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STUDY 270 (2014-15): Ambient and Mitigation Monitoring in Urban Areas in Southern California during Fiscal Year 2014 – 2015

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1.0 INTRODUCTION

Urban runoff is an important source of pesticide loading into surrounding waterways, justifying monitoring efforts to characterize pesticide composition in surface waters receiving urban inputs. In California, the Department of Pesticide Regulation (CDPR) requires pesticide use reporting for urban applications by licensed applicators. Reported use is categorized into agricultural and non-agricultural use. Agricultural use includes both production and non-production agricultural (i.e. golf courses, rights-of way, parks) applications. Non-agricultural use includes applications for residential, industrial, institutional, structural, or vector control purposes (CDPR, 2010). However, urban pesticide use by individual homeowners is not reported, so that total use is greater than reported use. It has been estimated that urban pesticide use accounts for over 70% of the total pesticide use in California (UP3 Project, 2007). In 2012, over 790,000 pounds of pesticides were used for landscape maintenance and structural pesticide control in Los Angeles, Orange and San Diego Counties (Figure 1)(CDPR, 2014).

With this high volume of urban pesticide use there is a potential for pesticide runoff into urban creeks and rivers via storm drains. Numerous urban creeks are listed on the 2010 Federal Clean Water Act Section 303(d) list due to the historical presence of organophosphate (OP) pesticides (Cal/EPA, 2014), partially attributable to their presence in urban runoff. While urban uses of OPs have been sharply curtailed due to Federal regulatory actions, recent monitoring has continued to identify the presence of OPs in some samples (Oki and Haver, 2009). Additionally, recent monitoring has shown that urban waterways are frequently contaminated with pyrethroids, OPs, and fipronil. Many of the detected pesticides are at concentrations that exceed the acute toxicity to sensitive aquatic organisms (Oki and Haver, 2009; Weston *et al.*, 2005; Weston *et al.*, 2009). In 2008 CDPR initiated a statewide urban monitoring project to more fully characterize the presence of pesticides in urban waterways (CDPR, 2008). Preliminary monitoring data has been previously summarized (Ensminger et al., 2013). Several pyrethroids, imidacloprid, and fipronil (and breakdown products) insecticides, as well as synthetic auxin herbicides have been detected at high frequency at CDPR monitoring locations in southern California (Figure 2).

Study 270 is a continuation of monitoring efforts of Studies 249 and 265. Data from this study will be used to evaluate urban pesticide water quality trends and efficacy of implemented best management practices (BMPs). For example, surface water regulations were implemented in California in July 2012, with the intent of reducing pyrethroid concentrations in California surface waters (CDPR 2012). Long term monitoring will help determine the effectiveness of these regulations on the presence of pyrethroids in urban waterways. This project will continue to monitor storm drains and urban waterways at selected monitoring sites from CDPR's 2008 study as well as at monitoring stations established by the University of California (Oki and Haver, 2009). This long-term monitoring may be used to track the performance of local mitigation measures or public outreach programs. Modifications from the FY 13-14 sampling plan is presented in section 4.1.

2.0 OBJECTIVE

The overall goal of this project is to assess pesticide concentrations found in runoff at drainages and receiving waters within typical southern California urbanized areas during rain events and dry season conditions. Specific objectives include:

1) Determine presence and concentrations of selected pesticides in urban runoff under dry season and stormwater conditions;
2) Evaluate the magnitude of measured concentrations relative to water quality or aquatic toxicity benchmarks;
3) Evaluate the effectiveness of surface water regulations through long term (multiple year) monitoring at selected sampling locations;
4) Observe effects of a small constructed wetland to mitigate pesticide concentrations in urban runoff to surrounding receiving waters;
5) Observe the mitigation effects of a small water treatment facility receiving dry season flow;
6) Monitor deposition of pyrethroids bound to sediments within watershed.

3.0 PERSONNEL

The study will be conducted by staff from the CDPR's Surface Water Protection Program (SWPP), Environmental Monitoring Branch under the general direction of Kean S. Goh, Program Manager. Key personnel are listed below:

Project Leader: Robert Budd, Ph.D.
Field Coordinator: KayLynn Newhart.
Reviewing Scientist: Michael Ensminger, Ph.D.
Statistician: Yina Xie, PhD.
Laboratory Liaison: Sue Peoples
Analytical Chemistry: Center for Analytical Chemistry, Department of Food and Agriculture (CDFA)
Collaborator: Darren Haver, Ph.D., University of California at Davis, Center Director/Water Resources and Water Quality Advisor, South Coast Research and Extension Center, 7601 Irvine Blvd., Irvine, CA, 92618, Phone: (949) 653-1814, email: dlhaver@ucdavis.edu

Please direct questions regarding this study to Robert Budd, Senior Environmental Scientist, at (916) 445-2505 or rbudd@cdpr.ca.gov.

4.0 STUDY PLAN

4.1 Monitoring Sites

Ambient water quality monitoring will be conducted at eight sampling locations within Salt Creek (Figure 3), one each within Ballona (BAL) and Bouquet (BOQ) (Figure 4), one within

San Diego River (SDR) and two within Chollas Creek (CHO) (Figure 5) watersheds (Table 1). Mitigation monitoring will be conducted at the inlet and outlet of a small constructed wetland located within Wood Creek watershed (Figure 6). Details of site descriptions are provided in Appendix 1.

