Pesticides in Surface Water from Agricultural Regions of California 2006-2007

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ABSTRACT

The California Department of Pesticide Regulation (CDPR) collected surface water samples from six agricultural regions throughout the state between June 2006 and July 2007. Samples were analyzed for a variety of insecticides and herbicides.

Pesticide concentrations are compared to aquatic toxicity benchmarks and water quality criteria. Quantifiable pesticide concentrations are referred to as detections; the presence of an analyte at a concentration too low to be quantified is referred to as a "trace" detection. Of 95 water samples, 78 (82%) had detections of at least one AI (active ingredient); 61 samples (65%) had detections of more than one AI. There were a total of 194 detections, including 13 AIs and 2 degradates. The most frequently detected AIs were diazinon, chlorpyrifos, dimethoate, malathion and methomyl. At least one US EPA benchmark was exceeded in 52 samples (55%). US EPA benchmarks were exceeded for diazinon (50%), chlorpyrifos (27%), dimethote (23%), malathion (18%) and methomyl (12%).

INTRODUCTION

In California, a wide variety of pesticides are applied throughout the year; in 2007 over 300 pesticide AIs were applied in agricultural areas of the state (CDPR 2010a). For many of these, recent surface water monitoring data from areas of high use are lacking or outdated. Such monitoring data are needed in order to assess the potential impacts of California pesticide use on aquatic systems.

The objective of the study was to provide an assessment of California surface water pesticide contamination for several pesticide active ingredients in areas of high agricultural use during 2006-2007.

MATERIALS AND METHODS

Targeted Pesticides

Pesticide AIs were selected for monitoring based on their toxicity to aquatic organisms, relatively high agricultural use, and the lack of recent surface water monitoring data from the regions of high use (Starner 2006, 2007a). Targeted AIs were malathion, methomyl, simazine, atrazine, and thiram. AIs already undergoing DPR's reevaluation process due to concerns over surface water contamination (diazinon, chlorpyrifos, pyrethroid insecticides) were not included as targeted AIs in this project. Samples were collected in six regions, each with agricultural use of at least one targeted AI. Regions sampled were Salinas Valley, Pajaro Valley, Santa Maria Valley, Ventura, Napa/Sonoma and Imperial Valley (Figure 1).

Sample Collection and Handling

Samples for chemical analysis were collected into 1-liter amber glass bottles using a grab pole. Bottles were sealed with Teflon-lined lids and transported on wet ice and stored at 4 degrees C until extraction for chemical analysis.

Water Quality Measurements

At each sampling event, temperature, dissolved oxygen (DO), pH, salinity, and electrical conductivity (EC) were measured *in situ* at each sampling site. Measurements were made with YSI 85 and YSI 60 meters (YSI Incorporated, Yellow Springs, Ohio.) Instruments were calibrated according to manufacturer's recommendations.

Chemical Analysis

Chemical analyses were performed by the California Department of Food and Agriculture's Center for Analytical Chemistry. Analytical method details are presented in Table 1. Additional analytical details are provided on-line in the detailed analytical methods (CDPR 2010b).

In addition to the targeted AIs, several additional organophosphate and carbamate insecticides were applied in the monitored regions. These AIs include diazinon, chlorpyrifos, dimethoate, methidathion, disulfoton, carbaryl, carbofuran, and oxamyl. While not the primary focus of this study, these AIs are included in the analytical screens and these data provide additional useful surface water monitoring data.

Data Analysis

Use of each AI in the different regions was analyzed to assess the relationship between use and detection frequency. For each of the targeted AIs, agricultural use by season was compiled for the study period (July 2006 through June 2007). Pesticide use by season within each sampling region was then determined using CalWater 2.2 watershed maps (Figure 1). Total agricultural use and use density (use per unit area) were determined by spatial analysis. Based on use density, a relative use rank (very low to very high) was developed by AI for each region/season. The use rank allows for comparison of relative use of a specific AI between the sampling regions.

The primary crops treated with each of the targeted AIs during the study period were also determined from reported use data (CDPR 2010a).

For each targeted AI, analytical results were compared to available US EPA Office of Pesticide Programs' Aquatic Life Benchmarks ("benchmarks") (US EPA 2010a) and, when available, Water Quality Criteria developed by the University of California at Davis ("UCD-WQC") (UC Davis 2009, 2010a, 2010b) (Table 2). The comparisons were also completed for other frequently detected AIs. In general, the number of samples and frequencies of detection, trace detection, and exceedance of benchmarks were examined for each AI by region/season, use rank and sample site type (river or tributary).

According the US EPA, the benchmarks are “estimates of the concentrations below which pesticides are not expected to have the potential for adverse effects on aquatic life”. Additionally, “…benchmarks can be used as indicators of potential hazard to aquatic life, but they are not detailed toxicity and risk assessments. Concentrations of pesticides in streams…that exceed benchmarks indicate that further work needs to be done to gather more detailed information and…to characterize the likelihood of adverse effects on aquatic life” (US EPA 2010a).

RESULTS AND DISCUSSION

The primary crops treated with each AI were determined for each region/season and are presented in Table 3. Monitoring sites are presented in Appendix 1.

Water Quality Measurements

Water quality measurement data and sample site information are presented in Appendix 1.

Overall, the pH varied from 7.1 to 8.8. By region, samples from the Salinas Valley had the highest median pH (8.24); Pajaro Valley sample sites had the lowest median pH (7.66).

Salinity was generally between 0.1 and 2 parts per thousand (ppt). Exceptions were the tidally-influenced sites (especially POT, SAND, SAL_DM, PR_1, NR_CW, WS_S1, RRGP, Rev2) and sites at the Salton Sea (Obsid), (Appendix 1) which had higher measured salinity and specific EC. Higher salinity at the tidally-influenced river sites is an indication of the dilution of freshwater with incoming seawater. For samples from these sites, it is likely that the measured diluted pesticide concentrations and detection frequencies were lower that would have been obtained if undiluted runoff into the water bodies had been sampled directly.

Water temperature ranged from a low of 6.4 to a high of 28 degrees C. These results were as expected; lowest temperatures were measured in waters collected in winter and higher temperatures in spring and summer.

Pesticide Detections and Data Analysis

Pesticide analysis results by sampling site are presented in Appendix 2. Not all AIs were sampled at all sites; specific analytical screens included at each sample event are as indicated. Analytes included in each analytical screen are shown in Table 1. All Quality Control results are presented in Appendix 3.

A discussion of the relative use (use rank) is included below for each AI, and an example of the use rank calculation method is presented in Appendix 4.

A total of 95 water samples were collected from the six regions. Overall, 78 samples (82%) had detections of at least one AI; 61 samples (65%) had detections of more than one AI. There were a total of 194 detections, including 13 AIs and 2 degradates. At least one US EPA benchmark was exceeded in 52 samples (55%). The most frequently detected AIs were diazinon, chlorpyrifos, dimethoate, methomyl and malathion.

In several instances, multiple samples were collected from the same sample site over the course of one or two days. Pesticide detections in these samples indicate that in some cases aquatic organisms were likely exposed to specific AIs for at least several hours and up to 24 hours (Table 4). In some water bodies, organisms may be exposed for several days at a time. It has been shown previously that, in agricultural regions where organophosphate and carbamate insecticides are applied for extended periods, nontarget aquatic organisms may be exposed to these insecticides for up to several months (Gruber and Mund 1998). Chronic exposure may occur, and comparison of detected concentrations to chronic toxicity benchmarks may frequently be valid. As such, the chronic benchmarks, when available, are included in this report and analysis.

Detailed results for each AI, including detection frequencies and frequency of toxicity benchmarks exceedances, are presented below.

Malathion

Samples were collected for malathion analysis from five regions with agricultural use. Of 74 samples, malathion was detected in 13 samples (18%). An additional 8 samples (11%) contained trace concentrations. The US EPA acute invertebrate benchmark was exceeded in 5% of all samples; the chronic invertebrate benchmark was exceeded in 18% (Figure 2, Table 5). For malathion, a Continuous Concentration Aquatic Life Criteria (CCC) has been developed by the US EPA Office of Water. This chronic value was exceeded in 16% of all samples. Additionally, The University of California at Davis has recently developed both acute and chronic water quality criteria for malathion (UC Davis 2010a). These were exceeded in 8 and 18% of samples, respectively (Table 5).

In spite of only moderate use, the highest detection frequency and concentrations of malathion occurred in Imperial Valley in the spring, when use was primarily on alfalfa. For these samples, 80% of samples collected from rivers contained detections of malathion; an additional 20% had trace detections. In samples from tributaries, 67% of samples from Imperial Valley in spring had detections (Table 5). Follow-up monitoring in Imperial Valley focusing on malathion, and additional monitoring for malathion in other areas with high use on alfalfa, was added to subsequent CDPR monitoring plans based on these results (Starner 2007b).

Malathion detection frequencies were lower in Salinas Valley (8% overall) compared with Imperial Valley. Use of malathion in Salinas Valley was moderate to high and was primarily on strawberries and lettuce (Table 6).

The detection frequency of malathion in Salinas Valley relative to Imperial Valley (spring samples) is low despite higher use in Salinas Valley. This may be due in part to differences in the regional conditions, including agricultural practices. Most use in Imperial Valley is on alfalfa, which is flood-irrigated, resulting in relatively higher field runoff of irrigation water compared to strawberries and lettuce. Additionally, the pH of surface water samples collected from Imperial Valley was generally lower than that of samples from Salinas Valley. The median pH from Imperial Valley in samples collected in the spring was 7.75; the median pH measured in Salinas

Valley was 8.24. This difference in pH between the two regions could also be a factor in the higher detection frequency in Imperial Valley. In surface water, the degradation rate of malathion increases with increasing pH (Druzina and Stegu 2007, Ross *et al.* 1996, CDPR unpublished data). Additional factors may be also relevant, including soil type, regional hydrology, and other agricultural practices. In more recent CDPR monitoring efforts, malathion samples were acid-preserved in order to minimize the degradation due to relatively high environmental pH.

Malathion was detected in 2 of 4 samples in Santa Maria Valley, where use was moderate (Table 6). No malathion samples were collected from Santa Maria Valley in the summer, when use was very high. Summer season monitoring for malathion in Santa Maria Valley was added to subsequent CDPR monitoring plans based on the spring monitoring results (Starner 2007b).

As discussed above, the detection frequency of malathion was not higher in higher use areas. (Table 7). Overall, the detection frequency of malathion was the same (18%) for river sites as for tributary sites (Table 8). Trace concentrations were more frequent in tributary samples.

For the malathion analytical method used in this project, the method reporting limit was 0.04 ug/L (Table 1). Both the US EPA chronic invertebrate benchmark and the UC Davis Water Quality Criteria (Table 2) are below this concentration. As such, malathion at concentrations exceeding these benchmarks may go undetected with the current analytical method. Increasing the sensitivity of the analytical method for malathion is recommended.

Agricultural use of malathion is increasing; in 2009, use statewide was 40% higher than in 2006 (CDPR 2010a). Based on this and the results of malathion monitoring in these regions, continued monitoring for malathion in areas with significant agricultural use is recommended.

Methomyl

Samples were collected for methomyl analysis from five regions with agricultural use. Of 73 samples, methomyl was detected in 27 samples (37%), with trace detections in an additional 11 samples (15%). The chronic invertebrate benchmark was exceeded in 12% of all samples; the acute invertebrate benchmark was exceeded in 3% (2 samples) (Figure 2, Table 9).

Detection and exceedance frequencies were highest in Salinas Valley, where use is primarily on lettuce, strawberries, and onions. The overall detection frequency for Salinas Valley was 50%. Trace detections were found in an additional 25% of Salinas Valley samples. In summer, when use is very high, detection frequencies were as high as 100%. The chronic invertebrate benchmark was exceeded in18% of samples from Salinas Valley (Table 10). In summer of 2007, the acute invertebrate benchmark was exceeded in 2 samples from tributary sites in the region (Table 9). Detection frequencies were higher in higher use regions (Table 11).

Overall detection frequencies were similar when comparing samples taken from rivers to those taken from tributaries (35 and 39% respectively); however, concentrations and exceedance frequencies were higher in tributaries (Table 12).

Based on these results, continued monitoring for methomyl in areas of significant agricultural use is recommended.

Simazine

Samples for simazine analysis were collected from only one region with significant agricultural use. In this region, Napa/Sonoma (Figure 1), samples were collected in winter, the peak use period, under both dry weather conditions and during a winter storm. Detection frequency was 100% (7 of 7) during storm sampling. There were no dry weather detections of simazine among the 14 samples, although two of the samples had trace detections of simazine (Table 13). No aquatic life benchmarks were exceeded.

The reported use of simazine was moderate during the sample period, and nearly all reported applications were to wine grapes. Agricultural use on wine grapes has been decreasing due in part to concerns over groundwater contamination (CDPR 2008). In the Napa/Sonoma area, use of simazine on wine grapes in winter 2006-2007 was approximately 20% of that used three years prior (CDPR 2010a). Based on decreased use and the monitoring results presented here, continued sampling for simazine in the Napa/Sonoma region is not designated as a high priority. However, the data clearly show that storm runoff from vineyards in the Napa/Sonoma region can transport water-soluble pesticides to the Napa River and Sonoma Creek, both of which drain to the Delta, as well as to the Russian River, which drains to the Pacific Ocean (Appendix 2). Other AIs applied in relatively high amounts in the winter season in this region may be of interest in future monitoring efforts, especially any with aquatic toxicity, high water solubility and relatively long aquatic half-lives.

Atrazine

Samples for atrazine analysis were collected from only one region with significant agricultural use. In this region, Imperial Valley, samples were collected in the spring of 2007. Use in Imperial was primarily on sudangrass, with some use on sweet corn and sugar cane. Of 8 samples, there were 2 detections of atrazine. Two samples contained trace detections. None exceeded any benchmark (Table 14).

Atrazine use is low throughout California, with most use in Imperial Valley in the spring, when this monitoring was conducted. Based on these results, continued atrazine monitoring in Imperial Valley is not designated as a high priority at this time. Monitoring may be conducted in the future if use of atrazine in agricultural areas increases.

Thiram

Samples for thiram analysis were collected from five regions with agricultural use. Of 55 samples, there were no detections of thiram (Table 15). Use has decreased significantly in recent years; in 2007 irrigation season use was approximately 25% of that in 2004 (CDPR 2010a). Additional monitoring for thiram is not recommended at this time; monitoring may be conducted in the future if use of thiram in agricultural areas increases.

Additional AIs

The additional AIs discussed below were not included as targeted AIs in this project; that is, regions and sample sites were not chosen for monitoring specifically based on their use patterns. However, the use patterns for these AIs are generally similar to the targeted AIs in that their use is relatively high in several of the regions/seasons sampled.

Dimethoate

Samples were collected for dimethoate analysis from five regions with agricultural use. Of 74 samples, dimethoate was detected in 39% (29 samples). Trace detections were found in an additional 26% of samples. The chronic invertebrate benchmark was exceeded in 23% of samples (17 samples) (Figure 3, Table 16). These exceedances were primarily in samples from Salinas Valley. No other benchmarks were exceeded. In Salinas Valley, 50% of all samples had detections of dimethoate (Table 17). An additional 25% had trace detections. Use during the study period was high or very high in this region and was primarily on broccoli and lettuce. In Imperial Valley in the spring, dimethoate was detected in 100% of river samples (5 of 5) and 67% of tributary samples (2 of 3). The moderate use in Imperial Valley during this period was primarily on alfalfa.

