Los Angeles River Watershed Monitoring Program

2010 Annual Report

Council for Watershed Health

Prepared by:

The Council for Watershed Health
700 N. Alameda Street
Los Angeles, CA 90012

Aquatic Bioassay & Consulting Laboratories
29 N Olive St
Ventura, CA 93001

Acknowledgements

The Los Angeles River Watershed Monitoring Program (LARWMP) was funded and conducted by a number of public agencies and private nonprofit entities working in the watershed. These participants contributed staff time, laboratory analyses, and funding in a collaborative effort that included representatives from regulated, regulatory, environmental, and research organizations. A majority of the funding was provided by the Cities of Los Angeles and Burbank and the Los Angeles County Department of Public Works.

Agencies and Organizations
Arroyo Seco Foundation
City of Burbank
City of Downey
City of Los Angeles
Friends of the Los Angeles River
Los Angeles County Department of Public Works
Los Angeles Regional Water Quality Control Board
Los Angeles & San Gabriel Rivers Watershed Council
San Gabriel Mountains and Rivers Conservancy
Southern California Coastal Water Research Project
U.S. Environmental Protection Agency (USEPA)
U.S. Forest Service
Aquatic Bioassay and Consulting Laboratories
Brock Bernstein Consultant

Table of Contents

List of Acronyms **8**

Executive Summary **10**

Introduction **15**

Methods **14**

Program Quality Assurance **19**

Question 1. What is the condition of streams in the Los Angeles Watershed? **23**

Aquatic Chemistry **23**

Toxicity **32**

Bioassessment **34**

Physical Habitat Assessments and CRAM **44**

Relationships among Chemical, Toxicological, Physical and Biotic Conditions **47**

Chapter Summary **51**

Question 2. Are conditions at areas of unique interest getting better or worse? **53**

Target Sites **54**

Aquatic chemistry 55

Toxicity 60

Bioassessments 60

Los Angeles River Estuary **63**

Sediment Chemistry 63

Sediment Toxicity 64

Sediment Toxicity 64

High Value Habitat Sites **69**

Chapter Summary **71**

Question 3. Are receiving waters near discharges meeting water quality objectives? **72**

City of Los Angeles - TWRP 74

City of Los Angeles – LAGWRP 79

City of Burbank - BWRP 83

Chapter Summary **87**

Question 4: Is it safe to swim? **88**

Swim Sites **92**

Sentinel Sites **95**

Chapter Summary **98**

Question 5: Are locally caught fish safe to eat? 99
- **Total Mercury** 105
- **Selenium** 107
- **Total DDT** 107
- **Total PCB** 107
- **Chapter Summary** 110

Literature Cited 112

List of Tables

Table 1. Monitoring design, indictors and sampling frequency. 11
Table 2. Sampling and analysis responsibilities for random and target sites. 12
Table 3. Sampling and analysis responsibilities for bacteria monitoring. 13
Table 4. Sampling and analysis responsibilities for bioaccumulation monitoring. 13
Table 5. Analyte list and method for each program element. 17
Table 6. Fraction of dissolved metals at random sites. 27
Table 7. Water flea (*Ceriodaphnia dubia*) acute and chronic significant response endpoints.. 33
Table 8. IBI metrics, summed scores and IBI ranks for random sites for 2010. 37
Table 9. Correlations of So CA IBI scores vs. chemical, biological, and physical habitat measurements from 2008-2010. 48
Table 10. Component loadings for the first five principle components 49
Table 11. Location of Confluence Sites 55
Table 12. Summary of acute and chronic toxicity at target sites during 2010 60
Table 13. Sediment chemistry concentrations at the Los Angeles River Estuary 65
Table 14. Results of sediment amphipod (*Eohaustorius*) survival and bivalve (*Mytilus*) development toxicity tests from estuary station LAREST2 during the 2009 and 2010 survey. 66
Table 15. Ranked cumulative abundances of infauna at EST2 in 2009 and 2010. 66
Table 16. Infauna community metrics at EST2 in 2009 and 2010. 67Table 17. Integrated sediment quality objective score for EST2 in 2009 and 2010. 68
Table 18 Location of high-value habitat sites 69
Table 19. Station designations for NPDES monitoring sites. 72
Table 20. Acute toxicity (survival) to fathead minnows above and below the TWRP discharge 75
Table 21. Trihalomethane concentrations above (LATT603) and below (LATT610) the TWRP discharge 76
Table 22. Acute toxicity (survival) to fathead minnows above and below the LAGWRP discharge 82
Table 23. Summary of trihalomethane compounds above (R4) and below (R7) the LAGWRP discharge 82
Table 24. Acute toxicity (survival) to fathead minnows above (R1) and below (R2) the BWRP discharge 86

Table 25. Summary of trihalomethane concentrations above (R1) and below (R2) the BWRP discharge. 86
Table 26. Sampling locations and site codes for indicator bacteria. 90
Table 27. Indicator bacteria REC1 standards for freshwaters. 92
Table 28. E. coli concentrations (MPN/100 mL) at recreational swim sites 94
Table 29. 30-day geometric mean E. coli concentrations (MPN/100 mL) at recreational swim sites 95
Table 30. 30-day geometric mean E. coli concentrations (MPN/100 mL) at sentinel sites 96
Table 31. 30-day geometric mean bacteria concentrations (MPN/100 mL) at the Los Angeles River estuary 97
Table 32. Target fish species and their characteristics (SWAMP 2007b.) 100
Table 33. Number and average standard weight and length of the individual and composite fish samples. 103
Table 34. Fish contaminant goals (FCGs) for selected fish contaminants 105
Table 35. OEHHA advisory tissue levels (ATLs) for elected fish contaminants 105

List of Figures

Figure 1. 2010 LARWMP sampling locations. 10
Figure 2. Map of all random sites sampled 2008- 2010 25
Figure 3. Box and whisker plots of the median and range of representative constituents measured in 2008-2010. 26
Figure 4. Box and whisker plots of the median and range of representative metals measured in 2008-2010. 28
Figure 5. Dissolved metal concentrations at random sites compared to CTR chronic and acute thresholds. 30
Figure 6. Box and whisker plots of the median and range of representative nutrients measured in 2008-2010. 31
Figure 7. IBI scores for random sites sampled in 2008 and 2009. 36
Figure 8. Cumulative frequency distributions of IBI scores at random sites in 2008 -2010. 38
Figure 9. Two-way coincidence table of species and site groups from cluster analyses. 41
Figure 10. Station cluster groups for random sites from 2008 to 2010 with average IBI scores for each cluster group. 42

Figure 11. Relative proportion of macroinvertebrate functional feeding groups in each watershed sub-region for 2008-2010 random sites combined. 43
Figure 12. Median overall CRAM scores (A), and individual attribute scores (B). 45
Figure 13. Overall CRAM scores for random sites in 2008-2010. 46
Figure 14. Biplot of the first two principle components. 50
Figure 15. Location of confluence, estuary, and high-value habitat sites. 54
Figure 16. Nutrient concentrations at confluence sites sampled 2008-2010. 56
Figure 17. Dissolved metal concentrations at confluence sites sampled 2008-2010. 58
Figure 18. Southern CA IBI and CRAM scores at confluence sites sampled 2008-2010. 61
Figure 19. Station dendrograms from the cluster analyses for all watershed stations from the 2008-2010 surveys. 62
Figure 20. CRAM scores (2009-2010) at confluence sites, and upper and lower watershed high value sites. 70
Figure 21. Locations of NPDES receiving water sites 2010. 73
Figure 22. Cumulative frequency distributions of fecal coliform and nitrogenous compounds above and below the TWRP discharge. 75
Figure 24. Metals concentrations above and below the TWRP discharge. 78
Figure 25. Cumulative frequency distributions of fecal coliform and nutrient concentrations above and below the LAGWRP discharge. 80
Figure 26. Metals concentrations above and below the LAGWRP discharge compared to hardness adjusted CTR thresholds for acute and chronic effects. 81
Figure 27. Cumulative frequency distributions for *E.coli* and nutrient concentrations above and below the BWRP discharge. 84
Figure 28. Dissolved metals concentrations above and below the BWRP discharge 85
Figure 29. Sentinel, estuary, and recreational swimming site locations in 2009-2010. 89
Figure 30. Fish tissue sampling locations for the 2010 bioaccumulation survey. 102
Figure 31. Mercury concentrations (ppb wet weight) in fish tissue samples in 2010. 108
Figure 32. DDT concentrations (ppb wet weight) in fish tissue samples in 2010. 109
Figure 33. PCB concentrations (ppb wet weight) in fish tissue samples in 2010. 110

List of Acronyms

ATL	Advisory Tissue Levels
BMI	Benthic Macroinvertebrate
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
CRAM	California Rapid Assessment Method
CRM	Certified Reference Material
CTR	California Toxics Rule
DDT	Dichlorodiphenyltrichloroethane
DO	Dissolved Oxygen
DQO	Data Quality Objective
FCG	Fish Contaminant Goals
IBI	Index of Biological Integrity
LARWMP	Los Angeles River Watershed Monitoring Program
MLOE	Multiple Lines Of Evidence
MQO	Measurement Quality Objective
MS	Matrix Spike
MSD	Matrix Spike Duplicate
OEHHA	Office of Environmental Health and Hazard Assessment (CA)
PAH	Polycyclic Aromatic Hydrocabons
PCA	Principle Component Analysis
PCB	Polychlorinated Biphenyl (persistent organic pollutants)
RPD	Relative Percent Difference
SGRRMP	San Gabriel River Regional Monitoring Program
SQO	Sediment Quality Objective
TDS	Total Dissolved Solids
TEQ	Toxicity Equivalent
TIE	Toxicity Identification Evaluation
USEPA	United States Environmental Protection Authority
VOC	Volatile Organic Compound
WQO	Water Quality Objective
WRP	Water Reclamation Plant

Executive Summary

This report presents data collected during 2010 and represents the third year of monitoring for the Los Angeles River Watershed Monitoring Program (LARWMP). It is the third in an intended series of annual summary reports leading to a more comprehensive State of the Los Angeles River Watershed report that will be published following the fifth year of monitoring in 2013. This and subsequent annual reports are intended to describe the year's monitoring activities and to answer five specific questions of interest to a broad range of stakeholders in the watershed:

1. What is the condition of streams in the watershed?
2. Are conditions at areas of unique interest getting better or worse?
3. Are receiving waters near discharges meeting water quality objectives?
4. Is it safe to swim?
5. Are locally caught fish safe to eat?

Sampling in 2010 addressed each of these questions for the second time since the program was phased in over a two-year period commencing in 2008 (Figure 1). This implementation phase provided time for procuring the funding and contracting arrangements required for full implementation. The program combines both randomized and targeted, or fixed-site, sampling in order to answer questions at the appropriate spatial scale and to provide a broader context for interpreting data from fixed stations.

What is the condition of streams in the watershed?

The ambient condition of streams in the Los Angeles River Watershed was assessed using a variety of indicators collected at randomly selected sites in three sub-regions (natural, urban and effluent dominated). Indicators included water chemistry, toxicity, bioassessment and physical habitat condition.

- Dissolved oxygen, pH and temperature were greatest at effluent dominated sites and lowest at natural upper watershed sites. Water Reclamation Plants and urban run-off discharge into concrete lined channels, with limited canopy

cover. Therefore, sunlight has the opportunity to increase water temperature and encourage photosynthesis, which results in cyclic oscillation in pH, oxygen and carbon dioxide concentrations.

- The concentrations of zinc, selenium, lead, and nickel were highest at effluent dominated sites and arsenic, chromium and copper were higher at urban sites. Other than copper and selenium in urban streams, concentrations of the other metals were generally below CTR thresholds.
- Effluent-dominated sites had higher median concentrations of these nutrients compared to the other sub-regions and the range of values was greatest at the urban sites. Nitrogen concentrations at all watershed sub-regions were below the basin plan objective of 10 mg/L-N for nitrate and 1.0 mg/L-N for nitrite.
- Toxicity was evaluated based on the 7-day *Ceriodaphnia* survival and reproduction test in 2010. None of the 10 random sites recorded acute toxicity, however, seven of the ten sites showed chronic toxicity, three urban sites and four at upper watershed natural sites. There was no clear reason for this chronic toxicity.
- Watershed-wide, nearly 80% of the random sites sampled during the two year period had IBI scores that indicated degraded habitat or ecosystem conditions, most of these were concrete lined channels in the urban and effluent dominated sub-regions.
- Physical habitat conditions, as measured by CRAM, were poorest in the lower watershed, where concrete channels predominate, and best in the upper watershed.
- There was a strong positive correlation between good biological conditions (IBI scores) and epifaunal substrate cover, canopy cover, and cobble/gravel substrate. Each of these habitat characteristics was favorable for BMIs in the upper watershed where IBI scores were correspondingly high. IBI scores were generally lowest in the urban and effluent sub regions, where concrete lined channels predominate.

Are conditions at areas of unique interest getting better or worse?

Target Sites

- Temporal trends in aquatic chemistry parameters have not been discernible from the past 3-years monitoring at target sites. These will become more evident with future monitoring.
- No acute (survival) or chronic (reproductive) toxicity was measured in 2010.
- Biological conditions, as measured by the Southern CA IBI, were degraded at all four sites.
- Habitat quality at these sites, which are cement lined, was lower compared to the high value/ high-risk sites in the upper and lower watershed.

Estuary Site

- The bivalve development toxicity test showed significant toxicity at station EST2 in 2010.
- Cadmium and zinc exceeded the effects range low (ER-L) threshold in 2009 and 2010. Total PCBs were below the ER-L in both years, while total DDTs exceeded the ER-L in both years.
- The biological metrics used to calculate the SQO's showed that sediment conditions were better in 2010 compared to 2009.
- Integration of the chemistry, toxicity and infauna category scores showed that station EST2 had moderately disturbed conditions during both years.

High-Value habitat Sites

- Physical habitat conditions were assessed using CRAM analysis at nine high value / high-risk sites in the watershed. CRAM scores indicated better physical habitat quality at sites in the upper watershed compared to lower watershed sites.

Are receiving waters near discharges meeting water quality objectives (WQO)?

The cities of Los Angeles and Burbank POTW's monitor receiving waters downstream of their discharges as a requirement of their NPDES permits. Aquatic chemistry and toxicity values were below the described WQOs with a number of exceptions specific to each facility. The following patterns were shown to be consistent upstream and downstream at all facilities:

- *E.coli* and Fecal coliform concentrations were greater upstream of the discharge point compared to downstream and typically exceeded WQOs.
- Concentrations of nitrogenous compounds were typically higher below the discharges.
- Trihalomethanes were typically present below the discharges and lower or below detection upstream. In all cases, concentrations were below the WQO.

Is it safe to swim?

Between May and September 2009 water samples were collected from seven swim sites (n = 101), six sentinel sites (n = 109), and a single estuary site (n = 80) on a weekly basis. Major findings of this sampling effort include:

- In 2010, the popular water-contact recreation sites Eaton Canyon and Bull Creek recorded the highest frequency of exceedance of the single sample REC-1 standard. The greatest numbers of exceedances occurred on weekends and holidays indicating that there is a relationship between increases in recreational use and indicator bacteria concentrations.
    - Exceedances of the single sample REC1 standard were common at the six sentinel sites with the greatest frequency of exceedances of the single sample REC1 standard occurring in the highly urbanized Tujunga Wash, Burbank Channel and Cerritos Channel watershed areas.
    - The lowest bacteria concentrations, and fewest exceedances, occurred at sites at or below POTW discharges
    - Sentinel sites typically exceeded the 30-day geometric mean REC1 standard during each month and these findings are consistent with those reported by CREST (2008).
- Bacteria concentrations in the Los Angeles River Estuary routinely exceeded REC1 standards for total coliforms and rarely exceeded the REC-1 standards for *E.coli* and *Enterococcus* during the dry-weather monitoring period.

Are locally caught fish safe to eat?

The data collected in 2010 by the SWAMP Bioaccumulation Monitoring Program indicate that of the four contaminants of concern, mercury concentrations in largemouth bass from Legg Lakes would limit potential human consumption to less than one 8-oz. fillet meal per week.

- This research effort did not consider trout, catfish, or pan fish, which either are usually stocked or have feeding strategies that limit pollutant exposure. Based on the following results for bass and carp, which do accumulate pollutants, these stocked and pan fishes are unlikely to pose health risks from exposure to the pollutants analyzed in the Los Angeles River, even if consumed several days per week.
- Mercury concentrations were greatest in largemouth bass collected from Legg Lakes and Peck Road Lake where OEHHA thresholds suggest no consumption or limiting consumption to one meal per week, respectively, for children and women of child bearing age. Common carp could be consumed at the guideline maximum of three meals per week threshold.
- Selenium concentrations in fish from each location were well below the lowest OEHHA threshold.
- Total DDT concentrations were low in all fish tissues, and could be consumed at the guideline maximum of three meals per week threshold
- Total PCBs in common carp and largemouth bass from Echo Park suggest limiting their consumption to one-meal-per-week

Introduction

The Los Angeles River Watershed Monitoring Program (LARWMP) was developed during 2007 by a group of stakeholders representing major permittees, regulatory and management agencies, and conservation groups. The objectives of the program are to develop a watershed scale understanding of the condition of surface waters and to improve the coordination and integration of monitoring efforts for both compliance and ambient conditions. The LARWMP has incorporated some elements of existing water quality and biological monitoring in the watershed that focused on compliance monitoring around Water Reclamation Plant (WRPs) and extended this to the entire watershed area. LARWMP's sampling design, which integrates both random and fixed sites, provides the ability to track trends at these fixed sites and to evaluate them in the context of conditions in the watershed as a whole (random sites) (Figure 1). Therefore, expanding beyond individual discharge points to the watershed level to provide a more complete picture of conditions in the watershed relevant to the questions that concern managers and the public.

To determine the overall health of the watershed, the monitoring program was designed to address the following five questions that are relevant to both watershed managers and the public to determine the overall quality or health of the watershed:

1. What is the condition of streams in the watershed?
2. Are conditions at areas of unique interest getting better or worse?
3. Are receiving waters near discharges meeting water quality objectives?
4. Is it safe to swim?
5. Are locally caught fish safe to eat?

The LARWMP has followed a phased implementation plan, with a portion of the program being conducted in 2008 and full implementation in 2009). In 2010, each program element was sampled with support from program partners and contractors (Table 2, Table 3 and Table 4). This report is the third in a series of annual reports leading to a comprehensive "State of the Los Angeles River Watershed" report to be published in 2013 following 5 years of monitoring. The 2010 annual report expands the findings presented in the 2008 and 2009 reports. Future annual reports will build on the analyses presented here and include additional analyses as needed.

The 2010 sampling survey followed the Station Fire which occurred in September, 2009 and burned 161,000 acres of the Angeles National Forest of the Los Angeles River upper watershed. Recognizing the significance of this event and taking advantage of the adaptive program design, the LARWMP workgroup initiated a special study at three sites burned by the fire to explore the post-fire effects on water quality. Each of these sites had been sampled in either 2008 or 2009, providing a before and after sampling design.

Annual reports are intended to describe the year's monitoring activities and present highlights of the data summaries and analyses. Data and analyses will therefore be delivered in three complementary levels of detail:

- Highlights and principal findings, presented in the main body of the report
- Report analytical results for all parameters and sites, presented in appendices to the report
- Raw data, available on the program's website after the release of each annual report.

A more complete description of the LARWMP regional setting, motivating questions, its technical design, and its implementation approach can be found in the Los Angeles River Watershed Monitoring Program Monitoring Plan (CWH 2008), Annual Reports (CWH 2008 and 2009) and Quality Assurance Project Plans (CWH 2009, 2010 and 2011) posted on the website of the Council for Watershed Health (http://www.watershedhealth.org).

Figure 1. 2010 LARWMP sampling locations.

Table 1. Monitoring design, indictors and sampling frequency.

Question	Approach	Sites	Indicators	Frequency
Q1: What is the condition of streams?	Randomized design for streams in entire watershed, except 1st and 2nd order[1] streams Streams assigned to natural, effluent dominated, urban runoff dominated subpopulations	10 randomly selected each year	Triad: bioassessment, physical habitat, CRAM, water chemistry, toxicity	Annually, in spring
Q2: What is the trend of condition at unique areas?	Fixed stations in estuary and freshwater	12 (approx.) in freshwater • 6 (approx.) high[2] value • 4 confluence of tribs/mainstem • 1 or 2 background	Freshwater: • Riparian habitat using CRAM • Triad: bioassessment, water chemistry, toxicity • Riparian habitat using CRAM	 Annually, in spring Annually, in spring Annually, in spring
		1 in estuary	Estuary: • Conventional water quality • Full suite water quality • Sediment chemistry, toxicity, infauna	 Not determined Annually Annually
Q3: Are receiving waters near discharges meeting objectives?	Use existing NPDES water quality data collected by LA River dischargers from receiving waters upstream and downstream of their discharge points.	Sites located upstream and downstream of discharges: • Los Angeles/Glendale • City of Burbank • Tillman Water Reclamation Plant	Constituents with established water quality standards, e.g. CTR for dissolved metals; *e. coli* bacteria	Varies depending on permit :monthly, quarterly, annual
Q4: Is it safe to swim?	Focus on high-use areas	6 – 10 in river 9 sentinel	*E. coli*	Weekly in swim season
		15 beach	Total & fecal coliforms, *Enterococcus*	Weekly year round
Q5: Is it safe to eat locally caught fish?	Focus on: • Popular fishing sites • Commonly caught species • High-risk chemicals	3 lakes 2 river 1 estuary	Commonly caught fish at each location Mercury, Selenium, DDTs, PCBs,	Annually in summer

[1] Stream order is defined by a tributary's position in the branching network, with 1st order streams being headwater streams, 2nd order streams those with one tributary above them, and so on.

[2] High value sites are locations of relatively isolated unique habitat

Table 2. Sampling and laboratory analysis responsibilities for random and target sites.

SPRING 2010 SAMPLING		Chemistry			Benthos			Toxicity			CRAM	
Confluence Sites	**Site ID**	**sampling**	**lab analysis**	**funding**	**sampling**	**lab analysis**	**funding**	**sampling**	**lab analysis**	**funding**	**assessment**	**funding**
Rio Hondo and mainstem of LA River	LALT500	Weston	City of LA [1.]	LARWMP/LACDPW	Weston[4.]	Weston	LACDPW[2.]	Weston*	City of LA	LARWMP[3.]	ABC[5.]	LARWMP
Arroyo Seco and mainstem of LA River	LALT501	Weston	City of LA	LARWMP/LACDPW	Weston	Weston	LACDPW	Weston*	City of LA	LARWMP	ABC	LARWMP
Compton Creek and mainstem of LA River	LALT502	Weston	City of LA	LARWMP/LACDPW	Weston	Weston	LACDPW	Weston*	City of LA	LARWMP	ABC	LARWMP
Tujunga Creek and mainstem of LA River	LALT503	Weston	City of LA	LARWMP/LACDPW	Weston	Weston	LACDPW	Weston*	City of LA	LARWMP	ABC	LARWMP
Random Samples (10)												
Natural 1	LAR01096	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Natural 2	LAR01544	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Natural 3	LAR01196	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Natural 4	LAR01320	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Urban 1	LAR01208	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Urban 2	LAR01716	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Urban 3	LAR01972	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Urban 4	LAR01452	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Effluent 1	LAR02622	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
Effluent 2	LAR00318	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	ABC	City of LA	LARWMP	LARWMP/ABC	LARWMP
High Value Habitat/Minimal Impact Sites												
Arroyo Seco USGS Gage	LALT450	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
Glendale Narrows	LALT400	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
Golden Shores Wetlands	LALT404	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
Sepulveda Basin	LALT405	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
Eaton Wash	LALT406	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
Haines Creek Pools and Stream	LALT407	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
Tujunga Sensitive Habitat	LAUT401	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
Upper Arroyo Seco	LAUT402	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
Alder Creek	LAUT403	-	-	-	-	-	-	-	-	-	LARWMP/ABC	LARWMP
		Seawater and Seiment Chemistry			*Benthos*			*Sediment Toxicity*				
Estuary Sampling												
Fixed site	EST2	City of LA	City of LA	City of LA	City of LA	City of LA	City of LA	City of LA	City of LA	City of LA		

1. City of Los Angeles, Environmental Monitoring Division
2. Los Angeles County Department of Public Works
3. Los Angeles River Watershed Monitoring Program
4. Weston Solutions, Inc.
5. Aquatic Bioassay and Consulting Laboratories, Inc.

Table 3. Sampling and laboratory analysis responsibilities for bacteria monitoring.

	Site ID	*Bacteria Samples* sampling	lab analysis	funding	*Coordinates* Latitude	Longitude
Swimming sites (8 TBD) (May 18th to Sep 30th)						
Big Tujunga Delta Flat Day Use	LAUT206	ABC	City of LA	LARWMP	34.3007324	-118.2624297
Bull Creek Sepulveda Basin	LALT200	City of LA EMD	City of LA	LARWMP	34.17868512	-118.4969206
Upper Rio Hondo	LALT201	LASGRWC	City of LA	LARWMP	34.06218592	-118.06797
Eaton Canyon Natural Area Park	LALT204	LASGRWC	City of LA	LARWMP	34.19376629	-118.1036
Bosque del Rio Hondo	LALT205	LASGRWC	City of LA	LARWMP	34.03080833	-118.0698953
LA-Glendale R7	LALT207	City of LA EMD	City of LA	LARWMP	34.1227985	-118.2696028
Millard Campground	LAUT203	LASGRWC	City of LA	LARWMP	34.21692674	-118.1447758
Oakwilde Campground or Switzer Falls/Campground	LAUT208	ABC	City of LA	LARWMP		
Gould Mesa Campground	LAUT209	ABC	City of LA	LARWMP	34.22496223	-118.1786262
Sturtevant Falls	LAUT210	LASGRWC	City of LA	LARWMP	34.18728652	-118.0165433
Hidden Springs	LAUT211	LASGRWC	City of LA	LARWMP		
Peck Rd Park - Added after sampling began	LAUT212	LASGRWC	City of LA	LARWMP		
Sentinel Sites (8) (May 15th to Sep 30th)						
Stat&Trend Del Amo	LALT100	City of LA WPD	City of LA	LARWMP	33.84639241	-118.2071946
Stat&Trend Figueroa St	LALT101	City of LA WPD	City of LA	LARWMP	34.08116249	-118.2258255
LA River Riverside Dr Cross	LALT102	City of LA WPD	City of LA	LARWMP	34.15617915	-118.2932443
Tillman R7	LALT103	City of LA EMD	City of LA	LARWMP	34.16160645	-118.465523
LACDPW at Wardlow St	LALT104	City of LA EMD	City of LA	LARWMP	33.8216193	-118.2047174
Tillman Site I	LALT105	City of LA EMD	City of LA	LARWMP	34.17863269	-118.4968544
Stat&Trend Burbank	LALT106	City of LA WPD	City of LA	LARWMP	34.16029705	-118.3041901
Stat&Trend Tujunga Moorpak	LALT107	City of LA WPD	City of LA	LARWMP	34.15007881	-118.3918059
Arroyo Seco (Same as Gould Mesa Campground Site)						
Estuary (Weekly)						
Estuary	LAREST2	City of LA	City of LA	City of LA	??	??

Table 4. Sampling and laboratory analysis responsibilities for fish tissue bioaccumulation monitoring.

Fish Tissue (5)	*Chemistry* sampling	lab analysis	funding	*Coordinates* Latitude	Longitude
Echo Lake - Reg 4	CADFG/ABC	City of LA	LARWMP	34.07269	-118.26047
Hollenbeck Park Lake	CADFG/ABC	City of LA	LARWMP	34.03946	-118.21845
Legg Lake	CADFG/ABC	City of LA	LARWMP	34.0333	-118.05942
Lincoln Park Lake	CADFG/ABC	City of LA	LARWMP	34.06616	-118.20273
Peck Road Water Conservation Park	CADFG/ABC	City of LA	LARWMP	34.10231	-118.01268

CADFG - California Department of Fish and Game

Methods

The methods employed for the 2010 sampling effort are briefly described in the following paragraphs, and include references to reports, standard operating procedures and other documents with additional detail. More detailed discussions of the procedures are provided in each report chapter and in the LARWMP Program Design Plan and Quality Assurance Project Plan (QAPP) available for download on the Council for Watershed Health (http://watershedhealth.org).

Monitoring of overall stream status for Questions 1 – 3 was based on the triad or Multiple Lines of Evidence (MLOE) approach, in which bioassessment (and its associated suite of physical habitat measurements), aquatic toxicity, and chemistry data provide a variety of perspectives the condition of water and sediment quality at a site. The triad of measurements provides an opportunity to assess whether there are apparent linkages between observed levels of chemicals of concern, toxicity, and/or changes to physical habitat and impacts on the instream community itself. As shown in Table 2, ten random sites and four targeted sites located at major confluences located throughout the watershed were visited in 2010.

Based on land use and other characteristics, streams were assigned to one of three watershed sub-regions: natural streams were in the upper watershed, effluent dominated streams of the mainstem and the lower reach of some tributaries, and urban runoff dominated streams in the developed portions of tributaries. As a requirement of their NPDES permits, the cities of Los Angeles and Burbank are required to monitor surface waters receiving effluent from their POTWs. These data were used to assess Question 3, "Are receiving waters near discharges meeting water quality objectives?" These monitoring sites focused on POTW discharges and were therefore in the effluent dominated portion of the watershed.

Bioassessment, a measure of the structure of one or more components of the instream biological community, provides a direct measure of the ecological status of instream benthic macroinvertebrate (BMI) communities. The field protocols and assessment procedures followed the Surface Water Ambient Monitoring Program (SWAMP), with the most current version described in SWAMP (2007). BMIs collected from each site were identified to Level II as specified by the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) (Richards and Rogers 2006). From the BMI data, biological metrics including diversity, average tolerance scores, functional feeding groups and others were calculated. From these metrics, the multi-metric Southern California IBI was calculated for each site (Ode, et al., 2005). The IBI score derived for each site allows the biological community found there to be compared against reference site conditions in southern California. IBI Scores below 40 (on a scale of 100) represent "poor" conditions and those 40 and above represent sites where biological community conditions are similar to reference site conditions in the region.

Physical habitat conditions were assessed using a method originally developed by the USEPA and modified by SWAMP for use in California (SWAMP 2007). This method focuses on the habitat conditions found in the streambed and banks. A method for summarizing these data that would allow for comparison of overall habitat conditions across sites is not yet available. However, some of the data types collected by this method (canopy density, substrate size, etc.) were used to evaluate sites using multivariate statistics. In addition to these measures, the LARWMP used the California Rapid Assessment Method (CRAM) to more broadly characterize the overall biology of the riparian system (Collins et al. 2008). The greater the CRAM score, the better the biotic, physical, hydrologic and buffer zone condition of the habitat.

Aquatic toxicity bioassays provided another measure of potential impact; although the use of test organisms in the laboratory makes bioassays a less direct indicator of site-specific impacts than the bioassessment leg of the Triad. However, aquatic toxicity bioassay tests can furnish a more direct measure of potential impacts from chemical contaminants. During 2010 the water flea (*Ceriodaphnia dubia*; USEPA-821-

R-02-013) survival and reproduction test was used at each freshwater site. The silver sides (*Menidia beryllina*; USEPA/600/4-91-003) 7 day survival test was used at the three estuary sites to test for water toxicity. Estuary sediment samples were tested for toxicity using the amphipod (*Eohaustorius estuaries*; USEPA-600/R-94/025) 10 day survival test and bivalve (*Mytilus galloprovincialis*; developed from Anderson, et. al, 1996 and Phillips, et. al, 2003) 48 hour development test.

In 2010, the State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP) Bioaccumulation Monitoring Project collected and analyzed fish tissue samples for contaminants of concern. The project's sampling and analysis plan (SWAMP 2007b.) details the sampling and analysis protocols, and a summary of the analytical procedures is described here.

- Mercury was analyzed according to EPA 7473, "Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry" using a Direct Mercury Analyzer
- Selenium was digested according to EPA 3052M, "Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices", modified, and analyzed according to EPA 200.8, "Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry".
- Organochlorine pesticides and PBDEs will be analyzed according to EPA 8081AM, "Organochlorine Pesticides by Gas Chromatography" and PCBs will be analyzed according to EPA 8082M, "Polychlorinated Biphenyls (PCBs) by Gas Chromatography".

The analytical methods for each chemical constituent measured in water (fresh and seawater), sediments and fish tissues, are listed in Table 5. Detailed data quality objectives for each group of constituents can be found in the program QAPP (LASGRWC[1]):
(http://lasgrwc2.org/dataandreference/Document.aspx).

Table 5. Analyte list and method for each program element.

Analyte	Method	Units	Reporting Limit
Conventional Water Chemistry			
Temperature	YSI 556	°C	-5
pH	YSI 556	$-log[H^+]$	2-12
Conductivity	YSI 556	mS/cm	0-100
Dissolved Oxygen	YSI 556	mg/L	0
Salinity	YSI 556	ppt	0
Water Chemistry: freshwater			
Alkalinity as CaCO3	SM 2320 B	mg/L	10
Hardness as CaCO3	SM 2340 B	mg/L	1.32
Suspended Solids	SM 2540 D	mg/L	3
Nutrients			
Ammonia as N	EPA 350.1	mg/L	0.1
Nitrate as N	EPA 300.0	mg/L	0.1
Nitrite as N	EPA 300.0	mg/L	0.02
TKN	EPA 351.2 (1° Method) or SM4500-NH3 C (2° Method)	mg/L	0.1
Total Nitrogen	Calculated	NA	NA
Total Organic Carbon	SM 5310 C		
Dissolved Organic Carbon	SM 5310 C		
OrthoPhosphate as P	SM4500-P E	mg/L	0.1
Phosphorus as P	SM4500-P E	mg/L	0.1
Major Ions			
Chloride	EPA 300.0	mg/L	1.0
Sulfate	EPA 300.0	mg/L	1.0
Silica	SM4500-Si D	mg/L	0.1
Metals			
Trace metals (total and dissolved): As, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Se, Zn	SM 3114B (As, Se) EPA 200.8 (Cd, Cr, Cu, Fe, Ni, Pb, Zn) SM 3112B (Hg)	ug/L	As (0.1), Cd(0.2), Cr(0.5), Cu(0.5) Fe(50), Hg(0.2), Ni(1), Zn(1)
Organics			
Organophosphorus Pesticides	EPA 625	ng/L	2-16
Pyrethroids Pesticides	EPA 625 NCI	ng/L	0.5-5
Water Chemistry: Estuary (seawater)	SM 2320B	mg/L	10
Hardness as CaCO3	SM 2340B	mg/L	1.32
Suspended Solids	SM 2540D	mg/L	3
Dissolved Solids	SM 2540C	mg/L	37
Nutrients			
Ammonia	SM 4500-NH3 B&C; EPA 350.1	mg/L	0.1
Nitrate	EPA 300.0; EPA 353.2	mg/L	0.02
Nitrite	EPA 300.0; EPA 353.2	mg/L	0.02
TKN	EPA 351.2 (1° Method) or SM4500-NH3 C (2° Method)	mg/L	0.1
Dissolved Organic Carbon	SM 5310 C	mg/L	0.1
Total Organic Carbon	SM 5310 B	mg/L	0.1
OrthoPhosphate as P	SM 4500-P E	mg/L	0.1
Phosphorus as P	SM 4500-P E	mg/L	0.1
Metals			
Metals (total and dissolved): As, Cd, Cr, Cu, Fe, Hg, Pb, Ni, Se, Zn	SM 3114 B (As, Se) EPA 200.8 or 200.7 (Cd, Cr, Cu, Fe, Ni, Pb, Zn) SM 3112B (Hg)	ug/L	0.25-50
Organics			
Organophosphorus Pesticides	EPA 625	ng/L	2-16
Pyrethroid Pesticides	EPA 625-NCL	ng/L	0.5-5

Table 5 continued.

