SWAMP
Surface Water Ambient Monitoring Program

Monitoring Plan for Region 9	**2012/13**

San Diego River Watershed Bioassessment and Fish Tissue Analysis

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1 Summary Sheet

Beneficial Uses

This proposed monitoring plan for the Surface Water Ambient Monitoring Program (SWAMP) addresses multiple beneficial uses for the San Diego Hydrologic Unit (907, "San Diego River Watershed") within the San Diego Region. The bioassessment and fish tissue analysis will address the *aquatic life* beneficial uses. The fish tissue analysis will also address the *safe to eat* related beneficial uses.

Assessment Questions

The following assessment questions will be addressed by the California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) for the proposed monitoring plan:

What is the status of the aquatic life beneficial uses for wadeable streams in the upper San Diego Hydrologic Unit? Throughout this document, the aquatic life beneficial uses specifically refer to the beneficial uses defined in the Basin Plan for WARM and COLD, and in certain situations may also apply to RARE and SPWN. The Upper Watershed refers to the San Vicente, El Capitan, and Boulder Creek Hydrologic Areas.

Are freshwater fish within the San Diego River Watershed safe to eat? Throughout this document the safe to eat beneficial use specifically refers to the beneficial uses defined in the Basin Plan for COMM and REC-2.

We will use bioassessment to determine the biological condition of waters within the upper San Diego River Watershed. Specific questions to be addressed include:

1. What are the locations of biologically impacted water bodies? What are the conditions at the impacted sites?
2. What are the locations of Reference sites? What are the conditions at the Reference sites?
3. When comparing present bioassessment data to past bioassessment data, are the biological conditions increasing or declining?

We will use fish tissue to estimate the levels of bioaccumulative pollutants that recreational fisherman would be exposed to through fish consumption. Fish tissue data will be compared to state and federal tissue screening levels for human consumption. Specific questions to be addressed include:

1. What are the bioaccumulative pollutants of concern for fish tissues within the San Diego River Watershed?
2. What species of fish are safe to eat? What species of fish are not safe to eat and at what quantities?

3. What level of bioaccumulation is occurring within the San Diego River, and how does that compare to reservoirs in the San Diego River Watershed and San Diego Region?

Link to Statewide Monitoring Framework

The bioassessment conducted under this monitoring plan for streams in the upper San Diego River Watershed will support the statewide aquatic life use assessment of wadeable perennial streams. The statewide assessment is an on-going effort, funded by the statewide SWAMP program and supported by the California Water Quality Monitoring Council's Healthy Streams Partnership, and is based on a probabilistic design, with some targeted sites included in the assessment. The proposed study will also support the bioassessment study of the Stormwater Monitoring Coalition (SMC) which conducts regional monitoring of watersheds in southern California. Results from this monitoring plan will deliver data on new sites in the upper watershed, and will re-sample previous sites sampled by SWAMP, the SMC, and/or the San Diego Water Board to examine long-term trends.

The fish tissue analysis conducted under this monitoring plan will support the California Water Quality Monitoring Council and SWAMP's Bioaccumulation Oversight Group's (BOG) Bioaccumulation Strategy for California. The analysis will supplement existing statewide surveys of contamination in sport fish by providing information on rivers and targeted reservoirs within the San Diego Region.

Clean Water Act Sections 305(b)/303(d)

The data produced by this monitoring plan will be used in water body assessments required under Clean Water Act (CWA) sections 305(b) and 303(d).

San Diego Water Board Regional Monitoring Framework

The project will also focus on water body-oriented monitoring and assessment in conjunction with the San Diego Water Board's Regional Monitoring Framework (San Diego Water Board 2012). The study will assist in answering the following questions from the Framework:

1. Conditions Monitoring and Assessment: Are Fish and Shellfish Safe to Eat?
2. Conditions Monitoring and Assessment: Are Habitats and Ecosystems Healthy?
3. Stressor Identification Monitoring (Fish Tissue): What are the Primary Stressors Causing Unsatisfactory Conditions?
4. Performance Monitoring (Fish Tissue): Are Management Actions Effective?

Questions 3 and 4 will be addressed by the fish tissue study, but are not expected to be analyzed as part of the bioassessment study.

2 Background

2.1 Introduction

On December 12, 2012, the San Diego Water Board adopted Resolution No. R9-2012-0069, a *Resolution in Support of a Regional Monitoring Framework*. Efforts are currently underway to develop a Regional Monitoring Framework for the San Diego River Watershed (see Figure 1), in conjunction with state and federal agencies, local municipalities, water districts, academia, and not-for-profit organizations. This effort has identified additional data needed to answer questions regarding the San Diego River Watershed:

1. Is it safe to swim?
2. Are fish and shellfish safe to eat?
3. Are ecosystems healthy?
4. Is it safe to drink?

Monitoring and assessment efforts are already underway to address questions 1 and 3. However, insufficient data is available or being collected to fully address questions 2 and 3. Data collected in the San Diego Region by the San Diego Water Board and other agencies indicate the aquatic life beneficial uses are not supported in wadeable streams in the lower portion of the watershed. However, data collection in the upper watershed has been limited. Sites sampled have primarily been limited to identification of potential reference sites within specific hydrologic areas, as the upper watershed has limited discharge-related monitoring.

Data collected on fish tissue was conducted as part of a statewide assessment of lakes and reservoirs (Davis et al. 2010). Although three reservoirs within the San Diego River Watershed were sampled, there is incomplete coverage of species and non-reservoir waters, in addition to a lack of information regarding trends for bioaccumulative pollutants of concern. While historic data is available for the lower San Diego River, the most recent sampling of fish occurred 14 years ago.

Under this monitoring plan for Fiscal Years 2012-2013 (with monitoring occurring over the 2013 through 2014 calendar year), we propose to collect data in the upper San Diego River Watershed from areas sampled under SWAMP and other programs in the past. We also propose to collect fish tissue data from the lower watershed in conjunction with other sampling efforts.

In the upper watershed we will compare the new data to past data to detect possible trends or changes to the aquatic life beneficial use. We will also sample at new sites to better characterize the upper watershed and identify other potential areas where conditions do or do not support the aquatic life beneficial use.

For fish tissue we will compare data collected to previous results for reservoirs within the San Diego Region and historic data from the San Diego River. Observed pollutant levels in tissue composites will be compared to published State and Federal human health risk thresholds. More detailed risk assessments may be conducted in the future if site-specific fishing effort data is collected. Data collected will be shared with the SWAMP BOG and OEHHA.

