AUGUST 10, 2004

TECHNICAL ANALYSIS TO SUPPORT DEVELOPMENT OF DRINKING WATER POLICY FOR THE CENTRAL VALLEY BASIN PLAN:

Identification of Existing Data and Planned Monitoring

Prepared for:

CENTRAL VALLEY
DRINKING WATER POLICY WORKGROUP

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INTRODUCTION

The Central Valley Drinking Water Policy Workgroup (the Workgroup) is developing an inventory of existing major water quality databases, water quality reports, sanitary surveys, discharger reports, and other information sources for selected parameters. The purpose of collecting this information is to evaluate and recommend constituents for initial drinking water policy development. Additionally, the inventory will be used to recommend constituents that may be suitable for drinking water policy development after some additional monitoring to fill data gaps. The inventory focuses on recent data and has been completed for monitoring conducted from 1990 to the present, and includes some monitoring planned for the near future. The geographic scope of this inventory is Central Valley waters downstream from major dams, with the following priorities:

1. Mainstem Sacramento and San Joaquin rivers
2. Major tributaries of the Sacramento and San Joaquin rivers (prioritized by annual flows)
3. Smaller tributaries, including agricultural drains and urban creeks (prioritized by annual flows).

METHODS

The first step of the data collection effort consisted of identifying the data of interest. This included identifying parameters of interest, an initial list of sources of monitoring data, and monitoring program information to collect. Minimum data quality criteria were developed to select monitoring programs providing data sets considered adequate to support drinking water policy development.

An initial list of monitoring programs and primary contacts developed by consulting with the Workgroup and the Sacramento River Watershed Program participants (including agencies and other stakeholders), reviewing the Department of Water Resources Compendium of Water Quality Monitoring (1997), and through internet searches. This initial list of programs and contacts was provided to the Workgroup for review and revised as appropriate.

The second phase of the data collection process consisted of contacting and interviewing the primary program contacts and sources to acquire the monitoring program data. Some data were also acquired from internet information sources, if appropriate. During the interview process, LWA also request data and contacts for other monitoring programs, and then followed up with these new sources of information. Finally, the information for each monitoring program was entered in the database designed for this purpose. At the completion of the data collection process, a draft version of the information in the database was provided in an electronic format to the Workgroup for review and comment.

Water Quality Parameters Of Interest

The data inventory was developed for categories of constituents of interest to drinking water policy development. In addition to an initial list of parameters developed by the Workgroup, a number of parameters were added based on (1) their potential value as "signature" parameters for modeling and as surrogates for other parameters of interest, (2) relevance to drinking water

treatment issues, and (3) relatively widespread use as rice pesticides. A number of additional parameters of potential interest to drinking water policy development were considered but rejected as having little or no available data. These include viruses, endocrine disruptors, and pharmaceutical chemical, and less frequently used rice pesticides. The water quality parameters selected for the data inventory are listed in Table 1.

Table 1. Parameters of Interest for Drinking Water Policy Development

Conventional	***Disinfection Byproducts Precursors***	***Pesticides***
Cyanide	Total organic carbon (TOC)	Chlorpyrifos
Temperature(1)	Dissolved organic carbon (DOC)	Diazinon
Dissolved oxygen (DO) (1)	Bromide	Molinate
pH(1)	Ultraviolet Absorbance at 254 nm (UVA_{254})	Thiobencarb
Hardness(1)	Specific UVA (SUVA)	2,4-D(2)
Salinity(1)	Trihalomethane Formation Potential (THMFP)	Azoxystrobin(2)
Percent sand/silt/clay(1)	Chlorophyll *a*(3)	Bensulfuron(2)
Turbidity(3)		Carbaryl(2)
	Pathogens and Indicator Organisms	Carfentrazone(2)
Dissolved Minerals	*Giardia*	Copper sulfate(2)
Total dissolved solids (TDS)	*Cryptosporidium*	Cyhalofop-butyl(2)
Chloride	Total coliform	Cyhalothrin(2)
Conductivity	Fecal coliform	Difluebenzuron(2)
	Enterococcus	Fenoxaprop(2)
Nutrients	*E. coli*	Glyphosate(2)
Ammonia		Malathion(2)
Total nitrogen	***Trace Elements***	MCPA(2)
Total Kjehdahl nitrogen (TKN)	Arsenic	Methyl parathion(2)
Organic nitrogen		Pendimethalin(2)
Nitrate	***Hydrology***	Propanil(2)
Nitrite	Flow	Triclopyr(2)
Phosphorus		Trifluralin(2)
Orthophosphate		

(1) Added due to potential use as "signature" or surrogate parameter for modeling
(2) Added due to widespread use as rice pesticide (based on application to at least 5000 acres in 2001)
(3) Turbidity and chlorophyll *a* added due to relevance to drinking water treatment issues and THMFP

Sources Of Information

The initial step was to identify major monitoring programs throughout the Central Valley that can provide water quality data relevant to drinking water issues of concern. Ten monitoring programs were identified as first priority sources of monitoring program data:

- Sacramento River Watershed Program (SRWP)
- Sacramento River Coordinated Monitoring Program (CMP)
- Municipal Water Quality Investigations (MWQI) Program
- Interagency Ecological Program (IEP) – Environmental Monitoring Program (EMP)
- State Water Project Water Quality Monitoring (SWP)
- National Water Quality Assessment (NAWQA) and other USGS monitoring

- Surface Water Ambient Monitoring Program (SWAMP)
- San Joaquin River Agricultural Monitoring Program
- Central Valley Regional Water Quality Control Board's 13267 Monitoring Request
- California Data Exchange Center (CDEC)

Additional sources of data that were considered include:

- U.S. Fish and Wildlife Service (USFWS)/University of California, Davis (UC Davis) Nutrient Project
- National Pollutant Discharge Elimination System (NPDES) discharger reports and non-required monitoring by major dischargers (Sacramento and Stockton)
- Sanitary surveys
- Information Collection Rule Monitoring
- California Urban Water Agencies
- Metropolitan Water District of Southern California
- Contra Costa Water District
- NPDES Stormwater monitoring programs for the City and County of Sacramento, and the City of Stockton
- Grasslands Bypass Project
- San Joaquin River Dissolved Oxygen TMDL studies
- DWR's Northern District Tributary Monitoring Program and Offstream Storage Investigation (OSI) monitoring
- California State Water Project (SWP) monitoring
- Rice Pesticide Monitoring Program

Information about these data and monitoring programs were acquired by contacting and interviewing primary program contacts as well as from monitoring program Internet sites. The monitoring program information collected is listed in Table 2.

The information compiled for this effort is currently maintained in a Microsoft Excel™ workbook.

Table 2. Monitoring Program Information

Program Metadata	*Site Information*
Monitoring agency or group	Name or description
Monitoring program name	Lat-Long data
Monitoring strategy (e.g. scheduled or episodic)	Site ID
Sampling methods (grab/composites, depth)	Quality of location information
Monitoring frequency (samples per year)	
Quality control (QAPP)	***Parameter-Specific Information***
QA samples	Parameter and fraction
Data format (hard copy, DB, spreadsheet, etc.)	Analyzing laboratory
Data update frequency	Analytical method
Data availability	Reporting Limit
Contact information for program and data retrieval	Monitoring Period(s)

Criteria for Selecting Constituents Suitable for Initial Drinking Water Policy Development

Criteria for evaluating constituents for initial Drinking Water Policy development consisted of data quality criteria and the geographic coverage of monitoring for each constituent.

Minimum Data Quality Criteria

Minimum criteria for selecting data suitable for the Drinking Water Policy development effort were established in consultation with the Workgroup. The criteria used to make recommendations for data sets adequate for this effort were as follows:

Monitoring period: Monitoring must have been conducted over the period of at least one year to adequately characterize seasonal variability. Longer monitoring periods are required to assess longer term trends and patterns.

Monitoring frequency: A minimum of four samples should be collected per year.

Sampling Locations: Locations should be representative of water quality of interest to policy development.

Sampling methods: These should be compatible with analytical method and data use (sampling apparatus, scheduled/episodic, composite/grab)

Detection limits: Adequate DLs will be based on regulatory limits and expected ambient concentrations for each parameter of interest.

Analytical methods: Criteria are performance-based. Any USGS, Standard Methods, or EPA methods that produce adequate DLs, are acceptable. It was assumed that the accuracy and precision of any of these methods are sufficient to produce data adequate for drinking water policy development. Non-standard methods may be acceptable if demonstrated performance data are available or referenced. Potential for matrix interferences also should be considered, when relevant to specific parameters and locations.

Quality control: Each monitoring program providing data should have a documented quality control program (at least by reference), that describes sampling and analytical methods, and quality assurance procedures.

Geographic Coverage Criteria

The following geographic criteria were considered in evaluating the constituents for initial drinking water policy development:

Geographic coverage for the mainstems of the Sacramento and San Joaquin rivers was assessed based on data availability for specific defined reaches. For the Sacramento River, geographic coverage was evaluated based on seven reaches defined by confluences with two major tributaries (the American and Feather rivers) and five lesser tributaries (Cache Slough, Big Chico Creek, Antelope Creek, Cottonwood Creek, and Battle Creek). For the San Joaquin River, geographic coverage was evaluated based on five reaches defined by confluences with four major tributaries (Calaveras River, Stanislaus River, Tuolumne River, and Merced River). These reaches are illustrated in Figure 1.

Constituents were also evaluated for geographic coverage of the major tributaries of the Sacramento and San Joaquin rivers. For the Sacramento River, major tributaries are the American River, the Feather River, and the Yuba River. For the San Joaquin River, major tributaries are the Calaveras River, Stanislaus River, Tuolumne River, and Merced River. Minimum adequate coverage of the major tributaries was defined as at least one site below any significant tributaries and above the confluence with the mainstem (e.g. at the mouths of the tributaries).

Constituents should have at least some representative data for minor tributaries and agricultural drains for the Sacramento and San Joaquin rivers. Since there are no constituents with complete coverage of all lesser tributaries and agricultural drains, it was considered that some gaps in geographic coverage might be considered acceptable for initial drinking water policy development. For the purpose of assessing geographic coverage, completeness of coverage was summarized as a percentage of the total number of different tributary systems and drains monitored by the studies.

The same geographic criteria were applied to all constituents. Data availability and gaps were evaluated and summarized by completeness of mainstem and major tributary coverage and by the relative percent coverage of tributary basins and agricultural drains.

RESULTS

The results of this compilation of metadata for the Central Valley monitoring are discussed below. A brief summary of each of the major monitoring programs is provided, followed by a summary of data availability and geographic coverage.

Summary Of First Priority Monitoring Programs

Sacramento River Watershed Program (SRWP)

The Sacramento Regional County Sanitation District (SRCSD) created the SRWP in the 1990s to comprehensively manage the Sacramento River watershed for water quality. The issue at that time was high reported concentrations of metals, which could not be confirmed for accuracy and precision, in the Sacramento River. Following U.S. Environmental Protection Agency (EPA) funding, SRCSD was able to develop a long-range monitoring program to characterize water quality in the Sacramento River watershed. The key goals of the SRWP include water quality monitoring, identification of major water quality concerns, development of appropriate site-

specific water quality objectives, and development of effective programs to resolve major concerns in the Sacramento River and its tributaries. Over the history of the program, 33 sites have been sampled at a frequency varying from 3 to 12 events per year. For most constituents of interest, data from this program met all of the minimum data quality criteria for Drinking Water Policy development.

Sacramento River Coordinated Monitoring Program (CMP)

The SRCSD, the City of Sacramento, and the County of Sacramento Water Resources Division established the CMP in July 1991 in order to develop high-quality data for the development of water quality policy and regulations in the Sacramento region. Sampling for this program began in December 1992 on a biweekly schedule and continues on a bimonthly basis. The CMP also monitors up to three additional episodic storm events per year in coordination with the Sacramento Stormwater Monitoring Program. Five sites are currently monitored and a sixth site was discontinued in 1995 for trace metals, organophosphate pesticides, bacteria, and conventional water quality parameters. Data from this program met all of the minimum data quality criteria for Drinking Water Policy development. For most constituents of interest, data from this program met all of the minimum data quality criteria for Drinking Water Policy development.

