Department of Pesticide Regulation

Paul E. Helliker
Director

MEMORANDUM

TO: Kean S. Goh, Ph.D.
Agriculture Program Supervisor IV
Environmental Monitoring Branch

FROM: Juanita Bacey
Environmental Research Scientist
Environmental Monitoring Branch
(916) 445-3759

DATE: February 8, 2002

SUBJECT: PRELIMINARY RESULTS OF PESTICIDE RESIDUE ANALYSIS ACUTE AND CHRONIC TOXICITY TESTING OF SURFACE WATER MONITORED IN THE SAN JUAQUIN RIVER WATERSHED, WINTER 2000-2001

SCOPE OF THIS MEMORANDUM

This memorandum provides results of water sampling conducted on the San Joaquin River (SJR) by the Department of Pesticide Regulation (DPR) for the Dormant Spray Water Quality Program. Information presented is from December 4, 2000, to March 9, 2001, and includes results from chemical analysis conducted by the California Department of Food and Agriculture (CDFA) and bioassays conducted by the California Department of Fish and Game (DFG). This memorandum summarizes one year of a five-year study beginning in 1996, designed to monitor dormant spray insecticides (chlorpyrifos, diazinon, and methidathion) in the SJR watershed. In an effort to obtain more information about pesticide residues in surface water, samples were analyzed for additional insecticides as well as selected herbicides. This memorandum does not include an in-depth interpretation of the data which will be provided in the final report.

BACKGROUND

The SJR flows west from the Sierra Nevada Mountain Range then flows north through the San Joaquin Valley and terminates in the Sacramento-San Joaquin Delta. The river extends approximately 134 miles from Friant Dam to Stevinson where flows are intermittent and approximately 60 miles to Vernalis where flows are perennial (Figure 1). The river basin, including tributary watersheds, drains approximately 15,880 square miles (Central Valley Regional Water Quality Control Board, 1994). Runoff from rainfall occurring in the San Joaquin Valley and Sierra Nevada foothills during the rainy season, October through March, creates short-term increases in river discharge. With little significant rain from June through September, river discharge during the summer is composed of primarily dam releases of snow-melt water, which is subsequently used for agricultural, urban, recreational, and wildlife purposes.

It is during the rainy season that insecticides are applied to dormant nut and stone fruit trees. The insecticides are applied along with petroleum oils to control peach twig borer, San Jose scale, European red mite, brown mite, and other pests. Rainfall and subsequent surface runoff from agricultural areas provides a mechanism for off-site movement of pesticides to the SJR.

From 1988 to 1990, the Central Valley Regional Water Quality Control Board (CVRWQCB) conducted an aquatic toxicity survey in the San Joaquin Valley. Surface water samples collected from certain reaches of the San Joaquin River watershed during this survey were acutely toxic to the water flea, *Ceriodaphnia dubia* (Foe and Connor, 1991). The cause of toxicity was not determined but was attributed to pesticides in general. Further study was conducted in the Valley during the winter of 1991-92, and the resultant toxicity was attributed to the presence of chlorpyrifos and diazinon (Foe and Sheipline, 1993; Foe, 1995; Kuivila and Foe, 1995). The toxicity found in these studies was in violation of the CVRWQCB's narrative water quality objective (Foe, 1995) which states, "All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life" (CVRWQCB, 1994).

During the winters of 1991-92 and 1992-93, DPR monitored the San Joaquin River watershed. The peak concentrations of diazinon, chlorpyrifos, methidathion, and carbaryl reported in the 1992-93 winter season were higher than those reported in 1991-92. The relatively wet weather in 1992-93 is believed to have contributed to this difference. There were 108 samples collected in the two winters. Analyses showed 10 percent of these contained chlorpyrifos, 72 percent contained diazinon, 19 percent contained methidathion, and 12 percent contained carbaryl. Of these samples wherein pesticides were detected, 1 to 13 percent exceeded the LC_{50} for *C. dubia* indicating potential acute toxicity to this organism (Ross *et al.*, 1997).

In addition, in a 1993 U.S. Geological Survey (USGS)/CVRWQCB study, diazinon concentrations in the San Joaquin River at Vernalis were detected on 12 consecutive days, and the authors concluded that chronic toxicity to *C. dubia*, due to diazinon, might be problematic at this site (Kuivila and Foe, 1995). Diazinon was also detected at acutely toxic levels in Orestimba Creek, a tributary to the San Joaquin River, during the 1992-93 dormant spray period (Domagalski, 1995). Consequently, methods designed to reduce the mass of dormant spray insecticides leaving target areas have been under investigation by DPR and growers (Ando, 1996; Anonymous, 1996; Biermann, 1996; Ross *et al.*, 1997).

A USGS report of an investigation of pesticides in storm runoff from agricultural areas at a site along the Tuolumne River and from urban drains in Modesto, California found 6 different pesticides in the predominantly agricultural samples and 15 in the mainly urban runoff samples (Kratzer, 1998). Diazinon and chlorpyrifos were detected in agricultural runoff in 100 percent and 88 percent of the 8 samples, respectively. Diazinon, carbaryl, chlorpyrifos, and malathion were each detected in 100 percent of the 10 urban samples collected. The herbicides simazine, napropamide, and dacthal were detected in 100 percent of the 8 samples collected from the agricultural runoff site and metolachlor was detected in 88 percent of the samples. Simazine, dacthal, and trifluralin were detected in all the samples collected in the urban runoff, and metolachlor, EPTC, benfluralin, pendimethalin, prometon, napropamide, and propanil were detected in 10 to 90 percent of the samples.

During the winter of 1996-97, DPR conducted toxicity monitoring at two sites in the SJR Watershed (Bennett *et al*., 1998). This was the first year of sampling for the five-year study plan. The first half of winter was unusually wet with flooding followed by unseasonably dry weather during the second half of winter. Of the water samples collected from Orestimba Creek, 7 to 20 percent contained residues of diazinon, carbofuran, and dimethoate. *C. dubia* survival ranged from 40 to 100 percent for acute toxicity tests. Of the 24 water samples collected from the San Joaquin River near Vernalis, 12 percent contained diazinon residues, with a maximum concentration of 0.070 µg/L. Chronic toxicity was not detected in the eight weekly sets of water samples collected at this site.

During the winter of 1997-98, river discharge remained high from January through the end of sampling in March compared to historical levels for these months (Anderson *et al.*, 1995). It was a wet season (Department of Water Resources, 1998) much like the winter before. Eighteen samples were collected from Orestimba Creek. Insecticide detections included diazinon, with the highest concentration being 0.139 µg/L. Of the samples collected, 6 to 33 percent had herbicide detections of bromacil, cyanazine, diuron, and simazine. Four of the 18 samples tested for acute toxicity had significantly reduced survival compared to the control; only one sample with reduced survival correlated to a pesticide detection (diazinon, diuron, and simazine) (Ganapathy, 1998).

At the SJR site, during this same season, diazinon was detected in 33 percent of the 30 samples collected. Methidathion was detected in 10 percent and coincided with diazinon detections. The herbicides bromacil, cyanazine, diuron, and simazine were also detected at this site. In one sample collected, there was no *C. dubia* survival in the chronic toxicity test. The sample had detectible levels of diazinon, methidathion, diuron, and simazine. There was no significant toxicity found in the remaining samples.

During the 1998-99 winter, rainfall was significantly lower than the previous year during the same period. During this study (Ganapathy, 1999), there were no detections of organophosphate or carbamate insecticides in the 20 samples collected at the Orestimba Creek site. However, several herbicides were detected, including bromacil, simazine, cyanazine, and prometryn. Diuron was detected in all 20 samples. There was no significant mortality detected in any acute toxicity sample collected at Orestimba Creek.

Of the 30 samples collected from the SJR, diazinon was detected in 10 percent. Similar to the Orestimba Creek samples, there were no other organophosphate or carbamate insecticides detected. Several herbicides were detected, including diuron, which was detected in every sample. There was no significant mortality in any chronic toxicity sample collected at the SJR.

In the 1999-2000 winter season study (Jones, 2000), there were no detections of carbamate insecticides in the 20 samples collected at the Orestimba Creek site. However, a few organophosphates were detected. Diazinon was detected in 20 percent of the 20 samples collected. The herbicide diuron was detected in 80 percent of the samples. Several other herbicides were also detected including simazine, which was found in 55 percent of the samples. There was no significant mortality detected in any acute toxicity samples collected at Orestimba Creek.

From the SJR, diazinon was detected in 10 percent of the 30 samples collected. Fonofos was also detected one time. There were no other organophosphate or carbamate insecticides detected. Diuron was detected in every sample and simazine was detected in 50 percent of the samples. Bromacil, prometryn, and cyanazine were detected in 3 to 10 percent of the samples. There was no significant mortality in any chronic toxicity sample collected at the SJR.

This study is the fifth and last in DPR’s five-year effort that began during the winter of 1996-97. The objective of this study is to monitor dormant spray pesticides and the occurrence of acute and chronic toxicity to *C. dubia* in the SJR watershed during the dormant spray season. Monitoring was conducted specifically during winter months for organophosphate and carbamate insecticides that are historically applied to dormant nut and stone fruit orchards (Table 1). Additionally, in order to gain more information about pesticide residues in state surface waters, samples were analyzed for selected herbicides (Table 1). A companion study, similar to that reported in Nordmark (1998), was conducted to monitor pesticide levels and toxicity in the Sacramento River. Long-term monitoring of acute and chronic toxicity will help scientists at DPR to evaluate the effectiveness of programs designed to decrease the runoff of dormant spray insecticides.

MATERIALS AND METHODS

Site Description

The same sites were sampled as in the four previous years of DPR’s five-year effort. One site each was selected for acute and chronic toxicity monitoring. Acute toxicity sampling was conducted at Orestimba Creek, a western tributary to the SJR, as this site receives runoff that is predominantly agricultural (Figure 1). Chronic toxicity sampling was conducted at the SJR near Vernalis, as this site receives discharges from all of the rivers major agricultural tributaries, including the Merced, Tuolumne, and Stanislaus Rivers. Discharge records for both monitoring sites were available from collocated gauging stations.

Sample Collection and Handling
Background samples were collected during the week of December 4, 2000, prior to the onset of the dormant spray application season. Dormant-season sampling began on January 2, 2001 and continued through March 9, 2001, when dormant-spray applications ceased.

Water samples were collected near center channel at both Orestimba Creek at River Road and the SJR near Vernalis. Each sample was taken using a depth-integrated sampler (D-77), equipped with a Teflon® bottle and nozzle. When flow was too low to use the D-77 sampler at Orestimba Creek, a Teflon® bottle attached to a pole was used to collect the sample. At both sites, sub-samples were composited in a larger 38-liter stainless steel container until 12 liters were collected. This composite sample was then stored on wet ice until it was delivered to the DPR West Sacramento field office later that day.

Samples were transported to the field office, where they were split using a Geotech® 10-port splitter into nine 1-liter amber glass bottles with Teflon® lined caps. For both sites, two 1-liter samples were submitted to DFG for toxicity testing. Four 1-liter samples were submitted for chemical analyses: one each for the organophosphate, carbamate, diazinon, and herbicide analyses. Two 1-liter backups were stored at the field office and an additional 1-liter was used for acidification purposes (see below).

Samples designated for organophosphate and carbamate chemical analysis were preserved by acidification with 3N hydrochloric acid to a pH of 3.0 to 3.5. Most organophosphate and carbamate pesticides are sufficiently preserved at this pH (Ross *et al.*, 1996). Diazinon, however, rapidly degrades under acidic conditions and therefore was analyzed from a separate unacidified sample. Samples submitted for herbicide analysis and toxicity tests were not acidified. Samples were stored in a 4°C refrigerator until transported to the appropriate laboratory (on wet ice) for analysis. All primary samples were delivered to the testing laboratory the same day they were collected except when there was a Monday holiday, in which case samples were delivered early on Tuesdays.

