

Monitoring Urban Pesticide Runoff in California 2008 - 2009

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ABSTRACT

To determine the prevalent pesticides in urban surface waters in California, the California Department of Pesticide Regulation (CDPR) initiated a statewide urban surface water monitoring program in 2008. Water and sediment samples were collected at 25 sites in the Sacramento (SAC), San Francisco Bay (SFB), greater Los Angeles (Orange County), and San Diego (SD) areas. Samples were collected at stormdrain outflows and at receiving waters during rainy and during dryflow conditions. Water samples were analyzed for 63 pesticides or degradates. Sediment samples were only collected during dryflow and analyzed for pyrethroids and chlorpyrifos. In water samples, 18 insecticides and 12 herbicides or their degradates were detected above their reporting limits. Multiple detections were common; 50% of the samples had three or more pesticides and 25% had six or more pesticides. OC and SAC had the highest detection frequencies and SD had the fewest. The most frequently detected insecticides in water were bifenthrin, fipronil, fipronil sulfone, carbaryl, desulfinyl fipronil, and malathion. Chlorpyrifos and diazinon were detected, albeit infrequently, despite drastic reductions in urban use. Fipronil, fipronil sulfone, desulfinyl fipronil, and carbaryl were more frequently detected in OC than in other areas of the study. Other pyrethroids were infrequently detected in water samples but common contaminants of sediments. Half of the sediments contained five or more pyrethroids. The most common pyrethroids in sediments were bifenthrin, cyfluthrin, permethrin, deltamethrin, λ -cyhalothrin, and cypermethrin. Herbicides were detected at slightly higher frequencies than insecticides; the most frequently detected herbicides were 2,4-D, triclopyr, dicamba, diuron, MCPA, and pendimethalin. Except for bifenthrin, pesticides occurred with equal frequency in stormdrain outflows and in receiving waters. Bifenthrin was more frequently detected in stormdrain outflows than in receiving waters. Rain increased pesticide runoff for all of the pesticides but fipronil (and degradates). Fipronil appeared to have a continuous load dependent on use rather than rainfall. Detection of the herbicides diuron and pendimethalin also correlated with use but these herbicides are routinely applied during the rainy season when pesticide detections are generally highest. Bifenthrin, fipronil, and diuron were detected in water samples at concentrations that potentially could be toxic to aquatic organisms.

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I. INTRODUCTION

Annual California urban pesticide use is on the order of millions of kg of active ingredient (ai). Urban pesticide use includes structural pest control, landscape maintenance, rights-of-way and public health pest protection applications, as well as applications to commercial, institutional, and industrial areas, and residential home-and-garden applications. The California Department of Pesticide Regulation (CDPR) compiles pesticide use records for urban pesticide applications made by licensed applicators. Annually, professional applicators apply over 4 million kg ai of pesticides for urban (non-agriculture) pest control (CDPR 2010). However, urban pesticide use by individual homeowners is not reported, so that total urban use in California is greater than this reported use. Especially in dense urbanized areas, high homeowner pesticide use is anticipated. For example, a recent survey of four large home improvement stores in northern and southern California showed that 190 pesticide products, containing 79 different ai's, were being sold for outdoor use (Osienski et al. 2010). Other surveys have also shown that large numbers of pesticides are being sold in retail stores. Moran's (2005) survey indicated that more than 320 pesticide products containing 99 different ai's were being sold in the San Francisco Bay Area. Another survey in Sacramento, Stockton, and the San Francisco Bay area revealed 542 different products containing 112 different ai's were available for sale (Flint 2003). Efforts have been made to estimate this non-reported urban pesticide use in California by comparing CDPR's Pesticide Use Report (PUR) and sales database, but a recent analysis by Zhang and Spurlock (2010) demonstrated the high degree of uncertainty in those estimates. However, it has been estimated that non-agricultural pesticide uses account for approximately 20-25% of all total pesticide use in the United States; most of these uses are in urban areas (Aspelin and Grube 1999; Kiely et al. 2004). In 2009, excluding adjuvants, the total reported pesticide use in California was over 68 million kg ai (CDPR 2010). Thus, these data show that large amounts of pesticides are applied in California urban areas, although the exact amounts are unknown.

Due to the high volume of urban pesticide use and perhaps lack of consumer awareness, urban pesticide runoff may exceed agricultural runoff (Wittmer et al. 2011). Pesticide runoff into urban creeks and rivers can occur via stormdrains during dryflow or with stormwater runoff leading to concentrations that may be toxic to aquatic organisms (Hoffman et al. 2000; Revitt et al. 2001; Schiff and Sutula 2004; Budd et al. 2007; Sprague and Nowell 2008; Weston et al. 2009; Oki and Haver, 2009). Many urban use pesticides have been detected at concentrations that are sufficient to cause toxicity in laboratory bioassays (Werner, et al., 2000; Schiff et al. 2002; Hunt, et al., 2003; Holmes et al. 2008; Mize et al. 2008; Lao et al. 2010; Weston and Lydy 2010). In addition, numerous urban creeks are listed on the 2006 Federal Clean Water Act Section 303(d) list due to the presence of organophosphorus (OP) pesticides that often originated in urban runoff (Cal/EPA 2009). Most of these listings are due to the presence of chlorpyrifos or diazinon. Chlorpyrifos and diazinon have been banned from most urban (residential) uses due to unfavorable human health and ecological risks. However, some urban uses of these two OP insecticides are still allowed so that their presence in urban waterways is still possible. For instance, chlorpyrifos is allowed for sale in indoor ant and roach baits in child resistant packaging, as a fogger adult mosquitocide (when applied by a public

agency), and for use in golf course turf applications at reduced rates (US EPA 2010a). Currently in California, both chlorpyrifos and diazinon are used in urban areas for structural pest control, rights-of-way applications, and for landscape maintenance when applied by a licensed professional applicator. However, the overall urban use in California is less than 1% of the total usage prior to initiating the residential ban in 2000 (CDPR 2010).

Recent monitoring in California shows that urban waterways are frequently contaminated with pyrethroids, the OPs diazinon and chlorpyrifos, and fipronil (Oki and Haver, 2009; Weston et al. 2009; Weston and Lydy 2010; Lao et al. 2010). There is little or no published monitoring data for many other urban use pesticides in California, especially herbicides. Herbicides are often acutely toxic to algae, although the environmental impacts of herbicides on aquatic systems is not well understood (Jassby et al. 2003; Miller et al. 2005; Sommer et al. 2007). In addition, there are synergistic interactions between different pesticides to aquatic invertebrates (Lydy and Belden 2006). Additional monitoring of urban waterways is therefore needed in order to assess the potential impacts of urban pesticide use on urban surface waters. A consistent statewide monitoring program will provide useful data on the environmental fate of urban use pesticides and aid in the development and implementation of management measures. In 2008, CDPR initiated a statewide urban monitoring project to address the problems of pesticides in urban waterways. Specific objectives of this study were fourfold: 1) determine what pesticides, at what concentrations, are present in urban runoff; 2) evaluate the magnitude of measured concentrations relative to water quality or aquatic toxicity benchmarks; 3) assess the effect of waterbody type (e.g., stormwater drain vs. creek); and 4) assess the effect of season (dryflow vs. rainstorm).

II. MATERIALS AND METHODS

Study Area. Monitoring was conducted in four large metropolitan areas in northern and southern California. Twenty-five sites were sampled in total; four in the Sacramento area, seven in each of the San Francisco Bay, the greater Los Angeles, and San Diego areas (Figure 1). Water and sediment samples were collected from either stormdrain outflows or from downstream receiving waters (Figure 2); generally for each of the four main sampling areas, there were two or three stormdrain outflows for each receiving water site. Receiving waters comprised of: Pleasant Grove Creek (Sacramento [SAC] area), Grayson and Koopman/Martin Canyon Creeks (San Francisco Bay [SFB] area), and Wood Canyon and Salt Creeks (greater Los Angeles area, in Orange County [OC]), Lindo Lake (inflow), and the San Diego River (San Diego [SD] area). Two storm drain outflow sites at the San Diego River sites only contained water during rain events. Detailed information about the sampling sites can be found in [Appendix I, Table A1](#).

Field Sampling. This study was initiated in April 2008 and ended at the end of the August 2009. In northern California, four dryflow and four rainstorm sampling events were completed. However, due to limited rainfall in southern California, we were only

able to sample one rain event during both the 2008 and 2009 water years¹. To make up for the lack of rain sampling, we completed five dryflow sampling events. Pyrethroid monitoring was added about 10 months after this study was initiated, with sampling beginning in February 2009. Because of the limited rain in southern California, no pyrethroids were collected during rain events. We use the term dryflow for our base stream flow in urban surface waters as these waters likely never experience true baseflow, the condition where only groundwater contributes to surface water flow. Urban surface waters are augmented with water from other sources, as irrigation, washing of cars, etc. (Sprague and Nowell 2007). We will refer to dryflow conditions when surface waters receive no input from rain storms; usually in California from late April or early May through September or October.

Sediment samples were collected for pyrethroid and chlorpyrifos analysis. The collection of sediment sample timings differed somewhat from the water sample sampling. For pyrethroid analysis, sediments were collected twice during the study. In northern California, sediments were collected near the end of the rainy season and once in the summer. In southern California, sediments were collected in the late spring after the termination of the rainy season. Sediments were collected both from stormdrain outflows and, when feasible to do so, receiving waters. Sediments for chlorpyrifos analysis were only collected once, in the spring of 2009.

Water samples from receiving waters were collected from stream banks close to midstream as feasible directly into 1-L glass amber bottles using an extendable pole and sealed with Teflon®-lined lids. Stormdrain outflows, generally with less flow, were collected by hand directly into 1-L amber bottles. However, dependent on flow and water depth, occasionally water samples from stormdrain outflows were collected into a stainless steel container and aliquots were poured into 1-L glass bottles. During the rainstorm event in OC, storm samples were collected as a composite sample with a Hach-Sigma 900 Max automated sampler and split into 1-L amber bottles for transport. Sediment (up to a 2 cm depth) were collected using a stainless steel trowel or shovel, composited in a stainless steel container, and individual samples were placed into clear glass Mason® jars for later chemical analysis. Sediments could not be collected at all sites. Immediately after sampling, water and sediment samples were stored on wet ice for transport. Upon arrival at the laboratory, water samples were refrigerated (4°C) whereas sediments samples were frozen (–20°C) until chemical analysis.

Total Suspended Solids and Total Organic Carbon. We analyzed total suspended solids (TSS) in water samples and total organic carbon (TOC) in both water and sediment samples. TSS was analyzed following US EPA method 160.2 (US EPA, 1971). Briefly, water samples were filtered under vacuum through a Buchner funnel lined with a glass fiber filter, dried overnight at 103–105°C, and weighed. TOC was analyzed using a TOC-V CSH/CNS analyzer (Shimadzu Corporation, Kyoto, Japan).

¹A water year is from October of one year through September of the next; e.g., water year 2009 is from October 2008 through September 2009.

Field Measurements. Water physiochemical properties (dissolved oxygen [DO], electrical conductivity [EC], pH, turbidity, and temperature) were measured *in situ*. Measurements were taken with a YSI 6920 V2 meter (YSI Incorporated, Yellow Springs, OH). The meter was calibrated prior to field use (Doo and Lee 2008).

To get an estimate over overall pesticide load, flow data measurements were collected using a Global Flow Probe Flow Meter (Global Water, Gold River, CA). Flow could not be taken at all sites at all sampling dates, due to low or no flow or, in some cases, due to rapid flow in larger creeks. In specific cases, flow was estimated using the float method (timing the movement of an object on the surface) or by measuring volume over time (Appendix I).

Analytical Chemistry. We analyzed for a total of 63 different pesticides, or pesticide degradates, in this study. Most of the analysis were from the following pesticide groups: pyrethroids, carbamates, OP, fipronil (FP) and FP degradates, synthetic auxin herbicides, triazines/triazinones/uracils/ureas (photosynthesis inhibitor herbicides [PI]), and dinitroaniline herbicides (Table 1). Although some of the pesticides included in the chemical analysis are not urban use pesticides, they were analyzed and reported by the laboratory from the same analytical method.

We report the results as: 1) nd, not detected, concentrations below the minimum detection limit; 2) tr, trace detection, where in the chemist's best professional judgment the analyte does exist between the reporting limit and the minimum detection limit; 3) a numerical concentration in ng L^{-1} (pyrethroid water samples), $\mu\text{g L}^{-1}$ (all other water samples), or ng g^{-1} (dry weight; sediment samples).

QA/QC for Water and Sediment Samples. Quality control for this study followed the CDPR SOP guidelines on Chemistry Laboratory Quality Control (Segawa, 1995). Quality control consisted of blind spikes, laboratory matrix spikes, method blanks, field duplicates, and field blanks. Propazine was also used as a surrogate spike in the PI analytical screen. Fifteen percent of the field samples were field duplicates, field blanks, or blind spikes.

Statistics. Statistical analyses was conducted using the non-parametric Mann-Whitely mean comparison test, significance at the 0.05 level, with Minitab[®] Statistical Software (Release 15). Regression analysis was also determined using Minitab[®], significance also at the 0.05 level.

III. RESULTS AND DISCUSSION

Pesticides detected in surface waters

Of the 63 pesticides or analytes in the chemical analysis, we detected 30 different pesticides (including degradates) above their analytical reporting limit (18 insecticides and 12 herbicides). Many pesticides in the analyses were not urban use pesticides and

detections were not expected; nonetheless, 77% of the sampling sites contained at least one pesticide. Of the detected pesticides, OC and SAC had the highest detection frequency (24 and 20%, respectively), then SFB (14%) with SD having the fewest (4.5%). Frequently, more than one pesticide was detected in a water sample, which significantly differed among the four different study regions. OC had significantly higher median number of pesticides per water sample (6) than did SAC (4), which was significantly higher than SFB (2), which was significantly higher than SD (0; $p=0.000-0.135$, Figure 3). OC residents tend to have slightly more pest problems than residents in northern California which may warrant more pesticide applications (Flint 2003). Our data would suggest higher use than the other areas of the study. SD may also have higher levels of pesticides in surface water; for example, the San Diego Storm Water Department (2010) has recently reported high levels of pyrethroids in this area. And, although we report fewer pesticides found at one time in urban streams than in a 10 year review by Gilliom et al. (2006), different analyses, sampling regimes, or differences in pesticide use (e.g., much reduced urban use of diazinon or chlorpyrifos) may account for the differences.

The most frequently detected insecticides in surface waters were, in decreasing order, bifenthrin, fipronil (FP), FP sulfone, carbaryl, desulfinyl FP, malathion, and permethrin (Figure 4). Bifenthrin was the most frequently detected insecticide and second most detected pesticide in the study, with a 56% detection frequency. The high detection frequency was attributed to the high number of detections in SAC and SFB during rain runoff. For example, in northern California, bifenthrin dryflow detection frequency was 27% but increased to 97% during rainstorm events. We had similar dryflow detections of bifenthrin in southern California (29%) but because bifenthrin was added later in the study, there is no rainstorm sampling of bifenthrin in this part of the state. Because rainfall greatly enhances bifenthrin detections, additional sampling during rainstorm events in southern California is needed to determine the full contamination of bifenthrin in the urban runoff.

Other pyrethroids were detected in waters samples, albeit infrequently. The detection frequency of other pyrethroids in water samples: permethrin (both cis and trans isomers) 9.7%; cypermethrin 4.2%; esfenvalerate/fenvalerate, cyfluthrin, and λ -cyhalothrin, 1.4%. All pyrethroids were detected above their analytical reporting limit.

Fipronil and degradates were frequently detected. This group had a higher percentage of trace detections than detections above their analytical reporting limit. Fipronil had a 30% detection frequency; if trace detections are included, detection frequency increased to 73%. This was also observed for the five degradates (percentage of detections above reporting limit, detections including trace detections):

- FP sulfone (27%; 77%);
- Desulfinyl FP (17%; 79%);
- FP amide (4.5%; 64%);
- Desulfinyl FP amide (3%; 42%);
- FP sulfide (0.6%; 54%).

Fipronil, FP sulfone, and desulfinyl FP had higher detection frequencies in OC than in other areas of California (Figure 5).

Carbaryl was the fourth most frequently detected insecticide in surface waters (18% detection frequency, with trace detections, 28%). Carbaryl was also more frequently detected in OC than in other areas of the state (Figure 5). Three OPs were detected. Malathion was most frequently detected of these, with a 14% detection frequency (with trace detections, 25%). Diazinon and chlorpyrifos were also infrequently detected, with a 6.5% and 4.5% detection frequency, respectively. The reduced urban detections of diazinon and chlorpyrifos over past sampling (Gilliom 2006) are likely due to the drastic reduction of these insecticides in urban areas (US EPA 2010a, 2010b). The only other insecticide detected in the study was oxamyl (a carbamate), detected once in a water sample from southern California.

The most frequently detected herbicides were 2,4-D, triclopyr, dicamba, diuron, MCPA, and pendimethalin (Figure 6). 2,4-D was the most frequently detected pesticide in this study and as a group, the synthetic auxin herbicides (2,4-D, triclopyr, dicamba, and MCPA) were frequently detected in all areas but SDR. MCPA was also rarely detected in OC. For urban use, these four herbicides have similar uses and application timings. Frequency of detection ranged from 23% (MCPA) to 65% (2,4-D); detection frequency increased from 30% - 72% if trace detections are considered. Diuron was also frequently detected (30% detection frequency; with trace detections, 57%).

The dinitroaniline herbicides pendimethalin, oryzalin, and prodiamine were also detected, albeit less frequently than the synthetic auxins and diuron. Their detection frequency ranged from 8% - 20% and if trace detections are considered, detection frequency increased to 21% - 37% (Figure 6). Of these, pendimethalin had much higher detection frequency in SAC (54% detection frequency) than in other areas (SFB was second highest, with 19% detection frequency). Prodiamine was only detected in northern California. Simazine, prometuron, and oxyfluorfen were detected less than 5% of the time.

Pesticides detected in sediments

We did not detect chlorpyrifos in any sediment samples, but pyrethroids were abundant. All of the sediments contained at least one pyrethroid, over half contained at least five pyrethroids (median), and up to eight different pyrethroids were detected in one sediment sample (Figure 7, A). Bifenthrin was the most frequently detected pyrethroid; it was detected in all but two sediment samples. Sediment also commonly contained cyfluthrin, permethrin (both cis and trans isomers), deltamethrin λ -cyhalothrin, and cypermethrin; in addition esfenvalerate/fenvalerate and resmethrin were detected (Figure 7, B).

Appendix I contains the complete analytical results (for both water and sediment) for the study ([Tables A2-A10](#)).

The effect of waterbody type (storm drain vs. creek receiving water) on pesticide detections in urban surface waters.

There were little differences between detection frequencies between storm drain outflows and receiving waters, with most pesticides having less than 10% difference between these two different water bodies (Figure 8). Bifenthrin was the main exception. Bifenthrin had a 64% detection frequency in stormdrain outflows but only a 36% detection frequency in receiving waters. Except for bifenthrin and pendimethalin, there were less than 10% differences between detections in receiving waters and stormdrain outflows. For most pesticides, sampling at stormdrain outflows gives a good representation of urban runoff and is often easier and safer to sample than from larger receiving waters. Other pyrethroids may behave like bifenthrin, but we did not have sufficient detections in water to make this determination.

In addition, there were no significant differences in the median number of pesticides detected per sample between stormdrain outflows and receiving waters (median 3.0 and 2.5, respectively; $p=0.584$).

The effect of season (dryflow vs. rainstorm) on pesticide detections in urban surface waters.