Municipal Water Quality Investigations (MWQI)

The Department of Water Resources created the Interagency Delta Health Aspects Monitoring Program in 1982, which later became the MWQI Program in 1990, to monitor and assess drinking water quality from the Sacramento-San Joaquin Delta. The program provides monitoring data to program participants and stakeholders, maintains program efficiency and information quality, and produces and provides valuable data assessments. There are 25 monitoring stations, which provide data for conventional water quality parameters, trace metals, bacteria, ultraviolet radiation, and disinfection byproducts. For most constituents of interest, data from this program met all of the minimum data quality criteria for Drinking Water Policy development. Note that there is coordination and data sharing with the Interagency Ecological Program, and that there is likely to be some duplication of data reported by these two programs.

Interagency Ecological Program (IEP) – Environmental Monitoring Program (EMP)

The EMP, which is conducted by the U.S. Bureau of Reclamation and the Department of Water Resources, was established in 1971 to provide information for flow-related water quality standards. Prior to 1995, there were 25 baseline sampling stations. Monthly monitoring for conventional water quality parameters, zooplankton, phytoplankton, and benthos is currently conducted at 11 sites in the Sacramento-San Joaquin Delta. For most constituents of interest, data from this program met all of the minimum data quality criteria for Drinking Water Policy development.

State Water Project (SWP) Water Quality Monitoring

The SWP water quality monitoring began in 1968 following the completion of the California Aqueduct to assess controlling eutrophication. Currently, aqueduct monitoring focuses more on providing a drinking water supply. Water quality monitoring stations are distributed from the upper Feather River Reservoirs to Lake Perris, a distance spanning over 500 miles. There are 17 stations, which manually and automatically monitor conventional water quality parameters as well as inorganic chemicals and pesticides. Data from this program generally met all of the minimum data quality criteria for Drinking Water Policy development.

USGS National Water Quality Assessment (NAWQA) and Other Monitoring Programs

The U.S. Geological Survey (USGS) has collected and analyzed physical, chemical, and biological properties of surface waters from sites all across the country. In 1991, the USGS initiated the NAWQA program to collect and analyze information from major river basins in the U.S. The purposes of this program were to evaluate the condition of the nation's streams and groundwater, estimate how these water bodies are changing over time, and determine how natural and human activities affect these water bodies. In the Central Valley region, NAWQA monitoring began in 1991 for the San Joaquin River basin and in 1994 for the Sacramento River basin. This program monitored conventional water quality parameters, major ions, nutrients, pesticides, trace elements, and volatile organic compounds. For all constituents of interest, data from this program met the minimum data quality criteria for Drinking Water Policy development.

Surface Water Ambient Monitoring Program (SWAMP)

The State Water Resources Control Board administers the SWAMP in a monitoring effort to assess the conditions of surface waters throughout California. The nine Regional Water Quality Control Boards are responsible for implementing the SWAMP in their geographical areas. The SWAMP's goals are to create an ambient monitoring program that consistently and objectively monitors all hydrological units in California, document ambient water quality conditions, identify specific water quality problems, and provide data to evaluate the effectiveness of water quality regulatory programs. Monitoring began in 2001 and has continued to the present. Some monitoring efforts slated to begin in 2002 and 2003 have been delayed or postponed and have not yet been implemented. When available, data from this program are expected to meet all of the minimum data quality criteria for Drinking Water Policy development.

13267 Monitoring

The State Water Resources Control Board required technical information pursuant of Section 13267 of the California Water Code. The purpose of this requirement is for NPDES dischargers to provide receiving water and effluent data to the Regional Board for the determination of water quality-based effluent limitations for priority pollutants, calculation of effluent limitations, and determination if immediate compliance with the effluent limitations is feasible. Monitoring includes 126 priority pollutants, as well as conventional water quality parameters. When available, data from this program are expected to meet all of the minimum data quality criteria for Drinking Water Policy development, and will serve to fill some of the gaps in the data sets from the other major monitoring programs. 13267 monitoring was required and performed by both major and minor NPDES dischargers, with reduced monitoring frequency requirements for minor dischargers. For the purpose of this evaluation, 13267 monitoring performed by the major Central Valley wastewater treatment facilities (for the cities of Sacramento, Stockton, Manteca, Modesto, and Tracy) was considered.

San Joaquin River Agricultural Monitoring

The Central Valley Regional Water Quality Control Board Agricultural Unit initiated a water quality monitoring program for selected inorganic constituents on the lower San Joaquin River in May 1985. There are eight monitoring sites, which provide data for characterizing the effects of subsurface agricultural drainage inflows. Sampling for the program was expanded to additional constituents in October 2000 in conjunction with SWAMP monitoring. For the constituents of

interest, data from this program generally appear to meet the minimum data quality criteria for Drinking Water Policy development.

California Data Exchange Center (CDEC)

Since 1932, the Department of Water Resources has collected hydrological data in California. The program provides a real-time central hydrologic information center for cooperators, public and private agencies, and the media. Monitoring includes meteorological parameters as well as a limited set of conventional water quality characteristics. However, much of the data from this program is provided in real time and has not been validated and is therefore be characterized as "preliminary". As a whole, the hydrological data from this site will be valuable in Drinking Water Policy development, but may require substantial validation prior to use in any conceptual modeling efforts. Water quality data reported in "real time" by CDEC may also be shared and reported by other monitoring programs (USGS, MWQI, IEP) after validation.

Evaluation of Additional Monitoring Programs

USFWS/UC Davis Nutrient Project

This is a joint project implemented by the USFWS, the U.S. Bureau of Reclamation, and UC Davis. The focus of this project is the characterization of nutrient cycling in the Sacramento River and San Joaquin River basins. Monitoring was conducted on a biweekly basis from October 1999 through October 2001, and included mainstem river sites, major tributaries, minor tributaries and agricultural drains. This project monitored a variety of parameters of interest to drinking water policy development.

Sanitary Surveys

Drinking water systems that utilize surface water sources are required under California law to perform watershed sanitary surveys on a 5-year cycle. Among other requirements, sanitary surveys compile and summarize various data for the watershed covered, and at a minimum, they include bacteriological monitoring data for source waters. The surveys generally do not perform significant new monitoring, but instead rely on existing data from other monitoring sources. Sanitary surveys generally do not meet the minimum data quality criteria for support of the drinking water policy development effort because monitoring is not sufficiently frequent and generally would not consist of periods of at least one year. Because they are typically secondary sources or compilers of data, sanitary surveys will be most valuable for filling specific data gaps, particularly in pathogen and pathogen indicator data. Because they are also required to activities and potential sources of contamination, watershed sanitary surveys also provide other information useful for drinking water policy development.

NPDES Discharger Reports

Required reports from NPDES dischargers to the Regional Boards may contain receiving water and effluent monitoring data that are potentially useful in development of drinking water policies. As a group, this monitoring category may provide significant additional data for selected parameters at a few sites in the Central Valley. The one significant limitation of this monitoring category is compiling the data, which may be maintained or provided in a variety of formats, ranging from hardcopy reports to electronic databases. Data would generally be available from the Regional Board or from individual dischargers, but would not be maintained in a consistent format and would not be easily accessible. Although quality assurance metadata

for this monitoring category were not cataloged specifically for every discharger, NPDES discharger reports and data generally are required to meet stringent data quality objectives (specified in individual permits) for determining compliance. On this basis, NPDES discharger reports and data are expected to meet the minimum data quality criteria for support of the drinking water policy development effort. Data available for the two largest NPDES dischargers in the Sacramento River and San Joaquin River watersheds (the Sacramento Regional Wastewater Treatment Plant and Stockton's Regional Wastewater Control Facility) were included in this evaluation, as well as data for the stormwater monitoring programs for these two municipalities. Note that there is substantial overlap between Sacramento Regional Wastewater Treatment Plant's NPDES monitoring requirements, its Priority Pollutant Prevention Program monitoring, and the Sacramento River Coordinated Monitoring Program, which coordinate to provide effluent and ambient monitoring data for different purposes.

Information Collection Rule Monitoring

The Information Collection Rule (ICR) data were collected as part of a national research project to support development of national drinking water standards. The ICR required water treatment facilities to collect data for pathogens (*Giardia*, *Cryptosporidium,* and viruses*)* and pathogen indicator organisms (total and fecal coliform bacteria and *E. coli*) in untreated drinking water sources, as well as disinfection byproducts in treated water. Monitoring was conducted approximately monthly from July 1997 through December 1998. The analytical methods used for the pathogens *Giardia* and *Cryptosporidium* by the ICR have since been replaced by more effective methods and are no longer consider adequate for characterizing numbers of these pathogens. However, bacteriological monitoring data from this program are valid and may be valuable in drinking water policy development. ICR data are available for a few Central Valley locations through a web querying system (http://www.epa.gov/enviro/html/icr/icr_query.html), EPA's *Envirofacts*. However, based on trial retrievals, compiling ICR monitoring data from this source will be difficult and inefficient.

Grasslands Bypass Project

The Grassland Bypass Project uses the Grassland Bypass Channel and the San Luis Drain to remove agricultural drainwater from wetland water supply channels. The Project is needed because prior to 1996 when the current project began, drainwater contaminated these channels with salts, selenium, and other trace elements. The Grassland Bypass Project compliance monitoring program is conducted to assess environmental conditions in the San Luis Drain (SLD) and to assess the changes in environmental conditions in Mud Slough, Salt Slough, and the San Joaquin River from pre-project conditions related to discharges from the SLD. This program monitors conventional water quality parameters, nutrients, selenium and boron. For all constituents of interest, data from this program met the data quality criteria for Drinking Water Policy development. The Grassland Bypass Project coordinates monitoring and shares data with the San Joaquin River Agricultural Monitoring program.

San Joaquin River Dissolved Oxygen TMDL studies

In support of the development of a scientific dissolved oxygen (DO) TMDL allocation, 13 research and monitoring projects examining various aspects of DO demand in the San Joaquin River (SJR) were conducted in the summers of 1999, 2000, and 2001. These studies identified four major factors contributing to the formation of a DO sag in the Stockton Deep Water Shipping Channel (DWSC): the deepening of the ship channel, ammonia discharges from the

Stockton Wastewater Treatment Plant (WWTP), transport of oxygen-consuming materials from the upper SJR into the DWSC, and production of oxygen-consuming organic matter in the channel. The actual impact of these factors is dependent on flow and temperature, where lower flows and higher temperatures allow a DO deficit to accumulate if the other factors are present.

The San Joaquin Valley Drainage Authority has been an active participant in the DO TMDL Steering Committee for the last several years. The Steering Committee, as part of their work plan, requested that a monitoring program be developed for the upstream part of the San Joaquin River between Stockton and Mendota Dam as a directed action effort to be funded by CALFED. Work began on the monitoring program by a group who had previously worked on the dissolved oxygen issue, including scientists from Lawrence Berkeley National Lab, University of the Pacific, University of California Davis, US Geological Survey and others.

This study is focused on understanding the sources of oxygen-consuming materials in the SJR upstream of the DWSC. The purpose of this study is to provide a comprehensive understanding of the sources and fate of oxygen-consuming materials in the SJR watershed between Channel Point and Lander Avenue. The study includes monitoring of hydrologic and water quality parameters to characterize the loading of algae, other oxygen-demanding materials, and nutrients from individual tributaries and subwatersheds of the SJR between Channel Point and Lander Avenue. The study hopes to identify sub-watersheds that are the most significant sources of algal biomass, nutrients, and BOD to the river. A total of 56 monitoring stations were selected for inclusion in this project. Thirty-five of these stations are river or primary stations and four stations are irrigation diversions taken directly from the SJR. These 39 stations are believed to represent all of the significant surface inflows and diversions from the upstream SJR in the study area. The remaining 17 sites were selected to allow the characterization of specific sub-watersheds contributing flows to the SJR. Monitoring data from this study will be made available on the Bay-Delta and Tributaries (B-DAT) database. Data from previously conducted monitoring studies (1999-2001) are available from the TMDL stakeholder website (www.sjrtmdl.org).

DWR Northern District Tributaries Monitoring and Offstream Storage Investigation

DWR's Northern District arm has conducted two fairly extensive monitoring efforts in the Sacramento River watershed. The Tributaries Monitoring Program is an ongoing effort to characterize tributaries of the Sacramento River (and other watersheds in the Northern District). Because of coordination between DWR and the Sacramento River Watershed Program (SRWP), some data from the Tributaries Monitoring Program (1998-2000) are available through the SRWP, and these data appear to meet data quality criteria for Drinking Water Policy development. Offstream Storage Investigation (OSI) studies were conducted between 1997 and 1999 to evaluate "offstream storage upstream of the Delta that will provide storage and flood control benefits in an environmentally sensitive and cost-effective manner." Data from the OSI have not yet been made publicly available and are of unknown quality. DWR's Northern District is in the process of preparing some or all of this data for inclusion in the Bay-Delta and Tributaries database being developed by DWR.