Environmental Measurements
Temperature, dissolved oxygen (DO), pH, and electrical conductivity (EC) were measured *in situ* at each sampling site. DO was measured with an YSI (Yellow Springs Instruments®) DO meter (model 58). Water pH was measured with a Sentron® pH meter (model 1001). Water temperature and EC were measured with an Orion® conductivity meter (model 142). Additionally, the DFG's Aquatic Toxicity Lab (ATL) upon delivery of their samples measured alkalinity, hardness, and ammonia. Totals of alkalinity and hardness were measured with a Hach® titration kit. Total ammonia was measured with an Orion® multi-parameter meter (model 290A) fitted with an Orion® ammonia ion selective electrode
(model 95-12).

Daily rainfall and discharge data were also gathered for the study area. Daily rainfall measurements were obtained courtesy of the Modesto Irrigation District office in Modesto, CA about 15 miles east of the Vernalis site (Modesto Irrigation District, 2001) and Yancey Lumber and Hardware in Patterson, CA, 8 miles north west of the Orestimba Creek site (Figure 1) (Quiroba, 2001). Discharge data were collected at collocated USGS gauging stations at both the SJR at Vernalis and Orestimba Creek at River Road. Rainfall and discharge information will be used to follow annual changes in pesticide concentrations with respect to fluctuations in flow and will also be useful for modeling efforts, should they be undertaken.

Pesticide Analysis and Toxicity Tests

Analysis

Pesticides included in our analyses were chosen based on historical use during the dormant spray season in the watershed (DPR, 1995-2000), previous detections in the watershed, and the need to standardize analyses with the Sacramento River study. For this study, organophosphate and carbamate insecticides and soil applied herbicides (triazine herbicides, diuron, and bromacil) were analyzed. In this fifth year of sampling the herbicide norflurazon was added to the triazine screen along with three triazine breakdown products, ACET, DEA, and DACT. There were three separate screen analyses with diazinon being analyzed in a fourth (Table 1).

Chemical analyses were performed by the CDFA Center for Analytical Chemistry. The organophosphate insecticides were analyzed using gas chromatography (GC) equipped with a flame photometric detector. The carbamate insecticides were analyzed using High Performance Liquid Chromatography (HPLC), post column-derivatization, and a fluorescence detector. The herbicides were analyzed by LC/MS/MS with an APCI (Atmospheric Pressure Chemical Ionization) source. The pesticides and reporting limits are listed in Table 1. Detailed analytical methods will be provided in the final report.

Acute or chronic toxicity tests were performed on water samples that were collected. Acute toxicity tests were performed twice per week, with samples collected on Monday and Wednesday. One chronic toxicity test was conducted weekly using water samples collected on Monday, Wednesday, and Friday. Water collected on Monday was used to begin the chronic toxicity tests. Water collected on Wednesday and Friday was used to renew chronic test water.

Quality Control

Quality control (QC) for the chemistry portion of this study was conducted in accordance with Standard Operating Procedure QAQC001.00 (DPR, 1996), and consisted of a continuing QC program, plus the submission of four rinse blanks of the splitting equipment and 29 blind spikes submitted for the Sacramento and San Joaquin river studies. Blind spike and continuing QC results for each of the analytical screens are presented in Tables 2 through 6. Study 199 and 200 refer to the Sacramento and San Joaquin river studies, respectively. There were no detections of any pesticides in any of the four rinse blank samples (not in tables). The 29 blind spikes were submitted for both studies along with the regular field samples. The blind spikes contained 36 chemical analytes (Table 2-6). More detailed quality control data, including method development, the establishment of control limits, spike recoveries, and analysis of QC will be included in the final report.

Toxicity Tests
For Orestimba Creek, one sample per collection event was delivered to the DFG's ATL for acute toxicity testing. Acute tests were performed in undiluted sample water using 96-hour, static-renewal bioassays with the cladoceran *C. dubia* in accordance with current U. S. Environmental Protection Agency procedures (U.S. EPA, 1993). From the SJR, one sample per collection event was delivered to DFG's ATL for chronic toxicity testing. Chronic tests were performed using a seven-day bioassay with *C. dubia* in accordance with current U.S. EPA (1994) procedures. Test organisms used in chronic testing were placed in sample water on day one of the testing. Test water was replenished on days three and five with new water collected from the site on Wednesdays and Fridays. All bioassays were commenced and renewal water used within 36 hours of sample collection. Data were reported as the percent survival for both acute and chronic tests and the average number of offspring per female adult (fecundity) for the chronic tests.

RESULTS

Environmental Measurements

Orestimba Creek
Temperature in Orestimba Creek ranged between 4.9 and 12 ^{O} C. Dissolved oxygen ranged from 9.0 to 11.57 mg/L, with percent saturation ranging from 81 to 95%. The pH measurements ranged between 7.6 and 8.2, and EC measurements ranged from 499 to 843 µS/cm (Figure 2).

Rainfall this winter season was similar to last year. The rainfall reported at Patterson, California during the monitoring period of January 2 to March 9, 2001 was 7.59 inches (Figure 3). Last year 8.52 inches of rainfall was reported at the same site during the same period. The daily mean discharge at the USGS gauging station along Orestimba Creek at River Road ranged from 0.99 to 495 cfs (cubic feet per second) (Figure 3), which is much lower than last year's range of 2.7 to 986 cfs. These data are provisional and subject to change.

San Joaquin River near Vernalis
Temperature in the San Joaquin River ranged between 7.4 and 13.2 ^{O} C. Dissolved oxygen ranged from 8.22 to 10.4 mg/L, with percent saturation ranging from 78 to 91%. The pH ranged between 6.7 and 7.8, and EC measurements ranged from 471 to 1067 µS/cm (Figure 4).

Rainfall reported by the Modesto Irrigation District during the monitoring period of January 2, 2001 to March 9, 2001 totaled 8.71 inches (Figure 5). Last year, 10.28 inches of rainfall occurred during the same period. The daily mean discharge at this site ranged from 2024 to 5679 cfs (Figure 5) compared to last year's discharge of 1581 to 15,514 cfs. These data are provisional and subject to change.

Pesticide Concentrations and Toxicity Data

Orestimba Creek

Of the 20 samples collected there were no carbamate insecticide detections and only one organophosphate detection (0.042 µg/L diazinon on January 4) (Figure 6). There had been no rain for a period of 21 days prior to this detection. There were many herbicide detections, with diuron being detected in 100% of the samples collected (Figures 6 & 7). Diuron detections ranged from 0.09 to 8.45µg/L, bromacil was detected three times (15%) at concentrations ranging from 0.066 to 0.073 µg/L, and prometryn four times (20%) at 0.06 to 0.212 µg/L. Prometon and hexazinone were both detected two times each (10%) prometon at 0.155 and 0.24 µg/L, and hexazinone at 0.06 and 0.05 µg/L. Simazine was detected twelve times (60%) and norflurazon eleven times (55%); of these detections, they were detected together ten times. Concentrations ranged from 0.058 to 0.237 µg/L for simazine and 0.05 to 0.304 µg/L for norflurazon. All pesticide detections are listed in Table 7.

Four of the 20 samples were acutely toxic to *C. dubia* (Table 7). Three of these samples had 40% or greater mortality. There were no detections of diazinon on any of these samples, but diuron detections ranged from 0.3 µg/l to 5.8 µg/l. Other pesticides detected in these samples included norflurazon, prometryn, simazine, and ACET, with detects ranging from 0.06 to 0.30 µg/l. No pesticide detections exceeded the 96 hour LC_{50} (Table 8) for the aquatic organism *Daphnia magna*.

San Joaquin River near Vernalis

Of the 29 samples collected there were no carbamate insecticides detected. Diazinon was detected 4 times (14%) ranging from 0.044 to 0.131 µg/L (Figures 8 & 9). Detections of diazinon occurred 1 to 6 days after a rain event. Each rain event totaled less than 0.91 inches of rain. Similar to Orestimba Creek, there were many herbicide detections, with diuron being detected in every sample collected, ranging from 0.125 to 5.16 µg/L (Figure 8). There were 14 detections (48%) of bromacil ranging from 0.05 to 0.342 µg/L. Every sample collected from February 5, 2001 to March 9, 2001 had a detection of prometryn; concentrations ranged from 0.05 to 0.51 µg/L. Simazine was detected 20 times (69%) at concentrations of 0.05 to 0.629 µg/L and norflurazon was detected 21 times (72%) at 0.053 to 0.557 µg/L. ACET was detected only 1 time (3%) at 0.097 µg/L. All pesticide detections are listed in Table 7.

Except for the February 12-16, 2001 and March 5-9, 2001 samples, no chronic toxicity test had less than 80% survival (Table 7). In the February 12-16, 2001 samples, there was 60% survival in the sample (control survival 90%) and no statistically significant difference between the reproduction in the control and in the samples. The March 5-9, 2001 samples had 50% survival in the sample (control survival 90%) and the mean fecundity was 6.3 offspring (control mean fecundity 21.7offspring). Diazinon was detected once on February 12, 2001 at 0.044 µg/l. Diuron was detected on all of these sample days with detects ranging from .92 to 4.26µg/l. The following pesticides were also found in all of these samples: bromacil, norflurazon, prometon, prometryn, and simazine. Detects ranged from 0.05 to 1.26 µg/l. The March 5-9 samples also had one detection of hexazinone (0.16 µg/l). No pesticide detections exceeded the 96 hour LC_{50} (Table 8) for the aquatic organism *Daphnia magna*.

References

Anderson S.W., P.D. Hayes, and G.L. Rockwell. 1995. Water resources data California, Water year 1994. Volume 3. Report CA-94-3. U.S. Geological Survey. Sacramento, California

Ando, C. 1996. Investigation of possible management practices to reduce dormant spray runoff from soil plots (study protocol). California EPA/Department of Pesticide Regulation, Environmental Hazards Assessment Program. May 24, 1996.

Anonymous, 1996. Everett Souza shares HUA story. Westside Water, March 1996.

Bennett, K.P., Nordmark, C.E. J. Schuette, H. Feng, J. Hernandez, and P. Lee. 1998. Occurrence of aquatic toxicity and Dormant-spray pesticide detections in the San Joaquin River Watershed, winter 1996-97. Department of Pesticide Regulation. Environmental Hazards Assessment Program. Sacramento, California Report # EH 98-02.

Biermann, H. 1996. Study 152: Effect of ground cover on dormant spray runoff from orchards (study protocol). Department of Pesticide Regulation, Environmental Hazards Assessment Program. November 1996.

CVRWQCB, 1994. (Central Valley Regional Water Quality Control Board) Water quality control plan (Basin Plan): Central Valley Region, Sacramento River and San Joaquin River Basins. December 9, 1994.

CA Dept. of Fish & Game. Hazard Assessment of the insecticide Diazinon to aquatic organisms in the Sacramento-San Joaquin River System. Report #94-2.

CA Dept. of Fish & Game. Aquatic Toxicology Laboratory. 2000.

California Department of Pesticide Regulation. 1995. Pesticide Use Report Database. Sacramento, California

California Department of Pesticide Regulation. 1996. Standard Operating Procedure for Chemistry Laboratory Quality Control. SOP # QAQC001.00. DPR, Environmental Hazards Assessment Program. Sacramento, California

California Department of Pesticide Regulation. Aquatic Toxicology Registration Database. 2001.

California Department of Water Resources. 1998. Web site address: http//cdec.water.ca/cgi-progs/iodir/WSIHIST.

Domagalski, J.L. 1995. Nonpoint sources of pesticides in the San Joaquin River, California: input from winter storms, 1992-93. U.S. Geological Survey Open-File Report 95-165. National Water-Quality Assessment Program. Sacramento, California.

