Initial Trends in Chemical Contamination, Toxicity and Land Use in California Watersheds:

Stream Pollution Trends (SPoT) Monitoring Program
Second Report - Field Years 2009-2010

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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 is a statewide monitoring effort focused on the Surface Water Ambient Monitoring Program (SWAMP) priority of assessing the levels to which aquatic life beneficial uses are supported in California streams. The program has three primary goals:

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.

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 registration and labeling, and local land use planning.

This report summarizes results of the 2009 and 2010 annual surveys and emphasizes identifying chemicals of concern and the watershed land uses associated with their presence in California streams. These data are compared to those of the 2008 SPoT sampling year, allowing a preliminary assessment of emerging trends. The results indicate detections of pyrethroid pesticides in sediment increased from 55% of the statewide samples in 2008 to 85% in 2010. Concentrations of several other classes of organic chemicals in sediment decreased or remained unchanged. Metals in sediments were unchanged between 2008 and 2010. The percentage of sediments that were toxic to amphipods remained relatively consistent among the three sampling years. The percentage of highly toxic samples increased from 6% to 67% when toxicity tests were conducted at a colder temperature that more closely matched the average surface water temperature in SPoT watersheds. This suggests that toxicity was caused by pyrethroid pesticides at these stations. The results also demonstrate that, on a statewide basis, levels of most measured pollutants in stream sediment increased as urban land cover in their watersheds increased. Industrial compounds, some metals, and many pesticides were found at higher concentrations in urban watersheds than in agricultural or “open” watersheds statewide. Conditions at the five SPoT reference sites remained unchanged with low contamination and no toxicity observed.

A preliminary assessment of the relationship between SPoT indicators of water quality and indicators of ecological degradation measured in statewide and regional macroinvertebrate bioassessment programs indicated significant correlations between amphipod survival in laboratory toxicity tests and increased abundance of amphipods and other crustacea in associated samples. There was not a statistically significant correlation between amphipod survival and the Index of Biological Integrity in these samples. Identification of these stations provides a foundation for future collaborations that link SPoT with other state and regional monitoring programs.

As part of long-term monitoring of trends in contaminants and toxicity in California watersheds, the SPoT program will emphasize evaluating changing trends in specific contaminant classes as new regulations are implemented. In the near future this includes changes in pyrethroid concentrations in urban watersheds that are anticipated to coincide with California Department of Pesticide Regulation management actions targeting these pesticides. In addition, the program is adding emerging contaminants of concern to the SPoT analyses as these are identified (e.g., fipronil).The data presented here 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.

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. 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 trends assessment program, and the data collected is 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.

SPoT sampling locations have been selected to provide a statewide network of sites at the drainage points of large watersheds to support collaboration with watershed-based monitoring programs throughout the state. The SPoT network 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 (CRWQCB-San Francisco Region, 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.

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. In 2010, a spatial and temporal variability study was initiated to validate the single site and once per year sampling design.

The SPoT reporting schedule is intended to summarize program findings biennially. The current report covers the second and third monitoring years (2009-2010), and presents data in support of the primary program goals discussed above. The first SPoT report summarized data for the first year of monitoring (Hunt et al., 2012). As the first program review to cover multi-year data, the current report emphasizes trends in watershed contamination and toxicity as it relates to land use over the initial three years of the program.

Methods

Monitoring Objectives and Design

Program methods were selected to meet the following monitoring objectives:

1. Determine concentrations of a suitable suite of contaminants in depositional sediment collected near the base of large California watersheds;

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

3. Quantify ancillary parameters such as land cover and impervious surface area, 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 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 were located at the base of large watersheds containing a variety of land uses. Because depositional sediment is needed for sample collection, sites were 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. One of the three main goals of SPoT was to form a statewide network of sites that provides statewide context for the findings of local and regional programs. A targeted approach allowed the SPoT program flexibility to link to established sites from other Regional Water Board monitoring programs that preceded SWAMP.

Site Selection and Survey Timing

In 2008, 92 sites were surveyed to census about half of the nearly 200 major hydrologic units (8-digit HUCs) in California. 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. Site locations were re-evaluated and some of the 2008 sites were relocated for better watershed representation for the 2010 sampling season (Figure 1).

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, in most cases on the order of an 8-digit hydrologic unit code (8-digit HUC = sub-basin = USGS cataloging unit); 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). 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.

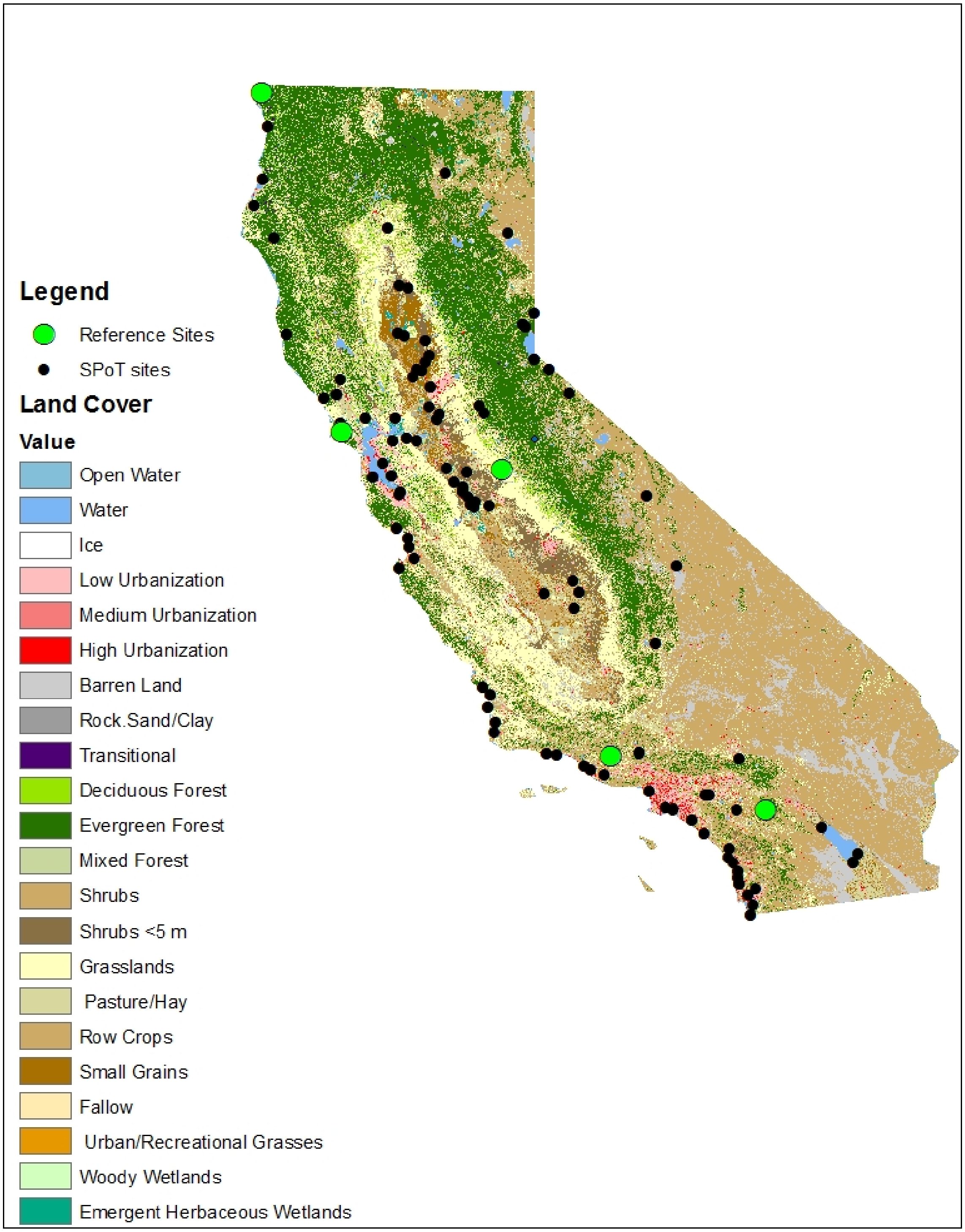

Figure 1. 2010 SPoT sites (black circles), reference sites (green circles), and land use categories.

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 matrix for evaluating annual trends.

The SPoT reference sites provide information on temporal trends in contamination and toxicity in the absence of significant contaminant-related land use change (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.

Maps of all SPoT sites with associated site names and location information are provided in the appendices of the first SPoT report (Hunt et al., 2012) and at the end of this report. Digital copies of the first SPoT report are available on line at: http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#spot.

Indicators and Measurement Parameters

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. Organic Contaminants - organophosphate, organochlorine, and pyrethroid pesticides, and polychlorinated biphenyls (PCBs);

3. Metal Contaminants - Ag, Al, As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Zn;

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

5. Tier 2 Contaminants – a subset of sediments was also measured for polycyclic aromatic hydrocarbons (PAHs) and polybrominated diphenyl ethers (PBDEs).

Analytical Chemistry, Toxicity Testing, Field Methods, and Data Storage

All 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). 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 2009-2010 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.

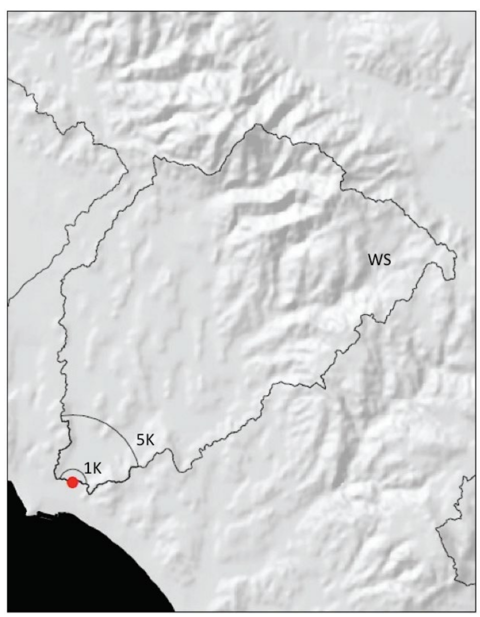

Figure 2. A depiction of watershed delineation. The red dot designates the site at the bottom of the watershed (WS, larger polygon). The semi-circular smaller areas are watershed areas 1 km (1K) and 5 km (5K) from the site.

Drainage area shapefiles 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. “Developed, Open Space” (NLCD 21) included areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses, such as large-lot single-family housing units, parks, and golf courses. “Urban” (NLCD 22, 23, 24) included low, medium, and high intensity developed areas. “Agricultural” land cover was represented by Pasture (NLCD 81) and Cultivated Crops (NLCD 82).

In correlation analyses, pollutant concentrations were compared to continuous percent land cover data as % urban, % developed open space, % pasture, and % cultivated crops. For analyses based on comparisons among watersheds types, watershed areas were characterized as “urban” if they had greater than 10% urban cover (NLCD categories 22+23+24). 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 10% cultivated crop cover (NLCD 82). Watersheds that did not meet these criteria were labeled as “open.”

Impervious surface area data were obtained from the National Land Cover Dataset (Imperv_nlc; NLCD2006 Percent Developed Imperviousness).

Statistical Analyses

Toxicity of sediment samples was determined using the U.S. EPA’s test of significant toxicity-TST (U.S. EPA, 2010). For any given year, sites that were not toxic were coded green, sites that were significantly toxic were coded yellow, and sites that were toxic and had percent survival lower than the high toxicity threshold for *Hyalella azteca* (38.6%) were coded red (Anderson et al., 2011). Toxicity results from multiple years were summarized using the following criteria: sites with no toxic samples were coded green for non toxic, sites with at least one toxic samples was coded yellow for some toxicity, sites with at least one sample below the high toxicity threshold were coded orange for moderate toxicity, and sites with an average survival less than the high toxicity threshold were coded red for high toxicity (see Table 3).

Because of the large number of sites and analytes, chemicals were grouped into classes for most statistical analyses. Total DDTs, Total PCBs, PBDEs, and Total 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 many analyses, eight relatively toxic trace metals (As, Cd, Cr, Cu, Pb, Hg, Ag, Zn; Mahler et al., 2006) were summed to provide an overall characterization of measured metal levels in sediment. Trace metals were also interpreted as the sum of four metals commonly released into the environment by human activity, and less affected by geologic abundance in California (Cd, Cu, Pb, Zn; (Topping and Kuwabara, 2003; Mahler et al., 2006; Bonifacio et al., 2010)). An aliquot of each sediment sample was also sieved to 63 um so that trace metal concentrations could be measured in both sieved (fine grained) and unsieved (whole) sediment. The sieved versus un-sieved metal comparison was included at the recommendation of the SPoT SRC because trace metals bind preferentially to smaller sediment size fractions, particularly clays, and concentrations measured on sieved sediment can be compared across watersheds with less variability related to differences in grains sizes among samples. Concentrations in unsieved sediments are the total metal concentrations and can be compared to thresholds for biological effects.

Multivariate Spearman rank correlations were used for all statistical evaluations of relationships between toxicity, pollutants, and land cover. All analyses were done using IBM SPSS Statistics Package (IBM Corporation, 2011).

Tables in the Results section provide probability (p) values indicating the strength of relationship among variables in the multiple correlations. These p values have not been adjusted to account for the number of simultaneous comparisons made (e.g., Bonferroni adjustment). There is debate in the statistical literature about the value of adjusting alpha values to account for inference based on many simultaneous tests (Perneger, 1998). Alpha adjustments were not made here because we are not interested in whether all null hypotheses are true simultaneously, but rather which relationship are of greatest interest in exploring connections between land use and stream pollution.

Results

Goal 1 – Long Term Trends in Toxicity and Chemical Concentrations

Reference Site Conditions – Toxicity and Chemistry

All references samples were nontoxic in all years except for the Smith River (103SMHSAR) tested in 2010 (Table 1). The range of Total Organic Carbon (TOC) and percent fine grained sediments at the reference sites were similar to those in the statewide monitoring sites. Concentrations of organic contaminants were generally lower than the other monitoring sites, except for pyrethroids in Lagunitas Creek in 2008 (201LAG125), and pyrethroids in Sespe Creek in 2010 (403STCSSP). The range of both sieved and unsieved metals in reference site sediments were also similar to the larger data set. The distribution of the sum of eight metals (As, Cd, Cr, Cu, Pb, Hg, Ag, and Zn) is often determined by geological abundance. All reference sites were located relatively short distances downstream of mountainous areas within their watersheds. The Lagunitas Creek reference site watershed contains serpentine outcroppings of the Franciscan formation, and the other reference site watersheds had moderate to high levels of historic mining activity.

Total phosphorus concentrations were lower in reference site sediments than in sediments from the non-reference sites (data not shown). Phosphorus can be geologically abundant in certain areas, and can also be elevated by urban and agricultural fertilizer applications or soil disturbance associated with land development.

Table 1. Toxicity and chemistry trends at references sites. Values with "NT" indicate a non-toxic result, and values with a "T" indicate toxicity. "ND" indicates non-detect (detection limits listed in Appendix 3).

Station	Year	Survival (% of Control)	TOC (%)	Fines (%)	Sum DDT (ng/g)	Sum Pyrethroids (ng/g)	Sum PCB (ng/g)	Sum of 8 Metals (µg/g)	Sum of 8 Metals (<63 µm) (µg/g)
103SMHSAR	2008	95 NT	4.17	72.8	ND	ND	ND	405	472
	2009	95 NT		14.3	ND	ND	ND	511	581
	2010	73 T	3.14	44.8	ND	0.145	ND	388	697
201LAG125	2008	100 NT	1.27	34.0	ND	10.6	0.312	255	364
	2009	91 NT		46.9	ND	ND	ND	312	422
	2010	99 NT	1.97	45.2	ND	0.103	ND	263	205
403STCSSP	2008	104 NT	1.26	87.1	1.49	ND	2.71	166	175
	2010	104 NT	1.78	62.1	ND	7.41	ND	120	143
535STC210	2008	97 NT	0.51	5.90	5.65	ND	ND	241	450
	2010	96 NT	5.34	37.6	ND	ND	ND	286	370
802SJCREF	2008	95 NT	1.8	91.2	1.69	ND	0.713	177	214
	2009	100 NT		39.1	ND	ND	ND	102	210
	2010	101 NT	0.49	34.0	ND	ND	ND	68.0	97.8

Statewide Conditions – Toxicity and Chemistry

Sediment Characteristics: Grain Size and TOC

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 were trained to collect the finest-grained material available, a number of samples were composed primarily of grains larger than 63 um (Figure 3). None of these samples contained substantial amounts of coarse sand or larger particles, but grains larger than 63 um made up the larger fraction in half of the samples from 2009 and a third of the samples from 2010.

Field teams were also trained to avoid or remove conspicuous debris, including leaves and other large organic material. TOC content cannot be readily determined in the field, and the sampling protocol has no set criterion for TOC concentration. Measured TOC in 2009 and 2010 ranged from 0.42% to 10.78% of the total sediment mass, with a median of approximately 2% (Figure 3). These results do not demonstrate any significant trend in either grain size or TOC in SPoT sediments over the initial three years of the program. This suggests that the observed trends in sediment contamination discussed below are unrelated to changes in these parameters.

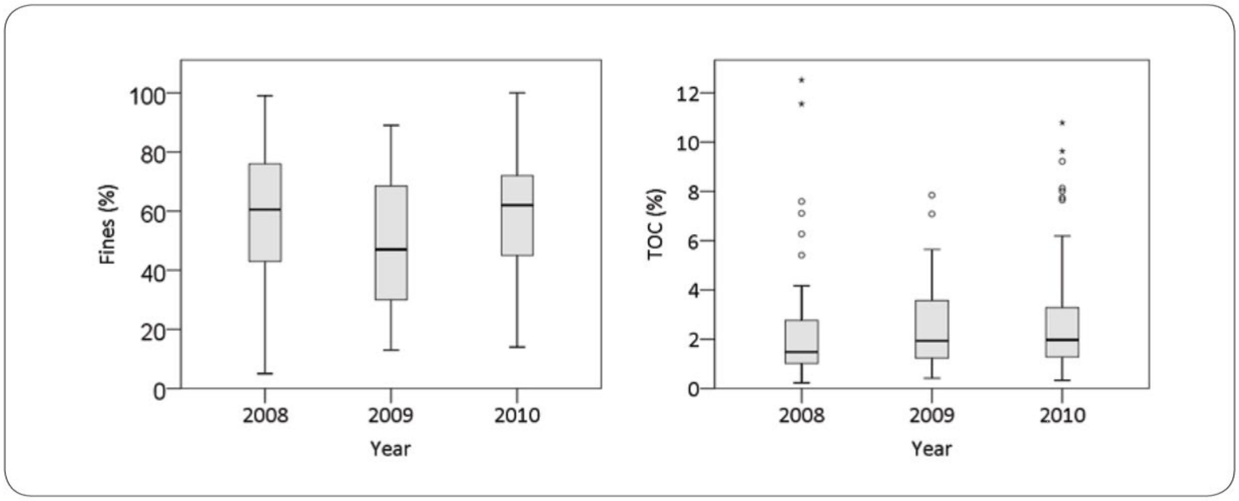

Figure 3. Three-year trends for percent fines and total organic carbon. Boxes represent first and third quartiles, line represents median, and t-bars represent 95% confidence limits. Additional points are outliers.

Toxicity Trends

While this report emphasizes data collected between 2009 and 2010, the following discussion includes toxicity results from 2008 through the 2011 sampling season to provide a four year depiction of statewide toxicity trends. The incidence of sediment toxicity has remained relatively stable between 2008 and 2011 (Table 2). The percentage of toxic and highly toxic samples increased in 2009, but this may reflect the reduced sample size during that year.

Table 2. SPoT sediment toxicity trends in tests conducted at 23 °C from 2008-2011.

Number of Sites Tested	**2008**	**2009**	**2010**	**2011**
	92	23	95	100
% Non-toxic	79	70	79	83
% Toxic	14	21	13	12
% Highly Toxic	7	9	8	5
% Toxic + % Highly Toxic	21	30	21	17

Significant toxicity was observed in 30% of the sediment samples collected in 2009 and 21% of the samples collected in 2010 (Table 2). Approximately 8.5% of the samples from both years were identified as highly toxic. Highly toxic samples were collected from agricultural watersheds in the Central Valley's Tulare basin, at sites on the central coast, in urban areas of southern California, and in the Tijuana River (watershed partly extending to Mexico). Other toxic samples were collected from a wide range of watershed types, including those along the north coast, the Sierra Nevada and urban and agricultural areas across the state. In some cases, high toxicity was observed at the same sites over multiple years in specific regions. Site-specific trends in contamination and toxicity are discussed below.

Table 3 depicts a four-year running 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 had at least some toxicity. As the program progresses it is expected that these figures could depict greater toxicity because as cumulative sampling progresses, the chance for detecting toxicity at any one site increases. The long term trend can be illustrated by tracking a running average of four years of data (i.e., two report cycles).

Note that the three color grading system is used when there is only one sample per site (e.g., for the year-by-year results presented in Table 3), and the four color system is used when multiple samples per site are evaluated (Table 3). The scheme for grading site toxicity when multiple samples have been collected is described in the SWAMP report summarizing toxicity in California waters (Anderson et al., 2011).

Table 3. Four-year average of toxicity in the SPoT Program.

Category	Percent of Sites	Description
Non-toxic	66	No samples are significantly toxic
Some Toxicity	23	Some toxic samples, but none lower than 38.6% survival
Moderate Toxicity	4	At least one sample below 38.6% survival
High Toxicity	7	Mean % survival of all samples less than 38.6%

Chemistry Trends

Sediment Organic Chemicals

The three year trends for the principal organic chemical constituents analyzed in SPoT sediments are presented in Table 4. Although this table depicts trends between 2008 and 2010, the 2009 SPoT program year only surveyed 23 stations, compared to 92 and 95 stations in 2008 and 2010, respectively; so smaller 2009 sample size should be considered when evaluating trends. Increases in the average concentrations of some organic chemicals may not be reflective of statewide trends. Of the general classes of organic chemicals measured, pyrethroid pesticides demonstrated an increasing trend in detections and concentrations in sediments. Both the average and range of total pyrethroid concentrations increased in 2010. In addition, the number of samples having at least one pyrethroid detected increased from 2008 to 2010 (Table 4). Since many of the pyrethroid detections occurred in sediments collected from SPoT sites in urbanized watersheds, trends in urban pyrethroid use are instructive.

Bifenthrin was the most commonly detected pyrethroid in the 2008 and 2010 SPoT samples. 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 pyrethroid use reported to the California Department of Pesticide Regulation did not increase between 2008 and 2010. The total pounds of active ingredients including bifenthrin, cyfluthrin, cypermethrin, L-cyhalothrin, and permethrin was 622,172 in 2008 and 582,581 in 2010.

Table 4. Three-year trends for detections of representative total chemical classes.

Sum of Chemical Class	Year	Percentage Detections	Average Detection	Minimum	Maximum
Pyrethroids (ng/g)	2008	55	16.9	0.516	113
	2009	52	12.8	1.36	48.5
	2010	81	30.4	0.084	1010
DDT (ng/g)	2008	73	31.8	0.361	365
	2009	78	77.8	0.456	420
	2010	33	12.1	1.00	43.8
Organophosphates (ng/g)	2008	12	25.9	5.2	116
	2009	4	59.2	59.2	59.2
	2010	0	NA	NA	NA
PCB (ng/g)	2008	49	15.6	0.113	125
	2009	39	13.0	0.581	31.6
	2010	10	17.05	2.10	36.3
PAH (ng/g)	2008	100	757	18.5	3567
	2009	100	1457	44.5	5535
	2010	93	293	1.70	4966
PBDE (ng/g)	2008	88	18.7	0.586	121
	2009	78	10.38	3.81	21.9
	2010	78	18.7	0.272	106
Metals 8 (μg/g)	2008	100	241	68.0	872
	2009	100	226	87.4	511
	2010	96	202	40.5	616

The chlorinated compounds DDT and PCBs saw a general decline over the three years. Detections and concentrations of PAHs, PBDEs and the sum of 8 metals remained constant. Note that PAHs and PBDEs were only measured in SPoT samples from Tier II sites, mostly in urban watersheds. Detections and concentrations of organophosphate pesticides in sediment also decreased between 2008 and 2010. For example, 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 the 95 SPoT sites sampled in 2010. Analysis of chlorpyrifos sales through the Department of Pesticide Regulation showed relatively consistent sales during this period (1.9 million lbs. active ingredient in 2008, 1.6 million lbs. in 2009 and 1.9 million lbs. in 2010; http://www.cdpr.ca.gov/docs/mill/nopdsold.html).