Detection frequency of dimethoate was greater than 35% in all region/seasons with moderate or higher use. Detection frequency was generally higher in the higher use regions (Table 18). No samples were collected in Santa Maria in summer, when use was high. As with several other AIs, detection frequencies in river and tributary samples were similar (35% vs. 40%, respectively), but exceedances occurred more frequently in tributary samples (Table 19). Based on the results presented here, continued monitoring for dimethoate in regions with agricultural use is recommended.

Chlorpyrifos

Samples were collected for chlorpyrifos analysis from five regions with agricultural use. Of 74 samples, chlorpyrifos was detected in 47% (35 samples). Trace detections were not reported for chlorpyrifos. The US EPA acute and chronic invertebrate benchmarks were each exceeded in over 20% of samples (Figure 4, Table 20).

The UCD chronic and acute water quality criteria (UC Davis 2009, Table 2) are both set at 0.01 ug/L; this was the reporting limit for the chlorpyrifos analytical method used in this study. As such, all detections exceed these criteria. The exceedance frequency of these criteria was 47% (35 of 74 samples). Detection frequencies were highest in Imperial and Santa Maria Valleys (Table 21). Detection frequency was greater than 50% for all regions with moderate or higher use (Table 22); all toxicity benchmarks were exceeded in at least 18% of samples. Detection frequencies were higher in tributaries (61%) than in rivers (35%) (Table 23).

In March 2004, CDPR placed chlorpyrifos into reevalution due to numerous detections in surface waters throughout California (Spurlock 2004, CDPR 2004). At that time, registrants were informed of their obligation to identify mitigation strategies that would reduce or eliminate chlorpyrifos residues in surface waters. The reevaluation process is ongoing; additional information on the California reevaluation process is available (CDPR 2001, 2010c). Spurlock (2004) included summary statistics for monitoring results from two samples sites in the Salinas Valley which are also included in this study. In that summary, 100% of samples from Quail Creek exceeded water quality criteria (WQC) developed by the California Department of Fish and Game; 75% of samples from Chualar Creek were exceedances. In the current study, the exceedance frequencies for those two sites (using the same WQC) were 100% and 50%, respectively. While the current study did not include nearly as many samples as in the Spurlock (2004) analysis, the available data indicate that, at the time of the study reported here, exceedance frequencies at these two sites had not decreased significantly.

In 2009, statewide reported use of chlorpyrifos had declined only slightly compared to use in 2007 (an approximately 15% decline) (CDPR 2010a). Continued inclusion of chlorpyrifos in agricultural ambient monitoring efforts in regions of high use is recommended.

Diazinon

Samples were collected for diazinon analysis from five regions with agricultural use. Of 74 samples, diazinon was detected in 78% (58 samples). Trace detections were not reported for diazinon. The acute invertebrate benchmark was exceeded in 50% of all samples; the chronic fish benchmark was exceeded in 22% (Figure 4, Table 24).

For diazinon, a Maximum Concentration Aquatic Life Criteria (CMC) has been developed by the US EPA Office of Water. This chronic value was exceeded in over 40% of all samples. Additionally, The University of California at Davis has recently developed both acute and chronic water quality criteria for diazinon (UC Davis 2010b). These were exceeded in 38 and 51% of samples, respectively (Table 24).

In summer in Salinas Valley, diazinon was detected in 100% of samples (28 of 28 samples) (Table 24). Use during this period was primarily on lettuce, with some use on broccoli and spinach. In Imperial Valley in fall, detection frequency was 100% (8 of 8 samples) (Table 25). Use during this period was mostly on lettuce and sugarbeets. Average detection frequencies by Use Rank were 75% or higher in all regions except where the use was very low (Table 26). Detection frequencies were higher in tributaries than in rivers (Table 27).

CDPR placed irrigation-season use of diazinon into reevaluation in June 2010 based on an analysis of diazinon in-season monitoring data (CDPR 2010d, Starner 2009). The diazinon data reported here were included in that analysis. The reevaluation process is ongoing (CDPR 2010c). Continued inclusion of diazinon in agricultural ambient monitoring efforts in regions of high use is recommended.

Methidathion

Methidathion was detected in 3 of thirteen samples in Salinas Valley in summer 2007. Trace detections were found in 4 samples during the same period (Appendix 2). No benchmarks were exceeded. All reported use of methidathion in Salinas Valley in 2007 was on artichokes; over

80% of that was applied during June and July. No methidathion was detected during the spring of 2007, when use was lower. Methidathion was not detected in summer 2006, likely because samples were collected in August, while most methidathion use was in June. While the use period is relatively narrow, continued monitoring for methidathion is warranted.

Carbofuran

Carbofuran was detected in 4 of 8 river/tributary samples in Imperial Valley in spring 2007. All 4 detections exceeded the US EPA chronic invertebrate benchmark; 3 of 4 exceeded the acute invertebrate benchmark (Appendix 2). Use was primarily on alfalfa. Based on these results, carbofuran was included in some subsequent CDPR monitoring efforts in the spring in Imperial Valley. However, effective December 31, 2009, US EPA revoked all carbofuran tolerances due to risks associated with carbofuran in food and drinking water. Additionally, US EPA is continuing the process to cancel all remaining carbofuran registrations (US EPA 2010b). As such, monitoring for carbofuran will not be a priority in future CDPR monitoring efforts.

Frequent Detection of Pesticide Mixtures

Multiple active ingredients were frequently detected simultaneously in surface water samples, from both river and tributary sites (Appendix 2). Moreover, the most commonly detected AIs were organophosphate and N-methyl-carbamate insecticides, which share a common mechanism of toxicity. These insecticides are all acetylcholinesterase (AChE) inhibitors, and research indicates that the effects of such mixtures on aquatic organisms are frequently additive or synergistic (Laetz *et al*.2009, Scholz *et al.* 2006, Lydy and Austin 2004, Lydy *et al.* 2004, Bailey *et al.* 1997). Interpreting the toxicological significance of such pesticide mixtures is complex (Macneale *et al.* 2010, Belden *et al.*2007, Junghans *et al.* 2006, Monosson 2005, Lydy *et al.* 2004); however, it is clear that the potential combined effects of such a mixture of pesticides is likely greater than indicated by a comparison of concentrations to individual toxicity benchmarks on a one-by-one chemical basis.

Overall, twelve different AChE-inhibiting insecticides were detected. Thirty samples had at least 3 co-occurring AChE-inhibiting insecticide detections; thirteen samples had at least 4 (Appendix 2). This count does not include any trace detections of AChE-inhibiting insecticides, which also occurred in many of these samples.

Samples with at least two co-occurring AChE-inhibiting insecticide detections were collected from all five of the primary monitoring regions. Such samples were not limited to tributary sites, but occurred in rivers as well. Ten river site samples in Imperial Valley and 18 in Salinas Valley had at least two co-occurring AChE-inhibiting insecticides. Co-occurrence was observed in every sample collected (both river and tributary) from four of the 12 region/season combinations. Overall, 80% of all samples collected from the five primary regions of use had at least two co-occurring AChE-inhibiting insecticide detections (Table 28). This is not including trace detections, which also occurred frequently in these samples.

As these results show, toxicologically-relevant surface water contamination is not limited to just the “usual suspect” AIs (i.e., diazinon, chlorpyrifos, pyrethroids), but also includes several other potentially deleterious compounds including malathion, dimethoate, methomyl, and methidathion. As such, management of only one or two high profile surface water contaminants may not effectively mitigate pesticide-associated risk to aquatic organisms.

This frequent simultaneous occurrence of multiple active ingredients in streams of agricultural areas of California underscores the need for improved regulatory and technical efforts to minimize offsite movement of pesticides. CDPR is currently developing regulations that would address the reduction of off-site movement of the most frequently detected pesticides in California, including those frequently detected in this study (CDPR 2010e).

Factors Affecting Offsite Movement of Pesticides

The amount of pesticide applied likely played a role in the frequency of detection; in general, detection frequencies were higher in areas of higher use. The differences in detection frequencies could also be partly due to differences between regions in the rate of off-site movement. In general, pesticides move off-site from agricultural fields into surface waters in runoff or drainage induced by either rain or irrigation (Larson et al. 1991). The four primary factors that affect pesticide transport in runoff are climate (amount and intensity of rainfall, as well as the timing of rainfall with respect to the pesticide applications), soil characteristics (soil texture, organic matter content, surface crusting and compaction, and slope and topography of the field), agricultural management practices (irrigation practices, use of subsurface drainage (i.e., tile drains), erosion control efforts, pesticide formulation and application rate), and the chemical and physical properties of the specific pesticides applied (Larson *et al.* 1991, Leonard 1990). Some or all of these factors vary between the monitored regions, and could potentially contribute to the observed differences in detection frequencies. Further investigation into the relative significance of these factors in off-site movement of pesticides could provide additional insight into the development of mitigation practices and regulatory guidelines.

CONCLUSIONS

The overall results of this study show that, in the agricultural regions monitored, several pesticide AIs frequently moved off-site, resulting in contamination of surface waters. These AIs include malathion, methomyl, dimethoate, methidathion, chlorpyrifos, diazinon and simazine. Detections were not limited to tributaries (smaller creeks and drains) but also occurred frequently in rivers. Most detections were insecticides and occurred in dry weather during the irrigation season.

Toxicity benchmarks were frequently exceeded; at least one US EPA benchmark was exceeded in 55% of samples. US EPA benchmarks were exceeded for diazinon (50%), chlorpyrifos (27%), dimethote (23%), malathion (18%) and methomyl (12%). Additionally, the combined effect of multiple AIs occurring in surface water simultaneously may indicate even greater impact on aquatic organisms than indicated by the comparison to individual toxicity benchmarks. Continued surface water monitoring for these AIs is recommended.

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Table 1.Department of Food and Agriculture, Center for Analytical Chemistry Method Details.

Organophosphate (OP) Insecticides in Surface Water by GC/FPD

Compound	***Method Detection Limit (µg/L)***	***Reporting Limit (µg/L)***
Azinphos methyl	0.0099	0.05
Chlorpyrifos	0.0008	0.01
Diazinon	0.0012	0.01
Dichlorvos	0.0098	0.05
Dimethoate	0.0079	0.04
Disulfoton	0.0093	0.04
Ethoprop	0.0098	0.05
Fenamiphos	0.0125	0.05
Fonofos	0.008	0.04
Malathion	0.0117	0.04
Methidathion	0.0111	0.05
Methyl Parathion	0.008	0.03
Phorate	0.0083	0.05
Profenofos	0.0114	0.05
Tribufos	0.0142	0.05

Carbamate (CB) Insecticides by LCMS.

Compound	***Method Detection Limit (µg/L)***	***Reporting Limit (µg/L)***
Aldicarb SO	0.0277	0.05
Aldicarb SO2	0.0214	0.05
Oxamyl	0.0255	0.05
Methomyl	0.0265	0.05
Mesurol SO	0.0264	0.05
3 OH-Carbofuran	0.0232	0.05
Mesuol SO2	0.0299	0.05
Aldicarb	0.0196	0.05
Carbofuran	0.0244	0.05
Carbaryl	0.0136	0.05
Mesurol	0.0270	0.05

Herbicides (TR) in Surface Water by LC/MS/MS.

Compound	***Method Detection Limit (µg/L)***	***Reporting Limit (µg/L)***
Atrazine	0.02	0.05
Simazine	0.013	0.05
Diuron	0.022	0.05
Prometon	0.016	0.05
Bromacil	0.031	0.05
Prometryn	0.016	0.05
Hexazinone	0.04	0.05
Metribuzin	0.025	0.05
Norflurazon	0.019	0.05
DEA	0.010	0.05
ACET	0.030	0.05
DACT	0.016	0.05

Thiram (TH) in Surface Water

Compound	***Method Detection Limit (µg/L)***	***Reporting Limit (µg/L)***
Thiram	0.10	0.50

Table 2. Aquatic Toxicity Benchmarks and Water Quality Criteria.

	US EPA								UCD WQC	
Chemical	AI	CI	AF	CF	CMC	CCC	ANV	AV	AWQC	CWQC
Atrazine	360	60	2650	65			1	37		
Carbaryl	0.85	0.5	110	6.8			660	1500		
Carbofuran	1.12	0.75	44	5.7						
Chlorpyrifos	0.05	0.04	0.9	0.57	0.083	0.041	140		0.01	0.01
Diazinon	0.11	0.17	45	< 0.55	0.17		3700		0.2	0.1
Dimethoate	21.5	0.5	3100	430			84			
Disulfoton	1.95	0.01	19.5	4						
Diuron	80	200	200	26			2.4	15		
Ethoprop	22	0.8	150	24			8400			
Malathion	0.3	0.035	16.4	8.6		0.1	2040		0.17	0.028
Mesurol	3.5	0.1	218	50						
Methidathion	1.5	0.66	1.1	6.6						
Methomyl	2.5	0.7	160	12						
Oxamyl	90	27	2100	770			120	30000		
Simazine	500	2000	3200	960			36	140		

All values are in ug/L.
AI= acute invertebrate; CI = chronic invertebrate; AF = acute fish; CF = chronic fish;
CMC = maximum concentration; CCC = continuous concentration;
ANV = acute nonvascular plant; AV = acute vascular plant;
AWQC = acute water quality criteria
CWQC = chronic water quality criteria.

Table 3. Primary crops by region for detected active ingredients, California, 2006-2007.

AI	Region	Spring	Summer	Fall	Winter
Atrazine	Imperial V.	sudangrass			
Chlorpyrifos	Imperial V.	alfalfa		sugarbeets (alfalfa)	
	Pajaro V.	(brussels sprouts)	(brussels sprouts)		
	S. Maria V.	broccoli (cailiflower)			
	Salinas V.	wine grapes, broccoli, cauliflower	broccoli (cauliflower)		
	Ventura	lettuce, cabbage			
Diazinon	Imperial V.	(melons, corn)		letttuce, sugarbeets (broccoli)	
	Pajaro V.	lettuce, spinach (tomatoes)	lettuce, spinach (corn)		
	S. Maria V.	lettuce, carrots			
	Salinas V.	lettuce (spinach)	lettuce (broccoli, spinach)		
	Ventura	raspberry, onion, spinach			
Dimethoate	Imperial V.	alfalfa		alfalfa (broccoli, lettuce)	
	Pajaro V.	(lettuce)			
	S. Maria V.	broccoli (cauliflower)			
	Salinas V.	broccoli (lettuce, cauliflower)	broccoli, lettuce		
	Ventura	(celerey)			
Malathion	Imperial V.	alfalfa		(alfalfa, bermuda grass)	
	Pajaro V.	strawberry (blackberry, raspbery)	strawberry		
	S. Maria V.	lettuce, strawberry	lettuce, strawberry		
	Salinas V.	strawberry, lettuce	strawberry, lettuce		
	Ventura	strawberry (celerey)			
Methomyl	Imperial V.	sweet corn, lettuce, alfalfa		lettuce (sweet corn, sugar beets)	
	Pajaro V.	(strawberry)	strawberry		
	S. Maria V.	lettuce, strawberry			
	Salinas V.	(lettuce, peas)	lettuce, strawberry, onion		
	Ventura	(cabbage, peppers)			
Simazine	Napa/Sonoma				wine grapes

Crops shown for primary AIs in regions/seasons where monitoring was conducted.
Lower use or secondary crops in parentheses.