Analyte	Method	Units	Reporting Limit
Sediment Chemistry: Estuary			
Sediment Particle Size (% fines)	SM 2560 D	um	<2000->0.2
Metals			
Trace Metals: As, Cd, Cr, Cu, Fe, Hg, Pb, Ni, Se, Zn	EPA 6010B (As, Cd, Cr, Cu, Fe, Pb, Ni, Se, Zn) EPA 7471A (Hg)	mg/dry Kg	0.01-100
Nutrients			
Total Kjeldahl Nitrogen (TKN)	EPA 351.2; SM4500-N ORG B	mg/kg	0.5
Total Organic Carbon	SM 5310 B	% dry wt	0.05
Phosphorus as P	SM 4500-P E	mg/kg	0.05
Organics			
Organochlorine Pesticides (DDTs)	EPA 8081A	ng/dry g	0.5-83.3
Polychlorinated Biphenyl (PCBs)	EPA 8082	ng/dry g	0.5-83.3
Poly Aromatic Hydrocarbons (PAHs)	EPA 8270C	ng/dry g	50
Tissue Chemistry: Fish			
Percent Lipids	Bligh, E.G. and Dyer ,W.J. 1959.	%	NA
Metals			
Trace Metals (Se, Hg)	EPA 6010B (Se), EPA 7471A (Hg)	mg/wet Kg	0.01-0.25
Organics			
Organochlorine Pesticides (DDTs)	EPA 8082	ug/wet Kg	1.7-83
Polychlorinated Biphenyl (PCBs)	EPA 8082	ug/wet Kg	1.7-83
Indicator Bacteria			
Total Coliform and E. coli	SM 9223 B	MPN/100mL	10
Enterococcus	Enterolert	MPN/100mL	10
Water Toxicity: Freshwater or Estuary			
Chronic Ceriodaphnia dubia (freshwater): primary test organism	EPA 821/R-02-013	% Survival, %reproduction	N/A
Chronic *Hyallela azteca* (freshwater): secondary test organism if conductivity is > 2,500 µS/cm	EPA 821/R-02-013m	% Survival	N/A
Sediment Toxicity: Estuary			
Chronic *Eohaustorius* sp. (sediment) 10 day survival	EPA 600/R-94/025	% survival	N/A
Chronic *Mytilus* Sediment Water Interface	USEPA 1995 & Anderson et al., 1996	% development	N/A
Habitat Assessments & Taxonomy			
Benthic Macroinvertebrate (freshwater) – Ode, 2007	SWAMP (2007), SAFIT STE	N/A	SAFIT Level 2
Infauna (marine)	SCCWRP (2008)*, SCAMIT STE	N/A	N/A
Attached Algae (freshwater)	SWAMP (2010)	N/A	N/A
Chlorophll a	SM 10200 H	ug/L	2
Ash-free dry mass	SM 2540 B	%	1
Qualitative Algae	SWAMP, In Development	N/A	N/A
Quantitative Diatom	SWAMP, In Development	N/A	N/A
Quantitative Algae	SWAMP, In Development	N/A	N/A
Riparian Condition (CRAM)	Collins et al., 2008	N/A	N/A

Program Quality Assurance

The LARWMP includes an emphasis on QA/QC for each phase of the program including the standardization of data formats so that monitoring results can be shared with local, state and federal agencies. The data quality objectives for the program are outlined in the LARWMP QAPP and were finalized prior to the 2009 survey (LARWMP[1], 2009). Therefore, the data reported herein from the 2008 survey were based on field sampling and laboratory analysis protocols agreed upon by the participants.

Measurement or Data Quality Objectives (MQOs or DQOs) are quantitative or qualitative statements that specify the tolerable levels of potential errors in the data and ensure that the data generated meet the quantity and quality of data required to support the study objectives. The DQOs for the LARWMP are detailed in the Program QAPP (LARWMP[1], 2009). The MQOs for the processing and identification of benthic macroinvertebrate samples are summarized in the LARWMP QAPP and detailed in the Southern California Regional Watershed Monitoring Program: Bioassessment Quality Assurance Project Plan, Version 1.0 (SCCWRP 2009). The DQOs and MQOs focused on five aspects of data quality: completeness, precision, accuracy, representativeness, and sensitivity. Brief summaries for the 2010 survey for each of these categories are presented in Appendix A, Table A-1 to A-4.

Completeness

Completeness describes the success of sample collection and laboratory analysis (biology, chemistry, toxicity) which should be sufficient to fulfill the statistical criteria of the project. Sampling completeness for 2010 was well within the 90% DQO. A total of 1 estuary, 10 randomly selected, 4 targeted, and 3 post fire sites were identified for sampling in 2010. The actual number of data results successfully generated for each analyte ranged from 0 to 100%. Freshwater targeted and random analysis completeness was 100% in 2010 except for suspended solid analysis. Suspended solids were not analyzed in 2010 and completeness was 0 % (Appendix A, Table A-1). Estuary water completeness was 100% for conventional constituents, and metals, conversely completeness was 0% for organophosphorous pesticides, pyrethroid pesticides and toxicity. Estuary sediment completeness was 100 % for *Mytilus* toxicity, nutrients, chlorinated pesticides, PAH's, PCB's and all metals except mercury. Mercury, organophosphorous pesticides, and *Eohaustorius* toxicity completeness was 0 % (Appendix A, Table A-2). These parameters were not measured due to a sample tracking error which has since been corrected. The sampling team and laboratories were notified of this deficiency to ensure 100% compliance in the coming sampling season.

Accuracy

Accuracy provides an estimate of how close a laboratory or field measurement of a parameter is to the true value. Field sampling accuracy was assessed by calibration of the water quality probes with standards of known concentration. The accuracy of physical habitat measurements was assessed during a field audit conducted by the Southern California Coastal Water Research Project (SCCWRP) and Mr. James Harrington of the Department of Fish and Game as part of the Stormwater Monitoring Coalitions (SMC) Southern California Regional Monitoring Survey, field calibration exercise. BMI sorting accuracy was assessed by a recount of 10% of sorted materials. The MQO of 95% was met for each lab reporting results for this program. Taxonomic identification accuracy was assessed through the independent re-identification of 10% of samples by the Department of Fish and Games Aquatic Biology Laboratory. MQOs for taxa count, taxonomic identification and individual identification rates were met.

Analytical chemistry accuracy measures how close measurements are to the true value. For analytical chemistry samples Certified Reference Materials (CRM), matrix spike / matrix spike duplicates and laboratory control standards are used to assess method accuracy. The LARWMP followed SWAMP protocols which allow one of these elements to fail in a batch and still be compliant. If more than one element fails, that analyte is listed as estimated for the entire batch. DQOs for accuracy are provided in the QAPP (LASGRWC[1] 2009). Two analytes had a single accuracy failure in 2010, but none were rejected (Appendix A, Table A-3).

Accuracy of toxicity test results is assessed by ensuring that EPA control response standards are met and that DMR inter laboratory test results were within criteria for each test. Each of these criteria was met in 2010 for the toxicity tests reported for this program.

Precision

Field duplicates were collected for chemistry, toxicity and benthic macroinvertebrates at 10% of the random sites visited in 2010. The MQO for field duplicates was a relative percent difference (RPDs) <25%, except for benthic macroinvertebrates. At this time, no MQO has been developed for benthic macroinvertebrate duplicate samples. For analytical chemistry results matrix spike (MS), matrix spike duplicates (MSD) and laboratory duplicates (DUP) were used to assess laboratory precision. RPDs <25% for either the MS/MSD or DUPs were considered acceptable. Of hundreds of analytes measured in 2010, only one exceeded the precision criteria (Appendix A, Table A-3).

Toxicity testing precision is measured through the development of control charts that include 20 reference toxicant tests for each organism. Each new reference toxicant test must fall within ± 2 standard deviations (SD) of the control chart average to be acceptable. All tests in 2010 met this criterion.

Taxonomic precision was assessed using three error rates: random errors which are misidentifications that are made inconsistently within a taxon; systemic errors occur when a specific taxon is consistently misidentified; taxonomic resolution errors occur when taxa are not identified to the proper taxonomic level. Error rates of <10% are considered acceptable and all precision requirements were met in 2010.

Laboratory Blanks

Laboratory blanks were used to demonstrate that the analytical procedures do not result in sample contamination. The MQO for laboratory blanks were those with values less than the reporting limit (RL) for the analyte. Eight results in five blanks had analytes that were detected above the RL (Appendix A, Table A-4).

Program Improvements and Standardization

An intercalibration study was conducted in 2006 sampling season by the Stormwater Monitoring Coalition's (SMC) Chemistry Workgroup. This intercalibration included all participating laboratories and covered nutrient and metal analyses. Intercalibration studies will be ongoing as part of the SMC Regional Monitoring Program.

Sampling procedures for each field team collecting samples for the LARWMP were audited by Raphael Mazor, Chris Solek and Betty Fetscher of the Southern California Coastal Water Research Project during the 2010 summer survey. The audit covered the SWAMP 2007 CRAM, algae, bioassessment and physical habitat protocols. Each team passed their audit.

Question 1. What is the condition of streams in the Los Angeles River Watershed?

To determine the condition of streams in the Los Angeles River watershed, data were collected at 30 random sites during three annual surveys in 2008, 2009 and 2010 (10 sites in each year) (Figure 2). Spatially, these sites were selected to represent conditions for the entire watershed and are equally representative of the three major sub-regions in the watershed: natural streams in the upper reaches of both the mainstem and tributaries; effluent dominated reaches in the mainstem and the lower portions of some estuaries, and urban runoff dominated reaches of tributaries flowing through developed portions of the watershed. The following sections present information on the aquatic chemical, toxicological, biological (stream invertebrates), and physical habitat characteristics of the stream segments, along with preliminary conclusions about the potential relationships among these three indicators of stream condition.

Aquatic Chemistry

Comparison of chemical constituent concentrations from the three sub-regions suggests differences in water chemistry based on watershed position. For the following constituents, the lowest median concentrations were recorded at natural sites in the upper watershed, including dissolved oxygen, conductivity, pH, temperature, hardness, total suspended solids, and total and dissolved fractions of organic carbon (Figure 3).

For the period 2008 through 2010, median values for dissolved oxygen, pH and temperature were greatest at effluent dominated sites. These sites are mostly cement lined channels with little vegetative canopy cover where increased sunlight can increase water temperature and photosynthetic activity, leading to increased oxygen and pH. Sites receiving urban run-off had higher median values for dissolved and suspended constituents, particularly electrical conductivity, alkalinity and total and dissolved organic carbon.

Figure 3 shows the water quality objectives (WQOs) described by both the USEPA (1986) and the Los Angeles Regional Water Quality Control Board (LARWQCB 1994) where available. Average dissolved oxygen concentrations for all sub-regions where above the minimum annual average objective of 7 mg/L and for most constituents, the median values obtained those objectives described for specific stream reaches. At effluent dominated sites, however, dissolved oxygen was recorded below 5 mg/L (4.89 mg/L) on one occasion and average pH value exceeded the upper guidance level of 8.5.

In 2010, organophosphorus pesticides were always below the method limit of detection with one exception- 11.6 ng/L of diazinon was detected at site LAR1208 in the Los Angeles River. Pyrethroids were also rarely detected. Bifenthrin was detected at concentrations between 2.5-3.5 ng/L, and cypermethrin at 7.21 ng/L, from the urban and effluent dominant sub-regions. Interestingly, 51.4 ng/L of Permethrin was detected in the relatively natural upper watershed at LAR01096 in Big Tujunga Creek.

Figure 2. Map of all random sites sampled 2008- 2010.

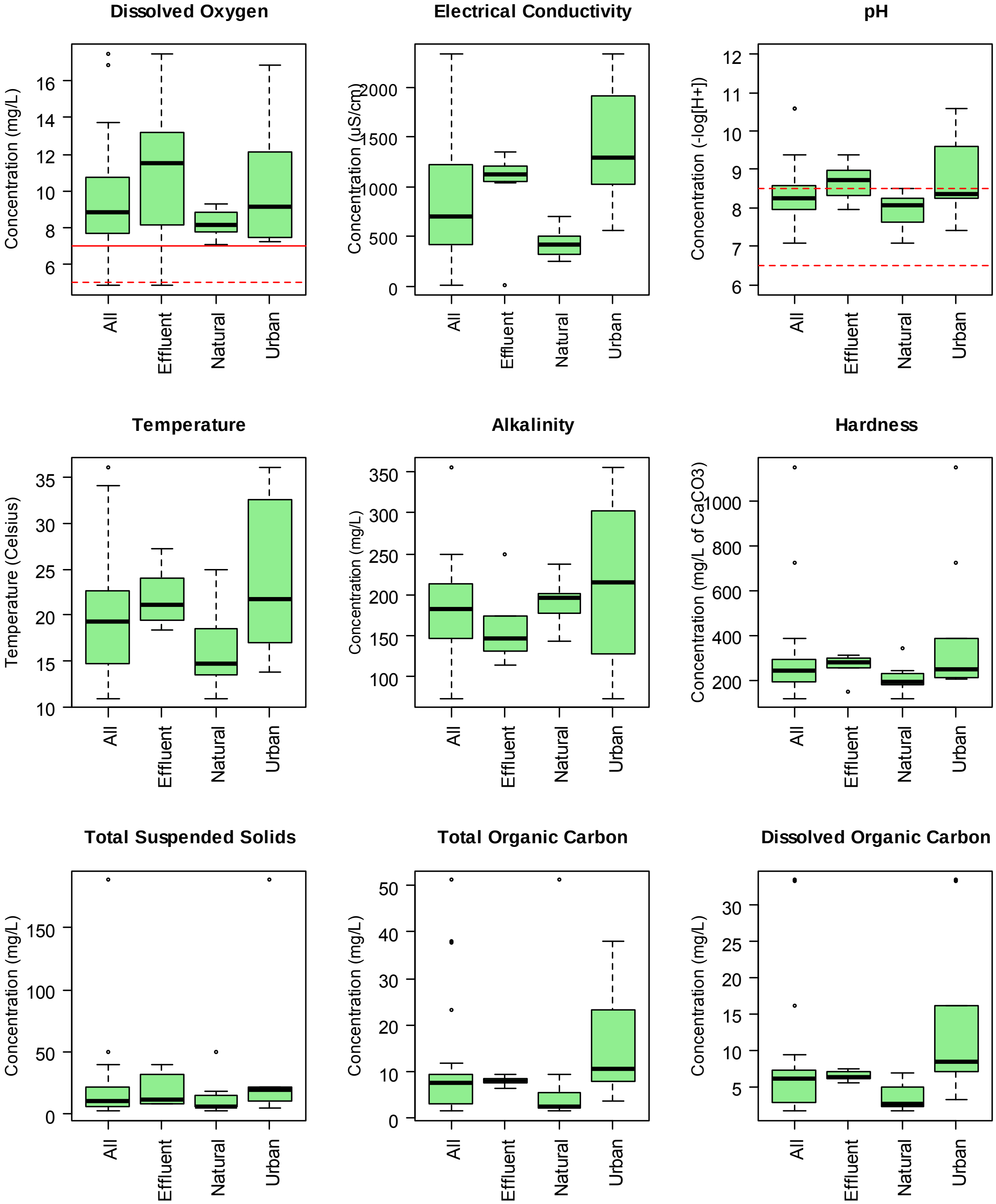


Figure 3. Box and whisker plots showing the median and range of representative constituents measured in each of the three Los Angeles River watershed regions 2008 through 2010. Dashed red lines represent single sample water quality objectives and the solid red line represents the minimum annual mean.

Table 6 shows the proportion of total metals as dissolved metals in each sub-region for 2008 through 2010. With the exception of iron, lead and zinc, the majority of metals observed at random sites were in the more bio-available dissolved phase. This is consistent with observations of others that during non-storm conditions the dissolved fraction of metals predominates (Stein and Ackerman 2007). Moreover, the total metal fraction is commonly correlated with TSS and this was confirmed in this study. Correlation analysis (results not shown) also revealed significant positive relationships between TSS and the dissolved forms of copper, chromium and lead.

Table 6. Fraction of dissolved metals at random sites sampled 2008-2010.

	Dissolved Metals (%)			
	All Sites	Natural	Effluent	Urban
As	71	64	93	66
Cr	75	82	73	69
Cu	67	47	79	65
Fe	3	3	11	3
Ni	76	73	91	69
Pb	21	13	36	19
Se	96	60	96	90
Zn	49	32	72	31

Figure 4 shows the concentrations of dissolved metals that were measured above the instrument detection limit for the period 2008 through 2010. The median concentrations were highest at sites dominated by urban run-off and POTW effluents. Specifically, zinc, selenium, lead, and nickel concentrations were highest at effluent dominated sites and arsenic, chromium and copper were higher at urban sites. The effluent dominated reaches of the Los Angeles River are adjacent to major freeways including the 5, 134 and 710 (Figure 2). Emissions from transport (mechanical wear and tear of brake pads and tires of cars, overhead lines of rail vehicles etc.) are known non-point sources of copper, zinc and lead and their contribution to the metal loadings in the Los Angeles River requires further clarification. Selenium was below detection at natural, upper watershed sites. For most metals, the spatial pattern for dissolved metals paralleled those seen for total metals.

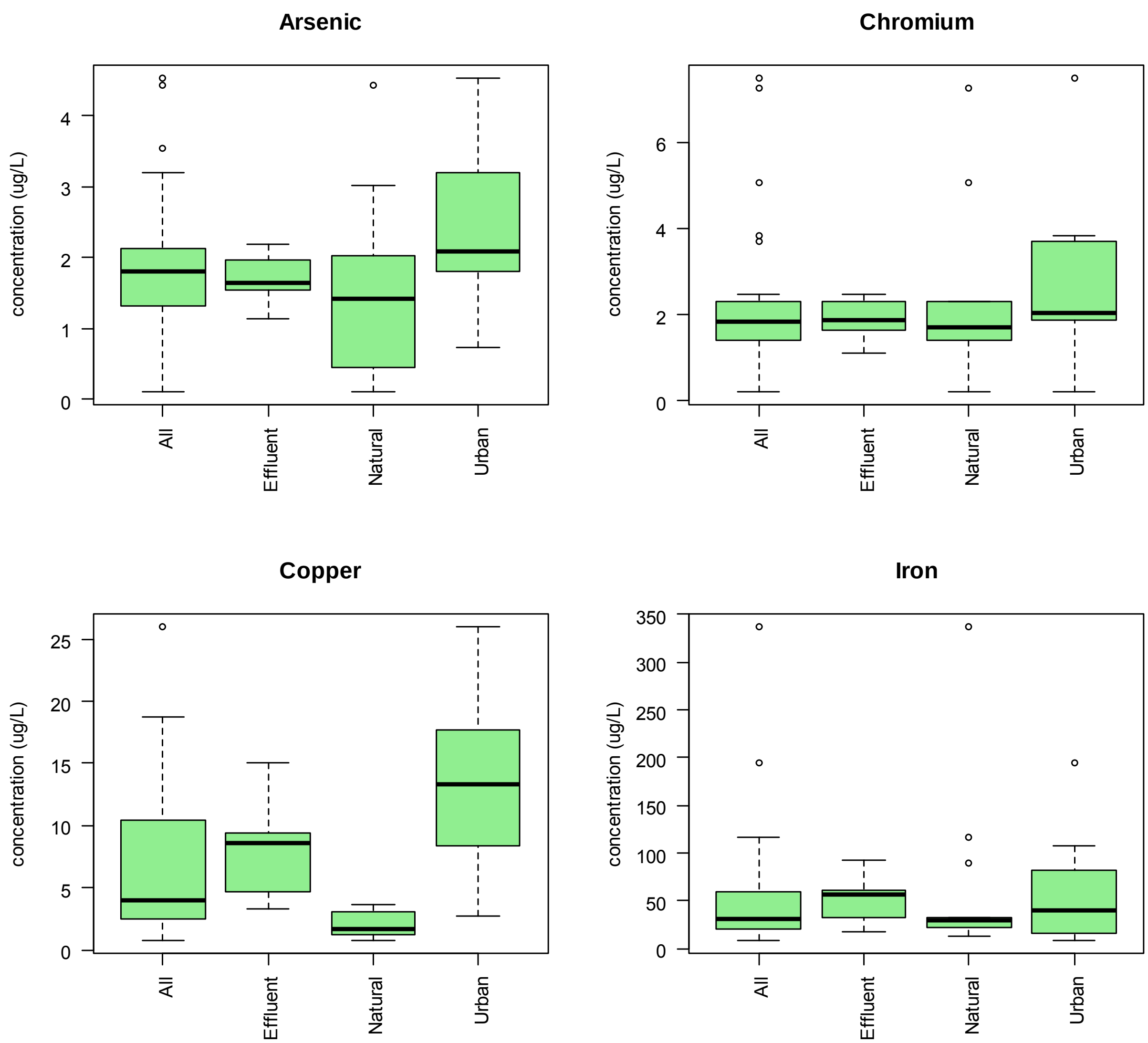


Figure 4. Box and whisker plots showing the median and range of representative metals measured in each of the three Los Angeles River watershed regions 2008-2010.

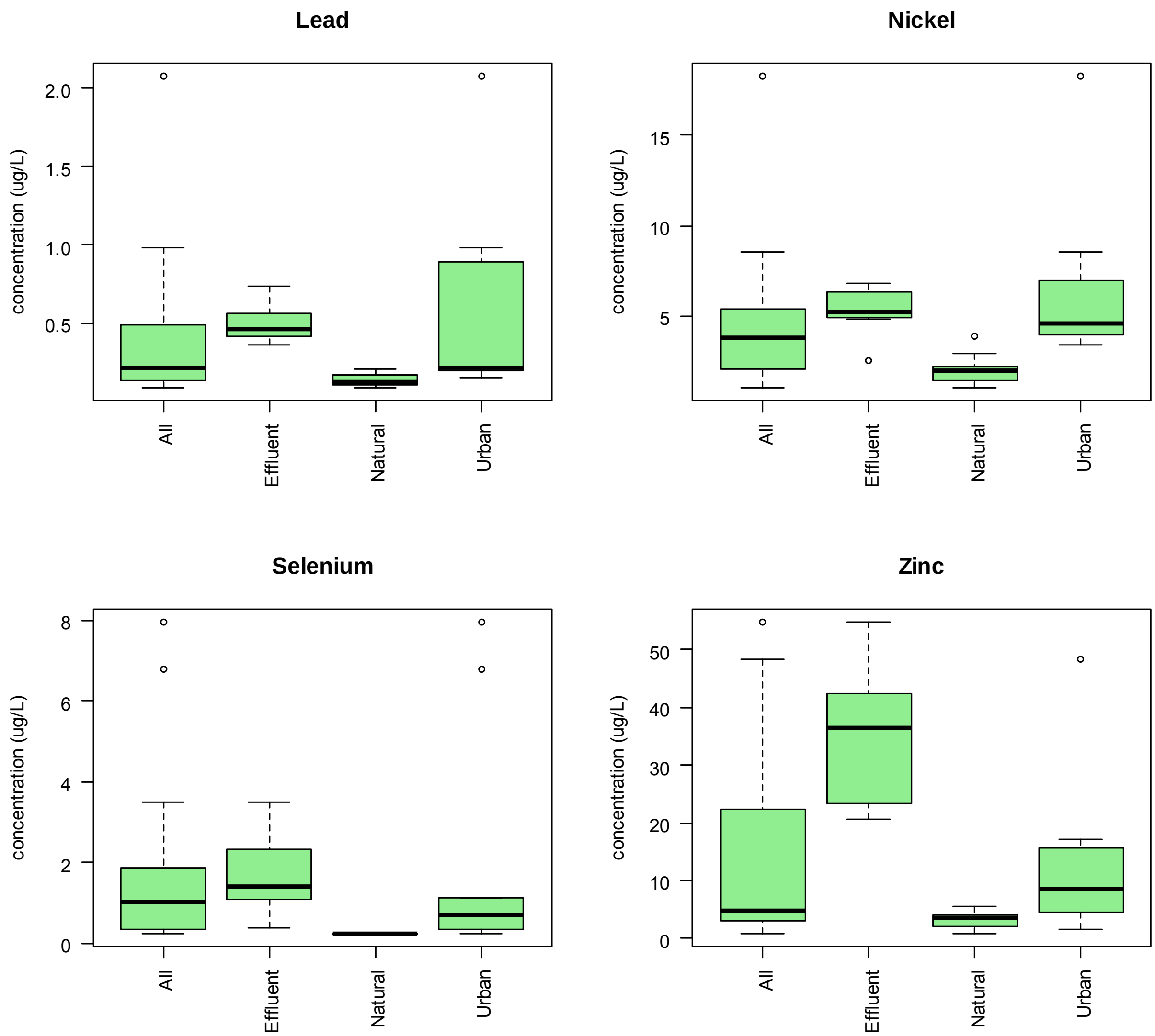


Figure 4. Continued.

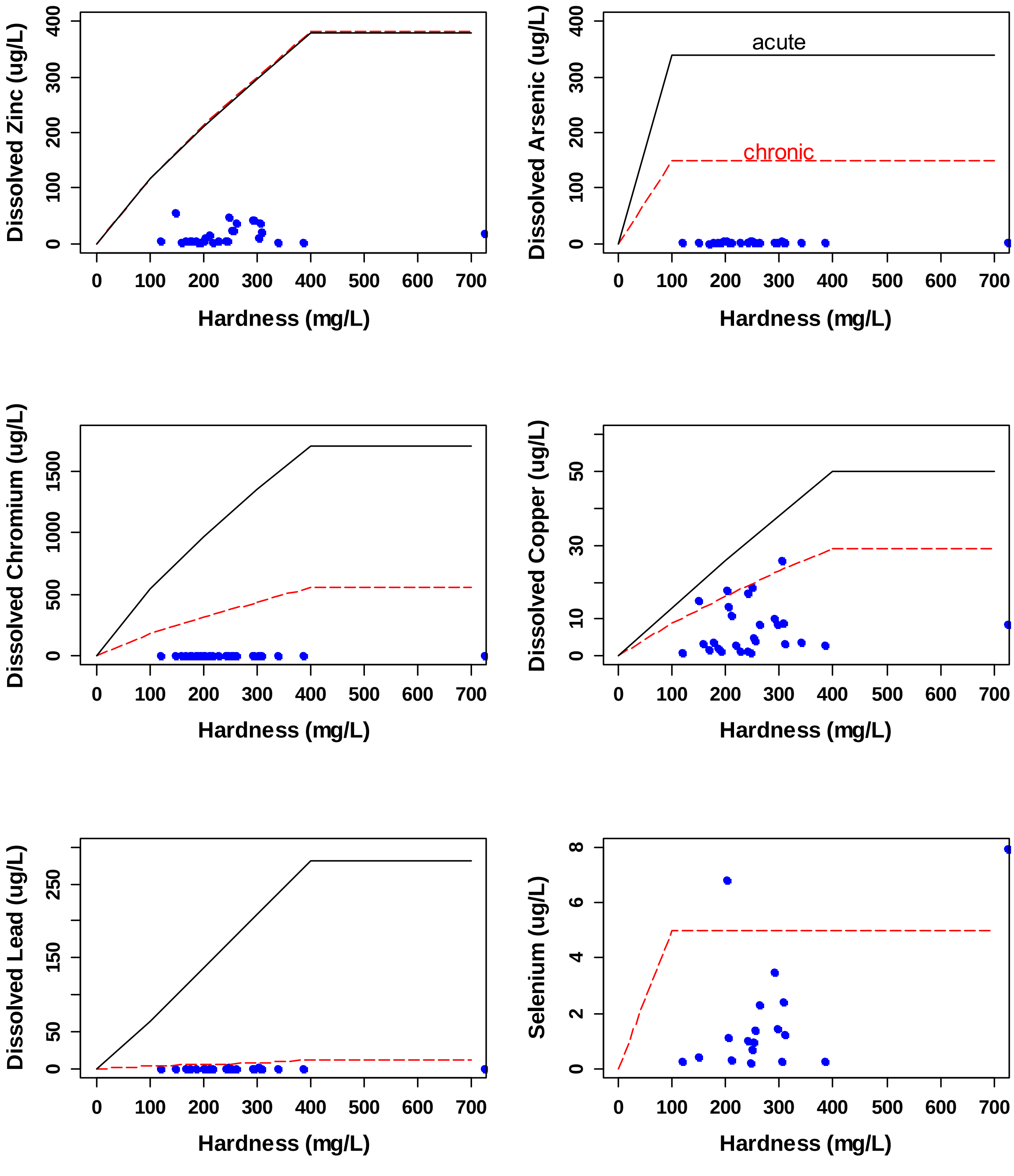


Figure 5. Dissolved metal concentrations at random sites compared to CTR chronic and acute thresholds.

The spatial variability of dissolved and total fractions of nitrogen and phosphorus are shown in Figure 6. Effluent-dominated sites had higher median concentrations of these nutrients compared to the other sub-regions and the range of values was greatest at the urban sites. Nitrogen concentrations at all watershed sub-regions were below the basin plan objective of 10 mg/L-N for nitrate and 1.0 mg/L-N for nitrite.

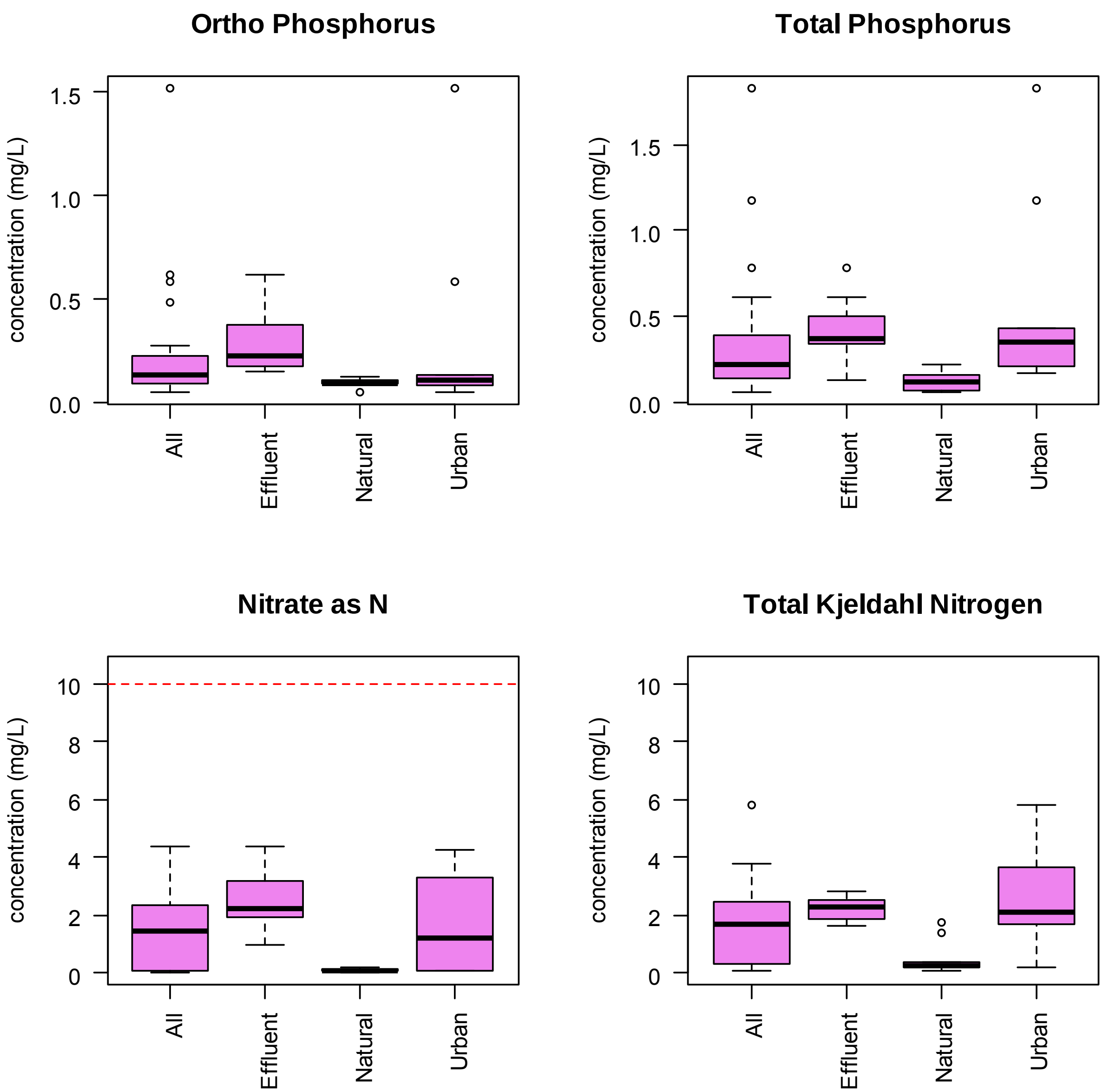


Figure 6. Box and whisker plots showing the median and range of representative nutrients measured in each of the three Los Angeles River watershed regions 2008-2010.

Toxicity

Toxicity was evaluated with the 7-day *Ceriodaphnia* survival and reproduction test in the 2010 LARWMP surveys (Table 7). Of the 10 random sites surveyed, no sites exhibited acute toxicity, while seven had chronic toxicity, including all four of the natural sites and three of the urban sites. This was similar to the 2009 survey when five of the ten sites showed chronic toxicity, one at an urban site and four at upper watershed natural sites. The cause of toxicity at natural sites where concentrations of nutrients, metals, orthophosphate pesticides, and pyrethroids was low or below detection is more uncertain. The Station Fire burned most of the upper watershed in September of 2009 and runoff from the fire areas might have contributed to the toxicity in 2010 due to increased dissolved metals or nutrients. However, runoff from the Station Fire does not explain the toxicity measured in 2009 before the fire occurred. Similar chronic toxicity results have been measured by the SMC Regional Monitoring Program at other upper watershed locations in the southern California region. These results may be linked to the underlying geology and associated water quality conditions at these sites. Hardness and alkalinity values from the upper watershed sites were similar to the laboratory control water used in the tests. This suggests that the test animals were probably responding to some other stressor.

Table 7. Water flea (*Ceriodaphnia dubia*) acute and chronic significant response endpoints for tests conducted in 2010. Toxic endpoints included only control adjusted responses that were statistically significant and were greater than the 80% evaluation threshold level specified by SWAMP. Toxic endpoints = magenta; not toxic = green; inconclusive = yellow.