Generally, we detected more pesticides during rainstorms than during dryflow sampling. Fipronil (and degradates) were a main contradiction; these were detected frequently during both dryflow and rainstorm events (Figure 9). This was biased by detections from OC, where dryflow sampling had high detections of fipronil (71% detection frequency) and its degradates (up to 77% detection frequency). Although first flush detections (first rainstorm of the water year) gave the highest detection frequencies in northern California and in San Diego, this was not true in Orange County. Detections of fipronil (and degradates) during the first flush in Orange County had similar detection frequencies as several of the dryflow sampling events. However, regardless of rain or dryflow sampling, detections from northern California correlated well with PUR use ($r^2=75\%$; $p=0.006$) but detections from southern California did not ($r^2=28\%$; $p=0.08$). The poor correlation in southern California was likely due to few detections with low to moderate use in San Diego and to high detections in Orange County with moderate use. Although fipronil runoff can be influenced by rainfall, it also behaves as other urban use pesticides that show a continuous load independent of rain events (Wittmer et al. 2011). The use of pesticides that have a continuous load into urban surface waters may be a concern. To prevent runoff, overall use would need to decrease, not just use during the rainy season. As fipronil use increases, runoff into urban surface waters will likely increase, regardless of season.

All other detected pesticides had detection frequencies between 18-69% higher during rainstorm sampling than during dryflow sampling. Bifenthrin was most frequently detected pesticide during rainstorms. Although bifenthrin has higher reported use during dry weather than during the rainy season (CDPR 2010)², detections were higher during

²Although we cannot account for homeowner use, this use likely follows application timings made by professional applicators.

rainstorm sampling. Bifenthrin had a 97% detection frequency during rain sampling compared to a 28% detection frequency during dryflow. Rain runoff may be initially driving bifenthrin into the water via sediment and organic carbon and keeping it suspended. Bifenthrin is known to be tightly bound to sediment and organic carbon. During rainstorm sampling events, the median concentrations of TSS, TOC, and turbidity were significantly higher than these parameters taken during dryflow sampling ($p=0.0000-0.0035$).

Herbicides were more frequently detected during rain sampling than during dryflow sampling. We had detection frequencies between 26-46% higher during rain sampling (Figure 9). In California, many herbicides are applied during the rainy season for residual weed control and would be less effective applied at other times of the year. Applications during the rainy season increase runoff into surface waters. Two of the herbicides we frequently detected, diuron and pendimethalin, had their highest use and detections during the rainy season (Figure 10). As use decreased in the spring through summer, the number of detections also decreased. Both diuron and pendimethalin had a good correlation between use and detections ($r^2=85\%$, $p=0.001$ and $r^2=94\%$, $p=0.01$, respectively). Synthetic auxin herbicides also had higher detections frequencies when sampled during rainstorm events than during dryflow. Synthetic auxins are used late in the rainy season (March – May) to control flushes of germinated weeds but they also have use in the summer months. Although our detections frequencies are higher during rain runoff, we also detected synthetic auxins in dryflow sampling. We did not have a good correlation between reported use and detections, possibly due to unreported homeowner use or to the persistence of some of these herbicides when applied in the late summer (Figure 10; August, September) and then are detected in some of the first rainfalls of the season (October, November).

Differences between the number of pesticides per sample during dryflow and rainstorm sampling give additional evidence that pesticides tend to runoff into urban surface waters when it rains. The median number of pesticides detected per sample during a rainstorm event was significantly greater than samples collected during dryflow (median 7.0 and 1.0, respectively; $p=0.000$).

Comparison of Pesticide Concentrations to Aquatic Toxicity Benchmarks

Established aquatic toxicity benchmarks can be used to interpret monitoring data and prioritize sites and pesticides for further investigation (US EPA 2010c). For this analysis, we used acute benchmarks available from US EPA OPP. But for pyrethroids we used established *H. azteca* LC₅₀s (where available) due to the sensitivity of this organism to pyrethroids (Anderson et al. 2006, Weston and Jackson 2009). In water samples, we detected eleven pesticides above their benchmarks or LC₅₀s (Table 2). In all, 76% of the sampling sites had at least one pesticide above its benchmark/LC₅₀. This value comparable to the 83% value for urban streams as stated by Gilliom et al. (2006) during a 10 year review (1992-2001) of USGS data. Any differences are likely due to changes in urban insecticide use that has occurred (decreased chlorpyrifos and diazinon use offset with increased pyrethroid use), as well as different sampling sites and monitoring regimes. Of OPs, we only detected chlorpyrifos twice above its benchmark value and malathion once, all in northern California. Pyrethroids (mostly bifenthrin), fipronil, and

diuron were the only other pesticides detected at concentrations above their toxicity benchmarks. None of the other pesticides were detected above their benchmarks.

Pyrethroids were frequently detected above their LC₅₀s and this group of pesticides had the highest percentage of detections with the potential to be toxic to sensitive aquatic organisms. Pyrethroids are highly hydrophobic and associate with the dissolved organic carbon and suspended sediment in water samples which may limit their bioavailability. Taking these factors into consideration with the equation by Spurlock et al. (2005) and using the K_{oc} value of 240000 (NPIC 2011), the bioavailability of bifenthrin ranged between 14% - 58% of the total concentrations. With these values, we would expect that approximately 20% of the bifenthrin detections would be toxic to *H. azteca*. However, K_{oc} values are highly variable. For bifenthrin, Laskowski (2002) lists a range of K_{oc} values from 116000 – 888000 ml g⁻¹. Based on this range of uncertainty in K_{oc}, the estimated fraction of bifenthrin detections with bioavailable concentrations sufficiently high to cause toxicity to *H. azteca* ranged between 3% and 30%. We cannot know precisely what the overall toxic potential for bifenthrin was in the urban waterways where we sampled. However, it is likely that some of the bifenthrin would have been available for uptake and toxicity to sensitive aquatic species in these waterways.

Although infrequently detected, cyfluthrin, cypermethrin, λ-cyhalothrin, and esfenvalerate were all detected above their respective benchmarks/LC₅₀s. Half of all the permethrin detections were also above its benchmark (Table 2, estimated bioavailability)

Fipronil had the second highest number of detections above its US EPA toxicity benchmark, with 20 detections (13% of all fipronil detections). Most of these detections above the benchmark (80%) were from OC, mostly during dryflow sampling. The fipronil degradates FP sulfone (MB46136) and FP sulfide (MB45950) are more toxic than fipronil itself (FAN 2010) even though fipronil has a lower benchmark. Using EPA benchmark values, Mize (et al. 2008) estimated LC₅₀ values for the sulfone and sulfide degradates to be 0.06 and 0.22 µg L⁻¹, respectively, for sensitive species. Using these LC₅₀s, FP sulfone was detected 36 times (23% of FP sulfone total detections, mostly in OC) over its LC₅₀. Likely FP sulfone has the potential to contribute to toxicity in these waters. No other fipronil degradates were detected above benchmarks (we could not find any toxicity values for desulfinyl FP or desulfinyl FP amide). This data also indicates that most of the potential toxicity of fipronil was in OC.

Diuron was the only herbicide that was detected above its US EPA benchmark for non-vascular plants. Eight water samples (5% of total) contained concentrations above its benchmark; all were detected in northern California, mostly during rainstorm sampling. In past work, the potential importance of diuron toxicity to the overall food chain has been overshadowed by pesticides that cause toxicity to aquatic invertebrates (Munn et al. 2006, Sprague and Nowell 2008). The ecological importance of diuron toxicity to phytoplankton is not well understood (Jassby et al. 2003, Miller et al. 2005, Sommer et al. 2007).

In pesticide risk assessment, toxicity is usually based on exposure to one stressor or contaminant. However, it is more common for aquatic organisms to be exposed to multiple stressors or contaminants, often in complex mixtures of herbicides and insecticides. For example, our results show that 50% of the water from one site contained 3 or more pesticides, 25% of the sites contained six or more pesticides, and 15% of the sites contained eight or more pesticides. Other work has shown similar results (Gilliom 2006). The accumulated number of pesticides found at one time likely has a negative effect on overall stream health. Generally, pesticides within the same pesticide class (with a common mode of action) are likely to have an additive effect whereas pesticides from different chemistry classes are likely to have more varied effects, such as synergism or antagonism (Lydy and Belden 2006). However, little is known about interactions among multiple pesticides on the toxicity to aquatic organisms as all chemical combinations (pairs, triplets, etc.) are impossible to investigate (Lydy and Belden 2006). These combinations, in addition to other chemical contaminants (e.g., metals and salts) and physical stressors (as dissolved oxygen concentrations, temperature, and habitat degradation) likely interact to degrade natural habitats. Our work suggests that multiple pesticide stressors are common occurrences in urban surface waters and that toxicity tests should investigate these interactions.

Water Quality

Water temperature, pH, EC, turbidity, DO, TSS, and TOC were measured in this study. DO, pH, and EC have specific water quality objectives and generally were within water quality objectives. DO exceeded water quality objectives 20% of the time but pH and EC only exceeded the objectives 2% and 9% of the time, respectively. Median concentrations of turbidity (3.1 NTU), TSS, and TOC were low (6.6 and 7.8 ppm, respectively). There were little differences in water quality between stormdrain outflows and receiving waters but there were some water quality differences between northern and southern California, and between dryflow and rain runoff. All of the water quality parameters can be found in the Appendix I, [Tables A11 - A15](#).

Quality Control

Quality control was acceptable for the study. Ninety-eight percent of all matrix and propazine spikes were recovered within acceptable levels and there were no detections in the lab blanks. [Appendix II](#) has more detailed information about quality control.

IV. CONCLUSIONS

The main conclusions from the study are listed below.

1. Urban water bodies contain numerous pesticides at any given time. We detected 30 different pesticides and degradates. The main insecticides detected in water samples were bifenthrin, fipronil, fipronil sulfone, carbaryl, desulfinyl fipronil, and malathion. The main herbicides detected were 2,4-D, triclopyr, dicamba, diuron, MCPA, and pendimethalin.

2. Urban surface waters often contain more than one pesticide. Fifty percent of the sampled waters had three or more pesticides and 25% of the sampled waters had six or more pesticides.
3. Fipronil, fipronil sulfone, desulfinyl fipronil, and carbaryl occur at higher frequencies in Orange County (greater Los Angeles area) than in other areas of California.
4. San Diego area had fewer pesticide detections than did other areas of the study.
5. Diazinon and chlorpyrifos are still detected in urban waters, albeit infrequently.
6. Pyrethroids are found in urban surface waters. Bifenthrin is the main pyrethroid (56% detection frequency) followed by permethrin (10% detection frequency). In urban surface waters, only about one-third of the pyrethroid concentration is bioavailable to aquatic organisms.
7. Sediments contain numerous pyrethroids and pyrethroids are more likely to occur in sediments than in water. Bifenthrin was most frequently detected (95% detection frequency), but cyfluthrin, cypermethrin, deltamethrin λ -cyhalothrin, and permethrin were common contaminants of urban sediments (32%-78% detection frequency).
8. Rainstorms drive most pesticides into urban surface waters. Bifenthrin, diuron, MCPA, 2,4-D, malathion, dicamba, triclopyr, pendimethalin, and carbaryl are more frequently found during rain runoff than during dryflow sampling.
9. Fipronil (and degradates) can be found frequently in urban surface waters during dryflow. Although rain may increase runoff, it is not needed to transport fipronil into urban surface waters.
10. Pesticides are detected in storm drain outflows and receiving waters with about equal frequency, except for bifenthrin (and perhaps other pyrethroids). Bifenthrin is more commonly found in stormdrain outflows than in receiving waters.
11. Bifenthrin, fipronil, and diuron are detected in water at concentrations that potentially could be toxic to aquatic life. Other pyrethroids are infrequently detected but at concentrations that potentially could be toxic to aquatic organisms. Fipronil sulfone may also have toxicological concerns.

From this work, we can make recommendation for future research:

1. Southern California, and especially the Orange County area, had high detections of insecticides. Other high urban use insecticides (i.e., imidacloprid) should be monitored to determine the extent of total insecticide runoff. We also had little storm runoff data for bifenthrin in Southern California; additional monitoring of bifenthrin during rainstorm events is warranted. Bioavailable concentrations of bifenthrin need to be estimated in monitoring studies.
2. Determine if other high urban use pesticides, like the fungicide chlorothalonil, are common contaminants of urban surface waters.
3. More work in the San Diego area is warranted to determine if the low level of detections are typical to this area. Future studies in the San Diego area should look at additional neighborhoods and creek sites to determine the extent of pesticide runoff.
4. Additional monitoring of fipronil during dryflow is warranted to determine if runoff is related to use rather than rainfall. Sampling should occur monthly, at the end of the month, to correspond with PUR monthly use summaries.
5. Determine if diuron and pendimethalin detections during rainy season occur only during rain runoff or if they are common in the rainy season when it is not raining.

6. Conduct toxicity testing with two-way and three-way mixtures of pesticides commonly found in urban waters. Tests should include algae and aquatic invertebrates common to California.

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Table 1. Pesticides analyzed by the California Department of Food and Agriculture in water or sediment, with their method detection and reporting limits, and holding times. Specific methods can be found at http://www.cdpr.ca.gov/docs/emon/pubs/em_methd_main.htm.

Analyte Group (method)	Method Detection Limit (µg L ⁻¹)	Reporting Limit (µg L ⁻¹)	Holding time (days)	
Carbamate Insecticides (HPLC; method EMON-SM 11.3)				
Analytes: aldicarb, aldicarb sufoxide, aldicarb sulfone, methomyl, carbofuran, 3-OH carbofuran, carbaryl, oxamyl, methiocarb	0.01 – 0.02	0.05	28 (acidified)	
Fipronil Insecticides (GC/MSD in SIM mode; method EMON-SM 05-013)				
Analytes: fipronil (FP), desulfinyl FP, desulfinyl FP amide, FP sulfide, FP sulfone, FP amide	0.003 – 0.005	0.05	14	
Organophosphorus Insecticides in Water (method EMON-SM 46-0)				
Analytes by GC/FPD: azinphos methyl, dichlorvos, dimethoate, disulfoton, ethoprop, fenamiphos, fonofos, malathion, methidathion, methyl parathion, phorate, profenofos, tribufos (plant growth regulator - defoliant)	0.008 – 0.0142	0.03 – 0.05	7	
Analytes by GC/MS: chlorpyrifos, diazinon	0.0008 – 0.0012	0.01	7	
Pyrethroid Insecticides (GC-ECD; water method, EMON-SM 05-003; sediment method EMON-SM 52.9)				
Analytes: bifenthrin, cyfluthrin, cypermethrin, deltamethrin/tralomethrin, esfenvalerate/fenvalerate, fenpropathrin, λ-cyhalothrin, permethrin (cis, trans), resmethrin	Water	0.001 – 0.008	0.005 – 0.015	4
	Sediment (µg kg ⁻¹)	0.107 – 0.183	1.0	183
Triazine/Triazinone/Uracil/Urea Herbicides (LC/MC/MC; method EMON-SM 62.9)				
Analytes: atrazine, ACET (deisopropyl atrazine), bromacil, DACT (diamino chlorotriazine), DEA (deethyl atrazine), diuron, hexazinone, metribuzin, prometon, prometryn, simazine and norflurazon (a phytoene desaturase inhibitor)	0.01 – 0.04	0.05	14	

Table 1 continued.

Synthetic Auxin Herbicides (GC/MS; method EMON-SM 05-012)			
Analytes: 2,4-D, dicamba, MCPA, triclopyr	0.064	0.1	12
Dinitroaniline Herbicides (GC/TQMS or LCQ; method EMON-SM 05-006)			
Analytes: benfluralin, ethalfluralin, oryzalin, pendimethalin, prodiamine, trifluralin, oxyfluorfen (diphenyl ether herbicide)	0.0048 – 0.015	0.05	14

Table 2. Detection frequencies (above reporting limits) of pesticides detected above US EPA benchmark or commonly accepted LC₅₀ values in water samples (N = 155; pyrethroids, N = 72).

Pesticide	Benchmark ($\mu\text{g L}^{-1}$) ^A	Detection Frequency (DF)	
		DF for the Study	DF greater than benchmark or LC ₅₀
Diuron	2.4	30%	5%
Fipronil (FP)	0.11	30%	13%
FP sulfone	0.36	27%	0.6%
Chlorpyrifos	0.05	4.5%	1.3%
Malathion	0.3	14%	0.6%
	Benchmark or LC ₅₀ (ng L ⁻¹)		--Pyrethroid DF above estimated bioavailable concentration ^E --
Bifenthrin ^B	7.7	56%	20%
Permethrin ^{A,C}	10	11.1%	5.6%
Cyfluthrin ^B	2.3	1.4%	1.4%
λ -Cyhalothrin ^A	3.5	1.4%	1.4%
Cypermethrin ^B	2.3	4.2%	4.2%
Esfenvalerate ^{A, D}	25	1.4%	1.4%

^A Lowest acute fish or invertebrate benchmark (US EPA 2010c)^B *Hyalomma azteca* LC₅₀ (Weston and Jackson 2009)^C Both cis and trans isomers^D Analysis does not differentiate between esfenvalerate and fenvalerate^E Using equation from Spurlock et al. (2005) and K_{oc} values from PPDB (2011) and NPIC (2011).

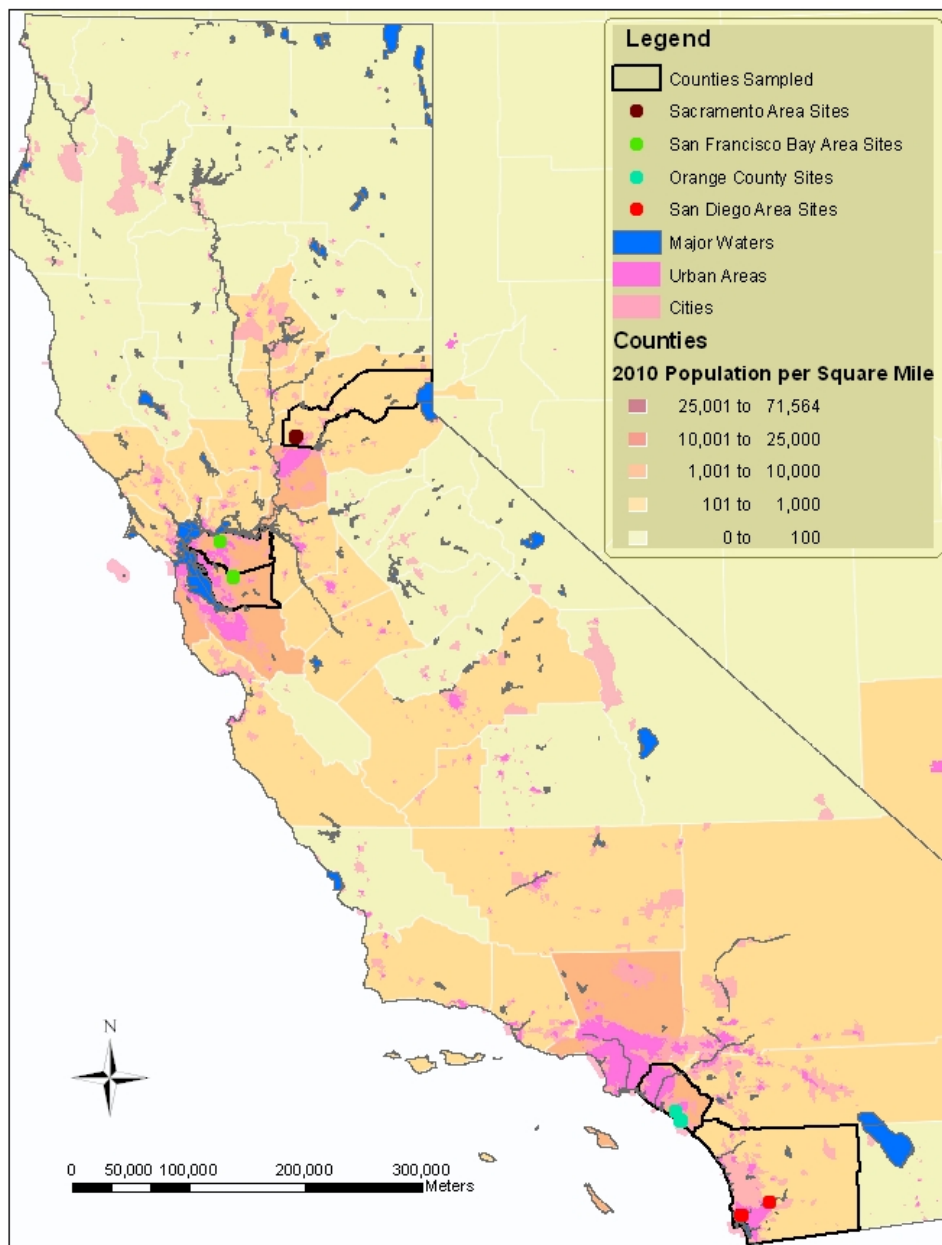


Figure 1. Sampling sites for CDPR's urban monitoring project in the Sacramento, San Francisco Bay, greater Los Angeles (Orange County), and San Diego areas, California.