Sampling stations within Salt Creek have been monitored consistently since 2009 as part of CDPR's urban monitoring program. The surrounding drainage areas within the Salt Creek watershed consist of single family dwellings, multiple family dwellings, light commercial buildings, parks, schools, and a golf course. Two monitoring stations within Salt Creek (SC3 and SC5) serve as long term ambient monitoring sites. SC3 is situated at a storm drain outfall receiving runoff from a small residential neighborhood, and is automated with sampler and water quality sensors, allowing for continuous flow and water quality parameters to be recorded. SC5 is located at the receiving waters of several urban inputs and will serve to evaluate pesticide concentrations in the watershed as well as downstream transport of pesticides. Samples collected at the long term monitoring sites will be monitored for fipronil (and breakdown products), imidacloprid, organophosphate and pyrethroid insecticides, chlorothalonil, as well as dinitroaniline, synthetic auxin and photosynthetic inhibitor herbicides. Sediment samples will also be collected for pyrethroid analysis dependent on available sediment deposition. Monitoring data from SC3 and SC5 will be utilized for temporal analysis of pesticide concentrations derived from drainages of primarily residential landscapes. The other sites within Salt Creek will follow the same sampling schedule with a modified list of analytes (Table 2). SC7A is located adjacent to SC7. During the dry season water is pumped from an intake at SC7 through a small ozone water treatment facility and returning through an outlet at SC7A. Samples are collected at SC7A during the dry season to determine the effect of the ozone treatment system on pesticide removal from the water column.

Monitoring locations within Wood Creek have also been monitored since 2009 as part of SWPP's mitigation evaluation monitoring. The monitoring sites are situated at the inlet (WC1) and outlet (WC2) of a small (~0.18 acres) constructed wetland designed to mitigate pollutants in the urban runoff. The wetland receives urban runoff from a drainage area consisting of entirely single and multiple family residential units. The primary objective of monitoring at these stations is to observe the efficacy of pesticide removal within the wetland system. Efficacy will be evaluated through comparisons in pesticide concentrations between outlet and inlet. Water samples will be collected during four events, with sediment collected during two dry season events.

Automated sampling equipment has been installed at two sites within Salt Creek and two within Wood Creek by the University of California (Oki and Haver, 2009); we will evaluate these sites for potential long-term monitoring in collaboration with the University of California.

Modifications from FY 13-14. The current sampling plan is an extension of sampling conducted during fiscal years 2010-2014. The details of the previous sampling is described in the document titled Study 270: Urban pesticide monitoring in southern California, available at: http://www.cdpr.ca.gov/docs/emon/pubs/protocol/study270protocol.pdf. The sampling and analysis schedule is similar to that for FY 13-14, with a few notable modifications (Table 3).

To increase the spatial evaluation of the presence of pesticides in surface waters located in southern California, monitoring locations were added within Ballona and Bouquet Creek (Los Angeles County), and Chollas and San Diego River (San Diego County) watersheds. These watersheds are generally larger than Salt and Wood Creek watersheds, and have additional inputs from commercial and light industrial areas. Agricultural inputs are limited within all watersheds. A monitoring station within Ballona Creek at Centinela Avenue will serve to evaluate pesticide inputs into a large mixed use (commercial and residential) watershed.

Modifications to the chemical analysis list were based on previous monitoring data and a SWPP model designed to assist in prioritizing pesticides for monitoring surface waters in California (Luo et al., 2013). The model is based on current use patterns and aquatic toxicity benchmark data. The product is a relative prioritization score. Appendix 2 is an abbreviated list of pesticides from the most current prioritization of urban pesticides in Los Angeles and Orange counties, California for the years 2009 – 2011. Scores below 6 are considered low priority due to their very low use and toxicity and are not shown. The list provides guidance to EM staff on pesticides to focus attention; however the decision to monitor for a pesticide is influenced by additional factors. For instance, metals (i.e. copper) have confounding factors such as variable background concentrations. Laboratory analysis of chiral compounds typically report the total or partial mixtures and not individual isomers, even though they might have products on the market refined for the most active isomer (i.e. beta-cyfluthrin, gamma-cyhalothrin, S-cypermethrin). Therefore, even though a specific isomer is not being monitored, their presence in surface waters would be indicated by the associated mixture.

4.2 Sampling

Water sampling. Samples will be collected for both ambient and mitigation monitoring during two dry season and two storm sampling events. Dry season sampling will occur between August - September, 2014 and May-June, 2015. We will conduct storm sampling with the first major storm (rain) event of the 2014-2015 season and with a major storm in the winter or early spring of 2015 (Table 4).

Most water samples will be collected as grab samples directly into 1-L amber bottles (Bennett 1997). Where the stream is too shallow to collect water directly into these bottles, a secondary stainless steel container will be used to initially collect the water samples. Water samples collected at SC2, SC3, SC4, WC1, and WC2 during storm events may be collected as composite samples utilizing automated sampling equipment set up by UC Cooperative Extension (CDPR, 2014b). Samples will be stored and transported on wet ice or refrigerated at 4°C until analyzed.

CDPR staff will collect and analyze water and sediment samples for total organic carbon (TOC) using a TOC-V CSH/CNS analyzer (Shimadzu Corporation, Kyoto, Japan) (Ensminger 2013a). Water samples will also be analyzed for suspended sediment (Ensminger 2013b).

Sediment sampling. Where applicable, sediment samples will be collected in 1-quart glass Mason Jars using passive sediment collection samplers (Budd, 2009) and analyzed for pyrethroids. Otherwise, enough sediment will be collected using stainless steel scoops from the top of the bed layer, biasing for fine sediments where possible.

Toxicity sampling. Water samples will be collected at a subset of sampling sites for toxicity analysis during four events of FY 14-15. Grab samples will be collected in 1-L amber I-Chem certified 200 bottles (or equivalent) and transported to the Aquatic Health Program at the University of California, Davis. Toxicity testing will measure percent survival of the amphipod *Hyalella azteca* in water (96-hr).

Sample Transport. CDPR staff will transport samples following the procedures outlined in CDPR SOP QAQC004.01 (Jones, 1999). A chain-of-custody record will be completed and accompany each sample.