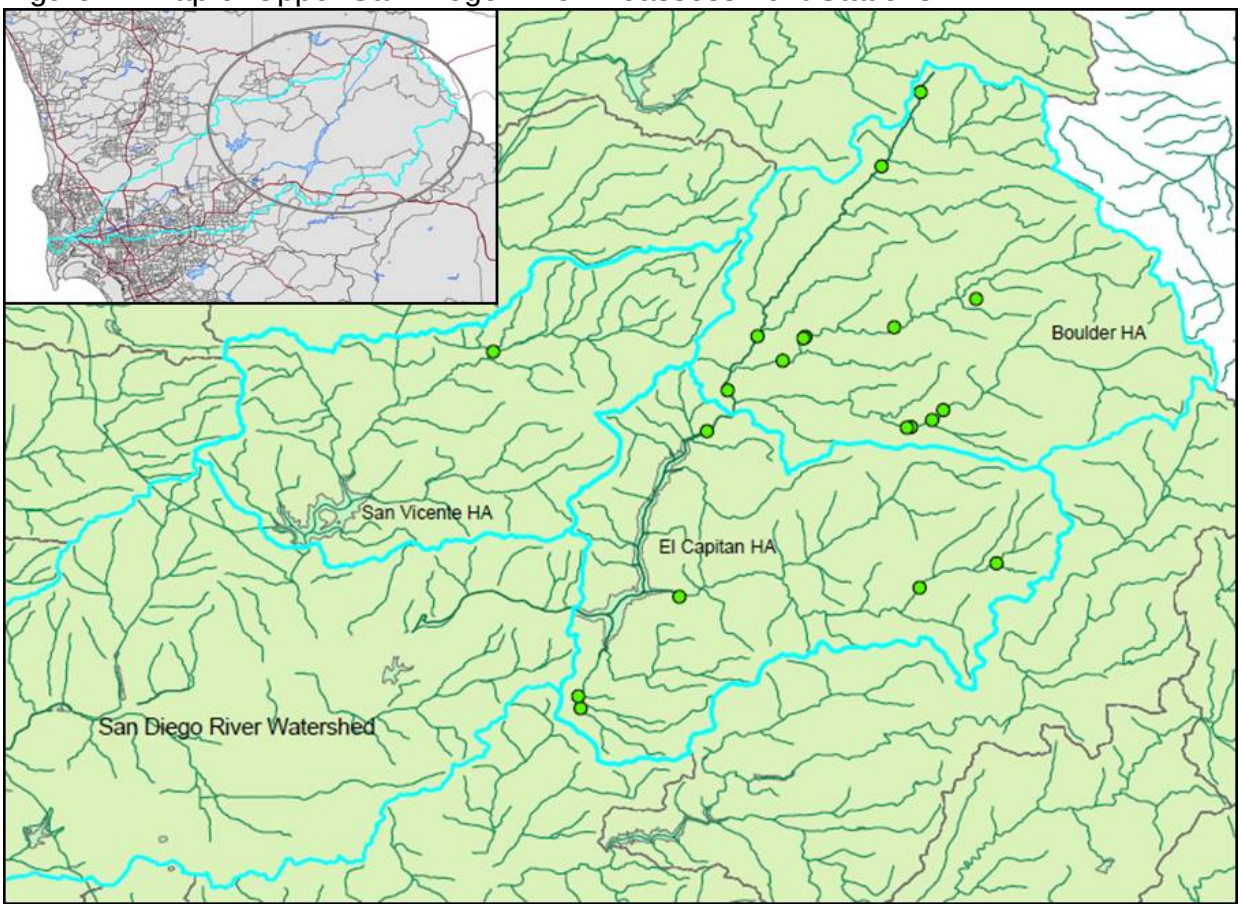
2.2 Past Monitoring

Bioassessment

Bioassessment monitoring has been conducted in the upper portion of the San Diego River Watershed by varying agencies and groups, including the San Diego Water Board, with data available from 1998 to the present. While all sites have water chemistry, the number of pollutants analyzed varies from station to station. The upper San Diego River Watershed consists of three hydrologic areas (HA, See Figure 1):

1. San Vicente HA (907.2)
2. El Capitan HA (907.3)
3. Boulder Creek HA (907.4)

Figure 1. Map of Upper San Diego River Bioassessment Stations



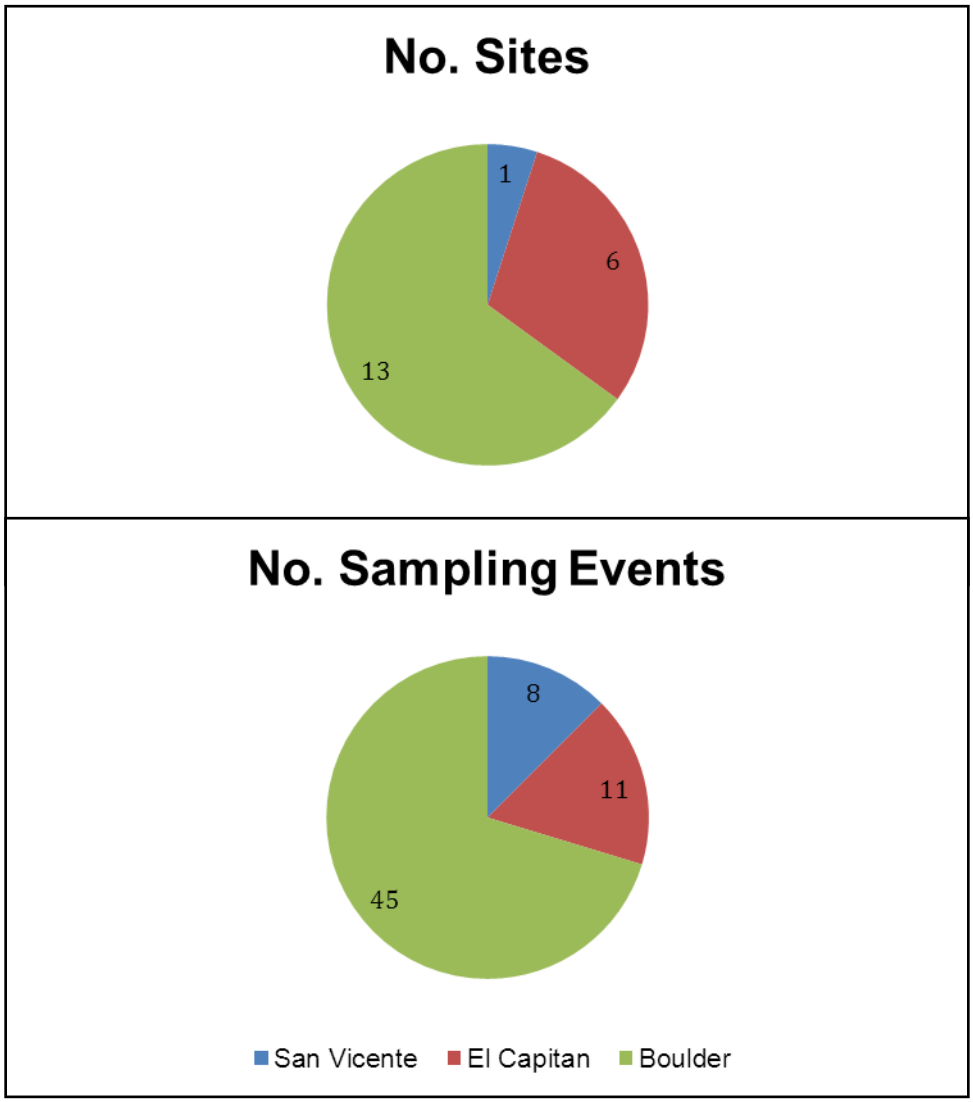
Sites within the watershed have been sampled by varying groups utilizing both targeted and probabilistic methods. Of the three hydrologic areas, Boulder Creek has the best spatial and temporal representation, with 13 sites sampled, and 4 of those sites sampled extensively since 1998 ($n \geq 5$, see Figure 2 and Table 1). El Capitan HA has four sites, with one site sampled consistently (n=6). San Vicente HA has only one site, though it has been sampled extensively (n=8). However, many of the samples were collected following large fire events in the upper watershed, and with the exception of several pre and post fire sites, the current condition of the hydrologic subareas is unknown due to an overall lack of spatial and temporal monitoring.

Table 1. San Diego River Watershed Upper Watershed Site Sampling

HA	Station Name	Receiving Water	No. Events	Index of Biotic Integrity Scores*
907.2	907SDSVC3	San Vicente Creek 3	8	27,10,TBD*
907.3	907S46499	San Diego River below El Capitan Truck Trail	1	46
907.3	907CONECR	Conejos Creek	6	22,33,41,29,14,16
907.3	907S01434	King Creek ~0.8mi above WF (Conejos)	1	10
907.3	907SDCHC3	Chocolate Creek	1	20
907.3	907CHC2xx	Chocolate Creek	1	16
907.3	907S03789	King Creek	1	TBD
907.4	REF-CC	Cedar Creek	1	39
907.4	REF-CC2	Cedar Creek	1	49
907.4	907S01418	Cedar Creek ~1.5mi above San Diego R.	1	8
907.4	907CCCR02	Cedar Creek	9	TBD
907.4	SMC04426	Cedar Creek	1	TBD
907.4	REF-BCR	Boulder Creek	5	25,31,35,28,44
907.4	907SDBOC2	Boulder Creek	9	16,19,27,64,25,27,24,TBD
907.4	907SD01610	Boulder Creek ~0.7mi above Boulder Cr. Rd.	1	26
907.4	SMC04682	Boulder Creek Above PL	1	TBD
907.4	907SRSD1x	San Diego River Headwaters above Highway 79	12	TBD
907.4	907S05514	San Diego River ~0.4mi above Boulder Cr.	1	TBD
907.4	907S03210	San Diego River below Ritchie Cr.	1	TBD
907.4	907S00577	San Diego River below Sentenac Cr.	1	11
	Totals	17 Sites	60	

* Based on the southern California index of biotic integrity (Ode et al. 2005). All site scores will be checked for accuracy. TBD: To be determined prior to site selection.

Figure 2. Upper San Diego Water Site and Sampling Event Distribution by Hydrologic Area



Bioaccumulation in Fish Tissue

Recent data on pollutants in fish tissues for the San Diego River Watershed (See Figure 3) is limited to reservoirs in the watershed. In 2002 SWAMP collected two composite samples from El Capitan Reservoir as part of the National Fish Tissue Study. These tissues were analyzed for PCBs, some pesticides, PAHs, and mercury, though no results were located. The most recent data are from 2007 and 2008 when the SWAMP BOG conducted a statewide survey of bioaccumulation in sport fish within lakes and reservoirs (Davis et al. 2010, "BOG study"). This statewide survey included targeted sampling of 300 lakes/reservoirs and random sampling of an additional 50 lakes/reservoirs in California. Three reservoirs where sampled within the San Diego River Watershed, with composite samples collected for channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), and carp (*Cyprinus carpio*,see Figure 3, see Table 2). For largemouth bass, only one composite sample was collected, which took place at El Capitan Reservoir in 2008. Other largemouth bass samples consisted of nine individual fish over a size range analyzed independently in order to estimate mercury bioaccumulation over time. This curve was then utilized to estimate the tissue concentration in a legal sized (350 mm) fish.