Rice Pesticide Monitoring Program

The Department of Pesticide Regulation (DPR) implemented the Rice Pesticides Program in 1983 to reduce discharges into surface waterways of the rice herbicides molinate and thiobencarb. In 1990, the objectives of these control efforts were expanded, following the adoption of amendments to the Central Valley Regional Water Quality Control Board's

(CVRWQCB) Water Quality Control Plan (Basin Plan). This plan established performance goals for molinate and thiobencarb beginning in 1990, and the insecticides methyl parathion, and malathion beginning in 1991. This program has conducted monitoring annually. Water samples are collected during the rice pesticide application period (typically from April-July) at four sites. Additionally in 2001, water samples were collected at the City of West Sacramento's drinking water intake. Data from this program appear to meet data quality criteria for Drinking Water Policy development and are made available through DPR's Surface Water Database.

Data Availability

The availability of data varies greatly among monitoring programs. Data from the MWQI (prior to 1998), SWP, NAWQA, San Joaquin River Agricultural Monitoring (after 1997), Grasslands Bypass Project, ICR monitoring, and CDEC are readily available from the program Internet sites. Data from the CMP, SRWP, MWQI (after 1998), San Joaquin River Agricultural Monitoring (prior to 1997), USFWS Nutrient Project, IEP-EMP, NPDES discharger monitoring, and stormwater monitoring programs must be requested through the program contacts. Data from SWAMP will not be made available until the SWAMP monitoring for the program has been completed, data have been validated, and the database application has been developed and implemented. Additionally, 13267 monitoring data were submitted in a variety of formats and are still being compiled by the Regional Water Quality Control Boards. Pesticide monitoring data for several monitoring programs are available through the Department of Pesticide Regulation's Surface Water Database, but available data are limited to pesticides. A number of monitoring programs have also committed to make their data available in the Bay-Delta And Tributaries (B-DAT) database administered by DWR when that system is completed.

Geographic Coverage

Waterbodies sampled by the monitoring programs surveyed are listed in Table 3. Mainstem reaches of the Sacramento and San Joaquin rivers as defined for these evaluations are provided in Figure 1. The extent of monitoring coverage provided by the surveyed monitoring programs is summarized below.

Mainstem Sacramento River: There are substantial monitoring data for the mainstem Sacramento River from Keswick to the Sacramento-San Joaquin Delta, with the lower part of the watershed having the most monitoring. There is monitoring of most of the constituents of interest in all seven defined reaches, with limited data for a few constituents (cyanide, bromide, THMFP, total orthophosphate, and most pesticides in reaches 5–7 below Keswick).

Mainstem San Joaquin River: There are also substantial existing or planned monitoring data for the mainstem San Joaquin River from above the Merced River to the Sacramento-San Joaquin Delta. There is monitoring of most of the constituents of interest in all five defined reaches, with gaps for specific constituents occuring most often in the reaches between the Tuolumne River and Stanislaus River (Reach 3) and above the Merced River (Reach 5). Constituents with the least geographic coverage (i.e., the most gaps) include bromide, cyanide, THMFP, UVA_{254} and SUVA, total orthophosphate, protozoan pathogens, and most pesticides.

Major Sacramento River Tributaries: The major tributaries of the Sacramento River below Keswick Reservoir are the Feather River, the Yuba River, and the American River. For the Yuba River, water quality data from the major monitoring programs evaluated are available only from

the mouth of the river, near Marysville. Water quality for this tributary has been fairly well characterized, with good data sets for arsenic, all dissolved minerals, most conventional water quality parameters and nutrients, and some disinfection byproduct precursors, pesticides, and pathogens. The Feather River near its confluence with the Sacramento River has also been well characterized for most parameters of interest by the major regional monitoring efforts, with more limited monitoring performed upstream from the confluences with the Yuba River and Bear River. There are also robust data sets for most parameters of interest for the American River from Nimbus Dam to the confluence with the Sacramento River.

Major San Joaquin River Tributaries: The major tributaries of the San Joaquin River are the Calaveras River, Stanislaus River, the Tuolumne River, and the Merced River. Most water quality monitoring of the Calaveras River has been performed in the Stockton vicinity. Most water quality data for the Stanislaus River have been collected at Ripon and near Caswell State Park. None of the major monitoring programs collected samples upstream of Ripon. Monitoring of the Tuolumne River consists of two stations near Modesto. The Merced River has been monitored near its confluence with the San Joaquin River, at the River Road Bridge and at George Hatfield State Park (which may be the same monitoring location). For these four major tributaries of the San Joaquin River, the constituents with reported monitoring are similar to those for the mainstem San Joaquin River. Constituents for which little or no monitoring is reported or planned include bromide, UVA_{254}, THMFP, total orthophosphate, and pathogens.

Major Delta Tributaries: The two other major tributaries of the Delta (other than the Sacramento and San Joaquin rivers) are the Cosumnes River and the Mokelumne River. The Mokelumne River has been more frequently monitored in the past, but both rivers are the focus of substantial new monitoring by the SWAMP program, which includes most of the parameters of interest for drinking water policy development. Parameters with no planned or existing monitoring include bromide, cyanide, UVA_{254}, THMFP, protozoan pathogens, and nearly all of the pesticides of interest.

Smaller Tributaries: There are monitoring data available for many of the lesser tributaries to the Sacramento River and San Joaquin River. At least some water quality monitoring is reported or planned for 36 different Sacramento tributary basins, 28 different San Joaquin tributary basins, and 28 different internal Delta tributaries. However, the frequency of monitoring and length of data sets for these tributaries are more variable than for the mainstem and major tributaries. Typically, there are limited data available for many of the parameters of interest. The list of parameters monitored in at least 50% of reported tributaries was generally similar for the Sacramento River and San Joaquin Rivers, with fewer parameters monitored in at least 50% of reported Delta lesser tributaries. However, most parameters of interest were monitored in less than 50% of the total reported tributaries.

Agricultural Drains: Relative to the number of agricultural drains in the Central Valley, this category of waterbodies appears to be less well represented by the available data and planned monitoring. However, it should be noted that a number of waterbodies in the tributary category may be more representative of agricultural drains than natural tributaries. Three agricultural drains, Colusa Basin and Sacramento Slough in the Sacramento River basin, and Spanish Grant in the San Joaquin River basin, are the most extensively monitored sites with fairly robust data sets for many of the parameters of interest. Most of the other agricultural drains that have been sampled (9 in the Sacramento basin, 29 in the San Joaquin basin, and 8 within the Delta) have typically been monitored only for conventional water quality parameters and dissolved minerals.

NPDES Dischargers: There are at least 53 NPDES permitted facilities discharging to 32 different receiving waters (below reservoirs) in the Sacramento River and San Joaquin River watersheds. Receiving waters include the mainstem San Joaquin and Sacramento rivers, major and lesser tributaries, and agricultural drains. Permitted discharges from these facilities range from 0.04 to 125 million gallons per day. Some of these facilities have extensive effluent and receiving water monitoring requirements as part of their NPDES permits. However, because of the high level of effort required to retrieve and compile data from most of these dischargers, these data sets should be considered primarily when they can be expected to provide data useful in filling specific identified data gaps. Wastewater treatment plants for the largest urban areas (Sacramento and Stockton) in the central valley are exceptions. Data for POTWs serving these two areas are well-validated, maintained in standardized databases, and are available on request.

Urban Runoff: Urban runoff monitoring programs implemented by Sacramento and Stockton have characterized typical urban runoff quality for many of the constituents of interest for drinking water policy development. These programs monitor urban runoff and receiving waters during storm events and in dry weather conditions. Although these programs typically monitor only two to five events per year, they have been in effect since 1994 and have accumulated substantial data sets.

Table 3 Waterbodies Monitored by Surveyed Programs

Sacramento River		San Joaquin River		Delta
MAINSTEM REACHES		***MAINSTEM REACHES***		***MAJOR TRIBUTARIES***
1 – Delta to Cache Slough		1 – Delta to Calaveras River		Cosumnes River
2 – Cache Slough to American River		2 – Calaveras River to Stanislaus River		Mokelumne River
3 – American River to Feather River		3 – Stanislaus River to Tuolumne River		***TRIBUTARIES***
4 – Feather River to Big Chico Creek		4 – Tuolumne River to Merced River		Barker Sl.
5 – Big Chico Creek to Antelope Creek		5 – upstream from Merced River		Bear Creek
6 – Antelope Creek to Cottonwood Creek		***MAJOR TRIBUTARIES***		Bethel Island
7 – Cottonwood Creek to Keswick Dam		Calaveras River	Tuolumne River	Big Break
MAJOR TRIBUTARIES		Stanislaus River	Merced River	Cache Creek
American River	Yuba River	***TRIBUTARIES***		Cache Sl.
Feather River		Bear Creek	Los Banos Creek	Calhoun Cut
TRIBUTARIES		Black Creek	Mosher Sl.	Chadbourne Sl.
Arcade Creek	Hunters Creek	Cherry Creek	Mt. House Creek	Cordelia Sl.
Battle Creek	Indian Creek	Cottonwood Creek	Mud Sl.	Disappointment Sl.
Bear River	Jenny Creek	Deep Sl.	Orestimba Creek	Doughty Cut
Big Chico Creek	Linden Creek	Del Puerto Creek	Pixley Sl.	Dry Creek
Boulder Creek	Little Chico Creek	Dry Creek	Salado Creek	Franks Tract
Butte Creek	Little Churn Creek	Duck Creek	Salt Sl.	Goodyear Sl.
Butte Sl.	Logan Creek	French Camp Sl.	Solado Creek	Lindsey Sl.
Calaboose Creek	Mill Creek	Hospital Creek	Stanislaus River	Little Potato Sl.
Canyon Creek	Morrison Creek	Ingram Creek	Tom Payne Sl.	Middle River
Churn Creek	Mud Creek	Little Dry Creek	Turlock PH Tailrace	Montezuma Sl.
Clear Creek	Olney Creek	Lone Tree Creek	Turner Sl.	Mormon Sl.
Cottonwood Creek	Red Bank Creek	Lone Willow Sl.	Willow Creek	Old River
Cow Creek	Stone Corral Creek	***DRAINS***		Prospect Sl.
Deer Creek	Stony Creek	Agatha Canal	MID Canal	Putah Creek
Dry Creek	Strong Ranch Sl.	Arroyo Canal	New Jerusalem Drain	Rough and Ready Is.
Elder Creek	Sulphur Creek	Banta Carbona ID	Newman Wasteway	South Fork Mokelumne
Elk Grove Creek	Thermolito Afterbay	Camp 13 Drain	Olive Avenue Drain	Suisun Sl.
Flat Creek	Thomes Creek	CCID Main	Patterson ID	Sutter Creek
Funks Creek	Weaver Creek	Chowchilla Bypass	San Luis Drain	Sycamore Sl.
Grindstone Creek	Willow Creek	Eastside Bypass	Sante Fe Canal	Three Mile Sl.
DRAINS		El Solyo Water District	Smith Canal	***DRAINS***
Butte Sl.	Sacramento Sl.	Grassland Bypass	Spanish Grant Drain	Bacon Island
Cherokee Canal	Sutter Bypass	Grayson Drain	Stevinson Lower Lat.	Grantline Canal
Colusa Basin Drain	Willow Sl.	Harding Drain	TID Canal	Jersey Island
Main Drainage Canal	Yolo Bypass	Highline Canal	Volta Wasteway	Pescadero Tract
Natomas East Main Drain		James Bypass	West Stanislaus ID	Staten Island
		Livingston Canal	Westley Wasteway	Twitchell Island
		Marshall Road Drain		Venice Island
				West Canal

SUMMARY AND RECOMMENDATIONS

Data quality for the major regional monitoring programs of the Sacramento River, San Joaquin River, and the Delta is typically very good, and appears more than adequate to support drinking water policy development for most constituents of interest. However, additional monitoring is needed to provide the geographic coverage to support the conceptual modeling for initial policy development. Although monitoring of the mainstems and major tributaries of both river basins is fairly complete for many constituents of interest, lesser tributaries and agricultural drains do not appear to be adequately represented for many constituents of interest. Note that there are very few locations (primarily lower watershed mainstem river sites and a few Delta locations) with adequately long term monitoring history for reliable evaluation of seasonal and longer term trends for any parameters. These locations should continue to be monitored as integrator sites and as indicators of long term trends and variability. The remainder of this discussion is focused on the completeness of geographic coverage of monitoring.