Sediment Metals

Trace metals were measured in both whole sediments and sediments sieved to less than 63 um (Figure 4). Because trace metals bind preferentially to smaller sediment size fractions, particularly clays, it has been suggested that sieving sediments allows a better comparison of metal concentrations across watersheds by reducing the effects of grain size differences. Concentrations of metals in unsieved sediments give a measure of the total metal concentrations and these can be compared to published guideline values as an indication of the potential for biological effects. 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.

State wide, concentrations of the two metal sums did not change over the three year sampling period. Similarly, the mean concentrations of mercury in sediments were largely unchanged over the sampling period (Figure 4). 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 (discussed below).

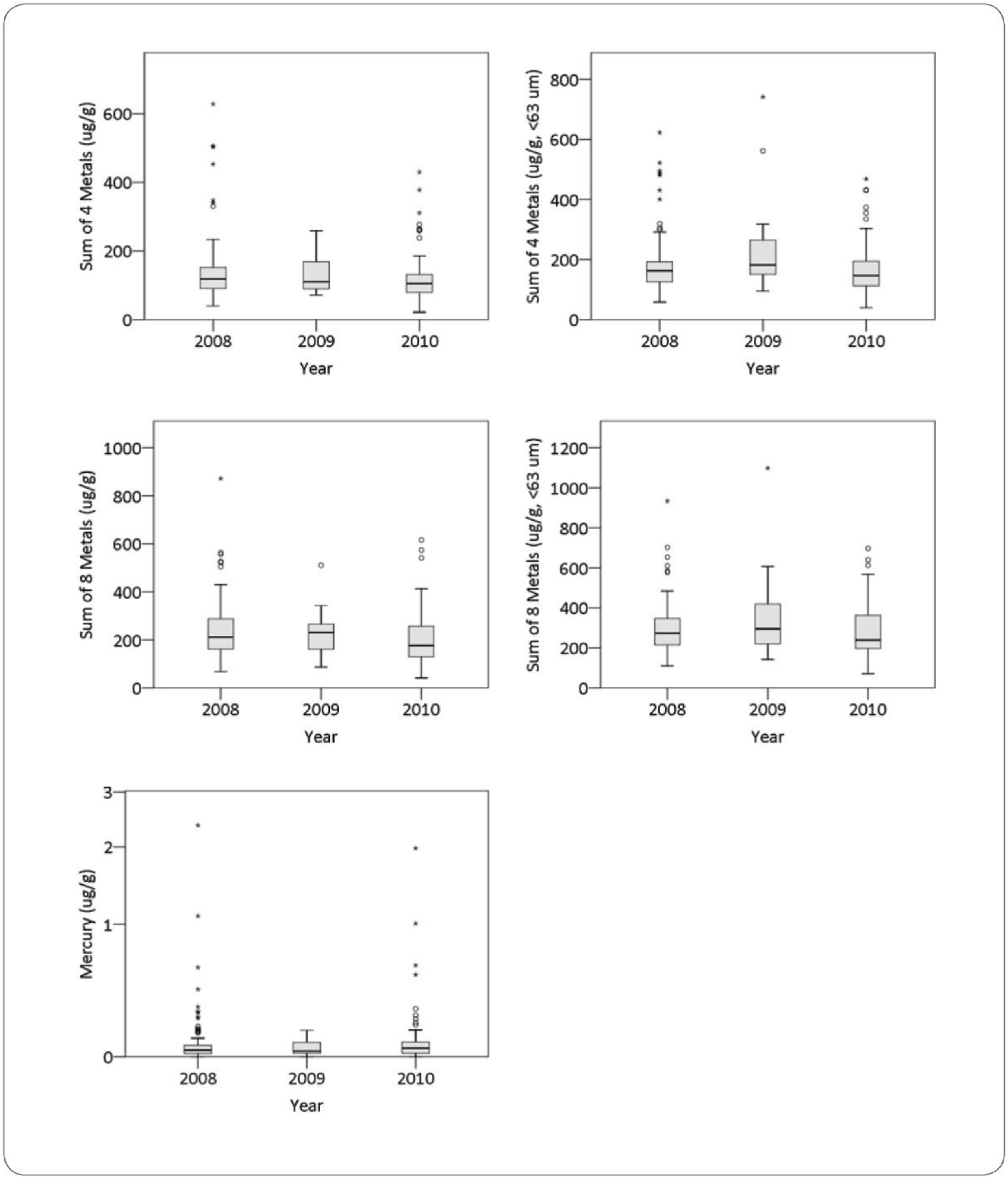

Figure 4. Three-year trends for four- (Cd, Cu, Pb, Zn) and eight- (As, Cd, Cr, Cu, Pb, Hg, Ag, and Zn) metal summations, and mercury (Hg) alone. Boxes represent first and third quartiles, line represents median, and t-bars represent 95% confidence limits. Additional points are outliers.

Results of sieved and unsieved metals analyses were compared among years. Summary statistics (means, standard deviations, and coefficients of variation) were compared for 23 samples that were analyzed in all three years. The average coefficients of variation presented in Table 5 represent the mean of individual coefficients of variation calculated from three years of samples (2008, 2009 and 2010). The variability among the three years for the sums of 4 and 8 metals was slightly higher in sieved samples versus unsieved samples. When the single metals copper and zinc were compared, the bulk samples were slightly more variable than the sieved samples. Because of the high variability observed between years or 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.

Table 5. Three-year trends for four- (Cd, Cu, Pb, Zn) and eight- (As, Cd, Cr, Cu, Pb, Hg, Ag, and Zn) metal summations, and mercury (Hg) alone. Boxes represent first and third quartiles, line represents median, and t-bars represent 95% confidence limits. Additional points are outliers.

Year	Bulk	Sieved
Sum 8 Metals*	21%	24%
Sum 4 Metals**	23%	25%
Copper	26%	23%
Zinc	32%	25%

Chemical Concentrations Related to Toxicity and Guideline Thresholds

The relationships between amphipod mortality and sediment chemical concentrations were investigated for the 2008-2010 sampling years using Spearman Rank correlations, and by comparing amphipod survival with individual chemical threshold values. Where possible, median lethal concentrations (LC50s) were used to evaluate chemistry data. Various other sediment quality guidelines were used when LC50s were not available. Several new pesticide LC50s were used to re-evaluate the 2008 data set. Sediment quality guidelines included probable effect concentrations and median effect concentrations. Fifty guideline and LC50 values were used to evaluate several chemical classes including pyrethroid pesticides, organochlorine pesticides, organophosphate pesticides, PAHs, PCBs, and metals.

Correlation results show that amphipod survival was related to a number of organic chemical classes in 2008. The strongest (negative) correlations were between amphipod survival and sum pyrethroid pesticides, sum PCBs and sum DDTs (Table 6). Note: a negative correlation in this case indicates that as a chemical concentration increases amphipod survival decreases. There were no significant correlations between amphipod survival and chemical classes in the 2009 dataset, likely because of the small sample size. In 2010, amphipod survival was significantly negatively correlated with pyrethroids, sum PCBs and sum DDTs.

Table 6. Results of Spearman rank correlations between amphipod survival and concentrations of various analyte groups (2008-2010). Cells with an "SN" indicate a significant negative correlation between survival and chemical concentration (α < 0.05).

Analyte Group	**2008**		**2009**		**2010**	
	Probability	**N**	**Probability**	**N**	**Probability**	**N**
Sum Pyrethroids	0.000 SN	92 SN	0.768	23	0.000 SN	95 SN
Sum DDT	0.009 SN	92 SN	0.281	23	0.021 SN	94 SN
Sum PAH	0.040 SN	28 SN	0.397	6	0.294	49
Sum PBDE	0.023 SN	32 SN	0.070	9		
Sum PCB	0.000 SN	92 SN	0.649	23	0.029 SN	94 SN
Sum Metals 8	0.062	92	0.637	23	0.169	95
Sum Metals 8 (<63 µm)	0.102	92	0.387	23	0.424	95
Sum Metals 4	0.048 SN	92 SN	0.604	23	0.124	95
Sum Metals 4 (<63 µm)	0.062	92	0.809	23	0.469	95
Percent Fines (<63 µm)	0.038 SN	92 SN	0.476	23	0.281	95

Of the fifty 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. The total chlordane probable effects concentration (PEC) was exceeded fourteen times between 2008 and 2010, but never by more than a factor of three. Only one sample from 2008 was highly 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 LC50s derived from dose-response experiments. Nickel and chromium most often exceeded the PEC. As with chlordane, the nickel PEC may not be a reliable indicator of toxicity to amphipods. For example, the nickel PEC is 48.6 mg/kg (Macdonald, 2000) but the nickel LC50 derived from recent sediment spiking experiments was found to be 521 mg/kg (Liber et al., 2011). Thus, while many samples exceeded the PEC for nickel, none exceeded the LC50. 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 13% of the samples collected in 2008, 9% in 2009, and 20% in 2010. Most of the elevated concentrations were for bifenthrin, and nearly half of the samples with an exceeded LC50 for pesticides were considered highly toxic. To better evaluate the contribution of pyrethroids to observed toxicity, concentrations were converted to toxic units (TUs) by dividing the measured concentration by the LC50 and summing across all pyrethroids. Approximately 50% mortality would be expected at one TU. Previous research has demonstrated that significant toxicity is observed when the TUs are greater than one (Weston et al., 2005). In the current data set, the proportion of toxic and highly toxic samples increases beyond 0.5 TUs. All samples were toxic at greater than 2.5 TUs (Figure 5). Although correlation analysis from 2008 and 2010 demonstrated relationships between a number of chemical classes and toxicity, only concentrations of pyrethroid pesticides and chlorpyrifos exceeded toxicity threshold values.

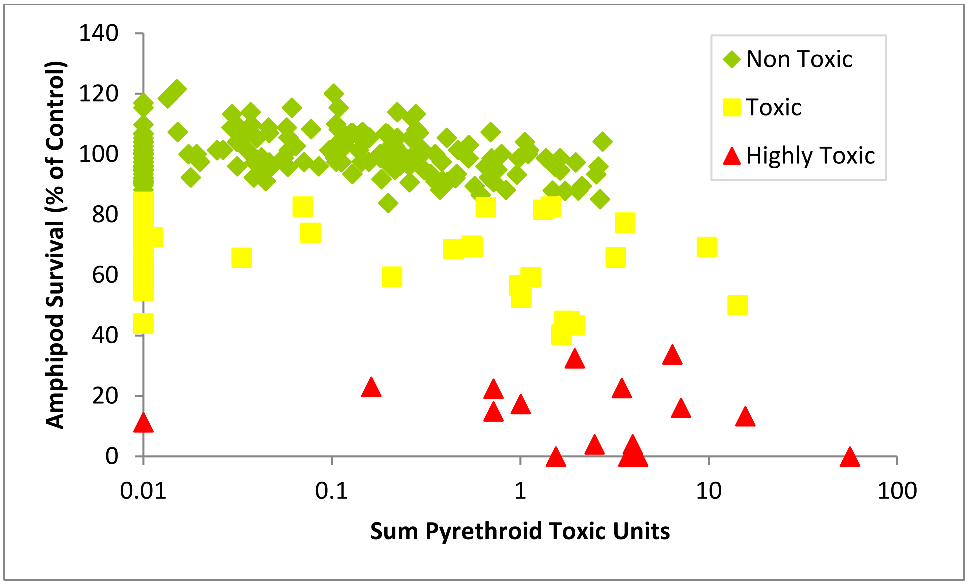

Figure 5. 2008-2010 toxicity data plotted against the sum of pyrethroid toxic units.

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). 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. Temperature effects were evaluated using a subset of SPoT stations starting in 2010 (n=15 samples). 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 (Table 7). Thirty-three additional low temperature comparisons were conducted as part of the SPoT variability study, also in 2010.

Table 7. Average surface water temperature in SPoT watersheds for each Regional Water Quality Control Board in California. Data present day-time water temperatures sampled at water depths less than 0.1 m. Data represent samples collected in all months.

Region	1	2	3	4	5	6	7	8	9	Statewide Average
Average Temperature (°C)	14.2	14.3	16.5	17.7	15.8	9.7	20.7	14.7	18.5	15.8
N	120	123	69	75	797	214	33	49	103	

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 8). Seven percent of the samples were highly toxic when tested at 23°C, while 67% were highly toxic when tested at 15°C. Pyrethroid pesticides were detected in all of these samples, and all of the toxic samples contained greater than 0.5 toxic units of total pyrethroids. Toxic units based on organic carbon corrected LC50s are also presented to provide a better estimation of bioavailable sediment associated pyrethroid concentrations. The results of the variability study stations (described below) are less striking. These stations were located in primarily open space and agriculturally dominated areas and were generally not toxic with low concentrations of pyrethroids. Three sites contained concentrations of pyrethroids with toxic unit values greater than 0.5. These stations all had significantly greater toxicity when tested at 15°C. The results indicate that pyrethroid pesticides likely played a role in the increased incidence of toxicity in these samples. Two temperature testing has been expanded in the SPoT program and results for the 2011 sampling year are comparable to those presented here.

Table 8. Comparison of percent survival in 2010 samples tested at 23° C and 15° C from base stations (A) and variability study stations. Comparison of percent survival in 2010 samples tested at 23° C and 15° C from variability study stations. "NT" denotes non-toxic samples, "T" denotes toxic samples, and "HT" denotes highly toxic samples. See methods for details.

Base Stations	23° C Survival (% of Control)	15° C Survival (% of Control)	Sum Pyrethroid TU*	OC-Corrected Sum Pyrethroid TU*
204SLE030	86 NT	22 HT	0.62	0.16
205GUA020	97 NT	10 HT	1.97	0.76
207LAU020	96 NT	22 HT	1.53	1.94
404BLNAxx	69 T	3 HT	9.78	2.59
405SGRA2x	69 T	1 HT	0.56	0.81
412LARWxx	95 NT	21 HT	1.63	0.82
504BCHROS	115 NT	96 NT	0.11	0.08
551LKI040	105 NT	105 NT	0.22	0.22
558PKC005	85 NT	8 HT	2.65	1.89
801CCPT12	77 T	18 HT	3.59	2.92
801SARVRx	83 T	35 HT	1.45	2.16
801SDCxxx	16 HT	1 HT	7.12	8.01
904ESCOxx	88 NT	65 T	1.49	1.21
906LPLPC6	93 NT	40 T	2.53	2.45
907SDRWAR	88 NT	85 T	2.03	1.51
% Non-toxic	66	13		
% Toxic	27	20		
% Highly Toxic	7	67		

Table 9. Comparison of percent survival in 2010 samples tested at 23° C and 15° C from variability study stations. The pyrethroid toxic units (TU) presented are based on LC50s for both dry-weight and organic carbon-normalized concentrations. “NT” denotes non-toxic samples, “T” denotes toxic samples, and “HT” denotes highly toxic samples. See methods for details.

Variability Study Stations	23° C Survival (% of Control)	15° C Survival (% of Control)	Sum Pyrethroid TU*	OC-Corrected Sum Pyrethroid TU*
504BCHROS	104 NT	92 NT	0.11	0.18
504BCHROS	109 NT	110 NT	0.03	0.11
504BCHBID	96 NT	84 NT	0.23	0.36
504BCHBID	109 NT	104 NT	0.05	0.13
504BCHBID	114 NT	91 NT	0.04	0.10
504BCHNOR	99 NT	42 T	1.62	1.34
504BCHNOR	107 NT	104 NT	0.02	0.10
504BCHNOR	120 NT	84 NT	0.10	0.14
504BCHRIV	95 NT	99 NT	0.22	0.38
504BCHRIV	107 NT	79 T	0.70	0.54
504BCHRIV	114 NT	75 T	0.22	0.42
551LKI040	103 NT	95 NT	0.22	0.19
551LKI040	107 NT	101 NT	0.15	0.13
551LKI041	103 NT	96 NT	0.06	0.15
551LKI041	108 NT	108 NT	0.28	0.27
551LKI041	113 NT	110 NT	0.03	0.14
551LKI043	99 NT	88 NT	0.23	0.44
551LKI043	105 NT	100 NT	0.26	0.32
551LKI043	113 NT	89 NT	0.28	0.16
551LKI044	101 NT	103 NT	0.30	0.22
551LKI044	105 NT	92 NT	0.41	0.27
551LKI044	109 NT	87 NT	0.06	0.16
558PKC001	101 NT	99 NT	0.19	0.39
558PKC001	107 NT	97 NT	0.29	0.30
558PKC001	112 NT	107 NT	0.27	0.39
558PKC003	74 T	100 NT	0.08	0.12
558PKC003	101 NT	101 NT	0.04	0.23
558PKC003	107 NT	104 NT	0.05	0.18
558PKC005	50 T	0 HT	14.26	16.97
558PKC005	100 NT	93 NT	0.22	0.43
558PKC010	99 NT	96 NT	0.04	0.22
558PKC010	107 NT	92 NT	0.04	0.15
558PKC010	107 NT	104 NT	0.13	0.67

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). Average surface water temperatures in the SPoT watersheds were evaluated by compiling all surface water temperature data from years 2001-2010 for each of the hydrologic units where SPoT stations are located (Table 7). Samples represent day-time temperatures measured at depths less than 0.1m as part of SWAMP routine monitoring, which is conducted during all months of the year (Cassandra Lamerdin, Moss Landing Marine Laboratories, personal communication). Based on these screening criteria, the average statewide surface water temperature for all regions 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.

Evaluation of Spatial and Temporal Variability Associated with SPoT Base Stations

The SPoT program is designed to assess one-hundred sites yearly to determine long-term trends in toxicity and chemical contamination. As described above, this design is based upon that used by the USGS NAWQA program. SPoT stations are located near the base of major watersheds, and sampling is conducted once per year after the rainy season. Based on recommendations from the SPoT SRC, additional testing has been conducted at selected SPoT sites to assess the temporal and spatial variability of toxicity and contamination. 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: Big Chico Creek, the South Fork of the Kings River, and Packwood Creek. These SPoT sites are in largely agricultural watersheds but also receive substantial urban stormwater runoff. Additional sites from urban-dominated watersheds were assessed in 2011. For each of the SPoT sites in this study, three additional stations were monitored upstream. These were located within a few kilometers of the base station in order to provide adequate spatial representation. All stations plus the base station were sampled three times per year to represent the summer, winter and spring 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 (without replication) on the spatial and temporal data within the 2010 sampling season. The results of these analyses determined if there were significant differences among the seasons within the year, or the stations within the watershed. The results from the three base station samples conducted within 2010 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.

There were no significant differences among the stations for toxicity at either temperature or bifenthrin. The stations in the Packwood Creek watershed were significantly different for TOC (Table 9). There were significant seasonal differences for toxicity at 23°C for Big Chico Creek and Lower Kings River. If the amphipod survival results are more variable among years than they are within a year, then it is assumed that yearly sampling is adequate to characterize long-term trends. Results of the F-Ratio tests indicate that annual variability was greater than seasonal variability at all three sites. These results indicate that in most instances, a single baseline sample was representative of sediment toxicity at proximate stations and in different seasons.

Table 10. Probability values for statistical comparisons among stations, seasons and years at variability sites. "SD" represents significant differences ($p<0.05$).

Station Name	Parameter	Significant Difference Among		F-Ratio Test (one tail)
		Stations	Seasons	H_o: Annual ≥ Seasonal
Big Chico Creek	23° Toxicity	0.295	<0.001 SD	0.487
	15° Toxicity	0.481	0.340	0.057
	TOC	0.312	0.303	
	Bifenthrin	0.717	0.344	
Lower Kings River	23° Toxicity	0.386	0.002 SD	0.949
	15° Toxicity	0.236	0.534	0.794
	TOC	0.393	0.871	
	Bifenthrin	0.721	0.542	
Packwood Creek	23° Toxicity	0.297	0.834	0.108
	15° Toxicity	0.052	0.478	0.370
	TOC	0.010 SD	0.060	
	Bifenthrin	0.302	0.413	

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. The current results suggest once per year sampling adequately represent highly variable indicators in particular watersheds, particularly for sites with less overall variability. No definitive conclusions regarding the SPoT sampling design can be made based on the limited number of sites and samples used for the current comparison. Additional variability samples were collected in 2011 and 2012. These were collected from two sites in highly urban watersheds (Coyote Creek and San Diego Creek). Analysis of data from repeated sampling of the same sites will help to better assess how well the current design characterizes trends in sediment contamination and toxicity. The additional temporal and spatial sampling in these two watersheds is also intended to allow for a more comprehensive assessment of the effectiveness of the newly implemented California Department of Pesticide Regulation's use restrictions for pyrethroid pesticides in urban environments. Results of these additional variability studies will be presented in the 2011-2012 SPoT report.

Regional Trends

The majority of toxicity data from SPoT stations sampled statewide from 2008 through 2010 demonstrated variable results over time. The specific sites that were highly toxic in every sampling year (when tested at 23°C) included: the Tembladero Slough and Santa Maria River stations in Region 3, San Diego Creek in Region 8, and the Tijuana River in Region 9. No SPoT sites from Region 1, 2, 6 or 7 were consistently categorized as highly toxic (i.e., during all three sampling years). As noted above, the number of sites demonstrating high toxicity increased when tests were conducted at 15°C, and this was likely due to the presence of pyrethroid pesticides. Sites for which high toxicity was observed in 15°C tests included: San Leandro Creek and Guadalupe Creek in Region 2, Ballona Creek and the San Gabriel and Los Angeles Rivers in Region 4, Packwood Creek in Region 5, and Chino Creek, San Diego Creek and the Santa Ana River in Region 8. As testing with two temperatures expanded to more sites in 2011 and 2012 the number of sites demonstrating consistently high toxicity increased when tested at 15°C. These data will be incorporated into the characterization of statewide and site-specific trends for the 2011-2012 SPoT report.

Individual regional trends in chemical contamination generally followed the statewide trends (Table 10). Average DDT concentrations in sediment decreased between 2008 and 2010 in all regions. Average PCBs in sediment were largely not detected in Regions 1, 3, 5, 6 and 7, and decreased in Regions 2 and 8. Average PCBs in sediment were basically unchanged in Regions 4 and 9, two of the most urbanized regions in the state. Average pyrethroid pesticide concentrations in sediments increased between 2008 and 2010 in Regions 1, 4, 5, 6, 7, 8, and 9, but were almost unchanged in Regions 2 and 3. The largest increase in average pyrethroid concentrations in sediment occurred in Region 4, and this was due to very large increases at two stations: Bouquet Creek and Ballona Creek. The highest SPoT total pyrethroid concentrations in the state in 2010 were measured in sediments from Bouquet Creek, Ballona Creek (both in Region 4), and the Tijuana River (Region 9). The high total pyrethroid concentrations at these sites were due to bifenthrin.

<u>Region 1 – North Coast</u>

Nine sites were sampled in 2008 and eight sites were sampled in 2010. One of the Russian River sites (114RRAXRV) was removed from the list. Information on specific SPoT sites is provided in Appendix 2. The incidence of sediment toxicity in Region 1 increased from 22% to 63% (Figure 6). While no samples were highly toxic, there was an increase of toxic samples. Two samples were collected in 2009, and were not toxic. No Region 1 samples were tested at 15°C. The percentage of pyrethroid detections increased from 22% to 38%, but the increase in the average sum measurement was fairly low. Chlorinated chemicals were not detected in 2010, and PAHs and PBDEs were not measured in 2008. The average concentration of the sum of anthropogenic metals decreased slightly between 2008 and 2010.

Region 2 – San Francisco Bay

Ten sites were sampled in 2008 and 11 sites were sampled in 2010. Sonoma Creek (206SON010) was added to the list. Sediment toxicity in Region 2 streams decreased between 2008 and 2010, but one highly toxic sample was collected in 2010 (Kirker Creek – 207KIR020, Figures 6 and 7). Three samples were collected in 2009. Two of these samples were significantly toxic, as they were in 2008. Three non toxic samples were also tested at 15°C., and were highly toxic at the lower temperature. All of these samples had greater than 0.5 TU of total pyrethroids. Overall, the percentage of pyrethroid and PAH detections and the average sum concentrations did not change significantly between 2008 and 2010, whereas detections and concentrations of DDT and PCBs decreased. Detections and concentrations of PBDE also decreased, but to a lesser extent. The average concentration of the sum of anthropogenic metals decreased between 2008 and 2010. Two sites in Region 2 had the highest sediment mercury concentrations measured in the SPoT program. These were Walker Creek Ranch (Hg = 1.01 – 2.36 µg/g) and Guadalupe Creek (1.09 – 1.98 µg/g).

