that these data are biased by the focus on episodic rainfall events, which are expected to result in elevated bacteria counts in surface waters. This also applies to other total and fecal coliform data, but to a lesser degree, since these data sets have longer and less biased monitoring histories.

- Of the six nitrogen and phosphorus compounds monitored by the SRWP, only nitrite and nitrate currently have relevant water quality objectives. Nitrite (as N) was observed to exceed the 1 mg/L MCL only in Sacramento Slough, and nitrate (as N) was not observed to exceed or approach the 10 mg/L MCL at any site monitored. Median concentrations of both constituents were well below their DHS and USEPA MCL (Table 21). Although excessive nutrient concentrations in source waters can be a factor in increased algal growth (and consequently taste and odor problems and increased treatment costs for domestic water suppliers), the effect of nutrient concentrations is generally not easily separated from the effects of storage and transport (e.g. increased temperature and sunlight exposure), and no specific limits for nutrients in source water have been developed to address these problems. Although there are currently no relevant objectives for ammonia, organic nitrogen, dissolved orthophosphate, or total phosphorus, U.S. EPA is in the process of developing

Ecoregional nutrient criteria. As part of this process, U.S. EPA will attempt to establish critical nutrient levels based on conditions in minimally impacted waterbodies ("reference" conditions), or on empirical data for waterbodies in each ecoregion if no appropriate reference conditions can be identified. The current generic guidelines provided in U.S. EPA guidance are 0.01 mg/L total phosphorus and 0.15 mg/L total nitrogen, but U.S. EPA expects that these values will be refined to be specific for each ecoregion or sub-ecoregion. Recommended criteria for the Central Valley sub-ecoregion have not yet been published, but recommended criteria based on data for the ecoregion which contains the Central Valley (Ecoregion III, "the Xeric West") have been released (USEPA 2000). These recommended criteria (0.022 mg/L total phosphorus, and 0.377 mg/L total nitrogen) are not based on reference conditions, but instead are empirically derived as the lower 25th percentile concentrations for data available for the ecoregion. Average total phosphorus and total nitrogen concentrations are expected to exceed these levels in many waterbodies in the Sacramento River watershed.

Table 21. Water Quality Objectives Relevant to Drinking Water Parameters(1)

Parameter	Units	Threshold Value	Basis
TDS	mg/L	500	DHS and USEPA Secondary Drinking Water Standard MCL
TOC	mg/L	2	D/DBP Rule Treatment Threshold
Nitrite, as N	mg/L	1	DHS and USEPA Primary Drinking Water Standard MCL
Nitrate, as N	mg/L	10	DHS and USEPA Primary Drinking Water Standard MCL
Sulfate	mg/L	250	DHS and USEPA Secondary Drinking Water Standard MCL
Fecal coliforms	MPN/100 mL	200, geo.mean(2) 400, maximum(3)	CVRWQCB Basin Plan, DHS Recommended Limits (CDHS 2000), and USEPA Recommended Criteria (USEPA 1999)
Total coliforms	MPN/100 mL	1,000, geo.mean(2) 10,000, maximum(3)	DHS Recommended Limits (CDHS 2000), USEPA Recommended Criteria (USEPA 1999),
E. coli	MPN/100 mL	126, geo.mean(2) 235, maximum(3)	CVRWQCB Basin Plan Amendment (CVRWQCB 2002)

(1) Primary and Secondary Drinking Water Standard MCLs have been adopted by reference in the Central Valley Basin Plan.
(2) This limit is intended to be applied to a 30-day geometric mean consisting of 5 samples.
(3) This limit is applied as a one-sample maximum.

Table 22. Comparisons with Total Organic Carbon Water Quality Goals

	% of Data Meeting Water Quality Goals[1]	
Location	2 mg/L	4 mg/L
Sacramento River above Shasta	100%	100%
Pit River above Shasta	88%	100%
McCloud River above Shasta	100%	100%
Sacramento River below Keswick	100%	100%
Spring Creek PP Discharge to Keswick Res.	100%	100%
Clear Creek near Mouth	97%	100%
Sacramento River above Bend Bridge	69%	99%
Mill Creek at Mouth	66%	91%
Deer Creek at Mouth	95%	100%
Sacramento River near Hamilton City	54%	90%
Big Chico Creek above Mud Creek	83%	99%
Mud Creek above Big Chico Creek	33%	84%
Sacramento River at Colusa	52%	95%
Colusa Basin Drain above KL	0%	3%
Sacramento Slough	3%	39%
Yuba River at Marysville	85%	100%
Feather River near Nicolaus	50%	98%
Sacramento River at Verona	37%	97%
Sacramento River at Veterans Bridge	44%	87%
American River at J Street	56%	98%
American River at Discovery Park	47%	96%
Natomas East Main Drain	0%	11%
Arcade Creek at Norwood Ave.	0%	2%
Sacramento River at Freeport	41%	95%
Sacramento River at River Mile 44	35%	89%
Cache Slough near Ryers Ferry	33%	67%

(1) Disinfectants/Disinfection Byproduct Rule treatment threshold for DBP precursor removal. If average source water TOC is >2 mg/L and ≤4 mg/L, water utilities may be required to remove up to 35% of the TOC in their influent. If average source water TOC is >4 mg/L and ≤8 mg/L, water utilities may be required to remove up to 45% of the TOC in their influent. TOC removal depends on source water alkalinity and treatment technologies used, and is not required when the running annual average TOC in source water or treated water is less than 2.0 mg/L, or if other specific D/DBP conditions are met.

2.5.2.2 What do these results say about attainment of beneficial uses and potential impairment, and how does this compare with any relevant 303(d) listings for parameter and sites?

The California 1998 303(d) list does not consider all of the contaminants of concern to drinking water supply, and few waterbodies in the Sacramento River watershed are cited on the 303(d) list for pollutants relevant to drinking water concerns (Table 24). Delta waterways, the Pit River, Clear Lake, and Whiskeytown Reservoir are listed for impairment due to electrical conductivity, nutrients, organic enrichment, and coliform bacteria. No waterbodies are listed for *Giardia* or *Cryptosporidium*. The Regional Board has also recommended addition of three creeks in the Sacramento River watershed to the 2002 303(d) list for impairments due to fecal coliform. It is clear however, that the Sacramento River and major tributaries generally provide water that is of very high quality for municipal and agricultural supply. Comparisons of drinking water parameters with relevant water quality goals and objectives for the Sacramento River watershed show that the mainstem Sacramento River, and major tributaries (the Yuba, Feather, and American rivers) consistently meet water quality goals and objectives, suggesting that these waterbodies achieve their beneficial uses as sources of municipal and agricultural supply water and contact recreation, as designated by the Central Valley Region Basin Plan (CVRWQCB 1995). Although the TOC concentrations measured in the Sacramento River from Bend Bridge to the Delta often exceed the 2.0 mg/l goal, it is not clear that these concentrations of organic carbon will result in a requirement for additional treatment for municipal drinking water suppliers to remove additional TOC in source water. The Stage 1 D/DBP Rule does not require such treatment if certain treatment technologies are used, or if other water quality requirements are met (e.g. for specific ultraviolet absorbance in source or treated water, TOC <2.0 mg/L in treated water, or trihalomethanes and haloacetic acids less than specified concentrations in treated water). Additionally, treatment technologies currently in use by many utilities are already able to remove ≥35% of TOC from Sacramento River water. If additional TOC removal is necessary, this requirement would increase treatment costs, but would not otherwise limit the water supply use. Additionally, comparisons of coliform bacteria data to limits recommended by USEPA, California Department of Health Services, and the CVRWQCB indicate that these limits are infrequently exceeded and suggest that recreational uses protected by these limits are generally well-supported in the mainstem Sacramento River and its major tributaries.

Table 23. Median Concentrations of Selected Drinking Water Parameters

Location	TDS, mg/L	TOC, mg/L	Total Coliform MPN/ 100mL	Fecal Coliform MPN/ 100 mL	*E. coli*, MPN/ 100 mL	Nitrate-N, mg/L	Total P, mg/L
Pit R. above Shasta	93	1.3	—[(c)]	—	—	—	—
McCloud R. above Shasta	62	0.7	—	—	—	—	—
Sac. R. above Shasta	60	1.5	—	—	—	—	—
Spring Ck Power Plant	52	1.3	—	—	—	—	—
Sac R. below Keswick	76	1.1	8	<2	—	—	—
Sac R. above Bend Br.	84	1.7	117	24	18	0.11	0.034
Mill Creek at Mouth	101	1.5	—	4	—	—	0.056
Deer Creek at Mouth	98	1.3	—	7.4	—	—	0.026
Big Chico Ck in Chico	104	1.2	—	37	—	—	0.017
Sac R. at Hamilton City	97	1.9	168	68	85	0.08	0.050
Sac R. at Colusa	92	2.0	140	30	24	0.14	0.059
Colusa Basin Drain	340	7.1	248	15	11	0.31	0.22
Sacramento Slough	196	4.5	464	104	95	0.13	0.14
Yuba R. at Marysville	57	1.3	244	82	61	0.05	0.011
Feather R. nr Nicolaus	65	2.0	142	16	18	0.09	0.024
Sac R. at Verona	90	2.2	—	—	—	0.12	0.051
Sac R. at Veterans Br.	105	2.2	468	30	17	0.11	0.10
Arcade Ck at Norwood	165	8.1	—	—	—	0.51	0.24
American R. at J St	39	1.9	—	—	—	0.06	0.010
American R. at Discovery Pk	41	2.1	329	53	23	<0.05	<0.02
Natomas East Main Drain	200	6.2	>1600	334	510	1.3	0.68
Sac. R. at Freeport	82	2..2	435	31	13	0.11	0.052
Sac. R. at Mile 44	100	2.4	297	—	—	0.13	0.085
Cache Creek	173	3.6	—	—	—	0.08	0.071
Cache Slough	140	2.8	154	32	—	—	—
Greene's Landing[b]	99[b]	2.4[b]	—	10	—	—	—
Barker Slough[b]	176[b]	6.3[b]	—	123[(d)]	—	—	—
Banks Pumping Plant[b]	254[b]	3.6[b]	—	—	—	—	—
San Joaquin R. at Vernalis[b]	361[b]	3.2[b]	—	—	—	—	—

Note: Table lists median values for available data from 1994-2002, except for mean data from Woodard (2000) which are generally based on longer periods of record.

(a) *Giarda* cysts per liter and *Cryptosporidium* öocysts per liter
(b) Mean data reported from Woodard (2000).
(c) "—" indicates parameter not evaluated at this location.
(d) Median data from MWQI data base (DWR 1999)

Table 24. Waterbodies cited for drinking water-related parameters on California 1998 303(d) list or recommended for addition to the 2002 303(d) List.

Waterbody	Cause for Listing	Source	Area Affected	Units
1998 303(d)-listed waterbodies				
Delta Waterways	Electrical Conductivity	Agriculture	16,000	Acres
Delta Waterways	Organic Enrichment, Low DO	Municipal point sources, sewers	75	Acres
Whiskeytown reservoir	Coliform bacteria	Septage disposal	100	Acres
Clear Lake	Nutrients	Unknown	43,000	Acres
Pit River	Nutrients, Organic Enrichment, Low DO	Agriculture, Grazing	100	Miles
Waterbodies recommended for addition to the 2002 303(d) List				
Clover Creek	Fecal coliform	Human and livestock sources	10.5	Miles
South Cow Creek	Fecal coliform	Human and livestock sources	7	Miles
Wolf Creek	Fecal coliform	Urban runoff, recreation, agriculture	14.5	Miles

2.5.3 Spatial and Temporal Distribution Patterns and Mass Loads

Because drinking water and recreational beneficial uses generally appear to be adequately supported for the Sacramento River watershed locations monitored by the SRWP, and the parameters monitored were not considered likely to impair these uses, spatial and temporal distributions were not evaluated for any of the drinking water-related parameters monitored in 2001-2002. Based on the same criterion, mass loads were also not evaluated for these parameters. Spatial and temporal trends and mass loading have been considered in previous Annual Monitoring Reports (SRWP 2000, 2001) for results of SRWP monitoring conducted 1998-2000 and from other major monitoring efforts.

2.5.4 Conclusions and Recommendations

The mainstem Sacramento River, and major tributaries (the Yuba, Feather, and American rivers) consistently meet water quality goals and objectives for drinking water-related parameters. Based on the best available indicators, these results suggest that designated beneficial uses as sources of municipal and agricultural supply water and recreational uses are generally being achieved:

- There was a general trend for concentrations of several parameters (TDS, organic carbon, nutrients) to increase in the mainstem Sacramento River from the upper watershed to the lower watershed. This trend can generally be attributed to a combination of natural and anthropogenic sources, and is moderated by high quality Sierra tributary inflows.
- The Basin Plan limit for median fecal coliform numbers (200 MPN/100mL) was exceeded at only one site (Natomas East Main Drain), and the maximum limit for single samples (400 MPN/100 mL) was exceeded infrequently in the Sacramento River, the American River, and Cache Slough. Recommended USEPA and DHS

single sample and geometric mean limits for total coliform are also infrequently exceeded at monitored locations. Recommended single sample Basin Plan limits for *E. coli* were exceeded at most locations monitored, but *E. coli* numbers exceeded the geometric mean limit only at Natomas East Main Drain. Note that comparisons for *E. coli* are based on limited data biased towards episodic events expected to result in elevated bacteria counts.

- TOC concentrations measured in the Sacramento River at Colusa, Verona, and Freeport often exceed the Stage 1 Disinfectant/Disinfection By-Product (D/DBP) Rule treatment threshold of 2.0 mg/l. The 2.0 mg/L threshold is significant because exceedance of this threshold may require utilities to remove up to 35% percent of TOC in their source water. It is not clear that the observed concentrations of organic carbon will result in a requirement for municipal drinking water suppliers to remove *additional* TOC in source water. The Stage 1 D/DBP Rule does not require such treatment if certain treatment technology requirements used, or if other water quality requirements are met in influent or treated water. Additionally, treatment technologies currently in use by many utilities are already able to remove ≥35% of source water TOC from Sacramento River water. Even if additional TOC removal is necessary, this requirement would not limit the water supply use. Limited Specific UV Absorbance (SUVA) data suggest that average SUVA in Sacramento River surface waters are greater than D/DBP alternative criteria (2.0 L/mg-m) and would not provide relief from additional treatment requirements.
- Nitrate and nitrite appear to meet USEPA and DHS MCLs at all locations monitored in the Sacramento River watershed. Other nitrogen and phosphorus compounds monitored (ammonia, total nitrogen, dissolved orthophosphate) currently have no relevant regulatory thresholds for comparison. However, total nitrogen and total phosphorus concentrations may exceed expected ecoregional nutrient criteria under development by USEPA in many Sacramento River watershed surface waters.

Although water from the Sacramento River from Hood and upstream is considered to be of high quality for drinking water supply, the quality of water in the Central and Southern Sacramento-San Joaquin Delta is often marginal for drinking water supply and compliance with increasingly stringent drinking water objectives is becoming more difficult. The Sacramento River alone provides up to 75% of the water entering the Delta, including a large portion of seasonal organic carbon and TDS mass loads. Although the Sacramento River therefore has a substantial effect on the quality of Delta drinking water supply source water, there are also significant internal sources of TOC and TDS within the Delta and from the San Joaquin River. As stated previously, the parameters of primary concern for drinking water quality—TOC, TDS, and pathogens—are currently largely unregulated by the RWQCB and the Water Quality Control Plan (Basin Plan). Expected changes in Sacramento River watershed land uses (e.g. increased urbanization and development) have the potential to increase regulated point source discharges and (relatively) unregulated non-point source discharges, and therefore to increase loads of TOC, TDS, and pathogens to the Delta. In order to address these and other drinking water concerns, the RWQCB is implementing a work plan for the development of an effective drinking water policy. This policy is expected to address these parameters and to establish water quality objectives for eventual inclusion in the revised Basin Plan.

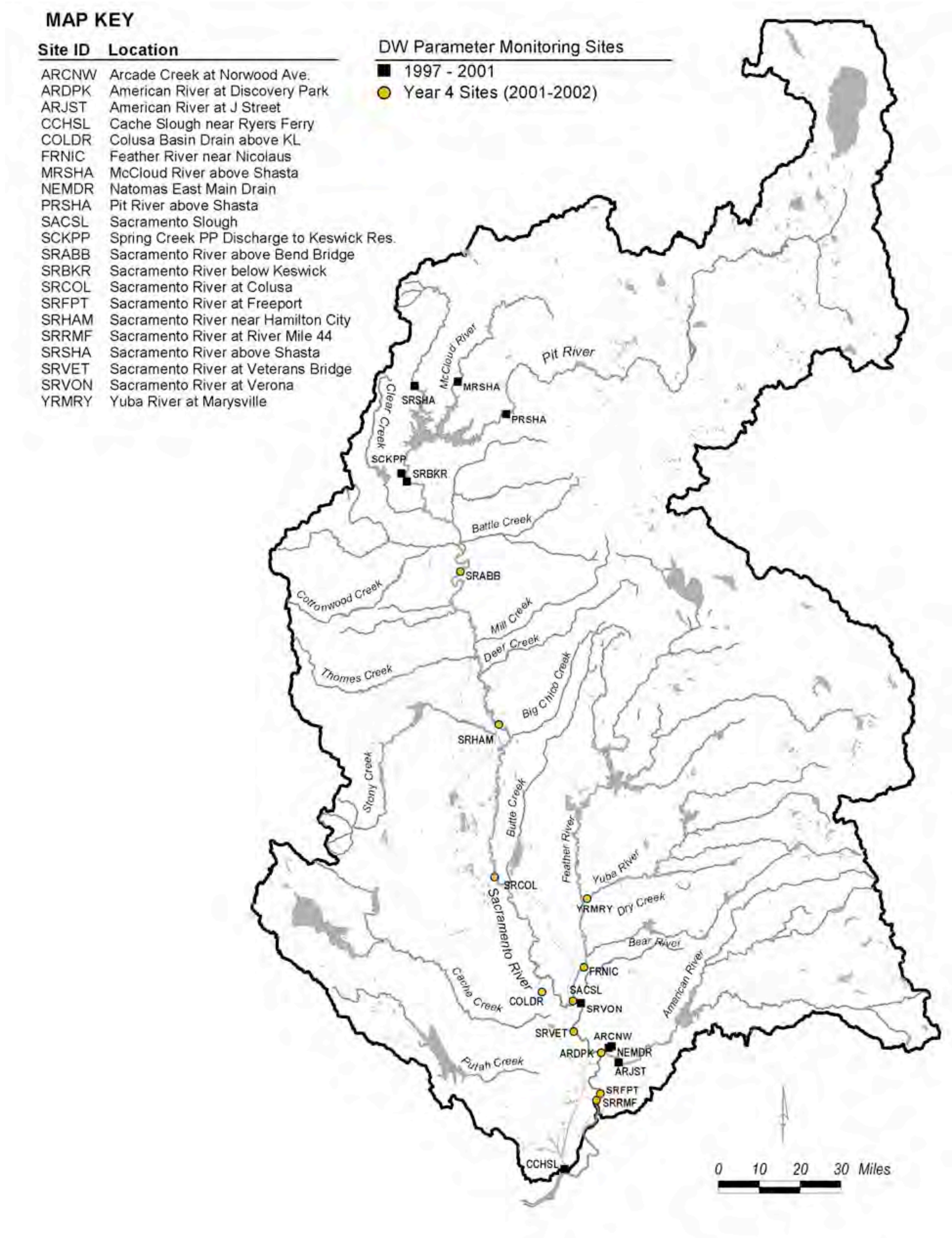


Figure 14. Drinking Water Constituent Monitoring in the Sacramento River Watershed, USGS NAWQA, Sacramento River CMP, City of Redding, DWR MWQI, and SRWP

2.6 Organochlorine Pesticides and PCBs in Fish Tissue

2.6.1 Background and Available Data Overview

In September and October of 1997-2001, the SRWP monitoring program collected fish from 18 locations and analyzed tissue for concentrations of organochlorine pesticides (DDTs, chlordanes, aldrin, dieldrin, endrin, hexachlorocyclohexanes, hexachlorobenzene, endosulfans, methoxychlor, mirex, and oxadiazinon) and PCB compounds. Monitoring in the Sacramento River watershed for these compounds in fish tissue has been performed previously by the Toxic Substances Monitoring Program (administered by the State Water Resources Control Board) between 1977 and 1996. Organochlorine pesticides and PCBs have also been analyzed in fish collected as part of DWR's tributary monitoring program (1999). Studies of these pollutants in fish tissue were also performed in San Francisco Bay in 1994 and 1997 (Table 25).

The locations of sites monitored in 1997–2001 by the SRWP are illustrated in Figure 15.

Table 25. Fish Contamination Monitoring Programs in the Sacramento River Watershed

Program	Monitoring Period	Parameters	Total # of locations & geographic reference
SRWP	Sep-Oct, 1997-2001	Organochlorine pesticides and PCBs in edible fish tissue	17 fish tissue sites, distributed throughout the watershed
TSMP (SWRCB)	1977–1999	metals, organics, and pesticides in fish	Many sites distributed throughout the watershed
SFBRWQCB	1994	mercury and organochlorines in fish	San Francisco Bay
SF Estuary RMP (SFEI)	1997	mercury and organochlorines in fish	San Francisco Bay
DWR	1999	Organochlorine pesticides and PCBs in edible fish tissue	Deer Creek, Mill Creek, Big Chico Creek, and Clear Creek watersheds

2.6.2 Attainment of Beneficial Uses and Potential Impairment

Comparisons with fish tissue screening values and 303(d) listings: What do the data say about attainment of beneficial uses and potential impairment? Concentrations of organochlorine pesticides and PCBs in fish tissue were compared primarily to California Office of Environmental Health Hazard Assessment screening values (OEHHA 1999; SFEI 1998), and to USEPA national screening values (SFRWQCB *et al*. 1995, USEPA 1995, USEPA 1998) adjusted for a fish consumption rate of 30 g/day and an updated PCB cancer slope factor (SFEI 1999). Exceedance of screening values is considered an indication that more intensive site-specific monitoring or evaluation of human health risks should be conducted (SFEI 1998, 1999). Note that these risk-based human health limits are based on assumptions of specific fish consumption rates that are typically averages for the general population. For individuals or populations consuming more fish than assumed for a specific limit or screening value (e.g. sport fisherman or some ethnic populations), the risk of adverse health effects is increased.

Consumption-weighted average organochlorine concentrations were also calculated by waterbody category in Table 28. The consumption-weighted average is an estimate of the average concentration in tissue for the total freshwater and estuarine fish consumed, and assumes that a combination of trophic level 3 and trophic level 4 fish are consumed. Although not adopted as official policy, USEPA Region 4 used this approach in a TMDL developed in Georgia, and compared the consumption-weighted average directly to the fish tissue-based water quality criterion for methylmercury to evaluate whether a waterbody should be considered impaired (USEPA 2001b). The approach is also consistent with the development of the fish tissue-based criterion for methylmercury (USEPA 2001), which assumes that fish consumed consist of a mix of different trophic level species. The consumption-weighted average concentration is calculated as:

CWA = (56.6% x *Trophic Level 3 avg.*) + (43.4% x *Trophic Level 4 avg.*).

Consumption-weighted averages, and averages for individual species and trophic levels were all compared to screening values. In all cases where concentrations were below detection, the average concentration was calculated with the tissue concentration set equal to one half the detection limit. The possible range for the average was also calculated by substituting zero and the detection limit for data below detection. Comparisons with screening values were made using the "best estimate" average values (based on the one half detection limit substitution) for the entire data set and for waterbodies grouped by the following categories:

- Lower Sacramento River mainstem, from Keswick to the "I" Street Bridge in Sacramento),
- Delta locations (Sacramento River below "I" Street Bridge, and Cache Slough),
- Major tributaries (Feather River and American River),
- Smaller tributaries, from above Shasta to Putah Creek,
- Agricultural drains (Colusa Basin Drain, Sacramento Slough, and Natomas East Main Drain).

Based on comparisons to OEHHA's screening values, the overall risks from organochlorine pesticides in fish tissue appear to be low. However, some individual samples and some species averages exceeded screening values. PCB concentrations in striped bass (34 ng/g, n=1) white catfish (27 ng/g, n=19) were greater than OEHHA's 20 ng/g screening value. In carp (n=4), average concentrations of DDTs (295 ng/g) and dieldrin (6.8 ng/g) exceeded screening values (100 ng/g, and 2.0 ng/g, respectively), but three of the four samples for this species were from one ag drain location (Colusa Basin Drain). Consumption-weighted averages also exceeded screening values for DDTs and dieldrin in fish from agricultural drains, but these exceedances were also strongly influenced by the average for one trophic level 3 species (carp in Colusa Basin Drain) with very high concentrations of these pesticides. Consumption-weighted averages also exceeded screening values for PCBs in fish from Delta locations, but this exceedance was also strongly influenced by the single sample for the one trophic level 3 species caught for this Delta locations (Sacramento sucker from Sacramento River at Mile 44). Review of the maximum ranges for consumption-weighted averages (based on substitution of zero and the detection limit for concentrations below detection) revealed that evaluations for dieldrin are the most sensitive to the substitution method used. Approximately 82% of the dieldrin results were below the reporting limit of 2.0 ng/g, and the reporting limit is equal to the OEHHA screening value for this pesticide. Based on the low percentage of concentrations detected above 2 ng/g, it is unlikely that average concentrations exceed the screening except in fish from agricultural drains.

Summaries of these evaluations are provided in Tables 26 and 27. Consumption-weighted averages are summarized in Table 28, and results for individual samples and trophic level 3 and 4 species are illustrated in Figures 16 and 17. The data set used for these evaluations is also presented in Appendix A.

There are several waterbodies included on the 1998 California 303(d) list for impairment due to organochlorine pesticides and PCBs (Table 29). Evaluation of consumption-weighted average concentrations suggests the need to re-evaluate several of these 303(d) listings. Consumption-weighted average concentrations of dieldrin and chlordane in SRWP fish samples from the Feather River and American River suggest that concentrations of these chemicals may not be sufficiently high in fish tissue to warrant 303(d) listing at these sites for Group A pesticides, and the Central Valley Regional Board has recommended removing the lower American River from the 2002 303(d) list. A recent review of TSMP and SRWP data (Lee and Jones-Lee 2002) also concluded that the original 303(d) listing for the lower American River was inappropriate because it was based on exceedance of a non-regulatory National Academy of Sciences "criterion." Consumption-weighted average concentrations of PCBs in fish from agricultural drains suggest that the 303(d) listing for PCBs in Natomas East Main Drain should also be re-evaluated. Additional data are also needed to evaluate the high consumption-weighted average concentrations of DDT and dieldrin estimated for agricultural drains. Results from the monitoring conducted in 2002 and planned for 2003 may provide additional data needed to adequately evaluate these results. This monitoring has been designed in concert with OEHHA to provide the more complete data needed to evaluate attainment of beneficial uses and the need for fish consumption advisories in the lower Sacramento River watershed.

2.6.3 Spatial and Temporal Distribution & Patterns

Concentrations of organochlorines accumulated in fish tissue are dependent on a number of factors in addition to exposure to these compounds, including species and trophic level, age, size, and tissue lipid concentrations. The species and size of fish analyzed for this study varied by location, and it is difficult to describe purely spatial variation independent of these factors. For this reason, concentrations in trophic level 3 species (e.g. rainbow trout), should not be directly compared with concentrations in trophic level 4 species (e.g. largemouth bass) as a means of inferring spatial differences in concentrations of bioavailable oganochlorine pesticides and PCBs. However, examination of the consumption-weighted average organochlorine concentrations for each waterbody category (Table 28) provides a relatively unbiased biased view of broad regional patterns in fish tissue concentrations. These results suggest that concentrations of organochlorines are generally low in fish from smaller tributaries. Although consumption-weighted average PCBs were highest in the Delta locations, and DDTs and dieldrin were highest in the fish from agricultural drains, these values were very dependent on high concentrations in a very limited number of samples or species. Considering only the two species collected from the most sites (white catfish and largemouth bass), there were no distinct or consistent differences in average concentrations for different waterbody categories.

Consumption weighted averages of organochlorine concentrations in fish tissue are summarized in Table 28 by waterbody category. Concentrations in individual species are illustrated for each location sampled in Figures 18 and 19.

There are currently insufficient data available to assess seasonal or long-term temporal trends in the concentrations of organochlorines in fish tissue.

2.6.4 Conclusions and Recommendations

- Based on comparisons to screening values for organochlorine pesticides and PCBs in fish tissue, consumers who eat a variety of fish from different locations appear to be at relatively low risk from these compounds in fish tissue. However, potential risks increase for people selectively consuming a limited number of higher trophic level species (e.g. white catfish, largemouth bass, striped bass), and for individuals consuming more fish than the 21 g/day (about six quarter-pound servings per month) on which the screening values were based.
- Consumption-weighted average concentrations of DDTs and dieldrin in fish from agricultural drains, and of PCBs in fish from Delta locations exceeded screening values, but these results were dependent on very limited data for trophic level 3 species. Additional data are needed to adequately assess the potential risks for these waterbodies.
- Evaluation of consumption-weighted average concentrations suggests the need to re-evaluate several of the waterbodies cited on the1998 303(d) for impairment due to organochlorine pesticides and PCBs. The results also support the Regional Board’s recommendation to remove the lower American River listing for “Group A” pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide,

hexachlorocyclohexanes including lindane, endosulfan, and toxaphene) from the updated 2002 303(d) list.

- Fish from smaller tributaries throughout the watershed tended to have lower concentrations of most organochlorines than other waterbodies. There was little evidence of other distinct spatial trends in organochlorine concentrations in fish tissue.
- Monitoring of organochlorine pesticides and PCBs in fish tissue has been continued for 2001-2002 monitoring on a very limited basis.

Table 26. Organochlorines in Fish Tissue: Regulatory Limits, Screening Values, and Summary of SRWP Data (1997-2000)

	PCBs (as Aroclors)	Sum of Chlordanes	Sum Of DDTs	Dieldrin
Updated USEPA Screening Values(1) (SFRWQCB *et al.* 1995)	23 ng/g	18 ng/g	69 ng/g	1.5 ng/g
OEHHA Screening Values(2) (OEHHA 1999, SFEI 1998)	20 ng/g	30 ng/g	100 ng/g	2 ng/g
FDA Action Levels(3)	2000 ng/g	300 ng/g	5000 ng/g	300 ng/g
Total number of samples analyzed (1997 – 2001)	102	102	102	102
Number of samples exceeding OEHHA screening value	22	0	4	12
Percent of samples exceeding OEHHA screening value	22%	0%	4%	12%
Species(4) exceeding screening values	CC, RT, WC, LMB, SB, PM, SS	—	CP, WC	CC, SMB, WC, PM, LMB, CP
Sites(5) exceeding screening values	SACSL SRBKR SRCOL SRVET SRRMF NEMDR ARDPK ARJST	—	COLDR SRRMF	COLDR SACSL ARDPK SRRMF CCHSL
Sites exceeding no screening values	SRABB, SRHAM, FRNIC			

(1) Screening value is based on a consumption rate of 30 g/day.
(2) Screening value is based on a consumption rate of 21 g/day.
(3) FDA Action Level is based on a consumption rate of 6.5 g/day.
(4) BT–Brown trout, CP–Carp, RT–Rainbow trout, LMB–Largemouth bass, PM–Sacramento pikeminnow, RS–Riffle sculpin, SB–Striped bass, SMB–Smallmouth bass, SS–Sacramento sucker, WC–White catfish, CC–Channel catfish
(5) Sites in downstream order: SRBKR–Sac. River below Keswick; SRABB–Sac. River at Bend Bridge; SRHAM–Sac. River at Hamilton City; SRCOL–Sac. River at Colusa; SRVET–Sac. River at Vets Bridge; COLDR–Colusa Basin Drain; SACSL–Sacramento Slough; Feather River near Nicolaus; ARJST–Amercian River at J Street; NEMDR–Natomas East Main Drain; ARDPK–American River at Discovery Park; PUTAH–Putah Creek; SRRMF–Sac. River at Mile 44; CCHSL–Cache Slough near Ryers Ferry.

Table 27. Comparisons to screening values for organochlorine pesticides

PCBs as Sum of Aroclors (OEHHA Screening Value[1] = 20 ng/g)	
Species averages	Overall species averages for striped bass (n=1) and white catfish (n=19) exceeded the Screening Value (SV). Species average concentrations were above the SV in white catfish and striped bass (n=1) for the lower Sacramento River mainstem, in white catfish and Sacramento sucker (n=1) for Delta locations, in white catfish amd pikeminnow for major tributaries, and inwhite catfish and channel catfish (n=1) in ag drains All species averages for smaller tributaries were below the SV.
Trophic Level (TL) averages	Overall TL3 and TL4 average concentrations were lower than the SV. Trophic level 3 average was above the SV for the Delta locations, but based on only one species and one sample. Trophic Level 4 average was above the SV for major tributaries and the lower Sacramento River mainstem
Consumption-weighted avg (CWA)	CWA above Screening Value for Delta locations, but result dependent on single high Sacramento sucker sample CWA below Screening Value for all other waterbody categories.
Summary of potential risks	Potential risk is highest at Delta locations (Sac. River at Mile 44 and Cache Slough), and low at other locations.
Sum of Chlordanes (OEHHA Screening Value = 30 ng/g)	
Species averages	All species averages were below the SV.
Trophic Level (TL) avg.	All were below the SV.
Consumption-weighted avg (CWA)	Below the SV for all waterbody categories
Summary of potential risks	Risk appears to be very low for all waterbody categories sampled (Lower Sac. River mainstem, Delta, major tributaries, smaller tribs, and ag drains).
Sum of DDTs (OEHHA Screening Value = 100 ng/g)	
Species averages	The overall average (n=4) and the ag drain average (n=3) for Carp exceeded the SV. All other overall species averages were below the SV.
Trophic Level (TL) averages	Three of 37 TL3 samples and one of 65 TL4 samples were above the SV. Overall Trophic Level 3 and 4 average concentrations were lower than the SV. Trophic level 3 average was above the SV for Ag drains, but based on only one species (Carp, n=3).
Consumption-weighted avg (CWA)	CWA was above the SV for Ag drains, but dependent on only one TL3 species (Carp, n=3). CWA was below the SV for all other waterbody categories.
Summary of potential risks	Some potential risks for fish from ag drains, but risk may be overestimated due to reliance on single TL3 species. Overall risk appears low .
Dieldrin (OEHHA Screening Value = 2 ng/g)	
Species averages	The overall average (n=4) and the ag drain average (n=3) for Carp exceeded the SV. The average for smallmouth bass (n=1) exceeded the SV. Other overall and waterbody category averages were below the SV.
Trophic Level (TL) averages	Three of 37 TL3 samples and 8 of 65 TL4 samples were above the SV. Overall TL3 and TL4 averages were below the SV
Consumption-weighted avg (CWA)	CWA was above the SV for Ag drains, but dependent on only one TL3 species (Carp, n=3). CWA was below the SV for all other waterbody categories.
Summary of potential risks	There may be some potential risks for fish from ag drains, but risk may be overestimated due to reliance on single TL3 species. Overall risks appear low .

(1) OEHHA screening value are based on a consumption rate of 21 g/day (OEHHA 1999)

Table 28. Consumption-weighted average organochlorine concentrations in fish

Site Category	Species	Trophic Level(1)	Count	Consumption-weighted Avg(2), ng/g Aroclors	Chlordanes	DDTs	Dieldrin
Lower Sac. R. Mainstem (Keswick to "I" Street Bridge)	Carp	3	1	**12.8** (10.2–15.4) *52% detects*	**1.1** (0.8–1.4) *39% detects*	**31.0** (30.9–31.0) *96% detects*	**1.0** (0.1–1.9) *9% detects*
	Rainbow trout	3	5				
	Sacramento sucker	3	5				
	Largemouth bass	4	2				
	Pikeminnow	4	6				
	Striped bass	4	1				
	White catfish	4	2				
Delta (Sac. River below "I" Street Bridge, and Cache Slough)	Sacramento sucker	3	1	**28.9** (27.4–30.3) *67% detects*	**1.3** (1.1–1.4) *67% detects*	**44.0** *100% detected*	**1.3** (0.4–2.1) *29% detects*
	Largemouth bass	4	8				
	Pikeminnow	4	1				
	White catfish	4	10				
Major tributaries (Feather River and American River)	Sacramento sucker	3	3	**15.8** (13.8–17.8) *68% detects*	**2.3** (2.0–2.5) *58% detects*	18.9 *100% detected*	**1.1** (0.2–1.9) *17% detects*
	Largemouth bass	4	6				
	Pikeminnow	4	6				
	White catfish	4	3				
Tributaries (Sac. R. above Shasta, Pit River, McCloud River, Clear Ck, Mill Ck, Deer Ck, Big Chico Ck, Putah Ck)	Brown trout	3	1	**7.1** (2.9–11.3) *8% detects*	**0.8** (0.4–1.1) *8% detects*	**18.1** (17.4–18.1) *44% detects*	**1.0** (0–2.0) *0% detects*
	Rainbow trout	3	7				
	Riffle sculpin	3	8				
	Sacramento sucker	3	1				
	Largemouth bass	4	4				
	Pikeminnow	4	1				
	Smallmouth bass	4	3				
Ag drains (Sacramento Sl., Colusa Drain, Natomas East Main Drain)	Carp	3	2	**10.7** (8.1–13.3) *50% detects*	**1.3** (0.8–1.5) *64% detects*	**231.9** *100% detects*	**5.6** (5.4–5.8) *50% detects*
	Largemouth bass	4	6				
	White catfish	4	4				
	USEPA Screening Values			*23 ng/g*	*18 ng/g*	*69 ng/g*	*1.5 ng/g*
	OEHHA Screening Values			*20 ng/g*	*30 ng/g*	*100 ng/g*	*2.0 ng/g*

(1) Trophic level 3 fish consume primarily zooplankton and benthic invertebrates. Trophic level 4 fish preferentially consume trophic level 3 and lower trophic level fish species, as well as benthic invertebrates. Larger individuals of some primarily trophic level 3 species (e.g. trout) may be piscivorous and function at trophic level 4.

(2) The average concentration for total fish consumed, as described USEPA 2001b. The consumption-weighted average is calculated as: (56.6% x *Trophic Level 3 avg.*) + (43.4% x *Trophic Level 4 avg.*). Averages are calculated by substituting 1/2 the reporting limit for concentrations below detection. Maximum ranges for averages based on substitution of zero and the reporting limit are presented in parentheses. Percent detected concentrations are shown in italics.

Table 29. Waterbodies cited on California's 1998 303(D) List for PCBs and organochlorine pesticides.

Water Body	Cause for 303(d) Listing	Source of Pollution	Size Affected	Unit
Delta Waterways	DDT	Agriculture	48,000	Acres
Delta Waterways	Group A Pesticides(1)	Agriculture	48,000	Acres
American River, Lower(2)	Group A Pesticides	Urban Runoff	23	Miles
Colusa Basin Drain	Group A Pesticides	Agriculture	70	Miles
Feather River, Lower	Group A Pesticides	Agriculture	60	Miles
Natomas East Main Drain	PCBs	Industrial Point Source	12	Miles
Natomas East Main Drain	PCBs	Urban Runoff	12	Miles

(1) Group A pesticides: aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan, and toxaphene

(2) Recommended for removal from 2002 303(d) by Regional Board (CVRWQCB 2001)

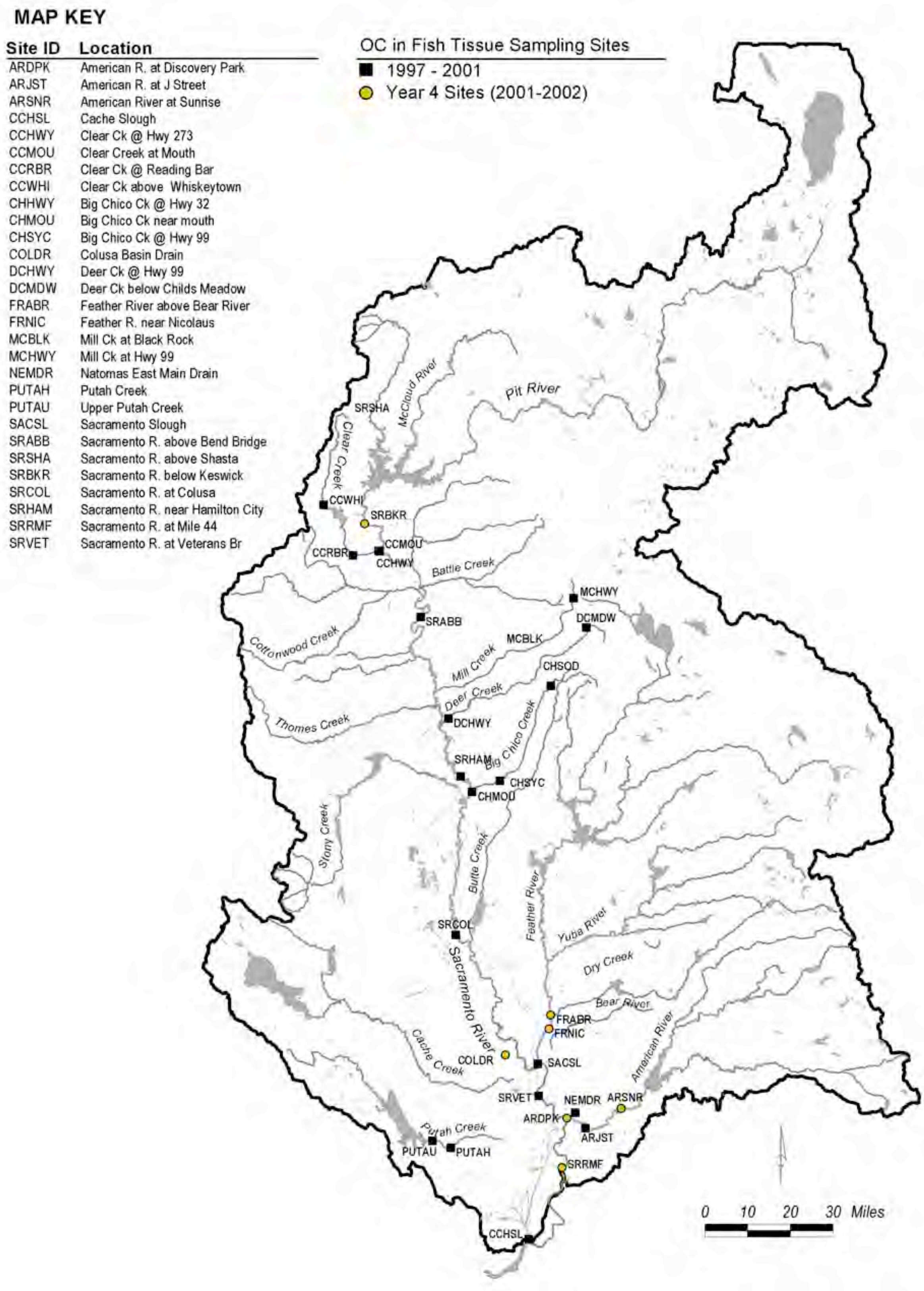


Figure 15. SRWP monitoring for organochlorines in fish tissue: 1997-2001 monitoring locations

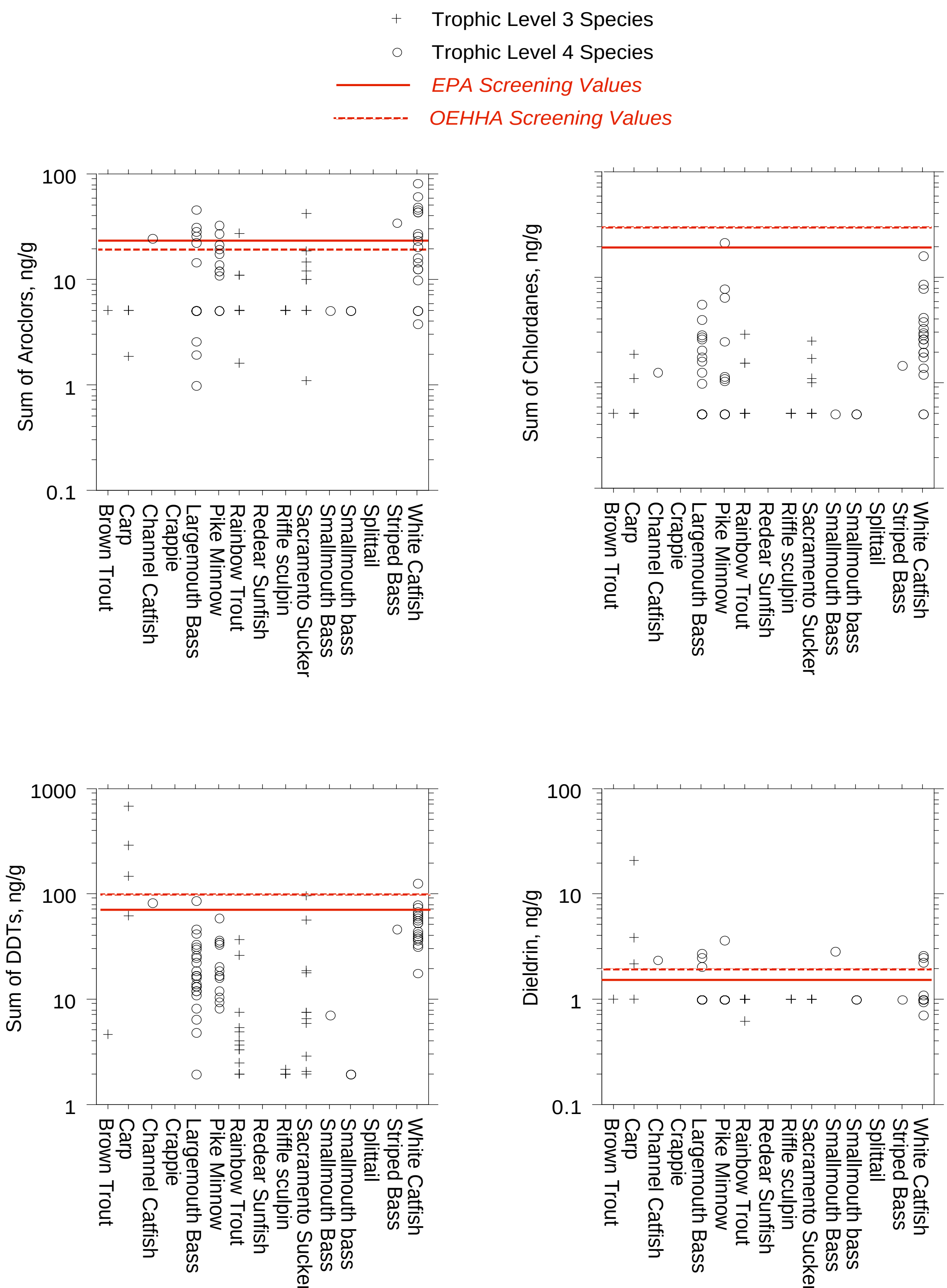


Figure 16. Organochlorine pesticides in fish tissue, summarized by species

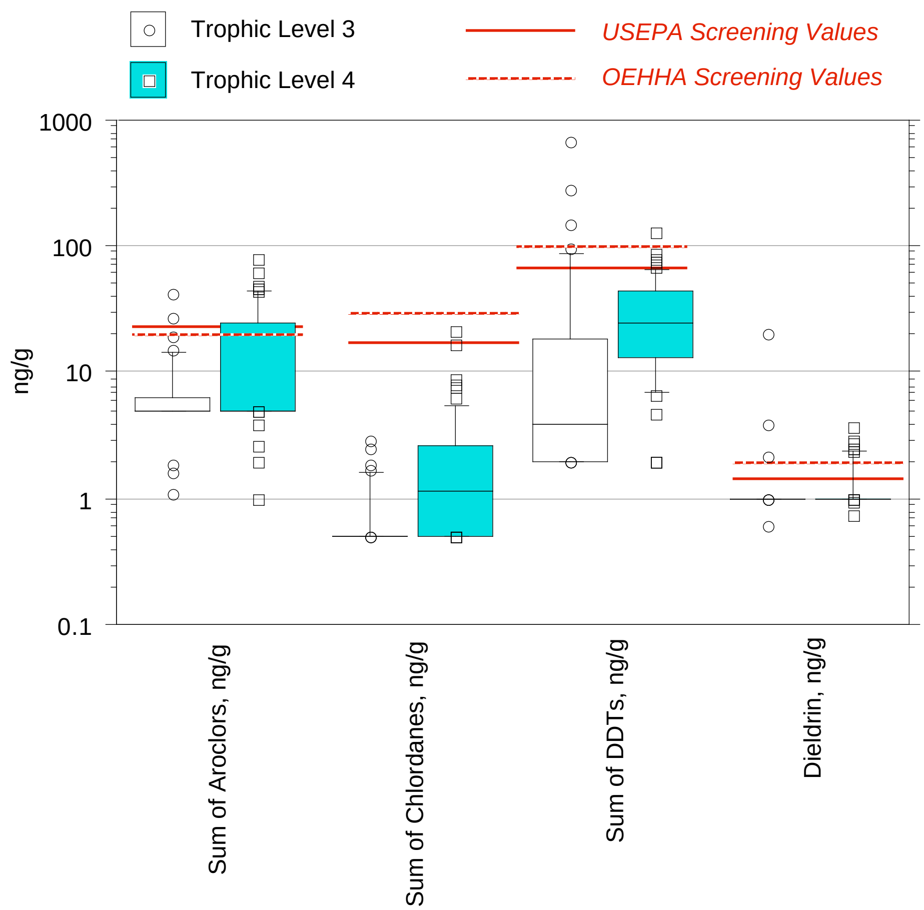


Figure 17. Organochlorine pesticides in fish tissue, summarized by trophic level
Trophic Level 4 species include largemouth bass, Sacramento pikeminnow, striped bass, white catfish, and smallmouth bass. Trophic Level 3 species include carp, rainbow and brown trout, riffle sculpin, and Sacramento sucker.

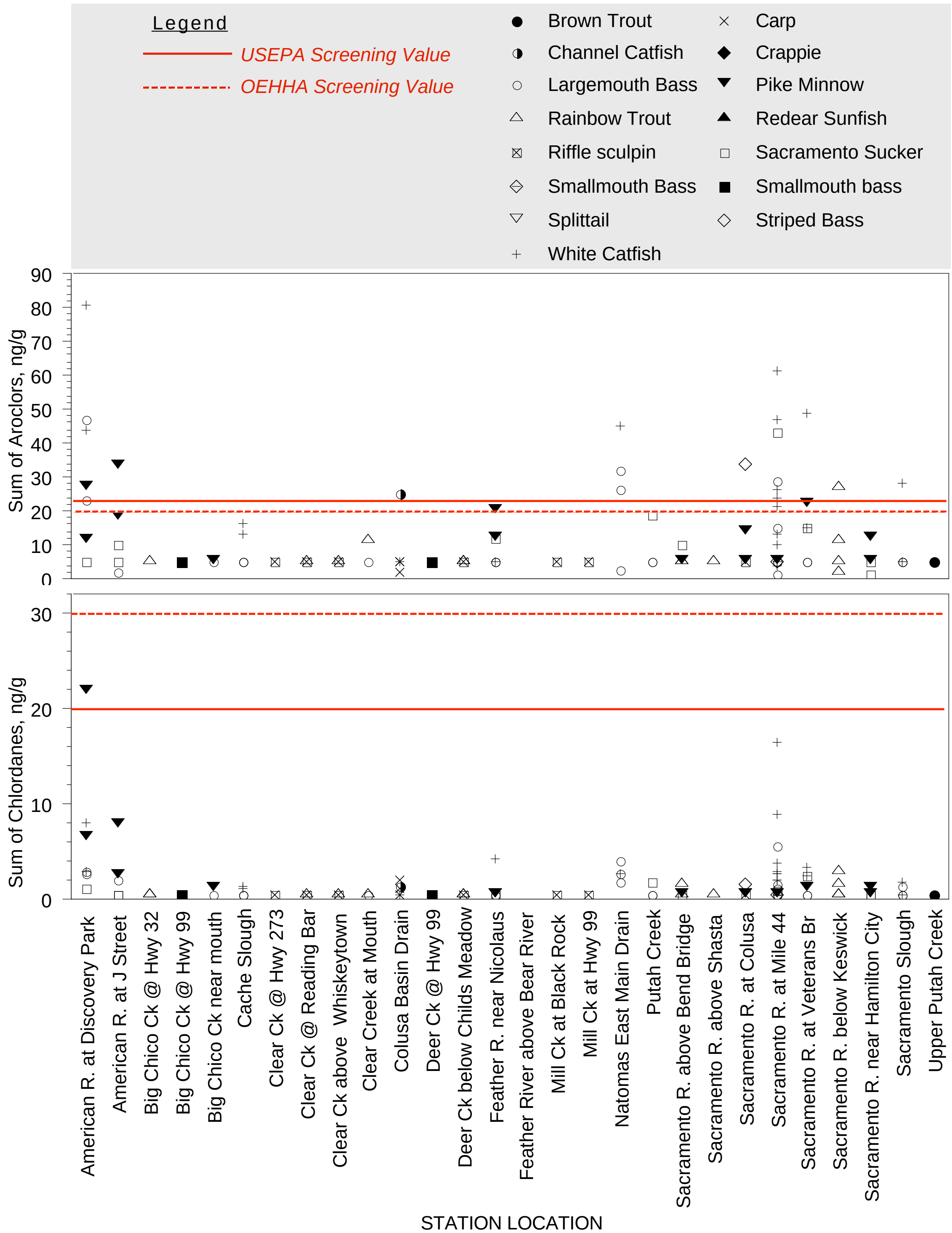


Figure 18. PCBs and Chlordanes in fish tissue: SRWP 1997 - 2001 data

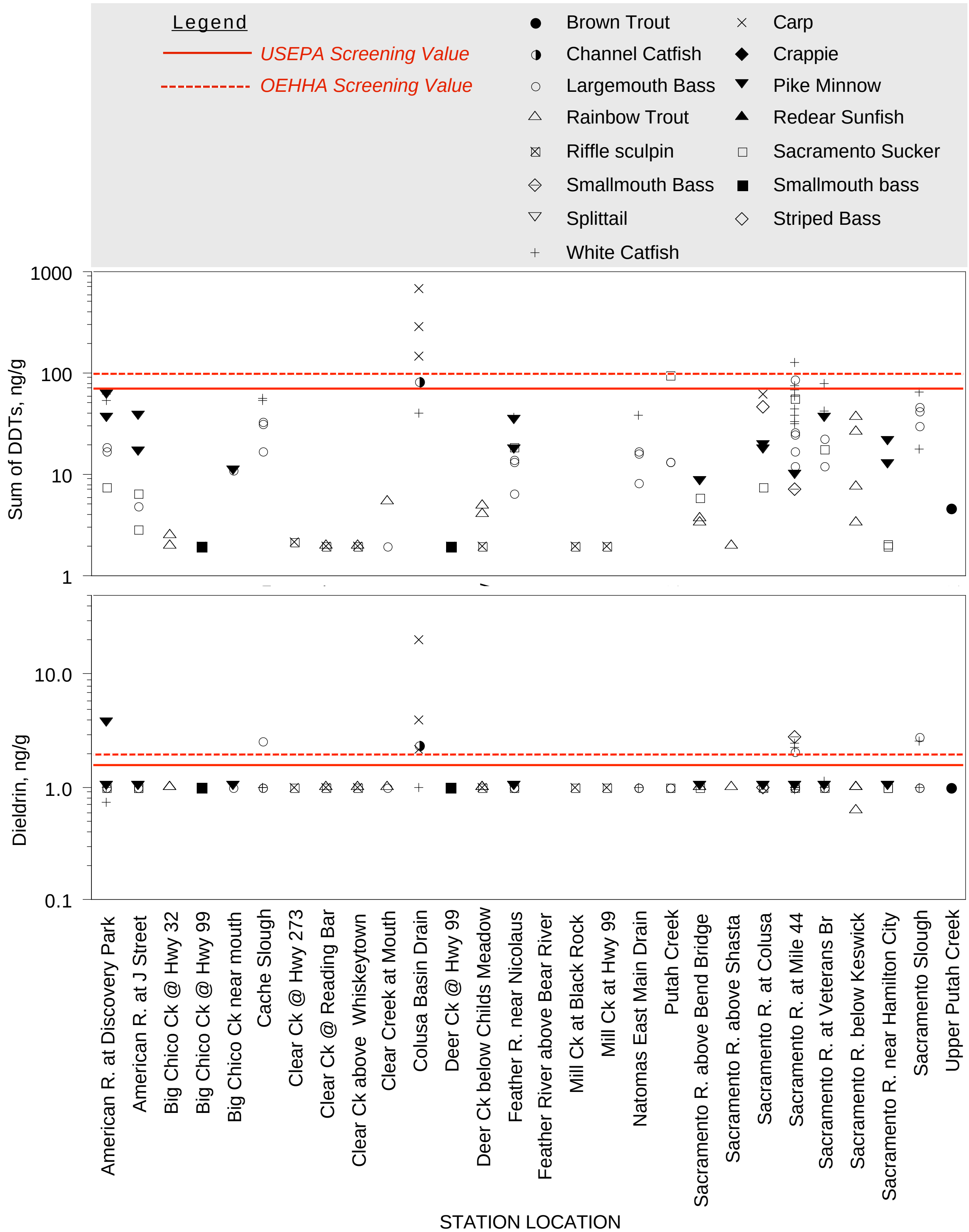


Figure 19. DDTs and Dieldrin in fish tissue: SRWP 1997 - 2001 data

3 Year 5 and 6 Monitoring Plans

A number of significant changes were implemented by the Monitoring Sub-Committee for the Year 3 monitoring effort. These changes were implemented to meet the following objectives:

- To provide more focus on the water quality issues of greatest concern (mercury and organophosphate pesticides);
- To provide additional support for development of Water Quality Management Strategies for these pollutants;
- To shift more funding to special studies designed to follow-up on identified water quality problems or to fill identified data gaps;
- To provide more funding to tributary watershed groups for monitoring and other projects.

In order to meet these monitoring and funding objectives for Year 3, the Monitoring Sub-Committee conducted a thorough evaluation and reprioritization of monitoring needs for Year 3, based on criteria designed to support the objectives outlined above.

The Year 4 monitoring effort was largely a continuation of the monitoring performed in Year 3, with a primary focus on supporting development of the management strategies for mercury and organophosphate pesticides. Monitoring was conducted primarily on an event-based schedule, and included elements in the following categories:

- Mercury and methylmercury in water;
- Organophosphate, carbamate, and triazine pesticides in water;
- Parameters related to drinking water uses and issues, including nitrogen and phosphorous compounds, coliform bacteria, organic carbon, and selected "conventional" parameters in water;
- Causes and sources of aquatic toxicity (*Ceriodaphnia* toxicity testing and Toxicity Identification Evaluations)
- Mercury and organochlorine pesticides and PCBs in fish tissue;
- Bioassessment (identification of reference conditions in the Sierra Nevada foothill ecoregion);

The frequency of monitoring was further reduced to 6 events for Year 4 (due to budget cuts for the program), and all events were conducted on an "episodic" basis. The scope of the Year 5 monitoring program planned to be implemented 2002–2003 is nearly identical to the Year 4 monitoring plan, with additional reductions in monitoring frequency and planned special studies. The Year 5 monitoring plan approved by the SRWP Monitoring Sub-Committee is summarized in Table 32.

Table 30. SRWP Monitoring for 2002-2003: Locations, Analytes, and Numbers of Sample Events

	Chemical Characteristics												Pathogens			Aquatic Toxicity		Fish Tissue		Bioassessment[(b)]	
Monitoring Locations [(c)]	Hg and MeHg (filtered and unfiltered)	TSS	Hardness	Alkalinity	TOC	DOC	UVA 254	TDS	Nitrogen and Phosphorus compounds	OP pesticides	carbamate pesticides	triazines	E. coli	Enterococcus	Total, Fecal Coliforms	Ceriodaphnia	WC Tox Followup (a)	Mercury	PCBs & OC pest.	Benthic Invertebrates	Habitat Assessment
Pit R. above Shasta			atox	atox												6	(a)			RB	
Sac. R. below Keswick	5	5	atox	atox				RED								6	(a)				
Cottonwood Ck at mouth			atox	atox												6	(a)				
Cottonwood Creek (3 tributary sites)	12	12																			
Battle Creek (3 tributary sites)	12	12																			
Sac. R. at Bend Br	5	5	atox	atox	6	6	6	6	6				6	6	6	6	(a)				
Mill Creek @ Los Molinos										3											
Deer Creek										3											
Thomes Creek (3 tributary sites)	12	12																			
Dry Creek (trib to Little Chico Ck)	4	4																			
Little Chico Creek	4	4																			
Big Chico Creek										3											
Sac. R. near Hamilton City	5	5	atox	atox	6	6	6	6	6	6			6	6	6	6	(a)				
Sac. R. @ Colusa	5	5	atox	atox	6	6	6	6	6	6			6	6	6	6	(a)				
Sac. Slough	4	4	atox	atox	6	6	6	6	6	6	6		6	6	6	6	(a)				
Colusa Basin Dr	4	4	atox	atox	6	6	6	6	6	6	6		6	6	6	6	(a)		(c)		
Yuba R. at Marysville	5	5	atox	atox	6	6	6	6	6	6	6		6	6	6	6	(a)				
Feather R. near Nicolaus	5	5	atox	atox	6	6	6	6	6	6		4	6	6	6	6	(a)	4			
Sac. R. at Veterans Br.	CMP	CMP	CMP	6	CMP	CMP	6	6	6	6		4	CMP	6	CMP						
Arcade Creek	4	4		atox						6	6	6				6	(a)				
Natomas East Main Drain			DWR	DWR	DWR	DWR	DWR	DWR	6				6	6	6						
American R. at Discovery Pk	CMP	CMP	CMP	atox	CMP	CMP	6	CMP	6	CMP			CMP	6	CMP	6	(a)	6	2		
Sac. R. at Freeport	CMP, GS	CMP	CMP	GS	CMP	CMP	6	CMP	6	GS	GS	GS	CMP	6	CMP	6	(a)				
Sac. R. at RM44	CMP	CMP	CMP	6	CMP	CMP	6	CMP	6	CMP			CMP	6	CMP			4	2		
Cache Creek at Rumsey																6	(a)				
Number of Sites	14	14	0	2	7	7	11	8	12	11	4	3	8	12	8	14	(c)	3	2	0	0
Number of Regular Analyses	86	86	0	12	42	42	66	48	72	57	24	14	48	72	48	84	(a)	14	4	0	0
Additional QC Analyses	12	9	0	0	12	12	12	6	12	12	12	12	6	6	6	12	(c)	0	0	0	0

Table Notes: Values indicate number of environmental samples collected annually. Additional samples are collected for Quality Assurance. All water quality monitoring will be "event-based". "atox" indicates parameter is measured as part of aquatic toxicity monitoring. Text entries indicate data or samples collected by primary coordinating programs: CMP = Sacramento River Coordinated Monitoring Program; GS = USGS CF = CALFED; RB = Central Valley Regional Board.
(a) A fixed budget of $60,000 is allocated for Toxicity follow-up consisting of chemistry, TIE testing, and additional sampling that has no fixed frequency.
(b) Bioassessment monitoring will consist primarily of identifying and validating potential reference sites in the Sierra Foothills and Central Valley, with an estimated budget of $21,600.
(c) Additional fish tissue samples may be collected and analyzed for this site if funds are made available from the SWRCB TSMP.

4 Database and Data Access

Larry Walker Associates (LWA) is responsible for both data management and database development for the Sacramento River Watershed Program. All data collected by the SRWP is currently stored in a normalized, relational database (Microsoft Access) specifically designed by LWA and the Department of Water Resources (Interagency Ecological Program) to house water chemistry and toxicity test data. The sampling crews and laboratories contracted to collect and analyze the Program's monitoring data provide the data manager (LWA) with electronic and hard copy data that are then imported into the SRWP Database. These data are then validated and qualified according to the protocols described in the SRWP QAPP. In addition to the results reported in SRWP Annual Monitoring Reports, final qualified data will be made available to all interested users on the SRWP website (http://www.sacriver.org) as text and excel files.

5 References

Agency for Toxic Substances and Disease Registry (ATDSR) 1999. Toxicological Profile for Mercury.

Bailey H, L Deanovic, E Reyes, T Kimball, K Larsen, K Cortright, V Connor, and D Hinton. 1997. Diazinon and Chlorpyrifos in Urban Waterways in Northern California. Environmental Toxicology and Chemistry.

Bailey H, C DiGiorgio, K Kroll, J Miller, D Hinton, and G Starrett. 1996. Development of procedures for identifying pesticide toxicity in ambient waters: Carbofuran, diazinon, and chlorpyrifos. Environmental Toxicology and Chemistry 15: 837-845.

Barbour M, J Gerritsen, B Snyder and J Stribling. 1997. Revision to rapid bioassessment protocols for use in stream and rivers: periphyton, benthic macroinvertebrates and fish. EPA 841-D-97-002. U.S. Environmental Protection Agency. Washington DC.

CDFG 1996. California Stream Bioassessment Procedure for Habitat Assessment and Biological Sampling. California Department of Fish and Game, Aquatic Bioassessment Laboratory and Water Pollution Control Laboratory, Rancho Cordova, California.

Connor V, C Foe, L Deanovic. 1993. Sacramento River Basin Biotoxicity Survey Results: 1988-2000. Staff Report to the Central Valley Regional Water Quality Control Board, Sacramento, California.

CVRWQCB 1995. The Water Quality Control Plan (Basin Plan) for the Central Valley Region, 4th Edition. California Regional Water Quality Control Board—Central Valley Region (CVRWQCB). Sacramento, California.

CVRWQCB 2000. Sacramento River Watershed Program Toxicity Testing Data Results Summary: 1998–99. California Regional Water Quality Control Board—Central Valley Region (CVRWQCB). Sacramento, California.

CVRWQCB 2001. Draft Staff Report on Recommended Changes to California's Clean Water Act Section 303(d) List. California Regional Water Quality Control Board—Central Valley Region (CVRWQCB). Sacramento, California.

CVRWQCB 2001. Clear Lake TMDL for Mercury, Draft Final Report. California Regional Water Quality Control Board—Central Valley Region (CVRWQCB). Sacramento, California.

CVRWQCB 2002. Amendment To The Water Quality Control Plan For The Sacramento River And San Joaquin River Basins For Bacteria. Staff Report And Functional Equivalent Document, *Draft, May 2002*. California Regional Water Quality Control Board—Central Valley Region (CVRWQCB). Sacramento, California.

CVRWQCB 2003. 2002 CWA Section 303(D) List Of Water Quality Limited Segments (*January 13, 2003 Draft*). California Regional Water Quality Control Board—Central Valley Region (CVRWQCB). Sacramento, California.

Davis W, B Syder, J Stribling and C Stoughton. 1996. Summary of state biological assessment program for streams and wadable rivers. EPA 230-R-96-007. U.S. Environmental Protection Agency; Office of Policy, Planning and Evaluation: Washington, DC.

De Vlaming V, V Connor, C DiGiorgio, H Bailey, L Deanovic, and D Hinton. 2000. Application of whole effluent toxicity test procedures to ambient water quality assessment. Environmental Toxicology and Chemistry 19:42-62.

DiGiorgio C, D Gonzalez, and C Huitt. 2002. Cryptosporidum and Giardia recoveries in natural waters by using Environmental Protection Agency Method 1623. Applied and Environmental Microbiology 68: 5952-5955.

Domagalski J. 1998. Occurrence and transport of total mercury and methyl mercury in the Sacramento River Basin, California. Journal of Geochemical Exploration 64: 277-291.

Domagalski J. 2000. Pesticide monitoring in the Sacramento River Basin, California, 2/96-9/98. USGS National Water-Quality Assessment Program. U.S. Geological Survey Water-Resources Investigations Report 00-4203. U.S. Geological Survey, Sacramento, California.

Domagalski J. 2000. Memorandum: Results of U.S. Geological Survey special Study on Mercury Source Identification of Upper Sacramento River. U.S. Geological Survey, Water Resources Division, Sacramento, California.

DTMC and SRWP 2002. Strategic Plan for the Reduction of Mercury-Related Risk in the Sacramento River Watershed. Delta Tributaries Mercury Council (DTMC) and Sacramento River Watershed Program (SRWP).

DWR 1997. Aquatic Invertebrate Sampling and Processing Methods (Draft). California Department of Water Resources (DWR) Northern District, Red Bluff, California.

Foe C, and W Croyle. 1998. Mercury Concentrations and Loads from the Sacramento River and From Cache Creek to the Sacramento-San Joaquin Delta Estuary. Central Valley Regional Water Quality Control Board, Sacramento, California.

Foe C, and R Sheipline. 1993. Pesticides in surface water from application on orchards and alfalfa during the winter and spring of 1991-92. Staff Report, Central Valley Regional Water Quality Control Board, Sacramento California.

Gibson G. 1996. Biological Criteria: Technical guidance for streams and small rivers. EPA 822-B-96-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Gill S. 2002. Preliminary results of pesticide residue analysis, and acute and chronic toxicity testing of surface water monitored in the Sacramento River watershed, winter 2000-2001 (Report 199). Memorandum to Don Weaver (January 22, 2002), Environmental Monitoring and Pest Management, Department of Pesticide Regulation, Sacramento, California.

DPR 1996. Information on rice pesticides submitted to the California Regional Water Quality Control Board Central Valley Region (December 31, 1996). Environmental Monitoring and Pest Management Branch, Department of Pesticide Regulation, Sacramento, CA.

DPR 1997. Information on rice pesticides submitted to the California Regional Water Quality Control Board Central Valley Region(December 31, 1997). Environmental Monitoring and Pest Management Branch, Department of Pesticide Regulation, Sacramento, CA.

DPR 1998. Information on rice pesticides submitted to the California Regional Water Quality Control Board Central Valley Region (December 31, 1998). Environmental Monitoring and Pest Management Branch, Department of Pesticide Regulation, Sacramento, CA.

DPR 1995. Information on rice pesticides submitted to the California Regional Water Quality Control Board Central Valley Region (December 28, 1995). Environmental Monitoring and Pest Management Branch, Department of Pesticide Regulation, Sacramento, CA.

Harrington J. 1996. California stream bioassessment procedures. California Department of Fish and Game, Water Pollution Control Laboratory. Rancho Cordova, California.

Holmes R, V de Vlaming, and C Foe. 1998. Sources and Concentrations of Diazinon in the Sacramento River Watershed During the 1994 Orchard Dormant Spray Season. Presented at the Northern California Society of Environmental Toxicology and Chemistry Annual Meeting, June 22, 1998.

Katznelson R, and T Mumley. 1995. Diazinon in Surface Waters in the San Francisco Bay Area: Occurrence and Potential Impact. Final Report prepared for the State Water Resources Control Board, Alameda County Flood Control and Water Conservation District and Alameda Countywide Clean Water Program.

Larsen K, L Deanovic, D Hinton and V Connor. 1998a. Sacramento River Watershed Program Toxicity Monitoring Results: 1996-1997. Staff Report, Central Valley Regional Water Quality Control Board, Sacramento California.

Larsen K, L Deanovic, D Hinton and V Connor. 1998b. Sacramento River Watershed Program Toxicity Monitoring Results: 1997-1998. Staff Report, Central Valley Regional Water Quality Control Board, Sacramento California.

LWA 1998. Sacramento River Watershed Program: Phase 1 Monitoring Plan. Prepared for the Sacramento River Watershed Program by Larry Walker Associates (LWA), Davis, California..

LWA 1998. Sacramento River Watershed Program: Quality Assurance Project Plan for the Year 1 Monitoring Program. Prepared for the Sacramento River Watershed Program by Larry Walker Associates (LWA), Davis, California.

LWA 1999. Quality Assurance Project Plan for Monitoring: June 1999 Revision. Prepared for the Sacramento River Watershed Program by Larry Walker Associates (LWA), Davis, California.

LWA 1999. Quality Assurance Project Plan for Monitoring: November 2000 Revision. Prepared for the Sacramento River Watershed Program by Larry Walker Associates (LWA), Davis, California.

LWA 1999. Sacramento Area Stormwater NPDES Permit Monitoring Program: Annual Report 1998-99. Prepared for the County of Sacramento and cities of Sacramento, Galt, and Folsom by Larry Walker Associates (LWA), Davis, California.

LWA 2002. Sacramento River Coordinated Monitoring Program 2001-2002. Annual Report. Prepared for the Sacramento Regional County Sanitation District, the City of Sacramento, and the County of Sacramento by Larry Walker Associates (LWA). Davis, California.

Newhart, KL. 2000. Thiobencarb Use In Colusa And Glenn Counties From 1994-2000. California Department of Pesticide Regulation, Sacramento, California.

Nordmark C, K Bennet, H Feng, J Hernandez, P Lee. 1998. Occurrence of Aquatic toxicity and Dormant-Spray Pesticide Detections in the Sacramento River Watershed, Winter 1996-97. California Department of Pesticide Regulation, Sacramento, California.

Nordmark C. 1998. Preliminary results of acute and chronic toxicity testing of surface water monitored in the Sacramento River watershed, winter 1997-98. Memorandum to Don Weaver (July 31, 1998), Environmental Monitoring and Pest Management, Department of Pesticide Regulation, Sacramento, California.

Nordmark C. 1999. Preliminary results of acute and chronic toxicity testing of surface water monitored in the Sacramento River watershed, winter 1998-99. Memorandum to Don Weaver (May 26, 1999), Environmental Monitoring and Pest Management, Department of Pesticide Regulation, Sacramento, California.

Nordmark C. 2000. Preliminary results of acute and chronic toxicity testing of surface water monitored in the Sacramento River watershed, winter 1999-2000. Memorandum to Don Weaver, Environmental Monitoring and Pest Management, Department of Pesticide Regulation, Sacramento, California.

OEHHA 1999. Prevalence Of Selected Target Chemical Contaminants In Sport Fish From Two California Lakes: Public Health Designed Screening Study, Final Project Report. California Office of Environmental Health and Hazard Assessment, Sacramento, California.

Ogle S, and J Cooke. 2000. Water Quality Management Issue: Pesticides in Surface Water Runoff. Toxics Sub-committee, Sacramento River Watershed Program.

Plafkin J, J Barbour, K Porter, S Gross, R Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish. EPA/444/4-89-001. U.S. EPA, Office of Water. Washington, D.C.

Resh V and J Jackson. 1993. Rapid assessment approaches to biomonitoring using benthic macroinvertebrates. In: D. M. Rosenberg and V. H. Resh, eds., Chapman and Hall, New York.

SFBRWQCB 1995. Contaminant Levels in Fish Tissue from San Francisco Bay. San Francisco Bay Regional Water Quality Control Board (SFBRWQCB), Oakland, California.

SFEI 1996. Quality Assurance Project Plan: Regional Monitoring Program for Trace Substances. San Francisco Estuary Institute (SFEI), Richmond, CA.

SFEI 1998a. San Francisco Estuary Regional Monitoring Program for Trace Substances: 1997 Annual Report. San Francisco Estuary Institute (SFEI), Richmond, California.

SFEI 1998b. Contaminant Concentrations in Fish from the Sacramento–San Joaquin Delta and Lower San Joaquin River. San Francisco Estuary Institute (SFEI), Richmond, CA.

SFEI 1999a. Persistent Toxic Chemical of Human Health Concern in Fish from San Francisco Bay and the Sacramento River, CA. San Francisco Estuary Institute (SFEI), Richmond, CA.

SFEI 1999b. 1997 Annual Report: San Francisco Estuary Regional Monitoring Program for Trace Substances. San Francisco Estuary Institute (SFEI), Richmond, CA.

SRWP 2001. Water Quality Management Strategy for Diazinon in the Sacramento and Feather Rivers. Sacramento River Watershed Program (SRWP), CA.

Slotton D, S Ayers, J Reuter, and C Goldman. 1995. Gold Mining Impacts on Food Chain Mercury in Northwestern Sierra Nevada Streams, Technical Completion Report. Division of Environmental Studies and Institute of Ecology, University of California, Davis.

Spurlock, C 2002. Analysis of Diazinon and Chlorpyrifos Surface Water Monitoring and Acute Toxicity Bioassay Data, 1991-2001. Environmental Hazards Assessment Program, Environmental Monitoring Branch, California Department of Pesticide Regulation. Sacramento, California.

SRWP 1999. Sacramento River Watershed Program Phase 1 Monitoring Plan. Prepared by Larry Walker Associates for the Sacramento River Watershed Program (SRWP).

SRWP 2000. Sacramento River Watershed Program Annual Monitoring Report: 1998-1999. Prepared by Larry Walker Associates for the Sacramento River Watershed Program (SRWP).

SRWP 2001. Sacramento River Watershed Program Annual Monitoring Report: 1999-2000. Prepared by Larry Walker Associates for the Sacramento River Watershed Program (SRWP).

Sutter County Department of Agriculture (personal communication). 1997. Results of sampling Sutter Basin agricultural drain for suspected phenoxy compounds. June 26, 1997. (in Ogle and Cooke 2000)

U.S. Environmental Protection Agency, Integrated Risk Information System [IRIS] database, March 13, 1998.

USEPA 2000. Ecological Effects Branch Pesticide EcoToxicity Database (July 2000 version)**.** Ecological Fate and Effects Division, Office of Pesticide Programs. U. S. Environmental Protection Agency, Washington, DC.

USEPA 1986. Quality Criteria for Water. EPA 440-5-86-001. U.S. Environmental Protection Agency (USEPA), Office of Water. Washington DC.

USEPA 1991. Methods for Aquatic Toxicity Identification Evaluations: Phase I Toxicity Characterization Procedures. EPA 600/6-91-003. Office of Research and Development.

USEPA 1992. Toxicity Identification Evaluation: Characterization of Chronically Toxic Effluents, Phase I. EPA 600/6-91-005F. U.S. Environmental Protection Agency (USEPA), Office of Research and Development.

USEPA 1993. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 1, Fish Sampling and Analysis, Second Edition. EPA 823-R-93-002. U.S. Environmental Protection Agency (USEPA), Office of Water, Washington, DC.

USEPA 1993a. Methods for Aquatic Toxicity Identification Evaluations: Phase II Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity (EPA 600/R-92-080). U.S. Environmental Protection Agency (USEPA), Office of Research and Development.

USEPA 1993b. Methods for Aquatic Toxicity Identification Evaluations: Phase I and III Toxicity Identification Procedures for Samples Exhibiting Acute and Chronic Toxicity (EPA 600/R-92-081). U.S. Environmental Protection Agency (USEPA), Office of Research and Development.

USEPA 1995. Final Water Quality Guidance for the Great Lakes System. Final Rule. 40 CFR Parts 9,122,123,131,and 132. Federal Register. Vol. 60 No. 56. March 23. Rules and Regulations.

USEPA 1995. National Toxics Rule. Environmental Protection Agency (USEPA), Office of Water. Promulgated in the Code of Federal Regulations, 40 CFR 131.31, December 1992, and amended in May 1995.

USEPA 1996. Drinking water Regulations and Health Advisories. EPA-822-B-96-002. U.S. Environmental Protection Agency (USEPA), Office of Water.

USEPA 1997. Mercury Study Report to Congress, Volumes 1–8.. EPA-452/R-97-009. U.S. Environmental Protection Agency (USEPA), Office of Air Quality Planning and Standards and Office of Research and Development.

USEPA 1998. 1997 National Listing of Fish Consumption Advisories. EPA-823-C-98-001/002. U.S. Environmental Protection Agency (USEPA), Office of Water. Washington, DC.

USEPA 1998. National Primary Drinking Water Regulations: Interim Enhanced Surface Water Treatment. Final Rule. 40 CFR Parts 9, 141, and 142 Federal Register. Vol. 63 No. 241. December 16, 1988. Rules and Regulations.

USEPA 1998. U.S. EPA Iris substance file: Polychlorinated biphenyls (PCBs). U.S. Environmental Protection Agency (USEPA), Washington, DC.

USEPA 1999. National Recommended Water Quality Criteria—Correction. EPA 822-Z-99-001. U.S. Environmental Protection Agency (USEPA), Office of Water. Washington, DC.

USEPA 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury (Final). EPA-823-R-01-001. U.S. Environmental Protection Agency, Office of Water, Washington DC.

USEPA 2001(b). Total Maximum Daily Load (TMDL) for Total Mercury in Fish Tissue Residue in Lake Bennett, GA. U.S. Environmental Protection Agency, Region 4.

USGS 2001. Sacramento River Watershed NAWQA data provided by Joseph Domagalski of the U.S. Geological Survey (USGS), Sacramento, California.

Woodard R. 2000. Sources and Magnitudes of Water Quality Constituents of Concern in Drinking Water Supplies Taken from the Sacramento-San Joaquin Delta. Prepared for the CALFED Bay-Delta Program.

APPENDIX A

Summary Statistics for Monitoring Data: SRWP, USGS NAWQA, Sacramento River CMP, and City of Redding

Summary Statistics: Mercury Data

Methylmercury, filtered

Units = ng/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRBKR	Sacramento River below Keswick	7/19/00	2/18/02	9	2	22%	0.021	0.022	ID	ID	ID	ID	0.020
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	1	50%	0.034	0.034	ID	ID	ID	ID	0.028
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	1	50%	0.048	0.048	ID	ID	ID	ID	0.028
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	1	50%	0.179	0.179	ID	ID	ID	ID	0.028
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	0	0%	ND	0	ID	ID	ID	ID	0.021
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	0	0%	ND	0	ID	ID	ID	ID	0.021
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	1	50%	0.295	0.295	ID	ID	ID	ID	0.028
SRABB	Sacramento River above Bend Bridge	7/19/00	2/19/02	12	4	33%	0.021	0.046	0.02	0.01	0.01	0.01	0.020
MCBLR	Mill Creek at Black Rock	4/6/01	4/6/01	1	0	0%	ND	0	ID	ID	ID	ID	0.020
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	4	100%	0.025	0.045	0.03	0.01	0.03	0.02	NR
MCMOU	Mill Creek at Mouth	7/19/00	5/15/01	9	9	100%	0.029	0.315	0.11	0.10	0.08	0.11	NR
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	1	50%	0.021	0.021	ID	ID	ID	ID	0.028
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	0	0%	ND	0	ID	ID	ID	ID	0.028
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	0	0%	ND	0	ID	ID	ID	ID	0.028
SRHAM	Sacramento River near Hamilton City	7/20/00	2/20/02	12	7	58%	0.020	0.05	0.02	0.01	0.020	0.01	0.020
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	3	3	100%	0.067	0.162	0.098	0.075	0.090	0.082	NR
LCBCH	Little Chico Creek below Chico	2/20/02	3/7/02	2	0	0%	ND	0.00	ID	ID	ID	ID	0.028
SRCOL	Sacramento River at Colusa	7/20/00	2/21/02	12	11	92%	0.021	0.081	0.036	0.019	0.033	0.023	0.020
COLDR	Colusa Basin Drain above KL	7/21/00	3/7/02	12	12	100%	0.024	0.32	0.099	0.098	0.068	0.10	NR
SACSL	Sacramento Slough	7/21/00	3/8/02	12	11	92%	0.021	0.11	0.057	0.033	0.049	0.045	0.028
YRMRY	Yuba River at Marysville	7/20/00	3/7/02	12	10	83%	0.030	0.15	0.063	0.041	0.052	0.055	0.020
FRNIC	Feather River near Nicolaus	7/21/00	3/8/02	13	11	85%	0.030	0.20	0.060	0.053	0.049	0.051	0.020
SRVET	Sacramento River at Veterans Bridge	10/17/00	8/6/02	21	17	81%	0.026	0.11	0.049	0.023	0.045	0.027	0.029
ARDPK	American River at Discovery Park	10/17/00	8/6/02	22	18	82%	0.022	0.073	0.039	0.014	0.037	0.019	0.018
ARCNW	Arcade Creek at Norwood Ave.	7/21/00	3/8/02	12	12	100%	0.030	1.2	0.23	0.38	0.13	0.23	NR
SRFPT	Sacramento River at Freeport	10/18/00	8/7/02	23	19	83%	0.009	0.094	0.043	0.022	0.037	0.030	0.029
SRRMF	Sacramento River at River Mile 44	10/18/00	8/7/02	24	21	88%	0.023	0.75	0.085	0.19	0.054	0.059	0.029
SRGRN	Sacramento River at Greene's Landing	1/1/00	10/1/01	27	26	96%	0.022	0.34	0.093	0.073	0.074	0.078	0.020

Methylmercury, unfiltered

Units = ng/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRBKR	Sacramento River below Keswick	7/19/00	2/18/02	9	3	33%	0.022	0.040	0.018	0.017	0.015	0.015	0.020
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	1	50%	0.054	0.054	ID	ID	ID	ID	0.028
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	1	50%	0.069	0.069	ID	ID	ID	ID	0.028
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	1	50%	0.433	0.433	ID	ID	ID	ID	0.028
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	0	0%	ND	0.000	ID	ID	ID	ID	0.021
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	2	100%	0.032	0.040	ID	ID	ID	ID	NR
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	2	100%	0.048	0.434	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	7/19/00	2/19/02	12	9	75%	0.021	0.101	0.036	0.028	0.028	0.033	0.020
MCBLR	Mill Creek at Black Rock	4/6/01	4/6/01	1	1	100%	0.020	0.020	ID	ID	ID	ID	NR
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	4	100%	0.030	0.067	0.056	0.022	0.053	0.033	NR
MCMOU	Mill Creek at Mouth	7/19/00	5/15/01	9	9	100%	0.025	0.403	0.18	0.13	0.13	0.20	NR
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	2	100%	0.037	0.085	ID	ID	ID	ID	NR
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	1	100%	0.110	0.11	ID	ID	ID	ID	NR
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	1	100%	0.066	0.066	ID	ID	ID	ID	NR
SRHAM	Sacramento River near Hamilton City	7/20/00	2/20/02	12	11	92%	0.034	0.21	0.07	0.06	0.05	0.05	0.020
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	4	4	100%	0.103	0.27	0.15	0.11	0.14	0.10	NR
LCBCH	Little Chico Creek below Chico	2/20/02	3/7/02	2	1	50%	0.06	0.063	ID	ID	ID	ID	0.0278
SRCOL	Sacramento River at Colusa	2/28/96	2/21/02	41	40	98%	0.046	1.3	0.17	0.23	0.12	0.12	0.025
COLDR	Colusa Basin Drain above KL	3/6/96	3/7/02	37	37	100%	0.021	0.89	0.22	0.17	0.17	0.19	NR
SACSL	Sacramento Slough	2/12/96	3/8/02	35	35	100%	0.045	1.2	0.22	0.23	0.16	0.18	NR
YRMRY	Yuba River at Marysville	7/20/00	3/7/02	14	14	100%	0.032	0.26	0.10	0.072	0.086	0.081	NR
FRNIC	Feather River near Nicolaus	7/21/00	3/8/02	13	13	100%	0.035	0.28	0.10	0.067	0.091	0.074	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	27	100%	0.0060	2.0	0.22	0.45	0.12	0.19	NR
SRVET	Sacramento River at Veterans Bridge	11/7/00	8/6/02	19	19	100%	0.047	0.22	0.120	0.040	0.113	0.060	NR
ARDPK	American River at Discovery Park	11/7/00	8/6/02	21	21	100%	0.039	0.16	0.083	0.037	0.076	0.050	NR
ARCNW	Arcade Creek at Norwood Ave.	7/21/00	3/8/02	12	12	100%	0.099	1.2	0.35	0.35	0.28	0.28	NR
SRFPT	Sacramento River at Freeport	2/20/96	8/7/02	66	65	98%	0.012	0.78	0.13	0.12	0.10	0.11	0.025
SRRMF	Sacramento River at River Mile 44	11/8/00	8/7/02	23	23	100%	0.062	0.20	0.120	0.037	0.11	0.055	NR
SRGRN	Sacramento River at Greene's Landing	1/1/00	10/1/01	33	32	97%	0.013	0.16	0.066	0.041	0.053	0.056	0.020
CCHRM	Cache Creek near Rumsey	2/21/99	8/18/99	11	11	100%	0.035	0.39	0.16	0.11	0.13	0.15	NR

Summary Statistics: Mercury Data

Mercury, total, filtered

Units = ng/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRBKR	Sacramento River below Keswick	7/19/00	2/18/02	9	7	78%	0.35	0.67	0.44	0.16	0.41	0.24	0.20
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	2	100%	0.77	0.79	ID	ID	ID	ID	NR
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	2	100%	1.47	1.62	ID	ID	ID	ID	NR
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	2	100%	0.36	0.71	ID	ID	ID	ID	NR
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	2	100%	0.23	0.36	ID	ID	ID	ID	NR
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	1	50%	0.38	0.38	ID	ID	ID	ID	0.20
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	2	100%	0.48	0.56	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	7/19/00	2/19/02	12	9	75%	0.36	2.67	0.58	0.88	0.42	0.49	0.20
MCBLR	Mill Creek at Black Rock	4/6/01	4/6/01	1	1	100%	5.18	5.18	ID	ID	ID	ID	NR
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	4	100%	1.13	5.34	3.08	2.24	2.41	3.78	NR
MCMOU	Mill Creek at Mouth	7/19/00	5/15/01	9	9	100%	0.59	2.24	1.40	0.55	1.30	0.90	NR
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	2	100%	0.61	7.22	ID	ID	ID	ID	NR
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	1	100%	6.35	6.4	ID	ID	ID	ID	NR
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	1	100%	10.1	10.1	ID	ID	ID	ID	NR
SRHAM	Sacramento River near Hamilton City	7/20/00	2/20/02	12	11	92%	0.43	2.2	0.8	0.59	0.6	0.56	0.20
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	3	3	100%	1.55	4.6	3.08	1.72	2.80	3.23	NR
LCBCH	Little Chico Creek below Chico	2/20/02	2/20/02	1	1	100%	2.7	2.7	ID	ID	ID	ID	NR
SRCOL	Sacramento River at Colusa	7/20/00	2/21/02	12	12	100%	0.22	3.8	0.85	1.2	0.61	0.74	NR
COLDR	Colusa Basin Drain above KL	7/21/00	3/7/02	12	11	92%	0.48	1.5	0.78	0.39	0.71	0.51	0.20
SACSL	Sacramento Slough	7/21/00	3/8/02	12	12	100%	0.28	3.2	0.98	0.92	0.75	0.87	NR
YRMRY	Yuba River at Marysville	7/20/00	3/7/02	13	13	100%	0.39	4.4	1.4	1.2	1.1	1.3	NR
FRNIC	Feather River near Nicolaus	7/21/00	3/8/02	13	13	100%	0.22	6.4	1.3	2.0	0.84	1.0	NR
SRVET	Sacramento River at Veterans Bridge	1/18/94	9/3/02	122	120	98%	0.35	8.0	1.7	1.2	1.4	1.3	0.50
ARDPK	American River at Discovery Park	1/18/94	9/3/02	116	107	92%	0.070	3.9	1.3	0.89	1.0	1.1	0.41
ARCNW	Arcade Creek at Norwood Ave.	7/21/00	3/8/02	12	12	100%	1.2	6.0	2.7	1.6	2.4	2.0	NR
SRFPT	Sacramento River at Freeport	2/15/94	9/4/02	121	120	99%	0.26	15	1.7	1.7	1.3	1.3	0.50
SRRMF	Sacramento River at River Mile 44	1/18/94	9/4/02	116	115	99%	0.46	11	1.7	1.5	1.4	1.3	0.50
SRGRN	Sacramento River at Greene's Landing	1/1/00	10/1/01	27	27	100%	0.15	2.6	0.88	0.66	0.71	0.71	NR

Summary Statistics: Mercury Data

Mercury, total, unfiltered

Units = ng/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRBKR	Sacramento River below Keswick	1/20/98	2/18/02	56	55	98%	0.19	10	1.4	1.6	1.1	1.1	0.030
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	11	11	100%	0.51	1.7	1.1	0.38	1.1	0.62	NR
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	2	100%	1.05	1	ID	ID	ID	ID	NR
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	2	100%	1.9	4	ID	ID	ID	ID	NR
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	2	100%	1.3	1	ID	ID	ID	ID	NR
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	2	100%	0.3	0.5	ID	ID	ID	ID	NR
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	2	100%	0.3	1	ID	ID	ID	ID	NR
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	2	100%	0.59	0.9	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	2/19/02	51	51	100%	0.42	32.6	3.45	5.5	2.11	2.77	NR
MCHWY	Mill Creek at Highway 36	6/23/98	4/17/00	19	19	100%	4.38	1910	155.2	581.5	42.8	104.4	NR
MCBLR	Mill Creek at Black Rock	6/23/98	4/6/01	19	19	100%	2.00	110.0	26.9	33.3	13.70	29.3	NR
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	4	100%	4.38	7.6	6.2	1.5	6.08	2.6	NR
MCMOU	Mill Creek at Mouth	6/23/98	5/15/01	28	28	100%	2.04	485.0	34.3	114.9	10.20	22.2	NR
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	2	100%	0.63	48.2	ID	ID	ID	ID	NR
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	1	100%	56.2	56.2	ID	ID	ID	ID	NR
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	1	100%	31.8	31.8	ID	ID	ID	ID	NR
DCMDW	Deer Creek below Childs Meadows	6/24/98	4/17/00	19	19	100%	0.16	7.0	1.2	1.8	0.74	1.0	NR
DCPON	Deer Creek at Ponderosa Way	6/24/98	11/8/99	12	12	100%	0.15	5.0	0.8	1.7	0.50	0.7	NR
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	4/17/00	20	20	100%	0.22	10.3	2.3	3.3	1.00	2.2	NR
DCMOU	Deer Creek at Mouth	6/24/98	4/17/00	14	14	100%	0.32	6.0	1.2	1.8	0.83	1.0	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	2/20/02	23	23	100%	0.87	32.4	4.4	8.0	2.37	3.3	NR
CHHWY	Big Chico Creek at Hwy 32	6/23/98	4/17/00	19	18	95%	0.18	5	0.9	1.2	0.6	0.8	3
CHASH	Big Chico Creek above Salmon Hole	6/23/98	2/14/00	16	15	94%	0.20	6.4	1.44	1.9	0.81	1.3	3.0
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/23/98	4/17/00	19	19	100%	0.23	10.0	1.4	2.7	0.78	1.1	0.0
CHMUD	Big Chico Creek above Mud Creek	6/23/98	4/17/00	21	20	95%	0.33	10	2.2	2.7	1.16	2.2	0.2
MUDCH	Mud Creek above Big Chico Creek	6/23/98	4/17/00	11	11	100%	0.40	58	7.4	22.7	2.2	5.6	0.00
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	3	3	100%	2.35	21	11.1	10	7.9	20.8	NR
LCBCH	Little Chico Creek below Chico	2/20/02	3/7/02	2	2	100%	2.3	16	ID	ID	ID	ID	NR
SRCOL	Sacramento River at Colusa	2/28/96	2/21/02	57	57	100%	0.60	105	8.5	17	4.9	6.3	NR
COLDR	Colusa Basin Drain above KL	3/6/96	3/7/02	49	49	100%	1.6	19	7.8	3.9	6.9	5.1	NR
SACSL	Sacramento Slough	2/12/96	3/8/02	46	46	100%	2.9	31	8.8	5.1	7.8	5.5	NR
YRMRY	Yuba River at Marysville	2/27/96	3/7/02	50	50	100%	1.0	47	5.4	8.4	3.3	4.1	NR
FRNIC	Feather River near Nicolaus	2/23/96	3/8/02	51	51	100%	1.5	46	7.0	8.0	5.1	5.4	NR
SRVON	Sacramento River at Verona	2/22/96	5/20/98	28	28	100%	2.5	40	8.6	8.2	6.9	6.3	NR
SRVET	Sacramento River at Veterans Bridge	1/18/94	9/3/02	123	123	100%	2.0	35	8.7	5.5	7.3	5.9	NR
ARDPK	American River at Discovery Park	1/18/94	9/3/02	120	120	100%	0.56	13	3.1	2.4	2.4	2.4	NR
ARCNW	Arcade Creek at Norwood Ave.	3/5/96	3/8/02	49	49	100%	1.1	54	11	11	7.7	9.2	NR
SRFPT	Sacramento River at Freeport	2/15/94	9/4/02	174	174	100%	1.2	36	8.1	6.3	6.4	6.1	NR
SRRMF	Sacramento River at River Mile 44	1/18/94	9/4/02	118	118	100%	1.7	73	9.1	9.3	6.9	7.0	NR
SRGRN	Sacramento River at Greene's Landing	1/1/00	10/1/01	26	26	100%	2.1	23	4.9	4.9	4.0	3.1	NR
CCHRM	Cache Creek near Rumsey	2/9/96	8/18/99	47	47	100%	2.7	2247.6	115	408	20	57	NR
YOLOB	Yolo Bypass near Woodland	1/31/97	4/30/98	10	10	100%	18	224	48	83	34	36	NR
CCHSL	Cache Slough near Ryers Ferry	6/25/98	2/16/00	11	11	100%	3.1	18	8.6	4.4	7.8	6.1	NR

Summary Statistics Table Notes:
monitoring period start and end — Dates of first and last reported data.
n — Total number of data reported.
n det — Total number of data above reporting limits.
% det — Percent of data above reporting limits.
min det — Minimum value for data detected above reporting limits.
max det — Maximum value of data detected above reporting limits.
mean — Arithmetic mean value. "ID" if insufficient data to calculate.
SD — Standard Deviation. "ID" if insufficient data to calculate.
median — 50th percentile value. "ID" if insufficient data to calculate.
IQR — Interquartile range. "ID" if insufficient data to calculate.
min RL — Lowest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.
max RL — Highest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.