At this time, the set of constituents with adequate data quality and the most complete geographic monitoring coverage to support initial drinking water policy development are limited to conventional and physical parameters, and some nutrients (Table 4). Within this category, the mainstem rivers and major tributaries are well represented, and the most apparent needs for additional monitoring are limited to a few parameters:

- organic carbon in lesser tributaries of the Sacramento and San Joaquin basins and within the Delta
- some nutrient compounds in lesser tributaries of the Sacramento and San Joaquin basins and in Delta agricultural drains
- TDS in San Joaquin River lesser tributaries and drains
- chloride in San Joaquin basin agricultural drains and in tributaries within the Delta.

A few additional constituents have adequate data quality and complete geographic coverage of mainstem reaches and major tributaries of the Sacramento basin, but with some additional monitoring needed to fill gaps in mainstem reaches and major tributaries of the San Joaquin basin and Delta (Table 5). These constituents include hardness, UVA_{254} and SUVA, and fecal coliform bacteria. All of these constituents would benefit from additional monitoring in the lesser tributaries and drains in all basins. Constituents with fairly complete coverage of the San Joaquin mainstem and major tributaries, but with some additional monitoring required to complete coverage of the Sacramento River mainstem include chlorphyll *a*, arsenic, total nitrogen, dissolved phosphorus, chlorpyrifos, and diazinon. These parameters require little additional monitoring to complete Sacramento River mainstem and Delta major tributary coverage, but may require more extensive additional monitoring to provide representative monitoring of tributaries and agricultural drains.

Table 7 lists parameters with fairly complete coverage of Sacramento River mainstem and major tributaries, but with relatively poor coverage of the San Joaquin basin and Delta. This set of constituents is comprised primarily of protozoan pathogens and pathogen indicators (plus malathion and particulate carbon). All of these parameters appear to require extensive additional monitoring to support initial conceptual modeling for drinking water policy development.

There are a few pesticides of interest that have fairly representative monitoring of the lower Sacramento and San Joaquin river mainstem reaches and in major tributaries (Table 8). However, there has been virtually no monitoring of major Delta tributaries or of tributaries and drains within the Delta. Substantial additional monitoring of these pesticides in Sacramento and San Joaquin basin tributaries and drains would also be required to provide representative coverage for these categories of waterbodies.

Constituents with inadequate data quality or with very incomplete geographic coverage are listed in Table 9. This set of constituents includes bromide, cyanide, THMFP, total orthophosphate, and several pesticides. Constituents with virtually no monitoring data available or currently planned are listed in Table 10, including viruses, many remaining pesticides of interest. Developing drinking water policies for these parameters would require large amounts of new and additional monitoring.

Geographic coverage of monitoring is illustrated in figures 2-12 for selected constituents of interest (chloride, conductivity, DOC, TOC, TDS, turbidity, UVA_{254}, arsenic, nitrate, fecal coliform bacteria, and chlorpyrifos).

There is one major additional factor to consider in assessing the need for new monitoring for the development of drinking water policy. Phase 1 monitoring for the Central Valley Regional Water Quality Control Board's Agricultural Waiver Program is slated to begin in July of 2004, with monitoring plans submitted to the Board by April 1, 2004. The monitoring efforts expected to be implemented by various agricultural coalition groups can be expected to fill many of the gaps in agricultural drain monitoring and at least some of the gaps in lesser tributary monitoring. When plans for these monitoring efforts are finalized, this information should be added to the monitoring program information already compiled for this assessment. At the least, the planned agricultural monitoring effort needs to be considered during planning of additional monitoring to fill data gaps.

Table 4 Constituent Set 1

- **monitoring in all defined San Joaquin River and Sacramento River mainstem reaches**
- **monitoring in all Sacramento River and San Joaquin River major tributaries**
- **monitoring in both Delta major tributaries (except for ammonia)**
- **"representative" monitoring in lesser tributaries and drains (generally > 33% of total sampled basins or drains)**

		Sacramento River Watershed				San Joaquin River Watershed				Delta		
Classification	Parameter	Mainstem Reaches (% of 7 defined reaches)	Major Tributaries Coverage (% of 3 major tribs)	Lesser Tributary Coverage (% of 36 total sampled tributaries)	Agricultural Drains Coverage (% of 9 total sampled drains)	Mainstem Reach Coverage (% of 5 defined reaches)	Major Tributary Coverage (% of 4 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 29 total sampled drains)	Major Tributary Coverage (of 2 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 8 total sampled drains)
General/Physical	Chloride	100%	100%	67%	56%	100%	100%	71%	34%	100%	21%	75%
General/Physical	Conductivity	100%	100%	81%	56%	100%	100%	75%	90%	100%	36%	88%
General/Physical	Dissolved Oxygen	100%	100%	78%	56%	100%	100%	75%	76%	100%	57%	88%
General/Physical	Flow	100%	100%	75%	11%	100%	100%	61%	45%	100%	14%	0%
General/Physical	Organic Carbon, Dissolved	100%	100%	36%	56%	100%	100%	32%	72%	100%	25%	75%
General/Physical	Organic Carbon, Total	100%	100%	28%	44%	100%	100%	75%	72%	100%	25%	75%
General/Physical	pH	100%	100%	83%	56%	100%	100%	75%	90%	100%	29%	75%
General/Physical	Temperature	100%	100%	92%	100%	100%	100%	82%	100%	100%	57%	88%
General/Physical	Total Dissolved Solids	100%	100%	72%	44%	100%	100%	25%	17%	100%	64%	88%
General/Physical	Total Suspended Solids	100%	100%	78%	44%	100%	100%	46%	79%	100%	61%	13%
General/Physical	Turbidity	100%	100%	83%	56%	100%	100%	39%	55%	100%	100%	100%
Nutrient	Ammonia, as N	100%	100%	61%	56%	100%	100%	75%	76%	50%	71%	88%
Nutrient	Nitrate as N	100%	100%	61%	56%	100%	100%	75%	69%	100%	71%	88%
Nutrient	Nitrogen, Organic	100%	100%	22%	44%	100%	100%	32%	62%	100%	57%	13%
Nutrient	Nitrogen, Total Kjeldahl	100%	100%	19%	22%	100%	100%	75%	69%	100%	61%	13%
Nutrient	Orthophosphate, Dissolved	100%	100%	33%	56%	100%	100%	68%	72%	100%	68%	88%
Nutrient	Phosphorus, Total	100%	100%	56%	44%	100%	100%	75%	76%	100%	61%	13%

Table 5 Constituent Set 2

- **monitoring in all defined Sacramento River mainstem reaches**
- **monitoring in all Sacramento River major tributaries**
- **gaps in San Joaquin River mainstem reach coverage (1-3 of 5 defined reaches)**
- **and/or gaps in San Joaquin River and/or Delta Major Tributary coverage (less than 100% of major tributaries)**

		Sacramento River Watershed				San Joaquin River Watershed				Delta		
Classification	Parameter	Mainstem Reaches (% of 7 defined reaches)	Major Tributaries Coverage (% of 3 major tribs)	Lesser Tributary Coverage (% of 36 total sampled tributaries)	Agricultural Drains Coverage (% of 9 total sampled drains)	Mainstem Reach Coverage (% of 5 defined reaches)	Major Tributary Coverage (% of 4 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 29 total sampled drains)	Major Tributary Coverage (of 2 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 8 total sampled drains)
General/Physical	Hardness	100%	100%	75%	44%	60%	100%	29%	28%	0%	25%	75%
General/Physical	Percent Solids <.0625 mm	100%	100%	11%	22%	60%	50%	18%	10%	0%	4%	0%
General/Physical	SUVA	100%	100%	14%	44%	20%	0%	0%	0%	0%	21%	75%
General/Physical	UVA254	100%	100%	3%	33%	40%	0%	14%	7%	0%	18%	75%
Pathogen	Fecal Coliform Bacteria	100%	100%	11%	33%	20%	25%	7%	3%	50%	18%	75%

Table 6 Constituent Set 3

- **monitoring in all defined San Joaquin River mainstem reaches**
- **monitoring in all San Joaquin River major tributaries**
- **some gaps in Sacramento River mainstem reach coverage (fewer than 7 out of 7 defined reaches)**
- **and/or gaps in monitoring of San Joaquin River and/or Delta major tributaries (less than 100% of major tributaries)**

		Sacramento River Watershed				San Joaquin River Watershed				Delta		
Classification	Parameter	Mainstem Reaches (% of 7 defined reaches)	Major Tributaries Coverage (% of 3 major tribs)	Lesser Tributary Coverage (% of 36 total sampled tributaries)	Agricultural Drains Coverage (% of 9 total sampled drains)	Mainstem Reach Coverage (% of 5 defined reaches)	Major Tributary Coverage (% of 4 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 29 total sampled drains)	Major Tributary Coverage (of 2 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 8 total sampled drains)
General/Physical	Chlorophyll A	57%	100%	17%	33%	100%	100%	32%	52%	100%	7%	0%
Metal	Arsenic	86%	100%	53%	44%	100%	100%	71%	14%	100%	68%	88%
Nutrient	Nitrogen, Total	86%	100%	19%	33%	100%	100%	14%	14%	100%	61%	13%
Nutrient	Phosphorus, Dissolved	86%	100%	22%	44%	100%	100%	29%	24%	100%	57%	13%
Pesticide	Chlopyrifos	86%	100%	42%	33%	100%	100%	36%	21%	50%	54%	13%
Pesticide	Diazinon	71%	100%	42%	33%	100%	100%	36%	21%	0%	7%	0%

Table 7 Constituent Set 4

- **monitoring in most defined Sacramento River mainstem reaches above the Delta (at least 5 of 6)**
- **monitoring in all Sacramento River major tributaries**
- **gaps in coverage of mainstem Sacramento River reaches within Delta (below Cache Slough) and above Colusa**
- **gap in coverage of mainstem San Joaquin River within Delta (below Calaveras River) and/or some gaps in coverage mainstem San Joaquin River above Calaveras River (0-80% coverage of mainstem reaches)**
- **little or no monitoring of drains or tributaries within Delta**
- **and/or gaps in San Joaquin River and/or Delta major tributary coverage (less than 100% of major tributaries)**

		Sacramento River Watershed				San Joaquin River Watershed				Delta		
Classification	Parameter	Mainstem Reaches (% of 7 defined reaches)	Major Tributaries Coverage (% of 3 major tribs)	Lesser Tributary Coverage (% of 36 total sampled tributaries)	Agricultural Drains Coverage (% of 9 total sampled drains)	Mainstem Reach Coverage (% of 5 defined reaches)	Major Tributary Coverage (% of 4 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 29 total sampled drains)	Major Tributary Coverage (of 2 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 8 total sampled drains)
General/Physical	Organic Carbon, Particulate	71%	100%	11%	22%	40%	75%	21%	24%	0%	4%	0%
Pathogen	Cryptosporidium	71%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pathogen	E.Coli	71%	100%	25%	33%	80%	50%	21%	7%	100%	4%	0%
Pathogen	Enterococcus	71%	100%	0%	33%	0%	0%	0%	0%	0%	0%	0%
Pathogen	Giardia	71%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pathogen	Total Coliform Bacteria	100%	100%	8%	33%	80%	50%	21%	7%	100%	4%	13%
Pesticide	Methyl Parathion	71%	100%	39%	33%	80%	75%	29%	17%	0%	4%	0%

Table 8 Constituent Set 5

- **gaps in coverage of defined Sacramento River and /or San Joaquin River mainstem reaches**
- **monitoring in most major Sacramento River or San Joaquin River tributaries (missing at most one major tributary)**
- **some monitoring of Sacramento River and San Joaquin River lesser tributaries and drains (less than 33% of total monitored basins and drains)**
- **little or no monitoring of major Delta tributaries, or lesser tributaries and drains within Delta**

		Sacramento River Watershed				San Joaquin River Watershed				Delta		
Classification	Parameter	Mainstem Reaches (% of 7 defined reaches)	Major Tributaries Coverage (% of 3 major tribs)	Lesser Tributary Coverage (% of 36 total sampled tributaries)	Agricultural Drains Coverage (% of 9 total sampled drains)	Mainstem Reach Coverage (% of 5 defined reaches)	Major Tributary Coverage (% of 4 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 29 total sampled drains)	Major Tributary Coverage (of 2 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 8 total sampled drains)
Pesticide	Carbofuran	43%	100%	3%	33%	80%	100%	21%	14%	0%	7%	0%
Pesticide	Malathion	57%	100%	11%	33%	80%	100%	36%	21%	0%	4%	0%
Pesticide	Molinate	43%	100%	3%	33%	80%	75%	21%	14%	0%	4%	0%
Pesticide	Pendimethalin	43%	100%	3%	33%	60%	75%	21%	14%	0%	4%	0%
Pesticide	Propanil	43%	33%	3%	33%	60%	75%	21%	14%	0%	4%	0%
Pesticide	Thiobencarb	57%	100%	6%	33%	100%	75%	29%	17%	50%	54%	13%
Pesticide	Trifluralin	43%	100%	3%	33%	60%	75%	21%	14%	0%	4%	0%