Station	Station Descrioption	Ceriodaphnia Toxicity	
		Survival	Reproduction
SMC00318	Effluent (Los Angeles River)	NSG	NSG
SMC02622	Effluent (Los Angeles River)	NSG	NSG
SMC01096	Natural (Big Tujunga Creek)	NSG	SL
SMC01196	Natural (Big Tujunga Creek)	NSG	SL
SMC01320	Natural (Big Tujunga Creek)	NSG	SL
SMC01544	Natural (Big Tujunga Creek)	NSL	SL
SMC01716	Urban (Bull Creek)	NSG	SL
SMC01972	Urban (Bull Creek)	NSG	SL
SMC01452	Urban (Eaton Wash)	NSG	NSG
SMC01208	Urban (Los Angeles River)	NSG	SL
	Total Number Toxic	0	7
	Effluent	0	0
	Natural	0	4
	Urban	0	3

NS = treatment and control not signifiantly different and response greater than 80%
SL = treatment and control significantly differnet and response less than 80%
NSG = treatment and control significantly different, but response grater than 80%
NSL = treatment and control not significantly different, but response less than 80%

Bioassessment

Southern California IBI

The Southern California Index of Biological Integrity (So CA IBI) is a multi-metric index that incorporates seven biological metrics that respond to different environmental stressors (Table 8); these include (1) EPT taxa, (2) Predator taxa, (3) Coleoptera taxa, (4) % Non-insect taxa, (5) % Intolerant individuals, (6) % Tolerant taxa, and (7) % Collector individuals. The So CA IBI was developed using data collected from over 200 sites throughout southern California, including both relatively pristine reference sites and sites influenced by human activities (Ode et al. 2005). As a result, the So CA IBI allows benthic assemblages at a site to be compared against reference conditions. Scores of 40 or below are considered to be impacted, while those greater than 40 are considered to be more like reference conditions (Ode et al. 2005).

The condition of BMI communities at effluent dominated and urban sites ranked in the 'very poor' range (<20) in 2010, which was similar to results for 2008 and 2009 (Figure 7 and Table 8). In contrast, IBI scores at natural sites in 2010 ranged from 20 to 40. However, the 2010 scores were less than in 2008 and 2009 when scores ranged from 35 to 77. Watershed-wide, nearly 80% of the random sites sampled during the two-year period had IBI scores that indicated degraded water quality conditions (Figure 8).

Degraded physical habitat was potentially the most prominent stressor on BMI communities at urban and effluent sites in the lower watershed. All of the sites in the lower watershed are located in highly urbanized areas and typically have streambed and riparian zone habitats that have been highly altered by dredging, shoring, and channelization. In a few cases, the urban sites had slightly better IBI scores as a result of unlined streambeds allowing for some habitat complexity, which is beneficial for BMIs. The effluent-dominated channels were almost completely composed of cement-lined channels, which provide no habitat complexity. The decrease in IBI scores at upper watershed natural sites in 2010 was most likely the due to the effects of the Station Fire which denuded the riparian corridors surrounding and upstream of these sites which decreased the quality habitat for BMIs. Moreover, the effects of post-fire run-off on surface water quality in Southern California include increases in metal loadings, PAH’s and nutrients compared to unburned sites (Stein 2009). Therefore, post-fire run-off potentially degraded water quality between the 2009 and 2010 sampling events.

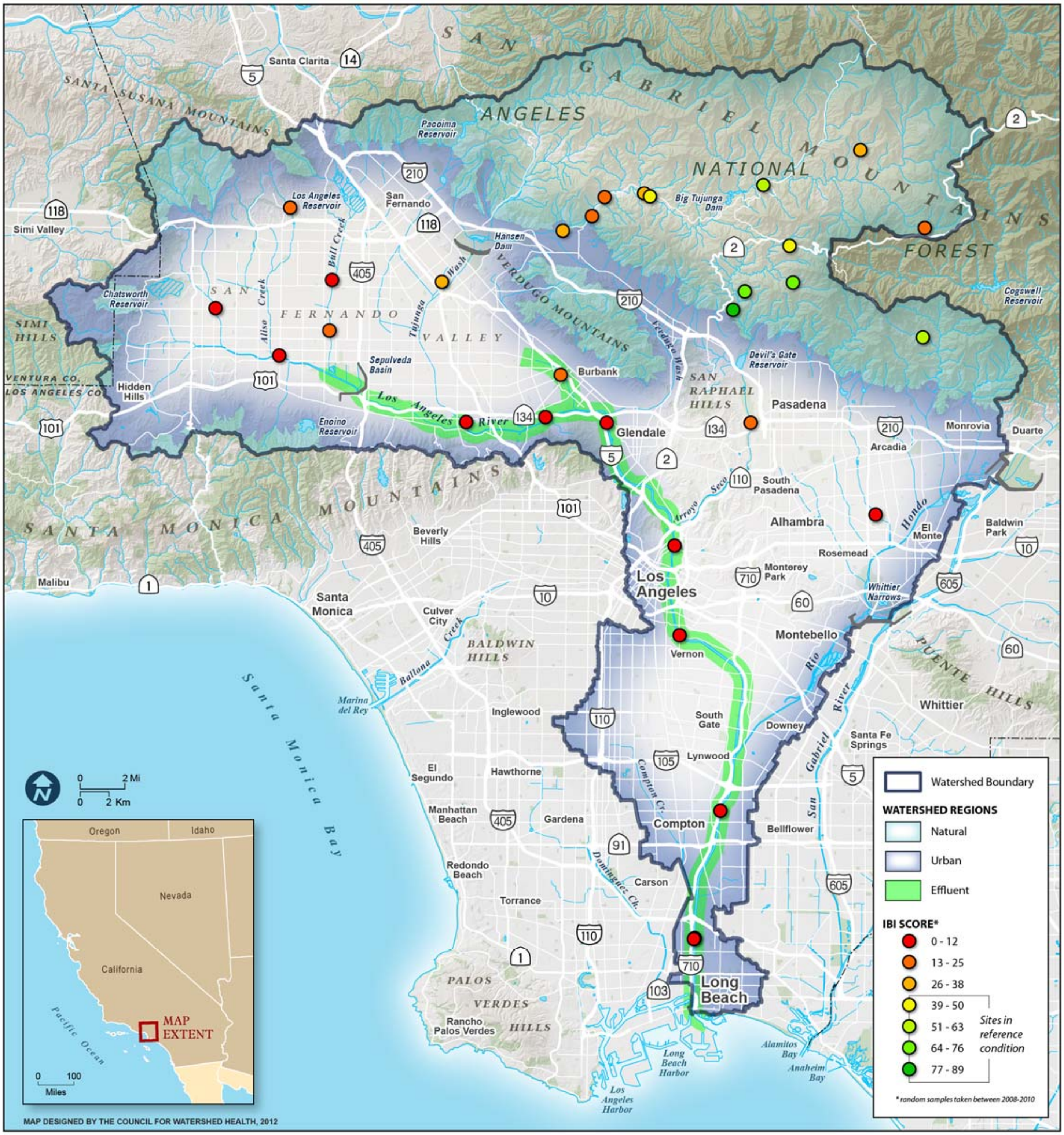


Figure 7. IBI scores for random sites sampled in 2008 and 2009.

Table 8. IBI metrics, summed scores and IBI ranks for random sites for 2010, organized by sub-region.

Metric	Effluent		Urban				Natural			
	LAR00318	LAR02622	LAR01208	LAR01452	LAR01716	LAR01972	LAR01096	LAR01196	LAR01544	LAR01320
EPT Taxa	0	0	0	0	0	0	0	0	0	0
Predator Taxa	0	0	0	0	0	0	0	4	8	0
Coleoptera Taxa	0	0	0	0	0	0	0	0	8	0
% Non-Insect Taxa	0	1	0	0	10	4	8	7	6	8
% Intolerant Individuals	0	0	0	0	0	0	0	0	0	0
% Tolerant Taxa	4	2	3	2	0	2	6	2	0	10
% Collector Individuals	0	0	1	0	0	0	1	1	6	9
Total	**4**	**3**	**4**	**2**	**10**	**6**	**15**	**14**	**28**	**27**
Adjusted Total	**5.72**	**4.29**	**5.72**	**2.86**	**14.3**	**8.58**	**21.45**	**20.02**	**40.04**	**38.61**
IBI Rating	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Very Poor**	**Poor**	**Poor**	**Fair**	**Poor**

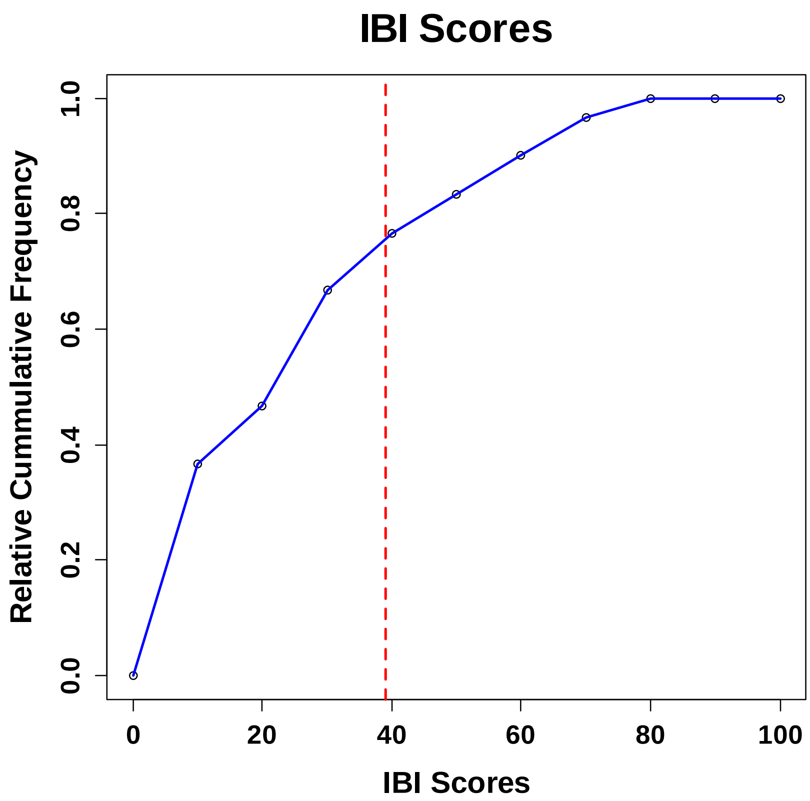


Figure 8. Cumulative frequency distributions of IBI scores at random sites in 2008 and 2010.

Cluster Analysis

Cluster analysis is a multivariate statistical method used to group sites based on composition of species and their relative abundances, so that sites that have similar communities of BMIs will group together. The station and species dendrograms produced from this analysis can be grouped into a single two-way table of species by site clusters or groups. The ecological characteristics of each site group can then be assessed by looking at the pollution tolerance and feeding strategies of the species that fall into each group.

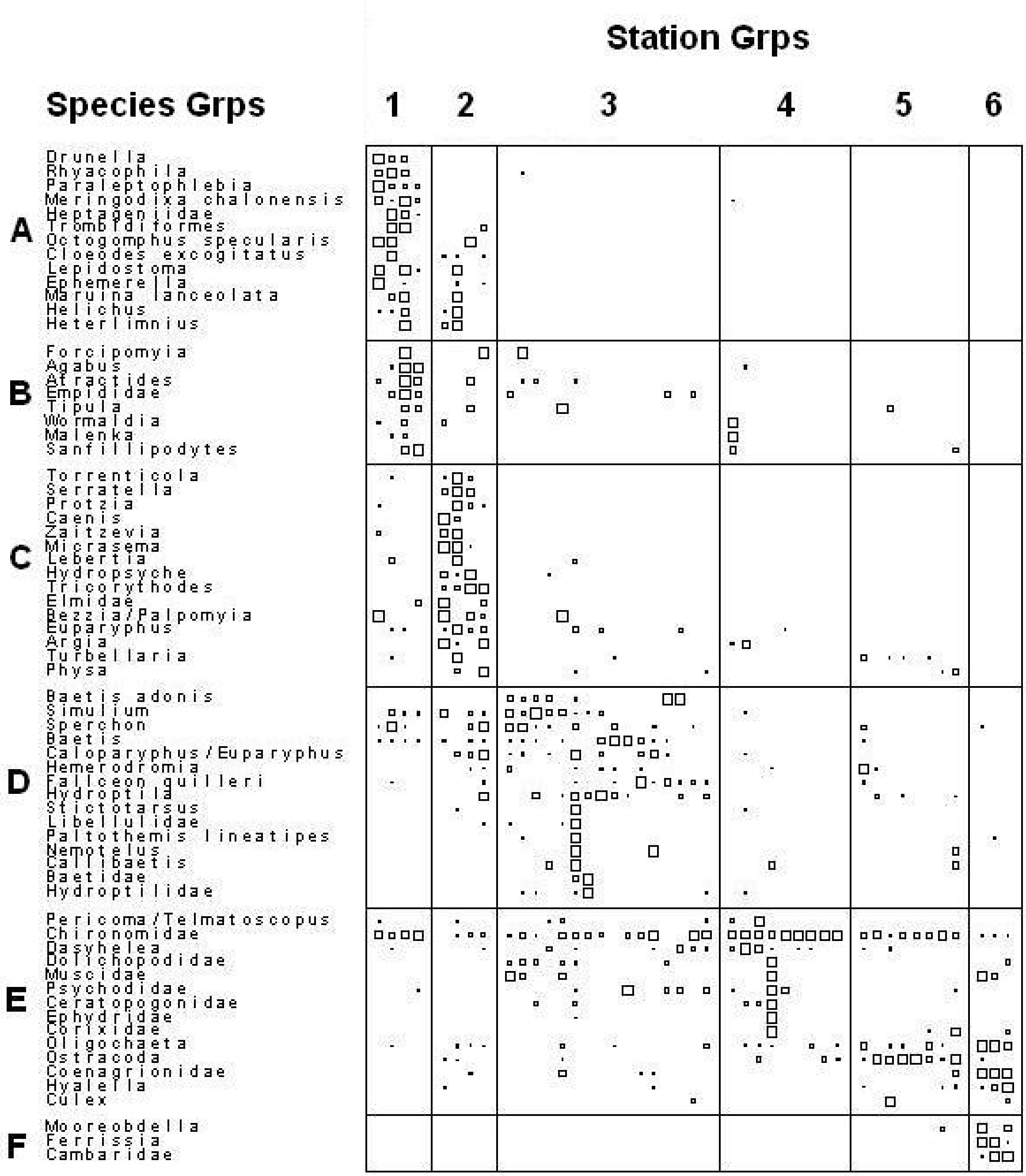


Figure 9 shows the two-way coincidence table of the relative distribution of species at each site from the 2008, 2009 and 2010 surveys. Horizontal and vertical lines on the two-way coincidence table identify major groupings of species and sites, respectively, and show the distribution across the watershed of stations in the six site groups. The abundance of each species was standardized in terms of its maximum at each site over all surveys. Smaller symbols represent a lower proportion of maximum abundance and larger symbols a larger proportion.

Results from this analysis grouped the stations into six main clusters (1 to 6), the first two representing natural sites in the upper watershed in 2008 and 2009, respectively (Figure 9). There was a clear demarcation between annual surveys with 2009 and 2008 stations grouping separately in each sub-region. Cluster group 3 represents sites located in the effluent and urban sub-regions, and sites located at natural upper watershed sites that burned during the Station Fire. Cluster 4 included sites located in cement lined channels in the lower watershed, but also included a single site at the top of the upper watershed (LAR0080).

Species grouped into five clusters (A to E) that were composed of species with varying ranges of pollution tolerance. Species group A predominated in upper watershed sites in 2009, while group D occupied upper watershed sites in both 2008 and 2009, and E dominated upper watershed sites in 2008. Average pollution tolerances of the species within these groups ranged from moderately sensitive (5.4, group A) to sensitive (3.1, group D). These species groups were relatively diverse and were composed of species that employ a wide range of feeding strategies.

Species group B exhibited a transition from the upper watershed to the lower watershed and had a moderate tolerance score. Group C included mostly species found at sites in the urban and effluent dominated sub-region. These sites were the least diverse of all sites and were represented by relatively pollution tolerant species that were, for the most part, collector gatherers.

The natural flowing upper watershed sites were characterized by an array of intolerant, semi-tolerant, and tolerant organisms typical of southern California coastal mountain habitats. Although not completely devoid of tolerant organisms that are more typical of poor habitat quality, these species did not dominate the upper watershed sites. Feeding strategies in the upper watershed sites included a healthy mixture of predators, scrapers, shredders, and collector gatherers/filterers (Figure 11). Feeding strategies within the urban/effluent dominated sites consisted primarily of collector gatherers and predators and filters were also relatively abundant at the urban sites. A lack of benthic macroinvertebrate diversity, in conjunction with a rather monotypic feeding strategy throughout all urban/effluent sites, is indicative of aquatic systems heavily affected by anthropogenic stressors, such as lined conveyance systems with very low habitat structure or diversity.

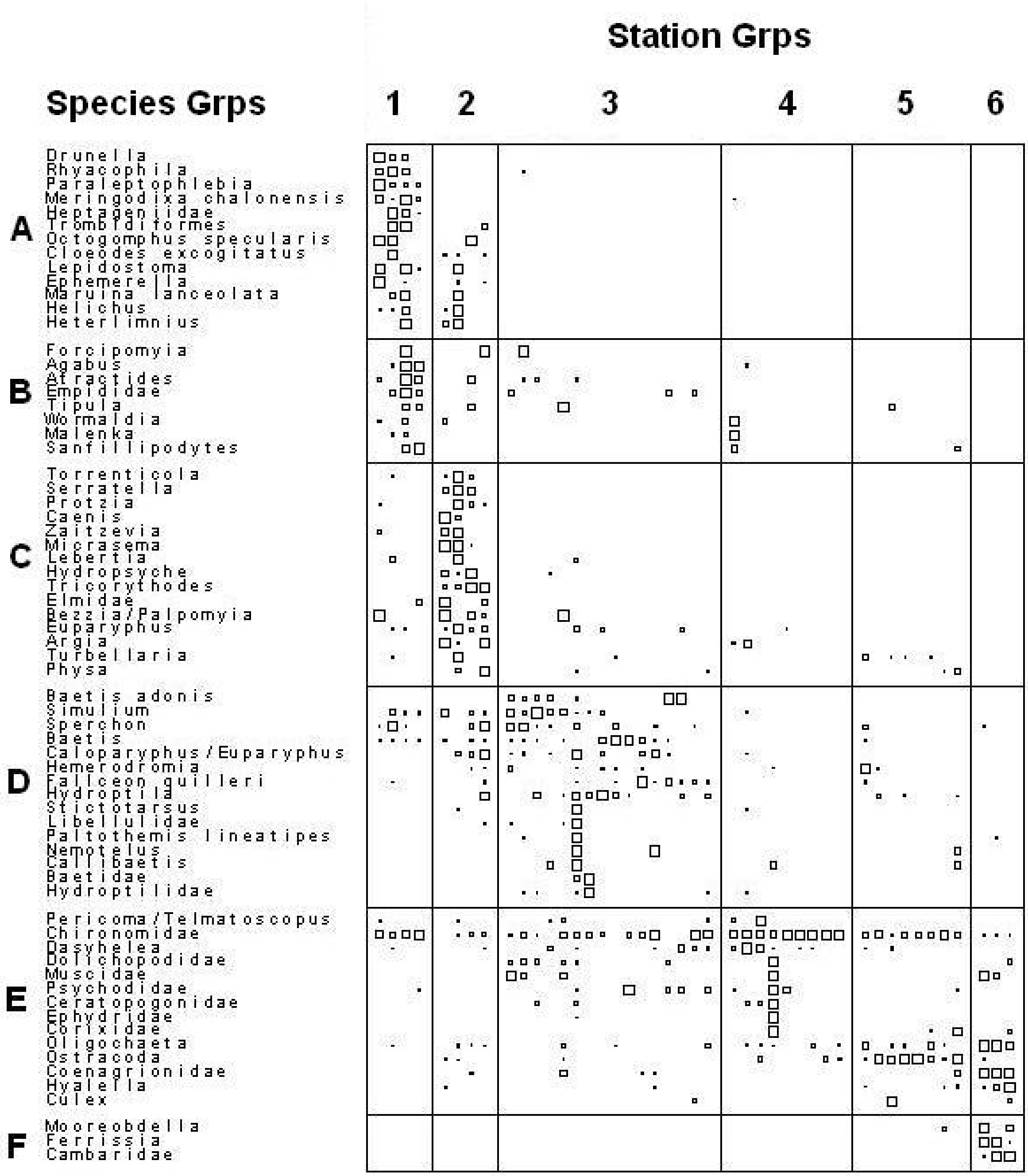
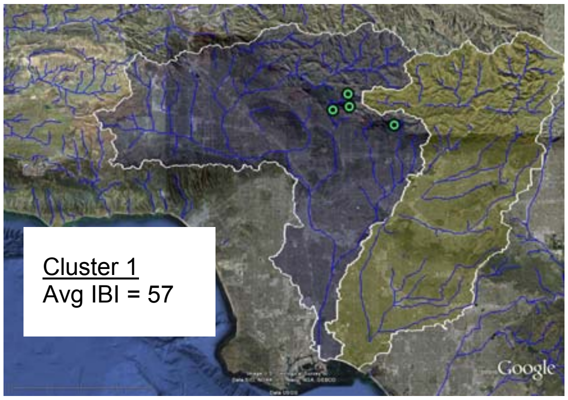
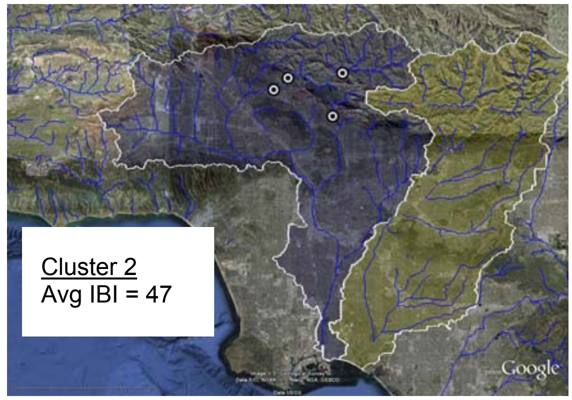


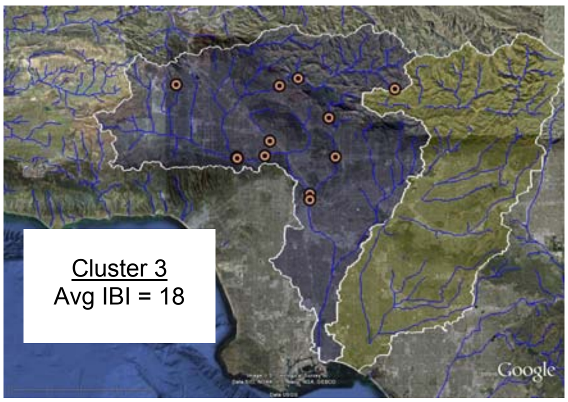
Figure 9. Two-way coincidence table of species and site groups from cluster analyses (Bray Curtis Similarity, square root transformed) for 2008 and 2010 random sites combined.



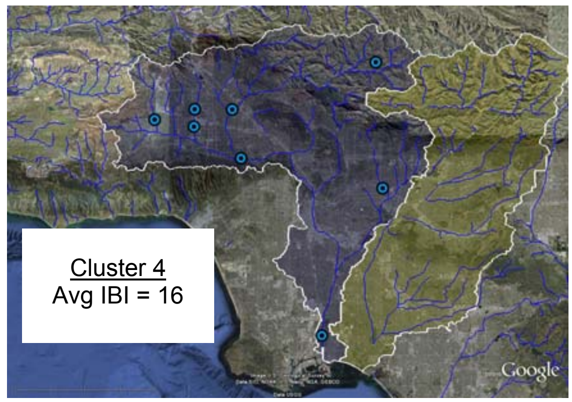
Upper watershed 2008, natural riparian



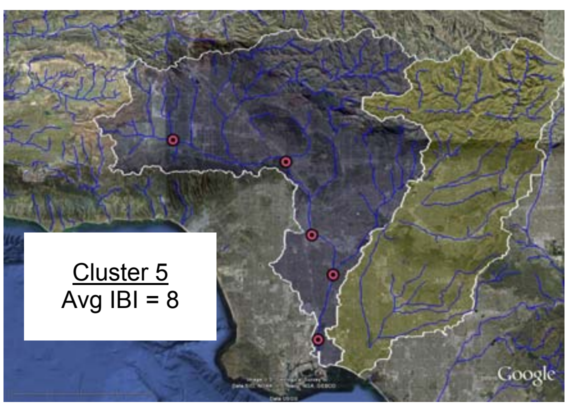
Upper watershed in 2009, natural riparian, prior to Station Fire



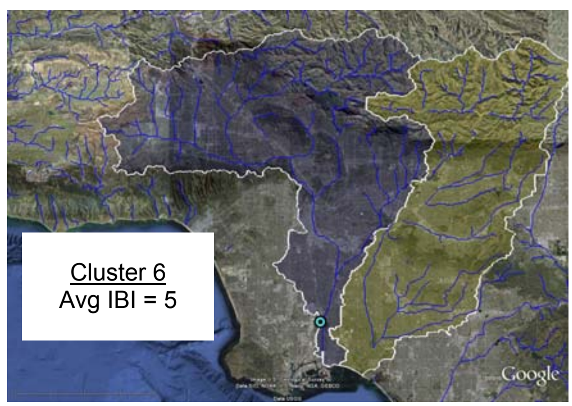
Lower watershed in 2008-09; upper watershed in 2010 after Station Fire



Lower watershed in 2008 and 2010; cement lined channels



Mainstem channel from 2008 to 2010; cement lined channel



Compton Creek from 2008 to 2010; cement lined channel

Figure 10. Station cluster groups for random sites from 2008 to 2010 with average IBI scores for each cluster group.

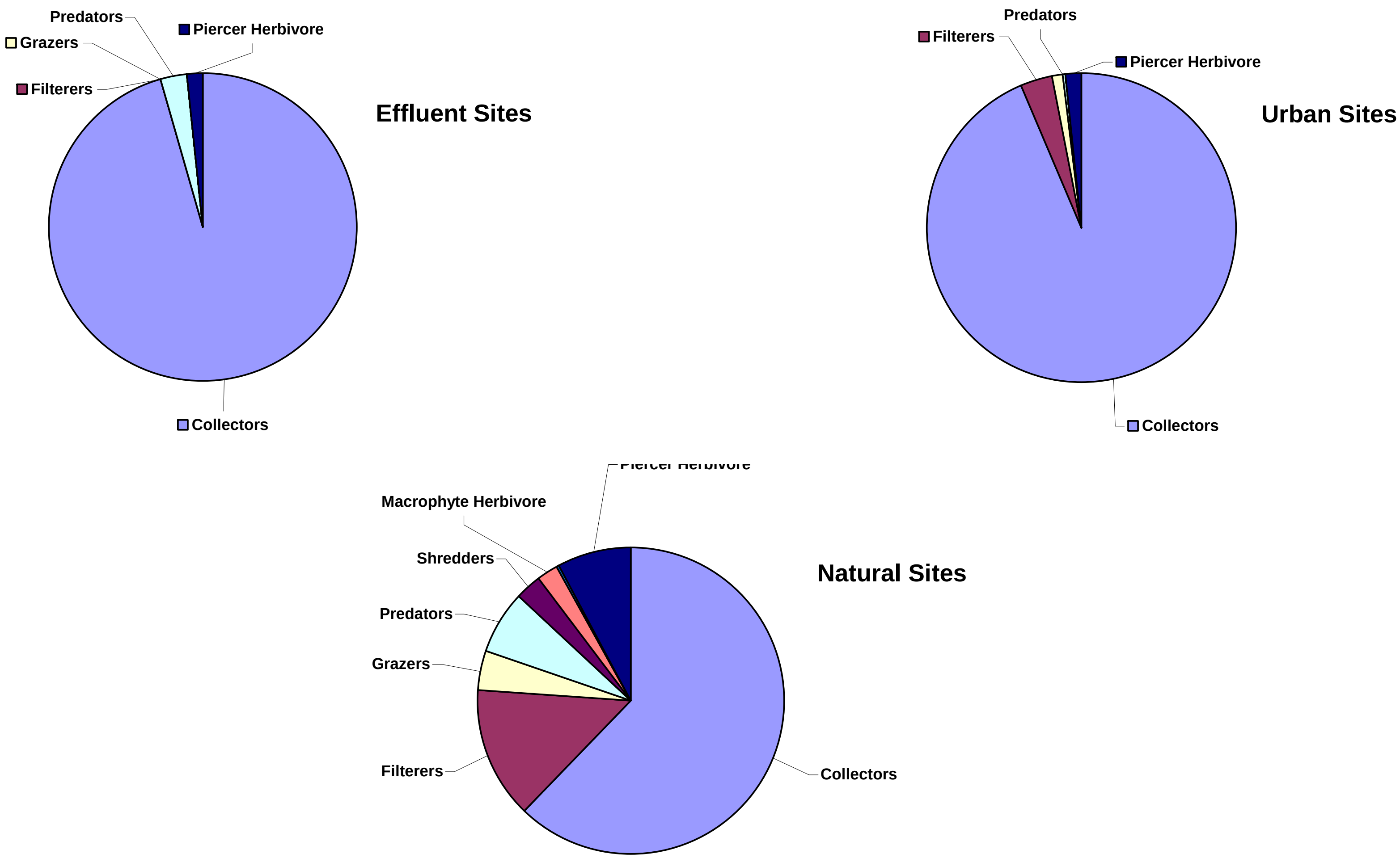


Figure 11. Relative proportion of macroinvertebrate functional feeding groups in each watershed sub-region for 2008 and 2010 random sites combined.

Physical Habitat Assessments and CRAM

Physical habitat was assessed at each random site from 2008 through 2010, and CRAM assessments commenced in 2009. SWAMP (2007) protocols describe the physical habitat assessment that focuses on streambed quality and the condition of the surrounding riparian zone out to 50 meters. The CRAM assessment focuses to a lesser extent on the streambed and includes more information on the surrounding riparian corridor, buffer zone, hydrologic connectivity, vegetative cover, and invasive plant species. Combined, these protocols provide a detailed assessment of the overall quality of the site and its surrounding habitat.

Streams in the watershed exhibit a broad range of physical habitat conditions in terms of overall integrity of the riparian and stream habitat (

, Figure 13). The CRAM scores at all sites ranged from 27% (with the minimum score possible of 27%) to 99% (out of a maximum possible score of 100%). The upper watershed, which is comprised of mostly natural streams, had the highest CRAM scores while the mainstem of Los Angeles River, which is a cement-lined channel, had the lowest CRAM scores (= 27). CRAM scores in the urban portion of the watershed were the most variable.

Each CRAM score is composed of four individual attribute scores that define the condition of the riparian buffer zone, hydrology, and physical and biotic structure (

). Natural sites were characterized by wide, undisturbed buffer zones, good hydrologic connectivity, and a multilayer, interspersed vegetative canopy composed of native species. In contrast, the effluent-dominant sites had no buffer zones, highly modified cement-lined channels, and lacked vegetative cover of any kind. Intermediate to these extremes were the urban sites that included sites that ranged from cement-lined channels to nearly undisturbed reaches.

The CRAM results underscore the contrast between the highly urbanized lower watershed and the relatively natural conditions found in the upper watershed. Development in the lower watershed has virtually eliminated natural streambed habitat and surrounding buffer zones. In most cases, the natural riparian vegetation has either been eliminated or replaced by invasive or exotic species.

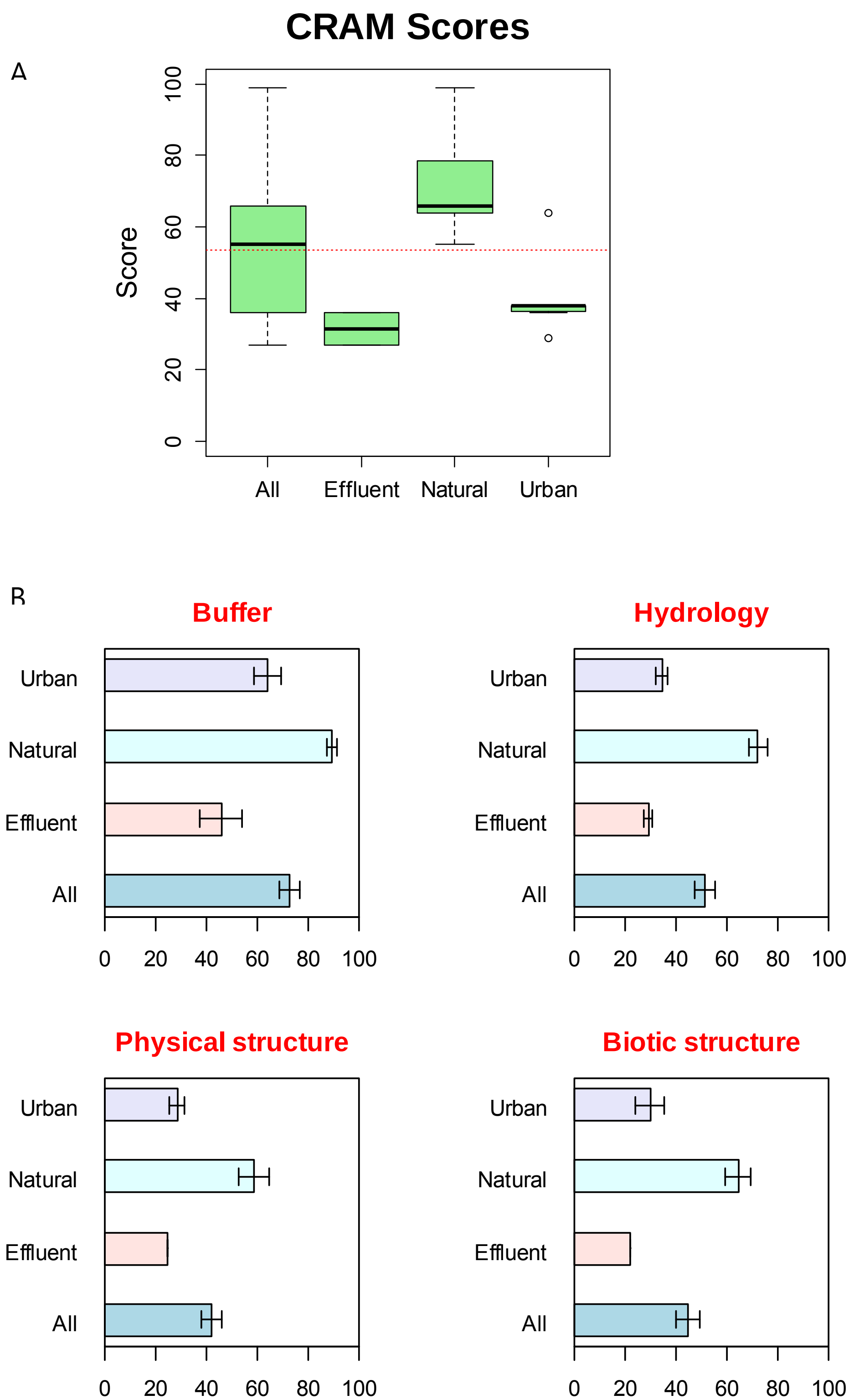


Figure 12. Median overall CRAM scores (A), and individual attribute scores (B), by watershed sub-region for all random sites combined from 2008 to 2010.

Figure 13. Overall CRAM scores for random sites in 2008 -2010.

