science for a changing world

Occurrence and Transport of Diazinon in the Sacramento River, California, and Selected Tributaries During Three Winter Storms, January–February 2000

Water-Resources Investigations Report 02-4101

Prepared in cooperation with the

CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION
SACRAMENTO RIVER WATERSHED PROGRAM

U.S. Department of the Interior
U.S. Geological Survey

Occurrence and Transport of Diazinon in the Sacramento River, California, and Selected Tributaries During Three Winter Storms, January–February 2000

By Peter D. Dileanis[1], Kevin P. Bennett[2], *and* Joseph L. Domagalski[1]

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 02-4101

Prepared in cooperation with the

CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION
SACRAMENTO RIVER WATERSHED PROGRAM

[1]U.S. Geological Survey, Water Resources Division, Placer Hall, 6000 J Street, Sacramento, California 95819-6129

[2]California Department of Pesticide Regulation, 1001 I Street, Sacramento, California 95812-4015

Sacramento, California
2002

U.S. DEPARTMENT OF THE INTERIOR
GALE A. NORTON, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

For additional information write to:

U.S. Geological Survey
Water Resources Division
Placer Hall, Suite 2012
6000 J Street
Sacramento, California 95819-6129

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, CO 80225-0286

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS, VERTICAL DATUM, AND ABBREVIATIONS

Multiply	By	To obtain
acre-foot (acre-ft)	1,223	cubic meter
cubic foot per second (ft^3/s)	28.317	liter per second
foot (ft)	0.3048	meter
inch (in.)	2.54	centimeter
mile (mi)	1.6093	kilometer
pound (lb)	0.4546	kilogram

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F = (1.8)°C + 32$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Water-Quality Information: Pesticide concentrations in water samples are given in nanogram per liter (ng/L) or microgram per liter (µg/L). One thousand nanograms per liter is equivalent to 1 microgram per liter (µg/L). Micrograms per liter is equivalent to "parts per billion." Nanograms per liter is equivalent to "parts per trillion."

Abbreviations and Acronyms

µg/L	microgram per liter
µm	micrometer
µS/cm	microsiemen per centimeter
lb. a.i.	pound active ingredient
L	liter
m^2	square meter
mg/L	milligram per liter
mL	milliliter
ng/L	nanogram per liter
ADCP	acoustic Doppler current profiler
CBD	Colusa Basin Drain
DPR	California Department of Pesticide Regulation
ELISA	enzyme-linked immunosorbent assay
DWR	California Department of Water Resources
GC	gas chromatography
GC/MS	gas chromatography with mass spectrometry
GC/ECD/TSD	gas chromatography with electron capture detector and thermionic specific detector
K_{oc}	organic carbon normalized adsorption coefficient
NAWQA	National Water-Quality Assessment (Program)
NWQL	National Water Quality Laboratory
OP	organophosphate
PTFE	polytetrafluoroethylene
Regional Board	Central Valley Regional Water Quality Control Board
SIM	selective ion monitoring
SRWP	Sacramento River Watershed Program
TMDL	total maximum daily load
USGS	U.S. Geological Survey

THIS PAGE INTENTIONALLY LEFT BLANK

Occurrence and Transport of Diazinon in the Sacramento River, California, and Selected Tributaries During Three Winter Storms, January–February 2000

By Peter D. Dileanis, Kevin P. Bennett, and Joseph L. Domagalski

ABSTRACT

The organophosphate pesticide diazinon is applied as a dormant orchard spray in the Sacramento Valley, California, during the winter when the area receives a majority of its annual rainfall. Dormant spray pesticides, thus, have the potential to wash off the areas of application and migrate with storm runoff to streams in the Sacramento River Basin. Previous monitoring studies have shown that rain and associated runoff from winter storms plays an important role in the transport of diazinon from point of application to the Sacramento River and tributaries.

Between January 30 and February 25, 2000, diazinon concentrations in the Sacramento River and selected tributaries were monitored on 5 consecutive days during each of three winter storms that moved through the Sacramento Valley after diazinon had been applied to orchards in the basin. Water samples were collected at 17 sites chosen to represent the effect of upstream land use at local and regional scales. Most samples were analyzed using an enzyme-linked immunosorbent assay (ELISA). Analysis by gas chromatography with electron capture detector and thermionic specific detector (GC/ECD/TSD) and gas chromatography with mass spectrometry (GC/MS) was done on split replicates from over 30 percent of the samples to confirm ELISA results and to provide lower analytical reporting limits at selected sites [30 ng/L (nanogram per liter) for ELISA, 20 ng/L for GC/ECD/TSD, and 2 ng/L for GC/MS]. Concentrations determined from ELISA analyses were consistently higher than concentrations for split samples analyzed by gas chromatography methods. Because of bias between diazinon concentrations using ELISA and gas chromatography methods, results from ELISA analyses were not compared to water-quality criteria. Load calculations using the ELISA analyses are similarly biased. Because the bias was consistent, however, the ELISA data is useful in site-to-site comparisons used to rank the relative levels and contributions of diazinon from individual subbasins in the watershed.