Foe, C. 1995. Insecticide concentrations and invertebrate bioassay mortality in agricultural return water from the San Joaquin Basin. Central Valley Regional Water Quality Control Board. December 1995.

Foe, C. and V. Connor. 1991. San Joaquin Watershed bioassay results, 1988-90. Central Valley Regional Water Quality Control Board. July 1991.

Foe, C. and R. Sheipline. 1993. Pesticides in surface water from applications on orchards and alfalfa during the winter and spring of 1991-92. Central Valley Regional Water Quality Control Board. February 1993.

Herbicide Handbook. 7th Edition, 1994. Weed Science Society of America

Quiroba, P. 2001. Personal communication, March 23, 2001. Daily rainfall data collected at Yancey Lumber and Hardware Store in Patterson, California. Data deemed reliable by staff at CDF, Del Puerto Station in Patterson.

Kratzer, C.R. 1998. Pesticides in storm runoff from agricultural and urban areas in the Tuolumne River Basin in the vicinity of Modesto, California. U.S. Geological Survey, Water-Resources Investigations report 98-4017. National Water-Quality Assessment Program. Sacramento, California.

Kuivila, K. And C. Foe. 1995. Concentrations, transport and biological effects of dormant spray pesticides in the San Francisco estuary, California. Environ. Toxicol. Chem. 14(7):1141-1150.

Modesto Irrigation District, 2001. 2000-2001 daily rainfall data. Personal communication with D.Bakker. March 23, 2001.

Nordmark, C. 1998. Study 178:Protocol for monitoring acute and chronic toxicity in the Sacramento River Watershed, Winter 1998-99. Department of Pesticide Regulation.

The Pesticide Manual. 11th Edition, 1994. C.D.S. Tomlin, British Crop Protection Council.

Ross, L.J., R. Stein, J. Hsu, J. White, and K. Hefner. 1996. Distribution and mass loading of insecticides in the San Joaquin River, California: Winter 1991-92 and 1992-93. Department of Regulation. Environmental Hazards Assessment Program. Sacramento, California. Report # EH 96-02.

Ross, L.J., K.P. Bennett, K. D. Kim, K.Hefner, J. Hernandez. 1997. Reducing dormant spray runoff from orchards. Department of Pesticide Regulation. Environmental Hazards Assessment Program. Sacramento, California. Report # EH 97-03.

U.S. Environmental Protection Agency. 1991. Pesticide Ecological Effects Database, Ecological Effects Branch, Office of Pesticide Programs, Washington, DC.

U.S. Environmental Protection Agency. 1993. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 4th ed. EPA/600/4-90/027F. August 1993.

U.S. Environmental Protection Agency. 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms. 3rd ed. EPA-600-4-91-002. July 1994.

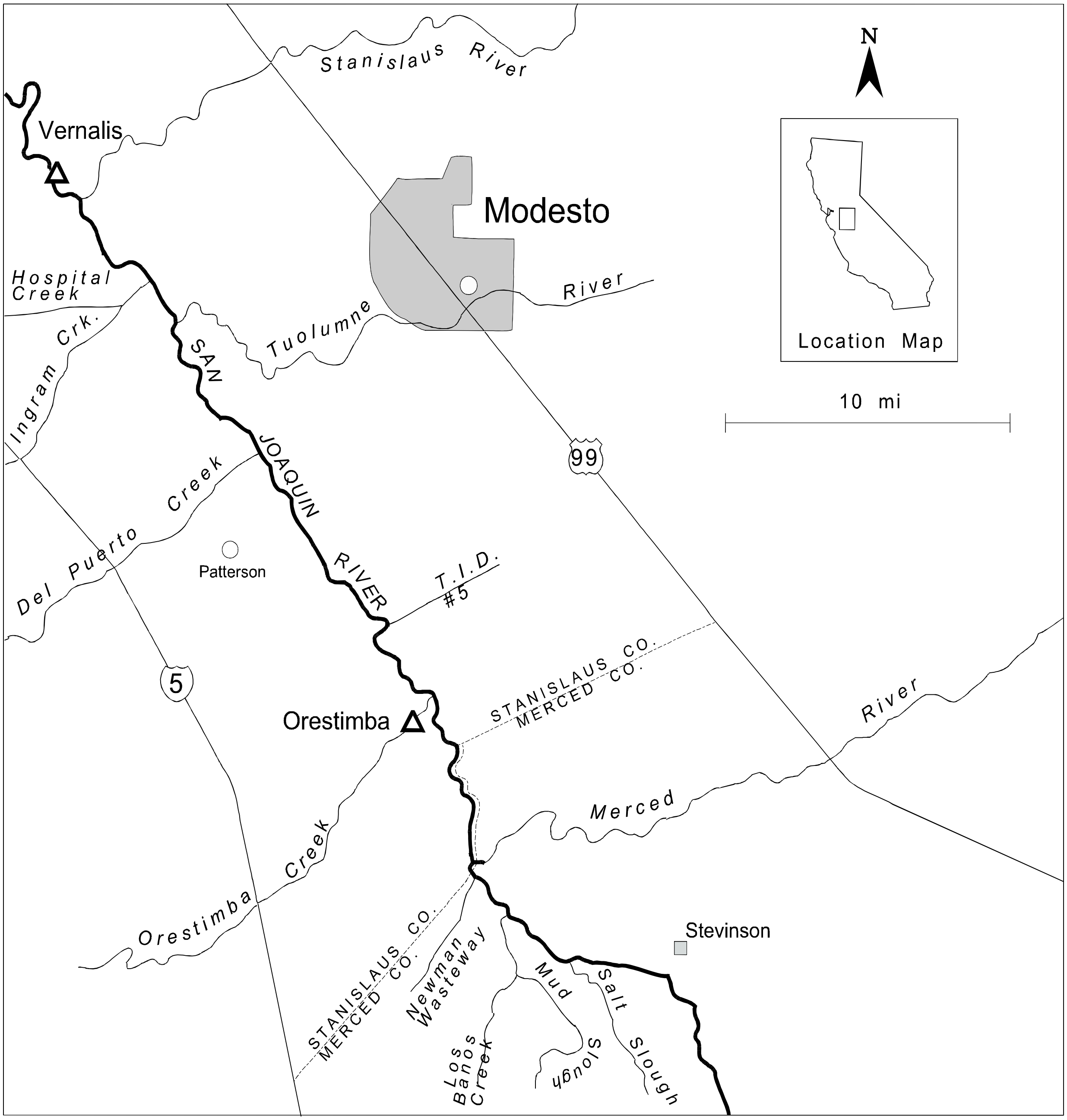
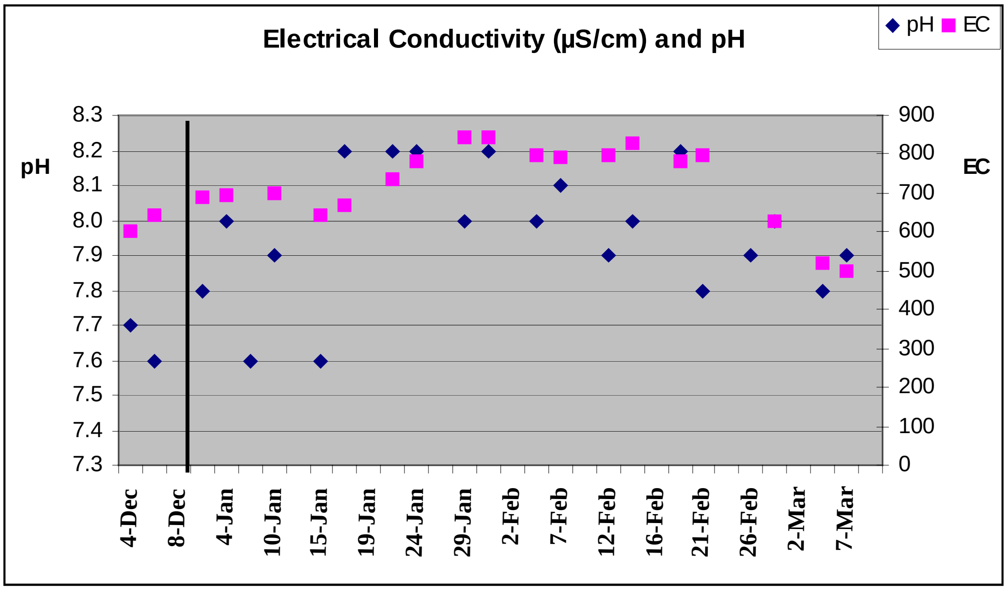


Figure 1. Location of toxicity sampling sites (Δ) and rainfall stations (○) in the San Joaquin River Watershed: Winter 1999-2000.



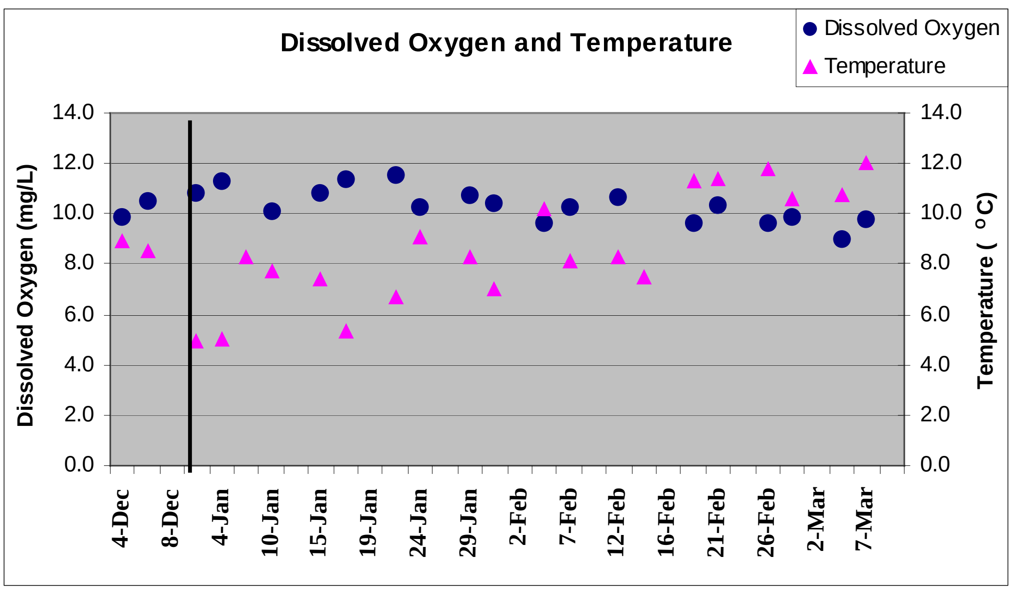


Figure 2. Environmental measurements for Orestimba Creek at River Road. Data was collected from December 4 through 8, 2000 for background samples and from January 2 through March 9, 2001 for dormant season samples. Data was collected two times each week during the study period.