Relationships among Chemical, Toxicological, Physical and Biotic Conditions

Finally, a comprehensive assessment of the condition of streams throughout the watershed requires an evaluation of the relationships between the measured chemical, physical habitat, and biotic conditions. Appendix B, Table B-1 represents a subset of all the possible correlations between IBI scores and 25 water quality and physical habitat measurements from 2008 through 2010. It includes their relative strength of association and statistical significance. Table 9 shows only the nine most significant correlations with IBI scores. The strongest positive correlations existed between IBI scores and epifaunal substrate cover, canopy cover, and cobble/gravel substrate. Each of these habitat characteristics was favorable for BMIs in the upper watershed where IBI scores were correspondingly high. Concrete and channel alteration were negatively correlated (-0.722 and -0.501, respectively) due to their prevalence in the lower watershed where IBI scores were correspondingly low. In addition, total nitrogen, temperature and conductivity were all elevated in the lower watershed, and were significantly negatively correlated with IBI scores.

The association of biological community condition with physical habitat condition has been observed in a number of other bioassessment programs in southern California watersheds (e.g., San Gabriel River, Ventura River, and County of Orange) (Viswanathan et al. 2010, Weston 2005, Weston 2006), while strong relationships between biological communities and individual aquatic chemistry parameters typically have not been as resolute. The relationships observed here may be causal, or they may simply reflect the fact that other factors (not currently measured) and physical habitat alteration are highly correlated in urbanized environments. Other bioassessment tools are currently under development and may help to elucidate these relationships. One of these uses attached algae (periphyton) communities in much the same way that aquatic invertebrates are currently being used to assess habitat conditions in a watershed (SWAMP 2008).

Principle component analysis (PCA) was employed to explore the relationship between the physical and chemical parameters and the watershed sub-regions. PCA was performed on 23 of the 25 variables shown in the correlation matrix. Salinity and epifaunal substrate cover were excluded from the analysis since they were highly correlated with other variables, e.g., electrical conductivity and canopy cover, respectively. Total Suspended Solids were not measured in 2010 due to over sight and were not included in this analysis.

Table 10 shows the first five principle components that explained 79% of the total variation in the aquatic chemistry and physical habitat data, with the first three components explaining 43%, 12%, and 11% of the variance, respectively. The component loadings correspond to the correlation between the variables and the newly formed components. The first principle components explained 43% of the variance and were negatively contributed to by all aquatic chemistry variables, with the exception of alkalinity, and positively contributed to by the physical and biological parameters, including canopy cover and IBI scores. The second component explained an additional 12% of the variance and was positively represented by alkalinity, hardness and nickel and negatively represented by temperature, pH, and canopy cover. These first two components show that the variability between sites throughout the watershed is explained by both chemical and physical parameters.

Table 9. Correlations of So CA IBI scores vs. chemical, biological, and physical habitat measurements from 2008-2010. Only the nine most significant parameters are shown.

	Channel Alteration	Epifaunal Cover	EC.	Salinity	Temp.	Concrete	Cobble	TKN	Canopy Cover
IBI Score	-0.501	0.860	-0.542	-0.482	-0.569	-0.722	0.767	-0.659	0.769

Table 10. Component loadings for the first five principle components. Bold values for the variable loadings are considered important for the respective component.

Importance of components:

	Comp.1	Comp.2	Comp.3	Comp.4	Comp.5
Proportion of Variance	0.429	0.117	0.110	0.070	0.063
Cumulative Proportion	0.429	0.546	0.656	0.726	0.790
Loadings					
Alkalinity	0.104	0.508	-0.117		-0.154
pH	-0.186	-0.225	0.291	0.189	
DO	-0.126		0.393		-0.13
As	-0.102			0.574	
Cr	-0.105	-0.157	0.17	-0.482	0.419
Cu	-0.266				0.233
DOC	-0.273		-0.203	0.222	-0.128
Hardness		0.542	0.139		
Fe			-0.506	-0.204	-0.157
Pb	-0.222	0.115	-0.268		0.299
Ni	-0.219	0.392			
TOC	-0.217		-0.297	0.109	-0.328
Zn	-0.249		-0.113	-0.289	0.14
Channel.Alt.	-0.231	-0.151		-0.274	0.123
Sediment Deposition				-0.462	-0.272
EC.	-0.21	0.289	0.142		-0.155
Temp	-0.212	-0.239	0.172	0.191	-0.304
Concrete	-0.296		0.115		0.136
Cobble	0.278		-0.123		-0.188
TP	-0.216		-0.328	0.126	0.281
TKN	-0.256	0.136			
Canopy Cover	0.264	-0.146	0.116	0.102	-0.117
IBI score	0.26			0.186	0.234

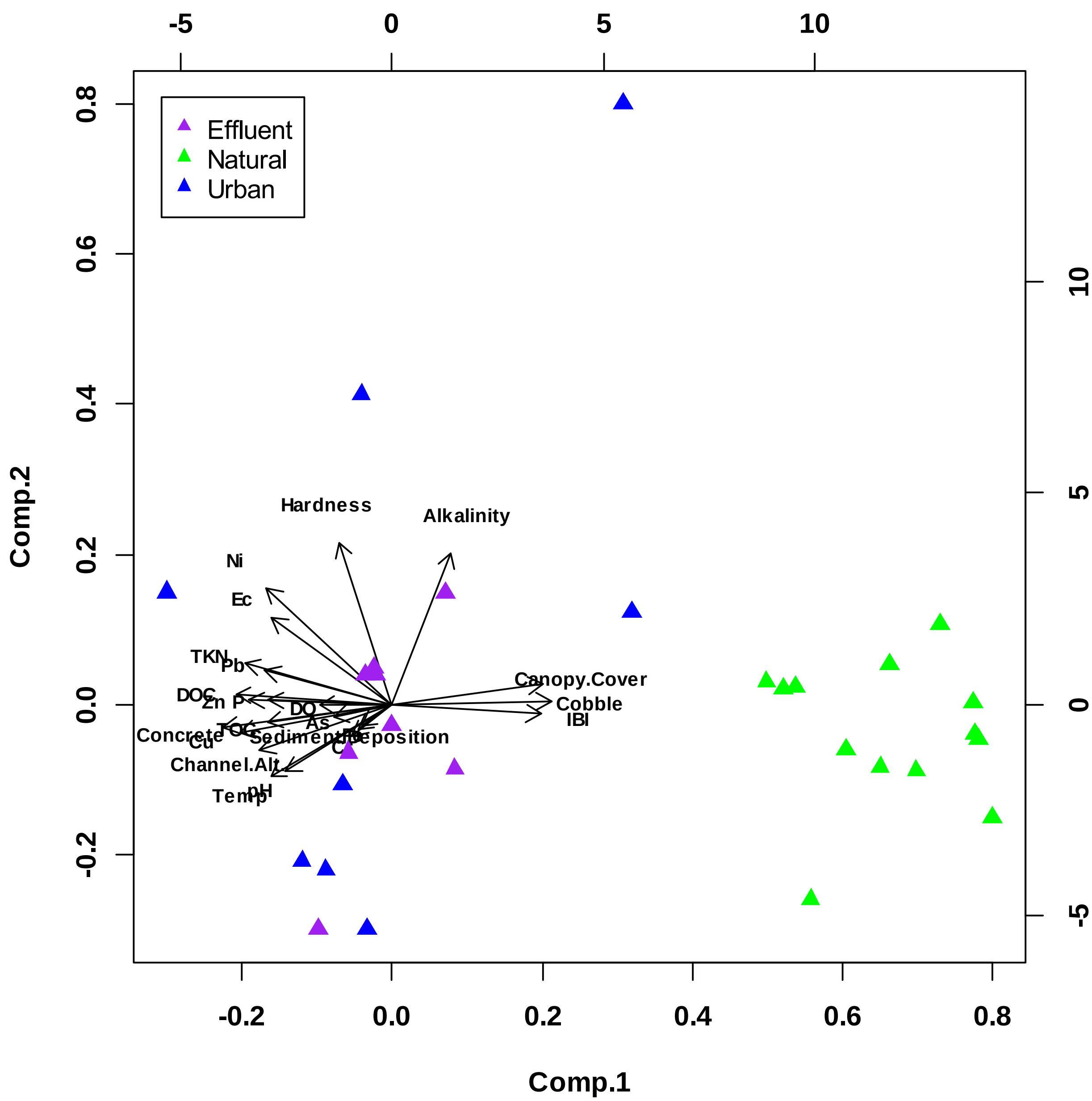


Figure 14. Biplot of the first two principle components using $\log_e(x+1)$ transformed data for 20 water quality variables and grouped by watershed sub-region.

Figure 14 shows the biplot of the first two retained principle components for the 20 variables and the watershed sub-regions. Sites in the effluent-dominated reaches are associated with concrete-lined channels and both elevated temperature and pH. These sites were also associated with higher levels of dissolved oxygen, suggesting that photosynthetic processes may be higher in this sub-region compared to other sites.

Figure 14 shows the negative association between alkalinity and DO, as well as pH and a slightly positive association with hardness. Since alkalinity typically increases as CO_2 is converted to carbonate species during photosynthesis, a positive association between the aforementioned variables is expected. In this study, the highest alkalinity values were recorded at the urban site LAR0044. Site LAR00440 is located in Aliso Canyon Wash, Granada Hills, in an unlined modified channel surrounded by residential housing. It drains 21 square miles and is the second major tributary to enter the Los Angeles River downstream of the Bell Creek/Calabasas Creek merge. The cause of high alkalinity at this site cannot be discerned based on the current and prior land-use in the area.

The urban sites were mostly associated with dissolved metals, nutrients, and hardness typical of streams dominated by urban runoff. In contrast to effluent and urban sites, the natural upper watershed sites were associated with greater canopy cover and high IBI scores for the benthic macroinvertebrate communities.

Chapter Summary

The ambient condition of streams in the Los Angeles River Watershed was assessed using a variety of indicators collected at randomly selected sites in three sub-regions (natural, urban and effluent dominated). Indicators included water chemistry, toxicity, bioassessment and physical habitat condition.

- Dissolved oxygen, pH and temperature were greatest at effluent dominated sites and lowest at natural upper watershed sites. Water Reclamation Plants and urban run-off discharge into concrete lined channels, with limited canopy cover. Therefore, sunlight has the opportunity to increase water temperature and encourage photosynthesis, which results in cyclic oscillation in pH, oxygen and carbon dioxide concentrations.

- The concentrations of zinc, selenium, lead, and nickel were highest at effluent dominated sites and arsenic, chromium and copper were higher at urban sites. Other than copper and selenium in urban streams, concentrations of the other metals were generally below CTR thresholds.
- Effluent-dominated sites had higher median concentrations of these nutrients compared to the other sub-regions and the range of values was greatest at the urban sites. Nitrogen concentrations at all watershed sub-regions were below the basin plan objective of 10 mg/L-N for nitrate and 1.0 mg/L-N for nitrite.
- Toxicity was evaluated based on the 7-day *Ceriodaphnia* survival and reproduction test in 2010. None of the 10 random sites recorded acute toxicity, however, seven of the ten sites showed chronic toxicity, three urban sites and four at upper watershed natural sites. There was no clear reason for this chronic toxicity.
- Watershed-wide, nearly 80% of the random sites sampled during the two year period had IBI scores that indicated degraded habitat or ecosystem conditions, most of these were concrete lined channels in the urban and effluent dominated sub-regions.
- Physical habitat conditions, as measured by CRAM, were poorest in the lower watershed, where concrete channels predominate, and best in the upper watershed.
- There was a strong positive correlation between good biological conditions (IBI scores) and epifaunal substrate cover, canopy cover, and cobble/gravel substrate. Each of these habitat characteristics was favorable for BMIs in the upper watershed where IBI scores were correspondingly high. IBI scores were generally lowest in the urban and effluent sub regions, where concrete lined channels predominate.

Question 2. Are conditions at areas of unique interest getting better or worse?

Question 2 addresses locations in the watershed that include the confluence of major tributaries to the Los Angeles River, the estuary, and natural habitat that is relatively scarce in the region. The monitoring approach and indicators for each of these locations is described below:

- To determine temporal trends and the relative differences between sub-watersheds, four target sites were established upstream of tributaries to major Los Angeles River confluence points. These sites differ from the random sampling component of the program because their locations are fixed and are sampled each year. Over time these data will be used to assess how parameters are trending and if changes in these trends can be attributed to natural, anthropogenic or watershed management changes. During 2010 samples were collected for the third year at each of these sites for water chemistry, toxicity, bioassessment and CRAM.

- To determine the condition of both the water and sediment quality in the Los Angeles River estuary, a single sampling location, representative of overall estuary conditions, was established in the Estuary near the Los Angeles River mainstem (Figure 15). This program was designed so that data assessment tools specific to the sediment quality objectives (SQOs) developed by SWAMP could be used to assess the condition of the Estuary (SCCWRP 2008). As a result, sediment samples were collected for chemistry, toxicity and benthic infauna. The results for both 2009 and 2010 are presented below.

- To determine the condition of areas of unique habitat, and follow conditions over time, the Workgroup chose eight high-value riparian locations in the watershed for annual CRAM assessments. The emphasis of this assessment is on habitat conditions, rather than water quality, and should provide valuable data for potential restoration or protection efforts in the watershed.

Trends at Freshwater Target Sites

A total of 12 samples have been collected from the four target sampling locations during the three annual surveys from 2008 to 2010 (Figure 15 and Table 11). Samples were collected and analyzed for aquatic chemistry, toxicity, biological and physical habitat condition at each site. The goal of repeated annual sampling at these locations is to monitor temporal and spatial changes in water quality conditions over time.

Figure 15. Location of confluence, estuary, and high-value habitat sites.

Table 11. Location of Confluence Sites

Targeted Sample Locations	Channel	Site ID	Latitude	Longitude
Confluence Sites				
Confluence of Rio Hondo and mainstem of LA River	Lined	LALT500	33.93557	-118.171
Confluence of Arroyo Seco and mainstem of LA River	Lined	LALT501	34.08009	-118.224
Confluence of Compton Creek and mainstem of LA River	Unlined	LALT502	33.84655	-118.209
Confluence of Tujunga Creek and mainstem of LA River	Lined	LALT503	34.14832	-118.389

Aquatic chemistry

Aquatic chemistry results were highly variable for most constituents during the three year period suggesting that detecting temporal trends in water quality will most likely require many years of monitoring. There were, however, some findings of interest. Both total and organic carbon was greatest at the Western Burbank Channel (LALT503) and Cerritos Channel (LALT502) confluences during the period (Figure 16). Nitrate concentrations at the Arroyo Seco confluence was greatest during each year, but was below the water quality threshold protective of aquatic life (10 mg/L) specified in the Los Angeles Basin Plan (LARWQCB 1994). Total nitrogen increased over the three years at the Western Burbank Channel from 3 to 11 mg/L and was variable and lower at each of the other confluence sites. Both orthophosphate and total phosphorus were greatest at Cerritos Channel in 2008 (1.9 and 2.1 mg/L, respectively), and then decreased in 2009-2010.

Dissolved metals were routinely higher at the Western Burbank Channel (arsenic, cadmium, copper and mercury) and Rio Hondo confluences (LALT500; lead, selenium and zinc) during the period (Figure 17). The exception to this was nickel which was also elevated at the Cerritos Channel, especially in 2008. As mentioned above, trends will become more evident with future monitoring.

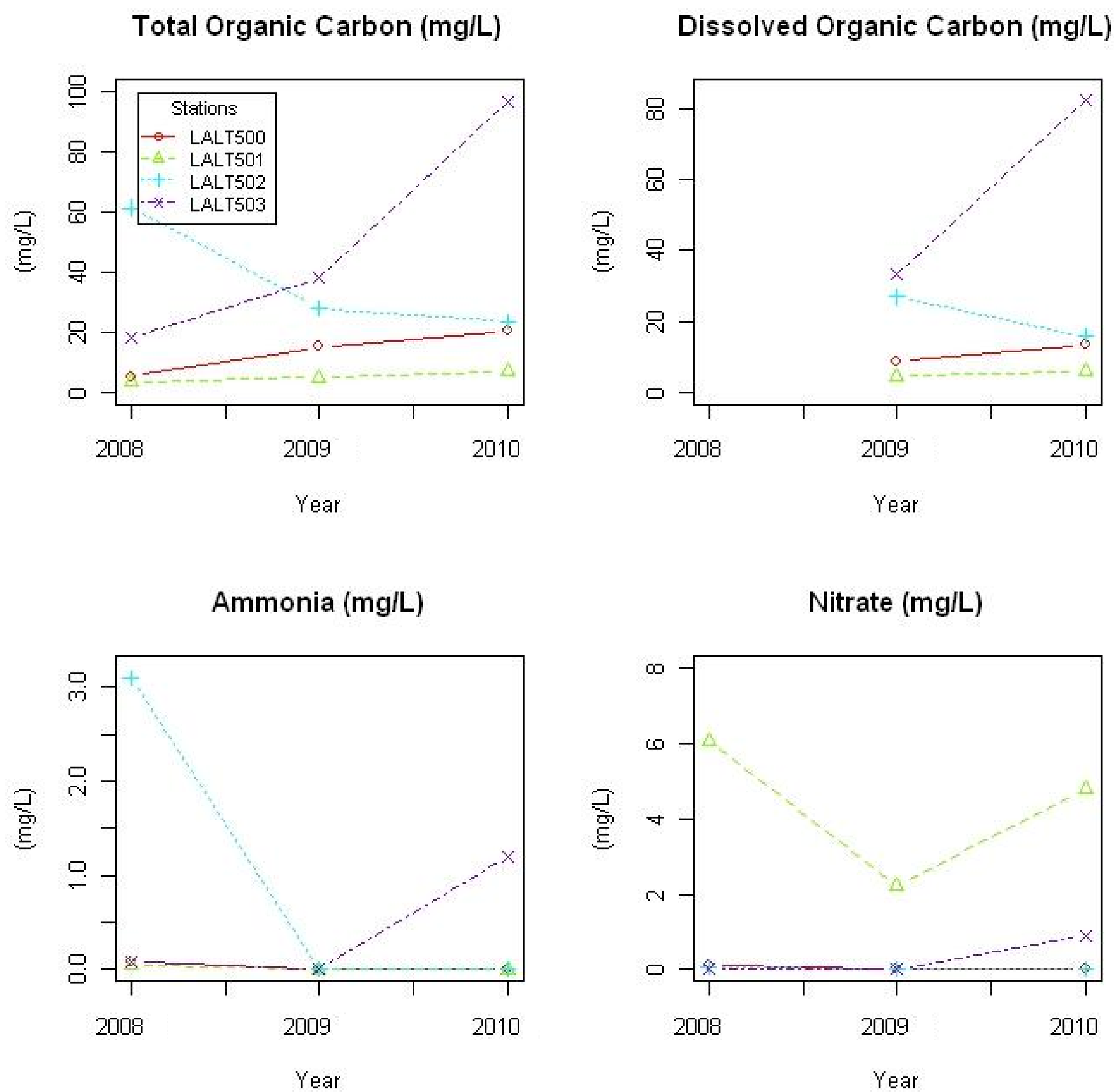


Figure 16. Nutrient concentrations at confluence sites sampled annually from 2008 to 2010.

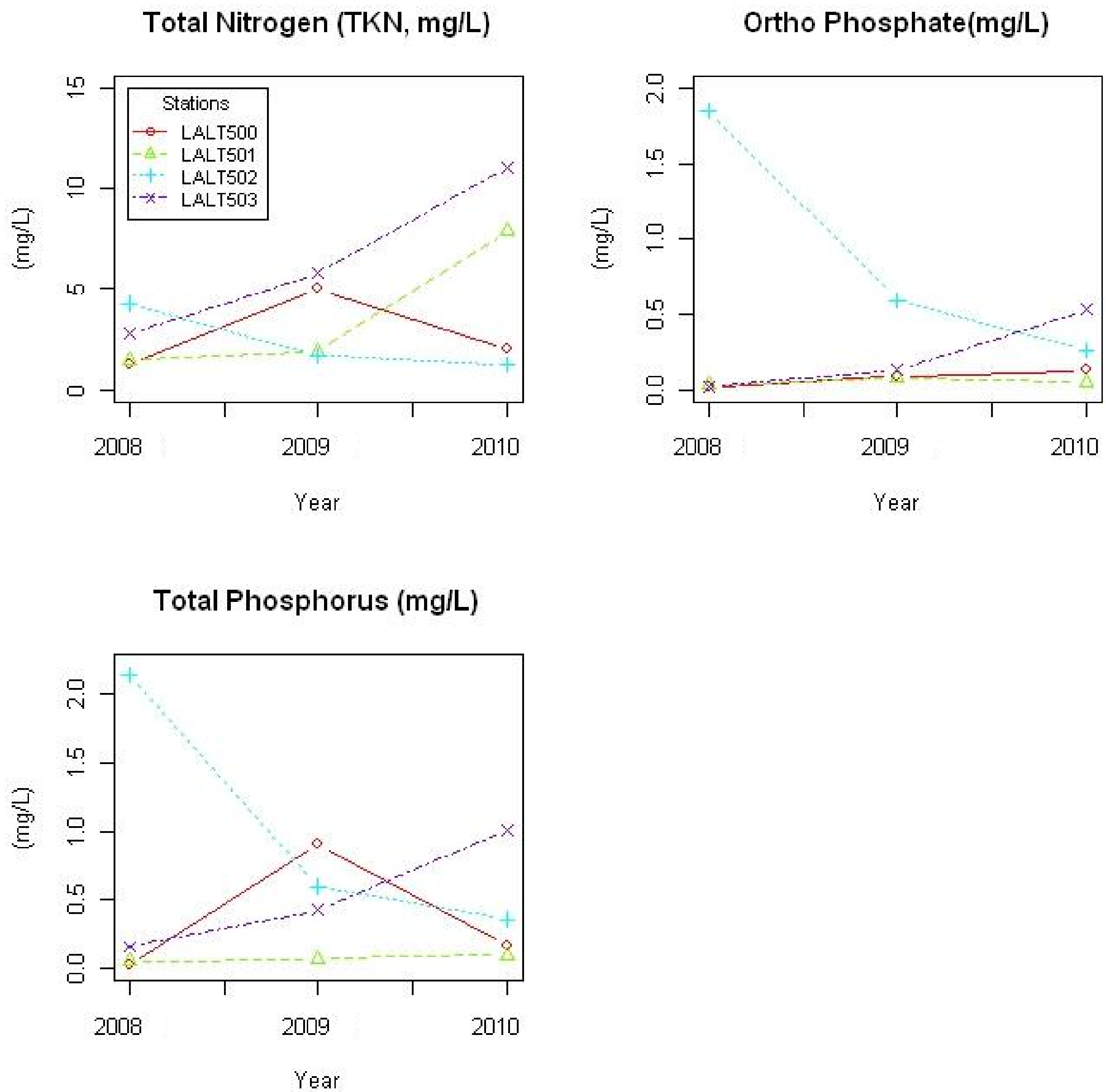


Figure 16. Continued

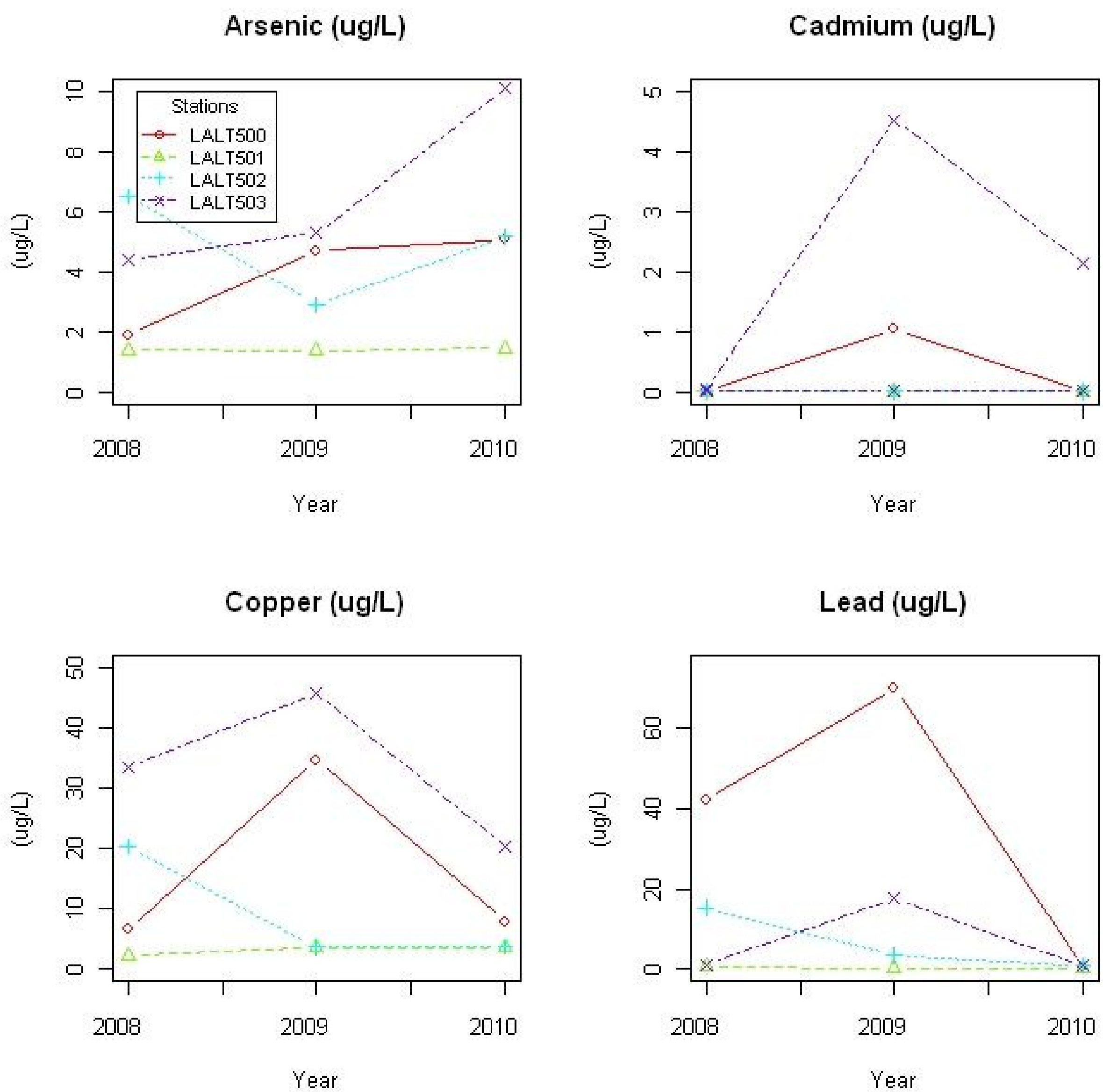


Figure 17. Dissolved metal concentrations at confluence sites sampled annually from 2008 to 2010.

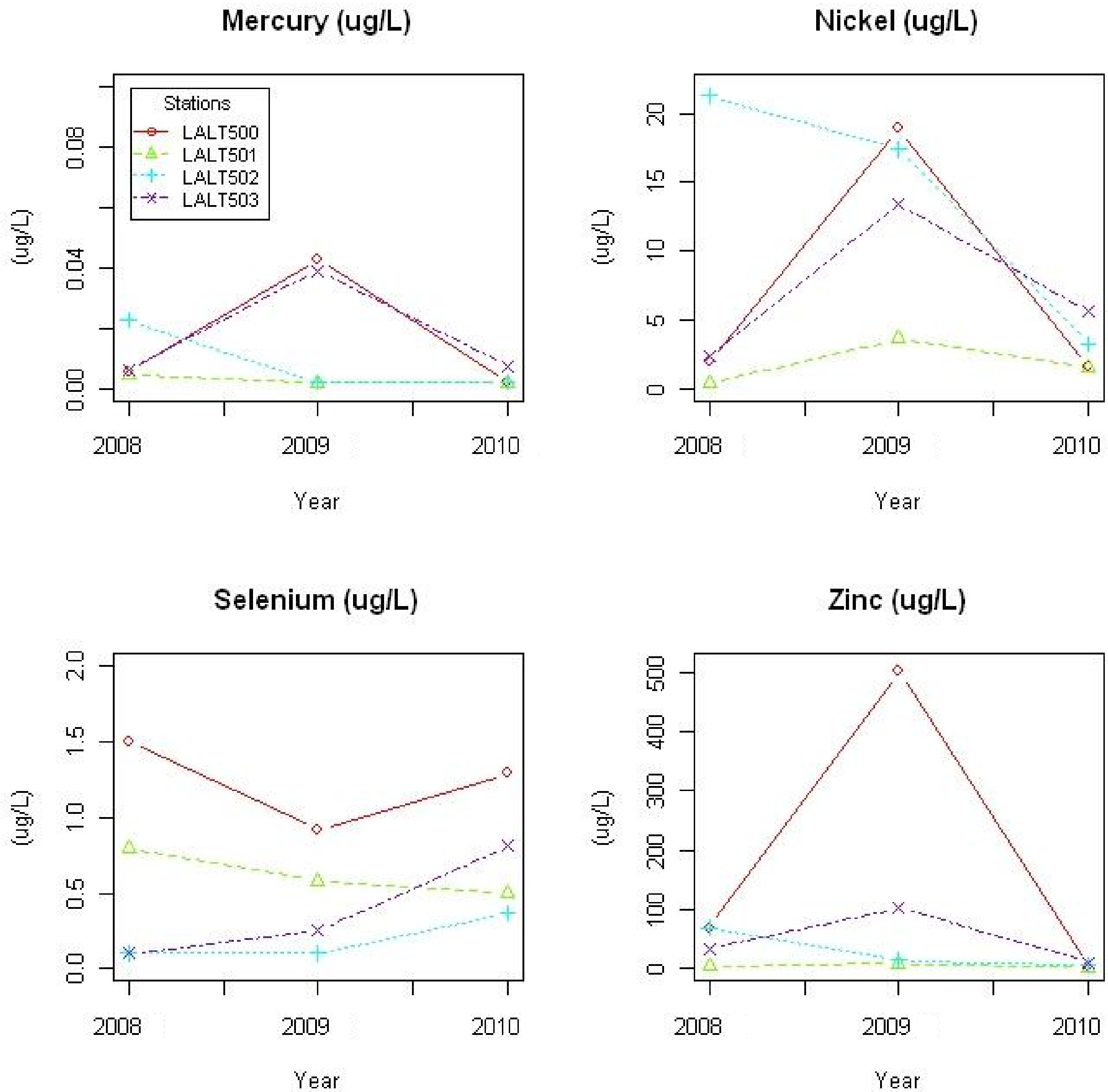


Figure 17. Continued

Toxicity

Toxicity was evaluated at the four target sites using the *Ceriodaphnia* chronic test (Table 12). No acute (survival) or chronic (reproductive) toxicity was measured in 2010.

Table 12. Summary of acute and chronic toxicity at LARWMP target sites during the 2010 watershed survey.

Station	Station Descrioption	Ceriodaphnia Toxicity	
		Survival	Reproduction
LALT500	Confluence of Rio Hondo and mainstem of LA River	NSG	NSG
LALT501	Confluence of Arroyo Seco and mainstem of LA River	NSG	NSG
LALT502	Confluence of Compton Creek and mainstem of LA River	NSG	NSG
LALT503	Confluence of Tujunga Creek and mainstem of LA River	NS	NSG
	Total Number Toxic	0	0

NS = treatment and control not signifiantly different and response greater than 80%
SL = treatment and control significantly differnet and response less than 80%
NSG = treatment and control significantly different, but response grater than 80%
NSL = treatment and control not significantly different, but response less than 80%

Biological and Physical Habitat Condition

Figure 18 presents Southern California IBI (So CA IBI) and CRAM scores for the targeted sites sampled from 2008 to 2010. The biological condition at each of the four sites scored in the 'very poor' range for all three years compared to 'reference site' conditions in southern California. CRAM scores were on the low end of the condition scale at each site ranging from poorest at the Arroyo Seco confluence (37) to best at the Cerritos Channel (55). This is not surprising given that these sites are located in highly modified channels in the urbanized portion of the watershed. In addition to good water quality conditions, healthy benthic macroinvertebrate communities require complex instream and riparian cover and a wide and undisturbed riparian and buffer zone.

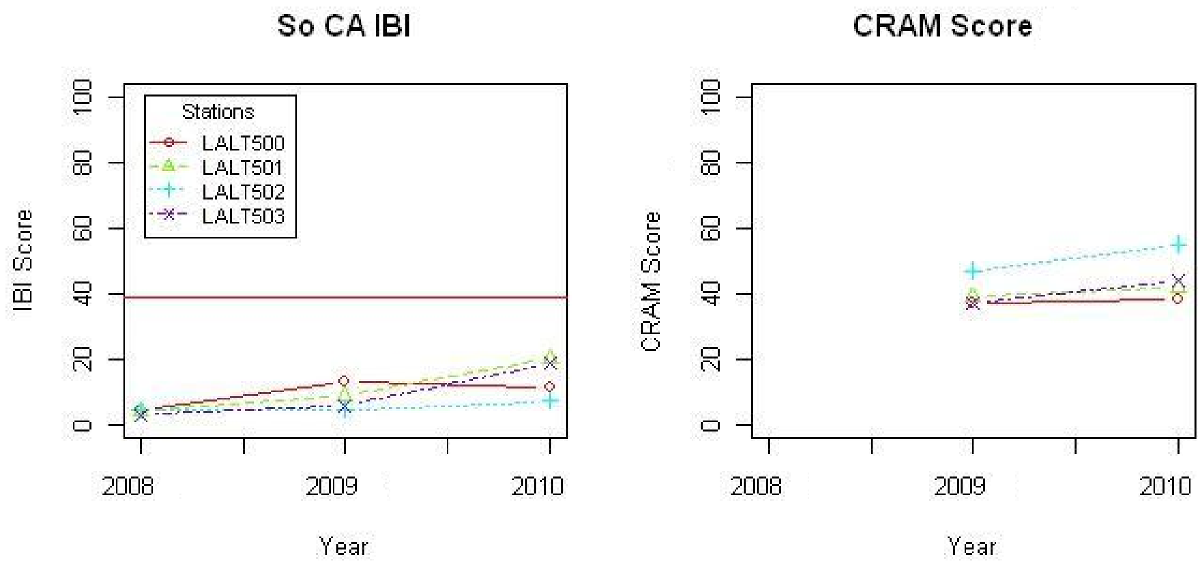


Figure 18. Southern CA IBI and CRAM scores at confluence sites sampled annually from 2008 to 2010.

Finally, the cluster analysis of biological data at random sites in 2008 thru 2010 was expanded to include data from targeted sites for each year (Figure 19). The first cluster-site group (A) is made up of sites in the natural portion of the watershed. The dendrogram shows that targeted sites were distributed among clusters B, C and D. Station LALT501 remained in cluster-site group B during the three year period, as did stations LALT500 and LALT502 (cluster-site group D). This indicates that the taxa composition and abundance at these sites was comparable among years. The exception to this was the BMI community composition at Station LALT503 (LAR00756 in 2009) in the Western Burbank Channel which shifted from site group B in 2008 and 2009 to cluster-site group C in 2010. This change was due to an increase in diversity and evenness at this site in 2010. Future samples from this site will help to determine if this shift is permanent.