Summary Statistics: Data for Pesticides Detected in SRWP Monitoring

Aldicarb

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	18	1	5.6%	0.70	0.70	ID	ID	ID	ID	0.40
SACSL	Sacramento Slough	6/22/99	5/16/02	17	0	0%	ND	ND	ID	ID	ID	ID	0.40
YRMRY	Yuba River at Marysville	9/25/01	3/7/02	4	0	0%	ND	ND	ID	ID	ID	ID	0.40
SRVET	Sacramento River at Veterans Bridge	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
ARDPK	American River at Discovery Park	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	17	0	0%	ND	ND	ID	ID	ID	ID	0.40
SRFPT	Sacramento River at Freeport	9/20/00	6/5/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
SRRMF	Sacramento River at River Mile 44	9/20/00	6/5/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.40

Bromacil

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	26	4	15%	0.40	0.50	ID	ID	ID	ID	0.40
SACSL	Sacramento Slough	6/22/99	5/16/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.40
YRMRY	Yuba River at Marysville	9/25/01	3/7/02	4	0	0%	ND	ND	ID	ID	ID	ID	0.40
SRVET	Sacramento River at Veterans Bridge	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
ARDPK	American River at Discovery Park	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	26	3	12%	0.40	1.0	ID	ID	ID	ID	0.40
SRFPT	Sacramento River at Freeport	9/20/00	6/5/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
SRRMF	Sacramento River at River Mile 44	9/20/00	6/5/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.40

Carbaryl

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.070
SACSL	Sacramento Slough	6/22/99	5/16/02	26	1	3.8%	0.14	0.14	ID	ID	ID	ID	0.070
YRMRY	Yuba River at Marysville	9/25/01	3/7/02	4	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRVET	Sacramento River at Veterans Bridge	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.070
ARDPK	American River at Discovery Park	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.070
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	26	5	19%	0.10	0.25	ID	ID	ID	ID	0.070
SRFPT	Sacramento River at Freeport	9/15/98	6/5/02	44	11	25%	0.003	0.072	ID	ID	ID	ID	0.0030
SRRMF	Sacramento River at River Mile 44	9/20/00	6/5/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10

Carbofuran

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	17	2	12%	0.070	0.41	ID	ID	ID	ID	0.070
SACSL	Sacramento Slough	6/22/99	5/16/02	16	1	6%	0.11	0.11	ID	ID	ID	ID	0.070
YRMRY	Yuba River at Marysville	9/25/01	3/7/02	4	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRVET	Sacramento River at Veterans Bridge	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.070
ARDPK	American River at Discovery Park	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.070
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	17	0	0%	ND	ND	ID	ID	ID	ID	0.070
SRFPT	Sacramento River at Freeport	9/15/98	6/5/02	44	4	9%	0.003	0.067	ID	ID	ID	ID	0.0030
SRRMF	Sacramento River at River Mile 44	9/20/00	6/5/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10

Chlorpyrifos

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
MCMOU	Mill Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.050
DCMOU	Deer Creek at Mouth	1/26/01	2/20/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.050
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	24	0	0%	ND	ND	ID	ID	ID	ID	0.050
CHMOU	Big Chico Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.050
SRCOL	Sacramento River at Colusa	6/24/99	5/15/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.050
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	26	1	3.8%	0.70	0.70	ID	ID	ID	ID	0.050
SACSL	Sacramento Slough	6/22/99	5/16/02	25	0	0%	ND	ND	ID	ID	ID	ID	0.050
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.050
FRNIC	Feather River near Nicolaus	7/21/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.050
SRVET	Sacramento River at Veterans Bridge	7/20/99	8/6/02	48	0	0%	ND	ND	ID	ID	ID	ID	0.050
ARDPK	American River at Discovery Park	9/19/00	7/9/02	21	0	0%	ND	ND	ID	ID	ID	ID	0.050
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	26	1	3.8%	0.050	0.050	ID	ID	ID	ID	0.050
SRFPT	Sacramento River at Freeport	9/15/98	8/7/02	59	2	3.4%	0.003	0.006	ID	ID	ID	ID	0.0040
SRRMF	Sacramento River at River Mile 44	9/20/00	8/7/02	21	0	0%	ND	ND	ID	ID	ID	ID	0.050

Summary Statistics: Data for Pesticides Detected in SRWP Monitoring

Diazinon

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
MCMOU	Mill Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.050
DCMOU	Deer Creek at Mouth	1/26/01	2/20/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.050
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	24	0	0%	ND	ND	ID	ID	ID	ID	0.050
CHMOU	Big Chico Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.050
SRCOL	Sacramento River at Colusa	6/24/99	5/15/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.050
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	26	2	7.7%	0.060	0.10	ID	ID	ID	ID	0.050
SACSL	Sacramento Slough	6/22/99	5/16/02	26	1	3.8%	0.050	0.050	ID	ID	ID	ID	0.050
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.050
FRNIC	Feather River near Nicolaus	7/21/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.050
SRVET	Sacramento River at Veterans Bridge	7/20/99	8/6/02	49	2	4.1%	0.040	0.050	ID	ID	ID	ID	0.050
ARDPK	American River at Discovery Park	9/19/00	7/9/02	21	3	14%	0.049	0.060	ID	ID	ID	ID	0.050
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	26	22	85%	0.060	0.83	0.24	0.19	0.18	0.22	0.050
SRFPT	Sacramento River at Freeport	9/15/98	8/7/02	59	14	24%	0.0010	0.047	ID	ID	ID	ID	0.0020
SRRMF	Sacramento River at River Mile 44	9/20/00	8/7/02	21	0	0%	ND	ND	ID	ID	ID	ID	0.050

Diuron

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
COLDR	Colusa Basin Drain above KL	6/23/99	6/22/01	21	5	24%	0.40	0.90	0.26	0.23	0.19	0.26	0.40
SACSL	Sacramento Slough	6/22/99	6/21/01	20	1	5.0%	0.70	0.70	ID	ID	ID	ID	0.40
SRVET	Sacramento River at Veterans Bridge	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
ARDPK	American River at Discovery Park	9/19/00	6/4/02	7	1	14%	0.60	0.60	ID	ID	ID	ID	0.40
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	6/22/01	21	6	29%	0.70	6.3	0.60	1.8	0.20	0.49	0.40
SRFPT	Sacramento River at Freeport	9/20/00	6/5/02	7	1	14%	0.40	0.40	ID	ID	ID	ID	0.40
SRRMF	Sacramento River at River Mile 44	9/20/00	6/5/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.40

EPTC

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
MCMOU	Mill Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10
DCMOU	Deer Creek at Mouth	1/26/01	2/20/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRHAM	Sacramento River near Hamilton City	7/20/00	5/14/02	12	1	8.3%	0.12	0.12	ID	ID	ID	ID	0.10
CHMOU	Big Chico Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRCOL	Sacramento River at Colusa	7/20/00	5/15/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.10
COLDR	Colusa Basin Drain above KL	7/21/00	5/15/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.10
SACSL	Sacramento Slough	7/21/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.10
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.10
FRNIC	Feather River near Nicolaus	7/21/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRVET	Sacramento River at Veterans Bridge	9/19/00	8/6/02	27	0	0%	ND	ND	ID	ID	ID	ID	0.10
ARDPK	American River at Discovery Park	7/17/01	7/9/02	13	0	0%	ND	ND	ID	ID	ID	ID	0.10
ARCNW	Arcade Creek at Norwood Ave.	7/21/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRFPT	Sacramento River at Freeport	9/15/98	8/7/02	51	3	5.9%	0.0020	0.0050	ID	ID	ID	ID	0.0020
SRRMF	Sacramento River at River Mile 44	7/18/01	8/7/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.10

Malathion

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
MCMOU	Mill Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10
DCMOU	Deer Creek at Mouth	1/26/01	2/20/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	24	0	0%	ND	ND	ID	ID	ID	ID	0.10
CHMOU	Big Chico Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRCOL	Sacramento River at Colusa	6/24/99	5/15/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.10
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	26	1	3.8%	0.24	0.24	ID	ID	ID	ID	0.10
SACSL	Sacramento Slough	6/22/99	5/16/02	25	1	4.0%	0.10	0.10	ID	ID	ID	ID	0.10
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.10
FRNIC	Feather River near Nicolaus	7/21/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRVET	Sacramento River at Veterans Bridge	7/20/99	8/6/02	48	0	0%	ND	ND	ID	ID	ID	ID	0.10
ARDPK	American River at Discovery Park	9/19/00	7/9/02	21	0	0%	ND	ND	ID	ID	ID	ID	0.10
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRFPT	Sacramento River at Freeport	9/15/98	8/7/02	59	7	12%	0.0050	0.022	ID	ID	ID	ID	0.0050
SRRMF	Sacramento River at River Mile 44	9/20/00	8/7/02	21	0	0%	ND	ND	ID	ID	ID	ID	0.10

Summary Statistics: Data for Pesticides Detected in SRWP Monitoring

Methomyl

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
COLDR	Colusa Basin Drain above KL	7/21/00	5/15/02	14	1	7.1%	0.19	0.19	ID	ID	ID	ID	0.070
SACSL	Sacramento Slough	7/21/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.070
YRMRY	Yuba River at Marysville	9/25/01	3/7/02	4	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRVET	Sacramento River at Veterans Bridge	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.070
ARDPK	American River at Discovery Park	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.070
ARCNW	Arcade Creek at Norwood Ave.	7/21/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.070
SRFPT	Sacramento River at Freeport	9/20/00	6/5/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.070
SRRMF	Sacramento River at River Mile 44	9/20/00	6/5/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10

Prometon

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
MCMOU	Mill Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10
DCMOU	Deer Creek at Mouth	1/26/01	2/20/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	24	0	0%	ND	ND	ID	ID	ID	ID	0.10
CHMOU	Big Chico Creek at Mouth	1/26/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRCOL	Sacramento River at Colusa	6/24/99	5/15/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.10
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.10
SACSL	Sacramento Slough	6/22/99	5/16/02	27	0	0%	ND	ND	ID	ID	ID	ID	0.10
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.10
FRNIC	Feather River near Nicolaus	7/21/00	5/16/02	17	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRVET	Sacramento River at Veterans Bridge	7/20/99	5/15/02	27	0	0%	ND	ND	ID	ID	ID	ID	0.10
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	31	5	16%	0.10	0.21	ID	ID	ID	ID	0.10
SRFPT	Sacramento River at Freeport	9/15/98	9/17/01	37	1	2.7%	0.0020	0.0020	ID	ID	ID	ID	0.015

Propazine

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
FRNIC	Feather River near Nicolaus	10/30/00	3/8/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.50
SRVET	Sacramento River at Veterans Bridge	10/30/00	3/7/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.50
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	25	2	8.0%	1.1	2.0	ID	ID	ID	ID	0.50

Prowl

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
MCMOU	Mill Creek at Mouth	1/27/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10
DCMOU	Deer Creek at Mouth	1/27/01	2/20/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	25	1	4.0%	0.18	0.18	ID	ID	ID	ID	0.10
CHMOU	Big Chico Creek at Mouth	1/27/01	3/6/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRCOL	Sacramento River at Colusa	6/24/99	5/15/02	25	0	0%	ND	ND	ID	ID	ID	ID	0.10
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.10
SACSL	Sacramento Slough	6/22/99	5/16/02	25	0	0%	ND	ND	ID	ID	ID	ID	0.10
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.10
FRNIC	Feather River near Nicolaus	7/18/00	5/16/02	14	0	0%	ND	ND	ID	ID	ID	ID	0.10
SRVET	Sacramento River at Veterans Bridge	7/20/99	8/6/02	40	0	0%	ND	ND	ID	ID	ID	ID	0.10
ARDPK	American River at Discovery Park	9/19/00	7/9/02	21	1	4.8%	0.11	0.11	ID	ID	ID	ID	0.10
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	26	2	7.7%	0.10	0.47	ID	ID	ID	ID	0.10
SRFPT	Sacramento River at Freeport	9/19/00	8/7/02	22	2	9.1%	0.11	0.20	ID	ID	ID	ID	0.10
SRRMF	Sacramento River at River Mile 44	9/20/00	8/7/02	21	2	9.5%	0.13	0.19	ID	ID	ID	ID	0.10

Summary Statistics: Data for Pesticides Detected in SRWP Monitoring

Tebuthiuron

Units = µg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.40
SACSL	Sacramento Slough	6/22/99	5/16/02	26	0	0%	ND	ND	ID	ID	ID	ID	0.40
YRMRY	Yuba River at Marysville	9/25/01	3/7/02	4	0	0%	ND	ND	ID	ID	ID	ID	0.40
SRVET	Sacramento River at Veterans Bridge	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
ARDPK	American River at Discovery Park	9/19/00	6/4/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.40
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	26	3	12%	0.40	3.0	ID	ID	ID	ID	0.40
SRFPT	Sacramento River at Freeport	9/15/98	6/5/02	44	0	0%	ND	ND	ID	ID	ID	ID	0.010
SRRMF	Sacramento River at River Mile 44	9/20/00	6/5/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.40

Summary Statistics Table Notes:
monitoring period start and end — Dates of first and last reported data.
n — Total number of data reported.
n det — Total number of data above reporting limits.
% det — Percent of data above reporting limits.
min det — Minimum value for data detected above reporting limits.
max det — Maximum value of data detected above reporting limits.
mean — Arithmetic mean value. "ID" if insufficient data to calculate.
SD — Standard Deviation. "ID" if insufficient data to calculate.
median — 50th percentile value. "ID" if insufficient data to calculate.
IQR — Interquartile range. "ID" if insufficient data to calculate.
min RL — Lowest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.
max RL — Highest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.

Summary Statistics: Other Conventional Water Chemistry Parameters

Alkalinity, total

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	12	12	100%	39	64	52	9.5	52	14	NR
PRSHA	Pit River above Shasta	7/22/98	5/14/02	17	17	100%	60	220	78	47	73	28	NR
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	17	17	100%	36	130	57	24	54	22	NR
SRBKR	Sacramento River below Keswick	7/22/98	5/14/02	36	36	100%	30	62	50	6.6	50	10	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	13	13	100%	24	78	42	14	41	16	NR
CCWHI	Clear Creek above Whiskeytown	6/22/99	8/17/99	3	3	100%	24	42	34	11	33	19	NR
CCMOU	Clear Creek near Mouth	6/22/99	8/17/99	3	3	100%	24	44	36	13	35	21	NR
CTMST	Cottonwood Ck at Main Street	10/31/01	5/14/02	3	3	100%	68	97	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	65	65	100%	30	62	50	6.1	50	8.6	NR
MCBLR	Mill Creek at Black Rock	6/22/99	4/17/00	6	6	100%	24	46	35	7.9	34	13	NR
MCGGE	Mill Creek at USGS gage	10/28/99	1/19/00	3	3	100%	38	51	43	8.2	43	13	NR
MCMOU	Mill Creek at Mouth	6/22/99	4/17/00	8	8	100%	24	51	38	10	37	16	NR
DCALN	Deer Creek at A Line Road	1/20/00	4/17/00	3	3	100%	24	40	33	10	33	17	NR
DCPON	Deer Creek at Ponderosa Way	6/23/99	11/8/99	4	4	100%	35	60	53	16	52	21	NR
DCHWY	Deer Creek at Highway 99	6/23/99	4/17/00	5	5	100%	32	84	56	23	52	37	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	17	17	100%	31	66	56	8.7	55	13	NR
CHHWY	Big Chico Creek at Hwy 32	10/28/99	1/19/00	3	3	100%	61	75	69	8.4	69	14	NR
CHASH	Big Chico Creek above Salmon Hole	6/22/99	8/17/99	3	3	100%	48	88	74	30	71	44	NR
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/22/99	4/17/00	7	7	100%	30	90	61	27	55	44	NR
CHAGC	Big Chico Creek above Golf Course	9/14/99	4/17/00	7	7	100%	29	90	70	25	65	43	NR
CHMUD	Big Chico Creek above Mud Creek	6/22/99	4/17/00	9	9	100%	28	89	70	24	65	40	NR
MUDCH	Mud Creek above Big Chico Creek	1/19/00	4/17/00	3	3	100%	38	62	50	13	49	24	NR
LCTEN	Little Chico Creek at Ten Mile	10/28/99	1/19/00	3	3	100%	49	79	65	17	63	31	NR
LCSTL	Little Chico Creek at Stilson Cyn	9/14/99	1/19/00	4	4	100%	57	92	82	23	81	29	NR
BCPLF	Butte Creek below Pool Four	9/14/99	1/19/00	4	4	100%	36	55	44	9.3	44	16	NR
BCOKD	Butte Creek above Okie Dam	9/14/99	1/19/00	4	4	100%	43	59	53	8.2	53	13	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	92	92	100%	36	72	56	7.3	56	10	NR
BCGGE	Butte Creek at USGS gage near Chico	6/23/99	4/19/00	6	6	100%	34	64	49	13	47	22	NR
BCHWY	Butte Creek at Colusa Highway	6/23/99	4/19/00	8	8	100%	43	110	87	28	82	46	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	87	87	100%	60	480	196	61	187	83	NR
SACSL	Sacramento Slough	2/12/96	5/16/02	78	78	100%	50	242	134	40	127	59	NR
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	32	32	100%	16	43	30	6.1	29	8.9	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	66	66	100%	22	51	39	5.8	38	8.2	NR
SRVON	Sacramento River at Verona	3/19/96	4/22/98	26	26	100%	24	73	54	10	53	15	NR
SRVET	Sacramento River at Veterans Bridge	6/24/98	5/15/02	38	38	100%	16	84	63	13	61	21	NR
ARJST	American River at J Street	2/21/96	4/16/98	27	27	100%	16	27	20	2.8	20	3.9	NR
ARDPK	American River at Discovery Park	6/23/98	5/16/02	39	39	100%	10	74	25	11	24	9.3	NR
NEMDR	Natomas East Main Drain	11/13/97	3/5/01	45	45	100%	28	169	86	34	79	46	NR
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/16/02	98	98	100%	19	130	68	29	62	41	NR
SRFPT	Sacramento River at Freeport	2/20/96	5/16/02	106	106	100%	21	82	55	11	54	16	NR
SRRMF	Sacramento River at River Mile 44	6/23/98	5/16/02	43	43	100%	36	130	58	16	57	18	NR
CCHRM	Cache Creek near Rumsey	9/23/01	5/16/02	4	4	100%	119	268	183	72	174	120	NR
CCHSL	Cache Slough near Ryers Ferry	6/23/98	4/18/00	25	25	100%	40	128	72	17	70	20	NR

Summary Statistics: Other Conventional Water Chemistry Parameters

Hardness

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	12	12	100%	32	76	46	12	45	15	NR
PRSHA	Pit River above Shasta	7/22/98	5/14/02	17	17	100%	14	68	48	12	47	17	NR
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	16	16	100%	32	94	49	16	48	18	NR
SRBKR	Sacramento River below Keswick	2/18/98	5/14/02	67	67	100%	36	82	45	6.4	45	6.7	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	12	12	100%	28	64	39	10	38	11	NR
CCWHI	Clear Creek above Whiskeytown	6/22/99	8/17/99	3	3	100%	16	52	36	21	32	40	NR
CCMOU	Clear Creek near Mouth	6/22/99	8/17/99	3	3	100%	40	44	ID	ID	ID	ID	NR
CTMST	Cottonwood Ck at Main Street	10/31/01	5/14/02	3	3	100%	76	101	90	15	89	26	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	65	65	100%	27	128	48	13	47	11	NR
MCBLR	Mill Creek at Black Rock	6/22/99	4/17/00	6	6	100%	28	48	38	7.0	38	11	NR
MCGGE	Mill Creek at USGS gage	10/28/99	1/19/00	3	3	100%	36	52	45	10	45	17	NR
MCMOU	Mill Creek at Mouth	6/22/99	4/17/00	8	8	100%	24	72	45	16	42	25	NR
DCMDW	Deer Creek below Childs Meadows	6/24/98	5/18/99	10	10	100%	12	25	19	3.5	19	5.0	NR
DCALN	Deer Creek at A Line Road	1/20/00	4/17/00	3	3	100%	20	30	26	6.4	26	10	NR
DCPON	Deer Creek at Ponderosa Way	6/23/99	11/8/99	4	4	100%	48	56	52	3.6	52	5.9	NR
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	5/18/99	10	10	100%	27	52	37	9.1	36	13	NR
DCHWY	Deer Creek at Highway 99	6/23/99	4/17/00	5	5	100%	28	72	46	20	43	31	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	25	25	100%	41	68	52	6.8	52	10	NR
CHHWY	Big Chico Creek at Hwy 32	10/28/99	1/19/00	3	3	100%	52	64	57	7.0	57	12	NR
CHASH	Big Chico Creek above Salmon Hole	6/22/99	8/17/99	3	3	100%	68	76	72	4.5	72	8.0	NR
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/22/99	4/17/00	7	7	100%	20	88	61	25	55	45	NR
CHAGC	Big Chico Creek above Golf Course	9/14/99	4/17/00	7	7	100%	24	76	62	21	58	35	NR
CHMUD	Big Chico Creek above Mud Creek	6/22/99	4/17/00	9	9	100%	24	78	55	19	51	32	NR
MUDCH	Mud Creek above Big Chico Creek	1/19/00	4/17/00	3	3	100%	32	58	44	15	43	26	NR
LCTEN	Little Chico Creek at Ten Mile	10/28/99	1/19/00	3	3	100%	44	74	62	19	60	32	NR
LCSTL	Little Chico Creek at Stilson Cyn	9/14/99	1/19/00	4	4	100%	52	88	75	19	74	29	NR
BCPLF	Butte Creek below Pool Four	9/14/99	1/19/00	4	4	100%	32	56	46	11	44	21	NR
BCOKD	Butte Creek above Okie Dam	9/14/99	1/19/00	4	4	100%	40	60	49	9.4	48	16	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	63	63	100%	30	104	54	11	53	13	NR
BCGGE	Butte Creek at USGS gage near Chico	6/23/99	4/19/00	6	6	100%	28	84	51	23	47	35	NR
BCHWY	Butte Creek at Colusa Highway	6/23/99	4/19/00	6	6	100%	44	132	83	35	77	58	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	71	71	100%	48	372	182	46	175	65	NR
SACSL	Sacramento Slough	2/12/96	5/16/02	65	65	100%	52	638	129	83	119	61	NR
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	32	32	100%	18	45	33	6.9	32	10	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	65	65	100%	22	98	42	14	40	15	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	26	26	100%	24	69	52	10	50	15	NR
SRVET	Sacramento River at Veterans Bridge	1/4/94	7/9/02	112	112	100%	28	97	61	13	59	17	NR
ARJST	American River at J Street	2/21/96	4/16/98	27	27	100%	16	28	20	3.1	20	4.2	NR
ARDPK	American River at Discovery Park	1/18/94	7/9/02	125	125	100%	14	103	27	11	25	11	NR
NEMDR	Natomas East Main Drain	11/13/97	3/5/01	45	45	100%	27	165	96	31	90	47	NR
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/16/02	81	81	100%	23	132	77	27	71	40	NR
SRFPT	Sacramento River at Freeport	1/4/94	7/10/02	157	157	100%	19	127	55	14	53	19	NR
SRRMF	Sacramento River at River Mile 44	2/1/94	7/10/02	97	97	100%	24	94	58	14	56	19	NR
CCHRM	Cache Creek near Rumsey	9/23/01	5/16/02	4	4	100%	119	283	182	83	171	128	NR
CCHSL	Cache Slough near Ryers Ferry	6/23/98	4/18/00	18	18	100%	59	116	74	17	73	22	NR

Organic Carbon, dissolved

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	11/15/99	5/16/00	4	4	100%	0.90	1.4	ID	ID	ID	ID	NR
PRSHA	Pit River above Shasta	11/15/99	5/16/00	4	4	100%	0.90	1.7	1.3	0.36	1.2	0.61	NR
MRSHA	McCloud River above Shasta	11/15/99	5/16/00	4	4	100%	0.50	0.80	0.65	0.14	0.64	0.24	NR
SRBKR	Sacramento River below Keswick	10/20/99	5/16/00	8	8	100%	0.90	1.2	1.0	0.13	1.0	0.20	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	10/20/99	4/18/00	4	4	100%	1.1	1.2	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	5/21/02	48	48	100%	0.78	4.3	1.5	0.65	1.4	0.64	NR
SRHAM	Sacramento River near Hamilton City	9/22/99	5/21/02	21	21	100%	0.82	5.8	1.8	1.2	1.6	0.97	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/21/02	40	40	100%	0.81	6.4	1.7	1.1	1.6	0.82	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/21/02	52	52	100%	2.5	12	6.1	2.1	5.8	2.8	NR
SACSL	Sacramento Slough	2/12/96	5/22/02	46	46	100%	1.4	9.0	4.2	1.7	3.8	2.3	NR
YRMRY	Yuba River at Marysville	2/27/96	5/21/02	50	50	100%	0.70	3.3	1.2	0.55	1.1	0.54	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/22/02	47	47	100%	1.2	4.2	1.8	0.69	1.7	0.74	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	27	100%	1.3	3.6	1.9	0.64	1.8	0.73	NR
SRVET	Sacramento River at Veterans Bridge	8/15/00	9/3/02	25	25	100%	0.70	5.4	2.1	1.1	1.9	1.2	NR
ARJST	American River at J Street	2/21/96	4/16/98	27	27	100%	1.1	6.4	1.7	1.2	1.6	0.67	NR
ARDPK	American River at Discovery Park	8/15/00	9/3/02	24	24	100%	0.90	3.8	1.8	0.61	1.7	0.70	NR
NEMDR	Natomas East Main Drain	11/13/97	3/5/01	49	49	100%	3.1	10	5.9	1.6	5.7	2.1	NR
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/17/00	46	46	100%	1.2	18	7.6	2.6	7.2	3.1	NR
SRFPT	Sacramento River at Freeport	2/20/96	9/4/02	91	90	99%	0.30	5.0	1.9	0.74	1.8	0.84	0.70
SRRMF	Sacramento River at River Mile 44	9/22/99	9/4/02	37	35	95%	1.3	5.3	2.3	1.0	2.1	1.1	0.70
CCHSL	Cache Slough near Ryers Ferry	10/20/99	2/16/00	3	3	100%	1.7	4.9	2.9	2.3	2.6	2.8	NR

Summary Statistics: Other Conventional Water Chemistry Parameters

Organic Carbon, total

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	11/15/99	5/16/00	4	4	100%	1.0	1.5	ID	ID	ID	ID	NR
PRSHA	Pit River above Shasta	11/15/99	5/16/00	4	4	100%	1.0	1.8	1.4	0.36	1.3	0.61	NR
MRSHA	McCloud River above Shasta	11/15/99	5/16/00	4	4	100%	0.60	0.90	0.75	0.14	0.74	0.24	NR
SRBKR	Sacramento River below Keswick	10/20/99	5/16/00	8	8	100%	1.0	1.3	1.1	0.13	1.1	0.20	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	10/20/99	4/18/00	4	4	100%	1.2	1.3	ID	ID	ID	ID	NR
CCMOU	Clear Creek near Mouth	11/17/98	8/17/99	6	6	100%	1.2	1.8	1.4	0.24	1.4	0.36	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	5/21/02	48	48	100%	0.83	6.5	1.8	0.95	1.7	0.82	NR
MCMOU	Mill Creek at Mouth	8/19/98	4/17/00	16	16	100%	0.70	8.2	2.0	2.1	1.5	1.5	NR
DCMOU	Deer Creek at Mouth	8/18/98	4/17/00	9	9	100%	0.90	1.8	1.3	0.33	1.3	0.49	NR
SRHAM	Sacramento River near Hamilton City	9/22/99	5/21/02	21	21	100%	0.94	8.9	2.3	2.0	1.9	1.5	NR
CHMUD	Big Chico Creek above Mud Creek	8/18/98	4/17/00	15	15	100%	0.60	3.1	1.4	0.75	1.2	0.87	NR
MUDCH	Mud Creek above Big Chico Creek	12/15/98	4/17/00	8	8	100%	1.3	3.7	2.6	1.0	2.5	1.6	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/21/02	38	38	100%	0.83	6.8	2.2	1.4	2.0	1.2	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/22/02	51	51	100%	3.9	14	7.4	2.2	7.1	2.9	NR
SACSL	Sacramento Slough	2/12/96	5/22/02	45	45	100%	1.6	12	4.9	2.1	4.5	2.7	NR
YRMRY	Yuba River at Marysville	2/27/96	5/21/02	50	50	100%	0.80	3.5	1.5	0.66	1.3	0.70	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/22/02	45	45	100%	1.2	4.8	2.1	0.79	2.0	0.88	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	24	24	100%	1.5	4.4	2.3	0.76	2.2	0.93	NR
SRVET	Sacramento River at Veterans Bridge	8/15/00	9/3/02	26	24	92%	1.3	6.6	2.5	1.4	2.2	1.6	0.20
ARJST	American River at J Street	2/21/96	4/16/98	26	26	100%	1.2	8.1	2.1	1.6	1.9	0.95	NR
ARDPK	American River at Discovery Park	8/15/00	9/3/02	24	24	100%	1.2	9.6	2.3	2.0	2.1	1.1	NR
NEMDR	Natomas East Main Drain	9/1/98	3/5/01	39	39	100%	3.1	12	6.5	2.3	6.2	3.0	NR
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/17/00	46	46	100%	2.0	22	8.7	3.5	8.1	3.7	NR
SRFPT	Sacramento River at Freeport	2/20/96	9/4/02	89	88	99%	0.80	5.5	2.3	0.95	2.2	1.1	0.70
SRRMF	Sacramento River at River Mile 44	9/22/99	9/4/02	37	36	97%	1.0	6.6	2.6	1.3	2.4	1.4	0.20
CCHSL	Cache Slough near Ryers Ferry	10/20/99	2/16/00	3	3	100%	1.9	5.4	3.2	2.5	2.8	3.1	NR

Total Dissolved Solids

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	10	10	100%	39	91	62	16	60	25	NR
PRSHA	Pit River above Shasta	7/22/98	5/16/00	11	11	100%	78	125	94	14	93	19	NR
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	10	10	100%	55	83	63	10	62	14	NR
SRBKR	Sacramento River below Keswick	1/20/98	12/19/00	55	55	100%	52	98	76	11	76	16	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	13	13	100%	43	59	52	4.4	52	6.7	NR
CCMOU	Clear Creek near Mouth	10/20/98	8/17/99	10	10	100%	50	74	60	8.3	59	13	NR
SRABB	Sacramento River above Bend Bridge	7/22/98	5/14/02	35	35	100%	53	149	86	20	84	27	NR
MCHWY	Mill Creek at Highway 36	10/28/99	2/14/00	3	3	100%	60	294	182	131	150	264	NR
MCMOU	Mill Creek at Mouth	8/19/98	2/14/00	14	14	100%	64	154	105	29	101	42	NR
DCMOU	Deer Creek at Mouth	8/18/98	4/17/00	9	9	100%	73	132	100	22	98	35	NR
SRHAM	Sacramento River near Hamilton City	8/18/99	5/14/02	14	14	100%	50	136	100	22	97	34	NR
CHMUD	Big Chico Creek above Mud Creek	6/22/99	2/14/00	4	4	100%	58	134	109	43	103	66	NR
MUDCH	Mud Creek above Big Chico Creek	12/15/98	2/14/00	7	7	100%	1.6	133	78	44	50	112	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	64	64	100%	17	159	95	20	92	30	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	46	46	100%	33	546	360	92	340	155	NR
SACSL	Sacramento Slough	2/12/96	5/16/02	40	40	100%	84	662	212	104	196	108	NR
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	41	41	100%	20	100	59	16	57	23	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	64	64	100%	22	137	68	21	65	26	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	26	26	100%	53	126	91	15	90	23	NR
SRVET	Sacramento River at Veterans Bridge	6/24/98	7/9/02	60	60	100%	50	193	109	27	105	37	NR
ARJST	American River at J Street	2/21/96	4/16/98	27	27	100%	24	52	40	6.7	39	10	NR
ARDPK	American River at Discovery Park	9/21/99	7/9/02	26	26	100%	16	88	46	20	41	30	NR
NEMDR	Natomas East Main Drain	11/13/97	3/5/01	48	48	100%	58	338	210	59	200	92	NR
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	6/22/99	39	39	100%	58	237	174	50	165	79	NR
SRFPT	Sacramento River at Freeport	2/20/96	7/10/02	32	32	100%	37	111	83	16	82	24	NR
SRRMF	Sacramento River at River Mile 44	6/23/98	7/10/02	56	56	100%	42	151	103	23	100	34	NR
CCHSL	Cache Slough near Ryers Ferry	6/25/98	2/16/00	13	13	100%	108	198	143	29	140	43	NR

Summary Statistics: Other Conventional Water Chemistry Parameters

Total Suspended Solids

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	10	1	10%	11	11	ID	ID	ID	ID	5.0
PRSHA	Pit River above Shasta	7/22/98	5/16/00	10	3	30%	6.0	12	3.8	4.3	2.6	3.9	5.0
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	10	1	10%	10.0	10	ID	ID	ID	ID	5.0
SRBKR	Sacramento River below Keswick	4/21/98	2/18/02	58	32	55%	0.1	13	1.6	2.1	1.0	1.6	0.1
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	12	1	8%	5.0	5	ID	ID	ID	ID	5.0
CCMOU	Clear Creek near Mouth	9/15/98	8/17/99	11	11	100%	0.2	12	2.8	3.7	1.5	3.5	NR
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	0	0%	0.0	0	ID	ID	ID	ID	5.0
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	1	50%	25.4	25	ID	ID	ID	ID	5.0
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	1	50%	10.0	10	ID	ID	ID	ID	5.0
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	1	50%	6.0	6	ID	ID	ID	ID	5.0
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	1	50%	8.1	8	ID	ID	ID	ID	5.0
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	2	100%	5.6	7	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	3/8/96	2/19/02	49	35	71%	3	355	25	62	9	21	5.0
MCHWY	Mill Creek at Highway 36	6/23/98	2/14/00	16	16	100%	0.8	130	30.2	43.3	10.7	34.6	NR
MCBLR	Mill Creek at Black Rock	6/23/98	4/6/01	12	11	91.7%	0.2	53.8	14	21	4	15	5.0
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	0	0%	0.00	0	ID	ID	ID	ID	5.0
MCMOU	Mill Creek at Mouth	6/23/98	5/15/01	23	18	78%	0.8	754	54	195	7.7	23	5.0
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	1	50%	226.00	226	ID	ID	ID	ID	5.0
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	1	100%	386.00	386	ID	ID	ID	ID	NR
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	1	100%	647.00	647.0	ID	ID	ID	ID	NR
DCMDW	Deer Creek below Childs Meadows	6/24/98	2/14/00	16	16	100%	0.20	93	7	33	1.3	3	NR
DCPON	Deer Creek at Ponderosa Way	6/24/98	11/8/99	10	10	100%	0.20	5	1.1	2	0.6	1.0	NR
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	2/14/00	17	17	100%	0.30	145.0	10.2	48.7	1.23	3.1	NR
DCMOU	Deer Creek at Mouth	6/24/98	11/18/99	12	12	100%	0.40	14	3	5	1.4	2.2	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	2/20/02	23	14	61%	5.20	218	33.6	68.2	4.5	21.5	5.0
CHHWY	Big Chico Creek at Hwy 32	6/23/98	2/14/00	14	14	100%	0.2	46	7	15	1.7	5	NR
CHASH	Big Chico Creek above Salmon Hole	6/23/98	2/14/00	15	15	100%	0.20	91	9.5	29	1.7	5.4	NR
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/23/98	2/14/00	15	15	100%	0.20	122	12.0	40	2.0	7.2	NR
CHMUD	Big Chico Creek above Mud Creek	6/23/98	2/14/00	15	15	100%	0.20	97	11	31	2.3	8.2	NR
MUDCH	Mud Creek above Big Chico Creek	6/23/98	2/14/00	9	9	100%	0.40	33	7	12	3.2	8.9	NR
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	3	2	67%	24.80	27	ID	ID	ID	ID	5.0
LCBCH	Little Chico Creek below Chico	2/20/02	3/7/02	2	2	100%	6	9	ID	ID	ID	ID	NR
SRCOL	Sacramento River at Colusa	2/28/96	2/21/02	40	40	100%	10	579	86	130	47	75	NR
COLDR	Colusa Basin Drain above KL	2/7/96	2/22/02	52	52	100%	21	373	118	69	102	83	NR
SACSL	Sacramento Slough	2/12/96	3/8/02	45	45	100%	15	182	66	36	59	41	NR
YRMRY	Yuba River at Marysville	2/27/96	3/7/02	51	30	59%	1.0	153	18	34	5.3	14	5.0
FRNIC	Feather River near Nicolaus	2/23/96	3/8/02	51	46	90%	5.0	123	25	28	16	24	5.0
SRVON	Sacramento River at Verona	2/22/96	3/25/98	25	25	100%	24	117	59	30	53	38	NR
SRVET	Sacramento River at Veterans Bridge	1/4/94	7/9/02	107	107	100%	4.0	200	37	28	31	27	NR
ARJST	American River at J Street	2/21/96	4/16/98	26	26	100%	2.0	116	14	27	6.7	11	NR
ARDPK	American River at Discovery Park	1/4/94	7/9/02	105	74	70%	1.0	41	5.6	7.6	3.0	5.1	1.0
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	3/8/02	51	51	100%	5.0	656	67	118	34	54	NR
SRFPT	Sacramento River at Freeport	1/4/94	7/10/02	202	201	100%	2.0	368	39	45	27	31	1.0
SRRMF	Sacramento River at River Mile 44	1/18/94	7/10/02	99	98	99%	2.0	230	34	36	24	30	1.0
SRGRN	Sacramento River at Greene's Landing	1/1/00	10/1/01	27	27	100%	8.2	167	27	36	20	17	NR
CCHSL	Cache Slough near Ryers Ferry	6/25/98	2/16/00	8	8	100%	8.0	43	23	14	19	21	NR

Summary Statistics: Other Conventional Water Chemistry Parameters

Turbidity

Units = NTU

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	10	10	100%	0.81	8.4	2.5	2.7	1.7	2.2	NR
PRSHA	Pit River above Shasta	7/22/98	5/16/00	10	10	100%	2.0	24	6.9	7.7	4.8	6.7	NR
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	10	10	100%	0.54	6.3	2.3	2.1	1.6	2.4	NR
SRBKR	Sacramento River below Keswick	1/20/98	12/19/00	55	55	100%	0.90	36	4.3	5.7	3.4	2.7	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	12	12	100%	0.42	1.9	1.1	0.57	0.95	0.84	NR
CCMOU	Clear Creek near Mouth	8/5/98	8/17/99	13	13	100%	1.0	16	2.9	5.1	2.0	2.0	NR
SRABB	Sacramento River above Bend Bridge	6/24/98	5/17/00	23	23	100%	2.1	48	9.5	12	5.8	7.9	NR
MCHWY	Mill Creek at Highway 36	6/23/98	2/10/00	22	22	100%	1.5	62	9.4	15	5.9	8.1	NR
MCBLR	Mill Creek at Black Rock	6/23/98	2/14/00	17	17	100%	0.60	25	4.9	6.6	3.0	5.2	NR
MCMOU	Mill Creek at Mouth	6/23/98	1/19/00	17	17	100%	1.4	53	8.4	15	4.5	7.3	NR
DCMDW	Deer Creek below Childs Meadows	6/24/98	5/8/00	21	20	95%	0.60	26	2.6	7.2	1.3	1.9	0.5
DCPON	Deer Creek at Ponderosa Way	6/24/98	6/6/00	12	12	100%	0.20	1.9	0.73	0.62	0.55	0.70	NR
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	6/6/00	21	21	100%	0.20	35	2.6	10	0.87	1.5	NR
DCMOU	Deer Creek at Mouth	6/24/98	4/17/00	13	13	100%	0.40	6.1	1.4	1.8	1.1	1.1	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	5/16/00	11	11	100%	2.0	140	26	50	7.9	21	NR
CHHWY	Big Chico Creek at Hwy 32	6/23/98	8/17/99	14	14	100%	0.20	1.2	0.51	0.28	0.45	0.34	NR
CHASH	Big Chico Creek above Salmon Hole	6/23/98	8/17/99	15	15	100%	0.20	2.3	0.60	0.68	0.44	0.46	NR
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/23/98	8/17/99	15	15	100%	0.30	3.2	0.84	0.91	0.62	0.68	NR
CHMUD	Big Chico Creek above Mud Creek	6/23/98	8/17/99	15	15	100%	0.30	4.6	1.0	1.3	0.74	0.82	NR
MUDCH	Mud Creek above Big Chico Creek	6/23/98	5/20/99	8	8	100%	1.4	7.4	3.5	2.2	3.0	3.0	NR
SRCOL	Sacramento River at Colusa	6/24/98	5/16/00	23	23	100%	2.9	261	32	64	18	29	NR
FRNIC	Feather River near Nicolaus	6/23/98	5/16/00	23	23	100%	1.1	57	8.9	14	5.7	7.8	NR
SRVET	Sacramento River at Veterans Bridge	6/24/98	7/9/02	44	44	100%	1.5	105	27	22	20	24	NR
ARDPK	American River at Discovery Park	7/17/01	7/9/02	21	21	100%	1.0	9.5	3.3	2.7	2.5	2.8	NR
SRFPT	Sacramento River at Freeport	6/23/98	7/10/02	43	43	100%	5.0	94	22	19	17	18	NR
SRRMF	Sacramento River at River Mile 44	6/23/98	7/10/02	45	45	100%	5.1	93	23	20	18	19	NR
CCHSL	Cache Slough near Ryers Ferry	6/25/98	2/16/00	11	11	100%	2.7	89	34	27	23	40	NR

UVA254

Units = 1/cm

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	9/27/01	5/17/02	4	4	100%	0.023	0.034	0.029	0.0050	0.028	0.0089	NR
SRHAM	Sacramento River near Hamilton City	9/27/01	5/17/02	4	4	100%	0.027	0.25	0.085	0.15	0.051	0.094	NR
SRCOL	Sacramento River at Colusa	9/27/01	5/17/02	4	4	100%	0.028	0.44	0.13	0.29	0.059	0.14	NR
COLDR	Colusa Basin Drain above KL	9/27/01	5/17/02	5	5	100%	0.16	0.31	0.21	0.068	0.21	0.090	NR
SACSL	Sacramento Slough	9/27/01	5/20/02	5	5	100%	0.057	0.20	0.13	0.058	0.11	0.10	NR
YRMRY	Yuba River at Marysville	9/27/01	5/17/02	5	5	100%	0.018	0.17	0.058	0.079	0.039	0.067	NR
FRNIC	Feather River near Nicolaus	9/27/01	5/20/02	5	5	100%	0.015	0.14	0.063	0.054	0.049	0.079	NR
SRVET	Sacramento River at Veterans Bridge	11/7/01	10/1/02	8	8	100%	0.035	0.14	0.073	0.040	0.065	0.055	NR
ARDPK	American River at Discovery Park	9/27/01	10/1/02	9	9	100%	0.034	0.072	0.044	0.013	0.043	0.016	NR
SRFPT	Sacramento River at Freeport	10/4/01	10/2/02	9	9	100%	0.035	0.40	0.10	0.15	0.067	0.077	NR
SRRMF	Sacramento River at River Mile 44	10/4/01	10/2/02	9	9	100%	0.038	0.35	0.091	0.13	0.067	0.071	NR

Summary Statistics Table Notes:

monitoring period start and end — Dates of first and last reported data.

n — Total number of data reported.

n det — Total number of data above reporting limits.

% det — Percent of data above reporting limits.

min det — Minimum value for data detected above reporting limits.

max det — Maximum value of data detected above reporting limits.

mean — Arithmetic mean value. "ID" if insufficient data to calculate.

SD — Standard Deviation. "ID" if insufficient data to calculate.

median — 50th percentile value. "ID" if insufficient data to calculate.

IQR — Interquartile range. "ID" if insufficient data to calculate.

min RL — Lowest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.

max RL — Highest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.

Summary Statistics: Pathogens Data

Cryptosporidium

Units = öocysts/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	7/21/99	5/15/01	20	4	20%	0.1	0.2	ID	ID	ID	ID	0.10
SRHAM	Sacramento River near Hamilton City	6/24/99	5/17/00	12	2	17%	0.3	0.5	ID	ID	ID	ID	0.10
SRCOL	Sacramento River at Colusa	7/21/99	5/16/01	20	2	10%	0.1	0.8	ID	ID	ID	ID	0.10
FRNIC	Feather River near Nicolaus	6/22/99	5/16/00	12	0	0%	ND	ND	ID	ID	ID	ID	0.08
SRVET	Sacramento River at Veterans Bridge	7/20/99	9/3/02	34	4	12%	0.2	0.3	ID	ID	ID	ID	0.10
ARDPK	American River at Discovery Park	7/17/01	9/3/02	14	2	14%	0.1	0.2	ID	ID	ID	ID	0.10
SRFPT	Sacramento River at Freeport	6/23/99	9/4/02	48	3	6.3%	0.1	0.1	ID	ID	ID	ID	0.10
SRRMF	Sacramento River at River Mile 44	7/19/00	9/4/02	23	3	13%	0.1	0.3	ID	ID	ID	ID	0.10
CCHSL	Cache Slough near Ryers Ferry	6/22/99	2/16/00	5	1	20%	0.2	0.2	ID	ID	ID	ID	0.10

Giardia

Units = cysts/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	7/21/99	5/15/01	20	15	75%	0.1	1.2	0.22	0.30	0.16	0.20	0.10
SRHAM	Sacramento River near Hamilton City	6/24/99	5/17/00	12	8	67%	0.1	0.6	0.19	0.19	0.13	0.20	0.10
SRCOL	Sacramento River at Colusa	7/21/99	5/16/01	20	13	65%	0.1	0.7	0.26	0.19	0.20	0.26	0.10
FRNIC	Feather River near Nicolaus	6/22/99	5/16/00	12	5	42%	0.1	0.2	ID	ID	ID	ID	0.10
SRVET	Sacramento River at Veterans Bridge	7/20/99	7/9/02	34	12	35%	0.1	0.6	0.11	0.14	0.05	0.11	0.10
ARDPK	American River at Discovery Park	7/17/01	7/9/02	12	2	17%	0.1	0.1	ID	ID	ID	ID	0.10
SRFPT	Sacramento River at Freeport	6/23/99	7/10/02	46	29	63%	0.1	0.8	0.19	0.19	0.12	0.18	0.10
SRRMF	Sacramento River at River Mile 44	7/19/00	7/10/02	21	10	48%	0.1	1.1	0.24	0.34	0.08	0.24	0.10
CCHSL	Cache Slough near Ryers Ferry	6/22/99	2/16/00	5	1	20%	0.3	0.3	ID	ID	ID	ID	0.10

E.Coli

Units = MPN/100 mL

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	9/25/01	5/15/02	4	4	100%	13	23	19	5.1	18	9.1	0.00
SRHAM	Sacramento River near Hamilton City	9/26/01	5/15/02	4	4	100%	13	1600	428	1080	85	483	0.00
SRCOL	Sacramento River at Colusa	9/26/01	5/16/02	4	4	100%	4	1600	405	1113	24	245	0.00
COLDR	Colusa Basin Drain above KL	9/26/01	5/16/02	5	5	100%	4	80	23	42	11	28	0.000
SACSL	Sacramento Slough	9/27/01	5/17/02	5	5	100%	30	140	108	55	95	93	0.00
YRMRY	Yuba River at Marysville	9/26/01	5/16/02	5	5	100%	4	1600	366	928	61	448	0.00
FRNIC	Feather River near Nicolaus	9/27/01	5/17/02	5	5	100%	2	170	54	80	18	83	0.00
SRVET	Sacramento River at Veterans Bridge	6/20/00	7/9/02	26	24	92%	8	300	31	70	17	24	2.00
ARDPK	American River at Discovery Park	6/20/00	7/9/02	25	25	100%	2	1400	118	348	23	66	0.00
NEMDR	Natomas East Main Drain	9/26/01	5/17/02	5	5	100%	50	1600	890	730	510	1587	0.00
SRFPT	Sacramento River at Freeport	7/19/00	7/10/02	23	22	96%	4	300	37	74	13	32	2.00

Enterococuss

Units = CFU/100 mL

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	9/25/01	5/15/02	4	4	100%	2	20	10	8.4	7.5	15	NR
SRHAM	Sacramento River near Hamilton City	9/26/01	5/15/02	4	4	100%	14	800	218	538	55	234	NR
SRCOL	Sacramento River at Colusa	9/26/01	5/16/02	4	3	75%	2	1500	ID	ID	ID	ID	10
COLDR	Colusa Basin Drain above KL	9/26/01	5/16/02	5	4	80%	24	40	28	9.2	27	14	2
SACSL	Sacramento Slough	9/27/01	5/17/02	5	4	80%	26	600	152	332	45	206	2
YRMRY	Yuba River at Marysville	9/26/01	5/16/02	5	5	100%	10	290	74	164	31	83	NR
FRNIC	Feather River near Nicolaus	9/27/01	5/17/02	5	4	80%	2	180	56	86	14	70	10
SRVET	Sacramento River at Veterans Bridge	9/26/01	5/16/02	5	5	100%	14	320	125	137	69	204	NR
ARDPK	American River at Discovery Park	9/26/01	5/17/02	5	5	100%	6	180	55	89	28	81	NR
NEMDR	Natomas East Main Drain	9/26/01	5/17/02	5	5	100%	48	10000	3132	4773	837	5923	NR
SRFPT	Sacramento River at Freeport	9/27/01	5/17/02	5	4	80%	4	500	132	258	13	173	2
SRRMF	Sacramento River at River Mile 44	9/27/01	5/17/02	5	5	100%	2	400	118	195	25	184	NR

Summary Statistics: Pathogens Data

Coliform, fecal

Units = MPN/100 mL

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRBKR	Sacramento River below Keswick	7/22/98	5/16/00	20	8	40%	1	9	1.5	2.5	0.5	1.4	1.0
CCMOU	Clear Creek near Mouth	8/20/98	8/17/99	9	9	100%	2	85	16	33	7.7	16	NR
SRABB	Sacramento River above Bend Bridge	6/24/98	5/14/02	36	32	89%	4	1100	85	224	24	59	2.0
MCHWY	Mill Creek at Highway 36	6/23/98	5/19/99	12	9	75%	1	33	4.8	12	1.7	4.7	1.0
MCBLR	Mill Creek at Black Rock	6/23/98	5/19/99	11	7	64%	1	10	2.8	3.5	1.3	3.4	1.0
MCMOU	Mill Creek at Mouth	6/23/98	5/19/99	12	12	100%	1	46	10	17	4.0	10	NR
DCMDW	Deer Creek below Childs Meadows	6/24/98	5/17/99	11	10	91%	1	41	11	13	5.5	14	1.0
DCPON	Deer Creek at Ponderosa Way	6/24/98	5/18/99	8	2	25%	1	2	ID	ID	ID	ID	1.0
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	5/17/99	11	7	64%	1	14	2.5	5.0	1.1	2.6	1.0
DCMOU	Deer Creek at Mouth	6/24/98	5/17/99	9	9	100%	2	224	31	101	7.4	20	NR
SRHAM	Sacramento River near Hamilton City	6/24/99	5/14/02	14	14	100%	4	1600	273	507	68	264	NR
CHHWY	Big Chico Creek at Hwy 32	6/23/98	4/20/99	11	9	82%	2	22	4.8	7.3	2.9	4.9	1.0
CHASH	Big Chico Creek above Salmon Hole	6/23/98	5/20/99	12	11	92%	1	20	5.5	6.4	3.1	6.4	1.0
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/23/98	5/20/99	11	10	91%	8	233	62	75	37	72	1.0
CHMUD	Big Chico Creek above Mud Creek	6/23/98	5/20/99	12	12	100%	10	1119	169	388	72	160	NR
MUDCH	Mud Creek above Big Chico Creek	6/23/98	5/20/99	7	7	100%	16	162	46	69	34	38	NR
SRCOL	Sacramento River at Colusa	6/24/98	5/15/02	35	34	97%	4	1600	185	439	30	103	2.0
COLDR	Colusa Basin Drain above KL	9/25/01	5/15/02	5	5	100%	4	170	41	98	15	44	NR
SACSL	Sacramento Slough	9/26/01	5/16/02	5	5	100%	30	170	120	63	104	112	NR
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	5	100%	4	1600	378	922	82	536	NR
FRNIC	Feather River near Nicolaus	6/23/98	5/16/02	28	27	96%	2	500	64	133	16	47	20
SRVET	Sacramento River at Veterans Bridge	10/29/96	7/9/02	68	66	97%	2	2400	88	377	30	59	2.0
ARDPK	American River at Discovery Park	10/29/96	7/9/02	66	66	100%	2	9000	294	1403	53	127	NR
NEMDR	Natomas East Main Drain	4/6/98	5/16/02	34	34	100%	52	12000	923	2518	334	735	NR
SRFPT	Sacramento River at Freeport	10/29/96	7/10/02	65	65	100%	4	8000	201	1344	31	78	NR
CCHSL	Cache Slough near Ryers Ferry	6/23/98	2/16/00	12	12	100%	6	1600	258	551	32	120	NR

Coliform, total

Units = MPN/100 mL

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRBKR	Sacramento River below Keswick	7/22/98	5/16/00	20	19	95%	1	62	15	16	8.1	18	1.0
SRABB	Sacramento River above Bend Bridge	6/24/98	5/14/02	35	35	100%	1	1700	285	451	117	300	NR
SRHAM	Sacramento River near Hamilton City	6/24/99	5/14/02	14	14	100%	17	2400	503	774	168	507	NR
SRCOL	Sacramento River at Colusa	6/24/98	5/15/02	35	35	100%	11	2200	345	541	140	324	NR
COLDR	Colusa Basin Drain above KL	9/25/01	5/15/02	5	5	100%	30	1600	512	762	248	873	NR
SACSL	Sacramento Slough	9/26/01	5/16/02	5	5	100%	300	1600	600	731	464	540	NR
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	5	100%	96	1600	455	848	244	535	NR
FRNIC	Feather River near Nicolaus	6/23/98	5/16/02	28	28	100%	3	1600	447	570	142	488	NR
SRVET	Sacramento River at Veterans Bridge	10/29/96	7/9/02	68	68	100%	17	16000	1115	2480	468	943	NR
ARDPK	American River at Discovery Park	10/29/96	7/9/02	66	66	100%	17	50000	2044	7759	329	920	NR
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	900	1600	ID	ID	ID	ID	NR
SRFPT	Sacramento River at Freeport	10/29/96	7/10/02	66	66	100%	13	9000	1011	1726	435	916	NR
SRRMF	Sacramento River at River Mile 44	5/20/99	12/14/99	6	6	100%	130	900	372	323	297	389	NR
CCHSL	Cache Slough near Ryers Ferry	6/23/98	2/16/00	12	12	100%	30	1600	345	511	154	385	NR

Summary Statistics Table Notes:
monitoring period start and end — Dates of first and last reported data.
n — Total number of data reported.
n det — Total number of data above reporting limits.
% det — Percent of data above reporting limits.
min det — Minimum value for data detected above reporting limits.
max det — Maximum value of data detected above reporting limits.
mean — Arithmetic mean value. "ID" if insufficient data to calculate.
SD — Standard Deviation. "ID" if insufficient data to calculate.
median — 50th percentile value. "ID" if insufficient data to calculate.
IQR — Interquartile range. "ID" if insufficient data to calculate.
min RL — Lowest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.
max RL — Highest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.

Summary Statistics: Nitrogen and Phosphorus Compounds

Ammonia as N

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	30	4	13%	0.02	0.09	ID	ID	ID	ID	0.015
MCHWY	Mill Creek at Highway 36	6/23/98	4/17/00	19	14	74%	0.01	0.08	0.025	0.021	0.017	0.025	0.01
MCMOU	Mill Creek at Mouth	6/23/98	4/17/00	19	3	16%	0.01	0.01	ID	ID	ID	ID	0.01
DCMDW	Deer Creek below Childs Meadows	6/24/98	4/17/00	18	2	11%	0.01	0.02	ID	ID	ID	ID	0.01
DCPON	Deer Creek at Ponderosa Way	6/24/98	11/8/99	12	2	17%	0.01	0.01	ID	ID	ID	ID	0.01
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	4/17/00	18	3	17%	0.01	0.01	ID	ID	ID	ID	0.01
DCMOU	Deer Creek at Mouth	6/24/98	4/17/00	13	1	7.7%	0.01	0.01	ID	ID	ID	ID	0.01
SRHAM	Sacramento River near Hamilton City	8/18/99	5/14/02	5	1	20%	0.11	0.11	ID	ID	ID	ID	0.2
CHHWY	Big Chico Creek at Hwy 32	6/23/98	4/17/00	17	6	35%	0.01	0.05	0.0086	0.014	0.0038	0.0089	0.01
CHASH	Big Chico Creek above Salmon Hole	6/23/98	4/17/00	17	5	29%	0.01	0.02	ID	ID	ID	ID	0.01
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/23/98	4/17/00	17	4	24%	0.01	0.02	ID	ID	ID	ID	0.01
CHMUD	Big Chico Creek above Mud Creek	6/23/98	4/17/00	17	8	47%	0.01	0.05	0.011	0.013	0.0065	0.011	0.01
MUDCH	Mud Creek above Big Chico Creek	6/23/98	4/17/00	10	7	70%	0.01	0.03	0.014	0.0086	0.011	0.012	0.01
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	37	12	32%	0.02	0.078	0.016	0.015	0.012	0.015	0.015
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	46	29	63%	0.02	0.638	0.081	0.13	0.042	0.073	0.015
SACSL	Sacramento Slough	2/12/96	5/16/02	41	19	46%	0.02	1.19	0.093	0.25	0.023	0.068	0.015
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	32	9	28%	0.015	0.068	0.013	0.014	0.0094	0.012	0.015
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	33	13	39%	0.018	0.37	0.027	0.083	0.012	0.023	0.015
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	9	33%	0.015	0.05	0.016	0.014	0.012	0.015	0.015
SRVET	Sacramento River at Veterans Bridge	9/26/01	7/9/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.1
ARJST	American River at J Street	2/21/96	4/16/98	27	8	30%	0.017	0.07	0.014	0.018	0.0071	0.014	0.015
ARDPK	American River at Discovery Park	9/21/99	7/9/02	7	0	0%	ND	ND	ID	ID	ID	ID	0.1
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	1	20%	0.54	0.54	ID	ID	ID	ID	0.2
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/17/00	47	38	81%	0.02	0.841	0.13	0.17	0.067	0.12	0.015
SRFPT	Sacramento River at Freeport	2/20/96	7/10/02	77	22	29%	0.02	0.082	0.017	0.013	0.014	0.014	0.015
SRRMF	Sacramento River at River Mile 44	6/23/98	7/10/02	39	23	59%	0.099	0.955	0.16	0.19	0.12	0.14	0.1
CCHRM	Cache Creek near Rumsey	2/21/99	8/18/99	11	1	9.1%	0.021	0.021	ID	ID	ID	ID	0.02

Nitrate as N

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	30	29	97%	0.055	0.23	0.12	0.046	0.11	0.058	0.05
SRHAM	Sacramento River near Hamilton City	9/25/01	5/14/02	4	3	75%	0.056	0.18	0.10	0.11	0.080	0.13	0.05
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	38	38	100%	0.040	1.1	0.18	0.20	0.14	0.12	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	46	42	91%	0.050	1.4	0.43	0.33	0.31	0.39	0.05
SACSL	Sacramento Slough	2/12/96	5/16/02	41	33	80%	0.050	0.37	0.15	0.091	0.13	0.11	0.05
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	31	18	58%	0.050	0.67	0.076	0.14	0.047	0.066	0.05
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	32	29	91%	0.040	1.6	0.14	0.36	0.087	0.10	0.05
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	27	100%	0.023	0.26	0.13	0.057	0.12	0.085	NR
SRVET	Sacramento River at Veterans Bridge	9/26/01	7/9/02	6	5	83%	0.065	0.21	0.13	0.069	0.11	0.10	0.1
ARJST	American River at J Street	2/21/96	4/16/98	27	14	52%	0.050	0.18	0.072	0.043	0.061	0.055	0.05
ARDPK	American River at Discovery Park	9/26/01	7/9/02	6	2	33%	0.071	0.10	ID	ID	ID	ID	0.05
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	0.53	2.6	1.5	0.83	1.3	1.4	NR
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/17/00	47	40	85%	0.12	2.3	0.66	0.50	0.51	0.56	0.21875
SRFPT	Sacramento River at Freeport	2/20/96	7/10/02	65	62	95%	0.051	0.25	0.12	0.049	0.11	0.066	0.05
SRRMF	Sacramento River at River Mile 44	6/23/98	7/10/02	28	19	68%	0.062	0.28	0.14	0.072	0.13	0.091	0.1
CCHRM	Cache Creek near Rumsey	2/21/99	8/18/99	11	8	73%	0.059	0.11	0.079	0.022	0.076	0.032	0.05

Nitrite as N

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	30	5	17%	0.010	0.020	ID	ID	ID	ID	0.01
SRHAM	Sacramento River near Hamilton City	9/25/01	5/14/02	4	0	0%	ND	ND	ID	ID	ID	ID	0.02
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	38	7	18%	0.010	0.029	ID	ID	ID	ID	0.01
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	46	28	61%	0.010	0.060	0.024	0.014	0.021	0.018	0.01
SACSL	Sacramento Slough	2/12/96	5/16/02	41	14	34%	0.010	0.10	0.012	0.019	0.0079	0.010	0.01
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	32	8	25%	0.010	0.19	0.011	0.044	0.0017	0.0063	0.01
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	32	9	28%	0.010	0.032	0.0075	0.0072	0.0053	0.0068	0.01
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	10	37%	0.010	0.035	0.0082	0.0087	0.0053	0.0080	0.01
SRVET	Sacramento River at Veterans Bridge	9/26/01	7/9/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.02
ARJST	American River at J Street	2/21/96	4/16/98	27	8	30%	0.010	0.020	ID	ID	ID	ID	0.01
ARDPK	American River at Discovery Park	9/26/01	7/9/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.02
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	3	60%	0.023	0.16	0.045	0.083	0.015	0.063	0.02
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/17/00	47	34	72%	0.010	0.090	0.034	0.021	0.029	0.027	0.01
SRFPT	Sacramento River at Freeport	2/20/96	7/10/02	77	21	27%	0.0030	0.030	0.0067	0.0053	0.0053	0.0053	0.006
SRRMF	Sacramento River at River Mile 44	6/23/98	7/10/02	28	0	0%	ND	ND	ID	ID	ID	ID	0.02
CCHRM	Cache Creek near Rumsey	2/21/99	8/18/99	11	0	0%	ND	ND	ID	ID	ID	ID	0.01

Summary Statistics: Nitrogen and Phosphorus Compounds

Orthosphosphate as P, dissolved

Units = mg/L

		monitoring period											
Site ID	Site Description	start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	30	26	87%	0.014	0.035	0.021	0.005	0.020	0.0070	0.01
MCHWY	Mill Creek at Highway 36	6/23/98	4/17/00	19	12	63%	0.01	0.03	0.015	0.0087	0.013	0.011	0.01
MCBLR	Mill Creek at Black Rock	6/23/98	4/17/00	14	2	14%	0.01	0.02	ID	ID	ID	ID	0.01
MCMOU	Mill Creek at Mouth	6/23/98	4/17/00	19	5	26%	0.01	0.03	0.0060	0.0082	0.0031	0.0061	0.01
DCMDW	Deer Creek below Childs Meadows	6/24/98	4/17/00	18	3	17%	0.01	0.01	ID	ID	ID	ID	0.01
DCPON	Deer Creek at Ponderosa Way	6/24/98	11/8/99	12	1	8.3%	0.01	0.01	ID	ID	ID	ID	0.01
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	4/17/00	18	4	22%	0.01	0.01	ID	ID	ID	ID	0.01
DCMOU	Deer Creek at Mouth	6/24/98	4/17/00	14	1	7.1%	0.01	0.01	ID	ID	ID	ID	0.01
SRHAM	Sacramento River near Hamilton City	8/18/99	5/14/02	5	3	60%	0.013	0.031	0.017	0.011	0.015	0.018	0.01
CHHWY	Big Chico Creek at Hwy 32	6/23/98	4/17/00	17	0	0%	ND	ND	ID	ID	ID	ID	0.01
CHASH	Big Chico Creek above Salmon Hole	6/23/98	4/17/00	17	2	12%	0.01	0.01	ID	ID	ID	ID	0.01
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/23/98	4/17/00	17	3	18%	0.01	0.02	ID	ID	ID	ID	0.01
CHMUD	Big Chico Creek above Mud Creek	6/23/98	4/17/00	17	5	29%	0.01	0.03	0.0065	0.0085	0.0035	0.0068	0.01
MUDCH	Mud Creek above Big Chico Creek	6/23/98	4/17/00	10	1	10%	0.02	0.02	ID	ID	ID	ID	0.01
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	37	35	95%	0.01	0.04	0.022	0.0077	0.021	0.010	0.01
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	46	34	74%	0.017	0.193	0.097	0.039	0.089	0.056	0.16
SACSL	Sacramento Slough	2/12/96	5/16/02	40	29	73%	0.025	0.13	0.075	0.036	0.066	0.054	0.01
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	32	5	16%	0.01	0.02	ID	ID	ID	ID	0.01
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	32	20	63%	0.01	0.029	0.011	0.0061	0.010	0.0073	0.01
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	25	93%	0.017	0.042	0.023	0.0074	0.022	0.0091	0.01
SRVET	Sacramento River at Veterans Bridge	9/26/01	7/9/02	6	6	100%	0.016	0.071	0.033	0.023	0.029	0.026	NR
ARJST	American River at J Street	2/21/96	4/16/98	27	6	22%	0.01	0.02	0.0066	0.0055	0.0049	0.0059	0.01
ARDPK	American River at Discovery Park	9/21/99	7/9/02	7	2	29%	0.011	0.016	ID	ID	ID	ID	0.01
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	0.209	1.9	0.70	0.86	0.52	0.80	NR
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/17/00	47	35	74%	0.05	0.278	0.14	0.069	0.12	0.092	0.01
SRFPT	Sacramento River at Freeport	2/20/96	7/10/02	76	72	95%	0.01	0.051	0.023	0.0081	0.021	0.011	0.01
SRRMF	Sacramento River at River Mile 44	6/23/98	7/10/02	29	6	21%	0.03	0.12	0.073	0.043	0.062	0.063	0.16
CCHRM	Cache Creek near Rumsey	2/21/99	8/18/99	11	5	45%	0.011	0.023	0.010	0.0064	0.0080	0.0079	0.01

Phosphorus, total

Units = mg/L

		monitoring period											
Site ID	Site Description	start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
CCMOU	Clear Creek near Mouth	9/15/98	8/17/99	12	10	83%	0.01	0.03	0.018	0.0091	0.016	0.013	0.01
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	30	29	97%	0.01	0.23	0.046	0.048	0.034	0.037	0.01
MCHWY	Mill Creek at Highway 36	6/22/99	4/17/00	7	7	100%	0.02	0.23	0.11	0.087	0.077	0.12	NR
MCBLR	Mill Creek at Black Rock	6/23/98	4/17/00	14	14	100%	0.01	0.15	0.041	0.040	0.033	0.033	NR
MCMOU	Mill Creek at Mouth	6/23/98	4/17/00	19	19	100%	0.02	0.63	0.10	0.17	0.056	0.081	NR
DCMDW	Deer Creek below Childs Meadows	6/24/98	4/17/00	18	16	89%	0.01	0.11	0.024	0.027	0.018	0.022	0.01
DCPON	Deer Creek at Ponderosa Way	6/24/98	11/8/99	12	10	83%	0.01	0.04	0.021	0.011	0.019	0.016	0.01
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	4/17/00	18	16	89%	0.01	0.14	0.026	0.037	0.019	0.020	0.01
DCMOU	Deer Creek at Mouth	6/24/98	4/17/00	13	12	92%	0.01	0.04	0.028	0.010	0.026	0.017	1
SRHAM	Sacramento River near Hamilton City	9/25/01	5/14/02	4	4	100%	0.03	0.13	0.060	0.059	0.050	0.062	NR
CHHWY	Big Chico Creek at Hwy 32	6/23/98	4/17/00	17	14	82%	0.01	0.07	0.020	0.017	0.016	0.015	0.01
CHASH	Big Chico Creek above Salmon Hole	6/23/98	4/17/00	17	15	88%	0.01	0.14	0.024	0.040	0.018	0.017	0.01
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/23/98	4/17/00	17	14	82%	0.01	0.14	0.024	0.038	0.017	0.020	0.01
CHMUD	Big Chico Creek above Mud Creek	6/23/98	4/17/00	17	16	94%	0.01	0.15	0.031	0.042	0.020	0.028	0.01
MUDCH	Mud Creek above Big Chico Creek	6/23/98	4/17/00	10	9	90%	0.01	0.06	0.025	0.017	0.020	0.023	0.01
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	37	37	100%	0.01	5.4	0.21	1.2	0.059	0.088	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	38	38	100%	0.11	0.36	0.23	0.064	0.22	0.094	NR
SACSL	Sacramento Slough	2/12/96	5/16/02	33	33	100%	0.03	0.27	0.15	0.058	0.14	0.10	NR
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	32	17	53%	0.01	0.11	0.019	0.027	0.011	0.018	0.01
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	32	27	84%	0.01	0.075	0.029	0.019	0.024	0.023	0.01
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	27	100%	0.01	0.17	0.059	0.033	0.051	0.042	NR
SRVET	Sacramento River at Veterans Bridge	9/26/01	7/9/02	6	5	83%	0.054	0.95	0.22	0.51	0.10	0.18	0.1
ARJST	American River at J Street	2/21/96	4/16/98	27	14	52%	0.01	0.09	0.018	0.022	0.010	0.018	0.01
ARDPK	American River at Discovery Park	9/26/01	7/9/02	6	0	0%	ND	ND	ID	ID	ID	ID	0.02
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	0.41	2.3	0.88	1.0	0.68	0.85	NR
ARCNW	Arcade Creek at Norwood Ave.	2/6/96	5/17/00	40	40	100%	0.11	1.16	0.28	0.20	0.24	0.17	NR
SRFPT	Sacramento River at Freeport	2/20/96	7/10/02	77	75	97%	0.015	0.265	0.060	0.040	0.052	0.039	0.05
SRRMF	Sacramento River at River Mile 44	6/23/98	7/10/02	22	20	91%	0.04	1.09	0.13	0.29	0.085	0.098	0.02
CCHRM	Cache Creek near Rumsey	2/21/99	8/18/99	11	10	91%	0.007	0.53	0.14	0.17	0.071	0.18	0.004

Summary Statistics: Nitrogen and Phosphorus Compounds

Nitrogen, Total Kjeldahl

Units = mg/L

Site ID	Site Description	monitoring period start	monitoring period end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRABB	Sacramento River above Bend Bridge	9/24/01	5/14/02	4	0	0%	ND	ND	ID	ID	ID	ID	0.50
SRHAM	Sacramento River near Hamilton City	8/18/99	5/14/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.50
SRCOL	Sacramento River at Colusa	9/25/01	5/15/02	4	1	25%	0.58	0.58	ID	ID	ID	ID	0.50
COLDR	Colusa Basin Drain above KL	6/23/99	5/15/02	17	11	65%	0.26	1.3	0.61	0.34	0.53	0.45	0.50
SACSL	Sacramento Slough	6/22/99	5/16/02	16	4	25%	0.20	0.92	0.31	0.24	0.24	0.27	0.50
YRMRY	Yuba River at Marysville	9/25/01	5/15/02	5	0	0%	ND	ND	ID	ID	ID	ID	0.50
FRNIC	Feather River near Nicolaus	1/19/00	5/16/02	6	2	33%	0.78	3.1	ID	ID	ID	ID	0.50
SRVET	Sacramento River at Veterans Bridge	9/26/01	7/9/02	6	2	33%	0.19	0.67	ID	ID	ID	ID	0.50
ARDPK	American River at Discovery Park	9/21/99	7/9/02	7	1	14%	0.16	0.16	ID	ID	ID	ID	0.50
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	0.55	1.6	1.0	0.48	0.96	0.81	NR
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/17/00	11	9	82%	0.52	1.6	0.95	0.44	0.86	0.66	0.50
SRFPT	Sacramento River at Freeport	9/15/98	7/10/02	43	38	88%	0.11	0.67	0.23	0.13	0.21	0.13	0.50
SRRMF	Sacramento River at River Mile 44	6/23/98	7/10/02	24	7	29%	0.21	1.1	0.30	0.28	0.23	0.27	0.20

Summary Statistics Table Notes:
monitoring period start and end — Dates of first and last reported data.
n — Total number of data reported.
n det — Total number of data above reporting limits.
% det — Percent of data above reporting limits.
min det — Minimum value for data detected above reporting limits.
max det — Maximum value of data detected above reporting limits.
percentiles — Percentile data are provided for data above reporting limits. "<RL" indicates insufficient data to calculate statistic.
min RL — Lowest reporting limit for data below detection. min RL only reported where percent detection (% det) < 100%.

Summary Statistics: Field Data

pH

Units = standard units

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	14	14	100%	7.4	8.9	8.0	0.43	8.0	0.63	NR
PRSHA	Pit River above Shasta	7/22/98	5/16/00	15	15	100%	7.3	8.5	8.0	0.36	8.0	0.53	NR
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	18	18	100%	7.1	8.5	7.9	0.36	7.9	0.52	NR
SRBKR	Sacramento River below Keswick	1/20/98	2/18/02	74	74	100%	6.7	8.6	7.7	0.43	7.7	0.60	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	18	18	100%	6.8	8.3	7.5	0.45	7.5	0.61	NR
CCWHI	Clear Creek above Whiskeytown	6/22/99	8/17/99	3	3	100%	8.1	8.6	ID	ID	ID	ID	NR
CCMOU	Clear Creek near Mouth	8/5/98	8/17/99	21	21	100%	7.1	8.0	7.4	0.21	7.4	0.27	NR
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	2	100%	8.0	8.5	ID	ID	ID	ID	NR
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	2	100%	7.3	8.5	ID	ID	ID	ID	NR
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	2	100%	7.4	8.2	ID	ID	ID	ID	NR
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	2	100%	8.0	8.3	ID	ID	ID	ID	NR
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	2	100%	7.7	8.4	ID	ID	ID	ID	NR
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	2	100%	7.9	8.1	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	76	76	100%	7.0	8.5	7.7	0.30	7.7	0.41	NR
MCHWY	Mill Creek at Highway 36	11/8/99	1/19/00	2	2	100%	7.1	7.2	ID	ID	ID	ID	NR
MCHTG	Mill Creek at Hole in the Ground	10/28/99	10/28/99	1	1	100%	7.1	7.1	ID	ID	ID	ID	NR
MCBLR	Mill Creek at Black Rock	6/22/99	4/6/01	7	7	100%	7.3	7.6	7.5	0.13	7.5	0.20	NR
MCGGE	Mill Creek at USGS gage	10/28/99	1/19/00	3	3	100%	7.3	7.6	7.4	0.18	7.4	0.30	NR
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	4	100%	7.3	7.8	7.5	0.23	7.5	0.41	NR
MCMOU	Mill Creek at Mouth	6/22/99	3/6/02	21	21	100%	7.1	9.2	7.9	0.52	7.9	0.74	NR
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	2	100%	8.3	8.4	ID	ID	ID	ID	NR
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	1	100%	8.1	8.1	ID	ID	ID	ID	NR
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	1	100%	8.2	8.2	ID	ID	ID	ID	NR
DCALN	Deer Creek at A Line Road	1/20/00	4/17/00	3	3	100%	7.3	7.8	7.6	0.32	7.6	0.50	NR
DCPON	Deer Creek at Ponderosa Way	6/23/99	11/8/99	4	4	100%	7.5	8.0	7.8	0.26	7.8	0.41	NR
DCHWY	Deer Creek at Highway 99	6/23/99	3/6/02	6	6	100%	6.9	8.4	7.7	0.51	7.7	0.77	NR
DCMOU	Deer Creek at Mouth	8/18/99	5/29/01	5	5	100%	7.1	8.8	7.8	0.70	7.8	1.18	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	53	53	100%	6.0	8.5	7.6	0.60	7.6	0.84	NR
CHACB	Big Chico Creek above Campbell Creek	9/14/99	9/14/99	1	1	100%	8.0	8.0	ID	ID	ID	ID	NR
CHHWY	Big Chico Creek at Hwy 32	10/28/99	1/19/00	3	3	100%	7.5	7.9	ID	ID	ID	ID	NR
CHASH	Big Chico Creek above Salmon Hole	6/22/99	8/17/99	3	3	100%	8.0	8.1	ID	ID	ID	ID	NR
LDMIS	Lindo Drain near Mission Ranch	1/11/00	1/11/00	1	1	100%	6.9	6.9	ID	ID	ID	ID	NR
LDERR	Lindo Drain near East Ave Railroad	1/11/00	1/11/00	1	1	100%	6.8	6.8	ID	ID	ID	ID	NR
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/22/99	4/17/00	7	7	100%	7.3	8.3	7.9	0.37	7.9	0.59	NR
CHAGC	Big Chico Creek above Golf Course	9/14/99	4/17/00	6	6	100%	7.5	8.2	7.9	0.32	7.9	0.5	NR
CHGLF	Big Chico Creek at Golf Course above Five-Mile Rec.	10/28/99	1/11/00	2	2	100%	7.5	7.6	ID	ID	ID	ID	NR
CHMUD	Big Chico Creek above Mud Creek	6/22/99	4/17/00	8	8	100%	7.4	8.4	7.9	0.43	7.9	0.68	NR
MUDCH	Mud Creek above Big Chico Creek	1/19/00	4/17/00	3	3	100%	7.2	7.4	7.3	0.11	7.3	0.20	NR
CHMOU	Big Chico Creek at Mouth	1/26/01	3/6/02	5	5	100%	7.4	8.4	7.9	0.40	7.9	0.67	NR
LCTEN	Little Chico Creek at Ten Mile	10/28/99	1/19/00	3	3	100%	7.2	8.0	7.5	0.49	7.5	0.79	NR
LCSTL	Little Chico Creek at Stilson Cyn	9/14/99	1/19/00	4	4	100%	7.3	8.3	7.8	0.49	7.8	0.87	NR
CDBID	Chico Drain at Bidwell Ave	1/11/00	1/11/00	1	1	100%	7.0	7.0	ID	ID	ID	ID	NR
CDBWS	Chico Drain below Warner Street	1/11/00	1/11/00	1	1	100%	6.8	6.8	ID	ID	ID	ID	NR
LCCPT	Little Chico Creek at Crown Point	9/14/99	9/14/99	1	1	100%	7.8	7.8	ID	ID	ID	ID	NR
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	3	3	100%	7.2	8.3	7.8	0.66	7.8	1.16	NR
LCBCH	Little Chico Creek below Chico	2/20/02	3/7/02	2	2	100%	7.3	7.6	ID	ID	ID	ID	NR
BCPLF	Butte Creek below Pool Four	9/14/99	1/19/00	4	4	100%	7.3	7.9	7.6	0.32	7.6	0.55	NR
BCOKD	Butte Creek above Okie Dam	9/14/99	1/19/00	4	4	100%	7.3	8.2	7.7	0.44	7.7	0.77	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	111	111	100%	6.9	8.6	7.8	0.31	7.8	0.42	NR
BCGGE	Butte Creek at USGS gage near Chico	6/23/99	4/19/00	6	6	100%	6.5	8.7	8.1	0.94	8.0	1.4	NR
BCHWY	Butte Creek at Colusa Highway	6/23/99	4/19/00	7	7	100%	6.6	8.5	7.9	0.82	7.8	1.3	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	74	74	100%	6.7	8.6	7.8	0.41	7.8	0.57	NR
SACSL	Sacramento Slough	2/12/96	5/16/02	67	67	100%	6.7	8.7	7.8	0.35	7.8	0.48	NR
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	52	52	100%	6.4	8.7	7.5	0.44	7.5	0.61	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	83	83	100%	6.6	8.7	7.7	0.34	7.7	0.46	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	27	100%	7.5	8.1	7.8	0.16	7.8	0.22	NR
SRVET	Sacramento River at Veterans Bridge	1/4/94	6/4/02	152	152	100%	6.8	8.9	7.7	0.41	7.6	0.55	NR
ARJST	American River at J Street	2/21/96	4/16/98	27	27	100%	7.0	7.7	7.4	0.15	7.4	0.22	NR
ARDPK	American River at Discovery Park	1/4/94	6/4/02	118	118	100%	6.4	8.6	7.4	0.48	7.4	0.66	NR
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	6.9	7.9	7.5	0.39	7.5	0.61	NR
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	43	43	100%	5.9	8.6	7.2	0.69	7.2	0.99	NR
SRFPT	Sacramento River at Freeport	2/20/96	5/16/02	131	131	100%	6.9	8.8	7.7	0.30	7.7	0.41	NR
SRRMF	Sacramento River at River Mile 44	1/18/94	6/5/02	131	131	100%	6.1	8.8	7.5	0.43	7.5	0.59	NR
CCHSL	Cache Slough near Ryers Ferry	6/23/98	4/18/00	23	23	100%	6.9	8.5	7.5	0.43	7.4	0.62	NR

Summary Statistics: Field Data

Specific Conductance

Units = µmhos/cm at 25˚C

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	15	15	100%	76	146	111	27	108	39	NR
PRSHA	Pit River above Shasta	7/22/98	5/16/00	16	16	100%	121	194	137	23	136	23	NR
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	18	18	100%	77	184	115	27	112	33	NR
SRBKR	Sacramento River below Keswick	1/20/98	2/18/02	74	74	100%	74	290	119	31	116	33	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	19	19	100%	69	85	76	5	76	7	NR
CCWHI	Clear Creek above Whiskeytown	6/22/99	8/17/99	3	3	100%	109	169	139	33	137	61	NR
CCMOU	Clear Creek near Mouth	8/20/98	8/17/99	15	15	100%	80	106	91	7	91	11	NR
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	2	100%	134	465	ID	ID	ID	ID	NR
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	2	100%	199	238	ID	ID	ID	ID	NR
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	2	100%	255	486	ID	ID	ID	ID	NR
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	2	100%	166	185	ID	ID	ID	ID	NR
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	2	100%	161	173	ID	ID	ID	ID	NR
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	2	100%	170	195	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	78	78	100%	85	362	135	42	130	44	NR
MCHWY	Mill Creek at Highway 36	11/8/99	1/19/00	2	2	100%	186	474	ID	ID	ID	ID	NR
MCHTG	Mill Creek at Hole in the Ground	10/28/99	10/28/99	1	1	100%	284	284	ID	ID	ID	ID	NR
MCBLR	Mill Creek at Black Rock	6/22/99	4/6/01	7	7	100%	37	234	124	65	111	102	NR
MCGGE	Mill Creek at USGS gage	10/28/99	1/19/00	3	3	100%	111	194	157	48	153	86	NR
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	4	100%	46	210	164	107	140	166	NR
MCMOU	Mill Creek at Mouth	6/22/99	3/6/02	23	23	100%	65	419	203	81	189	115	NR
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	2	100%	151	531	ID	ID	ID	ID	NR
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	1	100%	170	170	ID	ID	ID	ID	NR
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	1	100%	191	191	ID	ID	ID	ID	NR
DCALN	Deer Creek at A Line Road	1/20/00	4/17/00	3	3	100%	43	70	57	15	56	28	NR
DCPON	Deer Creek at Ponderosa Way	6/23/99	11/8/99	4	4	100%	102	117	112	8.0	112	12.1	NR
DCHWY	Deer Creek at Highway 99	6/23/99	3/6/02	6	6	100%	58	1034	263	509	148	268	NR
DCMOU	Deer Creek at Mouth	8/18/99	2/20/02	7	7	100%	134	217	176	34.2	173	54	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	54	54	100%	84	333	165	46	159	61	NR
CHACB	Big Chico Creek above Campbell Creek	9/14/99	9/14/99	1	1	100%	173	173	ID	ID	ID	ID	NR
CHHWY	Big Chico Creek at Hwy 32	10/28/99	1/19/00	3	3	100%	77	140	111	36	107	65	NR
CHASH	Big Chico Creek above Salmon Hole	6/22/99	8/17/99	3	3	100%	180	196	189	9	189	16	NR
LDMIS	Lindo Drain near Mission Ranch	10/27/99	1/11/00	2	2	100%	31	64	ID	ID	ID	ID	NR
LDERR	Lindo Drain near East Ave Railroad	10/27/99	1/11/00	2	2	100%	79	109	ID	ID	ID	ID	NR
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/22/99	4/17/00	7	7	100%	61	202	152	56.0	141	98	NR
CHAGC	Big Chico Creek above Golf Course	9/14/99	4/17/00	7	7	100%	60	209	146	56	136	98	NR
CHGLF	Big Chico Creek at Golf Course above Five-Mile Rec.	10/28/99	1/11/00	2	2	100%	135	184	ID	ID	ID	ID	NR
CHFIV	Big Chico Creek below Five-Mile Rec.	10/27/99	10/27/99	1	1	100%	196	196	ID	ID	ID	ID	NR
CHMUD	Big Chico Creek above Mud Creek	7/20/99	4/17/00	7	7	100%	59	200	146	60	134	103	NR
MUDCH	Mud Creek above Big Chico Creek	1/19/00	4/17/00	3	3	100%	79	176	126	54.2	120	99	NR
CHMOU	Big Chico Creek at Mouth	1/26/01	3/6/02	6	6	100%	148	375	228	90	218	119	NR
LCTEN	Little Chico Creek at Ten Mile	10/28/99	1/19/00	3	3	100%	104	152	133	31	131	50	NR
LCSTL	Little Chico Creek at Stilson Cyn	9/14/99	1/19/00	4	4	100%	121	190	166	38	163	55	NR
CDBID	Chico Drain at Bidwell Ave	10/27/99	1/11/00	2	2	100%	55	99	ID	ID	ID	ID	NR
CDBWS	Chico Drain below Warner Street	10/27/99	1/11/00	2	2	100%	110	160	ID	ID	ID	ID	NR
LCCPT	Little Chico Creek at Crown Point	9/14/99	9/14/99	1	1	100%	163	163	ID	ID	ID	ID	NR
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	3	3	100%	148	186	169	23	169	38	NR
LCBCH	Little Chico Creek below Chico	2/20/02	3/7/02	2	2	100%	96	160	ID	ID	ID	ID	NR
BCPLF	Butte Creek below Pool Four	9/14/99	1/19/00	4	4	100%	81	111	99	15	98	26	NR
BCOKD	Butte Creek above Okie Dam	9/14/99	1/19/00	4	4	100%	72	111	95	19	94	34	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	110	110	100%	95	261	147	31	144	37	NR
BCGGE	Butte Creek at USGS gage near Chico	6/23/99	4/19/00	6	6	100%	89	132	106	18	105	29	NR
BCHWY	Butte Creek at Colusa Highway	6/23/99	4/19/00	7	7	100%	128	227	183	43	179	69	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	76	76	100%	134	1283	647	232	602	321	NR
SACSL	Sacramento Slough	2/12/96	5/16/02	68	68	100%	94	1070	376	169	343	207	NR
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	52	52	100%	22	231	86	37	80	44	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	85	85	100%	32	171	96	27	93	35	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	27	100%	62	186	131	28	128	43	NR
SRVET	Sacramento River at Veterans Bridge	1/4/94	6/4/02	154	154	100%	21	316	157	43	150	61	NR
ARJST	American River at J Street	2/21/96	4/16/98	27	27	100%	40	68	51	6.6	51	9.3	NR
ARDPK	American River at Discovery Park	1/4/94	6/4/02	118	118	100%	28	139	57	16	55	19	NR
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	300	457	399	69	395	111	NR
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	45	45	100%	92	524	274	121	247	167	NR
SRFPT	Sacramento River at Freeport	2/20/96	5/16/02	130	130	100%	51	250	145	34	141	46	NR
SRRMF	Sacramento River at River Mile 44	1/18/94	6/5/02	133	133	100%	62	258	146	41	140	57	NR
CCHSL	Cache Slough near Ryers Ferry	6/23/98	4/18/00	18	18	100%	106	313	203	57	196	84	NR

Summary Statistics: Field Data

Temperature — Units = °C

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	15	15	100%	7.3	19.7	11.0	4.3	10.3	5.3	NR
PRSHA	Pit River above Shasta	7/22/98	5/16/00	16	16	100%	7.0	20.1	12.5	4.3	11.8	6.4	NR
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	20	20	100%	5.3	27.1	11.1	5.2	10.3	5.5	NR
SRBKR	Sacramento River below Keswick	1/20/98	2/18/02	75	75	100%	8.2	14.5	11.3	1.4	11.2	2.0	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	19	19	100%	7.6	13.5	11.1	1.8	11.0	2.7	NR
CCWHI	Clear Creek above Whiskeytown	6/22/99	8/17/99	3	3	100%	17.7	19.6	18.5	1.2	18.5	1.9	NR
CCMOU	Clear Creek near Mouth	8/5/98	5/29/01	25	25	100%	6.2	23.2	13.4	5.7	12.3	7.6	NR
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	2	100%	7.7	11.0	ID	ID	ID	ID	NR
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	2	100%	5.5	12.6	ID	ID	ID	ID	NR
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	2	100%	9.9	19.0	ID	ID	ID	ID	NR
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	2	100%	9.3	10.8	ID	ID	ID	ID	NR
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	2	100%	8.2	10.3	ID	ID	ID	ID	NR
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	2	100%	9.1	12.1	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	79	79	100%	7.7	15.5	11.7	1.6	11.6	2.2	NR
MCHWY	Mill Creek at Highway 36	11/8/99	1/19/00	2	2	100%	5.2	8.9	ID	ID	ID	ID	NR
MCHTG	Mill Creek at Hole in the Ground	10/28/99	10/28/99	1	1	100%	8.4	8.4	ID	ID	ID	ID	NR
MCBLR	Mill Creek at Black Rock	6/22/99	4/6/01	7	7	100%	5.7	16.2	10.7	4.2	10.0	6.7	NR
MCGGE	Mill Creek at USGS gage	10/28/99	1/19/00	3	3	100%	10.7	13.0	11.8	1.3	11.7	2.3	NR
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	4	100%	8.2	10.2	9.2	0.9	9.2	1.5	NR
MCMOU	Mill Creek at Mouth	6/22/99	3/6/02	23	23	100%	4.7	32.9	14.8	8.5	12.8	10.5	NR
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	2	100%	8.7	12.2	ID	ID	ID	ID	NR
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	1	100%	9.3	9.3	ID	ID	ID	ID	NR
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	1	100%	10.2	10.2	ID	ID	ID	ID	NR
DCALN	Deer Creek at A Line Road	1/20/00	4/17/00	3	3	100%	4.1	6.6	5.4	1.4	5.3	2.5	NR
DCPON	Deer Creek at Ponderosa Way	6/23/99	11/8/99	4	4	100%	9.5	18.8	15.1	4.6	14.6	7.7	NR
DCHWY	Deer Creek at Highway 99	6/23/99	3/6/02	6	6	100%	10.0	28.4	16.4	9.2	14.7	11.4	NR
DCMOU	Deer Creek at Mouth	8/18/99	2/20/02	7	7	100%	6.0	27.0	14.1	8.0	12.5	11.8	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	55	55	100%	6.4	18.2	13.0	2.9	12.7	4.3	NR
CHACB	Big Chico Creek above Campbell Creek	9/14/99	9/14/99	1	1	100%	12.7	12.7	ID	ID	ID	ID	NR
CHHWY	Big Chico Creek at Hwy 32	10/28/99	1/19/00	3	3	100%	6.4	8.9	7.6	1.4	7.6	2.5	NR
CHASH	Big Chico Creek above Salmon Hole	6/22/99	8/17/99	3	3	100%	19.1	20.1	19.6	0.6	19.6	1.0	NR
LDMIS	Lindo Drain near Mission Ranch	10/27/99	1/11/00	2	2	100%	11.0	17.8	ID	ID	ID	ID	NR
LDERR	Lindo Drain near East Ave Railroad	10/27/99	1/11/00	2	2	100%	11.8	18.2	ID	ID	ID	ID	NR
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/22/99	4/17/00	7	7	100%	9.9	23.5	16.5	6.3	15.4	9.7	NR
CHAGC	Big Chico Creek above Golf Course	9/14/99	4/17/00	7	7	100%	8.6	20.8	12.4	4.7	11.9	5.7	NR
CHGLF	Big Chico Creek at Golf Course above Five-Mile Rec.	10/28/99	1/11/00	2	2	100%	8.7	13.2	ID	ID	ID	ID	NR
CHFIV	Big Chico Creek below Five-Mile Rec.	10/27/99	10/27/99	1	1	100%	13.9	13.9	ID	ID	ID	ID	NR
CHMUD	Big Chico Creek above Mud Creek	10/28/99	1/19/00	3	3	100%	6.4	8.9	7.6	1.4	7.6	2.5	NR
MUDCH	Mud Creek above Big Chico Creek	1/19/00	4/17/00	3	3	100%	11.1	13.2	12.1	1.2	12.1	2.1	NR
CHMOU	Big Chico Creek at Mouth	2/21/02	3/6/02	2	2	100%	10.2	10.7	ID	ID	ID	ID	NR
LCTEN	Little Chico Creek at Ten Mile	10/28/99	1/19/00	3	3	100%	10.2	13.2	11.8	1.7	11.7	3.0	NR
LCSTL	Little Chico Creek at Stilson Cyn	9/14/99	1/19/00	4	4	100%	10.6	22.0	15.7	5.3	15.1	8.5	NR
CDBID	Chico Drain at Bidwell Ave	10/27/99	1/11/00	2	2	100%	10.6	17.5	ID	ID	ID	ID	NR
CDBWS	Chico Drain below Warner Street	10/27/99	1/11/00	2	2	100%	9.3	18.3	ID	ID	ID	ID	NR
LCCPT	Little Chico Creek at Crown Point	9/14/99	9/14/99	1	1	100%	16.9	16.9	ID	ID	ID	ID	NR
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	3	3	100%	10.5	13.5	11.5	2.3	11.5	2.9	NR
LCBCH	Little Chico Creek below Chico	2/20/02	3/7/02	2	2	100%	10.4	12.1	ID	ID	ID	ID	NR
BCPLF	Butte Creek below Pool Four	9/14/99	1/19/00	4	4	100%	8.4	18.1	11.9	5.2	11.4	6.8	NR
BCOKD	Butte Creek above Okie Dam	9/14/99	1/19/00	4	4	100%	9.5	18.1	13.1	4.1	12.7	6.2	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	112	112	100%	7.2	24.0	14.8	3.9	14.3	5.4	NR
BCGGE	Butte Creek at USGS gage near Chico	6/23/99	4/19/00	6	6	100%	7.3	19.4	13.4	4.9	12.6	8.4	NR
BCHWY	Butte Creek at Colusa Highway	6/23/99	4/19/00	7	7	100%	9.8	27.4	15.7	7.0	14.6	9.8	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	76	76	100%	3.7	30.9	17.2	6.4	15.9	9.3	NR
SACSL	Sacramento Slough	2/12/96	5/16/02	69	69	100%	7.0	30.5	17.5	6.0	16.5	8.4	NR
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	52	52	100%	8.1	21.4	12.6	3.3	12.3	4.4	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	85	85	100%	6.7	29.7	15.4	5.0	14.6	6.8	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	27	100%	8.7	22.5	15.4	4.5	14.7	6.6	NR
SRVET	Sacramento River at Veterans Bridge	1/18/94	6/4/02	153	153	100%	7.6	24.1	15.3	4.5	14.6	6.2	NR
ARJST	American River at J Street	2/21/96	4/16/98	27	27	100%	8.4	19.7	13.7	3.8	13.2	5.4	NR
ARDPK	American River at Discovery Park	1/4/94	6/4/02	118	118	100%	7.6	24.4	14.6	4.3	13.9	5.8	NR
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	12.6	22.1	17.3	3.8	17.0	6.6	NR
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	45	45	100%	6.1	28.0	16.6	6.2	15.4	8.9	NR
SRFPT	Sacramento River at Freeport	2/20/96	5/16/02	143	143	100%	7.1	24.0	16.1	4.5	15.4	6.3	NR
SRRMF	Sacramento River at River Mile 44	1/18/94	6/5/02	130	130	100%	7.9	22.9	15.6	4.5	14.9	6.3	NR
CCHSL	Cache Slough near Ryers Ferry	6/23/98	4/18/00	23	23	100%	8.4	22.6	15.3	4.9	14.5	7.2	NR

Summary Statistics: Field Data

Dissolved Oxygen

Units = mg/L

Site ID	Site Description	monitoring period start	end	n	n det	% det	min det	max det	mean	SD	median	IQR	min RL
SRSHA	Sacramento River above Shasta	7/22/98	5/16/00	9	9	100%	9.8	13	11.0	0.97	11.0	1.5	NR
PRSHA	Pit River above Shasta	7/22/98	5/16/00	9	9	100%	9.9	13	11.4	0.94	11.3	1.4	NR
MRSHA	McCloud River above Shasta	7/22/98	5/16/00	9	9	100%	8.3	12	10.6	1.36	10.5	2.0	NR
SRBKR	Sacramento River below Keswick	6/24/98	2/18/02	30	30	100%	7.6	14	10.8	1.29	10.7	1.8	NR
SCKPP	Spring Creek PP Discharge to Keswick Res.	6/24/98	4/18/00	12	12	100%	8.8	12	10.3	0.83	10.2	1.3	NR
CCMOU	Clear Creek near Mouth	8/20/98	3/6/02	16	16	100%	9.2	12	10.8	0.77	10.7	1.2	NR
CTMON	MF Cottonwood Ck near Ono	11/1/01	2/18/02	2	2	100%	9.8	11	ID	ID	ID	ID	NR
CTNMC	NF Cottonwood Ck at McCauliffe Rd	11/1/01	2/19/02	2	2	100%	9.6	11	ID	ID	ID	ID	NR
CTCNL	SF Cottonwood Ck at Anderson Canal	10/31/01	2/18/02	2	2	100%	8.2	10	ID	ID	ID	ID	NR
BANFA	North Fork Battle Ck at Wildcat Road	11/1/01	2/19/02	2	2	100%	9.7	10	ID	ID	ID	ID	NR
BASFA	South Fork Battle Creek at Manton Road	11/1/01	2/19/02	2	2	100%	10.2	11	ID	ID	ID	ID	NR
BACFH	Battle Ck below Coleman Fish Hatchery	11/1/01	2/19/02	2	2	100%	9.6	10	ID	ID	ID	ID	NR
SRABB	Sacramento River above Bend Bridge	2/13/96	5/14/02	63	63	100%	7.9	13	10.7	0.97	10.6	1.4	NR
MCHWY	Mill Creek at Highway 36	6/23/98	6/7/00	29	29	100%	7.9	14	10.4	1.18	10.3	1.7	NR
MCBLR	Mill Creek at Black Rock	6/23/98	4/6/01	19	19	100%	9.4	12	10.8	0.85	10.7	1.3	NR
MCHYN	Mill Creek at Highway 99	4/6/01	4/7/01	4	4	100%	8.1	12	10.4	2.06	10.3	3.6	NR
MCMOU	Mill Creek at Mouth	6/23/98	3/6/02	36	36	100%	6.1	17	10.4	1.94	10.3	2.6	NR
THPSK	Thomes Ck at Paskenta	11/2/01	2/20/02	2	2	100%	9.4	11	ID	ID	ID	ID	NR
THHNL	Thomes Ck at Henleyville	2/20/02	2/20/02	1	1	100%	10.5	11	ID	ID	ID	ID	NR
THRRB	Thomes Ck at Rawson Rd Bridge	2/20/02	2/20/02	1	1	100%	10.3	10	ID	ID	ID	ID	NR
DCMDW	Deer Creek below Childs Meadows	6/24/98	5/8/00	21	21	100%	9.4	12	10.5	0.73	10.4	1.1	NR
DCPON	Deer Creek at Ponderosa Way	6/24/98	6/6/00	13	13	100%	8.8	12	10.1	0.93	10.1	1.4	NR
DCUDD	Deer Creek at Upper Diversion Dam	6/24/98	6/6/00	21	21	100%	8.2	12	10.6	1.21	10.6	2	NR
DCHWY	Deer Creek at Highway 99	3/6/02	3/6/02	1	1	100%	8.8	9	ID	ID	ID	ID	NR
DCMOU	Deer Creek at Mouth	6/24/98	2/20/02	18	18	100%	6.9	17	10.4	2.28	10.3	2.7	NR
SRHAM	Sacramento River near Hamilton City	6/23/99	5/14/02	39	39	100%	7.6	15	10.2	1.62	10.1	2.2	NR
CHHWY	Big Chico Creek at Hwy 32	6/23/98	4/17/00	17	17	100%	9.3	12	10.6	0.71	10.5	1.1	NR
CHASH	Big Chico Creek above Salmon Hole	6/23/98	2/14/00	16	16	100%	8.9	12	10.6	1.31	10.5	1.9	NR
CHCHI	Big Chico Creek at Chico (Rose Ave.)	6/23/98	4/17/00	18	18	100%	8.8	12	10.2	0.90	10.2	1.3	NR
CHMUD	Big Chico Creek above Mud Creek	6/23/98	4/17/00	18	18	100%	8.8	12	10.5	0.86	10.5	1.3	NR
MUDCH	Mud Creek above Big Chico Creek	6/23/98	4/17/00	10	10	100%	7.8	14	10.6	1.73	10.5	2.7	NR
CHMOU	Big Chico Creek at Mouth	1/26/01	5/29/01	4	4	100%	9.5	17	12.0	3.75	11.7	5.4	NR
DRACC	Dry Creek above Cherokee Canal	11/3/01	3/7/02	3	3	100%	8.3	10	9.5	1.22	9.4	2.1	NR
LCBCH	Little Chico Creek below Chico	2/20/02	3/7/02	2	2	100%	9.8	10	ID	ID	ID	ID	NR
SRCOL	Sacramento River at Colusa	2/28/96	5/15/02	91	91	100%	7.7	16	10.3	1.15	10.2	1.4	NR
COLDR	Colusa Basin Drain above KL	2/7/96	5/15/02	58	58	100%	5.0	13	8.3	1.96	8.0	2.7	NR
SACSL	Sacramento Slough	2/12/96	5/16/02	55	55	100%	5.1	14	8.5	2.02	8.2	2.8	NR
YRMRY	Yuba River at Marysville	2/27/96	5/15/02	50	50	100%	6.5	16	10.9	1.57	10.7	2.2	NR
FRNIC	Feather River near Nicolaus	2/23/96	5/16/02	70	70	100%	7.5	16	10.2	1.44	10.1	1.9	NR
SRVON	Sacramento River at Verona	2/22/96	4/22/98	27	27	100%	7.3	13	9.8	1.22	9.7	1.8	NR
SRVET	Sacramento River at Veterans Bridge	1/18/94	6/4/02	137	137	100%	6.6	14	9.7	1.28	9.6	1.7	NR
ARJST	American River at J Street	2/21/96	4/16/98	26	26	100%	8.2	13	10.4	1.27	10.3	1.9	NR
ARDPK	American River at Discovery Park	1/4/94	6/4/02	119	119	100%	6.2	15	9.9	1.56	9.7	2.1	NR
NEMDR	Natomas East Main Drain	9/26/01	5/16/02	5	5	100%	2.0	8.5	6.7	3.39	6.0	5.2	NR
ARCNW	Arcade Creek at Norwood Ave.	6/22/99	5/16/02	31	31	100%	1.8	14	7.1	3.58	6.2	5.3	NR
SRFPT	Sacramento River at Freeport	2/20/96	5/16/02	115	115	100%	6.1	14	9.5	1.33	9.4	1.8	NR
SRRMF	Sacramento River at River Mile 44	1/18/94	6/5/02	127	127	100%	6.7	12	9.3	1.19	9.3	1.6	NR
SRGRN	Sacramento River at Greene's Landing	7/21/00	6/14/01	15	15	100%	7.2	13	9.7	1.57	9.6	2.4	NR
CCHSL	Cache Slough near Ryers Ferry	6/23/98	2/16/00	15	15	100%	7.0	11	9.1	1.32	9.1	2.0	NR

Summary Statistics Table Notes:
monitoring period start and end — Dates of first and last reported data.
n — Total number of data reported.
n det — Total number of data above reporting limits.
% det — Percent of data above reporting limits.
min det — Minimum value for data detected above reporting limits.
max det — Maximum value of data detected above reporting limits.
mean — Arithmetic mean value. "ID" if insufficient data to calculate.
SD — Standard Deviation. "ID" if insufficient data to calculate.
median — 50th percentile value. "ID" if insufficient data to calculate.
IQR — Interquartile range. "ID" if insufficient data to calculate.
min RL — Lowest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.
max RL — Highest reporting limit for data below detection. "NR" indicates there was no data below reporting limits.