Table 9 Constituent Set 6

- **missing 2 or more defined Sacramento River and /or San Joaquin River mainstem reaches**
- **varying degrees of coverage of Sacramento River, San Joaquin River, and Delta major tributaries (0 - 100% of possible tributaries)**
- **little or no monitoring of Sacramento River and San Joaquin River lesser tributaries or drains (less than or equal to 33% of total sampled basins and drains)**
- **varying degrees of coverage of Delta lesser tributaries and drains (0-75% of total sampled basins and drains)**

		Sacramento River Watershed				San Joaquin River Watershed				Delta		
Classification	Parameter	Mainstem Reaches (% of 7 defined reaches)	Major Tributaries Coverage (% of 3 major tribs)	Lesser Tributary Coverage (% of 36 total sampled tributaries)	Agricultural Drains Coverage (% of 9 total sampled drains)	Mainstem Reach Coverage (% of 5 defined reaches)	Major Tributary Coverage (% of 4 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 29 total sampled drains)	Major Tributary Coverage (of 2 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 8 total sampled drains)
General/Physical	Bromide	43%	100%	14%	33%	40%	0%	0%	0%	0%	21%	63%
General/Physical	Cyanide	29%	33%	0%	0%	60%	25%	7%	3%	0%	4%	0%
General/Physical	THMFP	43%	33%	3%	11%	20%	0%	0%	0%	0%	18%	75%
Nutrient	Orthophosphate, Total	29%	0%	0%	0%	60%	0%	7%	14%	50%	54%	13%
Pesticide	2,4-D	29%	33%	6%	33%	60%	100%	14%	3%	0%	7%	0%
Pesticide	Carbaryl	29%	100%	3%	33%	60%	75%	21%	14%	0%	4%	0%
Pesticide	MCPA	14%	0%	3%	11%	60%	75%	18%	10%	0%	0%	0%
Pesticide	Triclopyr	29%	33%	3%	33%	60%	75%	7%	0%	0%	0%	0%

Table 10 Constituent Set 7

- **little or no monitoring in any defined mainstem reaches of the Sacramento River or San Joaquin River**
- **little or no monitoring in major tributaries, lesser tributaries, or drains**

		Sacramento River Watershed				San Joaquin River Watershed				Delta		
Classification	Parameter	Mainstem Reaches (% of 7 defined reaches)	Major Tributaries Coverage (% of 3 major tribs)	Lesser Tributary Coverage (% of 36 total sampled tributaries)	Agricultural Drains Coverage (% of 9 total sampled drains)	Mainstem Reach Coverage (% of 5 defined reaches)	Major Tributary Coverage (% of 4 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 29 total sampled drains)	Major Tributary Coverage (of 2 major tribs)	Lesser Tributary Coverage (% of 28 total sampled tributaries)	Agricultural Drains Coverage (% of 8 total sampled drains)
General/Physical	Salinity	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pathogen	Viruses	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Azoxystrobin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Bensulfuron	0%	0%	0%	0%	20%	25%	4%	0%	0%	0%	0%
Pesticide	Carfentrazone	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Copper Sulfate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Cyhalofop-butyl	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Cyhalothrin	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Diflubenzuron	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Fenoxaprop	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Glyphosate	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Pesticide	Paraquat	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