Region 3 – Central Coast

The same 11 sites were sampled in 2008 and 2010. Incidence of toxicity was reduced by half during this period, but the number of highly toxic samples remained the same (Tembladero Slough – 309TDWxxx and Santa Maria River – 312SMAxxx, Figures 7 and 8). Three samples were collected in 2009, including the Santa Maria River, which was highly toxic. Two other samples that were toxic in 2008 were not toxic in 2010. No Region 3 samples were tested at 15°C. The number of pyrethroid detections increased, but the average sum was lower. The numbers of detections and concentrations of DDT were decreased, and PCBs were not detected in 2010. The concentrations of PAHs and PBDEs decreased, but the number of detections did not change. Metals were detected in every sample, but their concentrations were lower in 2010.

Region 4 – Los Angeles

Seven sites were sampled in 2008 and eight sites were sampled in 2010 (Figure 8). The Los Angeles River (412LAWRxx) was added to the list. The incidence of toxicity in Region 4 increased between 2008 and 2010, particularly with the addition of Bouquet Canyon Creek (403STCBQT), which was highly toxic and contained the highest concentration of pyrethroids measured in the program. Ballona Creek (405BLNAxx) and San Gabriel River (405SGRA2x) were also moderately toxic in 2010. Two Region

4 samples were collected in 2009, but only Ballona Creek was toxic. Three sites were tested at 15°C (Ballona Creek, San Gabriel River and Los Angeles River – 412LARWxx). All three sites became highly toxic when tested at the colder temperature. The Los Angeles River was not toxic when tested at 23°C. All three sites contained greater than 0.5 toxic units of pyrethroids. Pyrethroids were detected in all of the 2010 samples, whereas they were only detected in about half of the samples from 2008. The average sum concentration also increased approximately five-fold. Detections of DDT and PCBs decreased, but only the concentrations of DDT were lower in 2010. PBDEs were detected in every sample in 2008 and 2010, but their concentrations were lower in 2010. Metals were detected in every sample, but their concentrations were lower in 2010.

Region 5 – Central Valley

Thirty-one sites were sampled in 2008 and 34 sites were sampled in 2010. The Mokelumne River at Highway 49 (532CAL004) was removed from the list, but Harding Drain (535STC501), Marsh Creek (541MERECY), Del Puerto Creek (541STC516), and Mokelumne River at New Hope Road (544SAC002) were added (Figures 6-8). Considering the high number of samples collected in Region 5, the incidence of toxicity remained fairly constant. Marsh Creek and Orestimba Creek (541STC019) were both highly toxic, although Orestimba Creek was not toxic in 2008. Only four Region 5 samples were collected in 2009, and none of these were significantly toxic. Three sites were tested at 15°C and as part of the variability study: Big Chico Creek (504BCHROS), Lower Kings River (551LKI040), and Packwood Creek (558PKC005). All three of these sites were not toxic at 23°C, but Packwood Creek became highly toxic when tested at the lower temperature. This station also contained 2.65 toxic units of pyrethroids. Detections of pyrethroids increased from 42% of the samples to 76% of the samples, and the average total concentration increased three-fold. Detections and concentrations of all other contaminant classes decreased between 2008 and 2010.

Region 6 – Lahontan

Nine samples were collected in 2008 and ten samples were collected in 2010 (Figures 6 and 8). Deep Creek (628DEPSED) was added to the list. Pyrethroids were detected in half of the samples in 2008 and 2010, and the average total concentration increased in 2010. Detections and concentrations of DDT and PCBs went to zero in 2010, and those of PBDEs were reduced by half. PAHs and metals were detected in every sample, but total concentrations were lower in 2010.

Region 7 – Colorado River Basin

Three samples were collected in 2008 and 2009, but only two samples were collected in 2010. Region 7 is the only region to have a complete set of samples for the 2009 season. Only the New River was significantly toxic in all three years (723NROTWM). No samples in Region 7 were highly toxic (Figure 8). Pyrethroids were detected in both the Alamo and New River samples in all three samples years, and the average total concentration increased four-fold. A previous SWAMP study implicated pyrethroids as the cause of water column toxicity in the New River (Phillips et al., 2007). DDT and metals were detected in all of the samples, but concentrations were lower in 2010. PCBs were not detected in any samples and PBDEs were not measured. PAHs were not measured in 2008, but were detected in all 2010 samples.

Region 8 – Santa Ana

Five samples were collected in 2008, two in 2009, and four in 2010. One highly toxic sample from 2008 (845SGRDRE) was removed from the list, as was one of the San Jacinto River stations (802SJRGxx). Two stations were added in 2010 (Chino Creek – 801CCPT12, and Santa Ana River – 801SARVRx), and both were moderately toxic (Figure 8). Two sites were sampled in all three years, San Jacinto River reference (802SJCREF) and San Diego Creek (801SDCxxx). The reference site has not been toxic, but the San Diego Creek site was highly toxic every year. Detections of pyrethroids were similar from year to year, but the average total concentration increased in 2010. Detections and concentrations of DDT and PCBs decreased between 2008 and 2010, and although PAHs, PBDEs, and metals were detected in every sample, the concentrations of these contaminants also decreased between 2008 and 2010.

Region 9 – San Diego

Seven sites were sampled in 2008 and 2010, and a subset of three of these sites was sampled in 2009. Agua Hedionda Creek (904CBAHC6) and Forrester Creek (907SDFRC2) were removed from the list after 2008, and were replaced by San Dieguito River (905SDSDQ9) and the San Diego River (907SDRWAR). All of the Region 9 sites were non-toxic except for the Tijuana River (911TJHRxx), which was sampled in 2008 and 2010 and was highly toxic (Figure 8). Pyrethroids were detected in all of the samples collected in Region 9, and the average total concentration increased almost five-fold between 2008 and 2010. Detections of DDT, PCBs and PAHs all decreased, as did concentrations of DDT and PAHs. Detections of PBDEs increased, but average concentrations were similar. Metals were detected in all samples, and concentrations decreased slightly between 2008 and 2010.

Table 11. Summary of toxicity and chemistry results organized by Water Quality Control Board Region.

Region	Cate-gory	Toxicity		Detections & Averages	Pyrethroids		DDT		PCB		PAH		PBDE		Metals 4	
		2008	2010		2008	2010	2008	2010	2008	2010	2008	2010	2008	2010	2008	2010
1	% Toxic	22	63	% Detections	22	38	22	0	11	0		100		100	100	100
	% Highly Toxic	0	0	Average Sum	2.18	1.67	0.52	0	0.16	0		120		3.62	91.3	85.6
2	% Toxic	50	18	% Detections	89	82	80	50	100	20	100	100	100	88	100	100
	% Highly Toxic	0	9	Average Sum	25.6	24.6	26.4	5.72	33.0	4.19	1286	1132	34.1	19.4	248	190
3	% Toxic	36	18	% Detections	64	82	100	64	73	0	100	100	75	75	100	100
	% Highly Toxic	18	18	Average Sum	26.9	15.2	87.9	8.29	5.55	0	765	108	7.97	1.83	121	99.7
4	% Toxic	29	38	% Detections	43	100	100	25	100	75		100	100	100	100	100
	% Highly Toxic	0	13	Average Sum	33	184	32.1	5.23	15.9	15.1		151	121	65.5	158	131
5	% Toxic	6	9	% Detections	42	76	74	32	23	0	100	83	80	50	100	100
	% Highly Toxic	3	6	Average Sum	2.98	8.42	12.4	3.05	0.69	0	459	82.2	3.08	2.01	123	108
6	% Toxic	0	0	% Detections	44	50	11	0	11	0	100	100	100	50	100	100
	% Highly Toxic	0	0	Average Sum	3.44	8.69	0.16	0	0.05	0	172	29.0	1.36	0.59	120	95.6
7	% Toxic	33	50	% Detections	67	100	100	100	0	0		100			100	100
	% Highly Toxic	0	0	Average Sum	5.71	25.8	43.2	23.0	0	0		119			144	107
8	% Toxic	40	75	% Detections	80	75	100	75	100	25	100	100	100	100	100	100
	% Highly Toxic	40	25	Average Sum	46.8	79.6	22.6	3.83	25.0	1.25	426	152	12.1	8.06	224	108
9	% Toxic	14	14	% Detections	100	100	100	29	86	57	100	80	75	100	100	100
	% Highly Toxic	14	14	Average Sum	16.2	79.9	6.09	2.47	7.35	7.76	1035	310	6.98	5.68	185	160

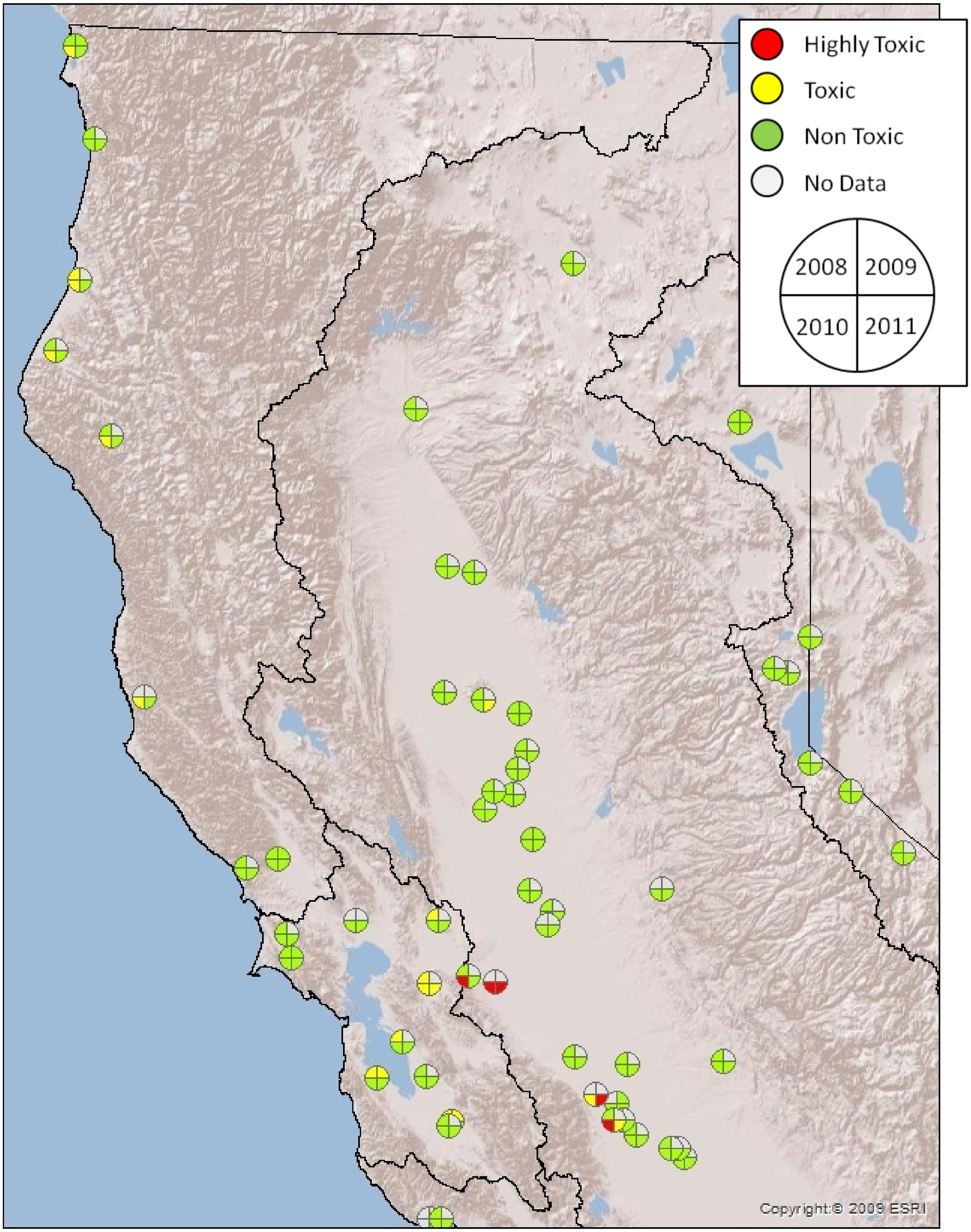

Figure 6. Regional toxicity trends in Northern California.

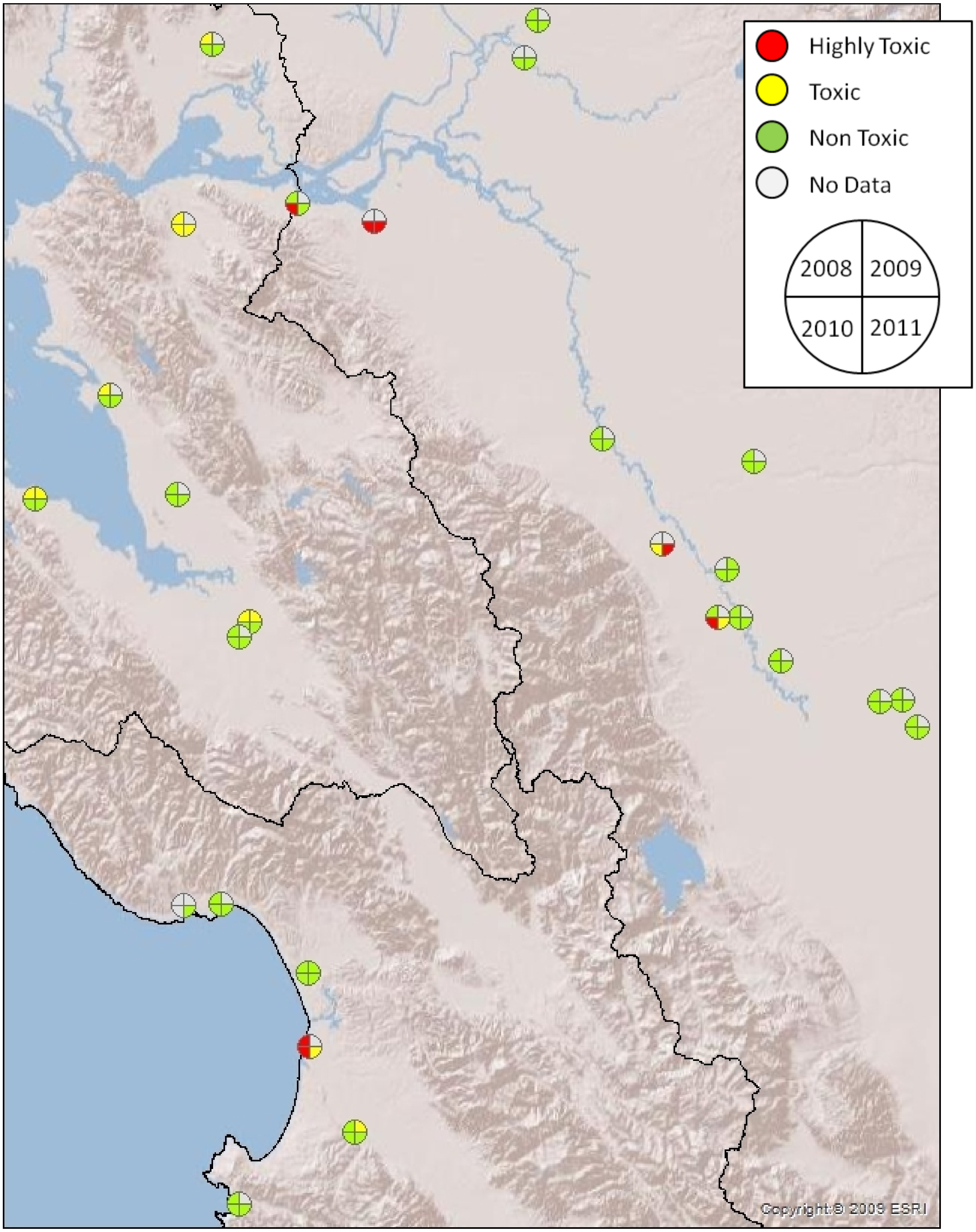

Figure 7. Detail of regional toxicity trends in Central California.

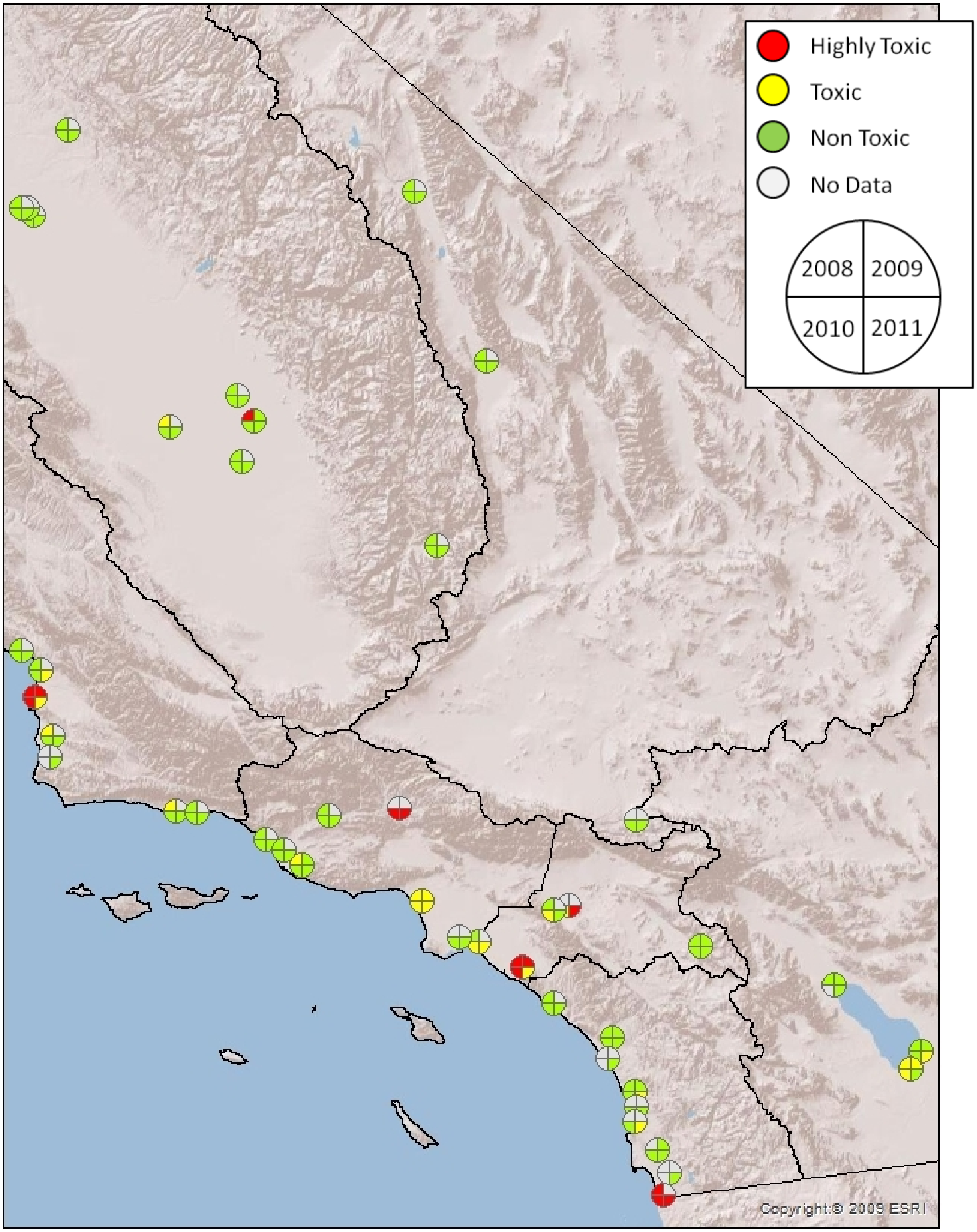

Figure 8. Regional toxicity trends in Southern California.

Goal 2 – Relationships between Water Quality Indicators and 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. Land use information is obtained from the National Land Cover Database (NLCD). The 2001 version of the NLCD was used for the 2008 SPoT report, and the 2006 version of the NLCD was used for the current report. Changes in land use for all of the SPoT watersheds were characterized for 3 different scales: 1 kilometer upstream of the sampling site, 5 k upstream, and the entire watershed above the site. To assess overall changes in land use, the average urban land use and agricultural land use (row crop and pasture) were calculated. Land use data presented in Table 11 shows that at the 1k scale, the average urban land use in all SPoT watersheds increased from 28% to 29% between 2008 and 2010, but decreased by one percent at the watershed scale. During this same period, agriculture land use increased at the 5K scale by 1%. Thus, changes in state wide land use between the 2001 and 2006 NLCD were minimal.

Table 12. Relative changes in urban and agricultural land use between 2008 and 2010. Numbers indicate the percentage of urban and agricultural land cover at each watershed scale.

SPoT WS	NLCD	Urban			Agriculture		
Year	Year	1K	5K	Watershed	1K	5K	Watershed
2008	2001	28	23	10	23	26	8
2010	2006	29	23	9	23	27	8

Correlations

Correlations between land cover and toxicity and chemistry indicators for SPoT watersheds from 2008-2010 are presented in Table 12. The vast majority of significant correlations for both sediment toxicity and chemical contaminants in SPoT watersheds were with urban land cover (i.e., the greater the percentage of urban land cover, the greater the in-stream sediment toxicity). There were significant correlations between urbanization and these indicators at all three watershed scales. Amphipod survival was negatively correlated with urban land cover in 2008 and 2010, and was also negatively correlated with developed open space land cover. In 2008, amphipod survival was negatively correlated with agricultural land cover (as Cropland) only at the watershed scale. In 2010, amphipod survival was negatively correlated with agriculture land cover at all three watershed scales.

Contaminant concentrations were most highly correlated with urban land cover during all three years. In 2008, urban land cover at all three scales was highly correlated with all of the classes of organic contaminants. Weaker relationships were observed in the 2009 dataset because of the smaller sample size. DDT was highly correlated with urban land cover in 2008, but was more strongly correlated with agriculture land cover at all three watershed scales in 2010. Sediment metals were significantly correlated with urban land uses in all three sampling years. However, stronger correlations were observed for the four metals associated with anthropogenic inputs (Cd, Cu, Pb, Zn; Table 12). Weaker correlations were observed for the eight metals that include constituents that have substantial geologic sources (Ni, Hg, Cr), and therefore would not necessarily be associated with urbanized landscapes. Correlations between the eight metals and urban land cover decreased between 2008 and 2010. Metals were sometimes correlated with developed open space and with pasture land on the 1 km scale in 2008 and 2010, but were not strongly correlated with agriculture land cover (Crop Land) in any of the three sampling years.

Impervious Surfaces

Percentage of watershed area covered by impervious surfaces at all three scales were negatively correlated with amphipod survival and positively correlated with sediment concentrations of most classes of contaminants (Table 13). Sum DDT did not correlate with impervious surface at the 1 and 5 km scales, but did correlate at the whole watershed scale. The sum of 8 metals, whether sieved or unsieved, only correlated with impervious surface at the 1 km scale. These results were very similar to the 2010 correlation results for urban land cover (Table 12).

Table 13. Correlations between sediment chemical contaminant concentrations, toxicity (% amphipod survival) and impervious surface cover within the watersheds generated using nonparametric multivariate Spearman's ρ test. Values with “SN” indicate statistically significant negative relationships between amphipod survival and land cover, or statistically significant positive relationships between chemical concentrations and land cover ($\alpha < 0.05$).

2010 Variable	1 km	5 km	Watershed
Survival (% of Control)	0.028 SN	<0.001 SN	0.003 SN
Sum Pyrethroids	<0.001 SN	<0.001 SN	<0.001 SN
Sum DDT	0.725	0.129	0.022 SN
Sum PAH	0.007 SN	0.001 SN	0.001 SN
Sum PCB	0.013 SN	0.001 SN	0.004 SN
Sum PBDE	<0.001 SN	<0.001 SN	<0.001 SN
Sum Metals 8	0.056	0.069	0.250
Sum Metals 8, <63 um	0.041 SN	0.173	0.723
Sum Metals 4	<0.001 SN	<0.001 SN	<0.001 SN
Sum Metals 4, <63 um	<0.001 SN	<0.001 SN	0.003 SN

Table 14. Results of correlation analyses between sediment chemical contaminant concentrations, toxicity (% amphipod survival) and percentage of land cover in four categories using nonparametric multivariate Spearman's ρ test. Values with "SN" indicate statistically significant negative relationships between toxicity and % land cover for each category, or statistically significant positive relationships between chemical variables and % land cover (α < 0.05). Dev-Open indicates developed open space, such as urban parks.