Fish Tissue Data:
SRWP and DWR, 1997 - 2000

YEAR	STATION LOCATION	Site ID	Site Category	Species Code	Species	Tissue	Sample Type	Species Code	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
1997	Colusa Basin Drain	COLDR	Ag Drain		White Catfish	fillet	Composite		5	288	78.8		0.304					
1997	Sacramento Slough	SACSL	Ag Drain		White Catfish	fillet	Composite		5	274	77.6		0.438					
1997	Cache Slough	CCHSL	Delta		White Catfish	fillet	Composite		5	279	78.7		0.552					
1997	Cache Slough	CCHSL	Delta		White Catfish	fillet	Composite		5	271	79.1		0.415					
1997	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Composite		5	258	79.9	0.92	0.285	9.4	12.9	2.83	32.7	0.96
1997	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Composite		5	256	80.3	1.55	0.390	33.4	46.7	8.78	67.8	2.43
1997	Sacramento R. above Bend Bridge	SRABB	Lower Sac. R. Mainstem		Rainbow Trout	fillet	Composite		5	313	75.3	2.54	0.032	7.3	ND	1.51	3.3	ND
1997	Sacramento R. below Keswick	SRBKR	Lower Sac. R. Mainstem		Rainbow Trout	fillet	Composite		5	366	72.4	3.99	0.032	23.8	27.0	2.88	26.4	0.62
1997	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem		White Catfish	fillet	Composite		5	249	79.0	0.84	0.553	10.7	14.7	3.25	42.9	1.11
1997	American R. at Discovery Park	ARDPK	Major Tributary		White Catfish	fillet	Composite		4	274	80.4	0.49	0.524	58.8	80.6	7.97	62.0	0.72
1997	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Composite		5	264	81.1	0.49	0.391	10.5	ND	4.29	36.4	1.01
1997	McCloud R. above Shasta	MRASH	Tributary		Rainbow Trout	fillet	Composite		5	274	76.9		0.053					
1997	Pit R. above Shasta	PRASH	Tributary		Rainbow Trout	fillet	Individual		1	332	86.0		0.047					
1997	Sacramento R. above Shasta	SRASH	Tributary		Rainbow Trout	fillet	Composite		5	321	78.8		0.064					
1998	Colusa Basin Drain	COLDR	Ag Drain		Carp	fillet	Composite		5	386	76.8	1.78	0.106	6.6	1.9	1.89	684.0	20.07
1998	Natomas East Main Drain	NEMDR	Ag Drain		Largemouth Bass	fillet	Composite		5	367	79.1	0.51	0.599	15.3	2.6	2.57	8.1	UJ
1998	Sacramento Slough	SACSL	Ag Drain		Largemouth Bass	fillet	Composite		5	381	78.1	1.23	0.506	5.5	1.0	ND	41.3	2.79
1998	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Composite		5	367	80.5	0.50	0.723	5.0	1.0	ND	32.7	2.53
1998	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Composite		5	345	77.0	0.86	0.748	6.2	1.0	ND	12.4	<2
1998	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Composite		5	334	76.6	0.90	0.895	116.9	1.0	1.01	25.0	2.01
1998	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Composite		5	286	80.5	1.67	0.518	46.5	3.8	3.78	75.9	2.28 J
1998	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Composite		5	250	80.0	1.94	0.258	57.1	10.0	16.40	129.5	<2
1998	Sacramento R. above Bend Bridge	SRABB	Lower Sac. R. Mainstem		Pike Minnow	fillet	Composite		5	254	79.8	1.06	0.119	8.7	1.0	ND	8.4	<2
1998	Sacramento R. below Keswick	SRBKR	Lower Sac. R. Mainstem		Rainbow Trout	fillet	Composite		5	399	74.0	4.40	0.036	26.1	1.6	1.55	36.5	<2
1998	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem		Carp	fillet	Composite		5	398	80.3	1.00	0.186	5.6	1.0	ND	62.7	<2
1998	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem		Pike Minnow	fillet	Composite		5	278	80.6	0.76	0.301	7.0	1.0	ND	17.3	<2
1998	Sacramento R. near Hamilton City	SRHAM	Lower Sac. R. Mainstem		Pike Minnow	fillet	Composite		5	286	79.1	1.30	0.216	10.0	1.0	1.14	20.9	<2
1998	Sacramento R. near Hamilton City	SRHAM	Lower Sac. R. Mainstem		Sacramento Sucker	fillet	Composite		5	322	79.1	1.24	0.030	1.4	1.1	ND	2.1	<2
1998	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem		Largemouth Bass	fillet	Composite		5	335	78.8	0.74	0.818	7.3	1.0	ND	22.5	<2
1998	American R. at Discovery Park	ARDPK	Major Tributary		Pike Minnow	fillet	Composite		5	283	75.0	4.02	0.418	35.7	11.0	21.78	58.2	3.67
1998	American R. at J Street	ARJST	Major Tributary		Largemouth Bass	fillet	Composite		4	375	78.5	0.67	0.659	5.3	2.0	2.01	4.8	<2
1998	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Composite		5	382	79.1	0.72	1.154	8.2	1.0	ND	14.1	<2
1999	Natomas East Main Drain	NEMDR	Ag Drain		Largemouth Bass	fillet	Composite		5	332	79.2	0.7	0.680	35.1	26.0	4.08	16.1	<2
1999	Natomas East Main Drain	NEMDR	Ag Drain		White Catfish	fillet	Composite		5	258	80.7		0.286					
1999	Sacramento Slough	SACSL	Ag Drain		White Catfish	fillet	Composite		5	263	79.1	0.4	0.639	1.2	ND	ND	17.9	<2
1999	Sacramento Slough	SACSL	Ag Drain		Largemouth Bass	fillet	Composite		5	381	80.6	1.0	0.442	11.0	ND	1.27	45.9	2.00
1999	Cache Slough	CCHSL	Delta		White Catfish	fillet	Composite		5		81.8	0.6		15.5	16.0	1.40	56.4	<2
1999	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Composite		5		79.6	0.4		6.5	ND	ND	17.0	<2
1999	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	385	76.6		0.877					
1999	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	340	78.3		0.747					
1999	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	340	78.6		0.872					
1999	Cache Slough	CCHSL	Delta		Carp	fillet	Composite		5	352	78.9		0.107					
1999	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	429	79.0		0.898					
1999	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	380	79.2		1.180					
1999	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	270	79.3		0.602					
1999	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	285	79.7		0.513					
1999	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	280	81.2		0.497					
1999	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	330	82.0		0.833					
1999	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	274	83.3		0.680					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Composite		5		80.4	1.2		18.1	21.0	1.99	31.5	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Composite		5		79.8	2.0		24.8	24.0	2.67	58.8	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Composite		5		79.8	1.0		26.0	26.0	2.58	44.3	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Composite		5		72.2	3.9		36.6	29.0	5.50	88.6	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Composite		5		77.7	1.1		11.0	ND	1.58	26.4	<2
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	250	58.9		0.197					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	283	69.3		0.448					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	379	76.7		1.010					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	385	76.7		1.340					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Bluegill	fillet	Composite		5	185	76.9		0.103					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	341	76.9		1.050					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	355	77.1		0.750					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	315	77.2		0.775					

YEAR	STATION LOCATION	Site ID	Site Category	Species Code	Species	Tissue	Sample Type	Species Code	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	341	77.2		0.524					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	317	77.6		0.867					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	358	78.1		0.883					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	350	78.4		1.350					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	259	78.5		0.327					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	265	78.9		0.536					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	277	78.9		0.563					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	309	78.9		0.426					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	286	78.9		0.673					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	295	78.9		0.375					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	261	80.3		0.238					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	305	80.4		0.271					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	290	80.5		0.256					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	265	81.1		1.140					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	275	81.3		0.237					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	281	82.3		0.515					
1999	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	233	82.6		0.204					
1999	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	381	82.8		1.370					
1999	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem		Sacramento Sucker	fillet	Composite		5	318	79.6	1.37	0.098	19.0	15.0	2.44	18.2	<2
1999	American R. at Discovery Park	ARDPK	Major Tributary		Largemouth Bass	fillet	Composite		5	340	78.5	0.7	0.850	22.7	23.0	2.86	18.3	<2
1999	American R. at Discovery Park	ARDPK	Major Tributary		Sacramento Sucker	fillet	Composite		5	314	79.6	1.0	0.247	9.7	ND	1.10	7.6	<2
1999	American R. at J Street	ARJST	Major Tributary		Pike Minnow	fillet	Composite		5	248	78.4	1.0	0.426	16.2	18.0	2.48	16.3	<2
1999	American R. at J Street	ARJST	Major Tributary		Sacramento Sucker	fillet	Composite		5	266	77.5	1.1	0.099	2.5	ND	ND	2.9	<2
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Pike Minnow	fillet	Composite		5	287	80.5	0.7	1.200	19.0	20.0	ND	33.3	<2
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Composite		5		76.7	0.9		7.4	ND	ND	13.3	<2
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Striped Bass	fillet	Individual		1	626	76.3		1.280					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Striped Bass	fillet	Individual		1	645	76.5		0.320					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	339	76.7		2.080					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	361	77.7		1.520					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	321	77.8		0.667					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	495	77.8		2.350					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	305	77.9		0.649					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	497	77.9		0.745					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	314	77.9		0.633					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	310	78.0		0.555					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	310	78.0		0.667					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	322	78.1		0.787					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	456	78.1		1.510					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Striped Bass	fillet	Individual		1	817	78.5		3.500					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	350	78.9		1.030					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		Bluegill	fillet	Composite		5	184	79.7		0.121					
1999	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	491	79.8		0.620					
1999	Clear Ck @ Hwy 273	CCHWY	Tributary		Riffle sculpin	fillet	Composite				79.3	1.13	0.241	2.7	ND	<RL	2.2	<2
1999	Clear Ck @ Reading Bar	CCRBR	Tributary		Riffle sculpin	fillet	Composite				80.0	0.83	0.160	<RL	ND	ND	<RL	<2
1999	Clear Ck @ Reading Bar	CCRBR	Tributary		Rainbow Trout	fillet	Composite				80.5	1.13	0.046	<RL	ND	ND	<RL	<2
1999	Clear Ck @ Reading Bar	CCRBR	Tributary		Riffle sculpin	liver	Composite				80.0	0.83	0.088					
1999	Clear Ck @ Reading Bar	CCRBR	Tributary		Rainbow Trout	liver	Composite				80.5	1.13	<.020					
1999	Clear Ck above Whiskeytown	CCWHI	Tributary		Rainbow Trout	fillet	Composite				78.1	1.96	0.050	0.9	ND	ND	<RL	<2
1999	Clear Ck above Whiskeytown	CCWHI	Tributary		Riffle sculpin	fillet	Composite				79.1	1.12	**0.107**	<RL	ND	ND	<RL	<2
1999	Clear Ck above Whiskeytown	CCWHI	Tributary		Rainbow Trout	liver	Composite				78.1	1.96	0.050					
1999	Clear Ck above Whiskeytown	CCWHI	Tributary		Riffle sculpin	fillet	Composite				79.1	1.12	**0.096**					
1999	Clear Ck above Whiskeytown	CCWHI	Tributary		Riffle sculpin	liver	Composite				79.1	1.12	0.213					
1999	Big Chico Ck @ Hwy 32	CHHWY	Tributary		Rainbow Trout	fillet	Composite				76.8	3.17	**0.041**	0.8	ND	ND	2.5	<2
1999	Big Chico Ck @ Hwy 32	CHHWY	Tributary		Rainbow Trout	fillet	Composite				76.8	3.17	**0.044**	0.8	ND	ND	2.5	<2
1999	Big Chico Ck @ Hwy 32	CHHWY	Tributary		Rainbow Trout	liver	Composite				76.8	3.17	0.037					
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary		Smallmouth bass	fillet	Composite				77.8	0.99	0.231	<RL	ND	<RL	<RL	<2
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary		Smallmouth bass	fillet	Composite				77.8	0.98		0.4	ND	ND	<RL	<2
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary		Riffle sculpin	fillet	Composite				79.6	0.61	0.146	<RL	ND	<RL	<RL	<2
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary		Smallmouth bass	liver	Composite				77.8	0.99	0.124					
1999	Big Chico Ck @ Hwy 99	CHSYC	Tributary		Riffle sculpin	liver	Composite				79.6	0.61	0.182					
1999	Deer Ck @ Hwy 99	DCHWY	Tributary		Riffle sculpin	fillet	Composite				77.2	2.84	0.082	0.4	ND	<RL	<RL	<2
1999	Deer Ck @ Hwy 99	DCHWY	Tributary		Smallmouth bass	fillet	Composite				79.2	0.93	0.075	<RL	ND	ND	<RL	<2
1999	Deer Ck @ Hwy 99	DCHWY	Tributary		Riffle sculpin	liver	Composite				77.2	2.84	0.043					
1999	Deer Ck @ Hwy 99	DCHWY	Tributary		Smallmouth bass	liver	Composite				79.2	0.93	0.044					
1999	Deer Ck below Childs Meadow	DCMDW	Tributary		Rainbow Trout	fillet	Composite				76.8	3.28	<.020	8.8	ND	<RL	4.9	<2

YEAR	STATION LOCATION	Site ID	Site Category	Species Code	Species	Tissue	Sample Type	Species Code	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
1999	Deer Ck below Childs Meadow	DCMDW	Tributary		Rainbow Trout	fillet	Composite				76.9	2.42		7.2	ND	<RL	4.0	<2
1999	Deer Ck below Childs Meadow	DCMDW	Tributary		Riffle sculpin	fillet	Composite				77.9	2.11	0.034	0.2	ND	ND	<RL	<2
1999	Deer Ck below Childs Meadow	DCMDW	Tributary		Rainbow Trout	liver	Composite				76.8	3.28	<.020					
1999	Deer Ck below Childs Meadow	DCMDW	Tributary		Riffle sculpin	liver	Composite				77.9	2.11	<.020					
1999	Mill Ck at Black Rock	MCBLK	Tributary		Riffle sculpin	fillet	Composite				79.1	0.73	0.327	<RL	ND	ND	<RL	<2
1999	Mill Ck at Black Rock	MCBLK	Tributary		Riffle sculpin	liver	Composite				79.1	0.73	0.353					
1999	Mill Ck at Hwy 99	MCHWY	Tributary		Riffle sculpin	fillet	Composite				79.7	1.01	0.279	0.2	ND	ND	<RL	<2
1999	Mill Ck at Hwy 99	MCHWY	Tributary		Riffle sculpin	liver	Composite				79.7	1.01	0.288					
1999	Putah Creek	PUTAH	Tributary		Sacramento Sucker	fillet	Composite		4	383	76.3	3.3	0.185	20.7	19.0	1.68	95.7	<2
1999	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Composite		5		77.9	0.6		3.9	ND	ND	13.2	<2
1999	Putah Creek	PUTAH	Tributary		White Catfish	fillet	Individual		1	470	73.3		0.146					
1999	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	425	76.0		0.592					
1999	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	354	76.7		0.396					
1999	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	410	77.0		0.540					
1999	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	345	77.1		0.231					
1999	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	402	78.6		0.630					
1999	Putah Creek	PUTAH	Tributary		Bluegill	fillet	Composite		5	112	78.9		0.097					
1999	Putah Creek	PUTAH	Tributary		Bluegill	fillet	Composite		5	135	79.5		0.123					
2000	Colusa Basin Drain	COLDR	Ag Drain		White Catfish	fillet	Composite		5	259.4	81.0	0.80	0.21	1.5	ND	ND	40.2	<RL
2000	Colusa Basin Drain	COLDR	Ag Drain		Carp	fillet	Composite		5	371.6	78.3	1.25	0.18	3.6	ND	ND	284.8	3.88
2000	Natomas East Main Drain	NEMDR	Ag Drain		Largemouth Bass	fillet	Composite		5	350.4	76.8	0.74	0.65	23.4	32.0	1.82	17.2	<RL
2000	Natomas East Main Drain	NEMDR	Ag Drain		White Catfish	fillet	Composite		4	275.75	78.8	2.00	0.21	37.0	45.0	2.66	37.9	<RL
2000	Natomas East Main Drain	NEMDR	Ag Drain		Striped Bass	fillet	Individual		1	494	72.0		0.81					
2000	Sacramento Slough	SACSL	Ag Drain		White Catfish	fillet	Composite		5	261.6	80.7	1.89	0.44	26.6	28.0	1.77	64.5	2.55
2000	Sacramento Slough	SACSL	Ag Drain		Largemouth Bass	fillet	Composite		5	355	78.6	0.60	0.49	4.3	ND	ND	30.8	<RL
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Composite		10	288.2	79.7	1.06	0.443096	9.7	13.0	1.21	54.7	<RL
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Composite		6	361.8	78.7	0.76	0.50	5.5	ND	ND	31.2	<RL
2000	Cache Slough	CCHSL	Delta		Sacramento Sucker	fillet	Composite		5	393.6	78.5		0.11					
2000	Cache Slough	CCHSL	Delta		Crappie	fillet	Composite		5	231.2	77.0		0.32					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	400	78.6		1.14					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	276	82.6		0.21					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	319	78.6		0.82					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	254	81.3		0.14					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	258	80.5		0.43					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	259	80.7		0.53					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	275	78.3		0.52					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	290	82.3		0.49					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	323	79.3		0.48					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	325	78.6		0.62					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	328	79.5		0.37					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	305	79.9		0.45					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	265	80.1		0.40					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	228	80.1		0.25					
2000	Cache Slough	CCHSL	Delta		White Catfish	fillet	Individual		1	385	83.8		1.00					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	560	76.2		1.27					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	348	77.3		0.31					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	340	77.5		0.53					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	382	77.8		0.48					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	348	78.3		0.49					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	365	76.2		0.59					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	388	77.5		0.60					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	270	79.5		0.39					
2000	Cache Slough	CCHSL	Delta		Largemouth Bass	fillet	Individual		1	290	80.1		0.31					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Composite		6	368.7	77.5	1.12	0.99	13.2	15.0	ND	16.8	<RL
2000	Sacramento R. at Mile 44	SRRMF	Delta		Sacramento Sucker	fillet	Composite		5	452.2	76.1	3.83	0.22	24.3	43.0	2.00	57.4	<RL
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Composite		7	287.86	79.6	1.46	0.386827	37.8	61.0	1.97	39.2	<RL
2000	Sacramento R. at Mile 44	SRRMF	Delta		Pike Minnow	fillet	Composite		5	252.2	81.7	0.96	0.11	5.0	ND	ND	9.7	<RL
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	327	75.9		0.92					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	345	75.9		0.89					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	350	74.1		0.86					

YEAR	STATION LOCATION	Site ID	Site Category	Species Code	Species	Tissue	Sample Type	Species Code	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	359	75.1		0.86					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Composite											
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	343	74.4		0.70					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	392	74.8		1.08					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	386	74.2		1.26					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	376	73.5		1.06					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	359	76.0		1.11					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	356	74.0		0.74					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Striped Bass	fillet	Individual		1	450	74.8		0.34					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	286	75.9		0.45					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	281	78.1		0.44					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	227	77.7		0.18					
2000	Sacramento R. at Mile 44	SRRMF	Delta		Largemouth Bass	fillet	Individual		1	247	76.6		0.34					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	317	80.6		0.56					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	314	81.3		1.04					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	259	77.3		0.18					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	296	72.0		0.29					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	294	79.2		0.25					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	270	79.0		0.16					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	265	77.1		0.24					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	227	76.2		0.22					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	207	75.9		0.24					
2000	Sacramento R. at Mile 44	SRRMF	Delta		White Catfish	fillet	Individual		1	345	79.4		0.72					
2000	Sacramento R. above Bend Bridge	SRABB	Lower Sac. R. Mainstem		Sacramento Sucker	fillet	Composite		5	457	75.3	7.04	0.10	10.6	10.0	ND	5.9	<RL
2000	Sacramento R. above Bend Bridge	SRABB	Lower Sac. R. Mainstem		Rainbow Trout	fillet	Composite		5	350	77.3	1.79	0.04	6.1	ND	ND	3.6	ND
2000	Sacramento R. below Keswick	SRBKR	Lower Sac. R. Mainstem		Rainbow Trout	fillet	Composite		4	422	73.9	5.32	0.04	11.3	11.0	ND	7.4	<RL
2000	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem		Pike Minnow	fillet	Composite		5	275.2	78.7	1.36	0.15	10.8	14.0	ND	19.0	<RL
2000	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem		Striped Bass	fillet	Individual		1	451	76.9	0.80	0.30	23.8	34.0	1.48	45.4	<RL
2000	Sacramento R. at Colusa	SRCOL	Lower Sac. R. Mainstem		Sacramento Sucker	fillet	Composite		5	290.4	79.7	0.86	0.06	3.8	ND	ND	7.5	ND
2000	Sacramento R. near Hamilton City	SRHAM	Lower Sac. R. Mainstem		Pike Minnow	fillet	Composite		5	298.2	79.0	1.05	0.29	9.1	12.0	ND	12.1	ND
2000	Sacramento R. near Hamilton City	SRHAM	Lower Sac. R. Mainstem		Sacramento Sucker	fillet	Composite		5	316.2	79.2	1.61	<.0314	0.6	ND	ND	ND	ND
2000	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem		Pike Minnow	fillet	Composite		4	266	80.3	0.63	0.25	25.5	22.0	1.07	34.2	<RL
2000	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem		White Catfish	fillet	Composite		5	263.6	78.4	3.04	0.21	40.5	49.0	2.40	77.0	<RL
2000	Sacramento R. at Veterans Br	SRVET	Lower Sac. R. Mainstem		Largemouth Bass	fillet	Composite		5	371.2	77.9	0.78	0.96	4.2	ND	ND	11.9	<RL
2000	American R. at Discovery Park	ARDPK	Major Tributary		Pike Minnow	fillet	Composite		5	277.8	78.1	1.94	0.42	27.4	27.0	6.38	35.0	<RL
2000	American R. at Discovery Park	ARDPK	Major Tributary		White Catfish	fillet	Composite		5	261.8	78.7	1.96	0.26	41.4	44.0	3.00	54.0	<RL
2000	American R. at Discovery Park	ARDPK	Major Tributary		Largemouth Bass	fillet	Composite		5	393.4	78.3	0.86	1.37	29.8	47.0	2.71	17.1	<RL
2000	American R. at Discovery Park	ARDPK	Major Tributary		Largemouth Bass	fillet	Individual		1	471	77.1		1.38					
2000	American R. at Discovery Park	ARDPK	Major Tributary		Redear Sunfish	fillet	Composite		5	192.8	77.0		0.30					
2000	American R. at J Street	ARJST	Major Tributary		Sacramento Sucker	fillet	Composite		5	249	79.6	1.32	0.08	7.6	10.0	ND	6.4	<RL
2000	American R. at J Street	ARJST	Major Tributary		Pike Minnow	fillet	Composite		5	264.6	77.6	2.85	0.54	32.3	33.0	7.71	36.6	<RL
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Pike Minnow	fillet	Composite		5	300.8	79.8	0.74	0.57	9.1	12.0	ND	16.9	<RL
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Composite		6	312.83	78.3	0.54	0.606581	5.7	ND	ND	6.5	ND
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Striped Bass	fillet	Individual		1	441	72.8		1.65					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	305	78.2		0.63					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	305	76.7		0.40					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	311	77.8		0.70					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	306	76.5		0.54					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	311	77.3		0.82					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	339	77.4		0.56					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Redear Sunfish	fillet	Composite		5	153.6	76.8		0.22					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Channel Catfish	fillet	Composite		5	478.6	72.2		0.73					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	272	80.5		0.39					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	269	79.4		0.85					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	545	69.2		0.55					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	305	75.6		0.47					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	334	75.8		0.79					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	362	76.9		1.00					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	236	77.7		0.21					

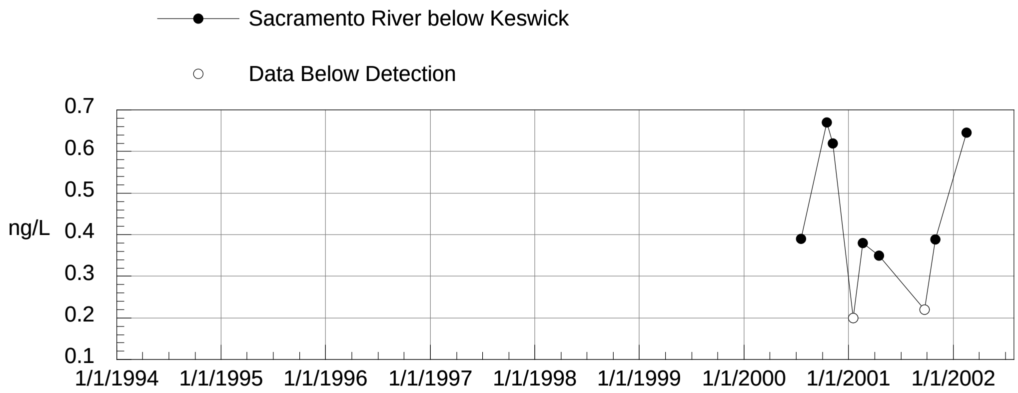
YEAR	STATION LOCATION	Site ID	Site Category	Species Code	Species	Tissue	Sample Type	Species Code	Number of fish	Length (mm)	% Moisture	% Lipid	Mercury, mg/kg	Sum of PCB Congeners, µg/kg	Sum of Aroclors, µg/kg	Sum of Chlordanes, µg/kg	Sum of DDTs, µg/kg	Dieldrin, µg/kg
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	233	78.6		0.27					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Striped Bass	fillet	Individual		1	556	75.2		1.22					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	492	69.6		0.55					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	670	73.2		1.25					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	334	74.9		0.55					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	321	75.8		0.42					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	302	78.2		0.67					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	355	75.9		0.86					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		Largemouth Bass	fillet	Individual		1	255	76.2		0.46					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	205	85.8		0.45					
2000	Feather R. near Nicolaus	FRNIC	Major Tributary		White Catfish	fillet	Individual		1	278	79.9		1.21					
2000	Clear Creek at Mouth	CCMOU	Tributary		Rainbow Trout	fillet	Composite		5	358.8	77.8	1.34	0.05	8.4	11.0	ND	5.3	ND
2000	Clear Creek at Mouth	CCMOU	Tributary		Largemouth Bass	fillet	Composite		5	376.4	80.0	0.50	0.45	4.0	ND	ND	ND	ND
2000	Big Chico Ck near mouth	CHMOU	Tributary		Pike Minnow	fillet	Composite		5	288.2	79.9	0.74	0.48	5.1	ND	1.11	10.4	ND
2000	Big Chico Ck near mouth	CHMOU	Tributary		Largemouth Bass	fillet	Composite		5	358.8	76.0	1.19	0.33	2.5	ND	ND	11.0	<RL
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Composite		8	348	77.8	0.50	0.45	6.2	ND	ND	13.6	<RL
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	324	77.8		0.26					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	376	78.2		0.45					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	384	77.7		0.57					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	409	77.3		0.82					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	390	77.4		0.64					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	306	77.8		0.28					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	210	77.3		0.10					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	385	74.3		0.50					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	319	78.9		0.34					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	342	78.5		0.34					
2000	Putah Creek	PUTAH	Tributary		Largemouth Bass	fillet	Individual		1	326	78.7		0.22					
2000	Putah Creek	PUTAH	Tributary		Bluegill	fillet	Composite		5	157a	79.8		0.16					
2000	Putah Creek	PUTAH	Tributary		Bluegill	fillet	Composite		5	147a	80.1		0.07					
2000	Putah Creek	PUTAH	Tributary		Bluegill	fillet	Composite		5	150a	78.2		0.16					
2000	Putah Creek	PUTAH	Tributary		Bluegill	fillet	Composite		5	148a	79.1		0.10					
2000	Upper Putah Creek	PUTAU	Tributary		Brown Trout	fillet	Composite		5	300.8	77.9	1.59	0.06	4.6	ND	ND	4.6	<RL
2000	Sacramento R. above Shasta	SRASH	Tributary		Rainbow Trout	fillet	Composite		5	318	81.1	0.47	0.06	3.5	ND	ND	ND	ND
2001	Sacramento R. at Mile 44	SRRMF	Delta		Splittail	fillet	Composite		4	387.5	78		0.37					
2001	Sacramento R. at Mile 44	SRRMF	Delta		Pike Minnow	fillet	Composite		5	270.8	79	2.12	0.18	13.4	12.0	ND	24.7	<RL
2001	Sacramento R. at Mile 44	SRRMF	Delta		Smallmouth Bass	fillet	Composite		5	338.2	78	0.67	0.57	6.6	ND	ND	7.0	2.82
2001	Colusa Basin Drain	COLDR	Ag Drain		Carp	fillet	Composite		5	398	79	0.87	0.17	5.8	ND	1.09	149.3	2.14
2001	Colusa Basin Drain	COLDR	Ag Drain		Channel Catfish	fillet	Composite					1.49		9.7	25.0	1.30	81.0	2.33
2001	Colusa Basin Drain	COLDR	Ag Drain		Crappie	fillet	Composite		5	240.8	79		0.08					
2001	American River at Sunrise	ARSNR	Major Tributary		Sacramento Sucker	fillet	Composite		5	462	76	6.20	0.20	63.1	92.0	3.62	68.1	<RL
2001	American R. at Discovery Park	ARDPK	Major Tributary		Redear Sunfish	fillet	Composite		5	169.4	78		0.08					
2001	American R. at Discovery Park	ARDPK	Major Tributary		Sacramento Sucker	fillet	Composite		5	489.4	78	3.28	0.35	62.7	102.0	17.89	43.3	<RL
2001	Sacramento R. below Keswick	SRBKR	Lower Sac. R. Mainstem		Rainbow Trout	fillet	Composite		5	321.2	76	3.03	<.007	9.8	ND	ND	3.3	<RL
2001	Feather River above Bear River	FRABR	Major Tributary		Redear Sunfish	fillet	Composite		5	159.2	77		0.10					
2001	Feather River above Bear River	FRABR	Major Tributary		Sacramento Sucker	fillet	Composite		5	496.6	77	3.50	0.27	25.3	31.0	ND	29.4	<RL
2001	Feather R. near Nicolaus	FRNIC	Major Tributary		Sacramento Sucker	fillet	Composite		5	469	79	2.22	0.28	12.3	12.0	ND	18.4	<RL
2001	Feather R. near Nicolaus	FRNIC	Major Tributary		Pike Minnow	fillet	Individual		1	500	71		0.64					

"<" indicates concentration not detected above specific reporting limit (for mercury and dieldrin)
"J" indicates the analyte was positively identified and the associated value is an estimated concentration
"ND" indicates "Not Detected"
"UJ" indicates that the analyte was not detected above the reported quantitation limit
<RL indicates not detected above reporting limits for individual compounds or congeners (for PCBs, aroclors, chlordanes, DDTs)
All tissue concentration data are provided on a "Wet Weight" basis
Blanks indicate data not reported or analyzed
Table Notes

APPENDIX B

Time Series Plots of Monitoring Data: SRWP, USGS NAWQA, Sacramento River CMP, and City of Redding

Time Series Plots of Monitoring Data: Mercury Data


Sacramento River below Keswick
Data Below Detection
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0.5
0.4
0.3
0.2
0.1
1/1/1994
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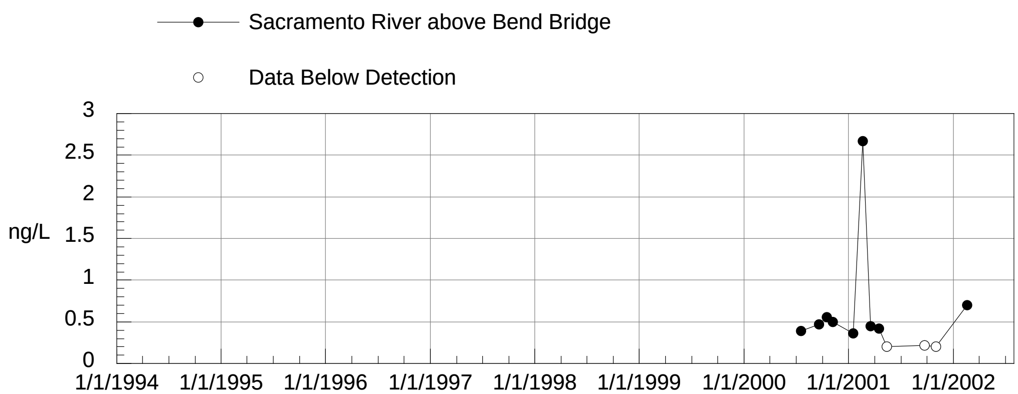
1/1/2001
1/1/2002


Sacramento River above Bend Bridge
Data Below Detection
ng/L
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2
1.5
1
0.5
0
1/1/1994
1/1/1995
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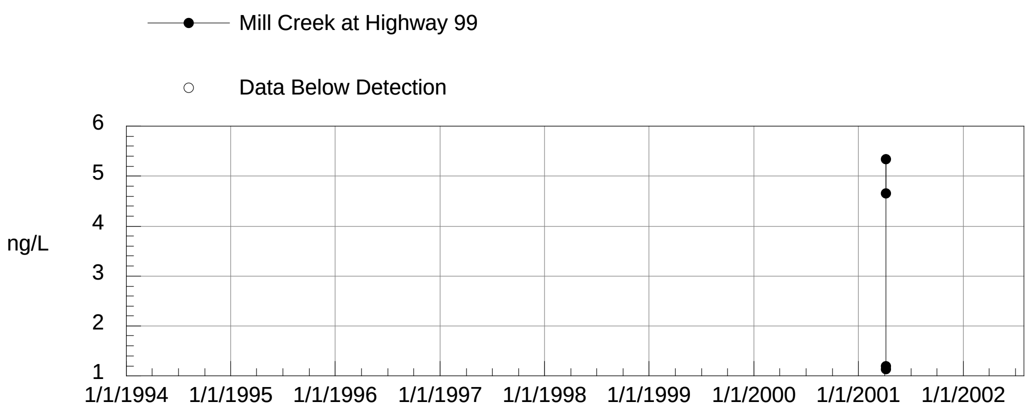
1/1/2001
1/1/2002


Mill Creek at Highway 99
Data Below Detection
ng/L
6
5
4
3
2
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1/1/1994
1/1/1995
1/1/1996
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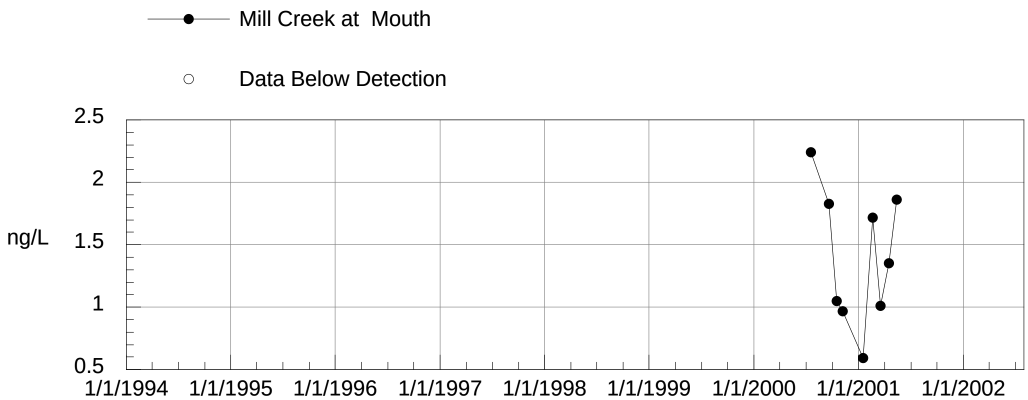
1/1/2001
1/1/2002


Mill Creek at Mouth
Data Below Detection
ng/L
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2
1.5
1
0.5
1/1/1994
1/1/1995
1/1/1996
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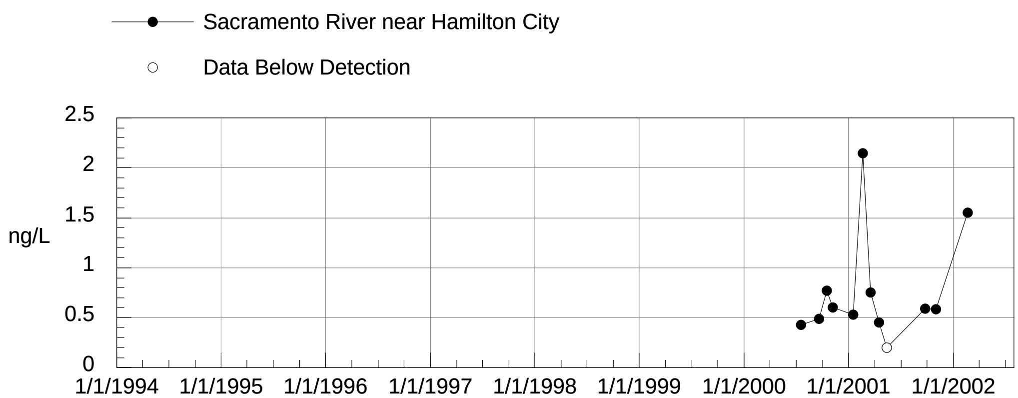
1/1/2001
1/1/2002


Sacramento River near Hamilton City
Data Below Detection
ng/L
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1.5
1
0.5
0
1/1/1994
1/1/1995
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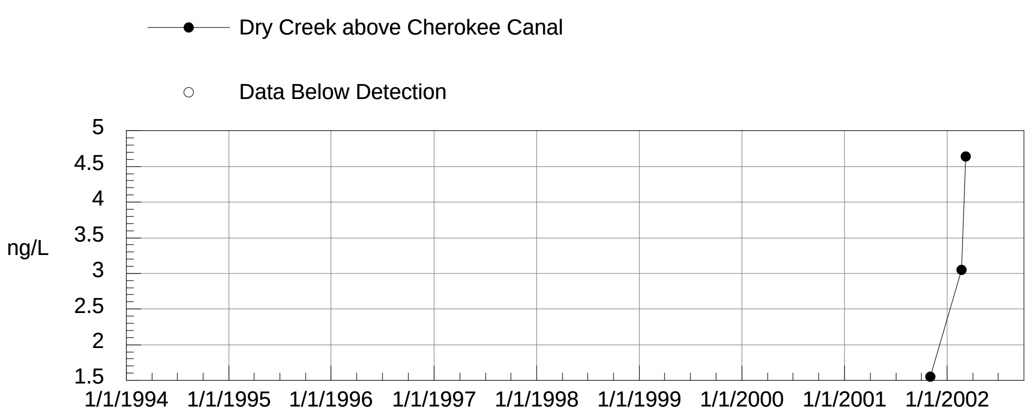
1/1/2001
1/1/2002


Dry Creek above Cherokee Canal
Data Below Detection
ng/L
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4.5
4
3.5
3
2.5
2
1.5
1/1/1994
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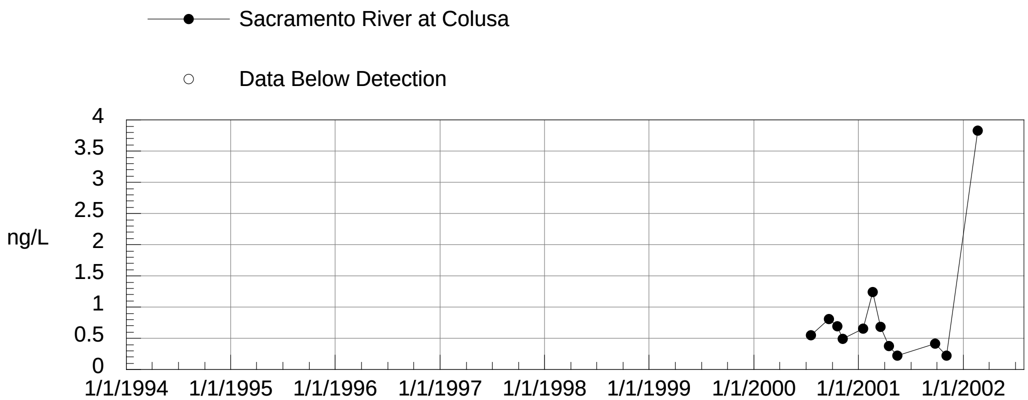
1/1/2001
1/1/2002


Sacramento River at Colusa
Data Below Detection
ng/L
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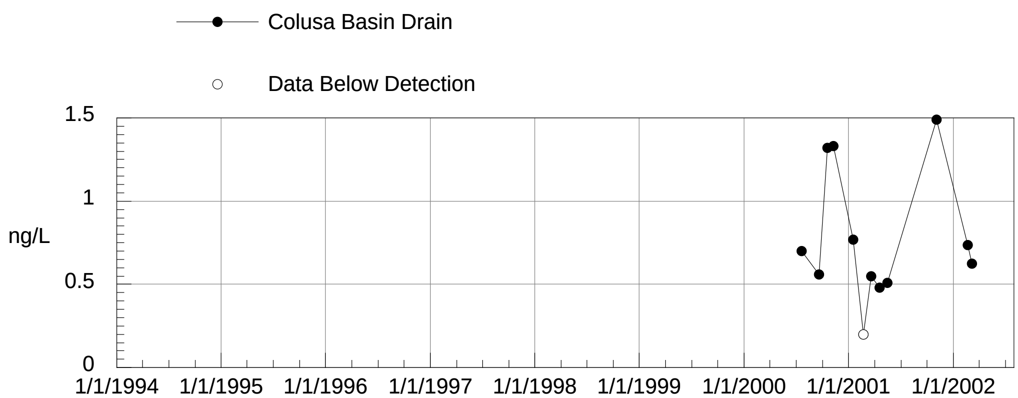
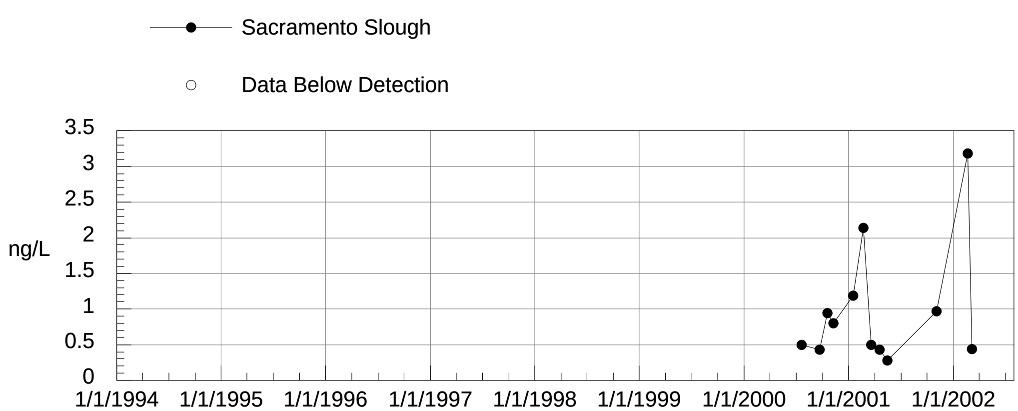
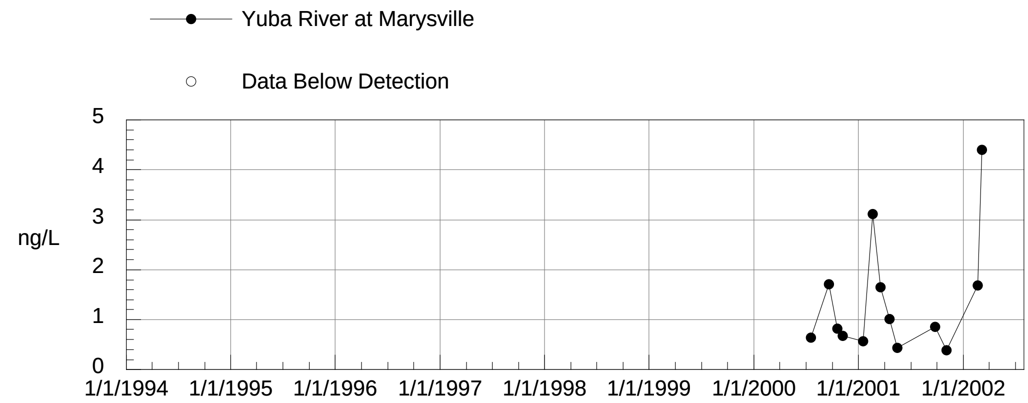
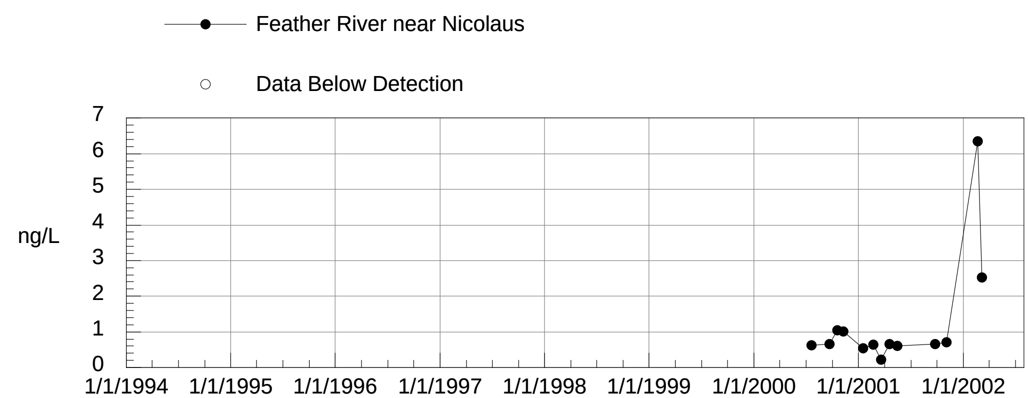
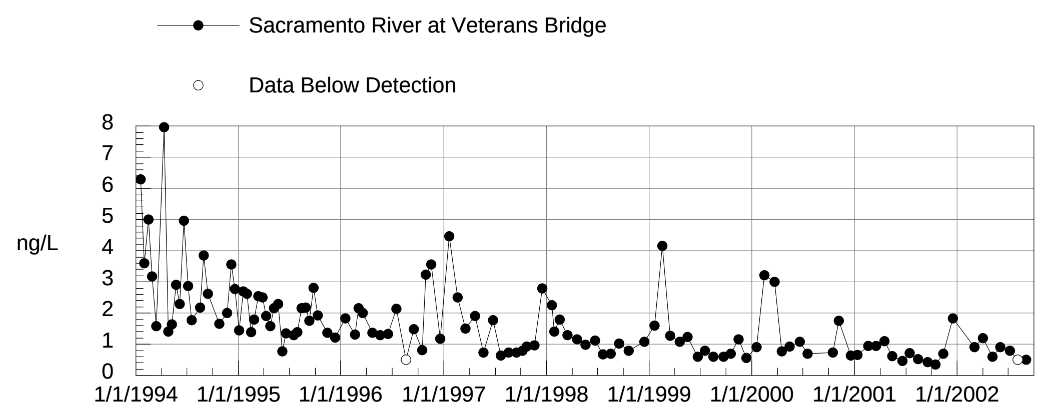
3
2.5
2
1.5
1
0.5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

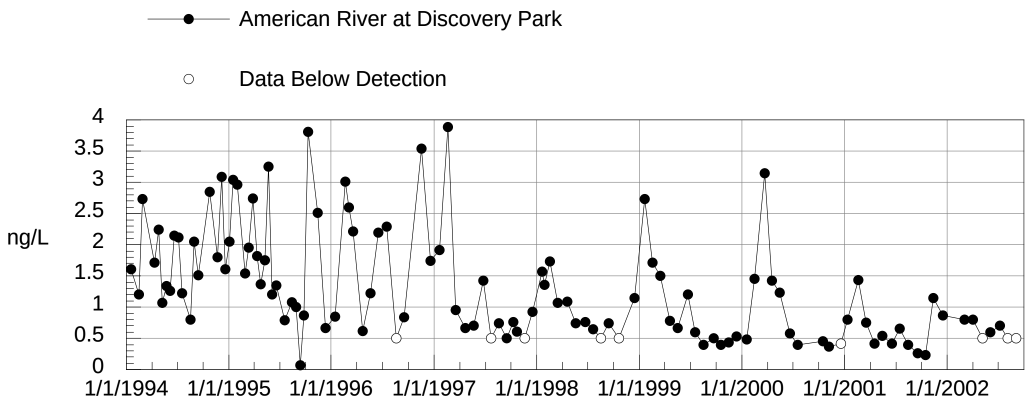

Colusa Basin Drain
Data Below Detection
ng/L
1.5
1
0.5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

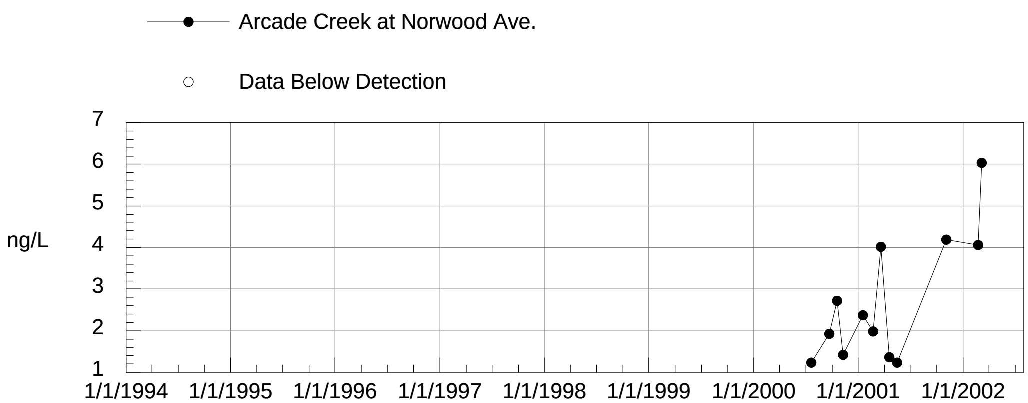

Sacramento Slough
Data Below Detection
ng/L
3.5
3
2.5
2
1.5
1
0.5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

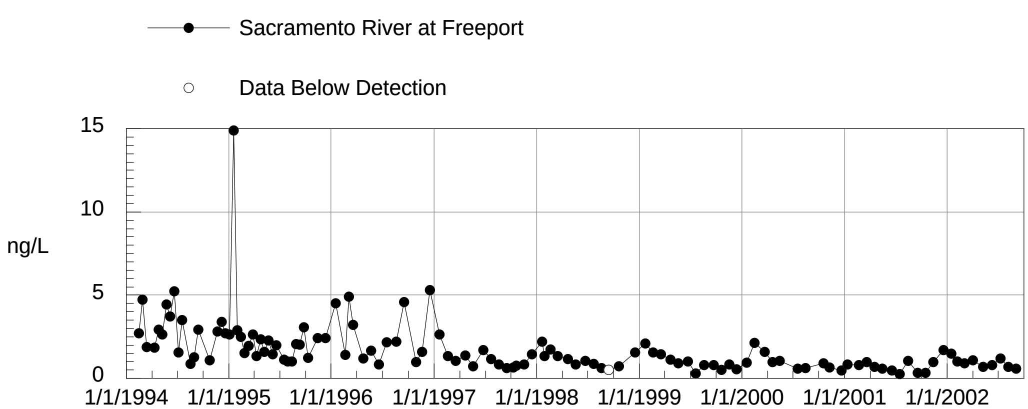

Yuba River at Marysville
Data Below Detection
ng/L
0
1
2
3
4
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

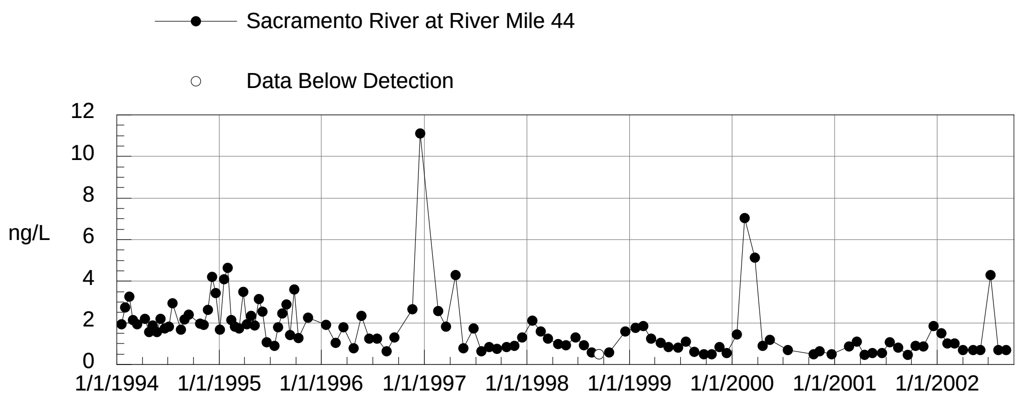

Feather River near Nicolaus
Data Below Detection
ng/L
0
1
2
3
4
5
6
7
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

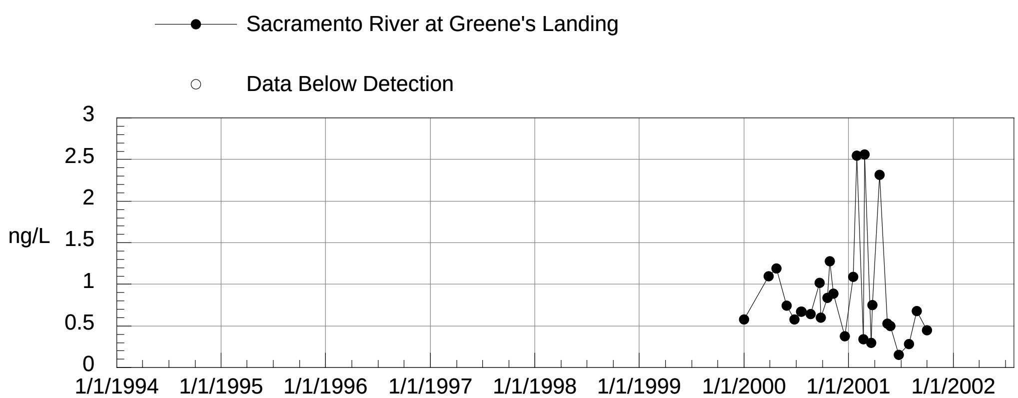

Sacramento River at Veterans Bridge
Data Below Detection
ng/L
0
1
2
3
4
5
6
7
8
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

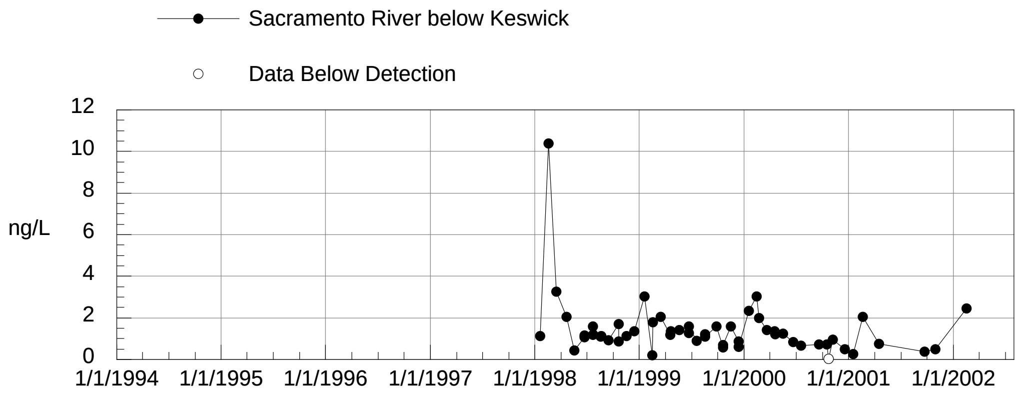

American River at Discovery Park
Data Below Detection
ng/L
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

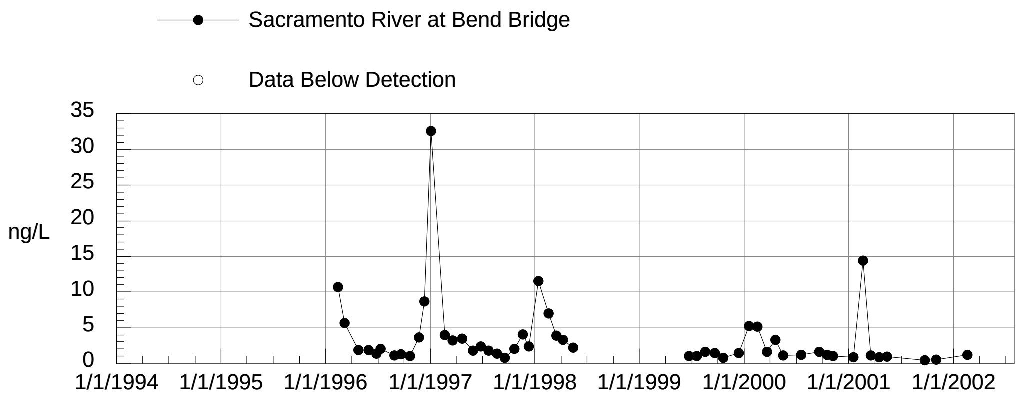

Arcade Creek at Norwood Ave.
Data Below Detection
ng/L
7
6
5
4
3
2
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

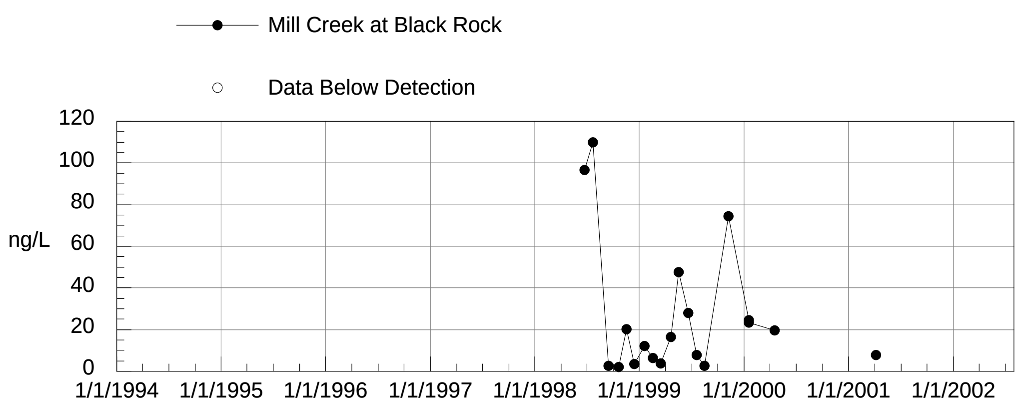

Sacramento River at Freeport
Data Below Detection
ng/L
15
10
5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at River Mile 44
Data Below Detection
ng/L
12
10
8
6
4
2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

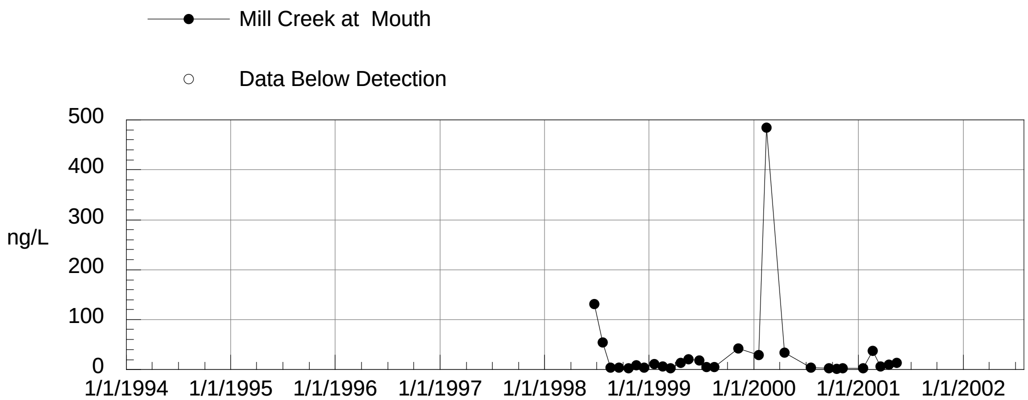

Sacramento River at Greene's Landing
Data Below Detection
ng/L
3
2.5
2
1.5
1
0.5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

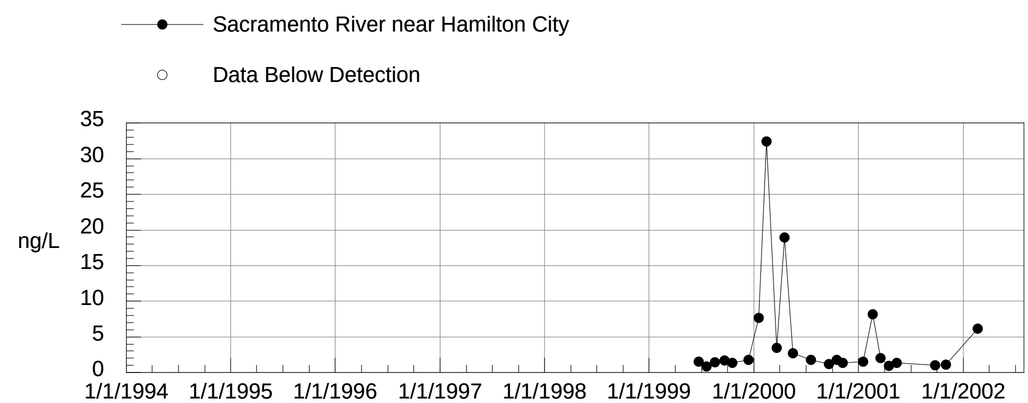

Sacramento River below Keswick
Data Below Detection
ng/L
12
10
8
6
4
2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

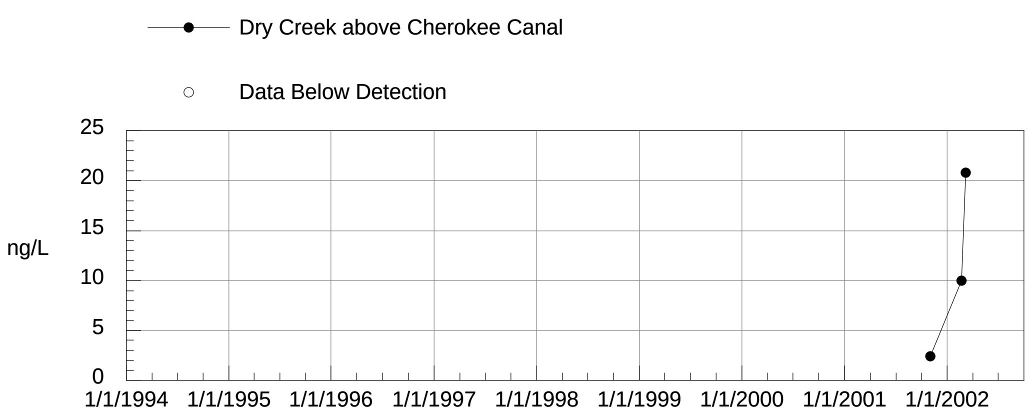

Sacramento River at Bend Bridge
Data Below Detection
ng/L
35
30
25
20
15
10
5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

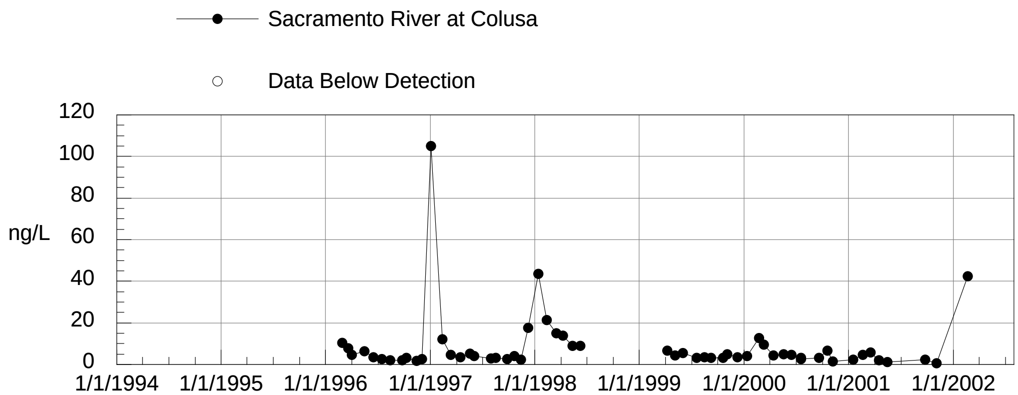

Mill Creek at Black Rock
Data Below Detection
ng/L
120
100
80
60
40
20
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

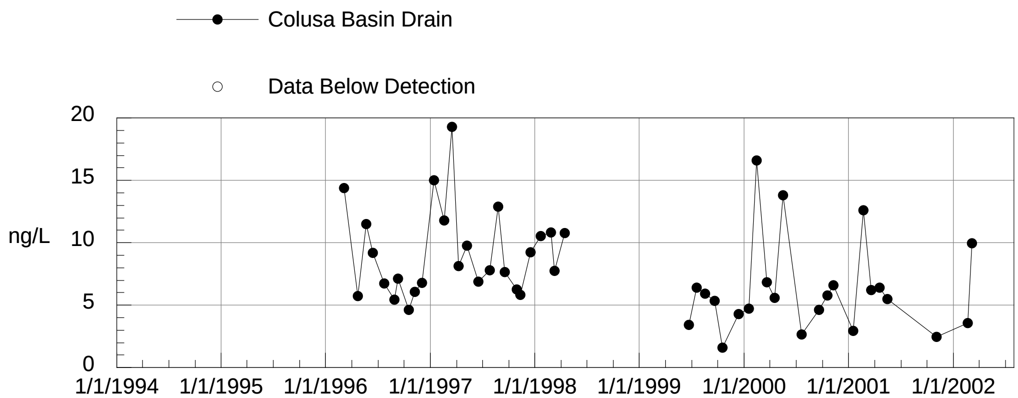
UNFILTERED MERCURY IN WATER

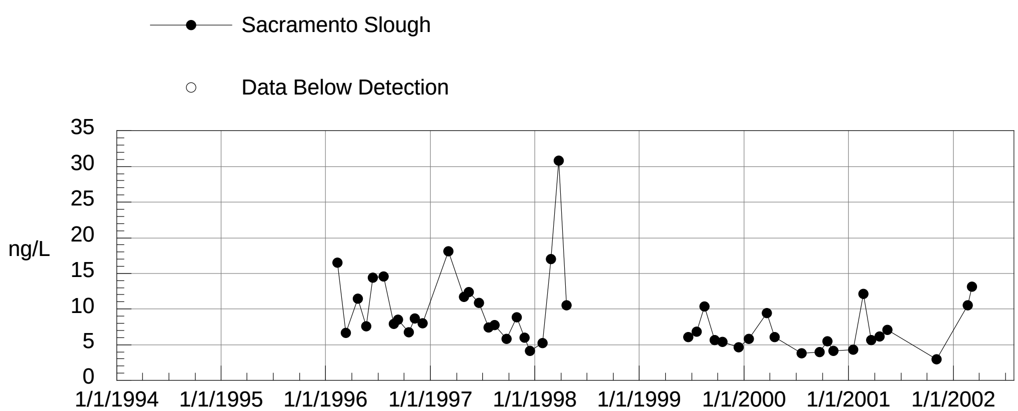


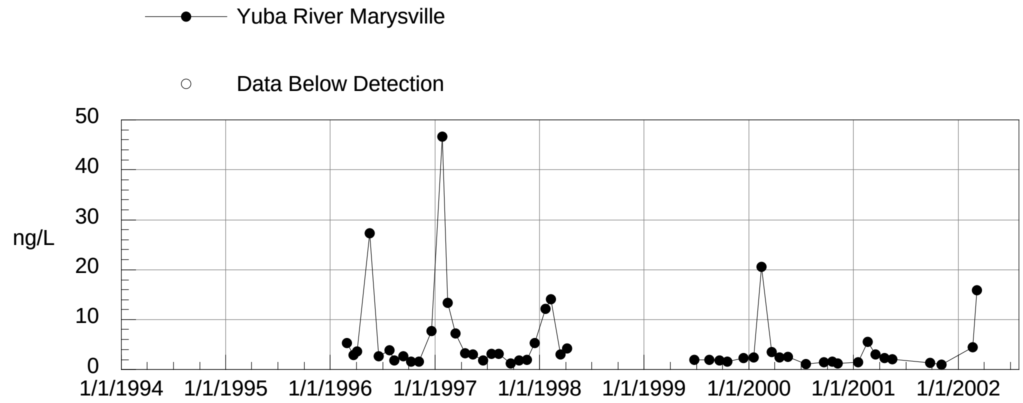


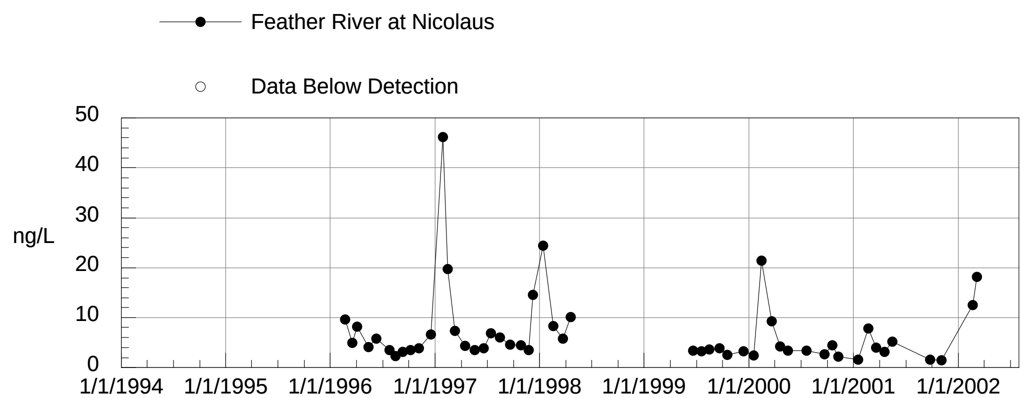


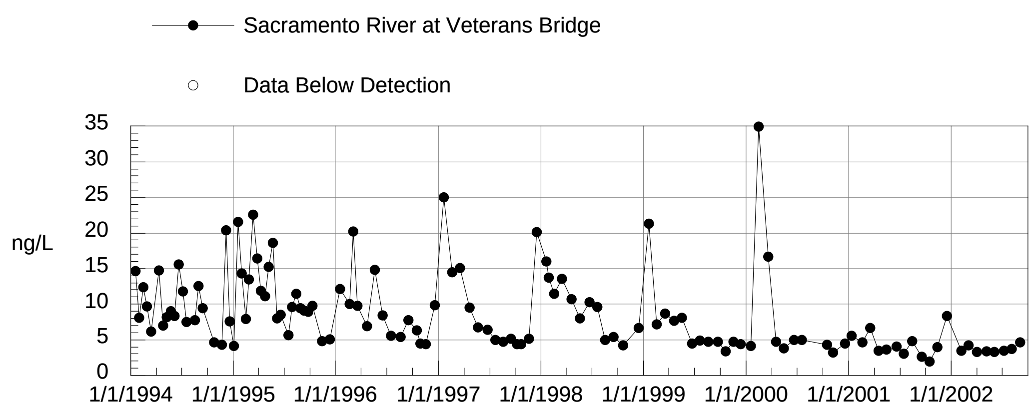

Sacramento River at Colusa
Data Below Detection
120
100
80
60
40
20
0
ng/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

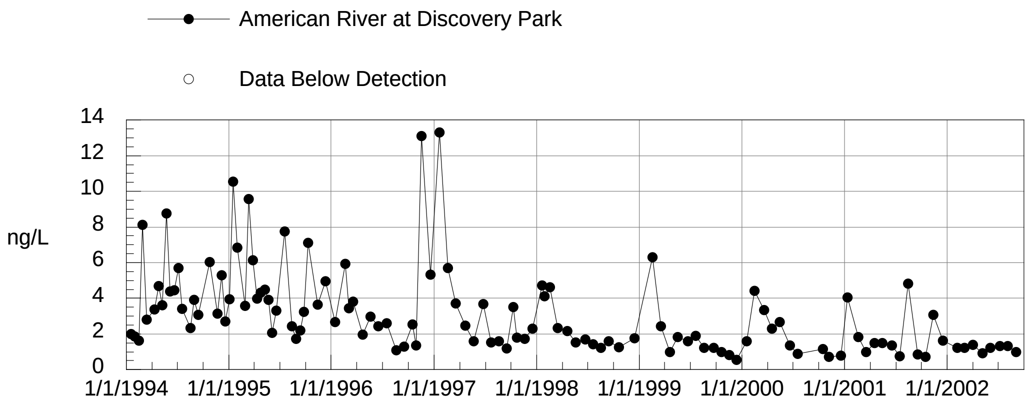

Colusa Basin Drain
Data Below Detection
20
15
10
5
0
ng/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

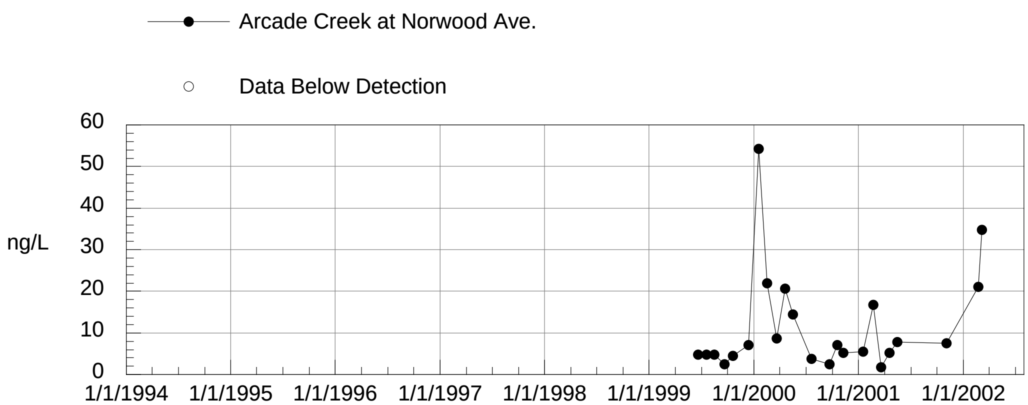

Sacramento Slough
Data Below Detection
35
30
25
20
15
10
5
0
ng/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

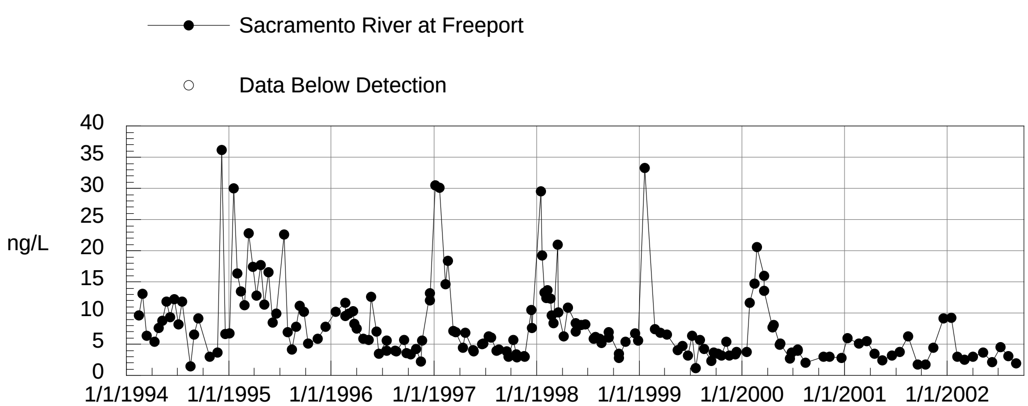

Yuba River Marysville
Data Below Detection
ng/L
50
40
30
20
10
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

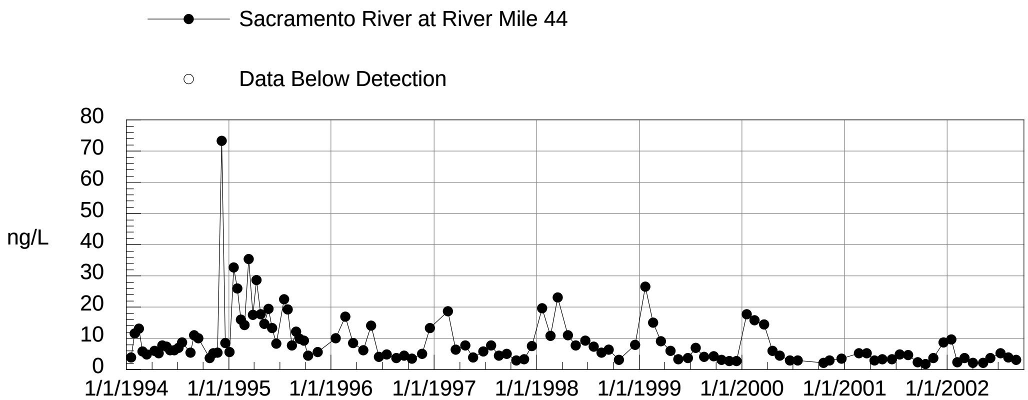

Feather River at Nicolaus
Data Below Detection
ng/L
50
40
30
20
10
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

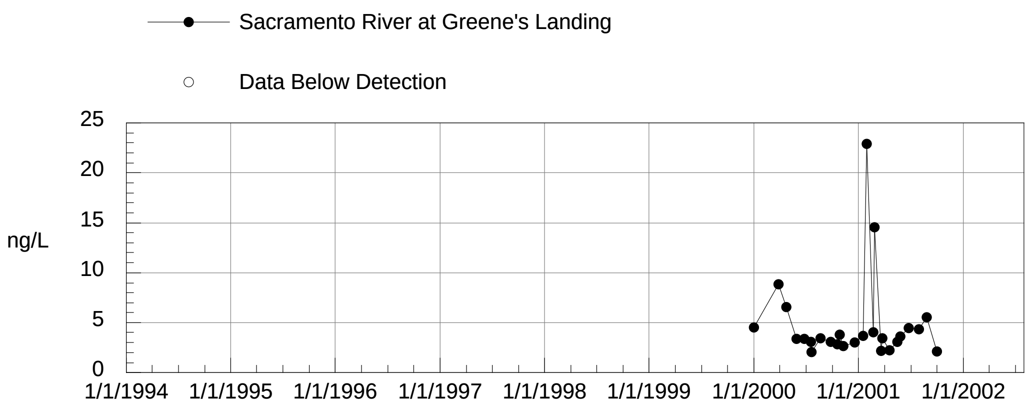

Sacramento River at Veterans Bridge
Data Below Detection
ng/L
35
30
25
20
15
10
5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

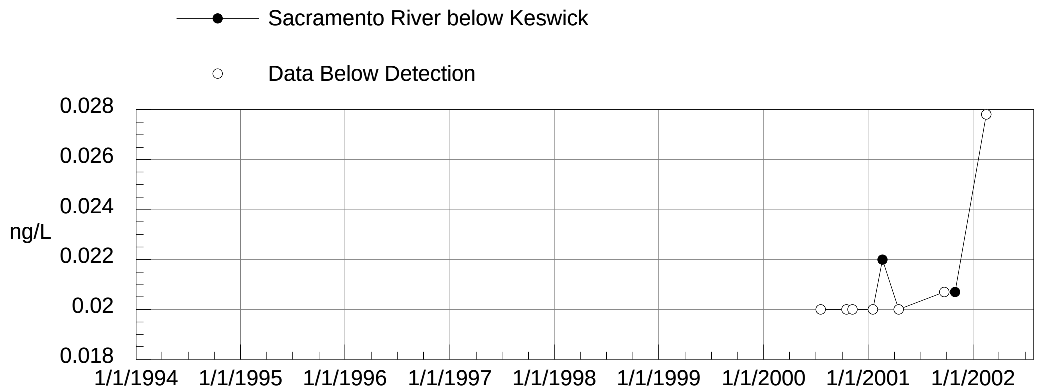

American River at Discovery Park
Data Below Detection
ng/L
14
12
10
8
6
4
2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

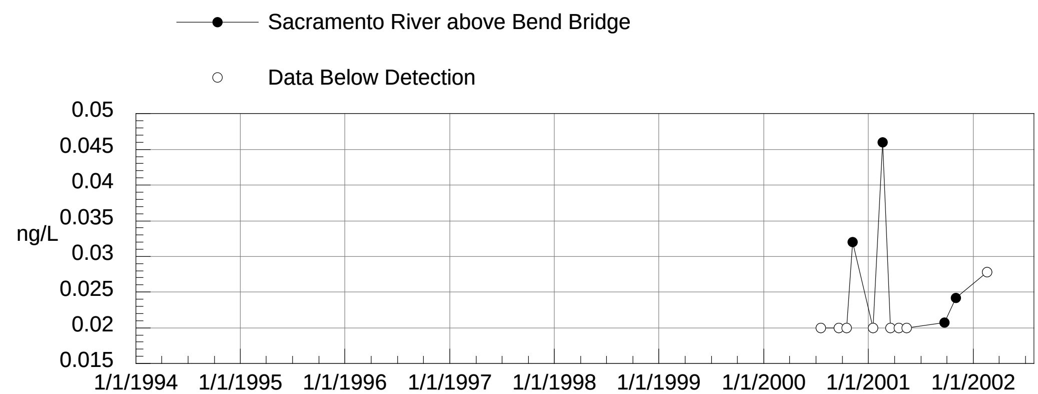

Arcade Creek at Norwood Ave.
Data Below Detection
ng/L
60
50
40
30
20
10
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

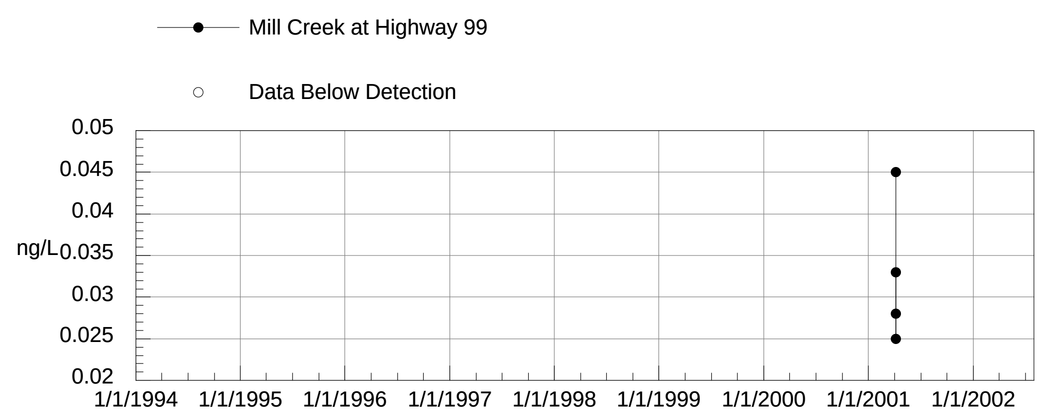

Sacramento River at Freeport
Data Below Detection
ng/L
40
35
30
25
20
15
10
5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at River Mile 44
Data Below Detection
ng/L
80
70
60
50
40
30
20
10
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

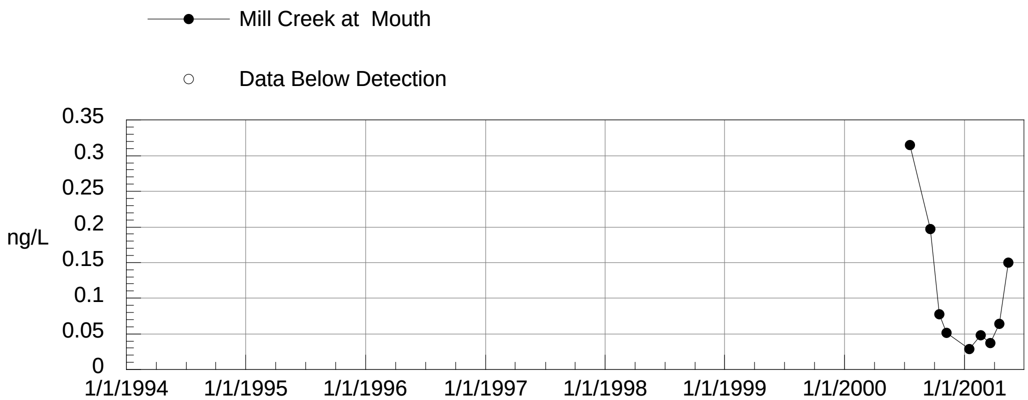

Sacramento River at Greene's Landing
Data Below Detection
ng/L
25
20
15
10
5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

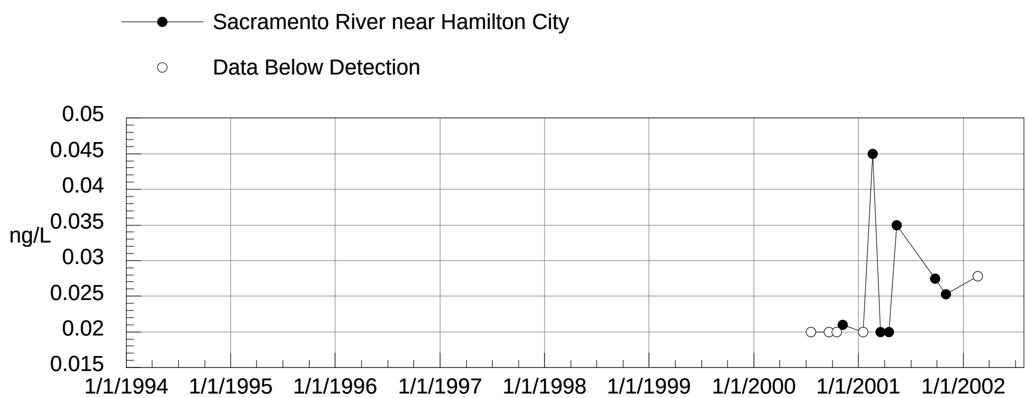

Sacramento River below Keswick
Data Below Detection
ng/L
0.028
0.026
0.024
0.022
0.02
0.018
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

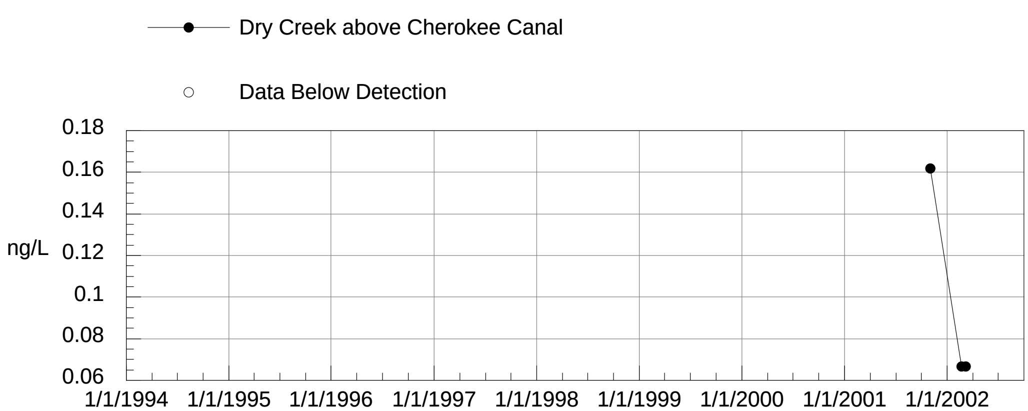

Sacramento River above Bend Bridge
Data Below Detection
ng/L
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0.015
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

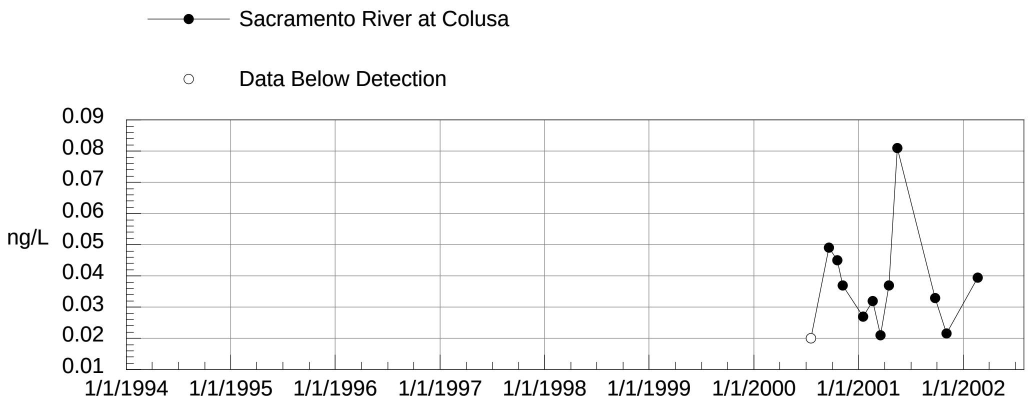

Mill Creek at Highway 99
Data Below Detection
ng/L
0.05
0.045
0.04
0.035
0.03
0.025
0.02
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

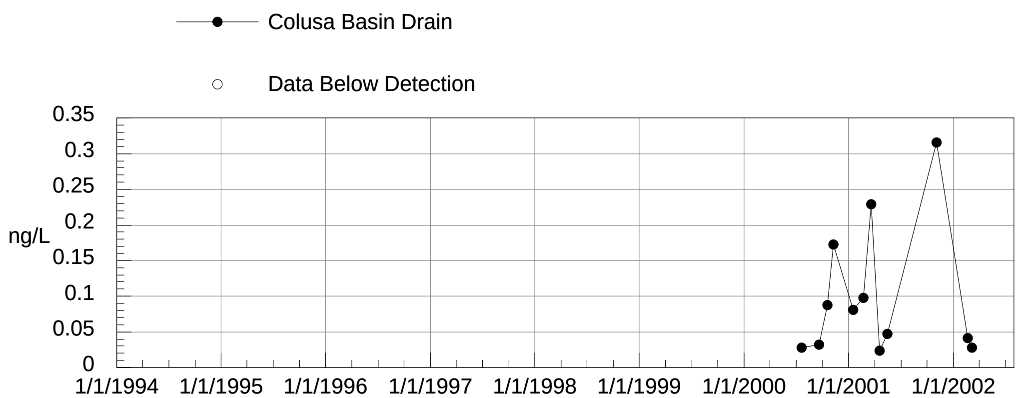
FILTERED METHYLMERCURY IN WATER

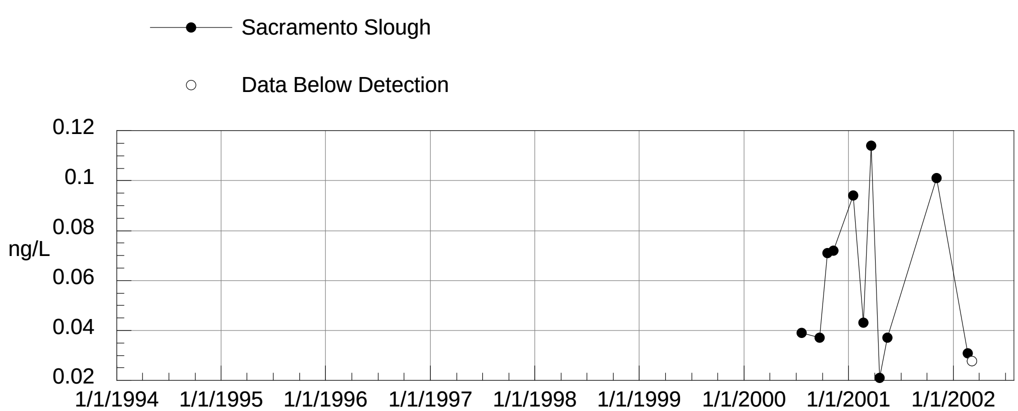


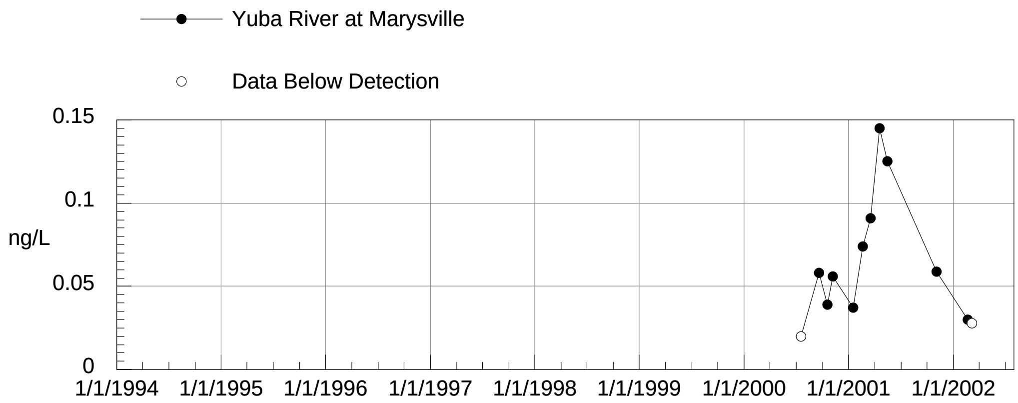


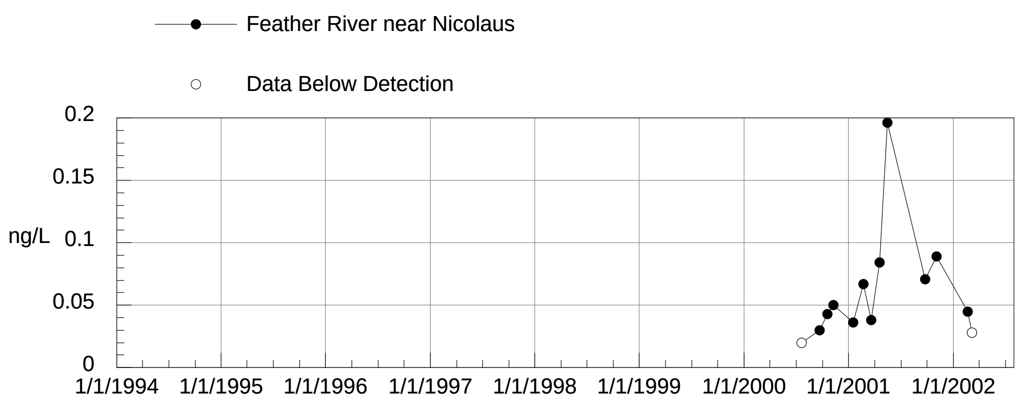


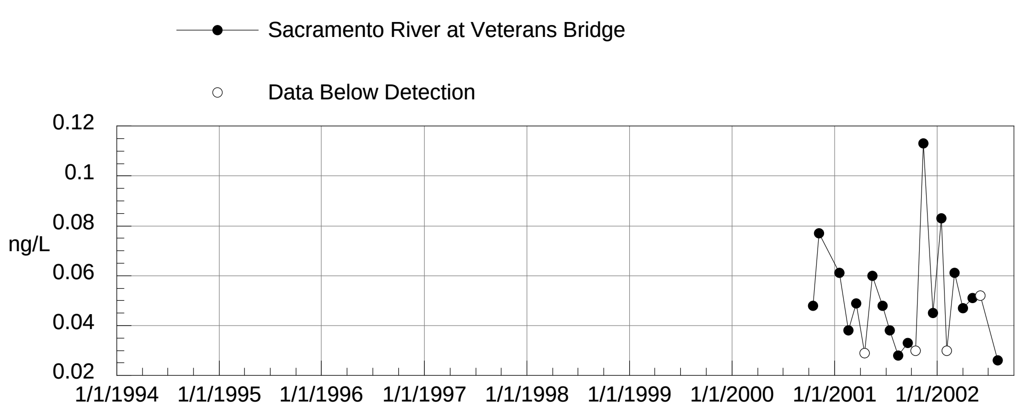

Sacramento River at Colusa
Data Below Detection
ng/L
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

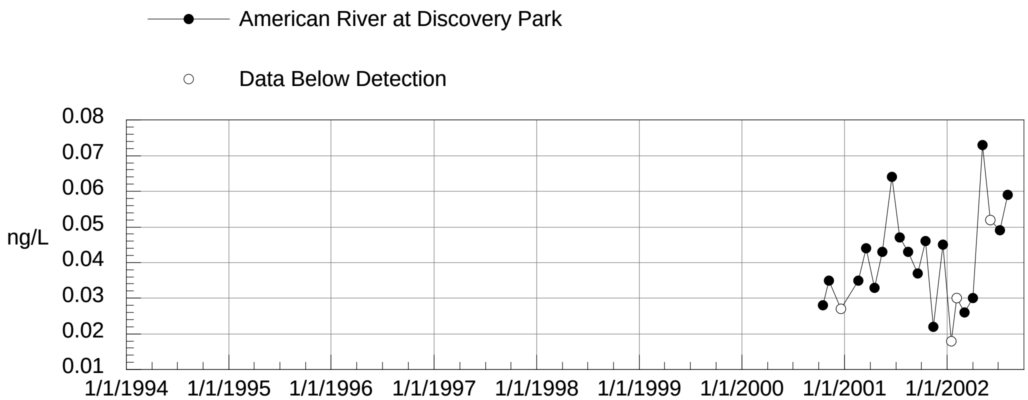

Colusa Basin Drain
Data Below Detection
ng/L
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

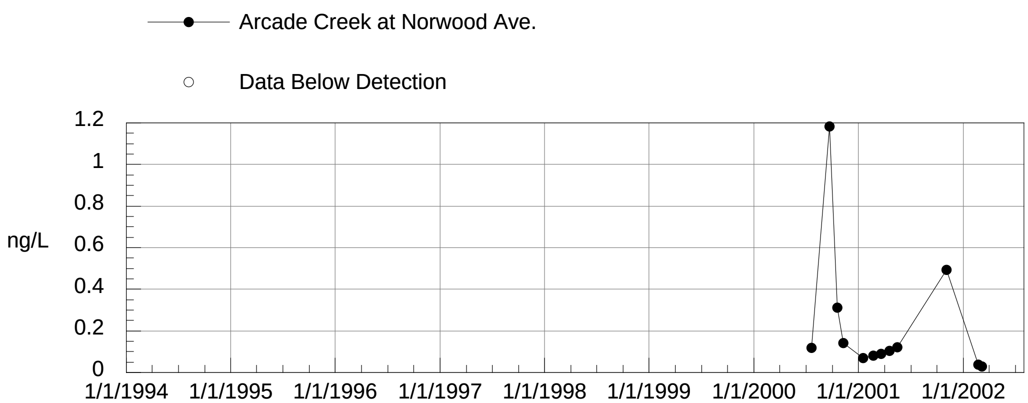

Sacramento Slough
Data Below Detection
ng/L
0.12
0.1
0.08
0.06
0.04
0.02
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

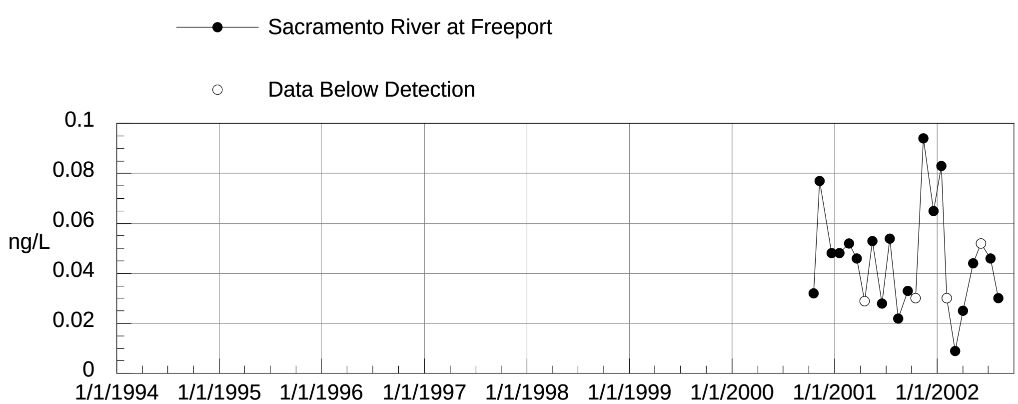

Yuba River at Marysville
Data Below Detection
0.15
0.1
ng/L
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

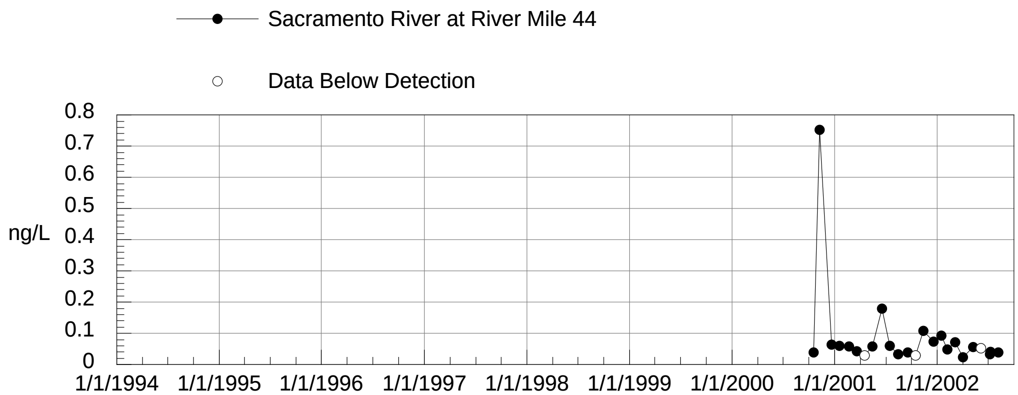

Feather River near Nicolaus
Data Below Detection
0.2
0.15
ng/L
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

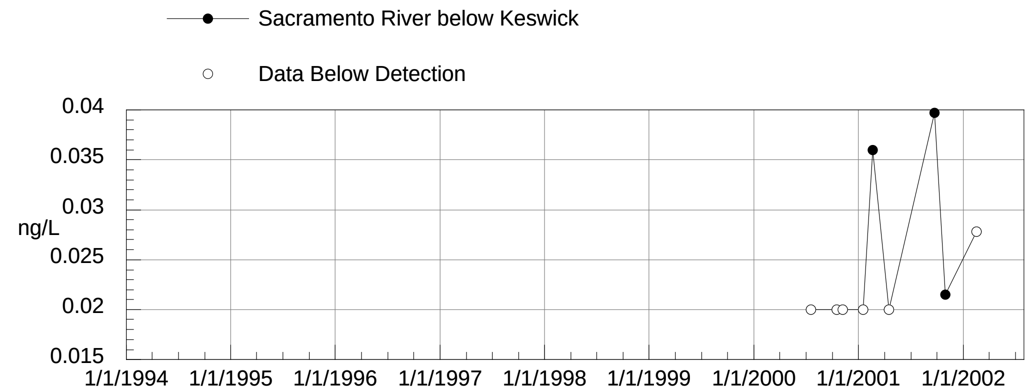

Sacramento River at Veterans Bridge
Data Below Detection
0.12
0.1
0.08
ng/L
0.06
0.04
0.02
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

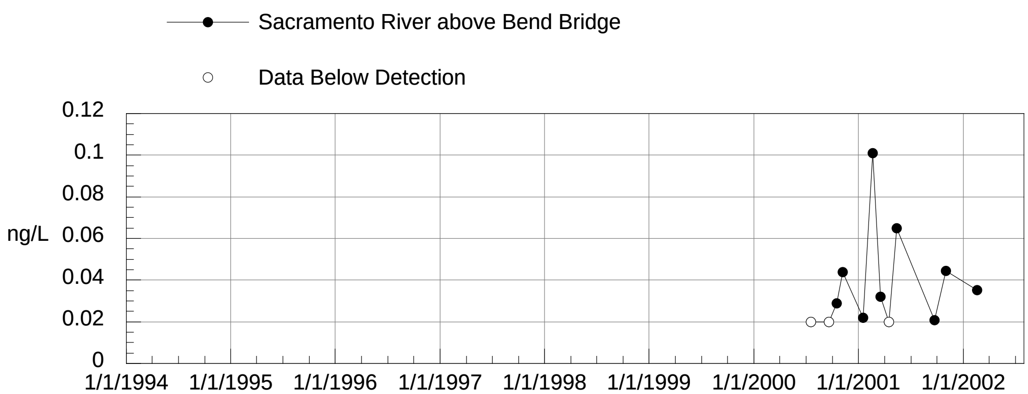

American River at Discovery Park
Data Below Detection
ng/L
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