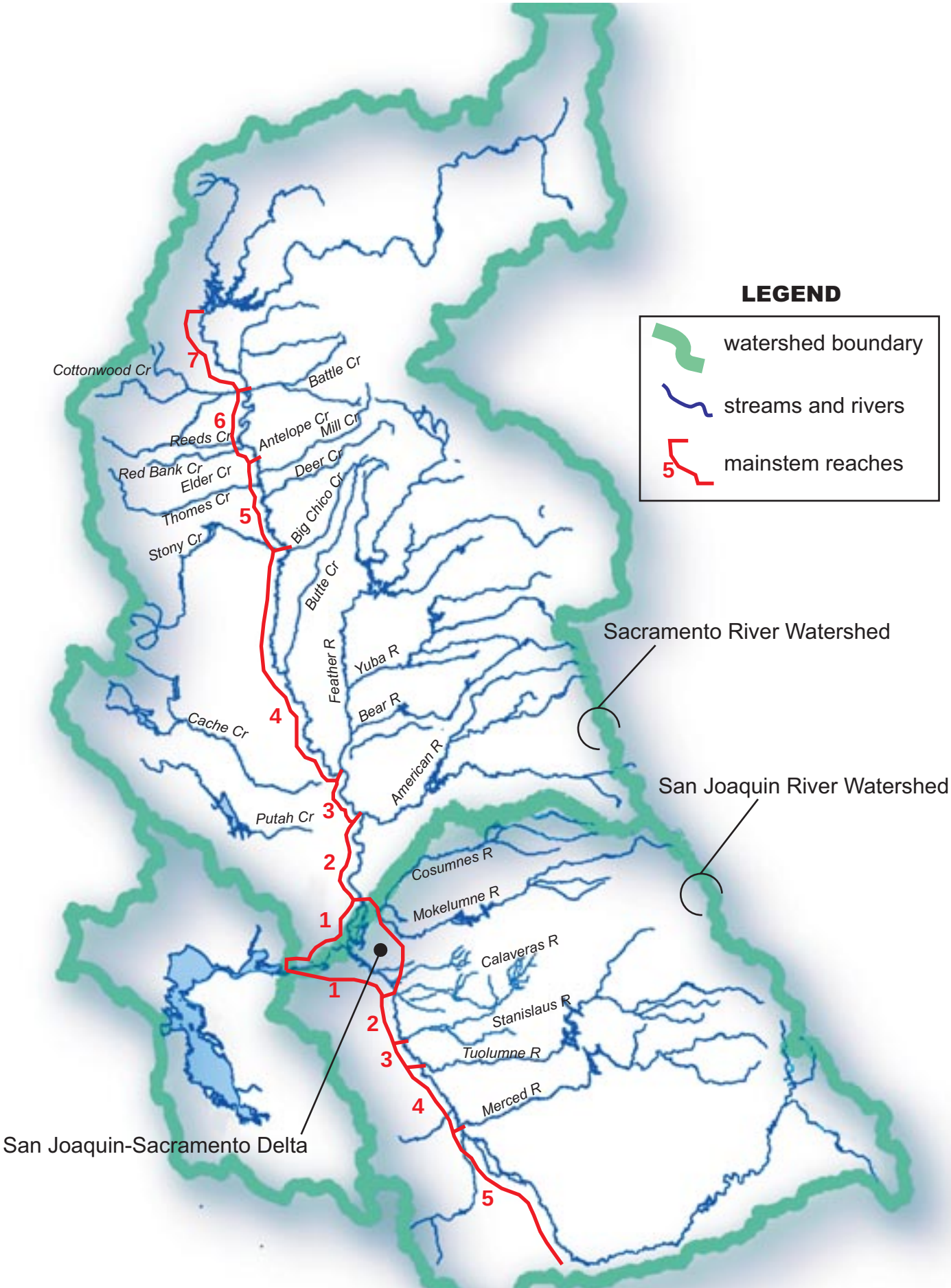

Figure 1 Sacramento and San Joaquin River Basins

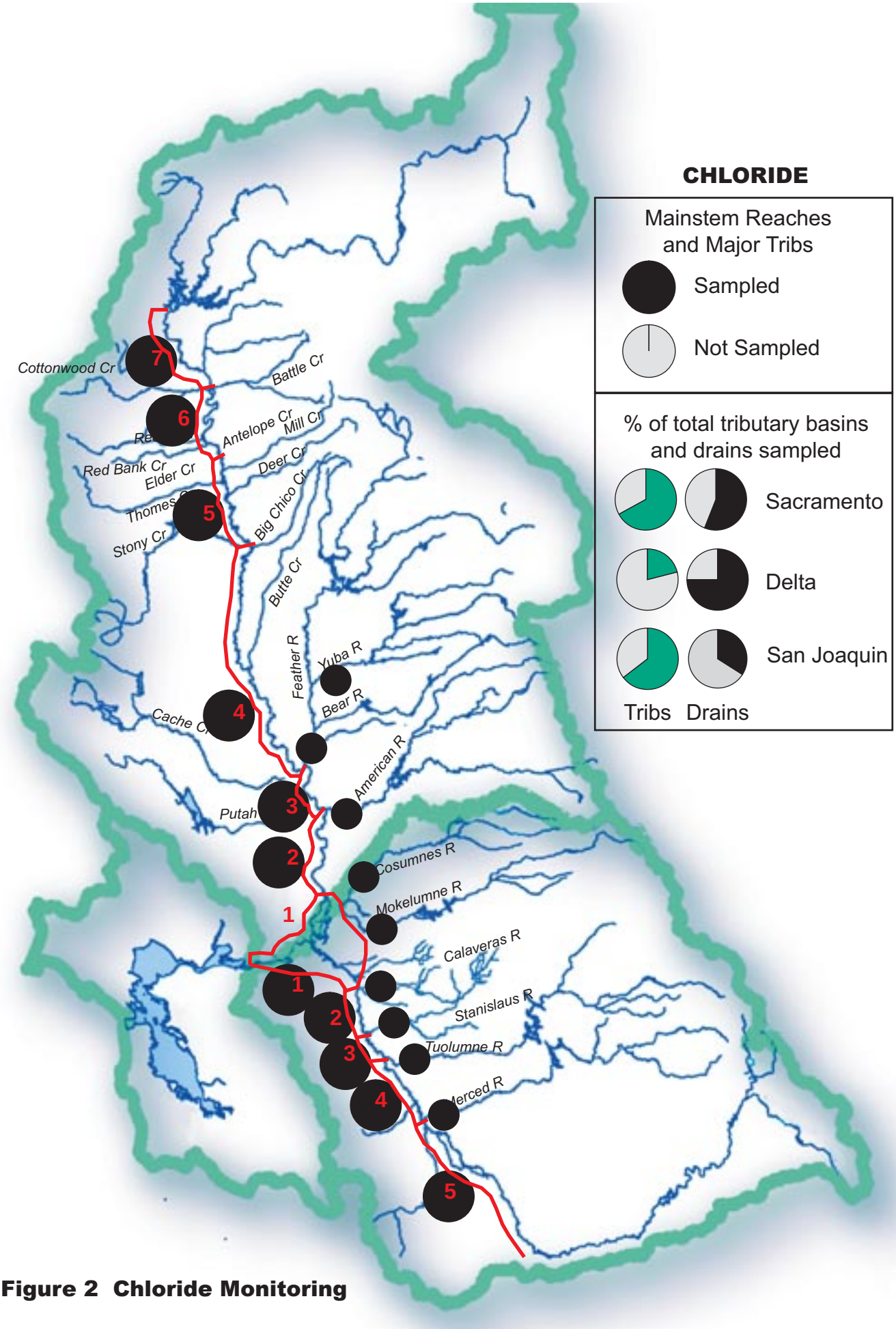

Figure 2 Chloride Monitoring

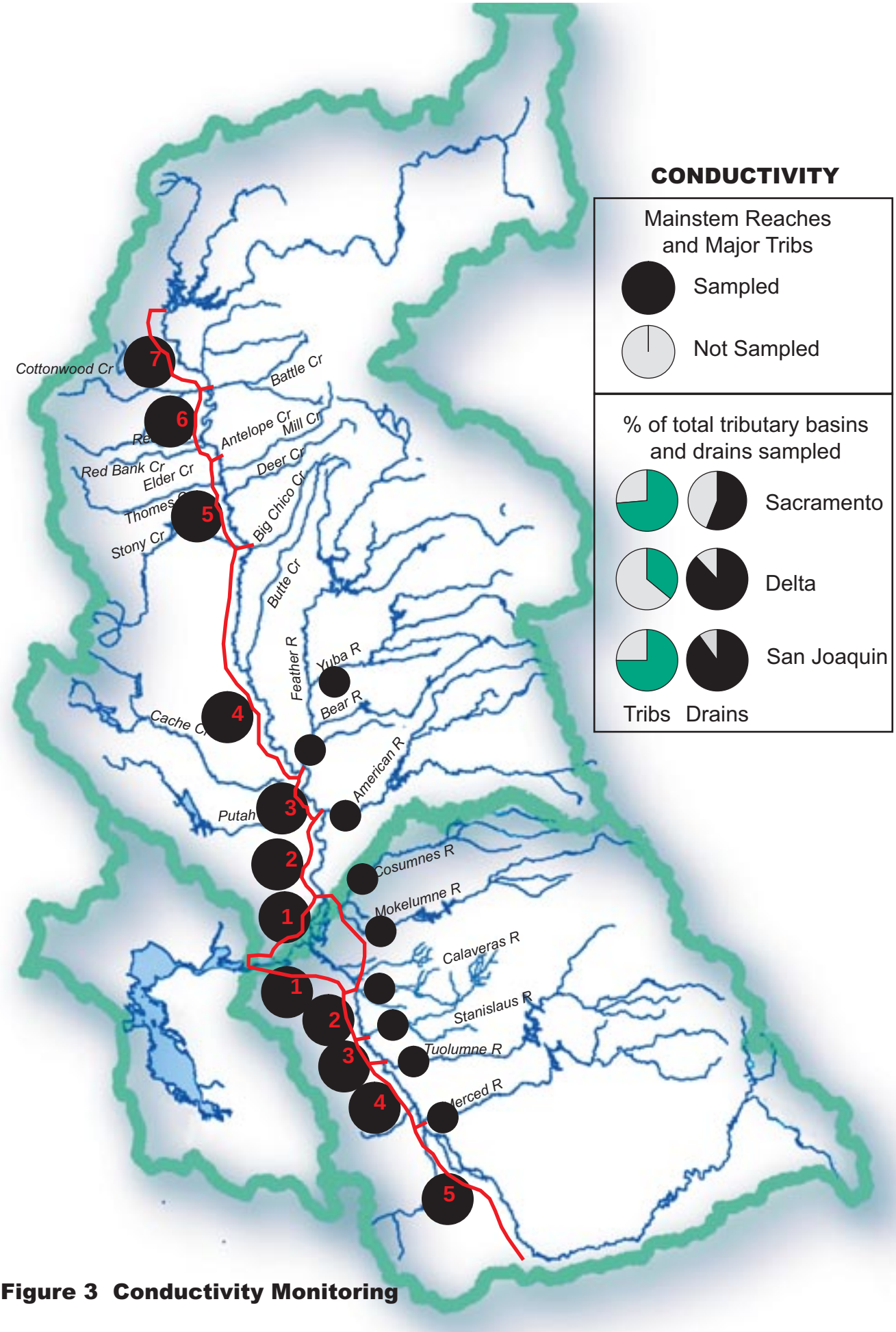

Figure 3 Conductivity Monitoring

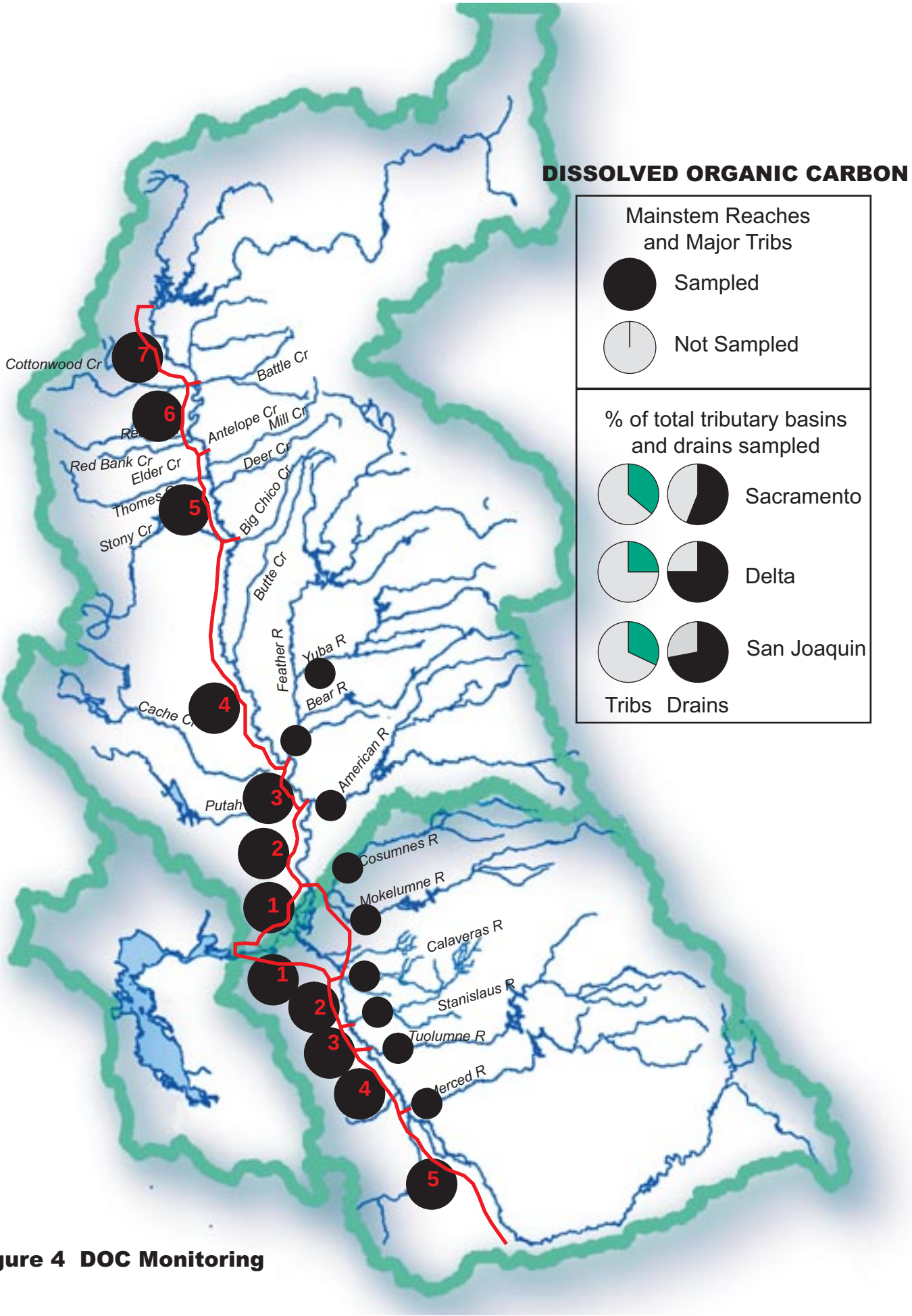

Figure 4 DOC Monitoring