Figure 3. Tissue Sampling Sites in the San Diego River Watershed.

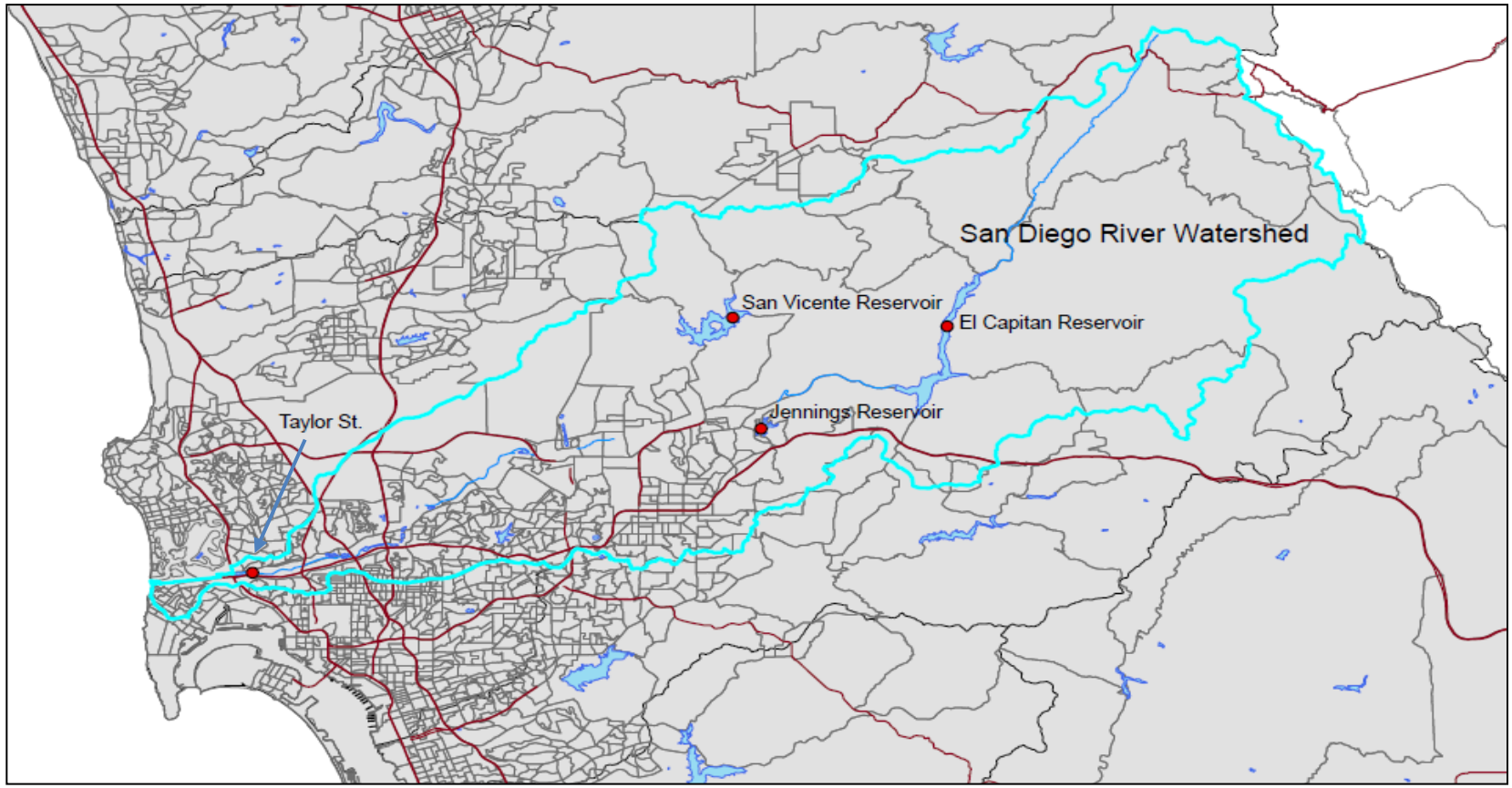


Table 2 – Existing Recent Data on Bioaccumulation in Fish and Invertebrate Tissue in the San Diego River Watershed

	Receiving Water	Year	Species	Composites*
1	El Capitan	2002	Channel Catfish, *Ictalurus punctatus*	1
1	El Capitan	2002	Largemouth Bass, *Micropterus salmoides*	1
1	El Capitan	2008	Largemouth Bass, *Micropterus salmoides*	3*
2	San Vicente	2007	Largemouth Bass, *Micropterus salmoides*	1*
2	San Vicente	2007	Carp, *Cyprinus carpio*	2
3	Lake Jennings	2008	Channel Catfish, *Ictalurus punctatus*	1
3	Lake Jennings	2008	Largemouth Bass, *Micropterus salmoides*	1*
4	Lower SD River	2004	Asian Clam, *Corbicula* sp.	2 clams
	Totals			10

*The only largemouth bass composite from 2007-08 was collected at El Capitan Reservoir. The other samples were calculated averages from 9 individual fish analyzed for mercury.

The BOG study analyzed composite samples for mercury, dieldrin, selenium, chlordane, DDT, and PCBs. Pollutants of concern for the San Diego River Watershed identified by the BOG study included mercury and PCBs. Pollutants found at levels below published human heath criteria as part of the BOG study included dieldrin, selenium, chlordane, and DDT. While the information collected for the reservoirs is valuable wherein it provides an estimation of pollutant levels and the pollutants of concern, the breadth of the BOG statewide study understandably leaves localized data gaps and unanswered questions for species and waters in the San Diego River Watershed that will be addressed by this Study. The most recent data from the San Diego River was collected in 2004, when SWAMP analyzed tissues from two invasive Asian clams in the lower San Diego River for PCBs and Selenium, with PCBs detected at levels above consumption guidelines (SWAMP 2007).

Historic fish and invertebrate tissue data are available for the San Diego River that were collected as part of the Toxic Substances Monitoring Program (TSMP). The bulk of the tissue data for the San Diego River were collected at a variety of sites from 1979-1994 (n=28, see Figure 4, Rasmussen and Blethrow 1990), with subsequent analysis focusing on organics and/or metals. The site with the highest frequency of sampling was the Old Mission Dam, which was sampled six times between 1979 and 1994 for organics and metals. Pollutants of concern identified in the historic TSMP sampling included DDT, PCBs, Dieldrin, Chlordane and Mercury (see Figure 5).

Figure 4. Historic Fish and Invertebrate Tissue Sampling Sites for the Lower San Diego Watershed