2008 Variable (n=92)	Urban			Developed Open Space			Pasture			Crop		
	1K	5K	Watershed	1K	5K	Watershed	1K	5K	Watershed	1K	5K	Watershed
Survival (% of Control)	0.016 SN	<0.001 SN	0.053	0.940	0.081	0.037 SN	0.227	0.583	0.066	0.334	0.101	0.029 SN
Sum Pyrethroids	<0.001 SN	<0.001 SN	<0.001 SN	0.516	0.005 SN	<0.001 SN	0.431	0.203	0.088	0.343	0.182	0.292
Sum DDT	0.004 SN	<0.001 SN	<0.001 SN	0.648	0.013 SN	<0.001 SN	0.936	0.461	0.313	0.095	0.067	0.004 SN
Sum PAH	0.012 SN	0.014 SN	0.046 SN	0.593	0.127	0.043	0.016	0.002 SN	<0.001 SN	0.042 SN	0.008 SN	0.001 SN
Sum PBDE	<0.001 SN	<0.001 SN	0.001 SN	0.977	0.141	0.007 SN	0.103	0.014 SN	0.024 SN	0.053	0.047	0.034 SN
Sum PCB	<0.001 SN	<0.001 SN	<0.001 SN	0.059	<0.001 SN	<0.001 SN	0.205	0.030 SN	0.003 SN	0.034 SN	0.006 SN	0.038 SN
Sum Metals 8	0.025 SN	0.067	0.205	0.961	0.824	0.204	0.042 SN	0.122	0.274	0.673	0.654	0.544
Sum Metals 8, <63 um	0.003 SN	0.029 SN	0.186	0.374	0.146	0.050	0.033 SN	0.136	0.194	0.584	0.971	0.537
Sum Metals 4	0.001 SN	0.001 SN	<0.001 SN	0.898	0.630	0.043 SN	0.007 SN	0.093	0.230	0.333	0.595	0.221
Sum Metals 4, <63 um	<0.001 SN	<0.001 SN	<0.001 SN	0.163	0.042 SN	0.003 SN	0.002 SN	0.058 SN	0.039 SN	0.444	0.316	0.089
2009 Variable (n=23)												
Survival (% of Control)	0.239	0.572	0.735	0.343	0.566	0.865	0.636	0.581	0.982	0.205	0.379	0.783
Sum Pyrethroids	0.268	0.093	0.056	0.397	0.458	0.239	0.258	0.911	0.362	0.476	0.456	0.356
Sum DDT	0.823	0.190	0.149	0.427	0.706	0.334	0.743	0.524	0.231	0.684	0.346	0.013 SN
Sum PAH	0.072	0.042 SN	0.787	0.208	0.544	0.872	0.158	0.140	0.208	0.158	0.158	0.872
Sum PBDE	0.104	0.032 SN	0.213	1.000	0.284	0.500	0.016 SN	0.069	0.284	0.459	0.459	0.559
Sum PCB	0.014 SN	<0.001 SN	0.066	0.343	0.007 SN	0.062	0.055	0.048 SN	0.129	0.546	0.086	0.561
Sum Metals 8	0.094	0.115	0.768	0.433	0.109	0.538	0.231	0.145	0.048 SN	0.511	0.215	0.125
Sum Metals 8, <63 um	0.260	0.268	0.691	0.686	0.405	0.672	0.789	0.189	0.008 SN	0.778	0.914	0.081
Sum Metals 4	0.029 SN	0.002 SN	0.124	0.522	0.093	0.308	0.086	0.348	0.605	0.179	0.114	0.529
Sum Metals 4, <63 um	0.330	0.110	0.491	0.986	0.371	0.321	0.143	0.085	0.049 SN	0.842	0.835	0.568
2010 Variable												

(n=95)												
Survival (% of Control)	0.043 SN	<0.001 SN	0.006 SN	0.472	0.002 SN	<0.001 SN	0.227	0.252	0.002 SN	0.015 SN	0.028 SN	0.015 SN
Sum Pyrethroids	<0.001 SN	<0.001 SN	<0.001 SN	0.218	<0.001 SN	<0.001 SN	0.049 SN	0.265	0.139	0.677	0.467	0.591
Sum DDT	0.694	0.101	0.032 SN	0.239	0.960	0.210	0.638	0.098	0.042 SN	0.004 SN	0.004 SN	0.002 SN
Sum PAH	0.005 SN	0.001 SN	0.006 SN	0.197	0.166	0.006 SN	0.777	0.057	0.110	0.186	0.010 SN	0.031 SN
Sum PBDE	0.055	0.002 SN	0.018 SN	0.974	0.900	0.033 SN	0.602	0.041 SN	0.014 SN	0.122	0.100	0.011 SN
Sum PCB	<0.001 SN	<0.001 SN	<0.001 SN	0.246	0.001 SN	<0.001 SN	0.539	0.060	0.110	0.013 SN	0.012 SN	0.037 SN
Sum Metals 8	0.105	0.058	0.278	0.457	0.783	0.243	0.027 SN	0.097	0.353	0.694	0.804	0.978
Sum Metals 8, <63 um	0.099	0.158	0.680	0.337	0.492	0.357	0.119	0.649	0.773	0.466	0.470	0.833
Sum Metals 4	0.001 SN	<0.001 SN	<0.001 SN	0.477	0.173	0.011 SN	0.007 SN	0.068	0.410	0.777	0.628	0.712
Sum Metals 4, <63 um	<0.001 SN	<0.001 SN	0.003 SN	0.270	0.074	0.037 SN	0.034 SN	0.399	0.421	0.734	0.675	0.227

Trends Related to Land Use

For the purposes of relating trends in chemical concentrations to land use, the watersheds were categorized based on the land use at all three scales as described above. The number of detections and the average concentrations of pyrethroid pesticides increased between 2008 and 2010 (Figure 9), and the concentrations of this chemical class significantly correlated with urban land use at all watershed scales. Because pyrethroids are hydrophobic and are often detected near their sources, viewing their concentrations in relation to land use at the 1 km scale is striking. Overall concentrations in the urban watersheds were higher than the agricultural watersheds, but concentrations in both types of watersheds at this scale showed a significant increase. The chlorinated compounds DDT and PCBs were also significantly correlated with urban land use. Figure 10 depicts the reduction of these compounds in urban watersheds at the watershed scale. The sum of 4 metals had more significant correlations with urban land use than the sum of 8 metals. The four-metal sum is reflective of the total concentrations of the more toxic divalent cations (Cd, Cu, Pb and Zn). Figure 11 shows the relative concentration ranges of metals in all three land use categories at the watershed scale. Although concentrations of metals did not vary state wide, concentration in urban watersheds decreased during the three year sampling period.

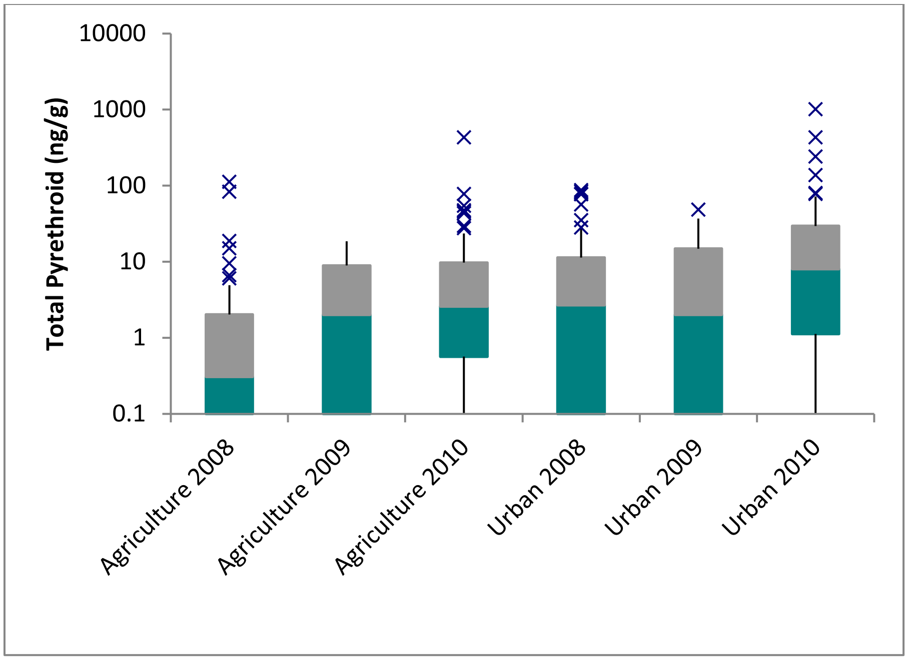

Figure 9. Total pyrethroid concentrations in agricultural and urban watersheds at the 1 km scale. Boxes represent first and third quartiles, line represents median, and t-bars represent 95% confidence limits. Additional points are outliers.

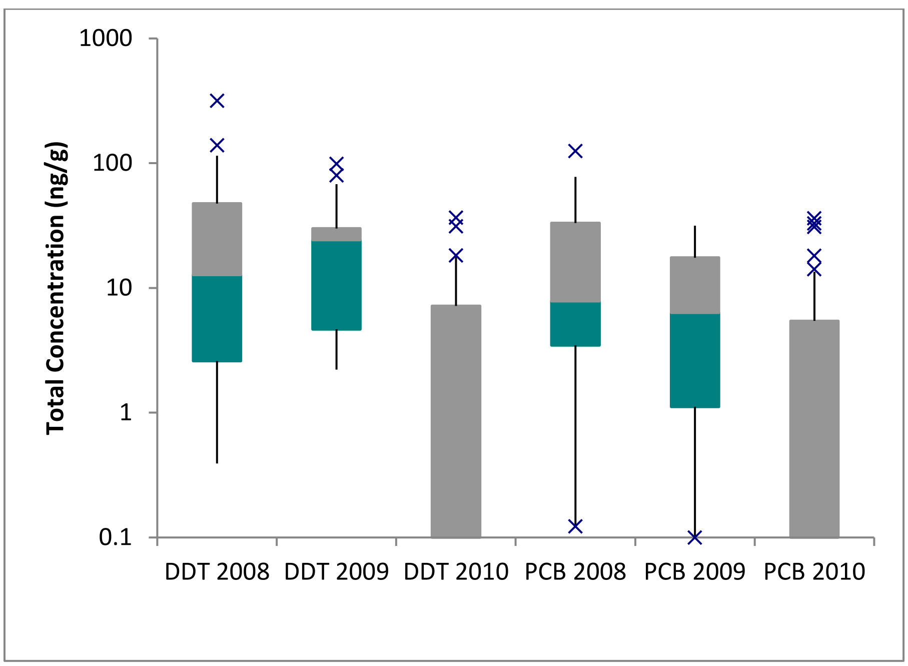

Figure 10. Total DDT and PCB concentrations in urban watersheds at the 1 km scale. Boxes represent first and third quartiles, line represents median, and t-bars represent 95% confidence limits. Additional points are outliers.

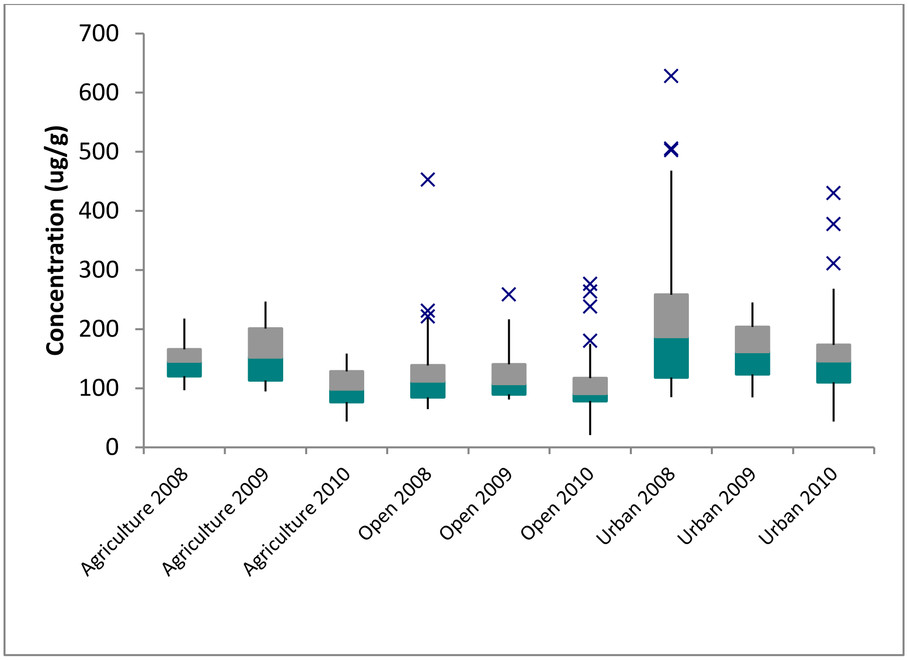

Figure 11. The sum of 4 metals concentrations (Cd, Cu, Pb and Zn) in all watershed types at the watershed scale. Boxes represent first and third quartiles, line represents median, and t-bars represent 95% confidence limits. Additional points are outliers.

Goal 3 – Collaboration with other Programs

SPoT complements the other SWAMP statewide monitoring programs: the Perennial Streams Assessment (PSA) program, the southern California Stormwater Monitoring Council (SMC), the San Francisco Bay area Regional Monitoring Coalition (RMC), and the bioaccumulation monitoring program of the Bioaccumulation Oversight Group (BOG). The PSA measures ecological endpoints related to wadeable streams statewide, and uses a probabilistic design to assess aquatic health. The PSA provides a baseline assessment of macroinvertebrate and algal communities in high quality streams, and provides direct evidence of aquatic life condition statewide. The SMC and RMC provide bioassessment data similar to the PSA, as well as toxicity and chemical contamination data. The BOG program measures contaminant concentrations in sport fish collected on a rotating basis from streams, lakes and coastal waters. 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 contributes to the attainment of 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 might be found 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.

Relationships between SPoT Indicators and 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 (reviewed in 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.

An abbreviated data set was assembled from the SWAMP Bioassessment Reporting Module with the assistance of the SWAMP Data Management Team. 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. While a number of the bioassessment samples were collected from the same coordinates as the SPoT stations, bioassessment samples that were collected within 15km upstream of the SPoT stations were included in order to provide a minimally sufficient dataset for correlation analysis. Data from eighteen stations were extracted from the SWAMP Reporting Module, and data from an additional eight SMC stations were provided by that program. Samples were compiled from 2008, 2009, and 2010, to correspond with the first three SPoT sampling years. 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. Correlations were conducted between toxicity and chemistry results and individual Index of Biological Integrity (IBI) scores calculated for each sample. The Northern California IBI calculator was applied to samples from northern California stations and to one northern station in the Santa Cruz area of the central coast region. The southern California IBI calculator was applied to the remaining central California and SMC samples. In addition to the IBI, several additional macroinvertebrate metrics were included in the correlations. All correlations were conducted using the Spearman Rank procedure described above.

Amphipod survival in laboratory tests was significantly correlated with the number of amphipods in the field samples and with the number of crustacea (Table 13). Sample sizes for these analyses were limited to 10 and 15, respectively. There was not a strong correlation between amphipod survival in laboratory sediment tests and the IBI at sites sampled within the same sampling year ($p = 0.081$; Table 13). A scatter diagram of these data demonstrate that amphipod survival in 79% of the corresponding SPoT stations were not toxic (Figure 12). IBI scores from the non toxic samples ranged from 0 to 54, but the IBI scores for the toxic and highly toxic samples ranged from 6 to 16. Most of the IBI scores in this dataset were less than or equal to 30, and therefore represent degraded macroinvertebrate communities. This suggests that additional factors beyond those that affect amphipod survival in acute laboratory toxicity tests are influencing macroinvertebrates at these sites. We note that when the northern California IBI calculator was used for the central California stations, amphipod survival in laboratory toxicity tests was significantly correlated with the IBI ($P = 0.043$; data not shown). These data also indicated weak negative correlations between amphipods and crustacea in the field samples and selected contaminants measured in the SPoT sediment samples, including metal concentrations in sediments and PAHs in sediments (crustacea only). The Ephemeroptera/Plecoptera/Trichoptera index indicates the relative densities of mayflies (ephemeroptera), stoneflies (plecoptera), and caddis flies (trichoptera), which represent three insect groups considered to be sensitive indicators of water quality. The EPT index and EPT taxa score were negatively correlated with percent fines in the sediments. Interestingly, while amphipod survival in laboratory tests were significantly correlated with the concentrations of pyrethroid pesticides in the SPoT samples (Table 6, above), none of the BMI metrics were correlated with these pesticides.

Previous California studies have demonstrated significant correlations between sediment and water toxicity in laboratory tests and macroinvertebrate community impacts. 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). It should be noted that the physical habitat data in the SWAMP/PSA and SMC datasets were not compiled in time for this analysis, so correlations between the various BMI metrics and habitat characteristics were not possible at the time of this report. These data are now being compiled. 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. It is anticipated that as SPoT, SWAMP/PSA, and SMC monitoring proceeds, the number of samples available for these correlations will grow. SPoT staff will continue to coordinate with SWAMP and other regional monitoring groups to build on these datasets. This will provide increased statistical power for assessing relationships between SPoT water quality indicators and stream ecological indicators to facilitate identification of the likely stressors causing degradation of California watersheds.

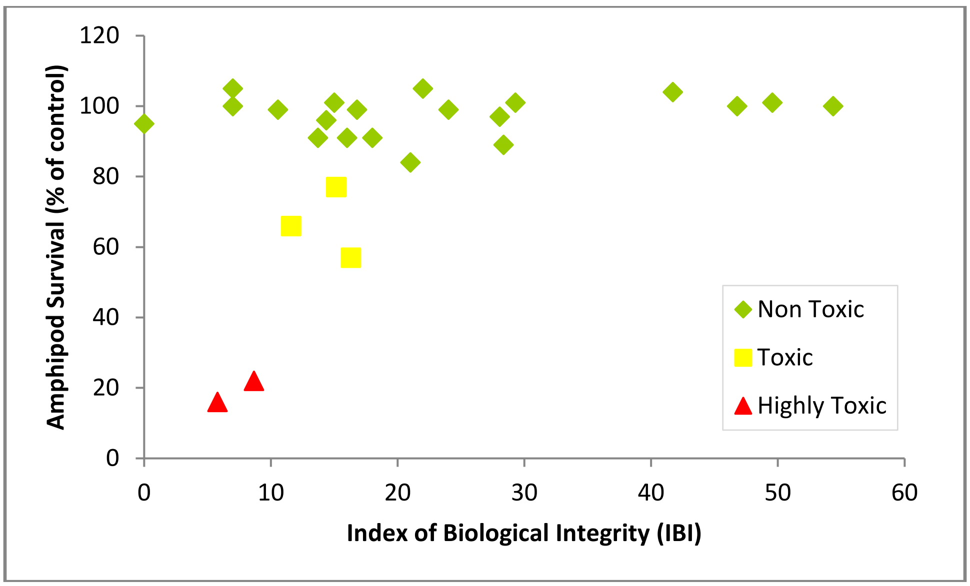

Figure 12. Relationship between amphipod survival in sediment toxicity tests and benthic macroinvertebrate IBI scores. IBI scores were calculated from field bioassessment data from 23 sites assessed during SWAMP and SMC monitoring conducted during 2008, 2009, and 2010, and corresponded to SPoT amphipod sediment toxicity tests conducted at the same or proximate stations during these three years. Amphipod survival is presented as a percentage of the respective control sample survival value.

Table 15. Results of Spearman Rank correlations between parameters measured by SPoT in samples collected from 2008 – 2010 and benthic macroinvertebrate community metrics measured as part of SWAMP/PSA and SMC monitoring during this same period. Statistically significant correlations are indicated by “PC” (positive correlation) or “NC" (negative correlation). *Amphipod survival depicts control-normalized survival of *Hyalella azteca* in SPoT 10d laboratory toxicity tests.

Analyte	Correlation & Sample Size	IBI Score	Sum Individuals	EPT Index (%)	EPT Taxa Score	*Amphipoda %*	*Crustacea %*	*Chironomidae %*	*Mollusca %*	*Oligochaeta %*	Shannon Diversity	Simpsons Index	Taxonomic Richness
Amphipod Survival*	Prob.	0.081	0.915	0.711	0.467	0.049 PC	0.006 PC	0.051	0.568	0.520	0.088	0.138	0.587
	N	25	26	17	25	10 PC	15 PC	17	16	18	18	18	18
Pyrethroids	Prob.	0.204	0.086	0.883	0.502	0.216	0.415	0.179	0.557	0.136	0.890	0.964	0.236
	N	25	26	17	25	10	15	17	16	18	18	18	18
DDT	Prob.	0.712	0.681	0.126	0.288	0.275	0.519	0.254	0.754	0.539	0.100	0.261	0.329
	N	25	26	17	25	10	15	17	16	18	18	18	18
PAH	Prob.	0.017 PC	0.082	0.645	0.079	0.895	0.044 NC	0.760	0.350	0.069	0.911	0.823	0.207
	N	10 PC	10	7	9	4	7 NC	7	7	8	8	8	8
PBDE	Prob.	0.840	0.534	0.645	0.409	0.368	0.057	0.036 PC	0.078	0.414	0.257	0.204	0.713
	N	10	10	7	9	4	7	7 PC	7	8	8	8	8
PCB	Prob.	0.443	0.075	0.274	0.454	0.211	0.101	0.598	0.197	0.009 NC	0.223	0.473	0.732
	N	25	26	17	25	10	15	17	16	18 NC	18	18	18
Metals 8	Prob.	0.921	0.995	0.282	0.439	0.032 NC	0.021 NC	0.229	0.118	0.218	0.489	0.913	0.773
	N	25	26	17	25	10 NC	15 NC	17	16	18	18	18	18
Metals 4	Prob.	0.978	0.447	0.293	0.523	0.813	0.286	0.726	0.087	0.059	0.663	0.906	0.829
	N	25	26	17	25	10	15	17	16	18	18	18	18
TOC %	Prob.	0.815	0.095	0.790	0.937	0.960	0.089	0.551	0.565	0.156	0.723	0.958	0.097
	N	25	26	17	25	10	15	17	16	18	18	18	18
Fines %	Prob.	0.675	0.688	0.024 NC	0.016 NC	0.866	0.488	0.350	0.823	0.935	0.005 NC	0.009 PC	0.172
	N	25	26	17 NC	25 NC	10	15	17	16	18	18 NC	18 PC	18

SPoT and the Integrated Report Process

SPoT was specifically designed to provide data that can inform regulatory programs and conservation initiatives. SPoT data can be incorporated directly into 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 (LOE) process used to evaluate sites for inclusion in regional 303(d) lists of degraded water bodies.

The following summary describes how SPoT 2008 data were used in the 2012 Integrated Report cycle (personal communication, Nancy Kapellas, SWRCB, OIMA unit). During data solicitation for the 2012 Integrated Report (IR), the SWAMP Data Management Team sent State Board staff the most current SWAMP data since the last listing cycle (it is intended that data will come from CEDEN for the next assessment cycle). The SPoT data being assessed for the 2012 assessment cycle is from April – October of 2008 (i.e., permanent data). Subsequent SPoT data will be assessed in the next IR assessment cycle (2014). Before the data were assessed, SPoT sample locations were plotted and then associated with specific water bodies. SPoT data are then used to develop specific Lines of Evidence for determination of water body impairment. Approximately half of the pollutants in the SPoT data set are run through the electronic LOE Processor (eLEP). This processor takes data spreadsheets and generates LOEs that are then uploaded into the SWRCB's California Water Quality Assessment (CalWQA) database. The SPoT LOEs to be generated by eLEP are for metals and selected organic pollutants in sediment. The eLEP LOEs have yet to be generated for most of Regions, but, as an example, Region 6 has 127 eLEP generated LOEs from the SPoT data set. The remaining pollutant LOEs are being developed manually by State Board staff, generally because their assessment is too complicated for the eLEP process. The SPoT manually-generated LOEs are for additional pollutants in sediment, including some that require summation (DDT, chlordane, PCBs, etc), as well as sediment toxicity. Statewide, there are about 189 manually generated LOEs from the SPoT data set. The Regional Board staff then review and comment on the manually created LOEs and the State Board staff respond to Regional Board staff comments. The LOEs are then revised, as needed. This process is now taking place for the 2008 SPoT dataset. Regional Board staff will use all the LOEs to make Decision Recommendations in the CalWQA database (anticipated to begin in January 2013), which recommend whether the assessed pollutant should or should not be listed for the water body. The public review process and subsequent list making decisions between State and Regional Board staffs then proceeds.

