SWAMP
Surface Water Ambient Monitoring Program

Stream Pollution Trends Program (SPoT) Technical Report	**2014**

Trends in Chemical Contamination, Toxicity and Land Use in California Watersheds: Stream Pollution Trends (SPoT) Monitoring Program Third Report - Five-Year Trends 2008-2012

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List of Acronyms

BMI:	Benthic Macroinvertebrate
BOG:	Bioassessment Oversight Group that directs the SWAMP bioaccumulation monitoring program
CDPR:	California Department of Pesticide Regulation
CEDEN:	California Environmental Data Exchange Network
DDT:	Dichlorodiphenyltrichloroethane, synthetic organochlorine pesticide known for its persistent toxicity and banned in the United States in 1972
DFW:	California Department of Fish and Wildlife
EPT:	Ephemeroptera/Plecoptera/Trichoptera Index
GIC:	The Geographic Information Center at California State University, Chico
IBI:	Index of Biological Integrity
LC50:	Median Lethal Concentration
MPSL:	Marine Pollution Studies Laboratory, consisting of the toxicology laboratory at Granite Canyon, and the logistics, data management, and trace metal analytical laboratory at Moss Landing
NAWQA:	National Water Quality Assessment, a program of the US Geological Survey
NLCD:	National Land Cover Dataset
PAH:	Polycyclic aromatic hydrocarbons, a suite of organic pollutants produced through combustion of fossil fuels
PBDE:	Polybrominated diphenyl ethers, which are widely employed as flame-retardants. In 2006 the State of California began prohibiting the manufacture, distribution, and processing of pentaBDE and octaBDE products.
PCB:	Polychlorinated biphenyls, a group of industrial compounds widely used for their insulating properties. PCB production was banned in the United States in 1979.
PEC:	Probable Effect Concentration. An empirically derived sediment quality objective that sets a concentration above which toxicity is expected to occur (Macdonald, 2000).
PSA:	Perennial Streams Assessment. The SWAMP statewide program measuring ecological indicators at probabilistically selected sites in California streams.
RMC:	Regional Monitoring Coalition
SRC:	Scientific Review Committee
SPoT:	Stream Pollution Trends Monitoring Program
SQO:	Sediment Quality Objectives
SWAMP:	Surface Water Ambient Monitoring Program
TMDL:	Total Maximum Daily Load
TOC:	Total Organic Carbon
TU:	Toxic Unit
WPCL:	California Department of Fish and Wildlife's Water Pollution Control Lab

Executive Summary

The Stream Pollution Trends (SPoT) program conducts statewide monitoring to provide information needed by the California Water Boards to assess the levels to which aquatic life beneficial uses are supported in California streams and rivers. As part of the Surface Water Ambient Monitoring Program (SWAMP), SPoT was initiated in 2008 with three primary goals:

1. Determine long-term, statewide trends in stream contaminant concentrations and effects.
2. Relate key water quality indicators to land-use characteristics and management efforts.
3. Establish a network of sites throughout the state to serve as a backbone for collaboration with local, regional, and federal monitoring programs.

The SPoT program is specifically designed to fill critical information needs for state, regional and local resource management programs, including Clean Water Act §303d impaired waters listing, CWA §305b condition assessment, total maximum daily load (TMDL) assessment and allocation, non-point source program water quality assessment, stormwater and agricultural runoff management, pesticide regulation, and local land use planning. The program also remains adaptive by monitoring contaminants of emerging concern through collaborations with the California Department of Pesticide Regulation, various federal and state agencies, university research groups, and others.

Watersheds described in this report represent approximately one half of California's major watersheds. Sediments deposited at the base of these watersheds tend to integrate contaminants transported from land surfaces throughout the drainage area, and chemical analyses of sediment combined with sediment toxicity testing allow an assessment of water quality trends in these watersheds and throughout the state. When combined with land use characterizations, SPoT data provide water quality managers with essential information about how land use affects water quality.

Toxicity of sediments was assessed using the amphipod *Hyalella azteca*, which represents a genus found throughout California watersheds. The percentage of sediments toxic to amphipods remained relatively consistent among the sampling years represented in this report, and averaged 19%.

Detections and concentrations of currently used pyrethroid pesticides continue to increase in California watersheds, primarily those with the highest percentage of urban land use. While the trend data do not show an increase in the incidence of sediment toxicity when testing is conducted at the standard protocol temperature, the incidence of toxicity greatly increased in a subset of sites when tests were conducted at a temperature that more closely reflects the ambient temperature in California watersheds (~15°C). Higher toxicity at colder temperature is diagnostic of toxicity due to pyrethroid pesticides. The pattern of increasing detections of pyrethroids coupled with the increase of cold temperature toxicity suggests that current monitoring using the standard protocol may under-estimate the occurrence of pyrethroid-associated toxicity.

While organochlorine compounds, such as PCBs and the legacy pesticide DDT continued to be detected in many of the state's watersheds, the concentrations have always been below those demonstrated to cause toxicity to *H. azteca*. These chemicals continue to be of concern in California because of their potential to bioaccumulate. While concentrations in fish do not often exceed thresholds of concern (Davis et al., 2013), numerous fish consumption advisories have been issued for lakes, rivers, bays, and coastal areas due to these contaminants. PBDEs also are not acutely toxic to *H. azteca*, but have potential to bioaccumulate in the environment, and may affect human health. These chemicals did not exhibit any significant trends at the statewide level, or by land use, and although PDBEs are in the process of being phased out in California, SPoT will continue to measure them to document the potential decreasing trend. Concentrations of metals in sediments were relatively stable, and selected metal concentrations were lower than toxicity thresholds established for *H. azteca*. Because of differences in sensitivity between *H. azteca* and other resident taxa, and the potential for particular metals to either be toxic to resident macroinvertebrates (Cd, Cu, and Zn) and stream algae, or to bioaccumulate (Hg), metals will continue to be important indicators of watershed contamination as SPoT proceeds.

In a recent summary of SWAMP surface water toxicity testing conducted between 2001 and 2010, Anderson et al. (2011) showed that approximately 45 to 50% of the sites monitored by State Water Resources Control Board programs demonstrated some water or sediment toxicity. Correlation and toxicity identification evaluation studies showed that the majority of toxicity was associated with pesticides, specifically organophosphate and pyrethroid pesticides. The results of SPoT monitoring corroborate these findings.

Given the evidence that pesticides are associated with ambient toxicity in California waters, certain emerging pesticides were prioritized for inclusion in the SPoT analyte list. The phenylpyrazole insecticide fipronil was measured in urban watersheds in 2013, and the neonicotinoid imidacloprid will likely be added in the coming years. Because SPoT utilizes toxicity testing, in part, to monitor for emerging chemicals of concern, in 2015 the program will test with an additional organism that is more sensitive to fipronil, imidacloprid, and their degradates. In collaboration with California State University Monterey Bay, the program also began statewide monitoring of algal toxins in sediment in 2013. These toxins represent an emerging threat to human and ecological health in California, and the SPoT data will complement those of other state and regional programs to assess this threat.

An assessment of the relationship between water quality indicators measured by SPoT and watershed ecological indicators measured by SWAMP and other benthic macroinvertebrate bioassessment programs showed a significant correlation between amphipod survival in laboratory toxicity tests and the Index of Biological Integrity (IBI) calculated from the bioassessments. This analysis also revealed a significant negative correlation with contaminant concentrations, particularly pyrethroid pesticides. The IBI was also negatively correlated with some habitat parameters. As more benthic macroinvertebrate data are incorporated into the databases, a more detailed assessment of these relationships will be possible. These statistical relationships provide a basis for developing hypotheses for assessing causal relationships between in-stream ecological degradation and toxicity and chemical stressors.

Based on SPoT's statewide coverage, the program is positioned to detect changes in toxicity and contamination in California watersheds as management actions are implemented. For example, SPoT is collaborating with the California Department of Pesticide Regulation to determine if use restrictions and outreach to professional pesticide applicators result in a decline in sediment-associated pyrethroids in urban watersheds. SPoT sites and data also are used by several Regional Water Boards to detect and monitor trends in stream contaminant concentrations and effects. The SPoT program will provide data on the effectiveness of urban and agricultural management practices, such as low impact development and vegetated buffer zones, and will track source controls, such as the phase-out of copper in vehicle brake pads.

The data presented in this report describe the baseline condition for the SPoT long-term trends assessment. They also demonstrate a significant relationship between land use and stream pollution, and provide data directly relevant to a number of agency water quality protection programs. Analysis of five years of SPoT data has suggested that elements of the program should be adjusted in coming years to accommodate the evolving data needs of water quality managers. Suggested revisions include the strategic addition of contaminants of emerging concern as they are identified, and the concomitant de-emphasis of legacy contaminants that pose less of an environmental threat to California watersheds. The program is also revising the number and frequency of statewide stations monitored to maximize its ability to address key management questions concerning contaminants that pose the greatest risk to California's surface waters.

Introduction

SPoT in the SWAMP Assessment Framework

The Stream Pollution Trends program (SPoT) is a core component of the Surface Water Ambient Monitoring Program (SWAMP) and monitors changes in water quality and land use in major California watersheds throughout the state. SPoT provides water quality information to regional and statewide water quality managers responsible for evaluating the effectiveness of regulatory programs and conservation efforts at a watershed scale. SPoT is a long-term statewide trends assessment program, and the data collected are being used to detect changes in contamination and associated biological effects in large watersheds at temporal and spatial scales appropriate for management decision making. A complete discussion of assessment questions and links to various water quality programs is included in Appendix 1.

The three specific program goals are to:

1. Determine long-term trends in stream contaminant concentrations and effects statewide.

2. Relate water quality indicators to land-use characteristics and management effort.

3. Establish a network of sites throughout the state to serve as a backbone for collaboration with local, regional, and federal monitoring.

Monitoring Objectives and Design

The methods of the program were selected to meet the following monitoring objectives:

1. Determine concentrations of a relevant suite of current-use and legacy contaminants in depositional sediment collected near the base of large California watersheds;

2. Determine whether these depositional sediments are toxic to a representative species;

3. Quantify land cover data available from the National Land Cover Dataset and other public sources;

4. Analyze data to evaluate relationships between contaminant concentrations, toxicity, and land cover metrics;

5. Conduct trends analyses to detect the direction, magnitude, and significance of change in the above parameters over time.

The SPoT indicators are measured in stream sediment because this environmental compartment integrates chemical contamination over time. Most trace metal and organic pollutants that enter streams adhere to suspended sediment particles and organic matter, and this sediment-associated phase is the major pathway for contaminant loading in streams and downstream waterways. In addition, river benthic environments are ecologically important because they provide habitat to key elements of aquatic macroinvertebrate communities. Sediment measurements are appropriate for long-term trend monitoring because pollutants that accumulate in depositional sediment on the stream bed are much more stable over time (~months to years) than dissolved or suspended pollutants that move downstream in pulses that are highly variable over short time scales (~hours). SPoT surveys are timed to collect sediment in summer after the high water season when most sediment and pollutant transport takes place. It should be noted that SPoT has been discussing the possibility of expanding the program to include water column monitoring. This is intended to address newer classes of pesticides which, based on their high solubility, would not be expected to partition to sediments.

The monitoring design was based on the US Geological Survey's National Water Quality Assessment (USGS – NAWQA: http://water.usgs.gov/nawqa/). The NAWQA program is designed to increase understanding of water-quality conditions, of whether conditions are getting better or worse over time, and how natural features and human activities affect those conditions. The NAWQA integrator site concept provided the basis for the SPoT monitoring design. NAWQA integrator sites are established near the base (discharge point) of larger, relatively heterogeneous drainage basins with complex combinations of environmental settings. Sediments collected from depositional areas at integrator sites provide a composite record of pollutants mobilized from throughout the watershed. While many hydrologic, engineering, and environmental variables affect the ability of this record to adequately characterize all pollutant-related activities, sediment samples collected from such areas are considered to be a relatively good and logistically feasible means of assessing large watersheds for long-term trends (e.g., Horowitz and Stephens, 2008; see, http://pubs.usgs.gov/circ/circ1112/sediment_tissue.html).

SPoT employs a targeted monitoring design to enable trend detection on a site-specific basis. To serve their purpose as integrator sites, SPoT sites are located at the base of large watersheds containing a variety of land uses. Because depositional sediment is needed for sample collection, sites are targeted in locations with slow water flow and appropriate micro-morphology, to allow deposition and accumulation. SPoT and NAWQA use integrator sites because both programs focus on understanding causes and sources of water quality impairment. The connection with land use is a major part of the assessment, and targeted sites allow greater discretion to adjust to significant land cover variation in low watershed areas. A targeted approach allows SPoT flexibility to link to established sites and to support collaboration with watershed-based monitoring programs.

Coordination and Collaboration with other Programs

The SPoT network of sites was established through coordination with Regional Board monitoring coordinators and stormwater agencies, under the guidance of the SPoT Scientific Review Committee (SRC). The Southern California Stormwater Monitoring Coalition participated in site selection for the southern California SPoT sites. A representative from the Bay Area Stormwater Management Agencies Association served on the SWAMP committee that designed the program, and all SPoT sites in the San

Francisco Bay Region are aligned with the Regional Monitoring Coalition monitoring sites for the Municipal Regional Stormwater NPDES Permit (BASMAA (Bay Area Stormwater Agencies Association), 2011). SPoT sites in the Central Coast and Central Valley Regions are shared by the Cooperative Monitoring Program for agriculture and Irrigated Lands Regulatory Program, respectively (Appendix 2). In most cases, the SPoT assessments of sediment toxicity and chemistry complement water column measurements made by cooperating programs. SPoT data have also been included in a series of California Regional Water Quality Control Board reports that are in the series "Toxicity in California Waters".

SPoT is one of three statewide monitoring programs conducted under the SWAMP framework. The Perennial Streams Assessment program (PSA) and the Bioaccumulation Oversight Group (BOG) also conduct statewide surveys, but have different assessment questions from those of SPoT. While all three programs seek to measure aquatic ecosystem health on a statewide level, the PSA uses probability-based assessments of macroinvertebrate and algal communities to determine stream condition. This program examines the relationship between the stream condition and land use, and determines which stressors are related to the biological condition (Ode et al., 2011). Other than nutrients, the PSA program does not measure chemical contaminants. The focus of BOG is on fishing as a beneficial use (Davis et al., 2013). BOG uses a targeted design to sample sport fish from popular fishing areas in rivers and streams. Selected contaminants are analyzed in fish tissue to determine if established concentrations of concern have been exceeded. SPoT also uses a targeted sampling design to revisit the same sites yearly. This design allows for succinct trend analysis, and allows the program to detect emerging chemicals through consistent use of toxicity testing. BOG focuses on chemicals that bioaccumulate, such as mercury and PCBs.

SPoT complements the PSA by focusing on the magnitude of pollution in streams, using toxicological endpoints to establish causal connections between these chemicals and biological impacts, and by analyzing land cover as part of a watershed-scale evaluation of the sources of pollutants affecting aquatic life. The PSA helps address SPoT goals by assessing the overall health of wadeable perennial streams, and by testing assumptions about the status of reaches upstream of the intensive land uses that are associated with pollutants measured by SPoT. SPoT complements the BOG by identifying watershed sources for contaminants measured in fish from downstream waterways. The BOG complements SPoT by providing perspectives on the fate and human health aspects of pollutants in streams, particularly as related to their uptake in fish tissue and risk associated with human consumption. PSA, BOG, and SPoT together provide freshwater data similar to those used in other programs to develop sediment quality objectives (SQOs) in marine and estuarine habitats. Co-location of sites or addition of specific indicators across the PSA, BOG, and SPoT programs could allow for development of freshwater SQOs for California.

More recently, SPoT has been working with the California Department of Pesticide Regulation (DPR) to increase monitoring at four sites to capture short-term trends in the reduction of pyrethroids. DPR recently implemented regulations to reduce the quantity of pyrethroids applied by professional applicators on impervious surfaces in urban areas. Funding provided by DPR has enabled SPoT to increase monitoring at two base stations, and add two DPR stations to the program. The four stations are monitored four times per year for sediment toxicity, as well as pyrethroid and fipronil concentrations in sediment. This intensive monitoring began in 2013 and initial results will be discussed in the next report. It is anticipated that additional toxicity testing with the chironomid *Chironomus dilutus* will be included to account for fipronil toxicity at the most urban (Tier II) sites in 2015.

In 2013 SPoT began monitoring cyanotoxins from cyanobacteria to provide statewide baseline data for this class of contaminants in sediment. Cyanobacteria blooms are expected to increase due to nutrient enrichment, warming surface water temperatures and extreme weather associated with climate change. Microcystins are a class of potent cyanotoxins occurring primarily in freshwater environments. California State University Monterey Bay (CSUMB) researchers analyzed SPoT sediments for microcystin-LR. Microcystin-LR, the most toxic and often most common variant of microcystin, was identified in 77% of the 83 samples analyzed. This is the first statewide survey of microcystin presence in California sediments. This monitoring also began in 2013 and initial results will be discussed in the next report.

SPoT was specifically designed to provide data that can inform regulatory programs and conservation initiatives. SPoT data can be incorporated directly into the Clean Water Act § 303[d] listing of impaired waters, as well as into the statewide status assessments required by § 305[b]. SPoT data are included in the Integrated Report process and incorporated into the lines of evidence process used to evaluate sites for inclusion in regional 303(d) lists of degraded water bodies. Statewide, there are 409 manually generated lines of evidence from the SPoT data set.

The SPoT focus on causes and sources of pollutants in watersheds feeds directly into Total Maximum Daily Load program efforts to quantify pollutant loadings and understand sources and activities that contribute to those loadings. By coordinating with local and regional programs, SPoT provides statewide context for local results, and provides information useful for local management and land use planning activities. SPoT is also specifically designed to assist with the watershed-scale effectiveness evaluation of management actions implemented to improve water quality, such as pesticide reduction or irrigation management on farms, and installation of stormwater treatment devices or low impact development in urban areas. Use of SPoT data for watershed scale evaluations of management practice effectiveness is currently limited by the lack of a comprehensive and standardized reporting system for practice implementation. This is the subject of on-going efforts at DPR, County Agriculture Commissioner Offices, and the Regional Boards.

Report Outline

The SPoT reporting schedule is intended to summarize program findings biennially. This report summarizes results of five years of SPoT monitoring from sites representing approximately one half of California's major watersheds, and presents data in support of the primary program goals discussed above. Methods and quality assurance sections cover the 2011 and 2012 sampling seasons. The focus of the current report is on five-year trends in toxicity and chemical measurements as they relate to land use, but the combined Results and Discussion sections cover six topics: contaminant trends related to land use, toxicity trends related to land use and contaminants, SPoT indicators in relation to stream ecology, regional trends summarized based on individual Regional Board coverage, statistical relationships among SPoT parameters, and evaluation of the current program design. These data will inform evolution of the next several years of the program.

Methods

Site Selection and Survey Timing

SPoT has surveyed 92 to 100 sites in four of the five years covered in this report. SPoT program funding was greatly reduced in 2009 and only 23 sites were sampled. Full funding was restored in 2010, and 95 stations were surveyed, followed by 100 in both 2011 and 2012 (Figure 1, Appendix 2). In 2009 sites were chosen based on several factors: input from Regional Boards and regional representation, inclusion of reference sites, and some focus on known toxic locations.

A number of factors were considered when selecting SPoT sites (Hunt et al., 2012). The most important factors included location in a large watershed with heterogeneous land cover; location at or near the base of a watershed, defined as the confluence with either an ocean, lake, or another stream of equal or greater stream order; and location where site-specific conditions are appropriate for the indicators selected (e.g., depositional areas, sufficient flow, appropriate channel morphology, substrate). The current 100 SPoT sites represent 58 8-digit USGS hydrologic unit code watershed in the California Region and 4 in the Great Basin Region. Availability of previous data on sediment contaminant concentrations, biological impacts, or other relevant water quality data was also an important consideration, particularly if sites could be co-located with key sites from cooperative programs. Two examples of co-location are the intensive monitoring sites currently monitored by CDPR to survey current-use pesticides, and storm water sites monitored for regional MS4 NPDES monitoring programs.

During sample collection at most SPoT sites, fine sediment particles were found in thin layers throughout the channel. Some sites were dominated by deep deposits of fine sediment. At many sites, however, there were fewer locations where fine sediment accumulated in layers thick enough to allow efficient sample collection (> 2 cm). To put the availability of depositional areas into context, consider that Hall *et al.* (2010) mapped fine sediment distributions at 99 transects in three California streams, each designated as agricultural, urban or residential. They estimated that an average of 17% of the stream bed was characterized as “depositional”. SPoT results should not be construed as a characterization of the entire stream in which study sites were located. Rather they are intended as relative indicators of the annual pollutant mobilization and transport within target watersheds, which is a useful metric for evaluating annual trends.

The SPoT reference sites provide information on temporal trends in contamination and toxicity in the absence of any obvious sources of contaminants based on land use (Figure 1). Five large watersheds with relatively low levels of human activity were selected, representing the north coast, San Francisco Bay Area, Sierra foothills, coast range, and southern California inland areas. Sites in these watersheds were selected based on the criteria outlined above. Two reference sites are USGS NAWQA sites in the San Joaquin and Santa Ana River study units: Tuolumne River at Old La Grange bridge 535STC210 (San Joaquin) and San Jacinto River Reference Site 802SJCREF (Santa Ana).

SPoT surveys are timed so that sediment is collected from recent stream bed deposits during base flow periods after the high flow season, when most sediment and pollutant transport and loading take place. In general, surveys began in coastal southern California in late spring, ran through coastal central California in early summer, the Central Valley in mid-summer, the eastern Sierra in late summer, and ended at the North Coast and Colorado River Basins in the fall. This timing has been consistent among sampling years to minimize intra-annual variation as a factor affecting long term trends.

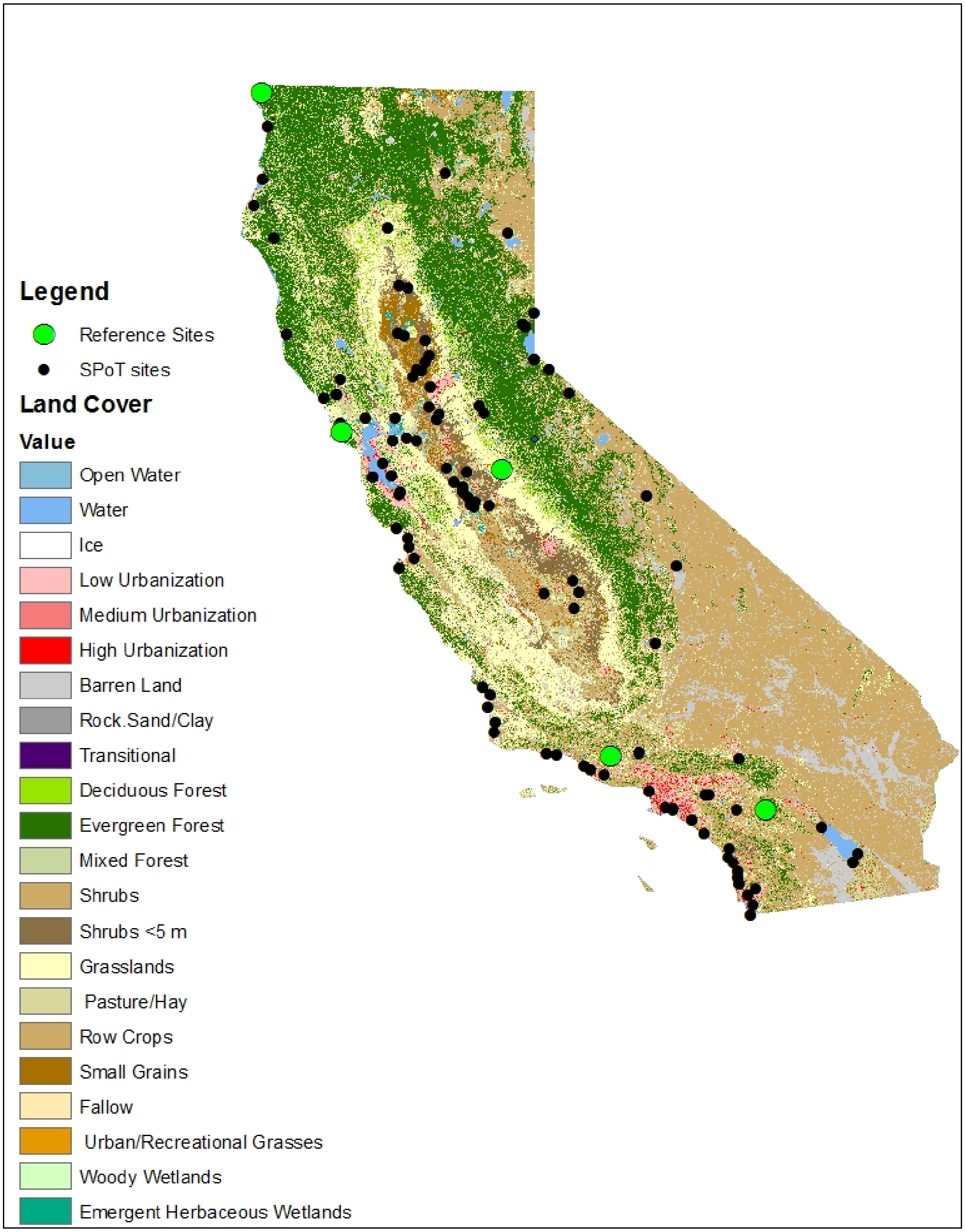

Figure 1. 2012 SPoT sites (black circles), reference sites (green circles), and land use categories.

Indicators and Parameters Measured

SPoT indicators were selected to measure contaminants previously demonstrated to be of concern in California streams, as well as assess toxicity to a benthic crustacean representing a resident genus. Indicators were chosen based on criteria outlined in the SPoT 2008 Report (Hunt et al., 2012). Based on these criteria, the following sediment indicators were selected:

1. Toxicity – 10-day growth and survival test with the representative freshwater amphipod *Hyalella azteca*, to estimate biological effects of contaminants;

2. Tier I Contaminants - Organic Contaminants (organophosphate, organochlorine, pyrethroid pesticides, and polychlorinated biphenyls (PCBs)) and Metal Contaminants - Ag, Al, As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Zn;

3. Tier II Contaminants – a subset of sediments from the most urban watersheds was also measured for polycyclic aromatic hydrocarbons (PAHs) and polybrominated diphenyl ethers (PBDEs). Fipronil was added to the Tier II list in 2013;

4. Total organic carbon (TOC) and sediment grain size;

5. Algal Toxins - the cyanotoxin microcystin-LR was added to all sites in 2013.

Participating Laboratories and Data Storage and Management

All 2011-2012 chemical analyses and toxicity tests were performed by SWAMP laboratories: the California Department of Fish and Wildlife (DFW) Water Pollution Control Laboratory (trace organics), the Marine Pollution Studies Laboratory at Moss Landing (MPSL, trace metals), and the UC Davis MPSL at Granite Canyon (toxicity). Microcystin-LR was analyzed by Cal State University Monterey Bay (CSUMB- starting in 2013). All methods and quality assurance/quality control (QA/QC) requirements are listed in the SPoT Quality Assurance Project Plan (SPoT, 2010). The results of QA/QC measurements for the 2011-2012 surveys are provided in Appendix 3.

All data collected for this study are maintained in the SWAMP database, which is managed by the data management team at Moss Landing Marine Laboratories (http://swamp.mpsl.mlml.calstate.edu/). The complete dataset includes QA data (quality control samples and blind duplicates) and additional ancillary information (specific location information, and site and collection descriptions). The complete dataset from this study is also available on the web at http://www.ceden.org/. Data for the SPoT program can be accessed from the CEDEN query system, http://www.ceden.us/AdvancedQueryTool.

Geographic Information System Analyses

Anthropogenic contaminant concentrations in streams are influenced by the mobilization of pollutants in their watersheds. The analyses described here evaluate the strength of relationships between human activity in watersheds, as indicated by land cover, and pollutant concentrations in recently deposited stream sediment. Watershed delineations and land cover data extractions were conducted by the Geographic Information Center (GIC) at California State University, Chico (http://www.gic.csuchico.edu/index.html). The entire drainage area specific to each SPoT site was delineated using automated scripts based on digital elevation models. Each delineation file was reviewed by GIC and SPoT program staff for accuracy. Reviews included comparisons to National Hydrologic Dataset catchments, and Google Earth® images of drainage areas as kml files. Drainage areas near the site were delineated with 1 km and 5 km radius buffers to create the 1K and 5K drainage areas for analysis (along with analyses of the entire watershed area draining to each site; Figure 2). Semi-circular buffers were used because engineered drainage structures and other low-watershed features made more precise delineation impossible within the scope of this analysis.

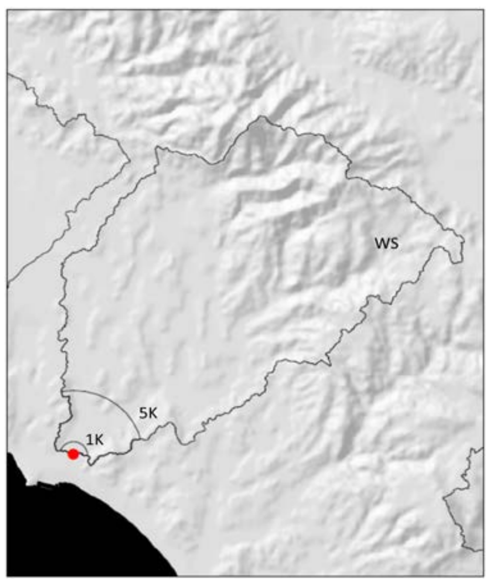

Figure 2. A depiction of watershed delineation. The red dot designates the site at the bottom of the watershed (WS, larger polygon). The semi-circular smaller areas are watershed areas 1 km (1K) and 5 km (5K) from the site.

Drainage area shape files were used to extract land cover grids from the National Land Cover Dataset (NLCD, depicted with different colors in Figure 1). The following NLCD categories were used in the analyses relating land cover to water quality. "Urban" (NLCD 22, 23, 24) included low, medium, and high intensity developed areas. "Agricultural" land cover was represented by cultivated crops (NLCD 82). For the purposes of trend analyses by land use, pollutant concentrations were compared to continuous percent land cover data as percent urban, percent agricultural, and percent open. For analyses based on comparisons among watershed types, watershed areas were characterized as "urban" if they had greater than 20% urban cover (NLCD categories 22+23+24) at the 5 km scale. This characterization is in line with studies indicating stream degradation where impervious surface cover exceeds 10% (Schueler, 1994). Watershed areas were characterized as "agricultural" if they had greater than 20% cultivated crop cover (NLCD 82). Watershed areas were characterized as "open" if they had greater than 50% combined undeveloped space (forest, wetland, shrub, barren and grassland). One site could not be defined by these criteria (603BSP002), but was considered open based on land use in the larger watershed. Thirteen sites were placed in more than one category (Table 1). It was difficult to isolate purely open watersheds at any scale. In 2012, at the 5 km scale, seven watersheds were classified as open combined with agriculture or urban, including one reference site. Six sites were defined as both agriculture and urban.

Table 1. Number of stations sampled in each 5 km land use category.

	Year				
Land Use	2008	2009	2010	2011	2012
Urban	36	12	37	40	40
Agriculture	32	9	35	36	36
Open	35	9	35	37	37
Total Sites Sampled	92	23	95	100	100

Toxicity Testing and Statistical Analyses

Toxicity tests with *Hyalella azteca* were conducted following U.S. EPA standard methods (U.S. EPA, 2000; SWAMP, 2008), and the toxicity of sediment samples was determined using the U.S. EPA's test of significant toxicity-TST (U.S. EPA, 2010; Denton et al., 2011; Diamond et al., 2011). For any given year, sites that were not toxic were coded light blue, sites that were significantly toxic were coded dark blue, and sites that were highly toxic (had percent survival lower than the high toxicity threshold for *Hyalella azteca,* 38.6%) were coded dark purple (Anderson et al., 2011). Toxicity results from multiple years were summarized using the following criteria: sites with no toxic samples were coded light blue for non toxic, sites with at least one toxic samples was coded dark blue for some toxicity, sites with at least one sample below the high toxicity threshold were coded light purple for moderate toxicity, and sites with an average survival less than the high toxicity threshold were coded dark purple for high toxicity (see Figure 11).

Because of the large number of sites and analytes, chemicals were grouped into classes for most statistical analyses. DDTs, PCBs, PBDEs, and PAHs were summed, where appropriate, in each analyte class, in accordance with previous studies evaluating sediment quality guidelines, (Macdonald, 2000). All detected pyrethroids were summed together where indicated, and pyrethroids were also summed as carbon normalized toxic units (Amweg et al., 2005). For statistical analyses, the sum of four metals (Cd, Cu, Pb and Zn) was used as an indicator of metal contamination commonly released into the environment by human activity. These metals are less likely to be influenced by geologic abundance in California (Topping and Kuwabara, 2003; Mahler et al., 2006; Bonifacio et al., 2010).

Multivariate principal components analysis was used for all statistical evaluations of relationships between toxicity, pollutants, and land cover. The analysis was run with a correlation matrix and varimax rotation, and included any factors which accounted for greater than 10% of the total variance. A component loading cutoff value of 0.50 was used in selecting variables for inclusion into factors (Tabachnick and Fidell, 1996). Statewide trends within each land use were analyzed using one-way analysis of variance. All analyses were done using IBM SPSS Statistics Package (IBM Corporation, 2011) or Q1 Macros for Excel (KnowWare International, Inc.). Power analysis was conducted using Program MONITOR (Gibbs et al., 2010).

Results and Discussion

Physical and Chemical Trends Related to Land Use

The SPoT program is designed to detect long-term changes in watershed contaminants and toxicity as they relate to changes in land use. After five years of monitoring, several clear trends are emerging in California surface waters monitored by SPoT. The following box plots divide toxicity and chemical concentrations among the three primary land uses described above. Analysis of variance was used to determine if concentrations were significantly increasing or decreasing based on the mean concentration and the variability among concentrations within the land use categories. Furthermore, multivariate analysis was used to investigate the relationships among toxicity, sediment chemical concentrations and land use.

Sediment collection for SPoT emphasizes collecting fine-grained depositional sediments, as many contaminants associate with the smaller size fraction (<63 µm), which accumulate in low energy depositional areas. Fine sediment particles can be found throughout the channel at many sites in thin layers covering other dominant substrate, including sand, cobble, boulders, concrete, and woody debris. Fine sediments form deeper layers in pockets and larger depressions where micro-hydrological and geomorphic conditions favor deposition. These deeper depositional areas were targeted for sample collection because they allowed the most effective collection of fine material. In some sampling areas, fine sediments formed large and deep deposits across the channel.