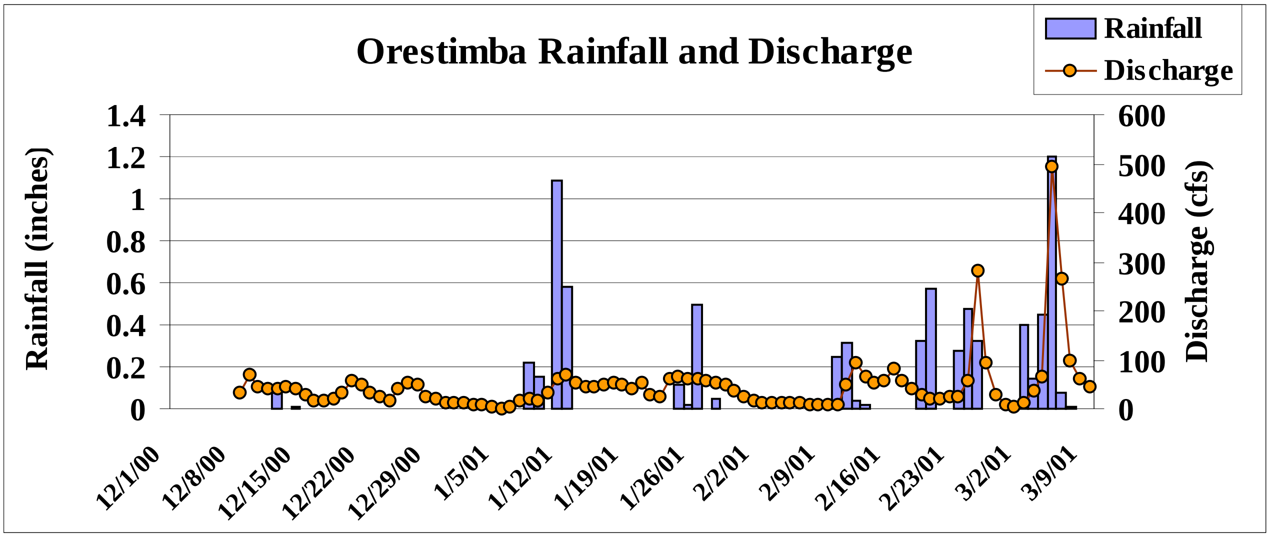
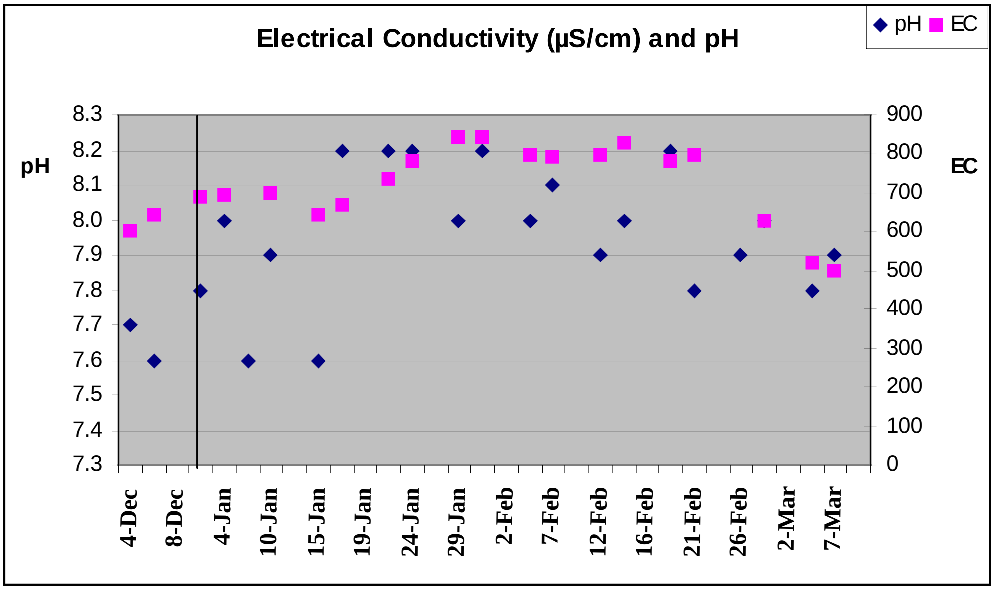


Figure 3. Rainfall measured at Patterson, CA. Discharge measured in Orestimba Creek at River Road.



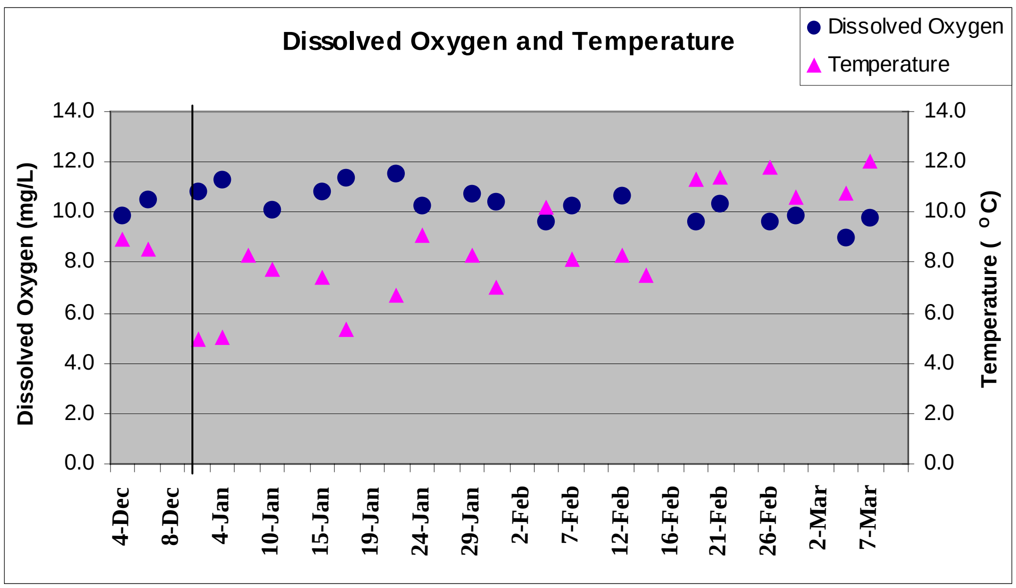


Figure 4. Environmental measurements for the San Joaquin River at Vernalis. Data was collected from December 2 and 4, 2000 for background samples and January 2 through March 9, 2001 for dormant season samples. Data was collected three times each week during the study period.

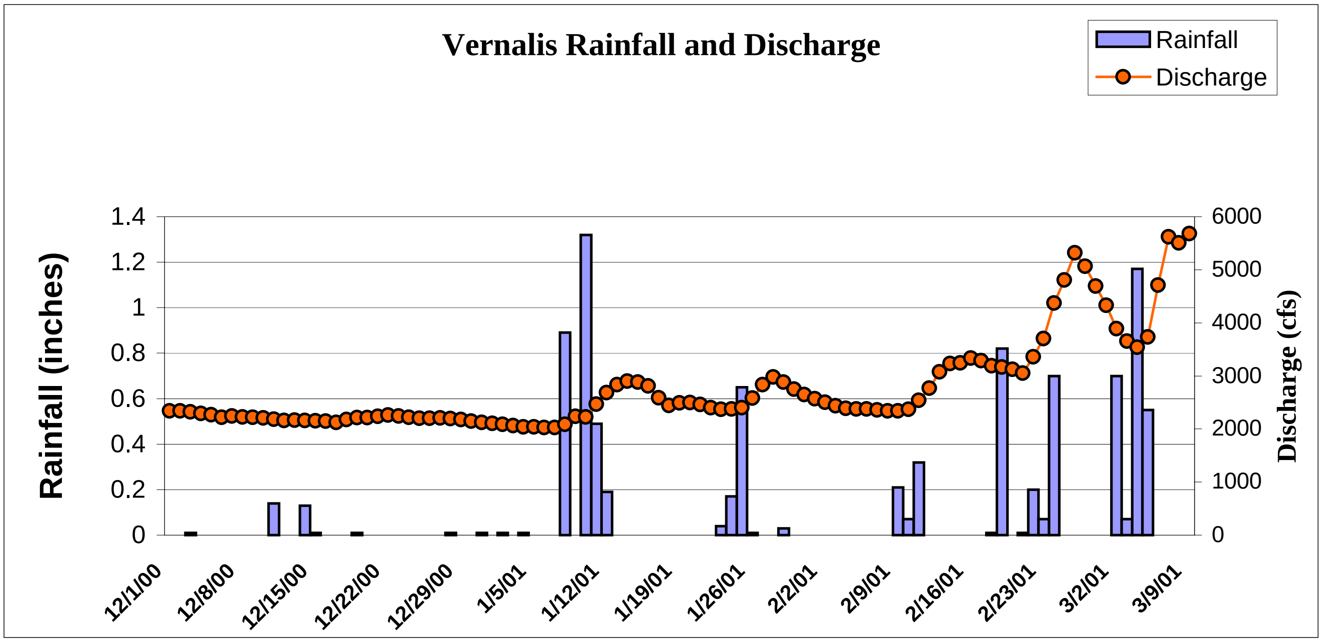
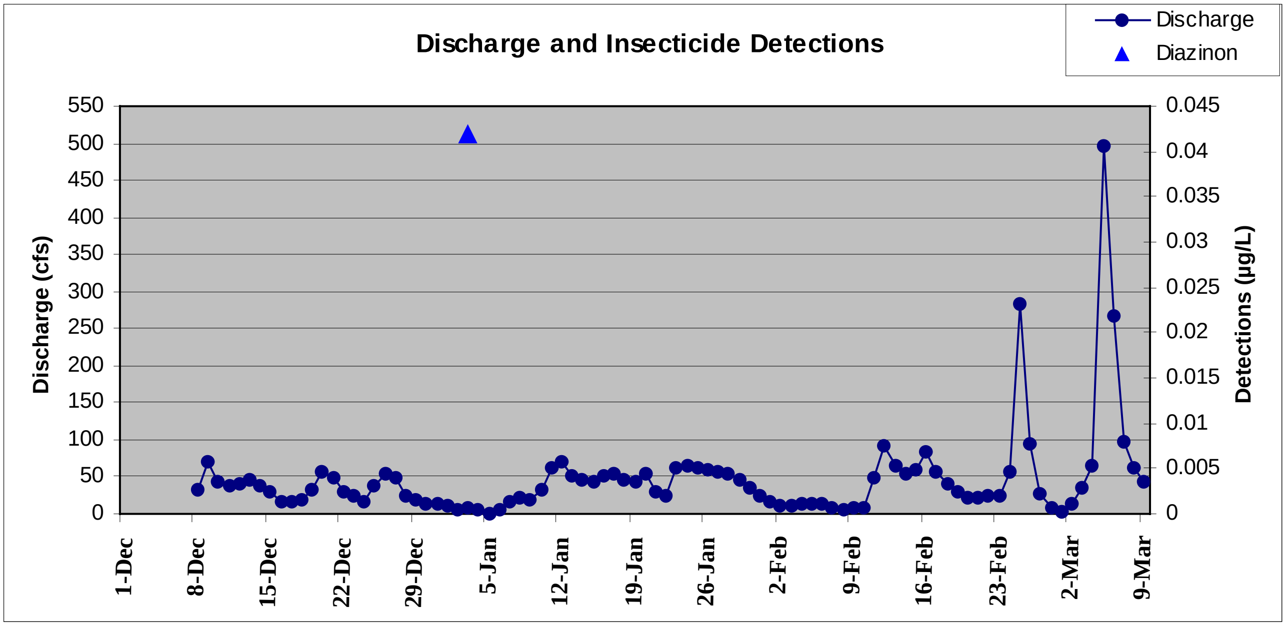


Figure 5. Rainfall measured at Modesto. Discharge measured in the San Joaquin River near Vernalis.