4.3 Field Measurements

Physiochemical properties of water column will be determined using a YSI 6920 V2-2 multiparmeter Sonde according to the methods describe by Doo and He (2008). At each site, water parameters measured *in situ* will include pH, temperature, conductivity, turbidity, salinity, total dissolved solids, and dissolved oxygen.

Stormdrain discharge or stream flow rates will be measured to characterize the flow regime and to estimate the total loading of target pesticides. Discrete time flow estimations will be determined using either a Global portable velocity flow probe (Goehring, 2008), utilizing a float, or fill-bucket method. At SC2, SC3, and WC2 continuous flow rates will be determined by using an installed Hach Sigma 950 flow meter (Sisernoz et al. 2012).

5.0 CHEMICAL ANALYSIS

The Center for Analytical Chemistry, California Department of Food and Agriculture, Sacramento, CA (CDFA) will conduct the pesticide analysis in water samples for the study. They will analyze seven different analyte groups which will include up to 35 chemical compounds for analysis (Table 5, Appendix 3). Sediment samples will be sent to the California Department of Fish and Wildlife, Sacramento, CA (CDFW) for pesticide analysis. Sediment samples will be analyzed for pyrethroids pesticides (Table 5). Laboratory QA/QC will follow CDPR guidelines and will consist of laboratory blanks, matrix spikes, matrix spike duplicates, surrogate spikes, and blind spikes (Segawa 1995). Laboratory blanks and matrix spikes will be included in each extraction set.

6.0 DATA ANALYSIS

All data generated by this project will be entered to a central database that holds all data including weather and field information, field measurements, and laboratory analytical data. We will use various nonparametric and parametric statistical methods to analyze the data. The data collected from this project may be used to develop or calibrate an urban pesticide runoff model.

Our preliminary analysis (Ensminger and Budd, 2014) indicated that the sample data is heavily skewed and contains a number of non-detects with multiple reporting limits, which may violate the normality and equal variance assumptions of the parametric procedures (e.g., ANOVA and *t*-tests). In order to appropriately address the characteristics of the sample data, a more generic and distribution-free approach, the non-parametric statistics, will be used in this study. Helsel (2012) in his book illustrated the application of non-parametric procedures to skewed and censored environmental data. We will primarily reference to his book as a general guideline for data analysis of this study. The data will be analyzed by using R statistical program (R Core Team, 2014), the Nondetects And Data Analysis for environmental data (NADA) package for R (http://cran.r-project.org/web/packages/NADA/NADA.pdf), and Minitab (http://www.minitab.com/en-us/).

Based on the study objectives, preliminary analysis, and data availability, we propose the following statistical procedures for data analysis (Table 6).

1) Explanatory data analysis will be performed to summarize the characteristics of the sample data. Urban monitoring data has been collected since 2008 for a variety of analytes (i.e., Tables 5, Appendix 3) at multiple locations (i.e., Salt Creek, Wood Creek; Table 2) with different site types (i.e., stormdrain outfalls and receiving water), and between different seasons (i.e., dry and wet seasons). Plots, such as boxplots, histograms, probability plots, and empirical distribution functions, will be produced to explore any potential patterns implied by the data;
2) Hypothesis tests will be conducted to compare the concentration between groups of interest. For example, we will test whether or not there is significant difference in concentration between the dry and wet season, or between the difference locations. Non-parametric procedures will be used to compute the statistics for hypothesis test. For data with multiple reporting limits, it will be censored at the highest limit before proceeding if the test procedure allows only one RL;
3) Trend analysis will be included to depict the change in concentration over time. We are specifically interested in determining the effectiveness of CDPR regulation 6970 which went into effect July 19, 2012 to mitigate pyrethroid contamination in urban waters. The ambient monitoring data from SC3 and SC5 in Salt Creek, as well as WC1 in Wood Creek will be used. For the trend analysis, we will use Akritas-Thenil-Sen non-parametric regression, which regresses the censored concentration on time, or the Kaplan-Meier method, which tests the effects of year, month and location by developing a mixed linear model between the censored concentration and the spatial-temporal factors.

Finally, we will attempt to develop statistical models to assess the factors potentially impacting pesticide concentration in surface water. One possible attempt is to develop a logistic regression model to estimate and predict the likelihood of detection or exceedance. The response variable will be the probability of the concentration being greater than or equal to the RLs or the toxicity benchmark. A series of explanatory variables will be examined, including: rainfall, field measurements (e.g., flow rate, pH, water TOC, sediment TOC, and TSS), number of household drains water into the storm drain outfall/creek, residential density (percent of impervious areas), season (or month), year, regulation, and so on. Further literature review will be conducted to identify possible explanatory variables in favor of the model.

7.0 TIMELINE

Field Sampling:	Jul 2014 – Jun 2015	Data Entry into SURF:	Dec 2015 – Jun 2016
Chemical Analysis:	Jul 2014 – Oct 2015	Data Report:	Mar 2016 – Jun 2016

8.0 LABORATORY BUDGET

The estimated total cost for chemical analyses is $146, 010 (Table 2).

9.0 LITERATURE CITED

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Table 1. Summary of urban pesticide monitoring locations in California.