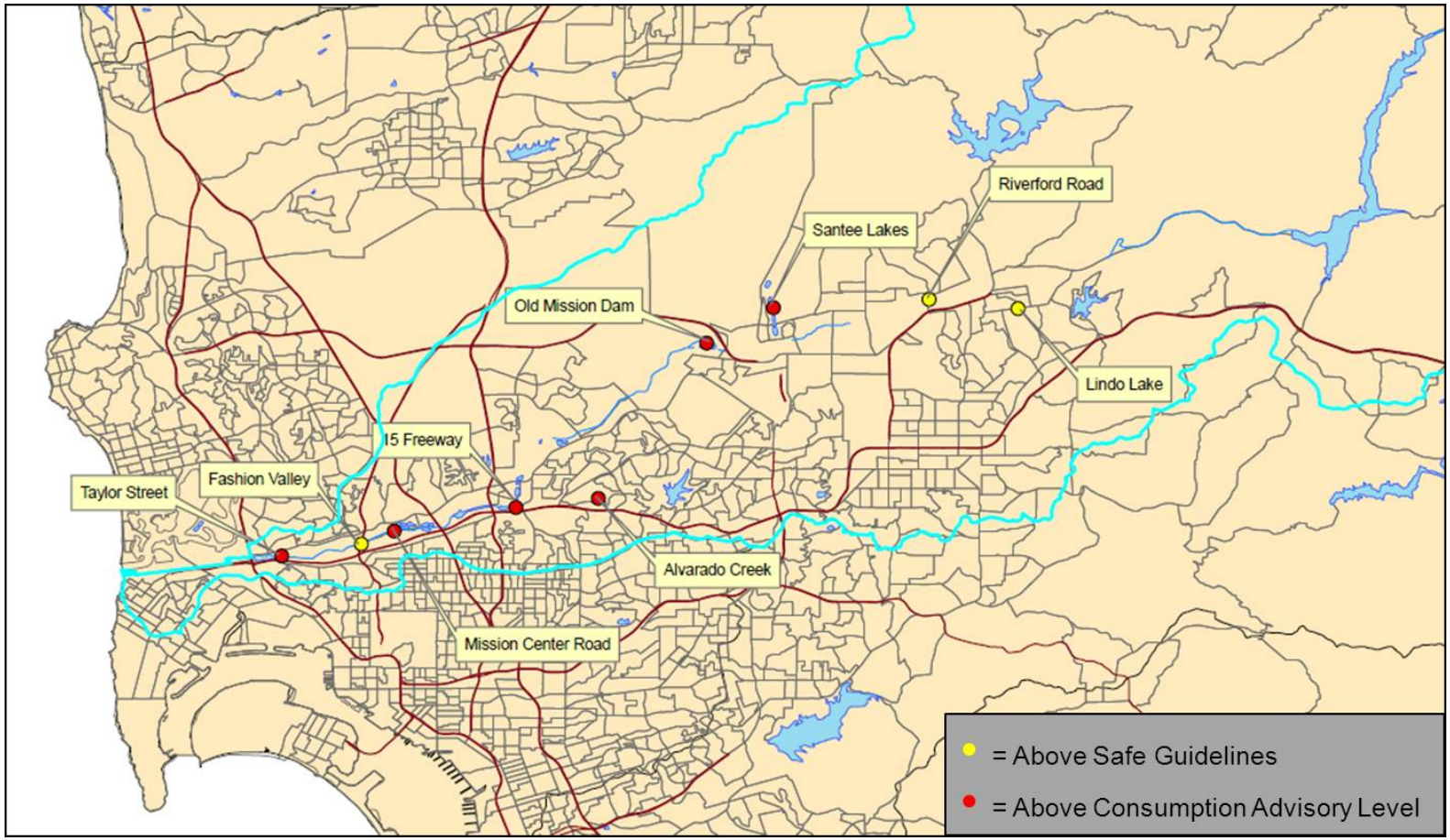
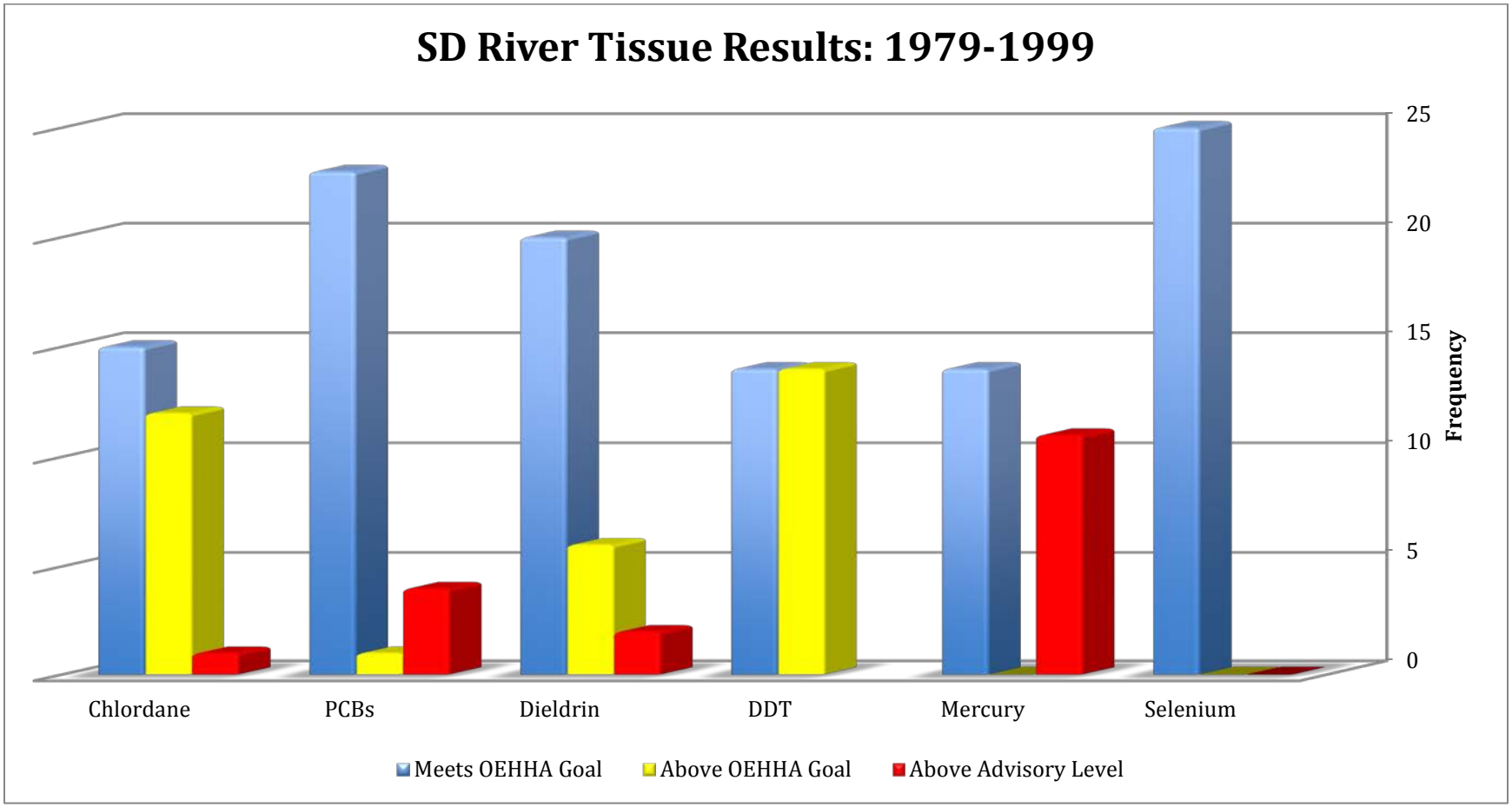


Figure 5. Comparison of Fish Tissue Pollutant Concentrations to OEHHA Advisory Tissue Levels and Contaminant Goals*.



*For California Sport Fish (Klasing and Brodberg 2008). Note site specific consumption advisories have not been developed for the San Diego River.

2.3 Proposed SWAMP Bioassessment Sampling for 2013 and 2014

The following objectives have been defined for the proposed study:

1. To address the status of aquatic life beneficial use for wadeable streams in the San Diego River's upper watershed;
2. To compare bioassessment data from past studies to data from this study and detect trends in biological impacts over time; and
3. To recommend management strategies based on the bioassessment sampling results and potential stressor identification.

Based on historical bioassessment data from various studies from 1998-2011, the aquatic life beneficial use may not be supported in wadeable perennial streams in the upper San Diego River Watershed. Comparing the new data from this study to historical data from these sites may detect trends in biological conditions to evaluate temporal conditions. Spatially, sample sites with the highest frequency of sampling are generally in close proximity to access points, which are subject to greater levels of human disturbance. Areas with limited access, such as in the San Vicente Reservoir area, predictably have limited bioassessment data (e.g. one sample site). We will sample sites in these areas to identify the biological condition in additional wadeable streams in the upper San Diego River Watershed.

In summary, bioassessment is an important tool to assess the quality of stream conditions for the following reasons:

1. Bioassessment provides data to determine the status of the aquatic life beneficial use;
2. Bioassessment integrates variation over time and constituents;
3. Bioassessment will provide data used to evaluate the ecological health of streams; and
4. Historical bioassessment data are available in the San Diego Region.

Results of bioassessment can be used to determine if a waterbody is biologically impaired impacted. In most cases, the cause(s) of the impact is unknown or has not been identified. Before appropriate management action can be taken, the stressor of the biological impact must be determined. Potential stressors may be identified through additional field sampling and measurements, such as for water chemistry and physical habitat assessment. Therefore, conventional water chemistry and a full physical habitat assessment will be measured at all sites under this project. This will provide a basis for any future use of the United States Environmental Protection Agency's (USEPA's) stressor identification tool Causal Analysis/Diagnosis Decision Information System (CADDIS) to try to determine the cause of the degraded biological communities.

The bioassessment conducted under this monitoring plan for streams in the upper San Diego River Watershed will be conducted concurrently with fish and invasive species surveys conducted by the California Department of Fish and Wildlife (CADFW) and the SDRPF respectively. Both of these groups will coordinate efforts with the San Diego Water Board.

The following audiences will be interested in the results of this monitoring: general public, stakeholder groups of the San Diego Watershed, the Southern California SMC, and the SWAMP program of the State Water Resource Control Board (State Water Board).