Table 4. Pesticides detected over multiple sample events, California 2006-2007.

Site	Date(s)	Detected in all samples	Event Description
Old Salinas River at Potrero Rd.	June 19-20, 2007	diazinon, methomyl, dimethoate, methidathion	4 events, 2 days
Old Salinas River at Potrero Rd.	Mar 26-27, 2007	diazinon	2 events, 2 days
Old Salinas River at Potrero Rd.	May 14-15, 2007	diazinon, methomyl, dimethoate	4 events, 2 days
Quail Creek at HWY 101	June 18, 2007	methomyl, dimethoate, diazinon, chlorpyrifos	2 events, 1 day
Reclamation Ditch at De La Torre	May 15, 2007	malathion, diazinon, dimethoate, methomyl	3 events, 1 day
Tembladero Slough at Preston	May 14, 2007	diazinon, dimethoate, methomyl, ethoprop, chlorpyrifos (2 of 3 samples)	3 events, 1 day
Tembladero Slough at Preston	June 19, 2007	diazinon, dimethoate, methomyl, methidathion	2 events, 1 day
Watsonville Slough at Shell Road	June 19, 2007	diazinon, dimethoate	2 events, 1 day

Table 5. Malathion monitoring results by region, season, use rank and site type, California 2006-2007.

Region	Season	Use Rank	Site Type	Samples	Detects	Trace	Detection Freq. (%)	Trace Freq. (%)	AI Exceed Freq. (%)	CI Exceed Freq. (%)	CCC Exceed Freq. (%)	AWQC Exceed Freq. (%)	CWQC Exceed Freq. (%)
Imperial V.	Fall 2006	very low	R	5	2	1	40	20	20	40	40	20	40
Imperial V.	Fall 2006	very low	T	3	0	0	0	0	0	0	0	0	0
Imperial V.	Spring 2007	moderate	R	5	4	1	80	20	20	80	60	20	80
Imperial V.	Spring 2007	moderate	SALT	2	0	0	0	0	0	0	0	0	0
Imperial V.	Spring 2007	moderate	T	3	2	0	67	0	0	67	67	0	67
Pajaro V.	Spring 2007	low	R	1	0	0	0	0	0	0	0	0	0
Pajaro V.	Spring 2007	low	T	2	0	0	0	0	0	0	0	0	0
Pajaro V.	Summer 2006	moderate	T	1	0	0	0	0	0	0	0	0	0
Pajaro V.	Summer 2007	moderate	R	2	0	0	0	0	0	0	0	0	0
Pajaro V.	Summer 2007	moderate	T	2	0	0	0	0	0	0	0	0	0
S. Maria V.	Spring 2007	moderate	T	4	1	1	25	25	0	25	25	0	25
Salinas V.	Spring 2007	low	R	9	0	1	0	11	0	0	0	0	0
Salinas V.	Spring 2007	low	T	11	1	3	9	27	9	9	9	9	9
Salinas V.	Summer 2006	moderate	R	3	0	0	0	0	0	0	0	0	0
Salinas V.	Summer 2006	moderate	T	4	0	1	0	25	0	0	0	0	0
Salinas V.	Summer 2007	high	R	7	0	0	0	0	0	0	0	0	0
Salinas V.	Summer 2007	high	T	6	2	0	33	0	17	33	33	33	33
Ventura	Spring 2007	low	R	2	0	0	0	0	0	0	0	0	0
Ventura	Spring 2007	low	T	2	1	0	50	0	0	50	50	50	50
All	All	All	All	74	13	8	18	11	5	18	16	8	18

Site Type: R= river, T = tributary (creek or drain), SALT = Salton Sea.
AI= acute invertebrate; CI = chronic invertebrate; CCC = continuous concentration; AWQC = acute water quality criteria; CWQC = chronic water quality criteria.

Table 6. Malathion monitoring results by region, California 2006-2007.

Region	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	CI Exceed Freq. (%)	CCC Exceed Freq. (%)	AWQC Exceed Freq. (%)	CWQC Exceed Freq. (%)
Imperial V.	18	8	2	44	11	44	39	11	44
S. Maria V.	4	1	1	25	25	25	25	0	25
Ventura	4	1	0	25	0	25	25	25	25
Salinas V.	40	3	5	8	13	8	8	8	8
Pajaro V.	8	0	0	0	0	0	0	0	0

Table 7. Malathion monitoring results by use rank, California 2006-2007.

Use Rank	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	AI Exceed Freq. (%)	CI Exceed Freq. (%)	CCC Exceed Freq. (%)	AWQC Exceed Freq. (%)	CWQC Exceed Freq. (%)
High	13	2	0	15	0	8	15	15	15	15
Moderate	26	7	3	27	12	4	27	23	4	27
Low	27	2	4	7	15	4	7	7	7	7
Very low	8	2	1	25	13	13	25	25	13	25

Table 8. Malathion monitoring results by site type, California 2006-2007.

Site Type	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	AI Exceed Freq. (%)	CI Exceed Freq. (%)	CCC Exceed Freq. (%)	AWQC Exceed Freq. (%)	CWQC Exceed Freq. (%)
R	34	6	3	18	9	6	18	15	6	18
T	38	7	5	18	13	5	18	18	11	18

Site Type: R= river, T = tributary (creek or drain).

Table 9. Methomyl monitoring results by region, season, use rank and site type, California 2006-2007.

Region	Season	Use Rank	Site Type	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	AI Exceed Freq (%)	CI Exceed Freq (%)
Imperial V.	Fall 2006	moderate	R	5	3	0	60	0	0	20
Imperial V.	Fall 2006	moderate	T	3	2	0	67	0	0	33
Imperial V.	Spring 2007	moderate	R	5	2	0	40	0	0	0
Imperial V.	Spring 2007	moderate	SALT	1	0	0	0	0	0	0
Imperial V.	Spring 2007	moderate	T	3	0	0	0	0	0	0
Pajaro V.	Spring 2007	low	R	1	0	0	0	0	0	0
Pajaro V.	Spring 2007	low	T	2	0	1	0	50	0	0
Pajaro V.	Summer 2006	high	T	1	0	0	0	0	0	0
Pajaro V.	Summer 2007	moderate	R	2	0	0	0	0	0	0
Pajaro V.	Summer 2007	moderate	T	2	0	0	0	0	0	0
S. Maria V.	Spring 2007	very low	T	4	0	0	0	0	0	0
Salinas V.	Spring 2007	moderate	R	9	0	5	0	56	0	0
Salinas V.	Spring 2007	moderate	T	11	3	5	27	45	0	0
Salinas V.	Summer 2006	very high	R	3	1	0	33	0	0	0
Salinas V.	Summer 2006	very high	T	4	4	0	100	0	0	50
Salinas V.	Summer 2007	very high	R	7	6	0	86	0	0	0
Salinas V.	Summer 2007	very high	T	6	6	0	100	0	33	83
Ventura	Spring 2007	very low	R	2	0	0	0	0	0	0
Ventura	Spring 2007	very low	T	2	0	0	0	0	0	0
All	All	All	All	73	27	11	37	15	3	12

Site Type: R= river, T = tributary (creek or drain), SALT = Salton Sea.
AI= acute invertebrate; CI = chronic invertebrate.

Table 10. Methomyl monitoring results by region, California 2006-2007.

Region	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	AI Exceed Freq (%)	CI Exceed Freq (%)
Salinas V.	40	20	10	50	25	5	18
Imperial V.	17	7	0	41	0	0	12
Pajaro V.	8	0	1	0	13	0	0
S. Maria V.	4	0	0	0	0	0	0
Ventura	4	0	0	0	0	0	0

AI= acute invertebrate; CI = chronic invertebrate.

Table 11. Methomyl monitoring results by use rank, California 2006-2007.

Region	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	AI Exceed Freq (%)	CI Exceed Freq (%)
very high	20	17	0	85	0	10	35
moderate	41	10	10	24	24	0	5
low	3	0	1	0	33	0	0
very low	8	0	0	0	0	0	0

AI= acute invertebrate; CI = chronic invertebrate.

Table 12. Methomly monitoring results by site type, California 2006-2007.

Region	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	AI Exceed Freq (%)	CI Exceed Freq (%)
R	34	12	5	35	15	0	3
T	38	15	6	39	16	5	21

Site Type: R= river, T = tributary (creek or drain); AI= acute invertebrate; CI = chronic invertebrate.

Table 13. Simazine monitoring results by region, season, use rank and site type, California 2006-2007.

Region	Season	Use Rank	Site Type	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)
Napa/Sonoma	Winter 2006-07 (storm)	moderate	T	4	4	0	100	0
Napa/Sonoma	Winter 2006-07 (storm)	moderate	R	3	3	0	100	0
Napa/Sonoma	Winter 2006-07 (dry)	moderate	T	5	0	2	0	40
Napa/Sonoma	Winter 2006-07 (dry)	moderate	R	9	0	0	0	0
all	all	all	all	24	7	2	29	29

Site Type: R= river, T = tributary (creek or drain).

Table 14. Atrazine monitoring results by region, season, use rank and site type, California 2006-2007.

Region	Season	Site Type	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)
Imperial V.	Spring 2007	T	3	0	0	0	0
Imperial V.	Spring 2007	R	5	2	2	40	40
Imperial V.	Spring 2007	all	8	2	2	40	40

Site Type: R= river, T = tributary (creek or drain).

Table 15. Thiram monitoring results by region, season, use rank and site type, California 2006-2007.

Region	Season	Use Rank	Site Type	Samples	Detections
Salinas V.	Summer 2007	low	R	7	0
Salinas V.	Summer 2007	low	T	6	0
Ventura	Spring 2007	low	R	2	0
Ventura	Spring 2007	low	T	2	0
Pajaro V.	Summer 2007	moderate	R	2	0
Pajaro V.	Summer 2007	moderate	T	2	0
Imperial V.	Spring 2007	very low	R	5	0
Imperial V.	Spring 2007	very low	T	3	0
Imperial V.	Spring 2007	very low	SALT	1	0
Pajaro V.	Spring 2007	very low	T	2	0
Pajaro V.	Spring 2007	very low	R	1	0
S. Maria V.	Spring 2007	very low	T	4	0
Salinas V.	Spring 2007	very low	T	11	0
Salinas V.	Spring 2007	very low	R	7	0
all	all	all	all	55	0

Site Type: R= river, T = tributary (creek or drain), SALT = Salton Sea.

Table 16. Dimethoate monitoring results by region, season, use rank and site type, California 2006-2007.

Region	Season	Use Rank	Site Type	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	CI Exceed Freq. (%)
Imperial V.	Fall 2006	very low	R	5	0	0	0	0	0
Imperial V.	Fall 2006	very low	T	3	0	0	0	0	0
Imperial V.	Spring 2007	moderate	R	5	5	0	100	0	0
Imperial V.	Spring 2007	moderate	SALT	2	0	0	0	0	0
Imperial V.	Spring 2007	moderate	T	3	2	0	67	0	0
Pajaro V.	Spring 2007	low	R	1	1	0	100	0	0
Pajaro V.	Spring 2007	low	T	2	0	0	0	0	0
Pajaro V.	Summer 2006	moderate	T	1	0	0	0	0	0
Pajaro V.	Summer 2007	moderate	R	2	0	1	0	50	0
Pajaro V.	Summer 2007	moderate	T	2	0	2	0	100	0
S. Maria V.	Spring 2007	moderate	T	4	0	4	0	100	0
Salinas V.	Spring 2007	high	R	9	4	2	44	22	11
Salinas V.	Spring 2007	high	T	11	8	1	73	9	36
Salinas V.	Summer 2006	very high	R	3	1	0	33	0	0
Salinas V.	Summer 2006	very high	T	4	3	0	75	0	50
Salinas V.	Summer 2007	very high	R	7	0	5	0	71	0
Salinas V.	Summer 2007	very high	T	6	4	2	67	33	50
Ventura	Spring 2007	very low	R	2	1	1	50	50	50
Ventura	Spring 2007	very low	T	2	0	1	0	50	0
all	all	all	all	74	29	19	39	26	23

Site Type: R= river, T = tributary (creek or drain), SALT = Salton Sea. CI = chronic invertebrate.

Table 17. Dimethoate monitoring results by region, California 2006-2007.

Region	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	CI Exceed Freq (%)
Imperial V.	18	7	0	39	0	0
Pajaro V.	8	1	3	13	38	0
S. Maria V.	4	0	4	0	100	0
Salinas V.	40	20	10	50	25	25
Ventura	4	1	2	25	50	25

CI = chronic invertebrate.

Table 18. Dimethoate monitoring results by use rank, California 2006-2007.

Use Rank	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	CI Exceed Freq (%)
very high	20	8	7	40	35	25
high	20	12	3	60	15	25
moderate	19	7	7	37	37	0
low	3	1	0	33	0	0
very low	12	1	2	8	17	8

CI = chronic invertebrate

Table 19. Dimethoate monitoring results by site type, California 2006-2007.

Site Type	Samples	Detections	Trace	Detection Freq. (%)	Trace Freq. (%)	CI Exceed Freq (%)
R	**34**	12	9	35	26	6
T	38	17	10	45	26	24

Site Type: R= river, T = tributary (creek or drain); CI = chronic invertebrate.

Table 20. Chlorpyrifos monitoring results by region, season, use rank and site type, California 2006-2007.

Region	Season	Use Rank	Site Type	Samples	Detections	Detection Freq. (%)	AI Exceed Freq. (%)	CI Exceed Freq. (%)	CMC Exceed Freq. (%)	CCC Exceed Freq. (%)
Imperial V.	Fall 2006	high	R	5	5	100	100	100	100	100
Imperial V.	Fall 2006	high	T	3	2	67	33	33	33	33
Imperial V.	Spring 2007	moderate	R	5	4	80	80	80	20	80
Imperial V.	Spring 2007	moderate	SALT	2	0	0	0	0	0	0
Imperial V.	Spring 2007	moderate	T	3	3	100	67	67	33	33
Pajaro V.	Spring 2007	moderate	R	1	0	0	0	0	0	0
Pajaro V.	Spring 2007	moderate	T	2	0	0	0	0	0	0
Pajaro V.	Summer 2006	low	T	1	0	0	0	0	0	0
Pajaro V.	Summer 2007	low	R	2	0	0	0	0	0	0
Pajaro V.	Summer 2007	low	T	2	0	0	0	0	0	0
S. Maria V.	Spring 2007	high	T	4	3	75	50	50	50	50
Salinas V.	Spring 2007	high	R	9	2	22	0	0	0	0
Salinas V.	Spring 2007	high	T	11	7	64	0	18	0	18
Salinas V.	Summer 2006	high	R	3	0	0	0	0	0	0
Salinas V.	Summer 2006	high	T	4	3	75	25	25	0	25
Salinas V.	Summer 2007	high	R	7	0	0	0	0	0	0
Salinas V.	Summer 2007	high	T	6	5	83	50	50	50	33
Ventura	Spring 2007	very low	R	2	1	50	0	0	0	0
Ventura	Spring 2007	very low	T	2	0	0	0	0	0	0
All	**All**	**All**	**All**	74	35	47	24	27	18	24

Site Type: R= river, T = tributary (creek or drain), SALT = Salton Sea.
AI= acute invertebrate; CI = chronic invertebrate; CMC = maximum concentration; CCC = continuous concentration.