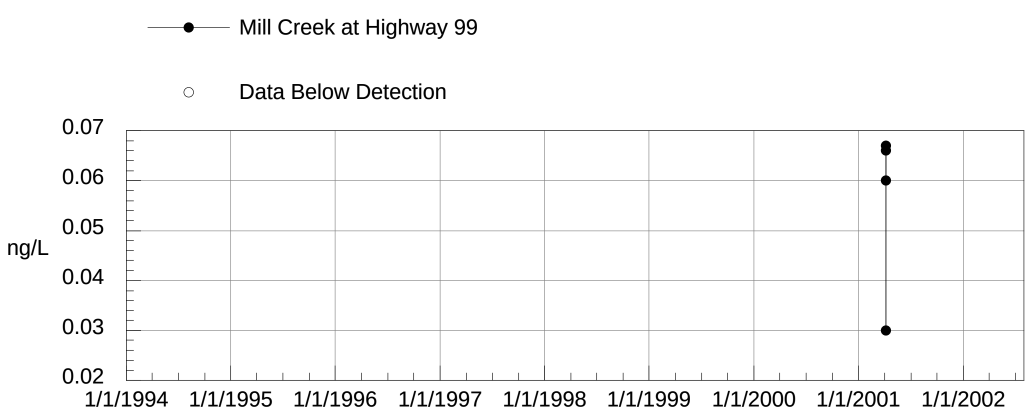

Arcade Creek at Norwood Ave.
Data Below Detection
ng/L
1.2
1
0.8
0.6
0.4
0.2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at Freeport
Data Below Detection
ng/L
0.1
0.08
0.06
0.04
0.02
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

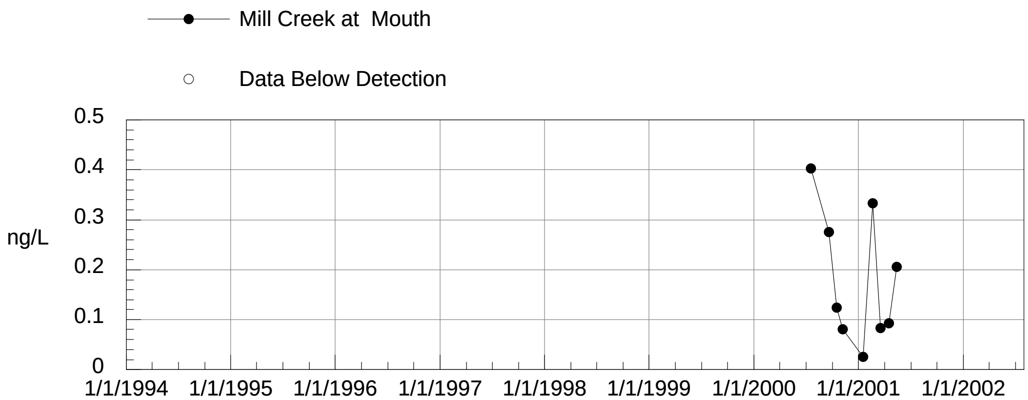

Sacramento River at River Mile 44
Data Below Detection
ng/L
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

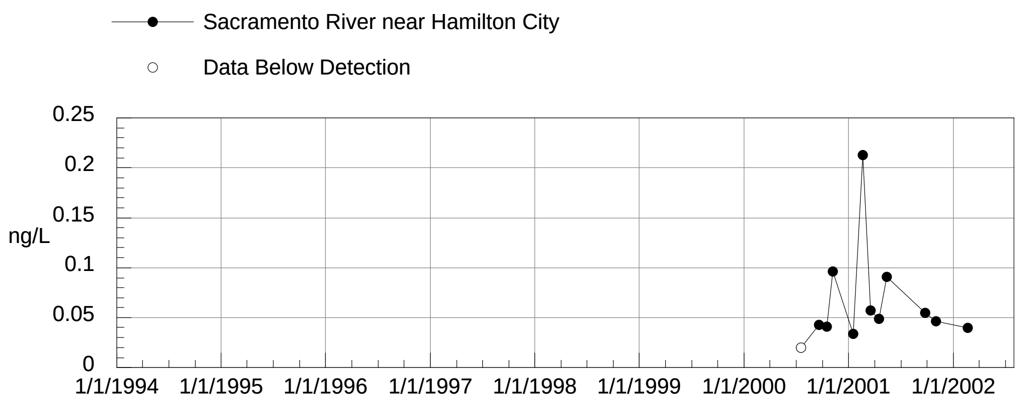

Sacramento River below Keswick
Data Below Detection
ng/L
0.04
0.035
0.03
0.025
0.02
0.015
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

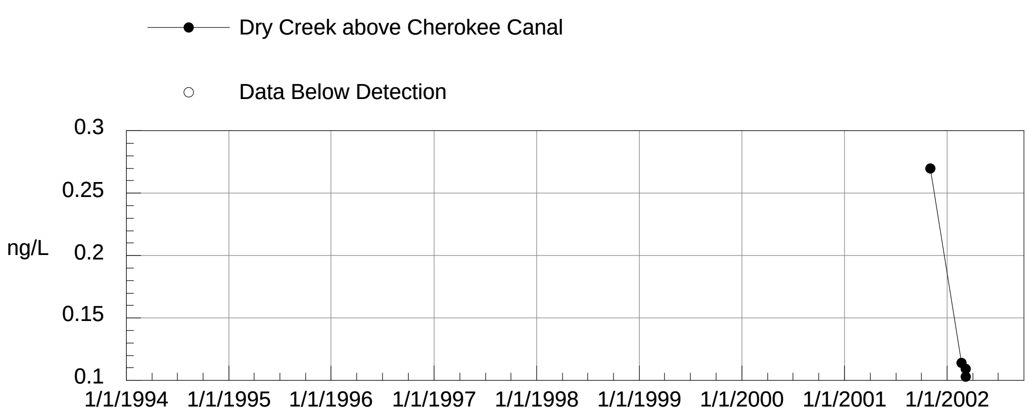

Sacramento River above Bend Bridge
Data Below Detection
ng/L
0.12
0.1
0.08
0.06
0.04
0.02
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

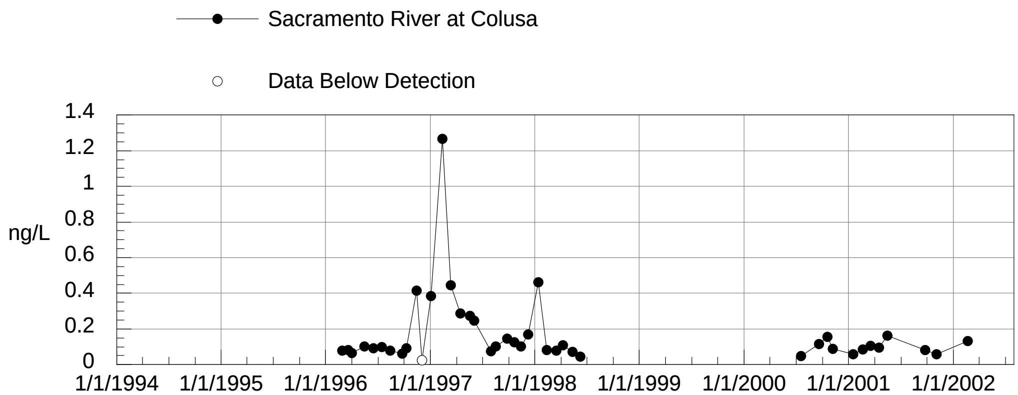

Mill Creek at Highway 99
Data Below Detection
ng/L
0.07
0.06
0.05
0.04
0.03
0.02
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

UNFILTERED METHYLMERCURY IN WATER

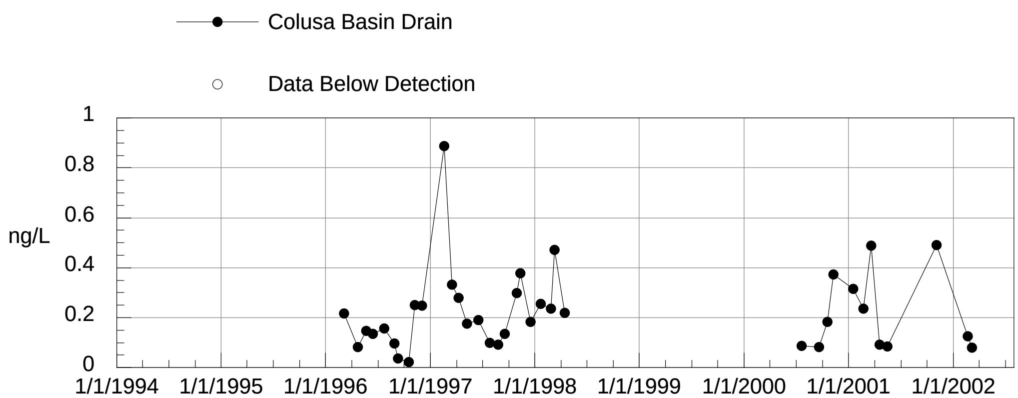




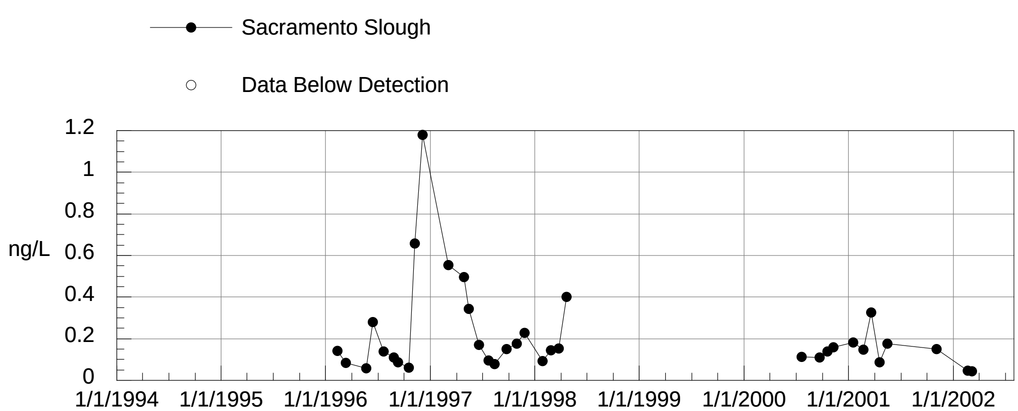




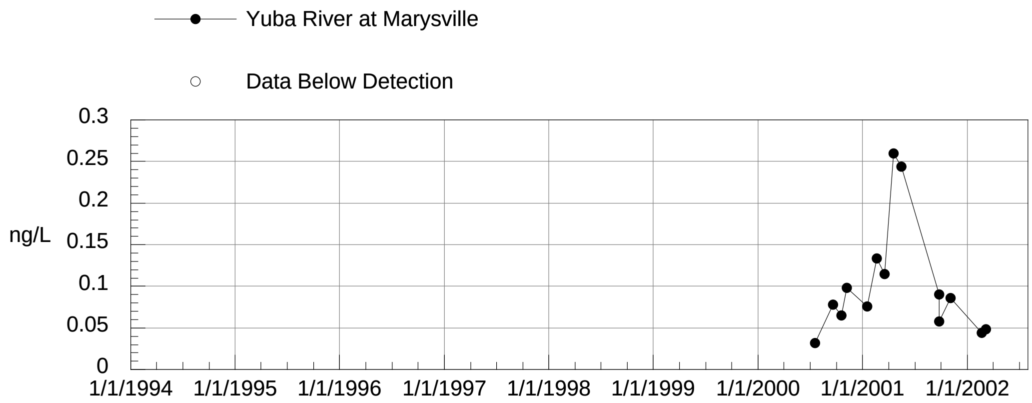
Sacramento River at Colusa
Data Below Detection
ng/L
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

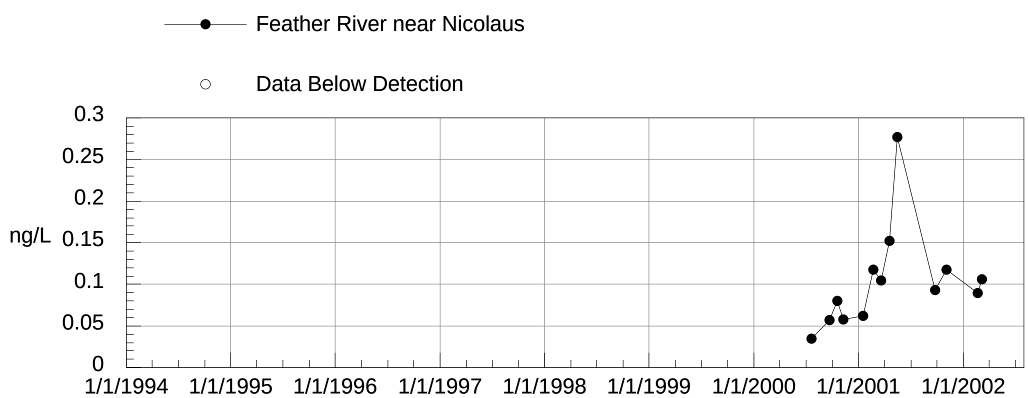


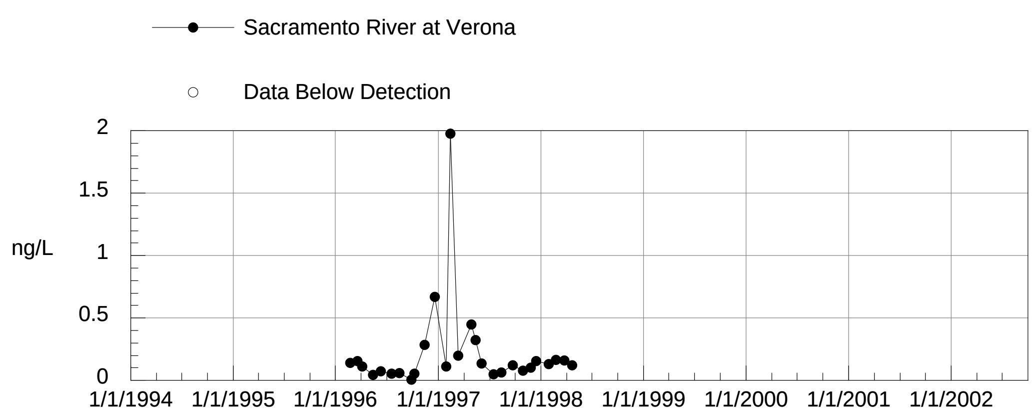
Colusa Basin Drain
Data Below Detection
ng/L
1
0.8
0.6
0.4
0.2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

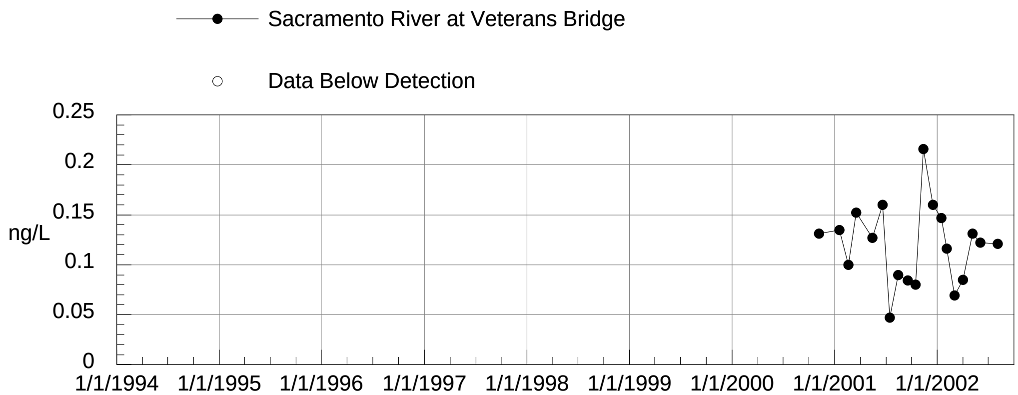


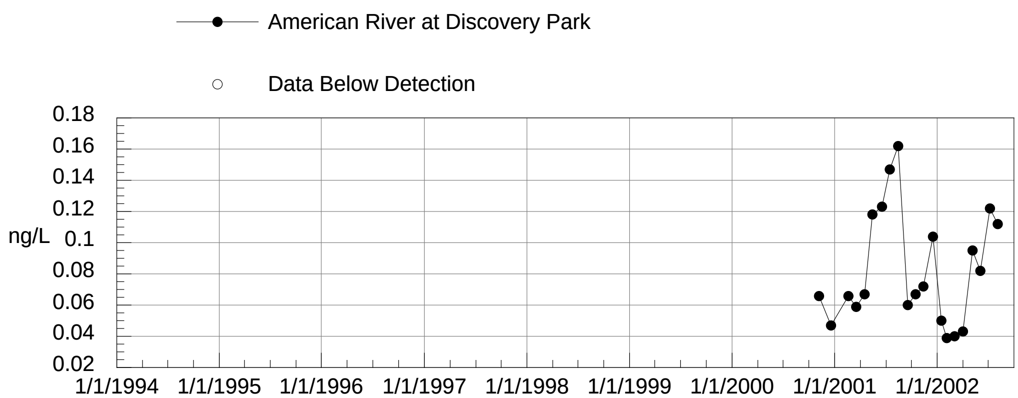
Sacramento Slough
Data Below Detection
ng/L
1.2
1
0.8
0.6
0.4
0.2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

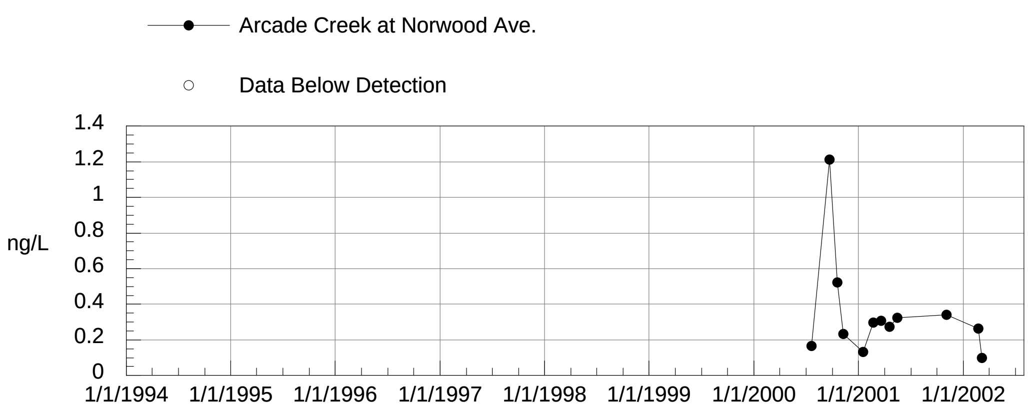

Yuba River at Marysville
Data Below Detection
ng/L
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

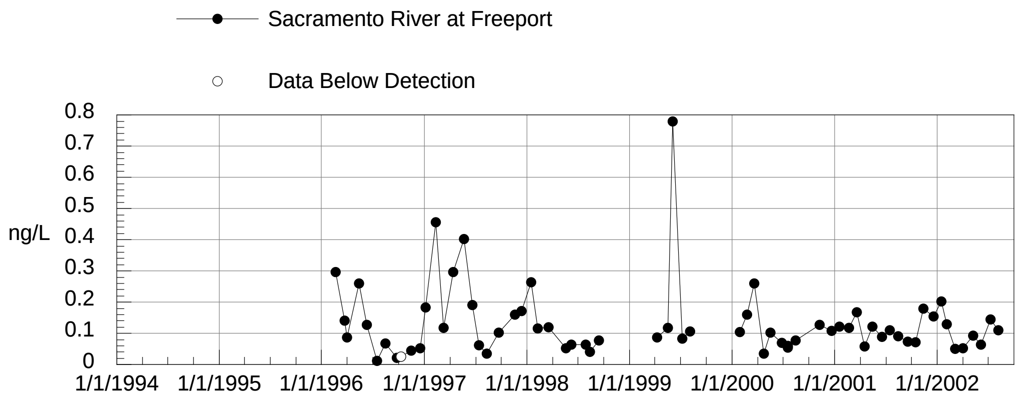

Feather River near Nicolaus
Data Below Detection
ng/L
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

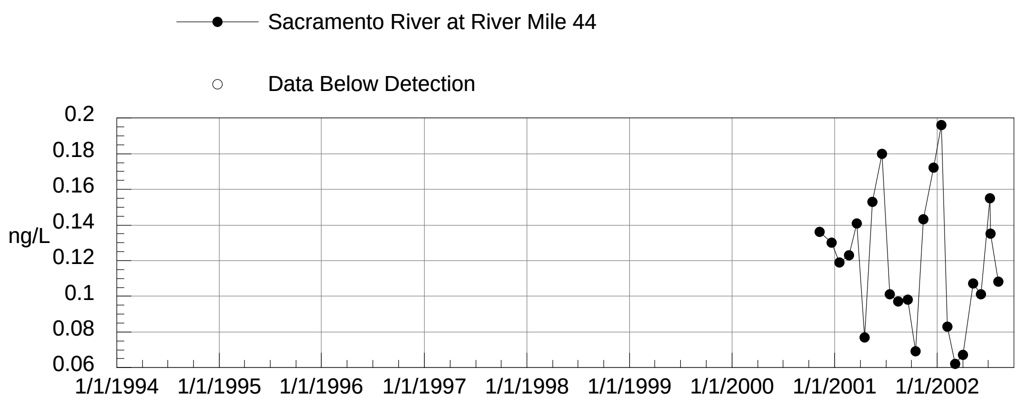

Sacramento River at Verona
Data Below Detection
ng/L
2
1.5
1
0.5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

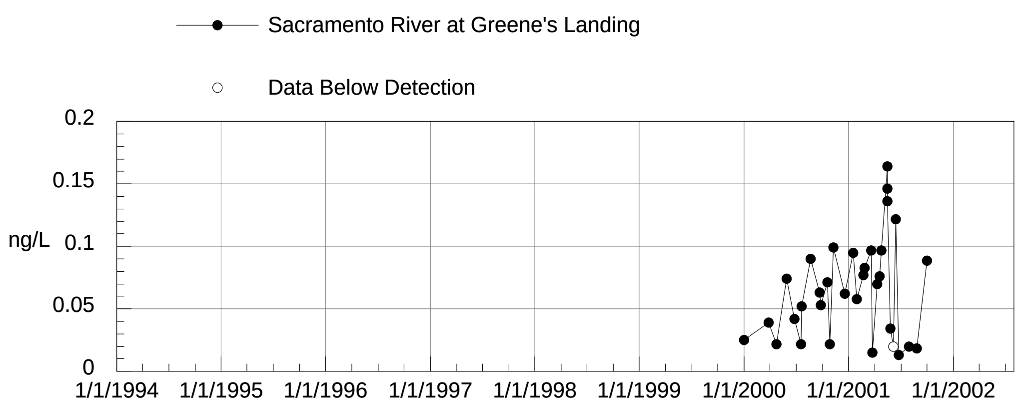

Sacramento River at Veterans Bridge
Data Below Detection
ng/L
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

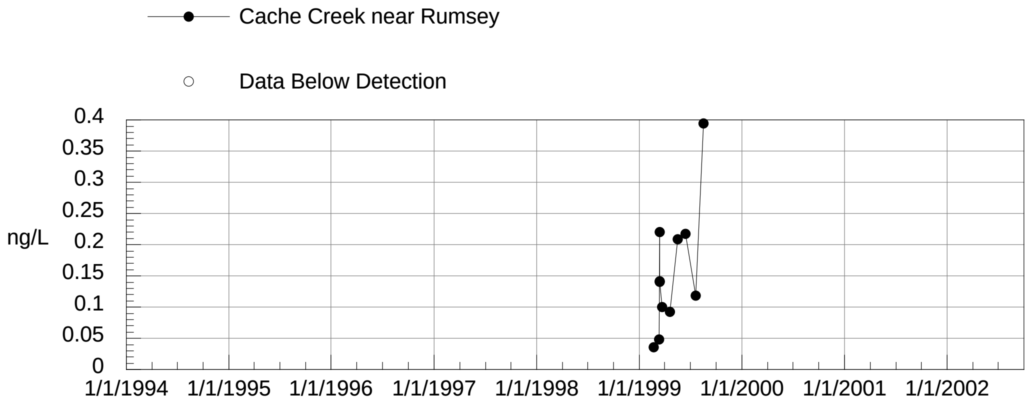

American River at Discovery Park
Data Below Detection
ng/L
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Arcade Creek at Norwood Ave.
Data Below Detection
ng/L
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at Freeport
Data Below Detection
ng/L
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

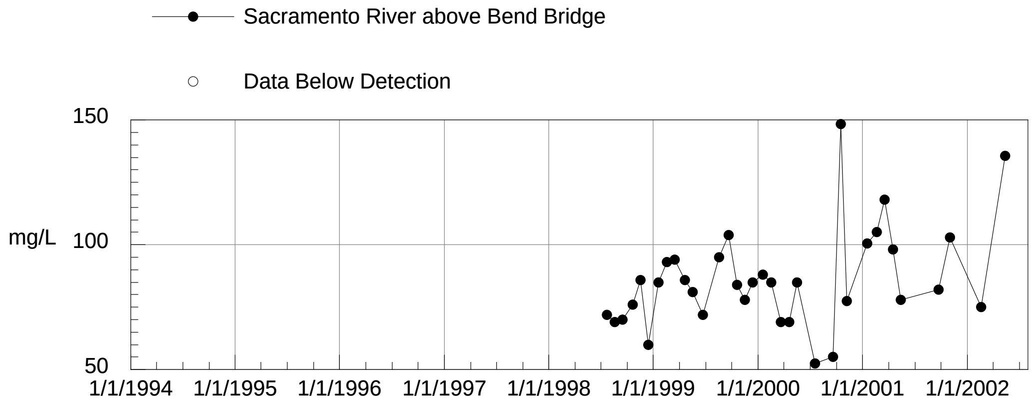

Sacramento River at River Mile 44
Data Below Detection
ng/L
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

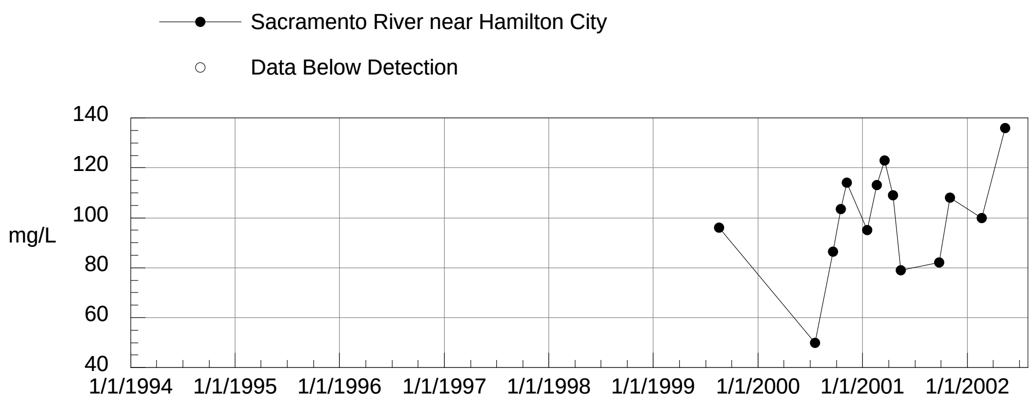

Sacramento River at Greene's Landing
Data Below Detection
ng/L
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

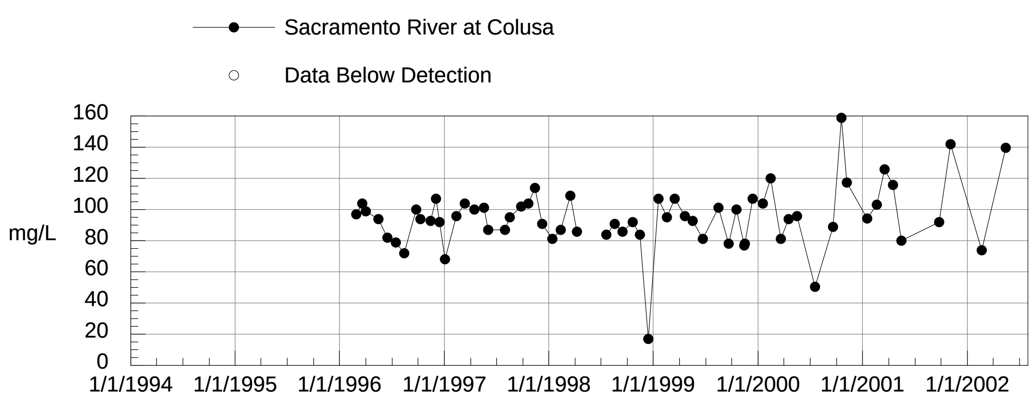

Cache Creek near Rumsey
Data Below Detection
0.4
0.35
0.3
0.25
ng/L
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

Time Series Plots of Monitoring Data: Drinking Water Parameters

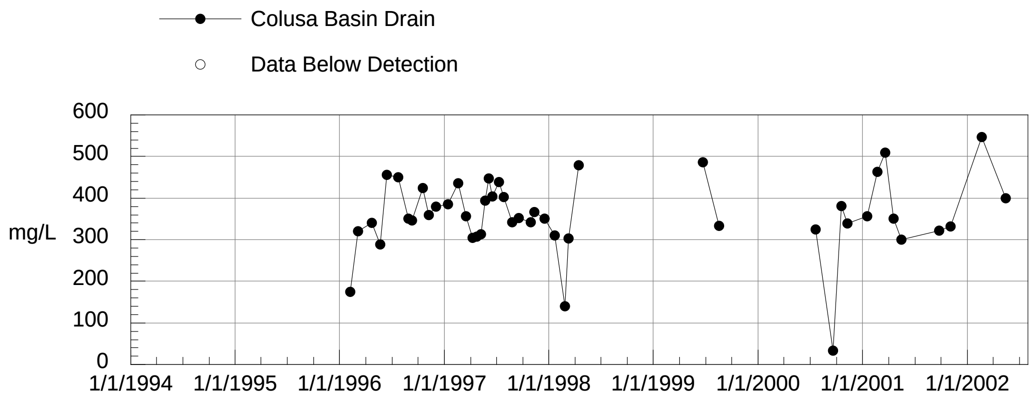
TOTAL DISSOLVED SOLIDS CONCENTRATIONS IN WATER

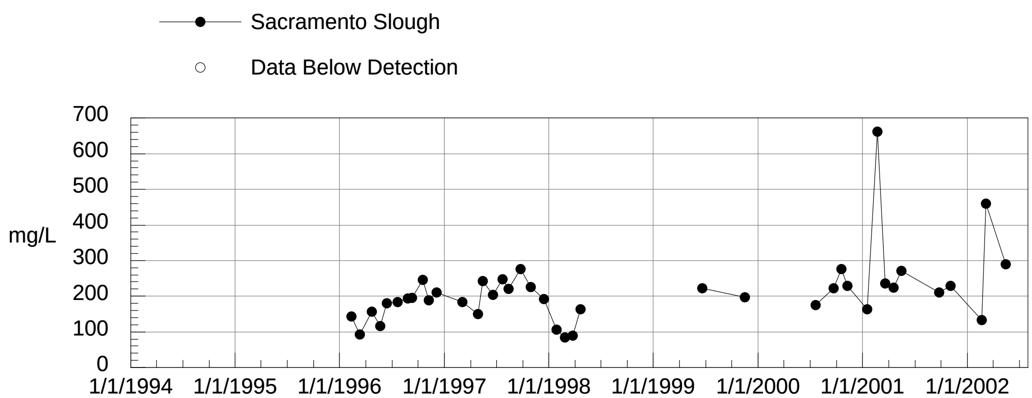


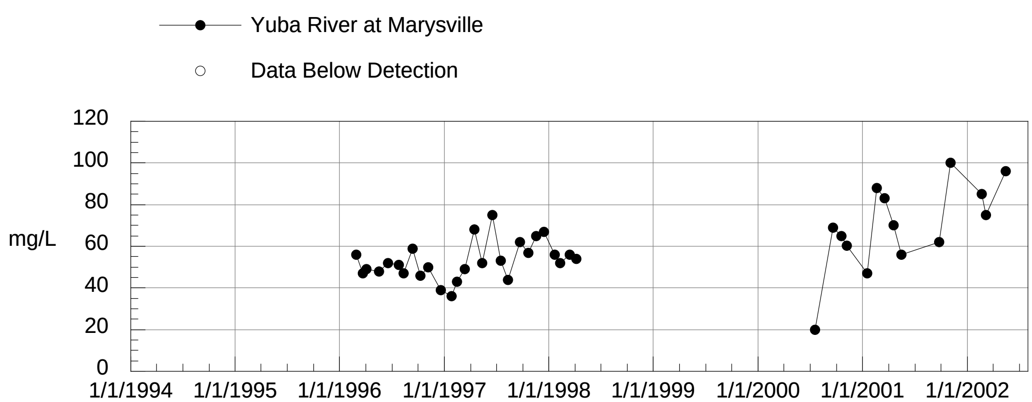




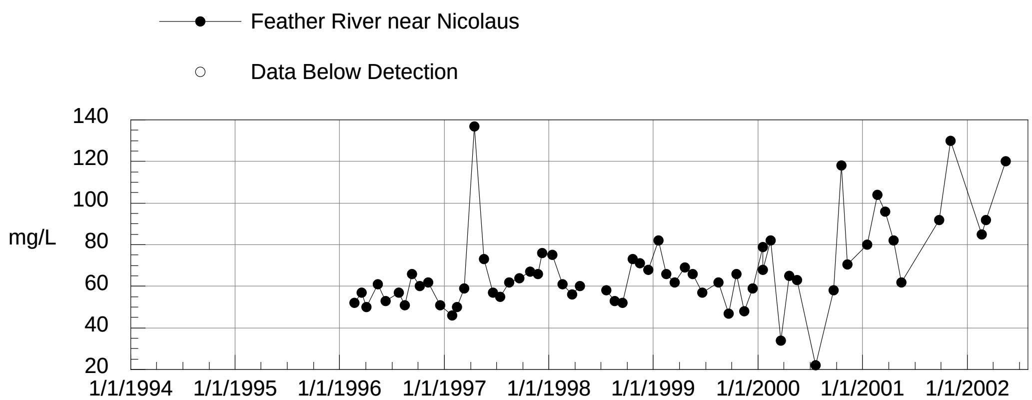
TOTAL DISSOLVED SOLIDS CONCENTRATIONS IN WATER

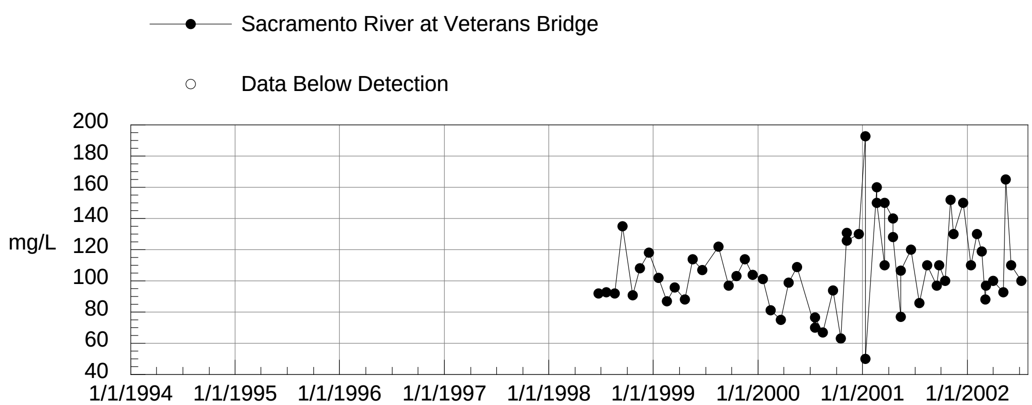


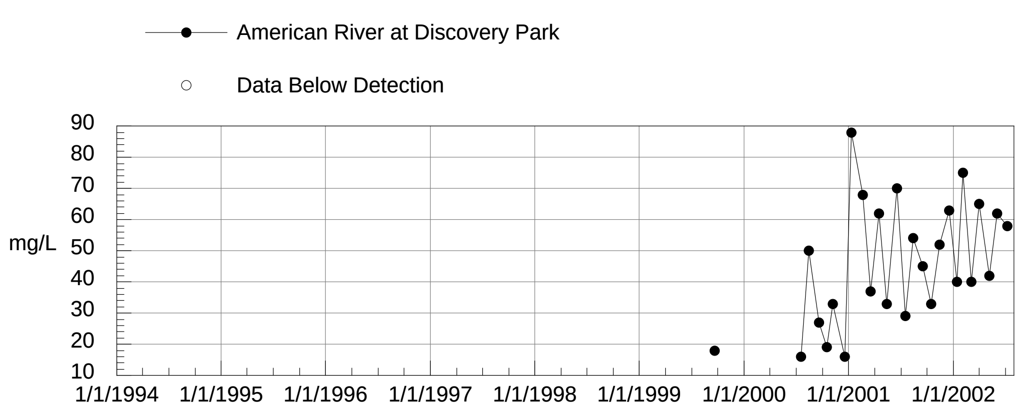




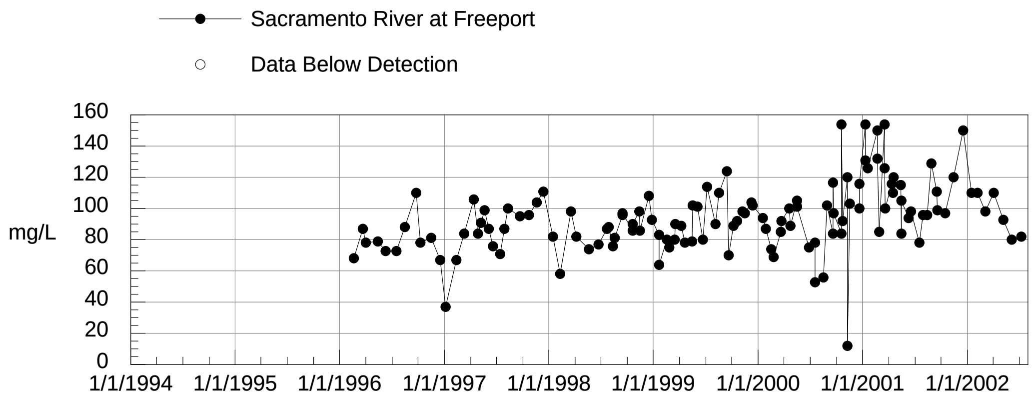
TOTAL DISSOLVED SOLIDS CONCENTRATIONS IN WATER

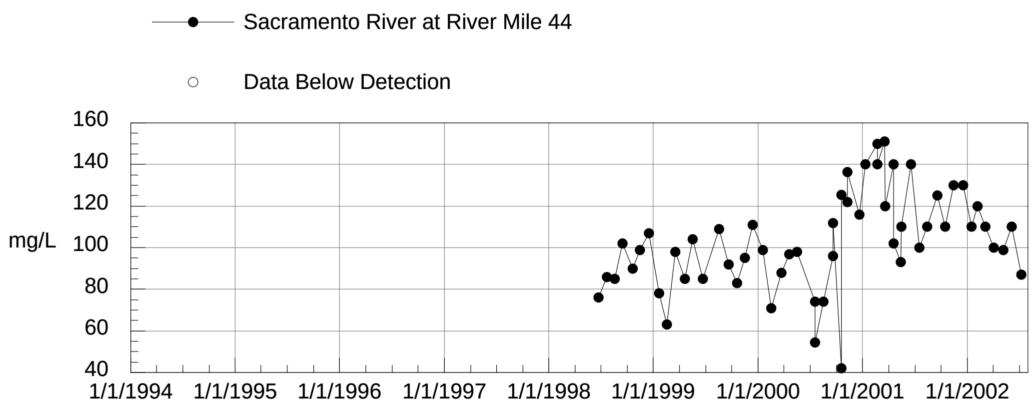




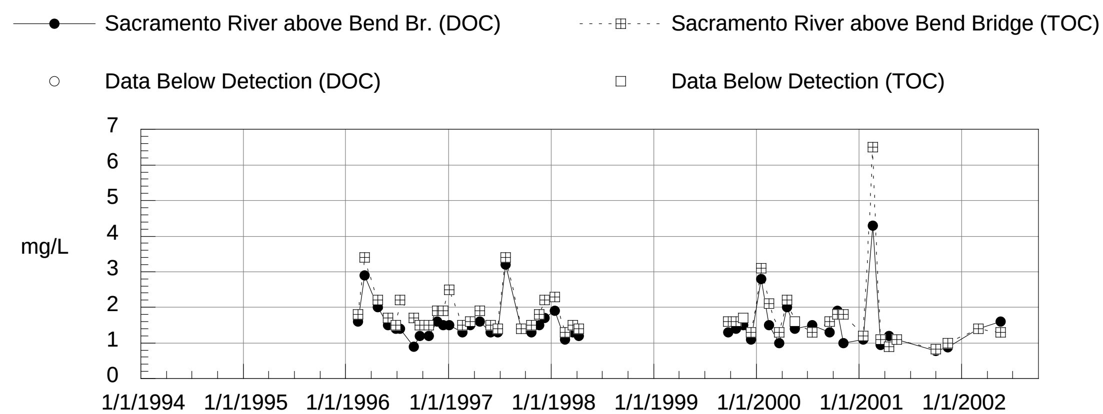


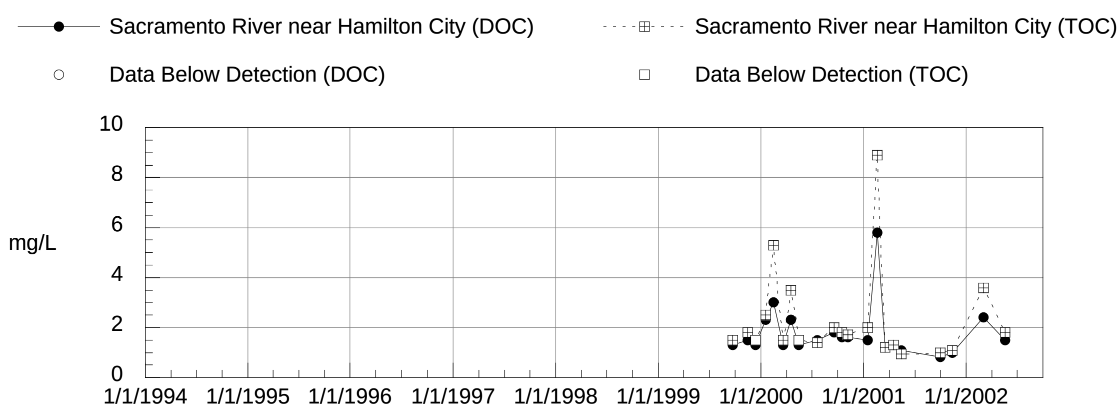
TOTAL DISSOLVED SOLIDS CONCENTRATIONS IN WATER

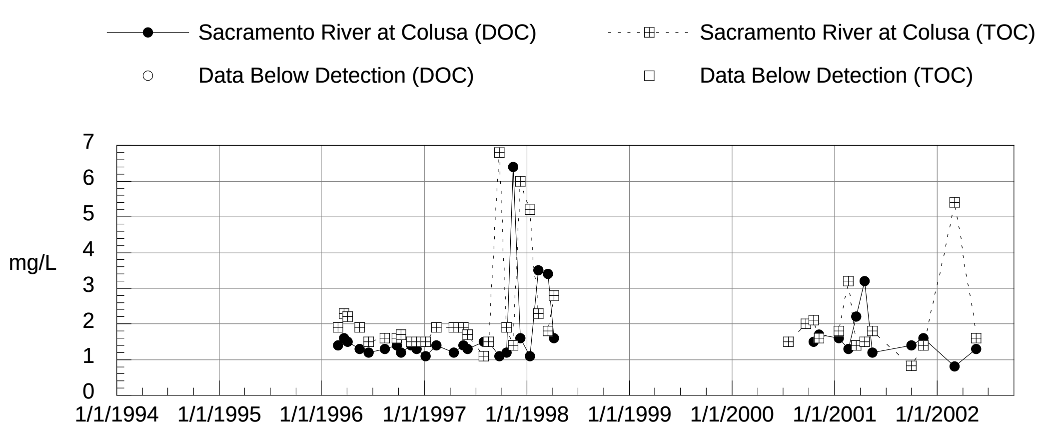




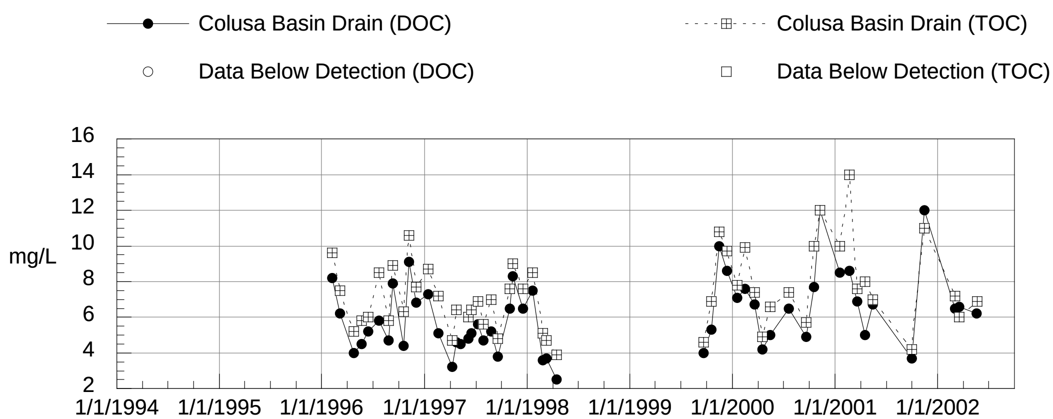
ORGANIC CARBON CONCENTRATIONS IN WATER

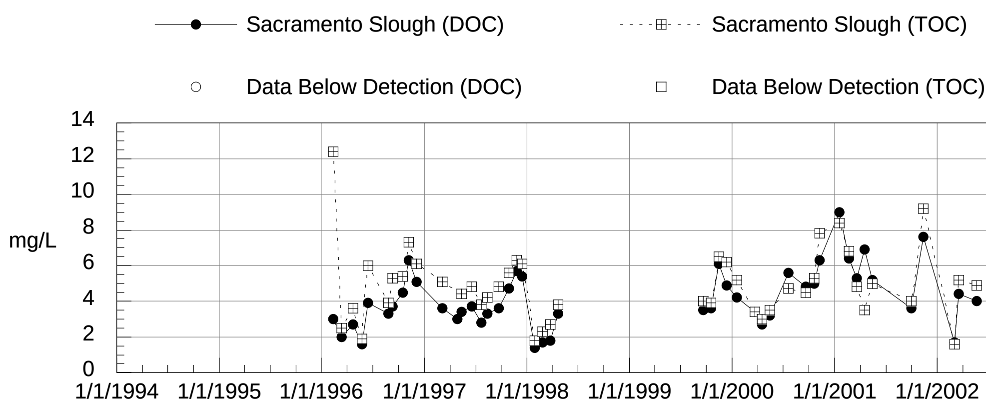


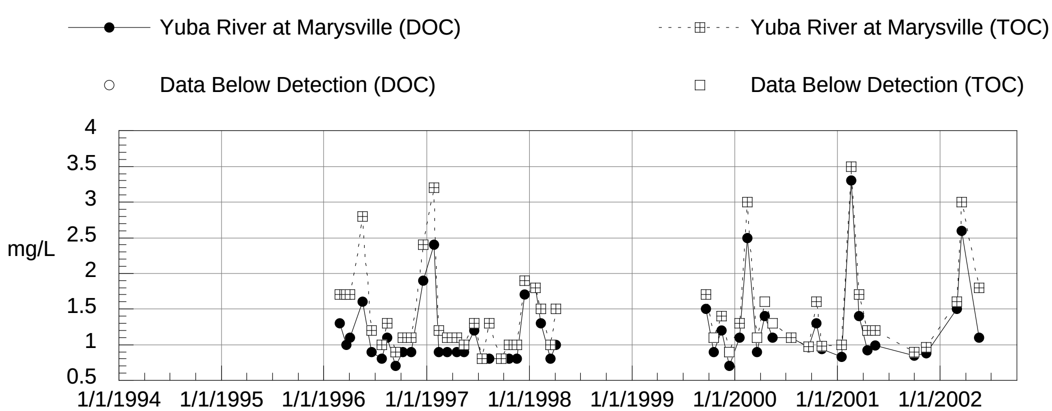




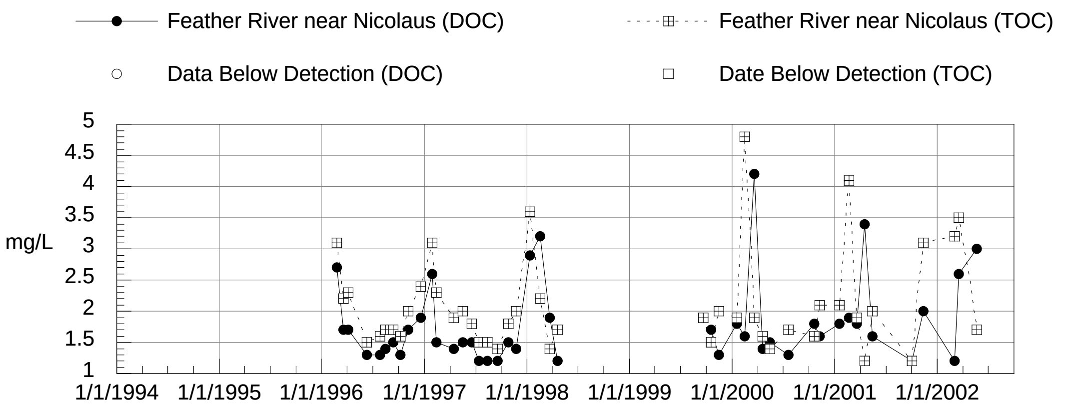
ORGANIC CARBON CONCENTRATIONS IN WATER

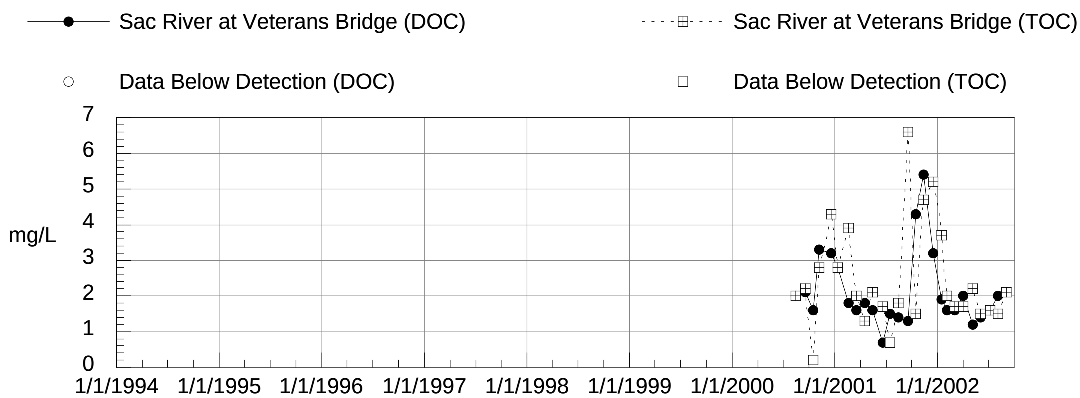


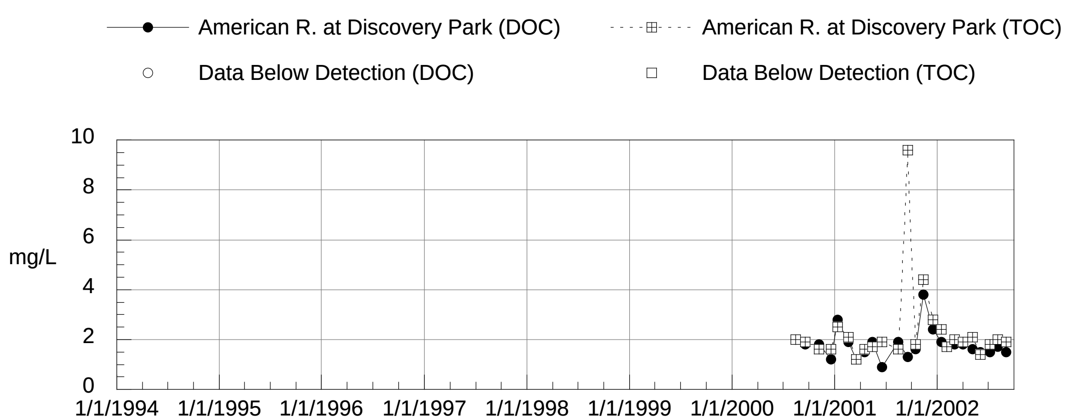




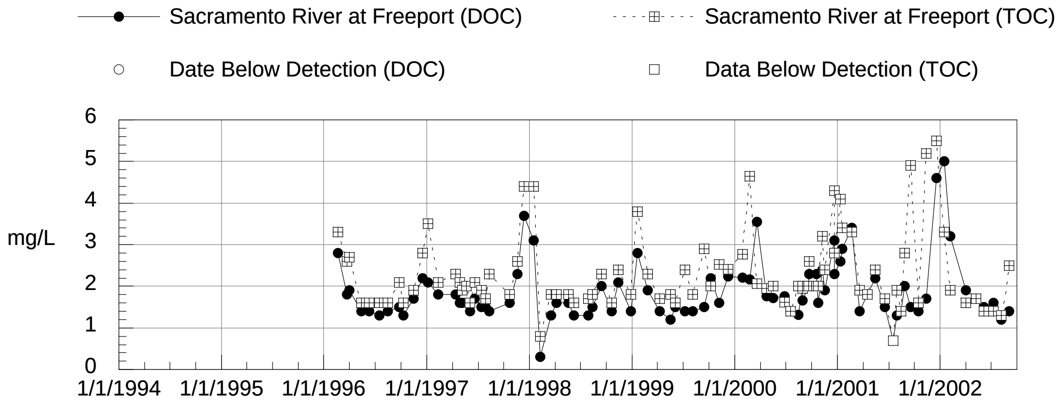
ORGANIC CARBON CONCENTRATIONS IN WATER

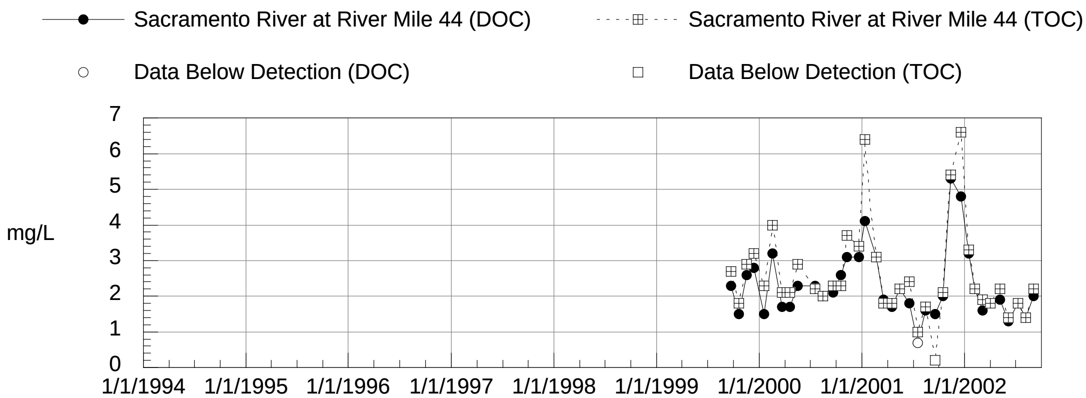


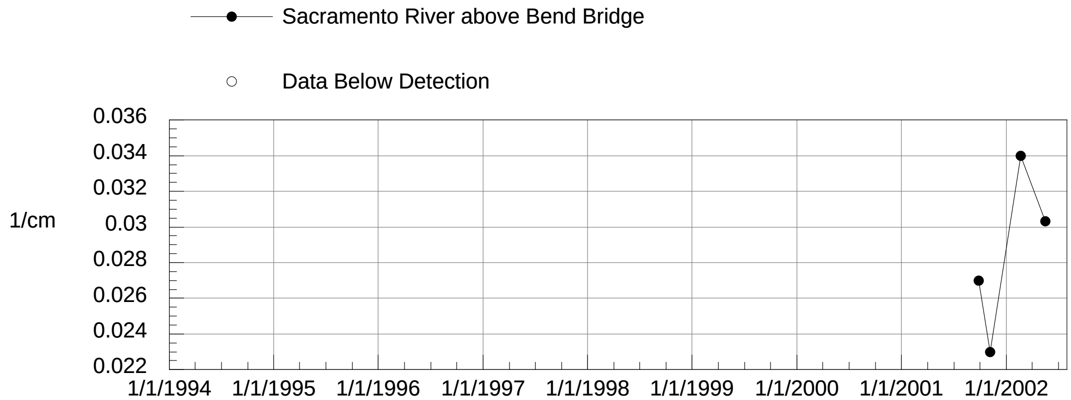


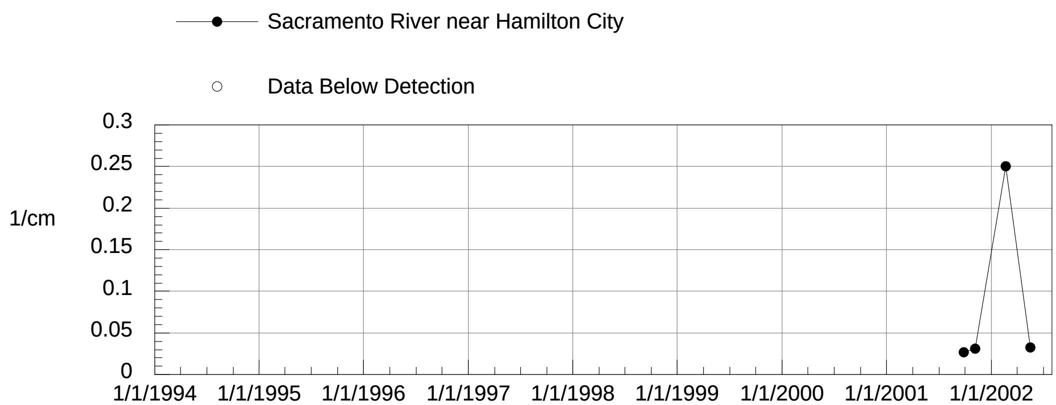


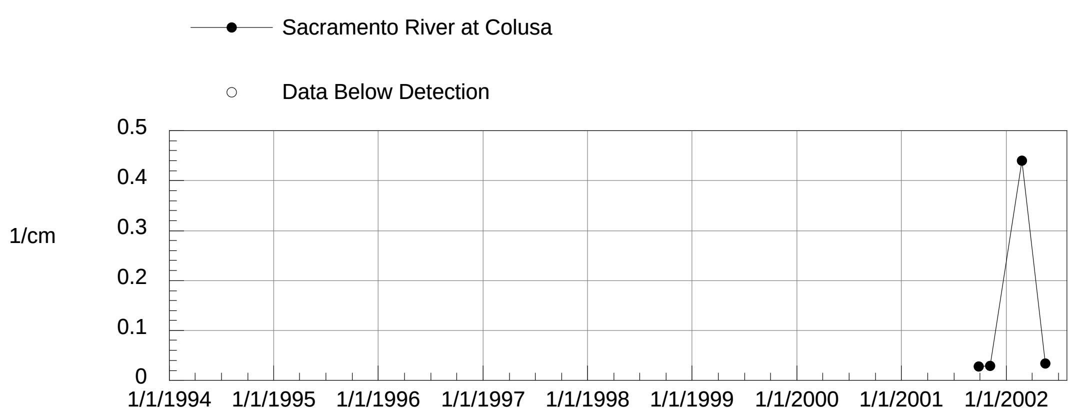
ORGANIC CARBON CONCENTRATIONS IN WATER

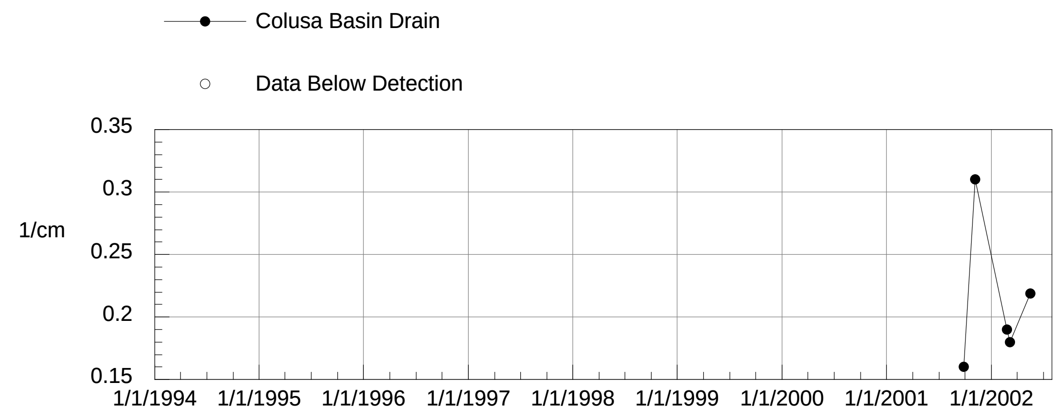


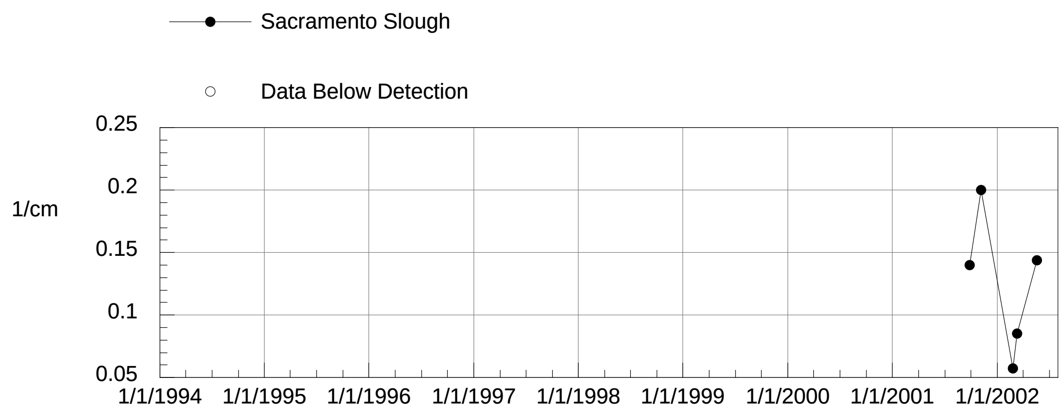


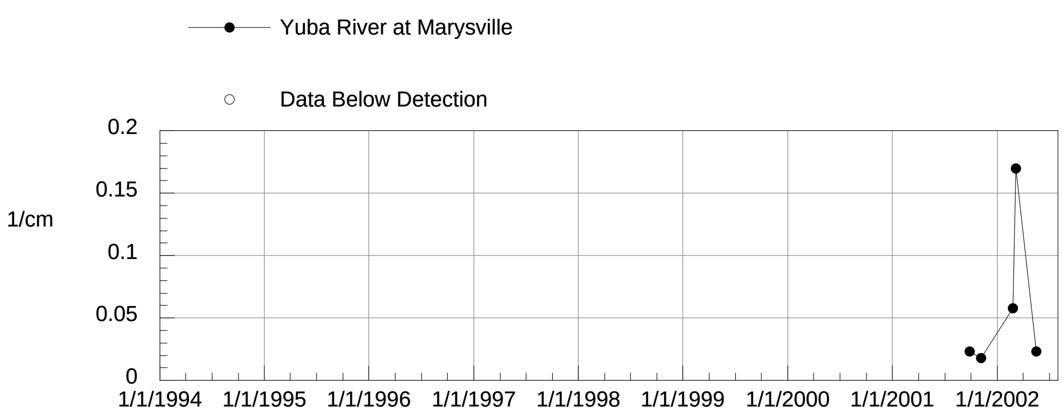

Sacramento River above Bend Bridge
Data Below Detection
1/cm
0.036
0.034
0.032
0.03
0.028
0.026
0.024
0.022
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

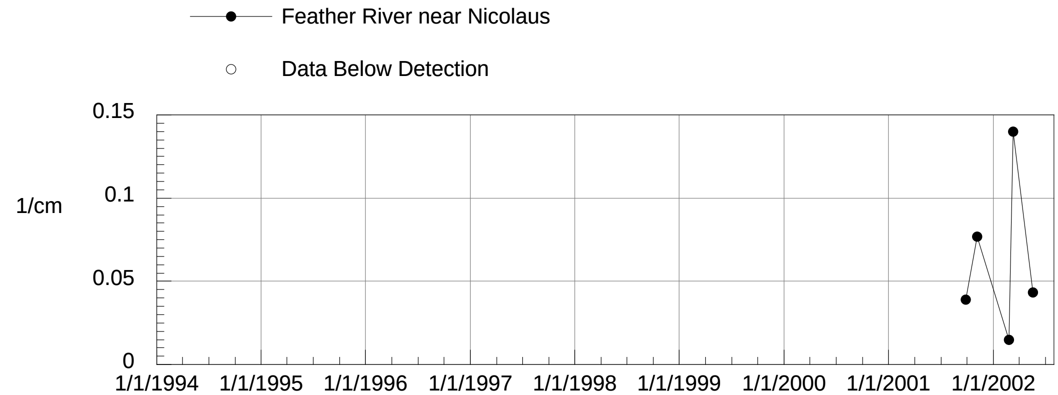

Sacramento River near Hamilton City
Data Below Detection
1/cm
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

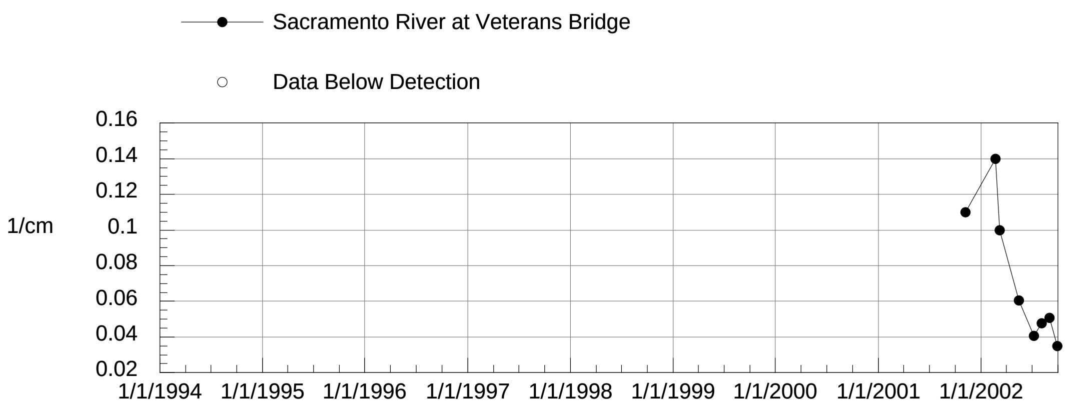

Sacramento River at Colusa
Data Below Detection
1/cm
0.5
0.4
0.3
0.2
0.1
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

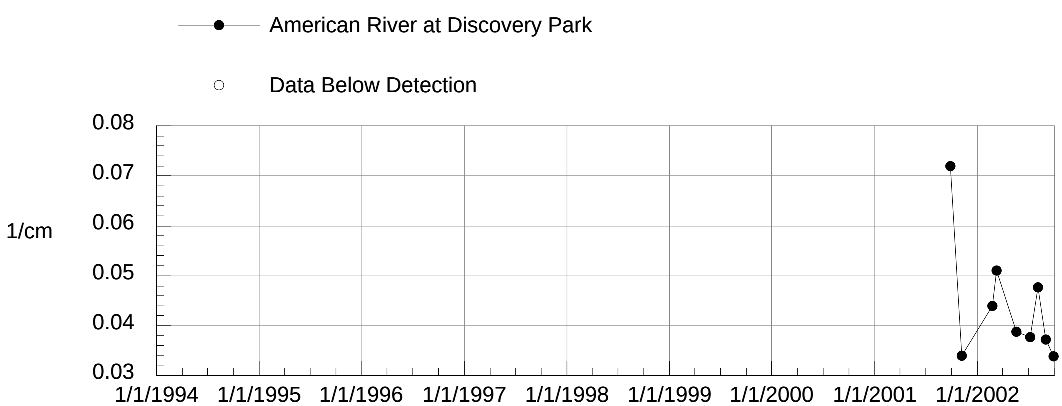

Colusa Basin Drain
Data Below Detection
1/cm
0.35
0.3
0.25
0.2
0.15
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

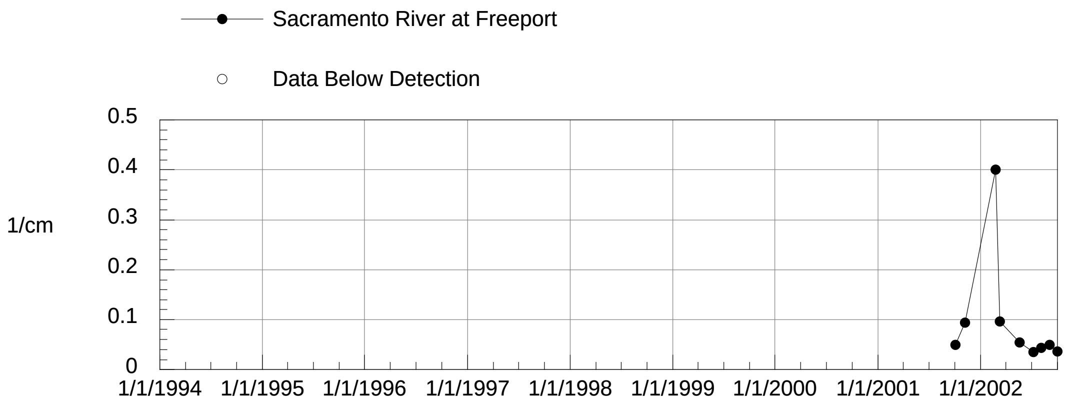

Sacramento Slough
Data Below Detection
1/cm
0.25
0.2
0.15
0.1
0.05
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

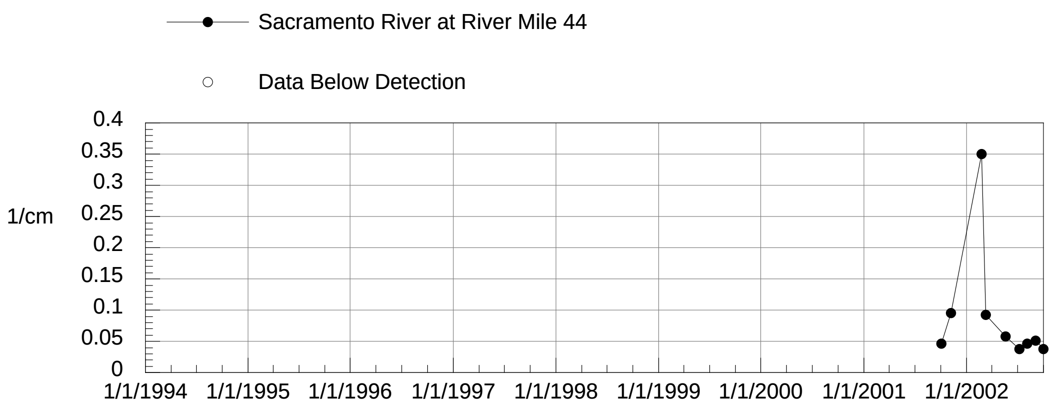

Yuba River at Marysville
Data Below Detection
1/cm
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

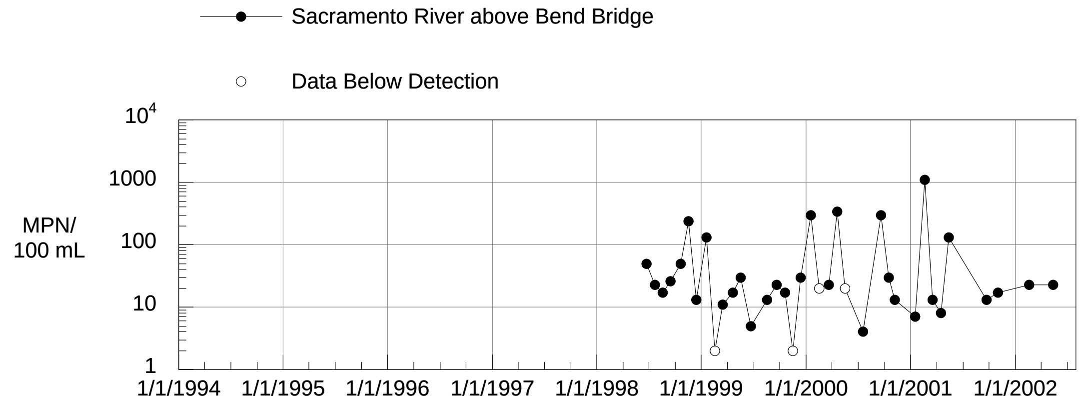

Feather River near Nicolaus
Data Below Detection
0.15
0.1
0.05
0
1/cm
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

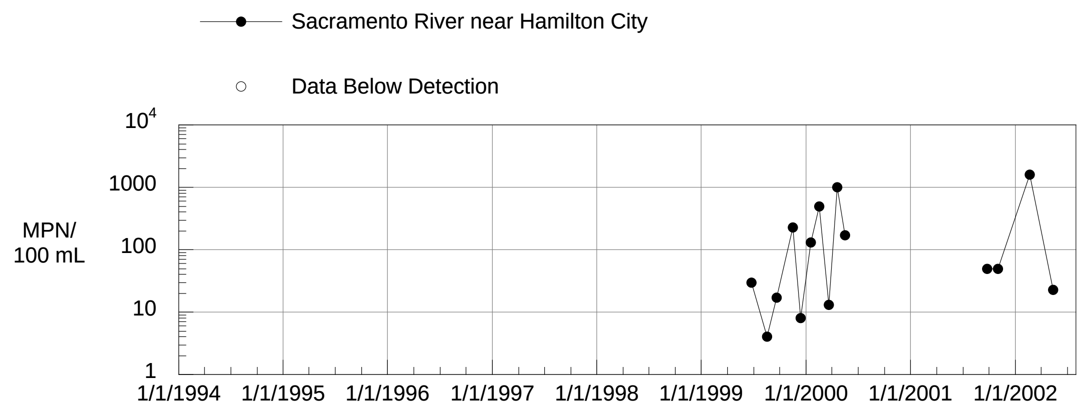

Sacramento River at Veterans Bridge
Data Below Detection
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
1/cm
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

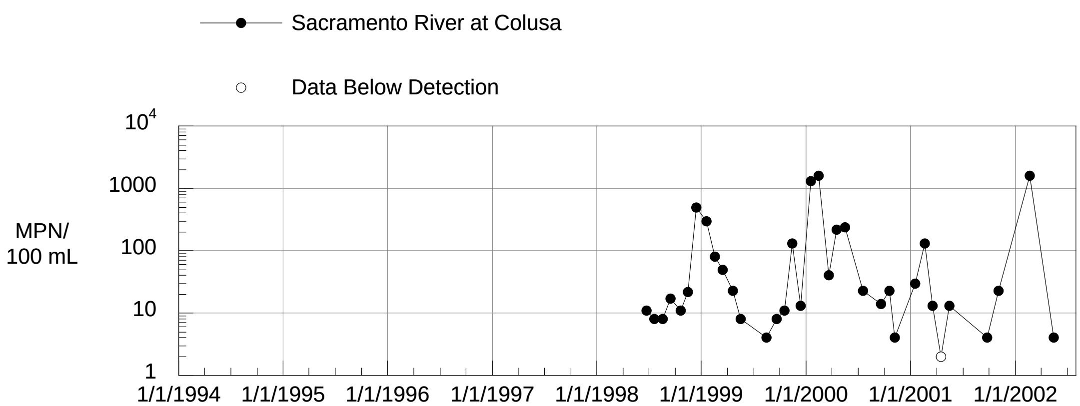

American River at Discovery Park
Data Below Detection
0.08
0.07
0.06
0.05
0.04
0.03
1/cm
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

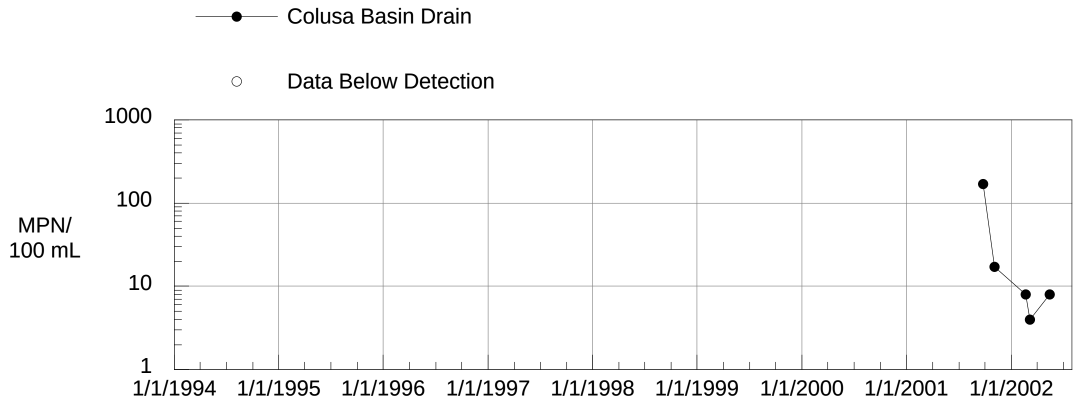

Sacramento River at Freeport
Data Below Detection
1/cm
0.5
0.4
0.3
0.2
0.1
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

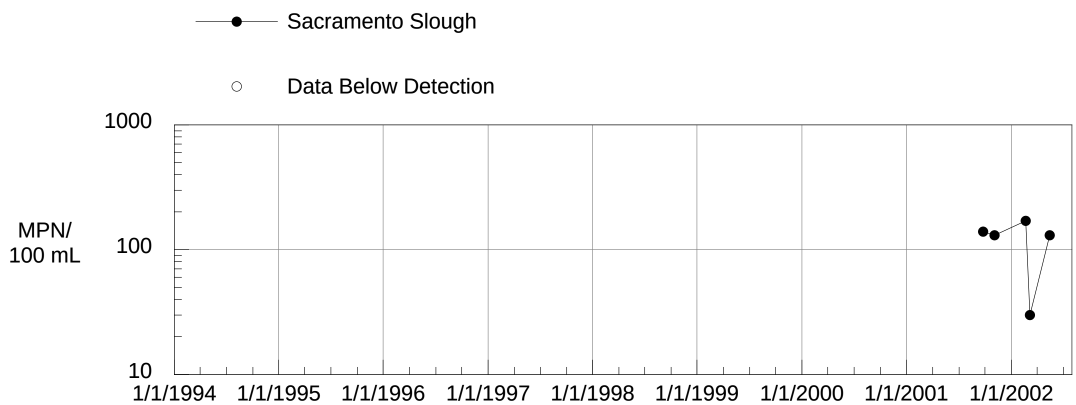

Sacramento River at River Mile 44
Data Below Detection
1/cm
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

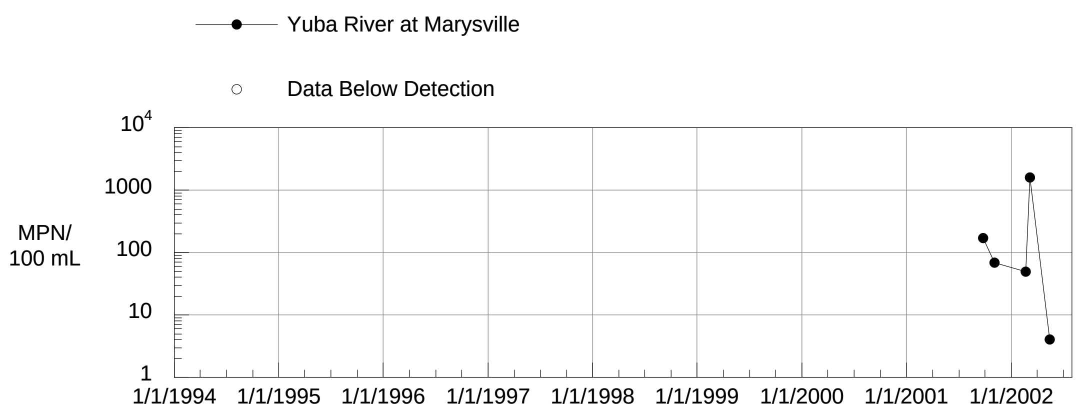

Sacramento River above Bend Bridge
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

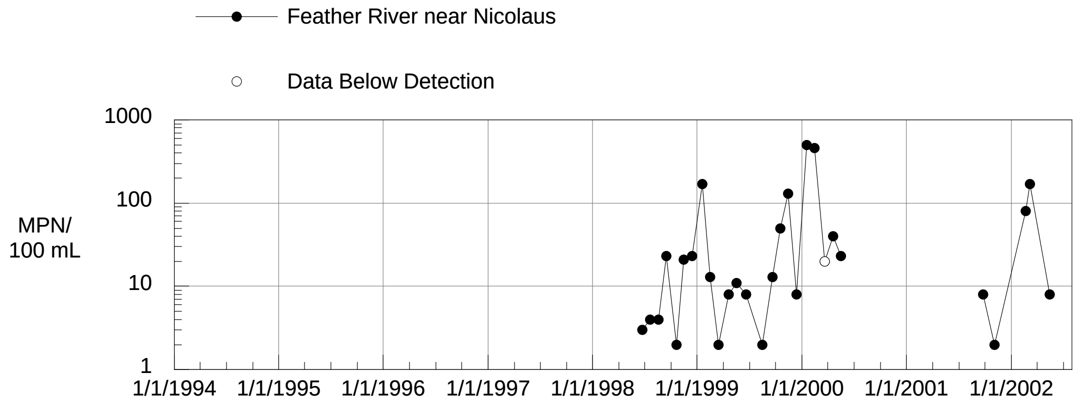

Sacramento River near Hamilton City
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

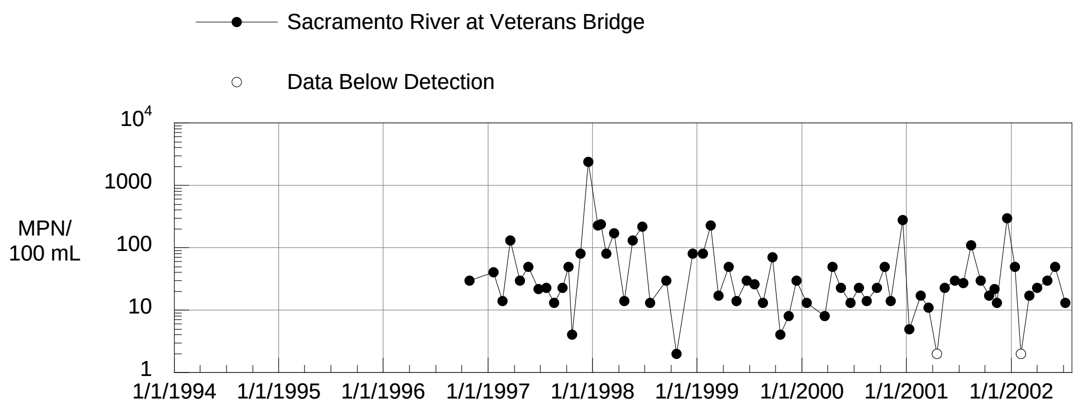

Sacramento River at Colusa
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

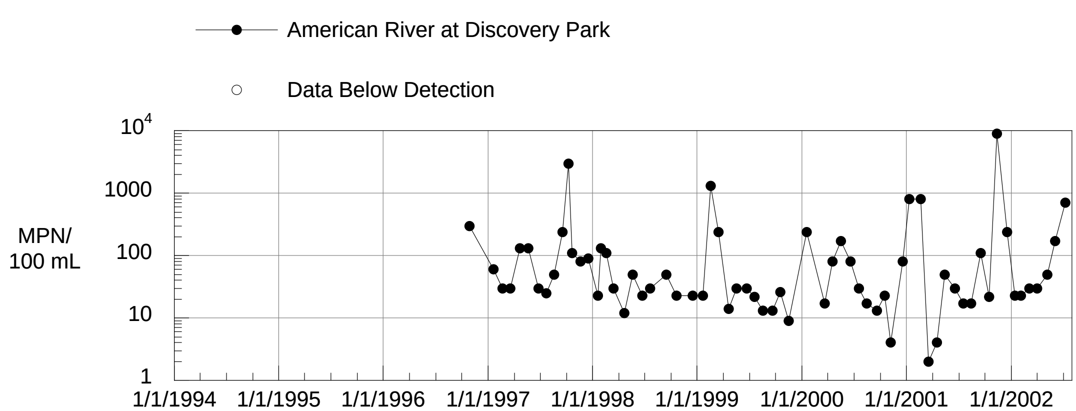

Colusa Basin Drain
Data Below Detection
1000
100
10
1
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

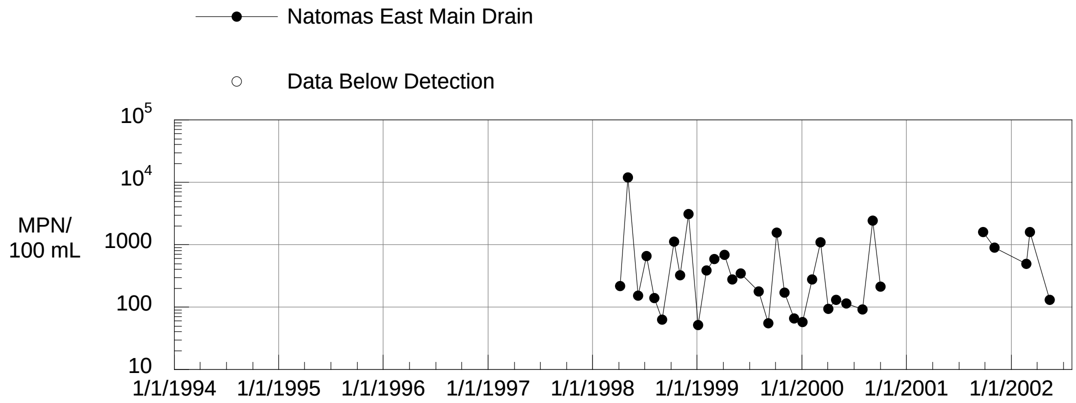

Sacramento Slough
Data Below Detection
1000
100
10
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

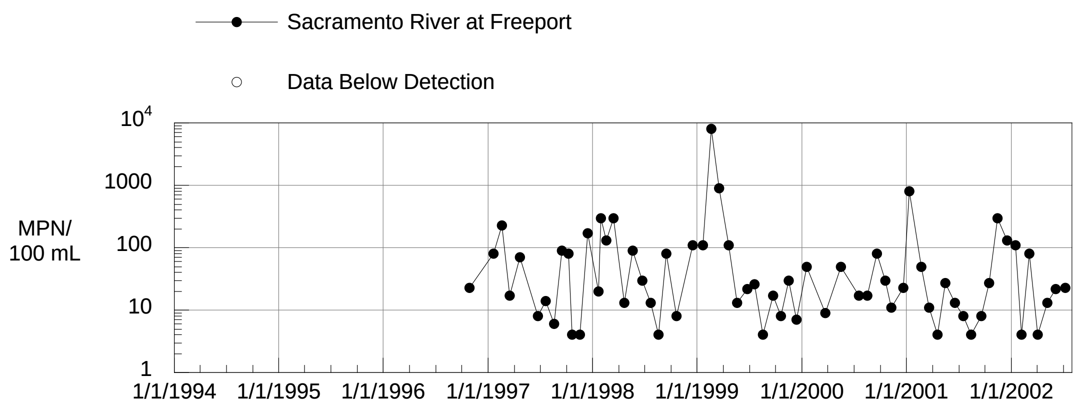

Yuba River at Marysville
Data Below Detection
10^4
1000
100
10
1
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

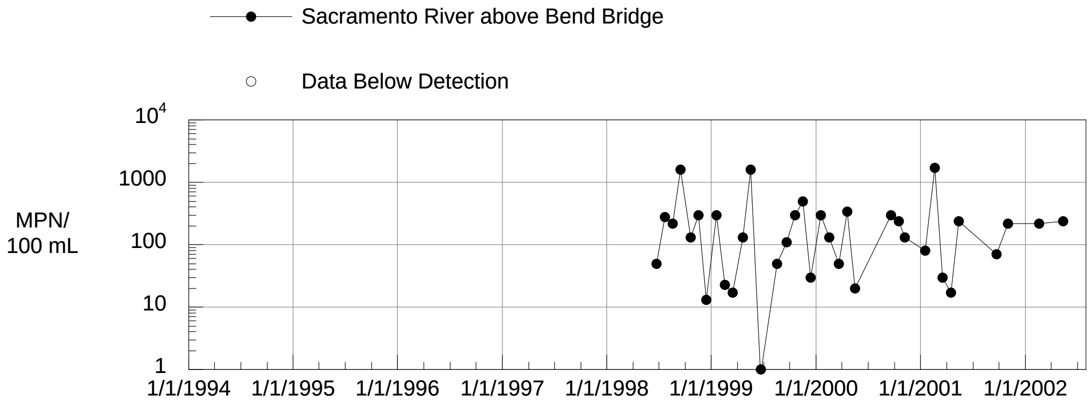

Feather River near Nicolaus
Data Below Detection
MPN/
100 mL
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

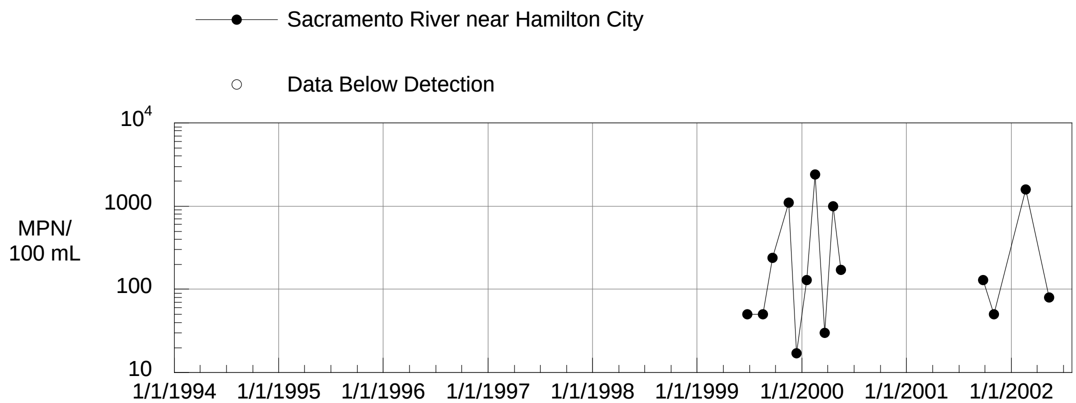

Sacramento River at Veterans Bridge
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

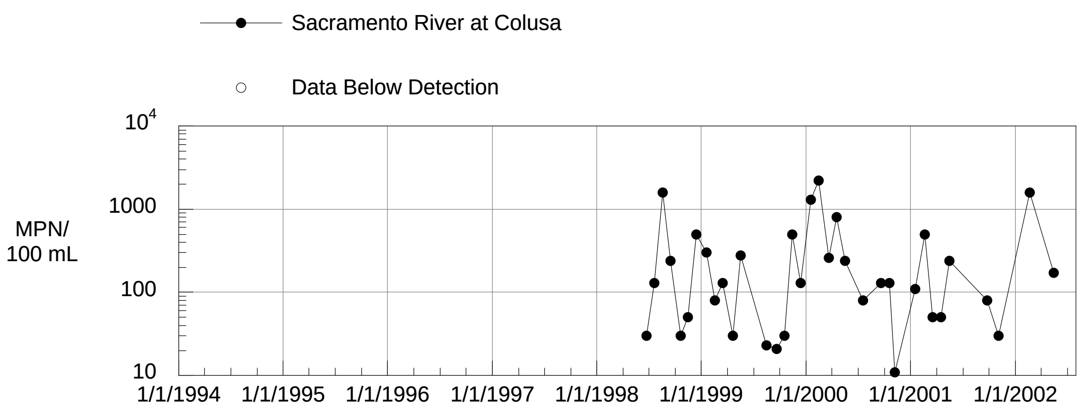

American River at Discovery Park
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

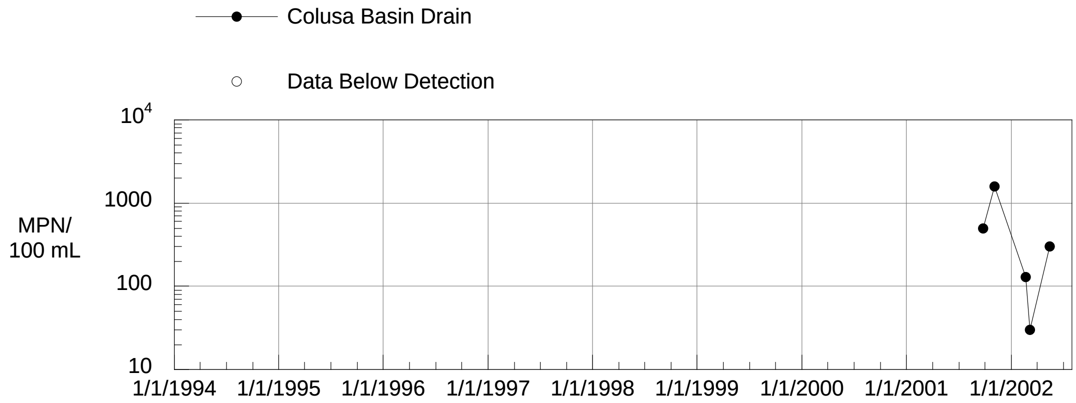

Natomas East Main Drain
Data Below Detection
MPN/
100 mL
10^5
10^4
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

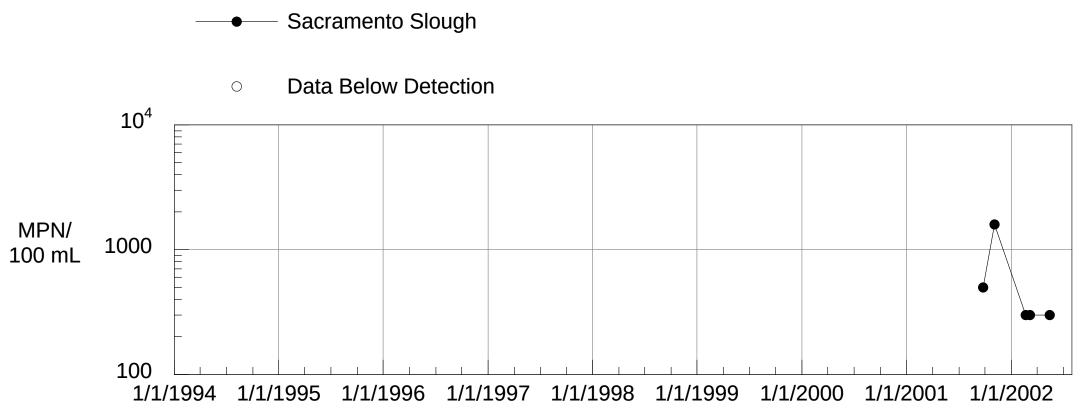

Sacramento River at Freeport
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

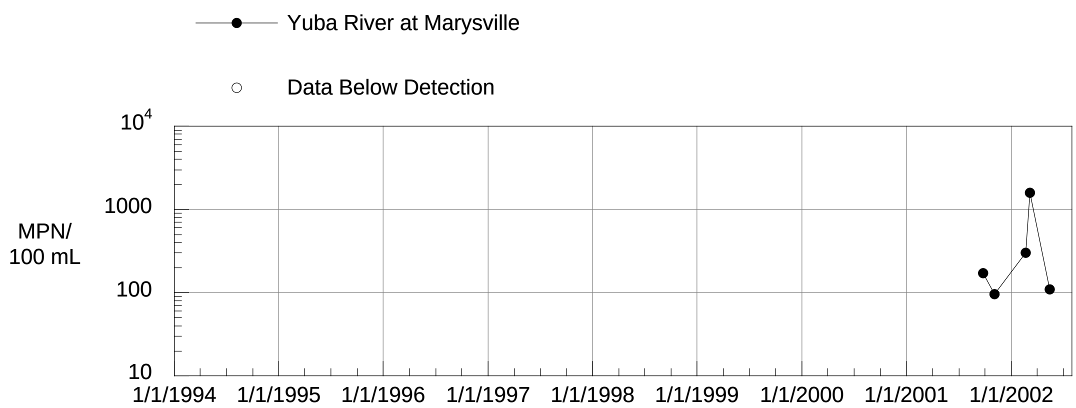

Sacramento River above Bend Bridge
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

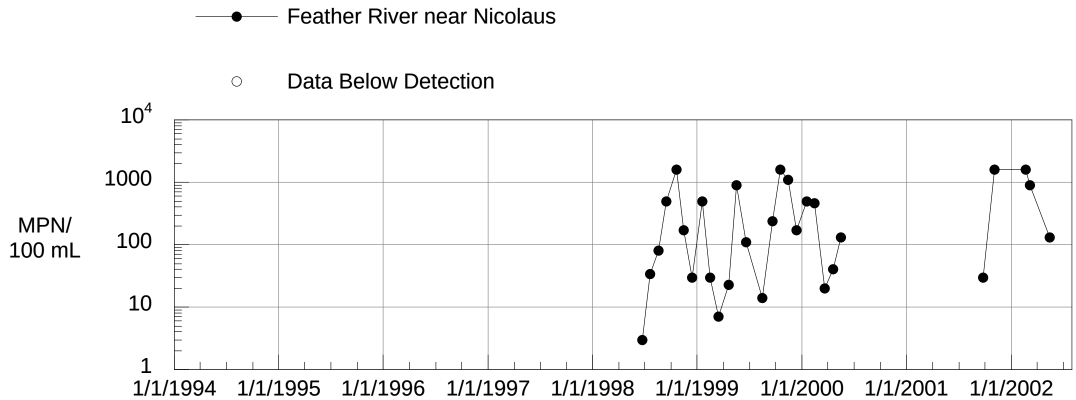

Sacramento River near Hamilton City
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at Colusa
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

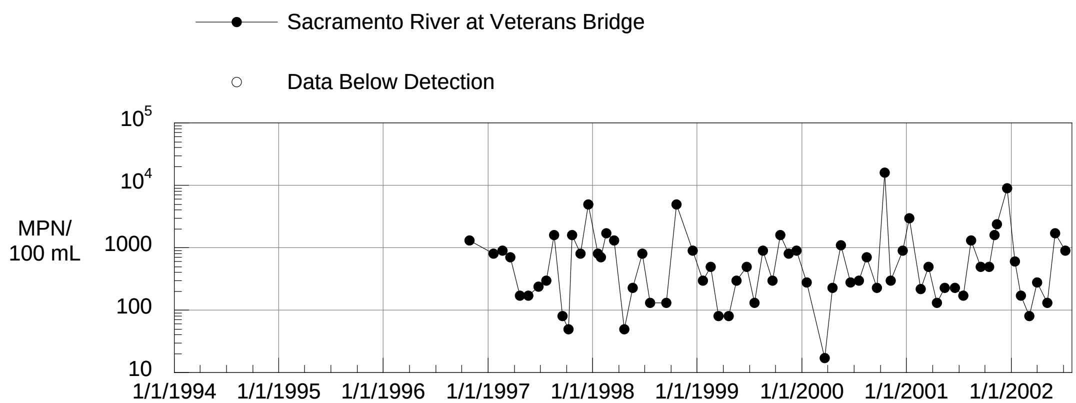

Colusa Basin Drain
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento Slough
Data Below Detection
MPN/
100 mL
10^4
1000
100
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

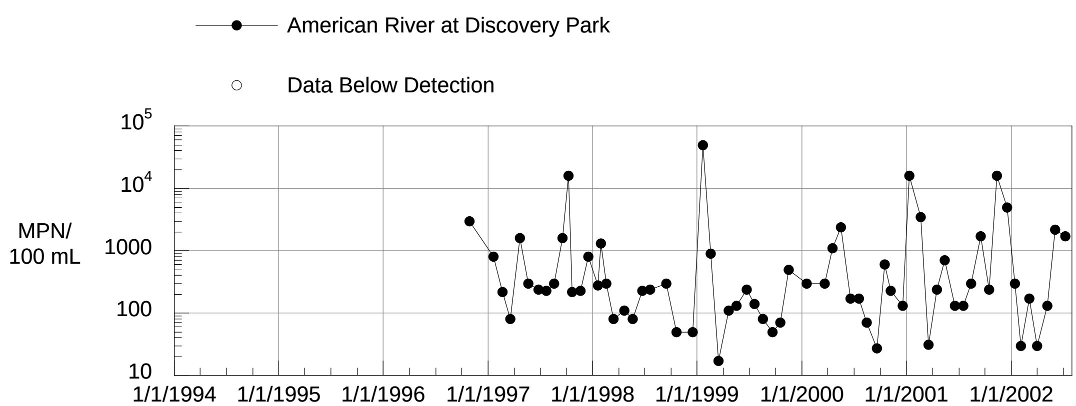

Yuba River at Marysville
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002



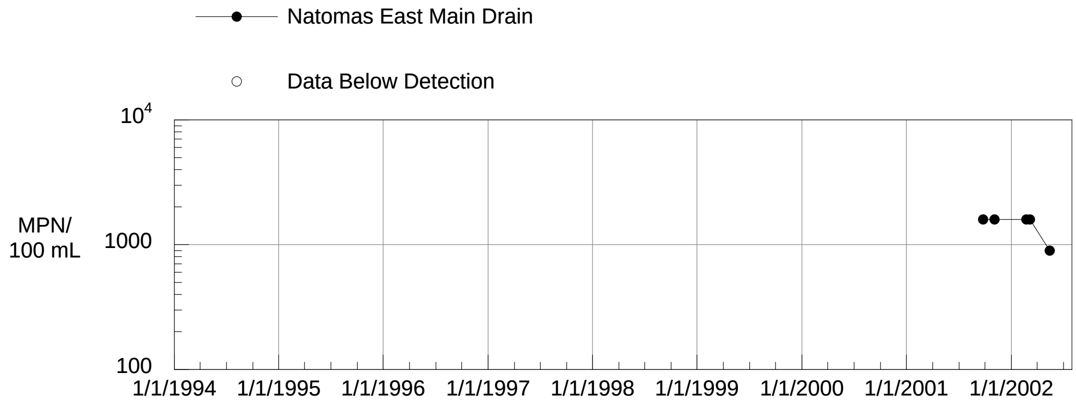
Feather River near Nicolaus
Data Below Detection
MPN/ 100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