Results from this study will provide evidence to identify what areas show biological impacts and if previously sampled sites have improved, declined, or neither. We will also attempt to identify potential stressors at the sites. This type of information will assist managers in planning management strategies to address an impacted/affected area(s).

2.4 Proposed SWAMP Fish Tissue Monitoring for 2013 and 2014

The following objectives have been defined for the proposed study:

1. To address the status of the COMM and REC-2 beneficial uses for the lower San Diego River Watershed;
2. To compare bioaccumulation results to historical data and published human health risk threshold values;
3. To recommend management strategies based on the bioaccumulation sampling results;
4. To support the SWAMP state-wide BOG's efforts by adding additional sites in the San Diego Region;

The purpose of this study is to collect data to answer the following *safe to eat?* Beneficial Use related monitoring questions:

1. Are freshwater fish within the lower San Diego River Watershed safe to eat?
   a. What pollutants are bioaccumulating in different species and at what levels?
   b. Which fish species are not safe to eat, and in what amounts?
   c. Which fish species are safe to eat, and in what amounts?

2. How do the observed bioaccumulative pollutant levels compare to lakes and reservoirs in the San Diego Region and throughout the State of California?

Based on the most recent bioaccumulation data from the 2002 SWAMP and 2007-08 BOG studies, the COMM beneficial use may not be supported in San Diego River Watershed. Fish exhibited levels of PCBs and mercury at levels of concern for human consumption. However, all of the fish tissue samples were collected from large reservoirs in the upper un-urbanized portion of the watershed. El Capitan and San Vicente reservoirs receive surface water flows from open space, tribal, and small portions of rural residential areas. Jennings reservoir receives surface flows from a mix of low density residential and open space areas. Thus the current condition of fish in the lower urbanized portion of the watershed remains unknown. Furthermore, the reservoirs sampled have primarily targeted sport fish for analysis, while CADFW creel surveys show consumption is typically focused primarily on stocked species (e.g. trout) or those that were not sampled, such as panfish (*R. Barabe*, *personal communication*).

This project proposes to “fill in the gaps” of the BOG sampling by focusing on lower watershed areas and species likely to be consumed. Spatially, San Diego River sample sites with the highest frequency of use and historic sampling efforts will be selected for sampling. Lower watershed area reservoirs are not proposed to be sampled due to limited pay-to-fish access, the high probability of consumption of stocked fish, and surface flow diversion structures. In addition, although recent samples from the lower watershed were of an invasive filter-feeding invertebrate and had a small sample size (n=2), PCB levels within the tissues were elevated, with tissue level above or near published OEHHA advisory levels (Klasing and Brodberg 2008).

In summary, bioaccumulation is an important tool to assess the quality of surface waters in the watershed for the following reasons:

1. Bioaccumulation provides data to determine the status of the COMM beneficial use;
2. Bioaccumulation provides data regarding pollutant impacts on the WILD and WARM beneficial use;
3. Bioaccumulation integrates the impact of pollutants over time and for multiple constituents; and
4. Past bioaccumulation data are available in the watershed and San Diego Region.

Results of bioaccumulation analysis can be used to determine if a waterbody is biologically impacted for human health and wildlife by comparing tissue concentrations to published advisory levels, and by conducting site-specific risk assessments. Identification of pollutants of concern can allow for appropriate management action(s) to be taken, and sources of the pollutant to potentially be identified.

The bioaccumulation conducted under this monitoring plan for the lower San Diego River Watershed will be conducted concurrently with fish population dynamics conducted by the CADFW. The CADFW will assist in the collection of fish for bioaccumulation analysis. In addition, the lower San Diego River Watershed is monitored for water chemistry, physical habitat, toxicity, bioassessment, trash, and invasive species by a diverse group of governmental, academic, non-profit and regulated groups. These monitoring efforts are currently being coordinated with the San Diego Water Board as part of a larger watershed assessment.

The following audiences will be interested in the results of this monitoring: general public, stakeholder groups of the San Diego River Watershed, the Southern California SMC, the SWAMP program of the State Water Board, the BOG, and academia.

3 Project Organization

3.1 Distribution List

Lilian Busse	California Water Quality Control Board - San Diego
Chad Loflen	California Water Quality Control Board - San Diego
Rusty Fairey	Marine Pollution Studies Lab at Moss Landing
Marco Sigala	Marine Pollution Studies Lab at Moss Landing
Eric von der Geest	Marine Pollution Studies Lab at Moss Landing
Autumn Bonnema	Marine Pollution Studies Lab at Moss Landing
Gail Cho	Water Pollution Control Laboratory
Dawn Hamilton	Ecoanalysts
Rosalina Hristova	California State University at San Marcos
Dan Pickard	Aquatic Bioassessment Laboratory
Russell Barabe	California Department of Fish and Wildlife -San Diego

3.2 Project/Task Organization (see Figure 6)

The SWAMP coordinator, Lilian Busse, will be responsible for general oversight of the project. The Project Manager and Coordinator, Chad Loflen, will serve as the primary point of contact and lead the San Diego Water Board and CADFW field teams for sampling.

Rusty Fairey will serve as the Contract Manager and ensure that the sample handling and analysis of the project samples under the SWAMP master contract are performed in accordance with the contractual obligations.

Marco Sigala will serve at the SWAMP database manager contact for the project.

Eric von der Geest will serve as the SWAMP QA contact for any QA questions that arise during the project.

Fish Tissue

Autumn Bonnema with the Marine Pollution Studies Lab at Moss Landing (MPSL) will serve as the Fish Tissue Logistics Coordinator and ensure that fish tissue samples are processed, handled, analyzed, and archived in accordance with the SWAMP master contract.

Gail Cho will be the laboratory contact for the CADFW's Water Pollution Control Laboratory (WPCL), and will ensure fish tissues received are analyzed in accordance with the SWAMP master contract.

Russell Barabe will be working with the San Diego Water Board to coordinate fish sampling efforts. Russell will lead any electrofishing sampling efforts.