Watershed	Stormdrain Outfall	Receiving Water/ Outfall	Total Sites
Ambient Monitoring			
Salt Creek	5	3	8
Ballona Creek	-	1	1
Bouquet Creek	-	1	1
San Diego River	-	1	1
Chollas Creek	-	2	2
Mitigation Monitoring			
Wood Creek	1	1	2
Total	6	9	15

Table 2. Analysis schedule and budget by site

Site	Analytical Suite	# Sites	Storm Samples	Dry Season Samples	Cost/ Sample	Cost
Ambient Monitoring						
SC3, SC5	Chlorothalonil	2	2	4*	660	$7920
	Chlorfenapyr**	2	2	2	600	4800
	Fipronil + OP (short)	2	2	2	840	6720
	Imidacloprid	2	2	2	600	4800
	Dinitroanalines	2	2	2	960	7680
	Synthetic auxin herbicides	2	2	2	690	5520
	Pyrethroids-6	2	2	2	600	4800
	Photosynthetic inhibitor herbicides	2	2	4*	450	5400
SC1, SC2, SC4, SC7	Fipronil + Met	4	2	2	600	7200
	Imidacloprid	4	2	2	600	7200
	Synthetic auxin herbicides	4	2	2	690	8280
	Pyrethroids-6	4	2	2	600	7200
BAL	Chlorothalonil	1	1	2	660	1980
	Chlorfenapyr	1	1	2	600	1800
	Fipronil + OP (short)	1	1	2	840	2520
	Imidacloprid	1	1	2	600	1800
	Dinitroanalines	1	1	2	960	2880
	Synthetic auxin herbicides	1	1	2	690	2070
	Pyrethroids-6	1	1	2	600	1800
	Photosynthetic inhibitor herbicides	1	1	2	450	1350
BOQ	Fipronil + Met	1	1	2	600	1800
	Imidacloprid	1	1	2	600	1800
	Synthetic auxin herbicides	1	1	2	690	2070
	Pyrethroids-6	1	1	2	600	1800
SC6, SC7a SDR, CHO, CHO2	Fipronil + Met	5	-	2	600	6000
	Imidacloprid	5	-	2	600	6000
	Synthetic auxin Herbicides	5	-	2	690	6900
	Pyrethroids-6	5	-	2	600	6000
		Ambient Monitoring Sub-total				126,090
Mitigation Monitoring						
WC1, WC2	Fipronil + Met	2	2	2	600	4800
	Imidacloprid	2	2	2	600	4800
	Synthetic auxin Herbicides	2	2	2	690	5520
	Pyrethroids-6	2	2	2	600	4800
		Mitigation Monitoring Sub-total				19,920
					Total	**$146,010**

OP = organophosphate, Met.=Metabolites * Includes QC samples ** Placeholder, cost estimated

Table 3. Modifications from sampling plan for fiscal year 2012-2013

Change from FY 13-14	Justification
Adding Ballona (BAL), Bouquet (BOQ), San Diego River (SDR) and Cholla (CHO) watersheds to dry season sampling	Increase spatial representation of urban watersheds in southern California
Adding chlorfenapyr analysis at SC3,SC5, and BAL stations	High urban score in prioritization model (16) for Orange and Los Angeles counties**
Removing storm sampling from SC6	Site inaccessible during storm events
CT, DN, TR* removed from SC7, added to Ballona	Increased spatial evaluation of presence of wide range of pesticides in southern California watersheds

*CT = chlorothalonil, DN=dinitroanalines, TR=photosynthetic inhibitors
** Luo et. al, 2013

Table 4. Sampling schedule for urban pesticide monitoring in Southern California.

Event Type	Date	IM	PX	PY-6	FP + Met	FP+OP	CT	DN	TR	PY-Sed	Tox	Total
Dry 1	Aug-Sep, 2014	15	15	15	12	3	3	3	3	5	5	79
Rain 1	Oct-Nov, 2014	10	10	10	7	3	3	3	3	-	5	54
Rain 2	Feb-Mar, 2015	8	8	8	6	2	2	2	2	-	5	43
Dry 2	May-Jun 2015	15	15	15	12	3	3	3	3	5	5	79
	Total	48	48	48	37	11	11	11	11	10	20	255

CT=chlorothalonil, FP+Met=fipronil+metabolites, OP=organophosphates, IM=imidacloprid, DN=dinitroanaline herbicides + oxyfluorfen, PX=synthetic auxin herbicides, PY=pyrethroid, TR=photosynthetic inhibitor herbicides + norfurazon, Sed=sediment, Tox=toxicity

Table 5. Chemical analysis of pesticides in the Southern California urban monitoring study.

Analyte Group	Media	Analytical Method	Method Detection Limit (µg L^{-1})	Reporting Limit (µg L^{-1})
Chlorothalonil	Water[a]	LC-MS/MS	0.0348	0.05
Dinitroanaline herbicides	Water	LC-MS/MS	0.01 – 0.015	0.05
Fipronil & degradates	Water	GC-MSD (SIM)	0.003 – 0.005	0.05
Imidacloprid	Water	GC-MS	0.01	0.05
Organophosphate insecticides	Water	GC-FPD	0.008 – 0.0142	0.05
	Water	GC-MS	0.0012 – 0.0079	0.01
Synthetic auxin herbicides	Water	GC-MS	0.064	0.1
Pyrethroid insecticides	Water	GC-ECD	1.09 – 7.68 (ng L^{-1})	5 – 15 (ng L^{-1})
	Sediment	GC-ECD	-	0.02 – 0.2 (ng g^{-1})
Photosynthetic inhibitor herbicides	Water	LC-MS/MS	0.0063 – 0.043	0.05

[a]Water samples analyzed by California Department of Food and Agriculture, sediment samples analyzed by the California Department of Fish and Wildlife.