Table 21. Chlorpyrifos monitoring results by region, California 2006-2007.

Region	Samples	Detection	Detection Freq (%)	AI Exceed Freq (%)	CI Exceed Freq (%)	CMC Exceed Freq (%)	CCC Exceed Freq (%)	CF Exceed Freq (%)	AF Exceed Freq (%)
Imperial V.	18	14	78	67	67	44	61	0	0
Pajaro V.	8	0	0	0	0	0	0	0	0
S. Maria V.	**4**	3	75	50	50	50	50	25	25
Salinas V.	40	17	43	10	15	8	13	0	0
Ventura	4	1	25	0	0	0	0	0	0

AI= acute invertebrate; CI = chronic invertebrate; CMC = maximum concentration; CCC = continuous concentration; CF = chronic fish; AF= acute fish.

Table 22. Chlorpyrifos monitoring results by use rank, California 2006-2007.

Use Rank	Site Type	Samples	Detection	Detection Freq (%)	AI Exceed Freq (%)	CI Exceed Freq (%)	CMC Exceed Freq (%)	CCC Exceed Freq (%)	CF Exceed Freq (%)	AF Exceed Freq (%)
high	all	52	27	52	23	27	21	25	2	2
moderate	all	13	7	54	46	46	15	38	0	0
low	all	5	0	0	0	0	0	0	0	0
very low	all	4	1	25	0	0	0	0	0	0

AI= acute invertebrate; CI = chronic invertebrate; CMC = maximum concentration; CCC = continuous concentration; CF = chronic fish; AF= acute fish.

Table 23. Chlorpyrifos monitoring results by site type, California 2006-2007.

Site Type	Samples	Detections	Detection Freq. (%)	AI Exceed Freq. (%)	CI Exceed Freq. (%)	CMC Exceed Freq. (%)	CCC Exceed Freq. (%)	CF Exceed Freq. (%)	AF Exceed Freq. (%)
R	**34**	**12**	35	26	26	18	26	0	0
T	38	23	61	24	29	18	24	3	3

Site Type: R= river, T = tributary (creek or drain); AI= acute invertebrate; CI = chronic invertebrate; CMC = maximum concentration; CCC = continuous concentration; CF = chronic fish; AF= acute fish.

Table 24. Diazinon monitoring results by region, season, use rank and site type, California 2006-2007.

Region	Season	Use Rank	Site Type	Samples	Detects	Detection Freq. (%)	AI Excd Freq. (%)	CI Excd Freq. (%)	CMC Excd Freq. (%)	CF Excd Freq. (%)	AWQC Excd Freq. (%)	CWQC Excd Freq. (%)
Imperial V.	Fall 2006	moderate	R	5	5	100	80	80	80	60	80	80
Imperial V.	Fall 2006	moderate	T	3	3	100	33	33	33	33	33	67
Imperial V.	Spring 2007	very low	R	5	0	0	0	0	0	0	0	0
Imperial V.	Spring 2007	very low	SALT	2	0	0	0	0	0	0	0	0
Imperial V.	Spring 2007	very low	T	3	0	0	0	0	0	0	0	0
Pajaro V.	Spring 2007	high	R	1	1	100	0	0	0	0	0	0
Pajaro V.	Spring 2007	high	T	2	2	100	0	0	0	0	0	0
Pajaro V.	Summer 2007	high	R	2	1	0	0	0	0	0	0	0
Pajaro V.	Summer 2006	high	T	1	1	0	0	0	0	0	0	0
Pajaro V.	Summer 2007	high	T	2	2	0	0	0	0	0	0	0
S. Maria V.	Spring 2007	low	T	4	3	75	25	25	25	25	25	25
Salinas V.	Summer 2007	very high	R	7	6	100	67	17	17	0	14	57
Salinas V.	Spring 2007	very high	T	11	11	100	82	55	55	36	55	82
Salinas V.	Summer 2006	very high	T	4	4	100	75	75	75	50	75	75
Salinas V.	Summer 2007	very high	T	6	6	100	100	100	100	50	100	100
Salinas V.	Spring 2007	very high	R	9	8	89	78	67	67	11	44	78
Salinas V.	Summer 2006	very high	R	3	1	33	33	33	33	0	33	33
Ventura	Spring 2007	very low	R	2	2	100	50	50	50	50	50	50
Ventura	Spring 2007	very low	T	2	2	100	0	0	0	0	0	0
All	**All**	**All**	**All**	**74**	**58**	**78**	**50**	**41**	**41**	**22**	**38**	**51**

AI= acute invertebrate; CI = chronic invertebrate; CMC = maximum concentration; CF = chronic fish; AWQC = acute water quality criteria; CWQC = chronic water quality criteria.

Table 25. Diazinon monitoring results by region, California 2006-2007.

Region	Samples	Detection	Detection Freq (%)	AI Exceed Freq (%)	CI Exceed Freq (%)	CMC Exceed Freq (%)	CF Exceed Freq (%)	AWQC Exceed Freq. (%)	CWQC Exceed Freq. (%)
Ventura	**4**	**4**	100	25	25	25	25	25	25
Salinas V.	**40**	**36**	90	75	58	58	25	53	75
S. Maria V.	**4**	3	75	25	25	25	25	25	25
Pajaro V.	**8**	**7**	88	0	0	0	0	0	0
Imperial V.	**18**	**8**	44	28	28	28	22	28	33
Imperial V. (Fall)	**8**	**8**	100	63	63	63	50	63	75

AI= acute invertebrate; CI = chronic invertebrate; CMC = maximum concentration; CF = chronic fish; AWQC = acute water quality criteria; CWQC = chronic.

Table 26. Diazinon monitoring results by use rank.

Use Rank	Samples	Detection	Detection Freq (%)	AI Exceed Freq (%)	CI Exceed Freq (%)	CMC Exceed Freq (%)	CF Exceed Freq (%)	AWQC Exceed Freq. (%)	CWQC Exceed Freq. (%)
very high	40	36	90	75	58	58	25	53	75
high	8	7	88	0	0	0	0	0	0
moderate	8	8	100	63	63	63	50	63	75
low	4	3	75	25	25	25	25	25	25
very low	14	4	29	7	7	7	7	7	7

AI= acute invertebrate; CI = chronic invertebrate; CMC = maximum concentration; CF = chronic fish; AWQC = acute water quality criteria; CWQC = chronic water quality criteria.

Table 27. Diazinon monitoring results by site type.

Site Type	Samples	Detections	Detection Freq. (%)	AI Exceed Freq. (%)	CI Exceed Freq. (%)	CMC Exceed Freq. (%)	CF Exceed Freq. (%)	AWQC Exceed Freq. (%)	CWQC Exceed Freq. (%)
R	34	24	71	50	38	38	15	32	50
T	38	34	89	53	45	45	29	45	55

AI= acute invertebrate; CI = chronic invertebrate; CMC = maximum concentration; CF = chronic fish; AWQC = acute water quality criteria; CWQC = chronic water quality criteria. Site Type: R= river, T = tributary (creek or drain).

Tale 28. Sample Sites with simultaneous detections of multiple acetylcholinesterase-inhibiting insecticides.

Region, Season	Site Type	No. Sites Sampled	Sites with > 1 AChE I	Percent > 1 AChE I
Imperial, Fall 2006	R	5	5	100
Imperial, Fall 2006	T	3	3	100
Imperial, Spring 2007	R	5	5	100
Imperial, Spring 2007	T	3	3	100
Pajaro, Spring 2007	R	1	1	100
Pajaro, Spring 2007	T	2	0	0
Pajaro, Summer 2006	T	1	0	0
Pajaro, Summer 2007	R	2	0	0
Pajaro, Summer 2007	T	2	0	0
Salinas, Spring 2007	R	9	6	67
Salinas, Spring 2007	T	11	10	91
Salinas, Summer 2006	R	3	1	33
Salinas, Summer 2006	T	4	4	100
Salinas, Summer 2007	R	6	6	100
Salinas, Summer 2007	T	6	6	100
S. Maria, Spring 2007	T	4	3	75
Ventura, Spring 2007	R	2	2	100
Ventura, Spring 2007	T	2	2	100
OVERALL	All	71	57	80

AChEI = acetylcholinesterase-inhibiting insecticide
Site Type: R= river, T = tributary (creek or drain).

Figure 1. Monitoring regions in agricultural areas of California, 2006-07.

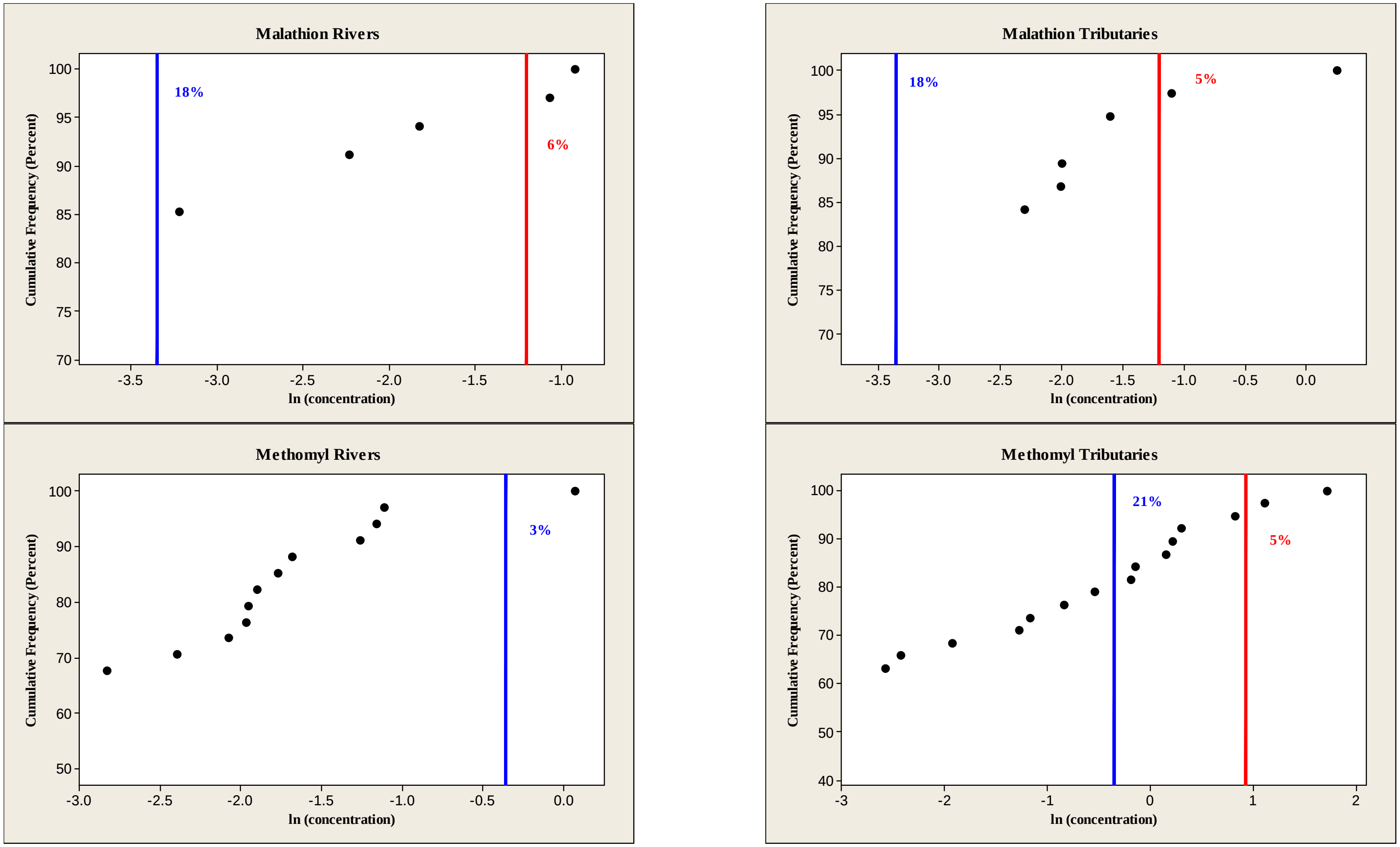

Figure 2. Cumulative frequency distribution of concentrations of malathion and methomyl in river and tributary water samples compared with US EPA benchmarks for invertebrates. Chronic invert. benchmark (blue line) = 0.035 ug/L for malathion and 0.7 ug/L for methomyl; acute invert. benchmark (red line) = 0.3 ug/L for malathion and 2.5 ug/L for methomyl. Percentages are the percentage of samples with concentrations higher than the benchmarks.

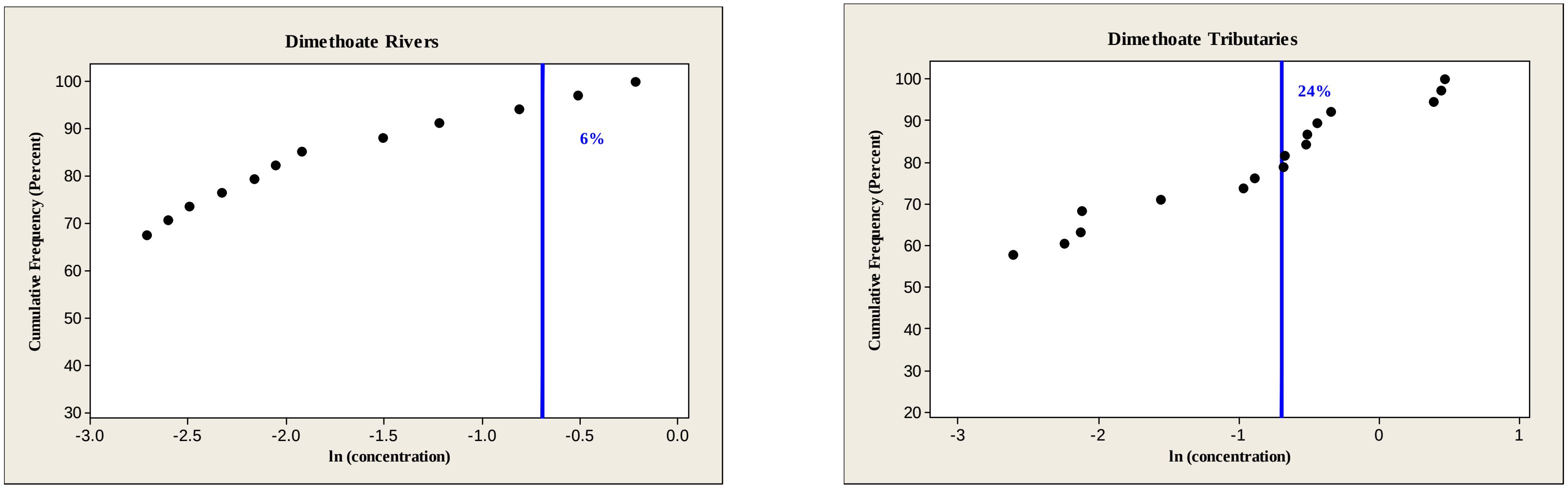

Figure 3. Cumulative frequency distribution of concentrations of dimethoate in river and tributary water samples compared with US EPA chronic benchmark for invertebrates. Chronic invertebrate benchmark (blue line) = 0.5 ug/L. No samples exceeded the acute invertebrate benchmark of 21.5 ug/L. Percentages are the percentage of samples with concentrations higher than the benchmarks.