While field teams strive to collect the finest-grained material available, a number of samples were composed primarily of grains larger than 63 µm (Figure 3) because fine-grained material was not available. There was a significant decrease in the overall amount of fine-grained sediments collected between 2008 and 2012 ($p = 0.036$). This overall trend was driven by a significant decrease in percent fines collected at urban sites ($p = 0.031$).

Field teams also avoid or remove conspicuous debris, including leaves and other large organic material. Total organic carbon (TOC) content cannot be readily determined in the field, and the sampling protocol has no set criterion for TOC concentration. Samples from urban sites generally had higher TOC content than agricultural or open space samples, but there were no significant upward or downward trends for TOC, indicating that the samples had consistent carbon content among sample years (Figure 4).

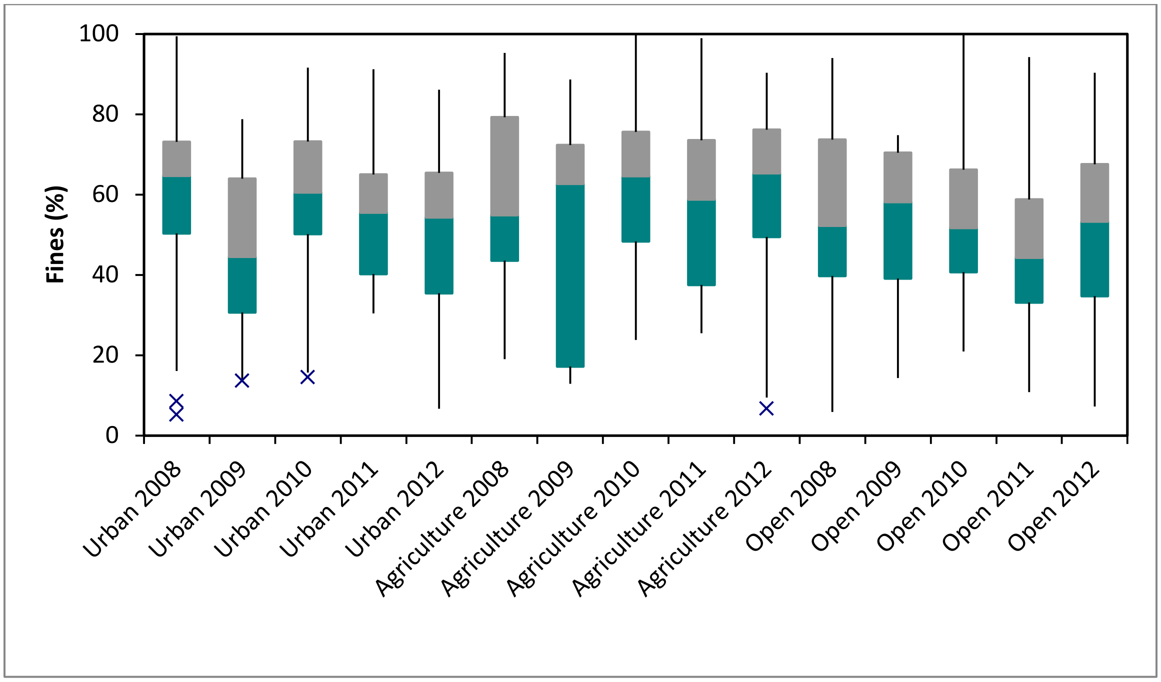

Figure 3. Percent fines versus land use. Boxes represent first and third quartiles, line represents median, and t-bars 1.5 times the inter-quartile range. Additional points are outside of the inter-quartile range.

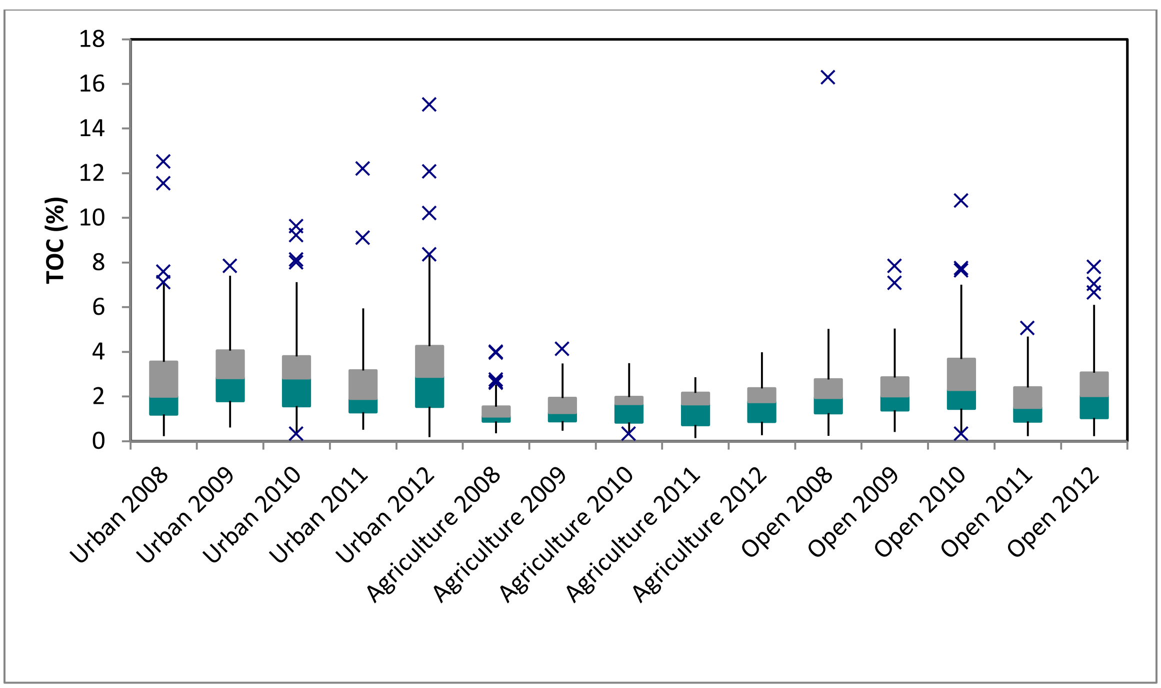

Figure 4. Total organic carbon versus land use. Boxes represent first and third quartiles, line represents median, and t-bars 1.5 times the inter-quartile range. Additional points are outside of the inter-quartile range.

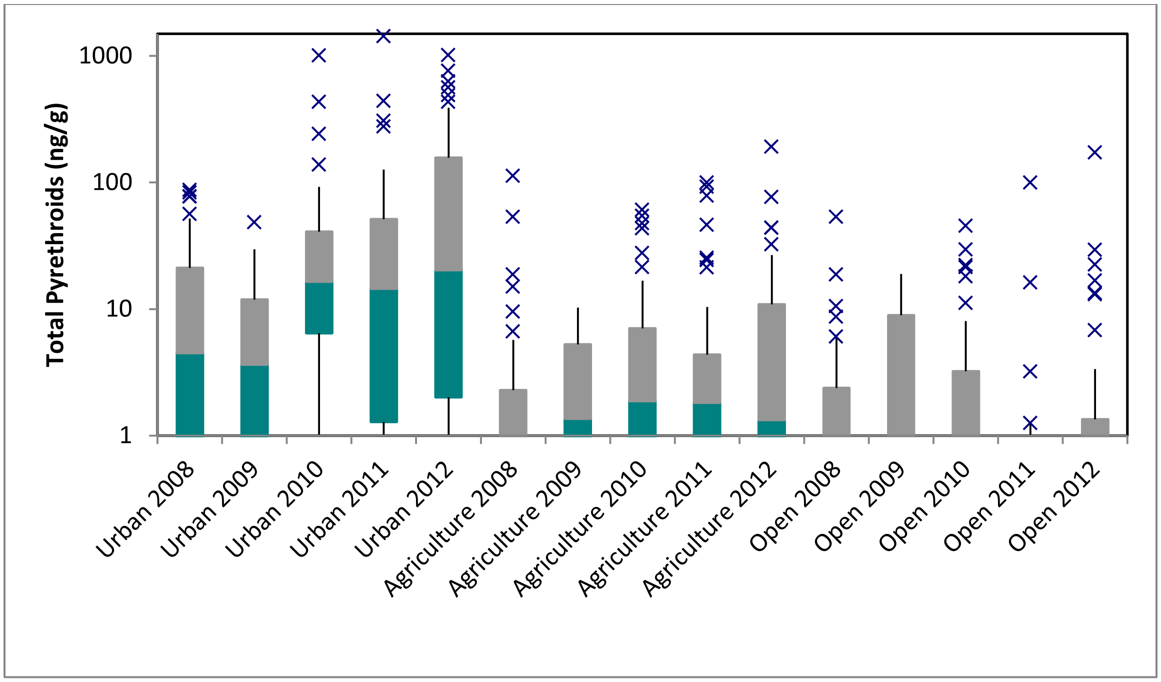

Figure 5. Total pyrethroids versus land use. Boxes represent first and third quartiles, line represents median, and t-bars 1.5 times the inter-quartile range. Additional points are outside of the inter-quartile range.

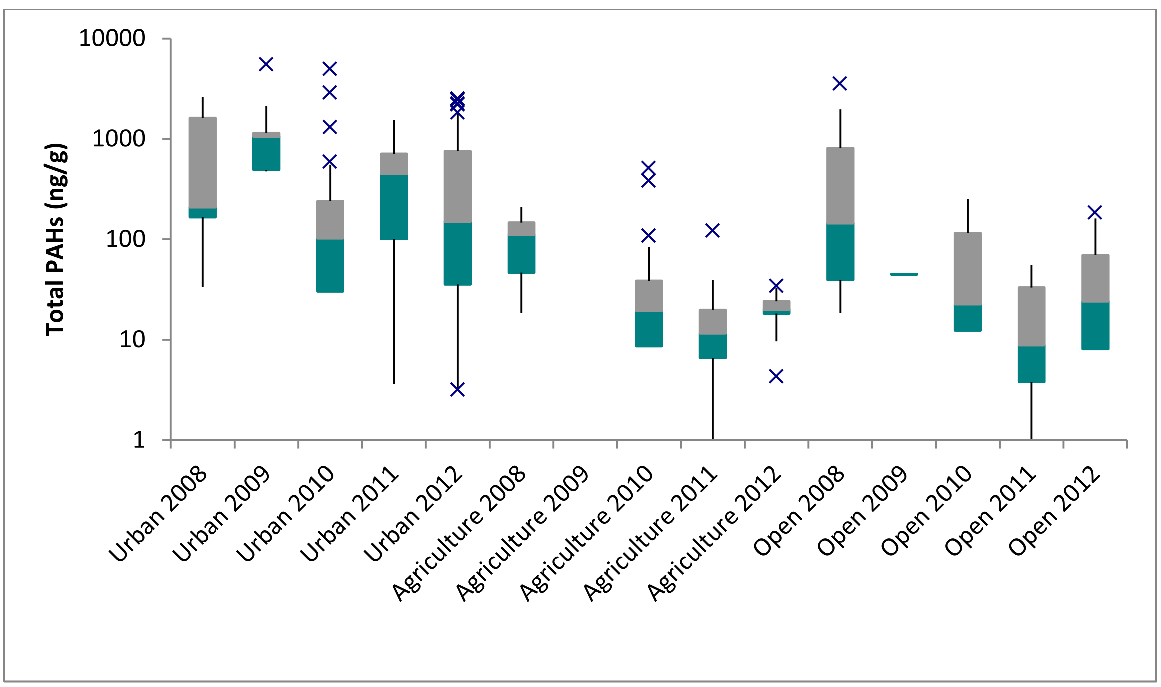

Figure 6. Total PAHs versus land use at Tier II sites. Boxes represent first and third quartiles, line represents median, and t-bars 1.5 times the inter-quartile range. Additional points are outside of the inter-quartile range.

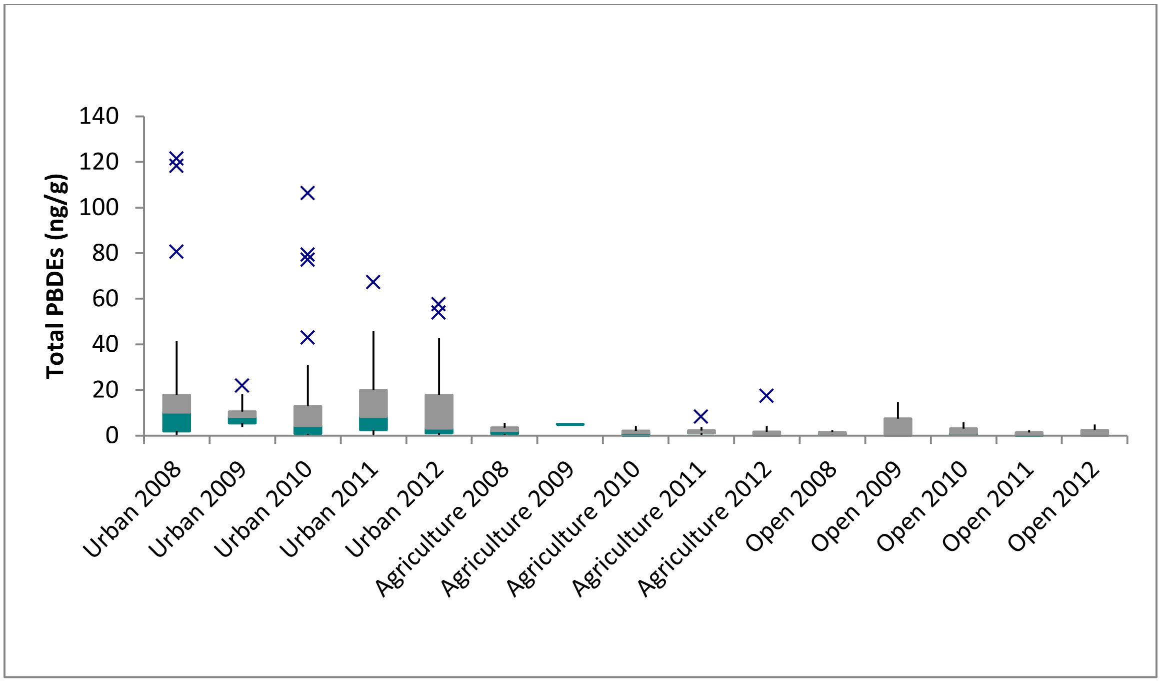

Figure 7. Total PBDEs versus land use at Tier II sites. Boxes represent first and third quartiles, line represents median, and t-bars 1.5 times the inter-quartile range. Additional points are outside of the inter-quartile range.

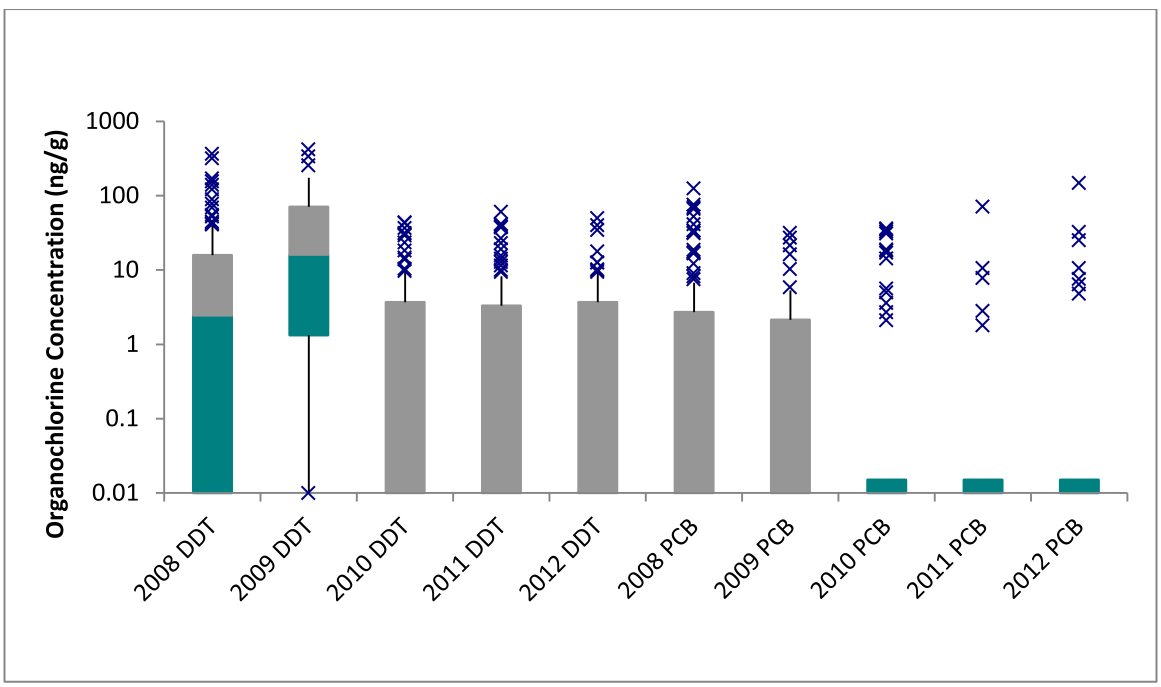

Figure 8. Organochlorine compound trends. Boxes represent first and third quartiles, line represents median, and t-bars 1.5 times the inter-quartile range. Additional points are outside of the inter-quartile range.

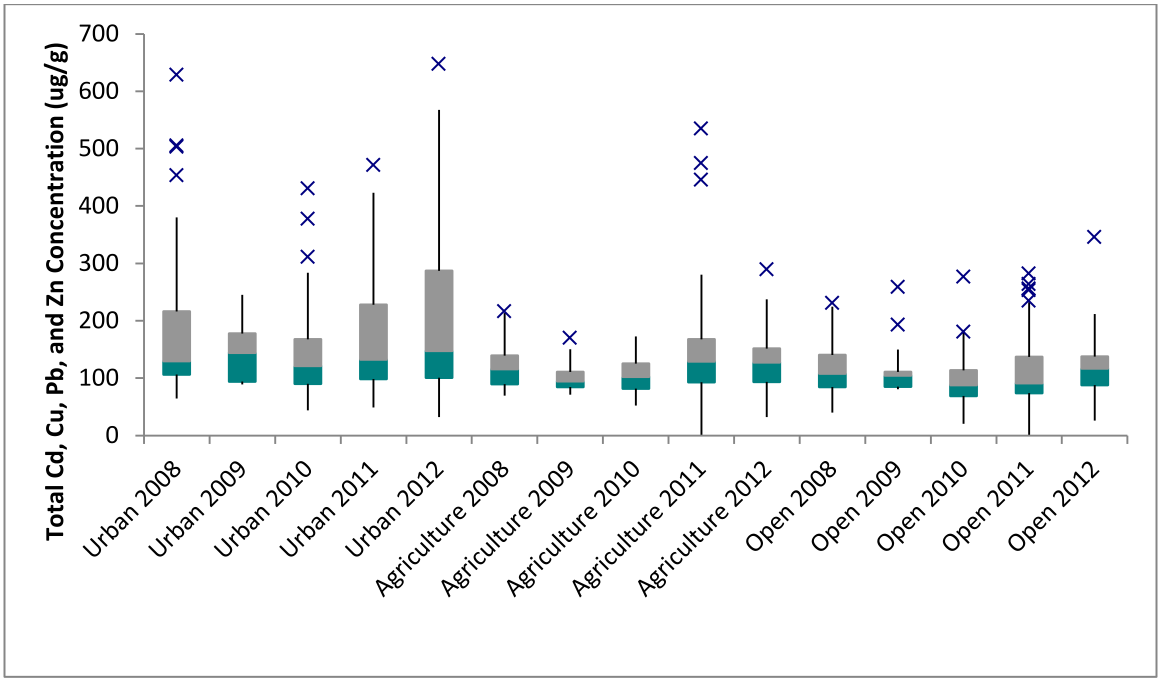

Figure 9. Sum of cadmium, copper, lead and zinc versus land use. Boxes represent first and third quartiles, line represents median, and t-bars 1.5 times the inter-quartile range. Additional points are outside of the inter-quartile range.

Pyrethroid pesticides demonstrated a significant increasing trend throughout the state (p = 0.004, Figure 5), likely driven by a significant increasing trend in urban watersheds. (p = 0.004). There were no significant pyrethroid trends in agricultural or open watersheds. Bifenthrin was the most commonly detected pyrethroid and was measured in 69% of the samples collected between 2008 and 2012. The remaining pyrethroids were detected in 19% to 39% of the samples, depending on the specific pyrethroid. There are two possible explanations for the increased detections of bifenthrin in these samples. One is that of all the pyrethroids, bifenthrin is the most stable in aquatic environments. At 20 °C, bifenthrin has an aerobic half-life in sediment ranging from 12 to 16 months. The half-life range is 25-65 months at 4 °C, and anaerobic half lives are much longer (Gan et al., 2005). Statewide bifenthrin use reported to the California Department of Pesticide Regulation increased between 2008 and 2012. The total pounds of active ingredients applied went from 120,089 pounds in 2008 to 285,941 pounds in 2012, with a peak of 354,390 pounds in 2010 (www.cdpr.ca.gov/docs/pur/purmain.htm).

PAHs and PBDEs were only measured in SPoT samples from Tier II sites, mostly in urban watersheds, but with some sites in agricultural and open watersheds (Figures 6 and 7). Concentrations of these chemical classes were higher in urban watersheds, but remained consistent throughout the study period with the exception of a significant decrease in PAHs in open watersheds (p = 0.027, Figure 6).

The concentrations of the chlorinated compounds (DDTs and PCBs) significantly decreased during the sampling period (Figure 8). Significant downward trends were noted in watersheds from each land use, as well as statewide (p = 0.000-0.017). It is interesting to note that the concentrations in 2008 and 2009 were much higher than those measured in 2010, 2011 and 2012. Laboratory reporting limits were higher during these years, but the difference in analytical reporting did not account for the downward trend the magnitude of detections significantly decreased over the five years. Because of the sharp decrease in concentrations between 2009 and 2010, additional sampling year data are necessary before these trends can be confirmed.

Trace metals were measured in both whole sediments and sediments sieved to less than 63 µm. Because trace metals bind preferentially to smaller sediment size fractions, particularly clays, it was suggested at the program's initiation that sieving sediments would allow for a better comparison of metal concentrations across watersheds by reducing the effects of grain size differences. Relative differences of metals in sieved and unsieved samples were compared to determine the benefit of this additional analysis to the SPoT program in detecting long term trends. Because of high variability observed in metals concentrations measured among years, and because of the high variability in results between sites, it was determined that sieved metals do not provide additional information beyond the results of the bulk metals analysis (Anderson et al., 2012).

There were no significant upward or downward trends in the sums of Cd, Cu, Pb, and Zn from unsieved samples based on statewide analysis or analysis by land use (Figure 9). While these metals are considered to be representative of human, rather than natural inputs, their concentrations are not equally weighted. Zinc concentrations drive the box plots in Figure 9 with concentrations approximately three times greater than copper. Copper concentrations are approximately twice those of lead, whereas cadmium concentrations average less than 0.5 µg/g. Individually, copper did not exhibit a significant statewide trend (data not shown), although continued monitoring of this metal will be important to determine the effectiveness of the reduced use of copper in automobile brake pads. This may be more apparent in urban watersheds so the possibility of this trend will be investigated in subsequent reports. Similarly, the mean concentrations of mercury in sediments were largely unchanged over the sampling period (data not shown). Mercury bioaccumulates in higher trophic level organisms and has been identified as one of the primary contaminants of concern in coastal sport fish tissues monitored by SWAMP's Bioassessment Oversight Group (BOG) (http://www.swrcb.ca.gov/water_issues/programs/swamp/coast_study.shtml). Mercury in sediment demonstrated high statewide variability, and specific sites in highly urbanized regions had the highest concentrations.

Detections and concentrations of organophosphate pesticides in sediment decreased between 2008 and 2012. Chlorpyrifos was detected in 12% of SPoT sites in 2008 and only 1 out of 23 sites sampled in 2009. No chlorpyrifos was detected in 2010, but one sample from 2011 contained this chemical. Analysis of chlorpyrifos use through the Department of Pesticide Regulation showed an 18% decrease in use of chlorpyrifos between 2008 and 2012 (www.cdpr.ca.gov/docs/pur/purmain.htm). It is likely that reductions in chlorpyrifos detections are related to regulatory controls implemented by the EPA and DPR (e.g., regulatory actions to minimize spray drift).

Summary of Contaminant Trends

The trend data show a statewide decrease in the organochlorine compounds DDT and PCBs, whereas several other chemical classes showed no significant change (Table 2). Some chemicals that showed no change at the statewide level did exhibit significant upward or downward trends at individual sites, including metals, PAHs, and PBDEs. Use of PBDE flame retardants is being restricted in California and changes in sediment concentrations of this class of chemicals will be the subject of continued SPoT monitoring in Tier II watersheds.

Table 2. Summary of trends at a statewide level, trends related to land use, and trends at individual sites.

Variable	Statewide	Urban	Agriculture	Open	Individual Sites
Survival	=	=	=	↑	4↑
Pyrethroids	↑	↑	=	=	3↑ 1↓
Cd, Cu Pb, Zn	=	=	=	=	1↑ 1↓
DDT	↓	↓	↓	↓	10↓
PAH	=	=	=	↓	1↑ 2↓
PCB	↓	↓	↓	↓	1↑
PBDE	=	=	=	=	1↑

Detections and concentrations of the pyrethroid pesticides continue to increase in California watersheds. While the data do not show an increase in the incidence of sediment toxicity when testing is conducted at the standard protocol temperature, the incidence of toxicity within years was greatly increased in a subset of sites when tests were conducted at a temperature that more closely reflects the ambient temperature in California watersheds (~15 °C, see below). Higher toxicity at colder temperature is diagnostic of toxicity due to pyrethroid pesticides, and the pattern of increasing detections of pyrethroids coupled with increasing toxicity in SPoT samples when tests are conducted at colder temperature suggests that current monitoring may under-estimate the occurrence of pyrethroid-associated toxicity using the standard protocol.

Management Actions and Anticipated Future Trends

California regulatory agencies recognize the role pesticide contamination plays in degradation of state waters and are now implementing plans to address sources of specific current-use pesticides. For example, the DPR implemented use restrictions for pyrethroid pesticides used by pest control businesses in urban settings and is providing outreach to pesticide applicators to instruct proper application techniques on impermeable surfaces. These are intended to reduce the mass of active ingredients applied and to minimize off-site runoff into stormwater systems and adjacent watersheds. DPR also plans on following urban restrictions with regulations to address agricultural use of pyrethroids affecting surface water quality. The U.S. EPA is also requiring label changes for pyrethroid products to reduce their impact on surface water quality (http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2008-0331-0021). SPoT is collaborating with DPR to monitor additional sites with greater intensity to determine if these regulations result in a decline in sediment-associated pyrethroids in urban watersheds.

In urban areas, municipal stormwater (MS4) NPDES permitting requires numerous management practices to reduce pollutant and sediment discharges. For example, incorporation of Low Impact Development practices on future construction projects is being required throughout the state. Statewide source controls have also been implemented in a few specific cases, e.g., the phase out of copper in vehicle brake pads, and prohibitions on use of lead in wheel weights and brake pads.

In agricultural areas, management actions requiring on-farm practices to reduce pollutants in runoff and in some cases to treat runoff are being incorporated into Water Board irrigated lands programs. For pesticides, in addition to restrictions on pounds of pesticide active ingredients applied per acre and number of applications per crop, growers are receiving recommendations, and in some cases requirements, for vegetated buffer zones and setbacks to limit the potential for off-field transport of pesticides in spray drift, irrigation and stormwater runoff.

Based on SPoT coverage of 62 8-digit hydrologic units, and the intensive sampling efforts conducted in partnership with DPR, the program is positioned to detect changes in pyrethroid contamination in California watersheds as these management actions are implemented. SPoT data provide water resource managers with short and long term readings of how effective use restrictions are in reducing contamination. Addition of emerging contaminants of concern to the SPoT analyte list will allow the program to evolve to address issues related to introduction of new chemicals in California watersheds.

Toxicity Trends Related to Land Use

The incidence of sediment toxicity has remained relatively stable between 2008 and 2012 (Table 3). The percentage of toxic and highly toxic samples increased in 2009, but this likely reflects the reduced sample size during that year and the increased weighting toward urban sites. The majority of toxic and highly toxic sites were located in urban areas (lower survival depicted in Figure 10). Highly toxic samples were collected from fifteen separate sites over the last five years. Eight of these sites were solely urban, and two were classified as urban/agriculture. Four sites were from agricultural watersheds, and one was classified as a combination of agriculture and open space. The locations of these sites were mostly in the southern California regions. There were no significant upward or downward trends in toxicity at urban or agricultural sites, but there was a significant decrease in toxicity at open sites ($p = 0.015$, Figure 3). Site-specific trends in toxicity are discussed in the regional summaries provided below.

Figure 11 depicts a five-year average of toxicity in the SPoT program. Sixty-six percent of the stations tested to date have not had a single toxic sample, whereas 34% have demonstrated at least some toxicity. The long-term trend can be illustrated by tracking a running average of five years of data.

Table 3. SPoT sediment toxicity trends in tests conducted at 23 °C from 2008-2012. Toxicity was determined based on the Test for Significant Toxicity (TST), and highly toxic sites had percent survival lower than the high toxicity threshold for *Hyalella azteca* (38.6%).

	2008	**2009**	**2010**	**2011**	**2012**
Number of Sites Tested	92	23	95	100	100
% Non-toxic	84	74	81	85	82
% Toxic	10	17	11	10	9
% Highly Toxic	7	9	8	5	9
% Toxic + % Highly Toxic	16	26	19	15	18

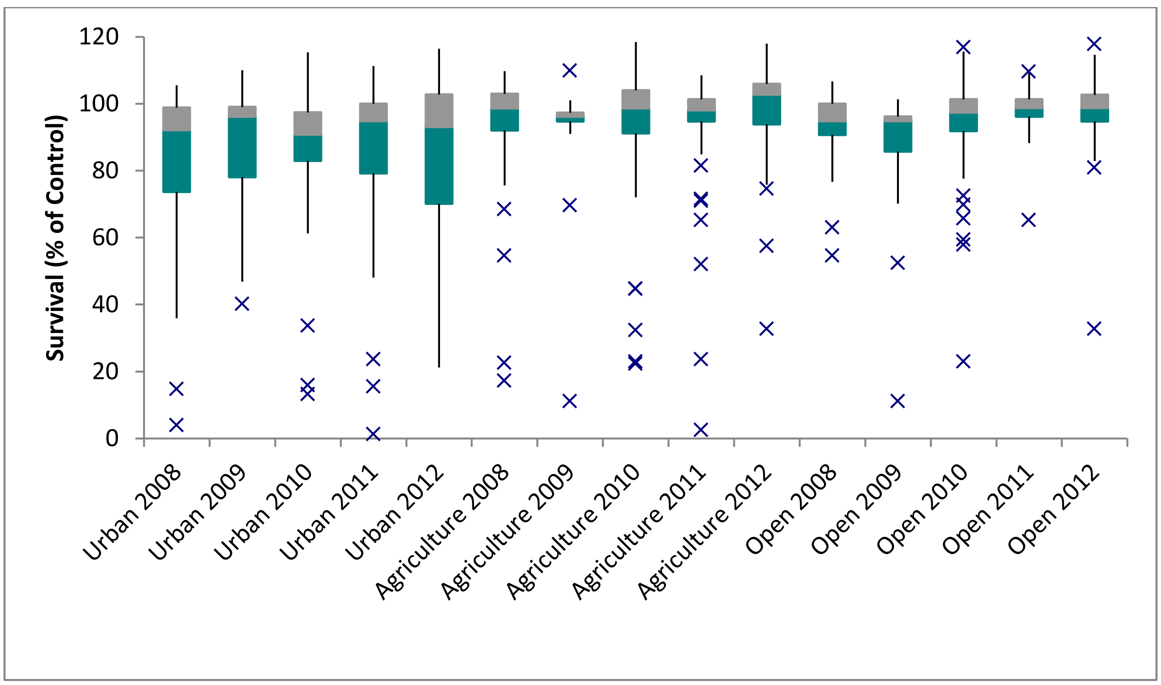

Figure 10. Survival in toxicity tests versus land use. Boxes represent first and third quartiles, line represents median, and t-bars 1.5 times the inter-quartile range. Additional points are outside of the inter-quartile range.

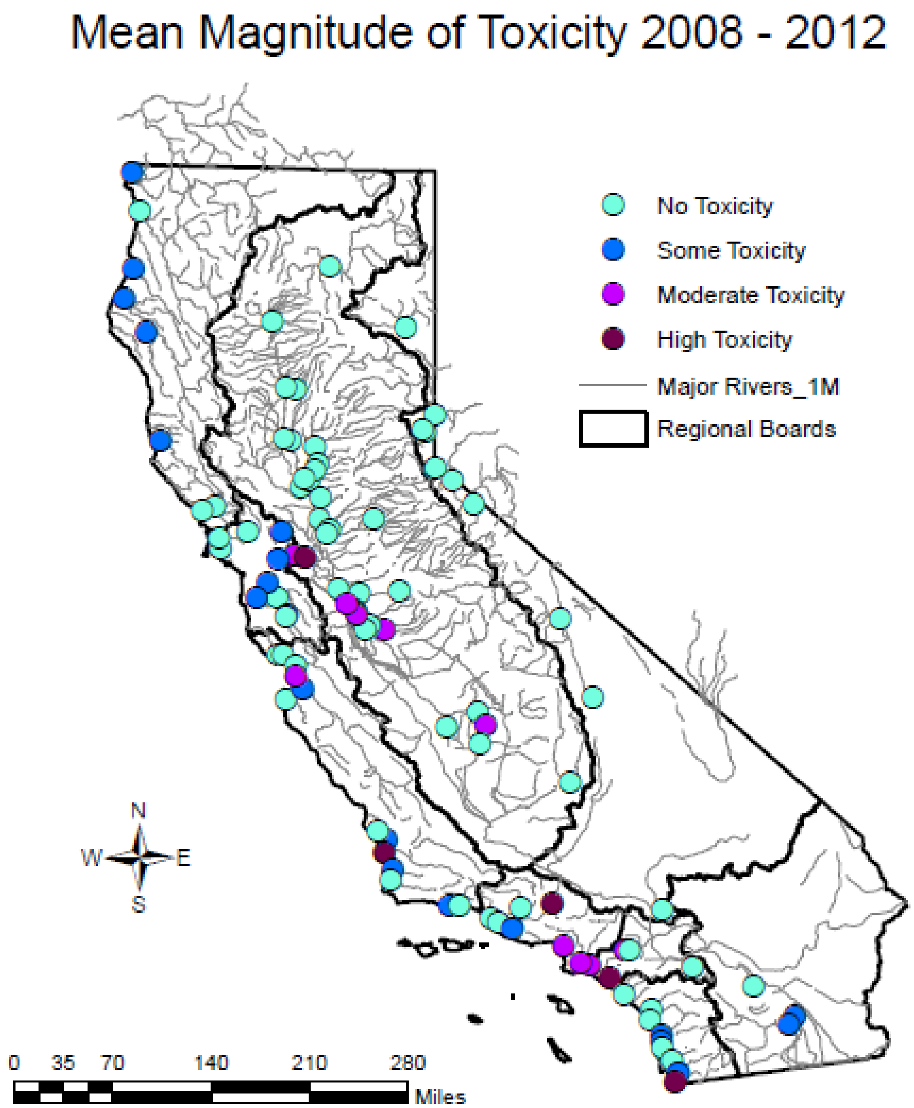

Figure 11. Five-year average of toxicity in the SPoT program.