Table 6: Non-parametric procedures frequently used for comparing paired data, two samples and three or more samples

Data	Non-Parametric Procedure
Paired data	*Wilcoxon signed-rank test* for uncensored data *Sign test* (modified for ties) for censored data with one RL *Score tests* for censored data with multiple RLs (the PPW test and the Akritas test)
Two samples	*Wilcoxon rank-sum (or Mann-Whitney) test* or *Kolmogorov-Smirnov test* for censored data with one RL *Score tests* for censored data with multiple RLs (the Gehan test and generalized Wilcoxon test)
Three or more samples in one-way layout	*Kruskal-Wallis test* (for unordered alternative) or *Jonckheere-Terpstra test* (for ordered alternative) for censored data with one RL *Generalized Wilcoxon score test* for censored data with multiple RLs *Multiple comparison* to detect which group is different
Three or more samples in two-way layout	*Friedman's test* (for unordered alternative) or *Page's test* (for ordered alternative) for censored data with one RL Multiple comparison to detect which group is different

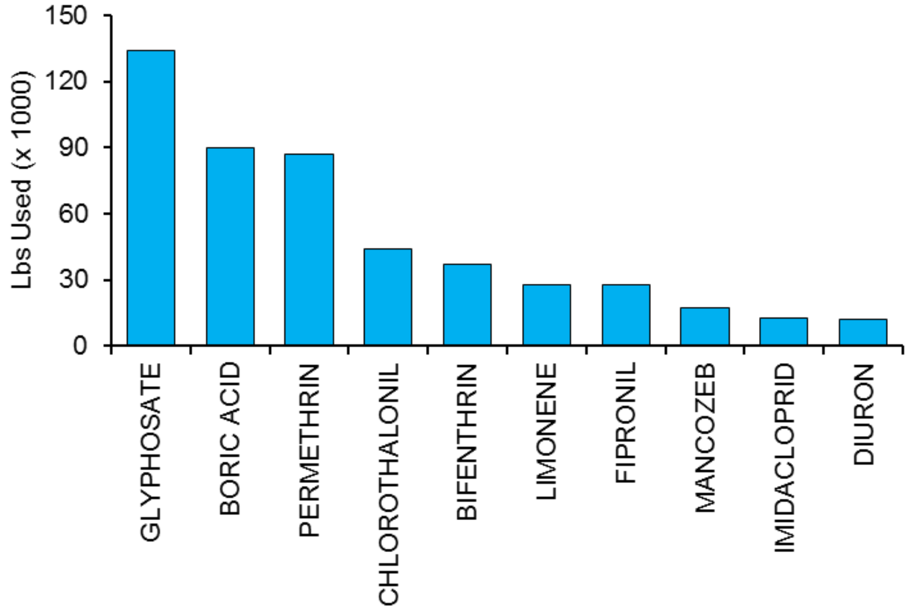

Figure 1. Reported use for pesticides (top ten) with associated toxicity data applied for landscape and structural pest control in Los Angeles, Orange, and San Diego counties in 2012.

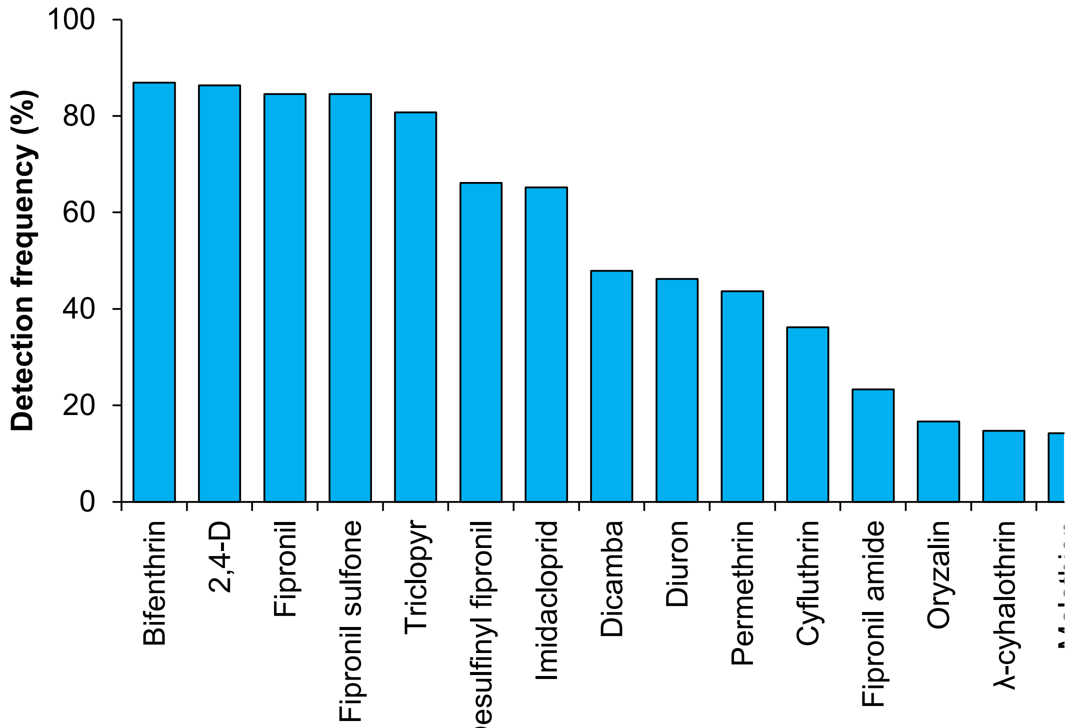

Figure 2. Frequency of detection (%) of pesticides at all monitored southern California stations between 2009 – 2013 (Pesticides <10% detection frequency not shown)