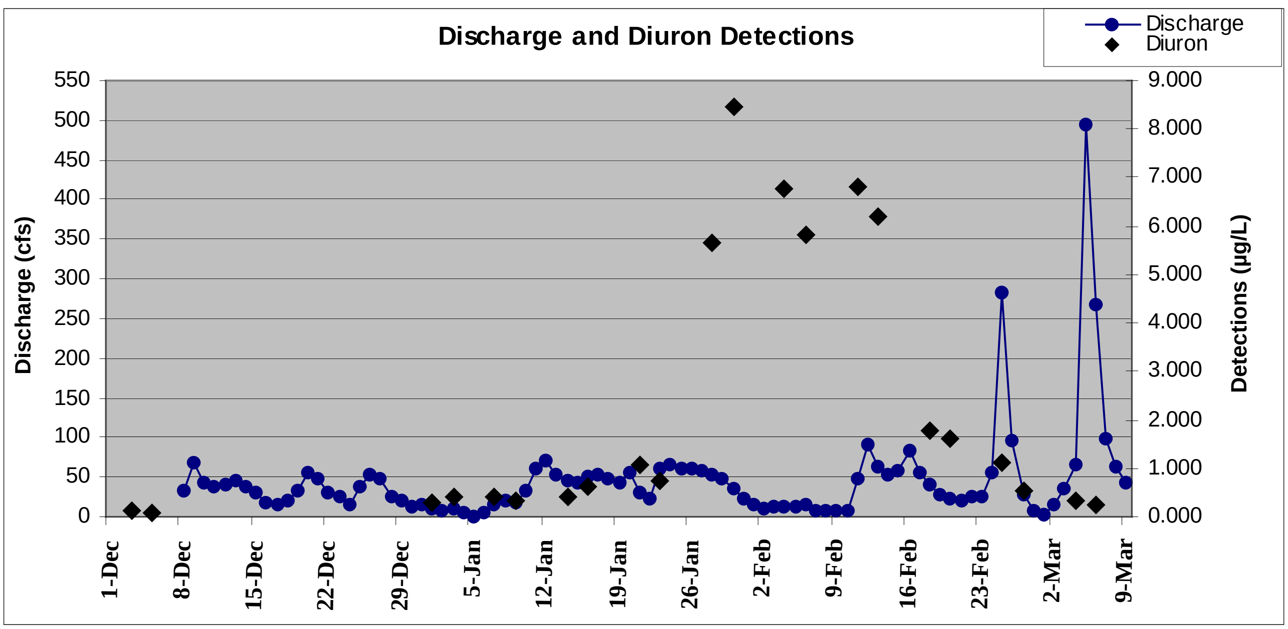


Figure 6. Discharge, insecticides, and diuron herbicide measured in Orestimba Creek at River Road.

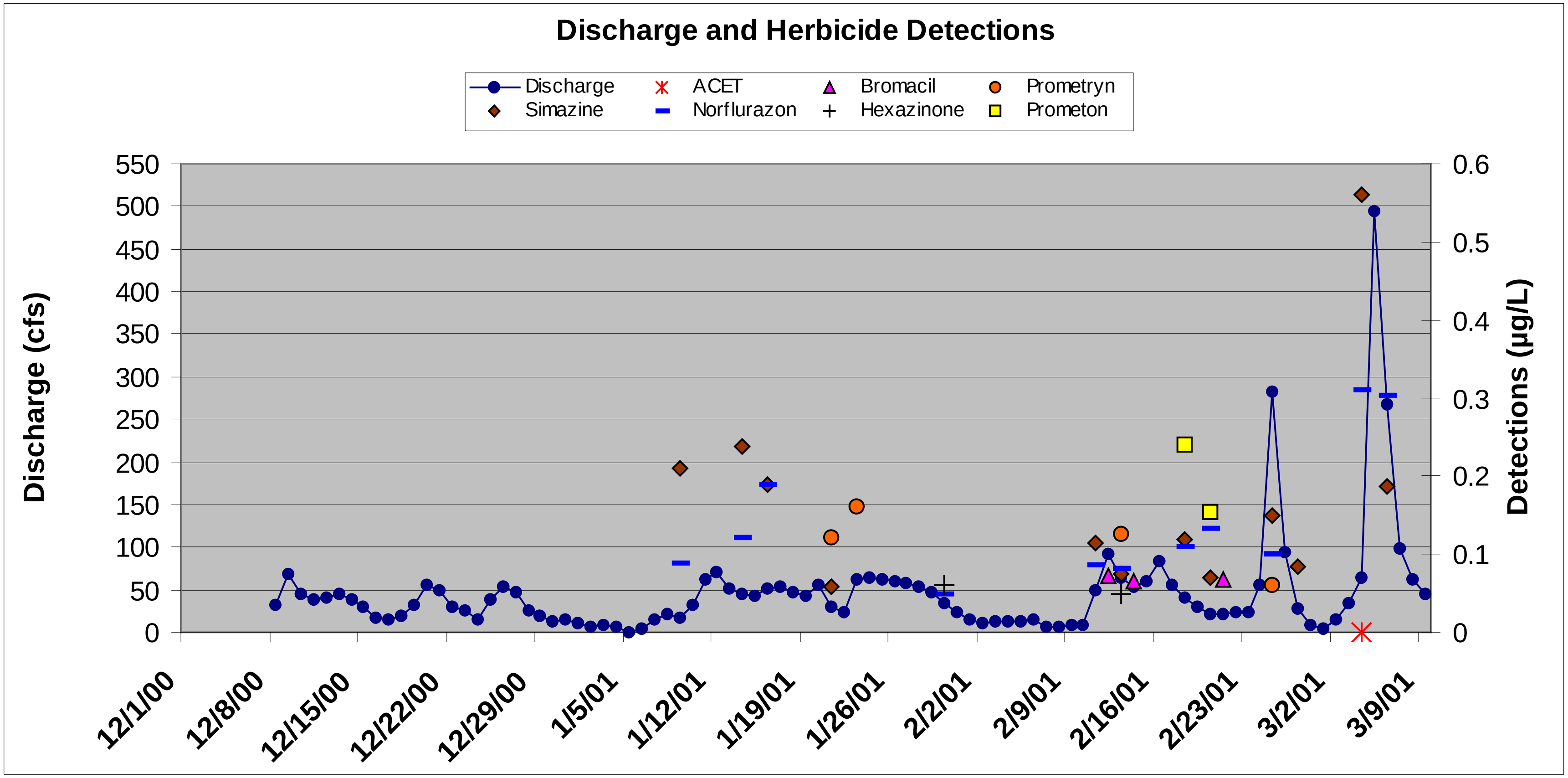


Figure 7. Discharge and other herbicides measured in Orestimba Creek at River Road.

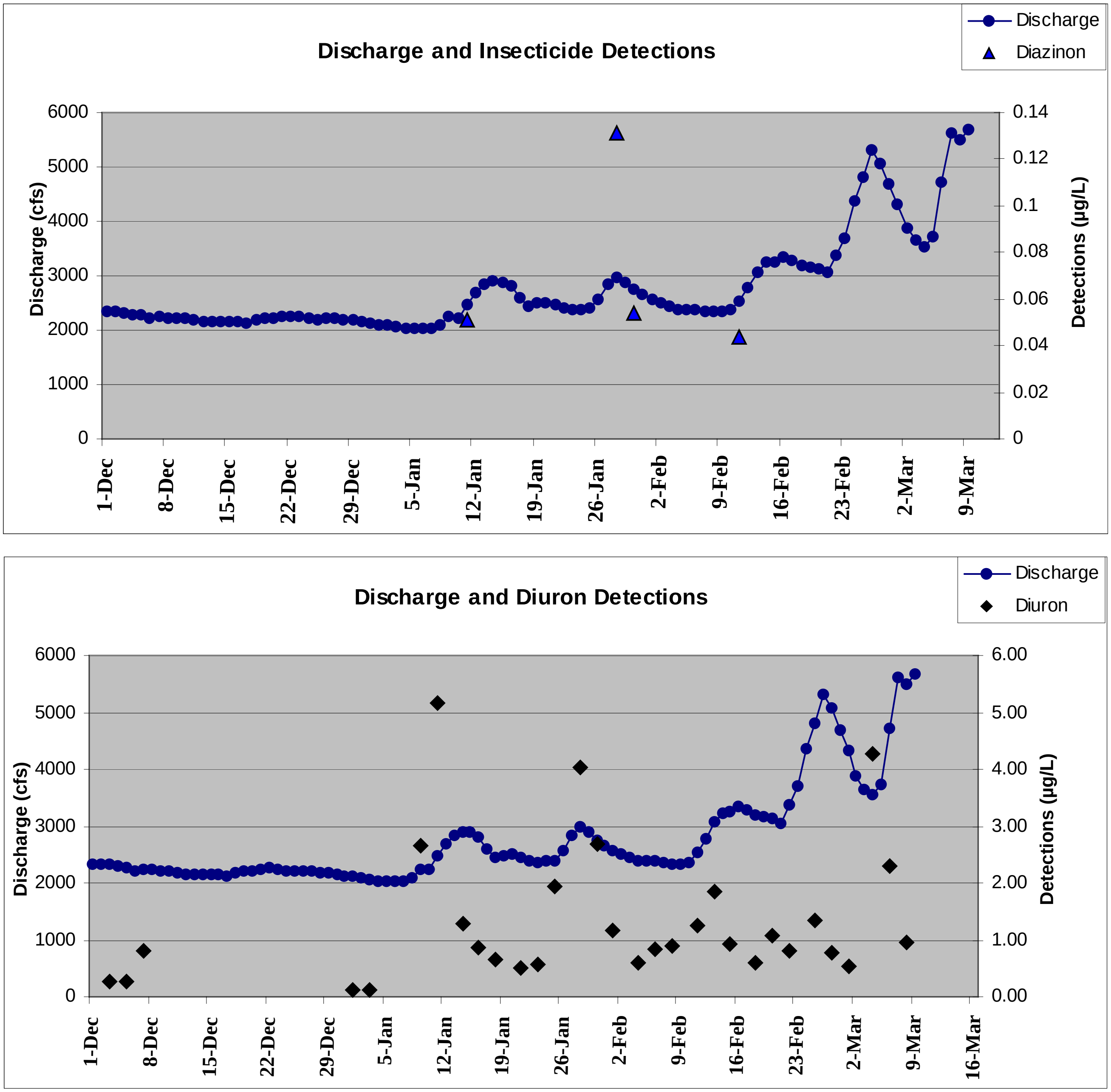


Figure 8. Discharge, insecticides, and diuron herbicide measured in the San Joaquin River near Vernalis.