The Relationship of Toxicity to Chemical Thresholds and Sediment Guideline Values

The relationships between amphipod mortality and sediment chemical concentrations are investigated with multivariate analysis described below. To further investigate the toxicological relevance of these relationships, amphipod survival was compared to individual chemical threshold values to determine which chemical occurred at toxic concentrations. Concentrations used are summarized in Appendix 3. Where possible, median lethal concentrations (LC50s) derived from spiked sediment toxicity studies using *Hyalella azteca* were used to evaluate chemistry data. Median lethal concentrations are preferable because they are derived from exposure experiments with single chemicals. The probable effects concentration (PEC) sediment quality guidelines were used when spiked-sediment LC50s were not available (Macdonald, 2000). Probable effects concentrations are consensus based guidelines that were developed from other empirically-derived sediment quality guideline values. The PEC is a concentration that if exceeded, harmful effects are likely to be observed (Macdonald, 2000). The PEC provides some predictive ability, but is not derived from direct dose-response experiments. Forty-nine threshold values for thirty-seven individual chemicals and sums were used to evaluate several chemical classes including pyrethroid pesticides, organochlorine pesticides, organophosphate pesticides, PAHs, PCBs, and metals. Twelve of these chemicals and sums were also evaluated with organic carbon-corrected threshold values.

Of the chemical thresholds evaluated, guideline values were exceeded for total chlordane and several metals, and LC50 values were exceeded for most pyrethroids and the organophosphate pesticide chlorpyrifos. Although the total chlordane probable effects concentration (PEC) was exceeded in approximately 6% of the samples, the samples with the highest concentrations were not consistently toxic. It should be noted that the PEC for chlordane may not be a reliable indicator of the potential for acute toxicity to amphipods. Recent dose-response experiments have shown that chlordane is essentially not toxic to the marine amphipod *Eohaustorius estuarius* at concentrations found in surficial sediments (Phillips et al., 2011). Trace metal concentrations exceeded PECs at many sites, but it is unlikely these concentrations contributed to observed toxicity to *Hyalella azteca* because the concentrations did not exceed published LC50s derived from laboratory dose-response experiments. For example, copper sometimes exceeded the PEC (149 µg/g), but concentrations were always well below the LC50s for this metal to *H. azteca* (LC50 = 260 µg/g). This was also true for arsenic (PEC = 33 µg/g; LC50 = 532 µg/g), and for nickel (PEC = 48.6 µg/g; LC50 = 521 µg/g). Chromium most often exceeded the PEC, but it is unlikely this metal is contributing to toxicity (Besser et al., 2004). As laboratory dose response data become available for more contaminants, these will be used as the primary values for assessing the potential for toxicity to *H. azteca*. Both nickel and chromium are geologically abundant, particularly in areas of serpentine soils, such as those common in the Franciscan formation of the central and northern coast ranges (Bonifacio et al., 2010). Both are also used in various industrial applications, so natural sources cannot be assumed for all elevated samples. It should be noted that the comparison of sediment metal concentrations to published guideline values and other effect thresholds emphasize toxicity to invertebrates. In the case of laboratory dose-response experiments, these usually involve standard test species. These comparisons do not consider possible effects on other stream communities, such as algal communities. These may be more sensitive to sediment metal concentrations.

Pesticide LC50s were exceeded in 19% of the samples collected between 2008 and 2012. Most of the elevated concentrations were for the pyrethroid pesticide bifenthrin. To better evaluate the contribution of pyrethroids to observed toxicity, concentrations were converted to toxic units (TUs). Toxic units are calculated by dividing the measured concentration of an individual pyrethroid by the LC50 value. Because pyrethroids in a mixture can work additively, the TUs are summed. Approximately 50% mortality would be expected at one TU, and previous research has demonstrated that significant toxicity is observed when the sum of the TUs is greater than one (Weston et al., 2005). This analysis is made more accurate by calculating the TU values based on LC50s that have been corrected for the concentration of organic carbon in the sediment. Elevated concentrations of organic carbon can reduce the bioavailability of organic chemicals such as pesticides (Maund et al., 2002), and normalizing concentrations to TOC account for the relative effect of this sediment constituent on toxicity. Although there was a significant correlation between organic carbon-corrected TUs and percent survival ($p < 0.001$, Figure 12), there were five samples with a toxic unit sum greater than 5 that were not toxic or moderately toxic (Figure 12). Considering the three non toxic samples with TU values greater than 5, all of these samples have demonstrated increasing total pyrethroid concentrations over the last five years with only moderate toxicity in one sample. The organic carbon concentrations at these sites have remained less than 5%, and were generally variable. The TOC measurement utilized by SPoT does not differentiate among the various types of organic carbon that might be present. It is possible that the carbon at these sites has greater binding capacity. Black carbon, which is derived from fossil fuels, can reduce the bioavailability of organic compounds beyond that of plant-derived organic carbon (Kukkonen et al., 2005)

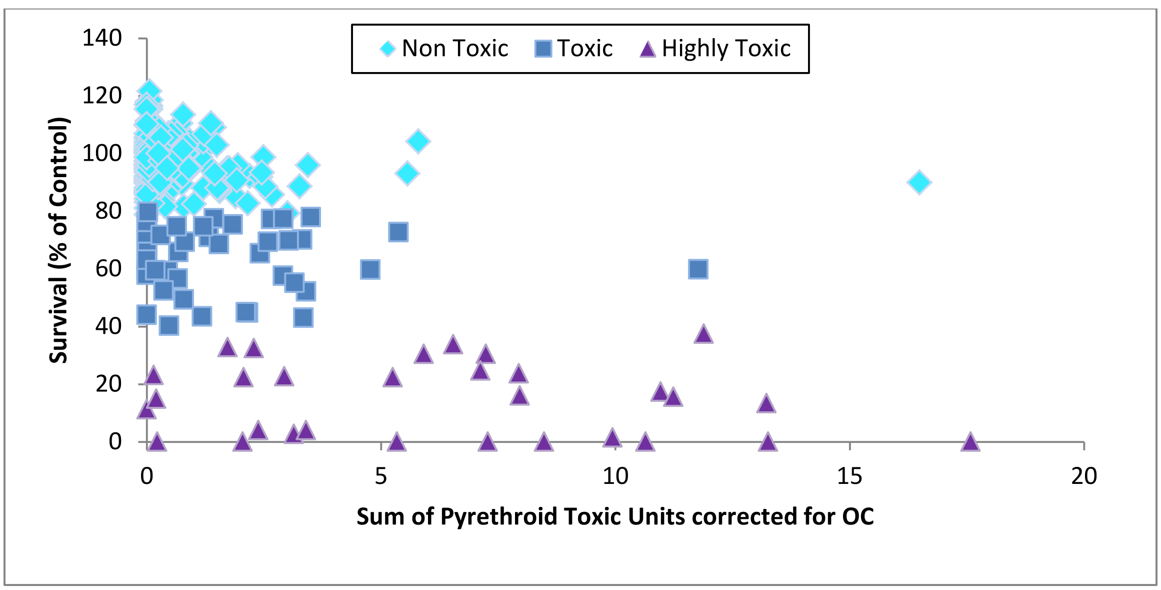

Figure 12. 2008-2012 toxicity data plotted against the sum of pyrethroid toxic units corrected for organic carbon. See text for explanation of toxic units and organic carbon correction.

Further Diagnosing the Contribution of Pyrethroids to Toxicity

The standard U.S. EPA protocol for *Hyalella azteca* specifies the test be conducted at 23 °C. It has long been recognized that some pyrethroid pesticides are more toxic at colder temperatures (Coats et al., 1989), and this characteristic has been used as a TIE tool to diagnose pyrethroid-associated toxicity (Anderson et al., 2008). A similar response to cold temperature was observed with DDT, but to a lesser extent (Weston et al., 2009). In a SWAMP statewide study of urban creek toxicity, Holmes et al. used this attribute to help identify pyrethroids as the likely cause of toxicity to *H. azteca* (Holmes et al., 2008).

Increasing toxicity with decreasing temperature has been demonstrated specifically with *H. azteca* in more recent studies (Weston et al., 2009), and also with chironomids (Harwood et al., 2009). Harwood et al. (2009) showed this is due to slower metabolic breakdown of pyrethroids at lower temperatures and increased nerve sensitivity.

The average statewide surface water temperature was calculated for water samples collected in SPoT hydrologic units as part of various SWAMP surveys. Samples represented daytime temperatures measured at depths less than 0.1 m as part of SWAMP routine monitoring, which was conducted during all months of the year (Cassandra Lamerdin, Moss Landing Marine Laboratories, personal communication). The average temperature for data collected between 2001 and 2010 was 15.8 °C, considerably lower than the standard test temperature (23 °C). Average temperatures ranged from a low of 9.7 °C in Region 6 to a high of 20.7 °C in Region 7. Since 2010, temperature effects were evaluated using a subset of SPoT stations. Tests were conducted at the standard 23 °C and also at 15 °C, to help diagnose toxicity due to pyrethroids. In addition, the 15 °C test temperature assesses toxicity at a more environmentally relevant temperature for California surface waters (Anderson et al., 2012).

Tests of samples from the SPoT base stations demonstrate that significantly more samples were toxic when tested at 15 °C, and the magnitude of toxicity was much greater at the lower test temperature (Table 4). Samples were approximately 2-3 times more likely to be toxic when tested at 15 °C. When the results of the 15 °C tests are plotted against toxic units as in Figure 12, it is apparent that the TU threshold has shifted to a lower value, indicating that less pyrethroid is necessary to create the same toxic response (Figure 13). These results suggest that pyrethroid pesticides likely played a role in the increased incidence of toxicity in these samples. Although DDT can cause a similar response at colder temperatures, the concentrations of DDT in the sediment were well below toxicity thresholds for *H. azteca*. These data also suggest that the potential for surface water toxicity is likely underestimated in SPoT watersheds based on assessing toxicity at the standard protocol temperature (23 °C).

Table 4. Comparison of percent survival in samples tested at 23 °C and 15 °C.

	2010		**2011**		**2012**	
Number of Sites	15		43		43	
Test Temperature	23°	15°	23°	15°	23°	15°
% Non-toxic	67	20	70	49	79	40
% Toxic	27	13	21	23	12	21
% Highly Toxic	7	67	9	28	9	40
% Toxic + % Highly Toxic	33	80	30	51	21	60

It should also be noted that the 10-day test protocol with *H. azteca* represents an acute exposure to sediment contaminants. Previous data have shown the 28-day protocol with this species is more sensitive than the 10-day growth and survival test because it incorporates growth over four weeks (Ingersoll et al., 2005). Because the more photo stable pyrethroids (e.g., bifenthrin) may persist for over a year, the potential for chronic impacts of these pesticides on California watersheds are also likely underestimated by SPoT results. MPSL compared the relative sensitivities of the 10-day and 28-day *H.*

azteca protocols as part of a project by the Central Valley Regional Water Quality Control Board to develop sediment quality criteria for bifenthrin. The results of these experiments determined that the shorter-term protocol was appropriate for the measurement of survival. Previous studies have shown that growth after 28d exposure in the longer-term protocol is a more sensitive endpoint. It is not clear whether the longer-term protocol is appropriate for future SPoT monitoring.

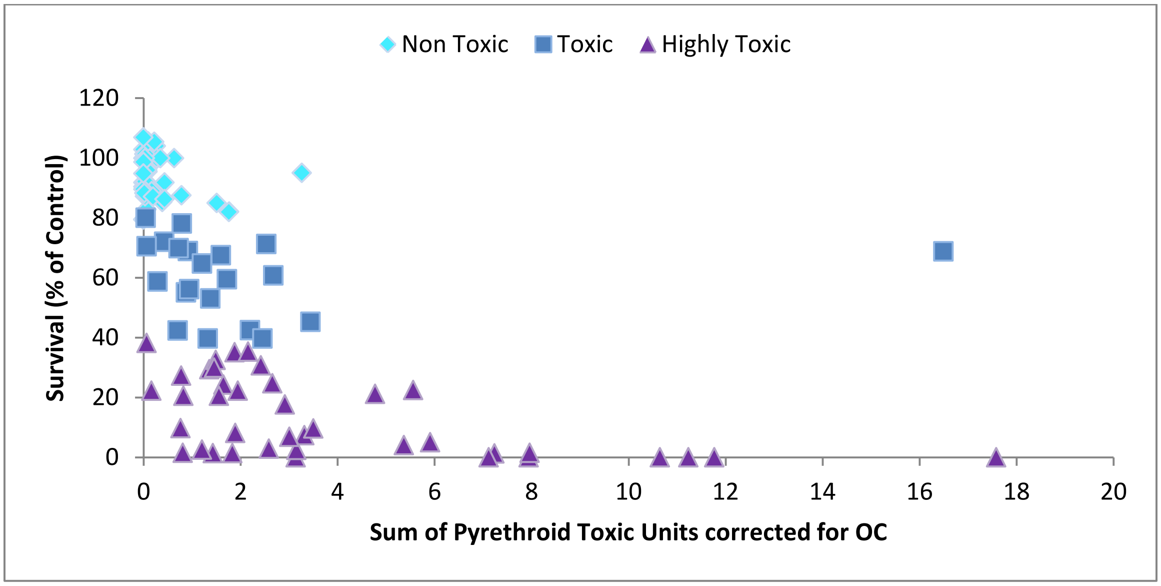

Figure 13. 2010-2012 toxicity data from 15 °C tests plotted against the sum of pyrethroid toxic units corrected for organic carbon. See text for explanation of toxic units and organic carbon correction.

Chemicals of Concern

In a recent summary of SWAMP surface water toxicity testing conducted between 2001 and 2010, Anderson et al. (2011) showed that approximately 45 to 50% of the sites monitored by SWRCB programs demonstrated some water or sediment toxicity. Correlation and toxicity identification evaluation studies showed that the majority of toxicity was associated with pesticides, specifically organophosphate and pyrethroid pesticides. The current SPoT results corroborate these findings. Previous analysis of SPoT data found that sediment toxicity was highly correlated with pyrethroid concentrations in sediment (Anderson et al., 2012; Hunt et al., 2012). There has been a steady decline in organophosphate pesticide concentrations detected in SPoT samples, including a statewide decline in the detections of chlorpyrifos. However, chlorpyrifos continues to be associated with sediment toxicity in certain agriculture regions of the state, such as the central coast (Phillips et al., 2012).

Given the evidence that pesticides are associated with ambient toxicity in California waters, certain emerging pesticides were prioritized for inclusion in the SPoT analyte list as monitoring proceeds. For example, recent regional monitoring has suggested an increase in the detection of the phenylpyrazole insecticide fipronil and its degradates in urban watersheds (Gan et al., 2005; Holmes et al., 2008). Because of increasing use and the potential for surface water toxicity due to fipronil, this pesticide was measured at Tier II sites in 2013. It should be noted that the current SPoT test organism, *H. azteca*, is approximately 20 times less sensitive to fipronil and its degradates than another commonly used freshwater sediment test organism, *Chironomus dilutus* (Weston and Lydy, 2014). This is an important point to consider for future monitoring. Because SPoT uses toxicity testing, in part, to monitor for emerging chemicals of concern, the program will need to be adaptive in its future choices for test organisms. This will require some re-alignment of funding for existing contaminant monitoring and a revision of program design to free-up resources for additional toxicity testing.

Other important classes of organic chemicals detected in SPoT samples included organochlorine pesticides and PCBs. While pesticides such as DDT continued to be detected in many of the state's watersheds, the concentrations have always been below those demonstrated to cause toxicity to *H. azteca*. PCBs were also detected in many of the watersheds, but concentrations were generally lower than guideline thresholds. Organochlorine chemicals (e.g., DDT and PCBs) continue to be of concern in California because of their potential to bioaccumulate. While concentrations in fish do not often exceed thresholds of concern (Davis et al., 2013), some fish consumption advisories have been issued due to these contaminants for lakes, rivers, bays, and coastal areas.

PBDEs are also not acutely toxic to *H. azteca*, but have potential to bioaccumulate in the environment, and affect human health. These chemicals did not exhibit any significant trends at the statewide level, or by land use, but did significantly decrease at one site. Because these chemicals are in the process of being phased out in California, SPoT will continue to measure them to document the potential decreasing trend.

Concentrations of metals in sediments were relatively stable during the last five years, and selected metal concentrations were lower than toxicity thresholds established for *H. azteca* (Cd, Cu and Zn). Because of differences in sensitivity between *H. azteca* and other resident taxa, and the potential for particular metals to either be toxic to resident macroinvertebrates (Cd, Cu, and Zn) and stream algae or to bioaccumulate (Hg), metals will continue to be important indicators of watershed contamination as SPoT proceeds.

SPoT Indicators in Relation to Stream Ecology

SPoT measures sediment toxicity to amphipods and chemical concentrations as indicators of stream water quality. Numerous studies have linked low amphipod survival in laboratory toxicity tests with ecological degradation as indicated by impacted benthic macroinvertebrate (BMI) communities in California watersheds (Anderson et al., 2011). The relationship between laboratory sediment toxicity test results, chemical contamination and macroinvertebrate community structure in SPoT watersheds was investigated for the current report to develop connections between the indicators of water quality impairment measured by SPoT and indicators of ecological impairment measured by the various programs conducting bioassessment monitoring in these watersheds.

The main source of these data was the SWAMP Bioassessment Reporting Module. Additional southern California data were provided through the cooperation of the southern California Stormwater Monitoring Council (SMC data compiled by Raphael Mazor, Southern California Coastal Water Research Project). To identify spatially appropriate data, coordinates from SPoT stations and stations from the SWAMP and SMC bioassessment programs were compared to determine which stations were reasonably proximate to the SPoT stations. Eight of the bioassessment sites used in the analysis were collected from the same coordinates as the SPoT stations, and twenty-one of the sixty-six samples analyzed were collected within one km of the SPoT site. The remaining bioassessment samples were collected within 15 km of SPoT stations. Bioassessment data from each year were matched with the toxicity and chemistry data from the appropriate SPoT sampling year. The SWAMP stations represented samples from southern, central and northern California, and the SMC stations were all from southern California. Spearman Rank correlations were conducted between toxicity and chemistry results and individual Index of Biological Integrity (IBI) scores calculated for each sample, as well as several habitat measurements conducted as part of the bioassessments. An IBI is calculated by combining several biological indicators (metrics), into a summary index. IBI scores were calculated using methods that were appropriate to each region, and in the case of these analyses, reflect the ecological complexity of the macroinvertebrate communities. The California Stream Condition Index is a more comprehensive next-generation index that is under development and will likely be used in the next reporting cycle.

Percent amphipod survival in laboratory toxicity tests was significantly positively correlated with the IBI ($p<0.01$, Figure 14), as were the Ephemeroptera/Plecoptera/Trichoptera index, taxonomic diversity and richness, and fine gravel substrates. The positive correlates are all indicators of healthy insect communities and desirable habitat. The EPT index indicates the relative densities of mayflies, stoneflies, and caddis flies, which represent three insect groups considered to be sensitive indicators of water quality. Pyrethroid pesticides, chlorinated compounds, and the benthic tolerance value were significantly negatively correlated with IBI. In addition, two measures of habitat, embeddedness, and particle sizes smaller than sand, were negatively correlated with the IBI. The data in Figure 14 demonstrate that amphipod survival in 77% of the corresponding SPoT stations were not toxic. IBI scores from the toxic and highly toxic samples ranged from 0.1 to 13.6, but the IBI scores for the non-toxic samples ranged from 0 to 73.3. This suggests that factors other than contaminants are influencing macroinvertebrates at these sites. Most of the IBI scores in this dataset were less than or equal to 30, and therefore represent degraded macroinvertebrate communities.

Previous California studies have demonstrated significant correlations between sediment and water toxicity in laboratory tests and degraded macroinvertebrate communities. These studies have indicated that toxicity observed in urban and agricultural water bodies is linked to declines in a number of BMI metrics and are also correlated with chemical contamination, particularly with pesticide concentrations in water and sediment (Anderson et al., 2003a; Anderson et al., 2003b; Phillips et al., 2004; Weston et al., 2005; Anderson et al., 2006; Phillips et al., 2006; Larry Walker Associates, 2009). Other studies have shown the importance of physical habitat in structuring BMI communities (Hall et al., 2007; Hall et al., 2009; Larry Walker Associates, 2009). In the current analysis the IBI was significantly negatively correlated with contaminants, particularly pyrethroid pesticides. The only habitat metric that had the same relationship with IBI was category of particles smaller than sand.

It is likely that these and other stressors interact to influence macroinvertebrate communities. The current analysis represents a preliminary attempt to determine relationships between the SPoT indicators of watershed degradation and ecological impacts measured by the SWAMP/PSA and SMC bioassessment programs. As SPoT, SWAMP/PSA, and SMC monitoring proceeds, the number of samples available for similar analyses will increase. SPoT staff will continue to coordinate with SWAMP and other regional monitoring groups to build on these datasets. As more BMI data are incorporated into the SWAMP and SMC databases, a more detailed assessment of these relationships will be investigated. These statistical relationships provide a basis for developing hypotheses for assessing causal relationships between in-stream ecological degradation measured in SWAMP and SMC monitoring and toxicity and chemical stressors measured by SPoT.

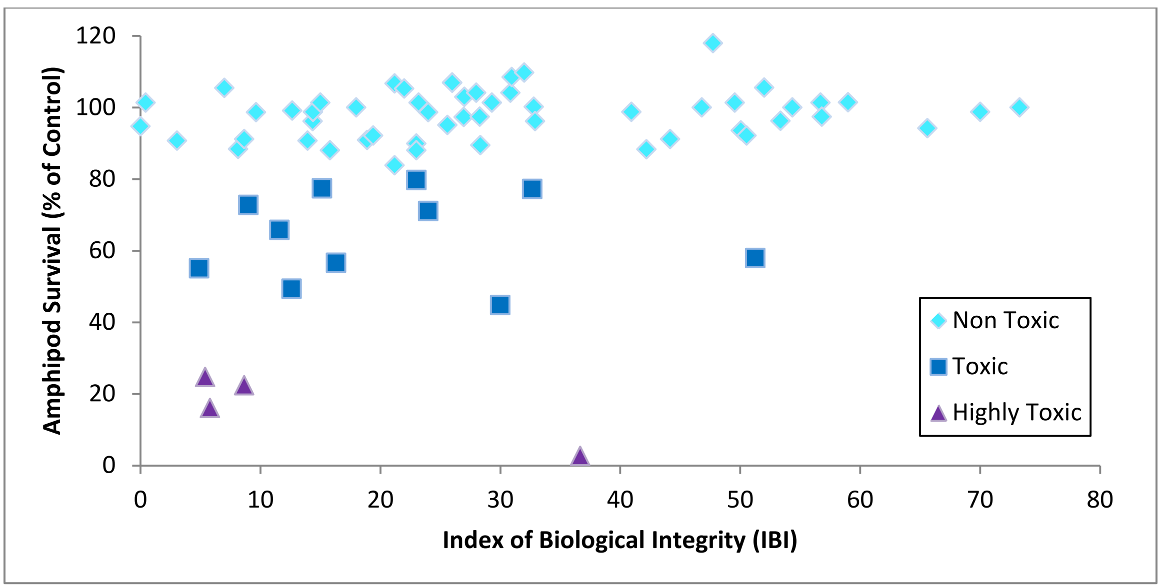

Figure 14. Relationship between amphipod survival in sediment toxicity tests and benthic macroinvertebrate IBI scores. IBI scores were calculated from field bioassessment data from 66 sites assessed during SWAMP and SMC monitoring conducted between 2008 and 2012, and corresponded to SPoT amphipod sediment toxicity tests conducted at the same or proximate stations during these years. Amphipod survival is presented as a percentage of the respective control sample survival value.

Regional Trends

The following sections summarize SPoT results for the nine Water Quality Board Regions on a site by site basis. Statistically significant trends at individual sites were determined using regression analysis, but non-significant trends are also noted. The power analysis, discussed below, determined that many trends could take greater than five years to emerge, so trend data in these sections should be viewed with this in mind. The toxicity summaries are listed using the same color code as depicted in Figure 11.

Region 1 – North Coast

All of the watersheds in Region 1 were classified as open land use at the 5 km scale (Table 5). Laguna de Santa Rosa (114LGMIR) also had some agricultural influence at the 5 km scale, although the proximity of agricultural operations apparently did not influence the detection of pesticides or the occurrence of toxicity at this site. Five of the eight sites in Region 1 had a single incidence of moderate toxicity in 2010, but all eight sites were not toxic in 2011 and 2012. Samples from the Mad River (109MAD101) and Eel River (111EELFRN and 111SF0933) were also tested at 15 °C in 2011 and 2012, but these samples were not toxic. There were no significant increasing or decreasing trends for the measured chemical classes. Chlorinated compounds were rarely detected, and metal concentrations remained unchanged. Samples from the Russian River (114RRDSDM) had the highest average pyrethroid concentrations of any SPoT site in Region 1.

Table 5. Summary toxicity and chemistry data for sites sampled in Region 1. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
103SM1009	Open	2008	2012	91	0.029		117	0	0	1.81
105KLAMKK	Open	2008	2012	96	0		121	0	0	
109MAD101	Open	2008	2012	89	0.036		93.7	0	0	
111EELFRN	Open	2008	2012	90	0.107		74.2	0	0	
111SF0933	Open	2008	2012	90	0	178	78.3	0	0	
113NA3269	Open	2010	2012	76	0		65.9	0	0	
114LAGWOH	Ag/Open	2008	2012	98	0.697		79.2	1.65	0	
114RRDSDM	Open	2008	2012	99	5.23	61.8	110	0.587	0.353	

Region 2 – San Francisco Bay

Eight of the eleven watersheds sampled in Region 2 were classified as urban at the 5 km scale (Table 6). Most of these watersheds are characterized as open at the watershed scale. Only Sonoma Creek (206SON010) was influenced by agriculture based on the NLCD, and only on the 1 km and 5 km scales. Although most of the sites in the region have urban influences, there was an overall trend of decreasing toxicity. Sites such as San Leandro (204SLE030) and San Mateo Creeks (204SMA020) had significant trends of increasing amphipod survival in toxicity tests. Most of the toxicity observed in the region occurred in 2008. There was one highly toxic site in 2010 (Kirker Creek, 207KIR020), and only Walker Creek (207WAL020) was moderately toxic in 2011 and 2012. Many of these sites were also tested at 15 °C. Walker Creek was moderately toxic when tested at 23 °C, but approximately 75% of the sites had significantly greater toxicity at the colder test temperature (data not shown). This suggests that pyrethroids play a large role in sediment toxicity at Region 2 SPoT sites. Despite a statewide increase in pyrethroid pesticides in urban watersheds, a significant reduction of pyrethroids was observed at Laurel Creek. Sediments collected at Lagunitas Creek (201LAG125) had lower pyrethroid concentrations after an initial detection in 2008, but sediments from Coyote Creek (205COY060), Guadalupe Creek (205GUA020), Sonoma Creek and Walker Creek all showed marked, but statistically insignificant increases in pyrethroids. A significant reduction in PBDEs was observed in San Lorenzo Creek, and significant reductions in organochlorine compounds were observed in San Mateo Creek. Other statistically insignificant trends included a reduction of PAHs at Kirker Creek and a reduction of DDT at Coyote Creek.

Table 6. Summary toxicity and chemistry data for sites sampled in Region 2. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
201LAG125	Open	2008	2012	97	2.17		83.5	0	0.062	
201WLK160	Open	2008	2012	95	0		64.9	0	0.124	
204ALA020	Urban	2008	2012	95	7.22	106	120	2.60	1.49	1.90
204SLE030	Urban	2008	2012	84 ↑	42.2	2704	451	47.6	42.1	68.2 ↓
204SMA020	Urban	2008	2012	84 ↑	33.1	1696	212	56.4 ↓	11.8 ↓	15.2
205COY060	Urban	2008	2012	87	148	1535	237	18.6	17.4	34.8
205GUA020	Urban	2008	2012	93	66.2	2370	330	31.0	82.5	40.1
206SON010	Agriculture	2010	2012	97	15.0	23.4	115	0	0	
207KIR020	Urban	2008	2012	75	28.0	147	219	0.551	0.960	3.00
207LAU020	Urban	2008	2012	85	17.9 ↓	95.5	134	0.32	0.417	4.58
207WAL020	Urban	2008	2012	71	37.8	1122	211	4.63	8.45	14.3

Region 3 – Central Coast

At the 5 km scale, five of the Region 3 watersheds are classified as urban (Table 7). Of the thirteen sites tested in 2012, four are classified as open and two were classified as agriculture. The remaining two sites were classified as combinations of agriculture with urban or open land use. Tembladero Slough (309TDW) and the Santa Maria River (312SMA) sites have been consistently toxic over the last five years. These two sites are the most significantly impacted by agriculture. Toxicity of Tembladero Slough sediment has been improving significantly, but the site remains classified as moderately toxic. Santa Maria River is classified as highly toxic, and has had only one moderately toxic response. Santa Maria River was the only site to exhibit significant decreasing trends for PAHs and DDTs. Although DDT seems to be decreasing at this site, past measurements of this chemical have been some of the highest in the state. The Salinas River at Davis Road (309DAV) and Arroyo Grande Creek (310ARG) both had large, but statistically insignificant increases in pyrethroid pesticide concentrations. Arroyo Grande Creek was moderately toxic in 2012, and appears to be trending toward increasing toxicity. The Salinas River at Davis Road, San Antonio Creek (313SAI) and Atascadero Creek (315ATA) were moderately toxic in 2008 or 2009, but have since been non toxic. Several sites were also tested at 15 °C in order to determine the influence of pyrethroid pesticides on the observed toxicity. Of these sites, only Arroyo Grande Creek was toxic in 2011 and 2012, but this site was highly toxic when tested at the colder temperature. Several other sites were also toxic or highly toxic at the colder temperature.

Table 7. Summary toxicity and chemistry data for sites sampled in Region 3. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
304SLRWAT	Urban	2011	2012	102	0.269		47.2	0	0	
304SOK	Urban	2008	2012	100	1.42		75.5	0.395	0	
305THU	Ag/Urban	2008	2012	100	9.90	108	116	130	0.116	1.91
307CML	Open	2008	2012	96	11.5		110	0.239	0.107	
309DAV	Open	2008	2012	86	48.6	427	157	62.7	6.13	5.89
309TDW	Agriculture	2008	2012	41 ↑	78.0	51.9	179	92.1	8.99	
310ARG	Urban	2008	2012	81	40.2		101	25.5	0.195	
310SLB	Open	2008	2012	99	4.10	251	105	0.334	1.88	
312SMA	Ag/Open	2008	2012	26	35.6	10.0 ↓	119	149 ↓	0.212	0.598
313SAI	Open	2008	2012	96 ↑	7.38	8.3	61.1	6.67	0	
314SYN	Agriculture	2011	2012	106	13.5		121	0.95	0	
315ATA	Urban	2008	2012	93	18.9	180	88.0	6.77	3.642	
315MIS	Urban	2008	2012	100	11.2	881	122	3.89	1.37	10.6

Region 4 – Los Angeles

Five of eight sites in Region 4 are classified as urban, or have urban influence at the 5 km scale (Table 8). No sites are solely agriculture at the 5 km scale, but three sites have agriculture mixed with urban or open land use. Region 4 has the greatest number of toxic sites in the state. Half of the sites were considered highly toxic in 2012, including three major Los Angeles basin watersheds [Los Angeles River (412LARWxx), Ballona Creek (404BLNAxx), and San Gabriel River 405SGRA2x)], as well as Bouquet Canyon Creek (403STCBQT) in northern Los Angeles County. Ballona Creek had a significant increase in pyrethroids, and the Los Angeles River had an increase in pyrethroids that was not statistically significant. San Gabriel River has demonstrated non-significant increases in toxicity and all chemical classes. Bouquet Creek consistently has the highest concentrations of total pyrethroid pesticides in the state, and is consistently rated as highly toxic. Three sites have never been toxic: Ventura River (402VRBOxx), Santa Clara River Estuary (403STCEST), and Sespe Creek (403STCSSP), the latter being one of the five SPoT reference sites. The Santa Clara River and Calluegas Creek also had significant decreases in DDT. Six of the eight Region 4 sites were also tested at 15 °C to determine the contribution of pyrethroid pesticides to the observed toxicity. All but one site, the Santa Clara River Estuary, had significantly greater toxicity when tested at the colder temperature. Toxic concentrations of pyrethroids were measured in all of the samples that were highly toxic at 15 °C.