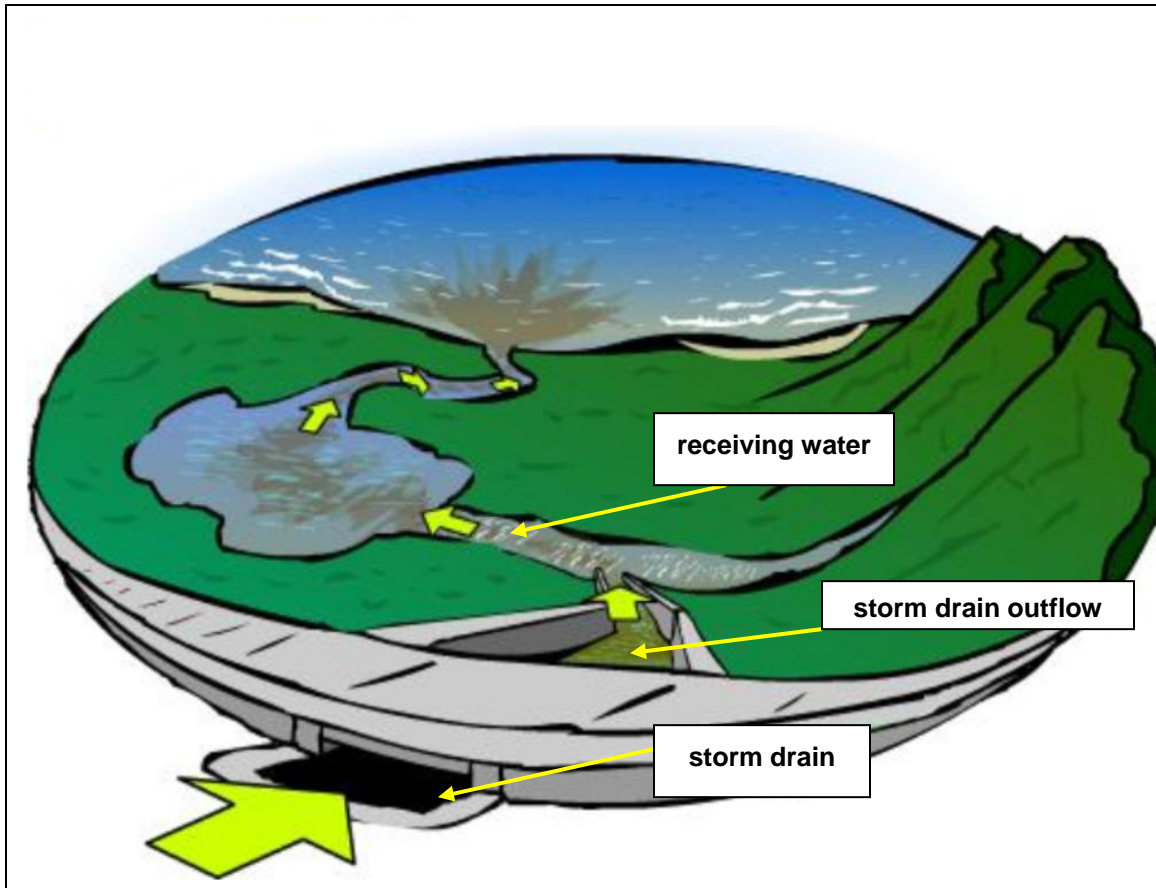


Figure 2. Cartoon depicting a storm drain outflow and receiving water (*from* <http://www.stormwater.co.trumbull.oh.us/>).

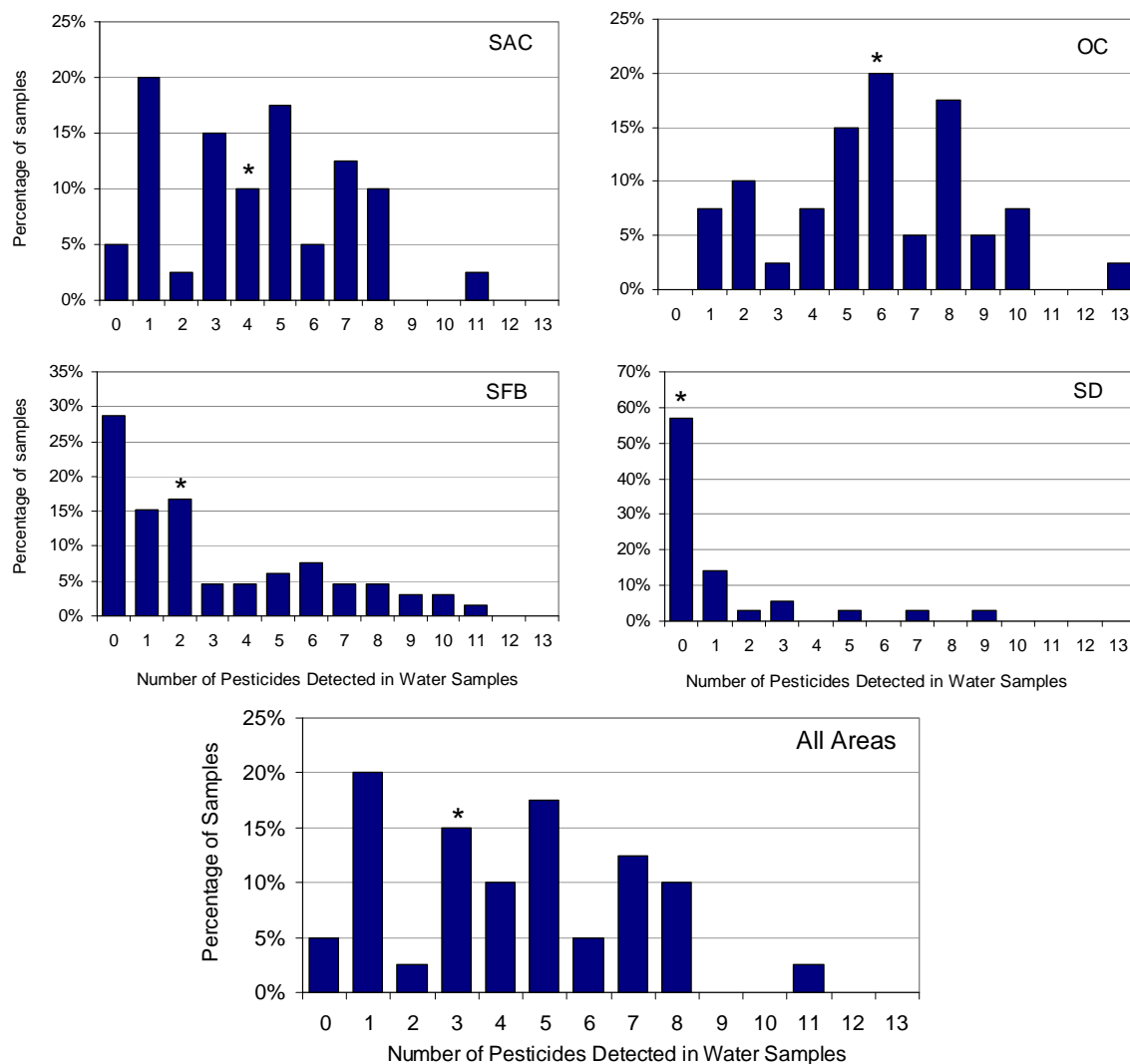


Figure 3. Number of pesticides detected in water samples collected from urban creeks and storm drain outflows in the four different sampling areas of California (Sacramento [SAC], San Francisco Bay [SFB], greater Los Angeles [OC], and San Diego [SD] areas of California, USA) and in samples combined from all four sampling areas. All detections were above the analytical reporting limit; * indicates the median number of pesticides detected per water sample.

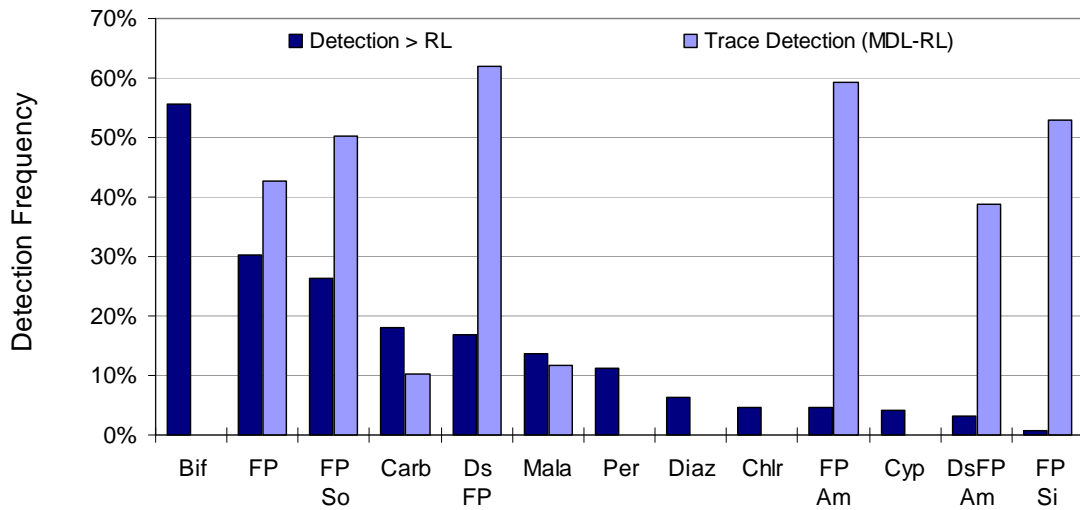


Figure 4. Detection frequency of insecticides from all sampling areas of California between April 2008 and August 2009. Bif, bifenthrin; FP, fipronil; FP So, FP sulfone; Carb, carbaryl; Ds FP, desulfinyl FP; Mal, malathion; Per, cis and trans-permethrin; Diaz, diazinon; Chlr, chlorpyrifos; FP Am, FP amide; Cyp, cypermethrin; Ds FP Am, DSFP amide; FP Si, FP sulfide. There was also one detection each of cyfluthrin, λ -cyhalothrin, esfenvalerate/fenvalerate, and oxamyl. RL, reporting limit; MDL, minimum detection limit.

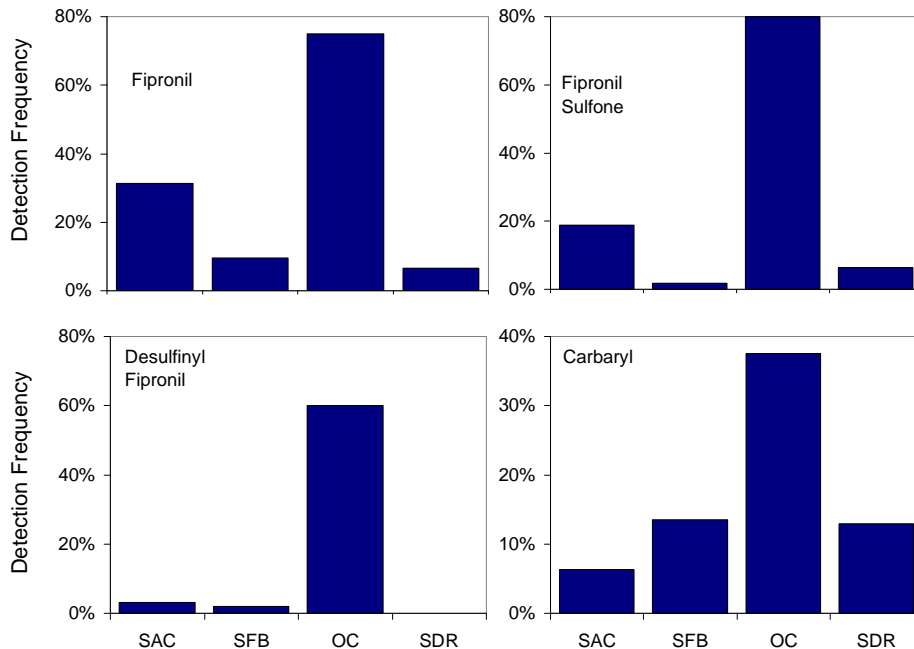


Figure 5. Detection frequency of fipronil, fipronil sulfone, desulfinyl fipronil, and carbaryl in the four different sampling areas of California (Sacramento [SAC], San Francisco Bay [SFB], greater Los Angeles [OC], and San Diego [SD] areas of California, USA). All detections were above the analytical reporting limit.

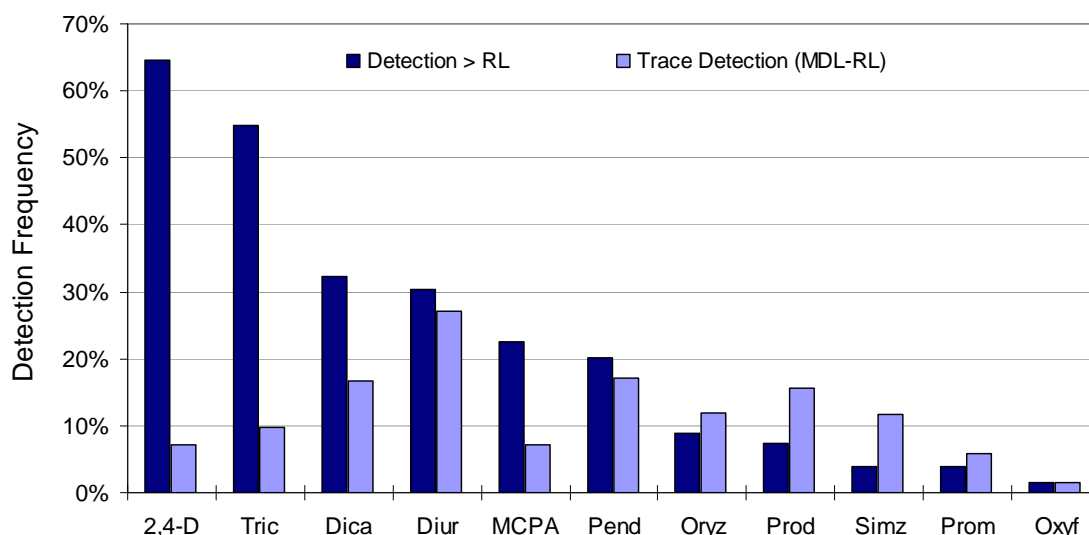


Figure 6. Detection frequency of herbicides from all sampling areas of California between April 2008 and August 2009. Tric, triclopyr; Dica, dicamba; Diur, diuron; Pend, pendimethalin; Oryz, oryzalin; Prod, prodiamine; Simz, simazine; Prom, prometon; Oxyf, oxyfluorfen. There was also one detection of ACET (deisopropyl atrazine), one trace detection of bromacil, and one trace detection of trifluralin. RL, reporting limit; MDL, minimum detection limit.

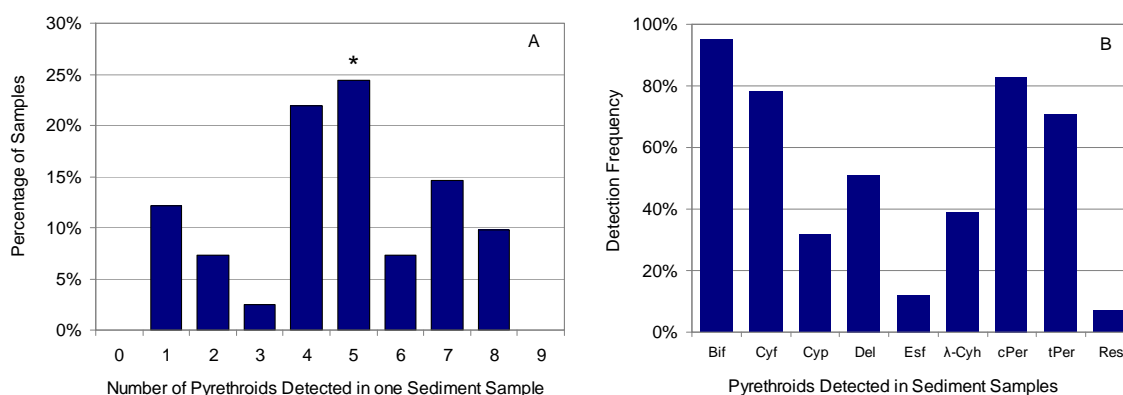


Figure 7. Detections of pyrethroids in sediments from all sampling areas of California. A, percentage of pyrethroid detections per sample (* indicates the median number of pyrethroids detected). B, detection frequency of pyrethroids in sediment samples (Bif, bifenthrin; Cyf, cyfluthrin; Cyp, cypermethrin; Del, deltamethrin; Esf, fenvalerate/esfenvalerate; λ-Cyh, λ-cyhalothrin; cPer, tPer, cis- and trans- permethrin; Res, resmethrin).