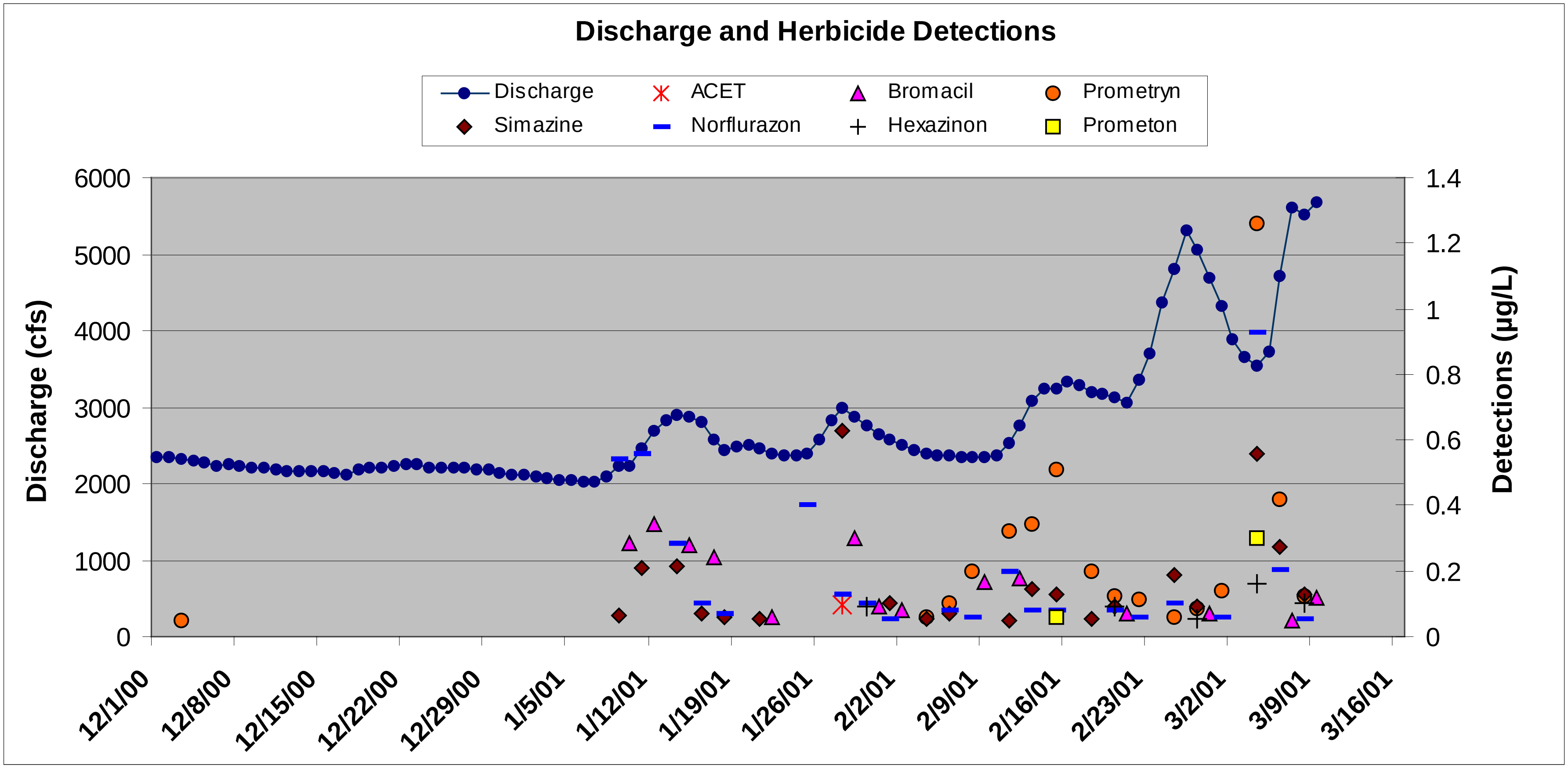


Figure 9. Discharge and other herbicides measured in the San Joaquin River near Vernalis.

Table 1. California Department of Food and Agriculture, Center for Analytical Chemistry organophosphate and carbamate insecticide and multiple herbicide screens for the San Joaquin River toxicity monitoring study.

Organophosphate Pesticides in Surface Water by GC Method: GC/FPD		N-Methyl Carbamate in Surface Water by HPLC Method: HPLC/Post Column-fluorescence		Herbicides in Surface Water by HPLC Method: HPLC/Post Column-fluorescence	
Compound	**Reporting Limit (µg/L)**	**Compound**	**Reporting Limit (µg/L)**	**Compound**	**Reporting Limit (µg/L)**
Chlorpyrifos	0.04	Carbaryl	0.05	Atrazine	0.05
Diazinon[1]	0.04	Carbofuran	0.05	Bromacil	0.05
Dimethoate (Cygon)	0.05			Diuron	0.05
Fonofos	0.05			Norflurazon	0.05
Malathion	0.05			Hexazinone	0.05
Methidathion	0.05			Metribuzin	0.05
Methyl parathion	0.05			Prometon	0.05
Phosmet	0.05			Prometryn	0.05
				Simazine	0.05
				AEA, ACET, DACT	0.05

[1] Diazinon is analyzed from a separate, unpreserved, split sample. Other OP and CB chemical samples are preserved with 3N HCl to a pH of 3-3.5 to retard analyte degradation. See text.

Table 2. Blind Spike Recoveries for the San Joaquin River and Sacramento River Studies.

Extraction Date	Study Number[a]	Sample Number	Screen	Pesticide	Spike Level	Recovery	Percent Recovery	Exceed CL[b]
1/9/01	200	158	Triazine	Atrazine	0.30	0.260	86.7	
				DEA	0.30	0.320	107	UWL
1/11/01	199	104	Organophosphate	Chlorpyrifos	0.30	0.286	95.3	
1/11/01	199	106	Diazinon	Diazinon	0.30	0.256	85.3	
1/12/01	199	105	Carbamate	Carbofuran	0.35	0.291	83.1	
1/16/01	199	107	Triazine	Prometon	0.40	0.315	78.8	
1/16/01	200	87	Diazinon	Diazinon	0.30	0.252	84.0	
1/16/01	200	85	Organophosphate	Dimethoate	0.20	0.16	80.0	
1/16/01	200	86	Carbamate	Carbaryl	0.25	0.237	94.8	
1/19/01	200	88	Triazine	DACT	0.50	0.427	85.4	
1/18/01	200	101	Organophosphate	Phosmet	0.30	0.422	141	UCL
1/18/01	199	146	Diazinon	Diazinon	0.20	0.151	101	[c]
1/18/01	200	102	Diazinon	Diazinon	0.20	0.173	86.5	[c]
1/18/01	199	145	Organophosphate	Chlorpyrifos	0.30	0.291	97.0	
1/23/01	200	137	Organophosphate	Methidathion	0.30	0.36	120	UWL
2/8/01	200	331	Triazine	Bromacil	0.20	0.20	100	
				DEA	0.20	0.18	90.0	
2/8/01	200	328	Organophosphate	Fonofos	0.30	0.289	96.3	
2/15/01	199	472	Triazine	Prometon	0.30	0.292	97.3	
				simazine	0.50	0.646	129	UCL
2/16/01	199	470	Carbamate	Carbaryl	0.25	0.239	95.6	
				Carbofuran	0.30	0.261	87.0	
2/15/01	199	471	Diazinon	Diazinon	0.20	0.176	88.0	
2/15/01	199	469	Organophosphate	Dimethoate	0.30	0.414	138	UCL
				Phosmet	0.20	0.318	159	UCL
2/21/01	200	259	Carbamate	Carbaryl	0.30	0.279	93.0	
2/20/01	200	260	Diazinon	Diazinon	0.25	0.213	85.2	
2/20/01	200	261	Triazine	ACET	0.30	0.26	86.7	
				DACT	0.25	0.21	84.0	
2/20/01	200	258	Organophosphate	Chlorpyrifos	0.25	0.249	99.6	
				Methidathion	0.25	0.256	102	
2/27/01	199	404	Diazinon	Diazinon	0.25	0.23	92.0	
2/27/01	199	402	Organophosphate	Methidathion	0.25	0.287	115	
2/28/01	199	403	Carbamate	Carbaryl	0.20	0.188	94.0	
2/26/01	199	405	Triazine	Atrazine	0.20	0.16	80.0	
3/16/01	200	338	Triazine	Norflurazon	0.25	0.22	88.0	

[a] 199 refers to the study number for the Sacramento River, 200 refers to the SJR.

[b] CL=Control Limit; Upper CL (UCL), Lower CL (LCL). CLs for these pestcides are listed in Tables 3 through 6.

[c] Blind spike duplicates. Percent difference is 15.4.

Table 3. Continuing Quality Control- Organophosphate Screen

Extraction Date	Sample Numbers	Percent Recovery						
		Dimethoate	Fonofos	Methyl Parathion	Malathion	Chlorpyrifos	Methidathion	Phosmet
12/7/00	199-1,7,13 and 200-1,7	110	96	104	97	107	111	119
12/11/00	199-19,25,36,37 and 200-13,19,25	114	103	106	104	113	121	122
1/3/01	199-37,43,55 and 200-31	91	104	102	93	107	112	124
1/5/01	199-61,67,73 and 200-43,49	92	102	97	89	103	105	119
1/9/01	199-79,85,91 and 200-55,61	106	80	97	89	77	100	116
1/11/01	199-97,104,108,114 and 200-67,73	95	94	102	98	100	102	102
1/16/01	199-120,126,132,139 and 200-79,85,89,95	111	97	106	110	90	120	133
1/18/01	199-145,147,154,160, and 200-101,103,109	99.9	99.2	103	101	102	104	106
1/23/01	199-166,172,176,183,189 and 200-115,121,125, 131,137	105	101	110	107	106	107	109
1/30/01	199-214,220,224,231, 237 and 200-150,160, 166	84.8	81.5	87.3	85.4	85.0	88.5	78.6
2/1/01	199-243,250,254,260 and 200-172,178	89.4	91.2	93.9	97.3	96.0	95.6	96.2
2/6/01	199-226,272,279,285 and 200-184,190,198, 199	79.3	79.0	84.0	85.2	84.1	88.7	90.7
2/8/01	199-291,298,304 and 200-206,212,328	89	84.2	88	89	90.3	90	92
2/13/01	199-310,316,322,329 and 200-218,224,230	87.6	81.1	88.1	90.7	89.0	91.8	93.8
2/15/01	199-335,342,348,(469) and 200-236,242	83.7	86.2	87	89.1	87.5	91	90.8
2/20/01	199-354,360,364, 370,377 and 200-248, 254,(258),262,268	85.7	72.7	83.2	87.4	85.5	89.1	90.0
2/22/01	199-383,390,396 and 200-274,280	87.3	77.9	86.6	89.1	87.8	88.9	92.0
2/27/01	199-(402),406,412,419 ,423,429 and 200-286, 292,298	92.7	89.1	91.3	94.3	93.8	96.9	95.9
3/2/01	199-435,442,448 and 200-304,310	89.5	89.3	93.2	93.2	91.9	92.0	92.4
3/6/01	199-454,460,467,479 and 200-316,322,326, 332	104	94.2	103	105	101	107	98.8
3/8/01	199-485,492,498 and 200-339,345	86.5	91.2	90.0	93.0	92.4	92.5	89.0
3/12/01	199-539,545 and 200-351	93.4	95.8	94.6	98.9	97.9	99.0	99.5
3/15/01	199-549,556,562,571, 577,583 and 591	79.0	85.3	88.2	87.5	112	88.4	83.8
Average Recovery		93.7	90.2	95.0	94.5	95.6	99.1	101.4
Standard Deviation		9.5	8.8	7.8	7.1	9.3	9.8	13.9
CV		10.16	9.80	8.22	7.51	9.73	9.84	13.70
Upper Control Limit		116	102	116	114	116	124	118
Upper Warning Limit		110	100	110	109	110	116	113
Lower Warning Limit		86	94	85	87	83	83	95
Lower Control Limit		80	92	79	81	76	75	90

*Highlighted cells are percent recoveries exceeding control limits

Table 4. Continuing Quality Control-Carbamate Screen

Extraction Date	Sample Numbers	Percent Recovery Carbofuran	Percent Recovery Carbaryl
12/6/00	199-2,8,14 and 200-2,8	98.8	99.8
12/11/00	199-20,26,35,38 and 200-14,20,26	85.2	90.6
1/4/01	199-44,50,56 and 200-32,38	87.5	93.2
1/8/01	199-62,68,74 and 200-44,50	91.4	96.4
1/10/01	199-80,86,92 and 200-56,62	94.0	101.0
1/12/01	199-98,105,109,115 and 200-68,74	83.8	99.1
1/17/01	199-121,127,133,140, and 200-80,86,90,96	88.2	97.9
1/22/01	199-148,155,161,167,173, and 200-104,110,116,122	79.9	91
1/24/01	199-177,184,190 and 200-126,132	90.3	91.2
1/25/01	199-196,203,209 and 200-139,145	79.0	89.4
1/31/01	199-215,221,225,232,238 and 200-151,161,167	95.3	103
2/2/01	199-244,251,255,261 and 200-173,179	79.1	87.6
2/7/01	199-267,273,280,286 and 200-185,191,194,201	91.6	94.8
2/9/01	199-292,299,305 and 200-207,213	92.4	97.7
2/14/01	199-311,317,323,330 and 200-219,225,231	87.8	93.6
2/16/01	199-336,343,349,470 and 200-237,243	93.6	99.0
2/21/01	199-355,361,365,371,378 and 249,255,259,263,269	96.7	101
2/28/01	199-403,407,413,420, 424,430 and 200-287,293,299	87.5	97.3
3/5/01	199-436,443,449,455 and 200-305,311,317,323	96.0	103
3/7/01	199-461,468,480 and 200-327,333	103	102
3/9/01	199-486,493,499 and 200-340,346	105	107
3/13/01	199-540,546,550, 557,563 and 200-352	100	101
3/16/01	199-572,578,584,592	84.6	100
Average Recovery		90.9	97.3
Standard Deviation		7.24	5.02
CV		7.97	5.16
Upper Control Limit		102	108
Upper Warning Limit		96.5	103
Lower Warning Limit		76.8	83.1
Lower Control Limit		71.8	78.1