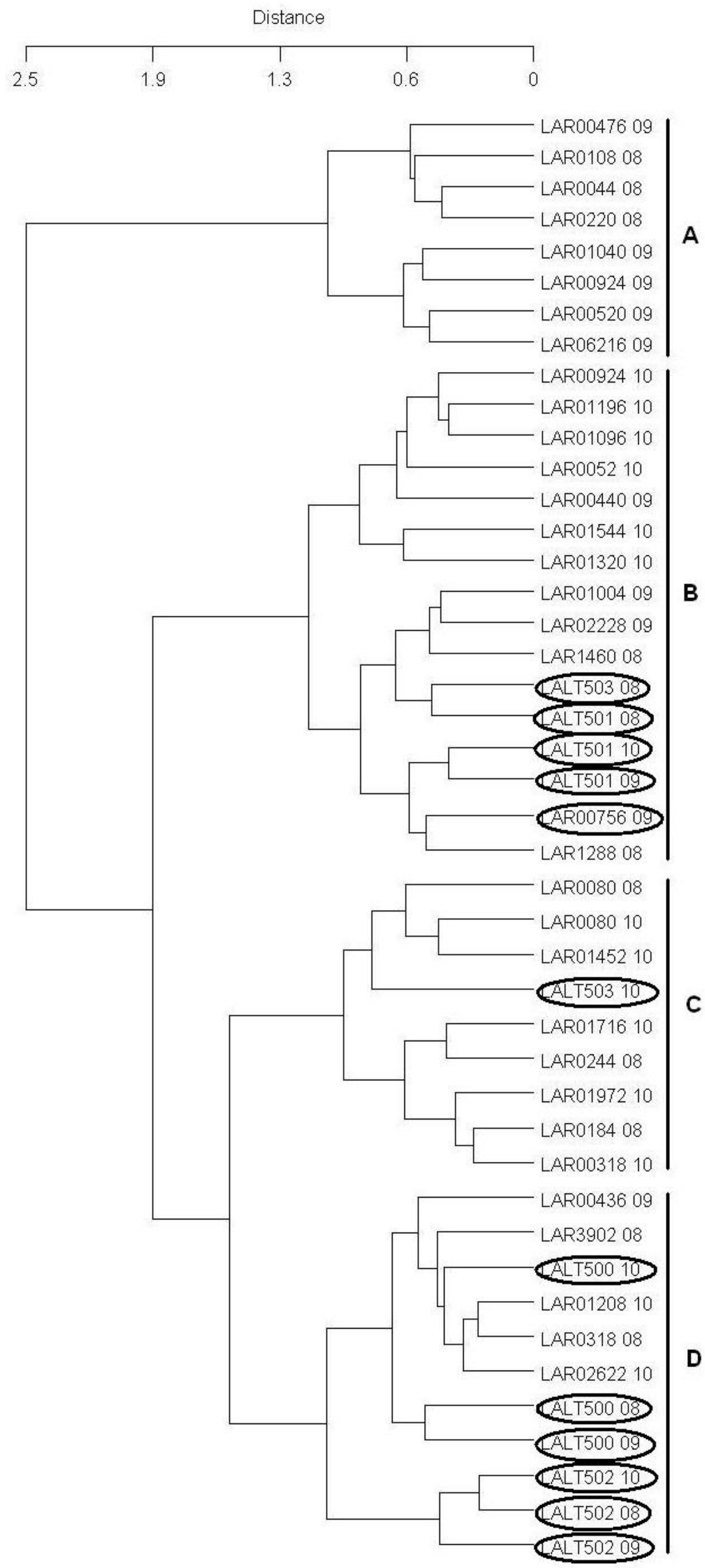


Figure 19. Station dendrograms from the cluster analyses for all watershed stations from the 2008 and 2010 surveys. Confluence sites for both years are circled. Random site LAR00756 was located at LALT503 in 2009 so that only a single set of samples was collected.

Los Angeles River Estuary

Sediment samples were collected in 2009 and 2010 at the mouth of the Los Angeles River Estuary near Queensway Bridge (Figure 15). The sediment chemical concentrations are compared against the effects range low (ER-L) and effects range medium (ER-M) threshold values (Long and Morgan 1990, Long et al. 1995) where possible. The ER-L represents a chemical concentration below which adverse impacts rarely occur and the ER-M represents concentrations above which effects frequently occur. Sediment toxicity testing included the 10-day amphipod (*Eohaustorius estuaries*) survival test and the 48 hour mussel (*Mytilus galloprovincialis*) development test. Infauna samples were collected and analyzed in adherence to protocols of the Southern California Bight Regional Monitoring Program (SCCWRP 2008).

The design of the LARWMP estuary monitoring program is based on a multiple line of evidence (MLOE) approach developed by SCCWRP for the State of California's Sediment Quality Objectives (SQO) program (SCCWRP 2008). This approach incorporates sediment chemistry, toxicity, and biological community assessments to evaluate the condition of sites located in marine embayments in southern California. The results of each of these analyses represent a line of evidence (LOE) that is converted to a condition category score. The three condition category scores are then combined to provide a single station assessment category.

Sediment Chemistry

Table 13 shows the concentrations of chemical constituents in the estuarine sediments. Of the eight metals measured that had corresponding ER-L and ER-M thresholds, cadmium and zinc exceeded the ER-L in 2009 and 2010 (Table 13). PAH concentrations were mostly below detection, except fluorene which exceed the ER-L 2009. Total PCBs were below the ER-L in both years, while total DDTs exceeded the ER-L in both years.

Sediment Toxicity

Both the amphipod survival and bivalve development toxicity tests showed significant toxicity at station EST2 in 2009, while the bivalve test was toxic in 2010 (Table 14). These results indicate that the test animals used for this study were sensitive to one or more sediment contaminants.

Benthic Infauna

During both 2009 and 2010, the benthic infauna populations were dominated by annelids (polychaetes) and arthropods (crustaceans) typical of those found in southern California bays and harbors (Table 15). In 2009 three polychaetes (*Mediomastus sp, Capitella capitata Cmplx and Prionospio (Minuspio) lighti*) and a crustacean (Grandidierella japonica) combined to make up 74% of the total population. In 2010 three crustaceans (Monocorophium acherusicum, Grandidierella japonica and Eochelidium sp A) and two polychaetes (*Euchone limnicola and Pseudopolydora paucibranchiata*) combined to make up 75% of the population. *Grandidierella japonica* was the only taxon in the top five most abundant species during both years.

The numbers of species and their total abundances at EST2 in 2010 were twice that collected in 2009, while Evenness, Shannon Diversity and dominance were similar between years (Table 16). The biological metrics used to calculate the SQO's include the Benthic Response Index (BRI), Benthic Response Index (BRI), Relative Benthic Index (RBI), and the Relative Benthic Index (RBI). The higher BRI, IBI and RBI scores in 2009 showed that sediment conditions were poorer compared to 2010. RIVPACS scores were the same between years (0.59) indicating that 60% of the species collected (observed) in each year were expected based on harbor reference sites located at similar depths in southern California. Integration of the chemistry, toxicity and infauna category scores showed that station EST2 had moderately disturbed conditions during both years (Table 17).

Table 13. Sediment chemistry concentrations at one site (EST2) in the Los Angeles River Estuary in 2009 and 2010. Concentrations are compared to NOAA ER-L and ER-M threshold values. Bold = exceeds ER-L.

AnalyteName	MDL	EST2		ERL	ERM
		2009	2010		
Metals (mg/Kg dry weight)					
Arsenic	0.2 - 0.22	3.89	0.93	8.2	70
Cadmium	0.009 - 0.02	3.89	1.13	1.2	9.6
Chromium	0.1 - 0.465	27.1	9.33	81	370
Copper	0.038 - 0.18	60.4	16	34	270
Lead	0.1 - 0.15	42.4	17.4	46.7	218
Mercury	0.0004	0.103	-	0.15	0.71
Silver	0.016 - 0.02	0.32	ND	1	3.7
Zinc	0.21 - 1	273	68	150	410
Organics (ug/Kg dry weight)					
Low Molecular Weight PAHs					
Acenaphthene	0.3 - 9.2	ND	ND	16	500
Acenaphthylene	0.3 - 8	ND	ND	44	640
Anthracene	0.2 - 11.5	ND	ND	85.3	1100
Fluorene	0.4 - 8.8	335	ND	19	540
Methylnaphthalene, 2-	13.6	ND	ND	70	670
Naphthalene	0.4 - 14.7	ND	ND	160	2100
Phenanthrene	0.2 - 7.3	ND	ND	240	1500
Sum LPAH	-	335	ND	552	3160
High Molecular Weight PAHs					
Benz(a)anthracene	0.2 - 8.2	ND	ND	261	1600
Benzo(a)pyrene	0.2 - 8	ND	ND	430	1600
Chrysene	0.2 - 9.3	316	ND	384	2800
Dibenz(a,h)anthracene	0.2 - 16.7	ND	ND	63.4	260
Fluoranthene	0.2 - 7.4	ND	ND	600	5100
Pyrene	0.2 - 9.3	359	ND	665	2600
Sum HPAH	-	675	ND	1700	9600
Total PAH	7.3 - 16.7	1010	ND	4022	44792
Total PCB	0.16 - 0.5	12.23	2.29	22.7	180
Total DDT	0.1 - 1	43.2	12.6	1.58	46.1

Table 14. Results of sediment amphipod (*Eohaustorius*) survival and bivalve (*Mytilus*) development toxicity tests from estuary station LAREST2 during the 2009 and 2010 survey. The bivalve test was not performed in 2010.

Sample Date	Station	Test Organism	Test Type	Endpoint
12-Aug-09	LAREST2	*Eohaustorius estuarius* (amphipod)	10 Day Survival	SL
12-Aug-09	LAREST2	*Mytilus galloprovincialis* (bivalve)	2 Day Development	SL
11-Aug-10	LAREST2	*Mytilus galloprovincialis* (bivalve)	2 Day Development	SL

NS = treatment and control not significantly different and response greater than 80%
SL = treatment and control significantly different and response less than 80%
NSG = treatment and control significantly different, but response greater than 80%
NSL = treatment and control not significantly different, but response less than 80%

Table 15. Ranked cumulative abundances of infauna at EST2 in 2009 and 2010.

Phylum	Class	Family	Species	% Cumulative Abundance
2009				
Annelida	Polychaeta	Capitellidae	Mediomastus sp	38%
Annelida	Polychaeta	Capitellidae	Capitella capitata Cmplx	66%
Annelida	Polychaeta	Spionidae	Prionospio (Minuspio) lighti	70%
Arthropoda	Malacostraca	Aoridae	Grandidierella japonica	74%
Annelida	Polychaeta	Opheliidae	Armandia brevis	78%
Arthropoda	Malacostraca	Pinnotheridae	Scleroplax granulata	81%
Annelida	Polychaeta	Spionidae	Polydora cornuta	84%
Annelida	Oligochaeta		Oligochaeta	86%
Arthropoda	Malacostraca	Diastylidae	Oxyurostylis pacifica	88%
Annelida	Polychaeta	Dorvilleidae	Dorvillea (Schistomeringos) annulata	90%
2010				
Arthropoda	Malacostraca	Corophiidae	Monocorophium acherusicum	40%
Annelida	Polychaeta	Sabellidae	Euchone limnicola	59%
Arthropoda	Malacostraca	Aoridae	Grandidierella japonica	67%
Annelida	Polychaeta	Spionidae	Pseudopolydora paucibranchiata	72%
Arthropoda	Malacostraca	Oedicerotidae	Eochelidium sp A	75%
Arthropoda	Malacostraca	Protellidae	Mayerella acanthopoda	78%
Platyhelminthes	Turbellaria	Leptoplanidae	Leptoplanidae	80%
Mollusca	Bivalvia	Solecurtidae	Tagelus affinis	83%
Annelida	Polychaeta	Terebellidae	Pista wui	85%
Nemertea	Anopla	Valenciniidae	Zygeupolia rubens	86%

Table 16. Infauna community metrics at EST2 in 2009 and 2010.

Metric	2009	2010
Community Metrics		
Number of Species	**26**	**54**
Total Abundance	**393**	**1058**
Evenness	**0.63**	**0.58**
Shannon Diversity	**2.06**	**2.31**
Schwartz Dominance	**5**	**5**
Sediment Quality Objectives (SQO) Metrics		
BRI	**47**	**32**
IBI	**2**	**1**
RBI	**4**	**1**
RIVPACS	**0.59**	**0.59**

Table 17. Integrated sediment quality objective score for EST2 in 2009 and 2010. [1]

Metric	2009	2010
Chemisty		
CA LRM	**4**	**3**
CSI	**3**	**2**
Integrated Chemistry Score	**4**	**3**
Toxicity		
Eohaustorius estuarius	**3**	**-**
Mytilus galloprovincialis	**3**	**3**
Integrated Toxicity Score	**3**	**3**
Infauna		
BRI	**2**	**1**
IBI	**2**	**1**
RBI	**4**	**1**
RIVPACS	**3**	**3**
Integrated Infauna Score	**3**	**1**
Integrated SQO Score	**3**	**3**
	Moderate Disturbance	**Moderate Disturbance**

[1] BRI is the abundance-weighted average pollution tolerance score of organisms occurring in a sample; IBI identifies community measures that have values outside a reference range; RBI is the weighted sum of: (a) several community parameters (total number of species, number of crustacean species, number of crustacean individuals, and number of mollusk species), and abundances of (b) three positive, and (c) two negative indicator species; and RIVPACS compares the assemblage at a site with an expected species composition determined by a multivariate predictive model that is based on species relationships to habitat gradients.

High Value Habitat Sites

The California Rapid Assessment method (CRAM) is comprised set of habitat metrics, including physical, biotic, hydrological and buffer attributes. CRAM was used to assess the condition of minimally impacted, high-value or high-risk sites in the watershed. CRAM assessments at these sites listed in Table 18 commenced in 2009 and Figure 20 shows the difference in habitat quality, as indicated by the CRAM score, in the different sub-regions of the watershed.

Figure 20 shows the individual CRAM scores for both the high value/ high risk freshwater sites (with the exception of LALT404- Golden Shores Wetland, which was calibrated against estuarine wetlands) as well as target sites at the confluences in 2009. Among the high value sites, the highest CRAM scores were recorded at sites in the upper watershed; the Upper Tujunga Wash Site had the highest CRAM score in 2009 approaching the state-wide calibration average. Notably, all of the sites in the watershed scored below the state-wide calibration average. As expected, habitat quality at confluence sites was decidedly lower than both the lower and upper watershed high value. Habitat sites.

Table 18 Location of high-value habitat sites

Targeted Sample Locations	Channel	Site ID	Latitude	Longitude
High Value Habitat/Minimal Impact Sites				
Arroyo Seco USGS Gage	Unlined	LALT450	34.18157	-118.173
Glendale Narrows	Unlined	LALT400	34.139368	-118.2752
Golden Shores Wetlands	Unlined	LALT404	33.76442	-118.2039
Sepulveda Basin	Unlined	LALT405	34.17666	-118.4934
Eaton Wash	Unlined	LALT406	34.17463	-118.0953
Haines Creek Pools and Stream	Unlined	LALT407	34.2679	-118.3434
Tujunga Sensitive Habitat	Unlined	LAUT401	34.28212	-118.2218
Upper Arroyo Seco	Unlined	LAUT402	34.22121	-118.1772
Alder Creek	Unlined	LAUT403	34.31109	-118.0699

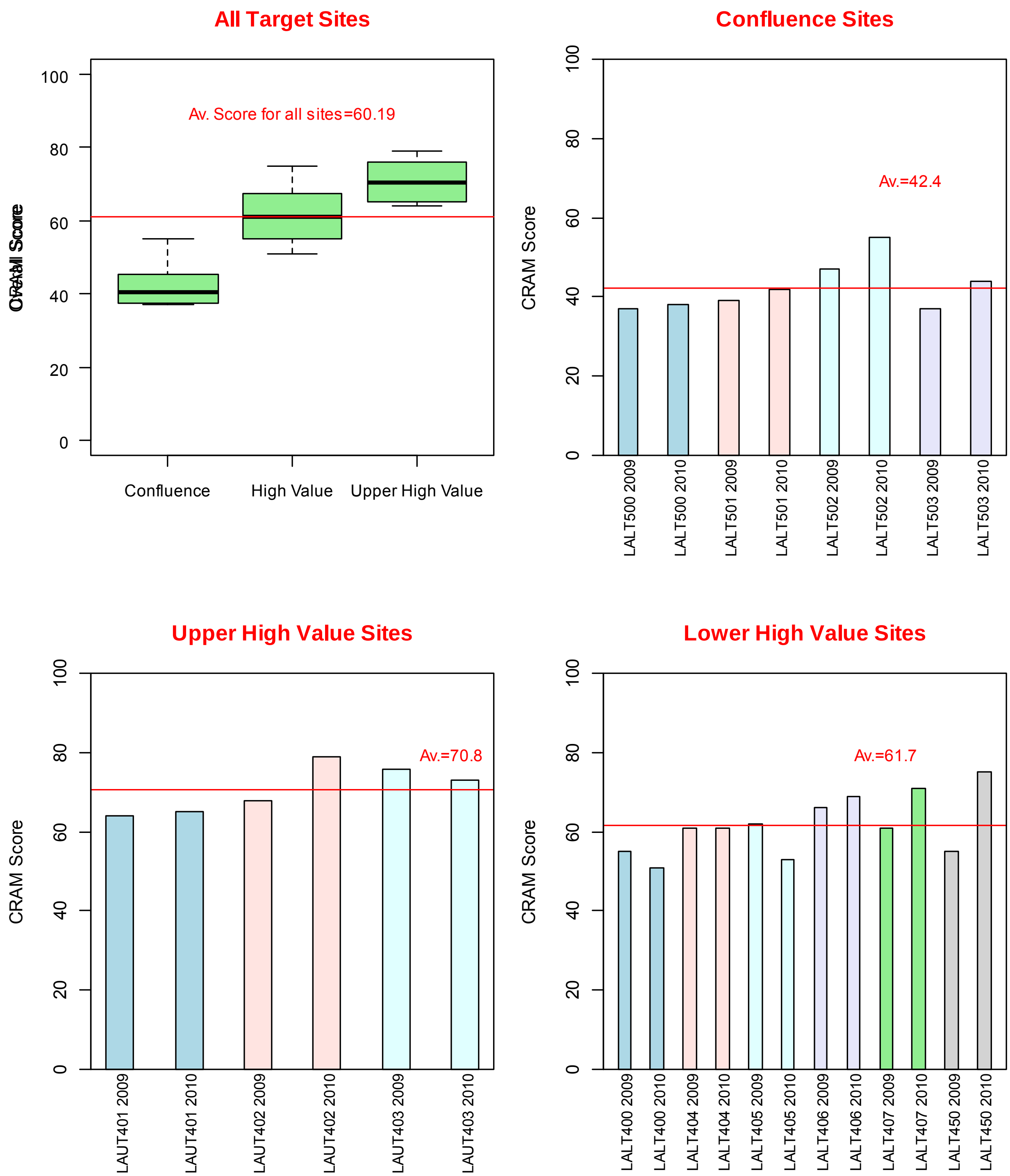


Figure 20. CRAM scores (2009-2010) at confluence sites, and upper and lower watershed high value sites. Red line represents the average CRAM score.

Chapter Summary

Target Sites

- Temporal trends in aquatic chemistry parameters have not been discernible from the past 3-years monitoring at target sites. These will become more evident with future monitoring.
- No acute (survival) or chronic (reproductive) toxicity was measured in 2010.
- Biological conditions, as measured by the Southern CA IBI, were degraded at all four sites.
- Habitat quality at these sites, which are cement lined, was lower compared to the high value/ high-risk sites in the upper and lower watershed.

Estuary Site

- The bivalve development toxicity test showed significant toxicity at station EST2 in 2010.
- Cadmium and zinc exceeded the effects range low (ER-L) threshold in 2009 and 2010. Total PCBs were below the ER-L in both years, while total DDTs exceeded the ER-L in both years.
- The biological metrics used to calculate the SQO's showed that sediment conditions were better in 2010 compared to 2009.
- Integration of the chemistry, toxicity and infauna category scores showed that station EST2 had moderately disturbed conditions during both years.

High-Value habitat Sites

- Physical habitat conditions were assessed using CRAM analysis at nine high value / high-risk sites in the watershed. CRAM scores indicated better physical habitat quality at sites in the upper watershed compared to lower watershed sites.

Question 3. Are receiving waters near discharges meeting water quality objectives?

Question 3 addresses the potential impacts from permitted point source discharges into the Los Angeles River and its tributaries. The LARWMP program document describes monitoring the concentration of chemical contaminants and toxicity upstream and downstream of point source discharges and to determine if they exceed water quality objectives, as well as determining the frequency of exceedances and changes in water quality over time.

The receiving water monitoring results were compiled for 2010 for the three major POTW discharges to the Los Angeles River: the City of Los Angeles' Tillman Water Reclamation Plant (TWRP) and Los Angeles Glendale Water Reclamation Plant (LAGWRP); and, the City of Burbank Water Reclamation Plant (BWRP). Figure 21 and Table 19 shows receiving water stations that are monitored by the permittees and best represent locations upstream and downstream of the discharge locations.

Table 19. Station designations for NPDES monitoring sites.

	Upstream Site	Downstream Site
POTW		
City of Burbank- Burbank	R-1	R-2
City of Los Angeles- Tillman	LATT612	LATT630
City of Los Angeles-Glendale	LAGT650	LAGT654

Figure 21. Locations of NPDES receiving water sites monitored by the City of Los Angeles and the City of Burbank during 2008 and 2009.

City of Los Angeles - TWRP

The cummulative frequency distributions for nutrients and fecal coliforms above and below the City of Los Angeles TWRP discharge location are shown in Figure 22. Fecal coliform concentrations were slightly lower below the discharge and the water quality objective of 400 MPN/100mL for REC-1 beneficial use was attained for 60% of all samples. The use of fecal and total coliforms as indicators of the presence of pathogens is currently under review (May 2012) and it is expected that the permit will be ammended to replace fecal coliforms with *E.coli* in conformance with a Basin Plan amendment. The concentrations of nitrogenous compounds were slightly higher below the TWRP discharge and no exceedances of basin plan WQOs were recorded for these nutrients. No acute toxicty to fathead minnows was recorded above or below the discharge location in 2010 (Table 20).

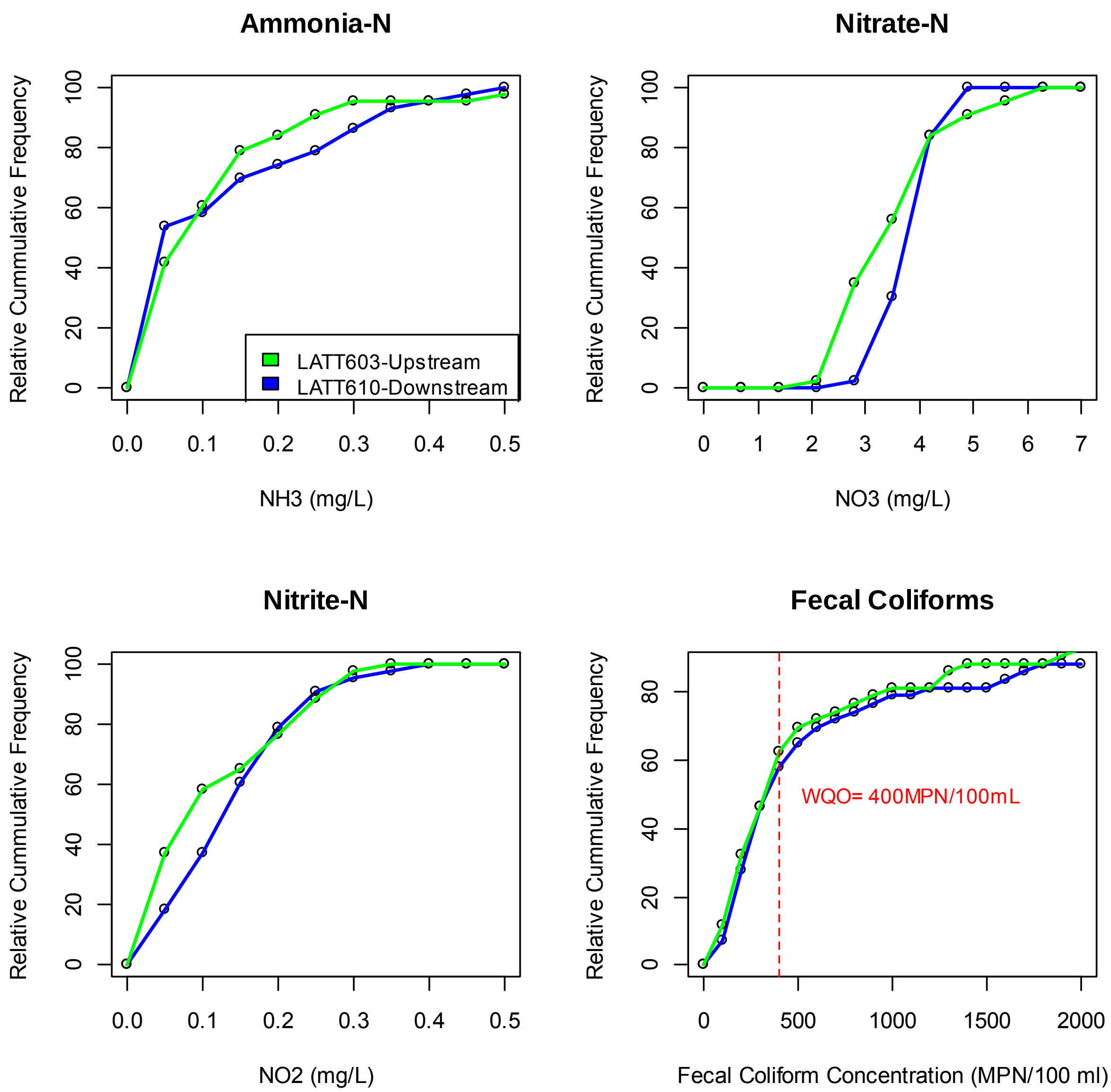


Figure 22. Cumulative frequency distributions of fecal coliform and nitrogenous compounds above and below the TWRP discharge. Water Quality Objectives (WQOs) denoted by dashed red line, where applicable.

Table 20. Acute toxicity (survival) to fathead minnows above and below the TWRP discharge.

Acute Toxicity, Fathead Minnow	Above (LATT603)	Below (LATT610)
Date	% Survival	
02/02/2010	100	97.5
05/19/2010	100	100
08/17/2010	100	100
11/16/2010	100	100

Common disinfection byproducts, trihalomethanes, were routinely detected below the discharge location at concentrations well below the EPA water quality objective of 0.08mg/L (USEPA, 2002) for toal trihalomethanes (Table 21. Trihalomethane concentrations above (LATT603) and below (LATT610) the TWRP discharge.

Table 21. Trihalomethane concentrations above (LATT603) and below (LATT610) the TWRP discharge.

Trihalomethanes (Total) (ug/L) (n=4)	Site	02/03/2010 (LATT603) 02/02/2010 (LATT610)	08/03/2010
Bromodichloromethane (ug/L)	LATT603	ND	ND
	LATT610	1.38	0.27
Bromoform (ug/L)	LATT603	0.04	1.02
	LATT610	0.26	ND
Chloroform (ug/L)	LATT603	0.16	0.13
	LATT610	2.94	1.16
Dibromochloromethane (ug/L)	LATT603I	ND	ND
	LATT610	0.81	ND
Trihalomethanes (Total) (ug/L)	LATT603	0.20	1.15
	LATT610	5.39	1.43

Figure 23 shows the concentration of select total recoverable metals both upstream and downstream of the TWRP discharge location. The metals shown below are compared to the California Toxics Rule (CTR) chronic and acute standards, which are typically applied to hardness-adjusted dissolved metals. It is important to note the total recoverable metals, rather than dissolved metals, were measured as a requirement of the NPDES permit and therefore were converteed to equivalent dissolved concentrations. With the exception of selenium, all concentrations were below the hardness-adjusted standards at both the upstream and downstream locations. Metal concentrations were typically greater upstream. Selenium concentrations upstream of the discharge exceeded the CTR chronic threshold on all occasssions, but on only one occasion at the downstream site (5.7 ug/L) on 2/12/2008. This was the same date when acute toxicity to the fathead minnow was greatest (67%).

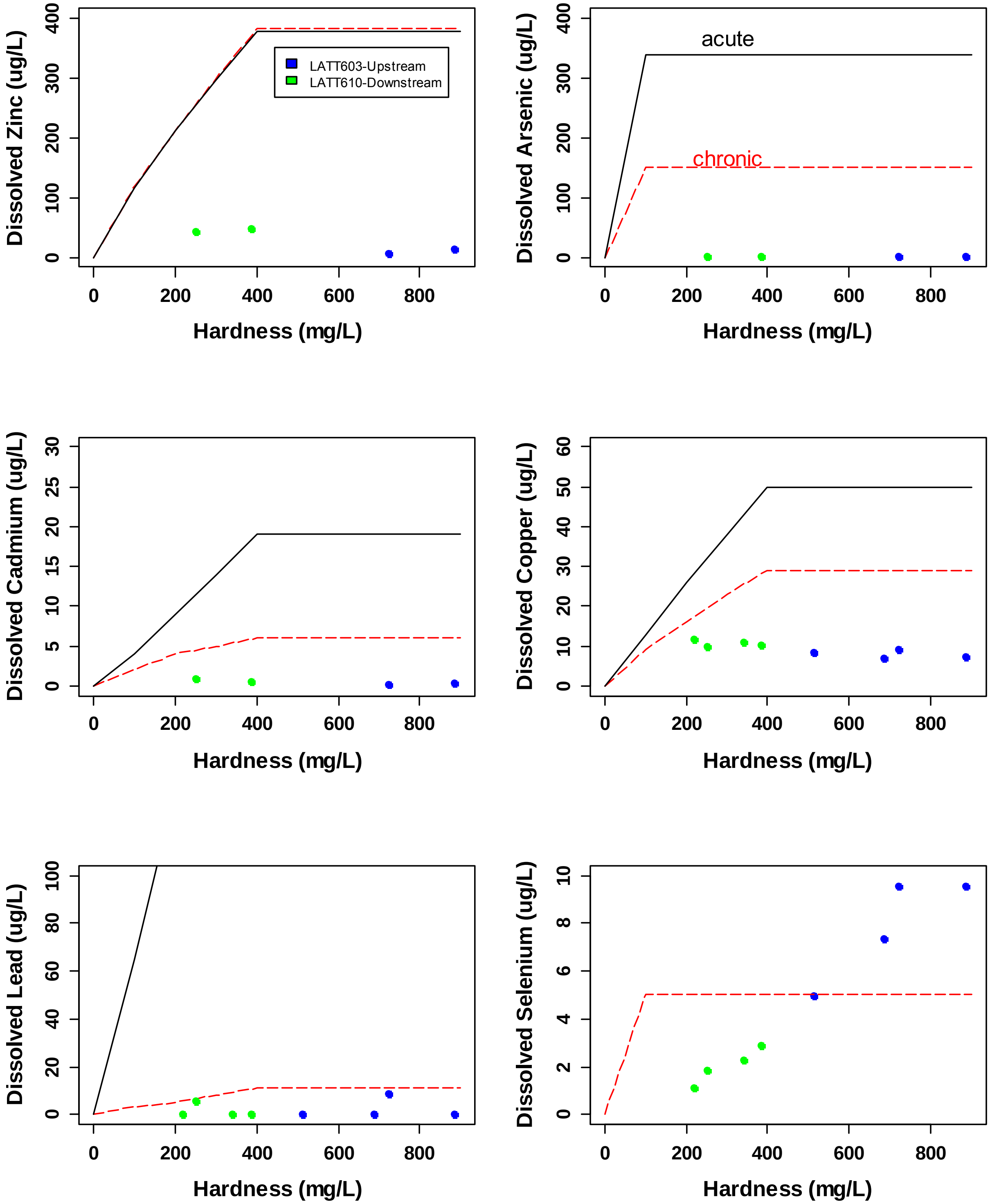


Figure 23. Total metals concentrations above and below the TWRP discharge compared to hardness adjusted CTR thresholds for acute and chronic effects.

City of Los Angeles – LAGWRP

Figure 24 shows the cumulative frequency distributions for *E.coli* and nutrients at sites above and below the discharge point at the Los Angeles Glendale WRP (LAGWRP). *E.coli* concentrations were higher upstream and approximately 60% of the measurements exceeded the WQO at this site compared to approximetely 20% downstream of the discharge. In contrast, nutrient concentrations were greater downstream, particularly ammonia and orthophosphate. Although nitrate was greater downstream it was much lower than the WQO of 10 mg/L. Total recoverable metals concentrations were below both the acute and chronic CTR thresholds for each metal (

Figure 25). Moreover, acute toxicity values were similar between the upstream and downstream sites, and the percentage survival of test organisms was typically greater than 97.5% (Table 22). Total Trihalomethane concentrations were routinely higher below the discharge location and concentrations at this location were well below the EPA water quality objective of 0.08mg/L (USEPA,2002).

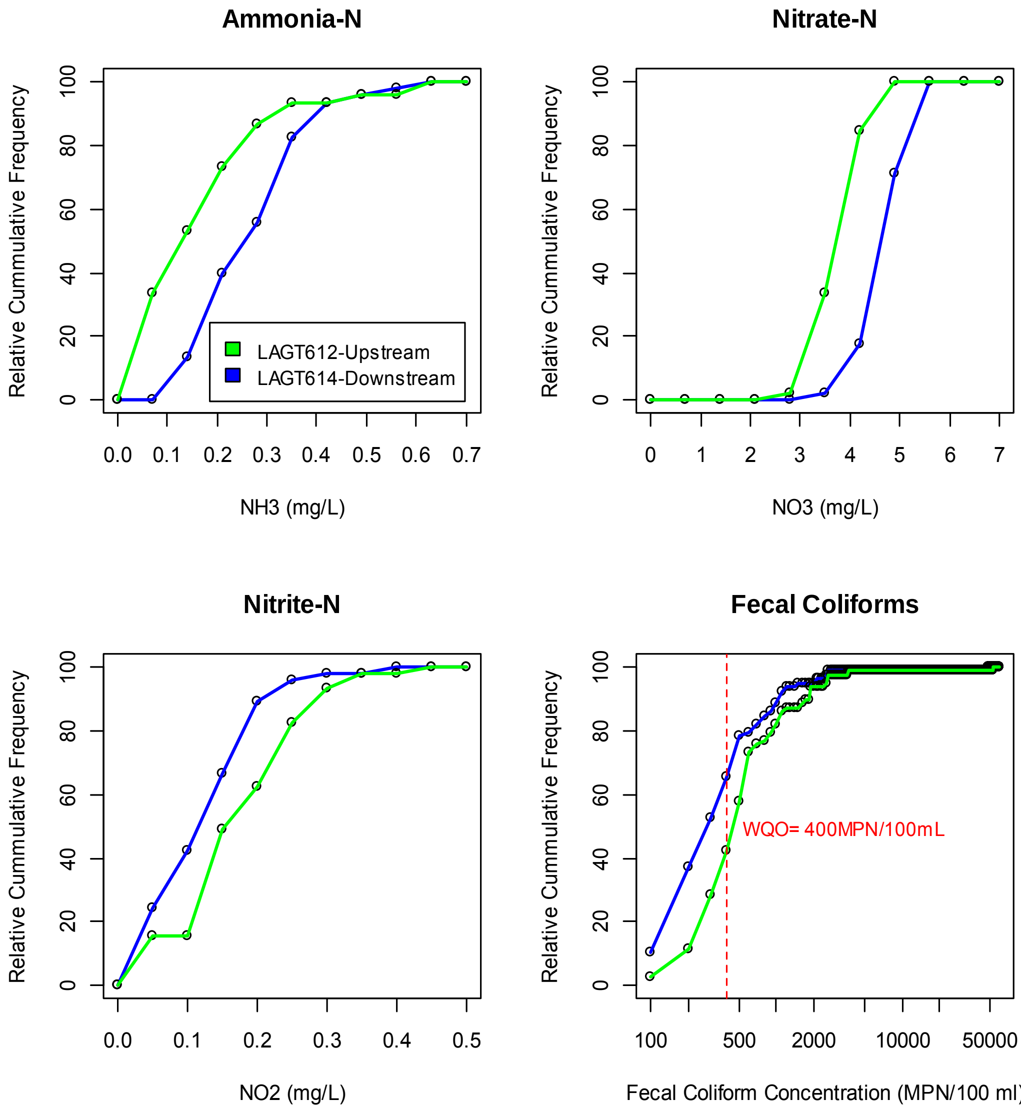


Figure 24. Cumulative frequency distributions of fecal coliform and nutrient concentrations above and below the LAGWRP discharge. Water Quality Objectives (WQOs) denoted by dashed red line, where applicable.