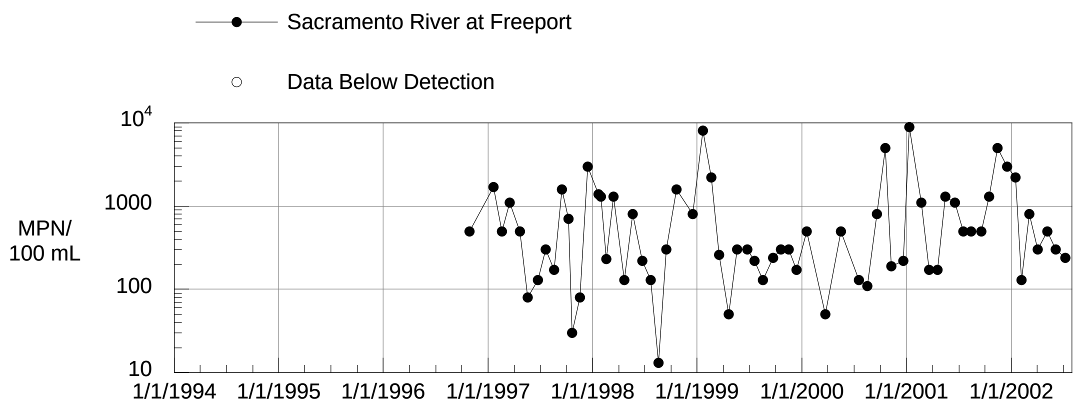


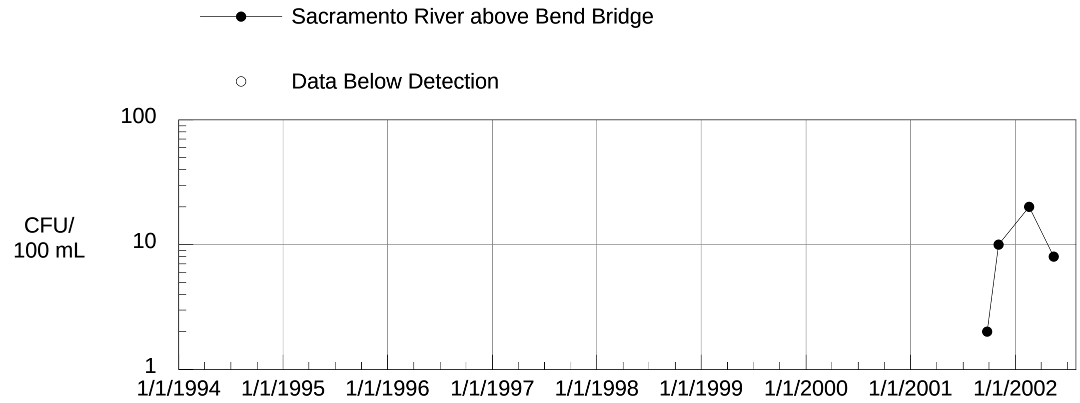
Sacramento River at Veterans Bridge
Data Below Detection
MPN/ 100 mL
10^5
10^4
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

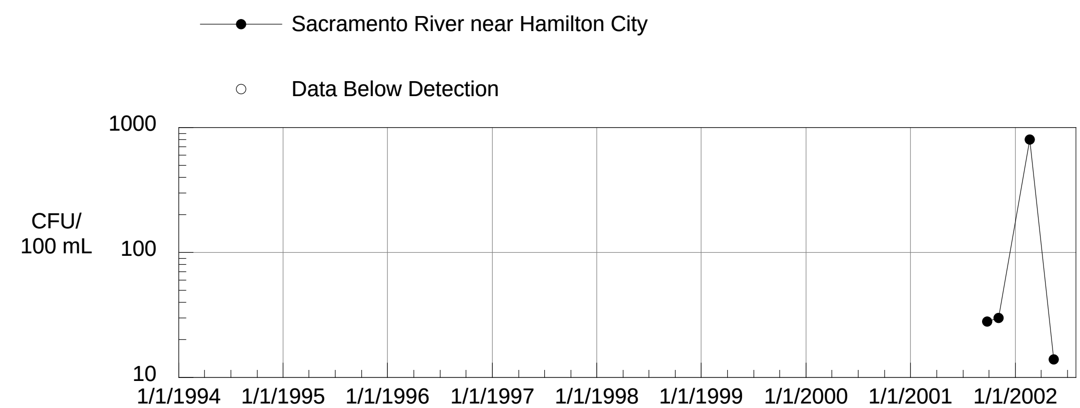


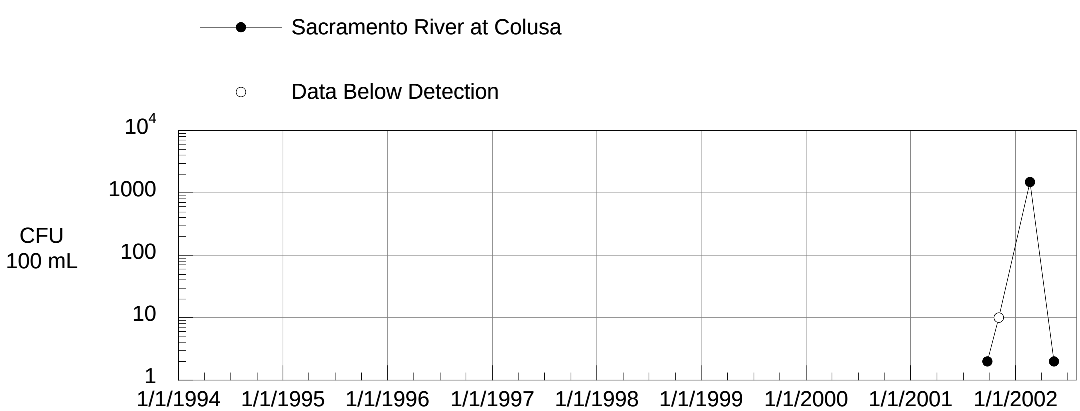
American River at Discovery Park
Data Below Detection
MPN/ 100 mL
10^5
10^4
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

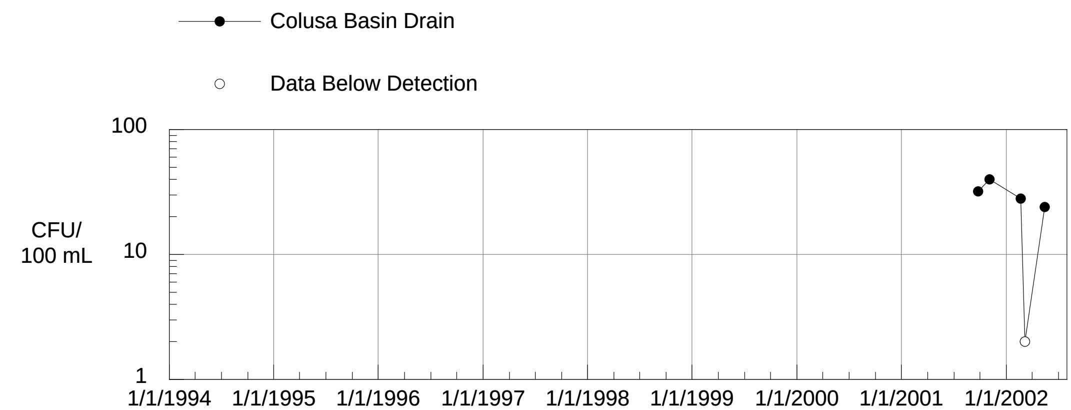

Natomas East Main Drain
Data Below Detection
10^4
1000
100
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

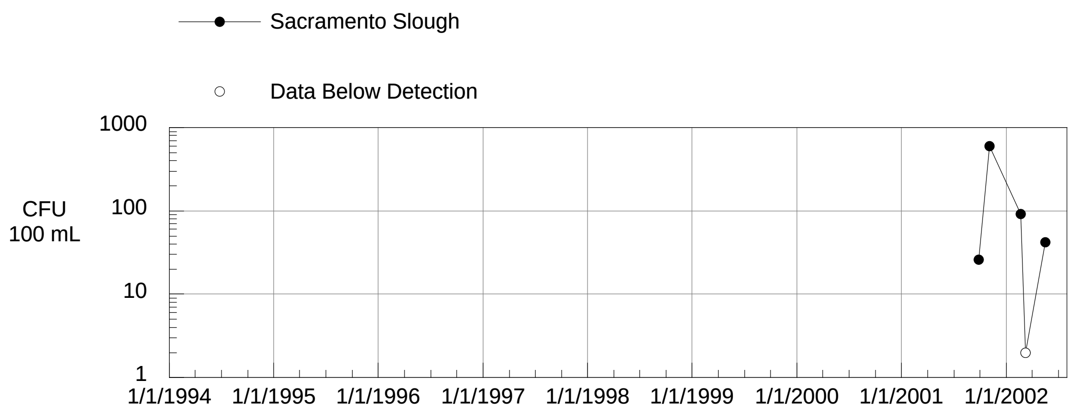

Sacramento River at Freeport
Data Below Detection
10^4
1000
100
10
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

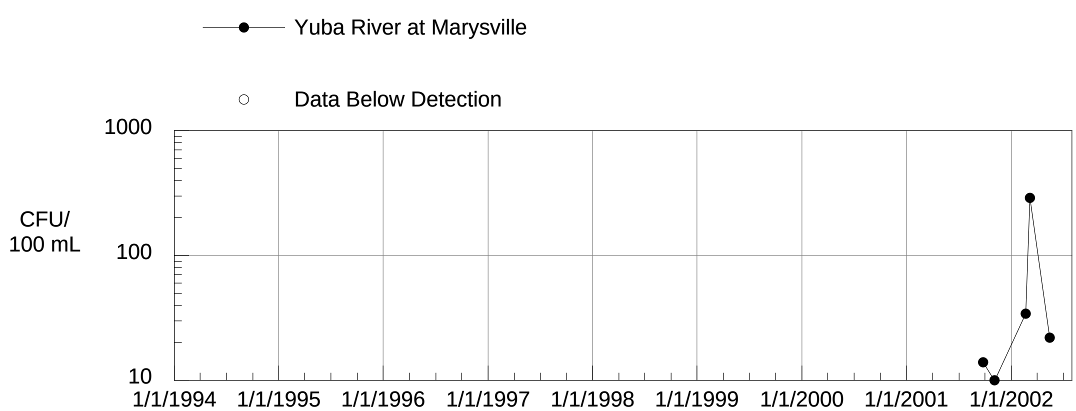

Sacramento River above Bend Bridge
Data Below Detection
CFU/
100 mL
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

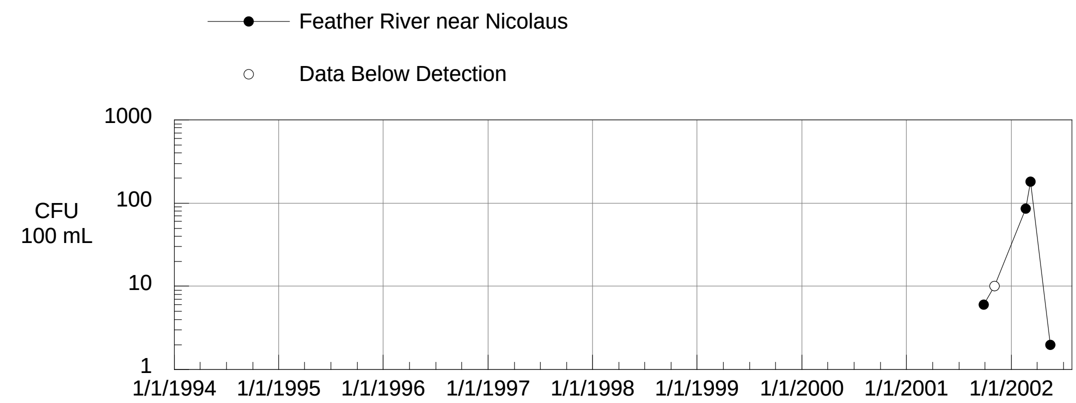

Sacramento River near Hamilton City
Data Below Detection
CFU/
100 mL
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

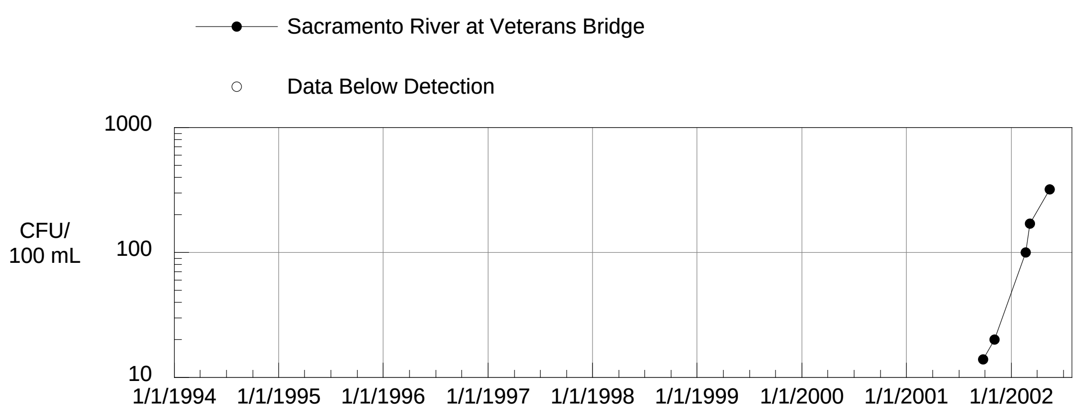

Sacramento River at Colusa
Data Below Detection
CFU
100 mL
10^4
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

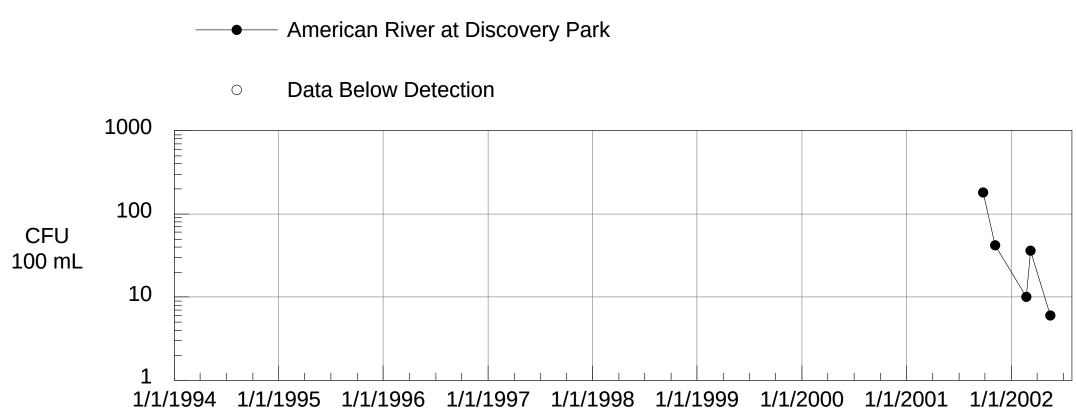

Colusa Basin Drain
Data Below Detection
CFU/ 100 mL
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

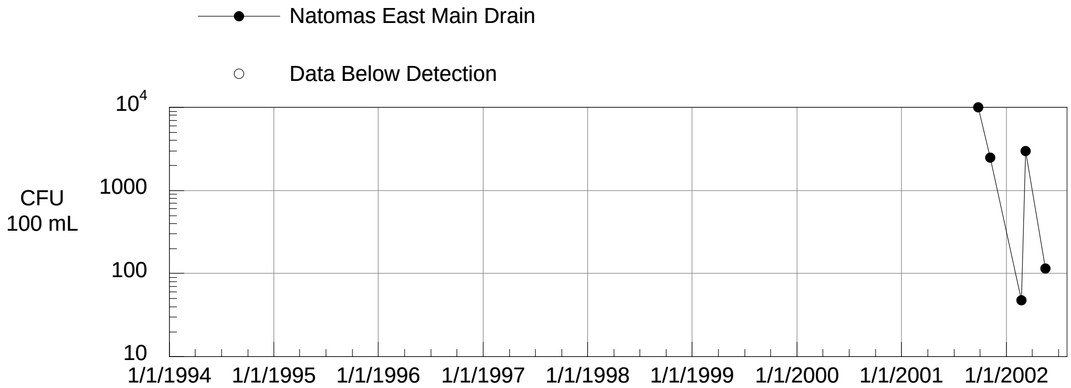

Sacramento Slough
Data Below Detection
CFU 100 mL
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

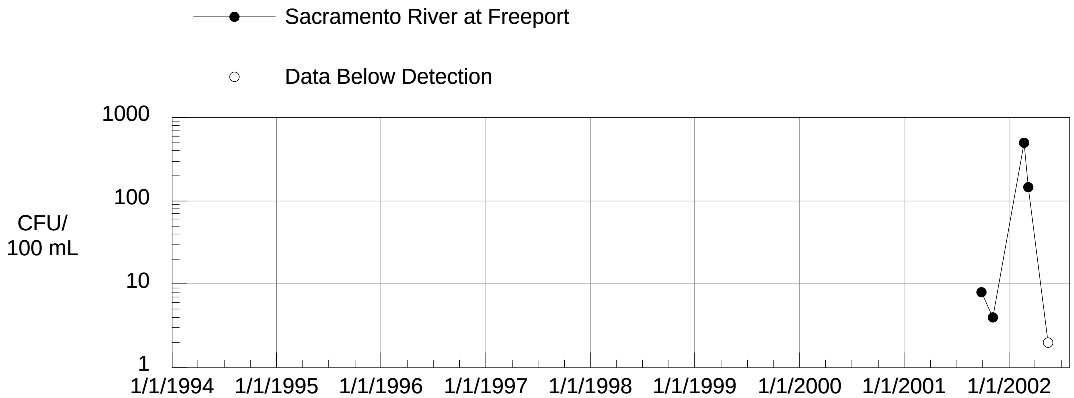

Yuba River at Marysville
Data Below Detection
CFU/ 100 mL
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

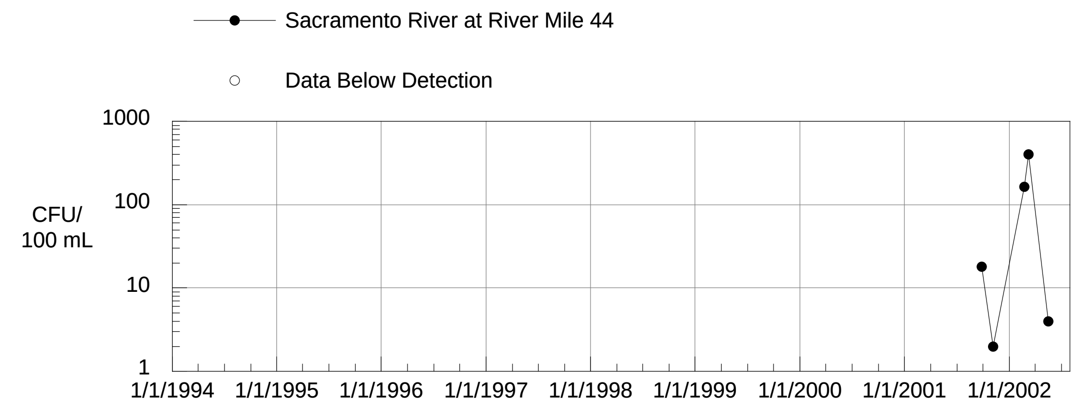

Feather River near Nicolaus
Data Below Detection
1000
100
10
1
CFU
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

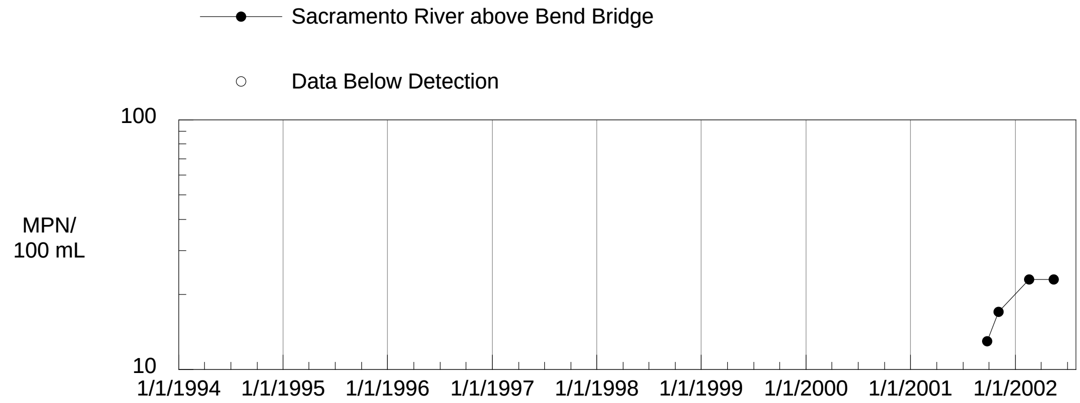

Sacramento River at Veterans Bridge
Data Below Detection
1000
100
10
CFU/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

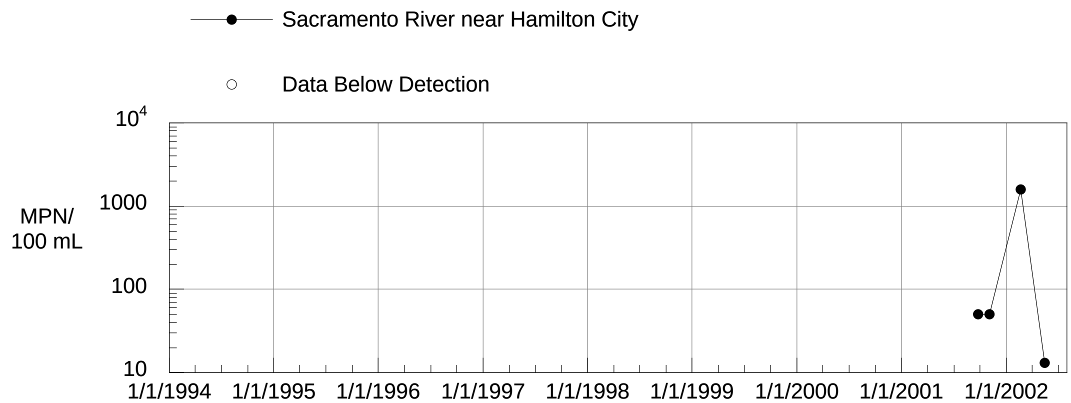

American River at Discovery Park
Data Below Detection
1000
100
10
1
CFU
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

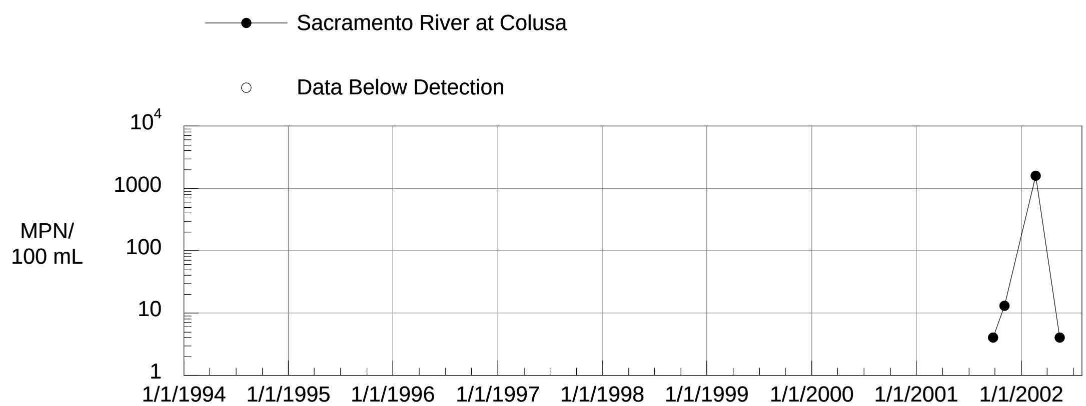

Natomas East Main Drain
Data Below Detection
10^4
1000
100
10
CFU
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

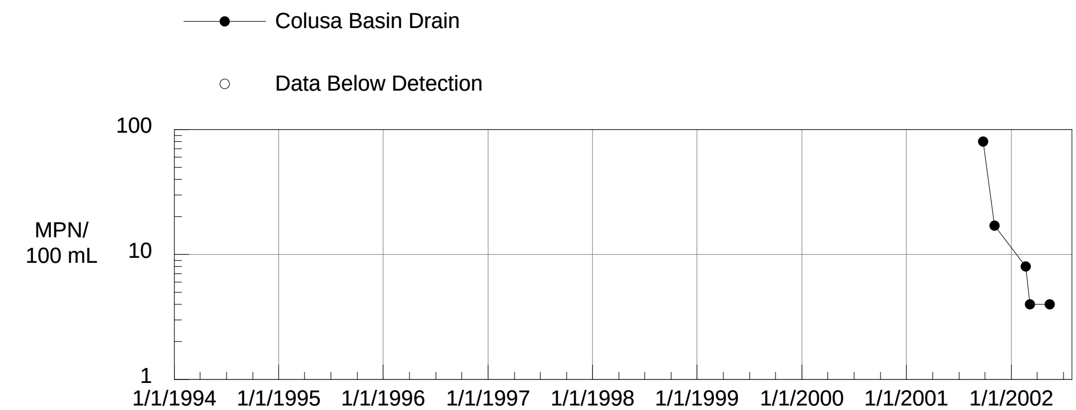

Sacramento River at Freeport
Data Below Detection
1000
100
10
1
CFU/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at River Mile 44
Data Below Detection
1000
100
10
1
CFU/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

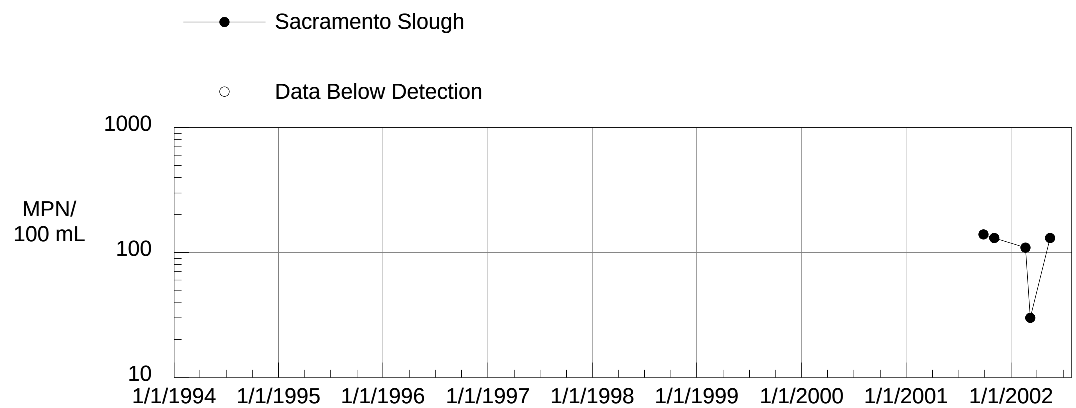

Sacramento River above Bend Bridge
Data Below Detection
100
MPN/
100 mL
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River near Hamilton City
Data Below Detection
10^4
1000
MPN/
100 mL
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

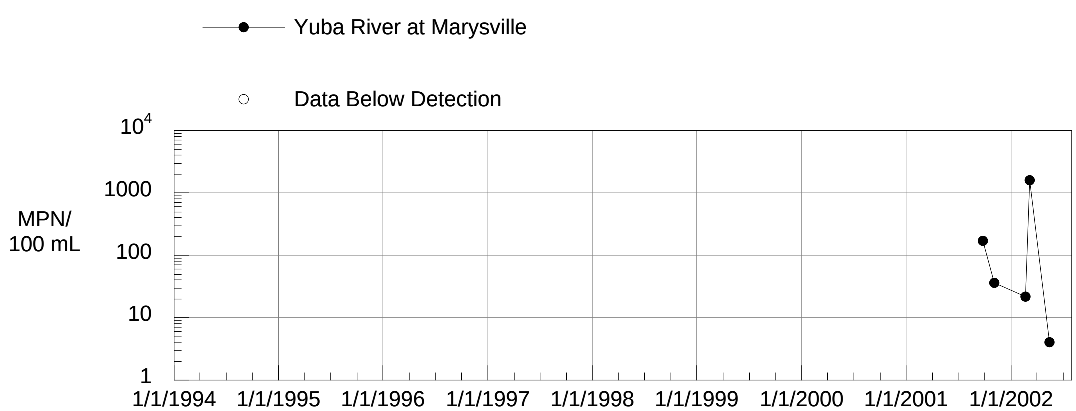

Sacramento River at Colusa
Data Below Detection
10^4
1000
MPN/
100 mL
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002



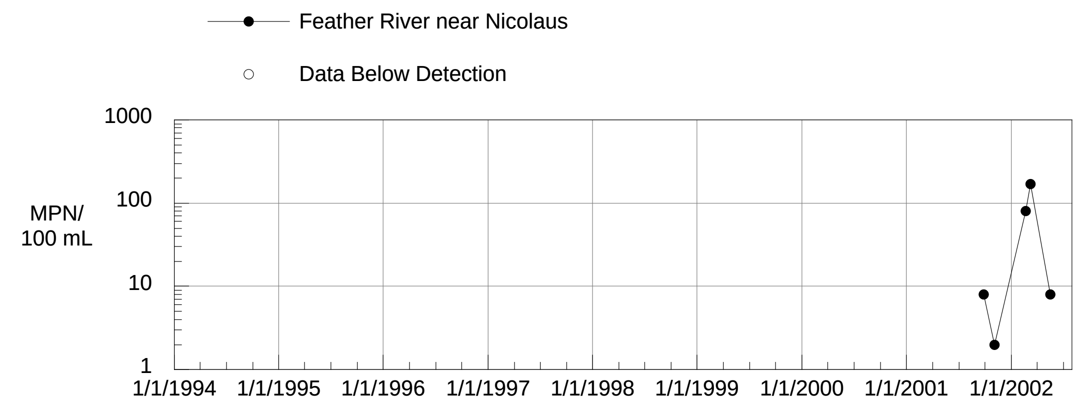
Colusa Basin Drain
Data Below Detection
100
10
1
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

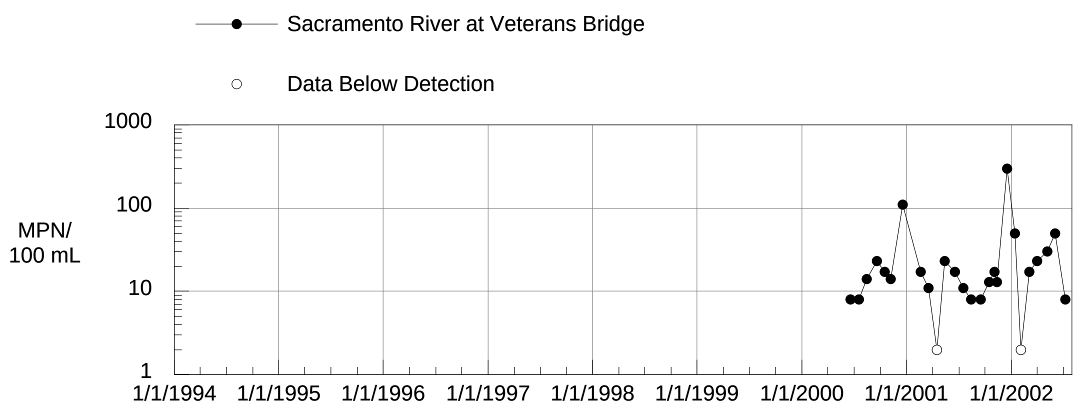


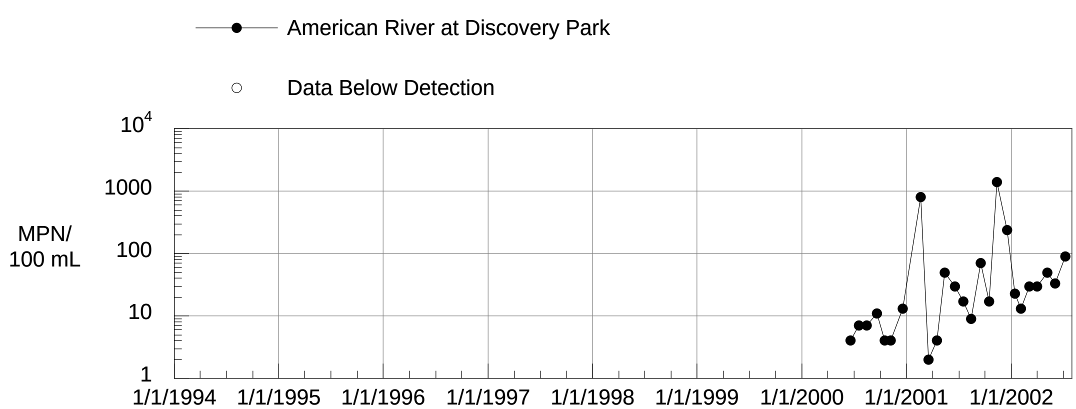
Sacramento Slough
Data Below Detection
1000
100
10
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

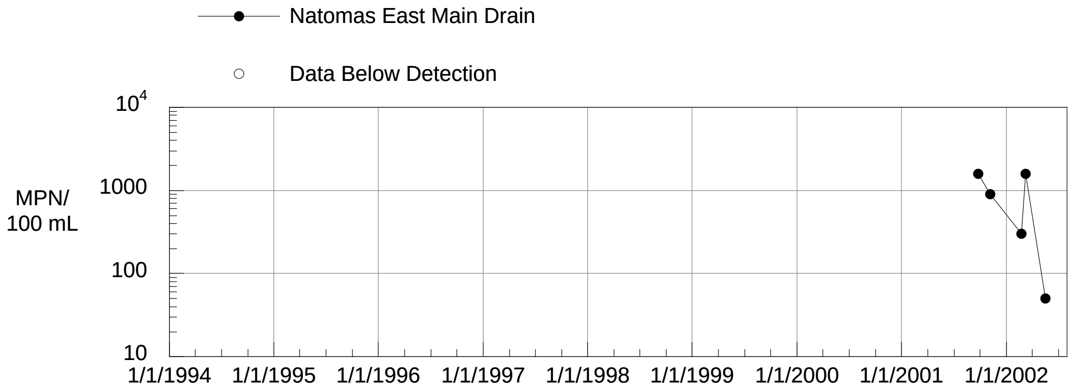


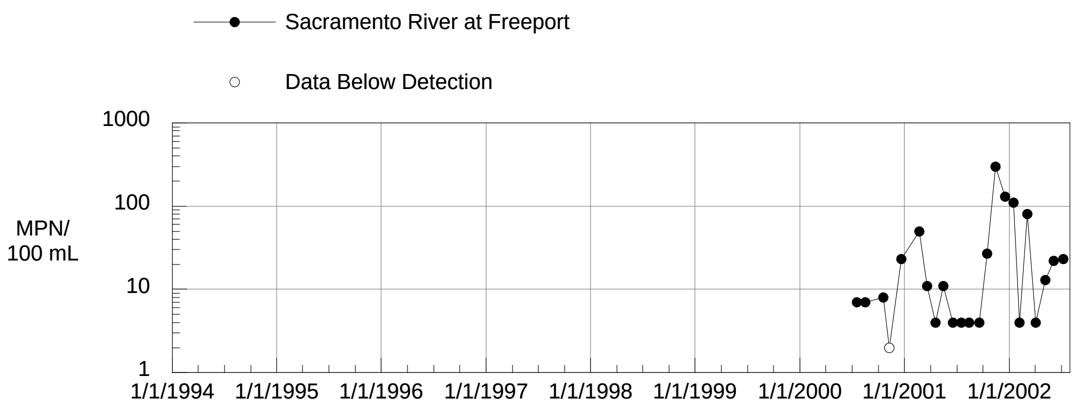
Yuba River at Marysville
Data Below Detection
10^4
1000
100
10
1
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Feather River near Nicolaus
Data Below Detection
1000
100
10
1
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

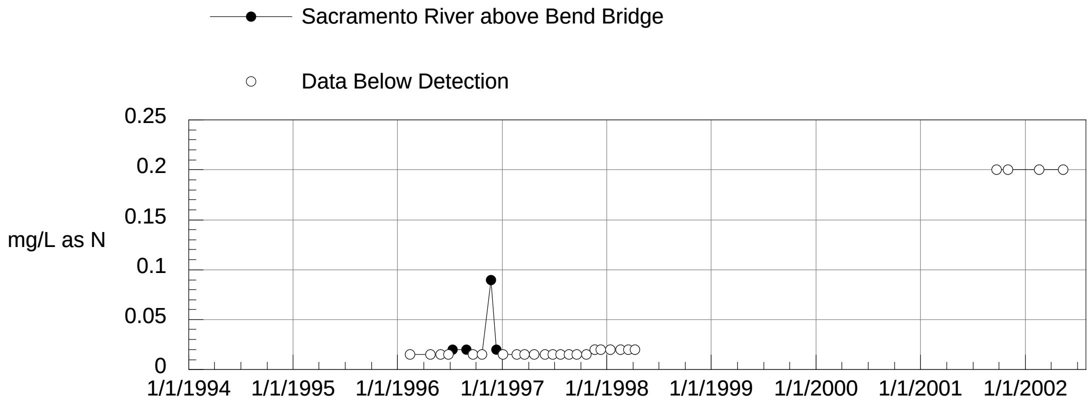

Sacramento River at Veterans Bridge
Data Below Detection
1000
100
10
1
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


American River at Discovery Park
Data Below Detection
10^4
1000
100
10
1
MPN/
100 mL
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

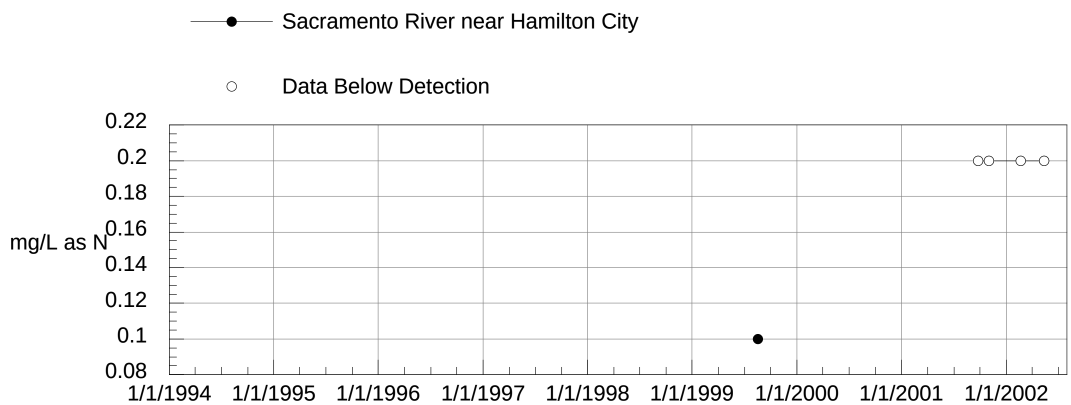

Natomas East Main Drain
Data Below Detection
MPN/
100 mL
10^4
1000
100
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at Freeport
Data Below Detection
MPN/
100 mL
1000
100
10
1
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

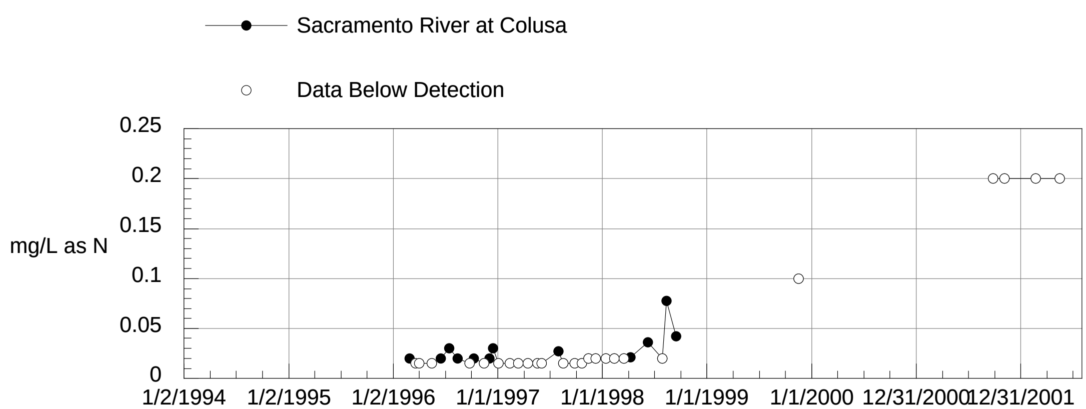
Time Series Plots of Monitoring Data: Nutrients



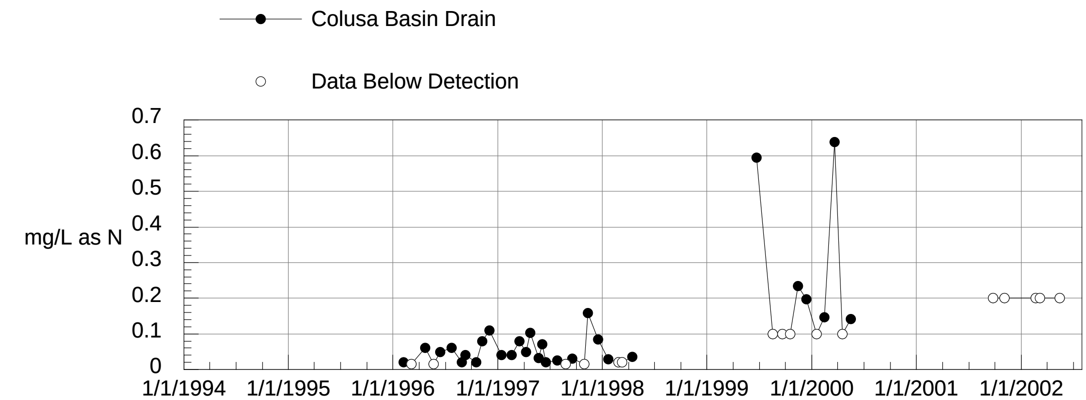
Sacramento River above Bend Bridge
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

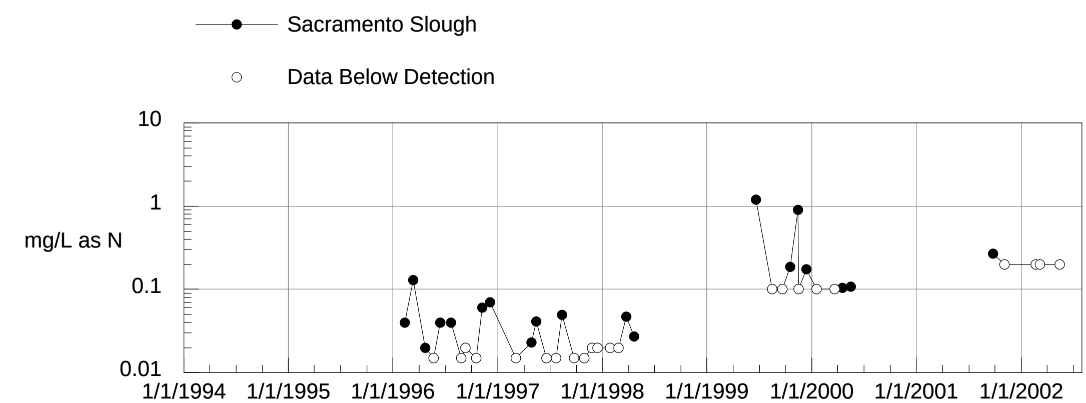


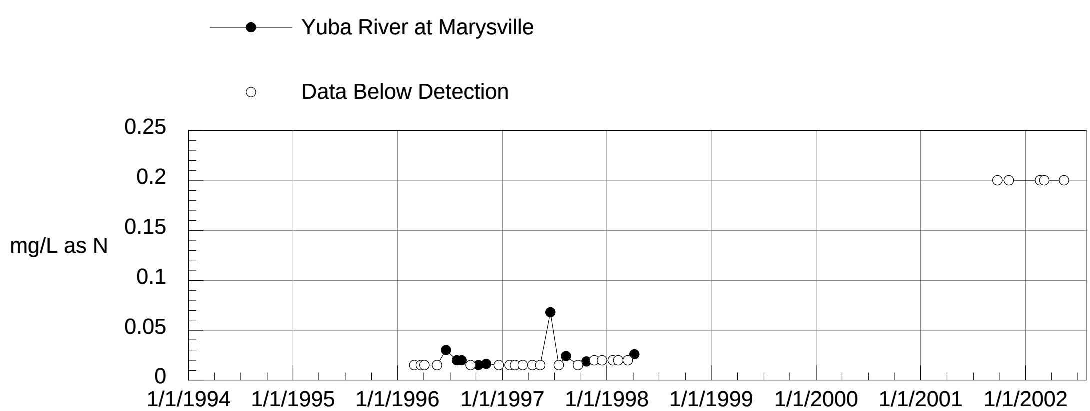
Sacramento River near Hamilton City
Data Below Detection
mg/L as N
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

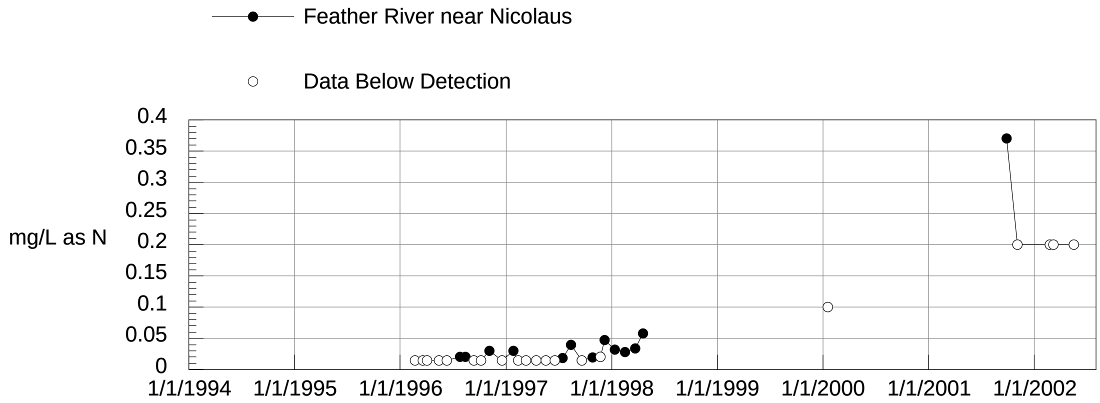


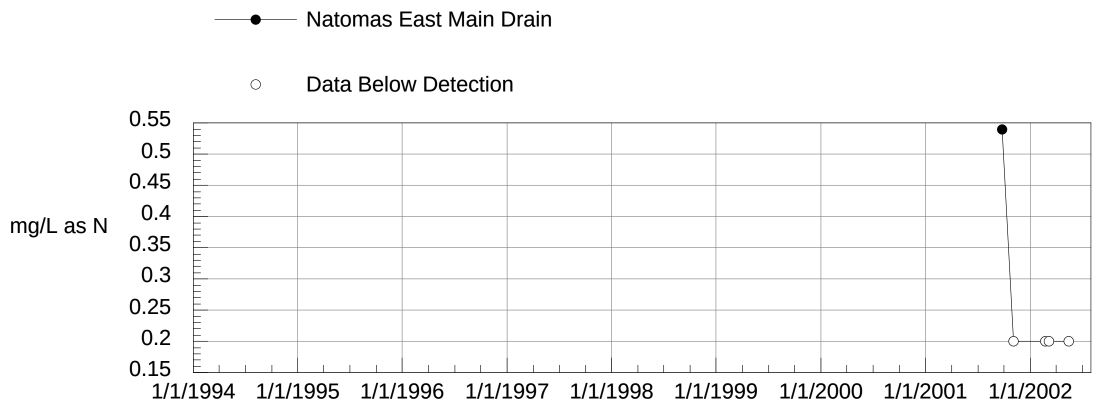
Sacramento River at Colusa
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
0
1/2/1994
1/2/1995
1/2/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
12/31/2000
12/31/2001

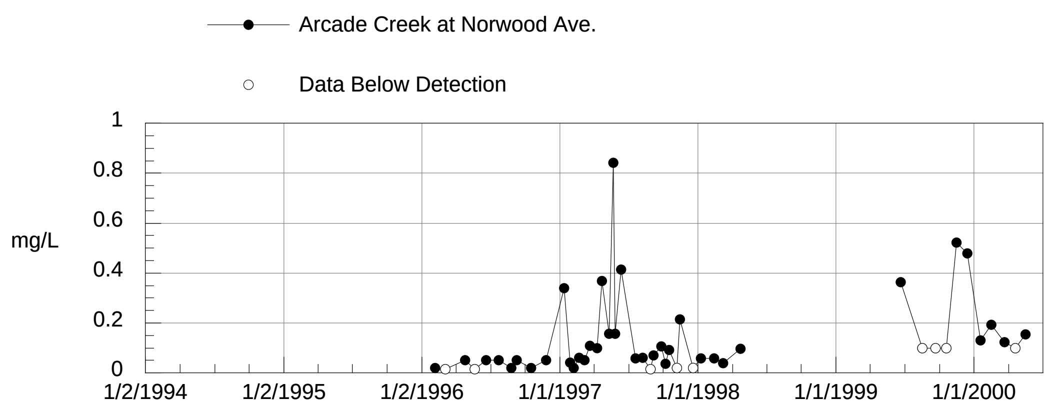

Colusa Basin Drain
Data Below Detection
mg/L as N
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

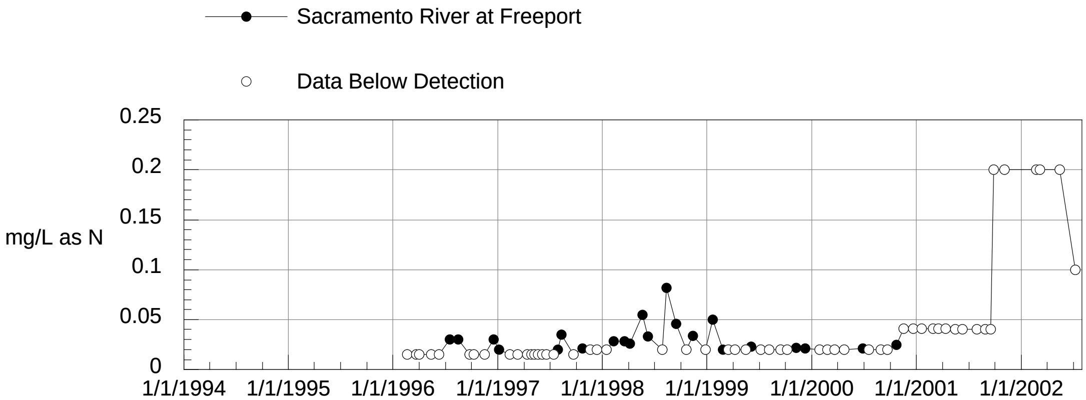

Sacramento Slough
Data Below Detection
mg/L as N
10
1
0.1
0.01
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

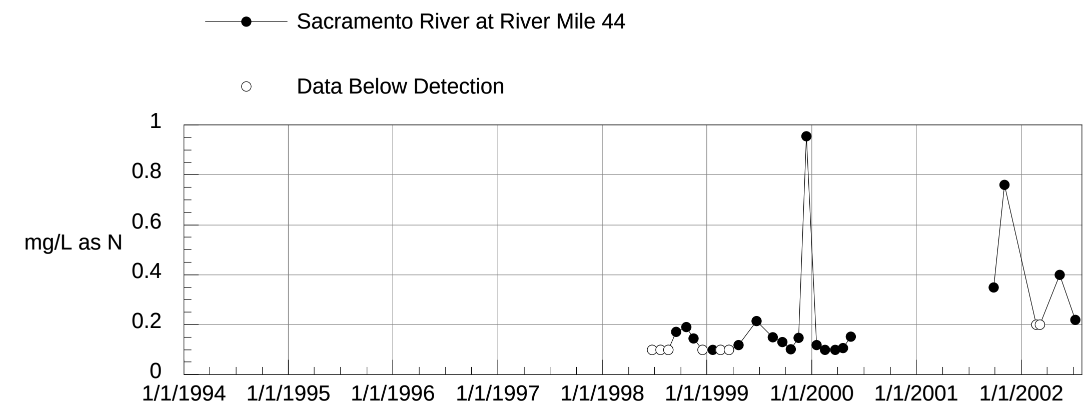

Yuba River at Marysville
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

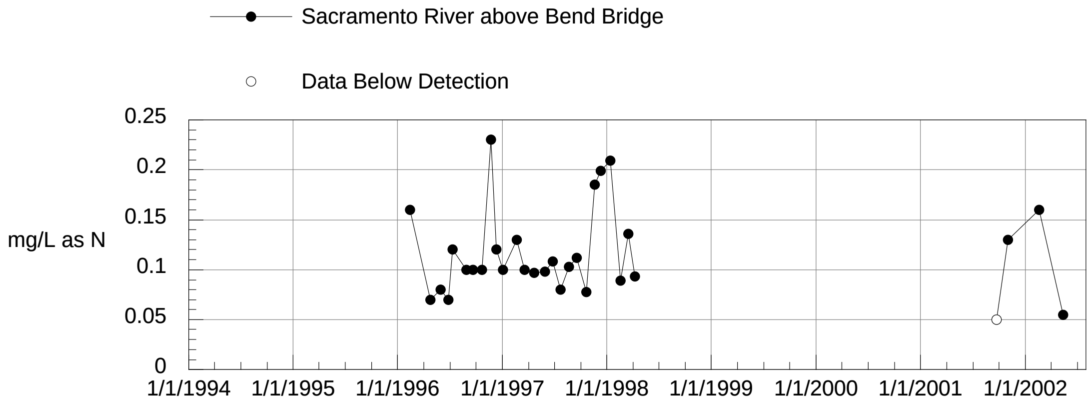

Feather River near Nicolaus
Data Below Detection
mg/L as N
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

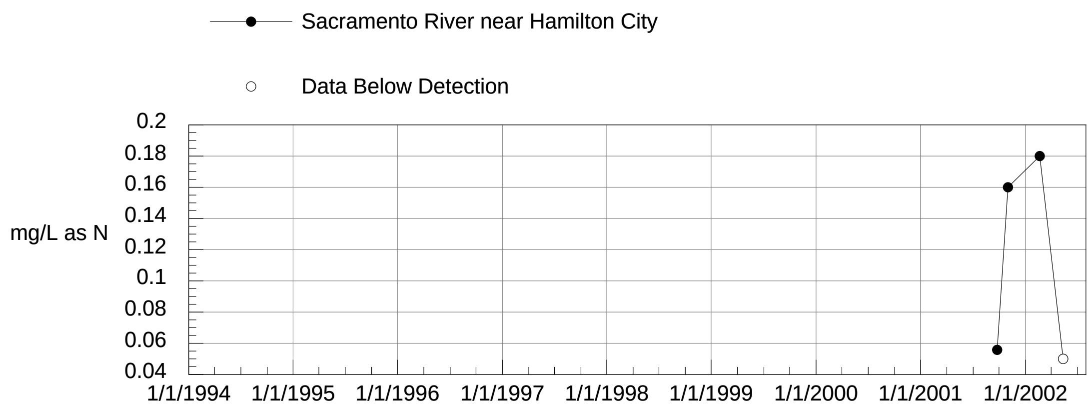

Natomas East Main Drain
Data Below Detection
mg/L as N
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

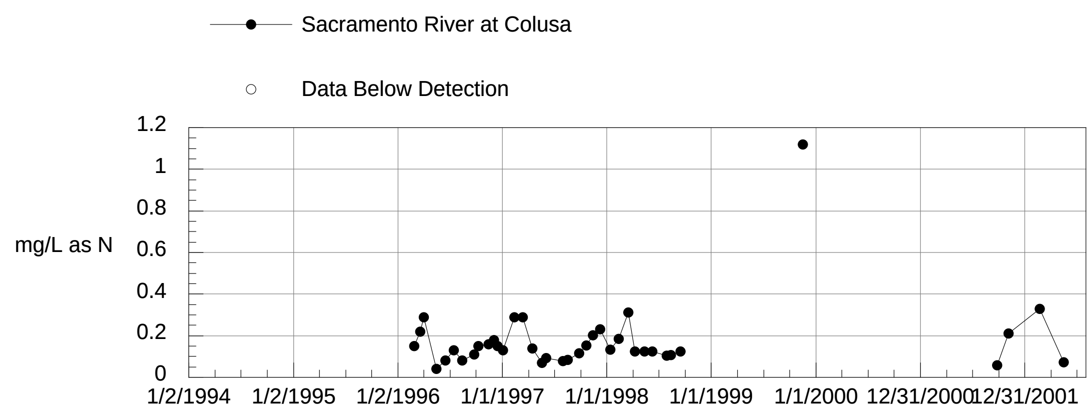

Arcade Creek at Norwood Ave.
Data Below Detection
mg/L
1
0.8
0.6
0.4
0.2
0
1/2/1994
1/2/1995
1/2/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000

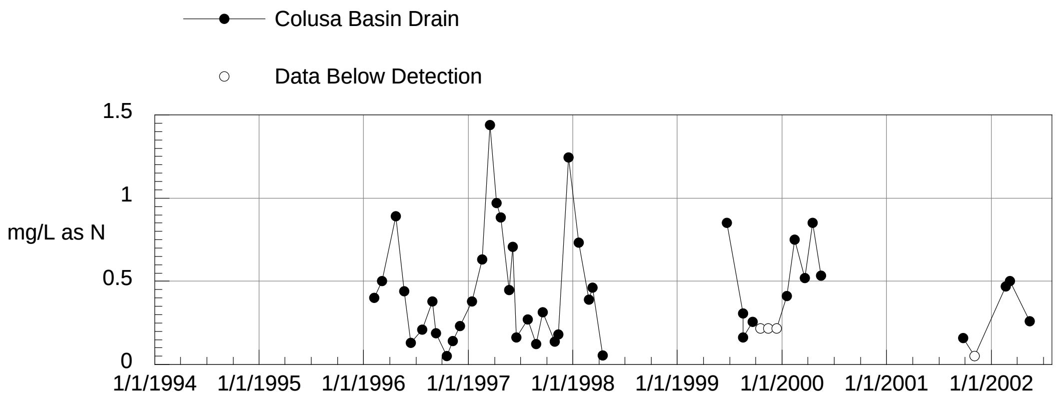

Sacramento River at Freeport
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

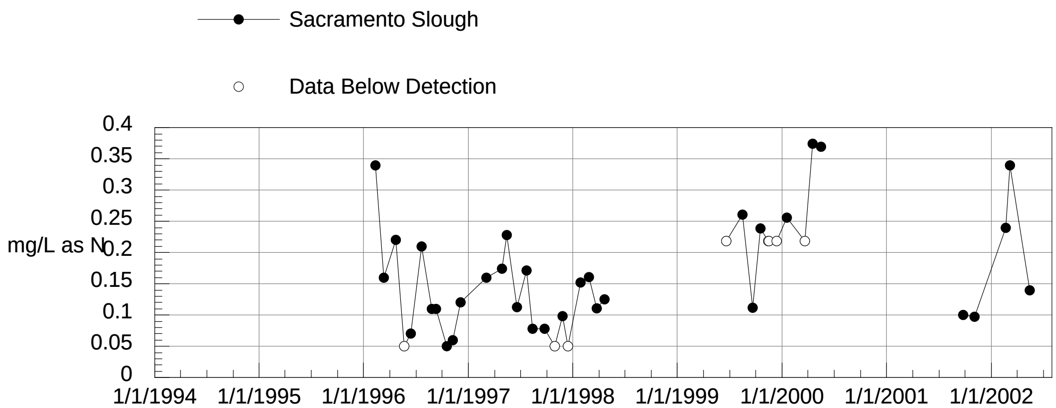

Sacramento River at River Mile 44
Data Below Detection
mg/L as N
1
0.8
0.6
0.4
0.2
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

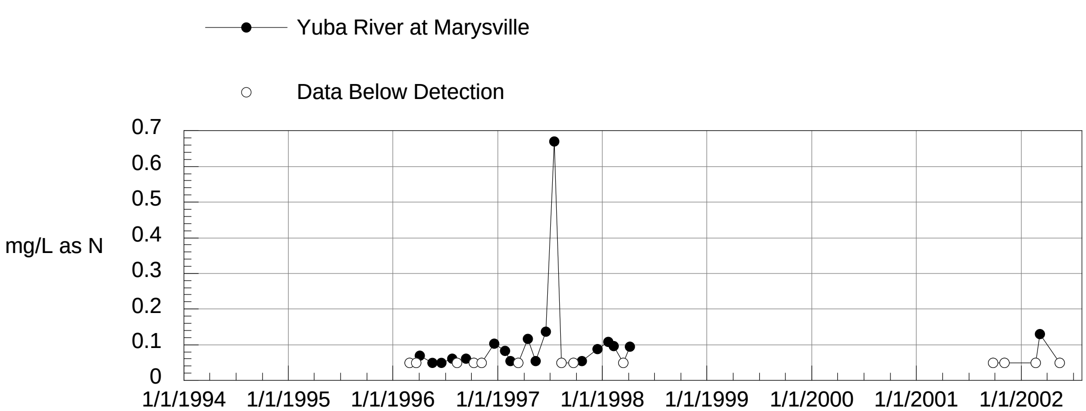

Sacramento River above Bend Bridge
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River near Hamilton City
Data Below Detection
mg/L as N
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

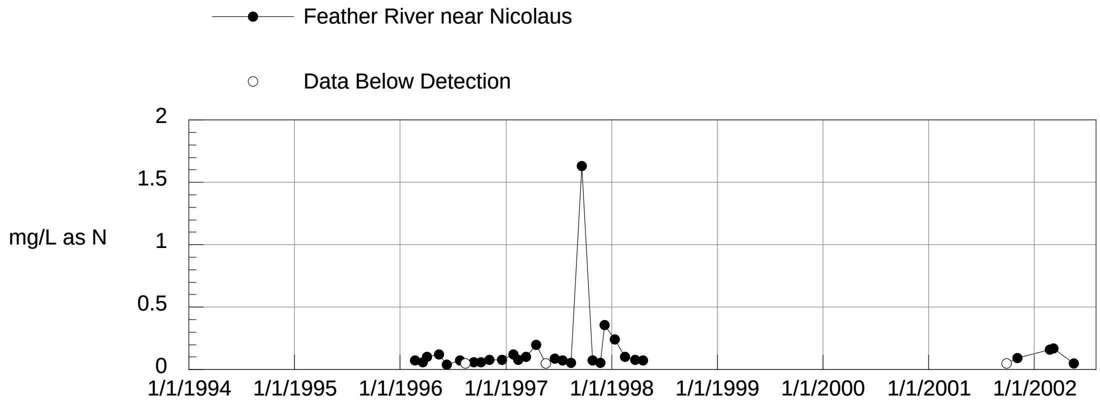

Sacramento River at Colusa
Data Below Detection
mg/L as N
1.2
1
0.8
0.6
0.4
0.2
0
1/2/1994
1/2/1995
1/2/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
12/31/2000
12/31/2001

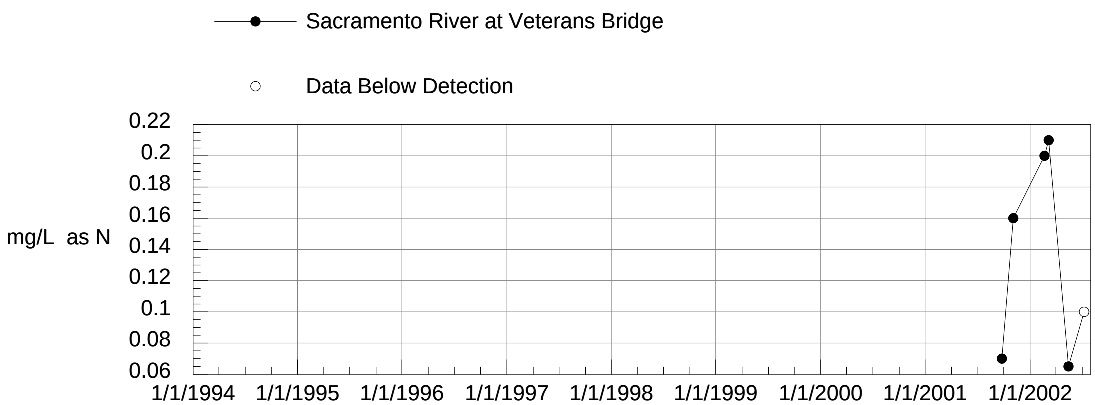

Colusa Basin Drain
Data Below Detection
mg/L as N
1.5
1
0.5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

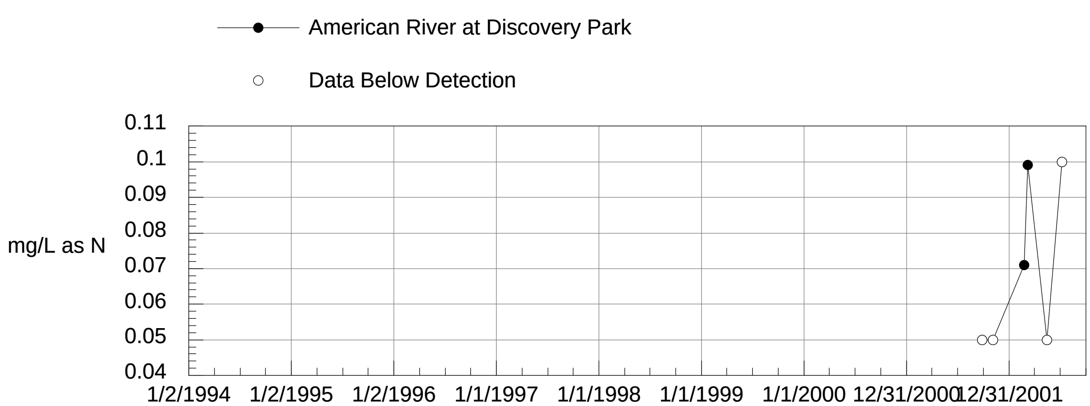

Sacramento Slough
Data Below Detection
mg/L as N
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

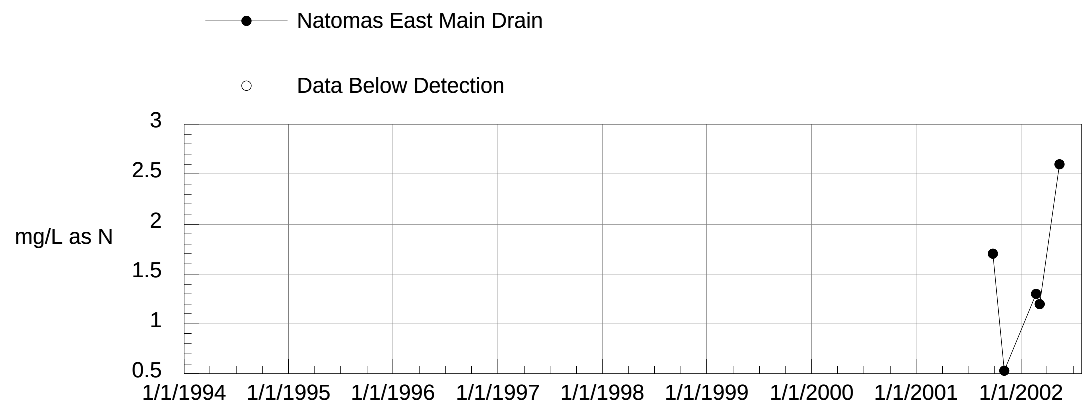

Yuba River at Marysville
Data Below Detection
mg/L as N
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

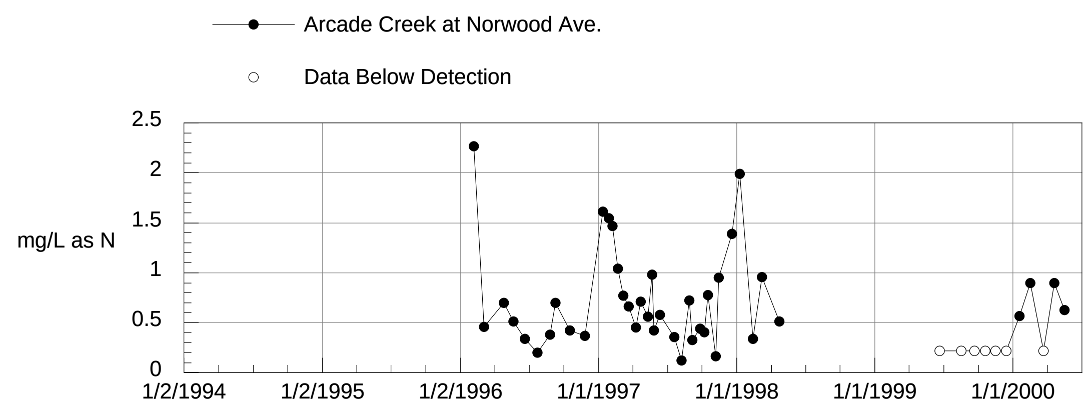
NITRATE CONCENTRATIONS IN WATER

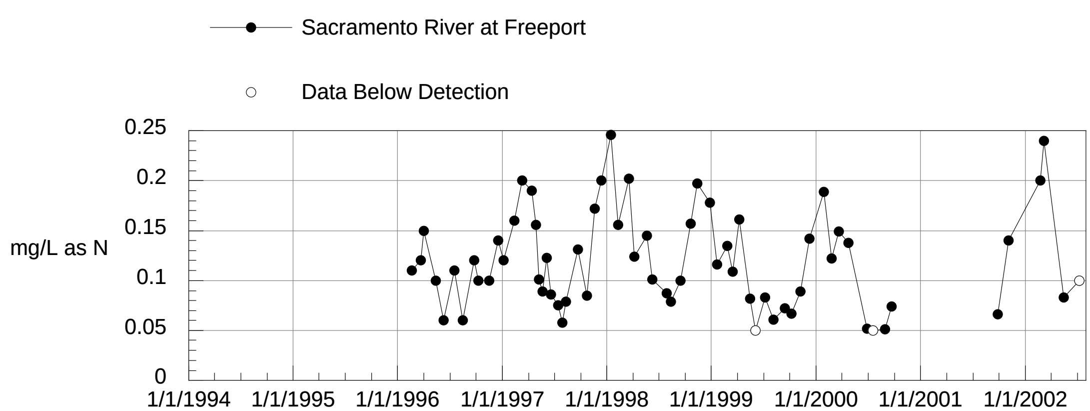


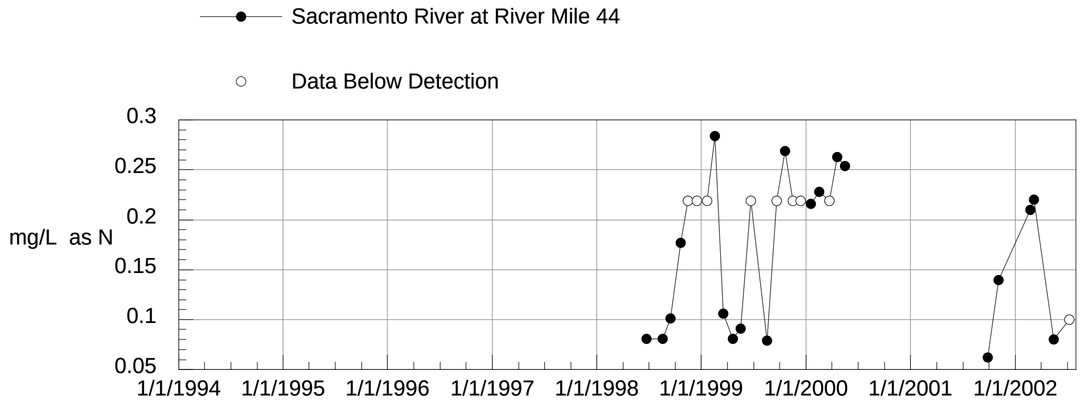


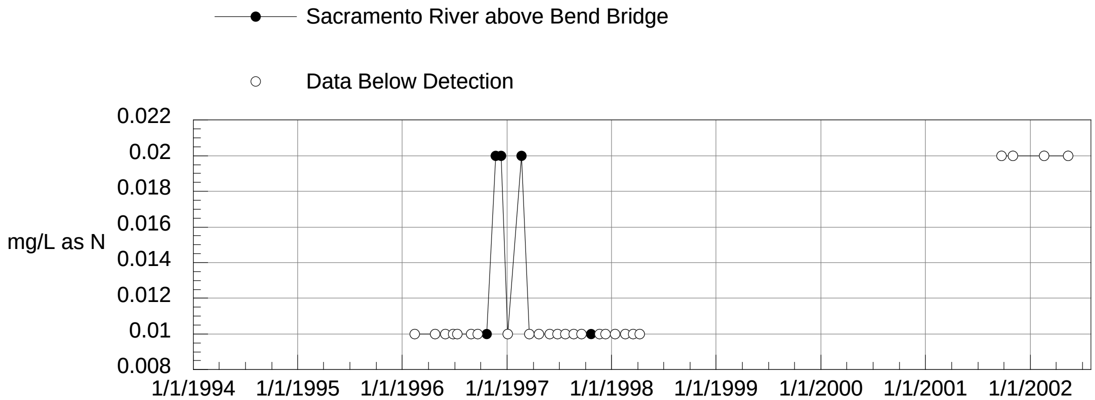


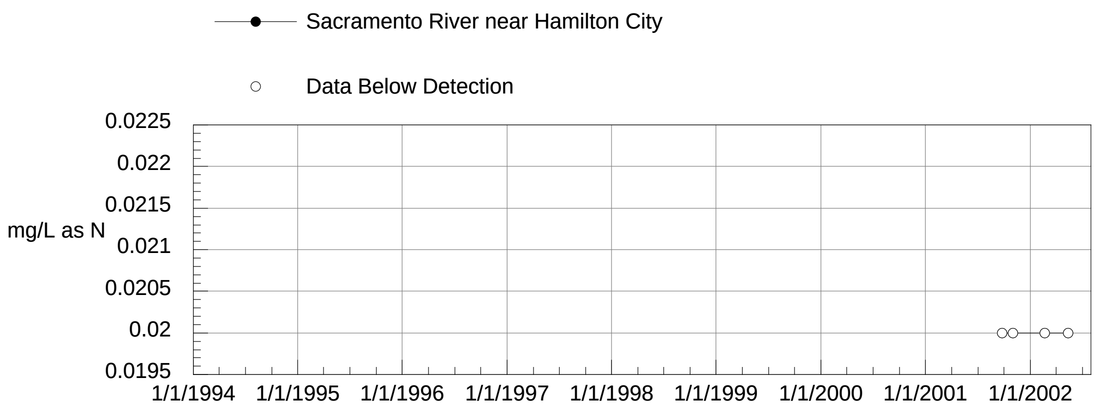

Natomas East Main Drain
Data Below Detection
mg/L as N
3
2.5
2
1.5
1
0.5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

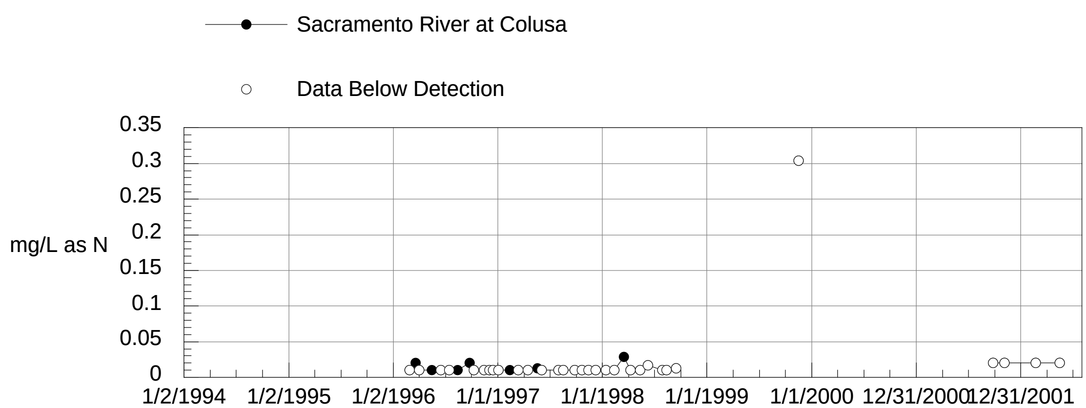

Arcade Creek at Norwood Ave.
Data Below Detection
mg/L as N
2.5
2
1.5
1
0.5
0
1/2/1994
1/2/1995
1/2/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000

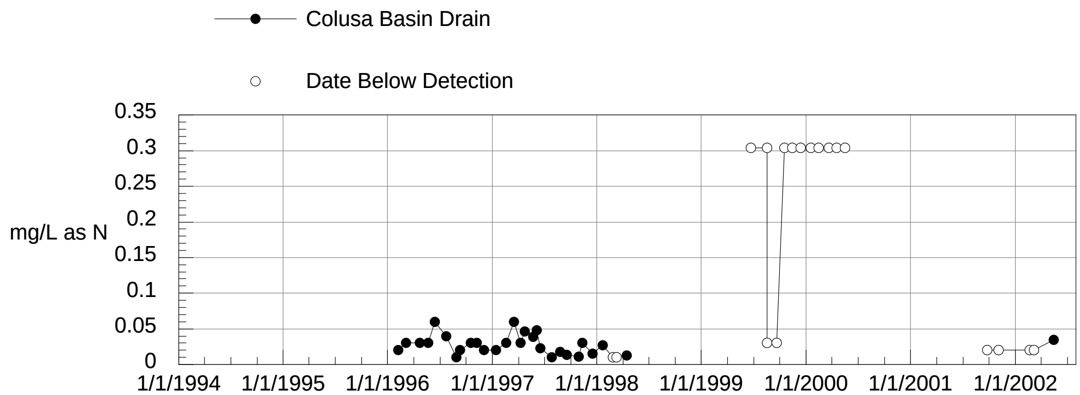

Sacramento River at Freeport
Data Below Detection
mg/L as N
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

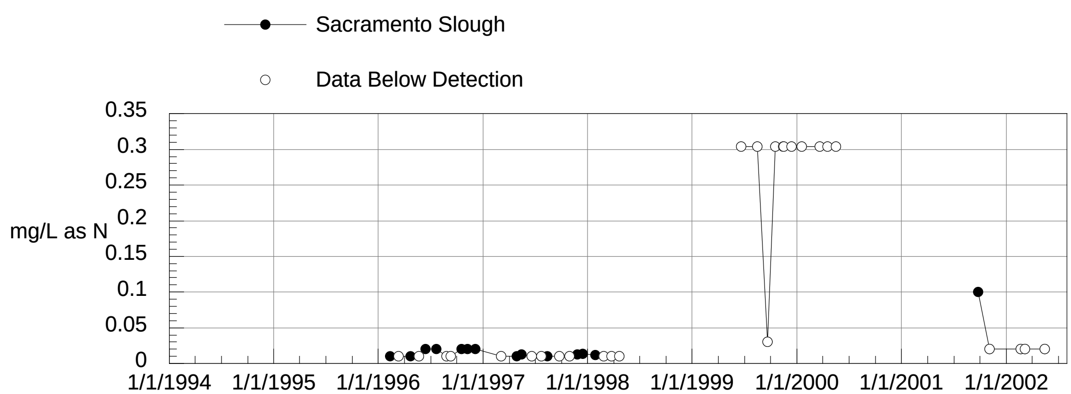

Sacramento River at River Mile 44
Data Below Detection
mg/L as N
0.3
0.25
0.2
0.15
0.1
0.05
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

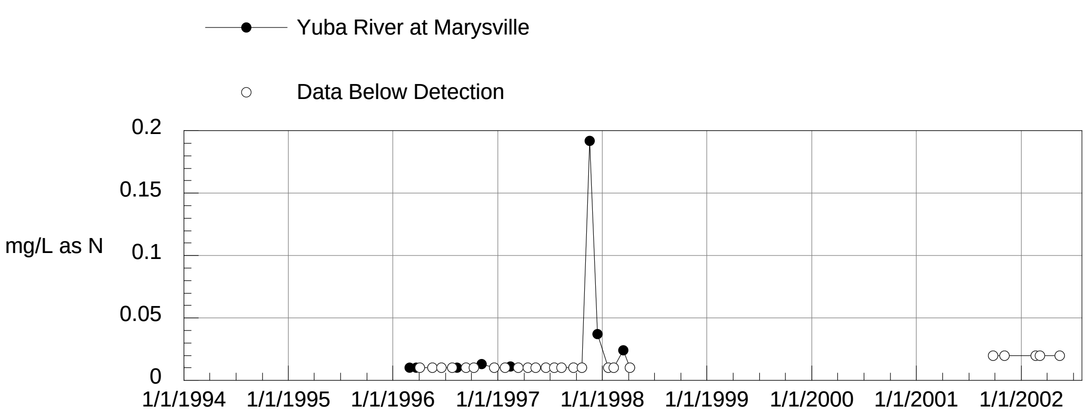

Sacramento River above Bend Bridge
Data Below Detection
0.022
0.02
0.018
0.016
0.014
0.012
0.01
0.008
mg/L as N
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

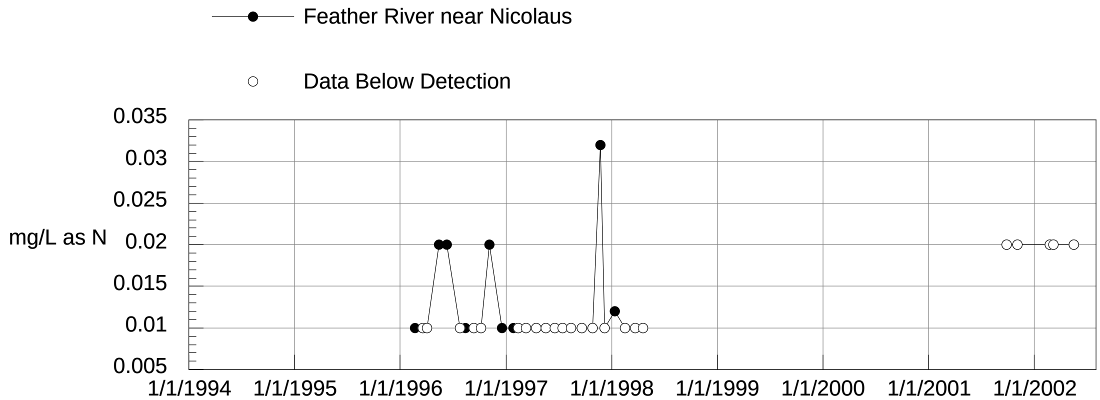

Sacramento River near Hamilton City
Data Below Detection
0.0225
0.022
0.0215
0.021
0.0205
0.02
0.0195
mg/L as N
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

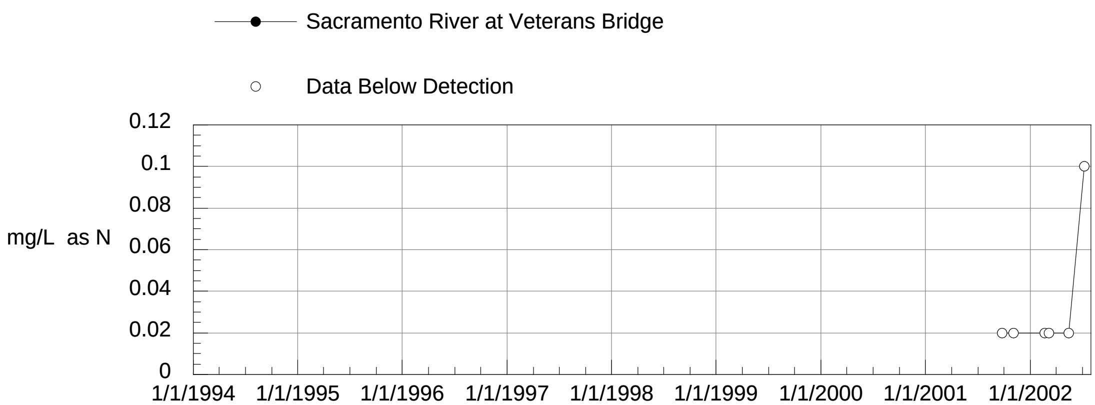

Sacramento River at Colusa
Data Below Detection
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
mg/L as N
1/2/1994
1/2/1995
1/2/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
12/31/2000
12/31/2001

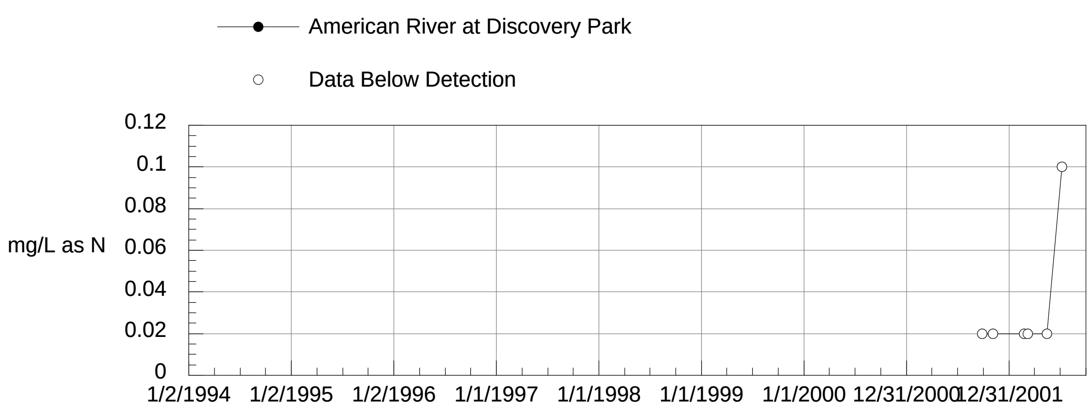

Colusa Basin Drain
Date Below Detection
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
mg/L as N
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

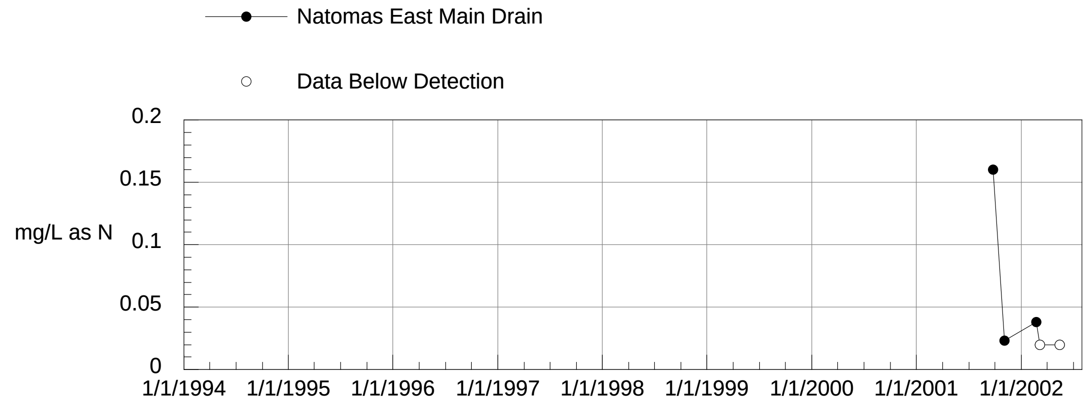

Sacramento Slough
Data Below Detection
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
mg/L as N
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

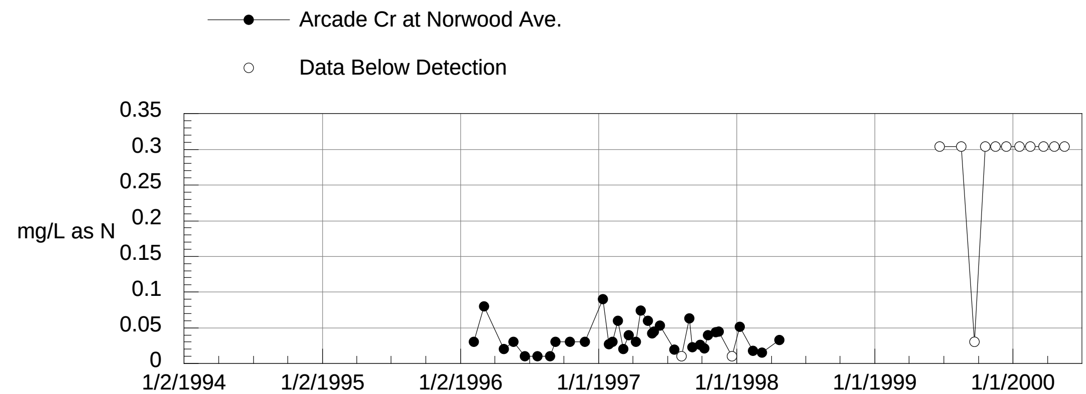

Yuba River at Marysville
Data Below Detection
0.2
0.15
0.1
0.05
0
mg/L as N
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

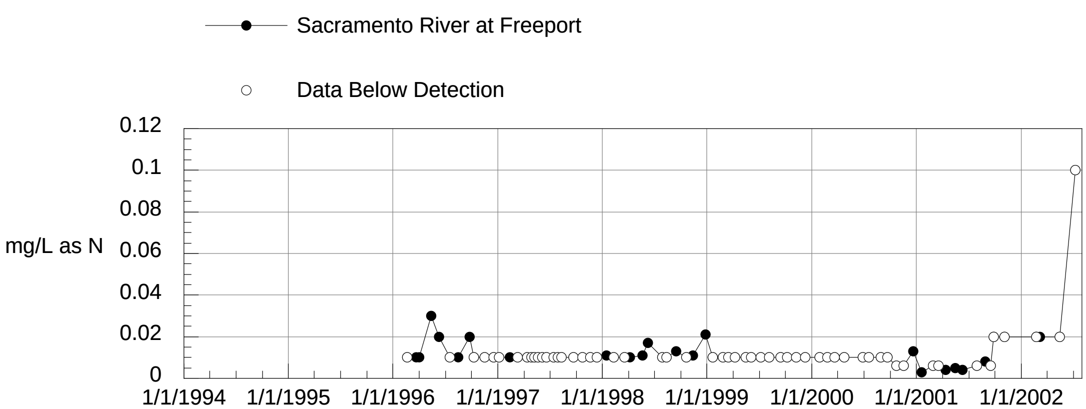

Feather River near Nicolaus
Data Below Detection
mg/L as N
0.035
0.03
0.025
0.02
0.015
0.01
0.005
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

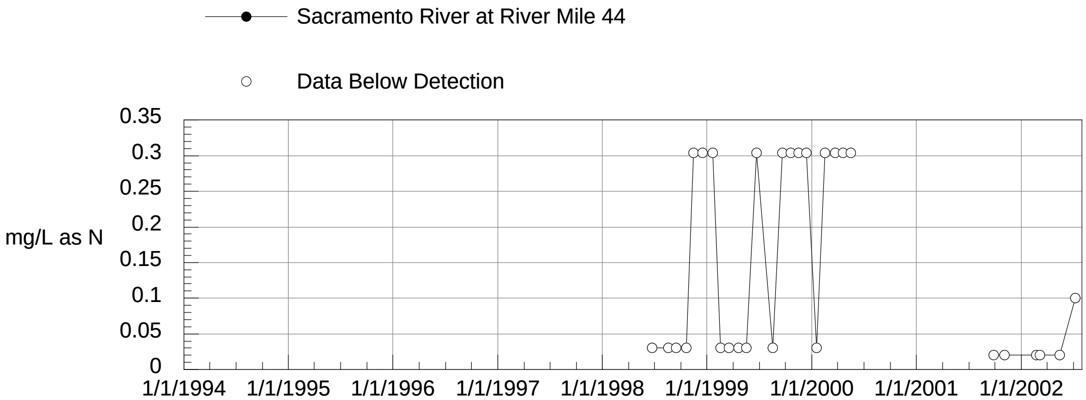

Sacramento River at Veterans Bridge
Data Below Detection
mg/L as N
0.12
0.1
0.08
0.06
0.04
0.02
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


American River at Discovery Park
Data Below Detection
mg/L as N
0.12
0.1
0.08
0.06
0.04
0.02
0
1/2/1994
1/2/1995
1/2/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
12/31/2000
12/31/2001


Natomas East Main Drain
Data Below Detection
mg/L as N
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

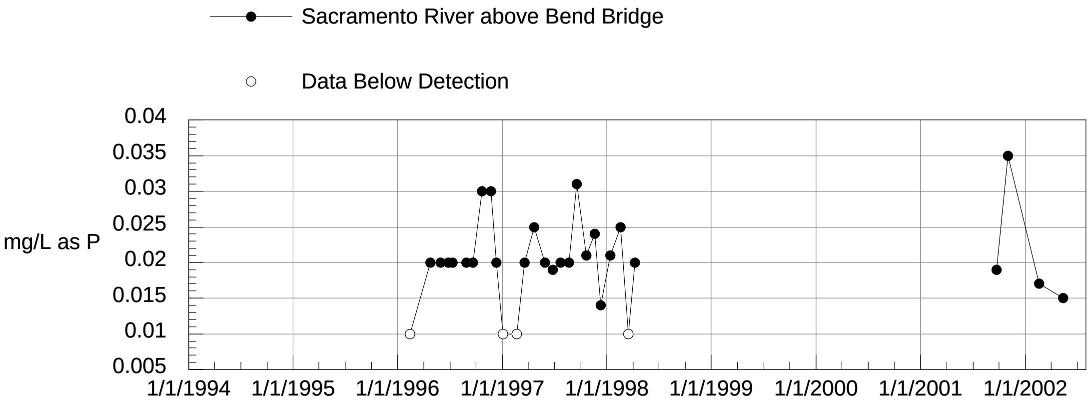

Arcade Cr at Norwood Ave.
Data Below Detection
mg/L as N
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1/2/1994
1/2/1995
1/2/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000

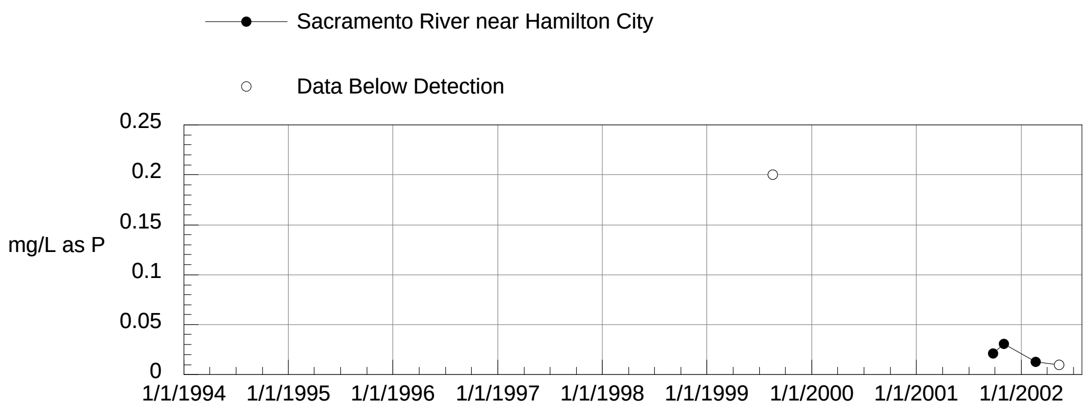

Sacramento River at Freeport
Data Below Detection
mg/L as N
0.12
0.1
0.08
0.06
0.04
0.02
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

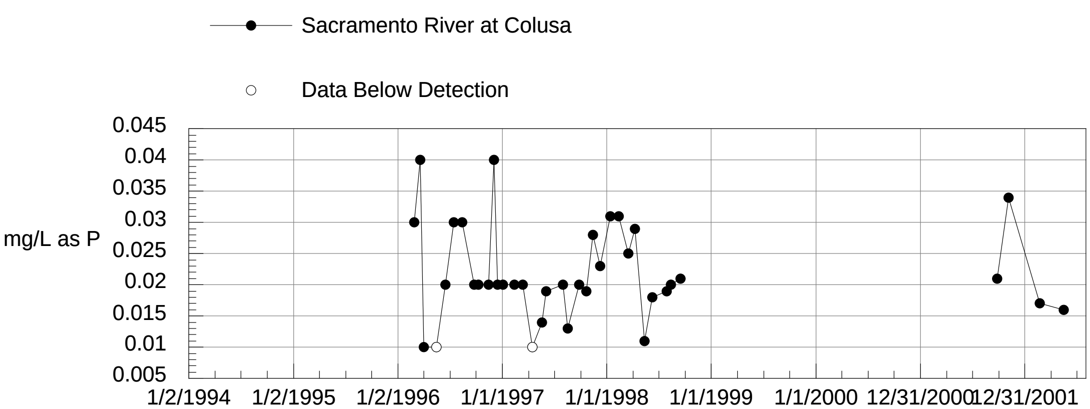


Sacramento River at River Mile 44
Data Below Detection
mg/L as N
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

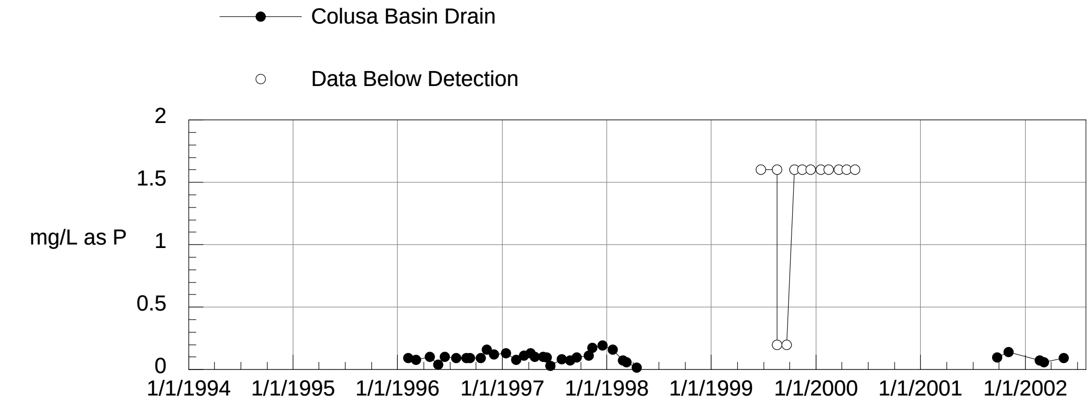
DISSOLVED ORTHOPHOSPHATE CONCENTRATIONS IN WATER

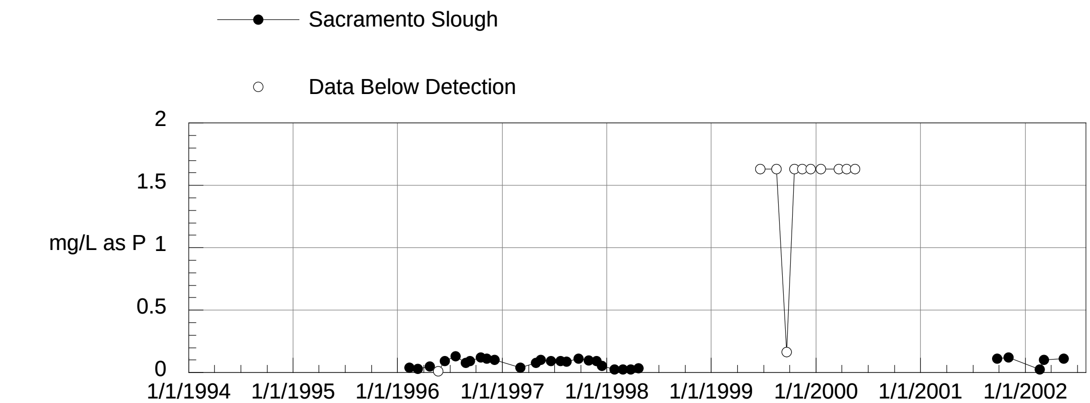


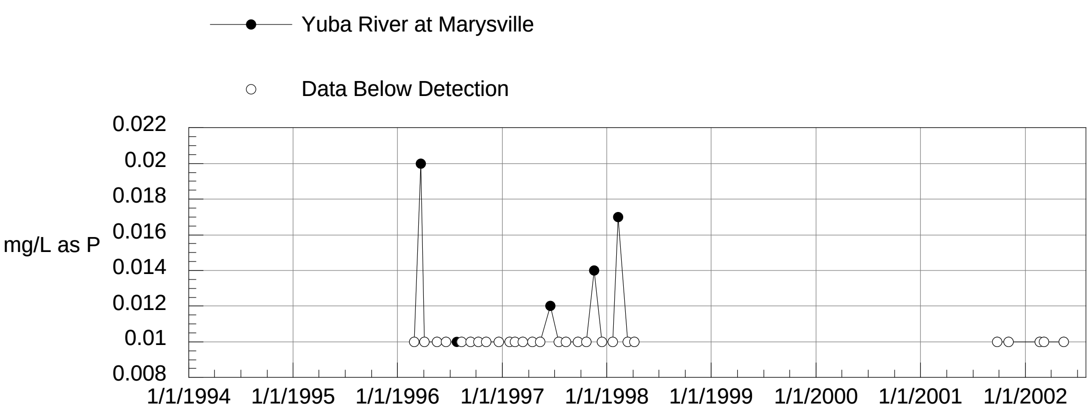




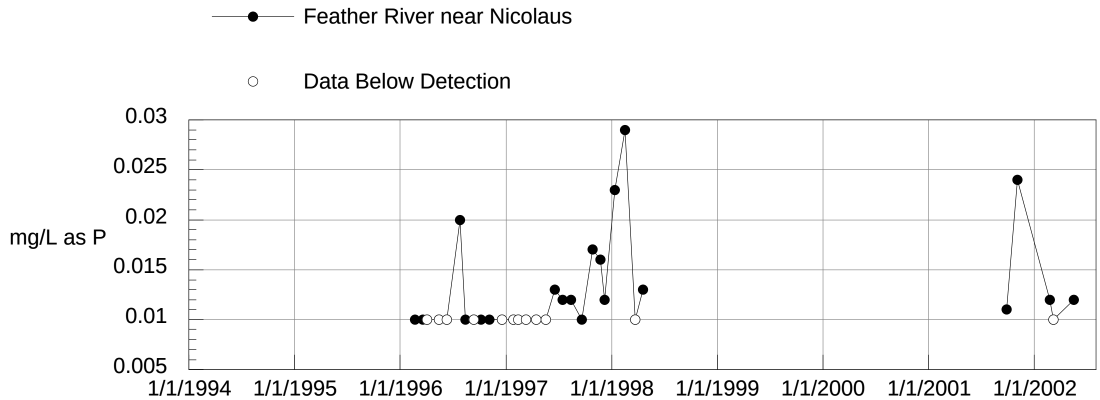
DISSOLVED ORTHOPHOSPHATE CONCENTRATIONS IN WATER