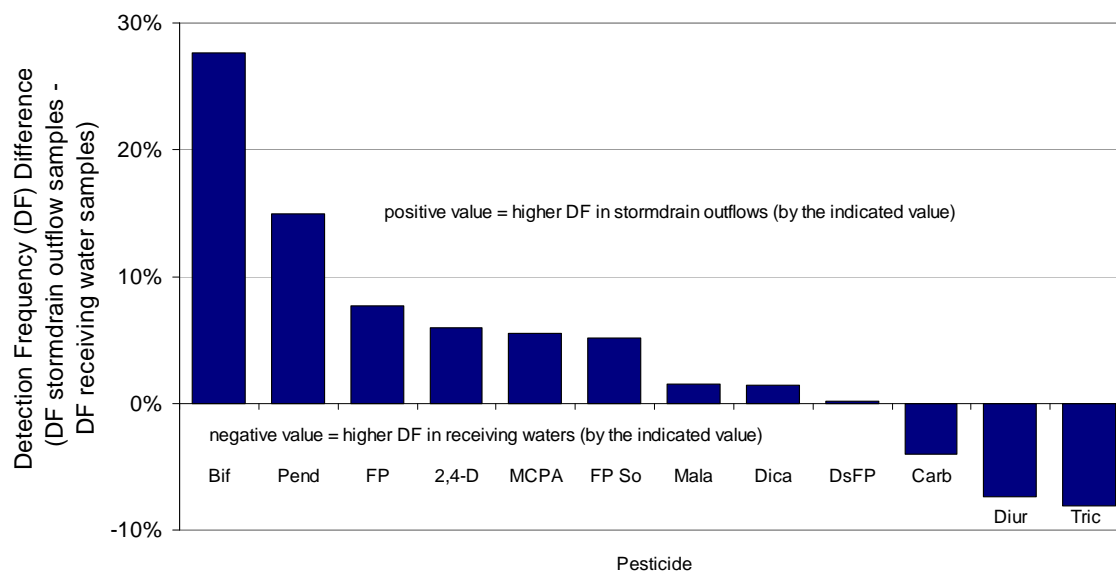


Figure 8. The influence of waterbody on frequency of pesticide detections. Detection Frequency (DF) differences were determined by subtracting the detection frequency of stormdrain outflow samples from the detection frequency of receiving water (DF receiving water – DF stormdrain outflow). Thus, a positive value on the y-axis (Detection Frequency Difference) indicates higher detection frequency in stormdrain outflows and a negative value indicates a higher detection frequency in receiving waters. Bif, bifenthrin; Pend, pendimethalin; FP, fipronil; FPSo, FP sulfone; Mala, malathion; Dica, dicamba; DsFP, desulfinyl FP; Carb, carbaryl; Diur, diuron; Tric, triclopyr. Only pesticides or degradates detected with a greater than 10% detection frequency during the entire study are included in the figure.

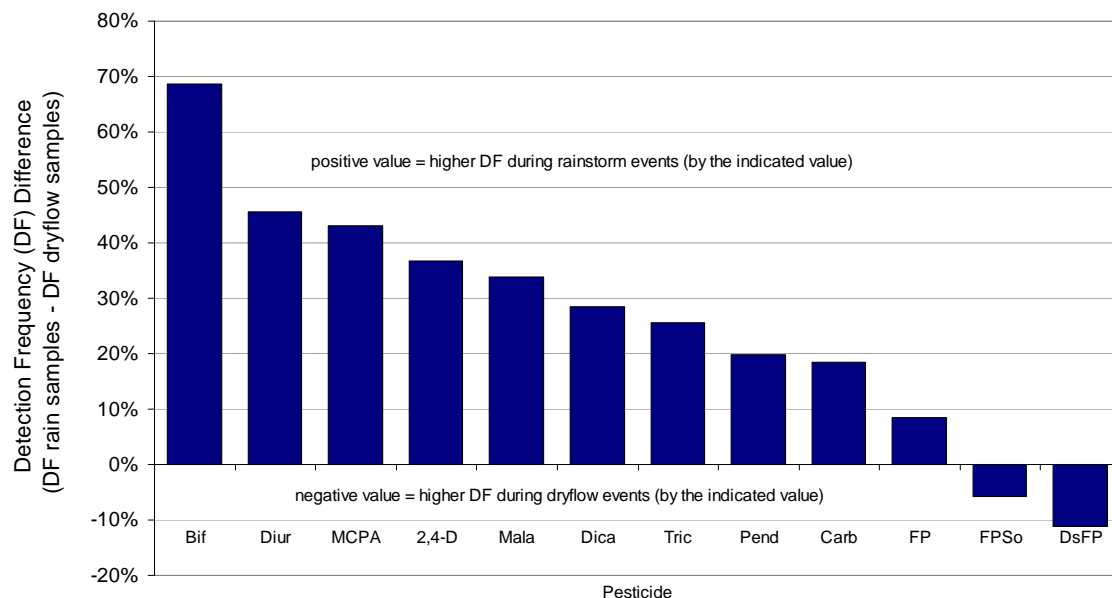


Figure 9. The influence of rain on frequency of pesticide detections. Detection Frequency (DF) differences were determined by subtracting the detection frequency of dryflow samples from the detection frequency of rainstorm samples (DF rainstorm – DF dryflow). Thus, a positive value on the y-axis (Detection Frequency Difference) indicates higher detection frequency during rainstorm sampling (by the indicated value) and a negative value indicates a higher detection frequency during dryflow sampling). Bif, bifenthrin; Diur, diuron; Mala, malathion; Dica, dicamba; Tric, triclopyr; Pend, pendimethalin; Carb; carbaryl; FP, fipronil; FPSO, FP sulfone; DsFP, desulfinyl FP. Only pesticides or degradates detected with a greater than 10% detection frequency during the entire study are included in the figure.

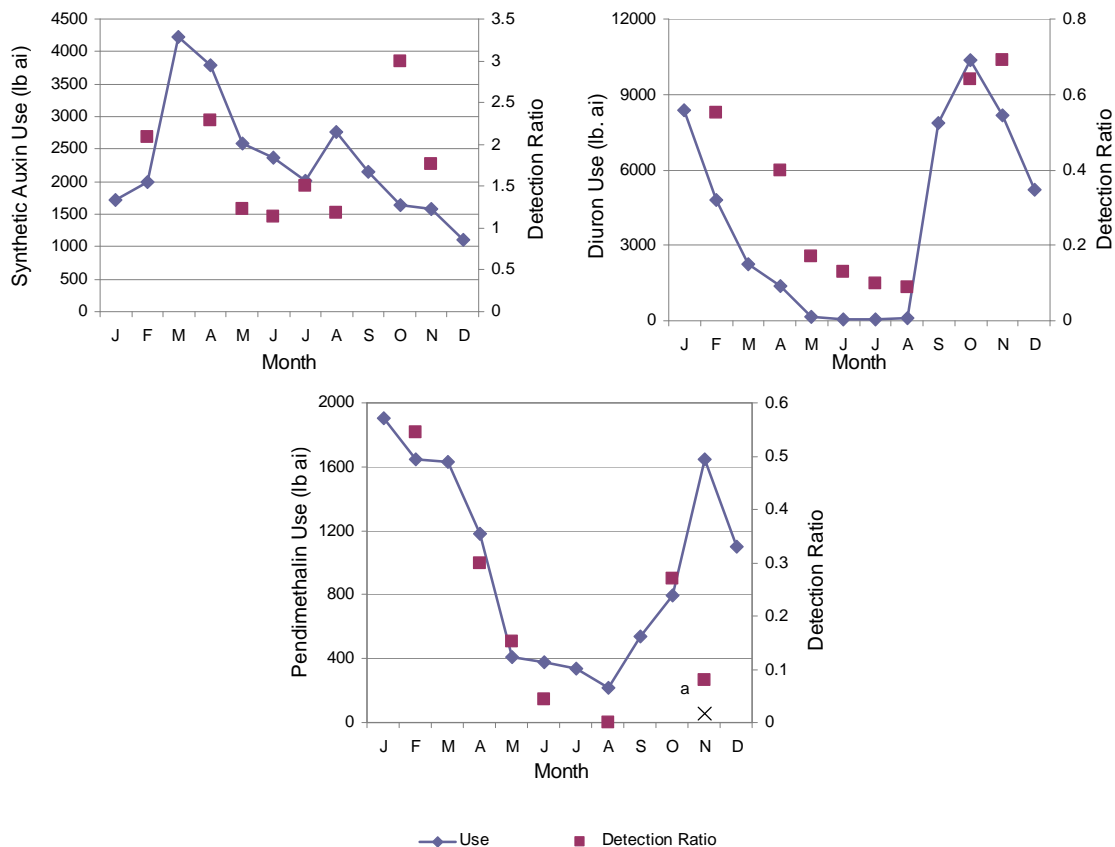


Figure 10. PUR reported use of diuron, pendimethalin, and synthetic auxin herbicides (2,4-D, dicamba, MCPA, and triclopyr) and their detection ratios. The detection ratio is the number of detections (greater than the reporting limit) per number of sampling events for that particular month. A detection frequency of 1.0 indicates that one pesticide was detected at one site. PUR use data was an average of 2008 – 2009 for the counties sampled, except: point a (pendimethalin), sampled only in southern California, x indicates actual use for the collected samples and this data was used in the correlation.

VI. APPENDIX I. DATA

Appendix I contains data for the urban study, April 2008 – August 2009. Abbreviations commonly used in the Appendix tables:

Abbreviation	Definition
FP	fipronil
mv	missing value, not data available or site not sampled
nd	not detected
ppm	parts per million (mg L^{-1})
RW	receiving water
StDr	storm drain outflow
tr	trace detection (below the reporting limit but above the minimum detection limit).

Table A1. Characteristics of the sampling sites in Study 249.

Watershed	Site Location	Site ID	Site Type	Urban Land Use	Approximate Area (Acres)	Approximate Residence Number	Datum: WGS84 (Decimal degrees)		City	County
							Longitude	Latitude		
Grayson Creek	Shadowood Park between Chilpancingo Parkway and 2nd Avenue South	GRY010	Storm Drain	Mixed residential and commercial	320	600	37.97967	-122.06878	Martinez/Pleasant Hill	Contra Costa
Grayson Creek	Blackwood Ave. and 2nd Ave South	GRY020	Storm Drain	Mixed residential and commercial	670	1200	37.98097	-122.06929	Martinez/Pleasant Hill	Contra Costa
Grayson Creek	Grayson Creek at Center Avenue	GRY030	Receiving Water	Mixed residential and commercial			37.983549	-122.0685	Martinez/Pleasant Hill	Contra Costa
Martin Canyon/Koopman Canyon Creek	Donohue Drive at Fire Station	MCC010	Storm Drain	Mostly residential	500	1300	37.70922	-121.93335	Dublin	Alameda
Martin Canyon/Koopman Canyon Creek	End of Millbrook Avenue	MCC020	Storm Drain	Mostly residential	225	650	37.71668	-121.93524	Dublin	Alameda
Martin Canyon/Koopman Canyon Creek	Dublin Blvd by Safeway and I-680	MCC030	Storm Drain	Mixed residential and commercial	290	450	37.70686	-121.92711	Dublin	Alameda
Martin Canyon/Koopman Canyon Creek	Dublin Blvd by Safeway and I-680	MCC040	Receiving Water	Mixed residential and commercial			37.706412	-121.92669	Dublin	Alameda
Pleasant Grove Creek	Dr. Paul J. Dugan Park on Diamond Woods Circle	PGC010	Storm Drain	Mostly residential	50	250	38.80477	-121.32733	Roseville	Placer

Table A1 continued.

Watershed	Site Location	Site ID	Site Type	Urban Land Use	Approximate Area (Acres)	Approximate Residence Number	Datum: WGS84 (Decimal degrees)		City	County
Pleasant Grove Creek	Opal and Parkside Way, righthand side of stream	PGC020	Storm Drain	Mostly residential	150	450	38.80232	-121.33855	Roseville	Placer
Pleasant Grove Creek	At Crocker Ranch Road	PGC030	Storm Drain	Mostly residential	85	300	38.79908	-121.34698	Roseville	Placer
Pleasant Grove Creek	At Veteran's Memorial Park	PGC040	Receiving Water	Mostly residential			38.79857	-121.34802	Roseville	Placer
Salt Creek	South neighborhood (contributing)	SC 1	Storm Drain	Mostly residential	96	460	33.50908	-117.6907	Laguna Nigel	Orange
Salt Creek	North neighborhood (contributing)	SC 3	Storm Drain	Mostly residential	120	245	33.51197	-117.6971	Laguna Nigel	Orange
Salt Creek	Below Niguel Road bridge	SC 5	Receiving Water	Mostly residential			33.50547	-117.709	Laguna Nigel	Orange
Wood Canyon	Above constructed wetland	WC 1	Storm Drain	Mostly residential	NA ¹	NA	33.58247	-117.7453	Aliso Viejo	Orange
Wood Canyon	Below constructed wetland	WC 2	Storm Drain	Mostly residential	194	283	33.58155	-117.7457	Aliso Viejo	Orange
Wood Canyon	South neighborhood (contributing)	WC 3	Storm Drain	Mostly residential	66	307	33.58158	-117.7457	Aliso Viejo	Orange
Wood Canyon	Receiving water below storm drains	AV01	Receiving Water	Mostly residential			33.58131	-117.74585	Aliso Viejo	Orange
San Diego River	At Fashion Valley Road	SDR101	Receiving Water	Mixed residential and commercial			32.76436	-117.1701	San Diego	San Diego
San Diego River	Above Fashion Valley Road	SDR102	Storm Drain	Mixed residential and commercial	NA	NA	32.76528	-117.16914	San Diego	San Diego
San Diego River	At Camino de la Reina	SDR103	Storm Drain	Commercial	NA	NA	32.76568	-117.16511	San Diego	San Diego
San Diego River	Camino de la Reina & Camino Del Arroyo	SDR104	Storm Drain	Mixed residential and commercial	NA	NA	32.76679	-117.15823	San Diego	San Diego

Table A1 continued.										
Watershed	Site Location	Site ID	Site Type	Urban Land Use	Approximate Area (Acres)	Approximate Residence Number	Datum: WGS84 (Decimal degrees)		City	County
Lindo Lake	At Lindo Lake	SDR151	Storm Drain	Mostly residential	NA	NA	32.85731	-116.9128	Lakeside	San Diego
Lindo Lake	At Lindo Lake	SDR156	Storm Drain	Mostly residential	NA	NA	32.85724	-116.91274	Lakeside	San Diego
Lindo Lake	At Lindo Lake	SDR158	Receiving Water	Mostly residential			32.85715	-116.91314	Lakeside	San Diego

¹Data not available

Table A2. Detections of insecticides in water samples from Sacramento area sampling sites. Concentrations are in $\mu\text{g L}^{-1}$ unless specified.

Sample Date	Site ID	Waterbody	Sampling Event	Carbaryl	Desulfinyl fipronil	Desulfinyl FP amide	Fipronil	Fipronil amide	Fipronil sulfide	Fipronil sulfone	Chlorpyrifos	Malathion	Bifenthrin (ng L^{-1})	Cyfluthrin (ng L^{-1})	Cypermethrin (ng L^{-1})	Permethrin cis (ng L^{-1})	Permethrin trans (ng L^{-1})
4/21/2008	PGC010	StDr	Dryflow	nd	tr	nd	tr	nd	nd	tr	nd	nd	mv	mv	mv	mv	mv
4/21/2008	PGC020	StDr	Dryflow	0.065	tr	nd	tr	nd	nd	tr	nd	tr	mv	mv	mv	mv	mv
4/21/2008	PGC030	StDr	Dryflow	nd	0.054	tr	0.064	tr	tr	0.118	nd	nd	mv	mv	mv	mv	mv
4/21/2008	PGC040	RW	Dryflow	nd	tr	tr	tr	tr	tr	0.078	nd	nd	mv	mv	mv	mv	mv
6/23/2008	PGC010	StDr	Dryflow	nd	tr	tr	tr	tr	tr	tr	nd	nd	mv	mv	mv	mv	mv
6/23/2008	PGC020	StDr	Dryflow	tr	tr	tr	0.164	tr	tr	tr	nd	nd	mv	mv	mv	mv	mv
6/23/2008	PGC030	StDr	Dryflow	nd	tr	nd	tr	nd	nd	tr	nd	nd	mv	mv	mv	mv	mv
6/23/2008	PGC040	RW	Dryflow	nd	tr	nd	tr	nd	nd	tr	nd	nd	mv	mv	mv	mv	mv
8/4/2008	PGC010	StDr	Dryflow	nd	tr	tr	tr	tr	tr	0.064	nd	nd	mv	mv	mv	mv	mv
8/4/2008	PGC020	StDr	Dryflow	nd	tr	tr	tr	tr	tr	tr	nd	nd	mv	mv	mv	mv	mv
8/4/2008	PGC030	StDr	Dryflow	nd	tr	tr	0.066	tr	tr	tr	nd	nd	mv	mv	mv	mv	mv
8/4/2008	PGC040	RW	Dryflow	nd	tr	tr	0.061	tr	tr	tr	nd	nd	mv	mv	mv	mv	mv
11/1/2008	PGC010	StDr	Rain	tr	tr	tr	0.107	tr	tr	0.059	nd	tr	mv	mv	mv	mv	mv
11/1/2008	PGC020	StDr	Rain	0.129	tr	tr	0.146	tr	tr	0.064	nd	0.357	mv	mv	mv	mv	mv
11/1/2008	PGC030	StDr	Rain	nd	tr	tr	0.064	tr	tr	tr	nd	tr	mv	mv	mv	mv	mv
11/1/2008	PGC040	RW	Rain	tr	tr	nd	tr	tr	tr	tr	nd	tr	mv	mv	mv	mv	mv
2/13/2009	PGC010	StDr	Rain	nd	tr	tr	0.057	tr	tr	tr	nd	tr	203	nd	18.9	nd	nd

Table A2 continued.

Sample Date	Site ID	Waterbody	Sampling Event	Carbaryl	Desulfinyl fipronil	Desulfinyl FP amide	Fipronil	Fipronil amide	Fipronil sulfide	Fipronil sulfone	Chlorpyrifos	Malathion	Bifenthrin (ng L ⁻¹)	Cyfluthrin (ng L ⁻¹)	Cypermethrin (ng L ⁻¹)	Permethrin cis (ng L ⁻¹)	Permethrin trans (ng L ⁻¹)
2/13/2009	PGC020	StDr	Rain	nd	tr	tr	0.118	tr	tr	0.058	nd	0.040	48.5	nd	nd	nd	nd
2/13/2009	PGC030	StDr	Rain	nd	tr	tr	0.067	tr	nd	tr	nd	nd	43.6	nd	nd	nd	nd
2/13/2009	PGC040	RW	Rain	nd	tr	nd	tr	nd	nd	tr	nd	nd	17	nd	nd	nd	nd
4/7/2009	PGC010	StDr	Rain	nd	tr	nd	tr	nd	nd	tr	nd	0.048	98.5	nd	nd	nd	nd
4/7/2009	PGC020	StDr	Rain	nd	tr	nd	tr	nd	nd	tr	nd	0.121	19.2	nd	nd	nd	nd
4/7/2009	PGC030	StDr	Rain	nd	tr	nd	tr	tr	nd	tr	nd	nd	46.7	nd	nd	nd	nd
4/7/2009	PGC040	RW	Rain	nd	tr	nd	tr	tr	nd	tr	nd	nd	7.74	nd	nd	nd	nd
4/13/2009	PGC010	StDr	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	25.7	nd	nd	nd	nd
4/13/2009	PGC020	StDr	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	8.58	nd	nd	nd	nd
4/13/2009	PGC030	StDr	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	20.8	18.9	nd	28.5	25.4
4/13/2009	PGC040	RW	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	nd	nd	nd	nd	nd
5/1/2009	PGC010	StDr	Rain	tr	tr	nd	tr	nd	nd	tr	nd	0.068	20.3	nd	15.1	nd	nd
5/1/2009	PGC020	StDr	Rain	nd	tr	nd	tr	nd	nd	tr	nd	0.064	14.5	nd	nd	nd	nd
5/1/2009	PGC030	StDr	Rain	nd	tr	nd	tr	tr	nd	tr	0.012	0.192	20.1	nd	nd	nd	nd
5/1/2009	PGC040	RW	Rain	tr	tr	nd	tr	nd	nd	tr	nd	0.040	8.87	nd	nd	nd	nd
8/27/2009	GRY010	StDr	Dryflow	nd	nd	nd	nd	tr	tr	tr	nd	nd	nd	nd	nd	nd	nd
8/27/2009	GRY020	StDr	Dryflow	nd	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd
8/27/2009	GRY030	RW	Dryflow	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
8/27/2009	MCC010	StDr	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	nd
8/27/2009	MCC020	StDr	Dryflow	nd	nd	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd
8/27/2009	MCC030	StDr	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	nd
8/27/2009	MCC040	RW	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	nd

Table A3. Detections of insecticides in water samples from San Francisco Bay area sampling sites. Concentrations are in $\mu\text{g L}^{-1}$ unless specified.