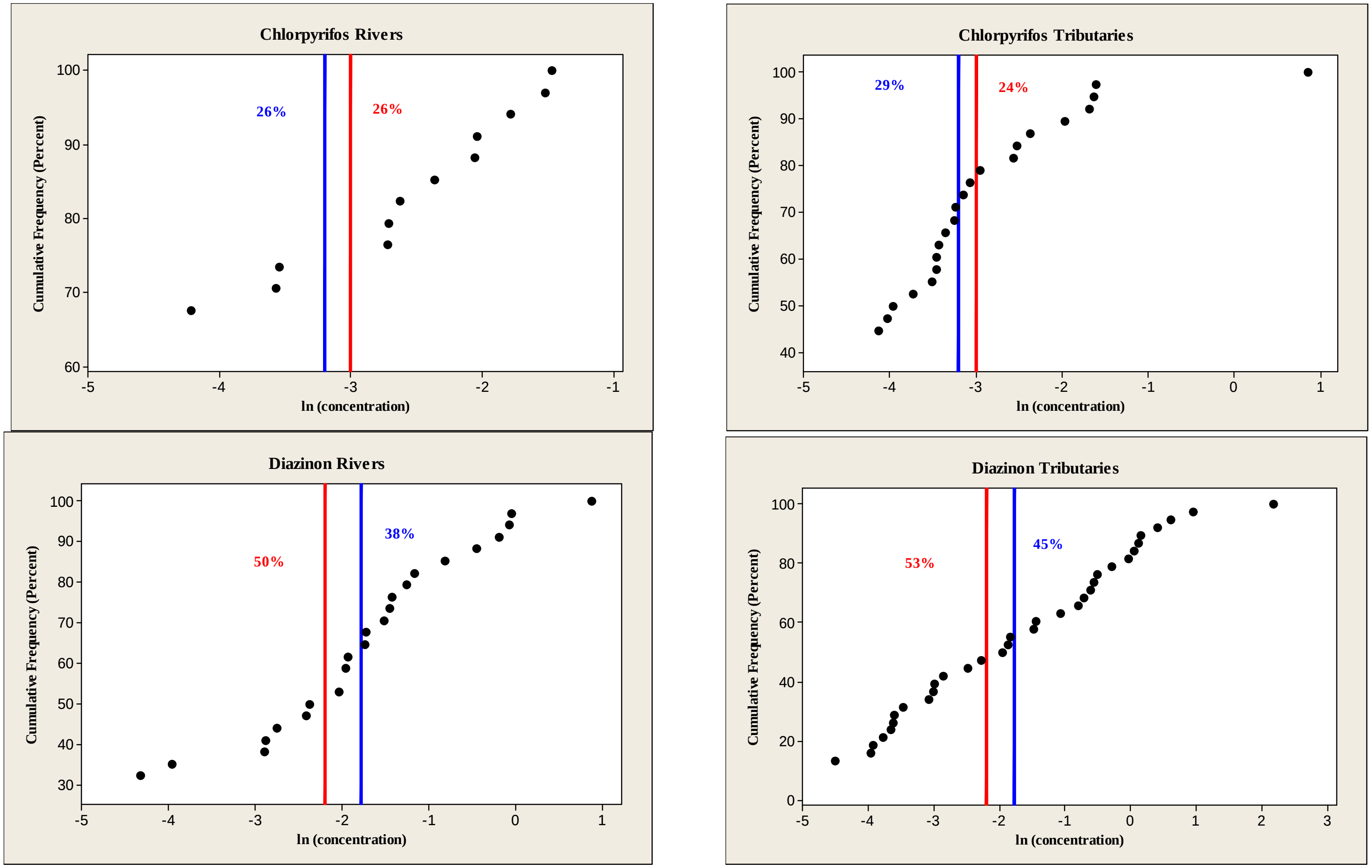

Figure 4. Cumulative frequency distribution of concentrations of chlorpyrifos and diazinon in river and tributary water samples compared with US EPA benchmarks for inverts. Chronic inverts. benchmark (blue line) = 0.17 ug/L for diazinon and 0.04 ug/L for chlorpyrifos; acute inverts. benchmark (red line) = 0.11 ug/L for diazinon and 0.05 ug/L for chlorpyrifos. Percentages are the percentage of samples with concentrations higher than the benchmarks.

Appendix 1. Water Quality Data and Field Site Information

Table A-1. Surface Water Monitoring Sample Sites.

Site Code	Sample Site	Latitude	Longitude	Region
Sal_G16	Salinas River at G16 - Greenfield	36.33785	-121.2035	Salinas
Al_78	Alamo River at HWY 78	32.97841	-115.46619	Imperial
Al_hunt	Alamo River at Hunt	32.7668	-115.35277	Imperial
Al_ruth	Alamo River at Rutherford	33.04454	-115.48738	Imperial
AlSL	Alisal Sl. Near Preston	36.76351	-121.75922	Salinas
BC	Verde Drain at Bonds Corner Rd	32.75549	-115.33678	Imperial
Call1	Calleguas Crk at HWY 1	34.1127	-119.08041	Ventura
Call2	Calleguas Crk at Lewis Rd	34.1801	-119.04302	Ventura
Chualar	Chualar Creek at River Rd	36.5581	-121.52821	Salinas
Corvina	Salton Sea at Corvina Beach	33.4774	-115.88973	Imperial
FC	Fowler Crk at Watmaugh	38.26375	-122.47338	Napa/Sonoma
Garst	Alamo River at Garst	33.19924	-115.59623	Imperial
GVC	Green Valley Crk at Old River Road	38.50259	-122.90707	Napa/Sonoma
HMD	Holtville Main Drain at HWY 115	32.93074	-115.40521	Imperial
Main	Main St. Ditch at HWY 166	34.95485	-120.4841	Santa Maria
malva	Malva Drain at Dunham Rd	33.05179	-115.48792	Imperial
MWC	Mark West Crk at Wohler Rd	38.49259	-122.88229	Napa/Sonoma
Nativ1	Natividad Creek nr Rhode Island Circle	36.70172	-121.60304	Salinas
Nativ2	Natividad Creek at E. Boronda Rd.	36.7021	-121.60112	Salinas
New_ruth	New River at Rutherford	33.04437	-115.52509	Imperial
New_vail	New River at Vail	33.10459	-115.66364	Imperial
NR_CW	Napa River at Cuttings Wharf	38.22594	-122.3067	Napa/Sonoma
NR_P	Napa River at Pope Street	38.5113	-122.45456	Napa/Sonoma
NR_T	Napa River at Trancas	38.32471	-122.28297	Napa/Sonoma
NR_Y	Napa R. at Yountville Cross Rd	38.41903	-122.35212	Napa/Sonoma
Obsid	Salton Sea at Obsidian Butte	33.17435	-115.64	Imperial
Orc	Orcutt Crk at W. Main	34.95757	-120.63149	Santa Maria
Orc2	Orcutt/Solomon Canyon Crk at HWY 1	34.94145	-120.57329	Santa Maria
Oso	Oso Flaco Crk at Oso Flaco Lake Rd	35.01637	-120.58655	Santa Maria
POT	Old Salinas River at Potrero Rd.	36.79062	-121.78937	Salinas
PR_1	Pajaro River near mouth	36.85586	-121.80226	Pajaro
PR_2	Pajaro River at Thurwacher Bridge	36.88006	-121.79204	Pajaro
Preston	Tembladero Slough at Preston	36.76485	-121.75829	Salinas
Quail	Quail Creek at HWY 101	36.60927	-121.55883	Salinas
Rec	Reclamation Ditch at De La Torre	36.66056	-121.61852	Salinas
Rev1	Revolon Slough at Hueneme	34.15081	-119.08743	Ventura
Rev2	Revolon Slough at HWY 1	34.11364	-119.08127	Ventura
RR_G128	Russian River at Geyserville (HWY 128)	38.71307	-122.89485	Napa/Sonoma
RR_H	Russian River at Healdsburg	38.60343	-122.85886	Napa/Sonoma
RR_SB	Russian River at Steelhead Beach	38.50026	-122.89851	Napa/Sonoma
RR_W	Russian River at Wohler Bridge	38.50859	-122.8828	Napa/Sonoma
RRG	Russian River at Guerneville	38.4998	-122.99612	Napa/Sonoma
RRGP	Russian R. at Goat Rock Park	38.44757	-123.12465	Napa/Sonoma
Sal_Ch	Salinas River at Chualar River Rd	36.55607	-121.54784	Salinas
SAL_DM	Salinas River at Del Monte	36.73153	-121.78144	Salinas
Sal_G16	Salinas River at G16 - Greenfield	36.33785	-121.2035	Salinas
Sal_SL	Salinas River at San Lucas Oasis Rd	36.11684	-121.02759	Salinas
SAND	Old Salinas at Sandholdt	36.79985	-121.78681	Salinas
SC_121	Sonoma Crk at HWY 121	38.24052	-122.45007	Napa/Sonoma
SC_GE	Sonoma Crk at Arnold, Glen Ellen	38.36263	-122.52396	Napa/Sonoma
WS_S1	Watsonville Sl at Shell Rd (down)	36.87127	-121.81727	Pajaro
WS_S2	Watsonville Sl at Shell Rd. (up)	36.87145	-121.81723	Pajaro

Latitude/Longitude Datum NAD27.

Table A-2. Water Quality Data.

Sample Site	Site Code	Type	Sample Date	Time	DO (mg/L)	pH	Specific EC (uS/cm)	T (C)	Salinity (ppt)
Salinas River at San Lucas Oasis Rd	Sal_SL	R	28-Aug-2006	1215	9.73	8.26	295	20.1	0.1
Salinas River at G16 - Greenfield	Sal_G16	R	28-Aug-2006	1315	8.3	8.37	321.4	23.3	0.2
Quail Creek at HWY 101	Quail	T	28-Aug-2006	1515	5.34	8.02	1405	25	0.7
Old Salinas River at Potrero Rd.	POT	R	29-Aug-2006	0805	2.2	8.05	46580	16.7	30.3
Tembladero Slough at Preston	Preston	T	29-Aug-2006	1015	6.74	8.18	2388	18.6	1.2
Reclamation Ditch at De La Torre	Rec	T	29-Aug-2006	1315	4.62	7.75	1372	21.2	0.7
Natividad Creek at E. Boronda Rd.	Nativ2	T	29-Aug-2006	1415	2.58	7.86	921	23.8	0.5
Watsonville Sl at Shell Rd. (up)	WS_S2	T	29-Aug-2006	1100	1.97	7.69	1273	16.9	0.6
New River at Vail	New_vail	R	24-Oct-2006	0945	5.77	7.73	4316	21.2	2.3
Verde Drain at Bonds Corner Rd	BC	T	24-Oct-2006	1115	7.51	7.96	2877	23	1.5
Alamo River at Hunt	Al_hunt	R	24-Oct-2006	1145	7.51	7.81	2917	22.4	1.5
Holtville Main Drain at HWY 115	HMD	T	24-Oct-2006	1230	8.38	8.02	3824	23.7	2
Alamo River at HWY 78	Al_78	R	24-Oct-2006	1345	8.42	7.92	3249	22.7	1.7
Alamo River at Rutherford	Al_ruth	R	24-Oct-2006	1430	8.78	7.95	3245	22.6	1.7
Malva Drain at Dunham Rd	malva	T	24-Oct-2006	1500	5.58	7.78	2294	28	1.2
Alamo River at Garst	Garst	R	24-Oct-2006	1545	8.01	7.7	3388	22.1	1.8
Napa River at Pope Street	NR_P	R	26-Jan-2007	0930	11.61	7.84	161	6.9	0.1
Napa R. at Yountville Cross Rd	NR_Y	R	26-Jan-2007	1015	9.99	7.73	322	7.1	0.2
Napa River at Trancas	NR_T	R	26-Jan-2007	1115	9.02	7.1	361	7.1	0.2
Sonoma Crk at Arnold, Glen Ellen	SC_GE	T	26-Jan-2007	1245	10.93	8.17	325	7.3	0.2
Fowler Crk at Watmaugh	FC	T	26-Jan-2007	1330	9.26	7.72	470	6.4	0.2
Sonoma Crk at HWY 121	SC_121	T	26-Jan-2007	1430	10.36	8.17	374	7.7	0.2
Napa River at Cuttings Wharf	NR_CW	R	26-Jan-2007	1500	11.46	7.73	16950	8.1	9.9
Russian River at Geyserville (HWY 128)	RR_G128	R	29-Jan-2007	1015	12.93	8.35	260	8.8	0.1
Russian River at Healdsburg	RR_H	R	29-Jan-2007	1100	11.89	8.43	270	9.9	0.1
Russian River at Wohler Bridge	RR_W	R	29-Jan-2007	1145	10.81	7.96	258	9.8	0.1
Mark West Crk at Wohler Rd	MWC	T	29-Jan-2007	1215	10.35	7.89	417	7.2	0.2
Green Valley Crk at Old River Road	GVC	T	29-Jan-2007	1245	12.62	7.81	338	7.2	0.2
Russian River at Guerneville	RRG	R	29-Jan-2007	1415	14.56	8.35	272	9.9	0.1
Russian R. at Goat Rock Park	RRGP	R	29-Jan-2007	1515	8.69	7.91	3690	11.7	2.0
Sonoma Crk at Arnold, Glen Ellen	SC_GE	T	09-Feb-2007	0945	10.94	7.73	152	10.9	0.1

Table A-2 (continued). Water Quality Data.