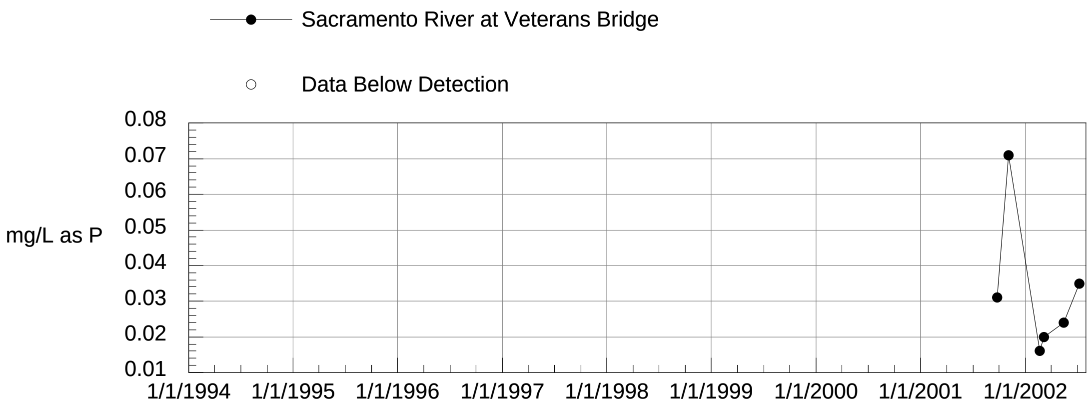


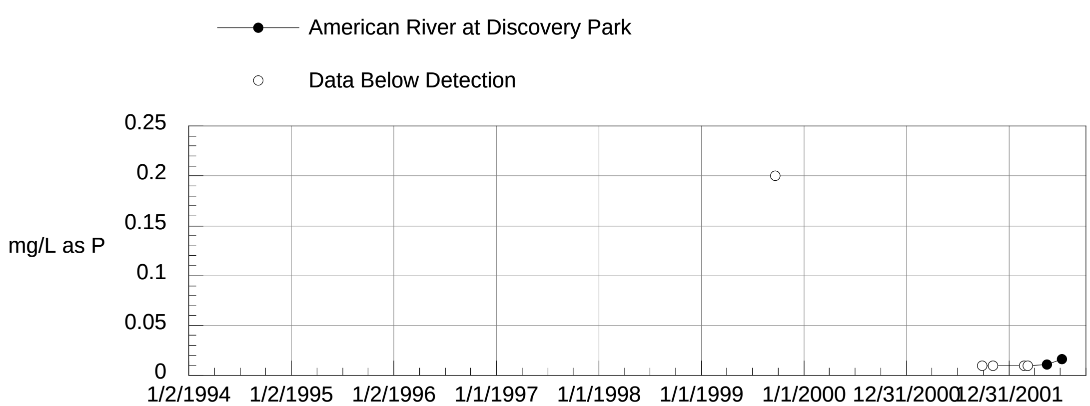




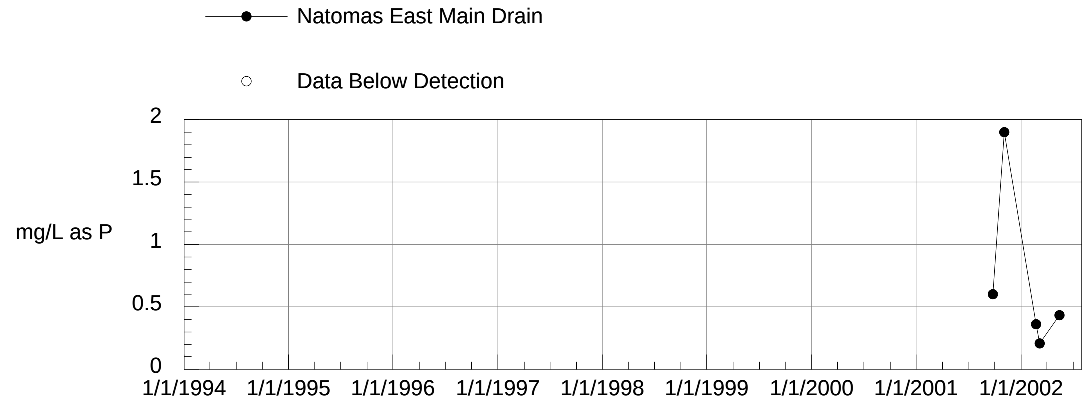
DISSOLVED ORTHOPHOSPHATE CONCENTRATIONS IN WATER

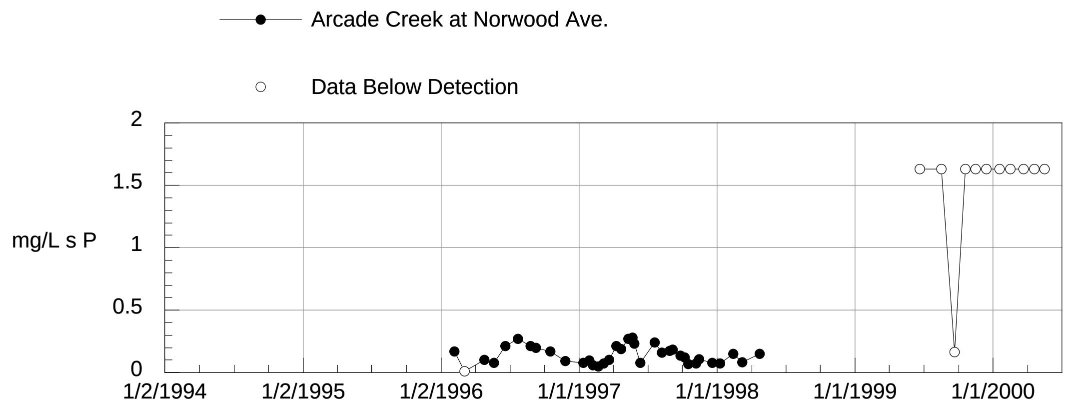


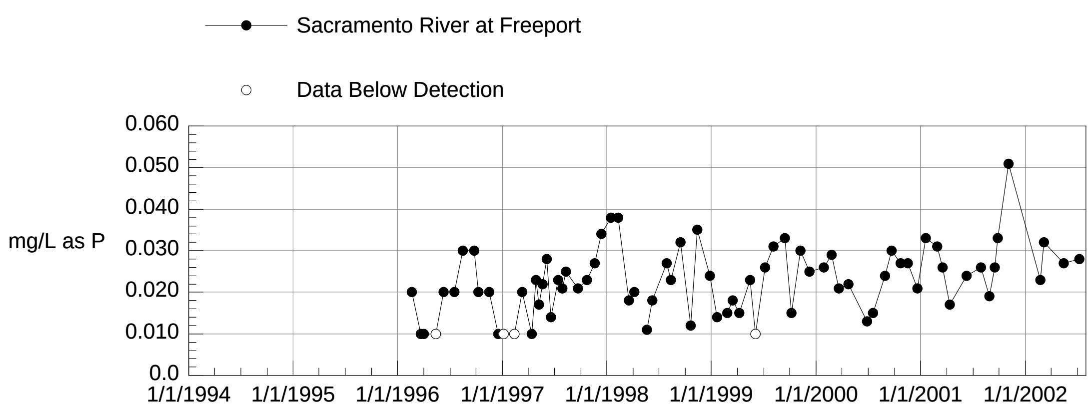




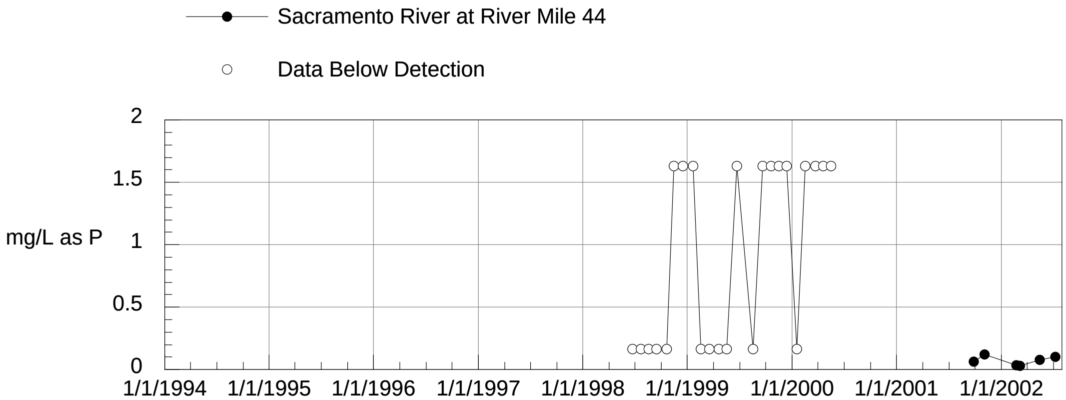
DISSOLVED ORTHOPHOSPHATE CONCENTRATIONS IN WATER



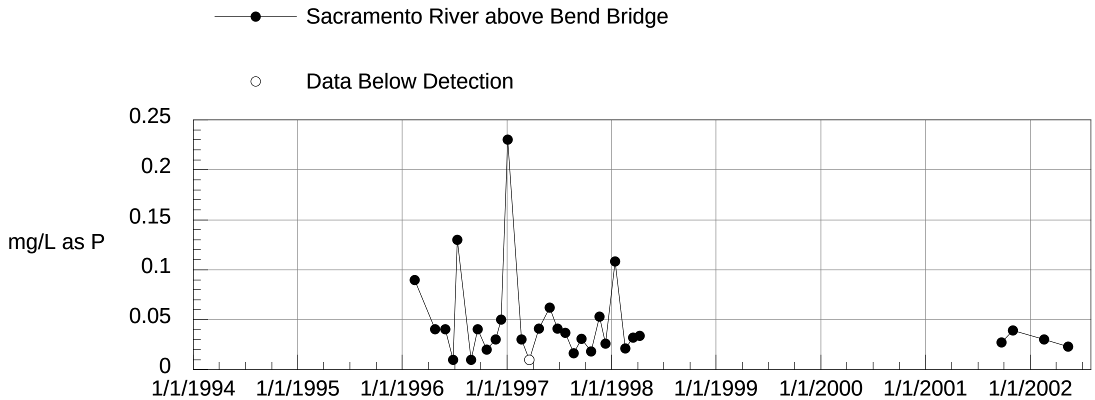


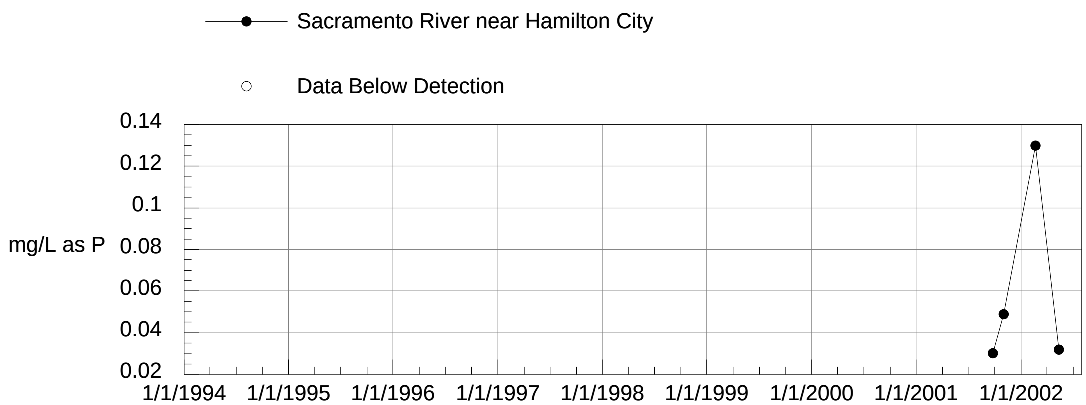


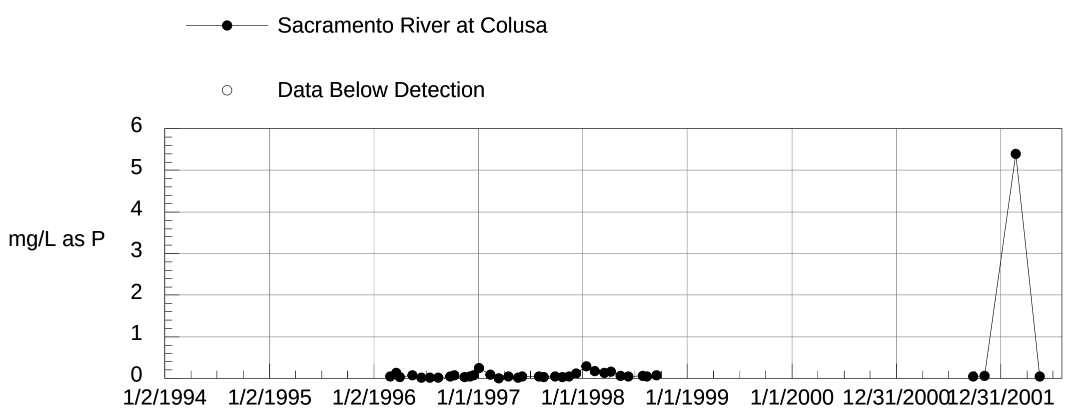
DISSOLVED ORTHOPHOSPHATE CONCENTRATIONS IN WATER



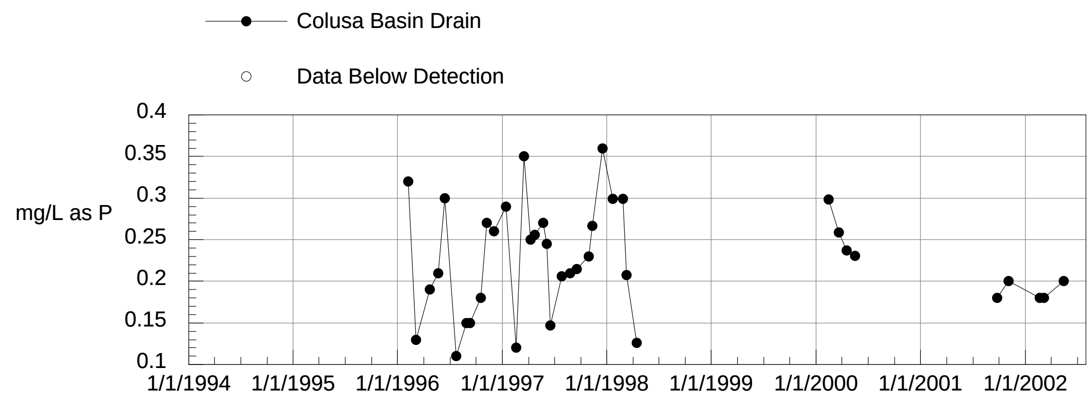
TOTAL PHOSPHOROUS CONCENTRATIONS IN WATER

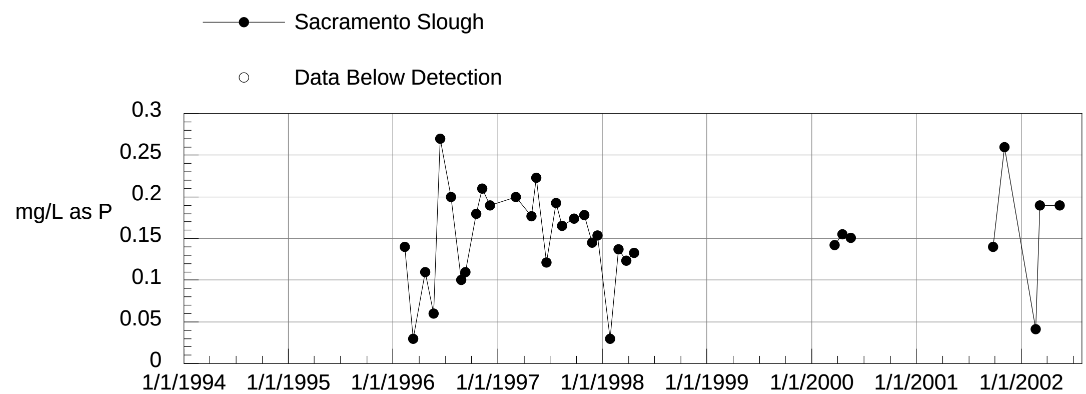


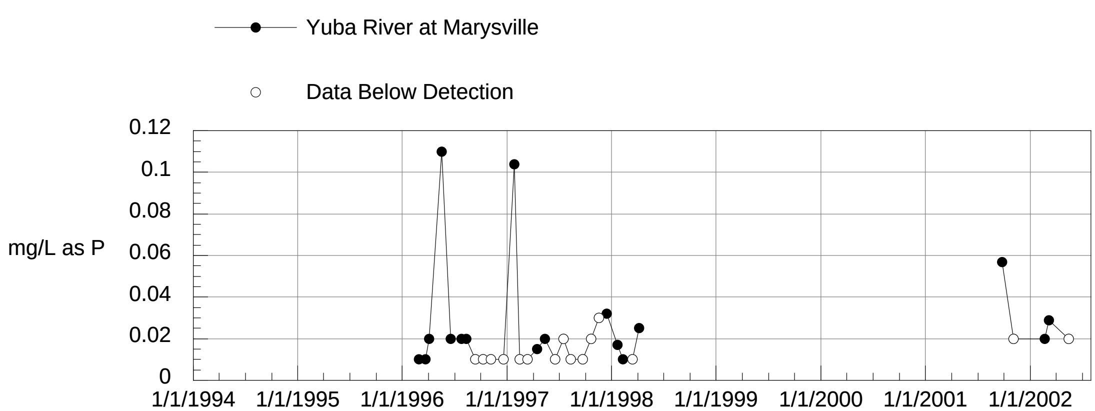




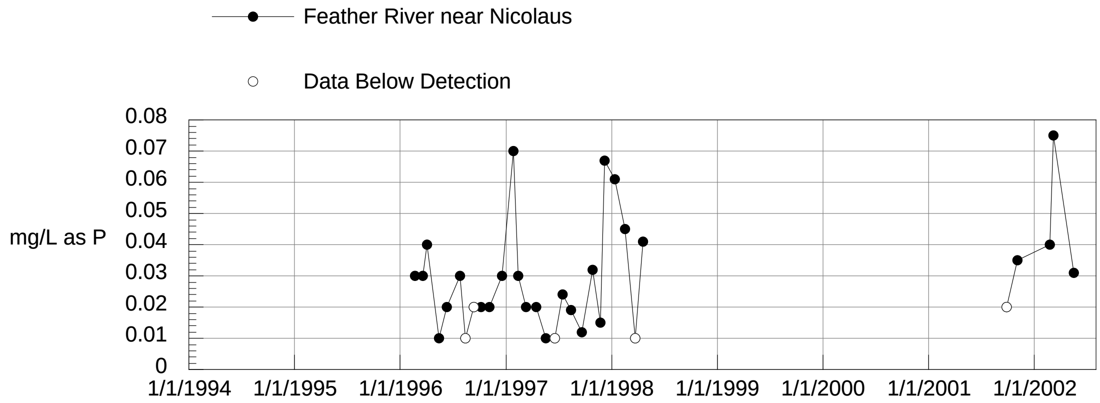
TOTAL PHOSPHOROUS CONCENTRATIONS IN WATER

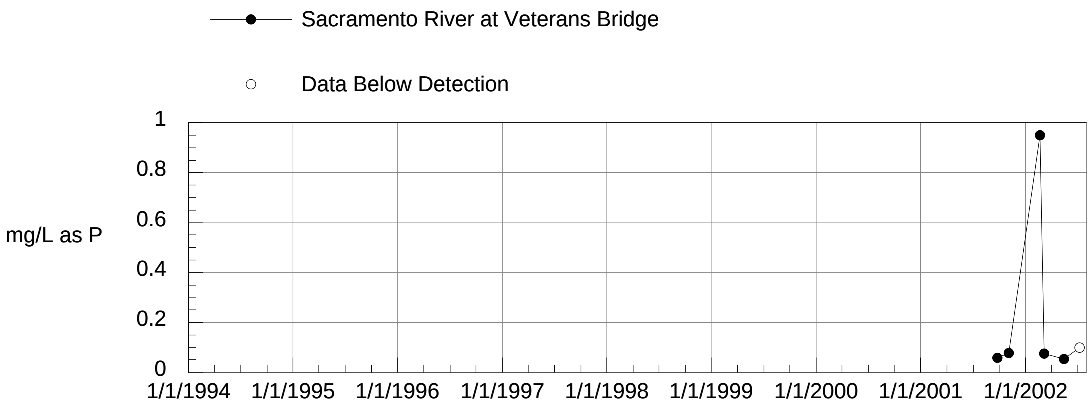


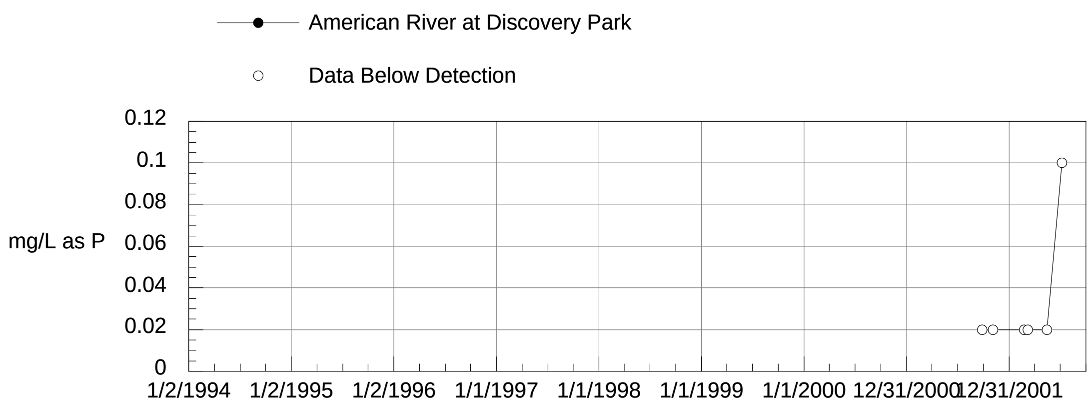




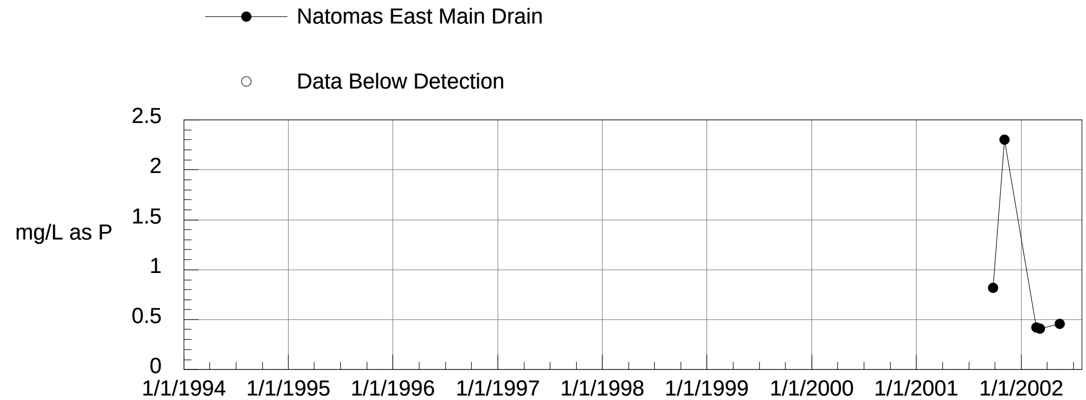
TOTAL PHOSPHOROUS CONCENTRATIONS IN WATER

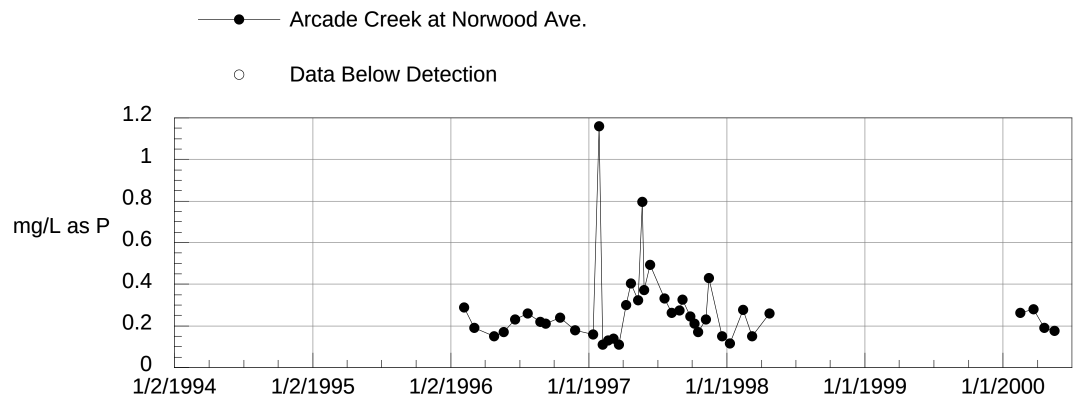


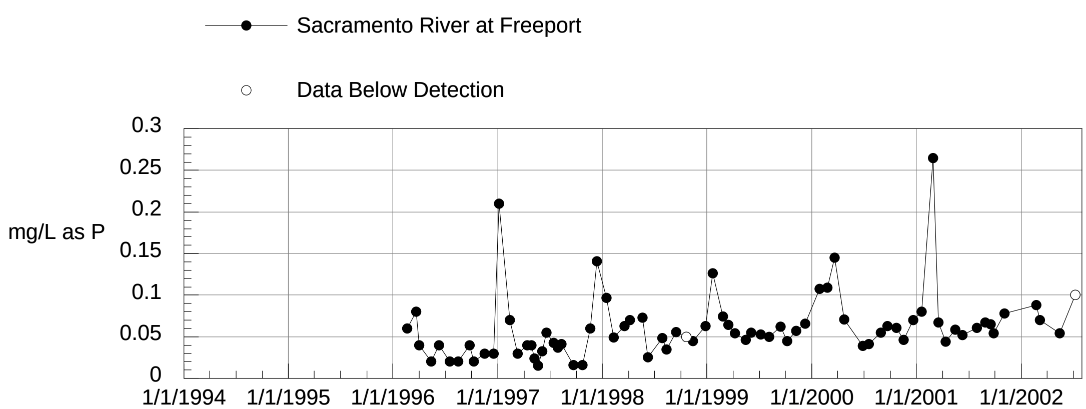




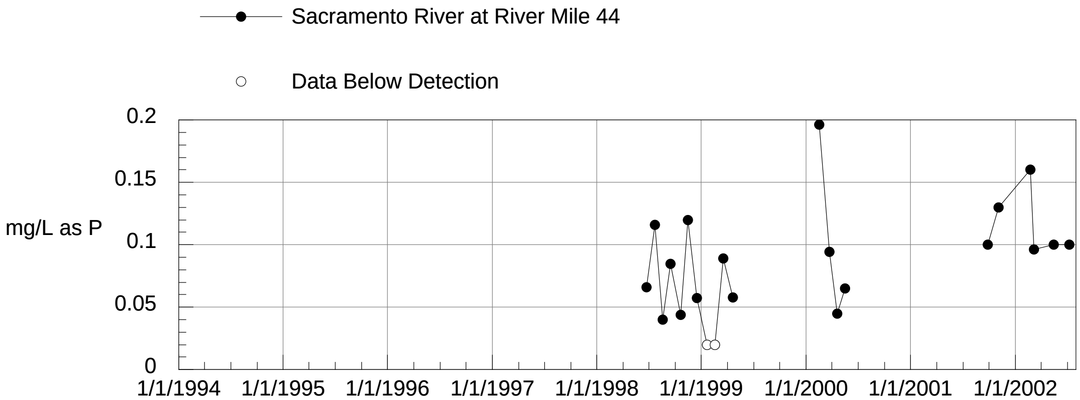
TOTAL PHOSPHOROUS CONCENTRATIONS IN WATER



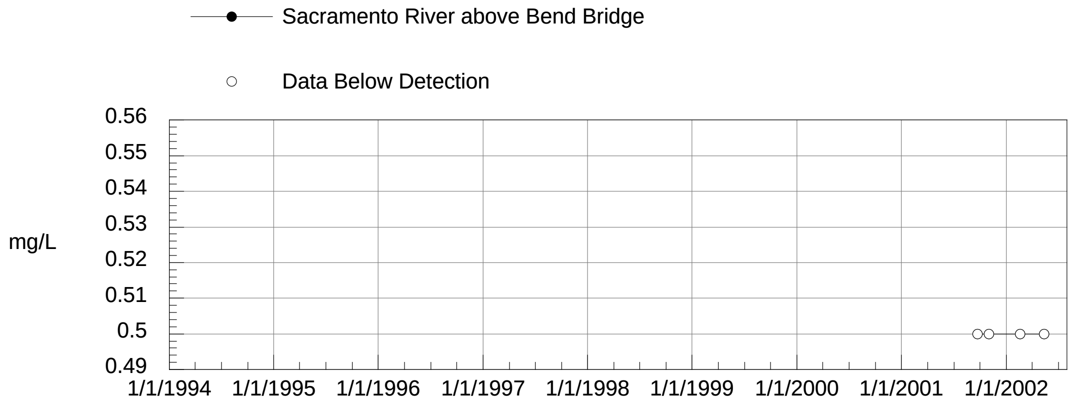


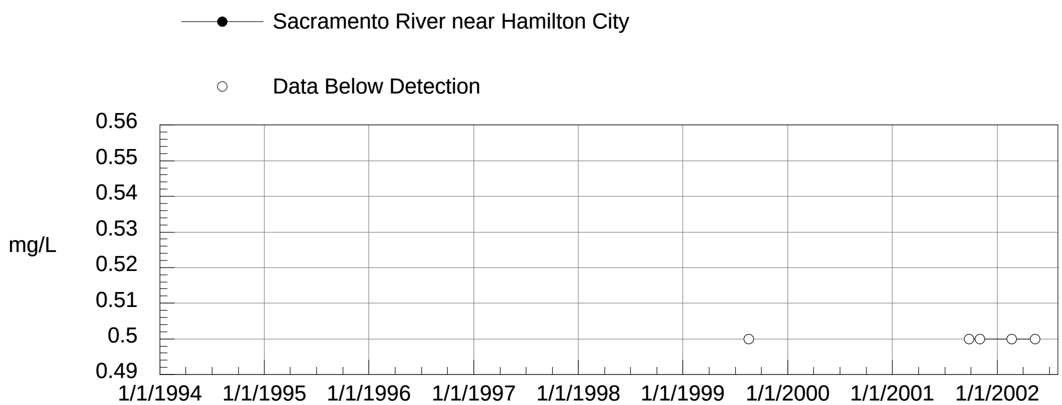


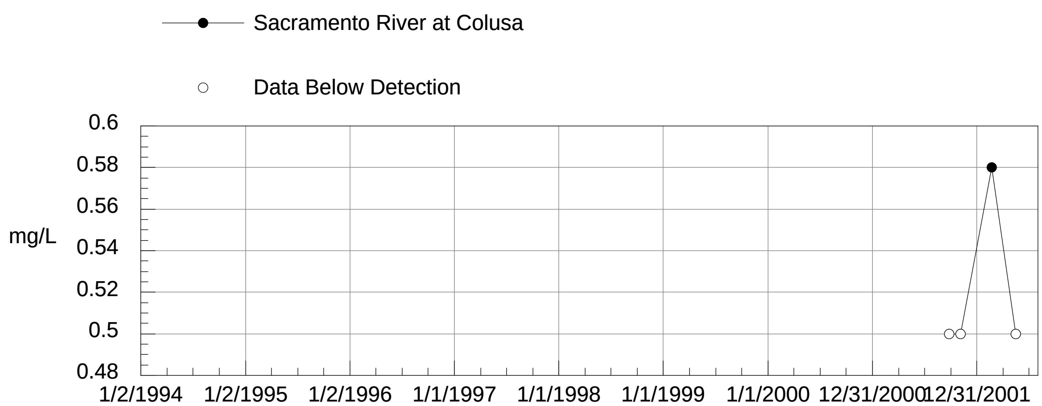
TOTAL PHOSPHOROUS CONCENTRATIONS IN WATER



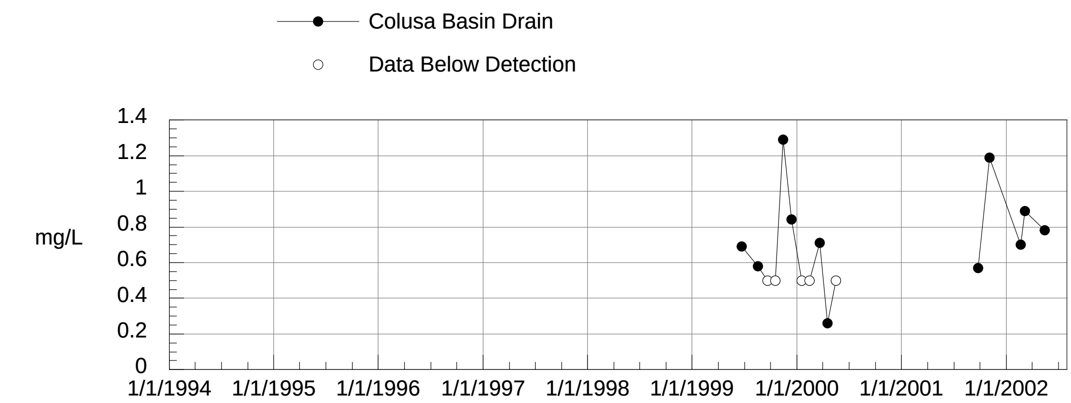
TOTAL KJELDAHL NITROGEN CONCENTRATIONS IN WATER

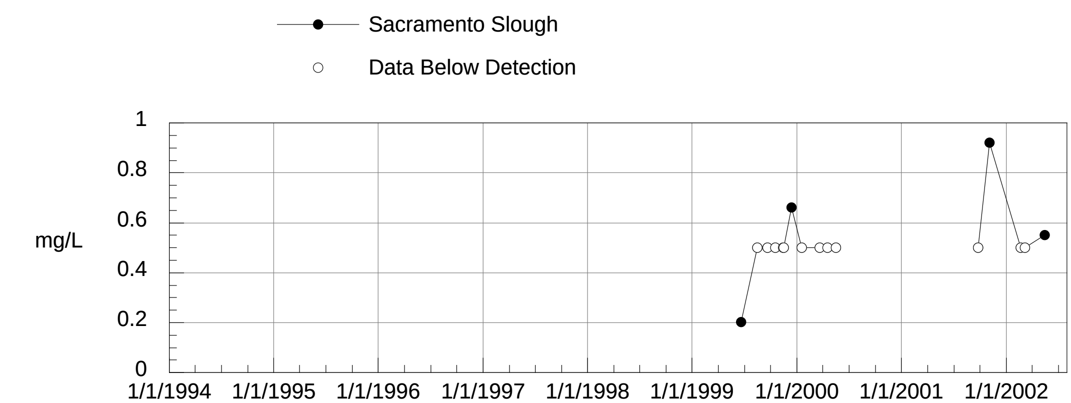


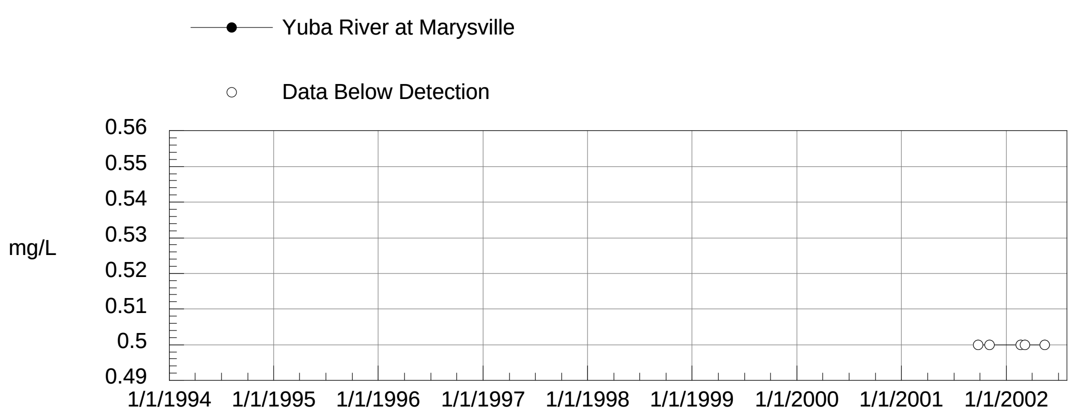




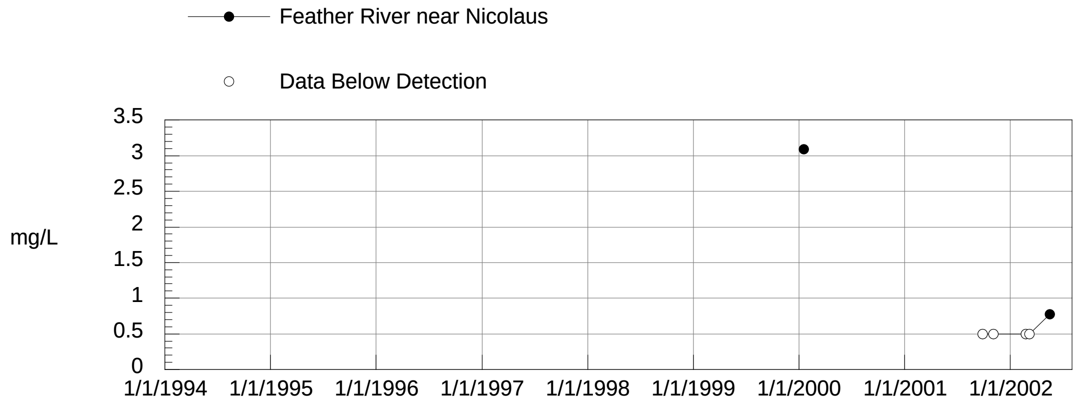
TOTAL KJELDAHL NITROGEN CONCENTRATIONS IN WATER

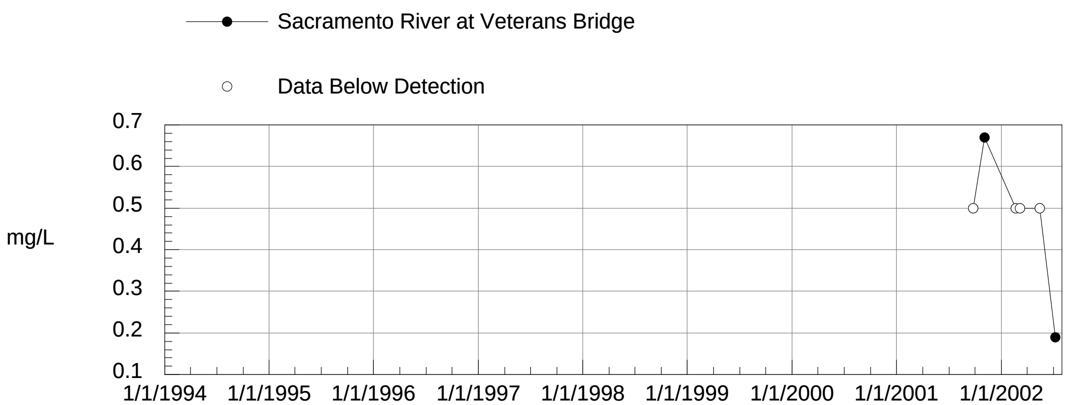


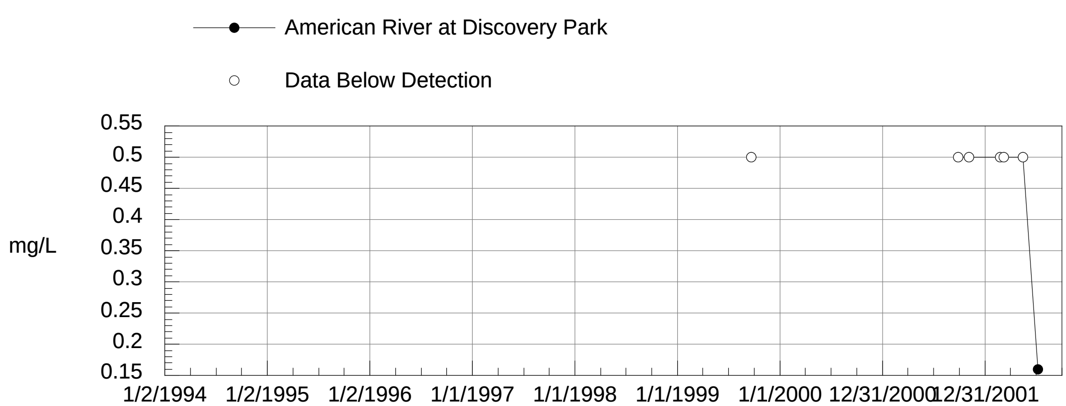




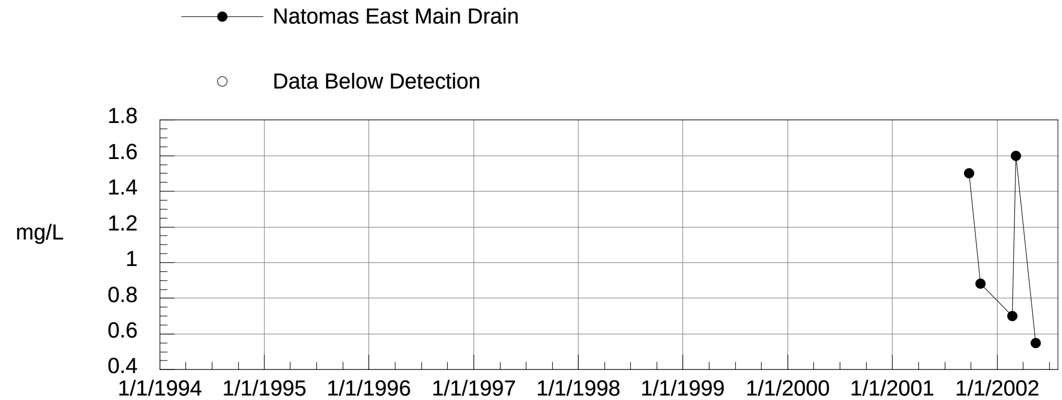
TOTAL KJELDAHL NITROGEN CONCENTRATIONS IN WATER

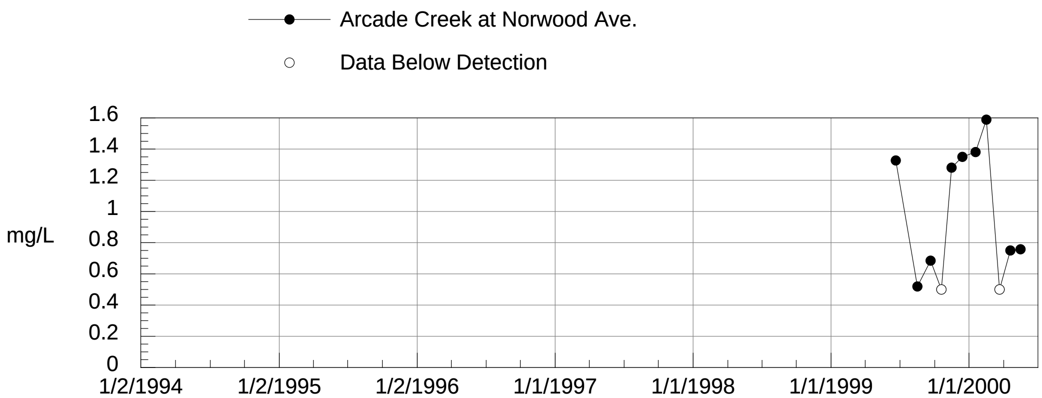


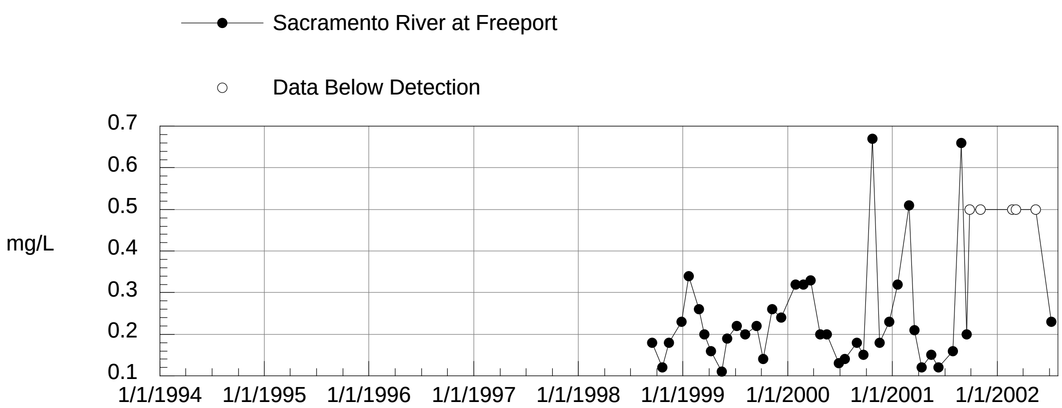




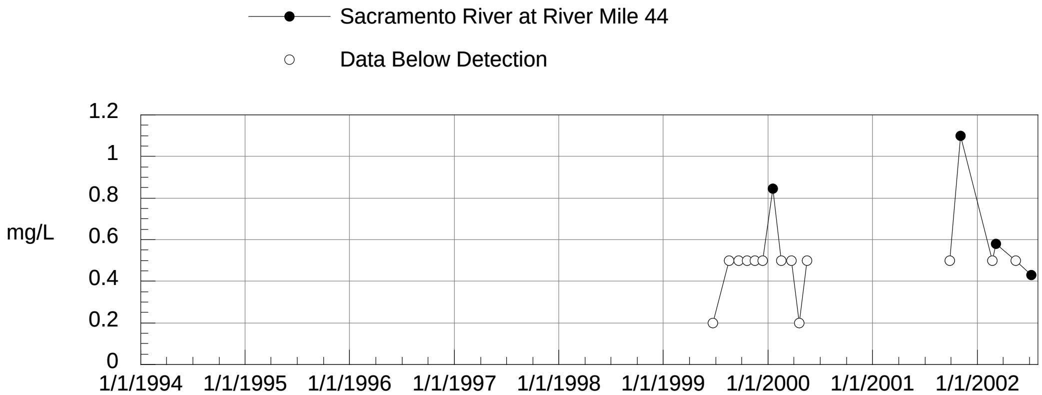
TOTAL KJELDAHL NITROGEN CONCENTRATIONS IN WATER



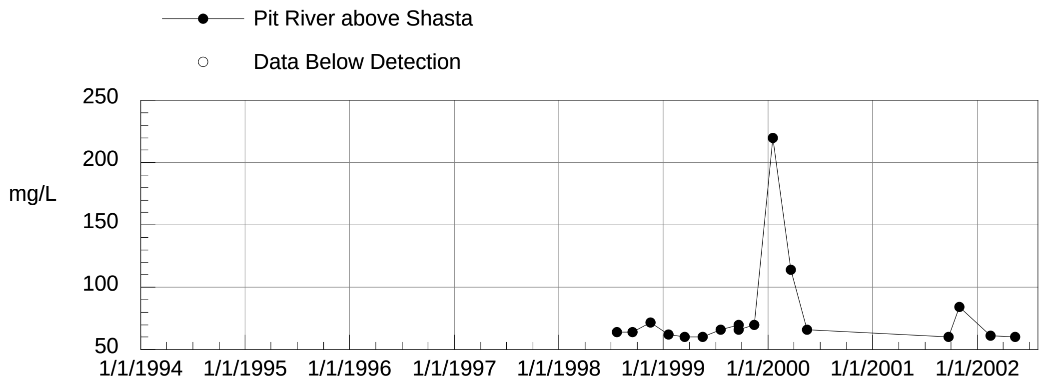




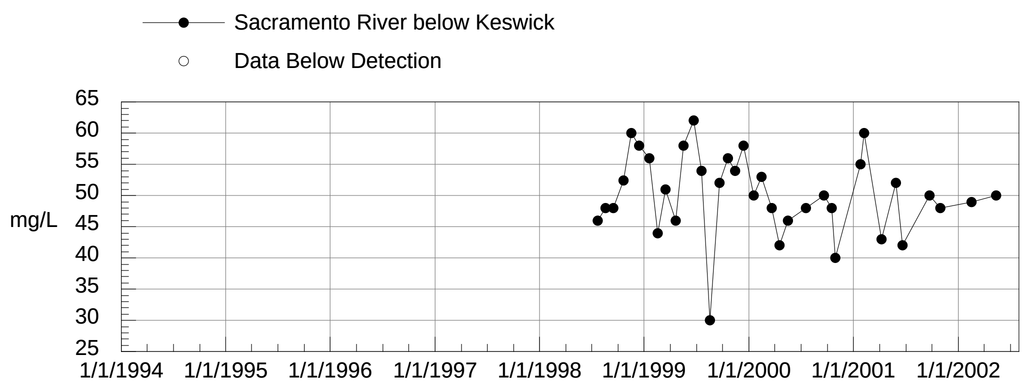
TOTAL KJELDAHL NITROGEN CONCENTRATIONS IN WATER



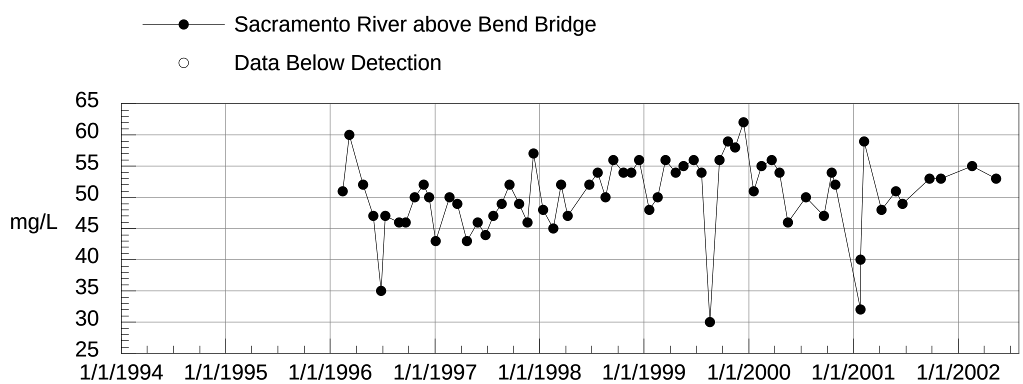
Time Series Plots of Monitoring Data: Other Conventional Water Chemistry Parameters



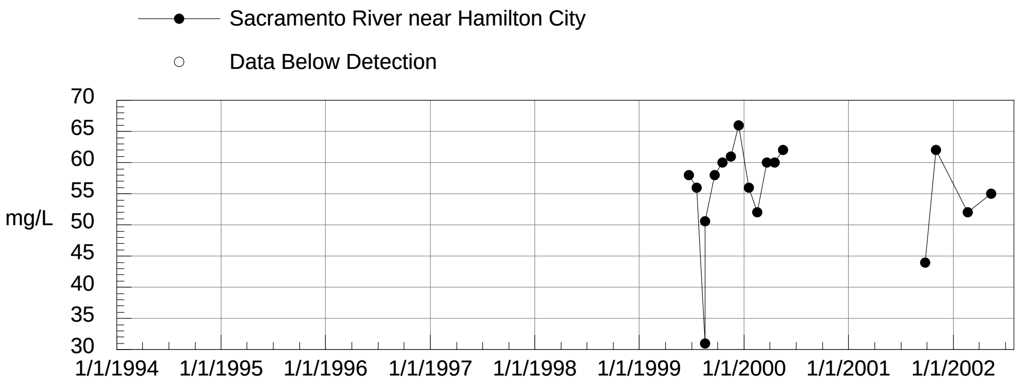
Pit River above Shasta
Data Below Detection
250
200
150
100
50
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

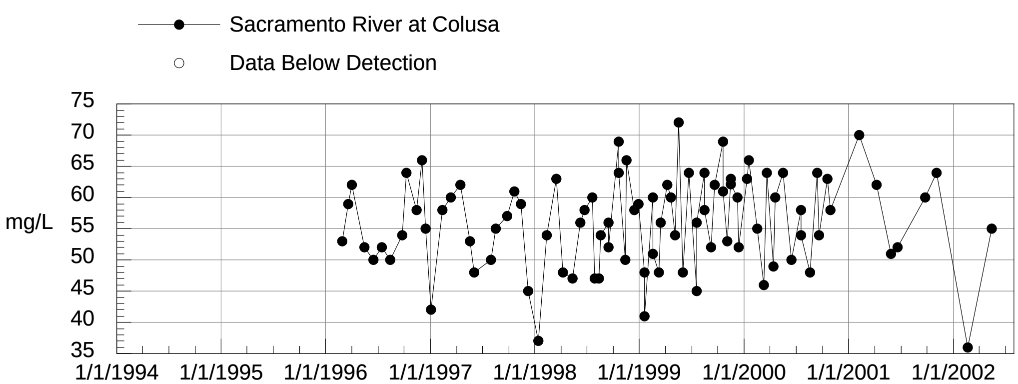


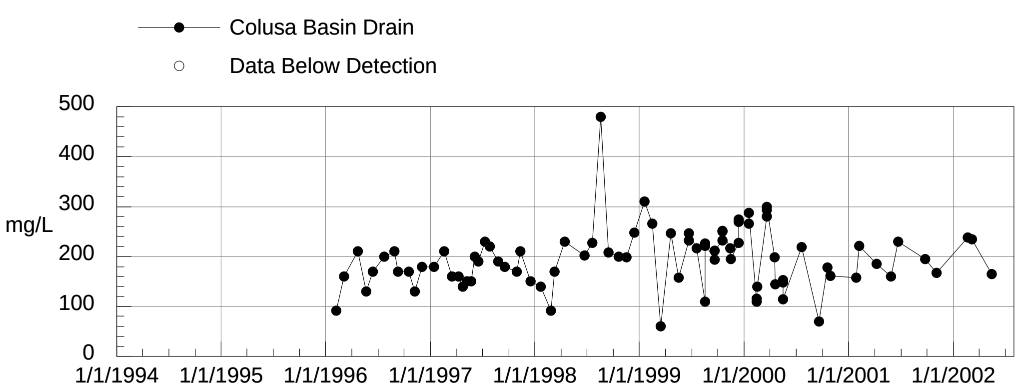
Sacramento River below Keswick
Data Below Detection
65
60
55
50
45
40
35
30
25
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

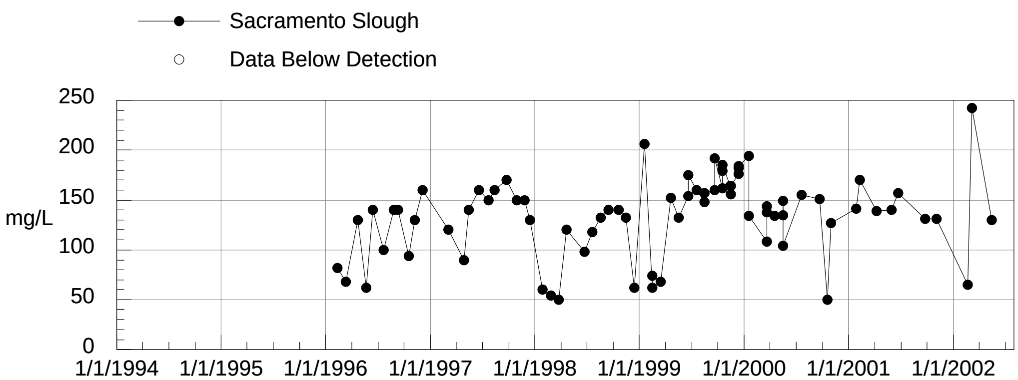


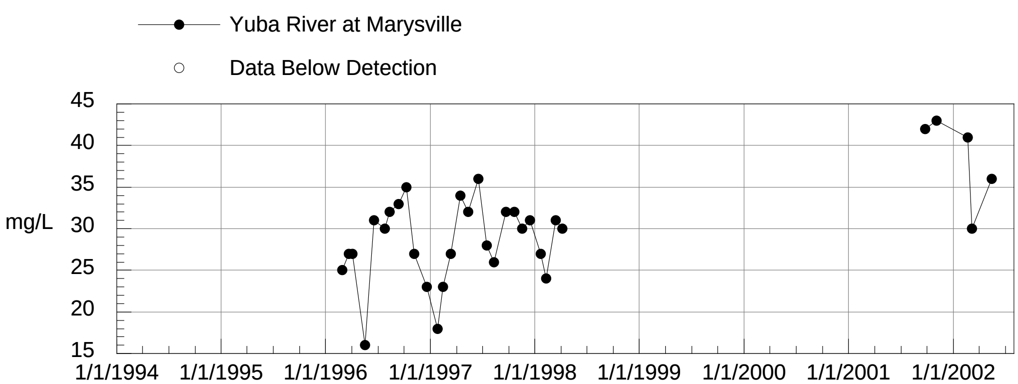
Sacramento River above Bend Bridge
Data Below Detection
65
60
55
50
45
40
35
30
25
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

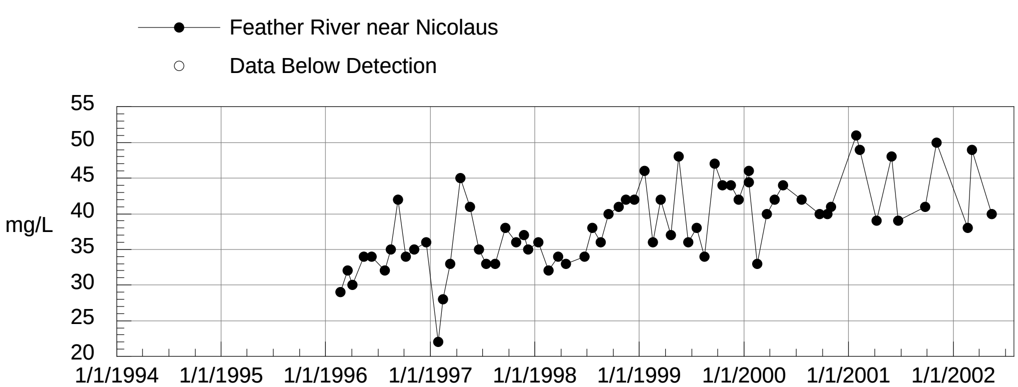

Sacramento River near Hamilton City
Data Below Detection
70
65
60
55
50
45
40
35
30
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

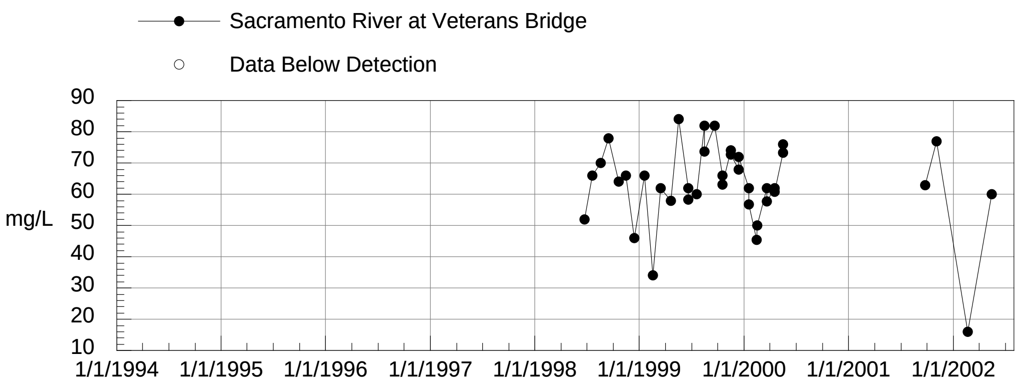

Sacramento River at Colusa
Data Below Detection
75
70
65
60
55
50
45
40
35
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

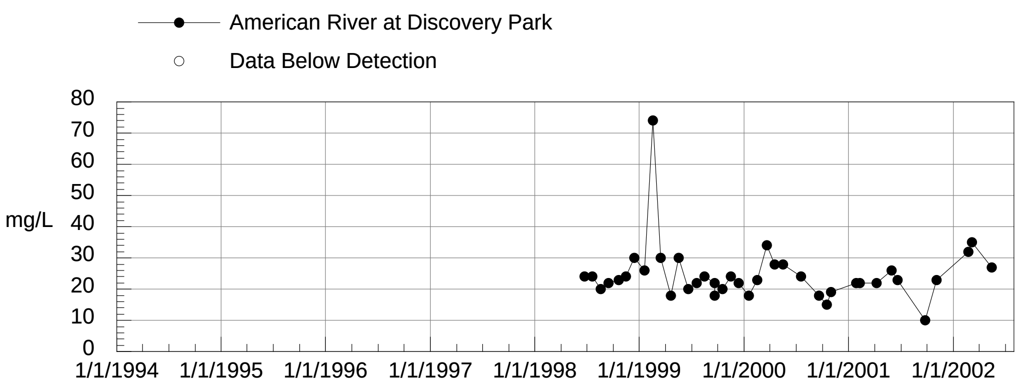

Colusa Basin Drain
Data Below Detection
500
400
300
200
100
0
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

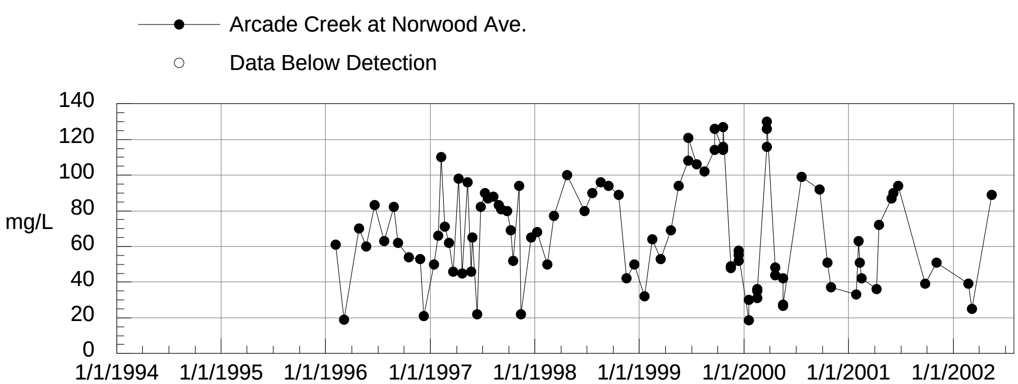

Sacramento Slough
Data Below Detection
mg/L
250
200
150
100
50
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

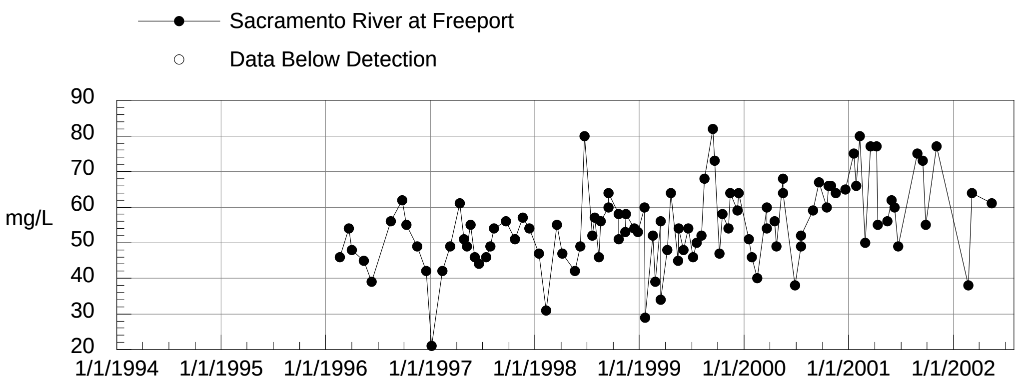

Yuba River at Marysville
Data Below Detection
mg/L
45
40
35
30
25
20
15
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

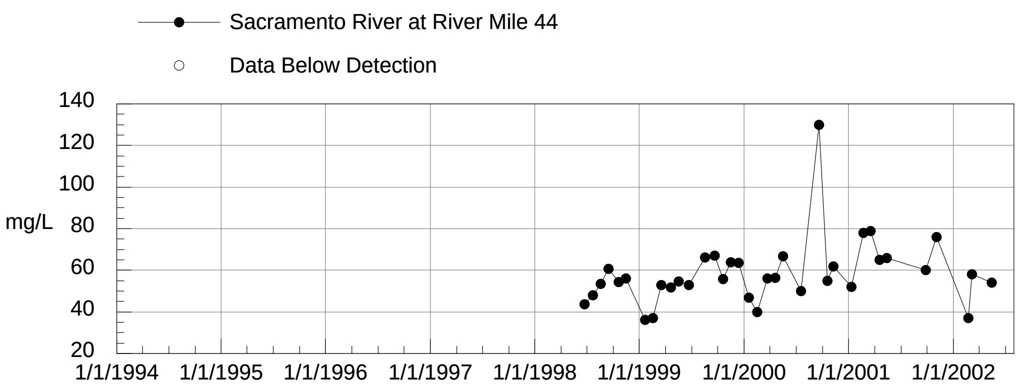

Feather River near Nicolaus
Data Below Detection
mg/L
55
50
45
40
35
30
25
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

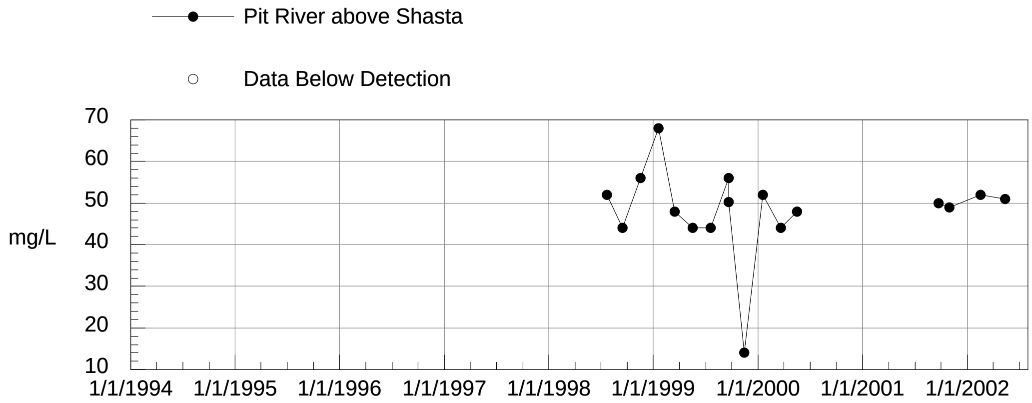

Sacramento River at Veterans Bridge
Data Below Detection
mg/L
90
80
70
60
50
40
30
20
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

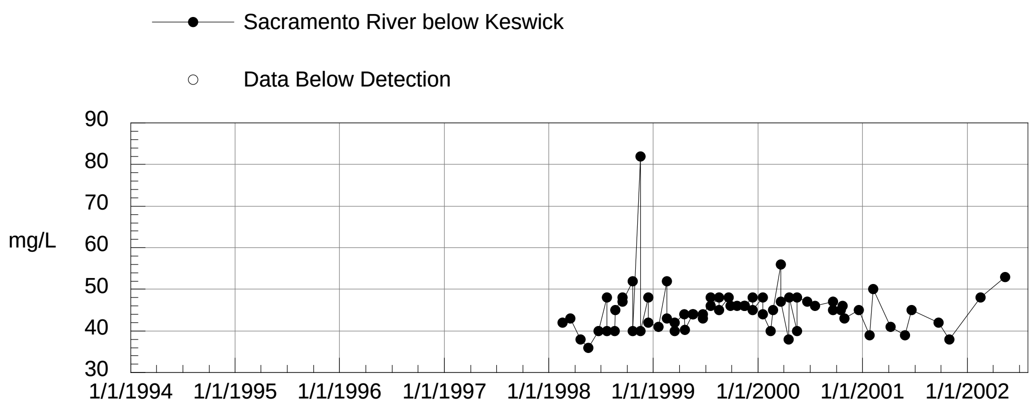

American River at Discovery Park
Data Below Detection
mg/L
80
70
60
50
40
30
20
10
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

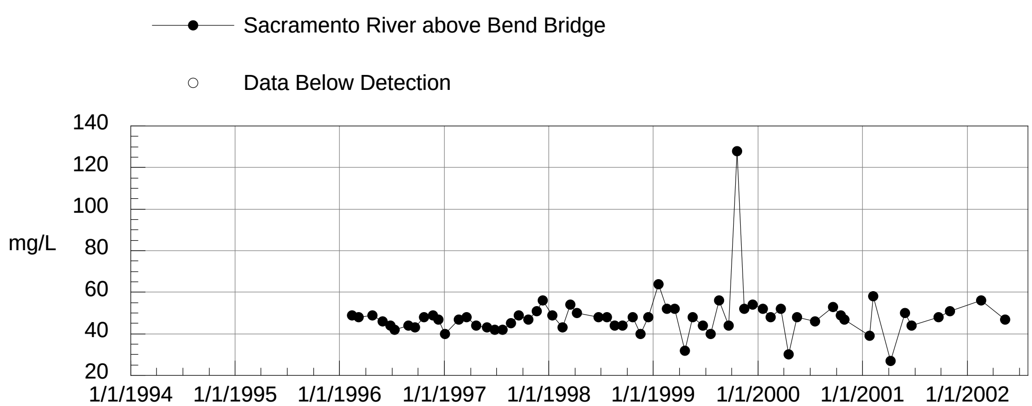

Arcade Creek at Norwood Ave.
Data Below Detection
mg/L
140
120
100
80
60
40
20
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

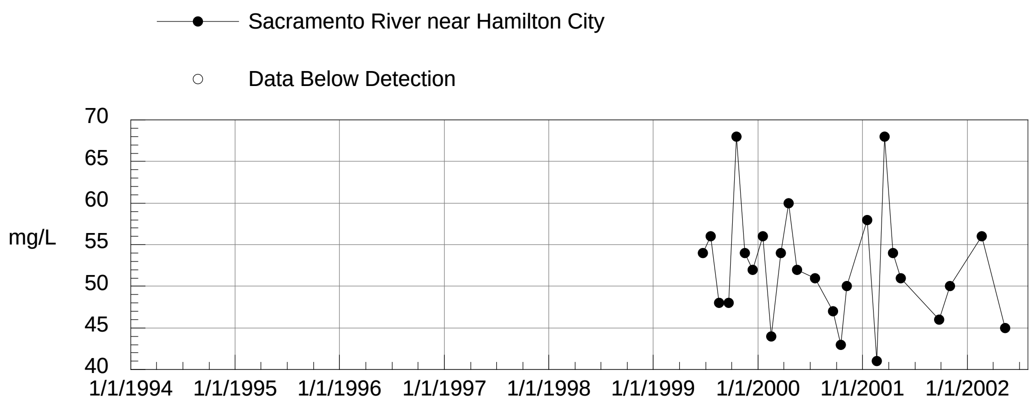

Sacramento River at Freeport
Data Below Detection
mg/L
90
80
70
60
50
40
30
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

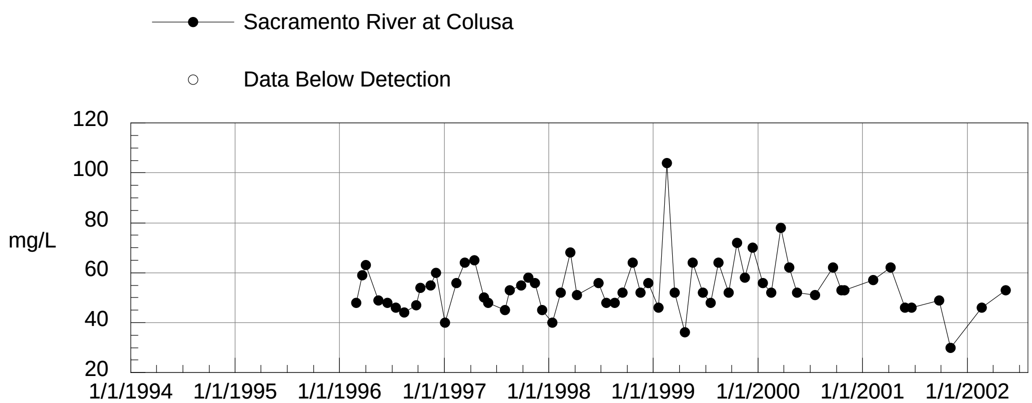

Sacramento River at River Mile 44
Data Below Detection
mg/L
140
120
100
80
60
40
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

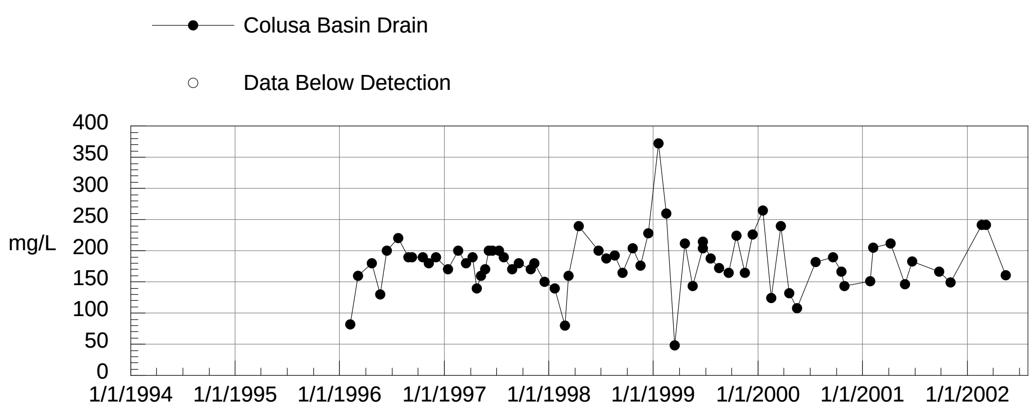

Pit River above Shasta
Data Below Detection
mg/L
70
60
50
40
30
20
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

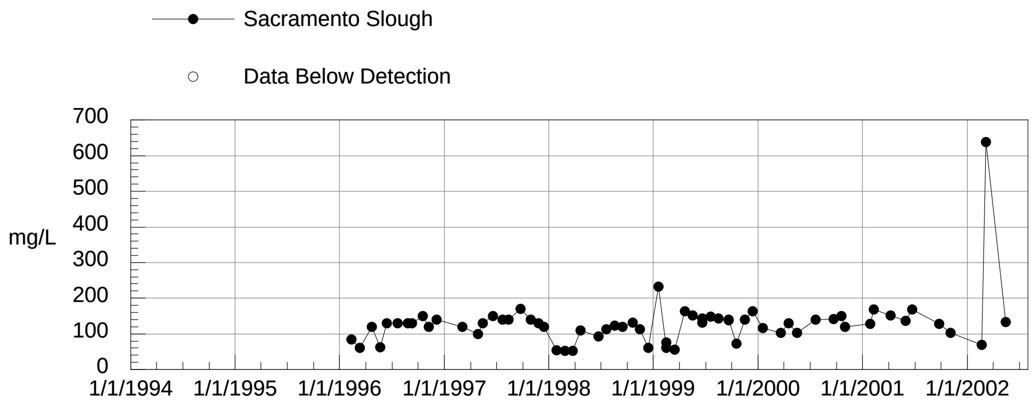

Sacramento River below Keswick
Data Below Detection
mg/L
90
80
70
60
50
40
30
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

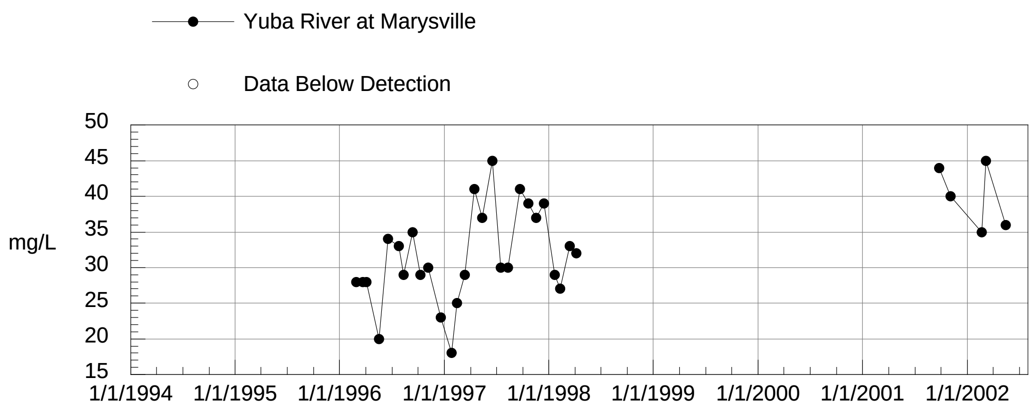

Sacramento River above Bend Bridge
Data Below Detection
mg/L
140
120
100
80
60
40
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

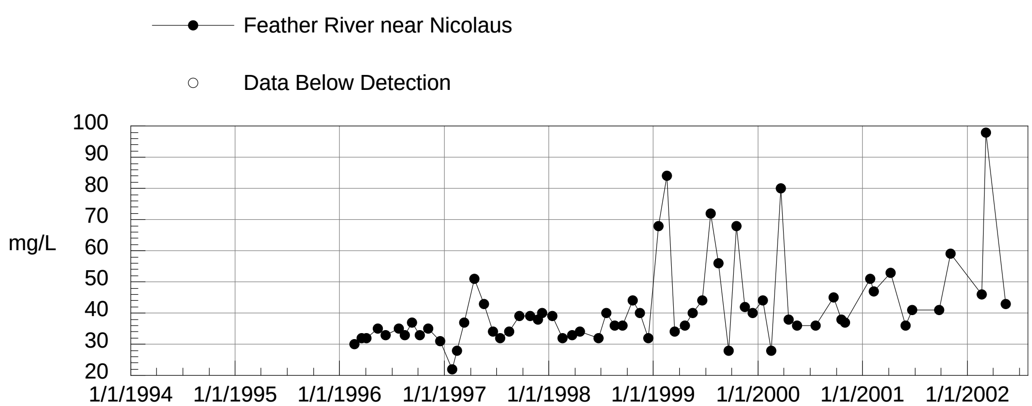

Sacramento River near Hamilton City
Data Below Detection
mg/L
70
65
60
55
50
45
40
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

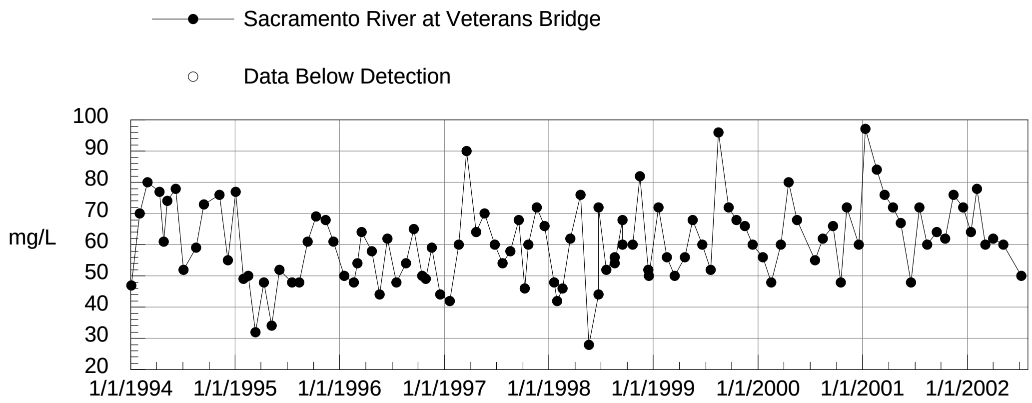

Sacramento River at Colusa
Data Below Detection
mg/L
120
100
80
60
40
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

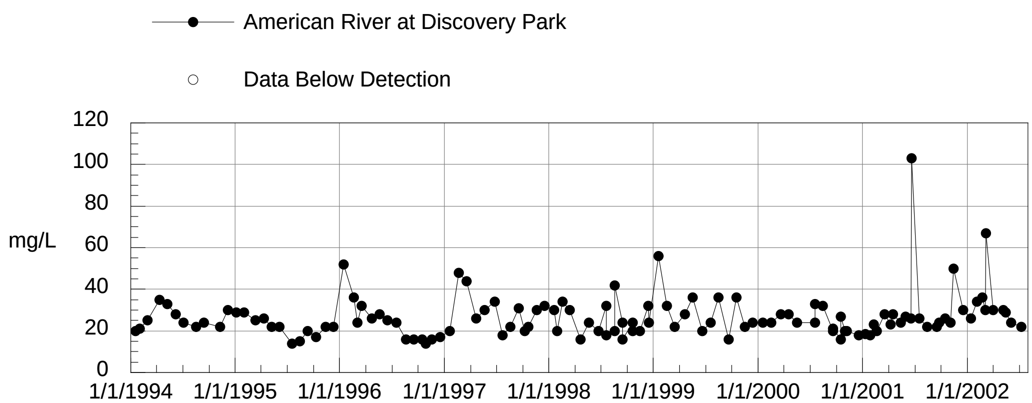

Colusa Basin Drain
Data Below Detection
mg/L
400
350
300
250
200
150
100
50
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

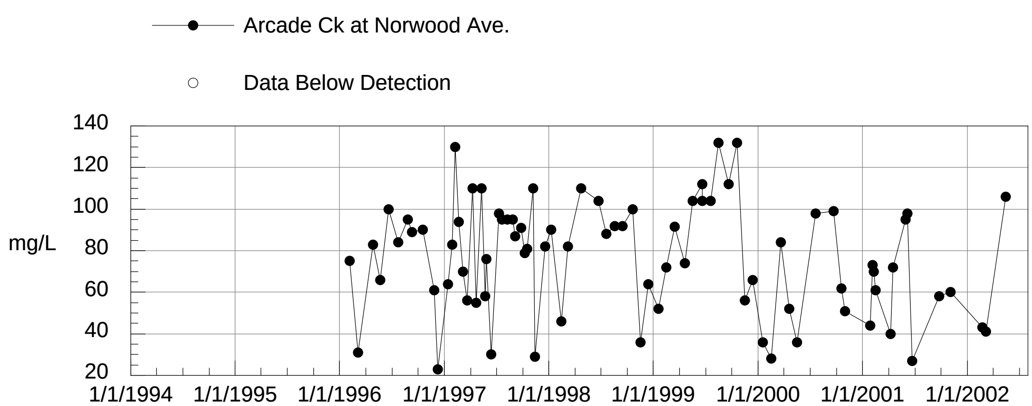

Sacramento Slough
Data Below Detection
mg/L
700
600
500
400
300
200
100
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

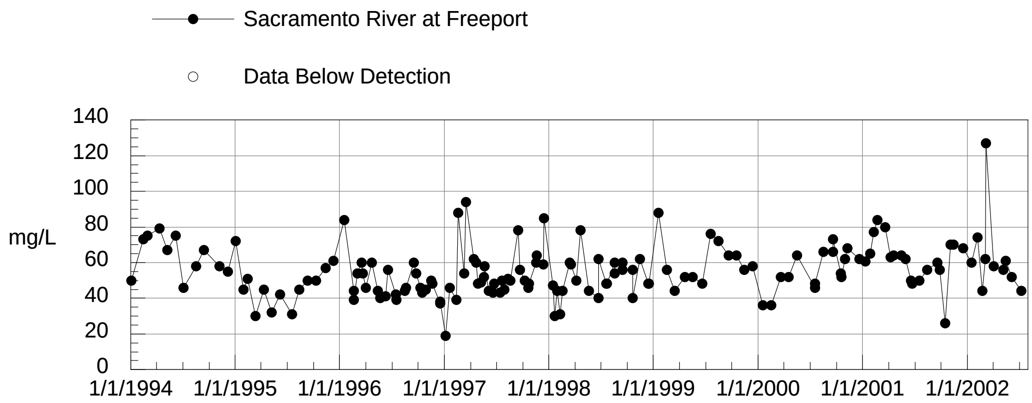

Yuba River at Marysville
Data Below Detection
mg/L
50
45
40
35
30
25
20
15
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

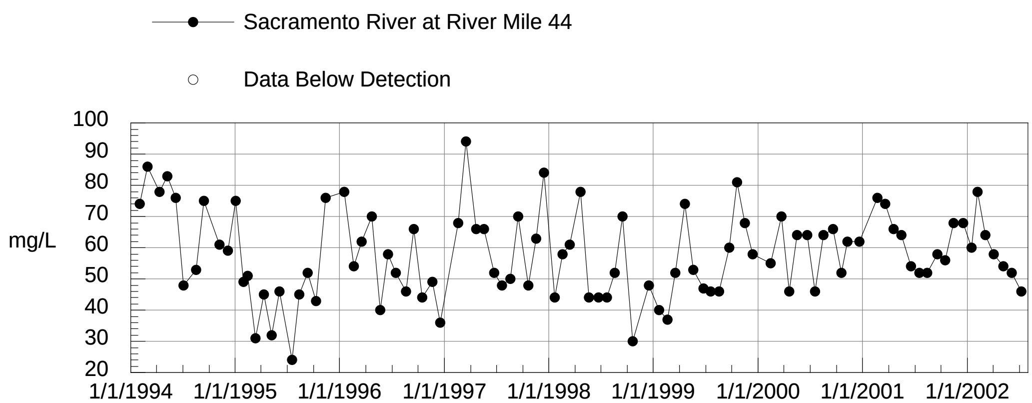

Feather River near Nicolaus
Data Below Detection
mg/L
100
90
80
70
60
50
40
30
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at Veterans Bridge
Data Below Detection
100
90
80
70
60
50
40
30
20
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

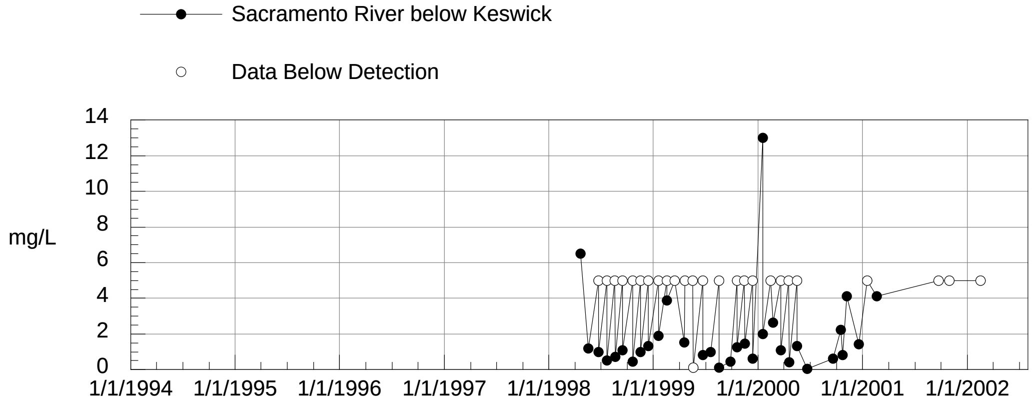

American River at Discovery Park
Data Below Detection
120
100
80
60
40
20
0
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

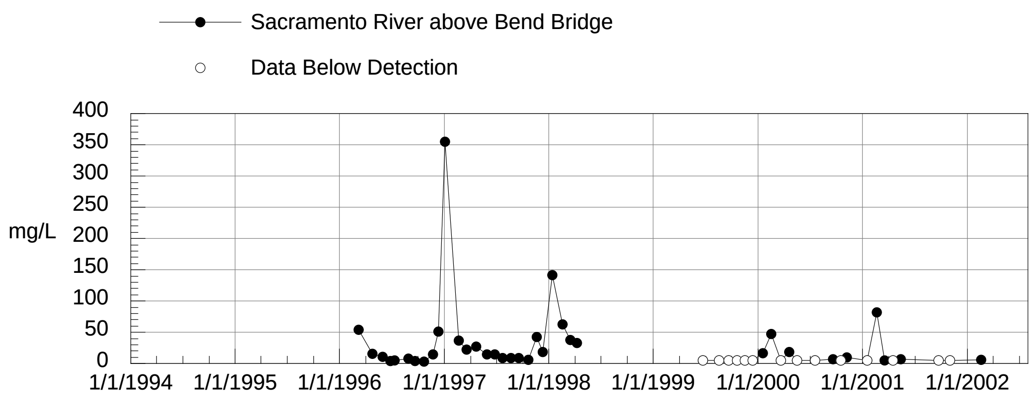

Arcade Ck at Norwood Ave.
Data Below Detection
140
120
100
80
60
40
20
mg/L
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

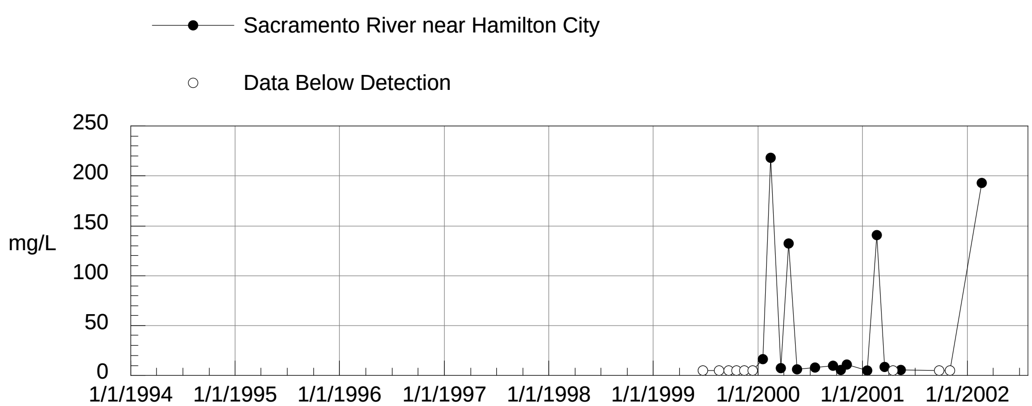

Sacramento River at Freeport
Data Below Detection
mg/L
140
120
100
80
60
40
20
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at River Mile 44
Data Below Detection
mg/L
100
90
80
70
60
50
40
30
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

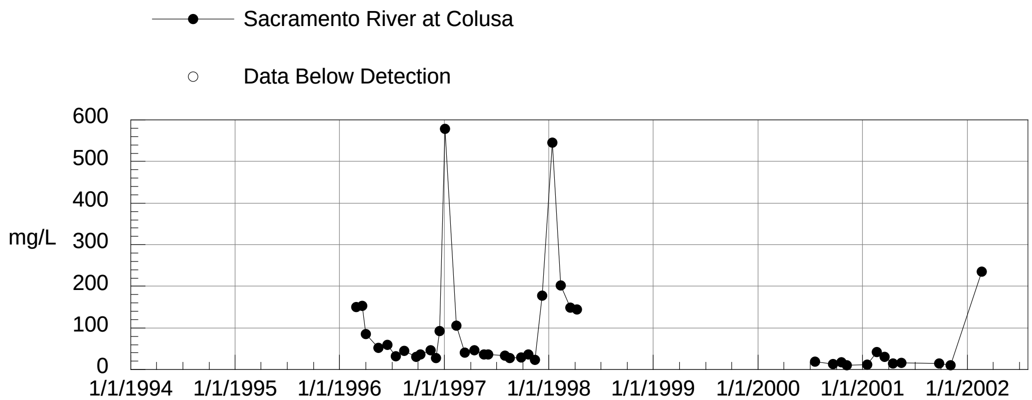
TOTAL SUSPENDED SOLIDS CONCENTRATIONS IN WATER

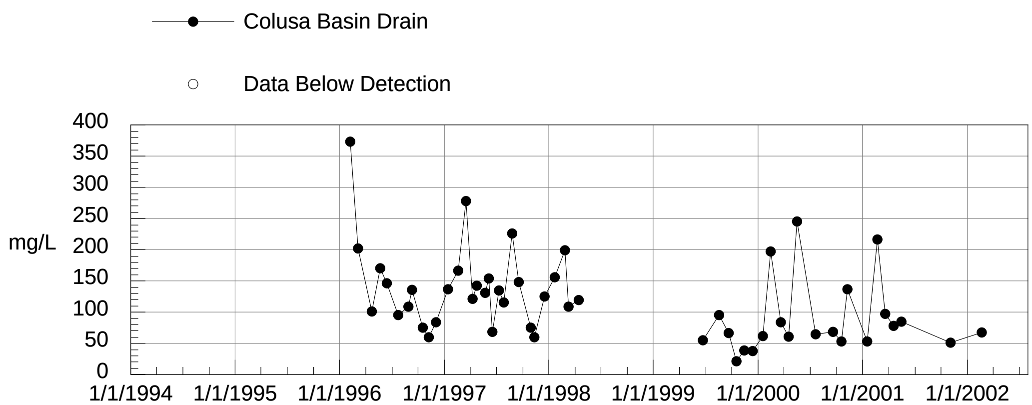


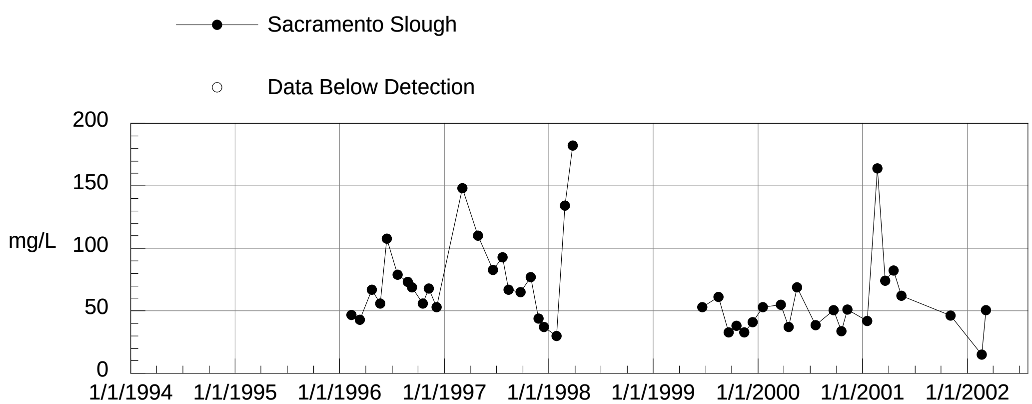




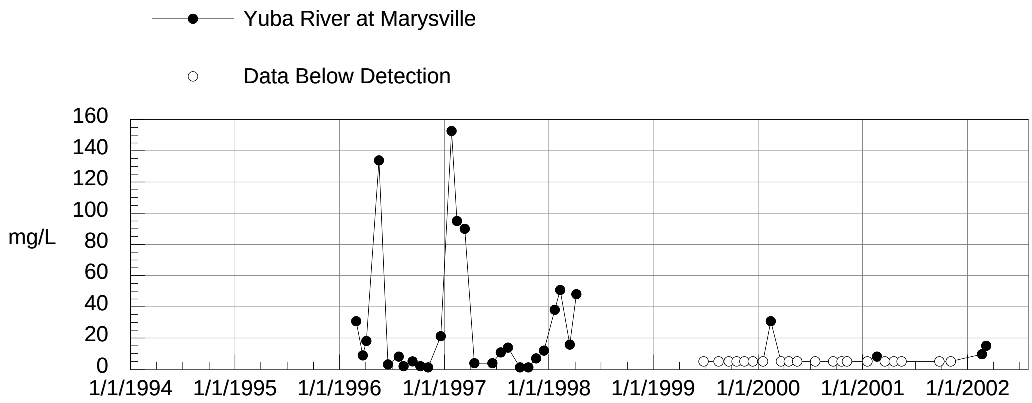
TOTAL SUSPENDED SOLIDS CONCENTRATIONS IN WATER

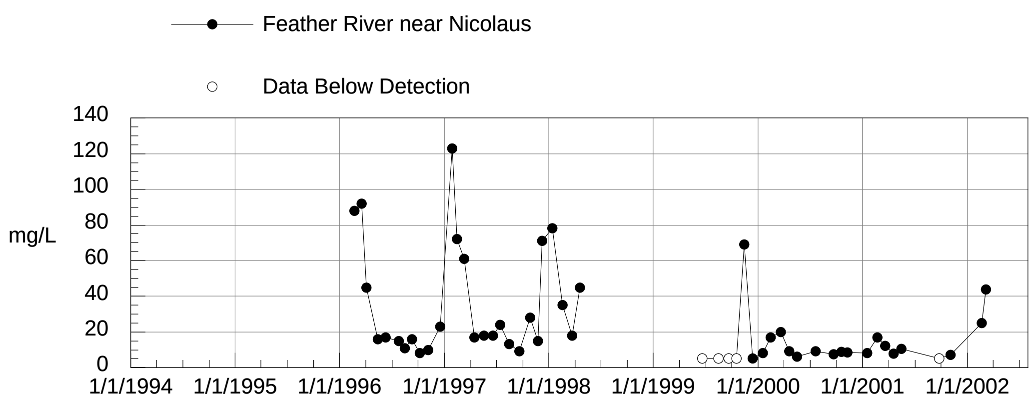


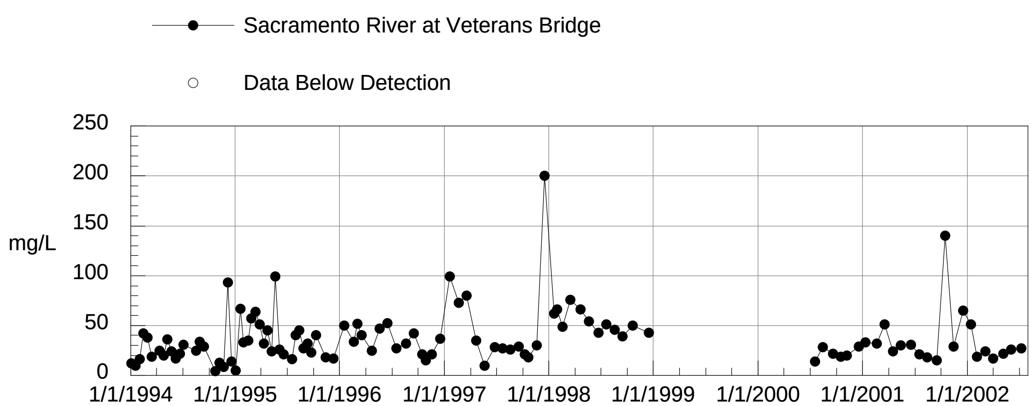




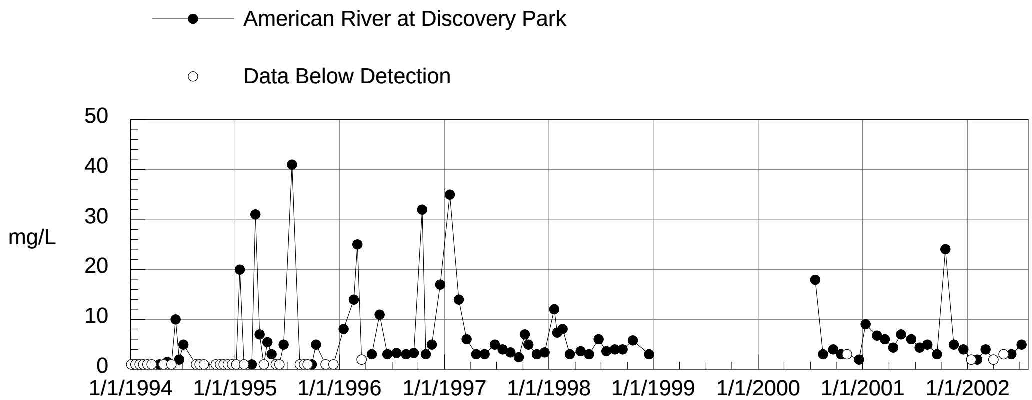
TOTAL SUSPENDED SOLIDS CONCENTRATIONS IN WATER

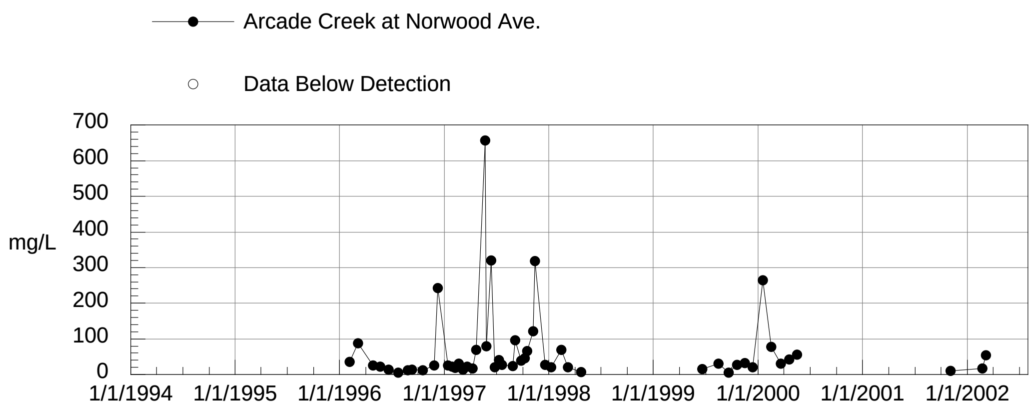


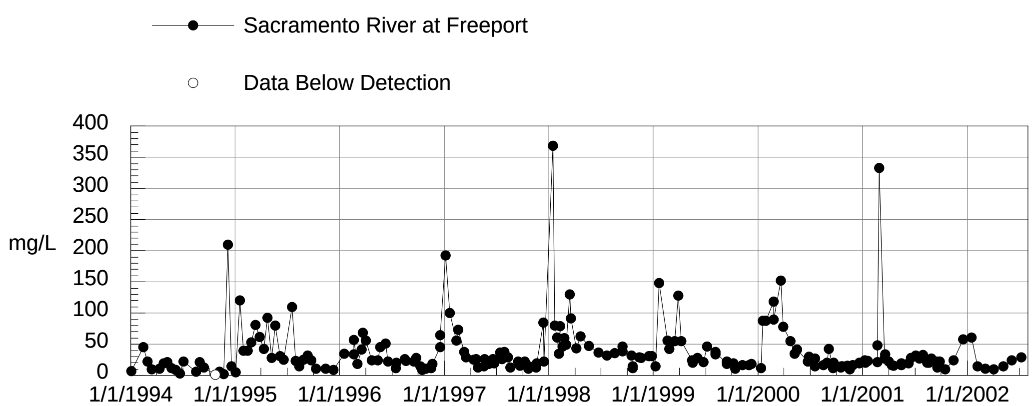




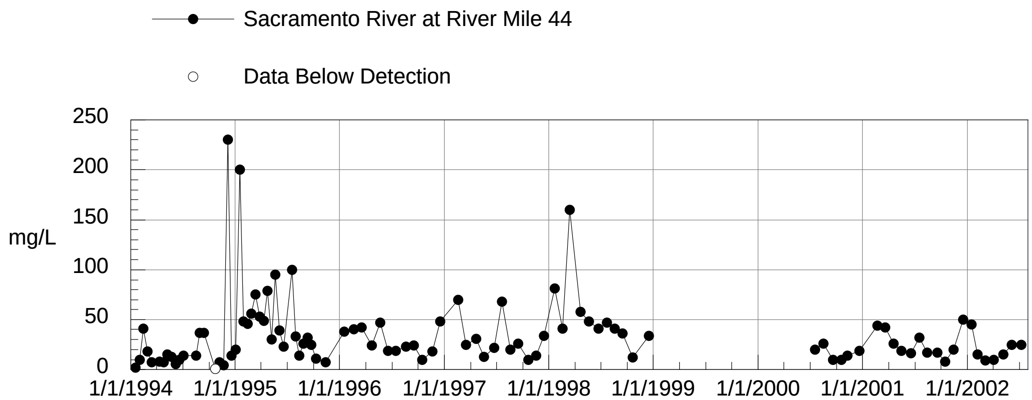
TOTAL SUSPENDED SOLIDS CONCENTRATIONS IN WATER