Sample Date	Site ID	Waterbody	Sampling Event	Carbaryl	Desulfinyl fipronil	Desulfinyl FP amide	Fipronil	Fipronil amide	Fipronil sulfide	Fipronil sulfone	Chlorpyrifos	Diazinon	Malathion	Bifenthrin (ng L^{-1})	Cypermethrin (ng L^{-1})	Permethrin cis (ng L^{-1})	Permethrin trans (ng L^{-1})
4/22/2008	GRY010	StDr	Dryflow	nd	nd	nd	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
4/22/2008	GRY020	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	mv	mv	mv	mv
4/22/2008	GRY030	RW	Dryflow	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	mv	mv	mv	mv
4/22/2008	MCC010	StDr	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	mv	mv	mv	mv
4/22/2008	MCC020	StDr	Dryflow	nd	nd	nd	nd	nd	nd	tr	nd	nd	nd	mv	mv	mv	mv
4/22/2008	MCC030	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	mv	mv	mv	mv
4/22/2008	MCC040	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	mv	mv	mv	mv
6/24/2008	GRY010	StDr	Dryflow	tr	nd	nd	tr	nd	tr	nd	nd	nd	nd	mv	mv	mv	mv
6/24/2008	GRY020	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	mv	mv	mv	mv
6/24/2008	GRY030	RW	Dryflow	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	mv	mv	mv	mv
6/24/2008	MCC010	StDr	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	mv	mv	mv	mv
6/24/2008	MCC020	StDr	Dryflow	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	mv	mv	mv	mv
6/24/2008	MCC030	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	mv	mv	mv	mv
6/24/2008	MCC040	RW	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	mv	mv	mv	mv
8/6/2008	GRY010	StDr	Dryflow	nd	tr	nd	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
8/6/2008	GRY020	StDr	Dryflow	nd	tr	nd	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
8/6/2008	GRY030	RW	Dryflow	nd	tr	nd	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
8/5/2008	MCC010	StDr	Dryflow	nd	tr	tr	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
8/5/2008	MCC020	StDr	Dryflow	nd	tr	tr	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
8/5/2008	MCC030	StDr	Dryflow	nd	tr	tr	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
8/5/2008	MCC040	RW	Dryflow	nd	tr	nd	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
11/1/2008	GRY010	StDr	Rain	nd	tr	nd	0.061	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
11/1/2008	GRY020	StDr	Rain	0.294	0.059	nd	0.458	tr	tr	0.085	nd	nd	nd	mv	mv	mv	mv
11/1/2008	GRY030	RW	Rain	0.28	tr	nd	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
11/1/2008	MCC010	StDr	Rain	nd	tr	nd	0.05	tr	tr	tr	nd	nd	0.075	mv	mv	mv	mv
11/1/2008	MCC020	StDr	Rain	nd	tr	nd	tr	tr	tr	tr	nd	nd	tr	mv	mv	mv	mv
11/1/2008	MCC030	StDr	Rain	tr	tr	nd	0.078	tr	tr	tr	nd	nd	tr	mv	mv	mv	mv
11/1/2008	MCC040	RW	Rain	nd	tr	nd	tr	tr	tr	tr	nd	nd	nd	mv	mv	mv	mv
2/15/2009	GRY010	StDr	Rain	nd	tr	nd	tr	tr	tr	tr	0.0104	nd	nd	16.2	nd	nd	nd
2/15/2009	GRY020	StDr	Rain	nd	tr	nd	tr	tr	tr	tr	nd	0.0547	nd	32.6	nd	nd	15.5
2/15/2009	GRY030	RW	Rain	nd	tr	nd	tr	tr	nd	tr	0.0228	0.0388	nd	23.4	nd	nd	nd
2/15/2009	MCC010	StDr	Rain	nd	tr	nd	tr	tr	nd	tr	0.014	0.0414	nd	19.7	nd	nd	nd

Table A3 continued.

Sample Date	Site ID	Waterbody	Sampling Event	Carbaryl	Desulfinyl fipronil	Desulfinyl FP amide	Fipronil	Fipronil amide	Fipronil sulfide	Fipronil sulfone	Chlorpyrifos	Diazinon	Malathion	Bifenthrin (ng L ⁻¹)	Cypermethrin (ng L ⁻¹)	Permethrin cis (ng L ⁻¹)	Permethrin trans (ng L ⁻¹)
2/15/2009	MCC020	StDr	Rain	nd	tr	tr	tr	tr	nd	tr	0.0229	0.0432	nd	13.7	nd	nd	nd
2/15/2009	MCC030	StDr	Rain	nd	tr	nd	tr	nd	nd	tr	0.0539	0.0458	nd	27.2	nd	16.1	23.9
2/15/2009	MCC040	RW	Rain	nd	tr	nd	tr	nd	nd	tr	0.0507	nd	nd	27.2	nd	16.1	23.9
4/7/2009	GRY010	StDr	Rain	nd	tr	nd	tr	tr	nd	tr	nd	nd	0.079	8.02	nd	nd	nd
4/7/2009	GRY020	StDr	Rain	nd	tr	nd	tr	tr	nd	tr	nd	nd	0.06	6.6	nd	nd	nd
4/7/2009	GRY030	RW	Rain	0.094	tr	nd	tr	tr	nd	tr	nd	nd	0.055	20	nd	nd	nd
4/14/2009	GRY010	StDr	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	nd	nd	nd	nd
4/14/2009	GRY020	StDr	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	nd	nd	nd	nd
4/14/2009	GRY030	RW	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	nd	nd	nd	nd
4/14/2009	MCC010	StDr	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	nd	nd	nd	nd
4/14/2009	MCC020	StDr	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	nd	nd	nd	nd
4/14/2009	MCC030	StDr	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	nd	nd	nd	nd
4/14/2009	MCC040	RW	Dryflow	mv	mv	mv	mv	mv	mv	mv	mv	mv	mv	nd	nd	nd	nd
5/1/2009	GRY010	StDr	Rain	tr	tr	nd	0.067	tr	tr	tr	nd	nd	nd	nd	nd	nd	nd
5/1/2009	GRY020	StDr	Rain	0.069	tr	nd	tr	tr	tr	tr	nd	nd	nd	9.2	nd	nd	nd
5/1/2009	GRY030	RW	Rain	0.187	tr	nd	tr	nd	nd	tr	nd	nd	tr	8.4	nd	nd	nd
5/1/2009	MCC010	StDr	Rain	tr	tr	nd	tr	nd	nd	tr	nd	nd	tr	5.89	nd	nd	nd
5/1/2009	MCC020	StDr	Rain	tr	tr	nd	tr	nd	nd	tr	nd	nd	nd	13.9	nd	nd	nd
5/1/2009	MCC030	StDr	Rain	0.119	tr	nd	tr	nd	nd	tr	nd	nd	nd	5.47	nd	nd	nd
5/1/2009	MCC040	RW	Rain	0.369	tr	nd	tr	nd	nd	tr	nd	nd	tr	5.25	nd	nd	nd
8/27/2009	GRY010	StDr	Dryflow	nd	nd	nd	nd	tr	tr	tr	nd	nd	nd	nd	nd	nd	nd
8/27/2009	GRY020	StDr	Dryflow	nd	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd
8/27/2009	GRY030	RW	Dryflow	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
8/27/2009	MCC010	StDr	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	nd
8/27/2009	MCC020	StDr	Dryflow	nd	nd	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd
8/27/2009	MCC030	StDr	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd	nd	nd
8/27/2009	MCC040	RW	Dryflow	nd	nd	nd	nd	tr	nd	nd	nd	0.0105	nd	nd	nd	nd	nd

Table A4. Detections of insecticides in water samples from Orange County area sampling sites. Concentrations are in $\mu\text{g L}^{-1}$ unless specified.

Sample Date	Site ID	Waterbody	Sampling Event	Carbaryl	Oxamyl	Desulfinyl fipronil	Desulfinyl FP amide	Fipronil	Fipronil amide	Fipronil sulfide	Fipronil sulfone	Diazinon	Malathion	Bifenthrin (ng L^{-1})	Fenvalerate/esfenvalerate (ng L^{-1})	Lambda-cyhalothrin (ng L^{-1})	Permethrin cis (ng L^{-1})	Permethrin trans (ng L^{-1})
4/8/2008	AV01	RW	Dryflow	0.159	nd	0.060	tr	0.232	tr	tr	0.107	nd	nd	mv	mv	mv	mv	mv
4/8/2008	SC1	StDr	Dryflow	0.078	nd	tr	tr	tr	tr	tr	0.051	nd	nd	mv	mv	mv	mv	mv
4/8/2008	SC3	StDr	Dryflow	tr	0.112	tr	tr	tr	tr	tr	0.068	nd	nd	mv	mv	mv	mv	mv
4/8/2008	SC5	RW	Dryflow	nd	nd	tr	tr	0.052	tr	tr	0.060	nd	nd	mv	mv	mv	mv	mv
4/8/2008	WC1	StDr	Dryflow	nd	nd	tr	tr	tr	tr	tr	tr	nd	nd	mv	mv	mv	mv	mv
4/8/2008	WC2	StDr	Dryflow	0.197	nd	tr	tr	0.140	tr	tr	0.092	nd	nd	mv	mv	mv	mv	mv
4/8/2008	WC3	StDr	Dryflow	nd	nd	0.118	0.072	0.359	0.145	tr	0.187	nd	nd	mv	mv	mv	mv	mv
5/13/2008	AV01	RW	Dryflow	0.091	nd	0.053	tr	0.099	tr	tr	0.064	nd	nd	mv	mv	mv	mv	mv
5/13/2008	SC1	StDr	Dryflow	nd	nd	tr	tr	tr	tr	tr	tr	nd	tr	mv	mv	mv	mv	mv
5/13/2008	SC3	StDr	Dryflow	nd	nd	0.126	tr	0.391	tr	tr	0.110	nd	tr	mv	mv	mv	mv	mv
5/13/2008	SC5	RW	Dryflow	tr	nd	tr	tr	tr	tr	tr	tr	nd	nd	mv	mv	mv	mv	mv
5/13/2008	WC1	StDr	Dryflow	0.682	nd	tr	tr	tr	tr	tr	0.053	nd	nd	mv	mv	mv	mv	mv
5/13/2008	WC2	StDr	Dryflow	0.086	nd	0.056	tr	0.106	tr	tr	0.066	nd	nd	mv	mv	mv	mv	mv
5/13/2008	WC3	StDr	Dryflow	0.130	nd	0.056	0.062	0.094	0.101	tr	0.104	nd	0.057	mv	mv	mv	mv	mv
6/13/2008	SC1	StDr	Dryflow	0.108	nd	tr	tr	0.076	0.051	tr	0.070	nd	tr	mv	mv	mv	mv	mv
6/13/2008	SC3	StDr	Dryflow	nd	nd	0.167	tr	0.175	nd	tr	0.140	nd	nd	mv	mv	mv	mv	mv
6/13/2008	SC5	RW	Dryflow	nd	nd	tr	tr	0.062	tr	tr	0.056	nd	0.232	mv	mv	mv	mv	mv
6/14/2008	AV01	RW	Dryflow	0.111	nd	0.061	tr	0.063	tr	tr	0.082	nd	nd	mv	mv	mv	mv	mv
6/14/2008	WC1	StDr	Dryflow	nd	nd	0.111	tr	0.179	tr	tr	0.080	nd	tr	mv	mv	mv	mv	mv
6/14/2008	WC2	StDr	Dryflow	0.161	nd	tr	tr	0.059	tr	tr	0.060	nd	nd	mv	mv	mv	mv	mv
6/14/2008	WC3	StDr	Dryflow	nd	nd	0.093	0.078	0.064	0.113	tr	0.171	nd	nd	mv	mv	mv	mv	mv
11/26/2008	AV01	RW	Rain	0.109	nd	0.085	0.058	0.164	0.088	tr	0.141	nd	tr	mv	mv	mv	mv	mv
11/26/2008	SC1	StDr	Rain	0.088	nd	tr	tr	0.103	tr	tr	0.076	nd	0.109	mv	mv	mv	mv	mv
11/26/2008	SC3	StDr	Rain	0.057	nd	0.050	tr	0.148	tr	tr	0.061	nd	0.168	mv	mv	mv	mv	mv
11/26/2008	SC5	RW	Rain	0.129	nd	0.059	tr	0.120	tr	tr	0.077	0.064	0.119	mv	mv	mv	mv	mv
11/26/2008	WC2	StDr	Rain	tr	nd	tr	tr	0.076	tr	tr	0.091	nd	tr	mv	mv	mv	mv	mv
11/26/2008	WC3	StDr	Rain	0.180	nd	0.093	tr	0.196	0.064	tr	0.160	nd	nd	mv	mv	mv	mv	mv
5/5/2009	AV01	RW	Dryflow	nd	nd	0.053	tr	0.072	tr	tr	tr	nd	nd	nd	nd	nd	nd	nd
5/5/2009	SC1	StDr	Dryflow	nd	nd	0.069	tr	0.085	tr	tr	0.064	nd	nd	nd	nd	nd	nd	nd
5/5/2009	SC3	StDr	Dryflow	nd	nd	0.129	tr	0.099	tr	tr	0.077	nd	nd	26.4	27.8	17.9	25.9	37.7
5/5/2009	SC5	RW	Dryflow	tr	nd	tr	tr	tr	tr	tr	tr	nd	tr	nd	nd	nd	nd	nd
5/5/2009	WC1	StDr	Dryflow	nd	nd	tr	tr	tr	tr	tr	tr	nd	nd	12.3	nd	nd	nd	nd
5/5/2009	WC2	StDr	Dryflow	nd	nd	0.051	tr	tr	tr	tr	tr	nd	nd	nd	nd	nd	nd	nd

Table A4 continued.

Sample Date	Site ID	Waterbody	Sampling Event	Carbaryl	Oxamyl	Desulfinyl fipronil	Desulfinyl FP amide	Fipronil	Fipronil amide	Fipronil sulfide	Fipronil sulfone	Diazinon	Malathion	Bifenthrin (ng L ⁻¹)	Fenvalerate/ esfenvalerate (ng L ⁻¹)	Lambda-cyhalothrin (ng L ⁻¹)	Permethrin cis (ng L ⁻¹)	Permethrin trans (ng L ⁻¹)
5/5/2009	WC3	StDr	Dryflow	nd	nd	0.061	tr	0.464	tr	tr	0.069	0.015	nd	5.18	nd	nd	nd	nd
8/1/2009	SC1	StDr	Dryflow	nd	nd	tr	tr	tr	tr	tr	tr	nd	nd	nd	nd	nd	nd	nd
8/1/2009	SC3	StDr	Dryflow	nd	nd	0.144	0.063	0.518	tr	tr	0.244	0.029	tr	23.7	nd	nd	21.7	25.9
8/1/2009	SC5	RW	Dryflow	nd	nd	0.064	tr	0.132	tr	tr	0.072	nd	nd	nd	nd	nd	nd	nd
8/1/2009	WC2	StDr	Dryflow	tr	nd	0.061	tr	0.126	tr	tr	0.07	nd	nd	nd	nd	nd	nd	nd
8/1/2009	WC3	StDr	Dryflow	nd	nd	0.102	tr	2.11	0.094	0.057	0.546	nd	nd	11.7	nd	nd	15.5	nd

Table A5. Detections of insecticides in water samples from San Diego area sampling sites. Concentrations are in $\mu\text{g L}^{-1}$.

Sample Date	Site ID	Waterbody	Sampling Event	Carbaryl	Desulfinyl fipronil	Desulfinyl fipronil amide	Fipronil	Fipronil amide	Fipronil sulfide	Fipronil sulfone	Diazinon	Malathion
4/7/2008	SDR101	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
4/7/2008	SDR102	StDr	Dryflow	0.05	nd	nd	nd	nd	nd	nd	nd	nd
4/7/2008	SDR151	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
4/7/2008	SDR156	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
4/7/2008	SDR158	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR101	RW	Dryflow	nd	tr	nd	nd	nd	nd	tr	nd	nd
5/12/2008	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR151	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR156	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR158	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR159C	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
6/12/2008	SDR151	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
6/12/2008	SDR156	StDr	Dryflow	nd	tr	nd	nd	nd	nd	nd	nd	nd
6/12/2008	SDR158	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
6/13/2008	SDR101	RW	Dryflow	nd	tr	nd	nd	nd	nd	tr	nd	nd
6/13/2008	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/26/2008	SDR101	RW	Rain	tr	tr	tr	tr	tr	nd	tr	nd	0.058
11/26/2008	SDR102	StDr	Rain	nd	tr	nd	tr	tr	nd	tr	nd	nd
11/26/2008	SDR103	StDr	Rain	nd	tr	nd	nd	nd	nd	nd	nd	nd
11/26/2008	SDR104	StDr	Rain	nd	tr	tr	tr	tr	nd	tr	nd	nd
11/26/2008	SDR151	StDr	Rain	0.066	tr	tr	0.053	tr	tr	0.071	nd	0.157
11/26/2008	SDR156	StDr	Rain	0.055	tr	tr	tr	tr	tr	tr	nd	0.248
11/26/2008	SDR158	RW	Rain	0.066	tr	tr	0.058	tr	tr	0.079	nd	0.154
5/6/2009	SDR101	RW	Dryflow	nd	tr	nd	nd	nd	nd	tr	0.0146	nd
5/6/2009	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/6/2009	SDR156	StDr	Dryflow	nd	tr	nd	nd	tr	nd	tr	nd	nd
5/6/2009	SDR158	RW	Dryflow	nd	tr	nd	nd	nd	nd	tr	nd	nd
8/1/2009	SDR101	RW	Dryflow	nd	tr	nd	nd	nd	nd	nd	nd	nd
8/1/2009	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd
8/1/2009	SDR156	StDr	Dryflow	nd	tr	nd	tr	nd	nd	tr	nd	nd
8/1/2009	SDR158	RW	Dryflow	nd	tr	nd	nd	nd	nd	nd	nd	nd

Table A6. Detections of herbicides in water samples from Sacramento area sampling sites. Concentrations are in $\mu\text{g L}^{-1}$.