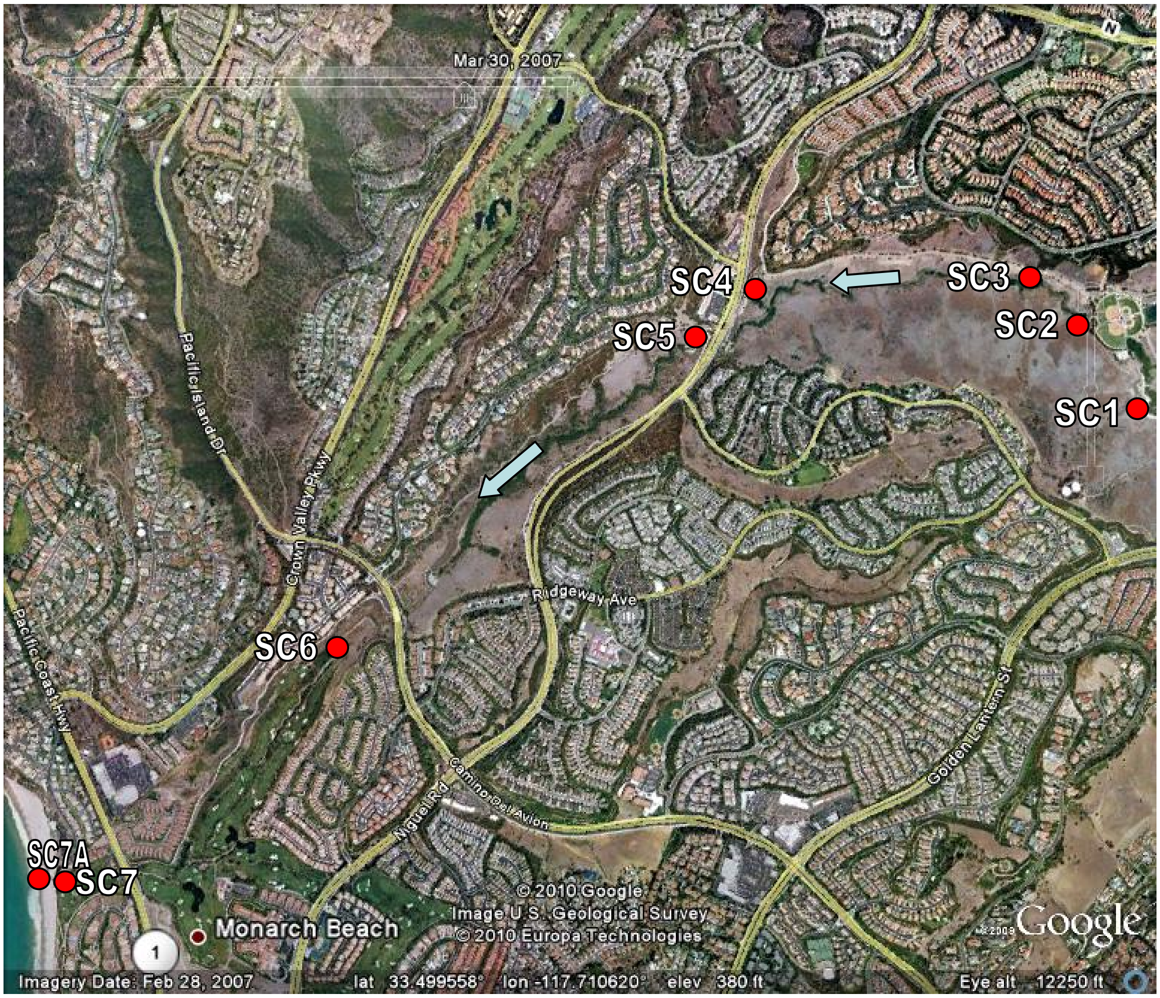

Figure 3. Sampling locations within Salt Creek watershed, Orange County, CA

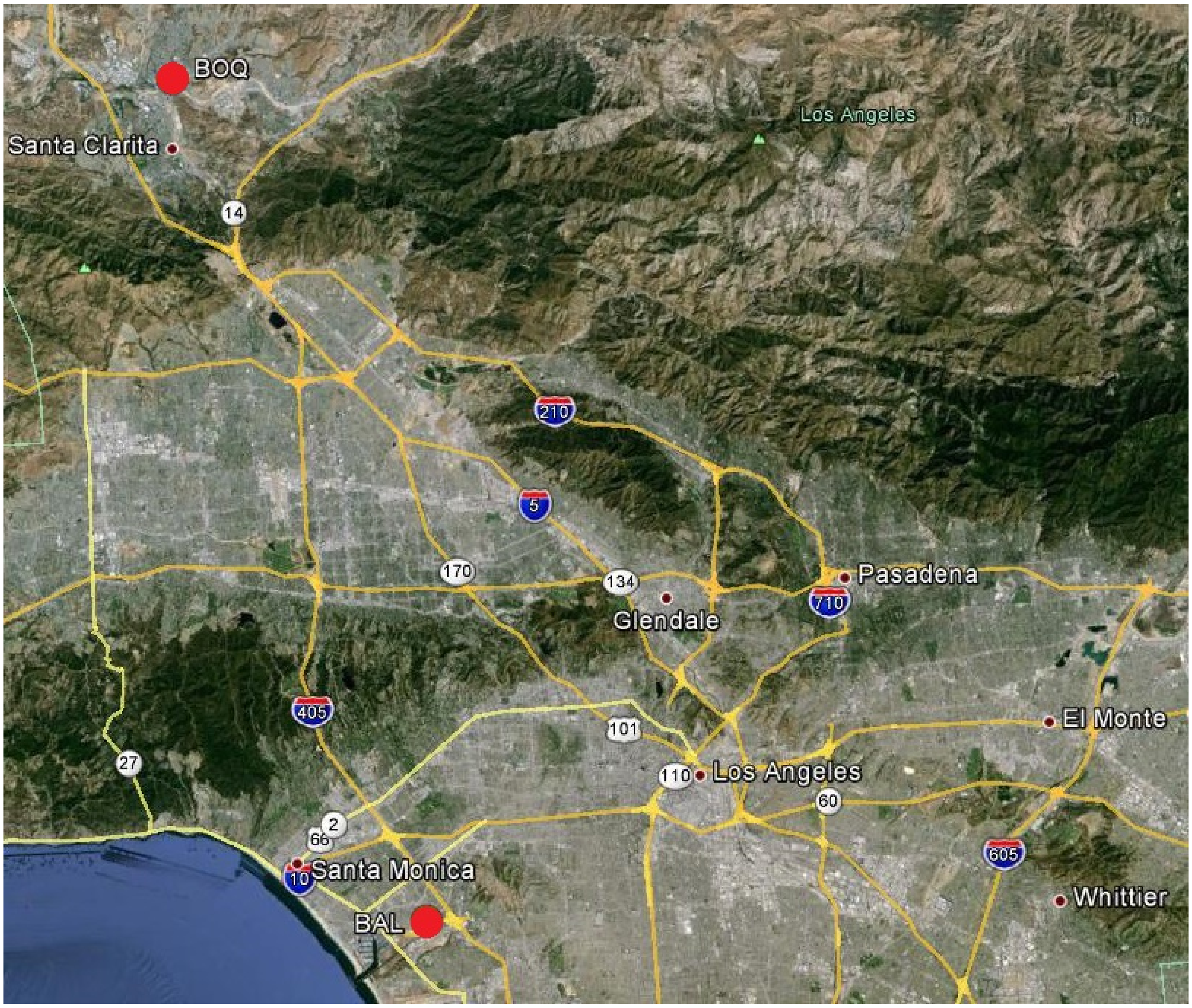

Figure 4. Sampling locations within Bouquet (BOQ) and