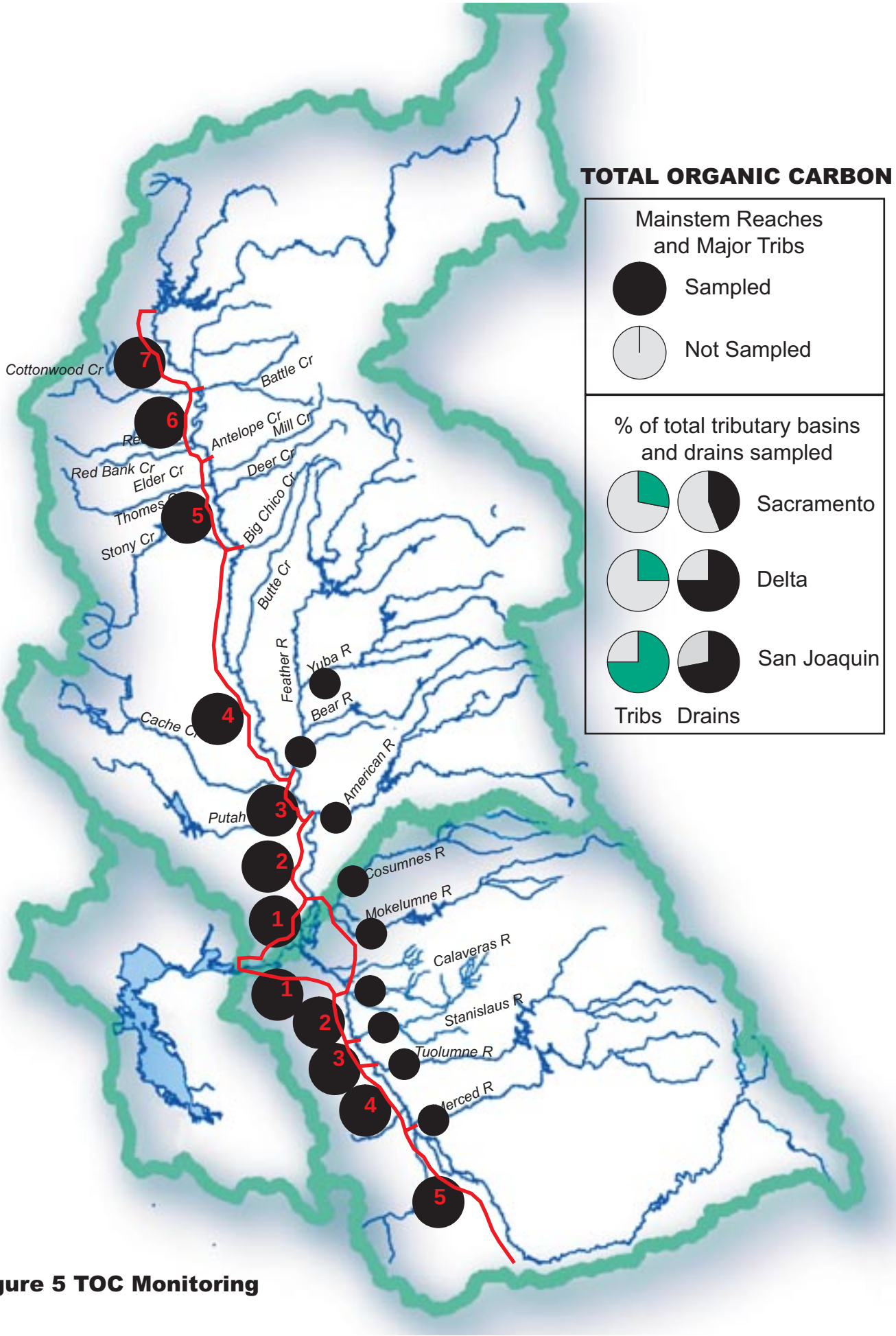

Figure 5 TOC Monitoring

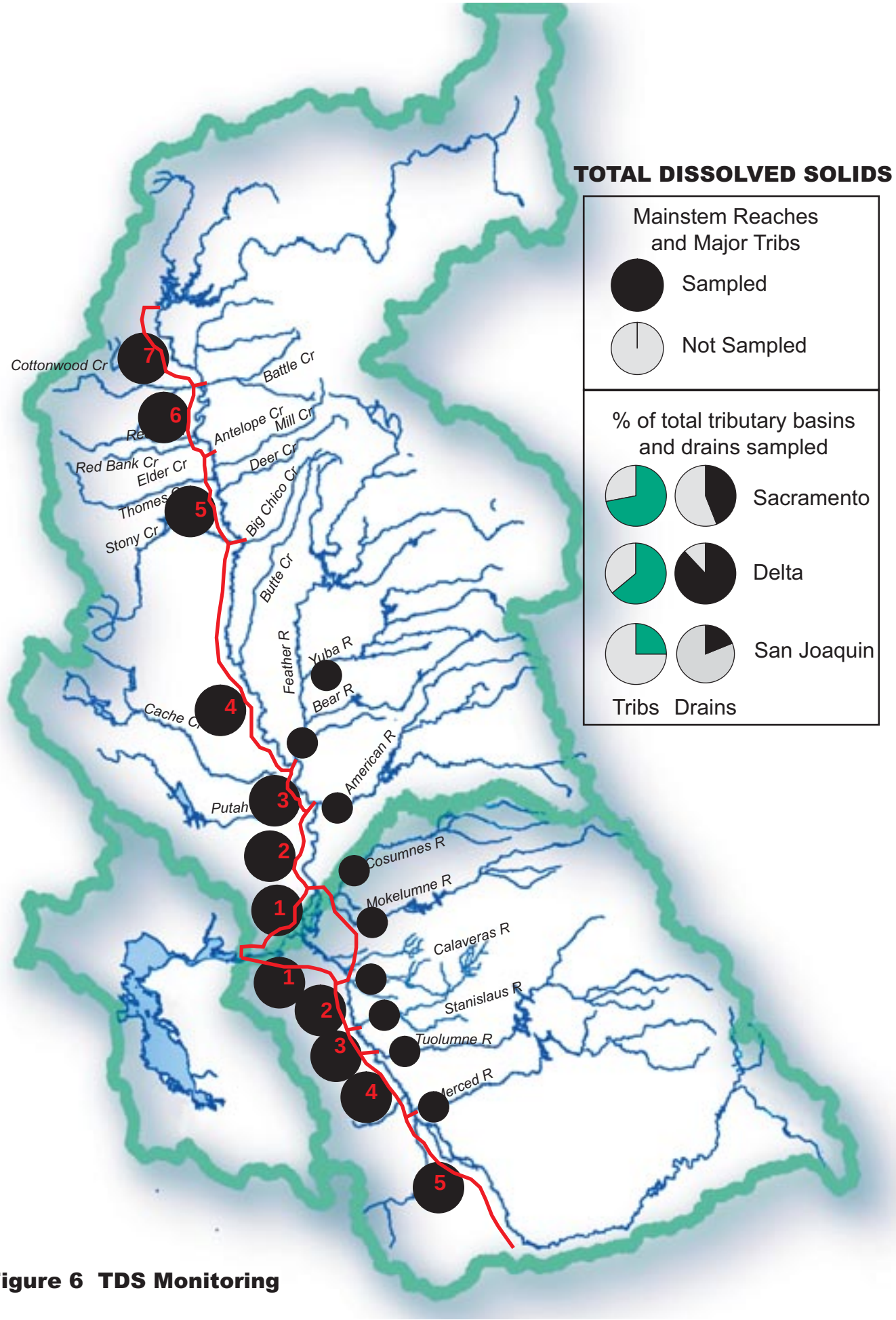

Figure 6 TDS Monitoring

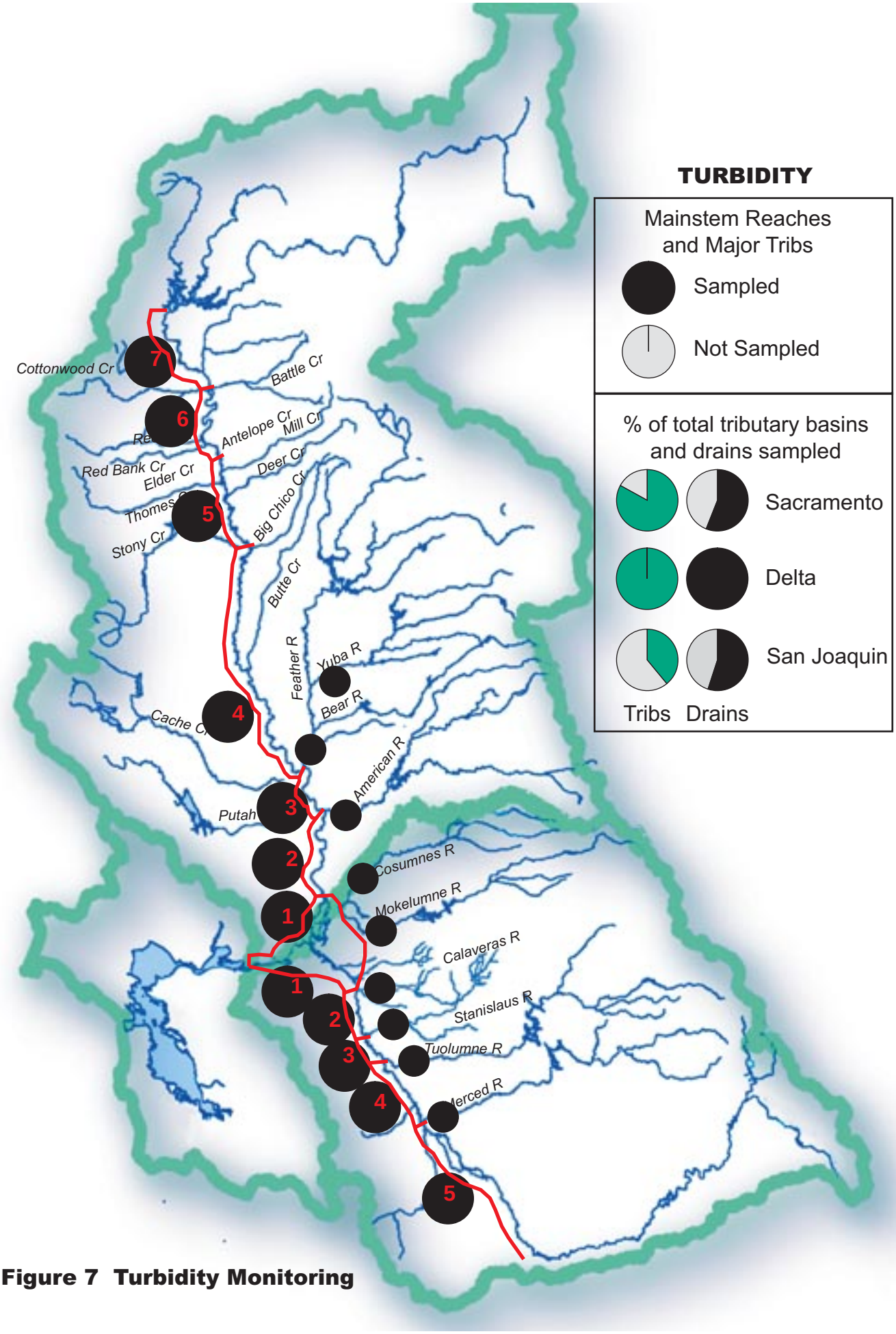

Figure 7 Turbidity Monitoring

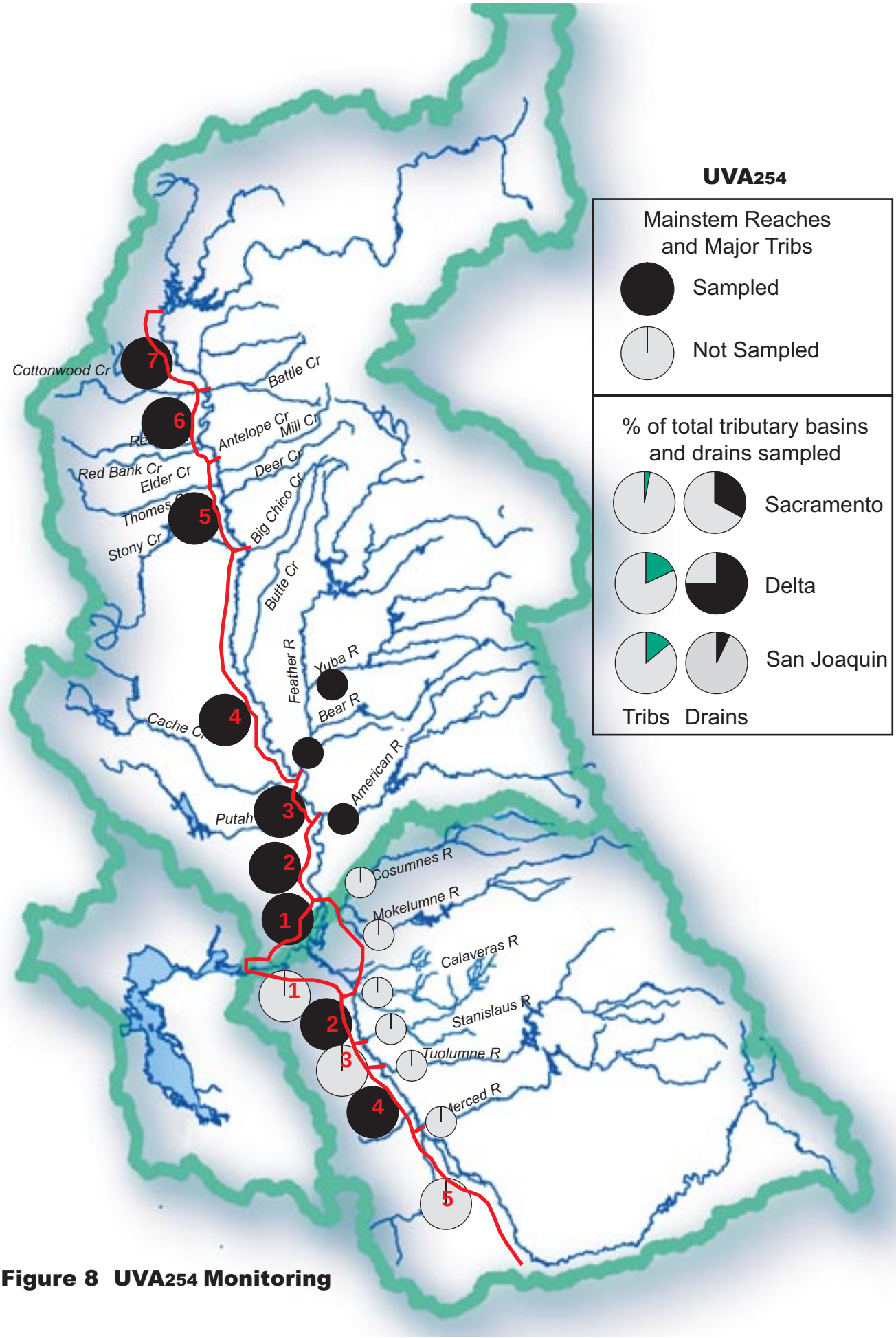

Figure 8 UVA254 Monitoring