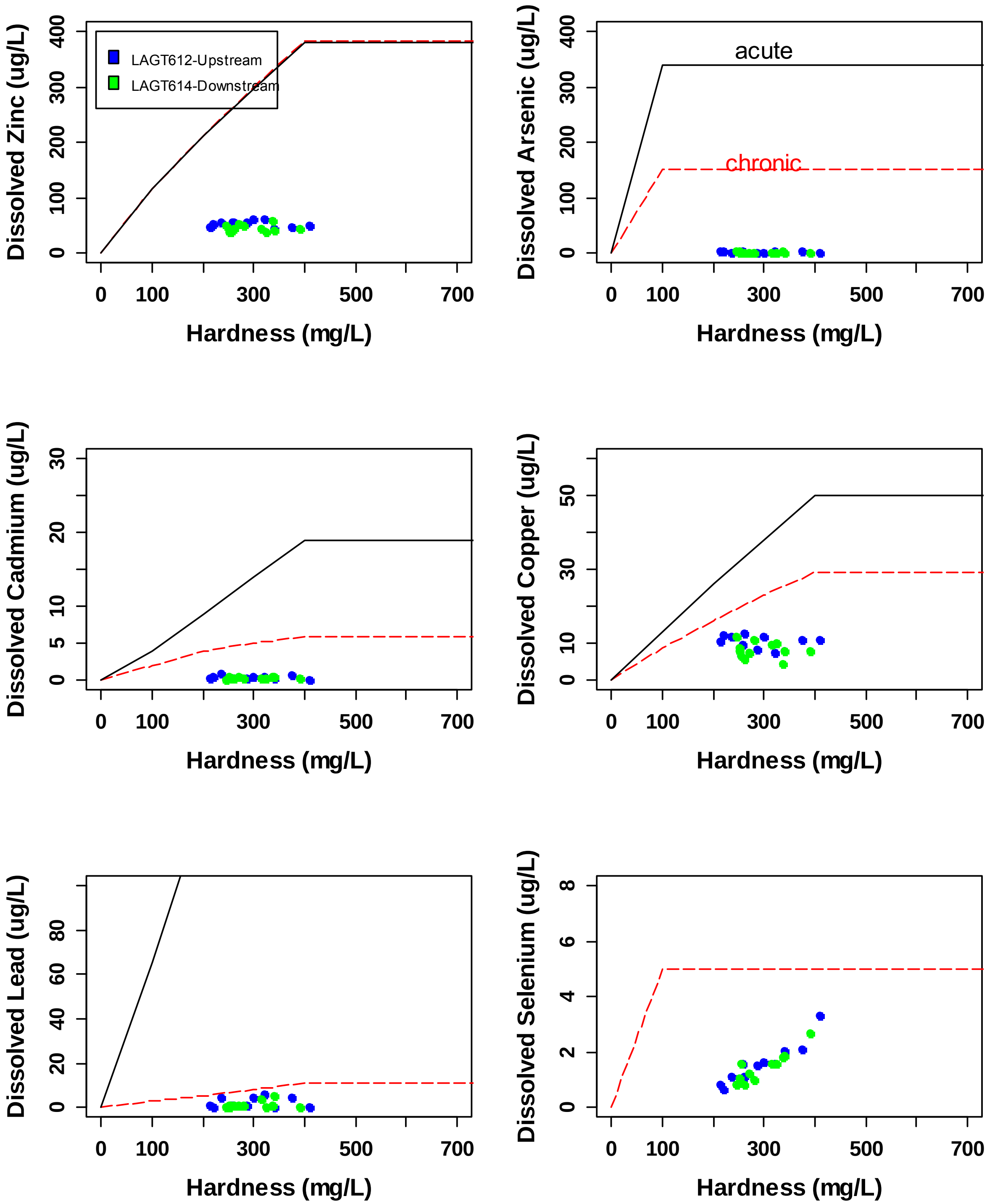


Figure 25. Total metals concentrations above and below the LAGWRP discharge compared to hardness adjusted CTR thresholds for acute and chronic effects.

Table 22. Acute toxicity (survival) to fathead minnows above and below the LAGWRP discharge.

Acute Toxicity, Fathead Minnow	R4	R-7
Date	% Survival	
02/17/2010	100	97.5
05/11/2010	100	100
08/04/2010	97.5	100
11/02/2010	100	100

Table 23. Summary of trihalomethane compounds above (R4) and below (R7) the LAGWRP discharge.

Trihalomethanes (Total) (ug/L) * (n=2)	Site	02/09/2010	08/04/2010
Bromodichloromethane (ug/L)	R4	0.15	0.08
	R-7	1	0.37
Chloroform (ug/L)	R4	0.45	0.22
	R-7	1.85	0.82
Dibromochloromethane (ug/L)	R4	0.11	0.11
	R-7	0.35	0.13
Bromoform (ug/L)	R4	ND	ND
	R-7	ND	ND
Trihalomethanes (Total) (ug/L)	R4	0.71	0.41
	R-7	3.2	1.32

City of Burbank - BWRP

E.coli levels at the Burbank Water Reclamation Plant (BWRP) were elevated at the upstream location compared to below the discharge and exceeded the WQO for 92% of samples. Temporal differences were also noted with the highest concentrations occurring upstream during the warm summer months and the lowest concentrations during the high-flow winter months. (Figure 26). Downstream of the discharge *E.coli* concentrations exceeded the WQO in approximately 50 percent of samples and seasonal trends were not discernible. Concentrations of ammonia and phosphorus were higher below the BWRP discharge (i.e., in the Burbank Western Channel and not necessarily BWRP outfall) compared to the TWRP and LAGWRP discharges. In 2010, the concentration of nitrate in all samples below the discharge point was below the WQO of 10 mg/L.

Figure 27 shows the hardness adjusted dissolved copper, selenium and zinc concentrations compared to the CTR chronic and acute standards. Dissolved metal concentrations were below the CTR threshholds at both upstream/downstream sites. Dissolved copper and zinc concentrations were slightly higher downstream and dissolved copper exceeded the chronic standard on one occasion at the downstream location. There was no acute toxicity measured either upstream or downstream of the discharge location, with the percentage survival of test organisms typically greater than 95 percent (Table 24). Total trihalomethanes were typically not detected above the discharge, and concentrations downstream of the discharge were below the WQO.

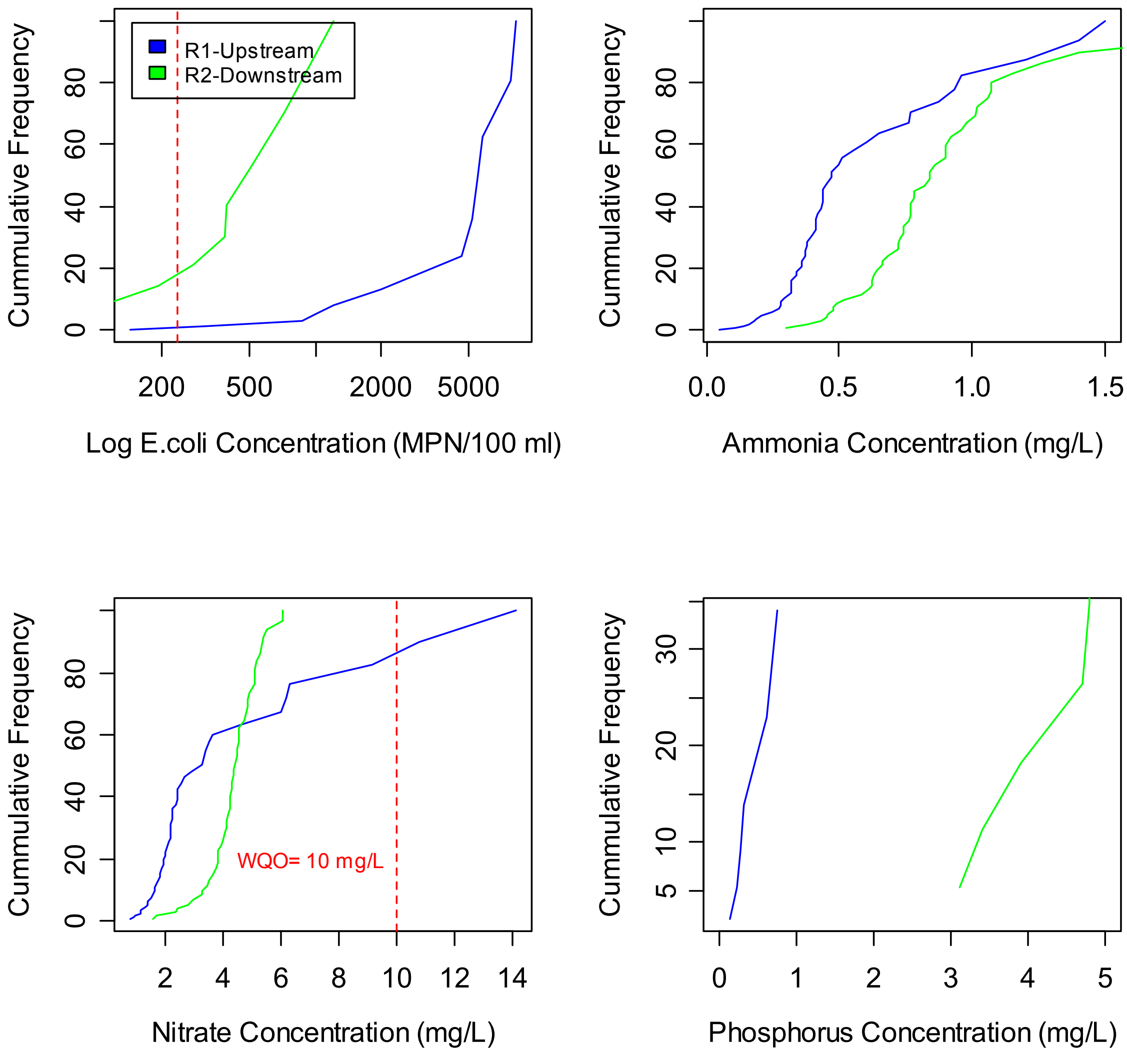


Figure 26. Cumulative frequency distributions for E.coli and nutrient concentrations above and below the BWRP discharge

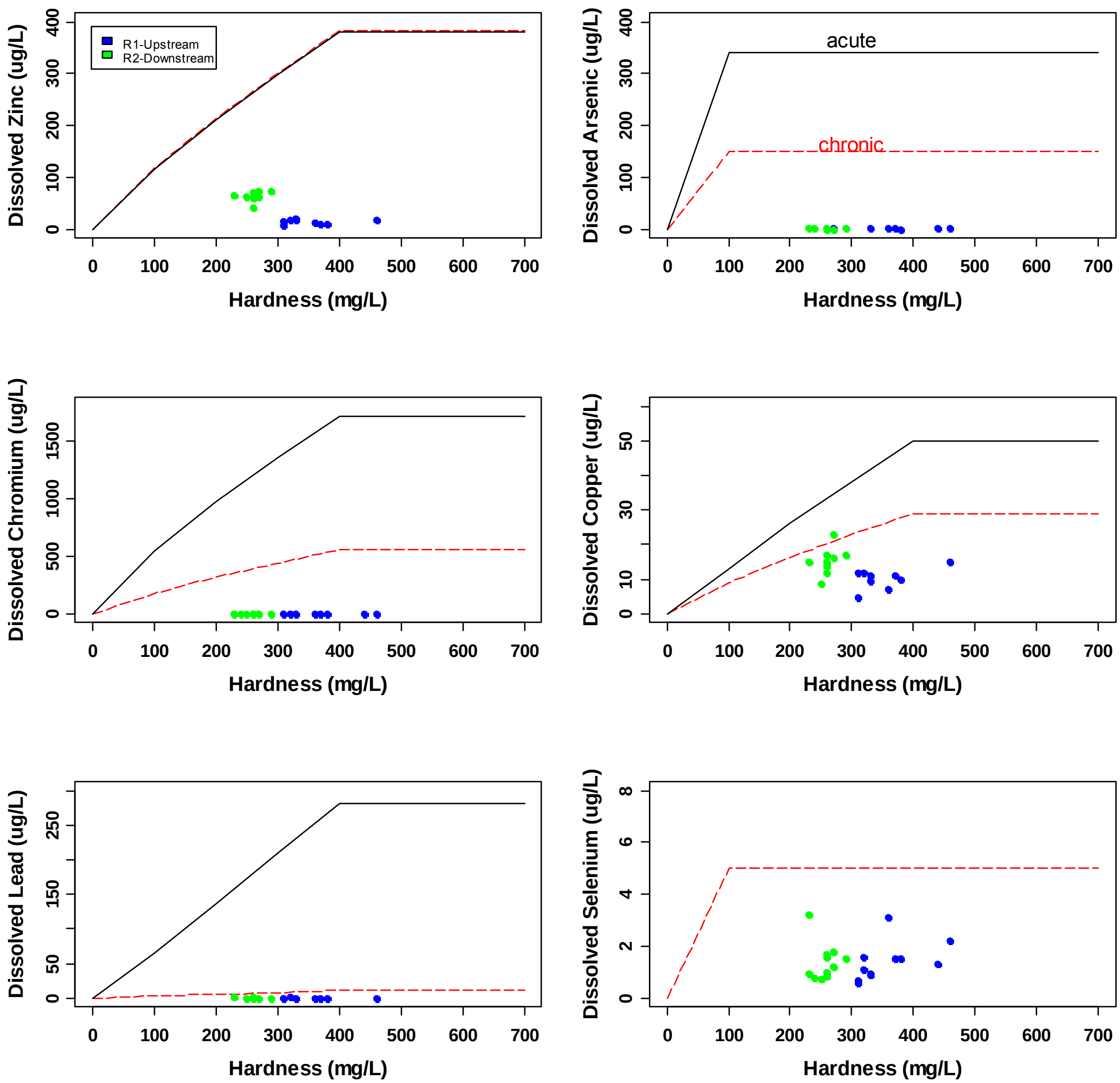


Figure 27. 2010 dissolved metals (total Se) concentrations above and below the BWRP discharge compared to hardness adjusted CTR thresholds for acute and chronic effects.

Table 24. Acute toxicity (survival) to fathead minnows above (R1) and below (R2) the BWRP discharge.

Acute Toxicity, Fathead Minnow	R1	R2
Date	% Survival	
2/1/2010	100	100
2/18/2010	95	100
8/11/2010	100	100

Table 25. Summary of trihalomethane concentrations above (R1) and below (R2) the BWRP discharge.

Date	Trihalomethanes (Total) (ug/L)	
	R1	R2
1/25/2010	2	11
2/1/2010	2	20
3/3/2010	2	12.1
4/8/2010	2	11.3
5/5/2010	2	10.8
6/9/2010	2	12.1
7/1/2010	2	11.6
8/11/2010	2	13.6
9/1/2010	2	13.8
10/13/2010	2	7.6
11/3/2010	2	7.1
12/1/2010	2	8.8

Chapter Summary

The cities of Los Angeles and Burbank POTW's monitor receiving waters downstream of their discharges as a requirement of their NPDES permits. Aquatic chemistry and toxicity values were below the described WQOs with a number of exceptions specific to each facility. The following patterns were shown to be consistent upstream and downstream at all facilities:

- *E.coli* and Fecal coliform concentrations were greater upstream of the discharge point compared to downstream and typically exceeded WQOs.
- Concentrations of nitrogenous compounds were typically higher below the discharges.
- Trihalomethanes were typically present below the discharges and lower or below detection upstream. In all cases, concentrations were below the WQO.

Question 4: Is it safe to swim?

The fourth element of the monitoring program assesses the beneficial use Water Contact Recreation (REC1). It reflects concerns about the risk posed by pathogen contamination to recreational users of the Los Angeles River, its tributaries, and nearby beaches potentially influenced by the River's plume. Swimming lakes in the region are managed by the Department of Recreation and Parks and are chlorinated to reduce pathogen levels. Because they are actively managed, they were not specifically included in the regional program design. Prior to the initiation of the LARWMP, the assessment of indicator bacteria concentrations in the watershed included permit mandated sampling near NPDES discharges as well as the City of Los Angeles Status and Trends program that monitored indicator bacteria at ten tributary and eight main channel sites in the Los Angeles River. The LARWMP expands on these previous monitoring efforts to address the following concerns (LASGRWC 2008):

1. Swimming safety – Weekly sampling for *E. coli* during the summer (May to September) at high use recreational swimming areas;
2. Sentinel sites - Weekly sampling for *E. coli* during the summer (May to September) at confluence sites located at major confluences in the lower watershed;
3. Year round, biweekly sampling for total coliforms, *E. coli,* and enterococcus bacteria in the Los Angeles River Estuary.

The location of these sites is shown in Figure 28. The types of data products resulting from this monitoring design and described in this chapter include:

- Weekly, site-by-site measures of bacterial indicator values
- Comparisons of bacterial indicator values with relevant standards or objectives on spatial and temporal scales that match sampling scales as closely as possible (e.g., data tables or charts that highlight exceedances)
- Site-by-site and regional trends over time in the numbers of exceedances

Figure 28. Sentinel, estuary, and recreational swimming site locations in 2009-2010.

Table 26. Sampling locations and site codes for indicator bacteria.

Program Element	Sampling Sites	Site Code
Swim Sites	Bull Creek Sepulveda Basin	LALT200
	Upper Rio Hondo	LALT201
	Eaton Canyon Natural Area Park	LALT204
	Bosque del Rio Hondo	LALT205
	Millard Campground	LAUT203
	Sturtevant Falls	LAUT210
	Peck Rd Water Conservation Park	LALT212
Sentinel Site	Bac-T Stat&Trend Del Amo	LALT100
	Stat&Trend Figueroa St	LALT101
	LA River Riverside Dr Cross	LALT102
	Tillman R7	LALT103
	LACDPW at Wardlow St	LALT104
	Tillman Site I	LALT105
	Stat&Trend Burbank	LALT106
	Stat&Trend Tujunga Moorpak	LALT107
	Arroyo Seco	LAUT108
Estuary	Estuary Site 1	EST1

To assess swim safety, samples were collected at seven sites throughout the watershed in 2010 (

Table 27). This is a is reduction from twelve sites in 2009 due to site closures resulting from the 2009 Station Fire in the upper watershed. Sites sampled for swim safety were selected based on the collective knowledge of the workgroup of the most frequently used swimming locations. Depending on the site, sources of

indicator bacteria and pathogen contamination could include human contact recreation, wildlife, urban runoff, and campgrounds.
The State of California REC1 bathing water standards (AB411) require that at least five samples be collected per month per site before the 30 day geometric mean standard can be applied. The 30-day geometric mean provides an indication of how persistent elevated bacterial concentrations are at a site. The standard overestimates persistent contamination when fewer than five samples are taken per month. As a result, the geometric means presented in herein may represent conservative estimates of this standard. The workgroup modified the 2010 sampling program to include five samples per month at each of the swimming sites. Also, in a similar program conducted in the San Gabriel River Watershed it was found that indicator bacteria levels were potentially greater on weekends and holidays when recreational use was greatest (SGRRMP 2009). As a result, bacteria sampling for the LARWMP was focused on weekends and holidays.

The sentinel site program included the weekly collection of samples at nine confluence points from May to September in the lower watershed with the intent of determining the concentrations of *E. coli* emanating from different areas of the lower watershed. These sentinel sites are not REC-1 recreational swim sites and public access is not allowed.

The third component of the program includes twice weekly sampling for total coliforms, *E. coli,* and enterococcus bacteria at Queensway Drive Bridge located at the lower end of the Estuary before its confluence with the Pacific Ocean. The purpose of this site is to assess the overall contribution of bacteria from the watershed to the estuary. Eventually, bacteria concentrations in the estuary may be linked to conditions on near shore beaches. It is important to understand that this site is not within a recreational swimming area.

Analyses for all indicator bacteria were conducted using Colilert™ (SM9223) for total coliform and *E. coli* and Enterolert™ for enterococcus bacteria. Each of the three

bacteria data sets were compared against State of California REC1 swimming standards (AB411) (
Table 27). Exceedances of REC1 standards at public swim sites indicate that there is a potential swimming safety issue. The sentinel sites are not REC1 bathing waters and public access is not allowed. Bacteria concentrations measured at these sites are compared against REC1 standards to provide context.

Table 27. Indicator bacteria REC1 standards for freshwaters.

Indicator	Single Sample Standard	30-Day Geometric Mean
Total Coliform	10,000 or 1,000 if *E. coli* / Total > 1,000	1,000
E. coli	235	126
Enterococcus bacteria	104	34

Swim Sites

During the summer of 2010 a total of 101 samples were collected from the seven swimming sites and analyzed for *E. coli* (Table 28). No rain occurred during the sampling season and sampling continued through September 7th, 2010.

Of the samples collected, 20% exceeded the single sample recreational water standard for *E. coli* (235 MPN/100 mL) in freshwaters. The greatest frequency of REC1 exceedances occurred in the lower watershed at Eaton Canyon, Peck Rd Water Conservation Park, Upper Rio Hondo and Bull Creek. These sites also exceeded the 30-day geometric mean REC1 standard for freshwaters (126 MPN/100 mL) in July (Table 29).

The Bull Creek and Eaton Canyon sites recorded the largest number of recreational-use daily exceedances, 29%. The Eaton Canyon site also exceeded the 30-day standard throughout the sampling period. These sites are heavily used by the public and many people wade or swim in the shallow pools and riffles. The greatest numbers of exceedances occurred on weekends and holidays indicating that there is a relationship between increases in recreational use and indicator bacteria concentrations (Table 28).

Although the Upper Rio Hondo and Peck Rd Water Conservation Park sites are frequented by the public, especially on the weekends, they are not considered a recreational swim area and bathers were never observed during the fourteen sampling events. In addition, several people that were informally interviewed by the sampling team indicated that they did not use this location for swimming. Single sample exceedances at all other swim sites ranged from zero to two over the three month period.

Humans, animals and birds have been identified as major sources of elevated *E. coli* levels in natural waters (Ricca and Cooney 1998). Therefore, the numbers of humans, animals and birds were recorded at each site on each sample day to determine if there was a relationship between *E. coli* levels and these factors. All of the swim sites were heavily used by the public during the warm summer months. Correlations were poor between the numbers of people, animals and birds present, and *E. coli* concentrations. This indicates that there is a large amount of variation inherent in bacteria data sets, which makes tracking elevated concentrations to their sources difficult.

Table 28. E. coli concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed from June through September 2009. <10 MPN/100 mL = non-detect. Sampling at Peck Rd Water Conservation Park began July 4th after Bosque del Rio Hondo went dry. Sampling ended after August 22nd at upper watershed sites following the onset of the Station Fire.

Station Location	5/31/2010	6/1/2010	6/7/2010	6/13/2010	6/19/2010	6/25/2010	7/4/2010	7/5/2010	7/14/2010	7/19/2010	7/28/2010	8/2/2010	8/7/2010	8/12/2010	8/22/2010	9/6/2010	9/7/2010	# Exceedance REC 1 Std.
Upper Rio Hondo	31	20	20	10	<10	171	221	**331**	**414**	75	31	10	98	120	84	**3260**	**3080**	4
Peck Rd Water Park	41	13.2	30	<10	**556**	**960**	122	42.6	216	120	**420**	**275**	10	75	10	63	31	4
Sturtevant Falls	10	<1	<10	63	<10	221	31	<1	<1	20	<10	31	97	<10	10	**473**	171	1
Eaton Canyon	**>2420**	75	201	122	228	73	216	**266**	121	52	98	**1020**	31	<10	20	**932**	**8160**	5
Millard Campground	NS	NS	41	20	75	75	31	<10	98	**243**	158	63	146	20	84	72	52	1
Bull Creek	NS	NS	41	135	10	**243**	**315**	**295**	187	187	**1050**	181	86	52	63	181	**364**	5
Bosque Rio Hondo	NS	NS	109	20	199	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0
# Exceedance REC 1 Std.	1	0	0	0	1	2	1	3	1	1	2	2	0	0	0	3	3	∑=20

Weekday

Weekend

Holiday

Table 29. 30-day geometric mean E. coli concentrations (MPN/100 mL) at recreational swim sites in the Los Angeles River Watershed during 2009. Exceedance >126 (MPN/100 mL) *E. coli*.

Station Location	June (n= 5)	July (n= 5)	August (n= 4)	Exceedances of 30 day Average
Bosque Rio Hondo	109	-	-	
Bull Creek	107	**407**	96	1
Eaton Canyon	**140**	**151**	**270**	**3**
Millard Campground	53	**133**	78	1
Peck Rd Water Conservation Park	**314**	**184**	93	2
Sturtevant Falls	61	13	37	0
Upper Rio Hondo	46	**214**	78	1

Sentinel Sites

Between May and September, 2010 a total of 109 samples were collected from six sentinel sites located on major confluences to the Los Angeles River in the lower watershed and analyzed for *E. coli.* Of these, 79 (72%) exceeded the single-sample recreational standard for *E. coli* (235 MPN/100 mL) (Table 30). The greatest frequency of single-sample exceedances occurred at LALT107 in the Tujunga Wash (100%), LALT106 in the Burbank Channel (83%), and LALT100 in the Cerritos Channel (88%). Each of these sites is located just upstream of major confluences to the Los Angeles River and conveys mostly urban runoff. The fewest exceedances occurred at sites at or below POTW discharges, including LALT101 downstream of the Los Angeles Glendale Water Reclamation Plant (LAGWRP). Monitoring by the City of Los Angeles in the mainstem of the Los Angeles River since 2001 as part of the Status and Trends Program demonstrated that dry-season bacteria concentrations below major POTWs were lower due to dilution of urban runoff by the high quality, disinfected tertiary-treated recycled water emanating from these POTWs (CREST 2006).

Exceedances of the 30-day geometric mean standard (126 MPN/100 mL) occurred for almost every month during the sampling period and across nearly every station (Table 30). The fewest number of exceedances of this standard occurred at LALT101 (n=3). These results indicate that the lower tributaries and main Los Angeles River Channel had persistently elevated *E. coli* concentrations during the entire dry-weather period in 2009.

Table 30. 30-day geometric mean E. coli concentrations (MPN/100 mL) at sentinel sites in the Los Angeles River Watershed during 2009. Single sample exceedance >235 (MPN/100 mL) *E. coli*; 30 day geometric exceedance >126 (MPN/100 mL) *E. coli*.

Site	Geometric Mean											Single Sample Exceedances	
	May	n=	June	n=	July	n=	August	n=	September	n=	Σ n=	#	%
LALT100	**258**	4	**622**	3	**680**	2	**2560**	3	**2398**	5	17	15	88
LALT101	124	3	**253**	6	**323**	4	94	2	**147**	4	19	4	21
LALT102	**370**	3	**1220**	4	**370**	4	**495**	3	**341**	4	18	13	72
LALT104	**191**	4	**708**	4	**616**	3	**1000**	4	**1266**	4	19	14	74
LALT106	**901**	3	**508**	4	**398**	4	**2448**	3	**467**	4	18	15	83
LALT107	**2972**	3	**7783**	4	**8300**	3	**9833**	4	**3067**	4	18	18	100

Los Angeles River Estuary

Eighty samples were collected for total coliforms, *E. coli*, and *Enterococcus* analyses from the Los Angeles River Estuary during the period from May through September 2010 (Table 31). These samples were compared to the total coliform objective of less than 1,000 per 100 ml for bays and estuaries and the marine waters *enterococci* objective of 104 colonies per 100 ml. *E.coli* levels were compared to the freshwater single-sample recreational standard for *E. coli* (235 MPN/100 mL). Of these, total coliforms exceeded the single-sample REC1 standard 39% of the time and the 30-day average during each of the five months. *E. coli* exceeded the single-sample standard in 4% of the samples and the 30-day average standard for June and *Enterococcus* bacteria exceeded the single-sample standard in 5% of the samples and the 30-day average standard for May and September.

It is acknowledged that the control of bacteria in urbanized watersheds poses an immense challenge, and that bacteria discharges can be highly erratic due to a myriad of potential human and non-human sources (CREST 2008). Several of the tributaries described above were previously identified on California's 2006 Clean Water Act Section 303(d) list as impaired for water contact and non-contact recreational beneficial uses (REC-1 and REC-2, respectively) by fecal coliform bacteria. In response, a Bacteria Total Maximum Daily Load (TMDL) was developed by the Los Angeles Region Regional Water Quality Control Board (RWQCB) in cooperation with the Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST) stakeholder group. A comprehensive Bacteria Source Identification (BSI) Study was undertaken and identified that approximately 85% of storm drain samples exceeded the 235 MPN/100 mL objectives (CREST 2008). It was recognized, however, that although hundreds of storm drain outfalls discharge varying levels of bacteria to the LA River during dry weather, other in-channel sources; including birds, homeless persons, and perhaps environmental re-growth also are significant.

Table 31. 30-day geometric mean bacteria concentrations (MPN/100 mL) at the Los Angeles River estuary site in the Los Angeles River Watershed during 2009. See Table 27 for exceedance thresholds.

Indicator	**30-Day Geometric Mean**						Single Sample Exceedances	
	May (n= 9)	June (n= 9)	July (n= 9)	August (n= 8)	September (n= 9)	n=	#	%
E. coli	47	**129**	70	70	99	80	3	4
Enterococcus	**45**	33	22	28	**69**	80	4	5
Total Coliform	**3617**	**7617**	**10978**	**15794**	**13548**	80	31	39

Chapter Summary

Between May and September 2009 water samples were collected from seven swim sites (n = 101), six sentinel sites (n = 109), and a single estuary site (n = 80) on a weekly basis. Major findings of this sampling effort include:

- In 2010, the popular water-contact recreation sites Eaton Canyon and Bull Creek recorded the highest frequency of exceedance of the single sample REC-1 standard. The greatest numbers of exceedances occurred on weekends and holidays indicating that there is a relationship between increases in recreational use and indicator bacteria concentrations.
    - Exceedances of the single sample REC1 standard were common at the six sentinel sites with the greatest frequency of exceedances of the single sample REC1 standard occurring in the highly urbanized Tujunga Wash, Burbank Channel and Cerritos Channel watershed areas.
    - The lowest bacteria concentrations, and fewest exceedances, occurred at sites at or below POTW discharges
    - Sentinel sites typically exceeded the 30-day geometric mean REC1 standard during each month and these findings are consistent with those reported by CREST (2008).
- Bacteria concentrations in the Los Angeles River Estuary routinely exceeded REC1 standards for total coliforms and rarely exceeded the REC-1 standards for *E.coli* and *Enterococcus* during the dry-weather monitoring period.

Question 5: Are locally caught fish safe to eat?

Question 5 addresses the human health risk associated with consuming contaminated fish caught at popular fishing locations in the watershed. The goal of this monitoring is to improve our understanding of health risks by identifying fish species (and their water bodies) that are of greatest concern for human consumption. This information will provide watershed managers with the information necessary to educate the public regarding the safety of consuming the fish they catch.

It is important to note that this program component does not include rainbow trout, a popular locally caught fish. Rainbow trout are stocked, caught very quickly, and have reduced survival rates during the summertime conditions in the watershed. Consequently, their short resident time in the watershed reduces their potential to accumulate contaminants.

In 2010, the SWAMP Bioaccumulation Monitoring Program monitored fish tissues in lakes throughout the Los Angeles River Watershed. This the long-term, statewide effort aims to identify and quantify contaminants in sport fish from California's lakes and reservoirs, and to evaluate exposure and risk in humans and wildlife. Consequently, the LARWMP did not sample additional lakes in 2010 and the results from the Bioaccumulation Monitoring Program are presented in this report.

The Bioaccumulation Monitoring Program is designed to answer three specific questions that are complimentary to the LARWMP:

1) What is the condition of California lakes with respect to contaminants in sport fish?

2) Should a specific lake be considered for inclusion on the 303(d) list due to bioaccumulation of contaminants in sport fish?

3) Should additional sampling of contaminants in sport fish at a lake be conducted for the purpose of developing consumption guidelines?

Target species were chosen based on those that are commonly caught and consumed by anglers as well as abundance, geographic distribution, and value as indicators for the contaminants of concern (SWAMP 2007b.). Two indicator species were targeted in each lake: 1) a top predator, such as largemouth bass, as a mercury indicator, and 2) a high lipid, bottom feeding species such as carp, as an organics and selenium indicator. This approach provides a characterization of both the pelagic and benthic food chains and the USEPA (2000b.) recommends this two species approach in their guidance document for monitoring in support of development of consumption advisories. To manage the uneven distribution of fish species across the state, a prioritized menu of several potential target species (Table 32) was used and primary target species were given the highest priority.

Table 32. Target species and their characteristics (SWAMP 2007b.)

	Foraging Type		Trophic Level	Distribution			
Species	Water column	Bottom feeder		Low Eleva-tion	Foothills	High Elevation	Priority for Collection
Largemouth bass	X		4	**X**	**X**		A
Smallmouth bass	X		4	x	**X**		A
Spotted bass	X		4	x	**X**		A
Sacramento pikeminnow	X		4	x	x		B
White catfish		X	4	x	x		A
Brown bullhead		X	3	x			B
Channel catfish		X	4	**X**	**X**		A
Carp		X	3	**X**	**X**		A
Sacramento sucker		X	3	x	x		B
Tilapia		X	3				B
Bluegill	X		3	**X**	**X**		B
Green sunfish	X		3	**X**	**X**		B
Crappie	X		3/4	x	x		B
Redear sunfish	X		3	**X**	**X**		B
Rainbow trout	X		3/4	x	x	**X**	A
Brown trout	X		3		x	x	A
Brook trout	X		3			x	A
Kokanee	X		3	?	x	x	B

Trophic levels are the hierarchical strata of a food web characterized by organisms that are the same number of steps removed from the primary producers. The USEPA's 1997 Mercury Study Report to Congress used the following criteria to designate trophic levels based on an organism's feeding habits:

Trophic level 1: Phytoplankton.
Trophic level 2: Zooplankton and benthic invertebrates.
Trophic level 3: Organisms that consume zooplankton, benthic invertebrates, and TL2 organisms.
Trophic level 4: Organisms that consume trophic level 3 organisms.

X widely abundant X less widely abundant "A" primary target for collection "B" secondary target for collection

In 2010, the Bioaccumulation Monitoring Program sampled the following lakes in the Los Angeles River watershed: Echo Lake, Legg Lakes, Lincoln Park Lake, Hollenbeck Park Lake and Peck Rd Water Conservation Park (Figure 29). Fish were collected using an electroshocking boat at a location in each lake near fishing activity and specific size ranges were targeted for each species. Predator species were analyzed for mercury only and as individual fish, and bottom-feeding species were analyzed as composites for organics, selenium, and mercury.