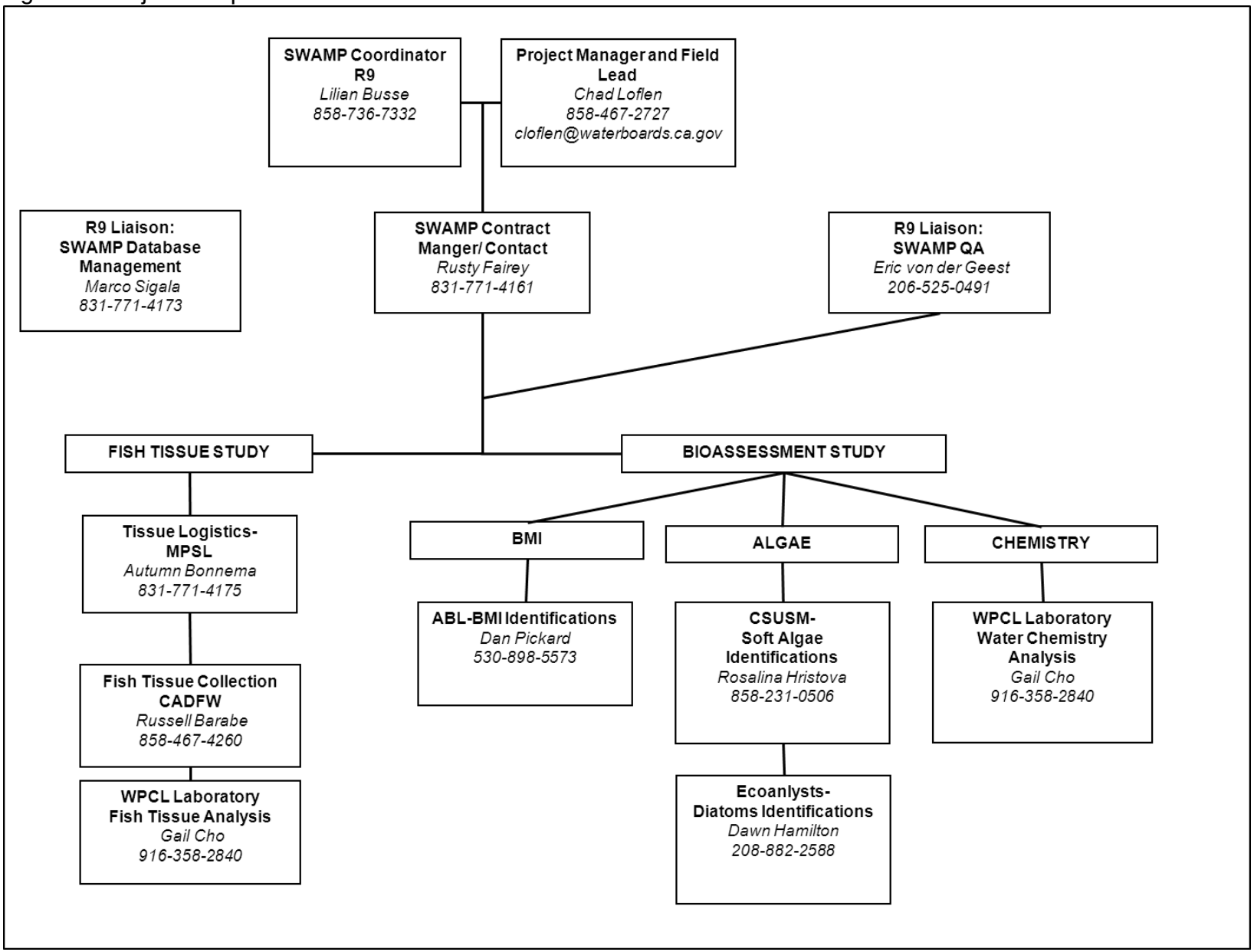
Bioassessment

Algae: Dawn Hamilton will serve as the Ecoanalysts diatom contact for the project, and will ensure that diatom samples are received and analyzed in accordance with the SWAMP master contract. Rosalina Hristova will serve as the California State University at San Marcos (CSUSM) soft-bodied algal contact for the project, and will ensure that samples are received and analyzed in accordance with the SWAMP master contract.

Benthic Macro Invertebrates (BMI): Dan Pickard will serve as the Aquatic Bioassessment Laboratory (ABL) contact for the project, and will ensure samples are received, sorted, and identified in accordance with the SWAMP master contract.

Water Chemistry: Gail Cho will be the laboratory contact for the CADFW's WPCL, and will ensure samples are received and analyzed in accordance with the SWAMP master contract.

Figure 6. Project Responsibilities



4 Bioassessment Study Methods

4.1 Monitoring Design

4.1.1 Site Selection

Due to constraints in funding, monitoring site selection for SWAMP Fiscal Years 2012-13 will be done the SMC probabilistic approach. A total of nine sites will be selected within the upper San Diego River Watershed for 2012/13.

The nine sites funded to be sampled will be stratified within the three hydrologic areas. As discussed, there is unequal representation of each hydrologic area from past sampling efforts. Thus, the probabilistic selection of sites is expected to result in a better representation of conditions in the upper watershed. However, it is possible that arid conditions in specific hydrologic areas may result in less representation of those hydrologic areas. New site selection will combine the use of geographic information system (GIS) data with ground-truthing.

Site selection will be based on the following criteria:

1. Sites must be geographically located as follows:
    a. Upstream of the San Vicente or El Capitan Reservoir;
    b. Main stem rivers and streams, just above the confluence with major tributaries; and
    c. Major tributaries, just above the confluence with the main stem rivers and streams;
2. Sites will be selected based on the presence of flow; and
3. At sites previously sampled, data for bioassessment should be available.

Locations of monitoring sites are subject to revision. Perennial stream sites will be targeted for sampling. Perennial sites that usually show consistent flow may not have adequate flow at the time of sampling, such as during very dry years. Alternate sites will be identified for sampling in order to ensure a full complement of samples is collected throughout the watershed area. The alternate sites will be selected using the same criteria discussed above.

Site selection will be coordinated with the CADFW and the SDRPF. The CADFW will be conducting fish population assessments concurrently with bioassessment efforts, and the SDRPF will conduct invasive plant monitoring. The San Diego Water Board will conduct a thorough analysis of bioassessment data collected in the past (see Section 2, above) before the proposed sampling will start. This analysis will include an attempt to detect trends of biological impairment at sites utilizing the southern California IBI (Ode et al. 2005, Ode 2007), in addition to an assessment of which sites will be re-sampled by existing regulatory programs within the foreseeable future. Based on the results of this analysis, the San Diego Water Board will decide which sites will be selected for the bioassessment sampling or which areas need additional sites.

4.1.2 Site Reconnaissance

Site reconnaissance will be conducted to determine site selection, including alternate sites.

Site reconnaissance is an important tool in effective assessment of ambient water quality monitoring programs. The San Diego Water Board will conduct sample site reconnaissance that will:

a. Document local watershed characteristics and features;
b. Document in-stream habitat conditions;
c. Document near stream habitat conditions;
d. Measure and characterize flow regime;
e. Identify land ownership and access issues;
f. Establish a reach for sampling;
g. Determine if the site meets reference site criteria for bioassessment (if applicable);
h. Provide photo-documentation of the site;
i. Record on the ground GPS coordinates (WGS 84, decimal degrees) for the site;
j. Map the site on both a watershed and reach scale; and
k. Identify and prioritize nearby alternate sites for contingency or follow-up monitoring.

4.1.3 Field location of sample collection sites

The field crew will collect samples at sites where the latitude and longitude (GPS coordinates) were previously recorded during reconnaissance of these sites. If a new site is being sampled, GPS coordinates and cross-referenced photographs will be provided for future reference. Any confusion about site location or prioritization of alternate sites will be resolved in consultation with a San Diego Water Board staff member present in the field or via phone. See Section 3.2 for further discussion of project roles and responsibilities.

4.2 Parameters and Analysis

Monitoring sites will be sampled only once per year during the standard dry-season index period (usually mid-May through mid-July) for the following parameters:

1. Conventional Water Chemistry;
2. Benthic Macroinvertebrates for Bioassessment;
3. Algae for Bioassessment; and
3. Full Physical Habitat Assessment.

The CADFW and SDRPF will also conduct fish community and invasive species surveys, respectively, in conjunction with bioassessment efforts.

4.2.1 Conventional Water Chemistry

Samples for conventional water chemistry analyses will be collected at each monitoring site. Conventional water chemistry samples will be collected simultaneously with the bioassessment samples and shipped to a SWAMP contracted laboratory for analysis within required holding times. This will provide information to assess possible causes or nature of any biotic effects observed in the bioassessment sampling. The following parameters will be tested:

1. Ortho-Phosphate[1];
2. Total Phosphorus[2];
3. Nitrate/Nitrite[1];
4. Ammonia[1];
5. Total Nitrogen[2];
6. Silica[2];
7. DOC[2]; and
8. Chloride[2].

In addition, the following parameters will be measured in-situ in the field at each site:

1. Dissolved oxygen;
2. Temperature;
3. Conductivity;
4. pH;
5. Turbidity;
6. Flow (Physical Habitat, see below); and
7. Alkalinity.

Dissolved oxygen, temperature, conductivity, and pH will be measured with a Hydrolab Quanta. Turbidity will be measured with a LaMotte 2020e. Flow will be measured using a Swoffer flowmeter. Alkalinity will be measured utilizing field titration.

4.2.2 Bioassessment and Physical Habitat Assessment

The San Diego Water Board will follow the latest SWAMP approved Standard Operating Procedures[3] (SOPs) for collection of water, benthic macroinvertebrate, and algal samples for bioassessment, and physical habitat assessment. These include:

1) *Collecting Benthic Macroinvertebrate Samples and Associated Physical and Chemical Data for Ambient Bioassessments in California*;
2) *Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Bioassessments in California*; and

[1] 48 hour holding time
[2] 28 day holding time
[3] See http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/standard-operating-procedures

3) *MPSL-DFG SOP for Conducting Field Measurements and Field Collections of Water and Bed Sediment Samples in the Surface Water Ambient Monitoring Program.*

4.2.3 Sampling, Laboratory Analyses and Quality Assurance

San Diego Water Board and CADFW staff will collect all water chemistry and bioassessment samples, which will be preserved as prescribed per SWAMP SOPs. Samples not analyzed in-situ will then will be shipped or driven to the appropriate lab for analysis. Each laboratory contact will be provided with a minimum two weeks advance notice of sampling dates to ensure holding time requirements are met. Soft-bodied algal samples will be driven by field staff to the CSUSM campus for analysis the day of or immediately following sampling. San Diego Water Board and CADFW staff will also conduct the full physical habitat assessment at all sites where bioassessment samples are taken. Bioassessment samples will have Quality Assurance/Quality Control (QA/QC) performed at a frequency of ten percent (10 percent) and shall follow SWAMP's *Standard Operating Procedures for Laboratory Processing and Identification of Benthic Macroinvertebrates in California*. Duplicate samples will be taken at 10 percent of the sites to assure QA/QC for field sampling.