Table 8. Summary toxicity and chemistry data for sites sampled in Region 4. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
402VRB0xx	Open	2008	2012	104	5.31		91.4	0.626	5.485	
403STCBQT	Urban	2010	2012	0	1153		329	0	11.6	
403STCEST	Ag/Urban	2008	2012	103	2.16		85.6	5.25 ↓	0.389	
403STCSSP	Ag/Open	2008	2012	107	1.98		99.1	0.372	0.677	
404BLNAxx	Urban	2008	2012	50	308 ↑	934	402	12.8	27.5	56.7
405SGRA2x	Urban	2008	2012	66	157	789	226	5.75	4.01	16.0
408CAL006	Ag/Open	2008	2012	90	9.28		80.6	59.7 ↓	6.56	
412LARWxx	Urban	2010	2012	72	137	215	232	3.17	6.07	42.1

Region 5 – Central Valley

Approximately one-third of SPoT sites are in Region 5. At the 5 km scale, these watersheds are mostly characterized as agricultural (Table 9). Three watersheds are characterized primarily as urban, and six as open land use. Three watersheds are agricultural combined with urban or open land use. The majority of the sites in Region 5 have never been toxic and generally have low concentrations of measured chemicals, including pesticides. Only five sites in the region have ever been toxic, and only three were toxic in 2011 or 2012. Marsh Creek (541MERECY) has been highly toxic every time it has been sampled. This site is influenced by urban and agricultural land use and has the highest concentrations of pyrethroids in the region. Orestimba Creek (541STC019) and Del Puerto Creek (541STC516) have also been highly toxic in 2010 and 2011, respectively, but in 2012 Orestimba Creek was not toxic and Del Puerto Creek was moderately toxic. These sites are classified as moderately toxic based on the five-year average. There has been a significant increase in the concentration of total pyrethroids measured at Orestimba Creek since 2008, and a significant decrease in DDT. Prior to 2012, Bear Creek (535MER007) had not been toxic, but high toxicity was observed that year. This watershed is two-thirds agriculture at the 5 km scale, but there were no obvious chemical causes for the observed toxicity based on detected chemicals. A number of significant trends have occurred in the remaining non toxic sites. These include decreases in DDT at Colusa Basin Drain (520CBDKLU) and San Joaquin River at Crows Landing (535STC504), and a decrease in PAHs at Bear Creek. Significant increases in pyrethroids, PAHs and metals were observed at Dry Creek (535STC206), one of the few urban watersheds in the region. Several sites demonstrated increases in pyrethroids that were not considered statistically significant. These include Bear Creek, Harding Drain (535STC501), San Joaquin River at Crows Landing and Marsh Creek. Two sets of ten samples were tested at 15 °C in 2011 and 2012 to determine the contribution of pyrethroid pesticides to the observed toxicity. In 2011 there were no differences between the toxicity responses at the two temperatures, but in 2012 one sample was moderately toxic at 23 °C, whereas four samples were toxic or highly toxic at 15 °C.

Table 9. Summary toxicity and chemistry data for sites sampled in Region 5. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
504BCHROS	Urban	2008	2012	107	2.61	221	117	42.7	0.381	6.55
504SACHMN	Agriculture	2008	2012	108	0.105		146	0	0	
508SACBLF	Open	2008	2012	98	2.95	97.2	277	0	0	1.30
510LSAC08	Agriculture	2008	2012	103	0.730	42.0	150	1.29	0	2.84
511CAC113	Agriculture	2008	2012	100	0.735		106	0.733	0	
515SACKNK	Agriculture	2008	2012	100	2.50		163	2.82	0	
515YBAMVL	Ag/Urban	2008	2012	98	1.34	63.7	111	0.163	0	8.92
519AMNDVY	Urban	2008	2012	97	1.31	55.9	114	0.462	0	0.475
519BERBRY	Agriculture	2008	2012	101 ↑	0.360		114	0	0	
519FTRNCS	Agriculture	2008	2012	102	0.434		125	0.330	0	
520BUTPAS	Agriculture	2008	2012	96	2.19		153	0.925	0	
520CBDKLU	Agriculture	2008	2012	99	5.40		167	7.72 ↓	0	
520SACLSA	Agriculture	2008	2012	100	0.228		161	0.683	0	
526PRFALR	Open	2010	2012	106	0.108		75.9	0	0	
531SAC001	Ag/Open	2008	2012	102	0.659	17.2	142	0.253	0	0.567
532AMA002	Open	2010	2012	99	7.13		107	0	0	
535MER007	Agriculture	2008	2012	78	1.58	40.3 ↓	89.5	1.01	0	1.16
535MER546	Agriculture	2008	2012	102	0.506		77.6	0.172	0	
535STC206	Urban	2008	2012	97	51.7 ↑	331 ↑	159 ↑	1.65	0	21.1
535STC210	Open	2008	2012	95	0.181		151	2.31	0	
535STC501	Agriculture	2009	2012	98	2.74	385	86.3	0.660	0	
535STC504	Agriculture	2008	2012	103	2.77		204	3.43 ↓	0	
541MERECY	Ag/Urban	2010	2012	8	115	4.8	199	23.1	0	0
541MER522	Agriculture	2008	2012	106	0.522		185	1.00	0	
541MER542	Open	2008	2012	97	0.171	0	58.7	0.162	0	
541SJC501	Agriculture	2008	2012	104	1.37	36.1	185	3.16	0	0.918
541STC019	Agriculture	2008	2012	71	15.8 ↑	0	122	44.2 ↓	0	
541STC516	Agriculture	2010	2012	42	37.2	1.7	124	6.57	0	
544SAC002	Agriculture	2010	2012	100	1.09		166	0.5	0	
551LKI040	Agriculture	2008	2012	96	1.58	29.8	89.4	2.09	0.520	
554SKR010	Open	2008	2012	104	0		123	0	0.046	
558CCR010	Agriculture	2008	2012	100	0.475	6.2	94.9	0.176	0.728	
558PKC005	Ag/Urban	2008	2012	79	22.2	513	163	16.9	1.25	
558TUR090	Agriculture	2008	2012	102	0.652	18.2	98.81	1.73	0.062	

Region 6 – Lahontan

Nine of the ten current Region 6 sites have been monitored continuously since the beginning of the program. Seven of these sites were characterized as open land use at the 5 km scale (Table 10). Two additional sites, the Upper Truckee River (634UTRSED) and the Truckee River at Trout Creek (635TROSED), also have urban influence at the 5 km scale. Bishop Creek (603BSP002) was the only Region 6 watershed to be characterized as urban. To date there have been no toxic samples in Region 6. The five-year average survival in all samples was >94%. There have also not been any significant upward or downward trends in chemical concentrations. Even though most of these sites are classified as being in watersheds dominated by open land use, pyrethroids were detected at eight of ten sites. Bifenthrin was detected most often, but a number of samples contained cyhalothrin, cypermethrin, deltamethrin and permethrin. Three Region 6 sites were tested at 15 °C in 2011 and 2012 to determine the potential contribution of pyrethroid pesticides to any observed toxicity. Testing at a colder temperature, one that is more relevant to temperatures measured in the region, did not increase the toxicity of any of the samples.

Table 10. Summary toxicity and chemistry data for sites sampled in Region 6. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
603BSP002	Urban	2008	2012	97	4.04	127	92.7	0.367	0	1.29
603LOWSED	Open	2008	2012	97	0		72.7	0	0	
628DEPSED	Open	2010	2012	101	0.839		99	0	0	
631WWKLAR	Open	2008	2012	97	0		154	0	0	
633WCRSED	Open	2008	2012	95	6.74	13.6	131	0	0	
634UTRSED	Urban/Open	2008	2012	94	0.058	66.7	145	0	0	0.343
635MARSED	Open	2008	2012	95	1.69		125	0	0	
635TRKSED	Open	2008	2012	97	4.56		111	0	0	
635TROSED	Urban/Open	2008	2012	100	2.83		106	0	0	
637SUS001	Open	2008	2012	98	0.434	44.5	111	0	0.084	0

Region 7 – Colorado River Basin

The three Region 7 sites that are evaluated as part of SPoT are also routinely monitored as part of other Regional Board programs. The Coachella Valley Stormwater Channel Outlet (719CVSCOT) was characterized with open land use at the 5 km scale, whereas the Alamo River Outlet (723ARGRB1) and the New River Outlet (723NROTWM) were both primarily agriculture (Table 11). Coachella Valley has never been toxic, but the southern river outlets have been moderately toxic intermittently. Two sediment toxicity identification evaluations (TIEs) were recently conducted on sediment collected from the Alamo River site as part of routine SWAMP monitoring. The toxicity and chemistry results suggest that pyrethroid pesticides were contributing to the observed toxicity. Pyrethroid concentrations have generally been higher at the New River site, and a previous study identified cypermethrin as the cause of water column toxicity at this site (Phillips et al., 2007). Significant decreases in DDT were observed at Coachella Valley and the New River, and a significant decrease in metals was observed at the Alamo River. The New River was also tested in 2011 and 2012 at 15 °C to determine the potential contribution of pyrethroid pesticides to the observed toxicity. Testing at the colder temperature did not affect the organism response in 2011, but increased the sample response from moderately toxic to highly toxic in 2012. The toxicity responses corresponded to higher concentrations of pyrethroids in the 2012 sample.

Table 11. Summary toxicity and chemistry data for sites sampled in Region 7. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
719CVSCOT	Open	2008	2012	99	3.94	6.85	161	12.2 ↓	0	0.353
723ARGRB1	Agriculture	2008	2012	86	5.44	19.0	99.9 ↓	24.7	0	0
723NROTWM	Agriculture	2008	2012	72	18.5	19.06	93.6	29.6 ↓	0	1.08

Region 8 – Santa Ana

Three of the four sites in the Santa Ana Region were classified as urban at the 5 km scale. The fourth site, San Jacinto Creek (802SJCREF), is one of the five SPoT reference sites, and was classified as open land use. No toxicity has been observed at San Jacinto Creek or at the Santa Ana River at Prado Basin (801SARVRx), but Chino Creek (801CCPT12) and San Diego Creek (801SDCxxx) have been significantly toxic in every sampling event (Table 12). San Diego Creek has been highly toxic in four of five sampling events, and Chino Creek was highly toxic in one of three events. The only significant trend observed in the chemistry data set was a decrease in DDT at San Diego Creek. There was also a non-significant increase in pyrethroid pesticides at this site. San Diego Creek has lower average concentration of pyrethroids than Chino Creek only because there was a very high detection of total pyrethroids in 2011 at Chino Creek. This detection corresponded to the one incidence of high toxicity at this site. The three urban sites were also tested at 15 °C to evaluate the potential contribution of pyrethroid pesticides to the observed toxicity. Although Chino Creek and San Diego Creek were already toxic or highly toxic, testing at the colder temperature increased the magnitude of toxicity in all cases, and caused the moderately toxic samples to become highly toxic. Santa Ana River also became highly toxic in 2012 when tested at 15 °C. All of the highly toxic samples contained toxic concentration of total pyrethroids.

Table 12. Summary toxicity and chemistry data for sites sampled in Region 8. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
801CCPT12	Urban	2010	2012	49	131	386	187	2.20	0	11.8
801SARVRx	Urban	2008	2012	93	12.7	450	135	5.55	5.57	16.8
801SDCxxx	Urban	2008	2012	21	104	203	123	17.9 ↓	2.10	2.41
802SJCREF	Open	2008	2012	99	0.544	145	110	0.337	0.143	0.586

Region 9 – San Diego

Nine sites were sampled in 2011 and 2012, up from seven in 2010. Eight of these sites had primarily urban land use at the 5 km scale, and the ninth site had a combination of urban and open space land use. Three sites were moderately toxic in 2011 and 2012, including Escondido Creek (904ESCOxx), San Dieguito River (905SDSDQ9), and Sweetwater River (909SWRWSx), but the Tijuana River (911TJHRxx) has been highly toxic since 2008 (Table 13). This site also has the highest average concentration of total pyrethroids, and has consistently been one of the most pyrethroid-contaminated sites in the state, based on SPoT monitoring. Los Penasquitos Creek (906LPLPC6) also had a very high total pyrethroid contamination in 2012, but the site was not toxic. In the three years this site has been sampled it has shown a non-significant increase in pyrethroid pesticides. There were several increasing or decreasing trends in the region, but they were not statistically significant. Concentrations of metals appear to be decreasing at Santa Margarita River (902SSMR07) and Escondido Creek, metal concentrations appear to be increasing at Los Penasquitos Creek, and PCBs are decreasing at San Diego River (907SDRWAR). Four sites were also tested in 2011 and 2012 at 15 °C to determine the contribution of pyrethroids to the observed toxicity. Of the eight samples tested over two years, two were moderately toxic at 23 °C, but four were moderately toxic and three were highly toxic at 15 °C. This suggests pyrethroids were playing a role in the toxicity of these samples. One sample remained non toxic (San Diego River).

Table 13. Summary toxicity and chemistry data for sites sampled in Region 9. Statistically significant trends are noted with arrows. Toxicity color scheme is described in introductory paragraph.

Station Code	Primary 5km Land Use	Years Sampled		Toxicity (5-Year % Survival)	Average Total Concentration (ng/g)					
					Pyrethroids	PAH	4 Metals	DDT	PCB	PBDE
901SJSJC9	Urban	2008	2012	93	12.2		96.6	0.811	0.513	
902SSMR07	Urban/Open	2008	2012	104	4.66	20.3	82.8	10.7	0.540	0.413
903SLRRBB	Urban	2011	2012	101	0.568		96.9	3.20	0	
904ESCOxx	Urban	2008	2012	85	11.3	473	170	1.24	1.31	3.81
905SDSDQ9	Urban	2010	2012	91	0.203	7.9	101	0	0	1.44
906LPLPC6	Urban	2010	2012	89	208	205	240	0	1.20	10.2
907SDRWAR	Urban	2009	2012	94	60.0	1663	344	14.0	18.8	9.57
909SWRWSx	Urban	2011	2012	69	52.2		133	4.15	0	
911TJHRxx	Urban	2008	2012	17	314	115	316	2.73	14.6	16.8

Reference Site Summary

All references samples were nontoxic in all years except for the Smith River (103SMHSAR) tested in 2010. The range of total organic carbon (TOC) and percent fine grained sediments at the reference sites were representative of those in the statewide monitoring sites (Figure 15). Concentrations of pyrethroids were below the median, but the average concentration at Lagunitas Creek (201LAG125) and Sespe Creek (403STCSSP) were clearly influenced by local agriculture and urban land uses. Average reference site concentrations of total DDT and total PCBs were less than 1 ng/g with the exception of Tuolumne River (535STC210) having an average total DDT concentration of 2.31 ng/g. The concentrations of the sum of Cd, Cu, Pb and Zn were representative of the statewide concentrations. Although the reference sites were in watersheds having limited human activity, concentrations of anthropogenic chemicals such as pesticides and metals are still detected to some degree. Although the concentrations of pyrethroid pesticides were below the median, these contaminants are still prevalent in these undeveloped watersheds. The concentrations of metals and organochlorine compounds were mostly between the first and third quartiles depicted in Figure 14.

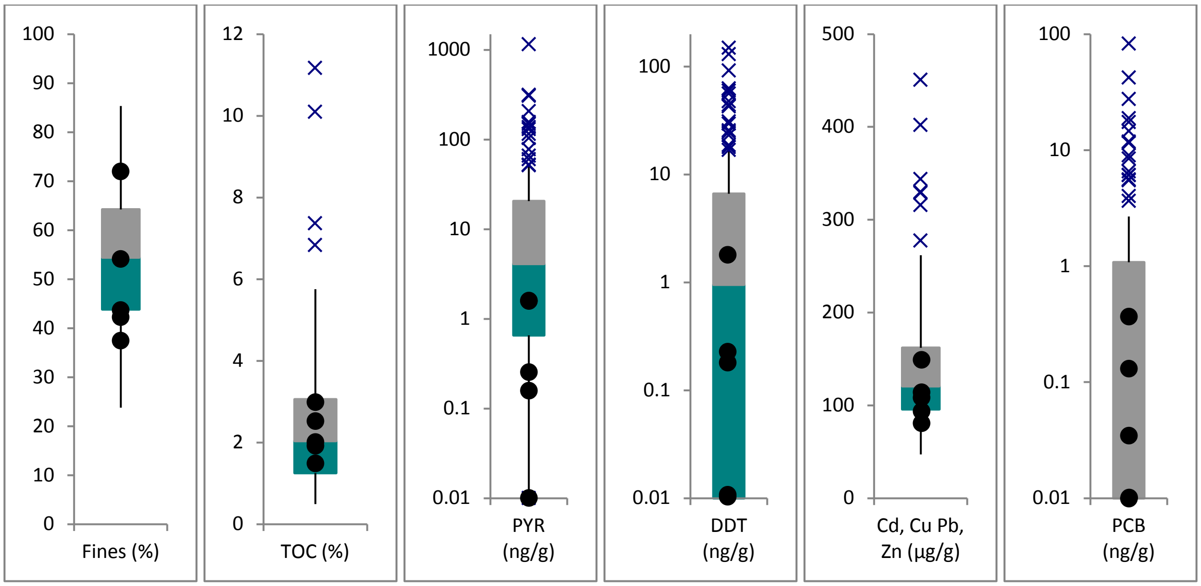

Figure 15. Average measured parameters from the five reference sites (black circles) plotted upon box plots of the averages from non-reference sites. Boxes represent first and third quartiles, line represents median, and t-bars represent 95% confidence limits. Additional points are outside of the inter-quartile range.

The Relationship among Measured SPoT Parameters

Principal components analysis (PCA) was used to examine significant relationships among the various parameters measured in the program. In addition, average yearly watershed discharge (cubic feet per second) was included to investigate the possible role of variations in yearly rainfall on contaminant concentrations. Two sets of analyses were performed. The first PCA included a complete set of the sites, but only the chemical parameters that were measured at all of the sites. The second PCA was conducted on the Tier II sites, and included the same chemicals as the first PCA, but also chemicals only measured at Tier II sites (PAHs, PBDEs). Urban and row crop land use at all three scales (1km, 5km, and whole watershed), physical characteristics (TOC and percent fines), and average watershed discharge were included for both analyses. A post-PCA regression analysis was performed to determine which PCA factors were most closely related to toxicity. This analysis was conducted by comparing the individual coefficients that were produced within each factor to the percent survival results.

In both analyses the row crop land use at all scales grouped with the average yearly discharge measured in each watershed (Table 14). This is an obvious relationship because SPoT watersheds that included row crop agriculture as the predominant land use were the largest in terms of discharge, so it is likely that average discharge is not the most appropriate measurement for the influence of runoff in a watershed. Subsequent reports will attempt to include actual rainfall data, particularly at locations proximate to the sampling station.

Urban land use at all scales grouped with two sets of organochlorine compounds in the greater data set, but a different result was observed for the Tier II data set. Only urban land use at the watershed scale grouped with any other components, including pyrethroids, the sum of four metals, and total organic carbon. These sediment constituents, along with percent fines grouped together in the main data set, but not with any land use. Hydrocarbons (PAHs) and PBDEs, which were strictly Tier II chemicals, grouped with PCBs and chlordanes in the Tier II analysis, but not with any land use. It is interesting to note that the pyrethroids, which showed a significant increasing trend in urban watersheds, did not group with urban land use in the main data set, and only grouped with the watershed scale urban land use in the Tier II data set. It is also interesting to note that the Tier II chemicals that were measured in the most urban watersheds did not group with urban land use at any scale.

Principal components regression analysis was performed between the individual coefficients within the PCA factors and percent survival. There were significant negative relationships between factors containing pyrethroid pesticides and percent amphipod survival for both sets of data ($p \leq 0.003$). For the larger data set there was also a significant relationship between percent survival and Factor 1, which contained watershed discharge and row crop land use.

Table 14. Results of principal components analyses for all data and Tier II data.

Factor	All Components	% of Variance	Tier II Urban Watershed Components	% of Variance
1	Row Crop Land Use (All Scales) Watershed Discharge	21.1	Row Crop Land Use (All Scales) Watershed Discharge	25.5
2	Urban Land Use (All Scales) PCBs Chlordanes	20.7	Urban Land Use (Watershed Scale) Pyrethroids Cd, Cu, Pb and Zn Total Organic Carbon	19.2
3	Pyrethroids Cd, Cu, Pb and Zn Total Organic Carbon Percent Fines	19.0	Chlordanes PCBs PBDEs PAHs	17.7

Pollutant Associations with Land Cover

Principal components analyses were used to determine relationships among contaminant factors and land use factors. At the statewide scale, PCBs and organochlorine pesticide chlordanes were associated with urban land use at all scales, but the pyrethroids, which have significantly increased in urban watersheds, were associated with metals, TOC and percent fines in this dataset. The highest concentrations of pyrethroids were detected in urban watersheds, but there were enough detections in watersheds dominated by agricultural and open land use to keep pyrethroids from associating solely with urban land use in the statewide PCA. In the Tier II (urban) data set, pyrethroids, metals and TOC were all related to urban land use at the watershed scale. The only factor related to row crop land use was average annual watershed discharge. This was somewhat expected because most of the larger watersheds monitored in the program flow through areas with heavy agricultural development. This result also indicates that average annual discharge might not be the most appropriate measure of watershed hydrography. Future analysis will consider rainfall, or more discrete measurements of discharge.

At the statewide level, principal components regression analysis showed significant relationships between toxicity and two separate factors. The first factor contained pyrethroids, metals, TOC and percent fines, and the second factor contained row crop land use. At the Tier II level, toxicity was significantly related to only the factor containing urban land use, pyrethroids, metals and TOC. None of the measured metals exceeded known toxicity thresholds, and this and all other evidence from SPoT analyses suggest that pyrethroids are driving the majority of observed toxicity.

Evaluation of the Current Program Design

Assessment of Variability

The SPoT program currently assesses one-hundred sites yearly to determine long-term trends in toxicity and chemical contamination. SPoT stations are located near the base of major watersheds, and sampling is conducted once per year after the rainy season. Following recommendations of the SPoT SRC, additional testing was conducted at selected SPoT sites to assess the temporal and spatial variability of toxicity and contamination on a more frequent time scale than once per year. Results of these additional assessments were analyzed to determine the extent to which a once-per-year summer sampling event at single SPoT stations provided adequate spatial and temporal representation of the watershed for the determination of long-term trends in contamination and toxicity.

Three Region 5 sites were selected for the initial phase of this study in 2010, and three additional sites were selected in Regions 4, 5 and 8 for 2011 and 2012. For each of the SPoT sites in this study, two to three additional stations were monitored upstream. These “variability sites” were located within a few kilometers of the base station in order to provide greater spatial representation. All stations plus the base station were sampled three times per year to represent the summer, fall and winter seasons.

Toxicity was estimated using 10-day amphipod survival tests, and contamination was characterized by measurement of pyrethroid pesticides. Pyrethroids were selected because of their pervasive use in urban and agricultural watersheds and increasing importance in driving sediment toxicity in California watersheds. Toxicity was also tested at two temperatures as described above. The toxicity and chemistry data were analyzed by first conducting a two-factor analysis of variance (ANOVA without replication) on the spatial and temporal data within the sampling season. The three stations in the watershed were the first factor, and the three seasons sampled was the second factor. The results of these analyses determined if there were significant differences among the seasons within the year, or the stations within the watershed, respectively. The results from the three base station samples conducted within each year were then compared to the base station results from other years using an F-Ratio test to determine if seasonal variability was significantly greater than annual variability. Three within-year base station results for Marsh Creek were compared to the three years Marsh Creek has been sampled. Coyote Creek and San Diego Creek had six within-year base station results, which were compared to the five years these sites have been sampled.

If the variability among years is greater than the variability within a year, then it is assumed that yearly sampling is representative of the watershed for any given year. Results of the F-Ratio tests indicate that annual variability was greater than seasonal variability in all cases except for toxicity measured at 15 °C at San Diego Creek and Marsh Creek (Table 15). The cold temperature tests were generally more toxic than the tests at 23 °C, but were also less variable because all of the tests had very low survival. Conclusions regarding the representativeness of the current once per year sampling depend on the spatial and seasonal variability of toxicity and chemistry at these sites. Variability components measured at these sites would likely change during years with heavier rainfall. The current results suggest once per year sampling adequately represent highly variable indicators in particular watersheds, especially for sites with less overall variability.

Table 15. Probability values for statistical comparisons among stations, seasons and years at variability sites. Shading represents significant differences ($p<0.05$). NA indicates not analyzed because Coyote Creek was not tested annually at 15 °C.

Station ID	Station Name	Parameter	Two-Factor ANOVA (no rep) Significant Difference Among Stations	Seasons	F-Ratio Test (one tail) Ho: Annual ≥ Seasonal
205COY060	Coyote Creek	23° Toxicity	0.788	0.987	0.311
		15° Toxicity	0.163	0.561	NA
		TOC	0.534	0.761	0.224
		Bifenthrin	0.518	0.446	0.345
541MERECY	Marsh Creek	23° Toxicity	0.622	0.802	0.473
		15° Toxicity	0.444	0.195	0.000
		TOC	0.267	0.410	0.486
		Bifenthrin	0.890	0.849	0.134
801SDCxxx	San Diego Creek	23° Toxicity	0.338	0.933	0.491
		15° Toxicity	0.279	0.866	0.002
		TOC	0.154	0.533	0.454
		Bifenthrin	0.471	0.165	0.381

Power Analysis

Power analyses were conducted on toxicity and chemistry data from the variability sites because these data provided power estimates for yearly sampling to compare to sampling three times per year. Power analyses were also conducted on a subset of base stations to determine the ability of the sampling regimes to measure significant trends. Based on the variability of parameters measured once per year for the last five years, it can take an average of 3 to 4 years to observe a 25% change in toxicity.

Parameters that are more variable, such as total pyrethroids, can take anywhere from 5 to 9 years to observe a 25% change. Power analysis conducted on the data from the variability sites demonstrated that trends could be detected more quickly by sampling the sites multiple times per year (Table 16). It is predicted that sampling three times per year at the variability sites could detect trends in toxicity and bifenthrin in an average of two years. More frequent sampling is advantageous for parameters that are expected to change quickly, such as pyrethroids (see discussion below), but trends for parameters that remain fairly constant, such as metals, could likely be detected by sampling on longer time scales. Chemical trends that are likely to change on a longer time scale will be analyzed every other year. These data informed revisions to the program for the 2015 sampling season (see below).

Table 16. Results of power analysis indicating the number of years necessary to observe a 25% change in toxicity or bifenthrin concentration if samples were collected once per year versus three times per year.

			Sampling 1x per Year Years to Detect a:		Sampling 3x per Year Years to Detect a:	
Station ID	Station Name	Parameter	-25% Change	+25% Change	-25% Change	+25% Change
205COY060	Coyote Creek	23° Toxicity	4	4	0.67	0.67
		Bifenthrin	10	5	3.33	2.67
541MERECY	Marsh Creek	23° Toxicity	10	8	1.67	1.33
		Bifenthrin	8	5	2	1.67
801SDCxxx	San Diego Creek	23° Toxicity	8	4	2.67	2
		Bifenthrin	9	5	3.67	2.67

Recommendations for SPoT Monitoring in 2015-2017

Most of the recommendations of the last report (Anderson et al., 2012) were implemented, including the completion of the base station representativeness study (which was adapted into the DPR collaboration for 2013-2014), addition of fipronil analysis to Tier II sites, and the discontinuation of unsieved metals analysis. The 2013 sampling season followed a similar format to previous years, and includes the monitoring of the same 100 base stations. Because of limited funding in 2014, the total number of base stations was reduced to 85, and the analysis of metals and organochlorine compounds were omitted for this sampling year. The decision to reduce these types of analyses was based on the stable or downward trends in these analytes exhibited in the 2008-2012 data set.

Following input from the Scientific Review Committee, we recommend the following for the 2015-2016 monitoring year:

1) Use the first five years of data, along with new data from 2013-2014 to redesign the program. The new design will focus on emerging contaminants and consider changes to the analyte list, as well as the addition of toxicity test organisms that are more sensitive to emerging contaminants. Some possibilities include:

- Maintaining a core set of 50 critical sites that are monitored once per year.
  - Monitor the remaining 50 sites every other year; rotating 25 in every year.
  - Testing a subset of sites (e.g., Tier II) with the midge *Chironomus dilutus* to screen for contaminants that are more toxic to this species, such as fipronil.
  - Reduce the frequency of metals analysis and the analysis of chlorinated compounds.
  - Consider collecting and testing water samples at a subset of sites to determine if more soluble pesticides such as neonicotinoids are present at toxic concentrations. Add water column testing with *Chironomus dilutus* to address toxicity of neonicotinoids and fipronil (likely to occur after 2015 as funding allows).
  - Collaborate with DPR to address emerging pesticides of concern.
2) Continue to develop a comprehensive database to explore statistical relationships between SPoT chemical and toxicity indicators and ecological indicators. Develop a collaboration with the Perennial Streams Assessment Program to create or relocate PSA sites to SPoT locations. Consistent bioassessment data at SPoT stations will support the connection between toxicity indicators and ecological indicators. Toxicity and chemistry data will support PSA causal assessments.
3) Continue monitoring microcystin-LR in sediments. Consider monitoring microcystin-LR in water samples as funding allows (likely to occur after 2015).

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References

Amweg, E.L., Weston, D.P., 2007. Whole-sediment toxicity identification evaluation tools for pyrethroid insecticides: I. Piperonyl butoxide addition. Environmental Toxicology and Chemistry 26, 2389-2396.

Amweg, E.L., Weston, D.P., Ureda, N.M., 2005. Use and toxicity of pyrethroid pesticides in the Central Valley, CA, U.S. Environmental Toxicology and Chemistry 24, 966-972.

Anderson, B.S., Hunt, J.W., Markewicz, D., Larsen, K., 2011. Toxicity in California Waters, Surface Water Ambient Monitoring Program. California Water Resources Control Board. Sacramento, CA.

Anderson, B.S., Hunt, J.W., Phillips, B.M., Nicely, P.A., de Vlaming, V., Connor, V., Richard, N., Tjeerdema, R.S., 2003a. Integrated assessment of the impacts of agricultural drainwater in the Salinas River (California, USA). Environ. Pollut. 124, 523-532.

Anderson, B.S., Hunt, J.W., Phillips, B.M., Nicely, P.A., Gilbert, K.D., De Vlaming, V., Connor, V., Richard, N., Tjeerdema, R.S., 2003b. Ecotoxicologic impacts of agricultural drain water in the Salinas River, California, USA. Environmental Toxicology and Chemistry 22, 2375-2384.

Anderson, B.S., Phillips, B.M., Hunt, J.W., Voorhees, J.P., Clark, S.L., Mekebri, A., Crane, D., Tjeerdema, R.S., 2008. Recent advances in sediment toxicity identification evaluations emphasizing pyrethroid pesticides. in: Gan, J., Spurlock, F., Hendley, P., Weston, D. (Eds.). Synthetic Pyrethroids: Occurrence and Behavior in Aquatic Environments. American Chemical Society, Washington, DC, pp. 370-397.

Anderson, B.S., Phillips, B.M., Hunt, J.W., Worcester, K., Adams, M., Kapellas, N., Tjeerdema, R., 2006. Evidence of pesticide impacts in the Santa Maria River watershed, California, USA. Environ Toxicol Chem 25, 1160-1170.

Anderson, B.S., Phillips, B.M., Siegler, K., Voorhees, J.P., 2012. Initial Trends in Chemical Contamination, Toxicity and Land Use in California Watersheds: Stream Pollution Trends (SPoT) Monitoring Program. Second Technical Report - Field Years 2009-2010. California State Water Resources Control Board, Sacramento, CA. 92 pp (with appendices).

BASMAA (Bay Area Stormwater Agencies Association), 2011. Creek Status Monitoring Program. Quality Assurance Project Plan. in: Coalition, B.R.M. (Ed.), p. 46.

Besser, J.M., Brumbaugh, W.G., Kemble, N.E., May, T.W., Ingersoll, C.G., 2004. Effects of sediment characteristics on the toxicity of chromium(III) and chromium(VI) to the amphipod, Hyalella azteca. Environmental Science & Technology 38, 6210-6216.

Bonifacio, E., Falsone, G., Piazza, S., 2010. Linking Ni and Cr concentrations to soil mineralogy: does it help to assess metal contamination when the natural background is high? Journal of Soils and Sediments 10, 1475-1486.

Brown, R.P., Landre, A.M., Miller, J.A., Kirk, H.D., Hugo, J.M., 1997. Toxicity of sediment-associated chlorpyrifos with the freshwater invertebrates *Hyalella azteca* (amphipod) and *Chironomus tentans* (midge). Health and Environmental Research Laboratories, Dow Chemical, Midland, MI, USA.

Coats, J.R., Symonik, D.M., Bradbury, S.P., Dyer, S.D., Timson, L.K., Atchison, G.J., 1989. Toxicology of synthetic pyrethroids in aquatic organisms: an overview. Environmental Toxicology and Chemistry 8, 671-679.

Davis, J.A., Ross, J.R.M., Bezalel, S.N., Hunt, J.A., Ichikawa, G., Bonnema, A., Heim, W.A., Crane, D., Swenson, S., Lamerdin, C., 2013. Contaminants in Fish from California Rivers and Streams, 2011. A Report of the Surface Water Ambient Monitoring Program (SWAMP). California State Water Resources Control Board, Sacramento, CA.

Denton, D.L., Diamond, J., Zheng, L., 2011. Test of Significant Toxicity: A statistical application of assessing whether an effluent or site water is truly toxic. Environ Toxicol Chem 1117-1126.

Diamond, J., Denton, D.L., Anderson, B.A., Phillips, B.M., 2011. It is time for changes in the analysis of whole effluent toxicity data. Integrated environmental assessment and management 8, 351-358.

Ding, Y.P., Weston, D.P., You, J., Rothert, A.K., Lydy, M.J., 2011. Toxicity of Sediment-Associated Pesticides to Chironomus dilutus and *Hyalella azteca*. Arch Environ Contam Toxicol 61, 83-92.

Gan, J., Lee, S.J., Liu, W.P., Haver, D.L., Kabashima, J.N., 2005. Distribution and persistence of pyrethroids in runoff sediments. J. Environ. Qual. 34, 836-841.

Gibbs, J.P., Ene, E., www.esf.edu/efb/gibbs/monitor/, U., 2010. Program Monitor: Estimating the statistical power of ecological monitoring programs. Version 11.0.0.

Hall, L.W., Killen, W.D., Alden, R.W., 2007. Relationship of farm level pesticide use and physical habitat on benthic community status in a California agricultural stream. Human and Ecological Risk Assessment 13, 843-869.

Hall, L.W., Killen, W.D., Anderson, R.D., Alden, R.W., 2009. The Influence of Physical Habitat, Pyrethroids, and Metals on Benthic Community Condition in an Urban and Residential Stream in California. Human and Ecological Risk Assessment 15, 526-553.

Harwood, A.D., You, J., Lydy, M.J., 2009. Temperature as a Toxicity Identification Evaluation Tool for Pyrethroid Insecticides: Toxicokinetic Confirmation. Environmental Toxicology and Chemistry 28, 1051-1058.