Sample Date	Site ID	Waterbody	Sampling Event	2,4-D	Dicamba	Diuron	MCPA	Oryzalin	Oxyfluorfen	Pendimethalin	Prodiamine	Prometon	Triclopyr
4/21/2008	PGC010	StDr	Dryflow	1.29	0.25	nd	tr	nd	nd	0.232	0.053	nd	nd
4/21/2008	PGC020	StDr	Dryflow	2.51	0.73	tr	0.101	nd	nd	0.067	nd	nd	nd
4/21/2008	PGC030	StDr	Dryflow	2.4	tr	nd	nd	nd	nd	0.396	tr	nd	0.324
4/21/2008	PGC040	RW	Dryflow	0.48	0.071	nd	tr	nd	nd	tr	nd	tr	0.1
5/27/2008	PGC010	StDr	Dryflow	11.475	0.296	nd	0.059	nd	nd	0.051	tr	0.234	nd
5/27/2008	PGC020	StDr	Dryflow	8.22	3.07	tr	13.59	nd	nd	0.07	tr	nd	1.484
5/27/2008	PGC030	StDr	Dryflow	1.494	tr	nd	nd	nd	nd	0.05	tr	nd	0.286
5/27/2008	PGC040	RW	Dryflow	0.747	0.069	nd	nd	nd	nd	nd	nd	tr	0.275
6/23/2008	PGC010	StDr	Dryflow	0.3	tr	nd	nd	nd	nd	tr	tr	tr	nd
6/23/2008	PGC020	StDr	Dryflow	3.622	0.114	nd	nd	nd	nd	nd	tr	nd	nd
6/23/2008	PGC030	StDr	Dryflow	0.079	nd	nd	nd	nd	nd	0.349	nd	nd	nd
6/23/2008	PGC040	RW	Dryflow	1.228	nd	nd	nd	nd	nd	nd	nd	nd	tr
11/1/2008	PGC010	StDr	Rain	0.209	0.186	tr	0.061	nd	nd	tr	tr	1.6	tr
11/1/2008	PGC020	StDr	Rain	0.697	0.069	tr	tr	tr	nd	nd	tr	tr	0.061
11/1/2008	PGC030	StDr	Rain	0.221	0.058	nd	tr	nd	nd	nd	0.085	nd	0.242
11/1/2008	PGC040	RW	Rain	0.214	tr	tr	0.086	nd	nd	nd	nd	nd	0.233
2/13/2009	PGC010	StDr	Rain	3.51	tr	0.214	tr	tr	nd	0.051	0.06	nd	tr
2/13/2009	PGC020	StDr	Rain	2.01	0.401	tr	1.05	1.04	nd	0.094	0.096	nd	0.415
2/13/2009	PGC030	StDr	Rain	0.147	0.096	tr	0.175	0.151	nd	tr	0.062	nd	nd
2/13/2009	PGC040	RW	Rain	tr	nd	0.429	nd	0.194	nd	tr	tr	nd	nd
4/7/2009	PGC010	StDr	Rain	10.4	0.947	tr	3.3	tr	nd	0.163	nd	nd	0.838
4/7/2009	PGC020	StDr	Rain	1.27	0.135	17.6	0.268	tr	nd	0.161	tr	nd	0.106
4/7/2009	PGC030	StDr	Rain	3.46	0.189	0.134	nd	tr	nd	0.096	tr	nd	tr
4/7/2009	PGC040	RW	Rain	1.02	0.085	6.76	0.141	tr	nd	tr	nd	nd	tr
5/1/2009	PGC010	StDr	Rain	0.429	0.079	nd	0.082	nd	nd	0.067	nd	0.268	nd
5/1/2009	PGC020	StDr	Rain	0.37	0.167	0.921	0.103	tr	nd	0.064	nd	nd	0.084
5/1/2009	PGC030	StDr	Rain	0.196	0.355	tr	0.44	tr	nd	0.084	nd	nd	0.137

Table A6 continued.

Sample Date	Site ID	Waterbody	Sampling Event	2,4-D	Dicamba	Diuron	MCPA	Oryzalin	Oxyfluorfen	Pendimethalin	Prodiamine	Prometon	Triclopyr
5/1/2009	PGC040	RW	Rain	0.479	0.114	0.135	0.266	tr	tr	nd	nd	nd	0.085
8/28/2009	PGC010	StDr	Dryflow	0.164	0.118	nd	nd	mv	mv	mv	mv	nd	nd
8/28/2009	PGC020	StDr	Dryflow	0.127	0.075	tr	nd	mv	mv	mv	mv	nd	0.136
8/28/2009	PGC030	StDr	Dryflow	0.162	0.07	nd	nd	mv	mv	mv	mv	nd	nd
8/28/2009	PGC040	RW	Dryflow	nd	0.543	nd	nd	mv	mv	mv	mv	nd	nd

Table A7. Detections of herbicides in water samples from San Francisco Bay area sampling sites. Concentrations are in $\mu\text{g L}^{-1}$.

Sample Date	Site ID	Waterbody	Sampling Event	2,4-D	ACET	Dicamba	Diuron	MCPA	Oryzalin	Oxyfluorfen	Pendimethalin	Prodiamine	Prometon	Triclopyr
4/22/2008	GRY010	StDr	Dryflow	nd	nd	nd	tr	nd	nd	nd	tr	nd	nd	tr
4/22/2008	GRY020	StDr	Dryflow	nd	nd	nd	0.11	nd	nd	nd	nd	nd	nd	0.126
4/22/2008	GRY030	RW	Dryflow	0.163	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.35
4/22/2008	MCC010	StDr	Dryflow	0.905	nd	tr	0.088	nd	nd	nd	nd	nd	nd	0.06
4/22/2008	MCC020	StDr	Dryflow	0.101	nd	nd	0.477	nd	nd	nd	nd	nd	nd	nd
4/22/2008	MCC030	StDr	Dryflow	nd	nd	nd	tr	nd	nd	nd	nd	nd	nd	nd
4/22/2008	MCC040	RW	Dryflow	10.1	nd	0.544	1.7	nd	nd	nd	nd	nd	nd	nd
5/28/2008	GRY010	StDr	Dryflow	0.069	nd	nd	tr	nd	nd	nd	nd	nd	nd	0.119
5/28/2008	GRY020	StDr	Dryflow	0.069	nd	nd	tr	nd	nd	nd	nd	nd	nd	0.119
5/28/2008	GRY030	RW	Dryflow	0.073	nd	tr	nd	tr	nd	nd	nd	nd	nd	1.075
5/28/2008	MCC010	StDr	Dryflow	0.052	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/28/2008	MCC020	StDr	Dryflow	0.047	nd	nd	0.072	nd	nd	nd	nd	nd	nd	tr
5/28/2008	MCC030	StDr	Dryflow	tr	nd	nd	tr	0.063	nd	nd	nd	nd	nd	tr
5/28/2008	MCC040	RW	Dryflow	nd	nd	nd	3	0.071	nd	nd	nd	nd	nd	tr
6/24/2008	GRY010	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	tr
6/24/2008	GRY020	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.124
6/24/2008	GRY030	RW	Dryflow	0.284	nd	nd	tr	nd	nd	nd	nd	nd	nd	0.325
6/24/2008	MCC010	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
6/24/2008	MCC020	StDr	Dryflow	0.142	nd	tr	0.148	nd	nd	nd	nd	nd	nd	nd

Table A7 continued.

Sample Date	Site ID	Waterbody	Sampling Event	2,4-D	ACET	Dicamba	Diuron	MCPA	Oryalin	Oxyfluorfen	Pendimethalin	Prodiamine	Prometon	Triclopyr
6/24/2008	MCC030	StDr	Dryflow	tr	nd	nd	0.233	nd	nd	nd	nd	nd	nd	nd
6/24/2008	MCC040	RW	Dryflow	tr	nd	nd	2.68	tr	nd	nd	nd	nd	nd	nd
11/1/2008	GRY010	StDr	Rain	0.093	nd	nd	0.391	nd	nd	nd	0.115	tr	nd	0.255
11/1/2008	GRY020	StDr	Rain	0.209	nd	0.096	0.414	0.207	nd	nd	0.05	tr	nd	0.228
11/1/2008	GRY030	RW	Rain	0.408	nd	0.064	0.169	0.127	0.116	nd	0.057	tr	nd	6.746
11/1/2008	MCC010	StDr	Rain	0.186	nd	tr	0.054	0.157	0.077	nd	nd	nd	nd	0.115
11/1/2008	MCC020	StDr	Rain	0.613	nd	tr	3.9	0.088	nd	nd	nd	tr	0.133	tr
11/1/2008	MCC030	StDr	Rain	0.103	nd	nd	0.306	0.098	tr	nd	tr	nd	1.6	0.173
11/1/2008	MCC040	RW	Rain	0.173	nd	tr	6.82	0.151	nd	0.07	tr	nd	nd	0.12
2/15/2009	GRY010	StDr	Rain	tr	nd	nd	tr	nd	tr	nd	tr	0.09	nd	nd
2/15/2009	GRY020	StDr	Rain	tr	nd	nd	0.445	nd	tr	nd	1.02	0.061	nd	nd
2/15/2009	GRY030	RW	Rain	0.118	nd	tr	0.26	tr	0.096	nd	0.073	0.142	nd	0.347
2/15/2009	MCC010	StDr	Rain	1.107	nd	tr	tr	0.167	0.129	nd	nd	nd	nd	0.2
2/15/2009	MCC020	StDr	Rain	0.461	nd	0.111	0.209	0.052	tr	nd	nd	nd	nd	0.076
2/15/2009	MCC030	StDr	Rain	0.121	nd	tr	tr	0.082	0.11	nd	0.604	nd	nd	0.137
2/15/2009	MCC040	RW	Rain	0.28	nd	tr	0.709	0.077	nd	nd	0.651	nd	nd	0.11
4/7/2009	GRY010	StDr	Rain	0.102	nd	0.054	nd	nd	0.06	nd	nd	tr	nd	0.322
4/7/2009	GRY020	StDr	Rain	0.251	nd	0.065	0.162	nd	nd	0.052	nd	0.052	nd	0.073
4/7/2009	GRY030	RW	Rain	0.423	nd	0.102	0.104	0.143	0.41	nd	0.675	0.056	tr	0.254
5/1/2009	GRY010	StDr	Rain	0.094	0.086	tr	nd	nd	nd	nd	nd	nd	nd	0.099
5/1/2009	GRY020	StDr	Rain	0.439	nd	0.101	tr	0.275	nd	nd	tr	nd	nd	0.153
5/1/2009	GRY030	RW	Rain	0.131	nd	tr	tr	nd	nd	nd	tr	tr	nd	0.179
5/1/2009	MCC010	StDr	Rain	0.339	nd	0.063	tr	0.079	tr	nd	nd	nd	tr	0.205
5/1/2009	MCC020	StDr	Rain	0.524	nd	0.05	27.6	0.212	nd	nd	nd	nd	nd	0.254
5/1/2009	MCC030	StDr	Rain	0.141	nd	tr	0.377	nd	nd	nd	tr	nd	nd	0.08
5/1/2009	MCC040	RW	Rain	0.275	nd	0.055	10.9	0.122	tr	nd	tr	nd	nd	0.207
8/27/2009	GRY010	StDr	Dryflow	nd	nd	nd	nd	nd	mv	mv	mv	mv	nd	0.054
8/27/2009	GRY020	StDr	Dryflow	tr	nd	nd	nd	nd	mv	mv	mv	mv	nd	0.172
8/27/2009	GRY030	RW	Dryflow	nd	nd	nd	nd	nd	mv	mv	mv	mv	nd	0.096
8/27/2009	MCC010	StDr	Dryflow	nd	nd	nd	nd	nd	mv	mv	mv	mv	nd	0.053
8/27/2009	MCC020	StDr	Dryflow	0.075	nd	nd	nd	nd	mv	mv	mv	mv	nd	nd
8/27/2009	MCC030	StDr	Dryflow	nd	nd	nd	nd	nd	mv	mv	mv	mv	nd	nd
8/27/2009	MCC040	RW	Dryflow	nd	nd	nd	1.49	nd	mv	mv	mv	mv	nd	nd

Table A8. Detections of herbicides in water samples from Orange County sampling sites. Concentrations are in $\mu\text{g L}^{-1}$.

Sample Date	Site ID	Waterbody	Sampling Event	2,4-D	Dicamba	Diuron	MCPA	Oxyfluorfen	Pendimethalin	Proflaminate	Prometon	Simazine	Triclopyr
4/8/2008	AV01	RW	Dryflow	0.39	nd	0.054	nd	nd	tr	nd	nd	0.058	0.11
4/8/2008	SC1	StDr	Dryflow	0.052	nd	tr	nd	nd	nd	nd	nd	0.057	0.11
4/8/2008	SC3	StDr	Dryflow	0.144	0.06	0.099	nd	tr	0.138	nd	nd	0.095	0.143
4/8/2008	SC5	RW	Dryflow	0.151	nd	tr	nd	nd	nd	tr	nd	0.06	0.387
4/8/2008	WC1	StDr	Dryflow	0.096	nd	tr	nd	nd	tr	nd	nd	tr	nd
4/8/2008	WC2	StDr	Dryflow	0.573	nd	0.051	nd	nd	tr	nd	nd	tr	0.149
4/8/2008	WC3	StDr	Dryflow	0.136	nd	tr	nd	nd	0.077	nd	nd	tr	0.115
5/13/2008	AV01	RW	Dryflow	nd	0.056	tr	nd	nd	tr	nd	nd	tr	0.138
5/13/2008	SC1	StDr	Dryflow	nd	tr	tr	nd	nd	nd	nd	nd	tr	0.462
5/13/2008	SC3	StDr	Dryflow	nd	tr	0.05	nd	nd	tr	nd	nd	tr	0.509
5/13/2008	SC5	RW	Dryflow	nd	0.117	nd	nd	nd	nd	nd	tr	tr	0.23
5/13/2008	WC1	StDr	Dryflow	nd	nd	tr	nd	nd	tr	nd	nd	tr	tr
5/13/2008	WC2	StDr	Dryflow	nd	nd	tr	nd	nd	nd	nd	nd	tr	0.073
5/13/2008	WC3	StDr	Dryflow	nd	nd	tr	nd	nd	nd	nd	nd	tr	0.061
6/13/2008	SC1	StDr	Dryflow	0.256	nd	tr	nd	nd	nd	nd	nd	tr	0.626
6/13/2008	SC3	StDr	Dryflow	0.058	nd	nd	nd	nd	nd	nd	nd	nd	nd
6/13/2008	SC5	RW	Dryflow	0.1	0.062	nd	nd	nd	nd	nd	nd	tr	0.152
6/14/2008	AV01	RW	Dryflow	0.152	nd	tr	nd	nd	nd	nd	nd	tr	0.265
6/14/2008	WC1	StDr	Dryflow	0.711	0.169	tr	0.482	nd	nd	nd	nd	tr	0.21
6/14/2008	WC2	StDr	Dryflow	0.276	tr	tr	nd	nd	nd	nd	nd	tr	0.208
6/14/2008	WC3	StDr	Dryflow	0.409	0.17	tr	nd	nd	nd	nd	nd	tr	0.297
11/26/2008	AV01	RW	Rain	0.1657	0.054	0.22	nd	nd	nd	nd	nd	nd	0.13
11/26/2008	SC1	StDr	Rain	0.547	tr	0.271	nd	nd	nd	tr	nd	nd	0.152
11/26/2008	SC3	StDr	Rain	0.111	nd	0.132	nd	nd	0.215	nd	nd	nd	0.299
11/26/2008	SC5	RW	Rain	0.204	nd	0.228	tr	nd	nd	nd	nd	nd	0.103
11/26/2008	WC2	StDr	Rain	1.571	0.369	tr	tr	nd	nd	nd	nd	nd	0.127
11/26/2008	WC3	StDr	Rain	0.191	tr	0.273	nd	nd	tr	nd	nd	nd	0.088
5/5/2009	AV01	RW	Dryflow	0.182	nd	nd	nd	nd	tr	nd	nd	nd	0.125
5/5/2009	SC1	StDr	Dryflow	0.57	0.314	nd	nd	nd	nd	tr	nd	nd	0.056
5/5/2009	SC3	StDr	Dryflow	0.969	nd	nd	nd	nd	nd	nd	nd	nd	0.086
5/5/2009	SC5	RW	Dryflow	0.406	tr	nd	nd	nd	nd	tr	nd	nd	0.073
5/5/2009	WC1	StDr	Dryflow	tr	nd	tr	nd	nd	nd	nd	nd	nd	tr
5/5/2009	WC2	StDr	Dryflow	0.351	nd	tr	nd	nd	tr	nd	nd	nd	0.287

Table A8 continued.

Sample Date	Site ID	Waterbody	Sampling Event	2,4-D	Dicamba	Diuron	MCPA	Oxyfluorfen	Pendimethalin	Prodiamine	Prometon	Simazine	Triclopyr
5/5/2009	WC3	StDr	Dryflow	0.196	nd	nd	nd	nd	0.292	nd	nd	nd	0.215
8/1/2009	AV01	RW	Dryflow	0.324	0.088	tr	nd	mv	mv	mv	nd	nd	0.074
8/1/2009	SC1	StDr	Dryflow	0.065	tr	nd	0.238	mv	mv	mv	nd	nd	tr
8/1/2009	SC3	StDr	Dryflow	1.454	0.517	nd	0.424	mv	mv	mv	nd	nd	0.086
8/1/2009	SC5	RW	Dryflow	tr	tr	nd	tr	mv	mv	mv	nd	nd	0.164
8/1/2009	WC2	StDr	Dryflow	0.745	0.150	0.063	nd	mv	mv	mv	nd	nd	tr
8/1/2009	WC3	StDr	Dryflow	0.330	0.193	tr	nd	mv	mv	mv	nd	nd	1.329

Table A9. Detections of herbicides in water samples from San Diego Sampling sites. Concentrations are in $\mu\text{g L}^{-1}$.

Sample Date	Site ID	Waterbody	Sampling Event	2,4-D	Bromacil	Dicamba	Diuron	MCPA	Oryzalin	Prodiamine	Prometon	Simazine	Triclopyr	Trifluralin
4/7/2008	SDR101	RW	Dryflow	0.052	nd	nd	nd	nd	nd	nd	tr	0.13	0.051	nd
4/7/2008	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4/7/2008	SDR151	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4/7/2008	SDR156	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	tr
4/7/2008	SDR158	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR101	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	tr	nd	nd
5/12/2008	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR151	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	tr	nd	nd
5/12/2008	SDR156	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR158	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/12/2008	SDR159C	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
6/12/2008	SDR151	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
6/12/2008	SDR156	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
6/12/2008	SDR158	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Table A9 continued.

Sample Date	Site ID	Waterbody	Sampling Event	2,4-D	Bromacil	Dicamba	Diuron	MCPA	Oryzalin	Prodiamine	Prometon	Simazine	Triclopyr	Trifluralin
6/13/2008	SDR101	RW	Dryflow	tr	nd	nd	nd	nd	nd	nd	nd	0.057	nd	nd
6/13/2008	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/26/2008	SDR101	RW	Rain	0.085	tr	nd	tr	nd	0.383	nd	1.34	nd	0.114	nd
11/26/2008	SDR102	StDr	Rain	nd	nd	nd	2.03	nd	nd	nd	nd	nd	nd	nd
11/26/2008	SDR103	StDr	Rain	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
11/26/2008	SDR104	StDr	Rain	tr	nd	nd	0.059	nd	0.208	nd	nd	nd	nd	nd
11/26/2008	SDR151	StDr	Rain	0.261	nd	0.053	0.234	0.11	nd	nd	nd	nd	0.059	nd
11/26/2008	SDR156	StDr	Rain	0.132	nd	nd	nd	nd	nd	nd	tr	nd	nd	nd
11/26/2008	SDR158	RW	Rain	0.339	nd	0.07	0.238	nd	tr	nd	nd	nd	nd	nd
5/6/2009	SDR101	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/6/2009	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/6/2009	SDR156	StDr	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5/6/2009	SDR158	RW	Dryflow	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
8/1/2009	SDR101	RW	Dryflow	nd	nd	nd	nd	nd	mv	mv	nd	nd	nd	mv
8/1/2009	SDR102	StDr	Dryflow	nd	nd	nd	nd	nd	mv	mv	nd	nd	nd	mv
8/1/2009	SDR156	StDr	Dryflow	nd	nd	nd	nd	nd	mv	mv	nd	nd	nd	mv
8/1/2009	SDR158	RW	Dryflow	nd	nd	nd	nd	nd	mv	mv	nd	nd	nd	mv

Table A10. Detections of pyrethroids in sediments (units, $\mu\text{g kg}^{-1}$ dry wt.). All sediments were collected during dryflow.