Eight SPoT sites are located in priority watersheds for the U.S. EPA Measure W program (also known as the Watershed Improvement Measure (WIM) or SP-12). 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.

Discussion

This report summarizes results of three years of SPoT monitoring from sites representing 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 combined with toxicity testing allow an initial 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 an initial indication of how land use affects water quality.

The short-term trends (three years) indicate increasing detections and concentrations of certain contaminants in many of the state's largest watersheds, and reduced concentrations of other contaminant classes. Increased contamination often coincided with increased sediment toxicity, and toxicity and contamination were particularly correlated with urbanization in these watersheds. The following discussion emphasizes the most obvious trends observed by SPoT from 2008 through 2010 and relates these patterns to the primary goals of the program.

Trends in Chemicals of Concern

Although this report describes data for 2008 through 2010, the 2009 SPoT program year monitored only about 25% of the program sites. As such, the 2009 data may not be reflective of statewide trends. Taken together however, the three years of data provide a snapshot of short term trends in contamination and toxicity. The data show a statewide decrease or no change in several classes of organic chemicals, including legacy organic chemicals like DDT and PCBs. Patterns for PBDEs in urban watersheds indicate little change in these chemicals over the three years. Use of these 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 urban watersheds. Concentrations of PAHs and metals in sediments were largely unchanged between 2008 and 2010.

The data also demonstrate that detections and concentrations of the current use pyrethroid pesticides are increasing in California watersheds. While the data do not show an increase in the incidence of sediment toxicity in California watersheds when testing is conducted at the standard protocol temperature (average statewide incidence of toxicity = 27.7% in tests conducted at 23 °C from 2008 - 2010), the incidence of toxicity greatly increased in 2010 at 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 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. 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 photostable pyrethroids (e.g., bifenthrin) may persist for over a year, the potential for chronic impacts of these pesticides on California watersheds are also likely under-estimated by SPoT results. MPSL is comparing the relative sensitivities of the 10-day and 28-day *H. azteca* protocols as part of an effort by the Central Valley Regional Water Quality Control Board to develop sediment quality criteria for bifenthrin. The results of these experiments will be used to determine whether the longer-term protocol is appropriate for future SPoT monitoring.

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 TIE studies showed that the majority of toxicity was associated with pesticides, specifically organophosphate and pyrethroid pesticides. The current SPoT results corroborate these findings. Hunt et al. (2012) found that sediment toxicity in SPoT watersheds was highly correlated with pyrethroid concentrations in sediment, and similar correlations were found in 2010 (current report). 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 will be prioritized for inclusion in the SPoT analyte list as the program's monitoring proceeds. For example, recent regional monitoring has suggested an increase in the detection of the phenylpyrazole insecticide fipronil 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 has been recommended by the SPoT Scientific Review Committee for statewide monitoring starting in 2013.

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 were always 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 and affect wildlife or exceed human health advisory guidelines for fish consumption (Davis et al., 2010). Continued monitoring of organochlorines by SPoT will document trends in this important class of organic chemicals. Concentrations of metals in sediments were relatively stable during the last three 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.

Pollutant Associations with Land Cover

Correlations of SPoT contamination and toxicity data with data from the National Land Cover Database continue to show strong associations between contamination, urbanization and impervious surface cover in California watersheds. This was true for both organic chemicals and metals. One exception was DDT, which was more highly correlated with agriculture land uses in 2010. As was observed by Hunt et al. (2012), there were strong correlations between urban land use and sediment toxicity in California watersheds, and strong correlations were observed at all three watershed scales. Similar relationships were observed between toxicity and measures of impervious surface. Sediment toxicity was also highly correlated with agriculture land uses in the 2010 SPoT dataset.

Hunt et al. (2012) noted two potential confounding factors that are not considered in the interpretation of how data from the NLCD could influence associated watersheds. These are the effects of dams on sediment transport in SPoT watersheds, and the specific contribution of point and non-point source pollution to contamination monitored at SPoT sites. Because the majority of rivers in California have dams, and these impede sediment transport, this likely influences the hydrologic connectivity between upstream sources of contaminants and downstream depositional areas where SPoT stations are located. The influence of dams was considered in the selection of SPoT sites, but the influence of dams was not considered in the GIS analyses of the drainage areas to the sites: land cover in drainage areas was considered equally whether or not a dam was present. Hunt et al. (2012) noted that this likely played a role in land cover influences on a watershed scale, but had less of an impact on the 1 and 5km drainage area scales. In addition, the influence of point source and non-point source discharges on contaminant loading and toxicity at different scales in SPoT watersheds was not considered in the current assessment.

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 U.S. EPA and the California Department of Pesticide Regulation (CDPR) have recently initiated reviews of pyrethroid pesticide registrations and CDPR is currently developing use restrictions for pyrethroid pesticides used by pest control businesses in urban settings (Personal Communication, John Sanders, CDPR). CDPR also plans on following urban restrictions with regulations to address agricultural use of pyrethroids affecting surface water quality. The U.S. EPA also is 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). Incorporation of Low Impact Development practices on future construction projects are being required throughout the state, and these coincide with revised storm water discharge rules as part of the municipal stormwater (MS4) NPDES permitting. In addition to restrictions on pounds of active ingredients applied per acre and number of applications per crop, use restrictions typically involve recommendations for vegetated buffer zones and setbacks to limit the potential for off-field transport of pesticides in spray drift, irrigation and stormwater runoff. Management actions that incorporate pesticide use restrictions and on-farm practices to reduce and treat runoff will be incorporated into irrigated lands programs on the Central Coast. Based on SPoT coverage of 50 major hydrologic units, 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.

A preliminary assessment of the relationship between water quality indicators measured by SPoT and watershed ecological indicators measured by SWAMP and SMC benthic macroinvertebrate bioassessment programs showed a significant correlation between amphipod survival in laboratory toxicity tests and two stream BMI metrics, the percentage of stream amphipods and crustacea. It is anticipated that as more BMI data are incorporated into the SWAMP and SMC databases, a more detailed assessment of these relationships will be investigated in future SPoT reports. These statistical relationships provide hypotheses for assessing causal relationships between in-stream ecological degradation measured in SWAMP and SMC monitoring and toxicity and chemical stressors measured by SPoT.

Recommendations for SPoT Monitoring in 2013

This report summarizes results of three years of statewide monitoring, and these data have been presented to the SPoT Scientific Review Committee and the SWAMP Round Table participants. Based on these discussions, we recommend the following for the 2013 monitoring year:

1) Continue evaluation of SPoT base station representativeness – In addition to continuing the long-term trend monitoring at the SPoT base stations, continue to evaluate spatial variability at the intensively sampled stations. Incorporate site specific data on non-point and point source pollution at these sites to ascertain how these features may affect contamination and toxicity results.
2) Revise the SPoT analyte list to add fipronil and its three primary degradates (fipronil sulfone, fipronil desulfinyl, fipronil sulfide) as emerging chemicals of concern for monitoring at urban (Tier II) watershed stations.
3) Discontinue comparison of sieved and unsieved metals, and analyze metals in unsieved sediment only.
4) Consider relative incidence of acute and chronic toxicity at a subset of SPoT stations by comparing results of the 10-day *H. azteca* toxicity test protocol to the 28-day protocol.
5) Develop more comprehensive databases to explore statistical relationships between SPoT chemical and toxicity indicators and SWAMP and SMC ecological indicators.

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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 2009-2010 Station Information

Station Code	Station Name	Sample Date	Latitude	Longitude	Coordination
103SMHSAR	Smith River at Sarina Road	15/Oct/2008	41.91357	-124.17160	None Specified
105KLAMKK	Klamath River at Kamp Klamath	15/Oct/2008	41.51695	-124.03893	None Specified
109MAD101	Mad River upstream Hwy 101	15/Oct/2008	40.91770	-124.08811	None Specified
111EELFRN	Eel River at Fernbridge	15/Oct/2008	40.61213	-124.20457	None Specified
111EELMYR	S Fork Eel River at Meyers Flat	14/Oct/2008	40.26266	-123.87965	None Specified
113NAVDMC	Fork Navarro River at Dimmick	14/Oct/2008	39.15703	-123.63474	None Specified
114LAGMIR	Laguna de Santa Rosa at Mirabel	14/Oct/2008	38.49385	-122.89214	None Specified
114RRAXRV	Russian River at Alexander RV Park	14/Oct/2008	38.65888	-122.83305	None Specified
114RRDSDM	Russian River downstream Duncan Mills	14/Oct/2008	38.44797	-123.05640	None Specified
201LAG125	Lagunitas Creek at Coast Guard Station	13/Aug/2008	38.07038	-122.79876	Reg Bd
201WLK160	Walker Creek at WC Ranch	18/Jun/2008	38.17584	-122.81949	Reg Bd
204ALA020	Alameda Creek E. of Alvarado Blvd	17/Jun/2008	37.58049	-122.05260	R2 MRP
204SLE030	San Leandro Creek at Empire Road	17/Jun/2008	37.72838	-122.18818	R2 MRP
204SMA020	San Mateo Creek at Gateway Park	18/Jun/2008	37.56951	-122.31669	R2 MRP
205COY060	Coyote Creek at Montague	17/Jun/2008	37.39601	-121.91512	R2 MRP
205GUA020	Guadalupe Creek at USGS Gaging Station	17/Jun/2008	37.37553	-121.93266	R2 MRP
207KIR020	Kirker Creek at Floodway	17/Jun/2008	38.01658	-121.83883	R2 MRP
207LAU020	Laurel Creek at Pintail Drive	17/Jun/2008	38.24836	-122.00650	R2 MRP
207WAL020	Walnut Creek at Concord Ave O.C.	17/Jun/2008	37.98082	-122.05154	R2 MRP
304SOKxxx	Soquel Creek at Knob Hill	21/Jul/2008	36.97930	-121.95690	Reg Bd
305THUxxx	Pajaro River at Thurwachter Bridge	21/Jul/2008	36.87917	-121.79364	Reg Bd
307CMLxxx	Carmel River at Hwy 1	17/Jun/2008	36.53561	-121.91145	Reg Bd
309DAVxxx	Salinas River at Davis Road	17/Jun/2008	36.64606	-121.70135	R3 CMP
309TDWxxx	Tembladero Slough at Monterey Dunes Way	21/Jul/2008	36.77142	-121.78652	R3 CMP
310ARGxxx	Arroyo Grande Creek at 22nd Street	11/Jun/2008	35.09517	-120.61145	Reg Bd
310SLBxxx	San Luis Obispo Creek at San Luis Bay Drive	11/Jun/2008	35.18826	-120.71879	Reg Bd
312SMAxxx	Santa Maria River at Estuary	11/Jun/2008	34.96145	-120.64115	R3 CMP
313SAIxxx	San Antonio Creek at San Antonio Rd West	10/Jun/2008	34.78239	-120.53015	Reg Bd
315ATAxxx	Atascadero Creek at Ward Dr	22/May/2008	34.42354	-119.81846	Reg Bd
315MISxxx	Mission Creek at Montecito St	10/Jun/2008	34.41376	-119.69544	Reg Bd
402VRB0xx	Ventura River at Hwy 101 Campground	19/May/2008	34.28270	-119.30864	SMC
403STCBQU	Santa Clara River at Bouquet Creek	19/May/2008	34.42403	-118.53811	None Specified
403STCEST	Santa Clara River at Estuary	19/May/2008	34.23597	-119.21704	None Specified
403STCSSP	Sespe Creek at Hwy 126	22/May/2008	34.39312	-118.94227	None Specified
404BLNAxx	Ballona Creek at Sawtelle	20/May/2008	33.98659	-118.41575	SMC
405SGRA2x	San Gabriel River RA-2	20/May/2008	33.79036	-118.09195	SMC
408CAL006	Calleguas Creek At Hwy 1	19/May/2008	34.16538	-119.06118	SMC
504BCHROS	Big Chico Creek at Rose Ave	30/Jun/2008	39.72704	-121.86348	Regional
504SACHMN	Sacramento River at Hamilton City	30/Jun/2008	39.75071	-121.99632	Regional

Station Code	Station Name	Sample Date	Latitude	Longitude	Coordination
508SACBLF	Sacramento River at Balls Ferry	30/Jun/2008	40.41690	-122.19377	Regional
510LSAC08	Sacramento River at Hood	16/Jul/2008	38.38330	-121.51926	Regional
511CAC113	Cache Creek at Hwy 113	20/Aug/2008	38.72078	-121.76482	Regional
515SACKNK	Sacramento Slough at Karnak	16/Jul/2008	38.78443	-121.65344	Regional
515YBAMVL	Yuba River at Maryville	19/Aug/2008	39.13393	-121.59273	Regional
519AMNDVY	American River at Discovery Park	16/Jul/2008	38.59910	-121.50709	Regional
519BERBRY	Bear River at Berry Road	19/Aug/2008	38.95440	-121.55126	Regional
519FTRNCS	Feather River at Nicolaus	19/Aug/2008	38.89898	-121.58805	Regional
520BUTEMR	Butte Slough at Meridian	19/Aug/2008	39.17024	-121.90069	Regional
520CBDKLD	Colusa Basin Drain at Knights Landing	20/Aug/2008	38.80077	-121.72352	Regional
520SACLSA	Sacramento River at Colusa	19/Aug/2008	39.21457	-122.00016	Regional
526P00008	Pit River at Pittville Bridge	30/Jun/2008	41.04513	-121.33258	Reg Bd
531SAC001	Cosumnes River at Twin Cities Road	22/Jul/2008	38.29075	-121.37574	Reg Bd
532CAL004	Mokelumne River at Hwy 49	22/Jul/2008	38.31222	-120.72120	None Specified
535MER007	Bear Creek near Bert Crane Road	23/Jul/2008	37.25620	-120.65187	R5 ILP
535MER546	Merced River at River Road	23/Jul/2008	37.35024	-120.96220	R5 ILP
535STC206	Dry Creek at La Loma Road	22/Jul/2008	37.64395	-120.98420	R5 ILP
535STC210	Tuolumne River at Old LaGrange Bridge	22/Jul/2008	37.66599	-120.46205	Regional
535STC504	San Joaquin River at Crows Landing	16/Jul/2008	37.43324	-121.01756	Reg Bd
541MER522	San Joaquin River at Lander Avenue	16/Jul/2008	37.29522	-120.85146 R5	R5 ILP
541MER531	Salt Slough at Lander Avenue	23/Jul/2008	37.24764	-120.85235 R5	R5 ILP
541MER542	Mud Slough downstream of San Luis Drain	23/Jul/2008	37.26333	-120.90613	Reg Bd
541SJC501	San Joaquin River at Airport Way	16/Jul/2008	37.67573	-121.26509	Reg Bd
541STC019	Orestimba Creek at River Road	22/Jul/2008	37.41402	-121.01556	R5 ILP
551LKI040	Fork Kings River	29/Apr/2008	36.25619	-119.85482	Reg Bd
554SKR010	S Fork Kern River at Fay Ranch Road	28/Apr/2008	35.67262	-118.28982	None Specified
558CCR010	Cross Creek at Road 60 and Hwy 99	29/Apr/2008	36.40368	-119.45497	Reg Bd
558PKC010	Packwood Creek at Road 68	29/Apr/2008	36.26852	-119.41846	Reg Bd
558TUR090	Tule River at Road	29/Apr/2008	36.08777	-119.42645	Reg Bd
603BSP002	Bishop Creek at East Line St	17/Sep/2008	37.36234	-118.38637	None Specified
603LOWSED	Lower Owens River near mouth	17/Sep/2008	36.55967	-117.99298	None Specified
631WWK008	West Walker River at Topaz	23/Sep/2008	38.54677	-119.49496	Reg Bd
633WCRSED	West Fork Carson River at Paynesville	22/Sep/2008	38.80883	-119.77720	None Specified
634UTRSED	Upper Truckee River near inlet to Lake Tahoe	22/Sep/2008	38.93439	-120.00034	Other
635MARSED	Martis Creek near mouth	22/Sep/2008	39.30185	-120.12118	None Specified
635TRKSED	Lower Truckee River near CA/NV state line	22/Sep/2008	39.42285	-120.03366	None Specified
635TROSED	Trout Creek (Truckee) near mouth	22/Sep/2008	39.33049	-120.16854	None Specified
637SUS001	Susan River near Litchfield	22/Sep/2008	40.37743	-120.39532	Reg Bd
719CVSCOT	Coachella Valley Stormwater Channel Outlet	29/Oct/2008	33.52430	-116.07836	Reg Bd
723ARGRB1	Alamo River Outlet	28/Oct/2008	33.19896	-115.59727	Reg Bd
723NROTWM	New River Outlet	28/Oct/2008	33.10460	-115.66475	Reg Bd
801SARVRx	Santa Ana River at River Road	04/Jun/2008	33.92379	-117.59770	SMC
801SDCxxx	San Diego Creek at Campus	20/May/2008	20/May/2008	33.65641	SMC

Station Code	Station Name	Sample Date	Latitude	Longitude	Coordination
802SJCREF	San Jacinto River - Reference Site	04/Jun/2008	33.73648	-116.82622	USGS NAWQA
802SJRGxx	San Jacinto River at Goetz/TMDL Site	03/Jun/2008	33.75159	-117.22351	SMC
845SGRDRE	Tributary channel to San Gabriel River	20/May/2008	33.77352	-118.09769	SMC
901SJSJC9	San Juan Creek 9 at Mariner Drive	21/May/2008	33.48157	-117.67761	None Specified
902SSMR07	Santa Margarita at Basilone Road	21/May/2008	33.31108	-117.34616	None Specified
904CBAHC6	Agua Hedionda Creek at El Camino Real	21/May/2008	33.14992	-117.29649	None Specified
904ESCOxx	Escondido Creek at Camino del Norte	21/May/2008	33.04799	-117.22643	SMC
906LPSOL4	Los Penasquitos Creek 6 at Hwy 5	21/May/2008	32.90244	-117.22529	None Specified
907SDFRC2	Forrester Creek 2 at Carlton Hills Blvd	21/May/2008	32.83940	-116.99782	None Specified
911TJHRxx	Tijuana River at Hollister Rd	22/May/2008	32.55114	-117.08411	SMC

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

Appendix 3: Quality Assurance Information

Quality Assurance/Quality Control (QA/QC)

The data generated for this section were evaluated in the Statewide Stream Pollution Trends (SPoT) report and will be used to determine stream pollution trends for California. Thorough objectives for achieving quality data are outlined in the SWAMP Quality Assurance Program Plan (SWAMP, 2008). 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_2009, SWB_SPoT_Pilot_2010, and SWB_SPoT_2010 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 metal, mercury, selenium, total phosphorus as P, total organic carbon, grain size, organochlorine pesticide, organophosphate pesticide, pyrethroid pesticide, polybrominated diphenyl ether, polychlorinated biphenyl as congener (PCB), and aroclor, and *Hyalella azteca* toxicity test results from SPoT. Data were classified into one of the following classification levels:

Compliant

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.

Qualified

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.

Estimated

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 the 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 SWAMP method quality objectives 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, certified reference materials and relative percent difference (RPD) for field and laboratory duplicates for sediments are presented in Table A3.1.

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 91 batches with the exception of one TOC batch. These data were classified as qualified.

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 168 laboratory method blanks (including one metals filter blank) met the MQO, with the exception of one method blank in batches BBLabs_ENV2498_S_PAH and WPCL_L-654-727-10_BS625_S_OCH. Ten PAH analytes and one dieldrin were detected above the RL in the method blanks and were classified as “qualified” with regard to the SWAMP QAPrP MQO for laboratory blanks (Table A3.2).

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 with the exception of sample 906LPLPC6 in batches IIRMES_TO-01-029_S_OCH, IIRMES_TO-01-029_S_PAH, and IIRMES_TO-01-029_S_PCB. Surrogates were not added to the sample analyzed for organochlorine pesticides, polynuclear aromatic hydrocarbons, and polychlorinated biphenyls. All associated analytes in the field sample were classified as qualified with regard to the SWAMP QAPrP MQO for surrogates (Table A3.3).

All surrogate percent recoveries were within the acceptance criteria listed in Table A3.1, with the exception of surrogates spiked in samples analyzed for PAHs, PCBs and organochlorine pesticides (Table A3.4). The associated analytes in these samples were classified as qualified with regard to the SWAMP QAPrP MQO for surrogates.

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 (Table A3.1).

This process was repeated on the same native samples to create a laboratory fortified MSDs. 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. All batches met the frequency with the exception of one batch for pyrethroid pesticides. T his batch was classified as qualified (Table A3.5).

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 A3.6. 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. All batches met the frequency with the exception of 23 batches analyzed for various pesticides, PAHs, and PCBs. These batches were classified as qualified (Table A3.7).

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 A3.8. 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. Ten percent of the batches (9 out of 84 total batches) did not include DUPs performed at the required frequency. These included eight total phosphorus batches and one grain size batch, and were classified as qualified (Table A3.9).

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 A3.10.

Field Duplicates

Field duplicates are analyzed to assess field homogeneity and field sampling procedures. Field duplicates were sampled at 904ESCOxx in June 2009 and May 2010, 207LAU020 in June 2010, 504BCHRIV in August 2010, 633WCRSED and 103SMHSAR in October 2010, 558PKC001 in January 2011 and 551LKI041 in February 2011. Sediment duplicates were obtained from homogenized field samples.

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 A3.11. 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

Five percent of the results (1,778 out of 38,172 total results) were outside the SWAMP QAPrP MQOs for holding times (Table A3.12). Of the 1,778 results, 26 TOC results were classified as estimated since the holding time was exceeded by more than two times and 1752 metal, grain size and PCB results were classified as qualified due holding time exceedances. Sediment metal samples exceeded the 1-year holding time criteria until analysis. Sediment TOC and grain size exceeded the 28 day holding time criteria until analysis. Sediment pyrethroid and PCB samples exceeded the 1-year holding time criteria until extraction. Although data were classified as estimated and qualified it was considered usable for the intended purposes for this report.

QA/QC Summary

There were 38,172 sample results, including; field observations, integrated samples, and field duplicates and laboratory QA/QC samples. Of these:

- 22,644 (59%) were classified as “compliant”
- 14,810 (39%) were classified as “qualified”
- 26 (0.06%) were classified as “estimated”
- 248 (1%) were classified as “screening”
- 0 (0%) were classified as “rejected”; and
- 444 (1%) were classified as “NA”, since the field observation results were not verified and results were not reported by the laboratory due to matrix interferences or laboratory error (sample was lost) and could not be verified.

Classification of this dataset is summarized as follows:

- All data presented in Table A3.2 were classified as qualified due to analytes detected at or above the RL in the laboratory blanks.
- All data presented in Tables A3.3, A3.5, A3.7, and A3.9, and 10 was classified as qualified due to insufficient QC samples performed.
- All data presented in Table A3.6 were classified as qualified due to surrogate recovery exceedances.
- All data presented in Tables A3.8, A3.10, A3.11 were classified as qualified due to RPD exceedances.
- Results for samples presented in Table A3.12 were classified as qualified or estimated due to holding time exceedances.
- 407 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 A3.1. 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 A3.2. Laboratory method blanks in which analytes were detected above the RL.

Analyte	Result	Res Qual Code	MDL	RL	Analysis Date	Method Name	Laboratory	Batch ID
Biphenyl; Total; ng/g dw	0.29	=	0.150	0.150	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Naphthalenes, C2-; Total; ng/g dw	0.52	=	0.350	0.350	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Chrysene/Triphenylene; Total; ng/g dw	0.49	=	0.170	0.170	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Benz(a)anthracene; Total; ng/g dw	0.29	=	0.130	0.130	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Methylnaphthalene, 2-; Total; ng/g dw	0.26	=	0.200	0.200	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Naphthalene; Total; ng/g dw	0.32	=	0.170	0.170	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Naphthalenes, C3-; Total; ng/g dw	1.03	=	0.350	0.350	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Dimethylnaphthalene, 2,6-; Total; ng/g dw	0.25	=	0.200	0.200	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Phenanthrene; Total; ng/g dw	0.16	=	0.150	0.150	23-Feb-11	EPA 8270M	BBL	BBLabs_ENV2498_S_PAH
Dieldrin; Total; ng/g dw	0.934	=	0.604	0.699	24-Feb-11	EPA 8081BM	DFW-WPCL	WPCL_L-654-727-10_BS625_S_OCH

Table A3.3. Laboratory batches in which surrogates were not spiked.