Holmes, R.W., Anderson, B.S., Phillips, B.M., Hunt, J.W., Crane, D., Mekebri, A., Blondina, G., Nguyen, L., Connor, V., 2008. Statewide Investigation of the Role of Pyrethroid Pesticides in Sediment Toxicity in California's Urban Waterways. Environ Sci Technol 42, 7003-7009.

Hunt, J.W., Phillips, B.M., Anderson, B.S., Siegler, C., Lamerdin, S., Sigala, M., Fairey, R., Swenson, S., Ichikawa, G., Bonnema, A., Crane, D., 2012. Statewide perspective on chemicals of concern and connections between water quality and land use. Surface Water Ambient Monitoring Program – Stream Pollution Trends (SPoT) Program. California State Water Resources Control Board. Sacramento, CA.

Ingersoll, C.G., Wang, N., Hayward, J.M.R., Jones, J.R., Jones, S.B., Ireland, D.S., 2005. A field assessment of long-term laboratory sediment toxicity tests with the amphipod *Hyalella azteca*. Environ Toxicol Chem 24, 2853-2870.

Kukkonen, J.V.K., Mitra, S., Landrum, P.F., Gossiaux, D.C., Gunnarsson, J., Weston, D., 2005. The contrasting roles of sedimentary plant-derived carbon and black carbon on sediment-spiked hydrophobic organic contaminant bioavailability to *Diporeia* species and *Lumbriculus variegatus*. Environmental Toxicology and Chemistry 24, 877-885.

Larry Walker Associates, 2009. Central Coast Cooperative Monitoring Program 2005-2008 Water Quality Report DRAFT. http://www.ccamp.org/ccamp/Reports.html#AgReports. San Jose, California, p. 132.

Liber, K., Doig, L.E., White-Sobey, S.L., 2011. Toxicity of uranium, molybdenum, nickel, and arsenic to Hyalella azteca and Chironomus dilutus in water-only and spiked-sediment toxicity tests. Ecotoxicology and Environmental Safety 74, 1171-1179.

Macdonald, D.D., Dipinto, L.M., Field, J., Ingersoll, C.G., Long, E.R., Swartz, R.C., 2000. Development and evaluation of consensus-based sediment effect concentrations for polychlorinated biphenyls. Environ Toxicol Chem 19, 1403-1413.

Macdonald, D.D., Ingersoll, C.G., Berger, T.A., 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch Environ Contam Toxicol 39, 20-31.

Mahler, B.J., Van Metre, P.C., Callender, E., 2006. Trends in metals in urban and reference lake sediments across the United States, 1970 to 2001. Environmental Toxicology and Chemistry 25, 1698-1709.

Maund, S.J., Hamer, M.J., Lane, M.C.G., Farrelly, E., Rapley, J.H., Goggin, U.M., Gentle, W.E., 2002. Partitioning, bioavailability, and toxicity of the pyrethroid insecticide cypermethrin in sediments. Environ Toxicol Chem 21, 9-15.

Nebeker, A.V., Schuytema, G.S., Griffis, W.L., Barbitta, J.A., Carey, L.A., 1989. Effect of sediment organic carbon on survival of Hyalella azteca exposed to DDT and endrin. Environ Toxicol Chem 8, 705-718.

Ode, P.R., Kincaid, T.M., T., F., Rehn, A.C., 2011. Ecological Condition Assessments of California's Perennial Wadeable Streams: Highlights from the Surface Water Ambient Monitoring Program's Perennial Streams Assessment (PSA) (2000-2007). A collaboration between the State Water

Resources Control Board's Non-Point Source Pollution Control Program (NPS Program), Surface Water Ambient Monitoring Program (SWAMP), California Department of Fish and Game Aquatic Bioassessment Laboratory, and the U.S. Environmental Protection Agency.

Phillips, B.M., Anderson, B.A., Hunt, J.W., Siegler, C., Voorhees, J.P., Tjeerdema, R.S., McNeill, K., 2012. Pyrethroid and organophosphate pesticide-associated toxicity in two coastal watersheds (California, USA). Environ Toxicol Chem 31, 1595-1603.

Phillips, B.M., Anderson, B.S., Hunt, J.W., Huntley, S.A., Tjeerdema, R.S., Richard, N., Worcester, K., 2006. Solid-phase Sediment Toxicity Identification Evaluation in an Agricultural Stream. Environ Toxicol Chem 25, 1671-1676.

Phillips, B.M., Anderson, B.S., Hunt, J.W., Nicely, P.A., Kosaka, R.A., Tjeerdema, R.S., de Vlaming, V., Richard, N., 2004. In situ water and sediment toxicity in an agricultural watershed. Environmental Toxicology and Chemistry 23, 435-442.

Phillips, B.M., Anderson, B.S., Hunt, J.W., Tjeerdema, R.S., Carpio-Obeso, M., Connor, V., 2007. Causes of Water Column Toxicity to Hyalella azteca in the New River, California (USA). Environmental Toxicology and Chemistry 26, 1074-1079.

Phillips, B.M., Anderson, B.S., Lowe, S., 2011. RMP Sediment Study 2009-2010, Determining Causes of Sediment Toxicity in the San Francisco Estuary. Regional Monitoring Program for Water Quality in the San Francisco Estuary. Contribution No. 626. San Francisco Estuary Institute. Oakland, CA.

Schueler, T.R., 1994. The importance of imperviousness. Watershed Protection Techniques 1, 100–111.

SPoT, 2010. Statewide Stream Pollution Trends (SPoT) Monitoring Program - Quality Assurance Project Plan. Surface Water Ambient Monitoring Program (SWAMP), May 2010. http://www.waterboards.ca.gov/water_issues/programs/swamp/qapp/qapp_spot_strms_pollute_final.pdf.

Suedel, B.C., Rodgers, J.H., Clifford, P.A., 1993. Bioavailability of fluoranthene in freshwater sediment toxicity tests. Environ Toxicol Chem 12, 155-165.

SWAMP, 2008. Surface Water Ambient Monitoring Program - Quality Assurance Program Plan Version 1. California Water Boards, Sacramento, CA.

Swartz, R.C., 1999. Consensus sediment quality guidelines for polycyclic aromatic hydrocarbon mixtures. Environmental Toxicology and Chemistry 18, 780-787.

Tabachnick, B.G., Fidell, L.S., 1996. Using Multivariate Statistics. Harper Collins College Publishers, New York, NY USA.

Topping, B.R., Kuwabara, J.S., 2003. Dissolved nickel and benthic flux in South San Francisco Bay: A potential for natural sources to dominate. Bull. Environ. Contam. Toxicol. 71, 46-51.

U.S. EPA, 2000. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. EPA/600/R-99/064. Office of Research and Development, Washington D.C.

U.S. EPA, 2003. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Dieldrin. Office of Research and Development. Washington, D.C.

U.S. EPA, 2010. National Pollutant Discharge Elimination System Test of Significant Toxicity Technical Document. EPA 833-R-10-004. Office of Wastewater Management. Washington DC.

Weston, D., You, J., Harwood, A., Lydy, M.J., 2009. Whole sediment toxicity identification evaluation tools for pyrethroid insecticides: III. Temperature manipulation. Environ Toxicol Chem 28, 173-180.

Weston, D.P., Holmes, R.W., You, J., Lydy, M.J., 2005. Aquatic toxicity due to residential use of pyrethroid insecticides. Environmental Science & Technology 39, 9778-9784.

Weston, D.P., Lydy, M.J., 2014. Toxicity of the Insecticide Fipronil and Its Degradates to Benthic Macroinvertebrates of Urban Streams. Environ Sci Tech.

Weston, D.P., You, J., Lydy, M.J., 2004. Distribution and toxicity of sediment-associated pesticides in agriculture-dominated water bodies of California's Central Valley. Environmental Science & Technology 38, 2752-2759.

Appendices

Appendix 1: Assessment Questions and Links to Water Quality Programs

The following is a summary of SPoT program elements in the context of the SWAMP Assessment Framework (Bernstein, 2010), with linkages to regulatory and resource management programs that can incorporate SPoT data. The SWAMP Assessment Framework provides guidance and context for developing question-driven monitoring to provide water quality information directly useful for resource management. The beneficial use that is assessed is aquatic life protections and the water body types that are assessed are streams that range from ephemeral creeks to large rivers. This summary states the assessment questions SPoT addresses, and lists the resource management programs to which SPoT provides essential information. Level 1 assessment questions are the highest level, as adopted by SWAMP and the California Water Quality Monitoring Council (Bernstein, 2010; page 8 and Figure 2). The Level 2 assessment questions apply to each of the two Level 1 questions.

Level 1 Assessment Questions:

I. Are our aquatic ecosystems healthy?

II. What stressors and processes affect our water quality?

Level 2 Assessment Questions for both of the Level 1 questions stated above:

I. Are beneficial uses impaired?

> Management goal: Determine whether aquatic life beneficial uses in California streams are impaired by sediment-associated chemical pollutants.
>
> **Supports: 303(d) listing and 305(b) reporting**
>
> Monitoring strategy: Analyze pollutant concentrations and toxicity in sediments collected from targeted depositional areas in 100 large watersheds statewide. Compare toxicity results to narrative standards; compare chemical concentrations to available sediment quality guidelines and threshold effects values.
>
> Certainty / precision: Analytical precision for chemical and toxicological measurements is high. Level of representativeness for all possible sites in the watersheds at all times of the year is moderate and being evaluated through integrated special studies.
>
> Reference conditions: Five reference sites in large watersheds across the state.
>
> Spatial scale: State of California. Results are interpreted on a statewide basis to allow perspective for local and regional analyses by partner programs.
>
> Temporal scale: Surveys on an annual basis over an extended period (> 10 years) to evaluate long-term trends.

II. Are conditions getting better or worse?

Management goal: Determine the magnitude and direction of change in concentrations of sediment-associated chemical pollutants and toxicity.

Supports: Basin Planning, implementation of urban and agricultural management practices, permit reissuance, EPA Measure W.

Monitoring strategy: Survey stream sites in up to 100 large watersheds statewide annually for an extended period (> 10 years). Evaluate temporal trends at each site.

Certainty / precision: Precision is evaluated through integrated special studies that survey three to four additional sites in each of a rotating subset of selected watersheds during three seasons within each year.

Reference conditions: as described above.

Spatial and Temporal Scale: as described above.

III. What is the magnitude and extent of any problems?

Management goal: Determine the number of large California watersheds potentially impaired by sediment-associated chemical pollutants and toxicity, and the magnitude of observed impairment.

Supports: 303(d), TMDL, stormwater permit monitoring, agricultural permit/waiver monitoring

Monitoring strategy: Survey stream sites in 100 large watersheds statewide; provide statewide perspective for local and regional permit and Basin Plan monitoring. Collaborate with statewide and local programs to determine upstream extent of observed impairment.

Certainty / precision: as described above.

Reference conditions: as described above.

Spatial and Temporal Scale: as described above.

IV. What's causing the problem?

Management goal: Determine relationships between stream pollution and watershed land cover. Compare chemical concentrations to observed toxicity, known toxicity thresholds and guideline values.

Supports: 305(b), TMDL, Basin Planning, County land use planning, pesticide surface water regulations and DPR pesticide registration (especially for pyrethroids).

Monitoring strategy: Analyze geospatial and statistical correlations between in-stream pollutant concentrations/toxicity and land cover data extracted for the watersheds draining to the stream sites. Evaluate statistical relationships between measured chemicals and observed toxicity.

Certainty / precision: high (n = 92 for year 2008 correlation analyses).

Reference conditions: Data from reference sites included in correlation gradients.

Spatial and Temporal Scale: as described above.

V. Are solutions working?

Management goal: Relate changes in concentrations and toxicity of sediment-associated pollutants with implementation of water quality management programs and practices.

Supports: TMDL, management practice implementation programs, EPA Measure W, urban and agricultural regulatory programs.

Monitoring strategy: Compare changes in in-stream chemical concentrations and implementation of management strategies and practices.

Certainty / precision: Currently low, due to the limited amount and standardization of quantitative information on implementation of management practices statewide. Efforts are underway to support and standardize reporting of practices implemented, land area affected, volume of water treated, and effectiveness of treatment. It is anticipated that improvements in this area will improve precision of analyses to determine whether implemented solutions are effective.

Reference conditions: Reference sites provide data for watersheds in which solutions are less necessary and fewer new management practices will be implemented.

Spatial and Temporal Scale: as described above.

Appendix 2: SPoT 2008-2012 Station Information

Station Code	Station Name	Latitude	Longitude	2008	2009	2010	2011	2012	Coordination
103SM1009	Smith River @ Sarina Road	41.9134	-124.17162	95	95	73	95	97	None
105KLAMKK	Klamath River @ Kamp Klamath	41.5171	-124.03896	95		86	100	103	None
109MAD101	Mad River upstream Hwy 101	40.91763	-124.08946	83		70	97	107	None
111EELFRN	Eel River @ Fernbridge	40.61129	-124.20407	90		66	99	104	None
111SF0933	Eel River - South Fork @ Meyers Flat	40.26178	-123.88023	100		59	96	104	None
113NA3269	Navarro River @ Dimmick State Park	39.15911	-123.63861			58	91	81	None
114LAGWOH	Laguna de Santa Rosa @ Wohler Street	38.49254	-122.88327	96	96	92	103	103	None
114RRDSDM	Russian River downstream Duncan Mills	38.4475	-123.05583	96		99	96	104	None
201LAG125	Lagunitas Creek @ Coast Guard Station	38.06915	-122.79809	100	91	99	99	99	Regional Board
201WLK160	Walker Creek Ranch	38.17545	-122.82044	88		92	101	99	Regional Board
204ALA020	Alameda Creek east of Alvarado Blvd	37.582	-122.052	92		93	101	92	Region 2 MRP
204SLE030	San Leandro Creek @ Empire Road	37.72556	-122.18361	66		86	91	95	Region 2 MRP
204SMA020	San Mateo Creek @ Gateway Park	37.57028	-122.31861	59	79	88	91	101	Region 2 MRP
205COY060	Coyote Creek @ Montague	37.3954	-121.91485	82	76	96	92	90	Region 2 MRP
205GUA020	Guadalupe Creek @ USGS GS 11169025	37.37389	-121.93194	89		97	95	89	Region 2 MRP
206SON010	Sonoma Creek @ Hwy 121	38.2405	-122.45127			97	95	99	Region 2 MRP
207KIR020	Kirker Creek @ Floodway	38.0165	-121.83881	93		34	86	86	Region 2 MRP
207LAU020	Laurel Creek @ Pintail Drive	38.2483	-122.00668	43		96	100	99	Region 2 MRP
207WAL020	Walnut Creek @ Concord Ave O.C.	37.98063	-122.0516	57		82	75	70	Region 2 MRP
304SLRWAT	San Lorenzo River below Water Street	36.97685	-122.0239				94	110	Regional Board
304SOK	Soquel Creek @ Knob Hill Parking Lot	36.98014	-121.95624	103		84	111	103	Regional Board
305THU	Pajaro River @ Thurwachter Road	36.87977	-121.79195	97	98	99	108	99	Regional Board
307CML	Carmel River @ Highway 1	36.53638	-121.91168	92		104	93	93	Regional Board
309DAV	Salinas River @ Davis Road	36.64681	-121.70139	91	53	99	97	92	Region 3 CMP
309TDW	Tembladero Slough @ Monterey Dunes	36.77218	-121.7866	23		32	52	58	Region 3 CMP
310ARG	Arroyo Grande Creek @ 22nd Street	35.09521	-120.60625	96		91	77	60	Regional Board
310SLB	San Luis Obispo Creek @ San Luis Bay Drive	35.18832	-120.71792	93		97	96	110	Regional Board
312SMA	Santa Maria River above Estuary	34.96377	-120.6418	0	11	23	65	33	Region 3 CMP
313SAI	San Antonio Creek @ San Antonio Rd West	34.78233	-120.52997	63		101	106	113	Regional Board
314SYN	Santa Ynez River at 13th Street	34.676617	-120.55339				104	109	Regional Board
315ATA	Atascadero Creek @ Ward Drive	34.42345	-119.81929	59		97	106	109	Regional Board
315MIS	Mission Creek @ Montecito Street	34.41304	-119.69401	92		100	104	104	Regional Board
402VRB0xx	Ventura River Bio 0	34.28173	-119.30669	107		101	110	97	SMC
403STCBQT	Bouquet Canyon Creek	34.42782	-118.54022			0	0	0	None
403STCEST	Santa Clara River Estuary	34.23557	-119.21674	101		91	103	116	None
403STCSSP	Sespe Creek	34.39414	-118.94096	104		104	101	118	None
404BLNAxx	Ballona Creek Downstream of Centinela	33.986	-118.417	44	40	69	73	22	SMC
405SGRA2x	San Gabriel River RA-2	33.78708	-118.09367	87		69	78	30	SMC
408CGCS06	Calleguas Creek Below Camrosa WWTP	34.17978	-119.04053	55	96	91	100	110	SMC
412LARWxx	Los Angeles River at Willow	33.8049	-118.205			95	92	30	None
504BCHROS	Big Chico Creek @ Rose Ave	39.72716	-121.86308	106		115	101	105	Regional
504SACHMN	Sac R @ Hamilton City	39.7511	-121.99798	110		118	100	105	Regional
508SACBLF	Sacramento River @ Balls Ferry	40.41762	-122.19334	90		103	96	103	Regional
510LSAC08	Clarksburg Marina	38.38312	-121.52057	100		101	102	108	Regional
511CAC113	Cache Creek @ Hwy 113	38.72066	-121.7643	100		92	100	107	Regional
515SACKNK	Sacramento Slough @ Karnak	38.78456	-121.65439	107		97	96	99	Regional
515YBAMVL	Yuba R @ Maryville	39.13421	-121.5929	92	95	97	101	104	Regional
519AMNDVY	American R @ Discovery Park	38.60094	-121.5055	94	96	101	92	103	Regional
519BERBRY	Bear River @ Berry Rd.	38.96175	-121.54677	95		101	101	106	Regional
519FTRNCS	Feather River @ Nicolaus	38.89746	-121.5905	99		99	101	111	Regional
520BUTPAS	Butte Slough upstream of Pass Road	39.18786	-121.90919	96		99	82	106	Regional
520CBDKLU	Colusa Basin Drain @ Knights Landing	38.80003	-121.72423	103		95	95	103	Regional
520SACLSA	Sacramento River at Colusa near Bridge St.	39.21415	-122.00031	95		100	96	110	Regional
526PRFALR	Pit River at Cassel-Fall River Road	40.99795	-121.43507			122	96	101	Regional Board
531SAC001	Cosumnes River at Twin Cities Road	38.29083	-121.37583	100		107	97	103	Regional Board
532AMA002	Sutter Creek @ Hwy 49	38.3925	-120.80139			99	97	102	Regional Board
535MER007	Bear Creek near Bert Crane Road	37.25556	-120.65194	101		110	100	0	Region 5 ILP

Station Code	Station Name	Latitude	Longitude	2008	2009	2010	2011	2012	Coordination
535MER546	Merced River @ River Road	37.34972	-120.95778	105		101	96	104	Region 5 ILP
535STC206	Dry Creek @ La Loma Rd.	37.64568	-120.98081	97		104	90	96	Region 5 ILP
535STC210	Tuolumne River @ Old LaGrange Bridge	37.66667	-120.46667	97		96	92	96	Regional
535STC501	TID 5 Harding Drain @ Carpenter Road	37.46444	-121.03028		97	96	100	99	None
535STC504	SJR @ Crows Landing	37.43323	-121.01597	96		107	101	107	Regional Board
541MERECY	Marsh Creek @ East Cypress Crossing	37.99107	-121.69626			0	24	0	None
541MER522	San Joaquin River @ Lander Avenue	37.29528	-120.85028	108		110	100	104	Region 5 ILP
541MER542	Mud Slough downstream of San Luis Drain	37.26389	-120.90611	104		93	101	90	Regional Board
541SJC501	San Joaquin River @ Airport Way	37.67556	-121.26417	108		107	97	103	Regional Board
541STC019	Orestimba Creek @ River Road	37.41389	-121.01417	99		22	71	91	Region 5 ILP
541STC516	Del Puerto Creek @ Vineyard Avenue	37.52139	-121.14861			45	3	77	None
544SAC002	Mokelumne River @ New Hope Road	38.23611	-121.41889			106	95	100	None
551LKI040	Kings River - South Fork	36.2558	-119.8551	83		105	94	103	Regional Board
554SKR010	South Fork Kern River @ Fay Ranch Road	35.6724	-118.28996	103		117	99	96	None
558CCR010	Cross Creek - Rd. 60 and Hwy 99	36.40437	-119.45697	101		104	99	95	Regional Board
558PKC005	Packwood Creek in pond upstream Rd. 94	36.27894	-119.35971	17	110	85	95	87	Regional Board
558TUR090	Tule River @ Road 64	36.08837	-119.42891	107		103	97	100	Regional Board
603BSP002	Bishop Creek @ East Line St	37.36156	-118.38606	92		99	101	96	None
603LOWSED	Lower Owens River near mouth	36.5498	-117.98175	91		96	101	99	None
628DEPSED	Deep Creek above Warm Springs	34.34205	-117.17413			115	91	96	None
631WWKLAR	West Walker River @ Topaz	38.54679	-119.49494	103		86	103	95	Regional Board
633WCRSED	West Fork Carson River @ Paynesville	38.80885	-119.77725	93		96	103	87	None
634UTRSED	Upper Truckee River near inlet to Lake Tahoe	38.93439	-120.00035	92		92	96	96	Other
635MARSED	Martis Creek near mouth	39.30211	-120.12135	88		97	101	94	None
635TRKSED	Lower Truckee River near CA/NV state line	39.46477	-120.0032	99		99	99	94	None
635TROSED	Trout Creek (Truckee) near mouth	39.3304	-120.1685	101		97	99	101	None
637SUS001	Susan River near Litchfield	40.37771	-120.39514	91	86	115	99	101	Regional Board
719CVSCOT	Coachella Valley Stormwater Channel Outlet	33.52444	-116.07778	99	96		101	100	Regional Board
723ARGRB1	Alamo River Outlet	33.1992	-115.5971	91	95	97	72	75	Regional Board
723NROTWM	New River Outlet	33.10472	-115.66361	69	70	45	104	75	Regional Board
801CCPT12	Chino Creek @ Euclid/Hwy 83	33.94016	-117.65427			77	16	55	None
801SARVRx	Santa Ana River @ Prado Basin Park Rd	33.92927	-117.59532	88		83	99	103	SMC
801SDCxxx	San Diego Creek @ Campus	33.65556	-117.84472	4	0	16	60	25	SMC
802SJCREF	San Jacinto River - Reference Site	33.737	-116.8263	95	100	101	106	94	USGS NAWQA
901SJSJC9	San Juan Creek 9	33.48443	-117.67577	99		91	95	88	None
902SSMR07	Santa Margarita @ Basilone Rd	33.31117	-117.34538	100	101	101	108	110	None
903SLSLR8	San Luis Rey River 8	33.21495	-117.36838				99	104	None
904ESCOxx	Escondido Creek @ Camino del Norte	33.04829	-117.22602	99	99	88	49	90	SMC
905SDSDQ9	San Dieguito River 9	32.97877	-117.23506			96	99	80	None
906LPLPC6	Los Penasquitos Creek 6	32.90588	-117.22703			93	79	93	None
907SDRWAR	San Diego River @ Ward Road	32.78032	-117.11046		100	88	95	93	None
909SWRWSx	Sweetwater River at Willow Street	32.6581	-117.0434				95	43	Regional Board
911TJHRxx	Tijuana River @ Hollister Rd	32.55142	-117.08394	15		13	1	38	SMC

Shaded station codes indicate 2012 Tier II stations.

CMP – Cooperative Monitoring Program
ILP – Irrigated Lands Program
MRP – Municipal Regional Permit Monitoring
Regional – Independent Regional Monitoring
Regional Board – SWAMP monitoring by Regional Board
SMC – Stormwater Monitoring Coalition
USGS NAWQA – USGS National Water Quality Assessment Program

List of retired, relocated, and renamed stations.

113NAVDMC	Navarro River @ Dimmick Campground	39.15693	-123.63427	Tributary of Navarro River
114LAGMIR	Laguna de Santa Rosa @ Mirabel	38.49376	-122.89191	Relocated and renamed, but used for trend analysis
114RRAXRV	Russian River @ Alexander RV Park	38.66143	-122.83286	Sampled upstream in addition to 114RRDSDM
403STCBQU	Santa Clara River Upstream Bouquet	34.42481	-118.54038	Sampled in the main channel of Santa Clara River
408CAL006	Calleguas Creek Main Stem	34.16443	-119.06255	Relocated and renamed, but used for trend analysis
520BUTEMR	Butte Slough @ Meridian	39.17007	-121.90046	Relocated and renamed, but used for trend analysis
526P00008	Pit @ Pittville Bridge	41.04554	-121.33035	Sampled 14km upstream of current site 526PRFALR
532CAL004	Mokelumne River @ Hwy 49	38.3125	-120.72083	Second Mokelumne site sampled a single time
541MER531	Salt Slough @ Lander Avenue	37.24861	-120.85111	Sampled a single time
558PKC010	Packwood Creek	36.269	-119.4211	Relocated and renamed, but used for trend analysis
635TRKSD1	Lower Truckee River upstream of CA/NV	39.42258	-120.03399	Relocated and renamed, but used for trend analysis
802SJRGxx	San Jacinto River @ Goetz/TMDL site	33.7511	-117.224	Second San Jacinto site sampled a single time
845SGRDRE	Drainage East of San Gabriel River @ 22	33.77401	-118.09489	Sampled a single time
904CBAHC6	Agua Hedionda Creek 6	33.14887	-117.29758	Sampled a single time
906LPSOL4	Soledad Canyon Creek 4	32.90248	-117.22564	Sampled a single time
907SDFRC2	Forrester Creek 2	32.83945	-117.00107	Sampled a single time

Appendix 3: Toxicity Threshold Evaluation Concentrations

Chemical	Type	Concentration	Reference
Pyrethroid Pesticides			
Bifenthrin	LC50	12.9	(Amweg et al., 2005)
Bifenthrin	LC50	0.52	(Amweg et al., 2005)
Cyfluthrin	LC50	13.7	(Amweg et al., 2005)
Cyfluthrin OC	LC50	1.08	(Amweg et al., 2005)
Cyhalothrin, Lambda	LC50	5.6	(Amweg et al., 2005)
Cyhalothrin, Lambda OC	LC50	0.45	(Amweg et al., 2005)
Cypermethrin	LC50	14.9	(Maund et al., 2002)
Cypermethrin OC	LC50	0.38	(Maund et al., 2002)
Deltamethrin/Tralomethrin	LC50	9.9	(Amweg et al., 2005)
Deltamethrin/Tralomethrin OC	LC50	0.79	(Amweg et al., 2005)
Esfenvalerate/Fenvalerate	LC50	41.8	(Amweg et al., 2005)
Esfenvalerate/Fenvalerate OC	LC50	1.54	(Amweg et al., 2005)
Fenpropathrin	LC50	177	(Ding et al., 2011)
Fenpropathrin OC	LC50	8.9	(Ding et al., 2011)
Permethrin	LC50	201	(Amweg et al., 2005)
Permethrin OC	LC50	10.9	(Amweg et al., 2005)
Organophosphate Pesticides			
Chlorpyrifos	LC50	399	(Brown et al., 1997)
Chlorpyrifos OC	LC50	1.77	(Amweg and Weston, 2007)
Diazinon	LC50	1085	(Ding et al., 2011)
Diazinon OC	LC50	54.6	(Ding et al., 2011)
Organochlorine Pesticides			
Sum DDT	LC50	11000	(Nebeker et al., 1989)
Sum DDT OC	LC50	367	(Nebeker et al., 1989)
Total Chlordane	PEC	17.6	(Macdonald, 2000)
Endrin	LC50	4400	(Nebeker et al., 1989)
Endrin OC	LC50	147	(Nebeker et al., 1989)
Dieldrin	LC50	2000	(U.S. EPA, 2003)
DDD (o,p')	LC50	1300	(Weston et al., 2004)
DDE (o,p')	LC50	8300	(Weston et al., 2004)
Heptachlor Epoxide	PEC	16	(Macdonald, 2000)
Methoxychlor	LC50	85.8	(Weston et al., 2004)
PAHs			
Sum PAH	LC50	1800	(Swartz, 1999)
Anthracene	PEC	845	(Macdonald, 2000)
Benz(a)anthracene	PEC	1050	(Macdonald, 2000)
Benzo(a)pyrene	PEC	1450	(Macdonald, 2000)
Chrysene	PEC	1290	(Macdonald, 2000)
Fluoranthene	LC50	1077	(Suedel et al., 1993)
Fluorene	PEC	536	(Macdonald, 2000)
Naphthalene	PEC	561	(Macdonald, 2000)
Phenanthrene	PEC	1170	(Macdonald, 2000)
Pyrene	PEC	1520	(Macdonald, 2000)
PCBs			
Sum PCB	LC50	400	(Macdonald et al., 2000)
Metals			
Arsenic	LC50	532	(Liber et al., 2011)
Cadmium	PEC	4.98	(Macdonald, 2000)
Chromium	PEC	111	(Macdonald, 2000)
Copper	LC50	260	MPSL Unpublished Data
Lead	PEC	128	(Macdonald, 2000)
Mercury	PEC	1.06	(Macdonald, 2000)
Nickel	LC50	521	(Liber et al., 2011)
Zinc	PEC	459	(Macdonald, 2000)

__Appendix 4: Quality Assurance Information__

Quality Assurance/Quality Control (QA/QC)

The data discussed below were evaluated in the Stream Pollution Trends (SPoT) report and were used to determine stream pollution trends for California. Thorough objectives for achieving quality data are outlined in the SWAMP Quality Assurance Program Plan (QAPrP). In general, data quality is demonstrated through analysis of the following quality control (QC) samples:

- Laboratory method blanks;
- Surrogate spikes;
- Matrix spikes (MSs) and matrix spike duplicates (MSDs);
- Certified reference materials (CRMs)/laboratory control spikes (LCSs);
- Laboratory duplicates (DUP)

Data for Project IDs SWB_SPoT_2011, SWB_SPoT_Variability_2011, SWB_SPoT_2012, and SWB_SPoT_Variability_2012 have been verified according to SWAMP Standard Operating Procedures (SOPs) for chemistry and toxicity data verification. The data verification process determines whether the data are compliant with the individual measurement quality objectives (MQOs) specified in the SWAMP QAPrP. The counts in the following sections represent field observations, metals, mercury, total organic carbon, grain size, organochlorine pesticides, organophosphorus pesticides, pyrethroid pesticides, polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls as congeners (PCBs) and aroclors, polynuclear aromatic hydrocarbons (PAHs), and *Hyalella azteca* toxicity test results from the SPoT program. Data were classified into one of the following classification levels:

<u>Compliant</u>

Data classified as “compliant” meet or exceed all of the MQOs and other data quality requirements specified in the SWAMP QAPrP. These data are considered usable for their intended purpose without additional scrutiny.

<u>Qualified</u>

Data classified as “qualified” do not meet one or more of the MQOs and other data quality requirements specified in the SWAMP QAPrP. These data are considered usable for its intended purpose following an additional assessment to determine the scope and impact of the quality control failure.

<u>Estimated</u>

Data classified as “estimated” are assigned to data batches and sample results that are not considered to be quantifiable. Included in this classification are results qualified with one of the following flags:

J–Estimated value (EPA Flag)

Screening

Data classified as “screening” are considered non-quantitative and marked as screening and may or may not meet the minimum data quality requirements specified in the SWAMP QAPrP. These data may not be usable for its intended purpose and requires additional assessment

Rejected

Data classified as “rejected” do not meet the minimum data quality requirements specified in the SWAMP QAPrP. These data are not considered usable for its intended purpose.

Not applicable

Data classified as “not applicable” refers to data that were not verified since there were no project MQOs or QC requirements for the specific parameter, or a failure result was reported and could not be verified.

No data have been validated. This section does not attempt to determine whether or not data should be used. Decisions regarding data use can only be made after data validation and comparison to project-specific data quality objectives (DQOs) is performed.

SWAMP criteria for percent recovery (%R) of surrogates, matrix spikes, and Certified Reference Materials and relative percent difference (RPD) for field and laboratory duplicates for sediments are presented in Table A1.

Laboratory Method Blanks

Laboratory method blanks are used to evaluate laboratory contamination during sample preparation and analysis. Blank samples undergo the same analytical procedure as samples with at least one blank analyzed per 20 samples. The required frequency was met for all 191 batches.

Data that met the MQO for method blanks are those with values less than the reporting limit (RL) for that particular analyte within each analytical batch. All 285 laboratory method blanks met the MQO.

Surrogate Spikes

Surrogate spikes are used to assess analyte losses during sample extraction and clean-up procedures, and must be added to every field and quality control sample prior to extraction. Whenever possible, isotopically-labeled analogs of the analytes should be used.

All field samples and QC were spiked with surrogates as required. Surrogates for organophosphorus pesticides analyzed by CSUMB-IIRMES were reported in the associated organochlorine pesticide batches.

All surrogate percent recoveries were within the acceptance criteria listed in Table A1, with the exception of surrogates spiked in sample 205COYSCL in batch WPCL_L-020-12_BS672_S_PYD, CRM L-019-12-SRM 1944-BS 682 in batch WPCL_L-019-12_BS682_S_OCH, and 000NONPJ in batch WPCL_L-259-12_BS705_S_PBDE. The associated pyrethroid, organochlorine pesticide, and PBDE analytes in these samples were classified as qualified with regard to the SWAMP QAPrP MQO for surrogates (Table A2).

Matrix Spikes and Matrix Spike Duplicates

A laboratory-fortified sample matrix (matrix spike, or MS) and a laboratory fortified sample matrix duplicate (MSD) are both used to evaluate the effect of the sample matrix on the recovery of the target analyte(s). Individually, these samples are used to assess the bias from an environmental sample matrix plus normal method performance. In addition, these duplicate samples can be used collectively to assess analytical precision.

Aliquots of randomly selected field samples were spiked with known amounts of target analytes. The %R of each spike was calculated as follows:

%R= (MS Result – Sample Result)/ (Expected Value – Sample Result) * 100

The %R acceptance criteria vary according to analyte groups (Appendix X, Table1).