All San Diego Region SWAMP sampling and analyses (bioassessment/physical habitat assessment and conventional water chemistry) will be performed under the State Water Board SWAMP statewide master contract and San Diego Water Board lab contract. Sample collection and subsequent processing and testing will be performed according to the most recent version of the SWAMP Quality Assurance Project Plan (SWAMP QAPP, 2008, and updates). For water chemistry analysis, sampling procedures, preservation requirements, measurement of quality objectives, reporting limits, and holding times of the SWAMP QAPP will be followed. However, the holding time of 48 hours for ortho-phosphate will not be met for the proposed study. Preliminary data show that ortho-phosphate remains almost unchanged if refrigerated over seven days (Ode, personal communication). The data for ortho-phosphate will be flagged in the SWAMP database as "qualified". However, these data can still be used for project purposes. Equipment utilized for in-situ field measurements will be calibrated no more than 24 hours prior to sampling departure, and post-calibrated upon return to the San Diego Water Board office.

All conjunctive sampling efforts by the CADFW and SDRPF will occur without disturbing sampling reaches and/or following the completion of SWAMP parameter collection.

4.3 Data

4.3.1 Data Quality Evaluation and Data Reporting

Data quality evaluation and data reporting will be as specified in the SWAMP QAPP. Quality control will include a minimum five percent (5 percent) field duplicate level for all parameters. We do not anticipate needing additional special data quality evaluation or data reporting procedures.

4.3.2 Data Analysis

For bioassessment data, the benthic macroinvertebrate IBI for southern California (Ode et al. 2005) will be applied in addition to the California Stream Condition Index (Ode personal communication). The IBI is a diagnostic tool to assess the attainment of the WARM and COLD beneficial uses for wadeable streams (Ode and Rehn 2005). Locations with IBI scores of Poor or Very Poor are considered biologically impaired with conditions in the water body not supporting the beneficial uses at those locations. Locations with IBI scores of Fair, Good, or Very Good are presumed to be unimpaired and the aquatic life beneficial use is presumed to be supported by conditions in the water body. Algal bioassessment scores will be calculated using the preliminary algal Index of Biotic Integrity (Fetscher 2013). IBI scores will be calculated for every bioassessment sampling site. Based on the IBI scores, the San Diego Water Board will identify and determine the location of biologically impaired sites. By comparing the IBI scores from this monitoring with past IBI scores, we will be able to look for trends in biological impairments and reference conditions. This will allow the San Diego Water Board to determine correlations between the results from physical habitat assessment (in-stream and riparian habitat), conventional water chemistry, and IBI scores to help explain patterns in the biological data.

Data will be compared to applicable water quality objectives and other relevant thresholds. We will compare IBI scores from reference sites and IBI scores from non-reference sites. However, biological objectives are currently under development for the State of California; if the biological objectives are adopted during this project, they will be used for data analysis.

4.3.3 Data Management

Data will be stored in the SWAMP database, and will be uploaded into CEDEN. Preliminary site data will be entered within one month of sample collection. The data produced by this study will be used for future water quality assessments under the Clean Water Act (CWA), sections 305(b) and 303(d).

5 Fish Bioaccumulation Study Methods

5.1 Monitoring Design

5.1.1 Site Selection

Due to constraints in funding, monitoring sites and species will be selected based on a targeted approach. Sites will be selected downstream from El Capitan, San Vicente, and Jennings reservoirs, which were sampled as part of the Statewide BOG study (Davis et al. 2010). For the proposed study, we will include new sites as well as new species that were not sampled in the past.

Funding is available to analyze a total of 10 composite samples. Concurrent efforts are underway to conduct a San Diego River Watershed fish consumption survey for lakes, streams, and reservoirs in conjunction with the SDRPF and CADFW. These efforts are expected to identify the species and areas within the watershed that receive the most consumptive use. However, this survey will take a year to complete, and no information is available to date on the level of pollutants within urbanized fishing areas in the San Diego River Watershed, including for some targeted species not sampled by the BOG. Thus, the sampling will be divided into a two year phased approach:

Year 1: Collection of baseline information on species of concern, and
Year 2: Focused efforts based on site and species consumption survey results.

The first year of sampling will be targeted as follows:

Table 3. Year One San Diego River Fish Tissue Sampling

Receiving Water	Species	No. Composites
El Capitan Reservoir	Black Crappie, *Pomoxis nigromaculatus*	1
San Diego River	Channel Catfish, *Ictalurus punctatus*	1
San Diego River	Largemouth Bass, *Micropterus salmoides*	1
San Diego River	One of the Sunfish species, genus *Lepomis* spp.	1

Year one will focus primarily on the lower San Diego River, sampling three potentially consumed species occupying differing trophic levels. Sampling will be conducted at the Old Mission Dam site to allow for a comparison to historical data from the TSMP. The Old Mission Dam site has also been extensively sampled for bioassessment, has on-going water quality measurements, and is a documented fishing location. El Capitan Reservoir will also be sampled for black crappie, a species of concern not included in previous BOG studies. Year one will also include angler consumption surveys by the CADFW, SDRPF, and San Diego Water Board.

Year two will conduct sampling for six additional composite samples utilizing information collected in the Year one angler consumption survey combined with the Year one tissue data results. Additional sites and species replicates may be collected and analyzed, in consideration of USEPA and OEHHA assessment recommendations which recommend a minimum of three replicate composites per species containing a cumulative minimum of nine fish (USEPA 2000a, Klasing and Brodberg 2003). If selenium is not found to be a pollutant of concern, as evidenced by historic and BOG data for the watershed, then funding for selenium analysis for the second year will be shifted to sampling individual largemouth bass for mercury to model bioaccumulation rates for the lower watershed.

5.1.2 Species Considerations

The angler consumption survey conducted in year one should provide useful information as to which species are targeted for consumption by anglers. Year one tissue data will provide a baseline for species at differing trophic levels which are typically found to bioaccumulate specific pollutants.

The largemouth bass is non-native to southern California but is considered a popular sport fish and an apex piscivorous predator in riverine and reservoir systems (Page and Burr 1991, Hambright et al. 1986). As an apex predator, mercury is a bioaccumulative pollutant of concern for the species. Existing San Diego reservoir data demonstrate that the species is primarily caught for sport (catch and release), and that mercury tissue levels are often above advisory levels. Size limits for largemouth bass are typically 355-381 mm (14-15 inches) total length. Samples for largemouth bass will thus be focused on this size class or larger, which conforms with USEPA 75 percent rule and size class recommendations (UESEPA 2000).

The black crappie (*Pomoxis nigromaculatus*) is non-native to southern California and is considered an intermediate level piscivorous predator (Page and Burr 1991). Unlike largemouth bass, black crappie are commonly targeted for consumption (*C. Loflen, personal observation*), though tissue data has not been collected. The size limit for crappie in El Capitan Reservoir is 254 mm (10 inches) total length. Samples for crappie will thus be focused on this size class or larger, which conforms with USEPA 75 percent rule and size class recommendations (UESEPA 2000).

The channel catfish is non-native to southern California and is considered a benthic omnivorous predator wherever found (Page and Burr 1991). Channel catfish exhibit higher lipid content than other predators, which may result in higher levels of bioaccumulation for organic constituents.

The sunfish genus (*Lepomis* spp.) includes various species (e.g. *L. microlophus, L. macrochirus, L. cyanellus*) that are non-native to southern California. These fish are considered lower trophic level predators, feeding mainly on invertebrates and small minnows (Page and Burr 1991, Hambright et al. 1986). As they occupy a lower trophic level and have a high growth rate, they often are considered safe for consumption in areas where other fish are not (e.g. May et al. 2000).

5.1.3 Method of Collection

Fish collection methods will be site and species specific, and consist of:
1. Electroshock
2. Beach Seine
3. Hook-and-Line
4. Trot-line
5. Trap

5.2 Fish Selection, Compositing and Analysis

5.2.1 Fish Selection and Field Measurements

Fish will be collected at each site by qualified San Diego Water Board and CADFW staff. Upon capture, the following measurements will be made in the field:
1. Total Length (mm)
2. Fork Length (mm)
3. Sex (if field dissected)
4. Weight (g)
5. External health (lesions, cuts, etc…)
6. Fish otoliths may be extracted to determine fish age at a later date.

Fish total lengths will be evaluated to determine if they meet the USEPA 75 percent rule and size class targeted (UESEPA 2000). Fish collected that are shorter than the target size class will immediately be returned to the receiving water. Fish to be utilized for composites will be tagged with a unique ID utilizing a t-bar, metal-coded, or similar tagging system.

5.2.2 Compositing

Composite samples will be utilized for each site and species, and contain no less than 5 individual fish[4] per composite. Composites will be created using the following guidelines:

1. Size: Specific size classes for largemouth bass and black crappie. All species must meet the 75 percent rule.
2. Location: Fish collected from different locations within a site will be distributed among composites.
3. Date of Catch: Fish collected at the same or different locations on different days will be distributed among composites.
4. Mode of Catch: It is expected one method will be utilized per species, but if different modes are utilized they will be distributed among composites.