Site ID	Area	Waterbody	Sample Date	Bifenthrin	Cyfluthrin	Cypermethrin	Deltamethrin	Fenvalerate/ esfenvalerate	Lambda- cyhalothrin	Permethrin cis	Permethrin trans	Resmethrin	Fenopropathrin
PGC010	SAC	StDr	8/4/2008	438.4	75.2	45.3	13.2	nd	8.1	89.2	38.4	nd	nd
PGC020	SAC	StDr	8/4/2008	196.2	13.2	6.7	2.8	nd	2.6	16.7	10.7	nd	nd
PGC020	SAC	StDr	8/4/2008	101.1	28.6	10.2	nd	nd	6.9	66.9	45.2	nd	nd
PGC020	SAC	StDr	8/4/2008	605.6	14.7	19.7	nd	nd	nd	22.6	12.2	nd	nd
PGC030	SAC	StDr	8/4/2008	63.5	9.8	4.6	2.1	nd	2.0	45.0	24.0	nd	nd
PGC010	SAC	StDr	4/13/2009	679.8	148.6	53.6	20.3	nd	14.8	113.1	52.8	nd	nd
PGC010	SAC	StDr	4/13/2009	41.5	5.5	nd	2.0	nd	nd	3.4	nd	nd	nd
PGC020	SAC	StDr	4/13/2009	61.4	4.4	nd	nd	nd	nd	7.4	2.9	nd	nd
PGC020	SAC	StDr	4/13/2009	323.5	83.7	22.7	7.5	4.9	4.1	40.7	35.6	nd	nd
PGC020	SAC	StDr	4/13/2009	267.9	49.6	22.6	14.0	nd	5.8	58.2	35.5	24.0	nd
PGC030	SAC	StDr	4/13/2009	24.0	2.9	nd	nd	nd	nd	5.2	3.1	nd	nd
MCC010	SFB	StDr	8/5/2008	37.5	23.4	nd	7.2	nd	nd	5.0	4.1	nd	nd
MCC020	SFB	StDr	8/5/2008	0.1	18.9	nd	nd	nd	nd	nd	nd	nd	nd
MCC030	SFB	StDr	8/5/2008	25.5	19.6	nd	5.2	nd	nd	3.8	nd	nd	nd
GRY010	SFB	StDr	8/6/2008	7.8	nd	nd	nd	nd	nd	nd	nd	nd	nd
GRY020	SFB	StDr	8/6/2008	13.1	2.9	nd	1.8	nd	nd	4.6	1.8	nd	nd
GRY030	SFB	RW	8/6/2008	8.9	1.9	nd	nd	nd	nd	2.2	nd	nd	nd
GRY030	SFB	RW	8/6/2008	9.3	nd	nd	nd	nd	nd	2.8	nd	nd	nd
GRY020	SFB	StDr	4/14/2009	17.9	2.1	nd	nd	nd	nd	3.3	2.2	nd	nd
GRY030	SFB	RW	4/14/2009	26.8	7.1	nd	2.3	nd	nd	7.0	5.2	nd	nd
GRY030	SFB	RW	4/14/2009	23.0	5.8	nd	nd	nd	nd	5.7	5.2	nd	nd
MCC010	SFB	StDr	4/14/2009	11.9	4.3	nd	nd	nd	1.5	4.3	4.1	nd	nd
SC1	OC	StDr	6/13/2008	45.0	14.1	nd	2.2	nd	nd	23.5	21.5	nd	nd
SC3	OC	StDr	6/13/2008	39.7	38.2	nd	26.8	nd	4.6	45.3	46.5	nd	nd
SC5	OC	RW	6/13/2008	25.2	7.0	nd	4.7	nd	1.9	11.5	8.6	nd	nd
AV01	OC	RW	6/14/2008	236.5	44.6	nd	12.3	9.4	21.6	45.7	27.5	nd	nd
WC1	OC	StDr	6/14/2008	323.7	89.3	18.2	15.7	4.0	31.9	149.0	206.7	nd	nd
WC2	OC	StDr	6/14/2008	141.0	39.0	nd	6.9	6.6	31.0	62.6	67.0	nd	nd
WC3	OC	StDr	6/14/2008	207.6	67.2	22.0	50.7	20.3	30.1	171.0	207.6	nd	nd
SC1	OC	StDr	5/5/2009	14.2	3.7	nd	5.8	nd	nd	16.4	19.5	nd	nd
SC3	OC	StDr	5/5/2009	nd	nd	nd	2.7	nd	7.5	6.8	15.6	nd	nd
SC5	OC	RW	5/5/2009	nd	nd	nd	nd	nd	3.1	2.2	2.7	8.3	nd
SDR151	SD	StDr	6/12/2008	3.3	nd	1.9	nd	nd	nd	nd	nd	nd	nd

Table A10 continued.

Site ID	Area	Waterbody	Sample Date	Bifenthrin	Cyfluthrin	Cypermethrin	Deltamethrin	Fenvalerate/ esfenvalerate	Lambda- cyhalothrin	Permethrin cis	Permethrin trans	Resmethrin	Fenopropathrin
SDR158	SD	RW	6/12/2008	1.3	nd	nd	nd	nd	nd	nd	nd	nd	nd
SDR101	SD	RW	6/13/2008	0.1	nd	nd	nd	nd	nd	nd	nd	nd	nd
SDR102	SD	StDr	6/13/2008	0.1	2.0	nd	nd	nd	nd	1.7	1.6	nd	nd
SDR101	SD	RW	5/6/2009	3.8	nd	nd	nd	nd	nd	nd	nd	nd	nd
SDR101	SD	RW	5/6/2009	4.6	nd	nd	nd	nd	nd	nd	nd	nd	nd
SDR102	SD	StDr	5/6/2009	3.2	3.1	nd	nd	nd	nd	6.5	8.4	5.0	nd
SDR156	SD	StDr	5/6/2009	8.3	4.2	7.9	nd	nd	nd	3.2	2.9	nd	nd
SDR158	SD	RW	5/6/2009	10.7	6.0	4.0	1.8	nd	nd	2.1	nd	nd	nd

Table A11. Summary of the water quality parameters for the entire study.

	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temperature (°C)	Turbidity (NTU)	TSS (mg L ⁻¹)	TOC (mg L ⁻¹)
Median	7.6	1.0	8.4	16.9	3.1	7.2	7.8
Range	6.1 – 8.6	0.06 – 4.47	1.5 – 18.3	6.9 – 25.9	0 – 236.6	0 – 844.3	1.2 – 106.4
Criteria for water quality ¹	6.5 – 8.5	> 3.0 (severe)	< 5.0	15.6 – 23.9 (seasonal), or not 2.8°C above natural levels	> 1 NTU or 20% based on natural levels ²	Shall not cause a nuisance or adversely affect beneficial uses.	--
Percent outside criteria	2%	9%	20%	--	Background natural levels unknown	unknown	

¹Criteria from Central Valley Regional Water Quality Board, Water Quality Control Plan for the Sacramento and San Joaquin River Basins, http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/; The San Diego Regional Water Quality Board, San Diego Region Basin Plan, http://www.waterboards.ca.gov/sandiego/water_issues/programs/basin_plan/; San Francisco Bay Area Regional Water Quality Control Board, basin plan, http://www.swrcb.ca.gov/rwqcb2/basin_planning.shtml

²Determined based on medians of sampling sites. If NTUs medians were between 1 – 5, and increase of 1 NTU over the median was an exceedance. If the medians were between 5 – 50 NTUs, an increase of 20% or more was an exceedance. Most exceedances (70%) were during rainstorm sampling and in stormdrain outflows (67%).

Water Quality Parameters by Category

There generally were little differences in water quality parameters between stormdrain outfalls and receiving waters. However, storm drain outflows had significantly higher DO and lower conductivity (EC) than receiving waters ($p=0.0031$ - 0.0163 ; Table A11). Rainfall was the biggest factor influencing differences between these water quality parameters. With dryflow conditions EC and temperature values were significantly higher than those observed with rainstorm events ($p=0.000$), whereas during rain events, DO, turbidity, TSS, and TOC were significantly higher than during dryflow ($p=0.000$ - 0.0035 ; Table A12). Between areas of the state, northern California had significantly higher DO ($p=0.000$) whereas southern California had significantly higher conductivity and temperature ($p=0.000$; Table A13). These may be rainfall effects.

Table A12. Water quality median concentrations between stormdrain outflows and receiving waters.

	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temperature (°C)	Turbidity (NTU)	TSS (mg L ⁻¹)	TOC (mg L ⁻¹)
Stormdrain outflows	7.63	0.82	8.4	17.2	2.6	7.1	7.3
Receiving waters	7.67	1.43	6.9	18.0	3.9	6.1	8.8
Significant p values	n.s.	0.0031	0.0163	n.s.	n.s.	n.s.	n.s.

Table A13. Water quality median concentrations between dryflow and rainstorm sampling.

	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temperature (°C)	Turbidity (NTU)	TSS (mg L ⁻¹)	TOC (mg L ⁻¹)
Dryflow	7.69	1.46	7.3	18.6	1.1	4.4	6.9
Rainstorm	7.62	0.29	9.0	15.8	17.4	31.1	9.5
Significant p values.	n.s.	0.000	0.000	0.000	0.000	0.000	0.0035

Table A14. Water quality median concentrations between northern and southern California.

	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temperature (°C)	Turbidity (NTU)	TSS (mg L ⁻¹)	TOC (mg L ⁻¹)
Northern California	7.7	0.37	8.7	16.7	2.9	7.1	6.9
Southern California	7.56	1.73	7.1	18.6	2.7	6.1	9.1
Significant p values	n.s.	0.000	0.000	0.000	n.s.	n.s.	n.s.

Table A15. Water quality parameters at the individual sampling sites of the urban study.

Region	Area	Sample Date	Site ID	Water Body	Sample Event	Flow (cfs) ¹	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temp (°C)	Turb (NTU)	TSS (ppm)	TOC (ppm)
NoCal	SAC	21-Apr-08	PGC010	StDr	Dryflow	nf	7.29	0.167	5.88	13.34	3.8	4.41	10.32
NoCal	SAC	21-Apr-08	PGC020	StDr	Dryflow	0.23	7.04	0.217	5.43	11.03	3.4	30.87	7.724
NoCal	SAC	21-Apr-08	PGC030	StDr	Dryflow	fl	7.66	0.143	9.28	15.17	2.5	4.37	9.432
NoCal	SAC	21-Apr-08	PGC040	RW	Dryflow	fl	7.75	0.487	7.75	13.58	mv	1.95	6.875
NoCal	SAC	27-May-08	PGC010	StDr	Dryflow	nf	7.35	0.183	8.33	17.66	13.2	5.73	11.29
NoCal	SAC	27-May-08	PGC020	StDr	Dryflow	nf	7.06	0.193	4.45	16.15	4.9	4.95	10.81
NoCal	SAC	27-May-08	PGC030	StDr	Dryflow	0.015	7.75	0.198	8.43	19.01	4.2	6.44	13.42
NoCal	SAC	27-May-08	PGC040	RW	Dryflow	nf	7.74	0.508	5.8	17.45	0.9	2.50	11.31
NoCal	SAC	23-Jun-08	PGC010	StDr	Dryflow	nf	7.11	0.215	4.3	21.89	2.5	4.21	11.65
NoCal	SAC	23-Jun-08	PGC020	StDr	Dryflow	0.05	6.82	0.176	3.2	20.78	0.1	2.93	10.47
NoCal	SAC	23-Jun-08	PGC030	StDr	Dryflow	0.035	7.5	0.144	7.52	23.65	1.3	2.63	8.931
NoCal	SAC	23-Jun-08	PGC040	RW	Dryflow	nf	7.57	0.369	4.24	22.78	1	3.23	8.983
NoCal	SAC	04-Aug-08	PGC010	StDr	Dryflow	nf	7.24	0.182	4.96	22.4	0	11.83	12.29
NoCal	SAC	04-Aug-08	PGC020	StDr	Dryflow	0.13	6.77	0.316	4.87	19.81	mv	2.26	9.34
NoCal	SAC	04-Aug-08	PGC030	StDr	Dryflow	0.0142	7.64	0.181	7.37	24.47	88.3	6.59	10.97
NoCal	SAC	04-Aug-08	PGC040	RW	Dryflow	nf	7.22	0.338	3.53	21.24	2.4	5.84	8.788
NoCal	SAC	01-Nov-08	PGC010	StDr	Rain	fl	7.22	0.198	9.06	16.64	6.7	8.47	10.73
NoCal	SAC	01-Nov-08	PGC020	StDr	Rain	2.22	7.59	0.15	8.13	16.68	4.5	7.53	7.919
NoCal	SAC	01-Nov-08	PGC030	StDr	Rain	1.28	7.7	0.135	9.47	17.31	9	7.14	7.967
NoCal	SAC	01-Nov-08	PGC040	RW	Rain	fl	7.52	0.313	6.47	15.88	18	66.36	12.1
NoCal	SAC	13-Feb-09	PGC010	StDr	Rain	2.49	7.62	0.113	11.26	6.94	12.2	13.88	13.95
NoCal	SAC	13-Feb-09	PGC020	StDr	Rain	4.99	7.57	0.204	11.02	7.47	24	mv	15.67
NoCal	SAC	13-Feb-09	PGC030	StDr	Rain	4.66	7.73	0.277	11.93	8.5	27	15.48	15.8
NoCal	SAC	13-Feb-09	PGC040	RW	Rain	135.98	7.68	0.174	10.57	7.8	45.4	81.14	mv
NoCal	SAC	07-Apr-09	PGC010	StDr	Rain	fl	7.4	0.129	8.5	13.47	6.5	4.88	6.759
NoCal	SAC	07-Apr-09	PGC020	StDr	Rain	fl	7.35	0.96	9.3	13.57	8.7	9.87	6.06
NoCal	SAC	07-Apr-09	PGC030	StDr	Rain	fl	7.67	0.105	9.91	14.23	mv	2.00	6.109
NoCal	SAC	07-Apr-09	PGC040	RW	Rain	fl	7.76	0.385	8.02	14	16.5	20.00	6.339
NoCal	SAC	13-Apr-09	PGC010	StDr	Dryflow	nf	6.99	0.184	1.5	14.23	2.2	1.12	8.749
NoCal	SAC	13-Apr-09	PGC020	StDr	Dryflow	nf	6.78	0.352	2.1	13.8	2	1.75	9.4495
NoCal	SAC	13-Apr-09	PGC030	StDr	Dryflow	fl	7.48	0.173	7.4	16.66	87.4	13.75	18.61
NoCal	SAC	13-Apr-09	PGC040	RW	Dryflow	fl	7.1	0.22	2.43	14.85	3.1	5.50	6.112
NoCal	SAC	01-May-09	PGC010	StDr	Rain	1.4	7.67	0.076	8.79	18.04	3.9	6.14	3.119
NoCal	SAC	01-May-09	PGC020	StDr	Rain	1.25	7.47	0.078	8.62	17.68	8.6	11.96	4.266
NoCal	SAC	01-May-09	PGC030	StDr	Rain	fl	7.38	0.063	9.57	16.8	5.8	14.46	4.122
NoCal	SAC	01-May-09	PGC040	RW	Rain	fl	7.89	0.267	8.72	16.56	7.2	12.24	6.084
NoCal	SAC	28-Aug-09	ANT001	StDr	Dryflow	0.02	7.99	0.493	7.24	24.46	2.8	2.62	20.45

Table A15 continued.

Region	Area	Sample Date	Site ID	Water Body	Sample Event	Flow (cfs) ¹	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temp (°C)	Turb (NTU)	TSS (ppm)	TOC (ppm)
NoCal	SAC	28-Aug-09	FOL001	StDr	Dryflow	0.02	6.61	0.201	6.69	21.46	0.3	0.71	5.698
NoCal	SAC	28-Aug-09	FOL002	StDr	Dryflow	fl	8.03	0.28	8.19	20.55	0	28.48	1.77
NoCal	SAC	28-Aug-09	NAT001	StDr	Dryflow	fl	mv	mv	mv	mv	mv	2.12	5.38
NoCal	SAC	28-Aug-09	PGC010	StDr	Dryflow	nf	6.96	0.206	2.11	23.37	2.4	6.07	9.713
NoCal	SAC	28-Aug-09	PGC020	StDr	Dryflow	0.01	6.74	0.153	1.17	21.1	0	5.20	10.14
NoCal	SAC	28-Aug-09	PGC030	StDr	Dryflow	fl	7.59	0.193	6.95	25.28	0.1	2.81	7.49
NoCal	SAC	28-Aug-09	PGC040	RW	Dryflow	nf	7.18	0.348	3.65	20.88	4	7.91	9.87
NoCal	SFB	22-Apr-08	GRY010	StDr	Dryflow	0.44	8.04	2.22	9.58	13.11	8.7	3.24	4.85
NoCal	SFB	22-Apr-08	GRY020	StDr	Dryflow	0.33	8.12	1.883	10.59	14.02	0.6	0.57	4.24
NoCal	SFB	22-Apr-08	GRY030	RW	Dryflow	5.53	8.36	1.581	14.77	17.12	1.1	2.80	4.295
NoCal	SFB	22-Apr-08	MCC010	StDr	Dryflow	0.41	8.25	1.822	12.6	15.86	1.1	9.90	3.288
NoCal	SFB	22-Apr-08	MCC020	StDr	Dryflow	fl	8.17	1.84	10.4	11	0.3	7.18	106.4
NoCal	SFB	22-Apr-08	MCC030	StDr	Dryflow	0.33	8.24	1.087	9.75	15.68	0.2	0.00	1.358
NoCal	SFB	22-Apr-08	MCC040	RW	Dryflow	fl	7.82	1.641	8.53	12.88	0.1	0.00	3.292
NoCal	SFB	28-May-08	GRY010	StDr	Dryflow	0.05	7.97	1.861	8.62	15.72	0.9	6.02	4.795
NoCal	SFB	28-May-08	GRY020	StDr	Dryflow	0.024	8.1	1.577	10.34	16.95	0.7	2.79	3.982
NoCal	SFB	28-May-08	GRY030	RW	Dryflow	2.02	8.3	1.497	12.8	20.51	1.7	5.51	4.348
NoCal	SFB	28-May-08	MCC010	StDr	Dryflow	0.28	8.15	1.853	9.77	16.87	0.5	12.08	3.307
NoCal	SFB	28-May-08	MCC020	StDr	Dryflow	0.29	8.21	1.484	9.57	14.25	0	0.74	6.571
NoCal	SFB	28-May-08	MCC030	StDr	Dryflow	0.27	8.16	1.077	8.89	17.61	0	4.98	2.466
NoCal	SFB	28-May-08	MCC040	RW	Dryflow	0.73	7.95	1.598	9.3	15.84	0	1.32	3.218
NoCal	SFB	24-Jun-08	GRY010	StDr	Dryflow	fl	8.18	1.296	7.5	18.77	2.4	19.52	4.843
NoCal	SFB	24-Jun-08	GRY020	StDr	Dryflow	0.01	8.18	2.01	12.14	18.78	0	3.06	3.745
NoCal	SFB	24-Jun-08	GRY030	RW	Dryflow	0.90	8.58	1.092	18.29	25.91	8.9	15.08	5.381
NoCal	SFB	24-Jun-08	MCC010	StDr	Dryflow	0.04	8.13	1.975	9.92	17.95	0	2.30	3.189
NoCal	SFB	24-Jun-08	MCC020	StDr	Dryflow	fl	8.26	1.591	9.23	15.92	0	0.67	5.83
NoCal	SFB	24-Jun-08	MCC030	StDr	Dryflow	1.23	7.85	1.147	5.83	19.08	0	mv	7.921
NoCal	SFB	24-Jun-08	MCC040	RW	Dryflow	2.18	7.72	1.648	4.69	18.22	0	mv	15.79
NoCal	SFB	05-Aug-08	MCC010	StDr	Dryflow	0.14	8.05	0.193	8.42	18.12	0	0.94	3.024
NoCal	SFB	05-Aug-08	MCC020	StDr	Dryflow	fl	8.34	1.564	8.27	16.93	2.2	12.90	6.985
NoCal	SFB	05-Aug-08	MCC030	StDr	Dryflow	0.1	8.17	0.82	7.68	19.93	0	16.79	9.464
NoCal	SFB	05-Aug-08	MCC040	RW	Dryflow	fl	7.66	1.644	3.71	19.63	9.7	2.28	5.015
NoCal	SFB	06-Aug-08	GRY010	StDr	Dryflow	0.0188	7.78	0.928	7.93	17.26	2.6	7.65	4.565
NoCal	SFB	06-Aug-08	GRY020	StDr	Dryflow	0.059	8.11	1.75	9.64	19.71	0.3	6.66	3.77
NoCal	SFB	06-Aug-08	GRY030	RW	Dryflow	5.15	8.17	0.699	7.45	20.38	3.9	8.79	3.826
NoCal	SFB	01-Nov-08	GRY010	StDr	Rain	7.00	7.17	0.306	8.86	16.99	177.2	844.31	12.48
NoCal	SFB	01-Nov-08	GRY020	StDr	Rain	0.42	7.42	0.383	9.21	17.4	97	470.73	15.01

Table A15 continued.