Surrogate	Batch ID	Notes	Laboratory
Tetrachloro-m-xylene(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_OCH	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_PAH	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_PAH	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES
Phenanthrene-d10(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_PAH	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES
Acenaphthene-d10(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_PAH	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES
Perylene-d12(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_PAH	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES
PCB 198(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_PCB	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES
PCB 030(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_PCB	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES
PCB 112(Surrogate); Total; % recovery	IIRMES_TO-01-029_S_PCB	no surrogate spiked in sample 906LPLPC6	CSULB-IIRMES

Table A3.4. Surrogate recoveries that met quality control acceptance criteria.

Surrogate	Station Code	Sample Type	Batch ID	% Recovery	Laboratory
Tetrachloro-m-xylene(Surrogate); Total; % recovery	412LARWxx	Integrated	IIRMES_TO-01-029_S_OCH	43	CSULB-IIRMES
Tetrachloro-m-xylene(Surrogate); Total; % recovery	802SJCREF	Integrated	IIRMES_TO-01-029_S_OCH	36	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	404BLNAxx	Integrated	IIRMES_TO-01-029_S_PAH	38	CSULB-IIRMES
Acenaphthene-d10(Surrogate); Total; % recovery	405SGRA2x	Integrated	IIRMES_TO-01-029_S_PAH	25	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	405SGRA2x	Integrated	IIRMES_TO-01-029_S_PAH	19	CSULB-IIRMES
Acenaphthene-d10(Surrogate); Total; % recovery	412LARWxx	Integrated	IIRMES_TO-01-029_S_PAH	35	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	412LARWxx	Integrated	IIRMES_TO-01-029_S_PAH	4	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	801SARVRx	Integrated	IIRMES_TO-01-029_S_PAH	22	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	905SDSDQ9	MS1	IIRMES_TO-01-029_S_PAH	17	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	905SDSDQ9	MS1	IIRMES_TO-01-029_S_PAH	38	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-029_S_PAH	48	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	310SLBxxx	Integrated	IIRMES_TO-01-073_S_PAH	43	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	310SLBxxx	Integrated	IIRMES_TO-01-073_S_PAH	42	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	313SAIxxx	Integrated	IIRMES_TO-01-073_S_PAH	48	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	541MER542	Integrated	IIRMES_TO-01-073_S_PAH	47	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	541MER542	Integrated	IIRMES_TO-01-073_S_PAH	0	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	541MERECY	Integrated	IIRMES_TO-01-073_S_PAH	41	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	541MERECY	Integrated	IIRMES_TO-01-073_S_PAH	31	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	541STC019	Integrated	IIRMES_TO-01-073_S_PAH	43	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	541STC019	Integrated	IIRMES_TO-01-073_S_PAH	3	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	541STC516	Integrated	IIRMES_TO-01-073_S_PAH	46	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	558PKC005	Integrated	IIRMES_TO-01-073_S_PAH	44	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	558PKC010	MS1	IIRMES_TO-01-073_S_PAH	49	CSULB-IIRMES
Perylene-d12(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-073_S_PAH	32	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	204SLE030	Integrated	IIRMES_TO-01-075_S_PAH	49	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	207LAU020	Integrated	IIRMES_TO-01-075_S_PAH	45	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	305THUxxx	Integrated	IIRMES_TO-01-075_S_PAH	46	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	309DAVxxx	Integrated	IIRMES_TO-01-075_S_PAH	29	CSULB-IIRMES
Acenaphthene-d10(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-075_S_PAH	33	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-075_S_PAH	0	CSULB-IIRMES
Perylene-d12(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-075_S_PAH	48	CSULB-IIRMES
Tetrachloro-m-xylene(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-117_S_OCH	22	CSULB-IIRMES

Surrogate	Station Code	Sample Type	Batch ID	% Recovery	Laboratory
Acenaphthene-d10(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-117_S_PAH	1	CSULB-IIRMES
Chrysene-d12(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-117_S_PAH	26	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-117_S_PAH	0	CSULB-IIRMES
Perylene-d12(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-117_S_PAH	19	CSULB-IIRMES
Phenanthrene-d10(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-117_S_PAH	23	CSULB-IIRMES
Acenaphthene-d10(Surrogate); Total; % recovery	111EELMYR	MS1	IIRMES_TO-01-123_S_PAH	46	CSULB-IIRMES
Acenaphthene-d10(Surrogate); Total; % recovery	111EELMYR	MS1	IIRMES_TO-01-123_S_PAH	48	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	111EELMYR	MS1	IIRMES_TO-01-123_S_PAH	49	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	111EELMYR	MS1	IIRMES_TO-01-123_S_PAH	36	CSULB-IIRMES
Perylene-d12(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-123_S_PAH	0	CSULB-IIRMES
PCB 030(Surrogate); Total; % recovery	114LAGWOH	Integrated	IIRMES_TO-01-123_S_PCB	34	CSULB-IIRMES
Perylene-d12(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-125_S_PAH	31	CSULB-IIRMES
DBCE(Surrogate); Total; % recovery	103SMHSAR	MS1	WPCL_L-024-717-09_BS569_S_OCH	41.8	CSULB-IIRMES
Tetrachloro-m-xylene(Surrogate); Total; % recovery	412LARWxx	Integrated	IIRMES_TO-01-029_S_OCH	43	CSULB-IIRMES
Tetrachloro-m-xylene(Surrogate); Total; % recovery	802SJCREF	Integrated	IIRMES_TO-01-029_S_OCH	36	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	404BLNAxx	Integrated	IIRMES_TO-01-029_S_PAH	38	CSULB-IIRMES
Acenaphthene-d10(Surrogate); Total; % recovery	405SGRA2x	Integrated	IIRMES_TO-01-029_S_PAH	25	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	405SGRA2x	Integrated	IIRMES_TO-01-029_S_PAH	19	CSULB-IIRMES
Acenaphthene-d10(Surrogate); Total; % recovery	412LARWxx	Integrated	IIRMES_TO-01-029_S_PAH	35	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	412LARWxx	Integrated	IIRMES_TO-01-029_S_PAH	4	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	801SARVRx	Integrated	IIRMES_TO-01-029_S_PAH	22	CSULB-IIRMES
Naphthalene-d8(Surrogate); Total; % recovery	905SDSDQ9	MS1	IIRMES_TO-01-029_S_PAH	17	CSULB-IIRMES
Perylene-d12(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-123_S_PAH	0	CSULB-IIRMES
PCB 030(Surrogate); Total; % recovery	114LAGWOH	Integrated	IIRMES_TO-01-123_S_PCB	34	CSULB-IIRMES
Perylene-d12(Surrogate); Total; % recovery	LABQA	LabBlank	IIRMES_TO-01-125_S_PAH	31	CSULB-IIRMES
DBCE(Surrogate); Total; % recovery	103SMHSAR	MS1	WPCL_L-024-717-09_BS569_S_OCH	41.8	CSULB-IIRMES

Table A3.5. Batches for which matrix spikes (MS) or matrix spike duplicates (MSD) were not run.

Analyte	Batch ID	Notes	Laboratory
Pyrethroid pesticides	WPCL_L-333-11_S_PYD	QAO: no MS/MSD	DFW-WPCL

Table A3.6. Matrix spikes (MS), matrix spike duplicates (MSD), percent recoveries (%R), and relative percent differences (RPD) that did not meet quality control acceptance criteria. Values with a "q" did not meet the quality control objective.

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Disulfoton; Total; ng/g dw	905SDSDQ9	24-May-10	**20q**	**21q**	5	IIRMES_TO-01-029_S_OP	CSULB-IIRMES
Phorate; Total; ng/g dw	905SDSDQ9	24-May-10	**43q**	**39q**	8	IIRMES_TO-01-029_S_OP	CSULB-IIRMES
Acenaphthene; Total; ng/g dw	905SDSDQ9	24-May-10	61	85	**33q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Acenaphthylene; Total; ng/g dw	905SDSDQ9	24-May-10	**41q**	68	**50q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Anthracene; Total; ng/g dw	905SDSDQ9	24-May-10	60	78	**27q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Benzo(a)pyrene; Total; ng/g dw	905SDSDQ9	24-May-10	59	86	**37q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Biphenyl; Total; ng/g dw	905SDSDQ9	24-May-10	**40q**	56	**34q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Dibenz(a,h)anthracene; Total; ng/g dw	905SDSDQ9	24-May-10	78	103	**28q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Dibenzothiophene; Total; ng/g dw	905SDSDQ9	24-May-10	80	107	**29q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Dimethylnaphthalene, 2,6-; Total; ng/g dw	905SDSDQ9	24-May-10	**45q**	67	**40q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Fluoranthene; Total; ng/g dw	905SDSDQ9	24-May-10	94	124	**27q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Methylnaphthalene, 1-; Total; ng/g dw	905SDSDQ9	24-May-10	41	57	**32q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Methylnaphthalene, 2-; Total; ng/g dw	905SDSDQ9	24-May-10	**31q**	**46q**	**39q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Naphthalene; Total; ng/g dw	905SDSDQ9	24-May-10	**28q**	**43q**	**41q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Perylene; Total; ng/g dw	905SDSDQ9	24-May-10	61	79	**26q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Phenanthrene; Total; ng/g dw	905SDSDQ9	24-May-10	94	121	**26q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Pyrene; Total; ng/g dw	905SDSDQ9	24-May-10	97	126	**26q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
Trimethylnaphthalene, 2,3,5-; Total; ng/g dw	905SDSDQ9	24-May-10	71	96	**30q**	IIRMES_TO-01-029_S_PAH	CSULB-IIRMES
DDT(p,p'); Total; ng/g dw	558PKC010	23-Sep-10	**31q**	79	**32q**	IIRMES_TO-01-073_S_OCH	CSULB-IIRMES
Methoxychlor; Total; ng/g dw	558PKC010	23-Sep-10	**25q**	**25q**	0	IIRMES_TO-01-073_S_OCH	CSULB-IIRMES
Chlorpyrifos; Total; ng/g dw	558PKC010	23-Sep-10	71	**46q**	**41q**	IIRMES_TO-01-073_S_OP	CSULB-IIRMES
Demeton-s; Total; ng/g dw	558PKC010	23-Sep-10	**30q**	**41q**	**31q**	IIRMES_TO-01-073_S_OP	CSULB-IIRMES
Disulfoton; Total; ng/g dw	558PKC010	23-Sep-10	**16q**	**18q**	10	IIRMES_TO-01-073_S_OP	CSULB-IIRMES
Parathion, Methyl; Total; ng/g dw	558PKC010	23-Sep-10	84	63	**28q**	IIRMES_TO-01-073_S_OP	CSULB-IIRMES
Phorate; Total; ng/g dw	558PKC010	23-Sep-10	**10q**	**12q**	22	IIRMES_TO-01-073_S_OP	CSULB-IIRMES
Anthracene; Total; ng/g dw	558PKC010	23-Sep-10	**39q**	**40q**	1	IIRMES_TO-01-073_S_PAH	CSULB-IIRMES
Biphenyl; Total; ng/g dw	558PKC010	23-Sep-10	**46q**			IIRMES_TO-01-073_S_PAH	CSULB-IIRMES
Dimethylnaphthalene, 2,6-; Total; ng/g dw	558PKC010	23-Sep-10	**49q**			IIRMES_TO-01-073_S_PAH	CSULB-IIRMES
Methylnaphthalene, 2-; Total; ng/g dw	558PKC010	23-Sep-10	**47q**			IIRMES_TO-01-073_S_PAH	CSULB-IIRMES
Naphthalene; Total; ng/g dw	558PKC010	23-Sep-10			4	IIRMES_TO-01-073_S_PAH	CSULB-IIRMES

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
PCB 189; Total; ng/g dw	558PKC010	23-Sep-10	65	95	**38q**	IIRMES_TO-01-073_S_PCB	CSULB-IIRMES
PCB 194; Total; ng/g dw	558PKC010	23-Sep-10	66	105	**47q**	IIRMES_TO-01-073_S_PCB	CSULB-IIRMES
PCB 209; Total; ng/g dw	558PKC010	23-Sep-10	89	64	**32q**	IIRMES_TO-01-073_S_PCB	CSULB-IIRMES
Endrin Aldehyde; Total; ng/g dw	205COY060	30-Jun-10		**48q**	5	IIRMES_TO-01-075_S_OCH	CSULB-IIRMES
Methoxychlor; Total; ng/g dw	205COY060	30-Jun-10	**44q**	**39q**	11	IIRMES_TO-01-075_S_OCH	CSULB-IIRMES
Bolstar; Total; ng/g dw	205COY060	30-Jun-10	89	59	**40q**	IIRMES_TO-01-075_S_OP	CSULB-IIRMES
Disulfoton; Total; ng/g dw	205COY060	30-Jun-10	**44q**	**35q**	24	IIRMES_TO-01-075_S_OP	CSULB-IIRMES
Fenchlorphos; Total; ng/g dw	205COY060	30-Jun-10	77	54	**36q**	IIRMES_TO-01-075_S_OP	CSULB-IIRMES
Fenthion; Total; ng/g dw	205COY060	30-Jun-10	78	60	**26q**	IIRMES_TO-01-075_S_OP	CSULB-IIRMES
Phorate; Total; ng/g dw	205COY060	30-Jun-10	**16q**	**17q**	6	IIRMES_TO-01-075_S_OP	CSULB-IIRMES
Tokuthion; Total; ng/g dw	205COY060	30-Jun-10	86	54	**45q**	IIRMES_TO-01-075_S_OP	CSULB-IIRMES
Trichloronate; Total; ng/g dw	205COY060	30-Jun-10	74	53	**33q**	IIRMES_TO-01-075_S_OP	CSULB-IIRMES
Methylphenanthrene, 1-; Total; ng/g dw	205COY060	30-Jun-10	**48q**			IIRMES_TO-01-075_S_PAH	CSULB-IIRMES
PCB 081; Total; ng/g dw	205COY060	30-Jun-10	86	60	**36q**	IIRMES_TO-01-075_S_PCB	CSULB-IIRMES
PCB 099; Total; ng/g dw	205COY060	30-Jun-10	106	80	**28q**	IIRMES_TO-01-075_S_PCB	CSULB-IIRMES
PCB 123; Total; ng/g dw	205COY060	30-Jun-10	85	62	**32q**	IIRMES_TO-01-075_S_PCB	CSULB-IIRMES
PCB 149; Total; ng/g dw	205COY060	30-Jun-10	92	71	**26q**	IIRMES_TO-01-075_S_PCB	CSULB-IIRMES
Endrin Aldehyde; Total; ng/g dw	504BCHBID	18-Aug-10	**0q**	75	**200q**	IIRMES_TO-01-115_S_OCH	CSULB-IIRMES
Endrin; Total; ng/g dw	504BCHBID	18-Aug-10	110	141	**30q**	IIRMES_TO-01-115_S_OCH	CSULB-IIRMES
HCH, beta; Total; ng/g dw	504BCHBID	18-Aug-10	**37q**	**41q**	14	IIRMES_TO-01-115_S_OCH	CSULB-IIRMES
Perthane; Total; ng/g dw	504BCHBID	18-Aug-10	117	145	**26q**	IIRMES_TO-01-115_S_OCH	CSULB-IIRMES
Demeton-s; Total; ng/g dw	504BCHBID	18-Aug-10	**0q**	**0q**	0	IIRMES_TO-01-115_S_OP	CSULB-IIRMES
Dichlorvos; Total; ng/g dw	504BCHBID	18-Aug-10	106	**12**	**157q**	IIRMES_TO-01-115_S_OP	CSULB-IIRMES
Phorate; Total; ng/g dw	504BCHBID	18-Aug-10	**0**	**25**	**200q**	IIRMES_TO-01-115_S_OP	CSULB-IIRMES
Tetrachlorvinphos; Total; ng/g dw	504BCHBID	18-Aug-10	**160q**	**158q**	4	IIRMES_TO-01-115_S_OP	CSULB-IIRMES
DDT(o,p'); Total; ng/g dw	633WCRSED	06-Oct-10			23	IIRMES_TO-01-117_S_OCH	CSULB-IIRMES
DDT(p,p'); Total; ng/g dw	633WCRSED	06-Oct-10	**29q**	**21q**	**28q**	IIRMES_TO-01-117_S_OCH	CSULB-IIRMES
Endrin Aldehyde; Total; ng/g dw	633WCRSED	06-Oct-10		**47q**	8	IIRMES_TO-01-117_S_OCH	CSULB-IIRMES
HCH, beta; Total; ng/g dw	633WCRSED	06-Oct-10	**49q**			IIRMES_TO-01-117_S_OCH	CSULB-IIRMES
Heptachlor; Total; ng/g dw	633WCRSED	06-Oct-10	**63q**	**45q**	**29q**	IIRMES_TO-01-117_S_OCH	CSULB-IIRMES
Methoxychlor; Total; ng/g dw	633WCRSED	06-Oct-10	**30q**	**29q**	1	IIRMES_TO-01-117_S_OCH	CSULB-IIRMES
Bolstar; Total; ng/g dw	633WCRSED	06-Oct-10	**12q**	**0q**	0	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Chlorpyrifos; Total; ng/g dw	633WCRSED	06-Oct-10	**11q**	**6q**	**47q**	IIRMES_TO-01-117_S_OP	CSULB-IIRMES

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Demeton-s; Total; ng/g dw	633WCRSED	06-Oct-10	**36q**	**43q**	22	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Disulfoton; Total; ng/g dw	633WCRSED	06-Oct-10	**6q**	**7q**	22	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Fenchlorphos; Total; ng/g dw	633WCRSED	06-Oct-10	**49q**	**43q**	10	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Fensulfothion; Total; ng/g dw	633WCRSED	06-Oct-10		**35q**	**34q**	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Fenthion; Total; ng/g dw	633WCRSED	06-Oct-10	**44q**	**34q**	21	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Malathion; Total; ng/g dw	633WCRSED	06-Oct-10		**44q**	23	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Parathion, Methyl; Total; ng/g dw	633WCRSED	06-Oct-10		**48q**	**26q**	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Phorate; Total; ng/g dw	633WCRSED	06-Oct-10	**7q**	**5q**	**28q**	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Tokuthion; Total; ng/g dw	633WCRSED	06-Oct-10	**31q**	**21q**	**34q**	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Trichloronate; Total; ng/g dw	633WCRSED	06-Oct-10	**28q**	**19q**	**31q**	IIRMES_TO-01-117_S_OP	CSULB-IIRMES
Benzo(a)pyrene; Total; ng/g dw	633WCRSED	06-Oct-10		**42q**	15	IIRMES_TO-01-117_S_PAH	CSULB-IIRMES
Benzo(e)pyrene; Total; ng/g dw	633WCRSED	06-Oct-10		**45q**	19	IIRMES_TO-01-117_S_PAH	CSULB-IIRMES
Perylene; Total; ng/g dw	633WCRSED	06-Oct-10	**42q**	**36q**	12	IIRMES_TO-01-117_S_PAH	CSULB-IIRMES
Demeton-s; Total; ng/g dw	111EELMYR	20-Oct-10	**22q**	**22q**	1	IIRMES_TO-01-123_S_OP	CSULB-IIRMES
Disulfoton; Total; ng/g dw	111EELMYR	20-Oct-10	**34q**	**32q**	5	IIRMES_TO-01-123_S_OP	CSULB-IIRMES
Fenthion; Total; ng/g dw	111EELMYR	20-Oct-10	102	69	**38q**	IIRMES_TO-01-123_S_OP	CSULB-IIRMES
Mevinphos; Total; ng/g dw	111EELMYR	20-Oct-10	77	107	**33q**	IIRMES_TO-01-123_S_OP	CSULB-IIRMES
Phorate; Total; ng/g dw	111EELMYR	20-Oct-10	**7q**	**7q**	3	IIRMES_TO-01-123_S_OP	CSULB-IIRMES
Acenaphthene; Total; ng/g dw	111EELMYR	20-Oct-10	**42q**	**0q**	**200q**	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Acenaphthylene; Total; ng/g dw	111EELMYR	20-Oct-10	**37q**	**16q**	**80q**	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Biphenyl; Total; ng/g dw	111EELMYR	20-Oct-10	**19q**	**22q**	15	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Dimethylnaphthalene, 2,6-; Total; ng/g dw	111EELMYR	20-Oct-10	**13q**	**2q**	**200q**	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Methylnaphthalene, 1-; Total; ng/g dw	111EELMYR	20-Oct-10	**4q**	**21q**	**200q**	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Methylnaphthalene, 2-; Total; ng/g dw	111EELMYR	20-Oct-10	**0q**	**0q**	0	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Methylphenanthrene, 1-; Total; ng/g dw	111EELMYR	20-Oct-10	**48q**			IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Naphthalene; Total; ng/g dw	111EELMYR	20-Oct-10	**31q**	**13q**	**200q**	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Trimethylnaphthalene, 2,3,5-; Total; ng/g dw	111EELMYR	20-Oct-10	**29q**	**18q**	**48q**	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
PCB 003; Total; ng/g dw	111EELMYR	20-Oct-10	77	58	**27q**	IIRMES_TO-01-123_S_PCB	CSULB-IIRMES
PCB 008; Total; ng/g dw	111EELMYR	20-Oct-10	89	63	**34**	IIRMES_TO-01-123_S_PCB	CSULB-IIRMES
Demeton-s; Total; ng/g dw	114RRDSDM	21-Oct-10	**42q**	**41q**	0	IIRMES_TO-01-125_S_OP	CSULB-IIRMES
Phorate; Total; ng/g dw	114RRDSDM	21-Oct-10	**37q**	**38q**	4	IIRMES_TO-01-125_S_OP	CSULB-IIRMES
Trichloronate; Total; ng/g dw	114RRDSDM	21-Oct-10	**29q**	**31q**	6	IIRMES_TO-01-125_S_OP	CSULB-IIRMES
Benzo(a)pyrene; Total; ng/g dw	114RRDSDM	21-Oct-10	**46q**			IIRMES_TO-01-125_S_PAH	CSULB-IIRMES