Figure 29. Fish tissue sampling locations for the 2010 bioaccumulation survey.

A total of three different fish species were collected including the bottom feeding common carp (*Cyprinus carpio carpio*), a priority predator, largemouth bass (*Micropterus salmoides*), and redear sunfish (*Lepomis microlophus*) (Table 33).

Table 33. Number and average standard weight and length of the individual and composite fish samples.

Waterbody	Sample Type	n	Species Name	CommonName	Average Weight (g)	Total Length Average (mm)	Min (mm)	Max (mm)
Echo Lake	Composite	5	*Cyprinus carpio*	Common Carp	901	377.2	360	390
Echo Lake	Composite	5	*Micropterus salmoides*	Largemouth Bass	928	377.2	338	421
Hollenbeck Park Lake	Composite	5	*Cyprinus carpio*	Common Carp	1406	418.4	388	481
Legg Lake	Composite	5	*Micropterus salmoides*	Largemouth Bass	1044	408.6	351	438
Legg Lake	Composite	5	*Lepomis microlophus*	Redear Sunfish	73.8	158.8	129	186
Legg Lake	Composite	5	*Micropterus salmoides*	Largemouth Bass	976	408.8	355	445
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	595	355	355	355
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	640	368	368	368
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	715	351	351	351
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1265	445	445	445
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1170	436	436	436
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1250	438	438	438
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	945	407	407	407
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1080	420	420	420
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1210	440	440	440
Legg Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1230	427	427	427
Lincoln Park Lake	Composite	5	*Cyprinus carpio*	Common Carp	1615.2	438.8	424	462
Lincoln Park Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	975	381	381	381
Lincoln Park Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1725	436	436	436
Lincoln Park Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	2000	450	450	450
Lincoln Park Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1795	444	444	444
Lincoln Park Lake	Individual	1	*Micropterus salmoides*	Largemouth Bass	1805	442	442	442
Peck Road Water Conservation Park	Composite	5	*Micropterus salmoides*	Largemouth Bass	846	359.6	335	396
Peck Road Water Conservation Park	Individual	1	*Micropterus salmoides*	Largemouth Bass	535	339	339	339
Peck Road Water Conservation Park	Individual	1	*Micropterus salmoides*	Largemouth Bass	635	338	338	338
Peck Road Water Conservation Park	Individual	1	*Micropterus salmoides*	Largemouth Bass	730	335	335	335
Peck Road Water Conservation Park	Individual	1	*Micropterus salmoides*	Largemouth Bass	1215	396	396	396
Peck Road Water Conservation Park	Individual	1	*Micropterus salmoides*	Largemouth Bass	1115	390	390	390

Total Fish	**60**
Total Composites	**8**
Total Individual Fish	**20**

OEHHA specifies that the muscle fillets from at least five individual fish of the same species and size class be combined together to form a composite sample from each sampling location. For the LARWMP study, a total of eight composite samples met this criterion and were analyzed for the 2010 survey. Four contaminants (mercury, selenium, total DDTs, and total PCBs) were selected for analysis based on their contribution to human health risk in California's coastal and estuarine fishes.

Analytical procedures for each of these constituents in tissues are provided in the sampling and analysis plan for the Bioaccumulation Monitoring Program (SWAMP

2007b.). It is widely assumed that nearly all (>95%) of the mercury present in fish is methyl mercury (Wiener et al. 2007). Consequently, monitoring programs usually analyze total mercury as a proxy for methyl mercury, as was done in this study. USEPA (2000) recommends that the conservative assumption that all mercury is present as methyl mercury is used since it is most protective of human health.

Concentrations of contaminants in each fish species were compared to State Fish Contaminant Goals (FCGs) and Advisory Tissue Levels (ATLs) for human consumption developed by the State of California's Office of Environmental Health Hazard Assessment (OEHHA 2008) (Table 34 and Table 35). The OEHHA Fish Contaminant Goals (FCGs) are estimates of contaminant levels in fish that pose no significant health risk to individuals consuming sport fish at a standard consumption rate of eight ounces per week (32 g/day), prior to cooking, over a lifetime. OEHHA also can provide a starting point to assist other agencies that wish to develop fish tissue-based criteria with a goal toward pollution mitigation or elimination. This guidance assumes a life time risk level of 1 in a million for fishermen who consume an 8-ounce fish fillet containing a given amount of a specific contaminant.

The OEHHA Advisory Tissue Levels (ATLs), while still conferring no significant health risk to individuals consuming sport fish in the quantities shown over a lifetime, were developed with the recognition that there are unique health benefits associated with fish consumption and that the advisory process should be expanded beyond a simple risk paradigm in order to best promote the overall health of the fish consumer. ATLs protect consumers from being exposed to more than the average daily reference dose for non-carcinogens or to a lifetime cancer risk level of 1 in 10,000 for fishermen who consume an 8-ounce fish fillet containing a given amount of a specific contaminant. For specific details regarding the assumptions used to develop the FCGs and ATLs, go to: http://oehha.ca.gov/fish/gtlsv/crnr062708.html (OEHHA, 2008).

Table 34. Fish contaminant goals (FCGs) for selected fish contaminants based on cancer and non-cancer risk * using an 8-ounce/week (prior to cooking) consumption rate (32 g/day). **

	FCGs (ppb, wet weight)
Contaminant Cancer Slope Factor (mg/kg/day)-1	
DDTs (0.34)	**21**
PCBs (2)	**3.6**
Contaminant Reference Dose (mg/kg-day)	
DDTs (5x10-4)	1600
Methylmercury (1x10-4)[S]	**220**
PCBs (2x10-5)	63
Selenium (5x10-3)	**7400**

*The most health protective Fish Contaminant Goal for each chemical (cancer slope factor- versus reference dose-derived) for each meal category is bolded.

**g/day represents the average amount of fish consumed daily, distributed over a 7-day period, using an 8-ounce serving size, prior to cooking.

[S]Fish Contaminant Goal for sensitive populations (i.e., women aged 18 to 45 years and children aged 1 to 17 years.)

Table 35. OEHHA (2008) advisory tissue levels (ATLs) for elected fish contaminants based on cancer or non-cancer risk using an 8-ounce serving size.

Contaminant	Three 8-ounce Servings* a Week	Two 8-ounce Servings* a Week	One 8-ounce Servings* a Week	No Consumption
DDTs[nc]**	≤520	>520-1,000	>1,000-2,100	>2,100
Methylmercury (Women aged 18-45 years and children aged 1-17 years)[nc]	≤70	>70-150	>150-440	>440
Methylmercury (Women over 45 years and men)[nc]	≤220	>220-440	>440-1,310	>1,310
PCBs[nc]	≤21	>21-42	>42-120	>120
Seleniumn[c]	≤2500	>2500-4,900	>4,900-15,000	>15,000

[c]ATLs are based on cancer risk

[nc]ATLs are based on non-cancer risk

*Serving sizes are based on an average 160 pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts (for example, individuals weighing 80 pounds should eat one 4-ounce serving a week when the table recommends eating one 8-ounce serving a week).

**ATLS for DDTs are based on non-cancer risk for two and three servings per week and cancer risk for one serving per week.

Total Mercury

Mercury is the contaminant of greatest concern with respect to bioaccumulation on a statewide basis. Since largemouth bass are common and widely distributed throughout lakes in CA, they were selected as appropriate pelagic predator indicator species for mercury in the 2010 study. The concentration of mercury in individual largemouth bass ranged from 40 ppb in Lincoln Park Lake to 605 ppb in Legg Lakes.

The concentration of mercury in one composite of bottom- feeding carp from Lincoln Park Lake was 49 ppb. 42% of samples (8 of 19) exceeded the FCGs for methyl mercury of 220 ppb wet weight.

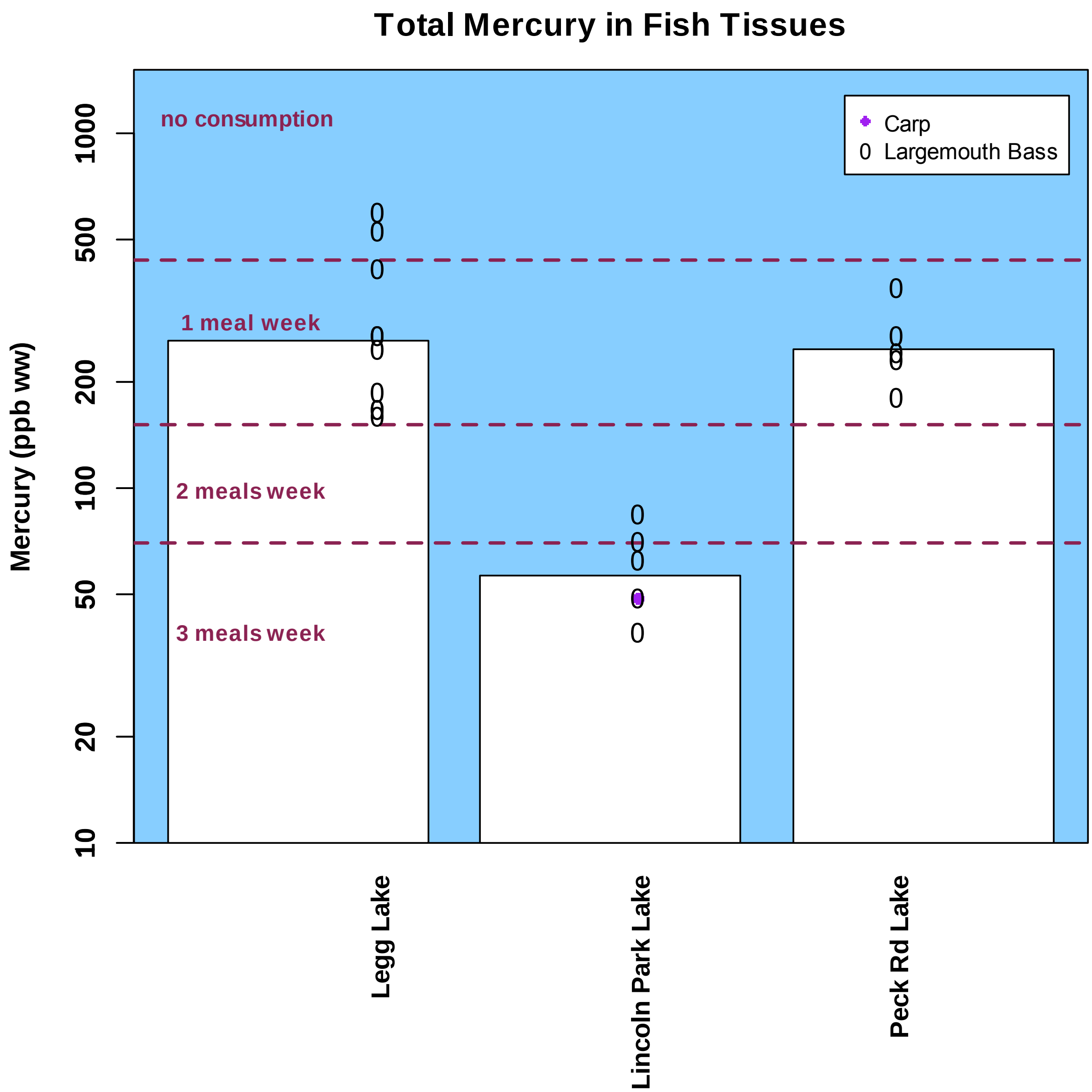


Figure 30 shows the mercury concentration in fish compared to the OEHHA ATL's for women of child bearing age and children. These are the most conservative guidelines and suggest either no consumption, or limiting consumption to one meal per week for largemouth bass caught in Legg Lakes. For individual largemouth bass caught at Peck Rd and Lincoln Park Lake, consumption guidelines suggest one meal per week, and two-three meals per week, respectively.

Selenium

Selenium was analyzed in 2 composites of largemouth bass from Legg Lake and was either not detected above the instrument limit of detection or was flagged as detected but not quantifiable (DNQ). A composite of redear sunfish from Legg Lake that contained insufficient sample was analyzed and selenium concentrations were detected but not quantifiable (DNQ).

Total DDT

Fish tissue concentrations of total DDTs ranged from ~7.5 ppb wet weight in composites of carp and largemouth bass from Echo lake to 16.3 ppb wet weight in a composite of largemouth bass in Legg Lakes (Figure 31). These levels were well below the FCG for DDTs of 1600 ppb wet weight. ATL consumption guidelines based on balancing health risk and benefits suggest three meals per week for all of the lakes sampled in the Los Angeles River watershed.

Total PCB

Total PCB concentrations ranged from below detection ~5.5 ppb wet weight in two composites of largemouth bass from Legg Lakes to 51 ppb wet weight in a composite of largemouth bass from Echo Lake. PCB concentrations in all lakes samples were below the FCGs of 63 ppb wet weight. OEHHA ATL guideline suggest that the consumption of carp and largemouth bass from Echo lake be limited to one meal per week and largemouth bass caught at Peck Road lake be limited to two meals per week.

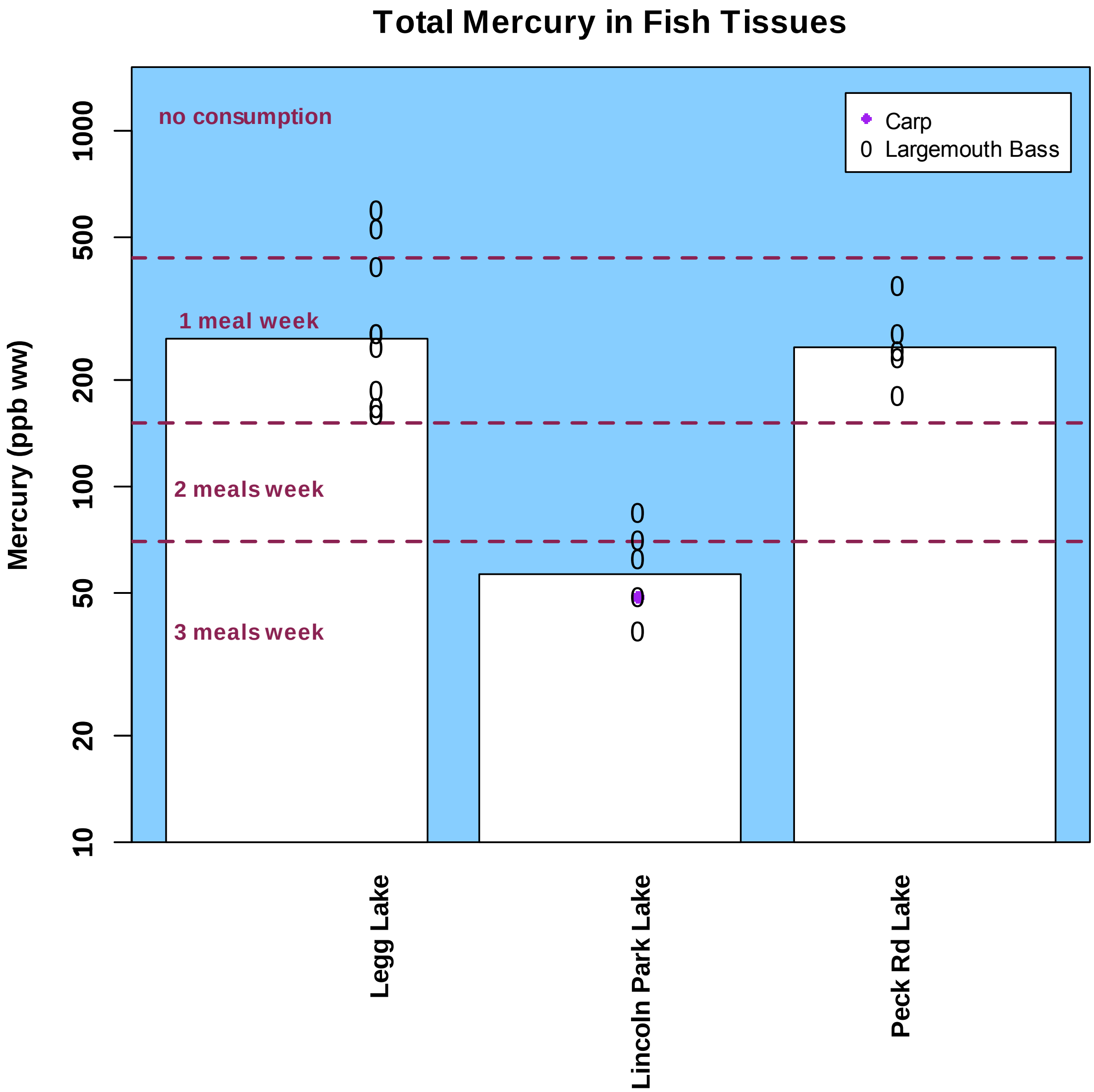


Figure 30. Mercury concentrations (ppb wet weight) in fish tissue samples collected at locations in the Los Angeles River Watershed in 2010. OEHHA ATLs are bolded; ATLs are color-coded based on the most conservative threshold for women aged 18 to 45 (Table 35). n=21.

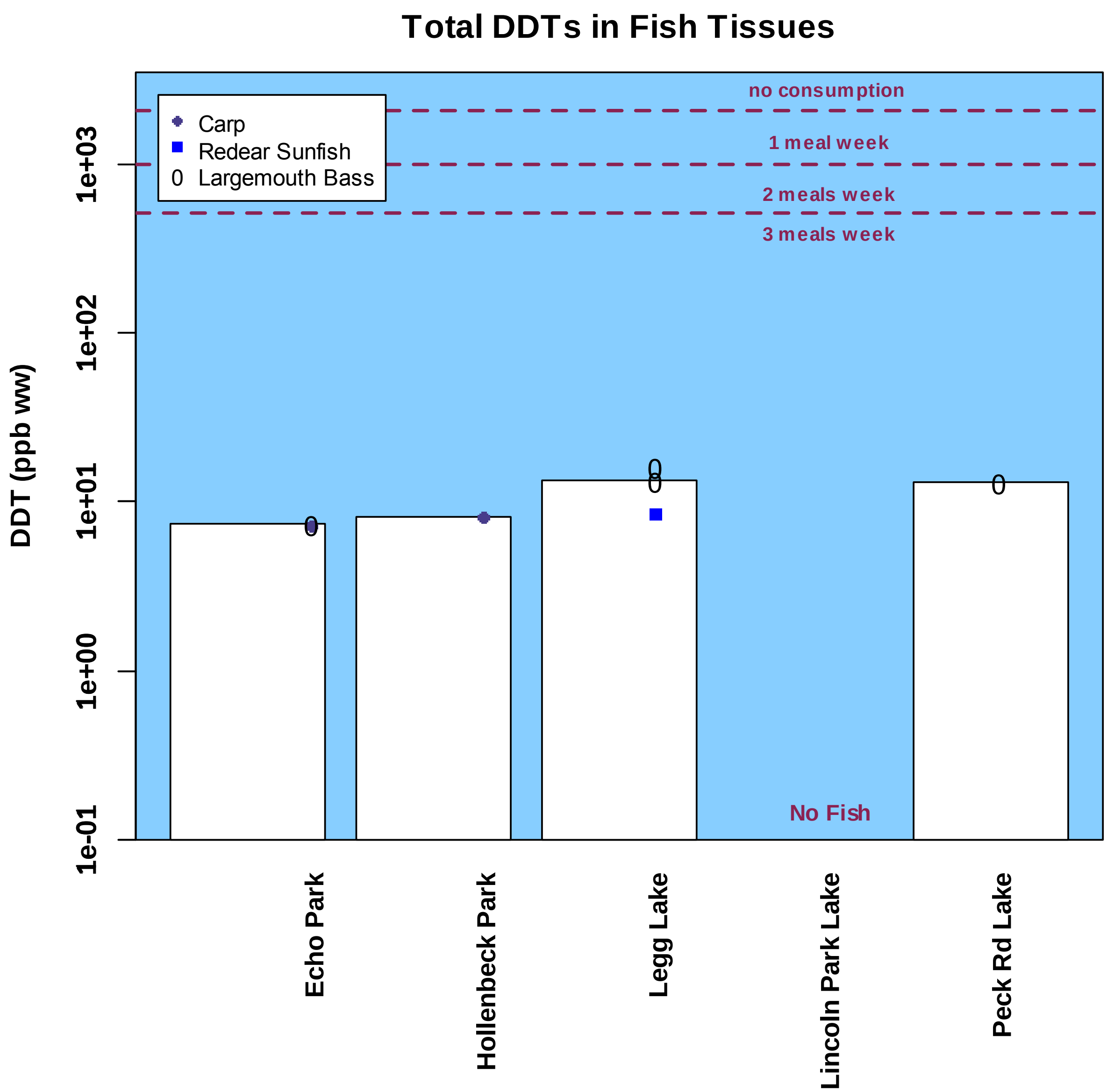


Figure 31. DDT concentrations (ppb wet weight) in composite fish tissue samples collected at fishing locations in the Los Angeles River Watershed in 2010. Concentrations exceeding the OEHHA ATLs are bolded; those exceeding the ATL thresholds are color-coded based.

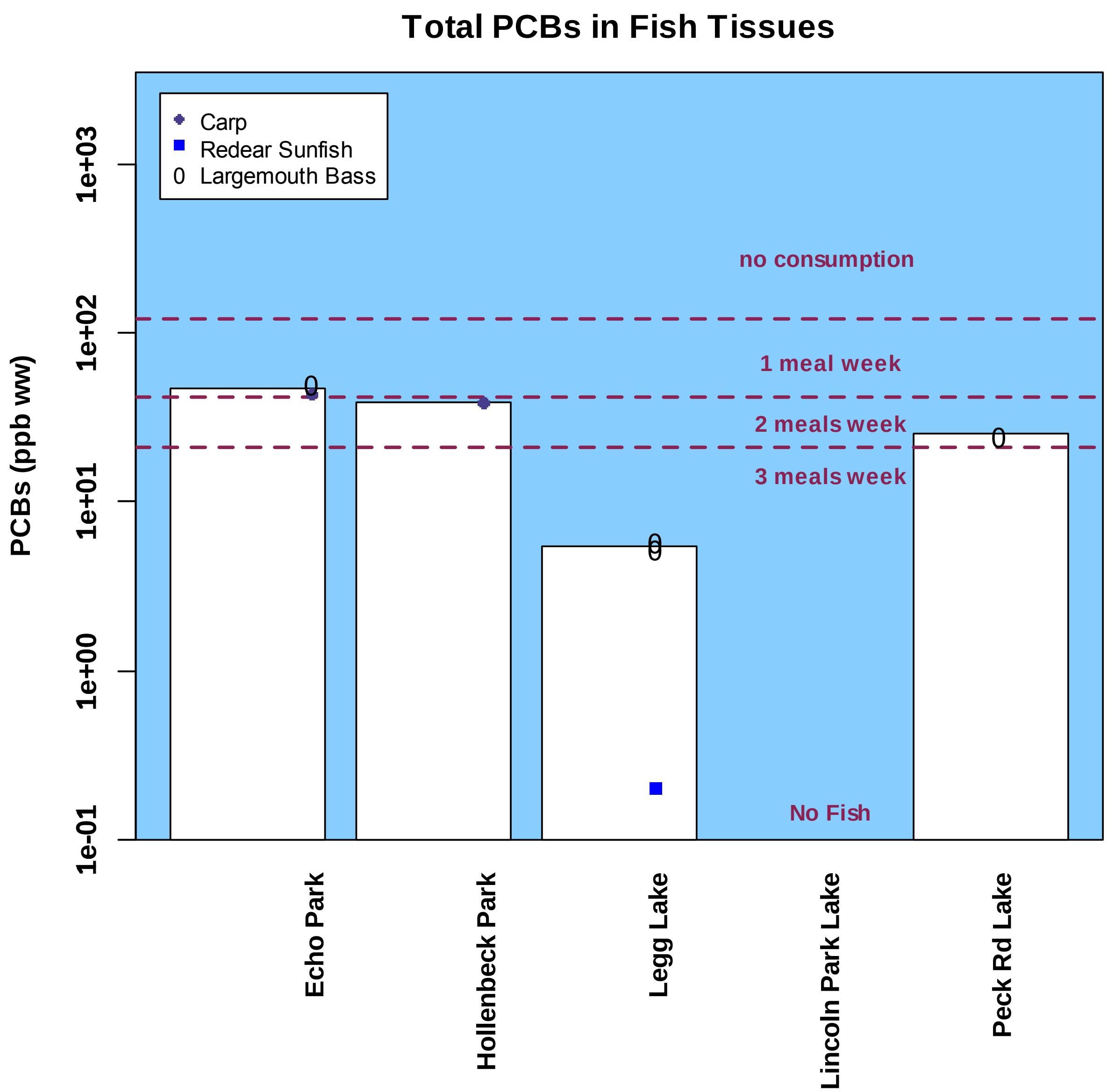


Figure 32. PCB concentrations (ppb wet weight) in composite fish tissue samples collected at fishing locations in the Los Angeles River Watershed in 2010.

Chapter Summary

The data collected in 2010 by the SWAMP Bioaccumulation Monitoring Program indicate that of the four contaminants of concern, mercury concentrations in largemouth bass from Legg Lakes would limit potential human consumption to less than one 8-oz. fillet meal per week.

- This research effort did not consider trout, catfish, or pan fish, which either are usually stocked or have feeding strategies that limit pollutant exposure. Based on the following results for bass and carp, which do accumulate pollutants, these stocked and pan fishes are unlikely to pose health risks from exposure to the pollutants analyzed in the Los Angeles River, even if consumed several days per week.
- Mercury concentrations were greatest in largemouth bass collected from Legg Lakes and Peck Road Lake where OEHHA thresholds suggest no consumption or limiting consumption to one meal per week, respectively, for children and women of child bearing age. Common carp could be consumed at the guideline maximum of three meals per week threshold.
- Selenium concentrations in fish from each location were well below the lowest OEHHA threshold.
- Total DDT concentrations were low in all fish tissues, and could be consumed at the guideline maximum of three meals per week threshold
- Total PCBs in common carp and largemouth bass from Echo Park suggest limiting their consumption to one-meal-per-week

Literature Cited

Allen JM, Jarvis ET, Raco-Rands V, Lyon G, Reyes JA, and Petschauer DM, 2008, Extent of Fishing And Fish Consumption by Fishers in Ventura and Los Angeles County Watersheds In 2005, Technical Report 574 SCCWRP, September 15, 2008

Anderson, B.S., J.W. Hunt, M. Hester, and B.M. Phillips. 1996. Assessment of sediment toxicity at the sediment-water interface. pp. 609-624 in: G.K. Ostrander (ed.), Techniques in aquatic toxicology. CRC Press Inc. Boca Raton, FL.

Balarin, J.D., 1979. *Tilapia*. A guide to their biology and culture in Africa. University of Stirling, Stirling, Scotland. 174 p.

Collins, J.N., E.D. Stein, M. Sutula, R. Clark, A.E. Fetscher, L. Grenier, C. Grosso, and A. Wiskind. 2008. California Rapid Assessment Method (CRAM) for Wetlands. Version 5.0.2. 151 pp.

CREST. 2006. Tier 2 Dry Season Bacteria Source Assessment of the Los Angeles River, Analysis of Measured Flow Rates, Water and Sediment Quality, Bacteria Loading Rates, and Land Uses. The Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST).

CREST. 2008. Los Angeles River Bacteria Source Identification Study: Final Report . The Cleaner Rivers through Effective Stakeholder-led TMDLs (CREST).

CWH. 2010. Los Angeles River Watershed-Wide Monitoring Program, Quality Assurance Project Plan. Los Angeles and San Gabriel River Watershed Council, Los Angeles, CA. Technical report: http://www.watershedhealth.org/dataandreference/Document.aspx?search=38

CWH[1]. 2009. Los Angeles River Watershed-Wide Monitoring Program, Quality Assurance Project Plan. Los Angeles and San Gabriel River Watershed Council, Los Angeles, CA. Technical report: http://www.watershedhealth.org/dataandreference/Document.aspx?search=38

CWH[2]. 2009. Los Angeles River Watershed Monitoring Program, Annual Report on Monitoring Activities, Los Angeles and San Gabriel River Watershed Council, Los Angeles, CA. Technical report: http://www.watershedhealth.org/dataandreference/Document.aspx?search=38

CWH. 2008. Los Angeles River Watershed Monitoring Program. Los Angeles and San Gabriel River Watershed Council, Los Angeles, CA. Technical report: http://lasgrwc2.org/dataandreference/Document.aspx?search=38

CWH. 2007. Summary of Existing Monitoring Programs in the Los Angeles River Watershed. Los Angeles and San Gabriel River Watershed Council, Los Angeles, CA. Technical report: http://lasgrwc2.org/dataandreference/Document.aspx?search=38

Kottelat, M. 1998. European freshwater fishes. Springer Netherlands, Vol 51: 1, pg 116.

LARWQCB. 1994. Water Quality Control Plan, Los Angeles Region. Los Angeles Regional Water Quality Control Board, Los Angeles, CA. http://www.swrcb.ca.gov/rwqcb4/water_issues/programs/basin_plan

Long, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. National Oceanic and Atmospheric Administration. Seattle, WA.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Ode, R.E., A.C. Rehn, and J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Env. Man., Vol. 35, No. 4, pp. 493-504.

OEHHA. Klasing, S. and R.Brodberg. 2008. Development of fish contaminant goals and advisory tissue levels for common contaminants in California sport fish: chlordane, DDTs, dieldrin, methylmercury, PCBs, selenium, and toxaphene. Pesticide and Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. 115 pp.

OEHHA (Office of Environmental Health Hazard Assessment). 2005. General protocol for sport fish sampling and analysis. Gassel, M. and R.K. Brodberg. Pesticide and Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. 11 pg.

Page, L.M. and B.M. Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston. 432 p.

Peters, W. (C.H.). 1852. Diagnosen von neuen Flussfischen aus Mossambique. Monatsberichte der Akademie der Wissenschaft zu Berlin 1852: 275-276, 681-685.

Phillips BM, BS Anderson, JW Hunt, B Thompson, S Lowe, R Hoenicke, RS Tjeerdema. 2003. Causes of sediment toxicity to *Mytilus galloprovincialis* in San Francisco Bay, California. *Arch. Environ Contam. Toxicol.* 45: 486-491.Ricca, D.M. and J.J. Cooney. 1998. Coliphages and indicator bacteria in birds around Boston Harbor. *Journal of Industrial Microbiology & Biotechnology* 21:28-30.

Richards, A.B and D.C. Rogers. 2006. List of freshwater macroinvertebrate taxa from California and adjacent states including standard taxonomic effort levels. Southwest Association of Freshwater Invertebrate Taxonomists. http://www.swrcb.ca.gov/swamp/docs/safit/ste_list.pdf

SCCWRP. 2009. Southern California Regional Watersheds Monitoring Program, Bioassessment Quality Assurance Project Plan, version 1.0. Prepared by Southern California Coastal Water Research Project, Costa Mesa, CA.

SCCWRP. 2008. Sediment Quality in California Bays and Estuaries. Technical Report 522, Southern California Coastal Water Research Project, Costa Mesa, CA.

SCCWRP. 2007. Regional Monitoring of Southern California's Coastal Watersheds, Stormwater Monitoring Coalition, Bioassessment Working Group. Technical Report 539, Southern California Coastal Water Research Project, Costa Mesa, CA.

SGRRMP. 2009. San Gabriel River Regional Monitoring Program, Annual Report on Monitoring Activities for 2008. Los Angeles and San Gabriel River Watershed Council, Los Angeles, CA. Technical report: http://lasgrwc2.org/Default2.aspx.

Stein, E.D. and D. Ackerman. 2007. Dry weather water quality loadings in arid, urban watersheds of the Los Angeles basin, California, USA. *Journal of the American Water Resources Association,* 43(2):1-16.

Stein, E.D. and J. Brown. 2009. Effects of Post-fire Runoff on Surface water Quality: Development of a Southern California Regional Monitoring Program with Management Questions and Implementation Recommendations. SCCWRP *Technical Report 598, August 2009*

SWAMP. 2010. Contaminants in fish from California lakes and reservoirs, 2007-2008: Summary report on a two-year screening survey. California Water Boards, Surface Water Ambient Monitoring Program (www.waterboards.ca.gov/swamp), Rancho Cordova, CA.

SWAMP. 2008. Standard operating procedures for collecting benthic macroinvertebrate samples and associated physical and chemical data for ambient bioassessments in California. California Water Boards, Surface Water Ambient Monitoring Program (www.waterboards.ca.gov/swamp), Rancho Cordova, CA.

SWAMP. 2007. Incorporating bioassessment using freshwater algae into California's surface water ambient monitoring program (SWAMP). California Water Boards, Surface Water Ambient Monitoring Program (www.waterboards.ca.gov/swamp), Rancho Cordova, CA.

SWAMP. 2007b. Sampling and Analysis Plan for a Screening Study of Bioaccumulation in California Lakes and Reservoirs. California Water Boards, Surface Water Ambient Monitoring Program (www.waterboards.ca.gov/swamp), Rancho Cordova, CA.

U.S. EPA (United States Environmental Protection Agency). 1986. Quality Criteria for Water. EPA 440/5-86-001.

U.S. EPA600/R-94-025. June 1994. Methods for Assessing the Toxicity of Sediment-associated Contaminants with Estuarine and Marine Amphipods. (NTIS /PB95-177374 or NEPIS: http://www.epa.gov/clariton/clhtml/pubtitleORD.html or http://www.epa.gov/ost/library/sediment/)

U.S. EPA 1994 600/4-91-003.Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Marine and Estuarine Organisms.Second Edition, July 1994. [(NSCEP or CD ROM or NEPI http://www.epa.gov/clariton/clhtml/pubtitleORD.html) superseded by EPA 821/R-02-014]

U.S. EPA 2000. Estimated per capita fish consumption in the United States: based on data collected by the United States Department of Agriculture's 1994-1996 continuing survey of food intake by individuals. Office of Science and Technology, Office of Water, Washington, DC. March.

U.S. EPA. 2000b. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories: Volume 1, Fish Sampling and Analysis, Third Edition. EPA 823-R-93-002B-00-007.

U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

USGS. 2009. B.C. Scudder, L.C. Chasar, D.A. Wentz, N.J. Bauch, M.E. Brigham, P.W. Moran, D.P. Krabbenhoft. Mercury in fish, bed sediment, and water from streams across the United States, 1998-2005. National Water-Quality Assessment Program Toxic Substances Hydrology Program. Scientific Investigations Report 2009-5109.

Viswanathan, S., K.A. Voss, A. Pohlman, D. Gibson, J. Purohit. 2010. Evaluation of the Biocriteria of Streams in the San Diego Hydrologic Region, Journal of Environmental Engineering, Vol. 136, No. 6, pp. 627-637.

Weston Solutions. 2006. Bioassessment Monitoring Program in Los Angeles County. Prepared for Los Angeles County Department of Public Works. June, 2007.

Weston Solutions, Inc. (B. Isham). 2005. Freshwater Stream Invertebrates: Response to Water Quality Impairment and Physical Habitat Alteration,Technical Paper #0508, StormCon® 2005, July 18-21, JW Marriott Grande Lakes, Orlando, FL, USA.