*Highlighted cells are percent recoveries exceeding control limits

Table 5. Continuing Quality Control-Diazinon Analysis

Extraction Date	Sample Numbers	Percent Recovery Diazinon
12/7/00	199-3,9,15 and 200-3,9	106.1
12/11/00	199-21,27,34 and 200-15,21,27	103.1
1/3/01	199-45,51,57 and 200-33,39	93.8
1/8/01	199-63,69,75 and 200-45,51	92.5
1/9/01	199-81,87,93 and 200-48,57,63	97.5
1/12/01	199-99,106,110,116 and 200-69,75	92.8
1/16/01	199-122,128,134,141 and 200-81,87,91,97	79.7
1/18/01	199-146,149,156,162 and 200-102,105,111	99.4
1/23/01	199-168,174,178,185,191 and 200-117,123,127,133	86.8
1/25/01	199-197,204,210 and 200-140,141	83.8
1/30/01	199-216,222,226,233,239 and 200-152,162,168	78.6
2/1/01	199-245,252,262 and 200-174,180	89.6
2/6/01	199-268,274,281,287 and 200-186,192,196,202	85.1
2/8/01	199-293,300,306 and 200-208,214	96.5
2/13/01	199-312,318,324,331 and 200-220,226,232	87.9
2/15/01	199-337,344,250,471 and 200-238,244	95.3
2/20/01	199-356,362,366,372,379 and 200-250,256,260,264,270	81.4
2/27/01	199-(404),408,414,421, 425,431 and 200-288, 294,300	88.0
3/6/01	199-437,444,450,456, 462,475,481	88.0
3/6/01	200-306,312,318,324, 328,334	90.3
3/8/01	199-487,494,535 and 200-341,347	96.4
3/12/01	199-541,547 and 200-353	84.1
3/14/01	199-551,558,564	89.7
3/16/01	199-573,579,585,593	99.4
Average Recovery		91.1
Standard Deviation		7.2
CV		7.95
Upper Control Limit		109
Upper Warning Limit		103
Lower Warning Limit		77.6
Lower Control Limit		71.4

Table 6. Continuing Quality Control- Triazine/Diuron/Bromacil Screen (Pam) (Page 1 of 2)

Extraction	Sample	Percent Recovery												
Date	Numbers	Atrazine	Simazine	Diuron	Prometon	Bromacil	Prometryn	Hexazinone	Metribuzin	Norflurazon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
12/12/00-Spike 1	199-22,28,33, 40 and 200-	75.5	83.5	84.5	80.5	88.0	82.5	71.5	87.0	92.5	88.0	82.0	90.0	78.5
12/12/00-Spike 2	199-22,28,33, 40 and 200-	83.0	91.0	129	88.5	101	90.0	87.0	101	104	94.0	90.5	101	86.5
12/28/00 - Spike 1	199-4,10,16	80.0	83.5	99.0	80.0	97.5	88.0	107.0	87.0	97.5	89.0	80.5	86.5	78.5
12/28/00 - Spike 2	199-4,10,16	88.0	85.5	127	96.0	102	99.5	125	96.5	126	97.0	95.0	99.5	85.0
1/9/01-Spike 1	199-8,88,94 and 200-58,64, 158	79.0	91.0	119	81.5	104	95.0	92.5	82.5	99.0	95.5	104.0	81.5	76.0
1/9/01-Spike 2	199-8,88,94 and 200-58,64, 158	88.5	95.0	114	104	105	105	106	93.0	103	105	108	95.0	88.5
1/16/01-Spike 1	199-100,107, 111,117,123, 129 and 200-	73.5	72.0	92.0	71.0	81.0	76.5	68.5	76.5	81.5	78.0	87.5	72.5	76.5
1/16/01-Spike 2	199-100,107, 111,117,123, 129 and 200-	74.5	74.5	87.0	69.0	85.0	72.5	68.5	74.5	78.5	78.0	81.0	76.0	73.5
1/23/01-Spike 1	199-150,157, 163,169,175 and 200-106,	83.5	92.5	112	98.0	101	99.5	91.0	90.5	109.5	99.5	101	97.5	87.0
1/23/01-Spike 2	199-150,157, 163,169,175 and 200-106,	99.5	99.5	116	107	103	110	111	98.0	121.5	105	111.0	103.0	93.0
1/29/01-Spike 1	199-198,205, 211,217,223 and 200-	79.0	85.5	95.5	84.0	82.5	89.5	77.5	88.0	98.0	90.0	89.0	81.5	79.0
1/29/01-Spike 2	199-198,205, 211,217,223 and 200-	77.5	73.5	80.5	79.5	91.5	81.0	76.0	81.5	87.0	84.0	81.5	75.0	75.5

*Highlighted cells are percent recoveries exceeding control limits

Table 6. Continuing Quality Control- Triazine/Diuron/Bromacil Screen - (Page 2 of 2)

Extraction Date	Sample Numbers	Percent Recovery Atrazine	Simazine	Diuron	Prometon	Bromacil	Prometryn	Hexazinone	Metribuzin	Norflurazon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
2/2/01-Spike 1	199-246,253, 257,263 and 200-175,181	77.0	80.0	92.5	78.5	94.0	78.5	75.5	82.5	92.5	86.0	95.5	96.0	73.0
2/2/01-Spike 2	199-246,253, 257,263 and 200-175,181	84	85	109	84.5	102	88	87.5	89	103	95.5	101	112	79.5
2/8/01-Spike 1	199-194,301, 307 200-209, 215,331	86	91.5	113	81.5	93.5	82.0	89.0	92.5	99.0	93.5	93.5	93.0	82
2/8/01-Spike 2	199-194,301, 307 200-209, 215,331	82.5	89.0	106	89.0	89.0	85.0	88.5	91.5	109	95.5	89.0	103	85.0
2/26/01 - Spike 1	199-(405),409 and 200-289	74.0	78.5	97.0	84.5	79.5	89.0	97.0	85.0	99.0	83.5	83.0	86.5	77.0
2/26/01 - Spike 2	199-(405),409 and 200-289	78.5	82.0	113	90.0	94.0	93.5	101	88.5	98.5	88.0	85.5	88.5	86.5
2/27/01 - Spike 1	199-415,422, 426,432 and 200-295,301	77.0	88.5	106	90.5	88.5	91.5	99.0	92.5	100	90.0	92.5	89.0	80.0
2/27/01 - Spike 2	199-415,422, 426,432 and 200-295,301	87.0	89.5	116	93.0	94.0	93.5	99.0	98.5	105	89.0	90.0	93.0	83.0
4/24/01-Spike 1	199-457,463,476, 482	97.0	89.5	86.0	87.0	95.5	90.0	89.5	85.5	98.5	92.0	86.0	90.0	83.5
4/24/01-Spike 2	199-457,463,476, 482	79.5	83.0	81.0	88.0	89.5	83.5	90.5	87.5	95.0	92.0	87.5	93.5	83.5
Average Recovery		82.0	85.6	103.3	86.6	93.6	89.3	91	88.6	99.8	91.3	91.6	91.0	81.4
Standard Deviation		6.91	7.0	14.5	9.25	7.63	9.11	14.39	6.73	10.82	7.10	8.81	9.84	5.23
CV		8.43	8.2	14.1	10.68	8.15	10.21	15.85	7.60	10.84	7.78	9.62	10.81	6.43
Upper Control Limit		107	108	147	112	129	110	112	119	126	111	121	105	114
Upper Warning Limit		100	101	134	105	119	103	104	110	118	105	112	99	107
Lower Warning Limit		71.5	74.2	81.1	75.8	80.6	74.9	72.4	73.1	85.9	77.9	76.7	74.9	76.3
Lower Control Limit		64.4	67.5	68.0	68.6	70.9	68.0	64.5	64.0	77.9	71.3	67.9	68.9	68.7

*Highlighted cells are percent recoveries exceeding control limits

Table 6. Continuing Quality Control- Triazine/Diuron/Bromacil Screen (Duc's) (Page 1 of 2)

Extraction Date	Sample Numbers	Percent Recovery Atrazine	Simazine	Diuron	Prometon	Bromacil	Prometryn	Hexazinone	Cyanazine	Metribuzin	Norflurazon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
1/4/01 - Spike 1	46,52,58 and 200-	69.0	75.0	79.5	68.0	78.5	71.0	75.0	72.0	81.5	76.5	76.0	85.5	70.0	64.5
1/4/01 - Spike 2	46,52,58 and 200-	79.0	76.0	83.5	78.0	89.5	79.5	84.0	78.5	90.5	84.0	84.0	81.0	78.0	78.0
1/5/01 - Spike 1	199-64,70,76	69.0	74.5	83.0	69.0	83.5	70.0	82.0	75.0	75.0	81.0	72.0	84.0	69.0	68.0
1/5/01 - Spike 2	199-64,70,76	77.5	80.5	96.0	76.5	87.0	76.5	85.0	83.0	91.0	87.0	81.5	92.5	77.0	77.0
1/19/01- Spike 1	199-135,142	75.5	70.5	90.0	70.0	83.5	71.0	69.0	75.5	77.5	81.0	82.0	83.0	73.0	68.5
1/19/01- Spike 2	199-135,142	79.5	79.5	94.5	70.5	89.0	71.5	75.5	81.0	84.5	88.0	88.5	94.5	80.5	74.5
1/25/01- Spike 1	199-179,186,	81.0	69.9	73.0	68.0	92.0	65.5	72.0	79.0	83.0	83.0	90.5	111.0	91.0	77.5
1/25/01- Spike 2	199-179,186, 192 and 200-	93.0	73.5	90.0	78.0	100.5	71.5	79.5	89.0	92.5	95.0	95.0	113.5	98.5	84.0
2/1/01- Spike 1	199-227,234,	85.0	80.5	87.0	71.5	91.0	81.5	81.0	83.0	87.0	83.0	86.0	86.5	73.5	83.5
2/1/01- Spike 2	199-227,234, 240, and 200-	79.0	81.0	92.5	69.0	89.5	80.5	73.0	75.0	74.0	82.5	86.5	88.0	66.5	76.0
2/5/01- Spike 1	199-269 and 200-	71.5	65.0	87.5	68.0	81.0	69.0	69.5	73.0	77.0	76.5	78.0	80.5	70.5	68.0
2/5/01- Spike 2	199-269 and 200-187,193	72.0	69.5	80.5	68.0	86.5	69.5	76.5	77.0	76.0	79.0	78.0	83.5	75.0	72.0
2/6/01- Spike 1	199-275,282, 288 and 200-197,203	83.0	79.5	87.5	77.0	92.0	82.5	88.5	87.5	89.5	88.0	87.0	85.5	74.0	81.5
2/6/01- Spike 2	199-275,282, 288 and 200-197,203	81.0	83.0	75.5	76.5	93.0	79.5	84.5	87.5	89.5	88.0	88.0	98.5	81.0	77.0
2/13/01- Spike 1	199-313,319, 325,332 and 200-221,227,	81.5	74.5	102.0	79.0	92.5	81.0	86.5	82.5	97.5	87.0	84.5	88.0	72.5	81.0

Table 6. Continuing Quality Control- Triazine/Diuron/Bromacil Screen (Duc's) (Page 2 of 2)