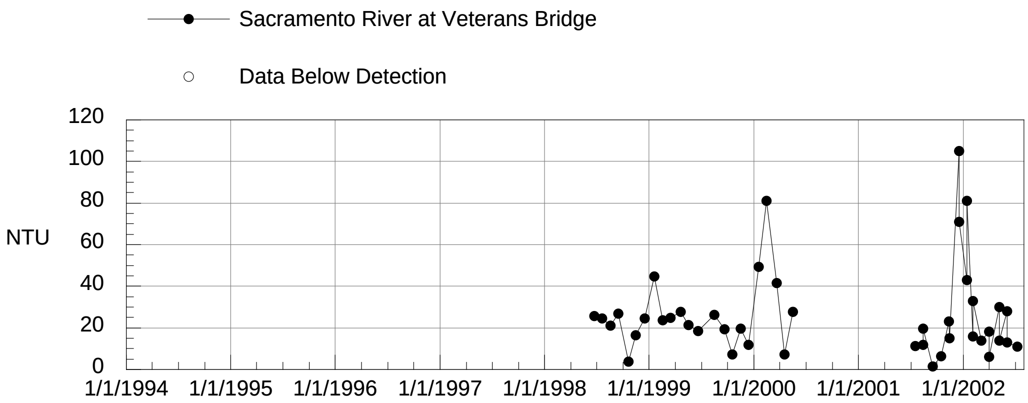


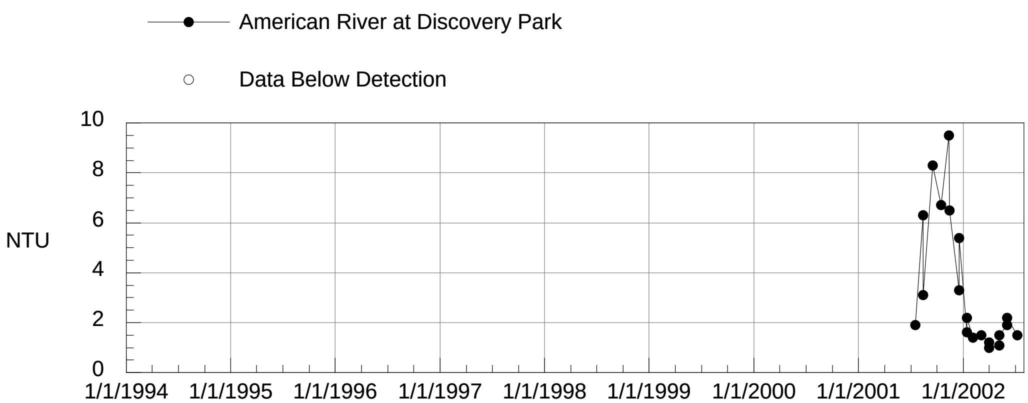


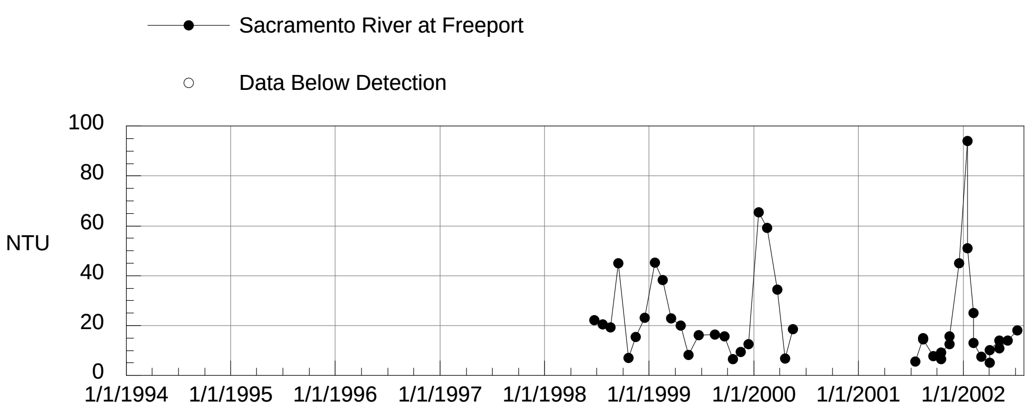


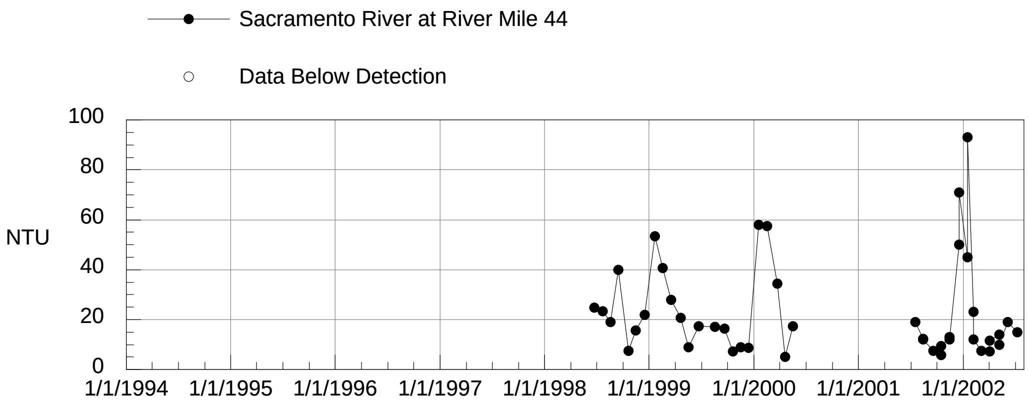
TOTAL SUSPENDED SOLIDS CONCENTRATIONS IN WATER

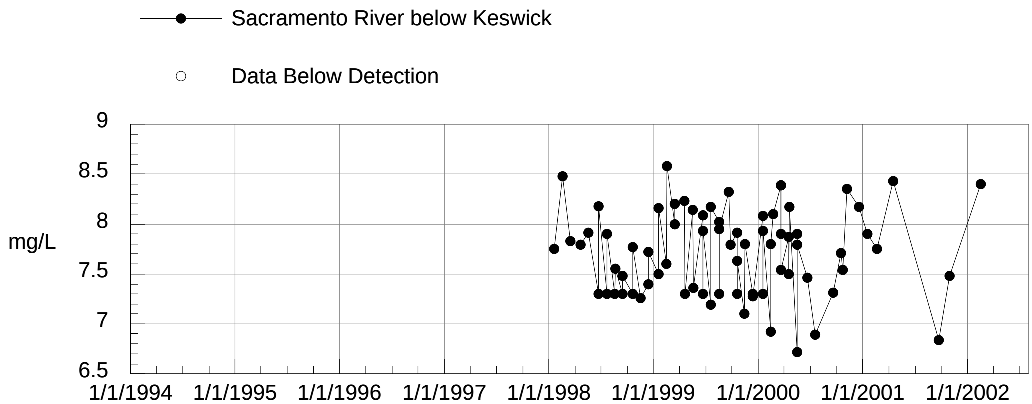


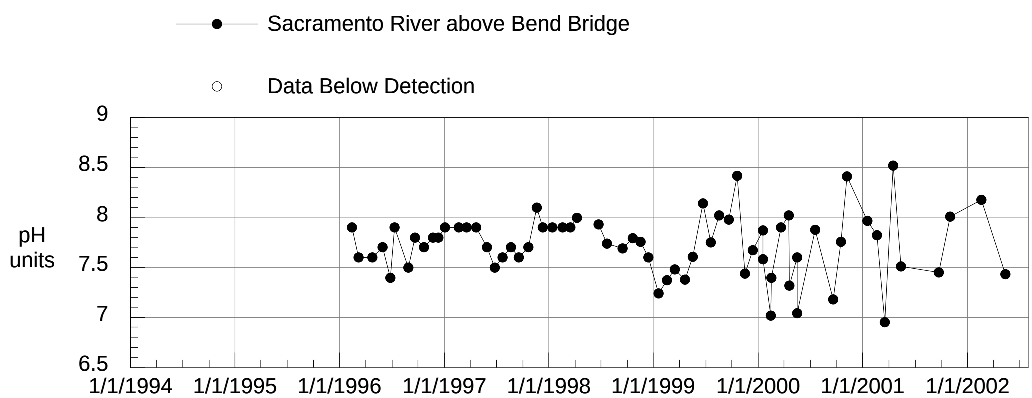

Sacramento River at Veterans Bridge
Data Below Detection
NTU
0
20
40
60
80
100
120
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

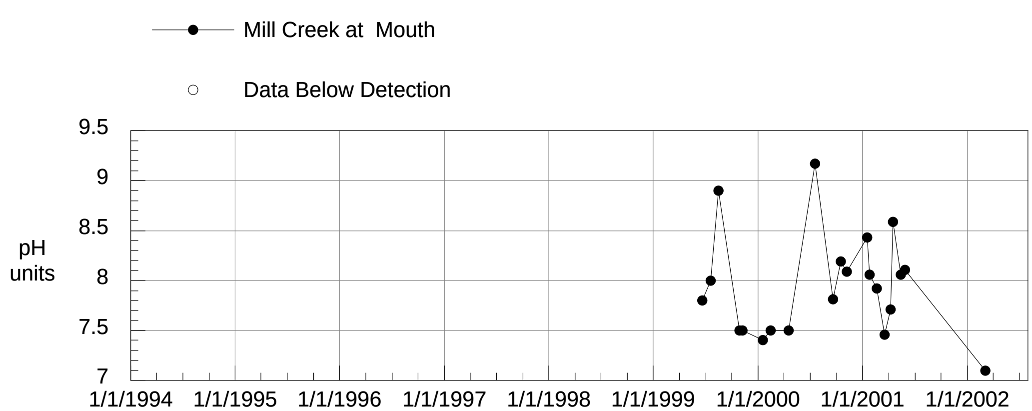

American River at Discovery Park
Data Below Detection
NTU
0
2
4
6
8
10
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

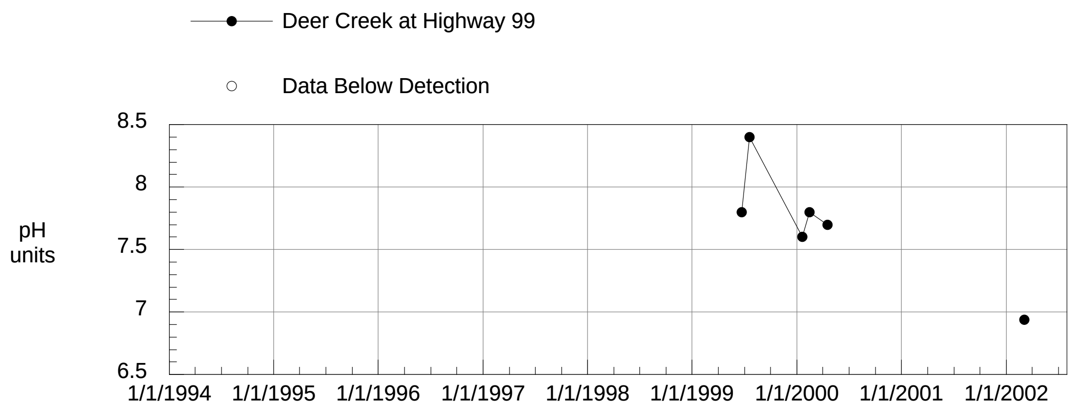

Sacramento River at Freeport
Data Below Detection
NTU
0
20
40
60
80
100
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

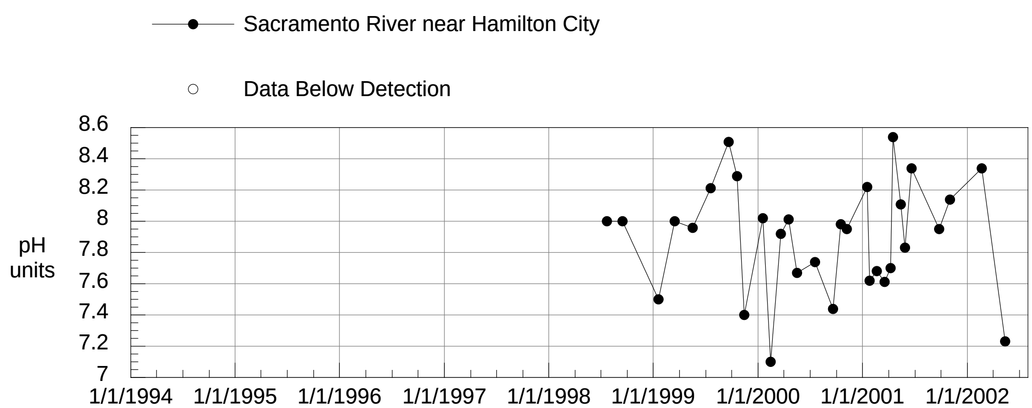

Sacramento River at River Mile 44
Data Below Detection
NTU
100
80
60
40
20
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

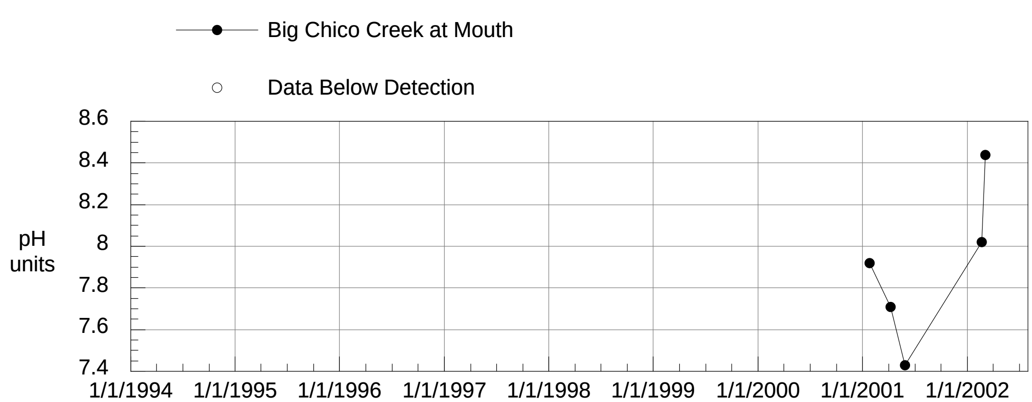

Sacramento River below Keswick
Data Below Detection
mg/L
9
8.5
8
7.5
7
6.5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

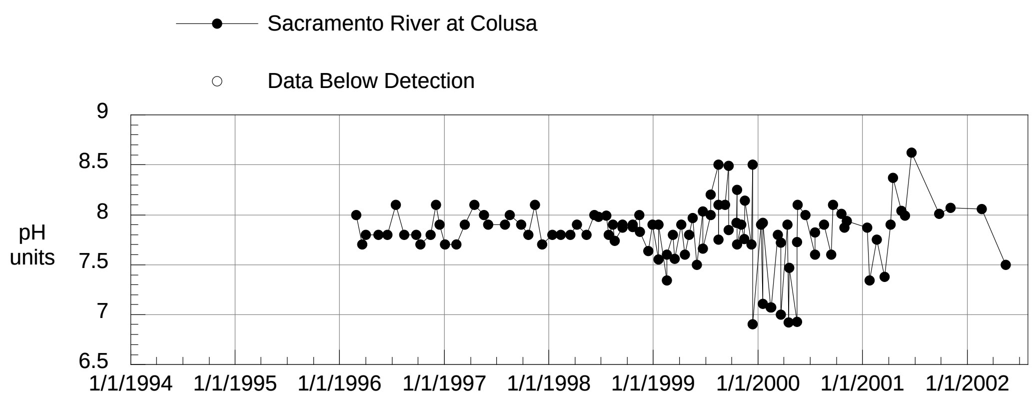

Sacramento River above Bend Bridge
Data Below Detection
pH units
9
8.5
8
7.5
7
6.5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

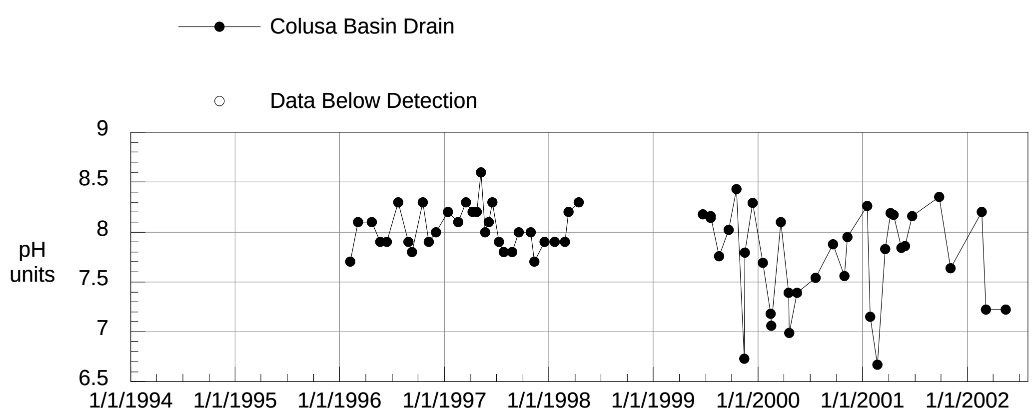

Mill Creek at Mouth
Data Below Detection
pH units
9.5
9
8.5
8
7.5
7
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

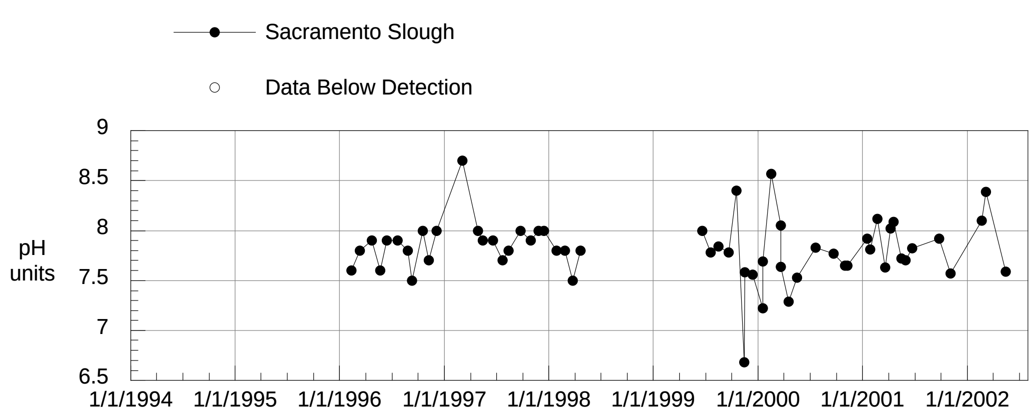

Deer Creek at Highway 99
Data Below Detection
pH units
8.5
8
7.5
7
6.5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

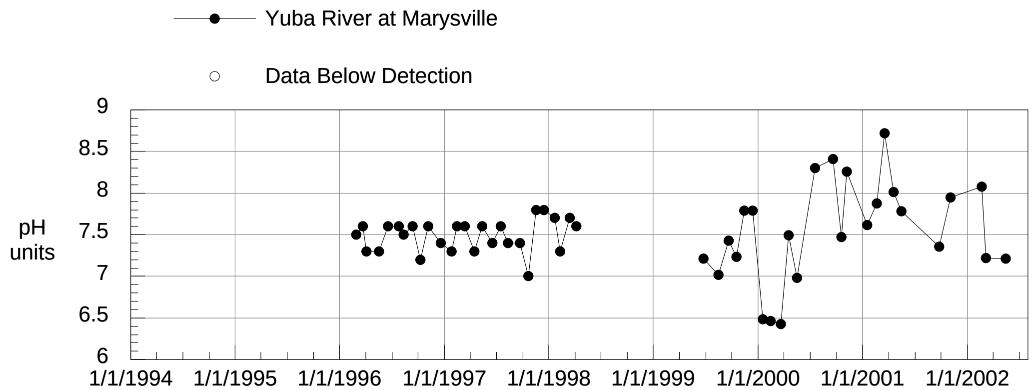

Sacramento River near Hamilton City
Data Below Detection
pH units
8.6
8.4
8.2
8
7.8
7.6
7.4
7.2
7
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

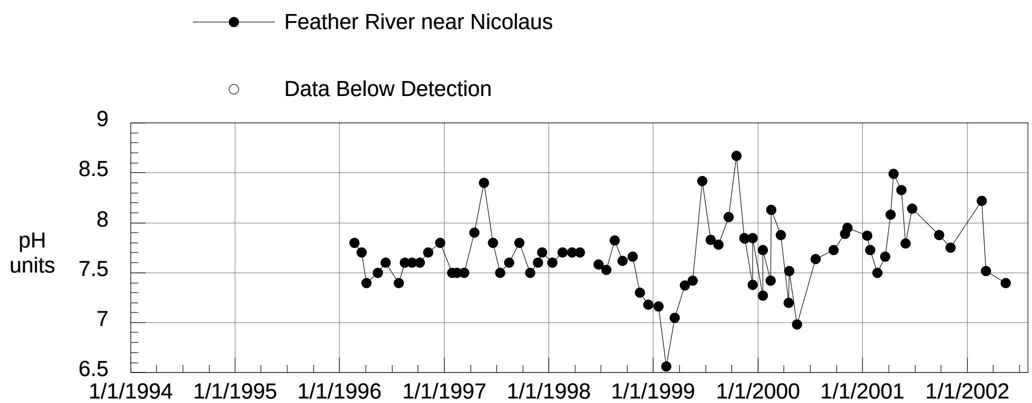

Big Chico Creek at Mouth
Data Below Detection
pH units
8.6
8.4
8.2
8
7.8
7.6
7.4
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

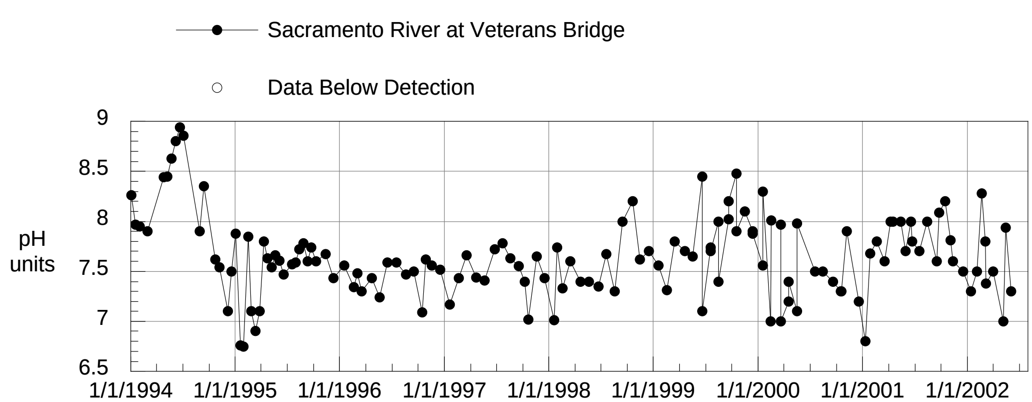

Sacramento River at Colusa
Data Below Detection
9
8.5
8
7.5
7
6.5
pH
units
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

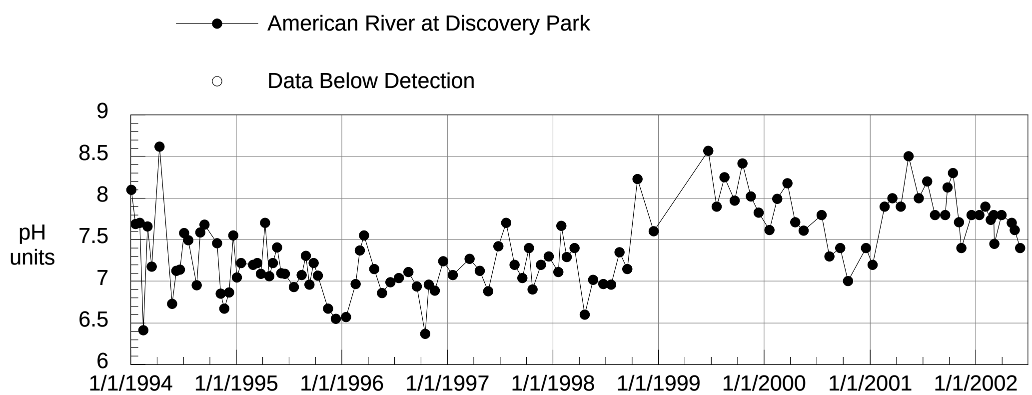

Colusa Basin Drain
Data Below Detection
9
8.5
8
7.5
7
6.5
pH
units
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento Slough
Data Below Detection
9
8.5
8
7.5
7
6.5
pH
units
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

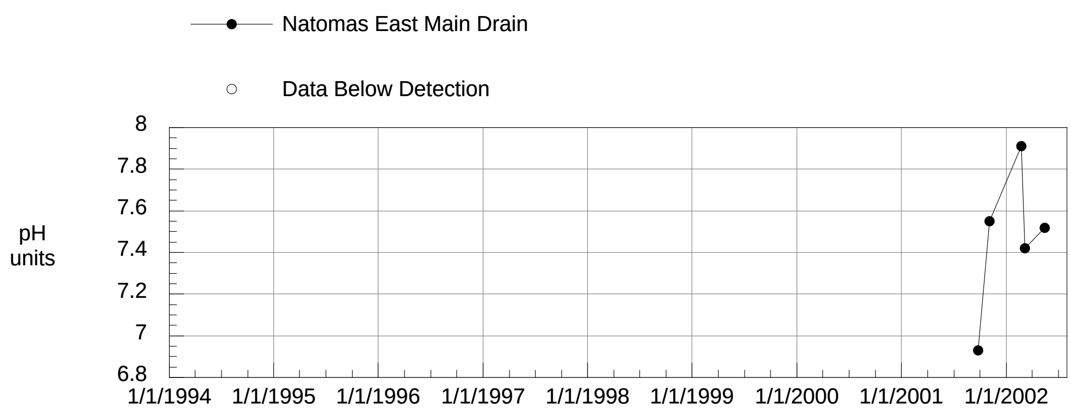

Yuba River at Marysville
Data Below Detection
pH units
9
8.5
8
7.5
7
6.5
6
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Feather River near Nicolaus
Data Below Detection
pH units
9
8.5
8
7.5
7
6.5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

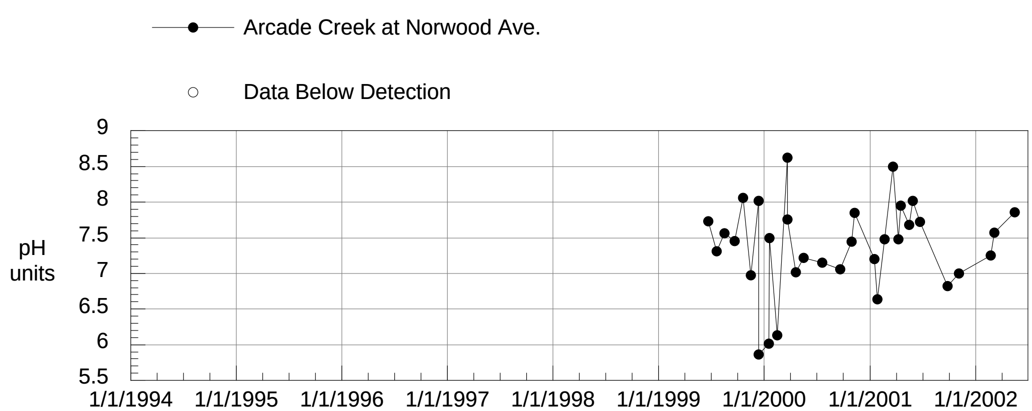

Sacramento River at Veterans Bridge
Data Below Detection
pH units
9
8.5
8
7.5
7
6.5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002



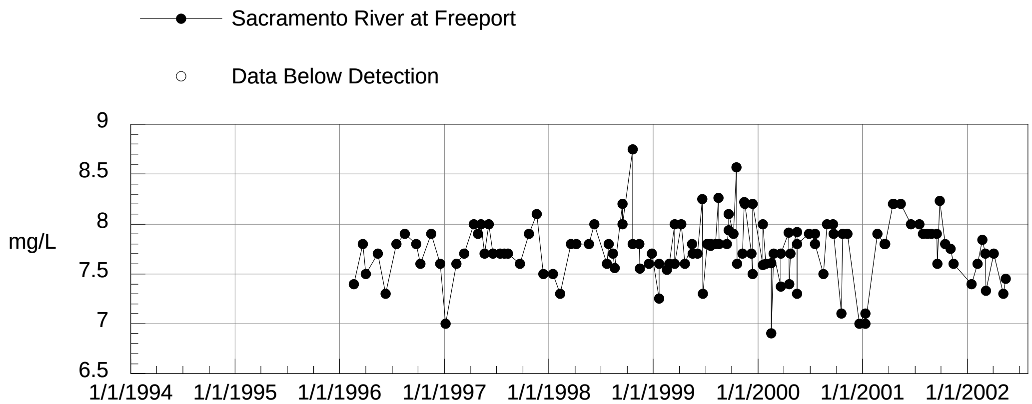
American River at Discovery Park
Data Below Detection
pH units
9
8.5
8
7.5
7
6.5
6
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

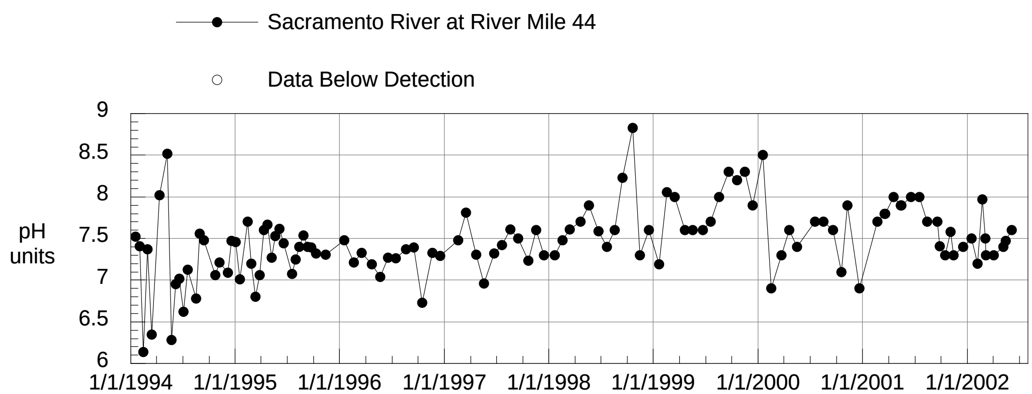


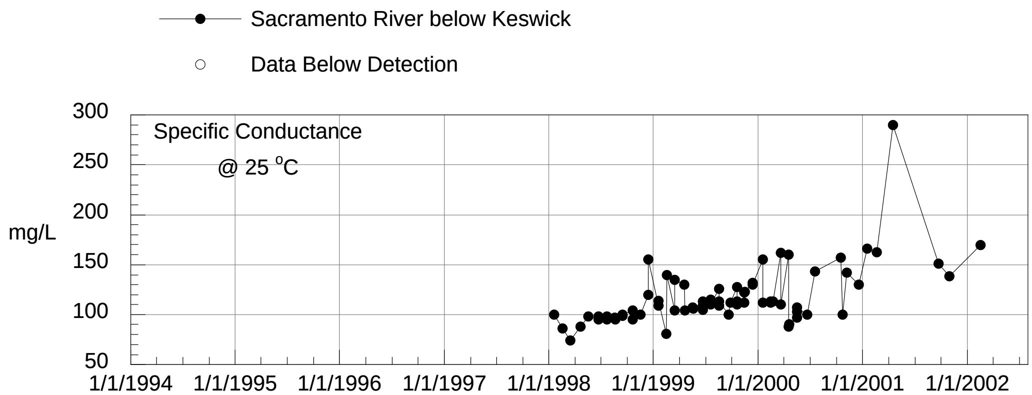
Natomas East Main Drain
Data Below Detection
pH units
8
7.8
7.6
7.4
7.2
7
6.8
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002



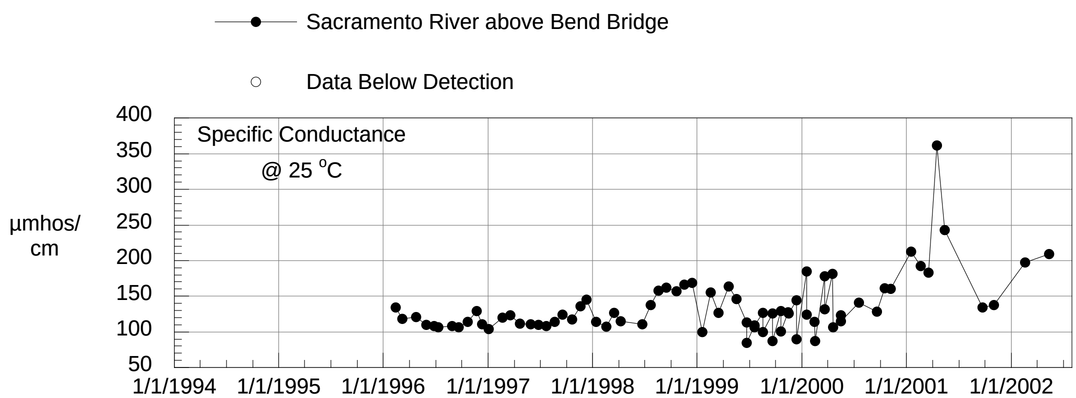
Arcade Creek at Norwood Ave.
Data Below Detection
pH units
9
8.5
8
7.5
7
6.5
6
5.5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at Freeport
Data Below Detection
mg/L
9
8.5
8
7.5
7
6.5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

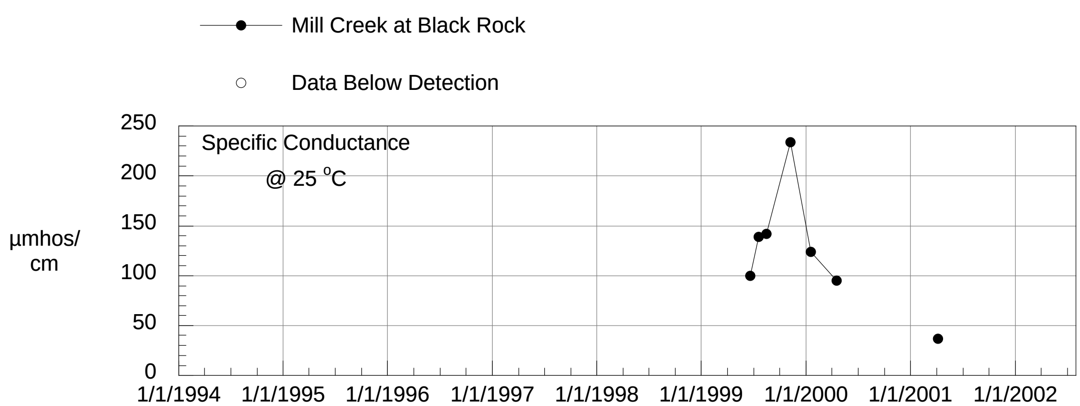

Sacramento River at River Mile 44
Data Below Detection
pH units
9
8.5
8
7.5
7
6.5
6
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002



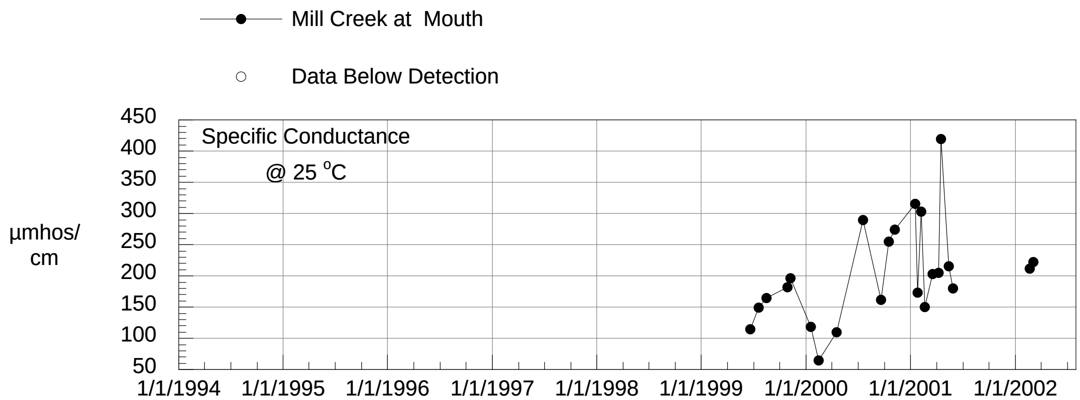
Sacramento River below Keswick
Data Below Detection
Specific Conductance
@ 25 °C
mg/L
300
250
200
150
100
50
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

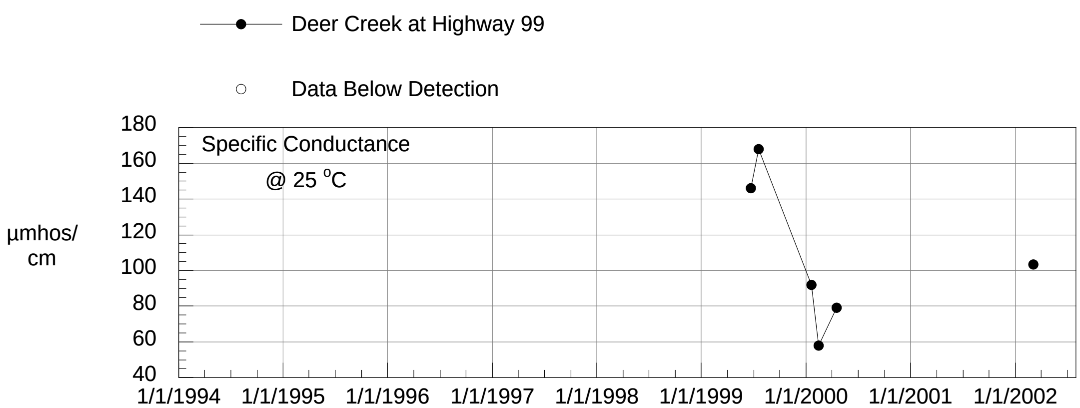


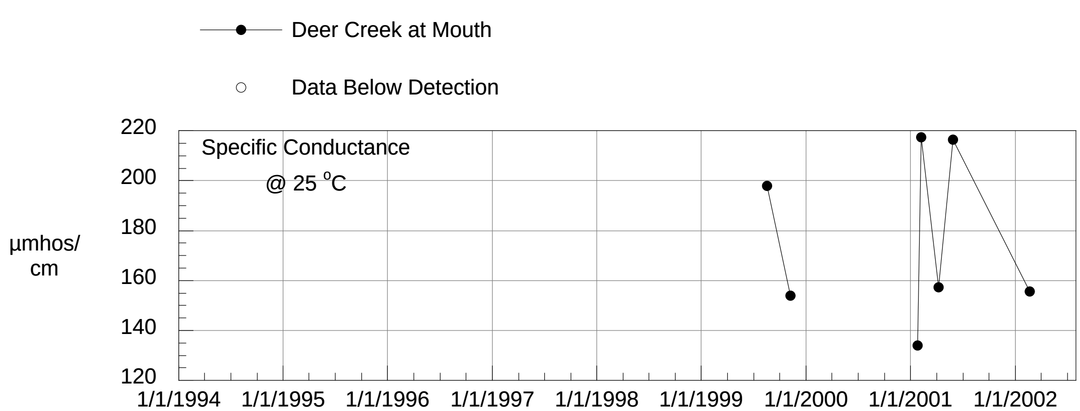
Sacramento River above Bend Bridge
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
400
350
300
250
200
150
100
50
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

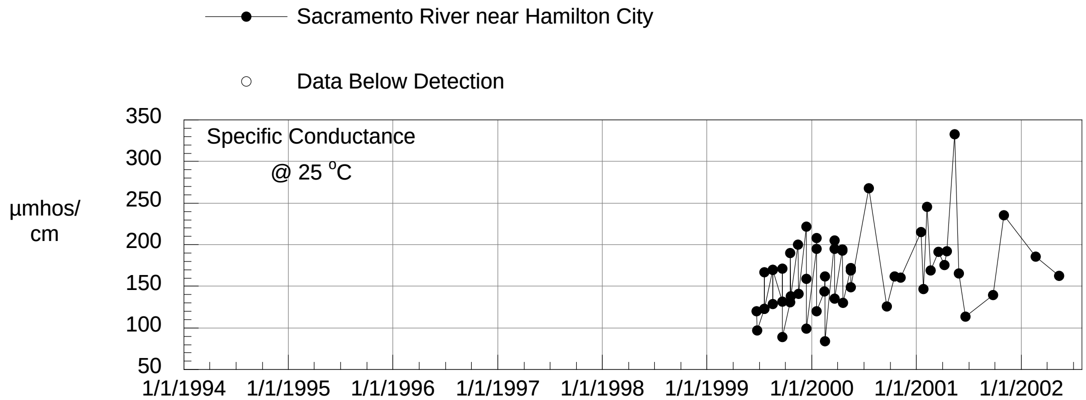


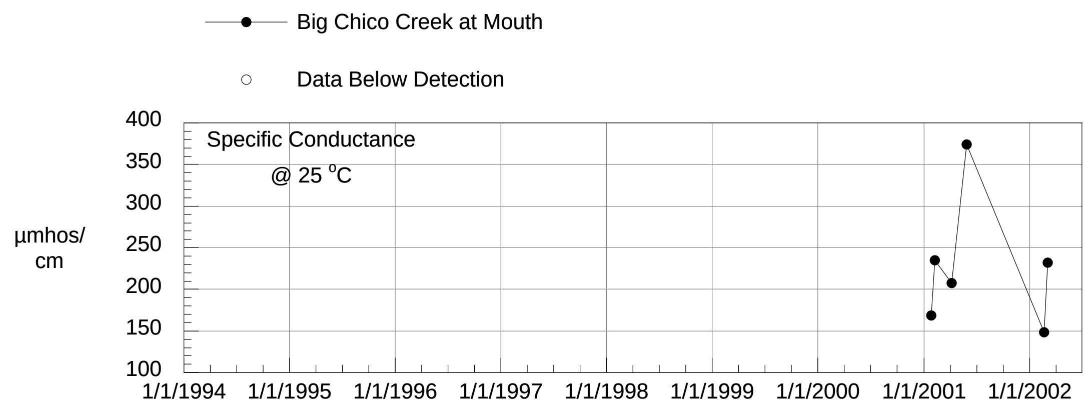
Mill Creek at Black Rock
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
250
200
150
100
50
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

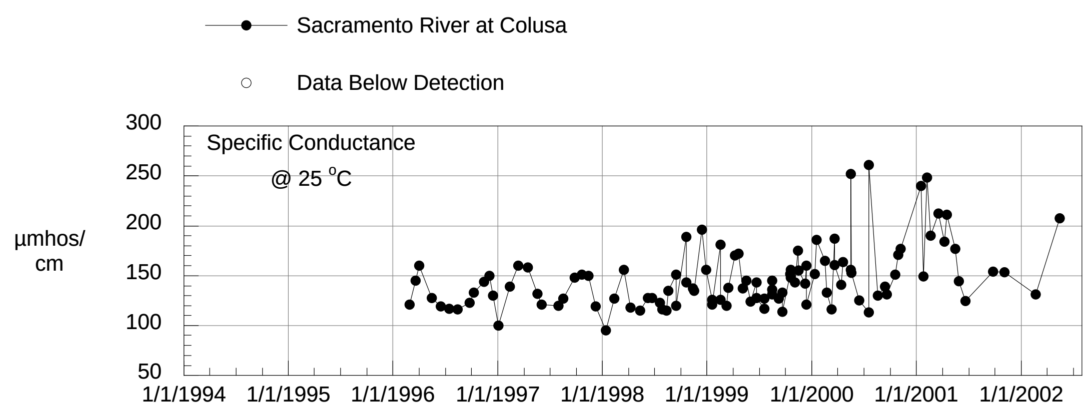

Mill Creek at Mouth
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
450
400
350
300
250
200
150
100
50
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

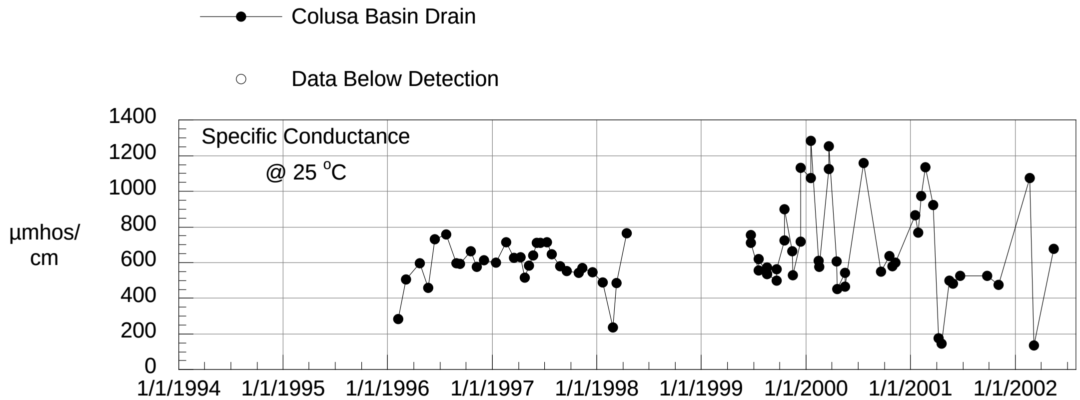

Deer Creek at Highway 99
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
180
160
140
120
100
80
60
40
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

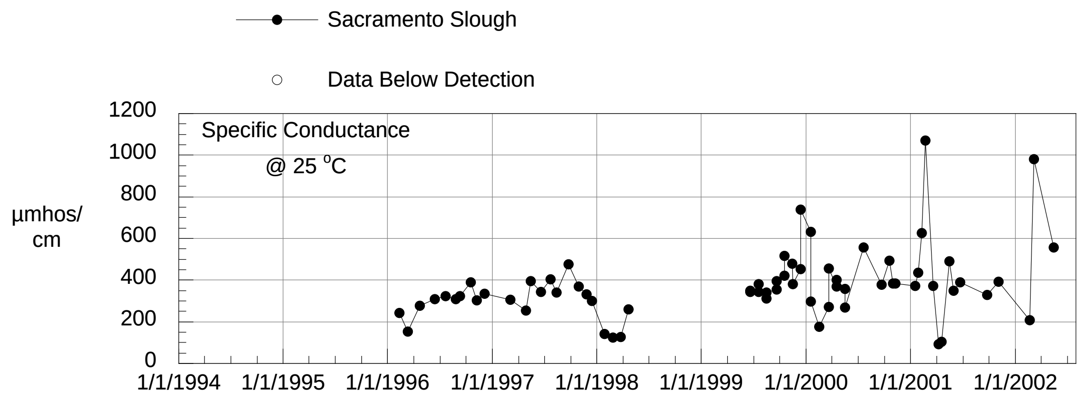

Deer Creek at Mouth
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
220
200
180
160
140
120
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

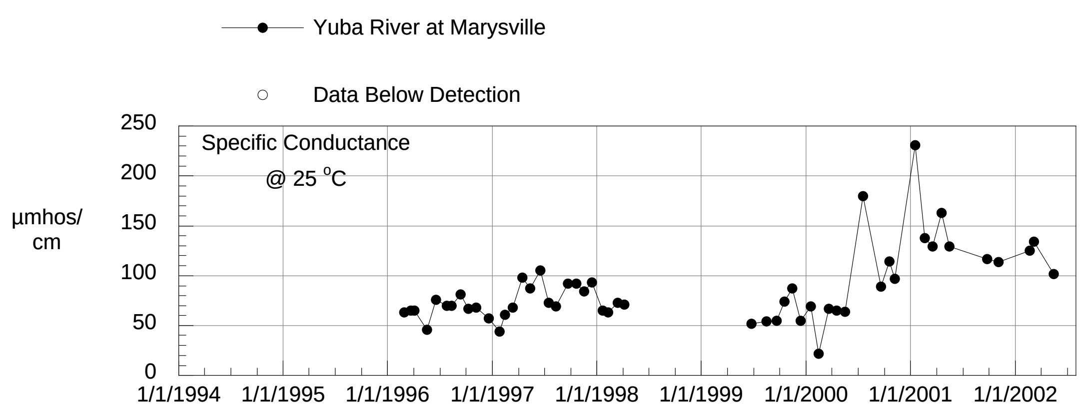

Sacramento River near Hamilton City
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
350
300
250
200
150
100
50
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

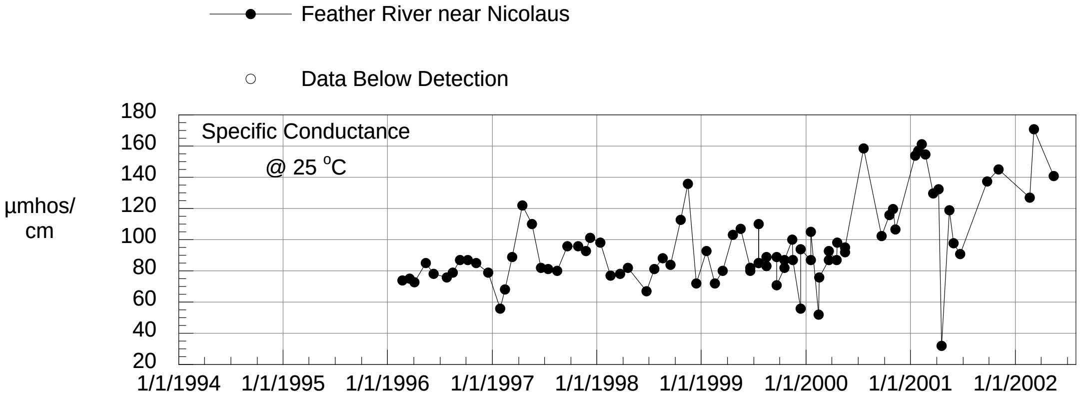

Big Chico Creek at Mouth
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
400
350
300
250
200
150
100
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

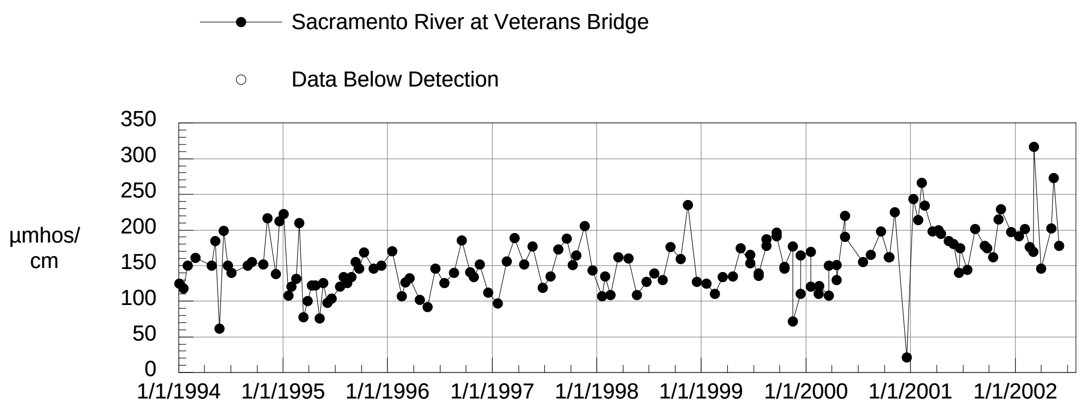

Sacramento River at Colusa
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
300
250
200
150
100
50
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

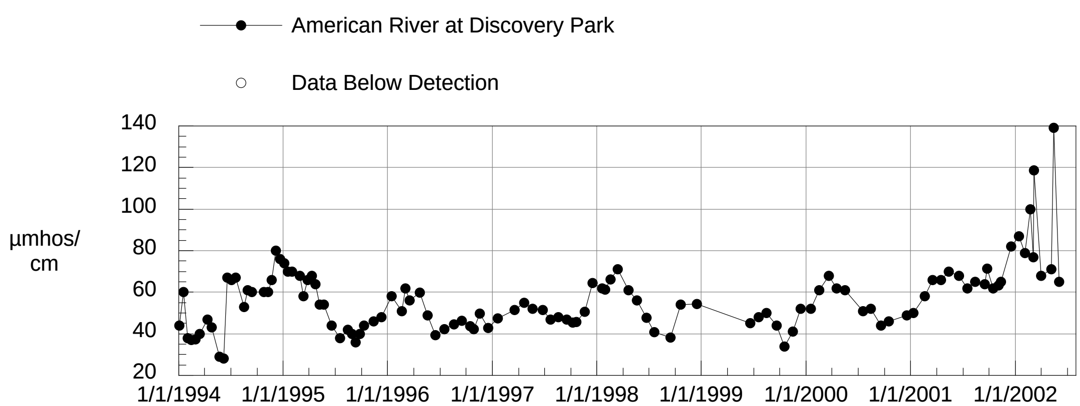

Colusa Basin Drain
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
1400
1200
1000
800
600
400
200
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

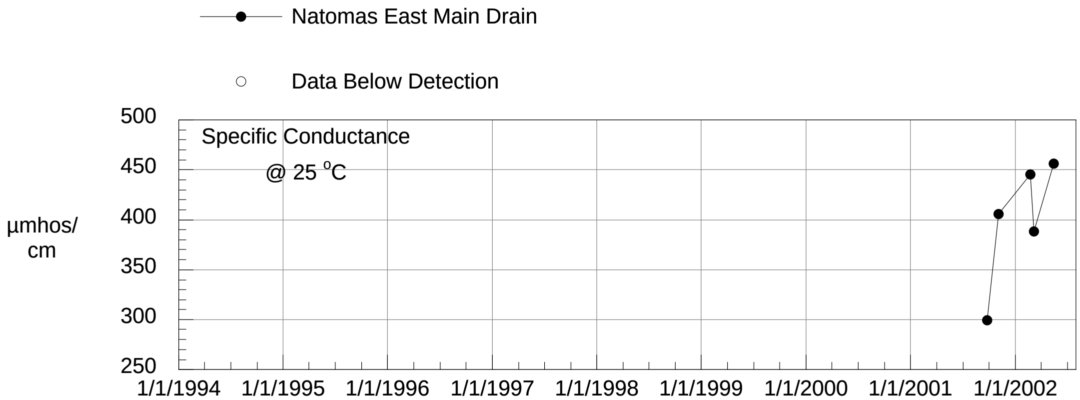

Sacramento Slough
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
1200
1000
800
600
400
200
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Yuba River at Marysville
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
250
200
150
100
50
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

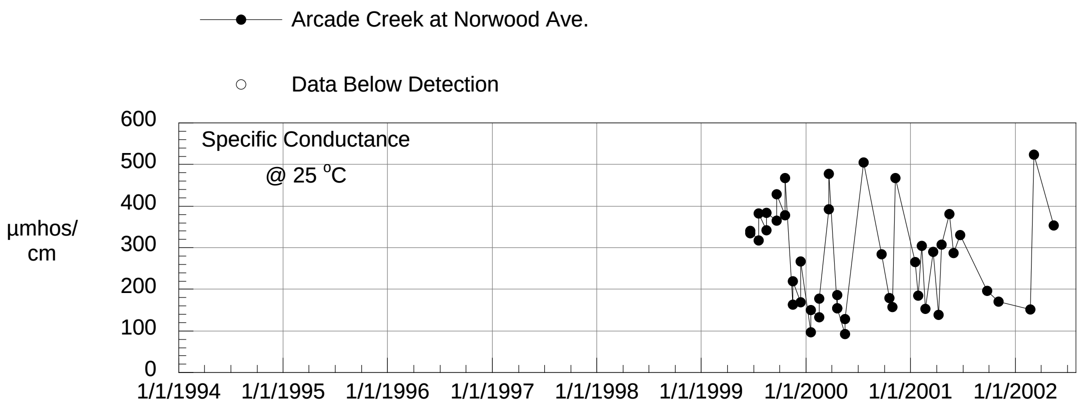

Feather River near Nicolaus
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/ cm
180
160
140
120
100
80
60
40
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at Veterans Bridge
Data Below Detection
µmhos/ cm
350
300
250
200
150
100
50
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

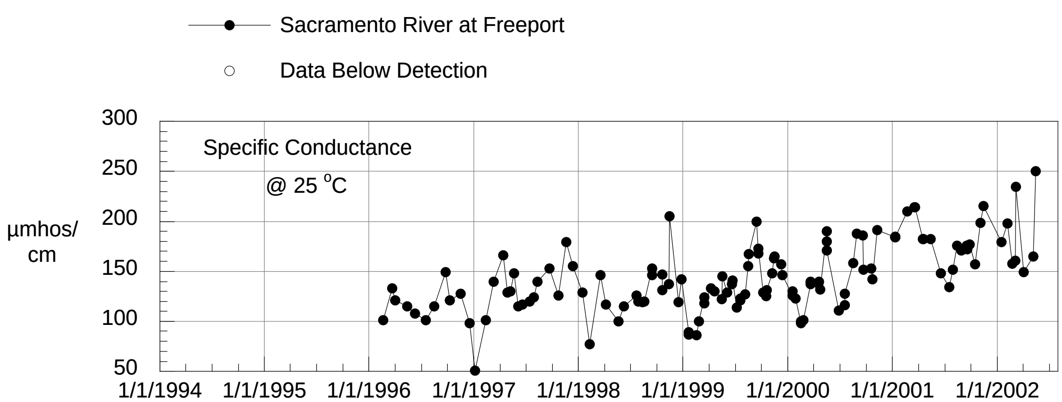

American River at Discovery Park
Data Below Detection
µmhos/ cm
140
120
100
80
60
40
20
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002



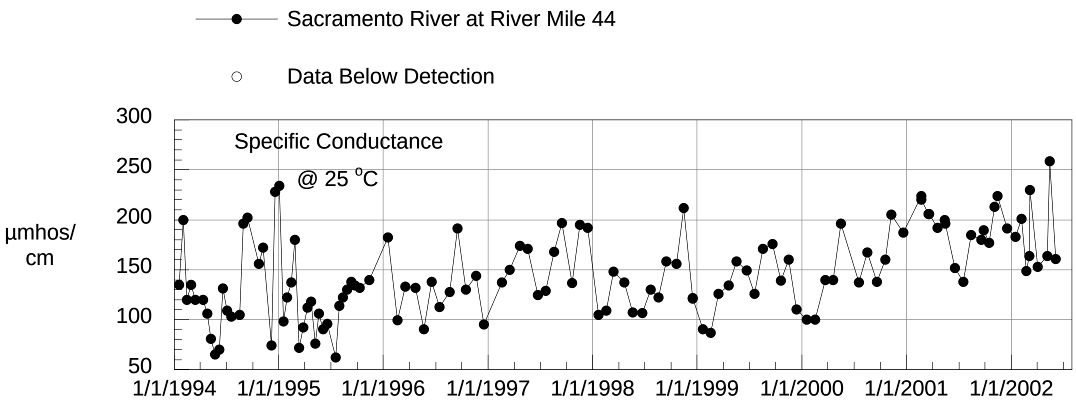
Natomas East Main Drain
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
500
450
400
350
300
250
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002



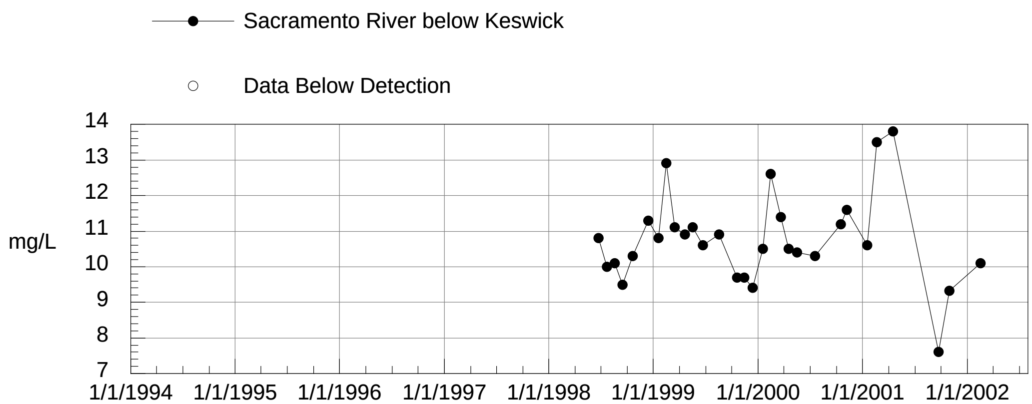
Arcade Creek at Norwood Ave.
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
600
500
400
300
200
100
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

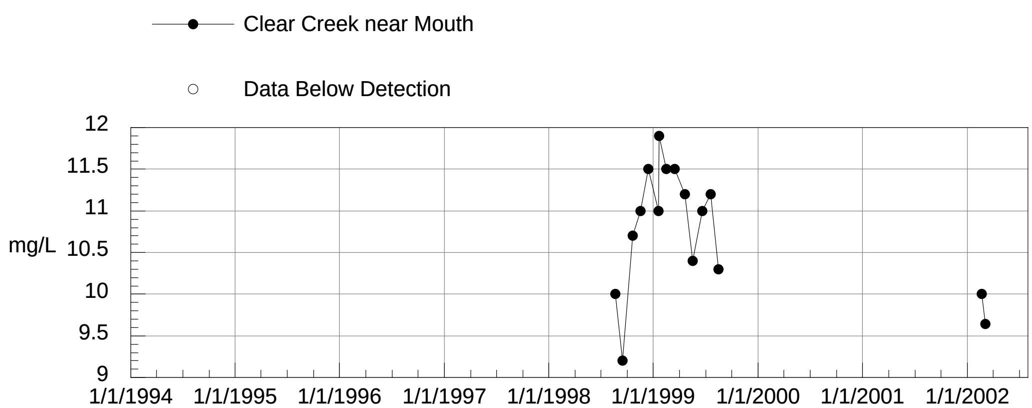


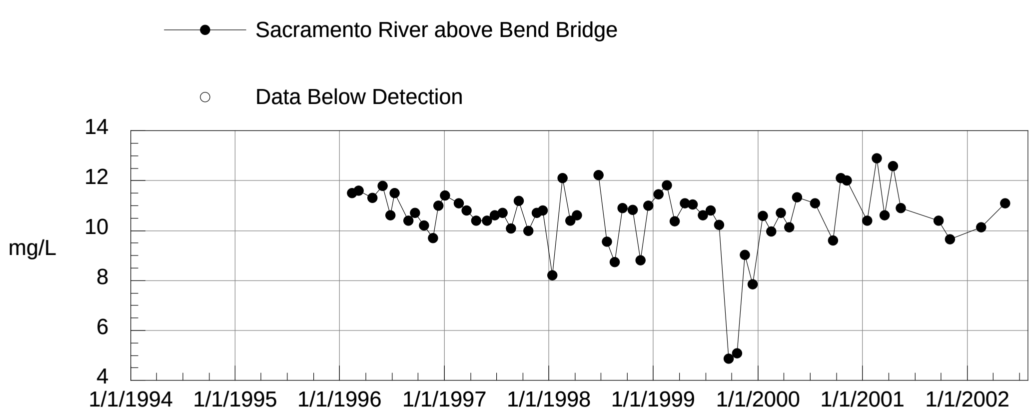
Sacramento River at Freeport
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
300
250
200
150
100
50
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at River Mile 44
Data Below Detection
Specific Conductance
@ 25 °C
µmhos/
cm
300
250
200
150
100
50
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

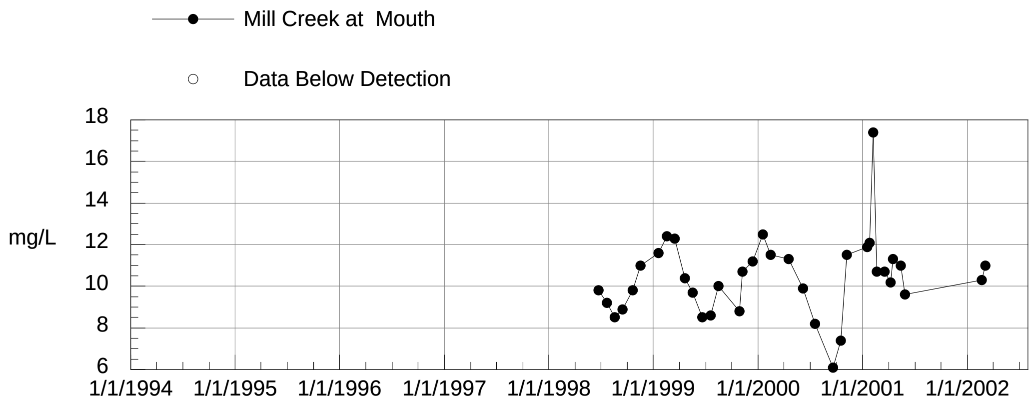
DISSOLVED OXYGEN CONCENTRATIONS IN WATER

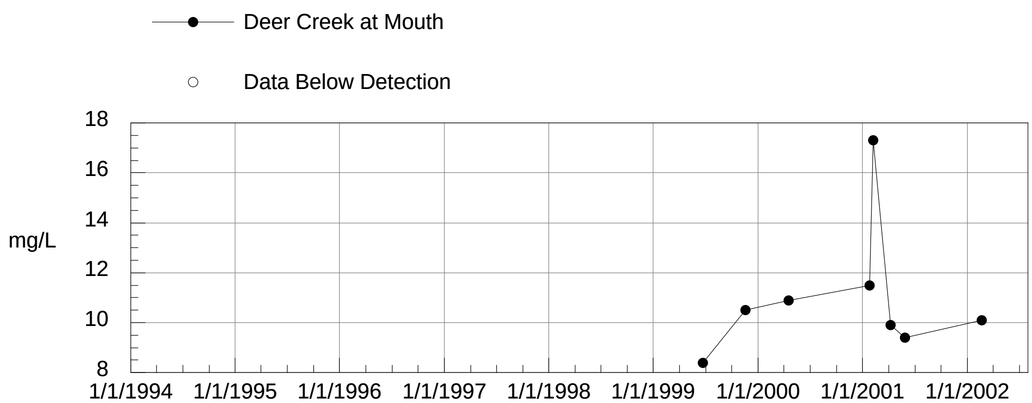


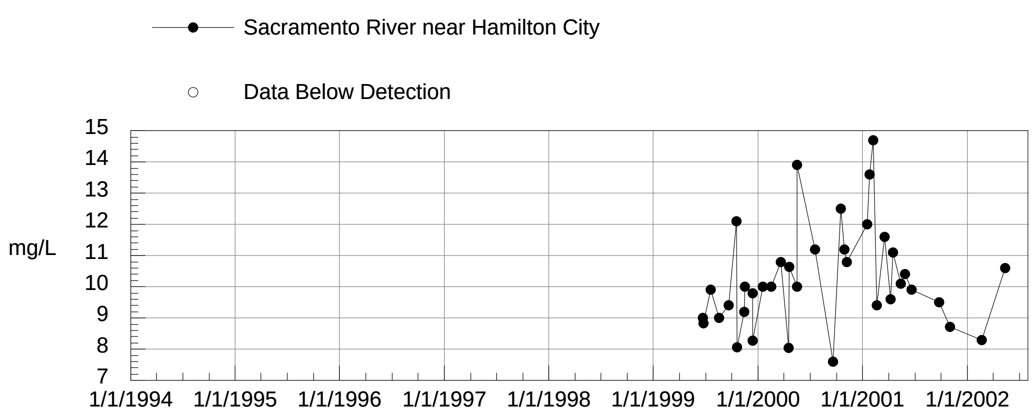




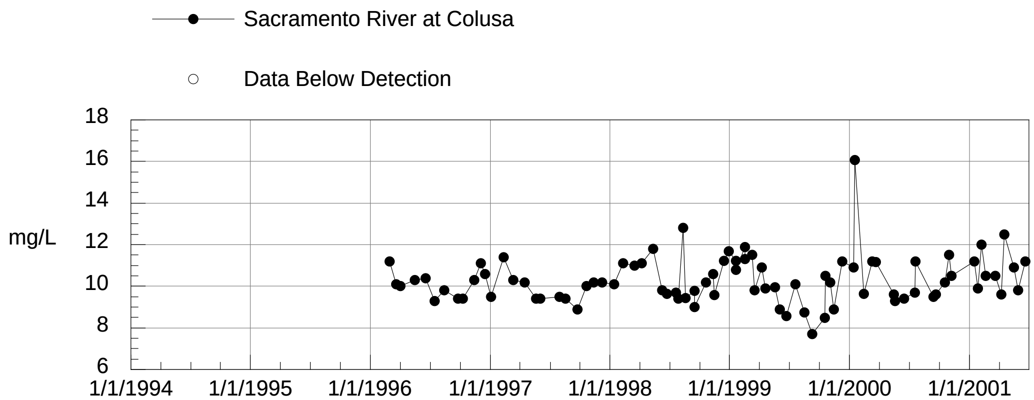
DISSOLVED OXYGEN CONCENTRATIONS IN WATER

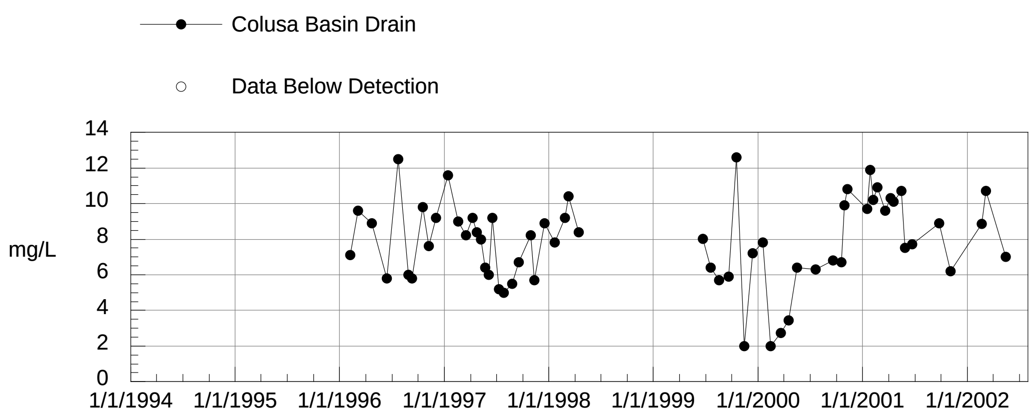


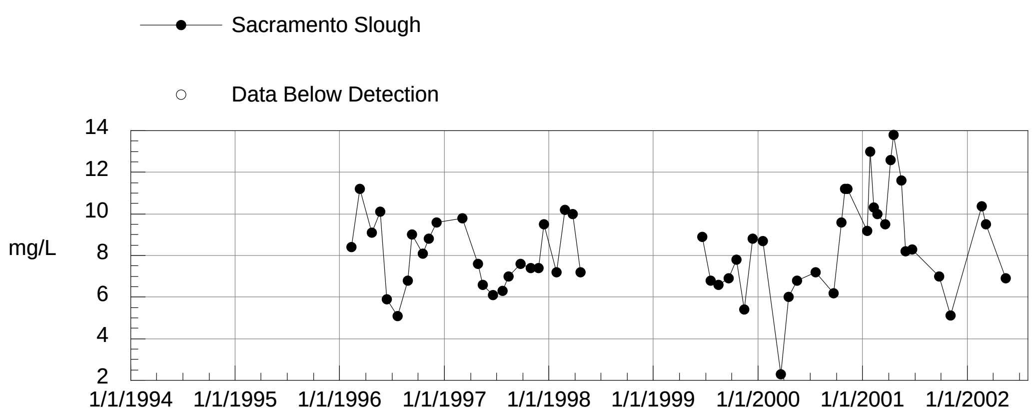




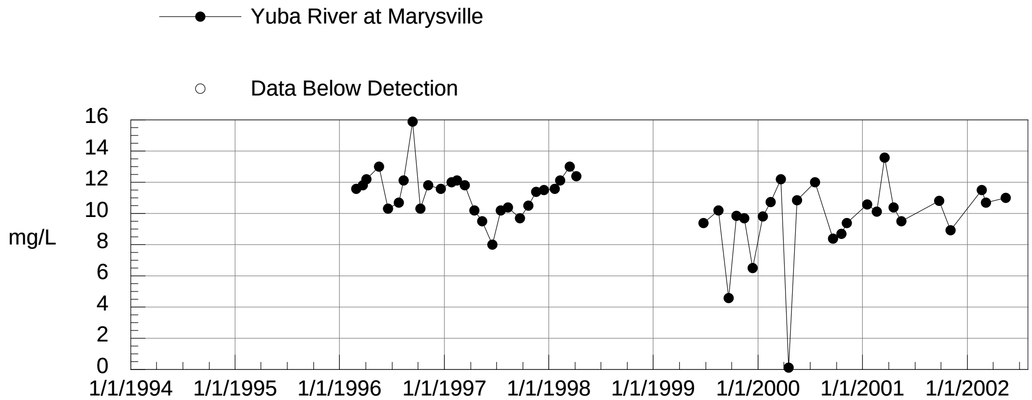
DISSOLVED OXYGEN CONCENTRATIONS IN WATER

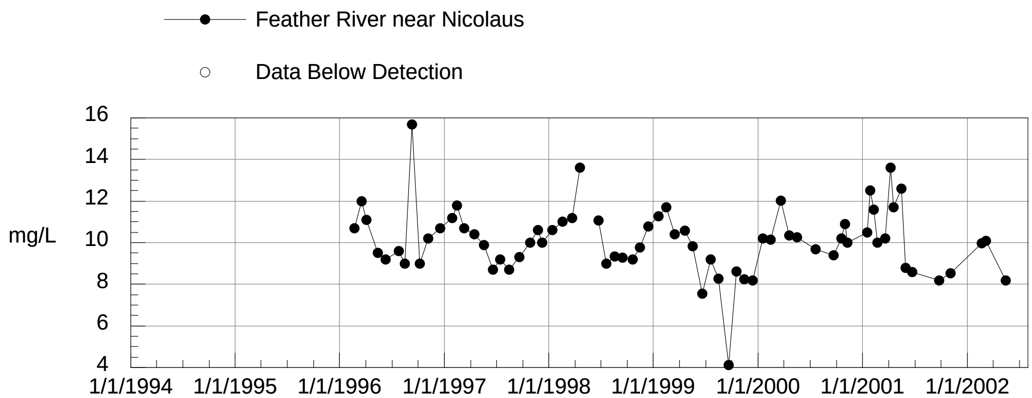


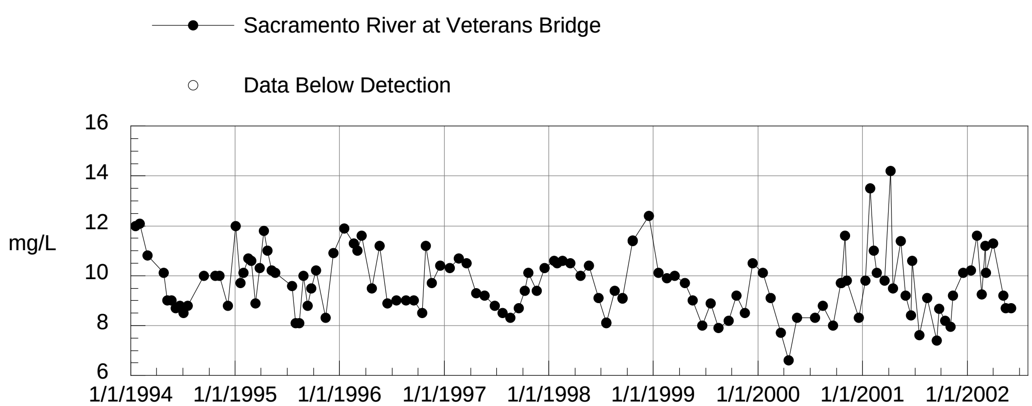




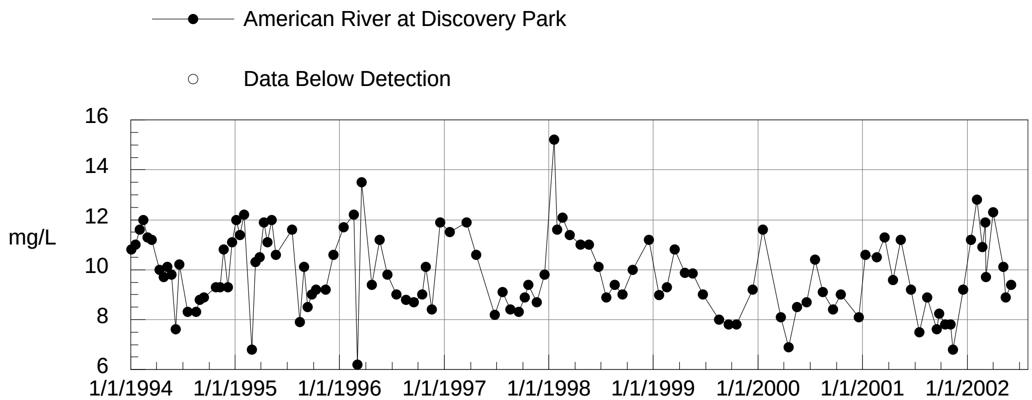
DISSOLVED OXYGEN CONCENTRATIONS IN WATER

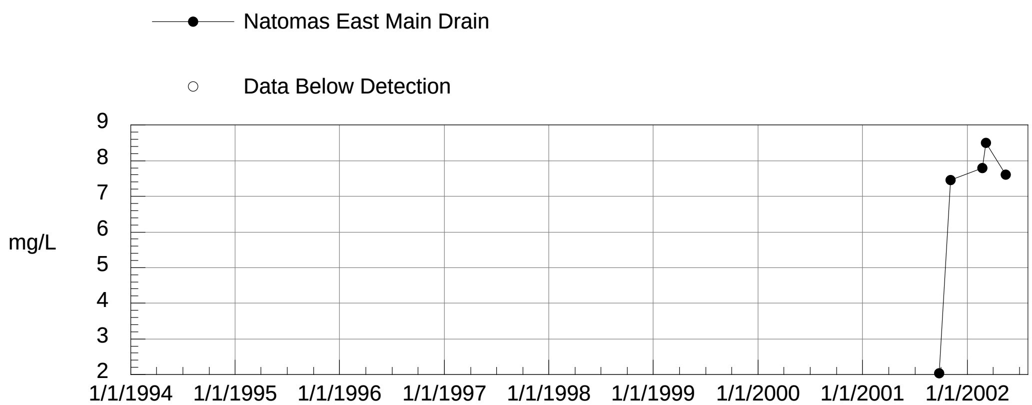


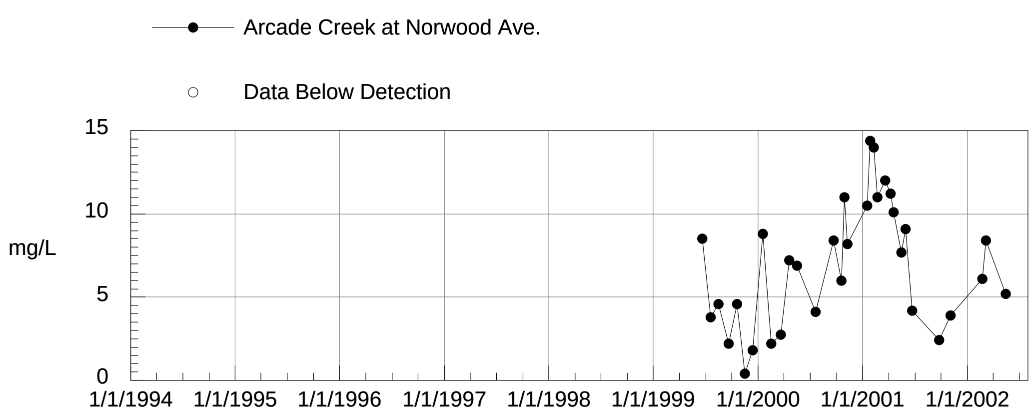




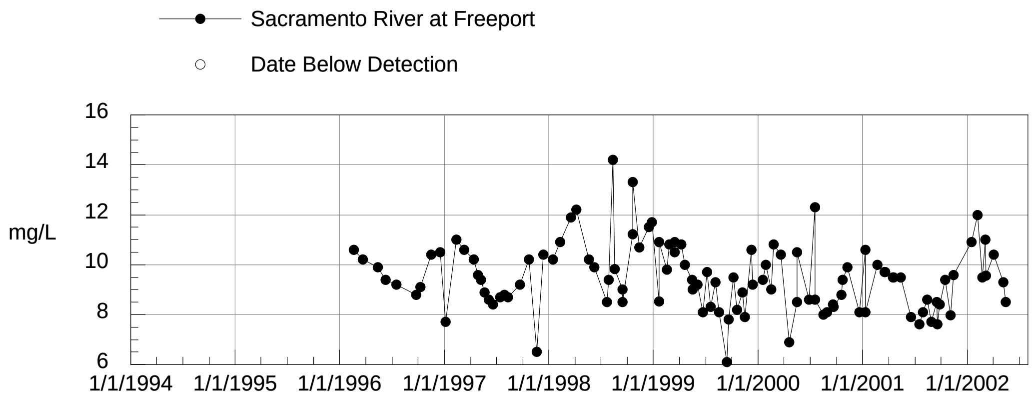
DISSOLVED OXYGEN CONCENTRATIONS IN WATER

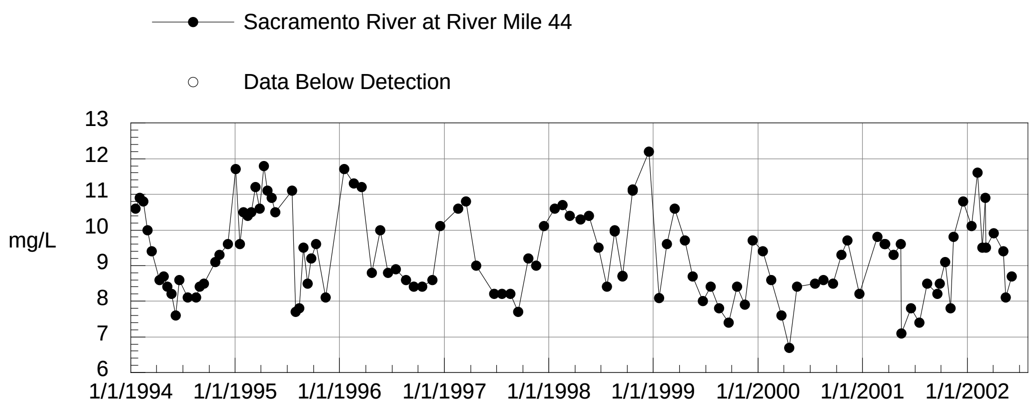


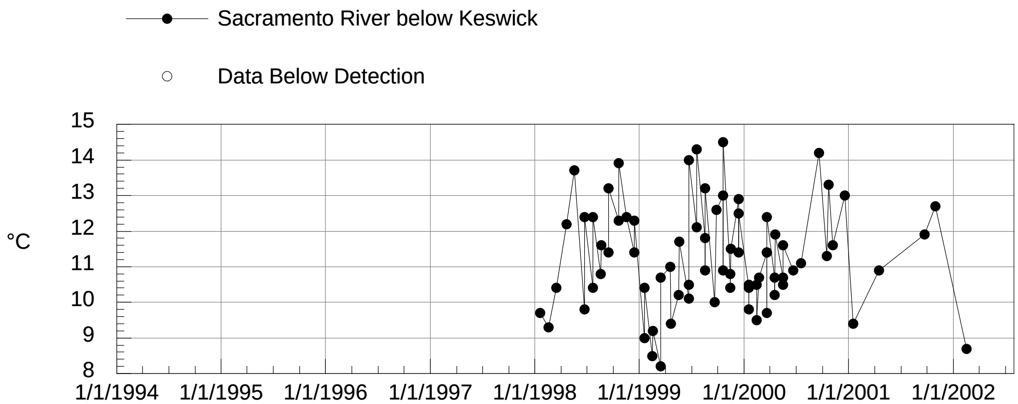


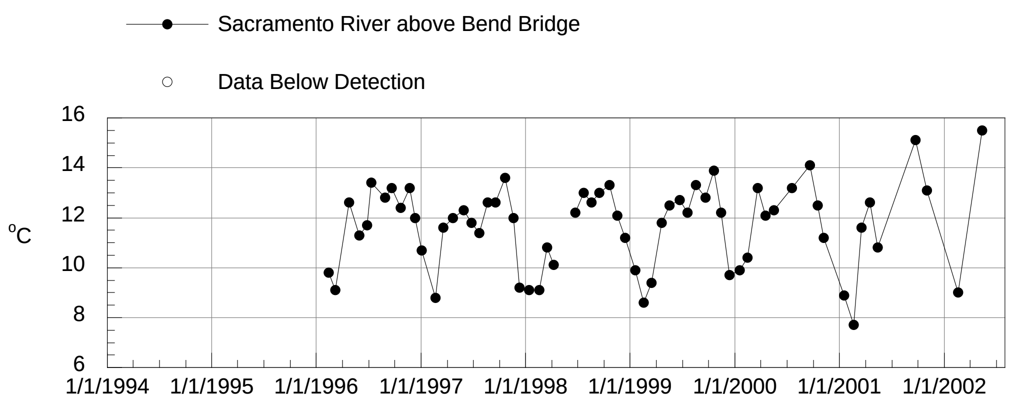


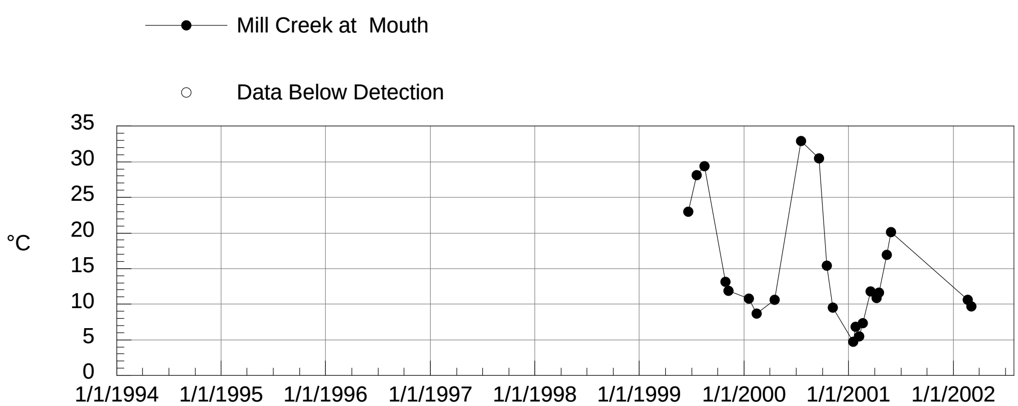
DISSOLVED OXYGEN CONCENTRATIONS IN WATER

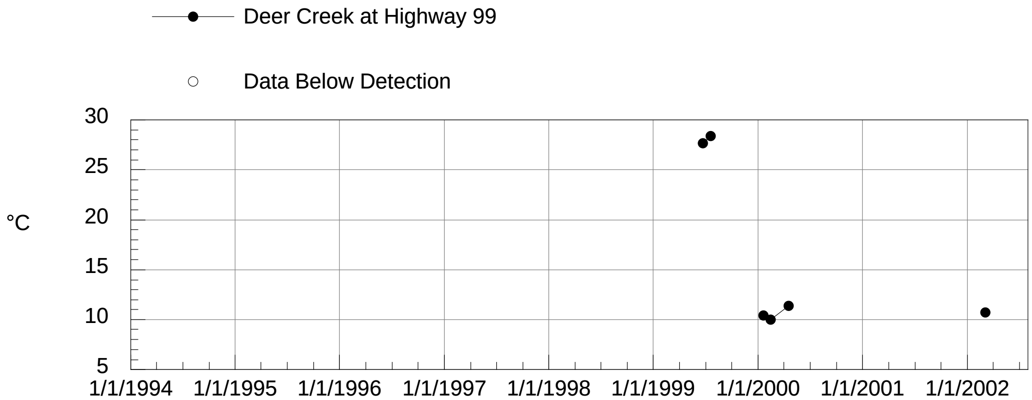


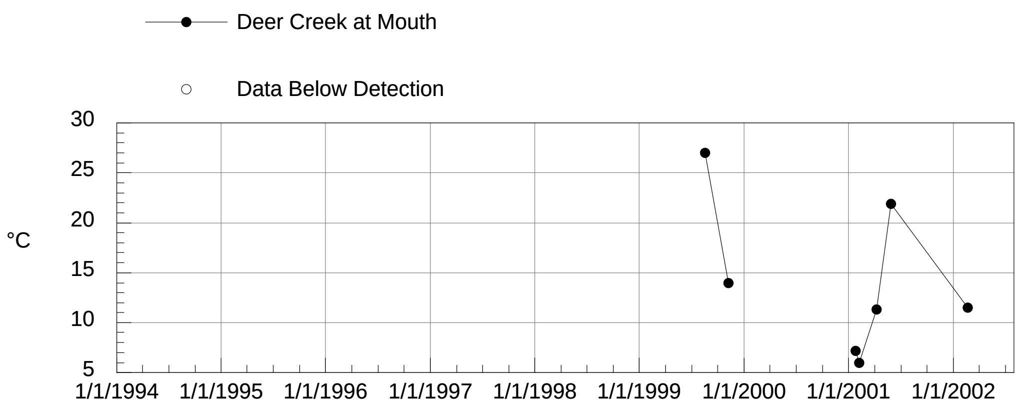


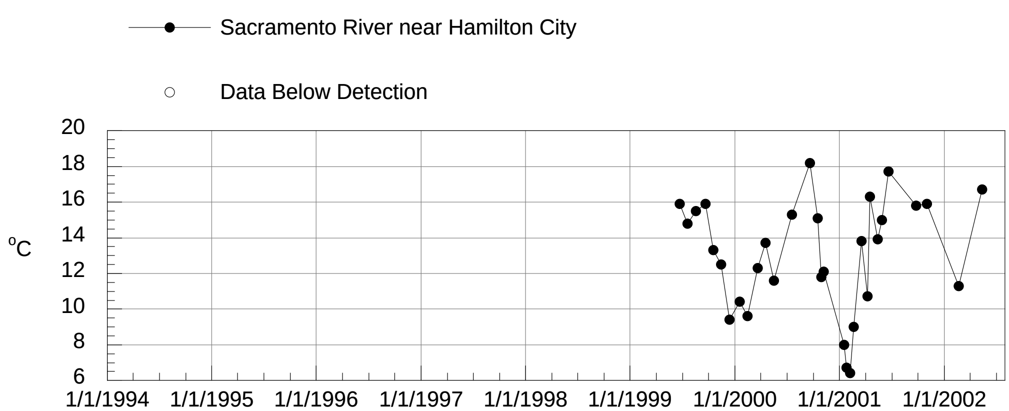

Sacramento River below Keswick
Data Below Detection
°C
15
14
13
12
11
10
9
8
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

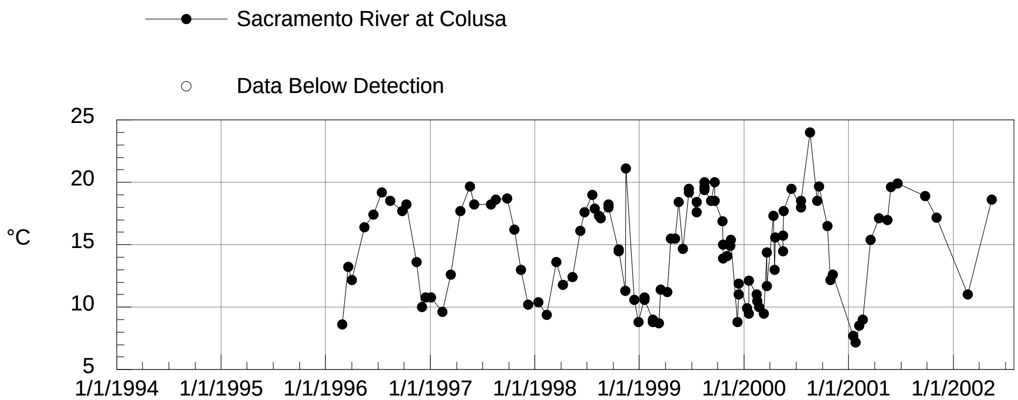

Sacramento River above Bend Bridge
Data Below Detection
°C
16
14
12
10
8
6
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

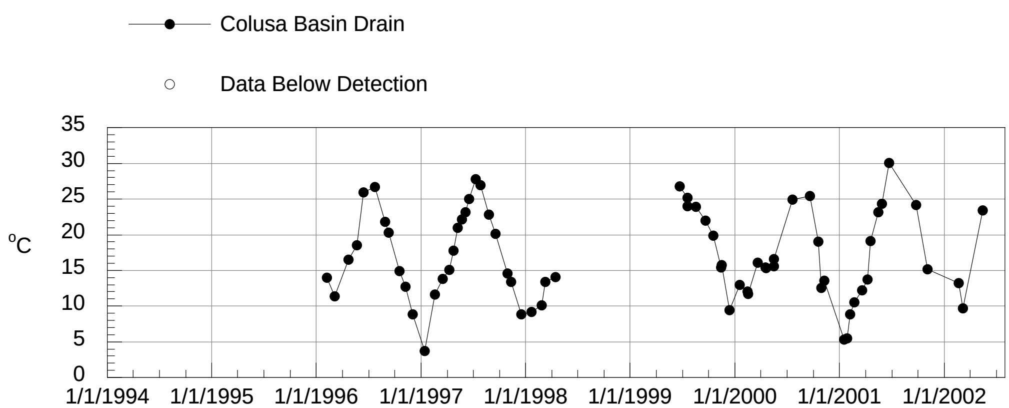

Mill Creek at Mouth
Data Below Detection
°C
35
30
25
20
15
10
5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

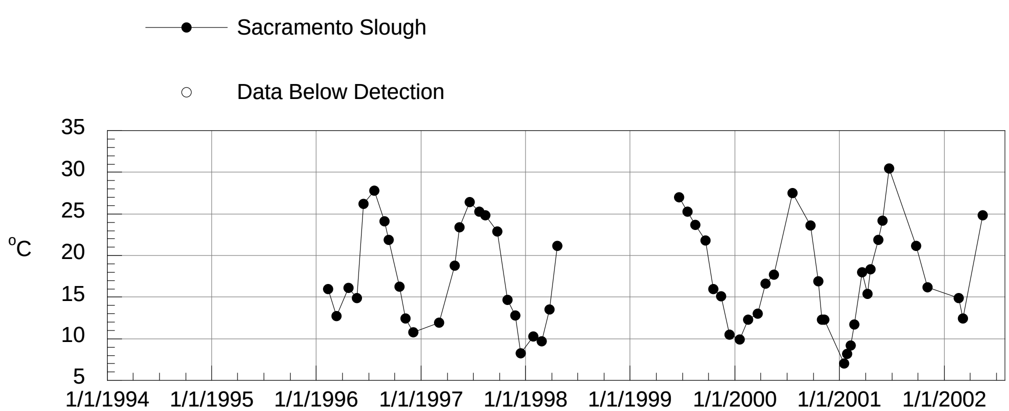

Deer Creek at Highway 99
Data Below Detection
°C
30
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

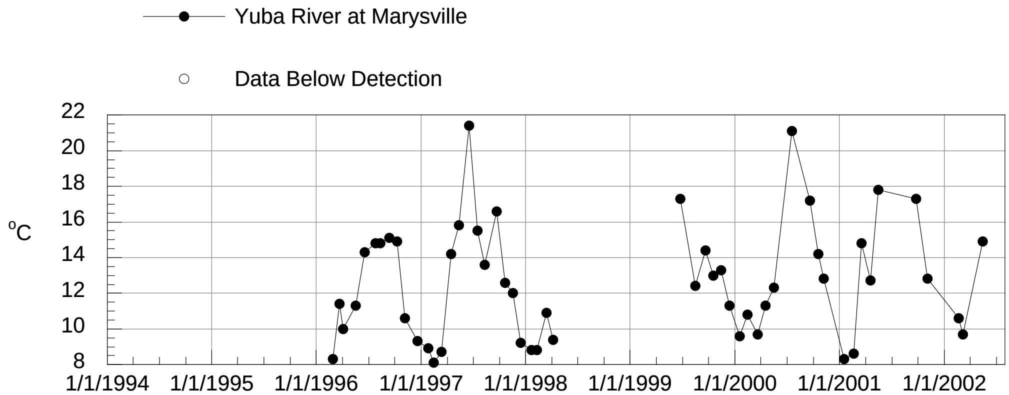

Deer Creek at Mouth
Data Below Detection
°C
30
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

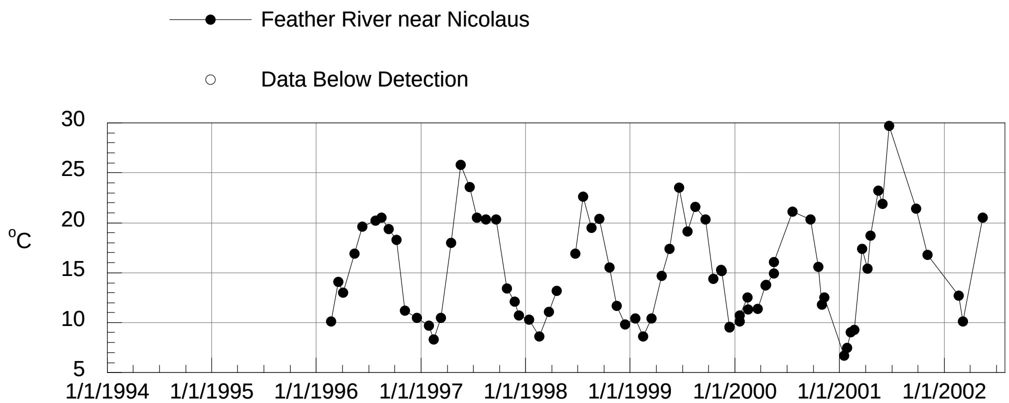

Sacramento River near Hamilton City
Data Below Detection
°C
20
18
16
14
12
10
8
6
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

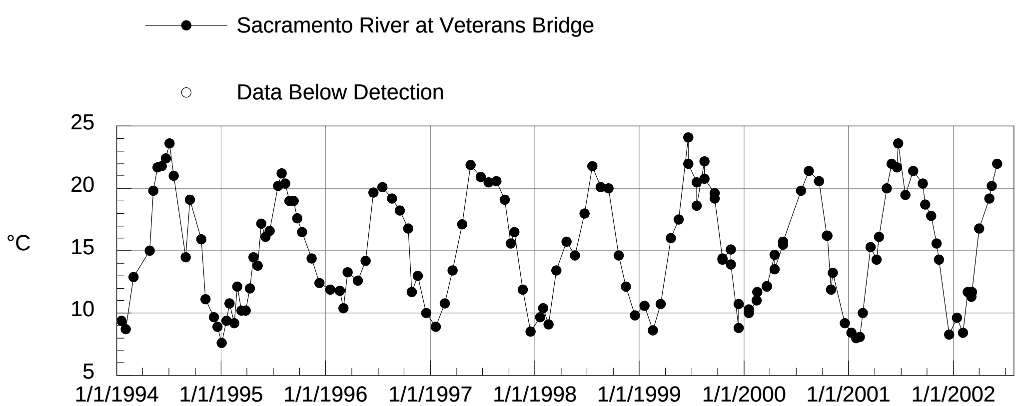

Sacramento River at Colusa
Data Below Detection
°C
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

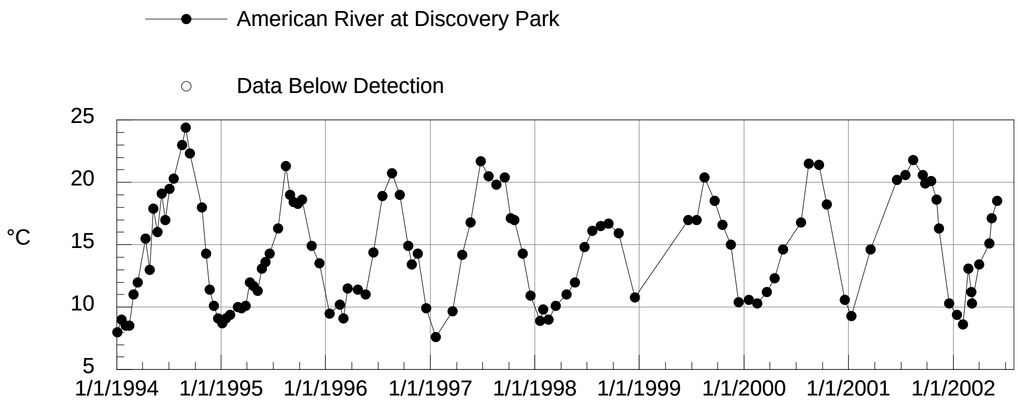

Colusa Basin Drain
Data Below Detection
°C
35
30
25
20
15
10
5
0
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

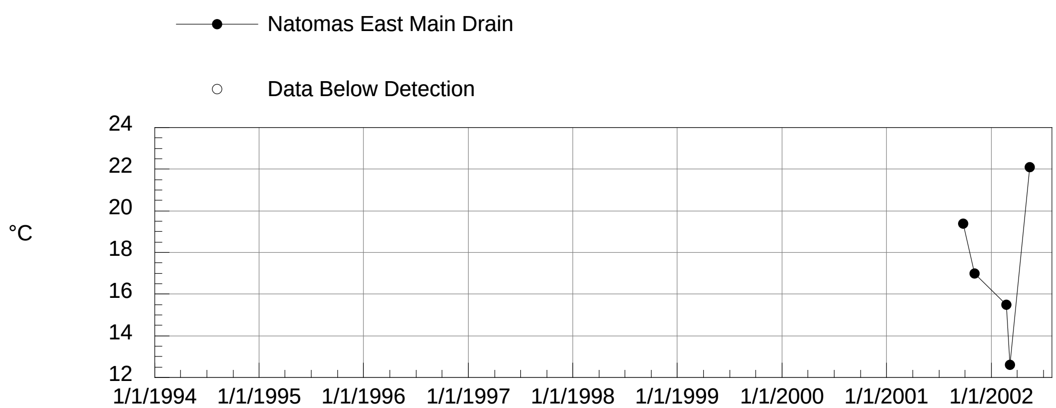

Sacramento Slough
Data Below Detection
°C
35
30
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

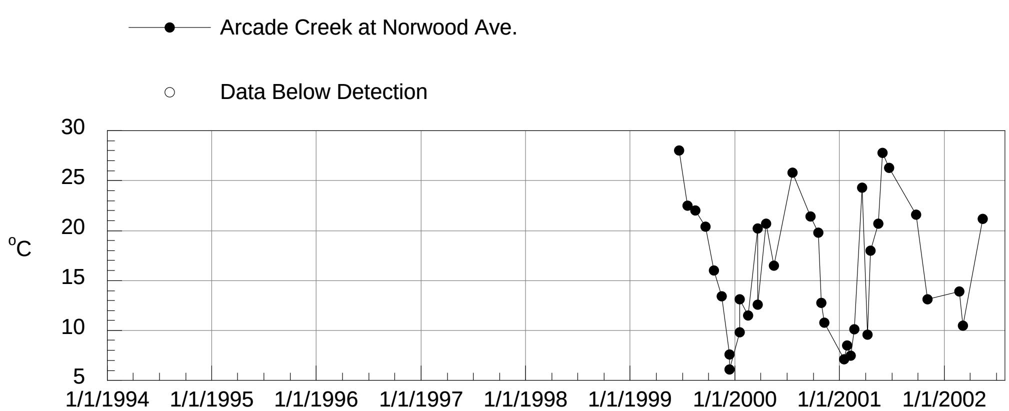

Yuba River at Marysville
Data Below Detection
°C
22
20
18
16
14
12
10
8
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

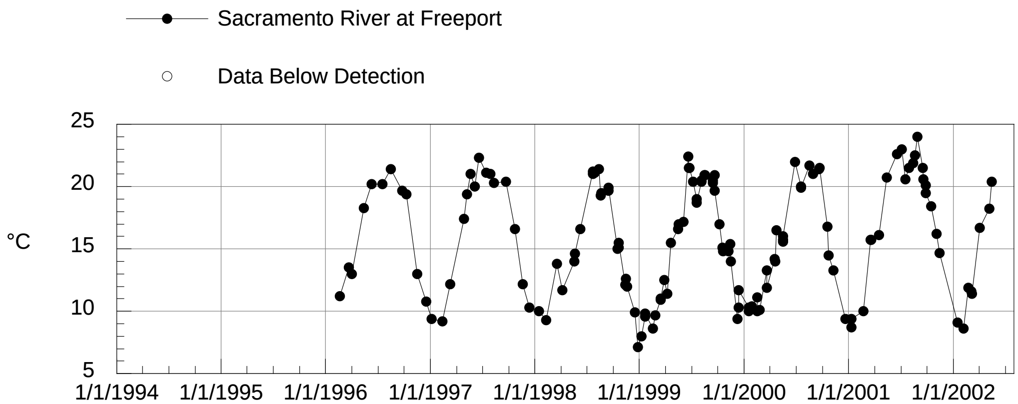

Feather River near Nicolaus
Data Below Detection
°C
30
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

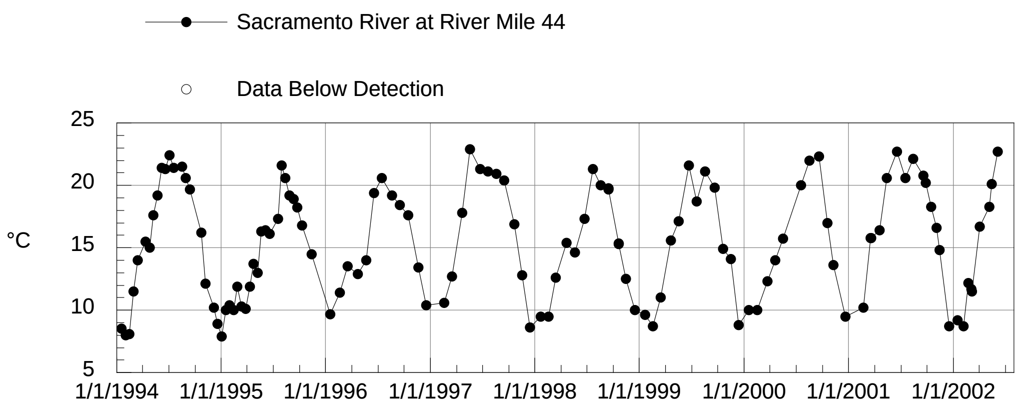

Sacramento River at Veterans Bridge
Data Below Detection
°C
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


American River at Discovery Park
Data Below Detection
°C
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Natomas East Main Drain
Data Below Detection
°C
24
22
20
18
16
14
12
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Arcade Creek at Norwood Ave.
Data Below Detection
°C
30
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at Freeport
Data Below Detection
°C
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002


Sacramento River at River Mile 44
Data Below Detection
°C
25
20
15
10
5
1/1/1994
1/1/1995
1/1/1996
1/1/1997
1/1/1998
1/1/1999
1/1/2000
1/1/2001
1/1/2002

APPENDIX C

Bioassessment Data

Table 3. Dominant macroinvertebrate taxa (and their percent contribution) by reach from samples collected from sites within the Sacramento River watershed in Fall 2000.