This process was repeated on the same native samples to create a laboratory fortified sample matrix spike duplicate (MSD). MSDs were used to assess laboratory precision and accuracy. MS/MSD RPDs were calculated as:

RPD = (|(Value1-Value2)|/(AVERAGE(Value1+Value2)))*100

where:

Value1 = matrix spike value, and Value2 = matrix spike duplicate value.

According to the SWAMP QAPrP for conventional, organic and inorganic analyses, at least one MS/MSD pair should be performed per 20 samples or one per batch, whichever is more frequent. The required frequency was met for all 191 batches.

Laboratory batches with MS/MSD %R and RPD values outside of acceptance criteria were either classified as compliant or qualified based on number of QC elements outside criteria. These are presented in Table A3. All other MS/MSD %Rs and RPDs were within acceptance criteria.

Certified Reference Materials and Laboratory Control Samples

Certified reference materials (CRMs) and laboratory control samples (LCSs) are analyzed to assess the accuracy of a given analytical method. As required by the SWAMP QAPrP, one CRM or LCS should be analyzed per 20 samples or one per batch, whichever is more frequent. The required frequency was met for all 191 batches.

Laboratory batches with CRM or LCS %R or RPD values outside of acceptance criteria were either classified as compliant or qualified based on number of QC elements outside criteria. These are presented in Table A4. All other CRM and LCS %Rs and RPDs were within acceptance criteria.

Laboratory Duplicates

Laboratory duplicates (DUPs) were analyzed to assess laboratory precision. As required by the SWAMP QAPrP a duplicate of at least one field sample per batch was processed and analyzed. Two percent of the batches (6 out of 285 total batches) did not include DUPs performed at the required frequency. One total organic carbon and five grain size batches were classified as qualified and are presented in Table A5.

The duplicates were compared and an RPD was calculated as described in Section 3.3. RPDs <25% were considered acceptable as specified in the QAPrP. All RPDs >25% were classified as qualified and are presented in Table A6.

Field Duplicates

Field duplicates are analyzed to assess field homogeneity and field sampling procedures. Sediment duplicates were obtained from homogenized field samples. Field duplicates sampled are presented in Table A7.

Field duplicate values were compared to field sample values from each site and RPDs were calculated as described in Section 3.3. RPDs <25% were considered acceptable as specified in the QAPrP. RPDs >25% are presented in Table A8. All other RPDs were acceptable.

Toxicity Tests

All *Hyalella azteca* data were classified as compliant with regard to the SWAMP QAPrP MQO for toxicity tests.

Holding times

Eight percent of the results (4,521 out of 55,284 total results) were outside the SWAMP QAPrP MQOs for holding times. Of the 4,521 results, 745 pyrethroid and PBDE results were classified as estimated since the holding time was exceeded by more than three times and 3,776 metals, mercury, PBDE, PAH, PCB, and pyrethroid results were classified as qualified due holding time exceedances. Sediment metal and mercury samples exceeded the 1-year holding time criteria until analysis. Sediment PBDE, PAH, PCB, and pyrethroid samples exceeded the 40 day holding time criteria from extraction to analysis. Although data were classified as estimated and qualified it was considered usable for the intended purposes for this report. The field samples affected (does not include laboratory QA/QC) are presented in Table A9.

QA/QC Summary

There were 55,284 chemistry results, including; integrated samples, and field duplicates and laboratory QA/QC samples. Of these:

- 47,882 (86.6%) were classified as "compliant"
- 6,510 (11.8%) were classified as "qualified"
- 695 (1.2%) were classified as "estimated"
- 150 (0.27%) were classified as "screening"
- 0 (0%) were classified as "rejected"; and

47 (0.08%) were classified as "NA", since results were not reported by the laboratory due to matrix interferences or results were not reported due to high native concentrations) and could not be verified.

Classification of this dataset is summarized as follows:

- All data presented in Table A2 were classified as qualified due to surrogate recovery exceedances.
- All data presented in Table A5 was classified as qualified due to insufficient QC samples performed.
- All data presented in Tables A3, 4A, A6, and A8 were classified as qualified due to RPD exceedances.
- All data presented in Tables A3 and A4 were classified as either compliant or qualified due to recovery exceedances.
- Results for samples presented in Table A9 were classified as qualified or estimated due to holding time exceedances.
- 150 screening level results (PAH analytes that could not be quantified or PCB aroclors) were classified as qualified.

Data that meet all SWAMP MQOs as specified in the QAPrP are classified as "SWAMP-compliant" and considered usable without further evaluation. Data that fail to meet all program MQOs specified in the SWAMP QAPrP, have analytes not covered in the SWAMP QAPrP, or are insufficiently documented such that supplementary information is required for them to be used in reports are classified as "qualified" non-compliant with the SWAMP QAPrP. No data were classified as rejected for this project during the data quality assessment (DQA) phase of reporting, end users may find qualified data batches meet project data quality objectives. A 100% completeness level was attained which met the 90% project completeness goal specified in the SWAMP QAPrP.

Table A1. Percent recovery (%R) and relative percent difference (RPD) acceptance criteria for different categories of analytes in water and sediment

Analyte Category	% Surrogate Recovery Acceptance Criteria	% MS/MSD Recovery Acceptance Criteria	% CRM & LCS Acceptance Criteria	RPD Criteria (MS/MSD, Laboratory Duplicate, Field Duplicate)
Conventional Constituents	NA	80-120	80-120	25
Trace Metals (Including Mercury)	NA	75-125	75-125	25
Organics (PCBs, OCHs, OPs)	50-150	50-150	50-150	25

Table A2. Surrogate recoveries that did meet quality control acceptance criteria.

Surrogate	Station Code	Sample Type	Batch ID	% Recovery	Laboratory
Dibromooctafluorobiphenyl, 4-4'-(Surrogate); Total; % recovery	205COYSCL	Integrated	WPCL_L-020-12_BS672_S_PYD	41.5	DFG-WPCL
PBDE 100-L (Surrogate); Total; % recovery	000NONPJ	Integrated	WPCL_L-259-12_BS705_S_PBDE	168	DFG-WPCL
DDD(p,p')(Surrogate); Total; % recovery	LABQA	CRM	WPCL_L-019-12_BS682_S_OCH	182	DFG-WPCL

Table A3. Matrix spikes (MS), matrix spike duplicates (MSD), percent recoveries (%R), and relative percent differences (RPD) that did not meet quality control acceptance criteria. Boldface type indicates values that did not meet the quality control objective.

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Phosphorus as P; Total; mg/Kg dw	205COY060	21-Oct-11	IIRMES_C-6019_CON_S_TPhos	125	100	18	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	801SDCALT	18-Jan-12	IIRMES_C-6021_CON_S_TPhos	121	104	9	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	508SACBLF	02-Aug-11	IIRMES_C-6037_CON_S_TPhos	118	123	2	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	403STCSSP	09-Jun-11	IIRMES_C-6038_CON_S_TPhos	134	111	6	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	109MAD101	11-Oct-11	IIRMES_C-6039_CON_S_TPhos	128	133	0	CSULB-IIRMES
Chlorpyrifos; Total; ng/g dw	515YBAMVL	18-Aug-11	IIRMES_TO-03-045_S_OP	92	61	41	CSULB-IIRMES
Phorate; Total; ng/g dw	515YBAMVL	18-Aug-11	IIRMES_TO-03-045_S_OP	108	81	27	CSULB-IIRMES

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Endrin Aldehyde; Total; ng/g dw	313SAI	10-Jun-11	IIRMES_TO-03-049_S_OCH	22	42	62	CSULB-IIRMES
Endrin Ketone; Total; ng/g dw	313SAI	10-Jun-11	IIRMES_TO-03-049_S_OCH	37	46	22	CSULB-IIRMES
Endrin Aldehyde; Total; ng/g dw	909SWRWSx	09-May-12	IIRMES_TO-03-079_S_OCH	37	52	34	CSULB-IIRMES
Phorate; Total; ng/g dw	909SWRWSx	09-May-12	IIRMES_TO-03-079_S_OP	7	15	77	CSULB-IIRMES
Endrin Aldehyde; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_OCH	115	74	46	CSULB-IIRMES
Phorate; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_OP	44	40	12	CSULB-IIRMES
Trichloronate; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_OP	47	68	32	CSULB-IIRMES
Benzo(b)fluoranthene; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_PAH	172	153	15	CSULB-IIRMES
Benzo(e)pyrene; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_PAH	166	146	16	CSULB-IIRMES
Benzo(k)fluoranthene; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_PAH	174	171	5	CSULB-IIRMES
Chrysene; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_PAH	152	132	17	CSULB-IIRMES
Phenanthrene; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_PAH	142	102	36	CSULB-IIRMES
Pyrene; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_PAH	177	121	41	CSULB-IIRMES
PBDE 066; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_PBDE	90	121	27	CSULB-IIRMES
PBDE 190; Total; ng/g dw	508SACBLF	11-Jul-12	IIRMES_TO-03-107_S_PBDE	111	78	38	CSULB-IIRMES
Phorate; Total; ng/g dw	551LKI040	17-Jul-12	IIRMES_TO-03-134_S_OP	77	55	34	CSULB-IIRMES
Demeton-s; Total; ng/g dw	628DEPSED	12-Sep-12	IIRMES_TO-03-138_S_OP	110	69	49	CSULB-IIRMES
Disulfoton; Total; ng/g dw	628DEPSED	12-Sep-12	IIRMES_TO-03-138_S_OP	110	68	50	CSULB-IIRMES
Disulfoton; Total; ng/g dw	633WCRSED	09-Oct-12	IIRMES_TO-03-140_S_OP	66	90	29	CSULB-IIRMES
DDT(p,p'); Total; ng/g dw	801SDCEYL	11-Jan-13	IIRMES_TO-03-146_S_OCH	93	72	26	CSULB-IIRMES
Cadmium; Total; mg/Kg dw	405SGRA2x	26-May-11	MPSL-DFG_2011Dig27_S_TM	53.3	57.7	7.8	MPSL-DFG
Silver; Total; mg/Kg dw	405SGRA2x	26-May-11	MPSL-DFG_2011Dig27_S_TM	96.5	3.28	187	MPSL-DFG
Cadmium; Total; mg/Kg dw	541MERSUN	21-Jul-11	MPSL-DFG_2011Dig31_S_TM	126	129	0.24	MPSL-DFG
Cadmium; Total; mg/Kg dw	541STC019	22-Jul-11	MPSL-DFG_2011Dig34_S_TM	152	130	15.5	MPSL-DFG
Silver; Total; mg/Kg dw	541STC019	22-Jul-11	MPSL-DFG_2011Dig34_S_TM	165	91.4	57.6	MPSL-DFG
Cadmium; Total; mg/Kg dw	541MERDEL	21-Jul-11	MPSL-DFG_2012Dig01_S_TM	114	83.2	28.1	MPSL-DFG
Silver; Total; mg/Kg dw	541MERDEL	21-Jul-11	MPSL-DFG_2012Dig01_S_TM	89.2	114	26	MPSL-DFG
Cadmium; Total; mg/Kg dw	541MERECY	21-Jul-11	MPSL-DFG_2012Dig02_S_TM	128	117	9.18	MPSL-DFG
Lead; Total; mg/Kg dw	541MERECY	21-Jul-11	MPSL-DFG_2012Dig02_S_TM	73.6	64.3	13.5	MPSL-DFG
Silver; Total; mg/Kg dw	541MERECY	21-Jul-11	MPSL-DFG_2012Dig02_S_TM	62.5	67.8	8.13	MPSL-DFG
Cadmium; Total; mg/Kg dw	558TUR090	11-Aug-11	MPSL-DFG_2012Dig04_S_TM	128	100	24.4	MPSL-DFG

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Nickel; Total; mg/Kg dw	558TUR090	11-Aug-11	MPSL-DFG_2012Dig04_S_TM	143	95.8	39.4	MPSL-DFG
Silver; Total; mg/Kg dw	558TUR090	11-Aug-11	MPSL-DFG_2012Dig04_S_TM	138	103	28.7	MPSL-DFG
Zinc; Total; mg/Kg dw	558TUR090	11-Aug-11	MPSL-DFG_2012Dig04_S_TM	119	91	26.9	MPSL-DFG
Silver; Total; mg/Kg dw	558TUR090	11-Aug-11	MPSL-DFG_2012Dig10_S_TM	56.8	52.9	7.12	MPSL-DFG
Cadmium; Total; mg/Kg dw	304SLRWAT	07-Sep-11	MPSL-DFG_2012Dig13_S_TM	69.5	91.4	27.2	MPSL-DFG
Silver; Total; mg/Kg dw	304SLRWAT	07-Sep-11	MPSL-DFG_2012Dig13_S_TM	194	179	7.79	MPSL-DFG
Cadmium; Total; mg/Kg dw	504BCHROS	10-Jul-12	MPSL-DFG_2012Dig23_S_TM	82.3	63.2	26.3	MPSL-DFG
Cadmium; Total; mg/Kg dw	504SACHMN	10-Jul-12	MPSL-DFG_2012Dig24_S_TM	129	111	15.2	MPSL-DFG
Silver; Total; mg/Kg dw	504SACHMN	10-Jul-12	MPSL-DFG_2012Dig24_S_TM	131	95.9	30.9	MPSL-DFG
Silver; Total; mg/Kg dw	508SACBLF	11-Jul-12	MPSL-DFG_2013Dig02_S_TM	71.2	99	32.7	MPSL-DFG
Silver; Total; mg/Kg dw	526PRFALR	11-Jul-12	MPSL-DFG_2013Dig07_S_TM	127	136	6.97	MPSL-DFG
Silver; Total; mg/Kg dw	541MER522	10-Sep-12	MPSL-DFG_2013Dig18_S_TM	136	109	21.7	MPSL-DFG
Dibenz(a,h)anthracene; Total; ng/g dw	723ARGRB1	11-Oct-11	WPCL_L-019-12_BS679_S_PAH	154	153	1.1	DFG-WPCL
Indeno(1,2,3-c,d)pyrene; Total; ng/g dw	723ARGRB1	11-Oct-11	WPCL_L-019-12_BS679_S_PAH	147	161	7.7	DFG-WPCL
Aldrin; Total; ng/g dw	719CVSCOT	11-Oct-11	WPCL_L-019-12_BS682_S_OCH	40	43.4	6.8	DFG-WPCL
Deltamethrin/Tralomethrin; Total; ng/g dw	635TROSED	25-Oct-11	WPCL_L-020-039-12_BS681_S_PYD	196	179	9.9	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	635TROSED	25-Oct-11	WPCL_L-020-039-12_BS681_S_PYD	180	188	3.8	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	635TROSED	25-Oct-11	WPCL_L-020-039-12_BS681_S_PYD	187	168	12	DFG-WPCL
Bifenthrin; Total; ng/g dw	403STCEST	09-Jun-11	WPCL_L-020-12_BS671_S_PYD	86.3	116	31	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	403STCEST	09-Jun-11	WPCL_L-020-12_BS671_S_PYD	164	158	2.4	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	403STCEST	09-Jun-11	WPCL_L-020-12_BS671_S_PYD	151	141	5.2	DFG-WPCL
Bifenthrin; Total; ng/g dw	207WAL020	07-Jul-11	WPCL_L-020-12_BS672_S_PYD	354	290	20	DFG-WPCL
Cyfluthrin, total; Total; ng/g dw	207WAL020	07-Jul-11	WPCL_L-020-12_BS672_S_PYD	197	180	9.6	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	207WAL020	07-Jul-11	WPCL_L-020-12_BS672_S_PYD	253	247	3.1	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	207WAL020	07-Jul-11	WPCL_L-020-12_BS672_S_PYD	210	205	2.8	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	207WAL020	07-Jul-11	WPCL_L-020-12_BS672_S_PYD	252	237	6.9	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	207WAL020	07-Jul-11	WPCL_L-020-12_BS672_S_PYD	204	201	1.7	DFG-WPCL
Bifenthrin; Total; ng/g dw	504BCHROS	01-Aug-11	WPCL_L-020-12_BS673_S_PYD	158	104	45	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	504BCHROS	01-Aug-11	WPCL_L-020-12_BS673_S_PYD	172	150	18	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	504BCHROS	01-Aug-11	WPCL_L-020-12_BS673_S_PYD	162	153	9.4	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	504BCHROS	01-Aug-11	WPCL_L-020-12_BS673_S_PYD	184	185	3.3	DFG-WPCL

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Cypermethrin, Total; Total; ng/g dw	519AMNDVY	19-Aug-11	WPCL_L-020-12_BS677_S_PYD	166	182	3	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	519AMNDVY	19-Aug-11	WPCL_L-020-12_BS677_S_PYD	248	248	6.5	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	519AMNDVY	19-Aug-11	WPCL_L-020-12_BS677_S_PYD	209	192	15	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	519AMNDVY	19-Aug-11	WPCL_L-020-12_BS677_S_PYD	214	198	14	DFG-WPCL
Cyfluthrin, total; Total; ng/g dw	801SDCALT	05-Oct-11	WPCL_L-020-12_BS678_S_PYD	155	157	2.8	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	801SDCALT	05-Oct-11	WPCL_L-020-12_BS678_S_PYD	250	225	15	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	801SDCALT	05-Oct-11	WPCL_L-020-12_BS678_S_PYD	251	260	0.6	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	801SDCALT	05-Oct-11	WPCL_L-020-12_BS678_S_PYD	266	247	12	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	801SDCALT	05-Oct-11	WPCL_L-020-12_BS678_S_PYD	182	186	2.7	DFG-WPCL
Deltamethrin/Tralomethrin; Total; ng/g dw	205COYSCL	03-Jan-13	WPCL_L-023-13_BS728_S_PYD	315	215	18	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	205COYSCL	03-Jan-13	WPCL_L-023-13_BS728_S_PYD	345	294	9.5	DFG-WPCL
Fenpropathrin; Total; ng/g dw	205COYSCL	03-Jan-13	WPCL_L-023-13_BS728_S_PYD	361	340	5.3	DFG-WPCL
Bifenthrin; Total; ng/g dw	310SLB	16-May-12	WPCL_L-213-12_BS698_S_PYD	158	110	22	DFG-WPCL
Cyfluthrin, total; Total; ng/g dw	310SLB	16-May-12	WPCL_L-213-12_BS698_S_PYD	183	158	20	DFG-WPCL
Deltamethrin/Tralomethrin; Total; ng/g dw	310SLB	16-May-12	WPCL_L-213-12_BS698_S_PYD	284	229	28	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	310SLB	16-May-12	WPCL_L-213-12_BS698_S_PYD	112	87.9	31	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	310SLB	16-May-12	WPCL_L-213-12_BS698_S_PYD	284	241	21	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	310SLB	16-May-12	WPCL_L-213-12_BS698_S_PYD	337	290	22	DFG-WPCL
Cyfluthrin, total; Total; ng/g dw	801SDCxxx	10-May-12	WPCL_L-213-278-12_BS699_S_PYD	134	154	3.7	DFG-WPCL
Deltamethrin/Tralomethrin; Total; ng/g dw	801SDCxxx	10-May-12	WPCL_L-213-278-12_BS699_S_PYD	134	167	5.7	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	801SDCxxx	10-May-12	WPCL_L-213-278-12_BS699_S_PYD	218	262	6.1	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	801SDCxxx	10-May-12	WPCL_L-213-278-12_BS699_S_PYD	266	306	6	DFG-WPCL
PBDE 047; Total; ng/g dw	000NONPJ	15-May-12	WPCL_L-259-12_BS705_S_PBDE	336	139	61	DFG-WPCL
PBDE 099; Total; ng/g dw	000NONPJ	15-May-12	WPCL_L-259-12_BS705_S_PBDE	178	69.3	54	DFG-WPCL
PBDE 100; Total; ng/g dw	000NONPJ	15-May-12	WPCL_L-259-12_BS705_S_PBDE	151	101	33	DFG-WPCL
Bifenthrin; Total; ng/g dw	519AMNDVY	29-Aug-12	WPCL_L-531-579-12_BS715_S_PYD	71.1	110	35	DFG-WPCL
Cyfluthrin, total; Total; ng/g dw	519AMNDVY	29-Aug-12	WPCL_L-531-579-12_BS715_S_PYD	85.1	112	26	DFG-WPCL
Cyhalothrin, Lambda, Total; Total; ng/g dw	519AMNDVY	29-Aug-12	WPCL_L-531-579-12_BS715_S_PYD	89.5	139	42	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	519AMNDVY	29-Aug-12	WPCL_L-531-579-12_BS715_S_PYD	78.8	106	28	DFG-WPCL
Fenpropathrin; Total; ng/g dw	519AMNDVY	29-Aug-12	WPCL_L-531-579-12_BS715_S_PYD	89.6	138	41	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	519AMNDVY	29-Aug-12	WPCL_L-531-579-12_BS715_S_PYD	80.6	123	40	DFG-WPCL

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Cyfluthrin, total; Total; ng/g dw	801SDCxxx	12-Sep-12	WPCL_L-579-646-12_BS716_S_PYD	444	413	7	DFG-WPCL
Cyhalothrin, Lambda, Total; Total; ng/g dw	801SDCxxx	12-Sep-12	WPCL_L-579-646-12_BS716_S_PYD	168	179	3.6	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	801SDCxxx	12-Sep-12	WPCL_L-579-646-12_BS716_S_PYD	279	295	4.9	DFG-WPCL
Deltamethrin/Tralomethrin; Total; ng/g dw	801SDCxxx	12-Sep-12	WPCL_L-579-646-12_BS716_S_PYD	190	221	12	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	801SDCxxx	12-Sep-12	WPCL_L-579-646-12_BS716_S_PYD	334	341	2	DFG-WPCL
Fenpropathrin; Total; ng/g dw	801SDCxxx	12-Sep-12	WPCL_L-579-646-12_BS716_S_PYD	160	163	1.2	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	801SDCxxx	12-Sep-12	WPCL_L-579-646-12_BS716_S_PYD	128	162	7.8	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	801SDCxxx	12-Sep-12	WPCL_L-579-646-12_BS716_S_PYD	162	167	1.7	DFG-WPCL

Table A4a. Batches containing certified reference material (CRM that did not meet quality control acceptance criteria.

Analyte	StationCode	Batch ID	% Recovery	Laboratory
Aluminum; Total; mg/Kg dw	srm PACS2 102	MPSL-DFG_2011Dig26_S_TM	68	MPSL-DFG
Aluminum; Total; mg/Kg dw	srm 1646a 25	MPSL-DFG_2011Dig28_S_TM	68.2	MPSL-DFG
Cadmium; Total; mg/Kg dw	srm 2702 42	MPSL-DFG_2011Dig28_S_TM	133	MPSL-DFG
Lead; Total; mg/Kg dw	srm mess3 56	MPSL-DFG_2011Dig35_S_TM	72.8	MPSL-DFG
Aluminum; Total; mg/Kg dw	srm pacs2 110	MPSL-DFG_2012Dig02_S_TM	69.2	MPSL-DFG
Acenaphthene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	29.2	DFG-WPCL
Anthracene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	42	DFG-WPCL
Benz(a)anthracene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	46.4	DFG-WPCL
Benzo(a)pyrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	52.1	DFG-WPCL
Benzo(b)fluoranthene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	54.9	DFG-WPCL
Benzo(e)pyrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	60.4	DFG-WPCL
Benzo(g,h,i)perylene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	36.4	DFG-WPCL
Benzo(k)fluoranthene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	57	DFG-WPCL
Biphenyl; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	45.9	DFG-WPCL
Chrysene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	44.5	DFG-WPCL
Fluoranthene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	67.3	DFG-WPCL
Fluorene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	36.9	DFG-WPCL
Indeno(1,2,3-c,d)pyrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	58.8	DFG-WPCL
Naphthalene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	46.5	DFG-WPCL
Perylene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	48.4	DFG-WPCL

Analyte	StationCode	Batch ID	% Recovery	Laboratory
Phenanthrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	62.3	DFG-WPCL
Pyrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	57.4	DFG-WPCL
Chlordane, cis-; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	135*	DFG-WPCL
DDT(p,p'); Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	163	DFG-WPCL
Hexachlorobenzene; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	62	DFG-WPCL
Nonachlor, cis-; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	110	DFG-WPCL
Nonachlor, trans-; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	134*	DFG-WPCL
PCB 151; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_PCB	62	DFG-WPCL
PCB 170; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_PCB	56.2	DFG-WPCL
Total Organic Carbon; Total; % dw	6772-CRM1	IIRMES_GC-01-133_S_TOC	123	CSULB-IIRMES
Acenaphthene; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	50	CSULB-IIRMES
Biphenyl; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	68	CSULB-IIRMES
Methylnaphthalene, 2-; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	67	CSULB-IIRMES
Naphthalene; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	67	CSULB-IIRMES
Perylene; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	69	CSULB-IIRMES
Aluminum; Total; mg/Kg dw	srm 1646a 40	MPSL-DFG_2012Dig23_S_TM	92.9	MPSL-DFG
Nonachlor, cis-; Total; ng/g dw	7292-CRM1	IIRMES_TO-03-138_S_OCH	132	CSULB-IIRMES
DDE(o,p'); Total; ng/g dw	7480-CRM1	IIRMES_TO-03-140_S_OCH	133	CSULB-IIRMES
Silver; Total; mg/Kg dw	CRM PACS2-129	MPSL-DFG_2013Dig13_S_TM	72.2	MPSL-DFG
Silver; Total; mg/Kg dw	CRM 2702-067	MPSL-DFG_2013Dig13_S_TM	174	MPSL-DFG
Aluminum; Total; mg/Kg dw	srm PACS2 102	MPSL-DFG_2011Dig26_S_TM	68	MPSL-DFG
Aluminum; Total; mg/Kg dw	srm 1646a 25	MPSL-DFG_2011Dig28_S_TM	68.2	MPSL-DFG
Cadmium; Total; mg/Kg dw	srm 2702 42	MPSL-DFG_2011Dig28_S_TM	133	MPSL-DFG
Lead; Total; mg/Kg dw	srm mess3 56	MPSL-DFG_2011Dig35_S_TM	72.8	MPSL-DFG
Aluminum; Total; mg/Kg dw	srm pacs2 110	MPSL-DFG_2012Dig02_S_TM	69.2	MPSL-DFG
Acenaphthene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	29.2	DFG-WPCL
Anthracene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	42	DFG-WPCL
Benz(a)anthracene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	46.4	DFG-WPCL
Benzo(a)pyrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	52.1	DFG-WPCL
Benzo(b)fluoranthene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	54.9	DFG-WPCL
Benzo(e)pyrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	60.4	DFG-WPCL
Benzo(g,h,i)perylene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	36.4	DFG-WPCL
Benzo(k)fluoranthene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	57	DFG-WPCL

Analyte	StationCode	Batch ID	% Recovery	Laboratory
Biphenyl; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	45.9	DFG-WPCL
Chrysene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	44.5	DFG-WPCL
Fluoranthene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	67.3	DFG-WPCL
Fluorene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	36.9	DFG-WPCL
Indeno(1,2,3-c,d)pyrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	58.8	DFG-WPCL
Naphthalene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	46.5	DFG-WPCL
Perylene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	48.4	DFG-WPCL
Phenanthrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	62.3	DFG-WPCL
Pyrene; Total; ng/g dw	L-019-12-SRM 1944-BS 679	WPCL_L-019-12_BS679_S_PAH	57.4	DFG-WPCL
Chlordane, cis-; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	135*	DFG-WPCL
DDT(p,p'); Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	163	DFG-WPCL
Hexachlorobenzene; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	62	DFG-WPCL
Nonachlor, cis-; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	110	DFG-WPCL
Nonachlor, trans-; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_OCH	134*	DFG-WPCL
PCB 151; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_PCB	62	DFG-WPCL
PCB 170; Total; ng/g dw	L-019-12-SRM 1944-BS 682	WPCL_L-019-12_BS682_S_PCB	56.2	DFG-WPCL
Total Organic Carbon; Total; % dw	6772-CRM1	IIRMES_GC-01-133_S_TOC	123	CSULB-IIRMES
Acenaphthene; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	50	CSULB-IIRMES
Biphenyl; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	68	CSULB-IIRMES
Methylnaphthalene, 2-; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	67	CSULB-IIRMES
Naphthalene; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	67	CSULB-IIRMES
Perylene; Total; ng/g dw	6508-CRM1	IIRMES_TO-03-107_S_PAH	69	CSULB-IIRMES
Aluminum; Total; mg/Kg dw	srm 1646a 40	MPSL-DFG_2012Dig23_S_TM	92.9	MPSL-DFG
Nonachlor, cis-; Total; ng/g dw	7292-CRM1	IIRMES_TO-03-138_S_OCH	132	CSULB-IIRMES
DDE(o,p'); Total; ng/g dw	7480-CRM1	IIRMES_TO-03-140_S_OCH	133	CSULB-IIRMES
Silver; Total; mg/Kg dw	CRM PACS2-129	MPSL-DFG_2013Dig13_S_TM	72.2	MPSL-DFG
Silver; Total; mg/Kg dw	CRM 2702-067	MPSL-DFG_2013Dig13_S_TM	174	MPSL-DFG

Note: *%R were outside the MQO but inside the CRM manufacture range

Table A4b. Batches containing laboratory control spike (LCS) that did not meet quality control acceptance criteria.

Analyte	Station Code/LabSampleID	Lab Batch ID	LCS %R	LCSD %R	RPD	Laboratory
Disulfoton; Total; ng/g dw	5687-BS1	IIRMES_TO-03-047_S_OP	**0**	**0**	0	CSULB-IIRMES
Demeton-s; Total; ng/g dw	5729-BS2	IIRMES_TO-03-051_S_OP	57	**48**	17	CSULB-IIRMES
Demeton-s; Total; ng/g dw	5752-BS1	IIRMES_TO-03-053_S_OP	**44**	57	**26**	CSULB-IIRMES
Mevinphos; Total; ng/g dw	5752-BS1	IIRMES_TO-03-053_S_OP	**28**	99	**112**	CSULB-IIRMES
Phorate; Total; ng/g dw	5752-BS1	IIRMES_TO-03-053_S_OP	60	79	**27**	CSULB-IIRMES
PCB 003; Total; ng/g dw	5752-BS1	IIRMES_TO-03-053_S_PCB	**40**	93	**80**	CSULB-IIRMES
PCB 008; Total; ng/g dw	5752-BS1	IIRMES_TO-03-053_S_PCB	65	99	**41**	CSULB-IIRMES
PCB 018; Total; ng/g dw	5752-BS1	IIRMES_TO-03-053_S_PCB	73	95	**26**	CSULB-IIRMES
Disulfoton; Total; ng/g dw	5955-BS1	IIRMES_TO-03-059_S_OP	**0**	**0**	0	CSULB-IIRMES
Deltamethrin/Tralomethrin; Total; ng/g dw	L-020-12-LCSD1	WPCL_L-020-12_BS670_S_PYD	57.2	**48.5**	16	DFG-WPCL
Bifenthrin; Total; ng/g dw	L-020-12-LCS3	WPCL_L-020-12_BS672_S_PYD	98.2	75.7	**26**	DFG-WPCL
Deltamethrin/Tralomethrin; Total; ng/g dw	L-020-12-LCS4	WPCL_L-020-12_BS673_S_PYD	**43.2**	53.1	21	DFG-WPCL
Deltamethrin/Tralomethrin; Total; ng/g dw	L-020-12-LCS6	WPCL_L-020-12_BS678_S_PYD	66.6	50.7	**27**	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	L-020-12-LCSD6	WPCL_L-020-12_BS678_S_PYD	51.9	**48.3**	7.1	DFG-WPCL
Endrin Aldehyde; Total; ng/g dw	6361-BS1	IIRMES_TO-03-079_S_OCH	**45**	**23**	**62**	CSULB-IIRMES
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	L-278-12-LCS	WPCL_L-278-358-12_BS700_S_PYD	119	82	**37**	DFG-WPCL
Permethrin, cis-; Total; ng/g dw	L-278-12-LCS	WPCL_L-278-358-12_BS700_S_PYD	111	83.8	**28**	DFG-WPCL
Phorate; Total; ng/g dw	6507-BS1	IIRMES_TO-03-107_S_OP	**36**	**32**	14	CSULB-IIRMES
Trichloronate; Total; ng/g dw	6507-BS1	IIRMES_TO-03-107_S_OP	**32**	**36**	13	CSULB-IIRMES
Deltamethrin/Tralomethrin; Total; ng/g dw	L-531-12-LCSD	WPCL_L-531-579-12_BS715_S_PYD	59.5	**49.9**	18	DFG-WPCL
Demeton-s; Total; ng/g dw	6507-BS1	IIRMES_TO-03-134_S_OP	68	**30**	**78**	CSULB-IIRMES
Endosulfan I; Total; ng/g dw	7291-BS1	IIRMES_TO-03-136_S_OCH	70	94	**29**	CSULB-IIRMES
Fensulfothion; Total; ng/g dw	7291-BS1	IIRMES_TO-03-136_S_OP	113	77	**38**	CSULB-IIRMES
Phorate; Total; ng/g dw	7291-BS1	IIRMES_TO-03-136_S_OP	55	**31**	**57**	CSULB-IIRMES
Diazinon; Total; ng/g dw	7291-BS1	IIRMES_TO-03-138_S_OP	**39**	68	**55**	CSULB-IIRMES
Phorate; Total; ng/g dw	7291-BS1	IIRMES_TO-03-138_S_OP	**47**	**20**	**82**	CSULB-IIRMES
Phorate; Total; ng/g dw	7479-BS1	IIRMES_TO-03-140_S_OP	**20**	**0**	**258**	CSULB-IIRMES
Cyfluthrin, total; Total; ng/g dw	L-023-13-LCS	WPCL_L-023-13_BS728_S_PYD	**151**	129	16	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	L-023-13-LCS	WPCL_L-023-13_BS728_S_PYD	**169**	**155**	8.7	DFG-WPCL

Table A5. Batches for which laboratory duplicates (DUP) were not run.

Analyte	Batch ID	Notes	Laboratory
GrainSize	IIRMES_GC-01-086_S_GS	QAO: no dup	CSULB-IIRMES
GrainSize	IIRMES_GC-01-087_S_GS	QAO: no dup	CSULB-IIRMES
GrainSize	IIRMES_GC-01-088_S_GS	QAO: no dup	CSULB-IIRMES
GrainSize	IIRMES_GC-01-095_S_GS	QAO: no dup	CSULB-IIRMES
GrainSize	IIRMES_GC-01-098_S_GS	QAO: no dup	CSULB-IIRMES
Total Organic Carbon	IIRMES_GC-01-092_S_TOC	QAO: no dup	CSULB-IIRMES

Table A6. Laboratory duplicate samples that did not meet quality control acceptance criteria.