Ballona (BAL) watersheds, Los Angeles County, CA

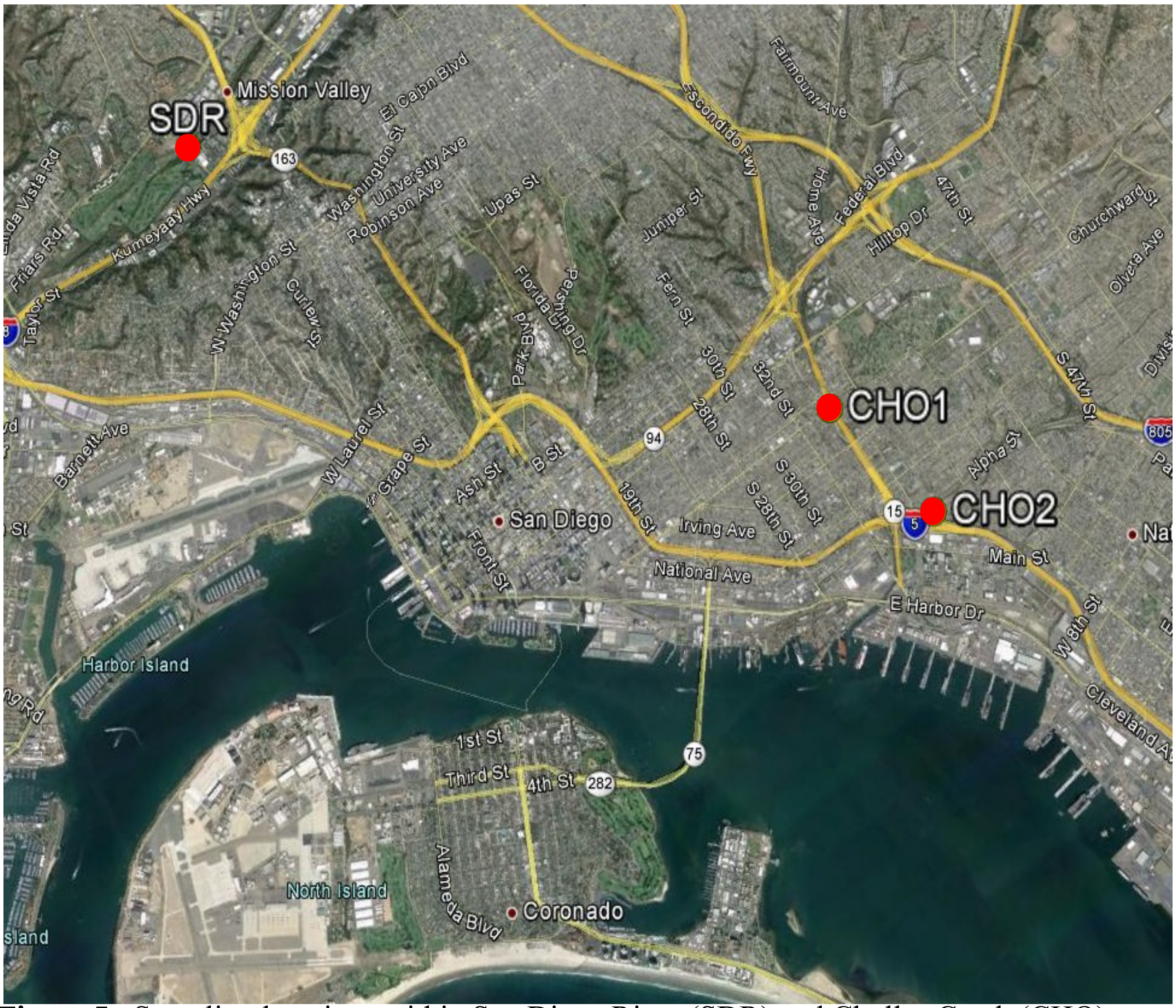

Figure 5. Sampling locations within San Diego River (SDR) and Chollas Creek (CHO) watersheds, San Diego County, CA