Wiener, J. G., R. A. Bodaly, S. S. Brown, M. Lucotte, M.C. Newman, D. B. Porcella, R. J. Reash, and E. B. Swain. 2007. Monitoring and evaluating trends in methylmercury accumulation in aquatic biota. Chapter 4 in R. C. Harris, D. P. Krabbenhoft, R. P. Mason, M. W. Murray, R. J. Reash, and T. Saltman (editors), Ecosystem Responses to Mercury Contamination: Indicators of Change. CRC Press/Taylor and Francis, Boca Raton, Florida. pp. 87-122.

Appendix A

Table A-1 Data quality objectives for field and laboratory measurements

Group	Parameter	Accuracy	Precision	Recovery	Completeness	Laboratory	Target Reporting Limits	MDL	Units
Conventional Water Chemistry	Dissolved Oxygen	± 0.5 mg/L	10%	NA	90%	ABC/Weston	0	N/A	mg/L
	Temperature	± 0.5 °C	5%	NA		ABC/Weston	-5	N/A	°C
	Conductivity	5%	5%	NA		ABC/Weston	0-100	N/A	mS/cm
	pH by meter	± 0.5 units	5%	NA		ABC/Weston	2-12	N/A	-log [H+]
Freshwater Chemistry	Ammonia	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	90%	CLA EMD	0.10	0.05	mg/L
	Dissolved Solids					CLA EMD	37.00	28	mg/L
	Nitrate					CLA EMD	0.02	0.01	mg/L
	Nitrite					CLA EMD	0.02	0.01	mg/L
	Total Alkalinity					CLA EMD	10.00	1.00	mg/L
	Total Hardness					CLA EMD	1.32	0.03	mg/L
	Total Nitrogen					CLA EMD	0.10	0.10	mg/L
	Total & Dissolved Org Carbon					CLA EMD	0.10	0.05	mg/L
	Total Orthophosphate					CLA EMD	0.10	0.05	mg/L
	Total Phosphorus					CLA EMD	0.10	0.05	mg/L
	Total Suspended Solids					CLA EMD	3.00	2.0	mg/L
Freshwater Major Ions	Chloride	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 90% to 110% of true value	Laboratory duplicate, or MS/MSD Duplicate, 25% RPD Laboratory duplicate minimum.	Laboratory Fortified Blank (LFB) and Laboratory Fortified Matrix (LFM) Recovery within 90% - 110%		CLA EMD	1.0	0.1	mg/L
	Sulfate					CLA EMD	1.0	0.1	mg/L
	Silica					CRG	0.1	0.1	mg/L
Freshwater Trace Metals	Arsenic (As)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 75% to 125% of true value	Field replicate, laboratory duplicate, or MS/MSD ± 25% RPD. Laboratory duplicate minimum.	Matrix spike 75% - 125%.	90%	CLA EMD	1.0	0.10	µg/L
	Cadmium (Cd)					CLA EMD	0.2	0.02	µg/L
	Chromium (Cr)					CLA EMD	0.5	0.09	µg/L
	Copper (Cu)					CLA EMD	0.5	0.08	µg/L
	Iron (Fe)					CLA EMD	50.0	5.00	µg/L
	Lead (Pb)					CLA EMD	0.5	0.11	µg/L
	Mercury (Hg)					CLA EMD	0.2	0.004	µg/L
	Nickel (Ni)					CLA EMD	1.0	0.20	µg/L
	Selenium (Se)					CLA EMD	1.0	0.10	µg/L
	Zinc (Zn)					CLA EMD	1.0	0.40	µg/L
Freshwater Organophosphorus Pesticides in	Bolstar (Sulprofos)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD ± 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at ± 3 standard deviations based on actual lab data.	90%	CRG	4	2.00	ng/L
	Chlorpyrifos					CRG	2	1.00	ng/L
	Demeton					CRG	2	1.00	ng/L
	Diazinon					CRG	4	2.00	ng/L
	Dichlorvos					CRG	6	3.00	ng/L
	Dimethoate					CRG	6	3.00	ng/L
	Disulfoton					CRG	2	1.00	ng/L
	Ethoprop (Ethoprofos)					CRG	2	1.00	ng/L
	Fenchlorophos (Ronnel)					CRG	4	2.00	ng/L
	Fensulfothion					CRG	2	1.00	ng/L
	Fenthion					CRG	4	2.00	ng/L
	Malathion					CRG	6	3.00	ng/L
	Merphos					CRG	2	1.00	ng/L
	Methyl Parathion					CRG	2	1.00	ng/L
	Mevinphos (Phosdrin)					CRG	16	8.00	ng/L

Group	Parameter	Accuracy	Precision	Recovery	Completeness	Laboratory	Target Reporting Limits	MDL	Units
Freshwater Organophosphorus Pesticides in (continued)	Phorate					CRG	12	6.00	ng/L
	Tetrachlorvinphos (Stirofos)					CRG	4	2.00	ng/L
	Tokuthion					CRG	6	3.00	ng/L
	Trichloronate					CRG	2	1.00	ng/L
Freshwater Pyrethroid	Bifenthrin	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD + 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at + 3 standard deviations based on actual lab data.	90%	CRG	0.5	0.50	ng/L
	Cyfluthrin					CRG	0.5	0.50	ng/L
	Cyhalothrin-lambda					CRG	0.5	0.50	ng/L
	Cypermethrin					CRG	0.5	0.50	ng/L
	Deltamethrin					CRG	0.5	0.50	ng/L
	Esfenvalerate					CRG	0.5	0.50	ng/L
	Fenvalerate					CRG	0.5	5.00	ng/L
	Permethrin					CRG	5	5.00	ng/L
Estuary (seawater) Water Chemistry	Ammonia	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at + 3 standard deviations based on actual lab data.	90%	CLA EMD	0.10	0.05	mg/L
	Dissolved Solids					CLA EMD	37	28	mg/L
	Nitrate					CLA EMD	0.02	0.01	mg/L
	Nitrite					CLA EMD	0.02	0.01	mg/L
	pH					CLA EMD	N/A	N/A	-log [H+]
	Total Alkalinity					CLA EMD	10	1	mg/L
	Total Hardness					CLA EMD	1.32	0.03	mg/L
	Total Nitrogen					CLA EMD	0.1	0.1	mg/L
	Total & Dissolved Organic Carbon					CLA EMD	0.1	0.05	mg/L
	Total Orthophosphate					CLA EMD	0.1	0.05	mg/L
	Total Phosphorus					CLA EMD	0.1	0.05	mg/L
	Total Suspended Solids					CLA EMD	3	2	mg/L
Estuary (seawater) Trace Metals	Aluminum (Al)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 75% to 125% of true value	Field replicate, laboratory duplicate, or MS/MSD + 25% RPD. Laboratory duplicate minimum.	Matrix spike 75% - 125%.	90%	CRG	50	10	µg/L
	Antimony (Sb)					CRG	0.50	0.04	µg/L
	Arsenic (As)					CRG	1.00	0.10	µg/L
	Beryllium (Be)					CRG	0.50	0.03	µg/L
	Cadmium (Cd)					CRG	0.20	0.02	µg/L
	Chromium (Cr)					CRG	0.50	0.09	µg/L
	Cobalt (Co)					CRG	5.00	0.04	µg/L
	Copper (Cu)					CRG	0.50	0.08	µg/L
	Iron (Fe)					CRG	50.00	5.00	µg/L
	Lead (Pb)					CRG	0.50	0.11	µg/L
	Manganese (Mn)					CRG	5.00	0.20	µg/L
	Mercury (Hg)					CRG	0.20	0.00	µg/L
	Molybdenum (Mo)					CRG	5.00	0.02	µg/L
	Nickel (Ni)					CRG	1.00	0.20	µg/L
	Selenium (Se)					CRG	1.00	0.10	µg/L
	Silver (Ag)					CRG	0.25	0.08	µg/L
	Thallium (Tl)					CRG	1.00	0.01	µg/L
	Tin (Sn)					CRG	10.00	4.00	µg/L
	Vanadium (V)					CRG	0.50	0.02	µg/L
	Zinc (Zn)					CRG	1.00	0.40	µg/L

Group	Parameter	Accuracy	Precision	Recovery	Completeness	Laboratory	Target Reporting Limits	MDL	Units
Estuary (seawater) Organophosphorus Pesticides in	Bolstar (Sulprofos)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD $\pm$ 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at $\pm$ 3 standard deviations based on actual lab data.	90%	CRG	4	2	ng/L
	Chlorpyrifos					CRG	2	1	ng/L
	Demeton					CRG	2	1	ng/L
	Diazinon					CRG	4	2	ng/L
	Dichlorvos					CRG	6	3	ng/L
	Dimethoate					CRG	6	3	ng/L
	Disulfoton					CRG	2	1	ng/L
	Ethoprop (Ethoprofos)					CRG	2	1	ng/L
	Fenchlorophos (Ronnel)					CRG	4	2	ng/L
	Fensulfothion					CRG	2	1	ng/L
	Fenthion					CRG	4	2	ng/L
	Malathion					CRG	6	3	ng/L
	Merphos					CRG	2	1	ng/L
	Methyl Parathion					CRG	2	1	ng/L
	Mevinphos (Phosdrin)					CRG	16	8	ng/L
	Phorate					CRG	12	6	ng/L
	Tetrachlorvinphos (Stirofos)					CRG	4	2	ng/L
	Tokuthion					CRG	6	3	ng/L
	Trichloronate					CRG	2	1	ng/L
Estuary (seawater) Pyrethroid	Bifenthrin	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD $\pm$ 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at $\pm$ 3 standard deviations based on actual lab data.	90%	CRG	0.5	0.5	ng/L
	Cyfluthrin					CRG	0.5	0.5	ng/L
	Cyhalothrin-lambda					CRG	0.5	0.5	ng/L
	Cypermethrin					CRG	0.5	0.5	ng/L
	Deltamethrin					CRG	0.5	0.5	ng/L
	Esfenvalerate					CRG	0.5	0.5	ng/L
	Fenvalerate					CRG	0.5	5	ng/L
	Permethrin					CRG	5	5	ng/L
Estuary Sediment Nutrients	Total Nitrogen	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25%. RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at $\pm$ 3 standard deviations based on actual lab data.	90%	CRG	0.50	2.0	mg/Kg
	Total Organic Carbon					CRG	0.05	0.1	% Dry Weight
	Total Phosphorus					CRG	0.05	0.016	mg/Kg
Estuary Sediment Trace Metals	Aluminum (Al)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 75% to 125% of true value	Field replicate, laboratory duplicate, or MS/MSD 30% RPD. Laboratory duplicate minimum.	Matrix spike 75% - 125%.	90%	CLA EMD	100	27	mg/dry Kg
	Antimony (Sb)					CLA EMD	1	0.27	mg/dry Kg
	Arsenic (As)					CLA EMD	1	0.22	mg/dry Kg
	Barium (Ba)					CLA EMD	1	0.20	mg/dry Kg
	Beryllium (Be)					CLA EMD	0.2	0.01	mg/dry Kg
	Cadmium (Cd)					CLA EMD	1	0.02	mg/dry Kg
	Chromium (Cr)					CLA EMD	1	0.10	mg/dry Kg
	Cobalt (Co)					CLA EMD	1	0.10	mg/dry Kg
	Copper (Cu)					CLA EMD	1	0.18	mg/dry Kg
	Iron (Fe)					CLA EMD	100	76	mg/dry Kg
	Lead (Pb)					CLA EMD	0.5	0.15	mg/dry Kg
	Manganese (Mn)					CLA EMD	1	0.90	mg/dry Kg
	Mercury (Hg)					CLA EMD	0.01	0.0004	mg/dry Kg
	Molybdenum (Mo)					CLA EMD	1	0.10	mg/dry Kg
	Nickel (Ni)					CLA EMD	2	0.2	mg/dry Kg
	Selenium (Se)					CLA EMD	1	0.35	mg/dry Kg
	Silver (Ag)					CLA EMD	1	0.02	mg/dry Kg
	Thallium (Tl)					CLA EMD	1	0.1	mg/dry Kg
	Vanadium (V)					CLA EMD	1	0.1	mg/dry Kg
	Zinc (Zn)					CLA EMD	2	0.21	mg/dry Kg

Group	Parameter	Accuracy	Precision	Recovery	Completeness	Laboratory	Target Reporting Limits	MDL	Units
Estuary Sediment Organophosphorus Pesticides in	Bolstar (Sulprofos)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD $\pm$ 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at $\pm$ 3 standard deviations based on actual lab data.	90%	CRG	10	2	ng/dry g
	Chlorpyrifos					CRG	10	1	ng/dry g
	Demeton					CRG	10	1	ng/dry g
	Diazinon					CRG	10	2	ng/dry g
	Dichlorvos					CRG	10	3	ng/dry g
	Dimethoate					CRG	10	3	ng/dry g
	Disulfoton					CRG	10	1	ng/dry g
	Ethoprop (Ethoprofos)					CRG	10	1	ng/dry g
	Fenchlorophos (Ronnel)					CRG	10	2	ng/dry g
	Fensulfothion					CRG	10	1	ng/dry g
	Fenthion					CRG	10	2	ng/dry g
	Malathion					CRG	10	3	ng/dry g
	Merphos					CRG	10	1	ng/dry g
	Methyl Parathion					CRG	10	1	ng/dry g
	Mevinphos (Phosdrin)					CRG	10	8	ng/dry g
	Phorate					CRG	10	6	ng/dry g
	Tetrachlorvinphos (Stirofos)					CRG	10	2	ng/dry g
	Tokuthion					CRG	10	3	ng/dry g
	Trichloronate					CRG	10	1	ng/dry g
Estuary Sediment Organochlorine pesticides & PCBs	4,4'-DDD	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD $\pm$ 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at $\pm$ 3 standard deviations based on actual lab data.	90%	CLA EMD	0.5	0.11	ng/wet g
	2,4'-DDD					CLA EMD	0.5	0.19	ng/wet g
	2,4'-DDE					CLA EMD	0.5	0.12	ng/wet g
	2,4'-DDT					CLA EMD	0.5	0.1	ng/wet g
	4,4'-DDE					CLA EMD	0.5	0.12	ng/wet g
	4,4'-DDT					CLA EMD	0.5	0.12	ng/wet g
	Aldrin					CLA EMD	1.7	0.9	ng/wet g
	BHC-alpha					CLA EMD	1.7	1.1	ng/wet g
	BHC-beta					CLA EMD	1.7	0.9	ng/wet g
	BHC-delta					CLA EMD	1.7	0.6	ng/wet g
	BHC-gamma					CLA EMD	1.7	1	ng/wet g
	Chlordane-alpha					CLA EMD	8.3	0.8	ng/wet g
	Chlordane-gamma					CLA EMD	8.3	0.9	ng/wet g
	cis-Nonachlor					CLA EMD	8.3	0.8	ng/wet g
	Dieldrin					CLA EMD	1.7	1	ng/wet g
	Endosulfan Sulfate					CLA EMD	1.7	0.8	ng/wet g
	Endosulfan-I					CLA EMD	1.7	1.2	ng/wet g
	Endosulfan-II					CLA EMD	1.7	0.7	ng/wet g
	Endrin					CLA EMD	1.7	0.9	ng/wet g
	Heptachlor					CLA EMD	1.7	1.4	ng/wet g
	Heptachlor Epoxide					CLA EMD	1.7	0.8	ng/wet g
	Methoxychlor					CLA EMD	6.7	3.3	ng/wet g
	Mirex					CLA EMD	1.7	0.8	ng/wet g
	Oxychlordane					CLA EMD	8.3	0.8	ng/wet g
	trans-Nonachlor					CLA EMD	8.3	0.9	ng/wet g
	Endrin Aldehyde					CLA EMD	1.7	0.5	ng/wet g
	Toxaphene					CLA EMD	83.3	5.8	ng/wet g
	PCB018					CLA EMD	0.5	0.21	ng/wet g
	PCB028					CLA EMD	0.5	0.33	ng/wet g
	PCB037					CLA EMD	0.5	0.5	ng/wet g
	PCB044					CLA EMD	0.5	0.29	ng/wet g
	PCB049					CLA EMD	0.5	0.21	ng/wet g
	PCB052					CLA EMD	0.5	0.19	ng/wet g
	PCB066					CLA EMD	0.5	0.35	ng/wet g
	PCB070					CLA EMD	0.5	0.19	ng/wet g
	PCB074					CLA EMD	0.5	0.2	ng/wet g
	PCB077					CLA EMD	0.5	0.24	ng/wet g
	PCB081					CLA EMD	0.5	0.18	ng/wet g
	PCB087					CLA EMD	0.5	0.22	ng/wet g

Group	Parameter	Accuracy	Precision	Recovery	Completeness	Laboratory	Target Reporting Limits	MDL	Units
Estuary Sediment Organochlorine pesticides & PCBs (continued)	PCB099					CLA EMD	0.5	0.18	ng/wet g
	PCB101					CLA EMD	0.5	0.18	ng/wet g
	PCB105					CLA EMD	0.5	0.24	ng/wet g
	PCB110					CLA EMD	0.5	0.34	ng/wet g
	PCB114					CLA EMD	0.5	0.18	ng/wet g
	PCB118					CLA EMD	0.5	0.2	ng/wet g
	PCB119					CLA EMD	0.5	0.23	ng/wet g
	PCB123					CLA EMD	0.5	0.18	ng/wet g
	PCB126					CLA EMD	0.5	0.18	ng/wet g
	PCB128					CLA EMD	0.5	0.35	ng/wet g
	PCB138					CLA EMD	0.5	0.19	ng/wet g
	PCB149					CLA EMD	0.5	0.22	ng/wet g
	PCB153+168					CLA EMD	1.0	0.41	ng/wet g
	PCB156					CLA EMD	0.5	0.17	ng/wet g
	PCB157					CLA EMD	0.5	0.21	ng/wet g
	PCB158					CLA EMD	0.5	0.29	ng/wet g
	PCB167					CLA EMD	0.5	0.41	ng/wet g
	PCB169					CLA EMD	0.5	0.2	ng/wet g
	PCB170					CLA EMD	0.5	0.2	ng/wet g
	PCB177					CLA EMD	0.5	0.19	ng/wet g
	PCB180					CLA EMD	0.5	0.22	ng/wet g
	PCB183					CLA EMD	0.5	0.17	ng/wet g
	PCB187					CLA EMD	0.5	0.2	ng/wet g
	PCB189					CLA EMD	0.5	0.22	ng/wet g
	PCB194					CLA EMD	0.5	0.45	ng/wet g
	PCB200					CLA EMD	0.5	0.22	ng/wet g
	PCB201					CLA EMD	0.5	0.16	ng/wet g
	PCB206					CLA EMD	0.5	0.4	ng/wet g
Estuary Sediment Hydrocarbons in	1-Methylnaphthalene	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD ± 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at ± 3 standard deviations based on actual lab data.	90%	CLA EMD	50	12.5	ng/wet g
	1-Methylphenanthrene					CLA EMD	50	8.4	ng/wet g
	2,6-Dimethylnaphthalene					CLA EMD	50	9.6	ng/wet g
	2-Methylnaphthalene					CLA EMD	50	29.5	ng/wet g
	Acenaphthene					CLA EMD	50	9.2	ng/wet g
	Acenaphthylene					CLA EMD	50	8.0	ng/wet g
	Anthracene					CLA EMD	50	11.5	ng/wet g
	Benz[a]anthracene					CLA EMD	50	8.2	ng/wet g
	Benzo[a]pyrene					CLA EMD	50	8	ng/wet g
	Benzo[b]fluoranthene					CLA EMD	50	12.5	ng/wet g
	Benzo[e]pyrene					CLA EMD	50	14	ng/wet g
	Benzo[g,h,i]perylene					CLA EMD	50	18.6	ng/wet g
	Benzo[k]fluoranthene					CLA EMD	50	10.4	ng/wet g
	Biphenyl					CLA EMD	50	11.4	ng/wet g
	Chrysene					CLA EMD	50	9.3	ng/wet g
	Dibenz[a,h]anthracene					CLA EMD	50	16.7	ng/wet g
	Fluoranthene					CLA EMD	50	8.8	ng/wet g
	Fluorene					CLA EMD	50	7.4	ng/wet g
	Indeno[1,2,3-c,d]pyrene					CLA EMD	50	16.0	ng/wet g
	Naphthalene					CLA EMD	50	14.7	ng/wet g
	Perylene					CLA EMD	50	10.1	ng/wet g
	Phenanthrene					CLA EMD	50	7.3	ng/wet g
	Pyrene					CLA EMD	50	9.3	ng/wet g
Estuary Sediment Grain Size	Sediment grain size	± 5% of point standard	Replicates within ± 20%	N/A	90%	CLA EMD	<2000 - >0.2	0.2	µm

Table A-2 Data quality objectives for field and laboratory measurements in fish tissue samples

Group	Parameter	Accuracy	Precision	Recovery	Completeness	Laboratory	Target Reporting Limits	MDL	Units
Tissue Trace Metals	Arsenic (As)	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 75% to 125% of true value	Field replicate, laboratory duplicate, or MS/MSD 30% RPD. Laboratory duplicate minimum.	Matrix spike 75% - 125%.	90%	CLA EMD	0.25	0.07	mg/dry Kg
	Mercury (Hg)					CLA EMD	0.01	0.0031	mg/dry Kg
	Selenium (Se)					CLA EMD	0.25	0.15	mg/dry Kg
Tissue Organochlorine Pesticides & PCBs	4,4'-DDD	Standard Reference Materials (SRM, CRM) or Lab Control Spikes (LCS) within 95% CL stated by provider of material. If not available then with 50% to 150% of true value	Field replicate or MS/MSD $\pm$ 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at $\pm$ 3 standard deviations based on actual lab data.	90%	CLA EMD	2	1	ug/wet Kg
	2,4'-DDD					CLA EMD	2	1	ug/wet Kg
	2,4'-DDE					CLA EMD	1.7	0.7	ug/wet Kg
	2,4'-DDT					CLA EMD	1.7	0.8	ug/wet Kg
	4,4'-DDE					CLA EMD	1.7	0.6	ug/wet Kg
	4,4'-DDT					CLA EMD	1.7	0.7	ug/wet Kg
	Aldrin					CLA EMD	1.7	0.3	ug/wet Kg
	BHC-alpha					CLA EMD	1.7	0.5	ug/wet Kg
	BHC-beta					CLA EMD	1.7	0.8	ug/wet Kg
	BHC-delta					CLA EMD	1.7	0.4	ug/wet Kg
	BHC-gamma					CLA EMD	1.7	0.7	ug/wet Kg
	Chlordane-alpha					CLA EMD	8.33	0.19	ug/wet Kg
	Chlordane-gamma					CLA EMD	8.33	0.18	ug/wet Kg
	cis-Nonachlor					CLA EMD	8.33	0.27	ug/wet Kg
	Dieldrin					CLA EMD	1.7	0.8	ug/wet Kg
	Endosulfan-I					CLA EMD	1.7	0.4	ug/wet Kg
	Endosulfan-II					CLA EMD	1.7	0.5	ug/wet Kg
	Endrin					CLA EMD	2	1	ug/wet Kg
	Heptachlor					CLA EMD	1.7	0.4	ug/wet Kg
	Heptachlor Epoxide					CLA EMD	1.7	1.1	ug/wet Kg
	Methoxychlor					CLA EMD	7	5	ug/wet Kg
	Mirex					CLA EMD	1.7	0.6	ug/wet Kg
	Oxychlordane					CLA EMD	8.33	0.9	ug/wet Kg
	trans-Nonachlor					CLA EMD	8.33	0.16	ug/wet Kg
	Endrin Aldehyde					CLA EMD	1.7	0.9	ug/wet Kg
	Toxaphene					CLA EMD	83	15	ug/wet Kg
	PCB018					CLA EMD	5	3	ug/wet Kg
	PCB028					CLA EMD	5	0.76	ug/wet Kg
	PCB037					CLA EMD	5	1.7	ug/wet Kg
	PCB044					CLA EMD	5	0.71	ug/wet Kg
	PCB049					CLA EMD	5	0.72	ug/wet Kg
	PCB052					CLA EMD	5	0.81	ug/wet Kg
	PCB066					CLA EMD	5	0.68	ug/wet Kg
	PCB070					CLA EMD	5	0.74	ug/wet Kg
	PCB074					CLA EMD	5	0.71	ug/wet Kg
	PCB077					CLA EMD	5	0.89	ug/wet Kg
	PCB081					CLA EMD	5	0.87	ug/wet Kg
	PCB087					CLA EMD	5	0.73	ug/wet Kg
	PCB099					CLA EMD	5	0.71	ug/wet Kg
	PCB101					CLA EMD	5	0.87	ug/wet Kg
	PCB105					CLA EMD	5	0.65	ug/wet Kg
	PCB110					CLA EMD	5	0.7	ug/wet Kg
	PCB114					CLA EMD	5	0.62	ug/wet Kg
	PCB118					CLA EMD	5	0.74	ug/wet Kg
	PCB119					CLA EMD	5	0.7	ug/wet Kg
	PCB123					CLA EMD	5	0.74	ug/wet Kg
	PCB126					CLA EMD	5	0.7	ug/wet Kg
	PCB128					CLA EMD	5	1.53	ug/wet Kg
	PCB138					CLA EMD	5	1.4	ug/wet Kg
	PCB149					CLA EMD	5	0.78	ug/wet Kg

Table A-3 Data quality objectives for field and laboratory measurements of bacterial indicators and toxicity

Group	Parameter	Accuracy	Precision	Recovery	Completeness	Laboratory	Target Reporting Limits	MDL	Units
Tissue Organochlorine Pesticides & PCBs	PCB153+168					CLA EMD	10	0.7	ug/wet Kg
	PCB156					CLA EMD	5	0.63	ug/wet Kg
	PCB157					CLA EMD	5	0.71	ug/wet Kg
	PCB158					CLA EMD	5	0.49	ug/wet Kg
	PCB167					CLA EMD	5	0.7	ug/wet Kg
	PCB169					CLA EMD	5	0.71	ug/wet Kg
	PCB170					CLA EMD	5	0.67	ug/wet Kg
	PCB177					CLA EMD	5	0.67	ug/wet Kg
	PCB180					CLA EMD	5	0.65	ug/wet Kg
	PCB183					CLA EMD	5	0.68	ug/wet Kg
	PCB187					CLA EMD	5	0.7	ug/wet Kg
	PCB189					CLA EMD	5	0.63	ug/wet Kg
	PCB194					CLA EMD	5	0.62	ug/wet Kg
	PCB201					CLA EMD	5	0.71	ug/wet Kg
	PCB206					CLA EMD	5	0.62	ug/wet Kg
Tissue Percent Lipids	Lipids	N/A	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate	N/A	90%	CLA EMD	N/A	N/A	%
Bacterial analysis: Freshwater Estuary waters	E. Coli Total Coliforms E. Coli Enterococcus	Laboratory positive and negative cultures – proper positive or negative response. Bacterial sample -–within the stated acceptance criteria.	R_{log} within 3.27*mean R_{log} (reference is section 9020B of 18th, 19th, or 20th editions of *Standard Methods*	N/A	90%	CLA EMD	10	10	MPN/100 mL
Toxicity Testing Water & Sediment	Acute Chronic	Meets EPA control response standards; DMR intralab results w/in criteria	Ref Tox ± 2 SD of preceding 20 tests	N/A	90%	CLA EMD CLA EMD	N/A	N/A	% survival % reproduction % development

Table A-4 Data quality objectives for field and laboratory measurements of benthic macroinvertebrates

Group	*Parameter*	*Accuracy*	*Precision*	*Recovery*	*Completeness*	*Laboratory*	*Target Reporting Limits*	*MDL*	*Units*
Freshwater Invertebrate Identifications	Sampling	≤10 seconds of nominal Lat/Long (300 m radius)	Record coefficient of variation of biological measures for duplicate samples (no DQO), frequency of 5% or at least one per project.	N/A	90%	ABC	1.0 seconds Lat/Long	N/A	N/A
	Sorting	Recount accuracy ≥95%. 10% frequency (external reference lab)	At least three grids or 25% of the total sample volume must be sorted.	N/A	-Sorting efficiency ≥95%, 100 % frequency (internal) -Processing efficiency ≥99%, 100% frequency	ABC	N/A	N/A	N/A
	Taxonomic ID	Taxa count error ≤5%. 10% frequency (external reference lab)	Random errors ≤ 2 taxa, 10% frequency (ref lab)	N/A	≥99% successful analysis of all sorted samples	ABC	SAFIT Level 2	N/A	N/A
		Taxa ID error ≤5%. 10% frequency (external reference lab)	Systemic errors ≤ 2. 10% frequency (external reference lab)						
		Individual ID error ≤5%. 10% frequency (external reference lab)							

Appendix B

Table B-1

	Parameter (units)	Natural n=13 Average	Natural n=13 Min.	Natural n=13 Max.	Effluent n=8 Average	Effluent n=8 Min.	Effluent n=8 Max.	Urban n=9 Average	Urban n=9 Min.	Urban n=9 Max.
General Chemistry	Alkalinity (mg/L)	192	144	238	161	114	250	216	74	356
	Conductivity (u/S)	421	245	699	1015	10	1355	1416	563	2334
	pH (-log[H^+])	8.0	7.1	8.5	8.7	8.0	9.4	8.8	7.4	10.6
	DO (mg/L)	8.3	7.1	9.3	11.0	4.9	17.5	10.2	7.3	16.8
	Temperature (^oC)	16.35	10.97	25.03	21.85	18.4	27.24	24.12	13.84	36.14
	Hardness (mg/L)	203.5	120	340	265.1	149	310	407.9	202	1150
	TOC (mg/L)	7.2	1.6	51.1	8.0	6.5	9.5	16.8	3.9	38.0
	TSS (mg/L)	14.2	2.3	49.4	18.567	8.2	39.6	48.78	5	188
Dissolved Metals (ug/L)	As	1.65	0.11	4.44	1.70	1.13	2.19	2.40	0.74	4.54
	Cr	2.20	0.21	7.26	1.89	1.09	2.46	2.71	0.22	7.50
	Cu	2.04	0.70	3.65	7.96	3.29	15.10	13.14	2.72	26.00
	Fe	61.38	13.00	337.00	51.38	18.00	93.00	59.88	8.00	195.00
	Pb	0.14	0.09	0.21	0.50	0.36	0.74	0.66	0.15	2.08
	Ni	1.95	1.03	3.87	5.27	2.53	6.83	6.72	3.44	18.30
	Se	0.24	0.23	0.25	1.70	0.40	3.50	2.08	0.24	7.95
	Zn	3.12	0.73	5.52	34.95	20.70	54.70	12.55	1.47	48.20
Nutrients (mg/L)	Total Phosphorus	0.1191	0.06	0.22	0.415	0.13	0.78	0.5567	0.17	1.83
	TKN	0.49	0.1	1.73	2.211	1.6	2.8	2.561	0.17	5.8
	Total Orthophospho	0.092	0.05	0.12	0.2986	0.15	0.62	0.3056	0.05	1.52
	Dissolved Nitrate	0.1075	0.04	0.22	2.492	0.98	4.39	1.6925	0.07	4.26
	IBI Scores	44.4	20.0	77.2	9.1	4.3	22.9	12.6	2.9	28.6

Table B-2	Alkalinity	pH	DO	As	Cr	Cu	DOC	Hardness	Fe	Pb	Ni	TOC	Zn
Alkalinity													
pH	-0.504												
DO	-0.154	0.512											
As	-0.036	0.332	0.024										
Cr	0.007	0.057	0.051	0.131									
Cu	-0.513	0.637	0.197	0.431	0.135								
DOC	-0.089	0.230	-0.040	0.600	0.129	0.719							
Hardness	0.632	-0.150	0.114	-0.127	-0.086	-0.039	0.049						
Fe	-0.050	-0.231	-0.231	-0.044	0.215	0.056	0.372	-0.146					
Pb	0.016	0.184	-0.025	0.389	0.070	0.625	0.820	0.130	0.311				
Ni	0.429	0.030	0.212	0.010	-0.075	0.189	0.314	0.893	-0.065	0.396			
TOC	-0.200	-0.073	-0.133	0.191	0.369	0.352	0.630	-0.108	0.852	0.430	0.052		
Zn	-0.227	0.274	0.255	0.134	-0.017	0.554	0.472	-0.017	0.200	0.651	0.262	0.203	
Channel Alteration	-0.441	0.187	-0.067	0.025	0.136	0.528	0.196	-0.104	-0.002	0.255	0.051	0.092	0.594
Epifaul Cover	0.297	-0.511	-0.355	-0.245	-0.317	-0.633	-0.505	-0.117	-0.161	-0.450	-0.357	-0.363	-0.631
Sediment Deposition	-0.080	0.141	0.171	-0.111	0.028	0.141	-0.025	-0.029	0.162	0.066	0.014	0.041	0.445
Ec	0.101	0.349	0.306	0.182	-0.012	0.565	0.445	0.677	-0.121	0.343	0.759	0.154	0.321
Salinity	0.296	0.126	0.151	0.088	-0.107	0.372	0.378	0.850	-0.092	0.366	0.901	0.089	0.252
Temp.	-0.510	0.748	0.363	0.334	0.313	0.665	0.372	-0.122	-0.064	0.096	0.066	0.238	0.218
Sand and Fines	0.635	-0.428	-0.272	-0.263	-0.022	-0.494	-0.314	0.426	-0.069	-0.207	0.228	-0.218	-0.392
Concrete	-0.530	0.626	0.441	0.267	0.066	0.751	0.508	-0.008	-0.048	0.497	0.285	0.215	0.659
Cobble	0.269	-0.399	-0.339	0.076	-0.108	-0.552	-0.405	-0.176	0.054	-0.435	-0.438	-0.181	-0.523
TP	-0.053	0.171	-0.050	0.386	0.229	0.614	0.783	-0.009	0.339	0.924	0.247	0.440	0.588
TKN	-0.104	0.246	0.299	0.300	0.110	0.583	0.537	0.249	-0.019	0.438	0.407	0.269	0.549
Canopy Cover	0.347	-0.497	-0.390	-0.120	-0.340	-0.472	-0.396	0.140	-0.169	-0.314	-0.101	-0.319	-0.514
IBI	0.217	-0.391	-0.377	0.010	-0.279	-0.456	-0.327	-0.240	-0.131	-0.293	-0.446	-0.291	-0.472

	Channel Alteration	Epifaul Cover	Sediment Deposition	Ec	Salinity	Temp.	Sand and Fines	Concrete	Cobble	TP	TKN	Canopy Cover
Channel Alteration												
Epifaul Cover	-0.603											
Sediment Deposition	0.399	-0.247										
Ec	0.234	-0.544	0.149									
Salinity	0.160	-0.442	-0.132	0.862								
Temp.	0.416	-0.646	0.154	0.483	0.230							
Sand and Fines	-0.346	0.508	-0.104	-0.021	0.118	-0.369						
Concrete	0.599	-0.879	0.127	0.497	0.389	0.631	-0.648					
Cobble	-0.471	0.734	-0.073	-0.505	-0.458	-0.505	0.241	-0.766				
TP	0.335	-0.477	-0.044	0.169	0.246	0.142	-0.277	0.506	-0.440			
TKN	0.504	-0.780	0.053	0.585	0.543	0.410	-0.354	0.724	-0.639	0.445		
Canopy Cover	-0.458	0.819	-0.202	-0.286	-0.144	-0.647	0.351	-0.736	0.703	-0.346	-0.547	
IBI	-0.501	0.860	-0.174	-0.542	-0.482	-0.569	0.190	-0.722	0.767	-0.307	-0.659	0.769