Sample Site	Site Code	Type	Sample Date	Time	DO (mg/L)	pH	Specific EC (uS/cm)	T (C)	Salinity (ppt)
Fowler Crk at Watmaugh	FC	T	09-Feb-2007	1015	10.84	7.63	155	11.0	0.1
Napa R. at Yountville Cross Rd	NR_Y	R	09-Feb-2007	1115	9.25	7.98	193	11.6	0.1
Russian River at Geyserville (HWY 128)	RR_G128	R	09-Feb-2007	1300	11.24	8.06	123	10.9	0.1
Mark West Crk at Wohler Rd	MWC	T	09-Feb-2007	1400	9.31	8.14	126	11.4	0.1
Russian River at Steelhead Beach	RR_SB	R	09-Feb-2007	1415	8.85	8.51	121	11.4	0.1
Green Valley Crk at Old River Road	GVC	T	09-Feb-2007	1445	9.91	7.56	145	11.0	0.1
New River at Vail	New_vail	R	13-Mar-2007	0900	5.4	7.66	4236	18.4	2.3
Salton Sea at Obsidian Butte	Obsid	Salton	13-Mar-2007	1000	7.05	8.34	52500	18.8	38.4
Alamo River at Garst	Garst	R	13-Mar-2007	1110	7.2	7.7	2775	18.3	1.4
New River at Rutherford	New_ruth	R	13-Mar-2007	1200	8.68	7.7	4946	19.8	2.7
Malva Drain at Dunham Rd	malva	T	13-Mar-2007	1230	7.63	8.07	1939	19.9	0.1
Alamo River at Rutherford	Al_ruth	R	13-Mar-2007	1300	8.52	7.75	2819	19.3	1.5
Holtville Main Drain at HWY 115	HMD	T	13-Mar-2007	1330	9.36	7.99	3144	18.4	1.7
Verde Drain at Bonds Corner Rd	BC	T	13-Mar-2007	1430	7.79	7.99	2439	22.7	1.3
Alamo River at Hunt	Al_hunt	R	13-Mar-2007	1500	8.24	7.6	2774	21.3	1.4
Salton Sea at Corvina Beach	Corvina	Salton	13-Mar-2007	1700	NA	NA	NA	NA	NA
Tembladero Slough at Preston	Preston	T	26-Mar-2007	1030	9.03	8.16	2337	15.9	1.2
Alisal Sl. Near Preston	AlSL	T	26-Mar-2007	1045	9.5	8.2	3505	16.6	1.9
Old Salinas River at Potrero Rd.	POT	R	26-Mar-2007	1130	5.68	8.31	14210	16.6	8.3
Salinas River at Del Monte	SAL_DM	R	26-Mar-2007	1530	6.9	8.37	3211	17.3	1.7
Old Salinas River at Potrero Rd.	POT	R	27-Mar-2007	1045	9.15	8.33	3420	13.5	1.8
Pajaro River near mouth	PR_1	R	26-Mar-2007	1215	9.54	8.01	11060	18.7	6.6
Watsonville Sl at Shell Rd (down)	WS_S1	T	26-Mar-2007	1300	10.02	7.29	23970	17.6	14.6
Oso Flaco Crk at Oso Flaco Lake Rd	Oso	T	03-Apr-2007	1015	9.61	7.7	2106	15.1	1.1
Main St. Ditch at HWY 166	Main	T	03-Apr-2007	1115	9.9	7.57	1785	16.7	0.9
Orcutt/Solomon Canyon Crk at HWY 1	Orc2	T	03-Apr-2007	1245	8.59	7.78	3008	21.7	1.6
Orcutt Crk at W. Main	Orc	T	03-Apr-2007	1415	7.75	7.81	2291	21.1	1.2
Revolon Slough at Hueneme	Rev1	T	04-Apr-2007	1115	7.92	7.82	3661	16.6	1.9
Calleguas Crk at Lewis Rd	Call2	R	04-Apr-2007	1215	8.22	8.11	1082	21.8	0.5
Calleguas Crk at HWY 1	Call1	R	04-Apr-2007	1300	10.95	8.41	2249	19.5	1.2
Revolon Slough at HWY 1	Rev2	T	04-Apr-2007	1330	11.13	8.06	4762	19.4	2.6

Table A-2 (continued). Water Quality Data.

Sample Site	Site Code	Type	Sample Date	Time	DO (mg/L)	pH	Specific EC (uS/cm)	T (C)	Salinity (ppt)
Watsonville Sl at Shell Rd. (up)	WS_S2	T	14-May-2007	1500	7.54	7.27	2066	15.6	1.1
Tembladero Slough at Preston	Preston	T	14-May-2007	1145	7.28	8.26	2264	15.9	1.2
Old Salinas River at Potrero Rd.	POT	R	14-May-2007	1230	4.92	7.67	20980	15.4	17.6
Tembladero Slough at Preston	Preston	T	14-May-2007	1345	10.3	8.34	2132	18	1.1
Old Salinas River at Potrero Rd.	POT	R	14-May-2007	1410	6.99	8.08	11320	19.1	7.8
Tembladero Slough at Preston	Preston	T	14-May-2007	1545	10.21	8.53	2032	19.8	1.1
Old Salinas River at Potrero Rd.	POT	R	14-May-2007	1615	6.7	8.13	4628	19.9	2.5
Reclamation Ditch at De La Torre	Rec	T	15-May-2007	0915	8.77	8.01	944	13.4	0.5
Natividad Creek nr Rhode Island Circle	Nativ1	T	15-May-2007	1100	8.97	8.42	1374	13.6	0.7
Reclamation Ditch at De La Torre	Rec	T	15-May-2007	1215	9.2	8.14	978	16.5	0.5
Quail Creek at HWY 101	Quail	T	15-May-2007	1245	10.35	8.25	1375	18.6	0.7
Chualar Creek at River Rd	Chualar	T	15-May-2007	1320	8.05	8.16	1685	21.2	0.9
Salinas River at Chualar River Rd	Sal_Ch	R	15-May-2007	1400	11.93	8.63	291.3	20.1	0.1
Reclamation Ditch at De La Torre	Rec	T	15-May-2007	1445	9.14	8.43	897	17	0.4
Old Salinas River at Potrero Rd.	POT	R	15-May-2007	1545	7.25	8.07	6510	19	3.6
Salinas River at Del Monte	SAL_DM	R	15-May-2007	1630	9.55	8.27	1994	18.7	1
Reclamation Ditch at De La Torre	Rec	T	18-Jun-2007	1115	7.97	8.45	1035	21.2	0.5
Quail Creek at HWY 101	Quail	T	18-Jun-2007	1200	3.48	8.06	907	24.1	0.4
Chualar Creek at River Rd	Chualar	T	18-Jun-2007	1230	7.84	8.8	19750	24.7	1
Quail Creek at HWY 101	Quail	T	18-Jun-2007	1530	2.98	8.08	871	23.9	0.4
Old Salinas River at Potrero Rd.	POT	R	19-Jun-2007	0920	7.05	8.22	3549	17.4	1.9
Pajaro River near mouth	PR_1	R	19-Jun-2007	1030	7.35	8.37	26570	18.2	16.6
Pajaro River at Thurwacher Bridge	PR_2	R	19-Jun-2007	1100	10.41	7.95	2658	18.4	1.4
Watsonville Sl at Shell Rd. (up)	WS_S2	T	19-Jun-2007	1130	6.14	7.37	2400	15.3	1.2
Old Salinas River at Potrero Rd.	POT	R	19-Jun-2007	1245	11.87	8.41	3481	18.6	1.8
Tembladero Slough at Preston	Preston	T	19-Jun-2007	1330	15.4	8.63	2264	19.3	1.1
Salinas River at Del Monte	SAL_DM	R	19-Jun-2007	1415	8.68	8.42	1966	20.6	1
Watsonville Sl at Shell Rd. (up)	WS_S2	T	19-Jun-2007	1515	6.47	7.35	1130	15.4	1.2
Old Salinas River at Potrero Rd.	POT	R	19-Jun-2007	1545	5.79	7.99	5790	17.3	3.5
Tembladero Slough at Preston	Preston	T	19-Jun-2007	1615		8.83	2271	19.9	1.2
Old Salinas at Sandholdt	SAND	R	20-Jun-2007	1035		7.94	7600	17.9	4.4
Old Salinas River at Potrero Rd.	POT	R	20-Jun-2007	1105		8.35	3647	18.7	1.9

Appendix 2. Raw Data.

Table A-3. Analytical Results.

Imperial Valley, Fall 2006

Sample Site	Type (1)	Sample Date	Time	Analyses (2)	Detections	Result (ug/L)	Benchmarks Exceeded (3)
New River at Vail	R	24-Oct-2006	0945	OP, CB	3-OH Carbofuran	0.052	No benchmark available
					Malathion	trace	none exceeded
					Diazinon	2.38	CF, AI, CI, CMC
					Chlorpyrifos	0.127	AI, CI, CMC, CCC
Verde Drain at Bonds Corner Rd	T	24-Oct-2006	1115	OP, CB	Methomyl	0.86	CI
					Diazinon	0.0459	none exceeded
Alamo River at Hunt	R	24-Oct-2006	1145	OP, CB	Methomyl	1.07	CI
					Chlorpyrifos	0.0942	AI, CI, CMC, CCC
					Diazinon	0.0553	none exceeded
Holtville Main Drain at HWY 115	T	24-Oct-2006	1230	OP, CB	Methomyl	0.31	none exceeded
					Diazinon	1.85	CF, AI, CI, CMC
					Chlorpyrifos	0.0393	none exceeded
Alamo River at HWY 78	R	24-Oct-2006	1345	OP, CB	Diazinon	0.827	CF, AI, CI, CMC
					Chlorpyrifos	0.167	AI, CI, CMC, CCC
					Malathion	0.161	CI, CCC
Alamo River at Rutherford	R	24-Oct-2006	1430	OP, CB	Methomyl	0.17	none exceeded
					Diazinon	0.926	CF, AI, CI, CMC
					Malathion	0.398	AI, CI, CCC
					Chlorpyrifos	0.217	AI, CI, CMC, CCC
Malva Drain at Dunham Rd	T	24-Oct-2006	1500	OP, CB	Chlorpyrifos	0.185	AI, CI,CMC,CCC
					Diazinon	0.102	none exceeded
Alamo River at Garst	R	24-Oct-2006	1545	OP, CB	Methomyl	0.14	none exceeded
					Diazinon	0.282	AI, CI, CMC
					Chlorpyrifos	0.23	AI, CI, CMC, CCC

(1) Type = Type of Sample Site; R = River, T = Tributary (creek or drain).
(2) Analyses: OP = organophosphates; CB = carbamates; TR = triazines / herbicides; TH = thiram. NDs not shown.
(3) Benchmarks: AI - acute invert; CI - chronic invert; CF = chronic fish; AF = acute fish; CCC = Continuous concentration; CMC = Maximum concentration.

Table A-3. Analytical Results (continued).
Imperial Valley, Spring 2007

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
New River at Vail	R	13-Mar-2007	0900	OP, CB, TH, TR	Malathion	0.107	CI, CCC
					Dimethoate	0.0825	none exceeded
					Chlorpyrifos	0.0659	AI, CI, CCC
Alamo River at Garst	R	13-Mar-2007	1110	OP, CB, TH, TR	Carbofuran	0.77	CI
					Dimethoate	0.221	none exceeded
					Atrazine	trace	none exceeded
					Malathion	0.107	CI, CCC
					Chlorpyrifos	0.0721	AI, CI, CCC
New River at Rutherford	R	13-Mar-2007	1200	OP, CB, TH, TR	Malathion	trace	none exceeded
					Dimethoate	0.0665	none exceeded
					Chlorpyrifos	0.0661	AI, CI, CCC
					Atrazine	trace	none exceeded
Malva Drain at Dunham Rd	T	13-Mar-2007	1230	OP, CB, TH, TR	Chlorpyrifos	0.194	AI, CI, CMC, CCC
					Dimethoate	0.106	none exceeded
Alamo River at Rutherford	R	13-Mar-2007	1300	OP, CB, TH, TR	Carbofuran	1.69	AI, CI
					Methomyl	0.091	none exceeded
					Disulfoton	trace	none exceeded
					Malathion	0.345	AI, CI, CCC
					Dimethoate	0.296	none exceeded
					Chlorpyrifos	0.13	AI, CI, CMC, CCC
Holtville Main Drain at HWY 115	T	13-Mar-2007	1330	OP, CB, TH, TR	Malathion	0.134	CI, CCC
					Chlorpyrifos	0.0519	AI, CI
					DEA	trace	No benchmark available
Verde Drain at Bonds Corner Rd	T	13-Mar-2007	1430	OP, CB, TH, TR	3-OH Carbofuran	0.514	No benchmark available
					Carbofuran	11.5	CF, AI, CI
					Dimethoate	0.378	none exceeded
					Malathion	0.135	CI, CCC
					Chlorpyrifos	0.0351	none exceeded
					Diuron	0.053	none exceeded
Alamo River at Hunt	R	13-Mar-2007	1500	OP, CB, TH, TR	Carbofuran	2.82	AI, CI
					Methomyl	0.186	none exceeded
					Dimethoate	0.443	none exceeded
					Malathion	0.04	CI
Salton Sea at Obsidian Butte	Salton	13-Mar-2007	1000	OP, CB, TH, TR	Atrazine	0.083	none exceeded
Salton Sea at Corvina Beach	Salton	13-Mar-2007	1700	OP, CB, TH, TR	Atrazine	0.076	none exceeded

Table A-3. Analytical Results (continued).

Napa-Sonoma, Winter 2006-07

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Mark West Crk at Wohler Rd	T	29-Jan-2007	1215	OP,TR	Diuron	0.052	none exceeded
					Simazine	trace	none exceeded
Napa River at Cuttings Wharf	R	26-Jan-2007	1500	OP,TR	Diuron	0.105	none exceeded
Napa River at Pope Street	R	26-Jan-2007	0930	OP,TR	Diuron	trace	none exceeded
Napa River at Trancas	R	26-Jan-2007	1115	OP,TR	Diuron	trace	none exceeded
Napa R. at Yountville Cross Rd	R	26-Jan-2007	1015	OP,TR	Diuron	trace	none exceeded
Sonoma Crk at HWY 121	T	26-Jan-2007	1430	OP,TR	Simazine	trace	none exceeded
Russian River at Geyserville (HWY 128)	R	29-Jan-2007	1015	OP,TR	none		none exceeded
Russian River at Healdsburg	R	29-Jan-2007	1100	OP,TR	none		none exceeded
Russian River at Wohler Bridge	R	29-Jan-2007	1145	OP,TR	none		none exceeded
Green Valley Crk at Old River Road	T	29-Jan-2007	1245	OP,TR	none		none exceeded
Russian River at Guerneville	R	29-Jan-2007	1415	OP,TR	none		none exceeded
Russian R. at Goat Rock Park	R	29-Jan-2007	1515	OP,TR	none		none exceeded
Sonoma Crk at Arnold, Glen Ellen	T	26-Jan-2007	1245	OP,TR	none		none exceeded
Fowler Crk at Watmaugh	T	26-Jan-2007	1330	OP,TR	none		none exceeded
Fowler Crk at Watmaugh	T	09-Feb-2007	1015	OP,TR	Simazine	0.182	none exceeded
Green Valley Crk at Old River Road	T	09-Feb-2007	1445	OP,TR	Simazine	0.858	none exceeded
Mark West Crk at Wohler Rd	T	09-Feb-2007	1400	OP,TR	ACET	0.078	No benchmark available
					Diuron	0.092	none exceeded
					Simazine	1.94	none exceeded
					Malathion	trace	none exceeded
Napa R. at Yountville Cross Rd	R	09-Feb-2007	1115	OP,TR	Diuron	0.095	none exceeded
					Simazine	0.556	none exceeded
Russian River at Geyserville (HWY 128)	R	09-Feb-2007	1300	OP,TR	Simazine	0.096	none exceeded
Russian River at Steelhead Beach	R	09-Feb-2007	1415	OP,TR	Diuron	0.077	none exceeded
					Simazine	0.842	none exceeded
Sonoma Crk at Arnold, Glen Ellen	T	09-Feb-2007	0945	OP,TR	Simazine	0.227	none exceeded

Table A-3. Analytical Results (continued).

Salinas Valley, Summer 2006

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Quail Creek at HWY 101	T	28-Aug-2006	1515	OP, CB	Dimethoate	1.55	CI
					Diazinon	1.51	CF, AI, CI, CMC
					Chlorpyrifos	0.0772	AI, CI, CCC
					Methomyl	1.34	CI
					Oxamyl	3.28	none exceeded
Old Salinas River at Potrero Rd.	R	29-Aug-2006	0805	OP, CB	Methomyl	0.15	none exceeded
					Diazinon	0.218	AI, CI, CMC
					Dimethoate	0.115	none exceeded
Tembladero Slough at Preston	T	29-Aug-2006	1015	OP, CB	Diazinon	0.446	AI, CI, CMC
					Dimethoate	0.0734	none exceeded
					Methomyl	0.28	none exceeded
Reclamation Ditch at De La Torre	T	29-Aug-2006	1315	OP, CB	Ethoprop	trace	none exceeded
					Malathion	trace	none exceeded
					Diazinon	8.84	CF, AI, CI, CMC
					Dimethoate	0.644	CI
					Chlorpyrifos	0.0313	none exceeded
					Methomyl	0.58	none exceeded
Natividad Creek at E. Boronda Rd.	T	29-Aug-2006	1415	OP, CB	Methomyl	2.27	CI
					Diazinon	0.0495	none exceeded
					Chlorpyrifos	0.019	none exceeded
Salinas River at G16 - Greenfield	R	28-Aug-2006	1315	OP, CB	none		none exceeded
Salinas River at San Lucas Oasis Rd	R	28-Aug-2006	1215	OP, CB	none		none exceeded

Table A-3. Analytical Results (continued).