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
PBDE 085; Total; ng/g dw	504BCHROS	18-Aug-10	99	74	**28q**	IIRMES_TO-01-125_S_PBDE	CSULB-IIRMES
Manganese; Total; mg/Kg dw	801SARVRx	25-May-10	70.2	100	**35.2q**	MPSL-DFG_2010Dig54_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	312SMAxxx	18-Aug-10	**93q**	**93.2q**	**38.2q**	MPSL-DFG_2011Dig03_S_TM	MPSL-DFW
Chromium; Total; mg/Kg dw	504SACHMN	18-Aug-10	92.5	**74.9q**	20.1	MPSL-DFG_2011Dig06_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	504SACHMN	18-Aug-10	97	75.1	**25.5q**	MPSL-DFG_2011Dig06_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	554SKR010	11-Aug-10	**69.4q**			MPSL-DFG_2011Dig07_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	628DEPSED	12-Aug-10	**63.8q**	**69.1q**	8.01	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	628DEPSED	12-Aug-10	97.4	**159q**	**48q**	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	508SACBLF	19-Aug-10	**73.2q**	**68.1q**	7.23	MPSL-DFG_2011Dig10_S_TM	MPSL-DFW
Zinc; Total; mg/Kg dw	508SACBLF	19-Aug-10		**74.1q**	1.39	MPSL-DFG_2011Dig10_S_TM	MPSL-DFW
Lead; Total; mg/Kg dw	519FTRNCS	24-Aug-10	127	98.8	**25.3q**	MPSL-DFG_2011Dig12_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	519FTRNCS	24-Aug-10	92.8	124	**28.9q**	MPSL-DFG_2011Dig12_S_TM	MPSL-DFW
Aldrin; Total; ng/g dw	103SMHSAR	15-Sep-09	**218q**	**206q**	6.1	WPCL_L-024-717-09_BS569_S_OCH	DFW-WPCL
Dieldrin; Total; ng/g dw	103SMHSAR	15-Sep-09	**160q**	**165q**	2.8	WPCL_L-024-717-09_BS569_S_OCH	DFW-WPCL
Oxychlordane; Total; ng/g dw	103SMHSAR	15-Sep-09	**165q**	**160q**	3.4	WPCL_L-024-717-09_BS569_S_OCH	DFW-WPCL
Tedion; Total; ng/g dw	103SMHSAR	15-Sep-09	**226q**	**206q**	9.9	WPCL_L-024-717-09_BS569_S_OCH	DFW-WPCL
PCB 008; Total; ng/g dw	103SMHSAR	15-Sep-09	70	101	**34q**	WPCL_L-024-717-09_BS569_S_PCB	DFW-WPCL
PCB 018; Total; ng/g dw	103SMHSAR	15-Sep-09	74.3	100	**28q**	WPCL_L-024-717-09_BS569_S_PCB	DFW-WPCL
Aldrin; Total; ng/g dw	309DAVxxx	16-Jun-09		**157q**	20	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Chlordane, cis-; Total; ng/g dw	309DAVxxx	16-Jun-09	96.5	85.8	**33q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Chlordane, trans-; Total; ng/g dw	309DAVxxx	16-Jun-09	93.2	91.2	**26q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDE(o,p'); Total; ng/g dw	309DAVxxx	16-Jun-09	96.6	83.3	**40q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDMU(p,p'); Total; ng/g dw	309DAVxxx	16-Jun-09	94.5	84.6	**37q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDT(o,p'); Total; ng/g dw	309DAVxxx	16-Jun-09	94.3	80.8	**34q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Endosulfan I; Total; ng/g dw	309DAVxxx	16-Jun-09	79.2	80.2	**36q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Endrin; Total; ng/g dw	309DAVxxx	16-Jun-09	80.7	83	**35q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
HCH, alpha ; Total; ng/g dw	309DAVxxx	16-Jun-09	83.1	80.4	**41q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
HCH, beta; Total; ng/g dw	309DAVxxx	16-Jun-09	77.8	74	**43q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
HCH, gamma; Total; ng/g dw	309DAVxxx	16-Jun-09	86	82.4	**42q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Heptachlor; Total; ng/g dw	309DAVxxx	16-Jun-09	65	65.1	**37q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Hexachlorobenzene; Total; ng/g dw	309DAVxxx	16-Jun-09	70.1	68.9	**37q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Methoxychlor; Total; ng/g dw	309DAVxxx	16-Jun-09	88.9	90.1	**37q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Mirex; Total; ng/g dw	309DAVxxx	16-Jun-09	75.8	74.9	**39q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
Nonachlor, cis-; Total; ng/g dw	309DAVxxx	16-Jun-09	85.7	88.8	**28q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Nonachlor, trans-; Total; ng/g dw	309DAVxxx	16-Jun-09	97	90	**32q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Oxadiazon; Total; ng/g dw	309DAVxxx	16-Jun-09	106	97	**39q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Tedion; Total; ng/g dw	309DAVxxx	16-Jun-09	**524q**	**463q**	**49q**	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
PBDE 017; Total; ng/g dw	309DAVxxx	16-Jun-09	75.7	77	**36q**	WPCL_L-717-09_BS570_S_PBDE	DFW-WPCL
PBDE 028; Total; ng/g dw	309DAVxxx	16-Jun-09	63.4	62.6	**39q**	WPCL_L-717-09_BS570_S_PBDE	DFW-WPCL
PBDE 066; Total; ng/g dw	309DAVxxx	16-Jun-09	66.7	71	**32q**	WPCL_L-717-09_BS570_S_PBDE	DFW-WPCL
PBDE 099; Total; ng/g dw	309DAVxxx	16-Jun-09	73.7	**323q**	**67q**	WPCL_L-717-09_BS570_S_PBDE	DFW-WPCL
PBDE 138; Total; ng/g dw	309DAVxxx	16-Jun-09	68.9	75.2	**29q**	WPCL_L-717-09_BS570_S_PBDE	DFW-WPCL
PBDE 183; Total; ng/g dw	309DAVxxx	16-Jun-09	80.8	85.6	**32q**	WPCL_L-717-09_BS570_S_PBDE	DFW-WPCL
PCB 008; Total; ng/g dw	309DAVxxx	16-Jun-09	89.6	89.1	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 018; Total; ng/g dw	309DAVxxx	16-Jun-09	91.9	91.2	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 027; Total; ng/g dw	309DAVxxx	16-Jun-09	92	92.3	**37q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 028; Total; ng/g dw	309DAVxxx	16-Jun-09	94.5	92.1	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 029; Total; ng/g dw	309DAVxxx	16-Jun-09	93.1	91.8	**39q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 031; Total; ng/g dw	309DAVxxx	16-Jun-09	95	93.7	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 033; Total; ng/g dw	309DAVxxx	16-Jun-09	99.3	97.6	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 044; Total; ng/g dw	309DAVxxx	16-Jun-09	101	97.6	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 049; Total; ng/g dw	309DAVxxx	16-Jun-09	92.5	92	**36q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 052; Total; ng/g dw	309DAVxxx	16-Jun-09	93.9	90.5	**36q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 056; Total; ng/g dw	309DAVxxx	16-Jun-09	96	94	**39**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 060; Total; ng/g dw	309DAVxxx	16-Jun-09	91	87.5	**41q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 064; Total; ng/g dw	309DAVxxx	16-Jun-09	90	87	**40q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 066; Total; ng/g dw	309DAVxxx	16-Jun-09	94.4	86.6	**44q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 070; Total; ng/g dw	309DAVxxx	16-Jun-09	93.3	85.6	**40q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 074; Total; ng/g dw	309DAVxxx	16-Jun-09	88.7	82	**43q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 077; Total; ng/g dw	309DAVxxx	16-Jun-09	89.8	89	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 087; Total; ng/g dw	309DAVxxx	16-Jun-09	92.9	92.3	**33q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 095; Total; ng/g dw	309DAVxxx	16-Jun-09	101	95.2	**35q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 097; Total; ng/g dw	309DAVxxx	16-Jun-09	96.4	95.8	**35q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 099; Total; ng/g dw	309DAVxxx	16-Jun-09	93.8	92.3	**35q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 101; Total; ng/g dw	309DAVxxx	16-Jun-09	98.7	98.5	**29q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 105; Total; ng/g dw	309DAVxxx	16-Jun-09	96.5	90.9	**37q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL

Analyte	Station Code	Sample Date	Lab Batch ID	MS %R	MSD %R	RPD	Laboratory
PCB 110; Total; ng/g dw	309DAVxxx	16-Jun-09	103	91.1	**35q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 114; Total; ng/g dw	309DAVxxx	16-Jun-09	86.8	85	**40q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 118; Total; ng/g dw	309DAVxxx	16-Jun-09	97.3	89.7	**35q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 126; Total; ng/g dw	309DAVxxx	16-Jun-09	89.8	84.9	**43q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 128; Total; ng/g dw	309DAVxxx	16-Jun-09	99.4	96.5	**37q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 137; Total; ng/g dw	309DAVxxx	16-Jun-09	94.2	88.6	**43q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 138; Total; ng/g dw	309DAVxxx	16-Jun-09	105	93.3	**36q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 141; Total; ng/g dw	309DAVxxx	16-Jun-09	91	88.3	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 146; Total; ng/g dw	309DAVxxx	16-Jun-09	91.7	87.1	**42q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 149; Total; ng/g dw	309DAVxxx	16-Jun-09	98.6	93.5	**34q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 151; Total; ng/g dw	309DAVxxx	16-Jun-09	91.7	86.1	**41q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 153; Total; ng/g dw	309DAVxxx	16-Jun-09	104	99.3	**32q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 156; Total; ng/g dw	309DAVxxx	16-Jun-09	95.8	82.8	**49q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 157; Total; ng/g dw	309DAVxxx	16-Jun-09	94.3	88.4	**44q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 158; Total; ng/g dw	309DAVxxx	16-Jun-09	92.4	83.8	**44q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 169; Total; ng/g dw	309DAVxxx	16-Jun-09	79.8	74.1	**45q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 170; Total; ng/g dw	309DAVxxx	16-Jun-09	96.5	85.2	**46q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 174; Total; ng/g dw	309DAVxxx	16-Jun-09	104	92.5	**45q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 177; Total; ng/g dw	309DAVxxx	16-Jun-09	102	91.2	**46q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 180; Total; ng/g dw	309DAVxxx	16-Jun-09	106	95.6	**39q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 183; Total; ng/g dw	309DAVxxx	16-Jun-09	96.1	93.1	**39q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 187; Total; ng/g dw	309DAVxxx	16-Jun-09	100	92.5	**40q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 189; Total; ng/g dw	309DAVxxx	16-Jun-09	101	93.7	**45q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 194; Total; ng/g dw	309DAVxxx	16-Jun-09	98.9	92.7	**41q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 195; Total; ng/g dw	309DAVxxx	16-Jun-09	95.5	92.8	**40q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 198/199; Total; ng/g dw	309DAVxxx	16-Jun-09	95.3	95.2	**38q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 200; Total; ng/g dw	309DAVxxx	16-Jun-09	93	97.2	**33q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 201; Total; ng/g dw	309DAVxxx	16-Jun-09	95.8	97.5	**32q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 203; Total; ng/g dw	309DAVxxx	16-Jun-09	106	101	**42q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 206; Total; ng/g dw	309DAVxxx	16-Jun-09	98	99.3	**35q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
PCB 209; Total; ng/g dw	309DAVxxx	16-Jun-09	94.6	98.5	**34q**	WPCL_L-717-09_BS570_S_PCB	DFW-WPCL
Arsenic; Total; mg/Kg dw	901S45253	18-May-10		**130q**	10.14	MPSL-DFG_2010Dig53_S_TM	MPSL-DFW
Endrin; Total; ng/g dw	723ARDP3A	06-Oct-10		**154q**	5.5	WPCL_L-654-727-10_BS625_S_OCH	DFW-WPCL

Table A3.7. Batches for which certified reference material (CRM) or laboratory control spike (LCS) samples were not run.

Analyte	Batch ID	Notes	Laboratory
Organochlorine pesticides	IIRMES_TO-01-029_S_OCH	QAO: not all compounds in CRM - no LCS	CSULB-IIRMES
Organophosphorus pesticides	IIRMES_TO-01-029_S_OP	QAO: no CRM or LCS	CSULB-IIRMES
Polynuclear Aromatic Hydrocarbons	IIRMES_TO-01-029_S_PAH	QAO: no CRM or LCS	CSULB-IIRMES
Polybrominated Diphenyl Ethers	IIRMES_TO-01-029_S_PBDE	QAO: no CRM or LCS	CSULB-IIRMES
Polychlorinated Biphenyls	IIRMES_TO-01-029_S_PCB	QAO: not all compounds in CRM - no LCS	CSULB-IIRMES
Organochlorine pesticides	IIRMES_TO-01-073_S_OCH	QAO: no CRM or LCS	CSULB-IIRMES
Organophosphorus pesticides	IIRMES_TO-01-073_S_OP	QAO: no CRM or LCS	CSULB-IIRMES
Polynuclear Aromatic Hydrocarbons	IIRMES_TO-01-073_S_PAH	QAO: no CRM or LCS	CSULB-IIRMES
Polychlorinated Biphenyls	IIRMES_TO-01-073_S_PCB	QAO: no CRM or LCS	CSULB-IIRMES
Organochlorine pesticides	IIRMES_TO-01-075_S_OCH	QAO: no CRM or LCS for some analytes	CSULB-IIRMES
Organophosphorus pesticides	IIRMES_TO-01-075_S_OP	QAO: no CRM or LCS	CSULB-IIRMES
Polynuclear Aromatic Hydrocarbons	IIRMES_TO-01-075_S_PAH	QAO: no CRM or LCS for acenapthylene or dibenzothiophene	CSULB-IIRMES
Polybrominated Diphenyl Ethers	IIRMES_TO-01-075_S_PBDE	QAO: no CRM or LCS	CSULB-IIRMES
Polychlorinated Biphenyls	IIRMES_TO-01-075_S_PCB	QAO: not all spiked in CRM no LCS analyzed for missing analytes	CSULB-IIRMES
Organochlorine pesticides	IIRMES_TO-01-115_S_OCH	QAO: no CRM or LCS for some compounds	CSULB-IIRMES
Organophosphorus pesticides	IIRMES_TO-01-115_S_OP	QAO: no CRM or LCS	CSULB-IIRMES
Polychlorinated Biphenyls	IIRMES_TO-01-115_S_PCB	QAO: not all spiked in CRM no LCS analyzed for missing analytes	CSULB-IIRMES
Organochlorine pesticides	IIRMES_TO-01-117_S_OCH	QAO: no CRM or LCS for some compounds	CSULB-IIRMES
Organophosphorus pesticides	IIRMES_TO-01-117_S_OP	QAO: no CRM or LCS	CSULB-IIRMES
Polynuclear Aromatic Hydrocarbons	IIRMES_TO-01-117_S_PAH	QAO: no CRM or LCS for acenapthylene or 2,3,5-Trimethylnaphthalene	CSULB-IIRMES
Polychlorinated Biphenyls	IIRMES_TO-01-117_S_PCB	QAO: not all spiked in CRM no LCS analyzed for missing analytes	CSULB-IIRMES
Organochlorine pesticides	IIRMES_TO-01-123_S_OCH	QAO: no CRM or LCS for some compounds	CSULB-IIRMES
Organophosphorus pesticides	IIRMES_TO-01-123_S_OP	QAO: no CRM or LCS	CSULB-IIRMES
Polynuclear Aromatic Hydrocarbons	IIRMES_TO-01-123_S_PAH	QAO: no CRM or LCS for acenapthylene or 2,3,5-Trimethylnaphthalene	CSULB-IIRMES
Polychlorinated Biphenyls	IIRMES_TO-01-123_S_PCB	QAO: not all spiked in CRM no LCS analyzed for missing analytes	CSULB-IIRMES
Organochlorine pesticides	IIRMES_TO-01-125_S_OCH	QAO: no CRM or LCS for some compounds	CSULB-IIRMES
Organophosphorus pesticides	IIRMES_TO-01-125_S_OP	QAO: no CRM or LCS	CSULB-IIRMES
Polynuclear Aromatic Hydrocarbons	IIRMES_TO-01-125_S_PAH	QAO: no CRM or LCS for acenapthylene or 2,3,5-Trimethylnaphthalene	CSULB-IIRMES
Polybrominated Diphenyl Ethers	IIRMES_TO-01-125_S_PBDE	QAO: no CRM or LCS	CSULB-IIRMES
Organochlorine pesticides	WPCL_L-717-09_BS570_S_OCH	QAO: changed BT code to LST more appropriate, no LCS for compounds that were lost	CSULB-IIRMES

Analyte	Batch ID	Notes	Laboratory
Polybrominated Diphenyl Ethers	WPCL_L-717-09_BS570_S_PBDE	QAO: no CRM or LCS	CSULB-IIRMES

Table A3.8. Batches containing certified reference material (CRM) or laboratory control spike (LCS) that did not meet quality control acceptance criteria.

Analyte	Station Code	Batch ID	% Recovery	Laboratory
DDD(p,p'); Total; ng/g dw	3534-CRM1	IIRMES_TO-01-029_S_OCH	66	CSULB-IIRMES
Hexachlorobenzene; Total; ng/g dw	3534-CRM1	IIRMES_TO-01-029_S_OCH	172	CSULB-IIRMES
Benzo(g,h,i)perylene; Total; ng/g dw	3534-CRM1	IIRMES_TO-01-029_S_PAH	68	CSULB-IIRMES
Chrysene; Total; ng/g dw	3534-CRM1	IIRMES_TO-01-029_S_PAH	133	CSULB-IIRMES
Dibenz(a,h)anthracene; Total; ng/g dw	3534-CRM1	IIRMES_TO-01-029_S_PAH	134	CSULB-IIRMES
PCB 066; Total; ng/g dw	3534-CRM1	IIRMES_TO-01-029_S_PCB	0	CSULB-IIRMES
DDD(p,p'); Total; ng/g dw	3535-CRM1	IIRMES_TO-01-075_S_OCH	64	CSULB-IIRMES
DDE(p,p'); Total; ng/g dw	3535-CRM1	IIRMES_TO-01-075_S_OCH	138	CSULB-IIRMES
DDT(p,p'); Total; ng/g dw	3535-CRM1	IIRMES_TO-01-075_S_OCH	0	CSULB-IIRMES
Benzo(g,h,i)perylene; Total; ng/g dw	3535-CRM1	IIRMES_TO-01-075_S_PAH	66	CSULB-IIRMES
PCB 066; Total; ng/g dw	3535-CRM1	IIRMES_TO-01-075_S_PCB	0	CSULB-IIRMES
PCB 195; Total; ng/g dw	2502-CRM1	IIRMES_TO-01-115_S_PCB	0	CSULB-IIRMES
Hexachlorobenzene; Total; ng/g dw	3487-CRM1	IIRMES_TO-01-123_S_OCH	0	CSULB-IIRMES
Acenaphthene; Total; ng/g dw	3487-CRM1	IIRMES_TO-01-123_S_PAH	46	CSULB-IIRMES
Dibenz(a,h)anthracene; Total; ng/g dw	3487-CRM1	IIRMES_TO-01-123_S_PAH	132	CSULB-IIRMES
Zinc; Total; mg/Kg dw	srm 1646a 16	MPSL-DFG_2010Dig75_S_TM	70.1	MPSL-DFW
Zinc; Total; mg/Kg dw	srm 1646a 16	MPSL-DFG_2011Dig03_S_TM	67	MPSL-DFW
Zinc; Total; mg/Kg dw	srm 1646a 16	MPSL-DFG_2011Dig06_S_TM	73.6	MPSL-DFW
Zinc; Total; mg/Kg dw	srm 1646a 17	MPSL-DFG_2011Dig07_S_TM	74	MPSL-DFW
Aluminum; Total; mg/Kg dw	srm pacs2 97	MPSL-DFG_2011Dig08_S_TM	46	MPSL-DFW
DDT(p,p'); Total; ng/g dw	L-717-09-SRM 1944-BS 569	WPCL_L-024-717-09_BS569_S_OCH	160	DFW-WPCL
Resmethrin; Total; ng/g dw	L-333-11-LCSD	WPCL_L-333-11_S_PYD	46	DFW-WPCL
Chlordane, trans-; Total; ng/g dw	L-654-10-SRM 1944-BS 625	WPCL_L-654-727-10_BS625_S_OCH	264	DFW-WPCL
DDT(p,p'); Total; ng/g dw	L-654-10-SRM 1944-BS 625	WPCL_L-654-727-10_BS625_S_OCH	145	DFW-WPCL
PCB 018; Total; ng/g dw	L-654-10-SRM 1944-BS 625	WPCL_L-654-727-10_BS625_S_PCB	145	DFW-WPCL
PCB 028; Total; ng/g dw	L-654-10-SRM 1944-BS 625	WPCL_L-654-727-10_BS625_S_PCB	156	DFW-WPCL
PCB 049; Total; ng/g dw	L-654-10-SRM 1944-BS 625	WPCL_L-654-727-10_BS625_S_PCB	138	DFW-WPCL
PCB 099; Total; ng/g dw	L-654-10-SRM 1944-BS 625	WPCL_L-654-727-10_BS625_S_PCB	69.6	DFW-WPCL

Analyte	Station Code	Batch ID	% Recovery	Laboratory
PCB 170; Total; ng/g dw	L-654-10-SRM 1944-BS 625	WPCL_L-654-727-10_BS625_S_PCB	59.7	DFW-WPCL
Acenaphthene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	37.4	DFW-WPCL
Anthracene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	47.1	DFW-WPCL
Benz(a)anthracene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	46.2	DFW-WPCL
Benzo(a)pyrene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	47.6	DFW-WPCL
Benzo(b)fluoranthene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	59.6	DFW-WPCL
Benzo(e)pyrene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	57.3	DFW-WPCL
Benzo(k)fluoranthene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	51.1	DFW-WPCL
Biphenyl; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	44.7	DFW-WPCL
Chrysene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	52.9	DFW-WPCL
Fluoranthene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	66.8	DFW-WPCL
Fluorene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	36.8	DFW-WPCL
Naphthalene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	51.7	DFW-WPCL
Perylene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	46.1	DFW-WPCL
Phenanthrene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	67.6	DFW-WPCL
Pyrene; Total; ng/g dw	L-669-09-SRM 1944-BS 590	WPCL_L-669-717-09_BS590_S_PAH	57.1	DFW-WPCL
Chlordane, trans-; Total; ng/g dw	L-717-09-SRM 1944-BS 570	WPCL_L-717-09_BS570_S_OCH	246	DFW-WPCL
DDT(p,p'); Total; ng/g dw	L-717-09-SRM 1944-BS 570	WPCL_L-717-09_BS570_S_OCH	146	DFW-WPCL
Hexachlorobenzene; Total; ng/g dw	L-717-09-SRM 1944-BS 570	WPCL_L-717-09_BS570_S_OCH	57.9	DFW-WPCL
PCB 170; Total; ng/g dw	L-717-09-SRM 1944-BS 570	WPCL_L-717-09_BS570_S_PCB	59.3	DFW-WPCL

Table A3.9. Batches for which laboratory duplicates (DUP) were not run.

Analyte	Batch ID	Notes	Laboratory
Grain Size	IIRMES_GC01-043_S_GS	No Duplicate	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	CALSCI_10-09-1335a_S_PO4	No Duplicate	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	CALSCI_10-09-1335b_S_PO4	No Duplicate	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	CALSCI_10-09-1335c_S_PO4	No Duplicate	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	CALSCI_10-09-1335d_S_PO4	No Duplicate	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	CALSCI_10-11-0117_S_PO4	No Duplicate	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	CALSCI_10-11-0118_S_PO4	No Duplicate	CSULB-IIRMES
Phosphorus as P; Total; mg/Kg dw	CLS_5842_S_TPHOS	No Duplicate (LCS, LCSD performed)	CLS
Phosphorus as P; Total; mg/Kg dw	CLS_5843_S_TPHOS	No Duplicate (LCS, LCSD performed)	CLS

Table A3.10. Laboratory duplicate samples that did not meet quality control acceptance criteria.