Figure 6. Sampling locations within Wood Creek watershed, Orange County, CA

Appendix 1. Detailed sampling site information

Watershed	Site ID	Northing	Easting	Site type
Salt Creek	SC-1	33 30 32.92	117 41 26.53	Stormdrain
Salt Creek	SC-2	33 30 40.57	117 41 40.67	Stormdrain
Salt Creek	SC-3	33 30 43.02	117 41 49.55	Stormdrain
Salt Creek	SC-4	33 30 31.00	117 42 26.34	Stormdrain
Salt Creek	SC-5	33 30 20.23	117 42 30.87	Receiving water
Salt Creek	SC-6	33 29 31.91	117 43 02.68	Stormdrain
Salt Creek	SC-7	33 28 53.97	117 43 26.55	Receiving water
Salt Creek	SC-7A	33 28 54.12	117 43 27.37	Receiving water
Ballona Creek	BAL	33 59 12.92	118 24 55.90	Receiving water
Bouquet Creek	BOQ	34 25 42.05	118 32 23.45	Receiving water
San Diego River	SDR	32 45 51.79	117 10 12.24	Receiving water
Chollas Creek	CHO-1	32 42 17.46	117 7 16.11	Receiving water
Chollas Creek	CHO-2	32 41 27.78	117 7 3.30	Receiving water
Wood Creek	WC-1	33 34.56.56	117 44 43.02	Stormdrain
Wood Creek	WC-2	33 34 53.70	117 44 44.65	Wetland outfall

Appendix 2. Priority model pesticides (>6 final score) based on urban usage in Los Angeles and Orange County, California (2009-2011).

Active Ingredient	Use (lbs)	Use score	OPP Benchmark	Tox score	Final score
Permethrin	99474	5	0.01	7	35
Bifenthrin	19727	5	0.075	6	30
Fipronil	23677	5	0.11	5	25
Cyfluthrin	10694	4	0.0125	6	24
Beta-cyfluthrin	4212	4	0.034	6	24
Lambda-cyhalothrin	2926	3	0.0035	7	21
Chlorothalonil	32250	5	1.8	4	20
Cypermethrin	13216	4	0.195	5	20
Deltamethrin	1810	3	0.055	6	18
Diuron	17300	4	2.4	4	16
Copper	8986	4	2.05	4	16
Chlorfenapyr	5291	4	2.915	4	16
Pendimethalin	4768	4	5.2	4	16
Malathion	1696	3	0.3	5	15
Diquat dibromide	1544	3	0.75	5	15
Mancozeb	14067	4	47	3	12
Imidacloprid	13783	4	35	3	12
Triclopyr, butoxyethyl ester	6130	4	70	3	12
Iprodione	4234	4	50	3	12
Prodiamine	2951	3	3	4	12
Bromacil	2855	3	6.8	4	12
Oxadiazon	936	3	5.2	4	12
DDVP	492	2	0.035	6	12
Esfenvalerate	217	2	0.025	6	12
Chlorpyrifos	213	2	0.05	6	12
Sulfometuron-methyl	577	2	0.48	5	10
Carbaryl	439	2	0.85	5	10
2,4-D, 2-ethylhexyl ester	3334	3	66	3	9
Oryzalin	3296	3	15.4	3	9
PCNB	2944	3	50	3	9
Hydroprene	2489	3	65	3	9
Propiconazole	2036	3	21	3	9
2,4-D	1393	3	13.1	3	9
Pyrethrins	1125	3	12.5	3	9
Thiophanate-methyl	5413	4	930	2	8
Pyraclostrobin	318	2	1.5	4	8
Propoxur	177	2	5.5	4	8
Trifluralin	160	2	7.52	4	8
Gamma-cyhalothrin	0	1	0.00024	8	8
Diflubenzuron	1	1	0.0014	7	7
(s)-Cypermethrin	0	1	0.0018	7	7
Acephate	3244	3	550	2	6
MCPA, dimethylamine salt	1183	3	130	2	6
Dithiopyr	844	2	20	3	6
Dichlobenil	618	2	30	3	6

Active Ingredient	Use (lbs)	Use score	OPP Benchmark	Tox score	Final score
Azoxystrobin	468	2	49	3	6
MCPP-p, dimethylamine salt	436	2	14	3	6
Hydramethylnon	374	2	45	3	6
Fludioxonil	301	2	70	3	6
Pyriproxyfen	294	2	56	3	6
Maneb	257	2	13.4	3	6
Dicamba	236	2	61	3	6
MCPA, 2-ethyl hexyl ester	229	2	20	3	6
Simazine	175	2	36	3	6
Thiamethoxam	166	2	17.5	3	6
Chlorsulfuron	82	1	0.055	6	6
Abamectin	24	1	0.05	6	6
Endosulfan	12	1	0.05	6	6
EPN	4	1	0.03	6	6
Tralomethrin	1	1	0.0195	6	6
Fenvalerate	0	1	0.015	6	6

Yellow = in current monitoring plan.

Appendix 3. Active ingredients within analytical chemical suites

CT	**IM**	**PY**
Chlorothalonil	Imidacloprid	Bifenthrin
		Cyfluthrin
		Cypermethrin
DN	**OP**	Deltamethrin/Tralomethrin
Benfluralin	Chlorpyrifos	Fenvalerate/esfenvalerate
Ethalfluralin	Diazinon	λ-cyhalothrin/epimer
Oryzalin	Malathion	cis-Permethrin
Oxyfluorfen		trans-Permethrin
Pendimethalin		
Prodiamine		
Trifluralin		
FP +Met	**PX**	**TR**
Desulfinyl fipronil	2,4-D	Bromacil
Desulfinyl fipronil amide	Dicamba	Diuron
Fipronil	MCPA	Hexazinone
Fipronil amide	Triclopyr	Prometon
Fipronil sulfide		Norflurazon
Fipronil sulfone		Simazine