While the composites will contain no less than five fish, the study will attempt to composite samples at each site utilizing exactly five fish per species per site to allow for a consistent statistical analysis without transformations needed for each composite. Due to unforeseen issues with transport, tissue quality and/or quantity, and timing, targets will be set to sample at least six-seven fish per species per site to ensure enough organisms are available to create composites of a set organism size.

[4] For smaller species (e.g. bluegill) 10 fish may be needed per composite.

Should individual largemouth bass be collected for mercury analysis, size ranges will be collected that are consistent with previous BOG sampling efforts (BOG 2008). These data can then be used to model the relationship between age and tissue concentration.

5.2.3 Sample Processing

Each fish collected will be tagged with a unique ID as described above, with multiple parameters measured in the field, including total length and weight. As lengths may change with freezing and thawing, it is best noted in the field for greatest accuracy and because it is the method fishermen and wardens use to determine whether a fish is legal size.

Whole fish will be placed on wet ice for transportation to the San Diego Water Board laboratory, where they will be wrapped in aluminum foil and stored frozen at 20°C until shipment to the appropriate laboratory. Fish will be kept frozen wrapped in foil until the time of dissection. Dissection of tissue will be conducted for skin off fillets, as prescribed in Davis et al. 2010. Dissection and compositing of muscle tissue samples will be performed following USEPA guidance (USEPA 2000). At the time of dissection, fish will be placed in a clean lab to thaw. After thawing, fish will be cleaned by rinsing with de-ionized (DI) and ASTM Type II water, and handled only by personnel wearing polyethylene or powder-free nitrile gloves (glove type is analyte dependent). All dissection materials will be cleaned by scrubbing with Micro® detergent, rinsing with tap water, DI water, and finally ASTM Type II water. Composites will be created based on the 75 percent rule recommended by USEPA (2000). In general, fish will be filleted, and only the fillet muscle tissue will be used for analysis. No portions of the skin will be used to create the composite. While whole or other portions of fish may be consumed by some anglers (e.g. eggs, digestive glands, etc…), budgetary constraints and the screening level of the study limits analysis to the primary area of edible muscle tissue.

Tissue compositing and analyses will be performed by the MPSL. Analysis of organics will occur at the CADFW's WPCL.

5.2.4 Analytes

Since the study is focused on assessing the impacts of bioaccumulation on the COMM beneficial use, the analyte list is driven by concerns about human exposure. Contaminants were included if they were considered likely to provide information relative to historic data and current consumption guidelines. Additional discussion of specific analytes is provided below.

Ancillary Parameters
Ancillary parameters to be measured in the lab include tissue moisture and lipid content.

Methylmercury (EPA 7374)
Methylmercury is the contaminant of greatest concern with respect to bioaccumulation on a statewide basis. Methylmercury will be measured as total mercury as nearly all of

the mercury present in edible muscle is methylmercury (Davis et al. 2010). Mercury will be analyzed in all composite samples because samples are expected to contain mercury and potentially exceed the threshold of concern as evidenced by the BOG reservoir sampling. Mercury in individual largemouth bass may also be analyzed to model rates of bioaccumulation.

Polychlorinated Biphenyls (PCBs, EPA 8082M)

PCBs are the contaminant of second greatest concern with respect to bioaccumulation on a statewide basis (Davis and Greenfield 2007), and San Diego Bay is listed as impaired on the Clean Water Act section 303(d) list of impaired waterbodies due to PCBs in sport fish tissue (San Diego Water Board 2010). Elevated PCB levels were also detected in the San Diego River reservoirs, though not above OEHHA advisory levels. Total PCBs will be analyzed in all composite samples using gas chromatography.

Selenium (EPA 7374)

Selenium will be analyzed in composite samples for the first year of the project. While selenium was not detected in any fish tissues from San Diego River reservoirs or at levels of concern in historic data, it has been identified as a pollutant causing impairment in Alvarado Creek, Forester Creek, and Los Coches Creek, all tributaries to the lower San Diego River. Selenium has also been shown to be a bioaccumulative pollutant of concern in aquatic ecosystems (Besser et al. 1996, Schlekat et al. 2004).

Organochlorine Pesticides (OC Pesticides, EPA 8081 AM)

OC Pesticides (DDT and Chlordane) were not detected at levels of concern within the San Diego River reservoirs. However, the reservoirs sampled have little agriculture upstream, with most historic use occurring in the lower San Diego River. For example, elevated levels of DDE and chlordane have been detected in San Diego Bay pacific green sea turtles (Komoroske et al. 2011), and some areas of San Diego Bay have been listed as impaired for chlordane (San Diego Water Board 2010). Thus OC Pesticides will be analyzed in all composite samples using gas chromatography.

Other Contaminants

Other potential contaminants considered for analysis included tributylin tin (TBT), PAHs, PBDEs, and pyrethroid pesticides. The additional cost of analyzing these pollutants is high, and there is a lack of funding for the additional testing. Thus, analysis for these additional parameters is not warranted at this time.

5.2.5 Quality Assurance

Staff from the San Diego Water Board and Marine Pollution Studies Laboratory will coordinate sampling, shipping, and composite sampling efforts. A minimum two week notice will be given to the Marine Pollution Studies Laboratory for sampling efforts. Fish outside the 75 percent rule or subject to shipping issues will not be utilized for fish composites. Any suspected shipping issues by those receiving the samples will result in notification to the Project Manager and Co-Manager to determine if additional

sampling of the target species is needed. Each composite created will be archived to allow for future analysis if needed. The compositing and analysis will be done in accordance with the Screening Study of Bioaccumulation in California Lakes and Reservoirs Quality Assurance Project Plan (BOG 2008, Bonnema 2009).

All San Diego Region SWAMP sampling and analyses will be performed under the State Water Board statewide SWAMP master contract.

5.3 Data

5.3.1 Data Quality Evaluation and Data Reporting

Data quality evaluation and data reporting will be as specified in the BOG QAPP (Bonnema 2009) and SWAMP QAPP. We do not anticipate needing additional special data quality evaluation or data reporting procedures.

5.3.2 Data Analysis

For fish tissue data, the level of pollutants in each composite for each species will be compared to OEHHA advisory levels (Klasing and Brodberg 2008, OEHHA 2009) and to Fish Contaminant Goals. Based on the levels, the San Diego Water Board will identify the species and location(s) where the COMM beneficial use is not being met. We will also compare the levels of pollutants between species and sites, and with historic data. Unfortunately the level of replication for composite samples is too low to conduct a meaningful statistical analysis. However, as the data will be comparable to that collected by the BOG, it may be utilized in state or region-wide analytical efforts.

5.3.3 Data Management

Data will be stored in the SWAMP database. The data will also be uploaded into CEDEN. The data produced by this study will be used for future water quality assessments under the Clean Water Act (CWA), sections 305(b) and 303(d).

6 Collaborations

The San Diego Water Board will collaborate with other agencies, non-governmental organizations, non-profit organizations (e.g. the San Diego River Park Foundation), and/or Tribal Nations within the San Diego River Watershed as part of the San Diego Water Board's Monitoring and Assessment Framework.

These efforts are part of the San Diego Watershed Monitoring Workgroup, which is in the process of integrating monitoring conducted by various entities throughout the watershed to develop watershed report cards, which are focused on the following questions:

1. Is it safe to swim?
2. Is it safe to eat fish and shellfish?
3. Is the ecosystem healthy?
4. Is it safe to drink?

The results from the project will assist in answering questions 2 and 3, which will in turn provide data to be used to generate the watershed report cards.

We will coordinate and integrate SWAMP monitoring with other San Diego River Watershed monitoring efforts. These non-SWAMP monitoring efforts include:

1. Fish population dynamics for the lower San Diego River;
2. Recreational Use Surveys of the lower San Diego River;
3. Monitoring conducted independently of regulatory requirements.

7 Deliverable Products/Reporting

The deliverable product will be a technical report that presents the findings of the bioassessment and fish tissue portions of the proposed study. The report should be available to the public on the San Diego Water Board website in March 2015. A project Fact Sheet will also be developed that summarizes the project and results. Project results will be presented to the San Diego River Coordination Group and SWAMP Roundtable.

8 Project Schedule

Field sampling for the proposed monitoring plan will start in spring/summer of 2013, and will continue through spring/summer of 2014. Laboratory analysis will start in spring 2013 and will continue until 2014. Data analysis and results will start in fall of 2013 and will continue until all data are available. The final technical report will be available in March 2015.

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