Extraction Date	Sample Numbers	Percent Recovery Atrazine	Simazine	Diuron	Prometon	Bromacil	Prometryn	Hexazinone	Cyanazine	Metribuzin	Norflurazon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
2/13/01-Spike 2	199-313,319, 325,332 and 200-221,227,	80.0	72.5	106.0	76.0	90.0	77.0	79.0	81.0	89.0	86.0	86.0	89.0	69.5	76.0
2/15/01-Spike 1	199-338,345,	92.0	100.0	86.5	91.0	103	91.0	91.5	89.0	95.0	96.5	96.5	107	102	86.0
2/15/01-Spike 2	199-338,345, 351,472	89.5	103.5	88.5	90.0	101.5	93.0	88.5	96.5	91.5	95.0	95.5	110	107	86.0
2/22/01 - Spike 1	199-386,393, 399 and	79.5	76.5	101.5	77.0	91.0	78.5	79.5	89.0	89.5	83.0	87.0	95.0	78.5	80.5
2/22/01 - Spike 2	199-386,393, 399 and	89.0	83.5	98.0	85.5	93.0	84.0	86.5	98.0	88.0	90.0	91.5	98.0	89.7	87.0
3/1/01 - Spike 1	199-438,445, 451 and	69.5	69.5	89.0	71.5	76.0	71.0	79.5	77.0	81.0	79.5	76.5	87.0	77.5	67.4
3/1/01 - Spike 2	199-438,445, 451 and	72.5	70.5	83.5	73.5	87.0	73.5	85.0	88.0	82.0	84.0	76.5	83.5	84.5	69.5
3/8/01 - Spike 1	199-488,495, 536 and	72.5	71.0	82.0	68.5	79.0	70.0	78.5	77.5	80.0	80.0	76.0	81.5	77.5	68.5
3/8/01 - Spike 2	199-488,495, 536 and	81.0	73.5	97.5	77.0	90.5	75.0	86.5	87.5	80.0	87.0	83.5	98.0	76.0	76.5
3/13/01 - Spike 1	199-542,548, 552,559,56	74.5	73.0	82.0	77.0	84.0	71.0	85.0	77.0	72.5	88.0	80.0	93.5	75.0	70.0
3/13/01 - Spike 2	199-542,548, 552,559,56	76.0	79.5	72.5	79.0	91.0	75.0	85.5	84.0	77.5	88.5	86.0	108.5	86.0	74.5
3/15/2001 Spike 1	199-574,580,58 6,594	79.0	74.0	106.5	98.5	94.0	76.0	101.0	90.5	97.0	93.5	87.0	85.0	76.5	82.0
3/15/2001 Spike 1	199-574,580,58 6,594	81.0	78.0	96.5	99.0	94.0	78.0	99.0	86.0	92.5	94.5	88.0	87.5	77.0	82.0
Average Recovery		79.0	77.1	89.0	76.8	89.4	76.2	82	82.8	85.1	85.9	84.6	92.1	79.5	76.3
Standard Deviation		6.60	8.4	9.2	8.78	6.49	6.54	7.70	6.82	7.30	5.60	6.33	9.96	9.95	6.50
CV		8.35	10.8	10.4	11.43	7.26	8.58	9.34	8.23	8.58	6.52	7.48	10.81	12.52	8.51
Upper Control Limit		105	108	118	106	117	111	121	162	110	113	116	140	101	115
Upper Warning Limit		98.2	101	109	99.2	111	105	113	144	103	107	109	128	95.7	107
Lower Warning Limit		72.2	73.2	73.4	73.8	84.9	78.9	76.9	70.9	75.0	84.8	79.1	78.3	73.7	72.4
Lower Control Limit		65.8	66.3	64.4	67.4	78.4	72.4	68.1	52.7	68.0	79.2	71.7	66.0	68.2	63.8

*Highlighted cells are percent recoveries exceeding control limits

Table 7. Concentrations of pesticides (ppb) detected in samples from Orestimba Creek and the San Joaquin River, winter 2000-2001

ORESTIMBA CREEK at RIVER ROAD								
Sampling Date	Diazinon	Bromacil	Diuron	Hexazinone	Norflurazon	Prometryn	Simazine	ACET
12/4/00	nd	nd	0.140	nd	nd	nd	nd	nd
12/6/00	nd	nd	0.090	nd	nd	nd	nd	nd
12/8/00								
1/2/01	nd	nd	0.284	nd	nd	nd	nd	nd
1/4/01	0.0420	nd	0.395	nd	nd	nd	nd	nd
1/8/01	nd	nd	0.410	nd	1.4900	nd	3.7000	0.0800
1/10/01	nd	nd	0.338	nd	0.0880	nd	0.2100	nd
1/12/01								
1/15/01	nd	nd	0.410	nd	0.1220	nd	0.2370	nd
1/17/01	nd	nd	0.620	nd	0.1900	nd	0.1900	nd
1/19/01								
1/22/01	nd	nd	1.087	nd	nd	0.2120	0.0580	nd
1/24/01	nd	nd	0.730	nd	nd	0.1600	nd	nd
1/29/01	nd	nd	5.655	nd	nd	nd	nd	nd
1/31/01	nd	nd	8.450	0.0600	0.0500	nd	nd	nd
2/2/01								
2/5/01	nd	nd	6.770	nd	nd	nd	nd	nd
2/7/01	nd	nd	5.840	nd	nd	nd	nd	nd
2/9/01								
2/12/01	nd	0.0730	6.830	nd	0.0860	nd	0.1140	nd
2/14/01	nd	0.0660	6.200	0.0500	0.0810	0.1260	0.0750	nd
2/16/01								
2/19/01	nd	nd	1.790	nd	0.1100	0.2400	0.1200	nd
2/21/01	nd	0.0680	1.616	nd	0.1320	0.1550	0.0710	nd
2/23/01								
2/26/01	nd	nd	1.130	nd	0.1000	0.0600	0.1500	nd
2/28/01	nd	nd	0.538	nd	nd	nd	0.0840	nd
3/2/01								
3/5/01	nd	nd	0.310	nd	0.31	nd	0.56	0.09
3/7/01	nd	nd	0.231	nd	0.3040	nd	0.1870	nd

1. Two numbers are reported for toxicity tests. The first is the result from the sample and the second i
2. nd = none detected
3. Test not rerun although control survival was < 90%
4. Test not rerun although control survival was < 80%

Table 7. (Cont.) Concentrations of pesticides (ppb) detected in samples from Orestimba Creek and the San Joaquin River, winter 2000-2001

SAN JOAQUIN RIVER near VERNALIS									
Sampling Date	Diazinon	Bromacil	Diuron	Hexazinone	Norflurazon	Prometon	Prometryn	Simazine	ACET
12/4/00	nd	nd	0.26	nd	nd	nd	0.05	nd	nd
12/6/00	nd	nd	0.26	nd	nd	nd	nd	nd	nd
12/8/00	nd	nd	0.82	nd	nd	nd	nd	nd	nd
1/2/01	nd	nd	0.132	nd	nd	nd	nd	nd	nd
1/4/01	nd	nd	0.125	nd	nd	nd	nd	nd	nd
1/8/01	nd	nd	0.19	nd	nd	nd	nd	nd	nd
1/10/01	nd	0.283	2.665	nd	0.54	nd	nd	0.067	nd
1/12/01	0.051	0.342	5.16	nd	0.557	nd	nd	0.211	nd
1/15/01	nd	0.278	1.286	nd	0.286	nd	nd	0.217	nd
1/17/01	nd	0.24	0.87	nd	0.1	nd	nd	0.07	nd
1/19/01	nd	nd	0.66	nd	0.07	nd	nd	0.06	nd
1/22/01	nd	0.059	0.494	nd	nd	nd	nd	0.055	nd
1/24/01	nd	nd	0.57	nd	nd	nd	nd	nd	nd
1/26/01	nd	nd	1.94	nd	0.4	nd	nd	nd	nd
1/29/01	0.131	0.3	4.023	nd	0.128	nd	nd	0.629	0.097
1/31/01	0.054	0.09	2.69	0.09	0.1	nd	nd	nd	nd
2/2/01	nd	0.079	1.169	nd	0.053	nd	nd	0.103	nd
2/5/01	nd	nd	0.593	nd	nd	nd	0.06	0.052	nd
2/7/01	nd	nd	0.85	nd	0.08	nd	0.1	0.07	nd
2/9/01	nd	0.168	0.902	nd	0.058	nd	0.197	nd	nd
2/12/01	0.044	0.175	1.257	nd	0.201	nd	0.321	0.05	nd
2/14/01	nd	nd	1.854	nd	0.082	nd	0.341	0.147	nd
2/16/01	nd	nd	0.92	nd	0.08	0.06	0.51	0.13	nd
2/19/01	nd	nd	nd	nd	nd	nd	0.198	0.054	nd
2/21/01	nd	0.072	1.0880	0.0910	0.0820	nd	0.123	0.092	nd
2/23/01	nd	nd	0.82	nd	0.0600	nd	0.11	nd	nd
2/26/01	nd	nd	1.33	nd	0.1000	nd	0.06	0.1900	nd
2/28/01	nd	0.0710	0.769	0.0550	nd	nd	0.085	0.0910	nd
3/2/01	nd	nd	0.55	nd	0.06	nd	0.14	nd	nd
3/5/01	nd	nd	4.26	0.16	0.93	0.3000	1.2600	0.5600	nd
3/7/01	nd	0.05	2.295	nd	0.205	nd	0.418	0.274	nd
3/9/01	nd	0.119	0.967	0.1	0.054	nd	0.124	0.128	nd

is the result from the corresponding control.

Table 8. Relative acute toxicity (48-hour LC50) of the pesticides in the insecticide and herbicide screens, compared to peak detections in San Joaquin Valley water bodies during the winter of 2000-2001[1].

LC_{50} (µg/L) [2]

Detected Pesticides	*Daphnia magna*	*Ceriodaphnia dubia*	Peak detections (µg/L)	
			Orestimba Creek	San Joaquin River
<u>Insecticides</u>				
Diazinon	0.96 a – *1.44* b [3]	0.44a	0.042	0.131
<u>Herbicides</u>				
Bromacil	119,000c – *121,000*d		0.073	0.342
Norflurazon	15,000e		0.304	0.557
Diuron	*8,000*c – 12,000f	12.1f	8.45	5.16
Hexazinone	*145,000*c – 442,000d		0.06	nd [4]
Prometon	*25,700*d – *59,800*f		0.24	nd
Prometryn	12,660c – 18,900e		0.212	0.51
Simazine	*1100*d – >100,000e		0.237	0.629

1 This table is for reference only and does not represent an exhaustive search of the literature. *Ceriodaphnia dubia* is often tested in toxicity studies because it is one of the three species used in the U.S. Environmental Protection (U.S.EPA) Agency's bioassay test. However, acute LC50 data for *C. dubia* is not always available because U.S.EPA does not require them as a condition for registration.

2 Number ranges may represent more than 2 individual studies.

3 Numbers in *italics* are 48-hour EC_{50} values.

4 nd = none detected

SOURCES:

a. CDFG, 1994.
b. CDPR, 2000
c. The Pesticide Manual, 1994.
d. U.S. EPA, 1991.
e. Herbicide Handbook, 1994.
f. CDFG, 2000.

dpr

Environmental Monitoring Branch
Department of Pesticide Regulation
P.O. Box 4015
Sacramento, CA 95812-4015

Document Title: Preliminary results of pesticide residue analyses, acute and chronic toxicity testing of surface water monitored in the San Joaquin River Watershed, winter 2001-02

Author: Juanita Bacey. ERS

Document Date: January 2002

APPROVED: ______________________ Date: 1/22/02
Frank Spurlock, Ph.D.
Sr. Environmental Research Scientist

APPROVED: ______________________ Date: 2/13/02
Kean S. Goh, Ph.D.
Ag. Program Supervisor IV

APPROVED: ______________________ Date: 2/14/02
John Sanders, Ph.D.
Branch Chief