Region	Area	Sample Date	Site ID	Water Body	Sample Event	Flow (cfs) ¹	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temp (°C)	Turb (NTU)	TSS (ppm)	TOC (ppm)
NoCal	SFB	01-Nov-08	GRY030	RW	Rain	fl	7.76	0.282	5.94	17.18	201.6	647.93	13.5
NoCal	SFB	01-Nov-08	MCC010	StDr	Rain	3.60	7.84	0.328	9.03	18.08	16.8	67.63	11.245
NoCal	SFB	01-Nov-08	MCC020	StDr	Rain	4.00	7.74	0.737	8.46	12.73	165.3	31.09	10.76
NoCal	SFB	01-Nov-08	MCC030	StDr	Rain	39.00	7.37	0.076	9.37	17.37	24.5	59.50	5.546
NoCal	SFB	01-Nov-08	MCC040	RW	Rain	81.00	7.59	0.186	8.66	18.61	56.7	282.61	9.503
NoCal	SFB	15-Feb-09	GRY010	StDr	Rain	18.60	7.73	0.41	11.06	9.46	79.2	187.93	8.006
NoCal	SFB	15-Feb-09	GRY020	StDr	Rain	5.73	7.67	0.279	11.2	9.38	55.8	150.87	3.714
NoCal	SFB	15-Feb-09	GRY030	RW	Rain	fl	7.68	0.193	10.54	9.96	52	111.13	4.58
NoCal	SFB	15-Feb-09	MCC010	StDr	Rain	6.46	8.04	0.434	11.36	11.41	4.1	7.00	4.817
NoCal	SFB	15-Feb-09	MCC020	StDr	Rain	2.80	8.1	0.539	10.84	10.57	2.9	7.50	5.004
NoCal	SFB	15-Feb-09	MCC030	StDr	Rain	7.32	7.52	0.141	10.31	12.21	21.1	19.70	4.819
NoCal	SFB	15-Feb-09	MCC040	RW	Rain	91.80	7.8	0.286	10.79	11.72	21.8	40.69	3.983
NoCal	SFB	07-Apr-09	GRY010	StDr	Rain	3.28	7.35	0.651	9.43	12.13	34.8	103.95	9.59
NoCal	SFB	07-Apr-09	GRY020	StDr	Rain	0.64	7.86	1.151	9.41	14.14	16.5	29.10	8.704
NoCal	SFB	07-Apr-09	GRY030	RW	Rain	52.50	7.55	0.399	8.41	13.39	101.9	115.50	9.607
NoCal	SFB	14-Apr-09	GRY010	StDr	Dryflow	0.07	8.04	2.277	9.15	12.11	0.7	3.12	5.717
NoCal	SFB	14-Apr-09	GRY020	StDr	Dryflow	0.07	8.06	1.44	10.38	14.33	2.6	26.52	4.556
NoCal	SFB	14-Apr-09	GRY030	RW	Dryflow	1.29	8.18	1.779	9.66	16.85	0	3.84	4.412
NoCal	SFB	14-Apr-09	MCC010	StDr	Dryflow	0.30	8.32	1.952	12.03	12.73	0	25.25	2.511
NoCal	SFB	14-Apr-09	MCC020	StDr	Dryflow	0.00	8.28	1.298	10.21	11.85	0	1.61	6.922
NoCal	SFB	14-Apr-09	MCC020 ¹	StDr	Dryflow	0.16	mv	mv	mv	mv	mv	12176.4 ²	259 ²
NoCal	SFB	14-Apr-09	MCC030	StDr	Dryflow	0.16	7.98	1.1	9.53	15.65	0	0.81	1.155
NoCal	SFB	14-Apr-09	MCC040	RW	Dryflow	0.164	7.88	1.685	9.78	13.25	0	0.10	2.684
NoCal	SFB	01-May-09	GRY010	StDr	Rain	9.00	7.62	1.09	8.39	15.75	31.8	43.59	12.27
NoCal	SFB	01-May-09	GRY020	StDr	Rain	1.66	7.6	0.364	9.3	16.64	13.1	11.90	9.507
NoCal	SFB	01-May-09	GRY030	RW	Rain	Fl	7.61	0.451	6.92	16.39	32.2	61.29	16.37
NoCal	SFB	01-May-09	MCC010	StDr	Rain	3.59	7.8	0.539	9	15.83	122.3	3.82	12.4
NoCal	SFB	01-May-09	MCC020	StDr	Rain	1.24	7.88	0.178	8.98	15.79	10.3	8.59	9.889
NoCal	SFB	01-May-09	MCC030	StDr	Rain	0.837	7.42	0.15	9.06	16.47	7.5	9.26	9.56
NoCal	SFB	01-May-09	MCC040	RW	Rain	Fl	7.68	0.212	9.41	15.89	6.6	11.31	9.067
NoCal	SFB	27-Aug-09	MCC010	StDr	Dryflow	0.08	8.21	2.07	9.65	18.01	0	1.31	6.161
NoCal	SFB	27-Aug-09	MCC020	StDr	Dryflow	fl	8.32	1.104	8.07	17.7	0	1.31	11.24
NoCal	SFB	27-Aug-09	MCC030	StDr	Dryflow	0.03	8.14	0.889	8.45	20	2.7	7.94	2.028
NoCal	SFB	27-Aug-09	MCC040	RW	Dryflow	nf	7.52	1.668	2.28	18.74	0.7	4.70	95.11
NoCal	SFB	27-Aug-09	GRY010	StDr	Dryflow	fl	7.34	0.8	1.33	16.77	3.9	12.94	6.757
NoCal	SFB	27-Aug-09	GRY020	StDr	Dryflow	fl	8.22	1.825	8.58	18.5	0	0.40	5.01
NoCal	SFB	27-Aug-09	GRY030	RW	Dryflow	0.96	8.26	1.025	12.26	24.44	7.5	7.58	6.021

² Values for TOC and TSS are high because this sample was mostly sediment, unlike the preceding sample from the same site.

Table A15 continued.

Region	Area	Sample Date	Site ID	Water Body	Sample Event	Flow (cfs) ¹	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temp (°C)	Turb (NTU)	TSS (ppm)	TOC (ppm)
SoCal	OC	08-Apr-08	SC1	StDr	Dryflow	0.02	7.53	4.289	7.72	14.46	3.2	5.19	8.963
SoCal	OC	08-Apr-08	SC3	StDr	Dryflow	0.05	8.2	1.527	9.58	16.43	6.8	17.18	15.55
SoCal	OC	08-Apr-08	SC5	RW	Dryflow	0.52	7.7	3.193	10.38	14.92	1.4	6.55	10.42
SoCal	OC	08-Apr-08	WC1	StDr	Dryflow	0.06	8.3	1.059	10	16.16	1.4	0.00	2.327
SoCal	OC	08-Apr-08	WC2	StDr	Dryflow	0.09	7.59	1.238	5.57	15.39	0	20.80	5.01
SoCal	OC	08-Apr-08	WC3	StDr	Dryflow	0.01	8.17	2.703	8.68	16.13	0.7	2.06	9.575
SoCal	OC	08-Apr-08	AV01	RW	Dryflow	0.12	7.94	1.28	9.09	16.54	4.3	7.60	5.414
SoCal	OC	13-May-08	SC1	StDr	Dryflow	nf	7.57	3.095	7.07	15.75	4.3	16.07	10.74
SoCal	OC	13-May-08	SC3	StDr	Dryflow	fl	8.53	1.793	7.6	17.6	mv	4.45	9.297
SoCal	OC	13-May-08	SC5	RW	Dryflow	1.46	7.82	4.287	9.53	16.07	0	8.25	9.302
SoCal	OC	13-May-08	WC1	StDr	Dryflow	0.12	8.28	1.039	8.66	17.65	0	0.51	3.588
SoCal	OC	13-May-08	WC2	StDr	Dryflow	0.32	7.58	1.244	4.91	17.86	0	0.40	5.412
SoCal	OC	13-May-08	WC3	StDr	Dryflow	fl	8.11	3.741	7.88	17.86	0.4	22.75	11.72
SoCal	OC	13-May-08	AV01	RW	Dryflow	3.20	7.68	1.638	5.76	17.86	2.4	9.62	7.806
SoCal	OC	13-Jun-08	SC1	StDr	Dryflow	fl	7.4	4.107	5.81	19.29	0.4	8.01	Mv
SoCal	OC	13-Jun-08	SC3	StDr	Dryflow	fl	8.14	2.315	8.18	22.42	3.1	12.75	33.33
SoCal	OC	13-Jun-08	SC5	RW	Dryflow	0.42	7.9	3.844	mv	19.85	0	3.77	10.85
SoCal	OC	14-Jun-08	WC1	StDr	Dryflow	0.10	8.13	0.907	mv	19.4	0	1.26	5.134
SoCal	OC	14-Jun-08	WC2	StDr	Dryflow	0.17	7.33	1.253	mv	17.27	0	1.05	6.443
SoCal	OC	14-Jun-08	WC3	StDr	Dryflow	0.05	8.01	1.529	8.55	19.04	0.4	17.89	10.08
SoCal	OC	14-Jun-08	AV01	RW	Dryflow	0.24	7.49	1.378	5.1	17.51	3.5	4.76	7.509
SoCal	OC	26-Nov-08	SC1	StDr	Rain	fl	6.08	0.646	7.87	15.46	mv	mv	mv
SoCal	OC	26-Nov-08	SC3	StDr	Rain	fl	6.63	0.305	8.31	15.82	mv	295.83	12.69
SoCal	OC	26-Nov-08	SC5	RW	Rain	fl	6.47	0.594	8.84	14.72	mv	211.25	9.343
SoCal	OC	26-Nov-08	WC2	StDr	Rain	fl	7.43	1.072	9.34	15.58	mv	24.29	6.213
SoCal	OC	26-Nov-08	WC3	StDr	Rain	fl	7.63	0.569	8.18	14.43	mv	116.02	7.416
SoCal	OC	26-Nov-08	AV01	RW	Rain	fl	7.41	1.379	7.44	15.23	mv	79.80	10.56
SoCal	OC	05-May-09	SC1	StDr	Dryflow	fl	6.98	4.472	6.45	20.55	mv	31.68	14.16
SoCal	OC	05-May-09	SC3	StDr	Dryflow	fl	7.6	1.658	7.61	21.14	mv	230.75	17.88
SoCal	OC	05-May-09	SC5	RW	Dryflow	fl	7.26	3.341	7.43	18.24	mv	2.53	10.68
SoCal	OC	05-May-09	WC1	StDr	Dryflow	nf	6.67	1.836	5.15	20.3	mv	434.44	5.696
SoCal	OC	05-May-09	WC2	StDr	Dryflow	fl	6.98	1.197	4.39	18.98	mv	0.00	4.392
SoCal	OC	05-May-09	WC3	StDr	Dryflow	fl	7.03	2.968	5.53	18.25	mv	4.95	12.315
SoCal	OC	05-May-09	AV01	RW	Dryflow	fl	6.82	1.362	5.24	18.94	mv	0.75	4.953
SoCal	OC	01-Aug-09	AV01	RW	Dryflow	fl	7.63	0.99	6.61	22.87	5	0.74	7.184
SoCal	OC	01-Aug-09	WC2	StDr	Dryflow	mv	mv	mv	mv	mv	mv	0.00	7.194
SoCal	OC	01-Aug-09	WC3	StDr	Dryflow	mv	mv	mv	mv	mv	mv	12.12	17.73

Table A15 continued.

Region	Area	Sample Date	Site ID	Water Body	Sample Event	Flow (cfs) ¹	pH	EC (mS cm ⁻¹)	DO (mg L ⁻¹)	Temp (°C)	Turb (NTU)	TSS (ppm)	TOC (ppm)
SoCal	OC	01-Aug-09	SC1	StDr	Dryflow	nf	mv	mv	mv	mv	mv	15.23	13.15
SoCal	OC	01-Aug-09	SC3	StDr	Dryflow	mv	mv	mv	mv	mv	mv	2.83	26.27
SoCal	OC	01-Aug-09	SC5	RW	Dryflow	fl	7.33	2.494	3.67	21.19	3.3	0.47	14.13
SoCal	SD	07-Apr-08	SDR101	RW	Dryflow	2.2	7.7	2.565	6.79	19.1	2.6	0.00	70.21
SoCal	SD	07-Apr-08	SDR102	StDr	Dryflow	0.06	7.44	3.176	7.17	20.59	11.5	26.91	3.611
SoCal	SD	07-Apr-08	SDR151	StDr	Dryflow	0.28	7.36	2.59	4.62	21.17	0	0.00	1.545
SoCal	SD	07-Apr-08	SDR156	StDr	Dryflow	0.01	8.13	0.993	9.04	17.08	0	0.00	1.553
SoCal	SD	07-Apr-08	SDR158	RW	Dryflow	nf	7.35	2.566	4.51	20.15	14.5	4.20	77.69
SoCal	SD	12-May-08	SDR101	RW	Dryflow	17.21	7.81	3.025	5.46	20.45	0.2	1.26	7.956
SoCal	SD	12-May-08	SDR102	StDr	Dryflow	fl	7.41	3.462	6.85	20.73	12.2	4.13	3.457
SoCal	SD	12-May-08	SDR151	StDr	Dryflow	0.5806	7.31	2.587	3.62	21.45	0	0.00	1.392
SoCal	SD	12-May-08	SDR156	StDr	Dryflow	fl	8.04	0.974	7.7	17.98	0	2.30	3.383
SoCal	SD	12-May-08	SDR158	RW	Dryflow	fl	7.41	2.559	4.59	20.73	8.1	7.25	1.565
SoCal	SD	12-May-08	SDR159C	StDr	Dryflow	0.43	7.36	2.595	4.6	21.36	0	0.00	1.493
SoCal	SD	12-Jun-08	SDR151	StDr	Dryflow	0.0668	7.22	2.578	3.62	21.61	0	0.00	1.284
SoCal	SD	12-Jun-08	SDR156	StDr	Dryflow	fl	7.78	0.678	mv	19.55	7.6	0.00	2.463
SoCal	SD	12-Jun-08	SDR158	RW	Dryflow	nf	7.21	2.547	5.05	21.39	4.8	6.41	1.689
SoCal	SD	13-Jun-08	SDR101	RW	Dryflow	1.07	7.55	3.015	2.32	22.64	0	1.33	9.852
SoCal	SD	13-Jun-08	SDR102	StDr	Dryflow	fl	7.38	3.237	6.2	20.97	9.9	21.10	4.142
SoCal	SD	26-Nov-08	SDR101	RW	Rain	67.50	7.71	1.489	7.1	16.88	37.7	98.20	10.8
SoCal	SD	26-Nov-08	SDR102	StDr	Rain	1.80	7.4	1.132	8.07	17.99	7.4	10.53	6.131
SoCal	SD	26-Nov-08	SDR103	StDr	Rain	0.03	8.15	0.195	8.75	17.22	0	4.25	16.25
SoCal	SD	26-Nov-08	SDR104	StDr	Rain	2.00	7.62	0.148	4.37	16.59	13.5	43.38	10.18
SoCal	SD	26-Nov-08	SDR151	StDr	Rain	nf	7.92	0.264	8.79	16.62	218	218.83	14.5
SoCal	SD	26-Nov-08	SDR156	StDr	Rain	fl	7.48	0.14	8.26	17.1	13.6	41.31	20.66
SoCal	SD	26-Nov-08	SDR158	RW	Rain	fl	7.4	0.29	8.37	16.32	236.6	213.67	14.19
SoCal	SD	06-May-09	SDR101	RW	Dryflow	3.22	7.6	2.947	3.68	21.88	0	6.12	8.313
SoCal	SD	06-May-09	SDR102	StDr	Dryflow	1.77	7.31	3.462	7.16	21.12	10.4	9.28	3.735
SoCal	SD	06-May-09	SDR156	StDr	Dryflow	0.01	8.13	0.977	8.82	18.24	0	43.51	1.745
SoCal	SD	06-May-09	SDR158	RW	Dryflow	nf	7.39	1.898	2.9	21.38	14.4	31.50	9.094
SoCal	SD	01-Aug-09	SDR101	RW	Dryflow	1.13	7.57	4.074	0.94	23.31	2	4.55	20.58
SoCal	SD	01-Aug-09	SDR102	StDr	Dryflow	0.13	7.48	3.588	6.75	22.37	12	4.61	9.694
SoCal	SD	01-Aug-09	SDR156	StDr	Dryflow	nf	8.17	0.815	7.01	22.36	94.2	1456.69	5.689
SoCal	SD	01-Aug-09	SDR158	RW	Dryflow	nf	7.32	2.637	0.88	23.22	8.2	3.91	10.52

¹fl, the water in the waterbody was flowing but flow could not be taken; nf, the water in the waterbody was not flowing.

VII. APPENDIX II. QUALITY CONTROL

1. Holding times. Holding times are the length of time from when the sample is collected to when it is extracted prior to analysis, and vary for the different analyte screens (Table 1). All analyses met there holding times, except for two synthetic auxin analyses. The holding times for two of these batches failed by one and two days. Due to a lab error, another batch was not extracted until 50 days after sampling. Conducting a lab duplicate analysis confirmed that exceeding the holding time did not affect the degradation of these samples.

2. Lab Blanks. There were no detections in any of the lab blanks.

3. Matrix and propazine surrogate spikes. With analytical batch, control water or sediment is spiked with known concentrations of the pesticides in that particular analytical screen. For the study there were 698 matrix spikes; 98% of these were recovered within acceptable limits. All 194 propazine surrogates (a triazine surrogate) were recovered with laboratory acceptable limits, as were all of the sediment matrix spikes.

4. Blind spikes, Field Blanks, and Field Duplicates. About 15% of the samples were blind spikes, field blanks, or field duplicates. Twenty-seven analytes in 15 blind spikes were all recovered within acceptable limits. However, in one analysis, fipronil was detected as a trace detection for fipronil, without fipronil added to the sample.

There were no detections in any of the 37 field blanks. Of 90 field duplicate analyses (water samples), 96% had good reproducibility (less than 25% difference) between the original field sample and the field duplicate. Sediment samples had more variation, with only 80% of the samples having good reproducibility. The sediment matrix may be interfering with the analysis and causing some variation in the data.