Analyte	Station Code	Sample Date	Parent Value	Duplicate Value	RPD	Laboratory	Batch ID
Phosphorus as P; Total; mg/Kg dw	403STCSSP	09-Jun-11	1033.4	773.4	29	CSULB-IIRMES	IIRMES_C-6038_CON_S_TPhos
Phosphorus as P; Total; mg/Kg dw	541MERECY	21-Jul-11	854.5	518.1	49	CSULB-IIRMES	IIRMES_C-6041_CON_S_TPhos
Total Organic Carbon; Total; % dw	544SAC002	19-Aug-11	0.35	0.25	33	CSULB-IIRMES	IIRMES_GC-01-099_S_TOC
PBDE 190; Total; ng/g dw	515YBAMVL	18-Aug-11	1.01	1.44	35	CSULB-IIRMES	IIRMES_TO-03-045_S_PBDE
Benzo(a)pyrene; Total; ng/g dw	508SACBLF	11-Jul-12	7.7	10.6	32	CSULB-IIRMES	IIRMES_TO-03-107_S_PAH
Aluminum; Total; mg/Kg dw	405SGRA2x	26-May-11	63372	44525	34.9	MPSL-DFG	MPSL-DFG_2011Dig27_S_TM
Cadmium; Total; mg/Kg dw	405SGRA2x	26-May-11	0.66	0.34	64.8	MPSL-DFG	MPSL-DFG_2011Dig27_S_TM
Cadmium; Total; mg/Kg dw	541MERSUN	21-Jul-11	0.18	0.35	61.7	MPSL-DFG	MPSL-DFG_2011Dig31_S_TM
Silver; Total; mg/Kg dw	541MERSUN	21-Jul-11	0.32	0.93	96.4	MPSL-DFG	MPSL-DFG_2011Dig31_S_TM
Cadmium; Total; mg/Kg dw	541STC019	22-Jul-11	0.13	0.26	70.5	MPSL-DFG	MPSL-DFG_2011Dig34_S_TM
Silver; Total; mg/Kg dw	541STC019	22-Jul-11	0.26	0.79	102	MPSL-DFG	MPSL-DFG_2011Dig34_S_TM
Cadmium; Total; mg/Kg dw	541STC516	22-Jul-11	0.12	0.40	104	MPSL-DFG	MPSL-DFG_2011Dig35_S_TM
Cadmium; Total; mg/Kg dw	541MERDEL	21-Jul-11	0.19	0.27	31.8	MPSL-DFG	MPSL-DFG_2012Dig01_S_TM
Aluminum; Total; mg/Kg dw	520SACLSA	18-Aug-11	56890	78374	31.8	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM
Arsenic; Total; mg/Kg dw	520SACLSA	18-Aug-11	7.03	10.4	38.9	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM
Cadmium; Total; mg/Kg dw	520SACLSA	18-Aug-11	0.57	0.94	50.1	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM
Chromium; Total; mg/Kg dw	520SACLSA	18-Aug-11	96.8	142	37.6	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM
Copper; Total; mg/Kg dw	520SACLSA	18-Aug-11	45.2	64	34.3	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM
Lead; Total; mg/Kg dw	520SACLSA	18-Aug-11	6.18	8.45	31.1	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM
Manganese; Total; mg/Kg dw	520SACLSA	18-Aug-11	482	651	29.9	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM
Nickel; Total; mg/Kg dw	520SACLSA	18-Aug-11	65.0	93.5	35.9	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM

Analyte	Station Code	Sample Date	Parent Value	Duplicate Value	RPD	Laboratory	Batch ID
Zinc; Total; mg/Kg dw	520SACLSA	18-Aug-11	111	153	31.6	MPSL-DFG	MPSL-DFG_2012Dig03_S_TM
Cadmium; Total; mg/Kg dw	558TUR090	11-Aug-11	0.11	0.15	30.8	MPSL-DFG	MPSL-DFG_2012Dig10_S_TM
Cadmium; Total; mg/Kg dw	109MAD101	11-Oct-11	0.14	0.10	30.9	MPSL-DFG	MPSL-DFG_2012Dig12_S_TM
Aluminum; Total; mg/Kg dw	504BCHROS	10-Jul-12	39701	53035	28.8	MPSL-DFG	MPSL-DFG_2012Dig23_S_TM
Silver; Total; mg/Kg dw	508SACBLF	11-Jul-12	0.22	0.71	106	MPSL-DFG	MPSL-DFG_2013Dig02_S_TM
Cadmium; Total; mg/Kg dw	526PRFALR	11-Jul-12	0.1	0.11	30.8	MPSL-DFG	MPSL-DFG_2013Dig07_S_TM
Silver; Total; mg/Kg dw	637SUS001	10-Jul-12	0.2	0.63	103	MPSL-DFG	MPSL-DFG_2013Dig09_S_TM
Cadmium; Total; mg/Kg dw	558CCR010	17-Jul-12	0.12	0.23	66.4	MPSL-DFG	MPSL-DFG_2013Dig11_S_TM
Cadmium; Total; mg/Kg dw	558PKC005	17-Jul-12	0.26	0.33	26.3	MPSL-DFG	MPSL-DFG_2013Dig12_S_TM
Cadmium; Total; mg/Kg dw	558TUR090	17-Jul-12	0.12	0.17	32.2	MPSL-DFG	MPSL-DFG_2013Dig13_S_TM
Arsenic; Total; mg/Kg dw	535STC206	06-Sep-12	2.31	5.66	83.9	MPSL-DFG	MPSL-DFG_2013Dig15_S_TM
Cadmium; Total; mg/Kg dw	535STC206	06-Sep-12	0.34	0.75	75.3	MPSL-DFG	MPSL-DFG_2013Dig15_S_TM
Cadmium; Total; mg/Kg dw	535STC210	06-Sep-12	0.13	0.33	88.8	MPSL-DFG	MPSL-DFG_2013Dig16_S_TM
Lead; Total; mg/Kg dw	535STC210	06-Sep-12	43.7	56.8	26.2	MPSL-DFG	MPSL-DFG_2013Dig16_S_TM
Cadmium; Total; mg/Kg dw	535STC504	06-Sep-12	0.12	0.20	47.3	MPSL-DFG	MPSL-DFG_2013Dig17_S_TM
Bifenthrin; Total; ng/g dw	901SJSJC9	24-May-11	4.49	6.17	32	DFG-WPCL	WPCL_L-020-12_BS670_S_PYD
Deltamethrin/Tralomethrin; Total; ng/g dw	403STCBQT	09-Jun-11	137	103	28	DFG-WPCL	WPCL_L-020-12_BS671_S_PYD
Permethrin, cis-; Total; ng/g dw	207LAU020	07-Jul-11	3.31	4.58	32	DFG-WPCL	WPCL_L-020-12_BS672_S_PYD
Cyhalothrin, Lambda, Total; Total; ng/g dw	541STC019	22-Jul-11	0.968	1.26	27	DFG-WPCL	WPCL_L-020-12_BS673_S_PYD
Bifenthrin; Total; ng/g dw	909SWRWSx	04-Oct-11	4.06	5.67	33	DFG-WPCL	WPCL_L-020-12_BS678_S_PYD
Deltamethrin/Tralomethrin; Total; ng/g dw	205COYGAL	03-Jan-13	13.2	10.2	26	DFG-WPCL	WPCL_L-023-13_BS728_S_PYD
Bifenthrin; Total; ng/g dw	310ARG	16-May-12	15.0	6.51	79	DFG-WPCL	WPCL_L-213-12_BS698_S_PYD
Cyfluthrin, total; Total; ng/g dw	310ARG	16-May-12	36.2	21.9	49	DFG-WPCL	WPCL_L-213-12_BS698_S_PYD
Cyhalothrin, Lambda, Total; Total; ng/g dw	310ARG	16-May-12	3.87	2.43	46	DFG-WPCL	WPCL_L-213-12_BS698_S_PYD
Cypermethrin, Total; Total; ng/g dw	310ARG	16-May-12	64.4	42.0	42	DFG-WPCL	WPCL_L-213-12_BS698_S_PYD
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	310ARG	16-May-12	5.00	3.30	41	DFG-WPCL	WPCL_L-213-12_BS698_S_PYD
Permethrin, cis-; Total; ng/g dw	310ARG	16-May-12	12.1	7.72	44	DFG-WPCL	WPCL_L-213-12_BS698_S_PYD
PBDE 047; Total; ng/g dw	000NONPJ	14-May-12	17.6	13.6	26	DFG-WPCL	WPCL_L-259-12_BS705_S_PBDE
PBDE 049; Total; ng/g dw	000NONPJ	14-May-12	1.88	1.38	30	DFG-WPCL	WPCL_L-259-12_BS705_S_PBDE
PBDE 099; Total; ng/g dw	000NONPJ	14-May-12	22.2	16.1	32	DFG-WPCL	WPCL_L-259-12_BS705_S_PBDE
PBDE 209; Total; ng/g dw	000NONPJ	14-May-12	284	395	33	DFG-WPCL	WPCL_L-259-12_BS705_S_PBDE

Table A7. Field Duplicate Samples

Station	Sample Date	Matrix	Analyte Group
109MAD101	11-Oct-11	sediment	Total Phosphorus as P
109MAD101	11-Oct-11	sediment	Total Organic Carbon
109MAD101	11-Oct-11	sediment	Grain Size
109MAD101	11-Oct-11	sediment	Organochlorine Pesticides
109MAD101	11-Oct-11	sediment	Organophosphorus Pesticides
109MAD101	11-Oct-11	sediment	Polychlorinated Biphenyls
109MAD101	11-Oct-11	sediment	Total Metals
109MAD101	11-Oct-11	sediment	Total Mercury
109MAD101	11-Oct-11	sediment	Pyrethroid Pesticides
109MAD101	11-Oct-11	sediment, <63 um	Total Metals
109MAD101	11-Oct-11	sediment, <63 um	Total Mercury
309TDW	23-Jun-11	sediment	Total Phosphorus as P
309TDW	23-Jun-11	sediment	Grain Size
309TDW	23-Jun-11	sediment	Total Organic Carbon
309TDW	23-Jun-11	sediment	Organochlorine Pesticides
309TDW	23-Jun-11	sediment	Organophosphorus Pesticides
309TDW	23-Jun-11	sediment	Polychlorinated Biphenyls
309TDW	23-Jun-11	sediment	Total Metals
309TDW	23-Jun-11	sediment	Total Mercury
309TDW	23-Jun-11	sediment	Pyrethroid Pesticides
309TDW	23-Jun-11	sediment, <63 um	Total Metals
309TDW	23-Jun-11	sediment, <63 um	Total Mercury
404BLNAxx	26-May-11	sediment	Total Phosphorus as P
404BLNAxx	26-May-11	sediment	Grain Size
404BLNAxx	26-May-11	sediment	Total Organic Carbon
404BLNAxx	26-May-11	sediment	Organochlorine Pesticides
404BLNAxx	26-May-11	sediment	Organophosphorus Pesticides
404BLNAxx	26-May-11	sediment	Polynuclear Aromatic Hydrocarbons
404BLNAxx	26-May-11	sediment	Polybrominated Diphenyl Ethers
404BLNAxx	26-May-11	sediment	Polychlorinated Biphenyls
404BLNAxx	26-May-11	sediment	Total Metals
404BLNAxx	26-May-11	sediment	Total Mercury
404BLNAxx	26-May-11	sediment	Pyrethroid Pesticides
404BLNAxx	26-May-11	sediment, <63 um	Total Metals
404BLNAxx	26-May-11	sediment, <63 um	Total Mercury
535MER007	08-Sep-11	sediment	Total Phosphorus as P
535MER007	08-Sep-11	sediment	Grain Size
535MER007	08-Sep-11	sediment	Total Organic Carbon

Station	Sample Date	Matrix	Analyte Group
535MER007	08-Sep-11	sediment	Organochlorine Pesticides
535MER007	08-Sep-11	sediment	Organophosphorus Pesticides
535MER007	08-Sep-11	sediment	Polynuclear Aromatic Hydrocarbons
535MER007	08-Sep-11	sediment	Polybrominated Diphenyl Ethers
535MER007	08-Sep-11	sediment	Polychlorinated Biphenyls
535MER007	08-Sep-11	sediment	Total Metals
535MER007	08-Sep-11	sediment	Total Mercury
535MER007	08-Sep-11	sediment	Pyrethroid Pesticides
535MER007	08-Sep-11	sediment, <63 um	Total Metals
535MER007	08-Sep-11	sediment, <63 um	Total Mercury
541STC019	22-Jul-11	sediment	Total Phosphorus as P
541STC019	22-Jul-11	sediment	Grain Size
541STC019	22-Jul-11	sediment	Total Organic Carbon
541STC019	22-Jul-11	sediment	Organochlorine Pesticides
541STC019	22-Jul-11	sediment	Organophosphorus Pesticides
541STC019	22-Jul-11	sediment	Polychlorinated Biphenyls
541STC019	22-Jul-11	sediment	Total Metals
541STC019	22-Jul-11	sediment	Total Mercury
541STC019	22-Jul-11	sediment	Pyrethroid Pesticides
541STC019	22-Jul-11	sediment, <63 um	Total Metals
541STC019	22-Jul-11	sediment, <63 um	Total Mercury
723ARGRB1	11-Oct-11	sediment	Total Organic Carbon
723ARGRB1	11-Oct-11	sediment	Grain Size
723ARGRB1	11-Oct-11	sediment	Total Metals
723ARGRB1	11-Oct-11	sediment	Total Mercury
723ARGRB1	11-Oct-11	sediment	Polynuclear Aromatic Hydrocarbons
723ARGRB1	11-Oct-11	sediment	Organochlorine Pesticides
723ARGRB1	11-Oct-11	sediment	Polychlorinated Biphenyls
723ARGRB1	11-Oct-11	sediment	Organophosphorus Pesticides
723ARGRB1	11-Oct-11	sediment	Pyrethroid Pesticides
723ARGRB1	11-Oct-11	sediment	Polybrominated Diphenyl Ethers
309TDW	05-Jun-12	sediment	Grain Size
309TDW	05-Jun-12	sediment	Total Organic Carbon
309TDW	05-Jun-12	sediment	Total Phosphorus as P
309TDW	05-Jun-12	sediment	Organochlorine Pesticides
309TDW	05-Jun-12	sediment	Organophosphorus Pesticides
309TDW	05-Jun-12	sediment	Polychlorinated Biphenyls
309TDW	05-Jun-12	sediment	Total Metals
309TDW	05-Jun-12	sediment	Total Mercury
309TDW	05-Jun-12	sediment	Pyrethroid Pesticides
309TDW	05-Jun-12	sediment, <63 um	Total Metals
309TDW	05-Jun-12	sediment, <63 um	Total Mercury

Station	Sample Date	Matrix	Analyte Group
535STC206	06-Sep-12	sediment	Grain Size
535STC206	06-Sep-12	sediment	Total Organic Carbon
535STC206	06-Sep-12	sediment	Total Phosphorus as P
535STC206	06-Sep-12	sediment	Organochlorine Pesticides
535STC206	06-Sep-12	sediment	Organophosphorus Pesticides
535STC206	06-Sep-12	sediment	Polynuclear Aromatic Hydrocarbons
535STC206	06-Sep-12	sediment	Polybrominated Diphenyl Ethers
535STC206	06-Sep-12	sediment	Polychlorinated Biphenyls
535STC206	06-Sep-12	sediment	Total Metals
535STC206	06-Sep-12	sediment	Total Mercury
535STC206	06-Sep-12	sediment	Pyrethroid Pesticides
535STC206	06-Sep-12	sediment, <63 um	Total Metals
535STC206	06-Sep-12	sediment, <63 um	Total Mercury
541STC516	27-Jun-12	sediment	Grain Size
541STC516	27-Jun-12	sediment	Total Organic Carbon
541STC516	27-Jun-12	sediment	Total Phosphorus as P
541STC516	27-Jun-12	sediment	Organochlorine Pesticides
541STC516	27-Jun-12	sediment	Organophosphorus Pesticides
541STC516	27-Jun-12	sediment	Polychlorinated Biphenyls
541STC516	27-Jun-12	sediment	Total Metals
541STC516	27-Jun-12	sediment	Total Mercury
541STC516	27-Jun-12	sediment	Pyrethroid Pesticides
541STC516	27-Jun-12	sediment, <63 um	Total Metals
541STC516	27-Jun-12	sediment, <63 um	Total Mercury
637SUS001	10-Jul-12	sediment	Grain Size
637SUS001	10-Jul-12	sediment	Total Organic Carbon
637SUS001	10-Jul-12	sediment	Total Phosphorus as P
637SUS001	10-Jul-12	sediment	Organochlorine Pesticides
637SUS001	10-Jul-12	sediment	Organophosphorus Pesticides
637SUS001	10-Jul-12	sediment	Polychlorinated Biphenyls
637SUS001	10-Jul-12	sediment	Total Metals
637SUS001	10-Jul-12	sediment	Total Mercury
637SUS001	10-Jul-12	sediment	Pyrethroid Pesticides
637SUS001	10-Jul-12	sediment, <63 um	Total Metals
637SUS001	10-Jul-12	sediment, <63 um	Total Mercury
907SDRWAR	09-May-12	sediment	Total Organic Carbon
907SDRWAR	09-May-12	sediment	Grain Size
907SDRWAR	09-May-12	sediment	Total Phosphorus as P
907SDRWAR	09-May-12	sediment	Organochlorine Pesticides
907SDRWAR	09-May-12	sediment	Organophosphorus Pesticides
907SDRWAR	09-May-12	sediment	Polynuclear Aromatic Hydrocarbons
907SDRWAR	09-May-12	sediment	Polybrominated Diphenyl Ethers

Station	Sample Date	Matrix	Analyte Group
907SDRWAR	09-May-12	sediment	Polychlorinated Biphenyls
907SDRWAR	09-May-12	sediment	Total Metals
907SDRWAR	09-May-12	sediment	Total Mercury
907SDRWAR	09-May-12	sediment	Pyrethroid Pesticides
907SDRWAR	09-May-12	sediment, <63 um	Total Mercury
205COY060	17-Jan-12	sediment	Total Phosphorus as P
205COY060	17-Jan-12	sediment	Grain Size
205COY060	17-Jan-12	sediment	Total Organic Carbon
205COY060	17-Jan-12	sediment	Organochlorine Pesticides
205COY060	17-Jan-12	sediment	Organophosphorus Pesticides
205COY060	17-Jan-12	sediment	Polychlorinated Biphenyls
205COY060	17-Jan-12	sediment	Total Metals
205COY060	17-Jan-12	sediment	Total Mercury
205COY060	17-Jan-12	sediment	Pyrethroid Pesticides
205COY060	17-Jan-12	sediment, <63 um	Total Metals
205COY060	17-Jan-12	sediment, <63 um	Total Mercury
541MERDEL	12-Jan-12	sediment	Total Phosphorus as P
541MERDEL	12-Jan-12	sediment	Grain Size
541MERDEL	12-Jan-12	sediment	Total Organic Carbon
541MERDEL	12-Jan-12	sediment	Organochlorine Pesticides
541MERDEL	12-Jan-12	sediment	Organophosphorus Pesticides
541MERDEL	12-Jan-12	sediment	Polychlorinated Biphenyls
541MERDEL	12-Jan-12	sediment	Total Metals
541MERDEL	12-Jan-12	sediment	Total Mercury
541MERDEL	12-Jan-12	sediment	Pyrethroid Pesticides
541MERDEL	12-Jan-12	sediment, <63 um	Total Metals
541MERDEL	12-Jan-12	sediment, <63 um	Total Mercury
801SDCxxx	12-Sep-12	sediment	Grain Size
801SDCxxx	12-Sep-12	sediment	Total Organic Carbon
801SDCxxx	12-Sep-12	sediment	Total Phosphorus as P
801SDCxxx	12-Sep-12	sediment	Organochlorine Pesticides
801SDCxxx	12-Sep-12	sediment	Organophosphorus Pesticides
801SDCxxx	12-Sep-12	sediment	Polychlorinated Biphenyls
801SDCxxx	12-Sep-12	sediment	Total Metals
801SDCxxx	12-Sep-12	sediment	Total Mercury
801SDCxxx	12-Sep-12	sediment	Pyrethroid Pesticides
801SDCxxx	12-Sep-12	sediment, <63 um	Total Metals
801SDCxxx	12-Sep-12	sediment, <63 um	Total Mercury
535MER007	08-Sep-11	sediment	Polynuclear Aromatic Hydrocarbons
535MER007	08-Sep-11	sediment	Polybrominated Diphenyl Ethers
535MER007	08-Sep-11	sediment	Polychlorinated Biphenyls
535MER007	08-Sep-11	sediment	Total Metals

Station	Sample Date	Matrix	Analyte Group
535MER007	08-Sep-11	sediment	Total Mercury
535MER007	08-Sep-11	sediment	Pyrethroid Pesticides
535MER007	08-Sep-11	sediment, <63 um	Total Metals
535MER007	08-Sep-11	sediment, <63 um	Total Mercury
541STC019	22-Jul-11	sediment	Total Phosphorus as P
541STC019	22-Jul-11	sediment	Grain Size
541STC019	22-Jul-11	sediment	Total Organic Carbon
541STC019	22-Jul-11	sediment	Organochlorine Pesticides
541STC019	22-Jul-11	sediment	Organophosphorus Pesticides
541STC019	22-Jul-11	sediment	Polychlorinated Biphenyls
541STC019	22-Jul-11	sediment	Total Metals
541STC019	22-Jul-11	sediment	Total Mercury
541STC019	22-Jul-11	sediment	Pyrethroid Pesticides
541STC019	22-Jul-11	sediment, <63 um	Total Metals
541STC019	22-Jul-11	sediment, <63 um	Total Mercury
723ARGRB1	11-Oct-11	sediment	Total Organic Carbon
723ARGRB1	11-Oct-11	sediment	Grain Size
723ARGRB1	11-Oct-11	sediment	Total Metals
723ARGRB1	11-Oct-11	sediment	Total Mercury
723ARGRB1	11-Oct-11	sediment	Polynuclear Aromatic Hydrocarbons
723ARGRB1	11-Oct-11	sediment	Organochlorine Pesticides
723ARGRB1	11-Oct-11	sediment	Polychlorinated Biphenyls
723ARGRB1	11-Oct-11	sediment	Organophosphorus Pesticides
723ARGRB1	11-Oct-11	sediment	Pyrethroid Pesticides
723ARGRB1	11-Oct-11	sediment	Polybrominated Diphenyl Ethers
309TDW	05-Jun-12	sediment	Grain Size
309TDW	05-Jun-12	sediment	Total Organic Carbon
309TDW	05-Jun-12	sediment	Total Phosphorus as P
309TDW	05-Jun-12	sediment	Organochlorine Pesticides
309TDW	05-Jun-12	sediment	Organophosphorus Pesticides
309TDW	05-Jun-12	sediment	Polychlorinated Biphenyls
309TDW	05-Jun-12	sediment	Total Metals
309TDW	05-Jun-12	sediment	Total Mercury
309TDW	05-Jun-12	sediment	Pyrethroid Pesticides
309TDW	05-Jun-12	sediment, <63 um	Total Metals
309TDW	05-Jun-12	sediment, <63 um	Total Mercury
535STC206	06-Sep-12	sediment	Grain Size
535STC206	06-Sep-12	sediment	Total Organic Carbon
535STC206	06-Sep-12	sediment	Total Phosphorus as P
535STC206	06-Sep-12	sediment	Organochlorine Pesticides
535STC206	06-Sep-12	sediment	Organophosphorus Pesticides
535STC206	06-Sep-12	sediment	Polynuclear Aromatic Hydrocarbons

Station	Sample Date	Matrix	Analyte Group
535STC206	06-Sep-12	sediment	Polybrominated Diphenyl Ethers
535STC206	06-Sep-12	sediment	Polychlorinated Biphenyls
535STC206	06-Sep-12	sediment	Total Metals
535STC206	06-Sep-12	sediment	Total Mercury
535STC206	06-Sep-12	sediment	Pyrethroid Pesticides
535STC206	06-Sep-12	sediment, <63 um	Total Metals
535STC206	06-Sep-12	sediment, <63 um	Total Mercury
541STC516	27-Jun-12	sediment	Grain Size
541STC516	27-Jun-12	sediment	Total Organic Carbon
541STC516	27-Jun-12	sediment	Total Phosphorus as P
541STC516	27-Jun-12	sediment	Organochlorine Pesticides
541STC516	27-Jun-12	sediment	Organophosphorus Pesticides
541STC516	27-Jun-12	sediment	Polychlorinated Biphenyls
541STC516	27-Jun-12	sediment	Total Metals
541STC516	27-Jun-12	sediment	Total Mercury
541STC516	27-Jun-12	sediment	Pyrethroid Pesticides
541STC516	27-Jun-12	sediment, <63 um	Total Metals
541STC516	27-Jun-12	sediment, <63 um	Total Mercury
637SUS001	10-Jul-12	sediment	Grain Size
637SUS001	10-Jul-12	sediment	Total Organic Carbon
637SUS001	10-Jul-12	sediment	Total Phosphorus as P
637SUS001	10-Jul-12	sediment	Organochlorine Pesticides
637SUS001	10-Jul-12	sediment	Organophosphorus Pesticides
637SUS001	10-Jul-12	sediment	Polychlorinated Biphenyls
637SUS001	10-Jul-12	sediment	Total Metals
637SUS001	10-Jul-12	sediment	Total Mercury
637SUS001	10-Jul-12	sediment	Pyrethroid Pesticides
637SUS001	10-Jul-12	sediment, <63 um	Total Metals
637SUS001	10-Jul-12	sediment, <63 um	Total Mercury
907SDRWAR	09-May-12	sediment	Total Organic Carbon
907SDRWAR	09-May-12	sediment	Grain Size
907SDRWAR	09-May-12	sediment	Total Phosphorus as P
907SDRWAR	09-May-12	sediment	Organochlorine Pesticides
907SDRWAR	09-May-12	sediment	Organophosphorus Pesticides
907SDRWAR	09-May-12	sediment	Polynuclear Aromatic Hydrocarbons
907SDRWAR	09-May-12	sediment	Polybrominated Diphenyl Ethers
907SDRWAR	09-May-12	sediment	Polychlorinated Biphenyls
907SDRWAR	09-May-12	sediment	Total Metals
907SDRWAR	09-May-12	sediment	Total Mercury
907SDRWAR	09-May-12	sediment	Pyrethroid Pesticides
907SDRWAR	09-May-12	sediment, <63 um	Total Mercury
205COY060	17-Jan-12	sediment	Total Phosphorus as P

Station	Sample Date	Matrix	Analyte Group
205COY060	17-Jan-12	sediment	Grain Size
205COY060	17-Jan-12	sediment	Total Organic Carbon
205COY060	17-Jan-12	sediment	Organochlorine Pesticides
205COY060	17-Jan-12	sediment	Organophosphorus Pesticides
205COY060	17-Jan-12	sediment	Polychlorinated Biphenyls
205COY060	17-Jan-12	sediment	Total Metals
205COY060	17-Jan-12	sediment	Total Mercury
205COY060	17-Jan-12	sediment	Pyrethroid Pesticides
205COY060	17-Jan-12	sediment, <63 um	Total Metals
205COY060	17-Jan-12	sediment, <63 um	Total Mercury
541MERDEL	12-Jan-12	sediment	Total Phosphorus as P
541MERDEL	12-Jan-12	sediment	Grain Size
541MERDEL	12-Jan-12	sediment	Total Organic Carbon
541MERDEL	12-Jan-12	sediment	Organochlorine Pesticides
541MERDEL	12-Jan-12	sediment	Organophosphorus Pesticides
541MERDEL	12-Jan-12	sediment	Polychlorinated Biphenyls
541MERDEL	12-Jan-12	sediment	Total Metals
541MERDEL	12-Jan-12	sediment	Total Mercury
541MERDEL	12-Jan-12	sediment	Pyrethroid Pesticides
541MERDEL	12-Jan-12	sediment, <63 um	Total Metals
541MERDEL	12-Jan-12	sediment, <63 um	Total Mercury
801SDCxxx	12-Sep-12	sediment	Grain Size
801SDCxxx	12-Sep-12	sediment	Total Organic Carbon
801SDCxxx	12-Sep-12	sediment	Total Phosphorus as P
801SDCxxx	12-Sep-12	sediment	Organochlorine Pesticides
801SDCxxx	12-Sep-12	sediment	Organophosphorus Pesticides
801SDCxxx	12-Sep-12	sediment	Polychlorinated Biphenyls
801SDCxxx	12-Sep-12	sediment	Total Metals
801SDCxxx	12-Sep-12	sediment	Total Mercury
801SDCxxx	12-Sep-12	sediment	Pyrethroid Pesticides
801SDCxxx	12-Sep-12	sediment, <63 um	Total Metals
801SDCxxx	12-Sep-12	sediment, <63 um	Total Mercury

Table A8. Field duplicate samples that did not meet quality control acceptance criteria.

Analyte	Matrix	Station Code	Date	Field Sample	Field Duplicate	RPD	Laboratory
Cadmium; Total; mg/Kg dw	sediment, <63 um	109MAD101	11-Oct-11	0.25	0.14	56	MPSL-DFG
Clay; <0.0039 mm; %	sediment	109MAD101	11-Oct-11	6	11.1	60	CSULB-IIRMES
Manganese; Total; mg/Kg dw	sediment	109MAD101	11-Oct-11	422	560	28	MPSL-DFG
Mercury; Total; mg/Kg dw	sediment	109MAD101	11-Oct-11	0.174	0.076	78	MPSL-DFG
Mercury; Total; mg/Kg dw	sediment, <63 um	109MAD101	11-Oct-11	0.128	0.182	35	MPSL-DFG

Analyte	Matrix	Station Code	Date	Field Sample	Field Duplicate	RPD	Laboratory
Sand; 0.0625 to <2.0 mm; %	sediment	109MAD101	11-Oct-11	70.4	54.7	25	CSULB-IIRMES
Silt; 0.0039 to <0.0625 mm; %	sediment	109MAD101	11-Oct-11	23.2	33.7	37	CSULB-IIRMES
Arsenic; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	3.49	9.66	94	MPSL-DFG
Bifenthrin; Total; ng/g dw	sediment	205COY060	17-Jan-12	13.5	45.7	109	DFG-WPCL
Cadmium; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	0.11	0.73	148	MPSL-DFG
Chromium; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	51.7	126	84	MPSL-DFG
Clay; <0.0039 mm; %	sediment	205COY060	17-Jan-12	17.9	23.9	29	CSULB-IIRMES
Copper; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	32.1	80.8	86	MPSL-DFG
Cyfluthrin, total; Total; ng/g dw	sediment	205COY060	17-Jan-12	32.0	106	107	DFG-WPCL
Cyhalothrin, Lambda, Total; Total; ng/g dw	sediment	205COY060	17-Jan-12	2.20	5.84	91	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	sediment	205COY060	17-Jan-12	16.6	26.7	47	DFG-WPCL
DDE(p,p'); Total; ng/g dw	sediment	205COY060	17-Jan-12	5.3	10.2	63	CSULB-IIRMES
Deltamethrin/Tralomethrin; Total; ng/g dw	sediment	205COY060	17-Jan-12	6.38	9.90	43	DFG-WPCL
Lead; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	17.1	44.3	89	MPSL-DFG
Manganese; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	279	566	68	MPSL-DFG
Mercury; Total; mg/Kg dw	sediment, <63 um	205COY060	17-Jan-12	0.243	0.349	36	MPSL-DFG
Mercury; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	0.144	0.204	34	MPSL-DFG
Nickel; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	48.5	120	85	MPSL-DFG
Permethrin, cis-; Total; ng/g dw	sediment	205COY060	17-Jan-12	11.0	24.8	77	DFG-WPCL
Permethrin, trans-; Total; ng/g dw	sediment	205COY060	17-Jan-12	10.5	19.3	59	DFG-WPCL
Sand; 0.0625 to <2.0 mm; %	sediment	205COY060	17-Jan-12	31.1	18.4	51	CSULB-IIRMES
Zinc; Total; mg/Kg dw	sediment	205COY060	17-Jan-12	132	347	90	MPSL-DFG
DDE(p,p'); Total; ng/g dw	sediment	309TDW	23-Jun-11	20	13	42	CSULB-IIRMES
Fenpropathrin; Total; ng/g dw	sediment	309TDW	23-Jun-11	7.26	5.11	35	DFG-WPCL
Lead; Total; mg/Kg dw	sediment, <63 um	309TDW	23-Jun-11	14.0	20.8	39	MPSL-DFG
Manganese; Total; mg/Kg dw	sediment	309TDW	23-Jun-11	998	713	33	MPSL-DFG
Mercury; Total; mg/Kg dw	sediment, <63 um	309TDW	23-Jun-11	0.070	0.098	33	MPSL-DFG
Permethrin, trans-; Total; ng/g dw	sediment	309TDW	23-Jun-11	9.40	6.62	35	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	sediment	309TDW	05-Jun-12	4.47	8.36	61	DFG-WPCL
Silver; Total; mg/Kg dw	sediment	309TDW	05-Jun-12	0.65	0.26	86	MPSL-DFG
Total Organic Carbon; Total; % dw	sediment	309TDW	05-Jun-12	2.46	3.23	27	CSULB-IIRMES
Aluminum; Total; mg/Kg dw	sediment, <63 um	404BLNAxx	26-May-11	27981	17645	45	MPSL-DFG
Anthracene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	30.2	18.9	46	CSULB-IIRMES
Arsenic; Total; mg/Kg dw	sediment, <63 um	404BLNAxx	26-May-11	12.9	7.34	55	MPSL-DFG
Benz(a)anthracene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	100.9	53.7	61	CSULB-IIRMES
Benzo(a)pyrene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	64.9	35.1	60	CSULB-IIRMES
Benzo(b)fluoranthene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	75	41.5	58	CSULB-IIRMES