Analyte	Station Code	Sample Date	Parent Value	Duplicate Value	RPD	Laboratory	Batch ID
Clay; <0.0039 mm; %	201WLK160	30-Jun-10	10.5	14.5	32	IIRMES_GC01-026_S_GS	CSULB-IIRMES
Sand; 0.0625 to <2.0 mm; %	201WLK160	30-Jun-10	52	38.6	30	IIRMES_GC01-026_S_GS	CSULB-IIRMES
Clay; <0.0039 mm; %	207WAL020	29-Jun-10	9	12.3	31	IIRMES_GC01-034_S_GS	CSULB-IIRMES
Clay; <0.0039 mm; %	541MERECY	08-Jul-10	19.4	15	26	IIRMES_GC01-034_S_GS	CSULB-IIRMES
Sand; 0.0625 to <2.0 mm; %	637SUS001	19-Aug-10	0.7	0.3	80	IIRMES_GC01-037_S_GS	CSULB-IIRMES
Total Organic Carbon; None; % dw	000NONPJ	18-Aug-10	1.5	0.85	55	IIRMES_GC01-045_S_TOC	CSULB-IIRMES
Clay; <0.0039 mm; %	504BCHBID	24-Feb-11	6.2	9	37	IIRMES_GC01-063_S_GS	CSULB-IIRMES
DDE(p,p'); Total; ng/g dw	558PKC010	23-Sep-10	10.3	7.4	33	IIRMES_TO-01-073_S_OCH	CSULB-IIRMES
Benz(a)anthracene; Total; ng/g dw	205COY060	30-Jun-10	9.9	12.8	26	IIRMES_TO-01-075_S_PAH	CSULB-IIRMES
Perylene; Total; ng/g dw	633WCRSED	06-Oct-10	7.8	10.3	28	IIRMES_TO-01-117_S_PAH	CSULB-IIRMES
Methylphenanthrene, 1-; Total; ng/g dw	111EELMYR	20-Oct-10	11.9	8.4	34	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Phenanthrene; Total; ng/g dw	111EELMYR	20-Oct-10	34.8	26.6	27	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Phenanthrene; Total; ng/g dw	114RRDSDM	21-Oct-10	11	7.8	34	IIRMES_TO-01-125_S_PAH	CSULB-IIRMES
PBDE 099; Total; ng/g dw	504BCHROS	18-Aug-10	2.02	1.46	32	IIRMES_TO-01-125_S_PBDE	CSULB-IIRMES
Cadmium; Total; mg/Kg dw	907S01434	13-May-09	0.27	0.2	31.8	MPSL-DFG_2009Dig24_S_TM	MPSL-DFW
Lead; Total; mg/Kg dw	907S01434	13-May-09	10.7	7.87	30.3	MPSL-DFG_2009Dig24_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	558PKC005	05-Jun-09	82564	57423	36	MPSL-DFG_2010Dig14_S_TM	MPSL-DFW
Arsenic; Total; mg/Kg dw	558PKC005	05-Jun-09	8.94	4.81	60.1	MPSL-DFG_2010Dig14_S_TM	MPSL-DFW
Chromium; Total; mg/Kg dw	558PKC005	05-Jun-09	69.8	39.1	56.4	MPSL-DFG_2010Dig14_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	558PKC005	05-Jun-09	0.28	0.42	40.8	MPSL-DFG_2010Dig14_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	723NROTWM	19-Oct-09	28557	37517	27.1	MPSL-DFG_2010Dig15_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	535STC501	15-May-09	0.24	0.39	49.5	MPSL-DFG_2010Dig19_S_TM	MPSL-DFW
Cadmium; Total; mg/Kg dw	801SARVRx	25-May-10	0.11	0.18	48	MPSL-DFG_2010Dig54_S_TM	MPSL-DFW
Cadmium; Total; mg/Kg dw	504BCHROS	18-Aug-10	0.12	0.2	54.5	MPSL-DFG_2010Dig75_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	312SMAxxx	18-Aug-10	0.2	0.42	69.7	MPSL-DFG_2011Dig03_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	504SACHMN	18-Aug-10	53970	20763	88.9	MPSL-DFG_2011Dig06_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	504SACHMN	18-Aug-10	458	316	36.7	MPSL-DFG_2011Dig06_S_TM	MPSL-DFW

Analyte	Station Code	Sample Date	Parent Value	Duplicate Value	RPD	Laboratory	Batch ID
Silver; Total; mg/Kg dw	504SACHMN	18-Aug-10	0.24	0.45	60.3	MPSL-DFG_2011Dig06_S_TM	MPSL-DFW
Cadmium; Total; mg/Kg dw	554SKR010	11-Aug-10	0.1	0.13	26	MPSL-DFG_2011Dig07_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	628DEPSED	12-Aug-10	43632	33817	25.3	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Arsenic; Total; mg/Kg dw	628DEPSED	12-Aug-10	5.16	2.26	33.8	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Chromium; Total; mg/Kg dw	628DEPSED	12-Aug-10	17.4	8.26	31.1	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Copper; Total; mg/Kg dw	628DEPSED	12-Aug-10	21.8	14.7	31.5	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	628DEPSED	12-Aug-10	1258	707	30	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Nickel; Total; mg/Kg dw	628DEPSED	12-Aug-10	11.4	7.4	30	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	508SACBLF	19-Aug-10	0.41	0.72	54.4	MPSL-DFG_2011Dig10_S_TM	MPSL-DFW
Chlordane, trans-; Total; ng/g dw	904ESCOxx	23-Jun-09	2.97	2.21	29	WPCL_L-024-717-09_BS569_S_OCH	DFW-WPCL
Oxadiazon; Total; ng/g dw	904ESCOxx	23-Jun-09	40.9	2.82	170	WPCL_L-024-717-09_BS569_S_OCH	DFW-WPCL
Bifenthrin; Total; ng/g dw	535STC501	08-Jul-10	0.848	1.14	29	WPCL_L-520-11_BS655_S_PYD	DFW-WPCL
Benzo(k)fluoranthene; Total; ng/g dw	904ESCOxx	23-Jun-09	18.9	14.5	26	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Dimethylnaphthalene, 2,6-; Total; ng/g dw	904ESCOxx	23-Jun-09	1.71	6.85	120	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Fluorenes, C1-; Total; ng/g dw	904ESCOxx	23-Jun-09	3.98	5.76	37	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Fluorenes, C3-; Total; ng/g dw	904ESCOxx	23-Jun-09	21.6	12.9	50	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Methylfluorene, 1-; Total; ng/g dw	904ESCOxx	23-Jun-09	1.1	1.47	29	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Naphthalenes, C2-; Total; ng/g dw	904ESCOxx	23-Jun-09	4	9.89	85	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Phenanthrene/Anthracene, C4-; Total; ng/g dw	904ESCOxx	23-Jun-09	7.97	12.3	43	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Chlordane, trans-; Total; ng/g dw	305THUxxx	16-Jun-09	3.88	3	26	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDE(o,p'); Total; ng/g dw	305THUxxx	16-Jun-09	5.3	4.01	28	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDE(p,p'); Total; ng/g dw	305THUxxx	16-Jun-09	209	154	30	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDMU(p,p'); Total; ng/g dw	305THUxxx	16-Jun-09	14.1	10.9	26	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDT(o,p'); Total; ng/g dw	305THUxxx	16-Jun-09	14	10.1	32	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDT(p,p'); Total; ng/g dw	305THUxxx	16-Jun-09	58.7	43.2	30	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Clay; <0.0039 mm; %	201WLK160	30-Jun-10	10.5	14.5	32	IIRMES_GC01-026_S_GS	CSULB-IIRMES
Sand; 0.0625 to <2.0 mm; %	201WLK160	30-Jun-10	52	38.6	30	IIRMES_GC01-026_S_GS	CSULB-IIRMES
Clay; <0.0039 mm; %	207WAL020	29-Jun-10	9	12.3	31	IIRMES_GC01-034_S_GS	CSULB-IIRMES

Analyte	Station Code	Sample Date	Parent Value	Duplicate Value	RPD	Laboratory	Batch ID
Clay; <0.0039 mm; %	541MERECY	08-Jul-10	19.4	15	26	IIRMES_GC01-034_S_GS	CSULB-IIRMES
Sand; 0.0625 to <2.0 mm; %	637SUS001	19-Aug-10	0.7	0.3	80	IIRMES_GC01-037_S_GS	CSULB-IIRMES
Total Organic Carbon; None; % dw	000NONPJ	18-Aug-10	1.5	0.85	55	IIRMES_GC01-045_S_TOC	CSULB-IIRMES
Clay; <0.0039 mm; %	504BCHBID	24-Feb-11	6.2	9	37	IIRMES_GC01-063_S_GS	CSULB-IIRMES
DDE(p,p'); Total; ng/g dw	558PKC010	23-Sep-10	10.3	7.4	33	IIRMES_TO-01-073_S_OCH	CSULB-IIRMES
Benz(a)anthracene; Total; ng/g dw	205COY060	30-Jun-10	9.9	12.8	26	IIRMES_TO-01-075_S_PAH	CSULB-IIRMES
Perylene; Total; ng/g dw	633WCRSED	06-Oct-10	7.8	10.3	28	IIRMES_TO-01-117_S_PAH	CSULB-IIRMES
Methylphenanthrene, 1-; Total; ng/g dw	111EELMYR	20-Oct-10	11.9	8.4	34	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Phenanthrene; Total; ng/g dw	111EELMYR	20-Oct-10	34.8	26.6	27	IIRMES_TO-01-123_S_PAH	CSULB-IIRMES
Phenanthrene; Total; ng/g dw	114RRDSDM	21-Oct-10	11	7.8	34	IIRMES_TO-01-125_S_PAH	CSULB-IIRMES
PBDE 099; Total; ng/g dw	504BCHROS	18-Aug-10	2.02	1.46	32	IIRMES_TO-01-125_S_PBDE	CSULB-IIRMES
Cadmium; Total; mg/Kg dw	907S01434	13-May-09	0.27	0.2	31.8	MPSL-DFG_2009Dig24_S_TM	MPSL-DFW
Lead; Total; mg/Kg dw	907S01434	13-May-09	10.7	7.87	30.3	MPSL-DFG_2009Dig24_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	558PKC005	05-Jun-09	82564	57423	36	MPSL-DFG_2010Dig14_S_TM	MPSL-DFW
Arsenic; Total; mg/Kg dw	558PKC005	05-Jun-09	8.94	4.81	60.1	MPSL-DFG_2010Dig14_S_TM	MPSL-DFW
Chromium; Total; mg/Kg dw	558PKC005	05-Jun-09	69.8	39.1	56.4	MPSL-DFG_2010Dig14_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	558PKC005	05-Jun-09	0.28	0.42	40.8	MPSL-DFG_2010Dig14_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	723NROTWM	19-Oct-09	28557	37517	27.1	MPSL-DFG_2010Dig15_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	535STC501	15-May-09	0.24	0.39	49.5	MPSL-DFG_2010Dig19_S_TM	MPSL-DFW
Cadmium; Total; mg/Kg dw	801SARVRx	25-May-10	0.11	0.18	48	MPSL-DFG_2010Dig54_S_TM	MPSL-DFW
Cadmium; Total; mg/Kg dw	504BCHROS	18-Aug-10	0.12	0.2	54.5	MPSL-DFG_2010Dig75_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	312SMAxxx	18-Aug-10	0.2	0.42	69.7	MPSL-DFG_2011Dig03_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	504SACHMN	18-Aug-10	53970	20763	88.9	MPSL-DFG_2011Dig06_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	504SACHMN	18-Aug-10	458	316	36.7	MPSL-DFG_2011Dig06_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	504SACHMN	18-Aug-10	0.24	0.45	60.3	MPSL-DFG_2011Dig06_S_TM	MPSL-DFW
Cadmium; Total; mg/Kg dw	554SKR010	11-Aug-10	0.1	0.13	26	MPSL-DFG_2011Dig07_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	628DEPSED	12-Aug-10	43632	33817	25.3	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Arsenic; Total; mg/Kg dw	628DEPSED	12-Aug-10	5.16	2.26	33.8	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW

Analyte	Station Code	Sample Date	Parent Value	Duplicate Value	RPD	Laboratory	Batch ID
Chromium; Total; mg/Kg dw	628DEPSED	12-Aug-10	17.4	8.26	31.1	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Copper; Total; mg/Kg dw	628DEPSED	12-Aug-10	21.8	14.7	31.5	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	628DEPSED	12-Aug-10	1258	707	30	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Nickel; Total; mg/Kg dw	628DEPSED	12-Aug-10	11.4	7.4	30	MPSL-DFG_2011Dig08_S_TM	MPSL-DFW
Silver; Total; mg/Kg dw	508SACBLF	19-Aug-10	0.41	0.72	54.4	MPSL-DFG_2011Dig10_S_TM	MPSL-DFW
Chlordane, trans-; Total; ng/g dw	904ESCOxx	23-Jun-09	2.97	2.21	29	WPCL_L-024-717-09_BS569_S_OCH	DFW-WPCL
Oxadiazon; Total; ng/g dw	904ESCOxx	23-Jun-09	40.9	2.82	170	WPCL_L-024-717-09_BS569_S_OCH	DFW-WPCL
Bifenthrin; Total; ng/g dw	535STC501	08-Jul-10	0.848	1.14	29	WPCL_L-520-11_BS655_S_PYD	DFW-WPCL
Benzo(k)fluoranthene; Total; ng/g dw	904ESCOxx	23-Jun-09	18.9	14.5	26	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Dimethylnaphthalene, 2,6-; Total; ng/g dw	904ESCOxx	23-Jun-09	1.71	6.85	120	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Fluorenes, C1-; Total; ng/g dw	904ESCOxx	23-Jun-09	3.98	5.76	37	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Fluorenes, C3-; Total; ng/g dw	904ESCOxx	23-Jun-09	21.6	12.9	50	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Methylfluorene, 1-; Total; ng/g dw	904ESCOxx	23-Jun-09	1.1	1.47	29	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Naphthalenes, C2-; Total; ng/g dw	904ESCOxx	23-Jun-09	4	9.89	85	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Phenanthrene/Anthracene, C4-; Total; ng/g dw	904ESCOxx	23-Jun-09	7.97	12.3	43	WPCL_L-669-717-09_BS590_S_PAH	DFW-WPCL
Chlordane, trans-; Total; ng/g dw	305THUxxx	16-Jun-09	3.88	3	26	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDE(o,p'); Total; ng/g dw	305THUxxx	16-Jun-09	5.3	4.01	28	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDE(p,p'); Total; ng/g dw	305THUxxx	16-Jun-09	209	154	30	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
DDMU(p,p'); Total; ng/g dw	305THUxxx	16-Jun-09	14.1	10.9	26	WPCL_L-717-09_BS570_S_OCH	DFW-WPCL
Aluminum; Total; mg/Kg dw	901S45253	18-May-10	45860	72098	44.5	MPSL-DFG_2010Dig53_S_TM	MPSL-DFW
Manganese; Total; mg/Kg dw	901S45253	18-May-10	1246	2439	64.7	MPSL-DFG_2010Dig53_S_TM	MPSL-DFW
Cadmium; Total; mg/Kg dw	904S01814	15-Jun-10	0.21	0.29	32	MPSL-DFG_2010Dig63_S_TM	MPSL-DFW
Aluminum; Total; mg/Kg dw	907S09286	15-Jun-10	36559	48440	27.95	MPSL-DFG_2010Dig60_S_TM	MPSL-DFW

Table A3.11. Field duplicate samples that did not meet quality control acceptance criteria.

Analyte	Station Code	Date	Field Sample	Field Duplicate	RPD	Laboratory
Aluminum; Total; mg/Kg dw	103SMHSAR	19-Oct-10	16954	12816	28	MPSL-DFW
Cadmium; Total; mg/Kg dw	103SMHSAR	19-Oct-10	0.13	0.23	56	MPSL-DFW
Mercury; Total; mg/Kg dw	103SMHSAR	19-Oct-10	0.07	0.095	30	MPSL-DFW
Phosphorus as P; Total; mg/Kg dw	103SMHSAR	19-Oct-10	260	1.1	198	CSULB-IIRMES
Silver; Total; mg/Kg dw	103SMHSAR	19-Oct-10	0.2	0.57	96	MPSL-DFW
Total Organic Carbon; None; % dw	103SMHSAR	19-Oct-10	3.14	1.62	64	CSULB-IIRMES
Copper; Total; mg/Kg dw	207LAU020	29-Jun-10	34	42.4	34	MPSL-DFW
Manganese; Total; mg/Kg dw	207LAU020	29-Jun-10	1477	1477	43	MPSL-DFW
Nickel; Total; mg/Kg dw	207LAU020	29-Jun-10	31.9	42.5	28	MPSL-DFW
Pyrene; Total; ng/g dw	207LAU020	29-Jun-10	7.8	10.4	29	CSULB-IIRMES
Zinc; Total; mg/Kg dw	207LAU020	29-Jun-10	154	154	47	MPSL-DFW
Total Organic Carbon; None; % dw	504BCHRIV	18-Aug-10	1.39	0.87	46	CSULB-IIRMES
Mercury; Total; mg/Kg dw	633WCRSED	06-Oct-10	0.022	0.034	43	MPSL-DFW
Chlordane, cis-; Total; ng/g dw	904ESCOxx	23-Jun-09	4.82	2.78	54	DFW-WPCL
Chlordane, trans-; Total; ng/g dw	904ESCOxx	23-Jun-09	5.28	2.97	56	DFW-WPCL
Nonachlor, trans-; Total; ng/g dw	904ESCOxx	23-Jun-09	5.01	3.28	42	DFW-WPCL
Oxadiazon; Total; ng/g dw	904ESCOxx	23-Jun-09	4.24	40.9	162	DFW-WPCL
Bifenthrin; Total; ng/g dw	904ESCOxx	24-May-10	13.9	28.9	70	DFW-WPCL
Permethrin, cis-; Total; ng/g dw	904ESCOxx	24-May-10	3.76	6.96	60	DFW-WPCL
Cadmium, Total mg/Kg dw	207LAU020	29/Jun/2010	0.16	0.28	55	MPSL-DFW
Chromium, Total mg/Kg dw	207LAU020	29/Jun/2010	39.3	51.8	27	MPSL-DFW
Copper, Total mg/Kg dw	207LAU020	29/Jun/2010	24.9	34	31	MPSL-DFW
Lead, Total mg/Kg dw	207LAU020	29/Jun/2010	13.6	17.8	27	MPSL-DFW
Manganese, Total mg/Kg dw	207LAU020	29/Jun/2010	632	1796	96	MPSL-DFW
Nickel, Total mg/Kg dw	207LAU020	29/Jun/2010	24.6	32.6	28	MPSL-DFW
Silver, Total mg/Kg dw	207LAU020	29/Jun/2010	0.21	0.3	35	MPSL-DFW
Zinc, Total mg/Kg dw	207LAU020	29/Jun/2010	80.8	115	35	MPSL-DFW
Cadmium, Total mg/Kg dw	904ESCOxx	24/May/2010	1.54	2.12	32	MPSL-DFW
Manganese, Total mg/Kg dw	904ESCOxx	24/May/2010	645	1460	77	MPSL-DFW
Silver, Total mg/Kg dw	904ESCOxx	24/May/2010	0.22	0.33	40	MPSL-DFW
Aluminum, Total mg/Kg dw	904ESCOxx	24/May/2010	71056	112269	45	MPSL-DFW
Arsenic, Total mg/Kg dw	904ESCOxx	24/May/2010	4.46	7.12	46	MPSL-DFW
Cadmium, Total mg/Kg dw	904ESCOxx	24/May/2010	1.68	2.5	39	MPSL-DFW
Chromium, Total mg/Kg dw	904ESCOxx	24/May/2010	26.0	37.3	36	MPSL-DFW
Manganese, Total mg/Kg dw	904ESCOxx	24/May/2010	593	959	47	MPSL-DFW
Nickel, Total mg/Kg dw	904ESCOxx	24/May/2010	12.6	18.9	40	MPSL-DFW
Silver, Total mg/Kg dw	904ESCOxx	24/May/2010	0.21	0.41	65	MPSL-DFW
Zinc, Total mg/Kg dw	904ESCOxx	24/May/2010	112	162	36	MPSL-DFW

Table A3.12. Samples that exceeded holding time, sampling date, and related analyte group.

Station	Sample Date	Analyte Group
103SMHSAR	15-Sep-09	Polychlorinated Biphenyls
103SMHSAR	15-Sep-09	Total Organic Carbon
103SMHSAR	19-Oct-10	Polybrominated Diphenyl Ethers
114LAGMIR	15-Sep-09	Polychlorinated Biphenyls
114LAGMIR	15-Sep-09	Total Organic Carbon
201LAG125	16-Jun-09	Polychlorinated Biphenyls
201LAG125	16-Jun-09	Total Organic Carbon
201LAG125	30-Jun-10	Pyrethroid Pesticides
201WLK160	30-Jun-10	Pyrethroid Pesticides
204ALA020	29-Jun-10	Pyrethroid Pesticides
204SLE030	29-Jun-10	Pyrethroid Pesticides
204SMA020	16-Jun-09	Polychlorinated Biphenyls
204SMA020	16-Jun-09	Total Organic Carbon
204SMA020	30-Jun-10	Pyrethroid Pesticides
205COY060	16-Jun-09	Polychlorinated Biphenyls
205COY060	16-Jun-09	Total Organic Carbon
205COY060	30-Jun-10	Pyrethroid Pesticides
205GUA020	30-Jun-10	Pyrethroid Pesticides
206SON010	29-Jun-10	Pyrethroid Pesticides
207KIR020	29-Jun-10	Pyrethroid Pesticides
207LAU020	29-Jun-10	Pyrethroid Pesticides
207WAL020	29-Jun-10	Pyrethroid Pesticides
304SOKxxx	02-Jul-10	Pyrethroid Pesticides
305THUxxx	16-Jun-09	Total Organic Carbon
305THUxxx	02-Jul-10	Pyrethroid Pesticides
307CMLxxx	02-Jul-10	Pyrethroid Pesticides
309DAVxxx	16-Jun-09	Total Organic Carbon
309DAVxxx	22-Jun-10	Pyrethroid Pesticides
309TDWxxx	21-Jun-10	Pyrethroid Pesticides
310ARGxxx	22-Jun-10	Pyrethroid Pesticides
310SLBxxx	21-Jun-10	Pyrethroid Pesticides
312SMAxxx	16-Jun-09	Total Organic Carbon
312SMAxxx	18-Aug-10	Pyrethroid Pesticides
313SAIxxx	21-Jun-10	Pyrethroid Pesticides
315ATAxxx	21-Jun-10	Pyrethroid Pesticides
315MISxxx	22-Jun-10	Pyrethroid Pesticides
402VRB0xx	27-May-10	Pyrethroid Pesticides
403STCBQT	26-May-10	Pyrethroid Pesticides
403STCEST	27-May-10	Pyrethroid Pesticides
403STCSSP	26-May-10	Pyrethroid Pesticides
404BLNAxx	24-Jun-09	Total Organic Carbon
405SGRA2x	26-May-10	Pyrethroid Pesticides
408CGCS06	24-Jun-09	Total Organic Carbon
408CGCS06	27-May-10	Pyrethroid Pesticides
412LARWxx	26-May-10	Pyrethroid Pesticides
504BCHBID	18-Aug-10	Pyrethroid Pesticides
504BCHNOR	18-Aug-10	Pyrethroid Pesticides
504BCHRIV	18-Aug-10	Pyrethroid Pesticides
504BCHROS	18-Aug-10	Pyrethroid Pesticides
504SACHMN	18-Aug-10	Pyrethroid Pesticides
508SACBLF	19-Aug-10	Pyrethroid Pesticides
510LSAC08	25-Aug-10	Pyrethroid Pesticides
511CAC113	24-Aug-10	Pyrethroid Pesticides
515SACKNK	24-Aug-10	Pyrethroid Pesticides
515YBAMVL	14-Sep-09	Total Organic Carbon
515YBAMVL	24-Aug-10	Pyrethroid Pesticides

Station	Sample Date	Analyte Group
519AMNDVY	14-Sep-09	Total Organic Carbon
519AMNDVY	25-Aug-10	Pyrethroid Pesticides
519BERBRY	24-Aug-10	Pyrethroid Pesticides
519FTRNCS	24-Aug-10	Pyrethroid Pesticides
520BUTPAS	24-Aug-10	Pyrethroid Pesticides
520CBDKLU	24-Aug-10	Pyrethroid Pesticides
526PRFALR	19-Aug-10	Pyrethroid Pesticides
531SAC001	01-Sep-10	Pyrethroid Pesticides
532AMA002	01-Sep-10	Pyrethroid Pesticides
535MER007	01-Sep-10	Pyrethroid Pesticides
535MER546	01-Sep-10	Pyrethroid Pesticides
535STC206	01-Sep-10	Pyrethroid Pesticides
535STC210	01-Sep-10	Pyrethroid Pesticides
535STC501	15-May-09	Total Metals
535STC501	15-May-09	Grain Size
535STC501	15-May-09	Organophosphorus Pesticides
535STC501	15-May-09	Total Organic Carbon
535STC501	15-May-09	Total Metals
535STC501	08-Jul-10	Pyrethroid Pesticides
535STC504	01-Sep-10	Pyrethroid Pesticides
541MER522	01-Sep-10	Pyrethroid Pesticides
541MER542	08-Jul-10	Pyrethroid Pesticides
541MERECY	08-Jul-10	Pyrethroid Pesticides
541SJC501	01-Sep-10	Pyrethroid Pesticides
541STC019	08-Jul-10	Pyrethroid Pesticides
541STC516	08-Jul-10	Pyrethroid Pesticides
544SAC002	01-Sep-10	Pyrethroid Pesticides
554SKR010	11-Aug-10	Pyrethroid Pesticides
558PKC005	05-Jun-09	Organophosphorus Pesticides
558PKC005	05-Jun-09	Organophosphorus Pesticides
558PKC005	05-Jun-09	Total Organic Carbon
628DEPSED	12-Aug-10	Pyrethroid Pesticides
637SUS001	14-Sep-09	Total Organic Carbon
637SUS001	19-Aug-10	Pyrethroid Pesticides
719CVSCOT	20-Oct-09	Total Organic Carbon
723ARGRB1	19-Oct-09	Total Organic Carbon
723NROTWM	19-Oct-09	Total Organic Carbon
801CCPT12	25-May-10	Pyrethroid Pesticides
801SARVRx	25-May-10	Pyrethroid Pesticides
801SDCxxx	24-Jun-09	Total Organic Carbon
801SDCxxx	26-May-10	Pyrethroid Pesticides
802SJCREF	24-Jun-09	Total Organic Carbon
802SJCREF	25-May-10	Pyrethroid Pesticides
901SJSJC9	24-May-10	Pyrethroid Pesticides
902SSMR07	23-Jun-09	Total Organic Carbon
902SSMR07	24-May-10	Pyrethroid Pesticides
904ESCOxx	23-Jun-09	Polychlorinated Biphenyls
904ESCOxx	23-Jun-09	Total Organic Carbon
904ESCOxx	24-May-10	Pyrethroid Pesticides
905SDSDQ9	24-May-10	Pyrethroid Pesticides
906LPLPC6	25-May-10	Pyrethroid Pesticides
907SDRWAR	23-Jun-09	Total Organic Carbon
907SDRWAR	25-May-10	Pyrethroid Pesticides
911TJHRxx	25-May-10	Pyrethroid Pesticides