Salinas Valley, Spring 2007

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Tembladero Slough at Preston	T	26-Mar-2007	1030	OP, CB, TH	Dimethoate	trace	none exceeded
					Diazinon	2.58	CF, AI, CI, CMC
					Chlorpyrifos	0.0177	none exceeded
Alisal Sl. Near Preston	T	26-Mar-2007	1045	OP, CB, TH	Diazinon	0.084	none exceeded
Old Salinas River at Potrero Rd.	R	26-Mar-2007	1130	OP, CB, TH, TR	Diazinon	0.439	AI, CI, CMC
					Diuron	0.121	none exceeded
Salinas River at Del Monte	R	26-Mar-2007	1530	OP, CB, TH, TR	Diazinon	0.056	none exceeded
					Diuron	trace	none exceeded
Old Salinas River at Potrero Rd.	R	27-Mar-2007	1045	OP, CB, TH, TR	Ethoprop	trace	none exceeded
					Dimethoate	trace	none exceeded
					Diazinon	0.636	CF, AI, CI, CMC
					Chlorpyrifos	0.0147	none exceeded
					Diuron	0.237	none exceeded
Tembladero Slough at Preston	T	14-May-2007	1145	OP, CB, TH	Methomyl	trace	none exceeded
					Ethoprop	trace	none exceeded
					Diazinon	0.141	AI
					Dimethoate	0.12	none exceeded
Old Salinas River at Potrero Rd.	R	14-May-2007	1230	OP, CB, TH	Diazinon	0.31	AI, CI, CMC
					Methomyl	trace	none exceeded
					Dimethoate	0.128	none exceeded
Tembladero Slough at Preston	T	14-May-2007	1345	OP, CB, TH	Methomyl	trace	none exceeded
					Ethoprop	trace	none exceeded
					Diazinon	0.153	AI
					Dimethoate	0.119	none exceeded
					Chlorpyrifos	0.0315	none exceeded

Table A-3. Analytical Results (continued).

Salinas Valley, Spring 2007 (continued)

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Old Salinas River at Potrero Rd.	R	14-May-2007	1410	OP, CB, TH	Diazinon	0.24	AI, CI, CMC
					Methomyl	trace	none exceeded
					Dimethoate	0.097	none exceeded
Tembladero Slough at Preston	T	14-May-2007	1545	OP, CB, TH	Methomyl	trace	none exceeded
					Ethoprop	trace	none exceeded
					Diazinon	0.237	AI, CI, CMC
					Dimethoate	0.12	none exceeded
					Chlorpyrifos	0.0428	CI,CCC
Old Salinas River at Potrero Rd.	R	14-May-2007	1615	OP, CB, TH	Diazinon	0.178	AI, CI, CMC
					Methomyl	trace	none exceeded
					Dimethoate	0.074	none exceeded
Reclamation Ditch at De La Torre	T	15-May-2007	0915	OP, CB, TH	Malathion	trace	none exceeded
					Diazinon	1.043	CF, AI, CI, CMC
					Dimethoate	0.6	CI
					Methomyl	0.146	none exceeded
Natividad Creek nr Rhode Island Circle	T	15-May-2007	1100	OP, CB, TH	Diazinon	0.158	AI
					Mesurol	0.223	CI
Reclamation Ditch at De La Torre	T	15-May-2007	1215	OP, CB, TH	Methomyl	0.088	none exceeded
					Malathion	trace	none exceeded
					Dimethoate	1.47	CI
					Diazinon	1.118	CF, AI, CI, CMC
					Chlorpyrifos	0.0324	none exceeded

Table A-3. Analytical Results (continued).

Salinas Valley, Spring 2007 (continued)

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Quail Creek at HWY 101	T	15-May-2007	1245	OP, CB, TH	Malathion	1.28	AI, CI, CCC
					Diazinon	0.571	CF, AI, CI, CMC
					Dimethoate	0.503	CI
					Chlorpyrifos	0.0461	CI,CCC
					Methomyl	trace	none exceeded
Chualar Creek at River Rd	T	15-May-2007	1320	OP, CB, TH	Methomyl	trace	none exceeded
					Dimethoate	0.21	none exceeded
					Diazinon	0.019158	none exceeded
					Chlorpyrifos	0.001218	none exceeded
Reclamation Ditch at De La Torre	T	15-May-2007	1445	OP, CB, TH	Methomyl	0.076	none exceeded
					Ethoprop	trace	none exceeded
					Malathion	trace	none exceeded
					Diazinon	0.538	AI, CI, CMC
					Dimethoate	0.508	CI
					Chlorpyrifos	0.0389	none exceeded
Old Salinas River at Potrero Rd.	R	15-May-2007	1545	OP, CB, TH	Ethoprop	trace	none exceeded
					Methomyl	trace	none exceeded
					Dimethoate	0.802	CI
					Diazinon	0.176	AI, CI, CMC
Salinas River at Del Monte	R	15-May-2007	1630	OP, CB, TH	Methomyl	trace	none exceeded
					Malathion	trace	none exceeded
					Dimethoate	trace	none exceeded
					Diazinon	0.13	AI
					Chlorpyrifos	0.0287	none exceeded
Salinas River at Chualar River Rd	R	15-May-2007	1400	OP, CB	none		none exceeded

Table A-3. Analytical Results (continued).

Salinas Valley, Summer 2007

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Reclamation Ditch at De La Torre	T	18-Jun-2007	1115	OP, CB, TH	Carbaryl	0.67	CI
					Methomyl	5.52	AI, CI
					Diazinon	0.6	CF, AI, CI, CMC
					Dimethoate	0.41	none exceeded
					Malathion	0.2	CI, CCC
					Chlorpyrifos	0.0241	none exceeded
Quail Creek at HWY 101	T	18-Jun-2007	1200	OP, CB, TH	Diazinon	0.75	CF, AI, CI, CMC
					Dimethoate	0.59	CI
					Malathion	0.33	AI, CI, CCC
					Chlorpyrifos	0.0939	AI, CI, CMC, CCC
					Methomyl	0.828	CI
Chualar Creek at River Rd	T	18-Jun-2007	1230	OP, CB, TH	Methomyl	3.02	AI, CI
					Ethoprop	trace	none exceeded
					Dimethoate	0.71	CI
					Diazinon	0.49	AI, CI, CMC
					Chlorpyrifos	0.0802	AI, CI, CCC
Quail Creek at HWY 101	T	18-Jun-2007	1530	OP, CB, TH	Methomyl	0.431	none exceeded
					Dimethoate	1.6	CI
					Diazinon	0.97	CF, AI, CI, CMC
					Chlorpyrifos	0.2	AI, CI, CMC, CCC
Old Salinas River at Potrero Rd.	R	19-Jun-2007	0920	OP, CB, TH	Dimethoate	trace	none exceeded
					Methidathion	0.19	none exceeded
					Diazinon	0.14	AI
					Methomyl	0.313	none exceeded
Old Salinas River at Potrero Rd.	R	19-Jun-2007	1245	OP, CB, TH	Dimethoate	trace	none exceeded
					Diazinon	0.232	AI, CI, CMC
					Methidathion	0.2	none exceeded
					Methomyl	0.329	none exceeded

Table A-3. Analytical Results (continued).

Salinas Valley, Summer 2007 (continued)

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Tembladero Slough at Preston	T	19-Jun-2007	1330	OP, CB, TH	Methidathion	trace	none exceeded
					Dimethoate	trace	none exceeded
					Diazinon	0.228	AI, CI, CMC
					Chlorpyrifos	0.03	none exceeded
					Methomyl	1.16	CI
Salinas River at Del Monte	R	19-Jun-2007	1415	OP, CB, TH	Methomyl	0.059	none exceeded
					Diazinon	0.019	none exceeded
Old Salinas River at Potrero Rd.	R	19-Jun-2007	1545	OP, CB, TH	Methomyl	0.283	none exceeded
					Dimethoate	trace	none exceeded
					Diazinon	0.144	AI
					Methidathion	0.14	none exceeded
Tembladero Slough at Preston	T	19-Jun-2007	1615	OP, CB, TH	Methidathion	trace	none exceeded
					Dimethoate	trace	none exceeded
					Diazinon	0.34	AI, CI, CMC
					Methomyl	1.23	CI
Old Salinas at Sandholdt	R	20-Jun-2007	1035	OP, CB, TH	Methidathion	trace	none exceeded
					Dimethoate	trace	none exceeded
					Diazinon	0.089	none exceeded
					Methomyl	0.142	none exceeded
Old Salinas River at Potrero Rd.	R	20-Jun-2007	1105	OP, CB, TH	Methomyl	0.125	none exceeded
					Methidathion	trace	none exceeded
					Dimethoate	trace	none exceeded
					Diazinon	0.14	AI
Salinas River at G16 - Greenfield	R	28-Aug-2006	1315	OP, CB	none	none	none exceeded

Table A-3. Analytical Results (continued).

Santa Maria Valley, Spring 2007

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Oso Flaco Crk at Oso Flaco Lake Rd	T	03-Apr-2007	1015	OP, CB, TH	Malathion	trace	none exceeded
					Dimethoate	trace	none exceeded
					Diazinon	0.023	none exceeded
Main St. Ditch at HWY 166	T	03-Apr-2007	1115	OP, CB, TH	Dimethoate	trace	none exceeded
					Malathion	0.1	CI, CCC
					Chlorpyrifos	0.016	none exceeded
Orcutt Crk at W. Main	T	03-Apr-2007	1415	OP, CB, TH	Dimethoate	trace	none exceeded
					Chlorpyrifos	2.34	AF, CF, AI, CI, CMC, CCC
					Diazinon	1.17	CF, AI, CI, CMC
Orcutt/Solomon Canyon Crk at HWY 1	T	03-Apr-2007	1245	OP, CB, TH	Dimethoate	trace	none exceeded
					Chlorpyrifos	0.14	AI, CI, CMC, CCC
					Diazinon	0.057	none exceeded

Ventura, Spring 2007

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Revolon Slough at Hueneme	T	04-Apr-2007	1115	OP, CB, TH	Diazinon	0.031	none exceeded
					Oxamyl	0.092	none exceeded
Calleguas Crk at Lewis Rd	R	04-Apr-2007	1215	OP, CB, TH	Diazinon	0.95	CF, AI, CI, CMC
					Dimethoate	0.6	CI
Calleguas Crk at HWY 1	R	04-Apr-2007	1300	OP, CB, TH	Dimethoate	trace	none exceeded
					Diazinon	0.093	none exceeded
					Chlorpyrifos	0.028	none exceeded
Revolon Slough at HWY 1	T	04-Apr-2007	1330	OP, CB, TH	Oxamyl	0.057	none exceeded
					Dimethoate	trace	none exceeded
					Malathion	0.2	CI, CCC
					Diazinon	0.05	none exceeded

Table A-3. Analytical Results (continued).

Pajaro Valley, Summer 2006, Spring and Summer 2007

Sample Site	Type	Sample Date	Time	Analyses	Detections	Result (ug/L)	Benchmarks Exceeded
Watsonville Sl at Shell Rd. (up)	T	29-Aug-2006	1100	OP, CB	Diazinon	0.0111	none exceeded
Pajaro River near mouth	R	26-Mar-2007	1215	OP, CB, TH, TR (4)	Dimethoate	0.146	none exceeded
					Diazinon	0.0637	none exceeded
Watsonville Sl at Shell Rd (down)	T	26-Mar-2007	1300	OP, CB, TH, TR (4)	Diazinon	0.0265	none exceeded
Watsonville Sl at Shell Rd. (up)	T	14-May-2007	1500	OP, CB, TH	Methomyl	trace	none exceeded
					Diazinon	0.0271	none exceeded
Pajaro River near mouth	R	19-Jun-2007	1030	OP, CB, TH	Dimethoate	trace	none exceeded
Pajaro River at Thurwacher Bridge	R	19-Jun-2007	1100	OP, CB, TH	Diazinon	0.0132	none exceeded
Watsonville Sl at Shell Rd. (up)	T	19-Jun-2007	1130	OP, CB, TH	Dimethoate	trace	none exceeded
					Diazinon	0.0257	none exceeded
Watsonville Sl at Shell Rd. (up)	T	19-Jun-2007	1515	OP, CB, TH	Dimethoate	trace	none exceeded
					Diazinon	0.0196	none exceeded

Appendix 3. Quality Control Data.

For the organophosphate (OP) insecticide screen, a total of eighteen QC samples were analyzed during the study. Of those, fourteen were blank-matrix spikes (Table A-4) and 4 were bind spikes (Table A-8). Recoveries for all of these samples were within the control limits.

For the carbamate (CB) insecticide screen, a total of twelve QC samples were analyzed. Of those, ten were blank-matrix spikes (Table A-5) and 2 were blind spikes (Table A-8). The upper control limits were exceeded for carbofuran and carbaryl in 3 blank-matrix spikes. Because the recoveries in the blank-matrix spike samples were greater than the UCL, the reported carbofuran and carbaryl concentrations in field samples analyzed with these QC samples may be biased upwards.

The associated field samples analyzed with these QC samples were collected in the field in March 2007 (Imperial Valley and Salinas Valley) and April 2007 (Santa Maria Valley). The only reported detections of these analytes in the associated samples were several carbofuran detections in samples collected in Imperial Valley in March 2007; these reported concentrations may be biased upwards.

For the triazine/herbicide (TR) screen, a total of 7 QC samples were analyzed during the study. Of those, 4 were blank-matrix spikes (Table A-6) and 3 were blind spikes (Table A-8). Recoveries for all of these samples were within the control limits.

For the thiram (TH) screen, a total of 6 QC samples were analyzed during the study. Of those, 4 were blank-matrix spikes (Table A-7) and 2 were blind spikes (Table A-8). Recoveries for the blank-matrix spikes were all within the control limits. For one of the blind spike samples, the spike was mistakenly made at a level too close to the reporting limit. The other blind spike analyzed on May 21, 2007 had low recoveries. The associated blank-matrix spike analyzed on the same day had acceptable recoveries. The reported thiram concentrations for associated field samples (collected in Salinas Valley in May, 2007) may be biased downward. All of these samples were reported as non-detections.

Table A-4. Quality Control - Organophosphate Screen.