	Dominant Taxon				
	1	2	3	4	5
STONY CREEK					
MFSC-MC	Orthocladinae (12)	*Rhithrogena* (12)	*Hydropsyche* (12)	*Baetis* (11)	*Serratella* (10)
SC-306	*Cheumatopsyche* (15)	*Tricorythodes* (11)	*Marilia* (11)	*Rhithrogena* (10)	*Psephenus* (8)
SC-401	Tanytarsini (26)	Orthocladiinae (8)	*Baetis* (7)	Tricorythodes (7)	*Ostracoda* (6)
SC-ASR	*Simulium* (16)	*Tanytarsini (15)*	*Tricorythodes (15)*	*Fallceon quilleri*	*Planaridae* (9)
SC-R	*Hydropsyche* (16)	Lymnaeiidae (9)	Planariidae (8)	*Microcylloepus* (6)	*Zaitzevia* (5)
SC-200A	*Hydropsyche* (45)	*Lymnaeidae* (8)	*Fossaria (8)*	*Optioservus* (7)	Orthocladinae (6)
SC-OR	*Hydropsyche* (39)	Planariidae (14)	*Baetis* (13)	Lymnaeidae (8)	Orthocladinae/ *Petrophila* (5/5)
COW CREEK					
SCC-PW	*Epeorus* (25)	*Lepidostoma* (17)	Chironomini (6)	*Micrasema* (6)	Tanytarsini (5)
OCC-WR	*Serratella* (19)	*Optioservus* (11)	*Baetis* (9)	*Epeorus* (9)	*Hydropsyche/ Lepidostoma* (9/9)
LCC-OR	*Baetis* (28)	Planariidae (15)	Philopotamidae (7)	Orthocladiinae (5)	*Hydropsyche* (4)
CC-CM	Orthocladinae (30)	*Baetis* (16)	*Prostoma* (13)	*Ophiogomphus* (5)	*Hydropsyche* (5)
CR-MPR	Orthocladinae (20)	*Baetis* (13)	*Tricorythodes* (13)	*Chimarra* (11)	Chironomini (7)
BATTLE CREEK					
NFBTC-44	*Optioservus* (18)	*Hydropsyche* (14)	*Heterlimnius* (12)	*Epeorus* (11)	*Baetis* (6)
NFBTC-WH	Orthocladiinae (19)	*Baetis* (11)	*Rhithrogena* (8)	*Hydropsyche* (7)	*Optioservus* (4)
NFBTC-MR	*Serratella* (23)	*Optioservus* (12)	Orthocladiinae (9)	*Baetis* (7)	*Hydropsyche* (6)

Table 3 (continued). Dominant macroinvertebrate taxa (and their percent contribution) by reach from samples collected from sites within the Sacramento River watershed in Fall 1999.

	Dominant Taxon				
	1	2	3	4	5
BATTLE CREEK					
BTC-FS	*Hydropsyche* (24)	*Cheumatopsyche* (12)	*Serratella* (8)	*Tricorythodes* (8)	*Baetis* (6)
BTC-GR	*Baetis* (13)	Planariidae (13)	Orthocladinae (11)	*Cheumatopsyche* (8)	*Chimarra*(8)
DEER CREEK					
DC-PPC	*Epeorus* (16)	Enchytraeidae (15)	*Baetis* (11)	*Serratella* (8)	*Hydropsyche* (8)
DC-PW	Orthocladiinae (22)	Naididae (17)	*Optioservus* (9)	*Serratella* (7)	*Isoperla* (5)
DC-FS	*Hydropsyche* (31)	*Baetis* (13)	Orthocladiinae (11)	*Cheumatopsyche* (11)	*Simulium* (3)
DC-M	*Simulium* (27)	*Baetis* (22)	Tanytarsini (15)	*Hydropsyche* (12)	Orthocladiina e (3)
BIG CHICO CREEK					
BCC-H32	*Hydropsyche* (13)	*Epeorus* (12)	*Orthocladiinae* (8)	*Serratella* (8)	*Ironodes* (8)
BCC-FR	Orthocladiinae (8)	*Baetis* (22)	*Optioservus* (9)	*Zaitzevia* (5)	*Sweltsa* (4)
BCC-BP	Lymnaeidae (25)	*Fossaria* (19)	*Tricorythodes* (10)	*Hydropsyche* (10)	Orthocladiina e(6)
BCC-RA	Planariidae (22)	*Optioservus* (20)	*Cheumatopsyche* (19))	Naididae (6)	Orthocladinae (5)
BUTTE CREEK					
BC-CHC	*Rhithrogena (19)*	*Baetis* (11)	*Heterlimnius* (8)	*Enchytraeidae* (8)	*Cinygmula/ Sweltsa* (6/6)
BC-DMR	*Baetis* (14)	*Epeorus* (13)	*Orthocladiinae* (8)	*Rhithrogena* (5)	*Hydropsyche* (5)

Table 3 (continued). Dominant macroinvertebrate taxa (and their percent contribution) by reach from samples collected from sites within the Sacramento River watershed in Fall 1999.

	Dominant Taxon				
	1	2	3	4	5
BUTTE CREEK					
BC-RR	*Serratella* (27)	*Baetis* (14)	*Hydropsyche* (8)	*Cheumatopsyche* (7)	Naididae (6)
BC-HR	*Serratella* (22)	*Baetis* (12)	*Cheumatopsyche* (10)	*Optioservus* (9)	*Hydropsyche* (9)
LBC-S	*Hydropsyche* (13)	*Heterlimnius* (10)	*Orthocladiinae* (8)	*Baetis* (7)	*Physa/Physella* (7)
LBC-HCR	Orthocladiinae (9)	*Ironodes* (9)	*Epeorus* (8)	*Hydropsyche* (7)	*Paraleptophlebia* (6)
NON-WADABLE SITES					
YR-M	*Hydropsyche* (19)	*Gammarus* (12)	*Baetis* (11)	*Serratella* (10)	Orthocladiinae (8)
FR-EN	Tanytarsini (26)	Orthocladiinae (15)	*Hydroptila* (11)	*Hydropsyche* (9)	Hygrobatidae/ Lebertidae (8/8)
SR-HAM	Orthocladiinae (35)	Naididae (17)	*Baetis* (12)	*Acentrella* (8)	*Hydropsyche* (7)
SR-SSP	Orthocladiinae (30)	Tanytarsini (17)	Naididae (17)	Enchytraeidae (10)	*Acentrella* (7)
AC-DPP	Chironomini (46)	Tanytarsini (16)	Orthocladiinae (9)	Oligochaeta (9)	*Tubificidae* (9)
AR-HB	*Tricorythodes* (16)	*Baetis* (15)	*Hydropsyche* (13)	Planariidae (13)	*Naididae* (11)

Table 4. Bioassessment metrics calculated from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

Stony Creek Watershed

	Middle Fork Stony Creek			**Stony Ck**			**Stony Ck**			**Stony Ck**			**Stony Ck**			**Stony Ck**			**Stony Ck**		
	Mill Creek			Road 306			Road 401			Alder Springs Rd.			Rancheria			Road 200A			Olive Road		
	MFSC-MC			SC-306			SC-401A			SC-ASR			SC-R			SC-200A			SC-OR		
Transect Number	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number	5161	5162	5163	5164	5165	5166	5167	5168	5169	5170	5171	5172	5173	5174	5175	5176	5177	5178	5179	5180	5181
Taxonomic Richness	30	38	28	29	31	30	34	30	27	28	27	21	34	33	43	24	24	29	25	18	20
Cumulative Taxa																					
Percent Dominant Taxon	26	17	20	17	22	20	12	28	38	26	30	42	14	17	17	46	28	60	41	40	36
Ephemeroptera Taxa	7	6	6	5	6	5	5	3	3	4	4	3	3	3	4	3	3	4	4	2	5
Plecoptera Taxa	4	4	5	3	3	1	0	0	0	1	0	1	0	1	2	0	0	0	0	0	0
Trichoptera Taxa	6	6	3	4	5	7	7	10	8	4	0	2	5	4	7	4	3	4	4	2	2
EPT Taxa	17	16	14	12	14	13	12	13	11	9	4	6	8	8	13	7	6	8	8	4	7
Cumulative EPT Taxa																					
EPT Index (%)	63	76	76	63	62	61	43	22	28	54	25	29	31	30	30	63	32	66	61	67	54
Sensitive EPT Index (%)	34	48	43	30	19	20	7	3	3	3	0	1	1	1	3	1	2	0	0	0	5
Shannon Diversity	2.6	2.9	2.6	2.7	2.7	2.7	3.0	2.4	2.4	2.5	2.5	2.1	3.0	3.0	3.1	2.1	2.3	1.8	2.1	1.9	2.1
Tolerance Value	3.5	2.9	3.3	3.3	3.7	3.7	4.5	5.7	5.1	4.5	4.9	5.2	4.5	4.7	4.7	4.6	4.9	4.4	4.6	4.6	4.4
Percent Intolerant Taxa (0-2)	34	49	43	30	21	21	11	2	4	3	7	1	5	9	8	0	1	0	0	0	5
Percent Tolerant Taxa (8-10)	0	4	10	0	2	1	1	18	0	2	2	2	11	7	7	4	4	1	4	3	3
Percent Collectors	53	32	51	32	39	19	40	54	28	56	41	38	26	34	21	22	16	8	23	35	17
Percent Filterers	14	19	8	20	17	31	32	31	54	21	33	54	26	25	27	47	29	62	45	44	38
Percent Grazers	15	29	25	27	21	27	14	7	11	5	3	1	31	33	29	24	45	24	15	10	27
Percent Predators	15	19	14	10	14	11	11	7	6	16	23	7	16	7	23	6	8	5	17	11	17
Percent Shredders	3	1	2	11	9	12	3	1	1	1	0	0	1	1	1	0	2	1	0	0	0
Abundance (#/ sample)	4877	1884	1875	3548	2879	3619	5215	4496	6479	4045	2419	4740	1572	2420	3474	3256	2887	1591	1927	3146	1961

Table 4. Bioassessment metrics calculated from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

	Cow Creek Watershed															**Battle Creek Watershed**								
	South Cow Ck			**Old Cow Ck**			**Little Cow Ck**			**Cow Creek**			**Cow Creek**			**NF Battle Ck**			**NF Battle Ck**			**NF Battle Ck**		
	Ponderosa Way			Whitmore Road			Oak Run			Coronado Mine			Milleville Planes			Hwy 44			Wilson Hill Road			Manton Road		
	SCC-PW			OCC-WR			LCC-OR			CC-CM			CC-MP			NFBTC-H44			NFBTC-WHR			NFBTC-MR		
Transect Number	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number	5182	5183	5184	5185	5186	5187	5188	5189	5190	5191	5192	5193	5194	5195	5196	5197	5198	5199	5200	5201	5202	5203	5204	5205
Taxonomic Richness	35	34	39	42	31	41	20	28	26	24	27	27	34	34	31	40	44	31	39	46	41	38	38	30
Cumulative Taxa																								
Percent Dominant Taxon	26	23	29	16	24	18	31	28	37	25	27	39	19	23	19	20	16	19	20	26	15	16	16	38
Ephemeroptera Taxa	6	7	7	7	6	9	4	4	3	2	2	2	4	4	5	8	6	6	8	8	9	6	7	6
Plecoptera Taxa	4	8	5	5	4	4	0	0	0	3	4	1	1	0	1	4	6	2	5	7	6	5	4	4
Trichoptera Taxa	6	6	7	8	6	9	5	4	5	3	5	4	7	6	6	6	6	5	6	6	6	4	7	2
EPT Taxa	16	21	19	20	16	22	9	8	8	8	11	7	12	10	12	18	19	13	19	21	21	15	18	12
Cumulative EPT Taxa																								
EPT Index (%)	72	77	79	68	74	76	50	43	49	36	38	19	53	45	49	46	43	43	57	48	68	55	51	54
Sensitive EPT Index (%)	62	61	56	45	57	54	7	1	3	5	3	2	3	1	1	21	21	14	32	26	40	37	33	47
Shannon Diversity	2.5	2.7	2.7	2.9	2.6	2.8	2.0	2.5	2.0	2.3	2.5	2.3	2.7	2.7	2.6	2.8	3.0	2.6	3.0	3.0	3.0	2.9	2.9	2.2
Tolerance Value	2.4	2.3	2.3	2.9	2.6	2.6	4.7	4.8	4.7	3.7	4.1	4.5	5.0	4.9	5.0	3.6	3.7	3.9	3.6	4.0	3.1	3.8	3.7	3.3
Percent Intolerant Taxa (0-2)	63	61	56	48	58	55	8	0	3	10	8	8	2	3	1	22	21	15	32	26	40	38	35	47
Percent Tolerant Taxa (8-10)	1	0	1	1	0	1	1	6	1	1	1	0	9	6	7	5	6	4	1	7	3	10	7	2
Percent Collectors	21	23	22	38	35	38	27	59	47	75	65	69	68	64	65	32	35	31	48	58	36	43	37	58
Percent Filterers	11	15	15	12	15	13	52	23	22	6	15	8	21	23	19	17	16	24	18	7	14	19	23	5
Percent Grazers	33	40	39	32	29	30	1	4	4	4	6	7	5	5	7	40	36	36	15	15	28	19	23	25
Percent Predators	8	7	10	14	8	10	14	14	25	14	13	17	6	8	8	10	12	7	11	15	18	17	17	12
Percent Shredders	27	14	13	4	13	9	7	0	2	1	0	0	0	0	1	3	1	1	9	5	4	1	1	0
Abundance (#/ sample)	3463	2253	1984	1317	3516	3459	3543	3781	3383	751	673	829	4632	5133	7096	5041	7723	4894	604	2497	1879	3003	3464	6336

Table 4. Bioassessment metrics calculated from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

	Battle Creek Watershed						**Deer Creek Watershed**											
	Battle Ck			**Battle Ck**			**Deer Creek**			**Deer Creek**			**Deer Creek**			**Deer Creek**		
	Fish Screen			Grover Road			Potato Patch Campground			Ponderosa Way			Fish Screen			Monastery		
	BTC-FS			BTC-GR			DC-PPC			DC-PW			DC-FS			DC-M		
Transect Number	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number	5206	5207	5208	5209	5210	5211	5212	5213	5214	5215	5216	5217	5218	5219	5220	5221	5222	5223
Taxonomic Richness	28	36	26	35	32	33	38	32	32	43	39	44	31	28	31	23	31	16
Cumulative Taxa																		
Percent Dominant Taxon	24	21	38	19	16	15	24	37	16	21	29	27	28	33	33	38	23	32
Ephemeroptera Taxa	6	4	3	7	6	4	9	8	9	9	7	8	6	4	7	4	4	3
Plecoptera Taxa	1	2	2	2	3	2	6	5	5	4	4	6	3	1	3	0	0	0
Trichoptera Taxa	8	6	6	8	6	7	7	6	1	8	6	9	5	7	6	3	4	2
EPT Taxa	15	12	11	17	15	13	22	19	15	21	17	23	14	12	16	7	8	5
Cumulative EPT Taxa																		
EPT Index (%)	72	61	78	62	49	39	70	45	74	38	19	30	58	80	72	40	53	25
Sensitive EPT Index (%)	18	7	13	12	10	7	55	29	36	26	16	22	7	8	8	0	0	0
Shannon Diversity	2.6	2.7	2.3	2.8	2.8	2.9	2.8	2.5	2.7	3.0	2.6	2.9	2.5	2.2	2.5	1.8	2.6	1.8
Tolerance Value	4.0	4.5	4.1	4.4	4.5	4.7	2.6	5.5	3.4	4.1	5.2	4.2	4.4	4.4	4.2	5.3	4.7	5.6
Percent Intolerant Taxa (0-2)	20	8	15	10	9	4	55	29	38	28	18	24	9	9	11	0	1	0
Percent Tolerant Taxa (8-10)	0	5	1	3	5	7	1	37	4	11	30	10	3	0	1	1	3	5
Percent Collectors	34	36	29	43	43	37	35	60	44	48	65	59	35	40	40	34	33	31
Percent Filterers	48	29	55	30	29	29	12	10	19	13	3	8	44	56	49	57	47	68
Percent Grazers	4	14	8	15	7	13	39	18	22	15	15	16	7	2	6	4	17	1
Percent Predators	14	20	7	13	19	19	10	9	11	23	16	16	13	2	5	5	3	1
Percent Shredders	0	1	0	0	1	1	5	4	4	1	0	1	0	0	0	0	0	0
Abundance (#/ sample)	6072	1718	4829	1534	4124	1490	2602	1310	2253	6141	4800	2941	4465	3217	4791	2976	5538	4378

Table 4. Bioassessment metrics calculated from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

	Big Chico Creek Watershed											
	Big Chico			**Big Chico**			**Big Chico**			**Big Chico**		
	Hwy 32			Forest Ranch			Bidwell Park			Rose Ave		
	BCC-H32			BCC-FR			BCC-BP			BCC-RA		
Transect Number	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number	5224	5225	5226	5227	5228	5229	5230	5231	5232	5233	5234	5235
Taxonomic Richness	43	43	31	34	37	47	25	29	28	26	21	25
Cumulative Taxa												
Percent Dominant Taxon	19	11	20	29	20	32	25	37	20	21	35	28
Ephemeroptera Taxa	7	10	9	7	6	8	2	4	3	1	1	1
Plecoptera Taxa	6	6	6	3	4	4	0	0	1	0	0	1
Trichoptera Taxa	10	8	1	4	3	8	4	8	4	8	1	2
EPT Taxa	24	24	16	14	13	20	6	12	8	9	2	4
Cumulative EPT Taxa												
EPT Index (%)	70	71	71	47	35	36	27	19	39	28	10	36
Sensitive EPT Index (%)	45	48	36	8	25	27	1	10	1	3	0	1
Shannon Diversity	3.0	3.2	2.9	2.4	2.9	2.9	2.4	2.2	2.6	2.4	2.1	2.2
Tolerance Value	2.9	2.8	3.2	4.7	4.0	4.1	5.3	5.2	5.1	4.4	4.8	4.5
Percent Intolerant Taxa (0-2)	45	47	37	8	26	24	1	10	1	3	0	2
Percent Tolerant Taxa (8-10)	3	0	2	1	6	6	4	5	4	7	13	1
Percent Collectors	34	36	36	64	54	54	29	12	21	21	30	13
Percent Filterers	19	14	22	15	5	2	8	6	28	30	16	33
Percent Grazers	34	29	21	16	19	21	47	72	40	24	13	30
Percent Predators	8	17	16	6	22	20	16	9	10	25	42	23
Percent Shredders	6	4	4	0	0	3	0	0	0	0	0	1
Abundance (#/ sample)	3545	3881	1429	1735	5968	1176	1675	5010	5039	1474	972	1087

Table 4. Bioassessment metrics calculated from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

Butte Creek Watershed

	Butte Creek			**Butte Creek**			**Butte Creek**			**Butte Creek**			**L. Butte Cr.**			**L. Butte Cr.**		
	Cherry Hill Camp.			Doe Mill Road			Rich Bar Road			Honey Run Bridge			Skyway			Hupp Coutolenc		
	BC-CHC			BC-DMR			BC-RBR			BC-HR			LBC-S			LBC-HCR		
Transect Number	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number	5236	5237	5238	5239	5240	5241	5242	5243	5244	5245	5246	5247	5248	5249	5250	5251	5252	5253
Taxonomic Richness	39	40	38	34	30	37	26	29	28	30	29	33	36	42	41	37	48	46
Cumulative Taxa																		
Percent Dominant Taxon	25	14	18	23	48	20	36	15	29	19	32	22	26	10	16	8	13	14
Ephemeroptera Taxa	8	9	8	8	6	9	6	6	7	6	8	7	5	7	8	9	8	6
Plecoptera Taxa	8	10	8	5	5	5	4	3	5	5	3	4	5	6	6	5	8	9
Trichoptera Taxa	7	8	8	7	5	7	4	4	6	4	4	5	5	4	6	6	8	8
EPT Taxa	23	27	24	20	16	21	14	13	18	15	15	16	16	17	21	21	25	24
Cumulative EPT Taxa																		
EPT Index (%)	76	74	66	71	41	56	85	64	81	71	74	70	61	46	46	70	76	56
Sensitive EPT Index (%)	59	46	44	54	18	33	52	37	46	21	43	32	28	22	26	51	40	36
Shannon Diversity	2.8	3.0	2.8	2.8	2.0	2.8	2.3	2.7	2.5	2.6	2.4	2.8	2.8	3.2	3.1	3.2	3.3	3.3
Tolerance Value	2.2	3.1	3.6	2.6	4.5	3.6	3.2	4.1	3.3	4.1	3.4	4.0	4.0	4.7	4.2	2.9	3.1	3.5
Percent Intolerant Taxa (0-2)	61	47	44	54	19	33	53	37	50	22	43	32	27	21	27	51	41	37
Percent Tolerant Taxa (8-10)	4	7	14	0	0	0	4	20	3	4	3	6	11	20	14	6	4	4
Percent Collectors	31	44	54	36	25	35	62	60	51	45	54	55	31	49	49	26	20	32
Percent Filterers	5	6	4	8	55	31	16	12	22	27	18	27	27	10	7	6	15	12
Percent Grazers	39	33	29	39	11	21	11	19	12	11	18	8	27	22	30	37	38	23
Percent Predators	20	12	9	10	6	11	11	10	14	17	10	9	10	13	12	17	18	22
Percent Shredders	4	5	4	7	3	2	0	0	0	0	0	0	5	6	3	14	9	10
Abundance (#/ sample)	1922	1619	852	1308	1005	3065	2562	4892	2591	3673	6087	2415	990	670	1005	1484	2342	1602

Table 4. Bioassessment metrics calculated from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

	Deepwater Sites																	
	Yuba River			**Feather R.**			**Sacramento R.**			**Sacramento R.**			**Arcade Creek**			**American River**		
	at Marysville			East Nicholas			Hamilton			Sacramento State Park			Del Paso Park			Harrington Bar		
	YR-M			FR-EN			SR-HAM			SR-SSP			AC-DPP			AR-HB		
Transect Number	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3	T1	T2	T3
ABL Laboratory Number	5254	5255	5256	5389	5390	5391	5386	5387	5388	5260	5261	5262	5257	5258	5259	5263	5384	5385
Taxonomic Richness	21	25	23	21	21	19	16	20	11	19	16	17	16	9	9	21	15	28
Cumulative Taxa																		
Percent Dominant Taxon	21	28	30	24	28	26	44	55	33	33	50	37	50	59	33	29	19	17
Ephemeroptera Taxa	5	6	5	5	5	5	1	3	3	5	2	3	1	0	0	5	3	5
Plecoptera Taxa	2	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera Taxa	3	3	3	2	2	2	2	2	1	3	2	2	1	0	1	1	1	2
EPT Taxa	10	11	10	7	8	7	3	5	4	8	4	5	2	0	1	6	4	7
Cumulative EPT Taxa																		
EPT Index (%)	72	33	66	38	29	35	3	4	77	19	25	6	1	0	0	49	44	44
Sensitive EPT Index (%)	22	13	15	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1
Shannon Diversity	2.5	2.4	2.4	2.4	2.3	2.1	1.6	1.6	1.8	2.0	1.7	1.8	1.5	1.1	1.7	2.2	2.2	2.6
Tolerance Value	3.8	4.3	4.0	4.8	4.8	5.4	6.2	5.9	4.7	5.5	5.2	7.7	6.6	6.5	6.8	5.7	5.4	5.4
Percent Intolerant Taxa (0-2)	21	12	15	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1
Percent Tolerant Taxa (8-10)	7	3	5	1	1	0	32	24	1	8	6	71	19	26	35	26	22	20
Percent Collectors	57	63	56	34	38	36	78	82	65	54	78	88	73	89	82	73	46	60
Percent Filterers	23	20	34	38	38	32	14	5	32	36	14	7	24	9	18	16	33	23
Percent Grazers	11	4	3	10	13	17	1	3	1	4	3	2	0	0	1	0	1	0
Percent Predators	10	13	7	18	11	15	6	7	2	6	2	4	3	1	0	11	20	16
Percent Shredders	0	1	0	0	0	0	1	3	0	0	3	0	0	0	0	0	0	1
Abundance (#/ sample)	1018	1565	2455	1112	1307	718	271	436	1207	1251	232	295	209	299	413	432	715	614

Table 5. Means and coefficients of variation calculated for bioassessment samples collected from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

Stony Creek Watershed

	Middle Fork Stony Creek		**Stony Ck**		**Stony Ck**		**Stony Ck**		**Stony Ck**		**Stony Ck**		**Stony Ck**	
	Mill Creek		Road 306		Road 401		Alder Springs Rd.		Rancheria		Road 200A		Olive Road	
	MFSC-MC		SC-306		SC-401A		SC-ASR		SC-R		SC-200A		SC-OR	
	Mean	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
Taxonomic Richness	32	17	30	3	30	12	25	15	37	15	26	11	21	17
Cumulative Taxa	52		47		50		43		54		39		30	
Percent Dominant Taxon	21	22	19	14	26	49	33	26	16	12	45	36	39	8
Ephemeroptera Taxa	6	9	5	11	4	31	4	16	3	17	3	17	4	42
Plecoptera Taxa	4	13	2	49	0	-	1	87	1	100	0	-	0	-
Trichoptera Taxa	5	35	5	29	8	18	2	100	5	29	4	16	3	43
EPT Taxa	16	10	13	8	12	8	6	40	10	30	7	14	6	33
Cumulative EPT Taxa	27		21		22		12		16		11		11	
EPT Index (%)	72	11	62	2	31	34	36	44	30	2	53	36	61	11
Sensitive EPT Index (%)	42	16	23	26	4	56	1	124	2	59	1	84	2	173
Shannon Diversity	2.7	6	2.7	1	2.6	13	2.4	10	3.0	2	2.0	13	2.0	4
Tolerance Value	3.2	10	3.6	7	5.1	13	4.9	7	4.6	2	4.7	5	4.5	2
Percent Intolerant Taxa (0-2)	42	18	24	23	6	78	3	93	7	30	0	173	2	173
Percent Tolerant Taxa (8-10)	4	105	1	61	6	159	2	9	9	30	3	57	3	23
Percent Collectors	45	26	30	34	41	32	45	22	27	24	16	45	25	37
Percent Filterers	13	42	23	33	39	34	36	46	26	4	46	36	42	9
Percent Grazers	23	33	25	13	10	35	3	58	31	7	31	40	17	52
Percent Predators	16	15	12	18	8	31	15	52	15	49	6	20	15	22
Percent Shredders	2	38	11	17	2	92	0	173	1	27	1	85	0	173
Abundance (#/ sample)	2879	60	3349	12	5397	19	3735	32	2489	38	2578	34	2345	30

Table 5. Means and coefficients of variation calculated for bioassessment samples collected from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

	Cow Creek Watershed										**Battle Creek Watershed**									
	South Cow Ck		**Old Cow Ck**		**Little Cow Ck**		**Cow Creek**		**Cow Creek**		**NF Battle Ck**		**NF Battle Ck**		**NF Battle Ck**		**Battle Ck**		**Battle Ck**	
	Ponderosa Way		Whitmore Road		Oak Run		Coronado Mine		Milleville Planes		Hwy 44		Wilson Hill Road		Manton Road		Fish Screen		Grover Road	
	SCC-PW		OCC-WR		LCC-OR		CC-CM		CC-MP		NFBTC-H44		NFBTC-WHR		NFBTC-MR		BTC-FS		BTC-GR	
	Mean	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
Taxonomic Richness	36	7	38	16	25	17	26	7	33	5	38	17	42	9	35	13	30	18	33	5
Cumulative Taxa	60		63		42		40		48		57		62		51		46		52	
Percent Dominant Taxon	26	11	19	20	32	14	30	25	21	12	18	13	20	26	23	55	28	33	16	12
Ephemeroptera Taxa	7	9	7	21	4	16	2	0	4	13	7	17	8	7	6	9	4	35	6	27
Plecoptera Taxa	6	37	4	13	0	-	3	57	1	87	4	50	6	17	4	13	2	35	2	25
Trichoptera Taxa	6	9	8	20	5	12	4	25	6	9	6	10	6	0	4	58	7	17	7	14
EPT Taxa	19	13	19	16	8	7	9	24	11	10	17	19	20	6	15	20	13	16	15	13
Cumulative EPT Taxa	31		29		11		15		16		25		30		22		18		22	
EPT Index (%)	76	5	72	6	47	8	31	33	49	8	44	4	58	18	53	4	70	13	50	23
Sensitive EPT Index (%)	60	5	52	12	3	94	3	46	2	72	19	22	33	21	39	19	13	44	10	27
Shannon Diversity	2.6	3	2.8	6	2.2	11	2.4	5	2.6	3	2.8	7	3.0	1	2.7	15	2.5	8	2.8	2
Tolerance Value	2.3	0	2.7	7	4.7	1	4.1	9	5.0	1	3.7	5	3.6	13	3.6	7	4.2	6	4.5	3
Percent Intolerant Taxa (0-2)	60	5	54	10	4	105	8	15	2	43	19	18	33	22	40	16	14	41	8	40
Percent Tolerant Taxa (8-10)	1	91	1	59	2	115	1	93	7	25	5	19	4	79	7	60	2	115	5	36
Percent Collectors	22	5	37	5	44	37	70	8	66	3	33	7	47	24	46	23	33	10	41	8
Percent Filterers	14	16	13	15	32	53	10	49	21	8	19	25	13	45	16	59	44	31	29	1
Percent Grazers	37	10	30	5	3	67	6	27	5	19	37	5	19	40	22	13	9	57	11	37
Percent Predators	8	18	11	29	18	37	15	14	7	15	10	26	15	25	15	20	14	46	17	23
Percent Shredders	18	42	9	49	3	119	0	173	0	110	2	49	6	38	1	56	0	173	1	57
Abundance (#/ sample)	2567	31	2764	45	3569	6	751	10	5621	23	5886	27	1660	58	4268	42	4207	53	2383	63

Table 5. Means and coefficients of variation calculated for bioassessment samples collected from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

	Deer Creek Watershed								Big Chico Creek Watershed							
	Deer Creek		**Deer Creek**		**Deer Creek**		**Deer Creek**		**Big Chico**		**Big Chico**		**Big Chico**		**Big Chico**	
	Potato Patch Campground		Ponderosa Way		Fish Screen		Monastery		Hwy 32		Forest Ranch		Bidwell Park		Rose Ave	
	DC-PPC		DC-PW		DC-FS		DC-M		BCC-H32		BCC-FR		BCC-BP		BCC-RA	
	Mean	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
Taxonomic Richness	34	10	42	6	30	6	23	32	39	18	39	17	27	8	24	11
Cumulative Taxa	52		58		46		36		59		63		45		41	
Percent Dominant Taxon	26	40	26	16	31	9	31	24	17	31	27	23	27	31	28	25
Ephemeroptera Taxa	9	7	8	13	6	27	4	16	9	18	7	14	3	33	1	0
Plecoptera Taxa	5	11	5	25	2	49	0	-	6	0	4	16	0	173	0	173
Trichoptera Taxa	5	69	8	20	6	17	3	33	6	75	5	53	5	43	4	103
EPT Taxa	19	19	20	15	14	14	7	23	21	22	16	24	9	35	5	72
Cumulative EPT Taxa	26		30		19		8		31		25		17		10	
EPT Index (%)	63	25	29	32	70	16	39	36	71	0	39	16	28	36	25	53
Sensitive EPT Index (%)	40	34	21	22	8	8	0	173	43	14	20	54	4	142	1	128
Shannon Diversity	2.7	6	2.8	7	2.4	8	2.0	22	3.0	6	2.8	10	2.4	7	2.3	7
Tolerance Value	3.9	39	4.5	13	4.3	2	5.2	9	3.0	8	4.3	9	5.2	1	4.5	5
Percent Intolerant Taxa (0-2)	41	33	23	22	9	14	0	173	43	13	19	51	4	128	2	78
Percent Tolerant Taxa (8-10)	14	140	17	65	2	84	3	64	2	92	5	62	4	11	7	82
Percent Collectors	46	27	57	16	38	6	32	5	35	4	57	10	21	40	21	40
Percent Filterers	13	35	8	60	49	12	57	18	18	22	7	88	14	87	26	36
Percent Grazers	26	44	15	5	5	48	7	118	28	23	19	15	53	32	22	39
Percent Predators	10	12	18	23	7	82	3	77	14	34	16	56	12	33	30	34
Percent Shredders	4	11	1	58	0	87	0	-	5	17	1	147	0	87	0	101
Abundance (#/ sample)	2055	33	4627	35	4158	20	4297	30	2952	45	2960	89	3908	49	1178	22

Table 5. Means and coefficients of variation calculated for bioassessment samples collected from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

Butte Creek Watershed

	Butte Creek		Butte Creek		Butte Creek		Butte Creek		L. Butte Cr.		L. Butte Cr.	
	Cherry Hill Camp.		Doe Mill Road		Rich Bar Road		Honey Run Bridge		Skyway		Hupp Coutolenc	
	BC-CHC		BC-DMR		BC-RBR		BC-HR		LBC-S		LBC-HCR	
	Mean	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
Taxonomic Richness	39	3	34	10	28	6	31	7	40	8	44	13
Cumulative Taxa	59		49		40		42		55		62	
Percent Dominant Taxon	19	29	30	50	27	40	24	28	17	44	12	27
Ephemeroptera Taxa	8	7	8	20	6	9	7	14	7	23	8	20
Plecoptera Taxa	9	13	5	0	4	25	4	25	6	10	7	28
Trichoptera Taxa	8	8	6	18	5	25	4	13	5	20	7	16
EPT Taxa	25	8	19	14	15	18	15	4	18	15	23	9
Cumulative EPT Taxa	39		27		20		18		26		30	
EPT Index (%)	72	7	56	26	77	14	72	2	51	17	67	15
Sensitive EPT Index (%)	50	16	35	51	45	17	32	34	25	12	42	19
Shannon Diversity	2.9	5	2.5	17	2.5	7	2.6	6	3.0	7	3.3	1
Tolerance Value	3.0	23	3.6	27	3.5	14	3.8	10	4.3	8	3.2	10
Percent Intolerant Taxa (0-2)	51	18	35	50	47	18	32	33	25	13	43	17
Percent Tolerant Taxa (8-10)	8	65	0	89	9	104	4	39	15	31	5	26
Percent Collectors	43	27	32	19	57	9	51	10	43	24	26	22
Percent Filterers	5	24	31	75	17	30	24	22	14	74	11	42
Percent Grazers	34	15	24	61	14	30	13	41	26	15	33	25
Percent Predators	14	42	9	30	11	20	12	35	12	13	19	15
Percent Shredders	4	20	4	60	0	173	0	87	4	36	11	24
Abundance (#/ sample)	1465	38	1793	62	3348	40	4058	46	888	21	1809	26

Table 5. Means and coefficients of variation calculated for bioassessment samples collected from macroinvertebrate samples collected from riffles in the Sacramento River watershed between September 26 and November 7, 2000.

Deepwater Sites

.	**Yuba River**		**Feather R.**		**Sacramento R.**		**Sacramento R.**		**Arcade Creek**		**American R.**	
	at Marysville		East Nicholas		Hamilton		Sacramento State Park		Del Paso Park		Harrington Bar	
	YR-M		FR-EN		SR-HAM		SR-SSP		AC-DPP		AR-HB	
	Mean	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**	**Mean**	**CV**
Taxonomic Richness	23	9	20	6	16	29	17	9	11	36	21	30
Cumulative Taxa	35		26		26		25		22		34	
Percent Dominant Taxon	26	19	26	7	44	25	40	23	47	28	21	31
Ephemeroptera Taxa	5	11	5	0	2	49	3	46	0	173	4	27
Plecoptera Taxa	2	0	0	173	0	-	0	-	0	-	0	-
Trichoptera Taxa	3	0	2	0	2	35	2	25	1	87	1	43
EPT Taxa	10	6	7	8	4	25	6	37	1	100	6	27
Cumulative EPT Taxa	15		8		7		8		3		8	
EPT Index (%)	57	37	34	14	28	153	17	58	1	132	46	7
Sensitive EPT Index (%)	17	30	1	32	0	173	0	173	0	-	1	85
Shannon Diversity	2.4	2	2.2	7	1.7	6	1.8	9	1.4	20	2.3	11
Tolerance Value	4.0	6	5.0	7	5.6	14	6.2	22	6.6	3	5.5	3
Percent Intolerant Taxa (0-2)	16	28	1	32	0	173	0	-	0	-	0	41
Percent Tolerant Taxa (8-10)	5	46	1	107	19	85	28	131	26	30	23	13
Percent Collectors	58	6	36	4	75	12	73	24	81	10	60	22
Percent Filterers	26	28	36	10	17	83	19	81	17	44	24	36
Percent Grazers	6	72	13	27	2	60	3	31	0	26	0	100
Percent Predators	10	28	15	23	5	55	4	49	1	102	16	30
Percent Shredders	0	173	0	-	2	103	1	173	0	-	0	173
Abundance (#/ sample)	1679	43	1046	29	638	78	593	96	307	33	587	24

Table 6. Physical habitat quality scores for sampling reaches within eight drainages within the Sacramento River watershed between September 26 and November 7, 2000. Scores for each habitat parameter range from 0 (poor) to 20 (excellent).

Habitat Parameter	STONY CREEK							COW CREEK				
	MFSC-MC	SC-306	SC-401	SC-ASR	SC-R	SC-200A	SC-OR	SCC-PW	OCC-WR	LCC-OR	CC-CM	CR-MPR
1. Instream Cover	18	14	13	14	13	13	12	17	14	14	17	17
2. Embeddedness	16	12	15	14	15	14	14	16	12	15	15	12
3. Velocity/ Depth Regimes	16	11	14	12	14	14	15	15	12	14	16	15
4. Sediment Deposition	16	13	18	13	14	14	13	16	14	15	16	12
5. Channel Flow	19	16	16	16	16	12	18	18	17	16	18	19
6. Channel Alteration	16	12	17	14	16	15	17	20	20	19	15	20
7. Riffle Frequency	17	14	17	16	16	16	16	17	17	13	15	15
8. Bank Vegetation	17	10	16	6	15	6	4	18	18	14	13	17
9. Bank Stability	17	6	16	8	13	10	6	18	18	12	15	16
10. Riparian Zone	18	16	17	16	18	20	17	20	17	18	18	17
TOTAL	**170**	**124**	**159**	**129**	**150**	**134**	**132**	**175**	**159**	**150**	**174**	**160**
Physical Condition	**Excellent**	**Good**	**Excellent**	**Good**	**Good**	**Good**	**Good**	**Excellent**	**Excellent**	**Good**	**Excellent**	**Excellent**

Table 6 (continued). Physical habitat quality scores for sampling reaches within eight watersheds within the Sacramento River watershed between September 26 and November 7, 2000. Scores for each habitat parameter range from 0 (poor) to 20 (excellent).

Habitat Parameter	BATTLE CREEK					DEER CREEK			
	NFBTC-H44	NFBTC-WH	NFBTC-MR	BTC-FS	BTC-GR	DC-PPC	DC-PW	DC-FS	DC-M
1. Instream Cover	18	17	17	15	16	15	15	14	14
2. Embeddedness	16	18	18	18	17	13	16	10	13
3. Velocity/ Depth Regimes	15	16	16	19	18	17	5	20	13
4. Sediment Deposition	16	17	16	17	17	14	14	8	15
5. Channel Flow	17	18	19	18	19	17	16	14	10
6. Channel Alteration	20	20	20	15	20	20	20	20	17
7. Riffle Frequency	17	17	16	14	14	13	18	7	8
8. Bank Vegetation	17	17	17	14	15	14	14	12	10
9. Bank Stability	16	19	17	13	15	17	17	17	13
10. Riparian Zone	20	20	20	17	17	19	20	19	13
TOTAL	**172**	**179**	**176**	**160**	**168**	**159**	**155**	**141**	**126**
Physical Condition	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Good**	**Good**

Table 6 (continued). Physical habitat quality scores for sampling reaches within eight watersheds within the Sacramento River watershed between September 26 and November 7, 2000. Scores for each habitat parameter range from 0 (poor) to 20 (excellent).

Habitat Parameter	BIG CHICO CREEK				BUTTE CREEK					
	BCC-H32	BCC-FR	BCC-BP	BCC-RA	BC-CHC	BC-DMR	BC-RR	BC-HR	LBC-S	LBC-HCR
1. Instream Cover	17	15	17	8	16	16	17	17	16	16
2. Embeddedness	13	10	15	8	14	14	14	12	17	14
3. Velocity/ Depth Regimes	10	17	12	15	7	18	17	17	12	15
4. Sediment Deposition	14	8	16	8	14	14	15	13	16	14
5. Channel Flow	17	14	17	18	17	15	18	13	19	16
6. Channel Alteration	17	20	20	5	20	17	18	19	18	20
7. Riffle Frequency	18	13	12	12	19	12	17	4	17	7
8. Bank Vegetation	13	15	18	17	9	12	17	16	17	16
9. Bank Stability	16	18	18	17	14	18	17	17	14	16
10. Riparian Zone	17	19	17	5	19	18	17	18	16	19
TOTAL	**152**	**149**	**162**	**113**	**149**	**154**	**167**	**146**	**162**	**153**
Physical Condition	**Excellent**	**Good**	**Excellent**	**Good**	**Good**	**Excellent**	**Excellent**	**Good**	**Excellent**	**Excellent**

APPENDIX D

Review of Quality Assurance Data

Review of Quality Assurance Data

The Quality Assurance procedures for the 2001-2002 SRWP monitoring program are documented in the Quality Assurance Project Plan (QAPP) (SRWP 2001). This appendix documents the types of quality control assessments used in the SRWP monitoring program (described below and summarized in Tables 1 through 6), and presents the results of those evaluations. Detailed procedures for preparation and analysis of quality control samples are provided in the analytical method documents referenced in the QAPP.

Quality Assurance Procedures and Objectives

Qualitative Objectives

Comparability— Comparability of the data can be defined as the similarity of data generated by different monitoring programs. For the purpose of the SRWP Monitoring Program, this objective is addressed primarily by using standard sampling and analytical procedures where possible. Additionally, comparability of analytical data is addressed by analysis of standard reference materials (discussed subsequently in this document).

Representativeness—Representativeness can be defined as the degree to which the environmental data generated by the monitoring program accurately and precisely represent actual environmental conditions. For the SRWP, this objective is addressed by the overall design of the monitoring program. Specifically, assuring the representativeness of the data is addressed primarily by selecting appropriate locations, methods, times, and frequencies of sampling for each environmental parameter, and by maintaining the integrity of the sample after collection. Each of these elements of the quality assurance program are addressed elsewhere in this document.

Completeness

Data completeness is a measure of the amount of successfully collected and validated data relative to the amount of data planned to be collected for the project. Completeness is usually expressed as a percentage value. A project objective for percent completeness is typically based on the percentage of the data needed for the program or study to reach valid conclusions. Because the SRWP is intended to be a long term monitoring program, data that are not successfully collected for a specific sample event or site can typically be recollected at a later sampling event. For this reason, most of the data planned for collection can not be considered absolutely critical, and it is difficult to set an meaningful objective for data completeness. However, some reasonable objectives for data are desirable, if only to measure the effectiveness of the Monitoring Program. The following program goals for data completeness are based on the planned sampling frequency and a subjective determination of the relative importance of the monitoring element within the Monitoring Program:

Table 1. SRWP goals for data completeness.

Monitoring Element	Completeness Objective
Mercury	90%
Pesticides	90%
General Water Quality Constituents	90%
Pathogens	90%
Aquatic Toxicity	90%
Benthic Invertebrates	95%
Fish Tissue	85%

Field Procedures

For basic water quality analyses, quality control samples to be prepared in the field consisted of field blanks and field duplicates.

Field Blanks

The purpose of analyzing field blanks is to demonstrate that sampling procedures and equipment do not result in contamination of the environmental samples. Field blanks were generally prepared and analyzed for all analytes of interest at the rate of one per sample event, along with the associated environmental samples. Field blanks consisted of laboratory-prepared blank water processed through the sampling equipment using the same procedures used for environmental samples. If the concentration in the associated environmental samples was less than five times the value detected in the field blank, the results for the environmental samples may be affected by contamination and were qualified as *below detection* at the reported value.

Field Duplicates

The purpose of analyzing field duplicates is to demonstrate the precision of sampling and analytical processes. Field duplicates were prepared and analyzed at a rate of 1 per event for most analytes. Field duplicates consisted of two aliquots from the same composite sample, or of two grab samples collected in rapid succession. If the relative Percent Difference (RPD) of field duplicate results was greater than 25% and the absolute difference is greater than the RL, environmental results were qualified as *estimated*.

Laboratory Analyses

For basic water quality analyses, quality control samples prepared in the contract laboratory(s) will typically consist of equipment blanks, method blanks, standard reference materials, laboratory duplicates, matrix spikes, and matrix spike duplicates. Laboratory analyses for *Giardia* and *Cryptosporidium*, and coliform bacteria will include negative and positive quality control samples, as specified in the method documents.

Equipment Blanks

The purpose of analyzing equipment blanks is to demonstrate that sampling equipment is free from contamination. Prior to using sampling equipment for the collection of environmental samples, the laboratory responsible for cleaning and preparation of the equipment will prepare bottle blanks and sampler blanks. These were prepared and analyzed at the rate of one each per batch of bottles or sampling equipment. The blanks were analyzed using the same analytical methods specified for environmental samples.

Method Blanks

The purpose of analyzing method blanks is to demonstrate that the analytical procedures do not result in sample contamination. Method blanks were prepared and analyzed by the contract laboratory at a rate of at least one for each analytical batch. Method blanks consisted of laboratory-prepared blank water processed along with the batch of environmental samples. If the result for a single method blank was greater than the MDL, the source(s) of contamination should be corrected, and the associated samples should be reanalyzed. If reanalysis was not possible, the associated sample results were qualified as *below detection* at the reported value.

Laboratory Control Samples

The purpose of analyzing laboratory control samples is to demonstrate the accuracy of the analytical method. Laboratory control samples were analyzed at the rate of one per sample batch for most analytes. Laboratory control samples consisted of laboratory fortified method blanks. If recovery of any analyte is outside the acceptable range for accuracy, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and the laboratory control sample should be reanalyzed. If reanalysis was not possible, the associated sample results were qualified as *low or high biased*.

Laboratory Duplicates

The purpose of analyzing laboratory duplicates is to demonstrate the precision of the analytical method. Laboratory duplicates were analyzed at the rate of one pair per sample batch. Laboratory duplicates will consist of duplicate laboratory fortified method blanks. If the Relative Percent Difference (RPD) for any analyte is greater than the precision criterion *and* the absolute difference between duplicates is greater than the RL, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and laboratory duplicates should be reanalyzed. If reanalysis was not possible, the associated sample results were qualified as *not reproducible* due to analytical variability.

Matrix Spikes and Matrix Spike Duplicates

The purpose of analyzing matrix spikes and matrix spike duplicates is to demonstrate the performance of the analytical method in a particular sample matrix. Matrix spikes and matrix spike duplicates were typically analyzed at the rate of one pair per sample batch for most analytes. Each matrix spike and matrix spike duplicate consisted of an aliquot of laboratory-fortified environmental sample.

If matrix spike recovery of any analyte is outside the acceptable range, the results for that analyte have failed the acceptance criteria for that specific matrix. If recovery of laboratory control samples is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. If the matrix problem can't be corrected, the results for that analyte were qualified as appropriate (*low or high biased*) due to matrix interference.

If matrix spike duplicate RPD for any analyte is greater than the precision criterion, the results for that analyte have failed the acceptance criteria for that specific matrix. If the RPD for laboratory duplicates is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. If the matrix problem can't be corrected, the results for that analyte were qualified as *not reproducible*, due to matrix interference.

Aquatic and Sediment Toxicity Quality Control

For aquatic and sediment toxicity tests, the acceptability of test results was determined primarily by performance-based criteria for test organisms, culture and test conditions, and the results of control bioassays. Control bioassays included testing with reference toxicants, reference sediments, and negative and solvent controls. Test acceptability requirements are documented in the method documents for each bioassay method and in the QAPP.

In addition to the QA requirements for the toxicity testing methods, a total of twenty percent of the samples collected for aquatic toxicity testing were reserved for other QC analyses. Ten percent of aquatic toxicity samples were split and tested at the California Department of Fish and Game Laboratory at Elk Grove. An additional ten percent of analyses consisted of laboratory splits, spikes, and blanks. The results of duplicate and interlaboratory split analyses are considered acceptable if the results are not significantly different at the 95% confidence level *or* the RPD for the results is less than 30%. Acceptable results for tests with blanks are no significant toxicity. Although the laboratory has no formal limit of acceptability for analysis of spiked samples, the pattern and progress of toxic responses are evaluated subjectively for consistency with expected responses for the level of the spiked compound.

Benthic Invertebrates Processing and Analysis

Accuracy of identifications and precision of enumeration of benthic invertebrate collections was assessed by re-analysis of samples at the rate of one for every ten samples analyzed. This consisted of complete re-examination of the organisms in the archived original sample, including remnants from the sorting process. If any additional organisms are identified in the "remnant" fraction of the archived sample, the numbers of taxa and organisms was recorded. The total number of organisms and enumeration of individual taxa for the re-examined sample should be within 5% of the original total. Discrepancies in taxonomic identification or enumeration were resolved by consultation between taxonomic analysts.

Fish Tissue

Quality control requirements and assessment procedures for analysis of contaminants in fish tissue were generally similar to those for water quality samples (documented above). However, for analysis of PCBs and chlorinated pesticides, surrogate compounds (internal standards) were added to each sample to assess analytical accuracy of classes of similar compounds. The acceptable range for recovery of surrogate compounds was set by the analyzing laboratory. If surrogate recoveries were outside the defined range, the sample batch was prepared again and reanalyzed. If reanalysis was not possible, the associated environmental data for all analytes by the specific method was qualified as low or high biased, consistent with the surrogate recovery bias. If surrogate recovery bias is inconsistent for different surrogate compounds, the associated environmental data was qualified as biased due to indeterminate surrogate recovery bias.

Table 2a. Project Quality Control Requirements for Analysis of Water Quality Samples for Trace Metals, Organic Carbon, and General Water Quality Constituents.

QA Procedure	QA Parameter	Frequency	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent batch.	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per event (trace metals and TOC)	< RL *or* < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per event	RPD ≤ 25% if |Difference| ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Method Blank	Contamination	≥1 per batch (trace metals and TOC)	< MDL *or*, if n≥3, avg ± 2 s.d. < RL	Identify contamination source. Reanalyze method blank and all samples in batch.
LCS or SRM	Accuracy	1 per batch	80-120% REC	Recalibrate and reanalyze LCS or SRM and samples
Lab Duplicate	Precision	1 per batch	RPD ≤ 20% if |Difference| ≥ RL	Recalibrate and reanalyze.
Matrix Spike	Accuracy	1 per batch	80-120% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike Duplicate	Precision	1 per batch	RPD ≤ 20%	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per planned sample event	90%	Reschedule sample events as necessary or appropriate.

MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

Table 2b. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Triazine Pesticide Analyses by EPA Method 619.

QA Procedure	QA Parameter	Frequency[1]	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per 3 events	< RL *or* < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per 6 events	RPD ≤ 25% if |Difference| ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS Atrazine Terbutryn Tributylphosphate Triphenlyphosphate	Accuracy	1 per batch	 28-163% REC 60-117% REC 60-150% REC 76-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: Atrazine Terbutryn	Precision	1 per batch	 31% RPD 25% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

(1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table 2c. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Organophosphosphate Pesticide Analyses by EPA Method 8141A.

QA Procedure	**QA Parameter**	**Frequency[1]**	**Criterion**	**Corrective Action**
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per event	< RL or < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per 2 events	RPD ≤ 25% if |Difference| ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS Phorate Diazinon Disulfoton Methyl Parathion Stirophos Ethion Tributylphosphate Triphenlyphosphate	Accuracy	1 per batch	 22-96% REC 57-130% REC 47-117% REC 55-164% REC 68-128% REC 65-134% REC 60-150% REC 76-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: Phorate Diazinon Disulfoton Methyl Parathion Stirophos Ethion	Precision	1 per batch	 24% RPD 21% RPD 22% RPD 24% RPD 25% RPD 20% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

(1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table 2d. Project Quality Control Requirements for Analysis of Water Quality Samples: Requirements for Carbamate Pesticide Analyses by EPA Method 8321.

QA Procedure	QA Parameter	Frequency1	Criterion	Corrective Action
Equipment Blanks: • bottle blanks • sampler blanks	Contamination	1 per bottle or reagent lot	< MDL	Identify contamination source. Reclean equipment. Reanalyze blank(s).
Field Blanks	Contamination	1 per 3 events	< RL or < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	1 per 6 events	RPD ≤ 25% if |Difference| ≥ RL	Reanalyze both samples. Identify variability source. Qualify data as needed.
Matrix Spike & LCS Methomyl Bromacil Neburon Oryzalin	Accuracy	1 per batch	 37-113% REC 58-111% REC 55-132% REC 40-140% REC	Check SRM recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike & LCS Duplicates: Methomyl Bromacil Neburon	Precision	1 per batch	 25% RPD 25% RPD 25% RPD	Check lab dup RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference;
RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample;
SRM = Standard Reference Material (=Certified Reference Material)

(1) The term “lot” refers to a set of bottles or reagents identifiable by a common production lot number, or to sampling equipment subjected to the same cleaning procedures as a set.
The term “batch”, as used in this document, refers to an uninterrupted series of analyses.

Table 3. Project Quality Control Requirements for Analysis of Water Quality Samples for Pathogens.

QA Procedure	Parameter	Frequency1	Criterion	Corrective Action
Coliform Bacteria Analyses				
Field Blanks	Contamination	1 per event	< RL or < sample ÷ 5	Examine field log. Identify contamination source. Qualify data as needed.
Method Blanks (Sterility Checks)	Contamination	1 per batch	< RL	Identify contamination source. Clean equipment and slides. Check reagents. Re-analyze blank.
Lab Duplicate	Precision2	1 per 10 samples, & at least 1 per batch	Rlog≤ 3.27•mean RLog	Recalibrate and reanalyze.
Cryptosporidium and Giardia Analyses				
Method Blanks	Contamination	1 per 20 samples	<1 cyst	Identify contamination source. Clean equipment and slides. Check reagents. Re-analyze blank.
Ongoing Precision and Recovery Samples	Precision	1 per 20 samples	56% RPD	Identify and correct problem. Re-examine OPR sample.
Ongoing Precision and Recovery Samples	Accuracy	1 per 20 samples	10-100% REC	Identify and correct problem. Re-examine OPR sample.
Matrix Spike	Accuracy	1 per 20 samples	11-100% REC	Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
All Pathogen Analyses				
Negative Control Samples	Contamination	1 per culture medium or reagent lot	< RL	Identify source. Clean equipment and prepare new media. Re-examine negative control
Negative Control Samples	Assay function	1 per culture medium or reagent lot	≥ RL	Identify and correct problem. Re-examine positive control.
Assess percent of data successfully collected	Data Completeness	1 per planned sample event	90%	Reschedule sample events as necessary or appropriate.

Notes: MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

(1) The method documentation defines an analytical batch as an “uninterrupted series of analyses”.

(2) Rlog is the absolute difference between logarithms of coliform counts for duplicate analyses. The mean Rlog is determined by performing duplicate analyses on the first 15 positive sample analyzed for each matrix type.

Table 4. Project Quality Control Requirements for Analysis of Benthic Invertebrates.

QA Procedure	Parameter	Frequency	Criterion	Corrective Action
Re-examination of sample	Accuracy Precision	1 per 10 benthic invertebrate samples	≤5% difference ≤5% difference	Resolve differences in identification and enumeration.
Assess percent of data successfully collected	Data Completeness	1 per planned sample event	100%	Reschedule sample events as necessary or appropriate.

Table 5. Project Quality Control Requirements for Analysis of Fish Tissue for Mercury.

QA Procedure	Parameter	Frequency	Criterion	Corrective Action
Method Blank (a.k.a. analytical blank or lab reagent blank)	Contamination	1 per batch	< MDL or < 10% of lowest sample	Identify contamination source. Reanalyze method blank and all samples in batch.
SRM (a.k.a. certified reference material)	Accuracy	1 per batch of 20 or fewer samples	Within 20% of the certified 95% confidence interval, or within 20% of the certified mean	Review raw data quantitation reports Check instrument response using calibration standard Recalibrate and reanalyze SRM and samples Repeat analysis until control limits are met
SRM (a.k.a. certified reference material)	Precision	1 per batch of 20 or fewer samples	RPD ≤ 35%, or RSD ≤ 30%	Recalibrate and reanalyze. If problem persists eliminate source of imprecision and reanalyze.
Field Duplicate (two aliquots from same composite sample: RMP calls this a lab duplicate)	Precision	1 per batch	RPD ≤ 35%	Recalibrate and reanalyze. If problem persists eliminate source of imprecision and reanalyze.
Matrix Spike	Accuracy	1 per batch	> 50% REC	Check SRM or LCS recovery. Review raw data quantitation reports Check instrument response using calibration standard Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike Duplicate	Precision	1 per batch	RPD ≤ 35%	Check lab duplicate RPD. Review raw data quantitation reports Check instrument response using calibration standard Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per planned sampling event	85%	Reschedule sampling as necessary or appropriate.

MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

Table 6. Project Quality Control Requirements for Analysis of Fish Tissue for Organochlorine Pesticides and PCBs.

QA Procedure	Parameter	Frequency	Criterion	Corrective Action
Method Blank (a.k.a. analytical blank or lab reagent blank)	Contamination	1 per batch	< MDL or < 10% of lowest sample	Identify contamination source. Reanalyze method blank and all samples in batch.
SRM (a.k.a. certified reference material)	Accuracy	1 per batch of 20 or fewer samples	As a group: 70% of the analytes within 35% of the 95% confidence interval Individually: No analyte >30% of 95% confidence interval for 2 consecutive analyses	Review chromatograms and raw data quantitation reports Check instrument response using calibration standard Recalibrate and reanalyze SRM and samples Repeat analysis until control limits are met
SRM (a.k.a. certified reference material)	Precision	1 per batch of 20 or fewer samples	RPD ≤ 35%, or RSD ≤ 30%	Recalibrate and reanalyze. If problem persists eliminate source of imprecision and reanalyze.
Field Duplicate (two aliquots from same composite sample: RMP calls this a lab duplicate)	Precision	1 per batch	RPD ≤ 35%	Recalibrate and reanalyze. If problem persists eliminate source of imprecision and reanalyze.
Matrix Spike	Accuracy	1 per batch	> 50% REC	Check SRM or LCS recovery. Review chromatograms and raw data quantitation reports Check instrument response using calibration standard Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Matrix Spike Duplicate	Precision	1 per batch	RPD ≤ 35%	Check lab duplicate RPD. Review raw data quantitation reports Check instrument response using calibration standard Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Surrogate Spike	Accuracy	1 per batch	set by analyzing laboratory	Check SRM or LCS recovery. Attempt to correct matrix problem and reanalyze sample. Qualify data as needed.
Assess percent of data successfully collected	Data Completeness	1 per planned sampling event	85%	Reschedule sampling as necessary or appropriate.

MDL = Method Detection Limit; RL = Reporting Limit; RPD = Relative Percent Difference; RSD = Relative Standard Deviation; REC = Recovery; LCS = Laboratory Control Sample; SRM = Standard Reference Material (=Certified Reference Material)

Summary of Quality Control Data

Aquatic Toxicity

For SRWP samples collected and analyzed in 2001-2002, aquatic toxicity tests met all performance criteria and all reported data were unqualified. The results for quality assurance analyses for aquatic toxicity testing are presented in monitoring data summaries produced by Pacific EcoRisk.

The overall completion rate was greater than the 90% objective for the program, and this monitoring element provided data that were adequate for the purposes of the SRWP.

Fish Tissue Monitoring

The results of Quality Assurance analyses performed for 2001 fish tissue monitoring are reported in "Quality Assurance/Quality Control Document for the Sacramento River Toxic Pollutant Control Program" prepared by the California Department of Fish and Game. All of the 2001-2002 results met data quality objectives. However, the overall completion rate was 55%, less than the 85% objective for the program. The low completion rate was due to poor success in capturing the desired numbers of fish of the target fish species. This occurred at least in part because of a low water year and late start for fish tissue monitoring, but also because of inadequate communication between monitoring managers and sampling contractors. Communication problems were addressed in the QAPP for the following monitoring year. Overall, this monitoring element provided data that were of adequate quality for the purposes of the SRWP, but did not meet completeness targets.

Bioassessment

Bioassessment monitoring was limited to habitat assessment of prospective reference sites in 2001-2002. No QA data are resulted from the bioassessment reference site development effort.

Water Column Chemistry and Microbiology Monitoring

Quality control data for SRWP monitoring data collected from July 2001 through June 2002 are summarized below. Quality control data were evaluated using methods documented in the Quality Assurance Project Plan (QAPP) for the SRWP (SRWP 2001). Sample results were reviewed for conformance with recommended allowable holding times for specific analyses and for compliance with SRWP Monitoring Program data quality objectives for laboratory and external QC results. Internal laboratory QC data reviewed include results for method blanks, laboratory control samples (standard reference materials), laboratory duplicates, matrix spikes, and matrix spike duplicates. Field and external laboratory QC data reviewed include results for field blanks and field duplicates. Program specifications for data quality are summarized in Tables 1-6.

Holding Times

Data quality objectives for holding times generally conformed to EPA recommendations specified for the analytical methods used for individual parameters. Allowable holding times for the project ranged from 24 hours for microbiological analyses to 6 months for metals and hardness (after preservation). 97% of the total analyses were performed within acceptable holding times. Analyses performed outside of acceptable limits resulted in qualification of some analytical results for alkalinity, dissolved orthophosphate, and UVA_{254}. Most of the qualified data were for UVA_{254} analyses analyzed after the 48-hour holding time objective, due to the short holding time and the logistics of getting samples to the lab from distant sampling locations. A summary of allowable holding times and compliance for individual analytes is presented in Table 7.

Laboratory Method and Filter Blanks

Laboratory method blanks and filter blanks were analyzed to evaluate the potential for contamination attributable to analytical reagents and sample processing. The project data quality objective for laboratory method and filter blanks was defined as below the project reporting limit. If detectable levels of an analyte were determined to be present in method or filter blanks, sample results were accepted without qualification if the associated environmental sample results were greater than five times the concentration detected in the blank. If detectable levels of an analyte were determined to be present in method or filter blanks and associated environmental sample results were less than five (5) times the concentration detected in the blank, the reported analytical results were qualified as an upper limit of the actual sample result.

For SRWP 2001-2002 monitoring results, mercury, methylmercury, total Kjeldahl nitrogen, and UVA_{254} were detected at greater than program reporting limits in laboratory method blanks in a total of 4 of 664 analyses. The overall success rate for analyses of laboratory method and filter blanks was 99%. These results indicate that laboratory contamination of water quality samples is not a significant problem. Results for laboratory method blanks are summarized in Table 8.

Laboratory Control Sample Recoveries

Laboratory control samples were analyzed to evaluate analytical accuracy. If recoveries were outside the acceptable range for the analysis, associated samples results were qualified as “low- or high-biased” as indicated by the control sample recovery.

For SRWP 2001-2002 monitoring results, 19 of 470 laboratory control sample recoveries were outside project specifications (one each for ammonia, methylmercury, and DOC, and 16 pesticide analyte results). The overall success rate for analysis of laboratory control samples was 96%. These results indicate that analytical accuracy was adequate for analysis of water quality samples for the project. Results for laboratory control sample recoveries are summarized in Tables 9a–9d.

Laboratory Duplicates

Analyses of duplicate samples were conducted to evaluate analytical precision. If laboratory duplicate results were outside the project data quality objective, associated samples results were qualified as "estimated" (not reproducible) due to analytical variability. An RPD greater than the project data quality objective was not considered cause for qualification of analytical results if measured differences between replicates were less than the reporting limit, or if matrix spike duplicate results were acceptable.

For SRWP 2001-2002 monitoring results, 1 of 196 laboratory duplicate results were outside program specifications. The overall success rate for analyses of laboratory control sample duplicate RPDs was 99.5%. These results indicate that analytical precision was adequate to produce reliable data for the SRWP. Results for laboratory duplicate analyses are summarized in Table 10.

Matrix Spike Recoveries

Analyses of matrix spike samples (spiked environmental samples) were performed to evaluate the effect of water quality sample matrix on analytical accuracy. When a matrix spike recovery does not meet the project data quality objective, associated sample results are considered "low- or high-biased" due to matrix interference, as indicated by the recovery.

For SRWP 2001-2002 monitoring results, reported matrix spike recoveries exceeded program specifications for 37 of 592 total analyses. The overall success rates for analyses of matrix spike recoveries were 96%, 90%, and 93% for pesticide analyses (by EPA methods 619, 8321, and 8141, respectively) and 96% for all other analyses. Organic carbon analyses exceeded the project DQO most frequently, with 14% of the total recoveries outside of program specifications. In combination with the results for laboratory control samples, these results indicate that with the exception of organic carbon, matrix interference did not represent a significant problem and that analytical accuracy was adequate to produce reliable data for water quality samples for the SRWP. Results for matrix spike recoveries are summarized in Tables□1a-d.

Matrix Spike Duplicates

Analyses of matrix spike duplicate samples were performed to evaluate the effect of water quality sample matrix on analytical precision. If matrix spike duplicate results were outside this range, associated samples results were qualified as "estimated" (not reproducible) due to matrix variability.

For SRWP 2001-2002 monitoring results, matrix spike duplicate RPDs exceeded project objectives in a total of 36 of 351 analyses. The overall success rate for analyses of matrix spike duplicates was 90%. In combination with the results for laboratory duplicates, these results indicate that matrix interference did not represent a significant problem for most analyses and that analytical precision was adequate to produce reliable water quality data for the SRWP. However, problems due to matrix effects on precision were more frequently observed for methylmercury and pesticide analyses than is desirable. Results for matrix spike duplicate RPDs are summarized in Table 12.

Field Blanks

Field blanks were submitted and analyzed to evaluate the potential for sampling equipment and procedures to contaminate water quality samples. The project data quality objective for field and equipment blanks was defined as below the program reporting limit. If detectable levels of an analyte were determined to be present in field blanks, sample results were accepted without qualification if the environmental results were greater than five (5) times the concentrations detected in the blank. If detectable levels of an analyte were determined to be present in field or equipment blanks and sample results were less than five (5) times the concentrations detected in the blank, the reported results were qualified as an upper limit of the true sample concentration.

For SRWP 2001-2002 monitoring results, SRWP analytes were detected above reporting limits in 6 of 407 field blank analyses: 1 ammonia analysis, 1 UVA_{254} analysis, 2 total mercury analyses, and 2 methylmercury analyses. The overall success rate for analysis of field blanks was 98.5%. Results of analyses of field blanks indicate that sampling procedures and equipment were generally adequate to prevent detectable or significant levels of contamination of samples collected for the SRWP. Results for field blank analyses are summarized in Table 13.

Field Duplicates

The purpose of analyzing duplicate field samples is to measure the reproducibility (i.e. precision) of analyte concentrations in field samples from replicate composite or grab samples. The results provide a measure of the variability attributable to sampling and sample handling procedures after sample collection. The project data quality objective for duplicates field samples was defined as a relative percent difference (RPD) of less than or equal to 25%. Duplicate RPDs outside this range resulted in the qualification of sample result data as “estimated” (not reproducible) due to sample variability. An RPD greater than 25% was not considered cause for qualification of data if measured differences between replicates were less than the reporting limit.

For SRWP 2001-2002 monitoring results, field duplicate RPDs exceeded program specifications for 8 of 402 pairs of analyses. The overall success rate for analysis of field duplicates was 98%. These results indicate that sampling and sample handling-generated variability was not excessive, and that sampling procedures were performed in a manner to provide adequate data for the SRWP. Results for field duplicates are summarized in Table 14.

Summary

From June 2001 through July 2002, the SRWP monitoring program successfully completed 3857 of 4505 planned water chemistry and aquatic toxicity analyses for a completion rate of 86%. The primary cause for this low completion rate was that one complete and one partial planned monitoring events were not conducted because precipitation conditions did not meet program sampling criteria. For events that met program criteria, 3857 of a total of 3919 attempted samples were collected, for a sampling completion rate of 98%. Of the 3857 completed analyses, data qualifications were required for 176 analytical results, leaving 3681 unqualified results for an overall analytical success rate of 94% for water chemistry, microbiology, and aquatic toxicity monitoring for 2001-2002. These results are summarized in Table 15.

The quality control results for 2001-2002 indicate that sampling and analytical methods for water column monitoring were generally adequate to produce reliable data for the SRWP.

Table 7. Summary of Compliance with Holding Times for SRWP Analyses, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
alkalinity - total	14 days	81	3	96
ammonia as NH3	28 days	65	0	100
coliform - fecal	24 hours	43	0	100
coliform - total	24 hours	43	0	100
e. coli	24 hours	43	0	100
enterococcus	24 hours	62	0	100
hardness (atox)	6 months	72	0	100
mercury - dissolved	6 months	57	0	100
mercury - total	6 months	58	0	100
methylmercury - dissolved	6 months	57	0	100
methylmercury - total	6 months	60	0	100
nitrate as NO3	28 days	65	0	100
nitrite as NO2	28 days	65	0	100
nitrogen - total Kjeldahl	28 days	65	0	100
organic carbon - dissolved	28 days[5]	39	0	100
organic carbon - total	28 days[5]	40	0	100
orthophosphate - dissolved	48 hours	65	2	97
pesticides - EPA 507	40 days	6	0	100
pesticides - EPA 619	40 days	17	0	100
pesticides - EPA 8141A	40 days	51	0	100
pesticides - EPA 8321A	40 days	26	0	100
phosphorus - total	28 days	65	0	100
total dissolved solids	7 days	40	0	100
total suspended solids	7 days	55	0	100
UVA_{254}	48 hours	59	35	41
	total for all parameters	1293	40	97%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO
(5) The QAPP (SRWP 2001) cites a holding time of 7 days. However, standard laboratory practice for this parameter is 28 days for properly preserved and stored samples, and no data were qualified based on exceedance of the 7 day holding time.

Table 8. Summary of Compliance with Laboratory Method Blank Results for SRWP Analyses, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ammonia as NH3	<RL or <S/5	8	0	100
mercury - total	<RL or <S/5	9	0	100
methylmercury - total	<RL or <S/5	33	1	97
nitrate as NO3	<RL or <S/5	11	0	100
nitrite as NO2	<RL or <S/5	10	0	100
nitrogen - total Kjeldahl	<RL or <S/5	6	1	83
organic carbon - dissolved	<RL or <S/5	38	0	100
organic carbon - total	<RL or <S/5	39	0	100
orthophosphate - dissolved	<RL or <S/5	10	0	100
pesticides - EPA 507	<RL or <S/5	2	0	100
pesticides - EPA 619	<RL or <S/5	55	0	100
pesticides - EPA 8141A	<RL or <S/5	254	0	100
pesticides - EPA 8321A	<RL or <S/5	146	0	100
phosphorus - total	<RL or <S/5	9	0	100
total dissolved solids	<RL or <S/5	10	0	100
total suspended solids	<RL or <S/5	8	0	100
UVA 254	<RL or <S/5	16	2	88
	total for all analyses	664	4	99%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 9a. Summary of Laboratory Control Sample and SRM Recoveries for SRWP Non-Pesticide Analyses, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ammonia as NH3	80% - 120%	8	1	88
mercury - total	80% - 120%	9	0	100
methylmercury - total	80% - 120%	11	1	91
nitrate as NO3	80% - 120%	9	0	100
nitrite as NO2	80% - 120%	12	0	100
nitrogen - total Kjeldahl	80% - 120%	6	0	100
organic carbon - dissolved	80% - 120%	11	1	91
organic carbon - total	80% - 120%	10	0	100
orthophosphate - dissolved	80% - 120%	14	0	100
phosphorus - total	80% - 120%	7	0	100
total dissolved solids	80% - 120%	5	0	100
total suspended solids	80% - 120%	4	0	100
	total for all analyses	106	3	97%

Table 9b. Summary of Laboratory Control Sample Recoveries for SRWP Triazine Pesticide Analyses by EPA Method 619, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ametryn	66% - 148%	4	0	100
atraton	50% - 164%	4	0	100
atrazine	28% - 163%	4	0	100
cyanazine	50% - 178%	4	0	100
prometon	50% - 169%	4	0	100
prometryn	57% - 161%	4	0	100
propazine	58% - 165%	4	0	100
simazine	35% - 135%	4	0	100
simetryn	54% - 166%	4	0	100
tributylphosphate (surrogate)	60% - 150%	4	0	100
triphenylphosphate (surrogate)	76% - 140%	4	0	100
terbuthylazine	62% - 159%	4	0	100
terbutryn	60% - 117%	4	0	100
	total for EPA method 8321A	52	0	100%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 9c. Summary of Laboratory Control Sample Recoveries for SRWP Organophosphate Pesticide Analyses by EPA Method 8141, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
azinphosmethyl	27% - 151%	7	0	100
bolstar	31% - 120%	7	0	100
chlorpyrifos	37% - 120%	7	0	100
coumaphos	46% - 134%	7	0	100
def/merphos	34% - 140%	8	1	88
demeton (total)	21% - 80%	7	2	71
diazinon	7% - 71%	7	0	100
dichlorvos	57% - 130%	7	0	100
dimethoate	13% - 145%	7	0	100
diphenamid	33% - 227%	1	0	100
disulfoton	47% - 117%	7	1	86
EPN	20% - 152%	7	0	100
EPTC	43% - 130%	7	0	100
ethion	47% - 118%	7	0	100
ethoprop	38% - 118%	7	0	100
fensulfothion	37% - 172%	7	0	100
fenthion	39% - 109%	7	1	86
malathion	54% - 121%	7	1	86
methidathion	44% - 128%	1	0	100
methyl trithion	30% - 192%	1	0	100
mevinphos	16% - 285%	7	0	100
naled	44% - 133%	7	0	100
ethyl parathion	55% - 164%	7	1	86
methyl parathion	22% - 96%	7	0	100
phorate	30% - 129%	7	0	100
phosalone	47% - 112%	1	0	100
phosmet	68% - 128%	1	0	100
prometon	50% - 114%	1	0	100
prowl	60% - 150%	7	0	100
ronnel	76% - 140%	7	1	86
simazine	47% - 112%	1	0	100
stirophos	68% - 128%	7	2	71
sulfotep	50% - 114%	7	1	86
tributylphosphate (surrogate)	60% - 150%	7	0	100
triphenylphosphate (surrogate)	76% - 140%	7	1	86
tokuthion	36% - 126%	7	0	100
trichloronate	36% - 115%	7	1	86
trifluralin	31% - 107%	7	0	100
total for EPA method 8141A		225	13	94%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 9d. Summary of Laboratory Control Sample Recoveries for SRWP Carbamate Pesticide Analyses by EPA Method 8321, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
aldicarb	22% - 146%	6	0	100
bromacil	58% - 111%	6	2	67
carbaryl	40% - 131%	6	0	100
carbofuran	44% - 128%	6	0	100
diuron	57% - 133%	6	0	100
fenuron	59% - 96%	6	0	100
fluometuron	66% - 158%	6	0	100
linuron	53% - 135%	6	0	100
methiocarb	42% - 129%	6	0	100
methomyl	37% - 113%	6	0	100
monuron	55% - 134%	6	0	100
neburon	55% - 132%	6	0	100
oryzalin (surrogate)	40% - 140%	3	0	100
tributylphosphate (surrogate)	60% - 150%	3	0	100
triphenylphosphate (surrogate)	76% - 140%	3	0	100
tebuthiuron	67% - 109%	6	1	83
	totals for EPA method 619	87	3	97%

Table 10. Summary of Laboratory Duplicate Results for SRWP Analyses, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ammonia as NH3	<=20% RPD	9	0	100
mercury - dissolved	<=20% RPD	3	1	67
mercury - total	<=20% RPD	5	0	100
methylmercury - total	<=20% RPD	9	0	100
nitrate as NO3	<=20% RPD	12	0	100
nitrite as NO2	<=20% RPD	11	0	100
nitrogen - total Kjeldahl	<=20% RPD	9	0	100
organic carbon - dissolved	<=20% RPD	36	0	100
organic carbon - total	<=20% RPD	38	0	100
orthophosphate - dissolved	<=20% RPD	15	0	100
phosphorus - total	<=20% RPD	10	0	100
UVA 254	<=20% RPD	39	0	100
	total for all analyses	196	1	99.5%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 11a. Summary of Matrix Spike Recoveries for SRWP Analyses, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ammonia as NH3	80% - 120%	13	0	100
mercury - dissolved	80% - 120%	3	0	100
mercury - total	80% - 120%	5	0	100
methylmercury - dissolved	80% - 120%	9	1	89
methylmercury - total	80% - 120%	8	1	88
nitrate as NO3	80% - 120%	15	0	100
nitrite as NO2	80% - 120%	15	1	93
nitrogen - total Kjeldahl	80% - 120%	12	1	92
organic carbon - dissolved	80% - 120%	12	0	100
organic carbon - total	80% - 120%	12	1	92
orthophosphate - dissolved	80% - 120%	14	0	100
phosphorus - total	80% - 120%	12	1	92
total dissolved solids	80% - 120%	5	0	100
total suspended solids	80% - 120%	4	0	100
total for all analyses		139	6	95.7%

Table 11b. Summary of Matrix Spike Recoveries for SRWP Pesticide Analyses by EPA Method 619, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ametryn	54% - 173%	4	0	100
atraton	26% - 199%	4	1	75
atrazine	62% - 191%	4	0	100
cyanazine	30% - 232%	4	1	75
prometon	50% - 169%	4	0	100
prometryn	57% - 161%	4	0	100
propazine	58% - 165%	4	0	100
simazine	35% - 135%	4	1	75
simetryn	54% - 166%	4	0	100
terbuthylazine	62% - 159%	4	0	100
terbutryn	60% - 117%	4	1	75
tributylphosphate (surrogate)	60% - 150%	23	0	100
triphenylphosphate (surrogate)	76% - 140%	23	0	100
total for all analyses		90	4	95.6%

Table 11c. Summary of Matrix Spike Recoveries for SRWP Pesticide Analyses by EPA Method 8321 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
aldicarb	22% - 146%	4	0	100
bromacil	58% - 111%	4	2	50
carbaryl	40% - 131%	4	0	100
carbofuran	44% - 128%	4	0	100
diuron	57% - 133%	4	1	75
fenuron	59% - 96%	4	2	50
fluometuron	66% - 158%	4	1	75
linuron	53% - 135%	4	1	75
methiocarb	42% - 129%	4	0	100
methomyl	37% - 113%	4	0	100
monuron	55% - 134%	4	0	100
neburon	55% - 132%	4	0	100
oryzalin (surrogate)	40% - 140%	12	0	100
tebuthiuron	67% - 109%	4	2	50
tributylphosphate (surrogate)	60% - 150%	14	0	100
triphenylphosphate (surrogate)	76% - 140%	14	0	100
total for all analyses		92	9	90.2%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 11d. Summary of Matrix Spike Recoveries for SRWP Pesticide Analyses by EPA Method 8141 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
azinphosmethyl	27% - 151%	4	0	100
bolstar	40% - 117%	4	0	100
chlorpyrifos	37% - 120%	4	0	100
coumaphos	46% - 134%	5	0	100
def/merphos	44% - 128%	7	0	100
demeton (total)	21% - 80%	5	1	80
diazinon	57% - 130%	4	0	100
dichlorvos	41% - 126%	5	0	100
dimethoate	51% - 161%	4	0	100
disulfoton	47% - 117%	5	0	100
EPN	37% - 159%	5	0	100
EPTC	43% - 130%	5	0	100
ethion	65% - 134%	5	0	100
ethoprop	38% - 118%	4	0	100
ethyl parathion	44% - 133%	5	0	100
fensulfothion	36% - 161%	5	0	100
fenthion	52% - 113%	5	0	100
malathion	54% - 121%	5	0	100
methyl parathion	55% - 164%	4	0	100
mevinphos	31% - 150%	4	0	100
naled	27% - 237%	4	1	75
phorate	22% - 96%	4	0	100
prometon	50% - 169%	1	0	100
prowl	32% - 128%	4	0	100
ronnel	47% - 112%	5	0	100
simazine	35% - 135%	1	0	100
stirophos	68% - 128%	5	2	60
sulfotep	50% - 114%	5	0	100
tokuthion	36% - 126%	4	0	100
tributylphosphate (surrogate)	60% - 150%	62	1	98
trichloronate	49% - 116%	4	0	100
trifluralin	33% - 105%	4	0	100
triphenylphosphate (surrogate)	76% - 140%	62	13	79
total for all analyses		259	18	93%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 12. Summary of Matrix Spike Duplicate Results for SRWP Analyses, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ammonia as NH3	<=20% RPD	10	1	90
mercury - dissolved	<=20% RPD	3	0	100
mercury - total	<=20% RPD	5	0	100
methylmercury - dissolved	<=20% RPD	9	3	67
methylmercury - total	<=20% RPD	8	2	75
nitrate as NO3	<=20% RPD	15	0	100
nitrite as NO2	<=20% RPD	14	0	100
nitrogen - total Kjeldahl	<=20% RPD	9	0	100
organic carbon - dissolved	<=20% RPD	12	0	100
organic carbon - total	<=20% RPD	12	0	100
orthophosphate - dissolved	<=20% RPD	9	0	100
pesticides - EPA 619	<=20% RPD	36	6	83
pesticides - EPA 8141A	<=20% RPD	141	14	90
pesticides - EPA 8321A	<=20% RPD	52	10	81
phosphorus - total	<=20% RPD	11	0	100
total dissolved solids	<=20% RPD	3	0	100
total suspended solids	<=20% RPD	2	0	100
total for all analyses		351	36	89.7%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 13. Summary of Field Blank Results for SRWP Analyses, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
ammonia as NH3	<RL or <S/5	4	1	75
coliform - fecal	<RL or <S/5	5	0	100
coliform - total	<RL or <S/5	5	0	100
e. coli	<RL or <S/5	5	0	100
enterococcus	<RL or <S/5	5	0	100
mercury - dissolved	<RL or <S/5	4	1	75
mercury - total	<RL or <S/5	4	1	75
methylmercury - dissolved	<RL or <S/5	4	1	75
methylmercury - total	<RL or <S/5	4	1	75
nitrate as NO3	<RL or <S/5	4	0	100
nitrite as NO2	<RL or <S/5	4	0	100
nitrogen - total Kjeldahl	<RL or <S/5	4	0	100
organic carbon - dissolved	<RL or <S/5	4	0	100
organic carbon - total	<RL or <S/5	4	0	100
orthophosphate - dissolved	<RL or <S/5	4	0	100
pesticides - EPA 507	<RL or <S/5	2	0	100
pesticides - EPA 619	<RL or <S/5	55	0	100
pesticides - EPA 8141A	<RL or <S/5	180	0	100
pesticides - EPA 8321A	<RL or <S/5	98	0	100
phosphorus - total	<RL or <S/5	4	0	100
UVA 254	<RL or <S/5	4	1	75
total for all analyses		407	6	98.5%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 14. Summary of Field Duplicate Results for SRWP Analyses, 2001-2002 Monitoring

Parameters	DQO (1)	Number tested (2)	Number outside DQO (3)	% success (4)
alkalinity - total	<=25% RPD	9	2	78
ammonia as NH3	<=25% RPD	4	0	100
hardness	<=25% RPD	9	0	100
mercury - dissolved	<=25% RPD	4	2	50
mercury - total	<=25% RPD	4	1	75
methylmercury - dissolved	<=25% RPD	4	1	75
methylmercury - total	<=25% RPD	5	1	80
nitrate as NO3	<=25% RPD	4	0	100
nitrite as NO2	<=25% RPD	4	0	100
nitrogen - total Kjeldahl	<=25% RPD	4	0	100
organic carbon - dissolved	<=25% RPD	3	0	100
organic carbon - total	<=25% RPD	4	0	100
orthophosphate - dissolved	<=25% RPD	4	0	100
pesticides - EPA 619	<=25% RPD	44	0	100
pesticides - EPA 8141A	<=25% RPD	180	0	100
pesticides - EPA 8321A	<=25% RPD	98	0	100
phosphorus - total	<=25% RPD	4	0	100
total dissolved solids	<=25% RPD	4	0	100
total suspended solids	<=25% RPD	6	0	100
UVA 254	<=25% RPD	4	1	75
total for all analyses		402	8	98%

(1) Data quality objectives (DQO) are as specified in the Quality Assurance Project Plan (SRWP 2001)
(2) Total number of results for parameter
(3) Number of results not achieving DQO
(4) Success rate, i.e. percent of results achieving DQO

Table 15. Summary of Planned and Completed Environmental Analyses for SRWP Monitoring, 2001-2002 Monitoring

parameter	total environ-mental analyses planned	total environ-mental analyses attempted	environ-mental analyses completed	total percent completeness	percent completeness for attempted events
Total mercury, filtered and unfiltered	172	114	112	65	98
Methylmercury, filtered and unfiltered	172	114	112	65	98
TSS	86	57	52	60	91
Hardness	84	72	72	86	100
Alkalinity	96	84	81	84	96
Organic carbon, dissolved and total	84	64	64	76	100
UVA 254	66	52	52	79	100
TDS	48	37	37	77	100
Nitrogen and phosphorus compounds	432	342	342	79	100
Pesticides - EPA 619	196	154	154	79	100
Pesticides - EPA 8321A	600	504	456	76	90
Pesticides - EPA 8141A	2166	2090	2090	96	100
E. coli	49	38	38	78	100
Enterococcus	72	57	57	79	100
Coliform - fecal	49	38	38	78	100
Coliform - total	49	38	38	78	100
Aquatic toxicity (*Ceriodaphnia*)	84	64	62	74	97
total for all analyses	4505	3919	3857	85.6%	98.4%
		minus total qualified data	*(176)*		
		total unqualified data	3681	82%	94%
		% success averaged by parameter		77%	98%

APPENDIX E

Response to Comments

RESPONSES TO SELECTED COMMENTS ON THE PUBLIC DRAFT ANNUAL MONITORNG REPORT, 2001-2002.

Comments were received from two peer reviewers of the Annual Monitoring Report (Rick Woodard and Dr. Revital Katznelson) and from Jeanne Walberg (Archibald & Walberg Consultants). The following were extracted as the substantive comments from these reviews and are followed by the responses addressing each comment. Editorial comments and simple clarifications are not discussed herein, but are generally addressed as recommended by the reviewers in the final report. The full text of the comments submitted by Rick Woodard and Jeanne Walberg are provided as separate documents. Comments from Dr. Katznelson were provided by telephone (5/9/03) and are provided only in this summary.

Rick Woodard's Comments (4/27/03):

Page 21, ¶ 2 – Reference is made to EPA's plan to revise its Hg criteria by 2002. Even though this report is for 2001 and 2002, we have the advantage of knowing whether they did it or not, and I think we should update this paragraph to reflect current knowledge.

Response: *This will be addressed as recommended.*

Page 41, last ¶ – The statement is made that the Cache Creek drainage is the single largest source of total Hg. The last sentence states historic Hg mines are a minor source. I thought the abandoned Hg mine at Clear Lake was a major source of Hg in that watershed. If so, isn't the text misleading?

Response: *Mercury loads from the Superfund mine site at Clear Lake do not appear to contribute a significant proportion of the total mercury loads from the Cache Creek watershed. The evidence compiled by the Delta Tributaries Mercury Council from their Strategic Plan for Mercury in the Sacramento River Watershed (2002, Available at www.sacriver.org/subcommittees/dtmc/documents.html.) indicate that erosion of native soils with naturally-elevated mercury concentrations is the predominant source of mercury loads from the highly erosive Cache Creek drainage, which have been estimated to be greater than 200 kg in wet years. On average, only about 5 kg of mercury is estimated to be discharged from Clear Lake annually (Clear Lake TMDL for Mercury, Regional Water Quality Control Board Central Valley Region Staff Report, Draft Final Report, November 2001, 114 pp.). This information will be added to the Annual Report.*

Page 90, ¶ 3, 1st sentence – (Compare to p. 91, 1st bullet, 1st sentence.) Is it misleading to say drinking water quality goals and objectives are consistently met, while next stating TOC concentrations often exceed the D/DBP rule threshold? Suggest eliminating this apparent inconsistency.

Response: *I believe that the complete text of the 1st bullet on p. 91 addresses this by clarifying that most treatment facilities are already able to meet the requirement to remove up to 35% of TOC in the source water. Since these facilities are typically able to produce safe high-quality drinking water from these sources without additional treatment, these concentrations of TOC do not appear to be limiting the use of these waters as sources of municipal drinking water.*

Summary Statistics - Organic Carbon – Within the past year or two, DWR has begun using a new combustion method, as compared to the earlier method of wet oxidation for preparing organic carbons samples for analysis. The combustion method routinely produces results that are typically about twice the concentrations measured by the wet oxidation method. It is not apparent from looking at the data summary whether the reported data are from one method only. DWR continues performing organic carbon analyses using both methods, so I suggest using only the wet oxidation results so they will be comparable with historic data.

Response: *No DWR results analyzed by the newer combustion method were used in calculating these summary statistics. We will track this to make sure only comparable organic carbon results are used in any future evaluations.*

Time Series Plots - Dissolved Oxygen Concentrations in Water – I realize it is probably the case that it is not intended to perform extensive interpretations of the data presented in the report, but thought might be given to plotting % saturation along with raw D.O concentrations; this would provide additional insight into the data.

Response: *It may make sense to perform this evaluation on a site-specific basis in future Annual Reports. This recommendation will be forwarded to the Monitoring and Toxics Subcommittees for their consideration.*

Time Series Plots - Organic Carbon Concentrations in Water - River stations – Plotting river flow along with organic carbon concentrations would likely provide additional insight into the data, as concentrations are positively correlated to flow, as a general rule.

Response: *I agree that this is generally the case, and the seasonal relationships between flows and concentrations of TOC (and several other constituents) have been addressed in previous annual reports. However, these evaluations are not repeated in this Annual Monitoring Report because TOC does not appear to be limiting beneficial uses.*

Dr. Revital Katznelson's Comments (submitted by telephone, 5/9/03):

The addition of hydrographs and sample timing for each sample site and event would be useful in interpreting the aquatic toxicity data. Particularly, in determining where samples were collected relative to the rising, peak, and falling portion of the hydrograph for each event.

Response: *I agree that this would be useful for the toxicity data interpretation. However, this level of detailed flow data has not been collected to date, and adding it for this Annual Report would be cost-prohibitive. This recommendation will be provided to the Monitoring and Toxics Subcommittees for their consideration for inclusion in future monitoring reports.*

Please provide a summary of the number of detected vs. the total number of samples for the pesticides of interest.

Response: *This will be addressed as recommended.*

It is unclear whether the data represent results of multiple or single samples per event and site. Also, it should be made clear whether analyses of all parameters are performed on the same sample for a particular site and event.

Response*—It will be clarified that data represent the results of a single individual grab samples (one per site per event), and that analytical results for different parameters are essentially for the same sample (within the limitations of sampling requirements for different parameters).*

TSS concentrations can be important for interpreting the results of toxicity tests; i.e. high TSS concentrations may explain low toxicity in samples with high pesticide concentrations. I recommend that TSS be analyzed with every toxicity sample.

Response: *This recommendation will be forwarded to the Monitoring and Toxics Subcommittees for their consideration.*

The report would be easier to follow with numbered sections and subsections.

Response: *This will be addressed as recommended.*

Because the events you monitor are selected on the basis of representing potentially "worst case" conditions for certain parameters, the event types should be tracked in the database. Monitoring events should also be described by the conditions they are intended to represent (e.g. OP pesticide application period, or first flush rain event).

Response: *These recommendations are already implemented in the report and the database.*

Jeanne Walberg's Comments (5/7/03):

Elissa Callman (City of Sacramento) asked me to look at the draft report on behalf of the water agencies that sponsored the additional May analyses for molinate and thiobencarb, i.e., City of Sacramento, County of Sacramento Department of Water Resources, City of

West Sacramento, and EBMUD. After discussing my report review with Elissa I would like to offer the following comments:

Please include an acknowledgment, if you deem it appropriate, of the sponsorship of these four agencies for that May testing.

Response: *This oversight will be addressed as recommended.*

On page 54, please include, for thiobencarb, a comparison to the primary□(70 ug/L) and secondary (1 ug/L) MCLs.□Comparison to MCLs was done for molinate but not for thiobencarb.

Response: *This will be addressed as recommended.*

Comments Submitted By Reviewers Of The April 2003 Public Draft Annual Monitoring Report

Note: Copies of original comments submitted by reviewers are available on request.

April 27, 2003

To: Claus Suverkropp

From: Rick Woodard

Subject: Comments on 2001-2002 Annual SRWP Monitoring Report

I have reviewed the subject document and offer the following comments:

In general I found the report to be well written and informative. The document would benefit from a table of contents. Also, all pages should be numbered. There is some redundancy in the text, but I suppose that is intentional, in case a reader might turn to a specific report section without reading a pertinent discussion elsewhere in the report.

The following are specific comments. Red text indicates recommended additions.

Page	**Paragraph**	**Line**	**Comment**
8	2	13	Metropolitan Water District of Southern California
11			I found the Percent Contributing Land Use columns of Table 1 to be particularly effective.
21	2	all	Reference is made to EPA's plan to revise its Hg criteria by 2002. Even though this report is for 2001 and 2002, we have the advantage of knowing whether they did it or not, and I think we Should update this paragraph to reflect current knowledge.
41	last		The statement is made that the Cache Creek drainage is the single largest source of total Hg. The last sentence states historic Hg mines are a minor source. I thought the abandoned Hg mine at Clear Lake was a major source of Hg in that watershed. If so, isn't the text misleading?
90	3	1	(Compare to p. 91, 1st bullet, 1st sentence.) Is it misleading to say drinking water quality goals and objectives are consistently met, while next stating TOC concentrations often exceed the D/DBP rule threshold? Suggest eliminating this apparent inconsistency.
91	4	9	…also significant sources of TOC and TDS within the Delta, and from the San Joaquin River.

Summary Statistics - Organic Carbon

Within the past year or two, DWR has begun using a new combustion method, as compared to the earlier method of wet oxidation for preparing organic carbons samples for analysis. The combustion method routinely produces results that are typically about twice the concentrations measured by the wet oxidation method. It is not apparent from looking at the data summary whether the reported data are from one method only. DWR continues performing organic carbon analyses using both methods, so I suggest using only the wet oxidation results so they will be comparable with historic data.

Time Series Plots - Specific Conductance in Water- Sacramento River below Keswick
A squiggle appears in the upper left corner of the graph where "Specific Conductance at 25 ^{o}C" seemingly should appear.

Time Series Plots - Dissolved Oxygen Concentrations in Water - All
I realize it is probably the case that it is not intended to perform extensive interpretations of the data presented in the report, but thought might be given to plotting % saturation along with raw D.O concentrations; this would provide additional insight into the data.

Time Series Plots - Organic Carbon Concentrations in Water - River stations
Plotting river flow along with organic carbon concentrations would likely provide additional insight into the data, as concentrations are positively correlated to flow, as a general rule.

Claus Suverkropp

From: AWCJEANNE@aol.com
Sent: Wednesday, May 7, 2003 7:19 AM
To: clauss@lwadavis.com
Cc: ecallman@cityofsacramento.org; myee@cityofsacramento.org; rpang@cityofsacramento.org; rmyers@cityofsacramento.org; mark.severeid@ci.west-sacramento.ca.us; williamsf@SacCounty.net; Dbruzzon@ebmud.com
Subject: Comments on SRWP 2001-2002 Draft Report

Claus,

Elissa Callman asked me to look at the draft report on behalf of the water agencies that sponsored the additional May analyses for molinate and thiobencarb, i.e., City of Sacramento, County of Sacramento Department of Water Resources, City of West Sacramento, and EBMUD. After discussing my report review with Elissa I would like to offer the following comments:

1. Please include an acknowledgment, if you deem it appropriate, of the sponsorship of these four agencies for that May testing.

2. On page 54, please include, for thiobencarb, a comparison to the primary (70 ug/L) and secondary (1 ug/L) MCLs. Comparison to MCLs was done for molinate but not for thiobencarb.

Call me if you wish to discuss either of these comments. Thank you.

Jeanne Wallberg
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