Analyte	Matrix	Station Code	Date	Field Sample	Field Duplicate	RPD	Laboratory
Benzo(e)pyrene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	54.7	32.1	52	CSULB-IIRMES
Benzo(g,h,i)perylene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	84.7	56	41	CSULB-IIRMES
Benzo(k)fluoranthene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	81	42.9	62	CSULB-IIRMES
Chromium; Total; mg/Kg dw	sediment, <63 um	404BLNAxx	26-May-11	46.6	32.1	37	MPSL-DFG
Chrysene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	161.7	83.3	64	CSULB-IIRMES
Copper; Total; mg/Kg dw	sediment, <63 um	404BLNAxx	26-May-11	171	92.9	59	MPSL-DFG
Dibenz(a,h)anthracene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	27.3	13.8	66	CSULB-IIRMES
Dimethylnaphthalene, 2,6-; Total; ng/g dw	sediment	404BLNAxx	26-May-11	34	54.4	46	CSULB-IIRMES
Fluoranthene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	240.4	151.7	45	CSULB-IIRMES
Indeno(1,2,3-c,d)pyrene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	84.3	46.1	59	CSULB-IIRMES
Lead; Total; mg/Kg dw	sediment, <63 um	404BLNAxx	26-May-11	58.3	32.2	58	MPSL-DFG
Manganese; Total; mg/Kg dw	sediment, <63 um	404BLNAxx	26-May-11	603	294	69	MPSL-DFG
Mercury; Total; mg/Kg dw	sediment	404BLNAxx	26-May-11	0.046	0.015	102	MPSL-DFG
Naphthalene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	9.6	7.3	27	CSULB-IIRMES
PBDE 099; Total; ng/g dw	sediment	404BLNAxx	26-May-11	14.8	2.22	148	CSULB-IIRMES
Perylene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	105.6	59	57	CSULB-IIRMES
Phenanthrene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	109.2	67.1	48	CSULB-IIRMES
Pyrene; Total; ng/g dw	sediment	404BLNAxx	26-May-11	233.3	142.7	48	CSULB-IIRMES
Silver; Total; mg/Kg dw	sediment, <63 um	404BLNAxx	26-May-11	1.00	0.29	110	MPSL-DFG
Zinc; Total; mg/Kg dw	sediment, <63 um	404BLNAxx	26-May-11	631	341	60	MPSL-DFG
Benzo(g,h,i)perylene; Total; ng/g dw	sediment	535MER007	08-Sep-11	1.1	1.5	31	CSULB-IIRMES
Chrysene; Total; ng/g dw	sediment	535MER007	08-Sep-11	1.1	1.8	48	CSULB-IIRMES
Clay; <0.0039 mm; %	sediment	535MER007	08-Sep-11	11.4	15.6	31	CSULB-IIRMES
Fluoranthene; Total; ng/g dw	sediment	535MER007	08-Sep-11	2.1	4.1	65	CSULB-IIRMES
Mercury; Total; mg/Kg dw	sediment, <63 um	535MER007	08-Sep-11	0.037	0.506	173	MPSL-DFG
Perylene; Total; ng/g dw	sediment	535MER007	08-Sep-11	1.1	1.5	31	CSULB-IIRMES
Pyrene; Total; ng/g dw	sediment	535MER007	08-Sep-11	1.7	3.5	69	CSULB-IIRMES
Sand; 0.0625 to <2.0 mm; %	sediment	535MER007	08-Sep-11	48.7	29.9	48	CSULB-IIRMES
Silt; 0.0039 to <0.0625 mm; %	sediment	535MER007	08-Sep-11	39.7	54.3	31	CSULB-IIRMES
Cadmium; Total; mg/Kg dw	sediment	535STC206	06-Sep-12	0.34	0.22	43	MPSL-DFG
Cadmium; Total; mg/Kg dw	sediment, <63 um	535STC206	06-Sep-12	0.13	0.32	84	MPSL-DFG
Chromium; Total; mg/Kg dw	sediment, <63 um	535STC206	06-Sep-12	30.0	57.6	63	MPSL-DFG
Clay; <0.0039 mm; %	sediment	535STC206	06-Sep-12	21.5	13	49	CSULB-IIRMES
Copper; Total; mg/Kg dw	sediment, <63 um	535STC206	06-Sep-12	27.6	48.7	55	MPSL-DFG
Cyfluthrin, total; Total; ng/g dw	sediment	535STC206	06-Sep-12	11.6	15.9	31	DFG-WPCL

Analyte	Matrix	Station Code	Date	Field Sample	Field Duplicate	RPD	Laboratory
Cypermethrin, Total; Total; ng/g dw	sediment	535STC206	06-Sep-12	7.00	12.1	53	DFG-WPCL
Lead; Total; mg/Kg dw	sediment	535STC206	06-Sep-12	19.2	27.0	33	MPSL-DFG
Lead; Total; mg/Kg dw	sediment, <63 um	535STC206	06-Sep-12	13.7	20.7	26	MPSL-DFG
Manganese; Total; mg/Kg dw	sediment, <63 um	535STC206	06-Sep-12	505	779	43	MPSL-DFG
Mercury; Total; mg/Kg dw	sediment, <63 um	535STC206	06-Sep-12	0.059	0.098	50	MPSL-DFG
Nickel; Total; mg/Kg dw	sediment, <63 um	535STC206	06-Sep-12	17.4	31.6	58	MPSL-DFG
Sand; 0.0625 to <2.0 mm; %	sediment	535STC206	06-Sep-12	26.9	43.1	46	CSULB-IIRMES
Bifenthrin; Total; ng/g dw	sediment	541MERDEL	12-Jan-12	24.9	78.2	103	DFG-WPCL
Cypermethrin, Total; Total; ng/g dw	sediment	541MERDEL	12-Jan-12	7.02	3.52	66	DFG-WPCL
Bifenthrin; Total; ng/g dw	sediment	541STC019	22-Jul-11	0.705	0.448	45	DFG-WPCL
Cyhalothrin, Lambda, Total; Total; ng/g dw	sediment	541STC019	22-Jul-11	1.56	0.968	47	DFG-WPCL
Esfenvalerate/Fenvalerate, Total; Total; ng/g dw	sediment	541STC019	22-Jul-11	19.1	11.4	50	DFG-WPCL
Mercury; Total; mg/Kg dw	sediment	541STC019	22-Jul-11	0.089	0.069	25	MPSL-DFG
Sand; 0.0625 to <2.0 mm; %	sediment	541STC019	22-Jul-11	1.3	2.2	51	CSULB-IIRMES
Manganese; Total; mg/Kg dw	sediment, <63 um	541STC516	27-Jun-12	915	691	28	MPSL-DFG
Benz(a)anthracene; Total; ng/g dw	sediment	723ARGRB1	11-Oct-11	1.08	0.720	40	DFG-WPCL
Chrysene; Total; ng/g dw	sediment	723ARGRB1	11-Oct-11	1.33	0.950	33	DFG-WPCL
Dacthal; Total; ng/g dw	sediment	723ARGRB1	11-Oct-11	5.87	3.86	41	DFG-WPCL
Dibenzothiophenes, C3-; Total; ng/g dw	sediment	723ARGRB1	11-Oct-11	0.760	1.03	30	DFG-WPCL
Silver; Total; mg/Kg dw	sediment	723ARGRB1	11-Oct-11	0.24	0.53	75	MPSL-DFG
Bifenthrin; Total; ng/g dw	sediment	801SDCxxx	12-Sep-12	57.4	120	71	DFG-WPCL
Clay; <0.0039 mm; %	sediment	801SDCxxx	12-Sep-12	9.2	6.8	30	CSULB-IIRMES
Cyfluthrin, total; Total; ng/g dw	sediment	801SDCxxx	12-Sep-12	4.51	8.03	56	DFG-WPCL
Cyhalothrin, Lambda, Total; Total; ng/g dw	sediment	801SDCxxx	12-Sep-12	3.81	5.07	28	DFG-WPCL
Mercury; Total; mg/Kg dw	sediment	801SDCxxx	12-Sep-12	0.05	0.031	47	MPSL-DFG
Mercury; Total; mg/Kg dw	sediment, <63 um	801SDCxxx	12-Sep-12	0.028	0.059	71	MPSL-DFG
Total Organic Carbon; Total; % dw	sediment	801SDCxxx	12-Sep-12	3.81	2.41	45	CSULB-IIRMES
Chromium; Total; mg/Kg dw	sediment	907SDRWAR	09-May-12	33.7	43.6	26	MPSL-DFG
Nickel; Total; mg/Kg dw	sediment	907SDRWAR	09-May-12	16.9	22.6	29	MPSL-DFG
Silver; Total; mg/Kg dw	sediment	907SDRWAR	09-May-12	1.49	0.71	71	MPSL-DFG

Table A9. Field Samples with holding time exceedances.

Station	Sample Date	Matrix	Analyte Group
103SM1009	24-Sep-12	sediment	Total Metals
103SM1009	24-Sep-12	sediment, <63 um	Total Metals
105KLAMKK	24-Sep-12	sediment	Total Metals
105KLAMKK	24-Sep-12	sediment, <63 um	Total Metals
109MAD101	25-Sep-12	sediment	Total Metals

Station	Sample Date	Matrix	Analyte Group
109MAD101	25-Sep-12	sediment, <63 um	Total Metals
111EELFRN	25-Sep-12	sediment	Total Metals
111EELFRN	25-Sep-12	sediment, <63 um	Total Metals
111SF0933	25-Sep-12	sediment	Total Metals
111SF0933	25-Sep-12	sediment, <63 um	Total Metals
113NA3269	25-Sep-12	sediment	Total Metals
113NA3269	25-Sep-12	sediment, <63 um	Total Metals
114LAGWOH	25-Sep-12	sediment	Total Metals
114LAGWOH	25-Sep-12	sediment, <63 um	Total Metals
114RRDSDM	25-Sep-12	sediment	Total Metals
114RRDSDM	25-Sep-12	sediment, <63 um	Total Metals
201LAG125	08-Jul-11	sediment, <63 um	Total Mercury
201LAG125	08-Jul-11	sediment	Total Mercury
201LAG125	13-Jun-12	sediment	Total Metals
201LAG125	13-Jun-12	sediment, <63 um	Total Metals
201LAG125	13-Jun-12	sediment	Pyrethroid Pesticides
201WLK160	08-Jul-11	sediment, <63 um	Total Mercury
201WLK160	08-Jul-11	sediment	Total Mercury
201WLK160	13-Jun-12	sediment	Total Metals
201WLK160	13-Jun-12	sediment, <63 um	Total Metals
201WLK160	13-Jun-12	sediment	Pyrethroid Pesticides
204ALA020	07-Jul-11	sediment, <63 um	Total Mercury
204ALA020	07-Jul-11	sediment	Total Mercury
204ALA020	15-Jun-12	sediment, <63 um	Total Metals
204ALA020	15-Jun-12	sediment	Total Metals
204ALA020	15-Jun-12	sediment	Pyrethroid Pesticides
204SLE030	07-Jul-11	sediment, <63 um	Total Mercury
204SLE030	07-Jul-11	sediment	Total Mercury
204SLE030	12-Jun-12	sediment	Total Metals
204SLE030	12-Jun-12	sediment, <63 um	Total Metals
204SLE030	12-Jun-12	sediment	Pyrethroid Pesticides
204SMA020	08-Jul-11	sediment, <63 um	Total Mercury
204SMA020	08-Jul-11	sediment	Total Mercury
204SMA020	24-Aug-12	sediment	Total Metals
204SMA020	24-Aug-12	sediment	Pyrethroid Pesticides
205COY060	17-Jan-12	sediment	Pyrethroid Pesticides
205COY060	05-Jul-12	sediment	Total Metals
205COY060	05-Jul-12	sediment, <63 um	Total Metals
205COY060	05-Jul-12	sediment	Pyrethroid Pesticides
205COY060	19-Sep-12	sediment	Total Metals
205COY060	19-Sep-12	sediment, <63 um	Total Metals
205COY060	03-Jan-13	sediment	Pyrethroid Pesticides
205COYGAL	05-Jul-12	sediment	Total Metals
205COYGAL	05-Jul-12	sediment, <63 um	Total Metals
205COYGAL	05-Jul-12	sediment	Pyrethroid Pesticides
205COYGAL	19-Sep-12	sediment	Total Metals
205COYGAL	19-Sep-12	sediment, <63 um	Total Metals
205COYGAL	03-Jan-13	sediment	Pyrethroid Pesticides
205COYSCL	05-Jul-12	sediment	Total Metals
205COYSCL	05-Jul-12	sediment, <63 um	Total Metals
205COYSCL	05-Jul-12	sediment	Pyrethroid Pesticides
205COYSCL	19-Sep-12	sediment	Total Metals
205COYSCL	19-Sep-12	sediment, <63 um	Total Metals
205COYSCL	03-Jan-13	sediment	Pyrethroid Pesticides

Station	Sample Date	Matrix	Analyte Group
205GUA020	08-Jul-11	sediment, <63 um	Total Mercury
205GUA020	08-Jul-11	sediment	Total Mercury
205GUA020	05-Jul-12	sediment, <63 um	Total Metals
205GUA020	05-Jul-12	sediment	Total Metals
205GUA020	05-Jul-12	sediment	Pyrethroid Pesticides
206SON010	07-Jul-11	sediment, <63 um	Total Mercury
206SON010	07-Jul-11	sediment	Total Mercury
206SON010	12-Jun-12	sediment, <63 um	Total Metals
206SON010	12-Jun-12	sediment	Total Metals
206SON010	12-Jun-12	sediment	Pyrethroid Pesticides
207KIR020	07-Jul-11	sediment, <63 um	Total Mercury
207KIR020	07-Jul-11	sediment	Total Mercury
207KIR020	12-Jun-12	sediment	Total Metals
207KIR020	12-Jun-12	sediment, <63 um	Total Metals
207KIR020	12-Jun-12	sediment	Pyrethroid Pesticides
207LAU020	07-Jul-11	sediment, <63 um	Total Mercury
207LAU020	07-Jul-11	sediment	Total Mercury
207LAU020	12-Jun-12	sediment	Total Metals
207LAU020	12-Jun-12	sediment, <63 um	Total Metals
207LAU020	12-Jun-12	sediment	Pyrethroid Pesticides
207WAL020	07-Jul-11	sediment, <63 um	Total Mercury
207WAL020	07-Jul-11	sediment	Total Mercury
207WAL020	12-Jun-12	sediment	Total Metals
207WAL020	12-Jun-12	sediment, <63 um	Total Metals
207WAL020	12-Jun-12	sediment	Pyrethroid Pesticides
304SLRWAT	07-Sep-11	sediment	Total Metals
304SLRWAT	07-Sep-11	sediment, <63 um	Total Metals
304SLRWAT	07-Sep-11	sediment, <63 um	Total Mercury
304SLRWAT	05-Jun-12	sediment, <63 um	Total Metals
304SLRWAT	05-Jun-12	sediment	Total Metals
304SLRWAT	05-Jun-12	sediment	Pyrethroid Pesticides
304SOK	23-Jun-11	sediment, <63 um	Total Mercury
304SOK	23-Jun-11	sediment	Total Mercury
304SOK	05-Jun-12	sediment, <63 um	Total Metals
304SOK	05-Jun-12	sediment	Total Metals
304SOK	05-Jun-12	sediment	Pyrethroid Pesticides
305THU	23-Jun-11	sediment, <63 um	Total Mercury
305THU	23-Jun-11	sediment	Total Mercury
305THU	05-Jun-12	sediment, <63 um	Total Metals
305THU	05-Jun-12	sediment	Total Metals
305THU	05-Jun-12	sediment	Pyrethroid Pesticides
307CML	23-Jun-11	sediment, <63 um	Total Mercury
307CML	23-Jun-11	sediment	Total Mercury
307CML	07-Jun-12	sediment	Total Metals
307CML	07-Jun-12	sediment, <63 um	Total Metals
307CML	07-Jun-12	sediment	Pyrethroid Pesticides
309DAV	05-Jun-12	sediment, <63 um	Total Metals
309DAV	05-Jun-12	sediment	Total Metals
309DAV	05-Jun-12	sediment	Pyrethroid Pesticides
309TDW	23-Jun-11	sediment	Total Mercury
309TDW	23-Jun-11	sediment, <63 um	Total Mercury
309TDW	23-Jun-11	sediment	Total Mercury
309TDW	23-Jun-11	sediment, <63 um	Total Mercury
309TDW	05-Jun-12	sediment, <63 um	Total Metals

Station	Sample Date	Matrix	Analyte Group
309TDW	05-Jun-12	sediment	Total Metals
309TDW	05-Jun-12	sediment	Pyrethroid Pesticides
309TDW	05-Jun-12	sediment	Pyrethroid Pesticides
310ARG	21-Jun-11	sediment, <63 um	Total Mercury
310ARG	21-Jun-11	sediment	Total Mercury
310ARG	21-Jun-11	sediment	Pyrethroid Pesticides
310ARG	16-May-12	sediment, <63 um	Total Metals
310ARG	16-May-12	sediment	Pyrethroid Pesticides
310SLB	21-Jun-11	sediment, <63 um	Total Mercury
310SLB	21-Jun-11	sediment	Total Mercury
310SLB	21-Jun-11	sediment	Pyrethroid Pesticides
310SLB	16-May-12	sediment, <63 um	Total Metals
310SLB	16-May-12	sediment	Pyrethroid Pesticides
312SMA	16-May-12	sediment	Polybrominated Diphenyl Ethers
312SMA	16-May-12	sediment, <63 um	Total Metals
312SMA	16-May-12	sediment	Pyrethroid Pesticides
313SAI	10-Jun-11	sediment	Total Mercury
313SAI	10-Jun-11	sediment, <63 um	Total Mercury
313SAI	16-May-12	sediment, <63 um	Total Metals
313SAI	16-May-12	sediment	Pyrethroid Pesticides
314SYN	16-May-12	sediment, <63 um	Total Metals
314SYN	16-May-12	sediment	Pyrethroid Pesticides
315ATA	10-Jun-11	sediment	Total Mercury
315ATA	10-Jun-11	sediment, <63 um	Total Mercury
315ATA	16-May-12	sediment, <63 um	Total Metals
315ATA	16-May-12	sediment	Pyrethroid Pesticides
315MIS	10-Jun-11	sediment	Total Mercury
315MIS	10-Jun-11	sediment, <63 um	Total Mercury
315MIS	10-Jun-11	sediment	Pyrethroid Pesticides
315MIS	16-May-12	sediment	Polybrominated Diphenyl Ethers
315MIS	16-May-12	sediment, <63 um	Total Metals
315MIS	16-May-12	sediment	Pyrethroid Pesticides
402VRB0xx	09-Jun-11	sediment	Total Mercury
402VRB0xx	09-Jun-11	sediment, <63 um	Total Mercury
402VRB0xx	16-May-12	sediment, <63 um	Total Metals
402VRB0xx	16-May-12	sediment	Pyrethroid Pesticides
403STCBQT	09-Jun-11	sediment	Total Mercury
403STCBQT	09-Jun-11	sediment, <63 um	Total Mercury
403STCBQT	09-Jun-11	sediment	Pyrethroid Pesticides
403STCBQT	15-May-12	sediment, <63 um	Total Metals
403STCBQT	15-May-12	sediment	Pyrethroid Pesticides
403STCEST	09-Jun-11	sediment	Total Mercury
403STCEST	09-Jun-11	sediment, <63 um	Total Mercury
403STCEST	16-May-12	sediment, <63 um	Total Metals
403STCEST	16-May-12	sediment	Pyrethroid Pesticides
403STCSSP	09-Jun-11	sediment	Total Mercury
403STCSSP	09-Jun-11	sediment, <63 um	Total Mercury
403STCSSP	15-May-12	sediment, <63 um	Total Metals
403STCSSP	15-May-12	sediment	Pyrethroid Pesticides
404BLNAxx	26-May-11	sediment, <63 um	Total Mercury
404BLNAxx	26-May-11	sediment	Total Mercury
404BLNAxx	26-May-11	sediment	Pyrethroid Pesticides
404BLNAxx	15-May-12	sediment	Polybrominated Diphenyl Ethers
404BLNAxx	15-May-12	sediment, <63 um	Total Metals

Station	Sample Date	Matrix	Analyte Group
404BLNAxx	15-May-12	sediment	Pyrethroid Pesticides
405SGRA2x	26-May-11	sediment	Total Mercury
405SGRA2x	26-May-11	sediment, <63 um	Total Mercury
405SGRA2x	10-May-12	sediment	Polybrominated Diphenyl Ethers
405SGRA2x	10-May-12	sediment	Total Metals
405SGRA2x	10-May-12	sediment, <63 um	Total Metals
405SGRA2x	10-May-12	sediment	Pyrethroid Pesticides
408CGCS06	09-Jun-11	sediment	Total Mercury
408CGCS06	09-Jun-11	sediment, <63 um	Total Mercury
408CGCS06	15-May-12	sediment	Total Metals
408CGCS06	15-May-12	sediment, <63 um	Total Metals
408CGCS06	15-May-12	sediment	Pyrethroid Pesticides
412LARWxx	26-May-11	sediment	Total Mercury
412LARWxx	26-May-11	sediment, <63 um	Total Mercury
412LARWxx	10-May-12	sediment	Polybrominated Diphenyl Ethers
412LARWxx	10-May-12	sediment	Total Metals
412LARWxx	10-May-12	sediment, <63 um	Total Metals
412LARWxx	10-May-12	sediment	Pyrethroid Pesticides
504BCHROS	01-Aug-11	sediment, <63 um	Total Mercury
504BCHROS	01-Aug-11	sediment	Total Mercury
504BCHROS	01-Aug-11	sediment	Pyrethroid Pesticides
504BCHROS	10-Jul-12	sediment, <63 um	Total Metals
504BCHROS	10-Jul-12	sediment	Pyrethroid Pesticides
504SACHMN	01-Aug-11	sediment, <63 um	Total Mercury
504SACHMN	01-Aug-11	sediment	Total Mercury
504SACHMN	10-Jul-12	sediment, <63 um	Total Metals
504SACHMN	10-Jul-12	sediment	Pyrethroid Pesticides
508SACBLF	02-Aug-11	sediment, <63 um	Total Mercury
508SACBLF	02-Aug-11	sediment	Total Mercury
508SACBLF	11-Jul-12	sediment, <63 um	Total Metals
508SACBLF	11-Jul-12	sediment	Pyrethroid Pesticides
510LSAC08	30-Aug-12	sediment	Total Metals
510LSAC08	30-Aug-12	sediment	Pyrethroid Pesticides
511CAC113	30-Aug-12	sediment	Total Metals
511CAC113	30-Aug-12	sediment	Pyrethroid Pesticides
515SACKNK	30-Aug-12	sediment	Total Metals
515SACKNK	30-Aug-12	sediment	Pyrethroid Pesticides
515YBAMVL	29-Aug-12	sediment	Total Metals
519AMNDVY	19-Aug-11	sediment	Pyrethroid Pesticides
519AMNDVY	29-Aug-12	sediment	Total Metals
526PRFALR	02-Aug-11	sediment, <63 um	Total Mercury
526PRFALR	02-Aug-11	sediment	Total Mercury
526PRFALR	11-Jul-12	sediment	Total Metals
526PRFALR	11-Jul-12	sediment, <63 um	Total Metals
526PRFALR	11-Jul-12	sediment	Pyrethroid Pesticides
531SAC001	06-Sep-12	sediment	Polybrominated Diphenyl Ethers
535MER007	08-Sep-11	sediment, <63 um	Total Metals
535MER007	08-Sep-11	sediment, <63 um	Total Mercury
535MER007	08-Sep-11	sediment, <63 um	Total Mercury
535MER007	10-Sep-12	sediment	Polybrominated Diphenyl Ethers
535STC206	06-Sep-12	sediment	Polybrominated Diphenyl Ethers
535STC206	06-Sep-12	sediment, <63 um	Total Metals
535STC206	06-Sep-12	sediment	Total Metals
535STC210	06-Sep-12	sediment	Total Metals

Station	Sample Date	Matrix	Analyte Group
535STC501	27-Jun-12	sediment	Total Metals
535STC501	27-Jun-12	sediment, <63 um	Total Metals
535STC501	27-Jun-12	sediment	Pyrethroid Pesticides
535STC504	08-Sep-11	sediment	Total Metals
541MER522	08-Sep-11	sediment	Total Metals
541MER542	27-Jun-12	sediment	Total Metals
541MER542	27-Jun-12	sediment, <63 um	Total Metals
541MER542	27-Jun-12	sediment	Pyrethroid Pesticides
541MERDEL	12-Jan-12	sediment	Pyrethroid Pesticides
541MERECY	12-Jan-12	sediment	Pyrethroid Pesticides
541MERECY	12-Jun-12	sediment	Total Metals
541MERECY	12-Jun-12	sediment, <63 um	Total Metals
541MERECY	12-Jun-12	sediment	Pyrethroid Pesticides
541SJC501	08-Sep-11	sediment	Total Metals
541SJC501	06-Sep-12	sediment	Polybrominated Diphenyl Ethers
541STC019	27-Jun-12	sediment	Total Metals
541STC019	27-Jun-12	sediment, <63 um	Total Metals
541STC019	27-Jun-12	sediment	Pyrethroid Pesticides
541STC516	27-Jun-12	sediment	Total Metals
541STC516	27-Jun-12	sediment, <63 um	Total Metals
541STC516	27-Jun-12	sediment	Pyrethroid Pesticides
551LKI040	17-Jul-12	sediment, <63 um	Total Metals
551LKI040	17-Jul-12	sediment	Pyrethroid Pesticides
554SKR010	03-Oct-11	sediment	Total Metals
554SKR010	11-Sep-12	sediment, <63 um	Total Metals
558CCR010	17-Jul-12	sediment	Total Metals
558CCR010	17-Jul-12	sediment, <63 um	Total Metals
558CCR010	17-Jul-12	sediment	Pyrethroid Pesticides
558PKC005	17-Jul-12	sediment	Total Metals
558PKC005	17-Jul-12	sediment, <63 um	Total Metals
558PKC005	17-Jul-12	sediment	Pyrethroid Pesticides
558TUR090	11-Aug-11	sediment	Total Metals
558TUR090	11-Aug-11	sediment	Total Mercury
558TUR090	17-Jul-12	sediment, <63 um	Total Metals
558TUR090	17-Jul-12	sediment	Total Metals
558TUR090	17-Jul-12	sediment	Pyrethroid Pesticides
603BSP002	09-Oct-12	sediment	Polybrominated Diphenyl Ethers
603BSP002	09-Oct-12	sediment	Total Metals
603LOWSED	10-Oct-12	sediment	Total Metals
628DEPSED	04-Oct-11	sediment	Total Metals
628DEPSED	12-Sep-12	sediment, <63 um	Total Metals
631WWKLAR	09-Oct-12	sediment	Total Metals
633WCRSED	09-Oct-12	sediment	Total Metals
634UTRSED	09-Oct-12	sediment	Polybrominated Diphenyl Ethers
634UTRSED	09-Oct-12	sediment	Total Metals
635MARSED	08-Oct-12	sediment	Total Metals
635TRKSED	08-Oct-12	sediment	Total Metals
635TROSED	08-Oct-12	sediment	Total Metals
637SUS001	01-Aug-11	sediment, <63 um	Total Mercury
637SUS001	01-Aug-11	sediment	Total Mercury
637SUS001	10-Jul-12	sediment	Total Metals
637SUS001	10-Jul-12	sediment	Total Metals
637SUS001	10-Jul-12	sediment, <63 um	Total Metals
637SUS001	10-Jul-12	sediment	Pyrethroid Pesticides

Station	Sample Date	Matrix	Analyte Group
719CVSCOT	11-Oct-11	sediment	Polynuclear Aromatic Hydrocarbons
719CVSCOT	11-Oct-11	sediment	Polychlorinated Biphenyls
719CVSCOT	11-Oct-11	sediment	Polybrominated Diphenyl Ethers
719CVSCOT	17-Oct-12	sediment	Polybrominated Diphenyl Ethers
723ARGRB1	11-Oct-11	sediment	Polynuclear Aromatic Hydrocarbons
723ARGRB1	11-Oct-11	sediment	Polychlorinated Biphenyls
723ARGRB1	11-Oct-11	sediment	Polybrominated Diphenyl Ethers
723ARGRB1	15-Oct-12	sediment	Polybrominated Diphenyl Ethers
723NROTWM	11-Oct-11	sediment	Polynuclear Aromatic Hydrocarbons
723NROTWM	11-Oct-11	sediment	Polychlorinated Biphenyls
723NROTWM	11-Oct-11	sediment	Polybrominated Diphenyl Ethers
723NROTWM	16-Oct-12	sediment	Polybrominated Diphenyl Ethers
801CCPT12	25-May-11	sediment	Total Mercury
801CCPT12	25-May-11	sediment, <63 um	Total Mercury
801CCPT12	25-May-11	sediment	Pyrethroid Pesticides
801CCPT12	09-May-12	sediment	Polybrominated Diphenyl Ethers
801CCPT12	09-May-12	sediment	Total Metals
801CCPT12	09-May-12	sediment, <63 um	Total Metals
801CCPT12	09-May-12	sediment	Pyrethroid Pesticides
801SARVRx	25-May-11	sediment	Total Mercury
801SARVRx	25-May-11	sediment, <63 um	Total Mercury
801SARVRx	09-May-12	sediment	Total Metals
801SARVRx	09-May-12	sediment, <63 um	Total Metals
801SARVRx	09-May-12	sediment	Pyrethroid Pesticides
801SDCALT	26-May-11	sediment	Total Mercury
801SDCALT	26-May-11	sediment, <63 um	Total Mercury
801SDCALT	05-Oct-11	sediment	Total Metals
801SDCALT	05-Oct-11	sediment	Pyrethroid Pesticides
801SDCALT	10-May-12	sediment	Total Metals
801SDCALT	10-May-12	sediment, <63 um	Total Metals
801SDCALT	10-May-12	sediment	Pyrethroid Pesticides
801SDCALT	12-Sep-12	sediment, <63 um	Total Metals
801SDCALT	11-Jan-13	sediment	Pyrethroid Pesticides
801SDCEYL	26-May-11	sediment	Total Mercury
801SDCEYL	26-May-11	sediment, <63 um	Total Mercury
801SDCEYL	26-May-11	sediment	Pyrethroid Pesticides
801SDCEYL	05-Oct-11	sediment	Total Metals
801SDCEYL	10-May-12	sediment	Total Metals
801SDCEYL	10-May-12	sediment, <63 um	Total Metals
801SDCEYL	10-May-12	sediment	Pyrethroid Pesticides
801SDCEYL	12-Sep-12	sediment, <63 um	Total Metals
801SDCEYL	11-Jan-13	sediment	Pyrethroid Pesticides
801SDCxxx	25-May-11	sediment	Total Mercury
801SDCxxx	25-May-11	sediment, <63 um	Total Mercury
801SDCxxx	25-May-11	sediment	Pyrethroid Pesticides
801SDCxxx	04-Oct-11	sediment	Total Metals
801SDCxxx	10-May-12	sediment	Polybrominated Diphenyl Ethers
801SDCxxx	10-May-12	sediment	Total Metals
801SDCxxx	10-May-12	sediment, <63 um	Total Metals
801SDCxxx	10-May-12	sediment	Pyrethroid Pesticides
801SDCxxx	12-Sep-12	sediment, <63 um	Total Metals
801SDCxxx	11-Jan-13	sediment	Pyrethroid Pesticides
802SJCREF	25-May-11	sediment	Total Mercury
802SJCREF	25-May-11	sediment, <63 um	Total Mercury

Station	Sample Date	Matrix	Analyte Group
802SJCREF	09-May-12	sediment	Total Metals
802SJCREF	09-May-12	sediment, <63 um	Total Metals
802SJCREF	09-May-12	sediment	Pyrethroid Pesticides
901SJSJC9	24-May-11	sediment	Total Mercury
901SJSJC9	24-May-11	sediment, <63 um	Total Mercury
901SJSJC9	08-May-12	sediment	Total Metals
901SJSJC9	08-May-12	sediment, <63 um	Total Metals
901SJSJC9	08-May-12	sediment	Pyrethroid Pesticides
902SSMR07	24-May-11	sediment	Total Mercury
902SSMR07	24-May-11	sediment, <63 um	Total Mercury
902SSMR07	08-May-12	sediment	Polybrominated Diphenyl Ethers
902SSMR07	08-May-12	sediment	Total Metals
902SSMR07	08-May-12	sediment	Pyrethroid Pesticides
903SLSLR8	01-Jun-12	sediment, <63 um	Total Metals
903SLSLR8	01-Jun-12	sediment	Total Metals
903SLSLR8	01-Jun-12	sediment	Pyrethroid Pesticides
904ESCOxx	24-May-11	sediment	Total Mercury
904ESCOxx	24-May-11	sediment, <63 um	Total Mercury
904ESCOxx	08-May-12	sediment	Total Metals
904ESCOxx	08-May-12	sediment, <63 um	Total Metals
904ESCOxx	08-May-12	sediment	Pyrethroid Pesticides
905SDSDQ9	24-May-11	sediment	Total Mercury
905SDSDQ9	24-May-11	sediment, <63 um	Total Mercury
905SDSDQ9	08-May-12	sediment	Total Metals
905SDSDQ9	08-May-12	sediment, <63 um	Total Metals
905SDSDQ9	08-May-12	sediment	Pyrethroid Pesticides
906LPLPC6	25-May-11	sediment	Total Mercury
906LPLPC6	25-May-11	sediment, <63 um	Total Mercury
906LPLPC6	09-May-12	sediment	Polybrominated Diphenyl Ethers
906LPLPC6	09-May-12	sediment	Total Metals
906LPLPC6	09-May-12	sediment, <63 um	Total Metals
906LPLPC6	09-May-12	sediment	Pyrethroid Pesticides
907SDRWAR	25-May-11	sediment	Total Mercury
907SDRWAR	25-May-11	sediment, <63 um	Total Mercury
907SDRWAR	09-May-12	sediment	Polybrominated Diphenyl Ethers
907SDRWAR	09-May-12	sediment	Total Metals
907SDRWAR	09-May-12	sediment, <63 um	Total Metals
907SDRWAR	09-May-12	sediment, <63 um	Total Metals
907SDRWAR	09-May-12	sediment	Pyrethroid Pesticides
909SWRWSx	09-May-12	sediment	Total Metals
909SWRWSx	09-May-12	sediment, <63 um	Total Metals
909SWRWSx	09-May-12	sediment	Pyrethroid Pesticides
911TJHRxx	25-May-11	sediment	Total Mercury
911TJHRxx	25-May-11	sediment, <63 um	Total Mercury
911TJHRxx	25-May-11	sediment	Pyrethroid Pesticides
911TJHRxx	09-May-12	sediment	Polybrominated Diphenyl Ethers
911TJHRxx	09-May-12	sediment	Total Metals
911TJHRxx	09-May-12	sediment, <63 um	Total Metals
911TJHRxx	09-May-12	sediment	Pyrethroid Pesticides