Study 238 Continuing Quality Control- Organophosphate Screen

Extraction Date	Sample Numbers	Percent Recovery: Ethoprop	Diazinon	Disulfoton	Chlorpyrifos	Malathion	Methidathion	Fenamiphos	Azinphos-Methyl	Dichlorvos	Phorate	Fonophos	Dimethoate	Methyl Parathion	Tribufos (DEF)	Profenofos
9/1/06	5001,5004,5007,5010,5013,5016,5019,5022,5025	87.1	86.0	73.0	88.0	91.4	85.3	75.5	89.8	76	73.5	80.6	85.0	86.0	106	91.6
10/27/06	7001, 7005, 7009, 7013, 7017, 7021, 7025, 7029	91.4	98.4	94.0	117	96	88.1	97.2	88.8	75.4	75.0	76.6	73.2	73.6	80.0	77.6
1/30/07	9016, 9019, 9013, 9010, 9007, 9004, 9001	99.4	94.0	94.4	102	101	101	100	101	80	82.3	84.4	87.6	90.5	91.2	94.5
1/31/07	9022, 9025, 9028, 9031, 9034, 9037, 3040	71.7	82.8	70.0	92.4	75.4	73.6	75.3	69.6	71.4	72.9	74.9	75.5	77.3	76.8	78.3
2/1/07	5075, 5077, 5079, 5081, 5083, 5073	80.9	82.8	81	82.4	80.2	81.2	80.9	74.0	79.3	83.7	83.0	87.5	88.0	87.4	90.4
2/13/06	9046, (9085), 9043, 9049, 9052, 9055, 9058, 9061	86.4	84.8	86.5	96.8	92.6	92.8	95.1	89.1	76.2	79.1	81.5	85.0	88.0	85.2	84.7
3/15/07	7033, 7039, 7045, 7051, 7056, 7061, 7066, 7071, 7076, 7081	83.8	96.4	83.8	103	86.0	87.6	83.3	80.2	76.5	82.7	84.4	83.9	85.7	90.3	90.6
3/16/07	7034, 7040, 7046, 7052, 7057, 7062, 7067, 7072, 7077, 7080	89.1	105	90.5	112	96.0	94.6	94.2	94.4	76.8	81.1	85.9	83.9	86	89.9	91.0
3/30/07	5037, 5042, 5048, 5049, 5054, 5059, 5064, 5069, 5085, 5091, (5145)	96.0	102	91.5	114	103	107	106	112	82.5	89.7	95.0	96.2	100	102	101
4/6/07	6001, 6004, 6009, 6014, 6019, 6024, 6029, 6034, 6039	103	99.6	96.9	103	112	108	105	98	84.4	83	87.1	95.0	105	104	108

Table A-4 (continued). Quality Control - Organophosphate Screen.

Study 238 Continuing Quality Control- Organophosphate Screen (continued)

Extraction Date	Sample Numbers	Percent Recovery: Ethoprop	Diazinon	Disulfoton	Chlorpyrifos	Malathion	Methidathion	Fenamiphos	Azinphos-Methyl	Dichlorvos	Phorate	Fonophos	Dimethoate	Methyl Parathion	Tribufos (DEF)	Profenofos
5/25/07	5097, 5100, 5103, 5106, 5107, 5111, 5112, 5116, 5119, 5122, 5125, 5130	100	99.2	95.8	103	105	109	109	110	88.7	89.9	103	98.5	100	94.6	93.7
5/25/07	5149, 5150, 5154, 5155, 5159, 5162, 5164, 5167, 5170, (5173), (5177), 5133	96.4	101	88.8	102	103	102	98.3	87.7	87.4	85.6	89	88.0	92	92.9	92.6
5/29/07	5134, 5136, 5137, 5139, 5140, 5141, 5142	93.7	100	78.3	98	92.2	81.2	74.2	67.4	87.4	88.9	90.2	90.0	92.5	94.3	89.2
6/21/07	5135, 5138, 5143, 5144	93.1	98.8	81.8	99.6	95.6	92.9	88.7	92.6	79.9	83.6	89.7	84.5	82.8	88.6	87.6
6/27/07	5178, 5181, 5184, 5190, 5193, 5194, 5199, 5200, 5204, 5207, 5208	79.9	100	72.1	99.2	84.4	84.5	84.2	85.9	80.3	80.0	89.6	77.6	82.2	88.4	84.8
6/28/07	5212, 5215, 5216, 5220, 5223, 5224, 5228, 5232, 5236, 5239	88.4	98.0	79.9	98.8	89.7	87.9	83.4	89.1	87.1	88.7	90.1	83.4	90.9	96.3	93.9
Average Recovery		90.0	88.7	84.9	96.3	94.0	92.3	90.6	89.4	80.6	82.5	86.5	85.9	88.8	91.8	90.6
Standard Deviation		8.37	3.45	8.76	6.05	9.60	10.6	11.5	12.7	5.19	5.46	6.82	6.98	8.20	7.98	7.52
CV		9.29	3.89	10.3	6.28	10.2	11.5	12.7	14.2	6.44	6.62	7.88	8.12	9.23	8.70	8.30
Upper Control Limit		123	117	119	119	126	128	125	137	106	110	113	117	119	126	125
Upper Warning Limit		113	109	109	111	116	117	115	122	98.2	102	105	108	111	116	115
Lower Warning Limit		70.7	77.2	68.1	77.2	75.7	74.6	77.3	64.0	67.0	73.5	75.5	73.2	76.6	74.9	74.2
Lower Control Limit		60.2	69.2	58.0	68.8	65.7	63.9	67.9	49.4	59.2	66.3	68.1	64.5	68.0	64.7	64.1

*Highlighted cells are percent recoveries exceeding control limits

Sample numbers in parenthesis are blind spikes.

(green)	Lower Warning Limit
(yellow)	Upper Warning limit

Table A-5. Quality Control - Carbamate Screen.

Study 238 Continuing Quality Control- Carbamate water analysis

Extraction Date	Sample Number	Spike	Percent Recovery: Aldicarb sulfoxide	aldicarb sulfone and oxamyl	Aldicarb Sulfone	methiocarb sulfoxide	methomyl	3-OH Carbofuran	methiocarb sulfone	aldicarb	carbofuran	carbaryl	methiocarb	Oxamyl
9/5/06	5002,5005,5008,5011, 5014,5017,5020,5023, 5026		110	114		97	110	107	93	85	102	102	92	
10/26/06	7002,7006,7010,7014,7018,7022,7026,7030		85.3		98.9		98.7	89.7		81.9	91.1	98.6	80.5	80.0
3/26/07	7035, 7041, 7047, 7053, 7058, 7033	Spike 1	88.0	107			113	111		109	113	112	139	
		Spike 2	83.3	103			100	103		90.0	93.3	93.3	96.7	
3/26/07	7068, 7073, 7078	Spike 1	78.0	93.0			96.7	99.3		94.0	98.7	100	105	
		Spike 2	85.3	100			107	108		109	111	110	105	
3/29/07	5038, 5043, 5050, 5055, 5060, 5065, 5070, 5086,	Spike 1	80.0	100			100	107		93.3	100	173	107	
		Spike 2	80.0	91.7			103	103		96.7	103	103	100	
4/10/07	6002, 6005, 6010, 6015, 6020, 6025, 6030, 6035,	Spike 1	93.3	117			120	120		113	120	120	113	
		Spike 2	80.0	105			103	103		100	103	103	103	
5/18/07	5098, 5101, 5104, 5108, 5113, 5117, 5168, 5171,	Spike 1	66.0		86.7		86.0	81.3		82.7	84.7	88.0		
		Spike 2											97.3	100
5/19/07	5120, 5123, 5126, 5131, 5151, 5156, 5160, 5163,	Spike 1	72.0		86.7		90.7	94.7		86.7	93.3	97.3		
		Spike 2											96.0	83.3
6/22/07	5179, 5182, 5185, 5191, 5188, 5195, 5201, 5205,	Spike 1	103	98.0			93.3	92.0		82.7	93.3	97.3		
		Spike 2											98.0	92.7
6/25/07	5221, 5225, 5229, 5233, 5237, 5240	Spike 1	84.0	90.7			86.7	85.3		79.3	88.7	90.7		
		Spike 2											89.3	103
Average Recovery			84.9	102	90.8	97.0	101	100	93.0	93.1	99.7	106	102	91.7
Standard Deviation			11.3	8.56	7.04		9.81	10.6		11.2	9.97	21.1	13.5	9.98
CV			13.4	8.42	7.76		9.75	10.6		12.0	10.0	19.8	13.3	10.9
Upper Control Limit											101	108		
Upper Warning Limit		The lab ran multiple validations during this study.									96.5	103		
Lower Warning Limit		Control limits were developed with another instrument after study.									76.8	83.1		
Lower Control Limit											71.8	78.1		

Carbofuran and carbaryl control limits from 2001 validation.

CDFA experienced difficulties with this method. The method has been redeveolped with an new instrument.

(Yellow) Upper Warning limit

Red Upper Control Limit

Table A-6. Quality Control - Triazine/Herbicide Screen.

Study 238	Continuing Quality Control- Triazine											
		Percent Recovery										
Extraction Date	Sample Numbers	Atrazine	Simazine	Diuron	Prometon	Bromacil	Hexazinone	Norflurazaon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
2/1/2007	9017,9020,9014, 9011,9008,9005, 9002	87.0	93.5	88.0	95.0	91.5	99.0	96.0	91.0	92.5	94.0	88.5
2/1/2007	9023,9026,9029, 9032,9035,9038, 9041	91.5	90.5	89.5	93.0	90.0	101	92.5	96.0	88.5	87.0	83.0
2/14/2007	9047,(9086),9044, 9050,9053, 9056,9059,9062	94.0	93.5	95.0	95.5	86.0	102	92.0	100	88.5	94.5	88.5
3/19/2007	7037,7043,7049, 7055,7060,7065, 7070,7075,7080, 7082	88.5	88.5	86.0	85.5	89.5	87.0	91.0	92.0	86.5	92.0	85.5
3/28/2007	5052,5072,5088, 5094,(5148)	92.0	91.5	103	95.0	101	99.5	103	94.0	81.5	92.5	85.0
Average Recovery		90.6	91.5	92.2	92.8	91.5	97.7	94.9	94.6	87.5	92.0	86.1
Standard Deviation		2.82	2.12	6.66	4.19	5.42	6.10	4.90	3.58	4.00	2.98	2.38
CV		3.11	2.32	7.22	4.52	5.92	6.24	5.17	3.78	4.57	3.24	2.77
Upper Control Limit		105	108	118	106	117	121	113	116	140	101	115
Upper Warning Limit		98.2	101	109	99.2	111	113	107	109	128	95.7	107
Lower Warning Limit		72.2	73.2	73.4	73.8	84.9	76.9	84.8	79.1	78.3	73.7	72.4
Lower Control Limit		65.8	66.3	64.4	67.4	78.4	68.1	79.2	71.7	66.0	68.2	63.8
All within QC limits												
Sample numbers in parenthesis are blind spikes.												

Table A-7. Quality Control - Thiram Screen.

Study 238 Continuing Quality Control- Thiram			
Extraction	Sample	Percent Recovery	
Date	Numbers	spike 1	spike 2
3/15/07	7036, 7042, 7048, 7054, 7059, 7064, 7069, 7074, 7079	78.1	86.1
3/29/07	(5147), 5044, 5051, 5056, 5061, 5066, 5071, 5087, 5093, 5039	76.8	84.3
4/6/07	6003, 6006, 6011, 6016, 6021, 6026, 6031, 6036, 6041	76.4	82.5
5/21/07	5099,5102,5105,5109,5110,5114,5115, 5118,5121,5124	94.9	76.5
5/21/07	5129, 5132, 5152, 5153, 5157, 5158, 5161, 5166, 5169, (5175)	76.3	67.5
6/25/07	5180, 5183, 5186, 5189, 5192, 5196, 5197, 5202, 5203, 5206, 5210, 5211	81.7	81.5
6/26/07	5214, 5218, 5219, 5222, 5226, 5227, 5230, 5231, 5234, 5235, 5238, 5241	78.7	81.0
Average Recovery		80.4	79.9
Standard Deviation		6.66	6.24
CV		8.28	7.81
Upper Control Limit		131	131
Upper Warning Limit		116	116
Lower Warning Limit		58.0	58.0
Lower Control Limit		44.0	44.0
All QC within control limits			
Sample numbers in parenthesis are blind spikes.			

Table A-8. Quality Control - Blind Spike Data.

Blind Spike Data for Study 238

Extraction Date	Sample Number	Screen	Pesticide	Spike Level	Recovery	Percent Recovery	Exceed CI[a]
2/13/07	9085	OP	Diazinon	100	86.1	86.1	No
2/14/07	9086	TR	Diuron	0.25	0.264	106	No
3/29/07	5146	CB	Carbofuran	0.25	0.24	96.0	No
3/29/07	5147	TH	Thiram	1.00	0.32	32.0	Yes*
3/28/07	239-1116	TR	Diuron	0.2	0.192	96.0	No
3/28/07	5148	TR	Diuron	0.25	0.246	98.4	No
			Bromacil	0.40	0.371	92.8	No
3/30/07	5145	OP	Malation	0.20	0.163	81.5	No
			Dimethoate	0.25	0.207	82.8	No
5/18/07	5174	CB	Aldicarb Sulfone	0.30	0.281	93.7	No
			Carbaryl	0.25	0.243	97.2	No
5/21/07	5175	TH	Thiram	4.00	1.31	32.8	Yes
5/25/07	5177	OP	Methidathion	0.25	0.214	85.6	No
5/25/07	5173	OP	Chlorpyrifos	0.35	0.316	90.3	No

*Spiked too close to RL

[a] CL=Control Limit; Upper CL (UCL), Lower CL (LCL).

All spike and results are ppb.

Appendix 4. Use rank calculation details and malathion example.

The area of each monitoring region (Figure 1) and the total agricultural use of each AI by season (CDPR 2010a) were determined by spatial analysis (Tables A-9 and A-10). From the use and area, the use density (pounds of AI applied per square mile of region) was calculated (Table A-11). The values for use density were classified using the Natural Breaks (Jenks) method in ArcGIS 9.3 (Table A-12) and the applicable use rank assigned to each region/season (Table A-13).

Table A-9. Area of monitoring regions, California, 2006-2007.

Region	Area (square miles)
Salinas	510
Pajaro	380
Imperial	1260
Santa Maria	330
Ventura	575

Table A-10. Use of malathion by monitoring region for sampling period.

Season	Salinas	Santa Maria	Pajaro	Imperial	Ventura
Summer 2006	17853	49653	7926	877	1625
Fall 2006	10967	25000	3119	5612	4850
Spring 2007	5560	24322	6614	27698	4850
Summer 2007	36765	54190	9467	0	6557

Use in pounds of AI applied.

Table A-11. Calculated use density of malathion by monitoring region.

Season	Salinas	Santa Maria	Pajaro	Imperial	Ventura
Summer 2006	35	150	21	1	3
Fall 2006	22	76	8	4	8
Spring 2007	11	74	17	22	8
Summer 2007	72	164	25	0	11

Density in pounds AI applied per square mile of region.

Table A-12. Use rank based on use density, malathion.

Use Density	Use Rank
0 - 4	very low
5 - 17	low
18 - 35	moderate
36 - 76	high
77 - 164	very high

Table A-13. Use rank for malathion by monitoring region.

Season	Salinas	Santa Maria	Pajaro	Imperial	Ventura
Summer 2006	moderate	very high	moderate	very low	very low
Fall 2006	moderate	high	low	very low	low
Spring 2007	low	high	low	moderate	low
Summer 2007	high	very high	moderate	very low	low