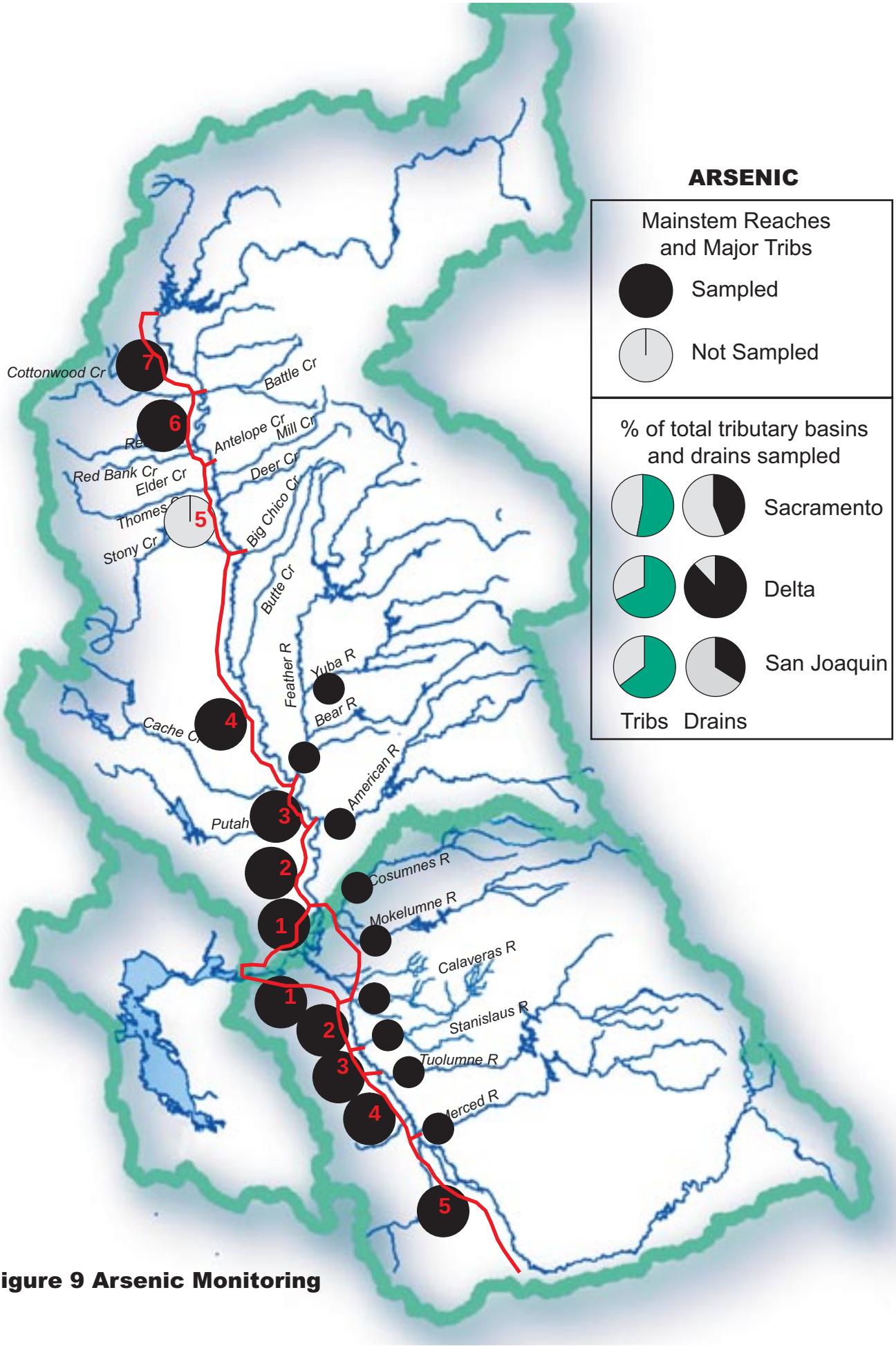

Figure 9 Arsenic Monitoring

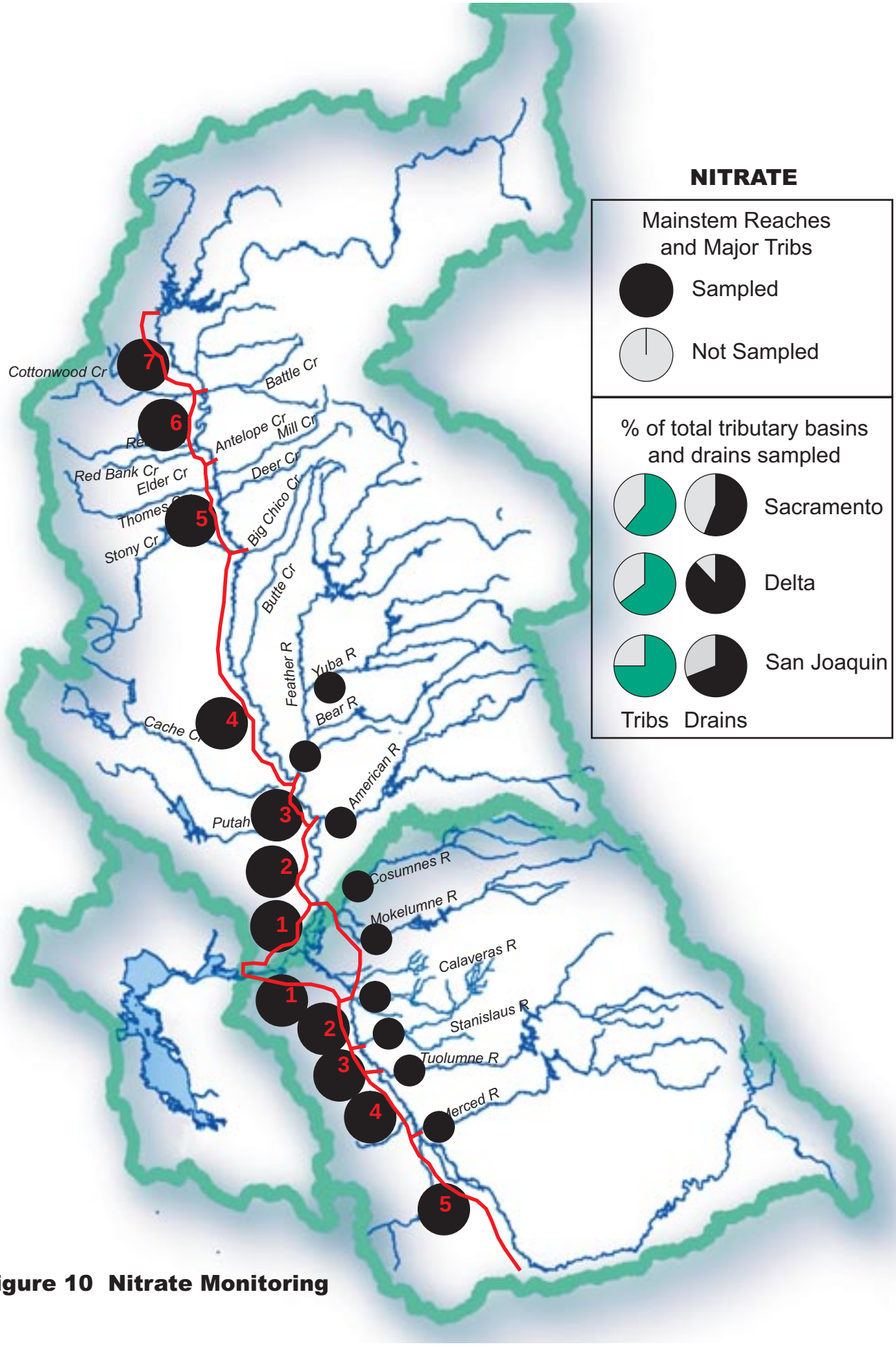

Figure 10 Nitrate Monitoring

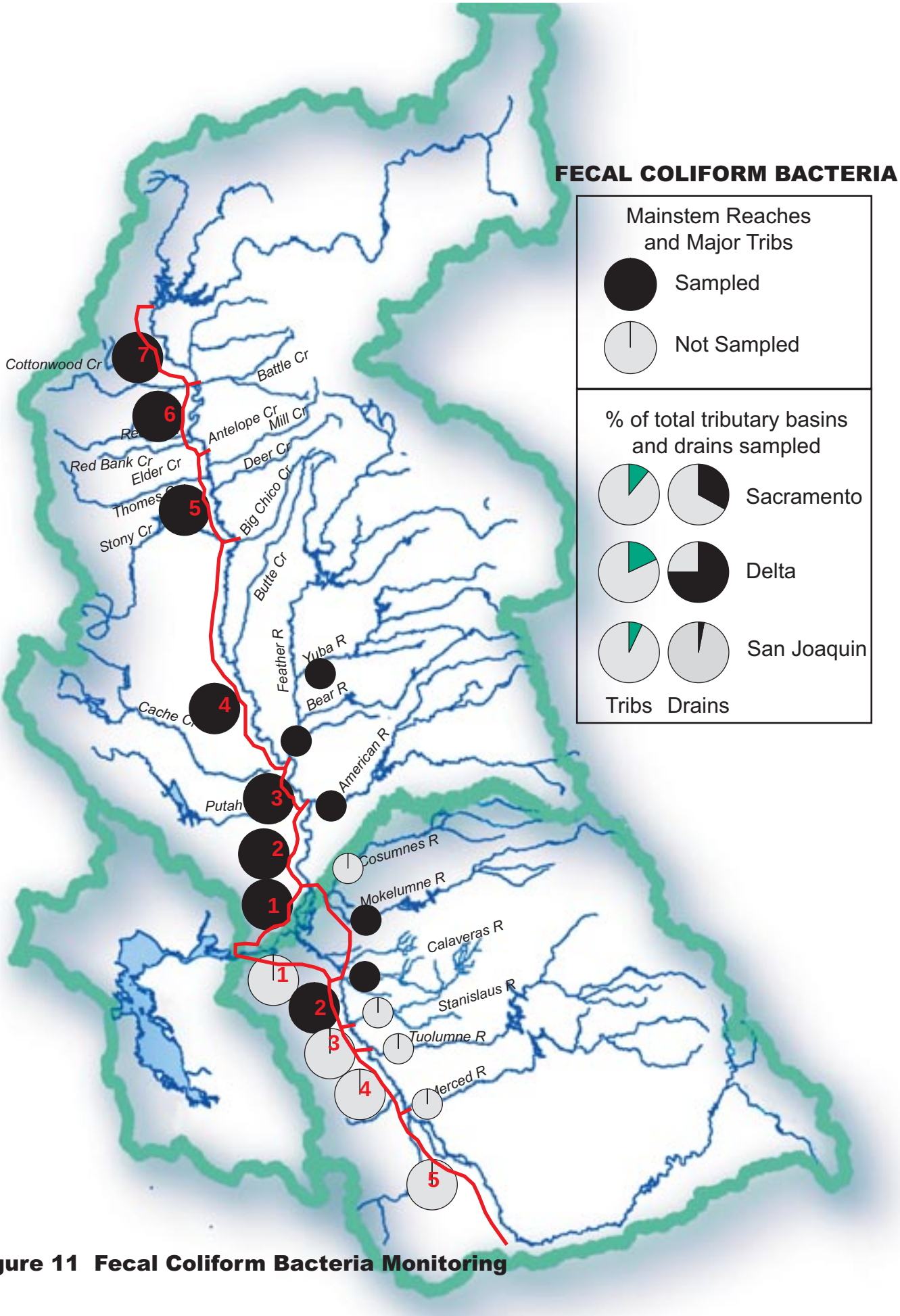

Figure 11 Fecal Coliform Bacteria Monitoring

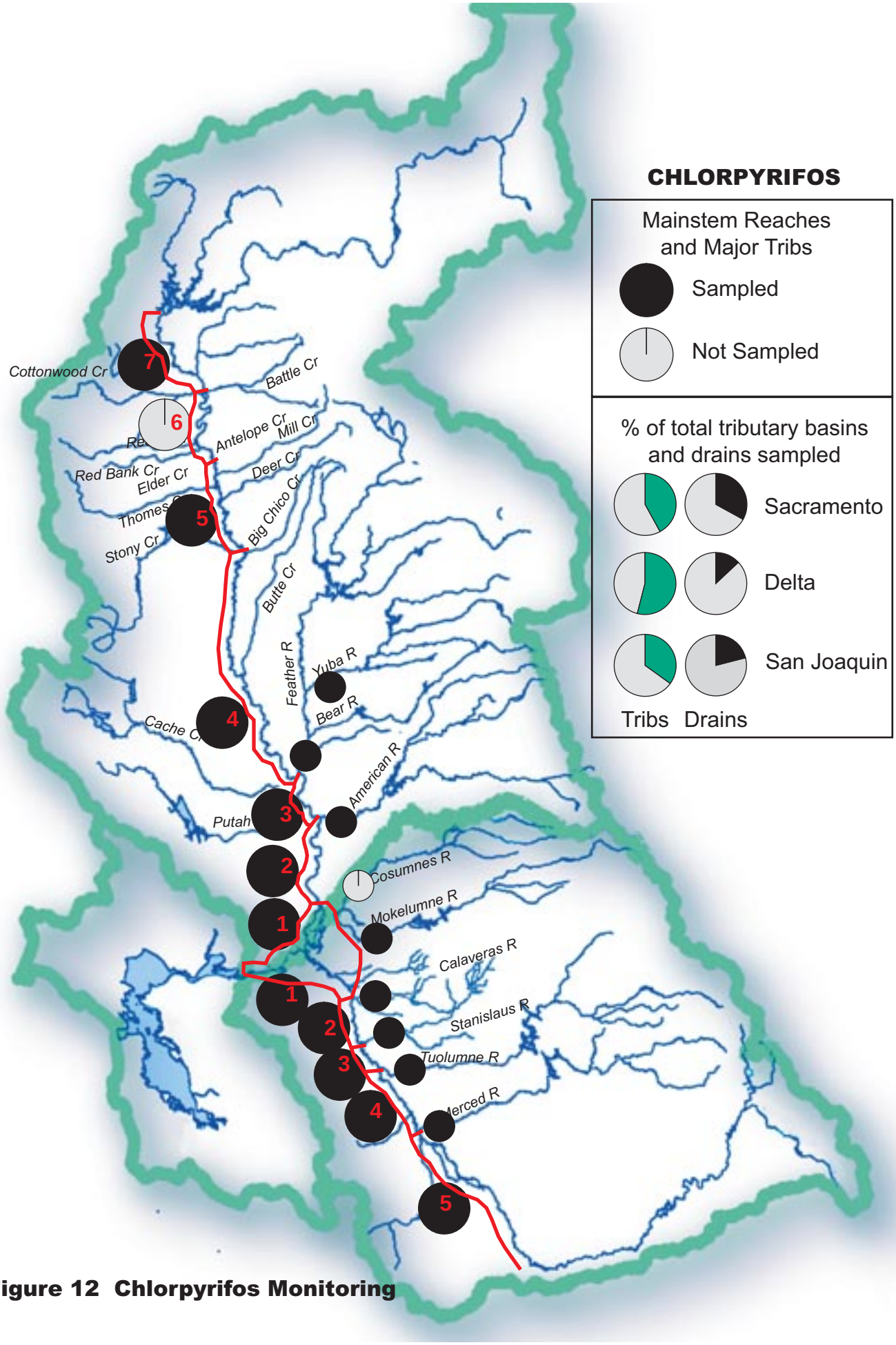

Figure 12 Chlorpyrifos Monitoring