Concentrations of diazinon in 138 samples analyzed by gas chromatography methods ranged from below detection (2 ng/L) to 2,890 ng/L with a median of 44 ng/L. Thirty percent of the samples had concentrations greater than 80 ng/L, which is considered by California as the criterion maximum concentration for the protection of aquatic habitat. Concentrations were highest in small tributaries and canals draining subbasins with predominantly agricultural land use and in a channel draining the Yuba City urban area.

Load estimates using concentrations derived from GC/MS analyses indicate that about 30 percent of the diazinon in the lower Sacramento River is from the Feather River Basin. Loads estimated using ELISA analyses show a similar, but slightly higher fraction of the total load coming from that basin. The source of over half the total load measured at Sacramento River at Alamar appears

to have originated in the part of the drainage basin upstream of the city of Colusa.

Of the diazinon reported applied to agricultural land in Sacramento Valley (about 42,500 pounds active ingredient) just before and during the monitoring period, about 0.4 percent appeared to be transported to the lower Sacramento River during the period of monitoring. A similar percent of applied diazinon was estimated to have entered the Feather River from upstream sources.

Diazinon use in the study area during the 1999–2000 dormant spray season was unusually low, about 60 percent of the average of the previous 4 years. Therefore, diazinon loadings may be higher in subsequent years, should use increase and pesticide management practices remain the same. Although diazinon was the most frequently detected pesticide and the pesticide detected at the highest concentrations, 10 other pesticides were detected in the samples collected. These included the insecticides methidathion and chlorpyrifos, and the herbicides simazine, molinate and thiobencarb.

INTRODUCTION

The occurrence of pesticides in surface water is controlled by the quantity and timing of use, transport mechanisms, chemical properties, and environmental conditions. In parts of the Sacramento River watershed, these factors contribute to the frequent detection of the organophosphorus pesticide diazinon during the winter.

Diazinon and the insecticides chlorpyrifos and methidathion are applied to nut and stone fruit trees during the winter dormant season to control peach twig borer, San Jose scale, and mite pests. The dormant season, which generally runs from December through March, is considered the best time to achieve control of these pests because the efficacy of pesticide applications is greatest when trees have lost their leaves and better pesticide coverage is possible (Zalom and others, 1995). Diazinon also is used in home, garden, and commercial applications in urban and industrial areas of the watershed.

Coincident with the dormant spray season, the watershed receives most of its annual rainfall. Previous monitoring studies have shown that rain and associated runoff from winter storms plays an important role in the transport of diazinon from its point of application to the Sacramento River and its tributaries (Foe and Sheipline, 1993; Kuivila and Foe, 1995; MacCoy and others, 1995; Domagalski, 1996; Ganapathy and others, 1997; Nordmark and others, 1998; Holmes and others, 2000). Diazinon also has been detected in air samples and in rain collected during the dormant spray season, indicating that atmospheric transport may play a role in the offsite movement of diazinon (Giddings and others, 2000).

Chemical properties that influence pesticide transport from a site of application fall in two general categories: those that characterize persistence in the environment; and those that characterize mobility, such as movement from soil to water or movement from water to air (Larson and others, 1997). Persistence is a function of the rate of degradation in the environmental conditions that the compound is likely to encounter. Degradation may result from chemical transformation processes such as hydrolysis (reactions with water) and photochemical reactions, and biological transformation processes such as microbial metabolism of organic pesticides. One measure of environmental persistence is the field dissipation half-life, an empirical determination that incorporates the many individual transformations and variables of the degradation process. Reported half-life values for diazinon range from 3 to 54 days, with the range of 3 to 13 days considered the most representative of actual field conditions (U.S. Department of Agriculture, 2000). Generally, the time needed for about 90 percent of the chemical residue to dissipate is four times the field dissipation half-life (U.S. Department of Agriculture, 2000).

Properties that affect pesticide movement from one environmental matrix to another, or to remain partitioned in a particular matrix, are water solubility, sorption coefficient, and Henry's law constant (Smith and others, 1987; Majewski and Capel, 1995; Larson and others, 1997). The degree to which a pesticide will dissolve in water is indicated by its solubility. Once in solution, a chemical may be transported from its point of application along with water. The solubility of diazinon in water is reported as between 38 and 68.8 mg/L (milligram per liter) (Howard, 1991; U.S. Department of Agriculture, 2000). These relatively high values indicate that solubility is probably not limiting the movement of diazinon into aqueous solution for transport in moving water.

The tendency of a pesticide to bind to soil or sediment particles is often characterized by its organic carbon normalized soil adsorption coefficient (K_{oc}). Pesticides with relatively high K_{oc} tend to remain in the soil or attach to soil particles entrained in flowing water, restricting or slowing their movement downstream. Pesticides with relatively low K_{oc} values tend to bind less tightly to soil particles and are, therefore, more likely to be leached from the soil and transported by moving water. The K_{oc} values for diazinon in a variety of soil types have been reported between 1,007 to 1,842 (U.S. Department of Agriculture, 2000), indicating that diazinon has a low to moderate tendency to remain bound to soil and sediment.

The tendency of a pesticide to remain in aqueous solution or to volatilize into the atmosphere is indicated by Henry's law constant, which is related to a pesticide's concentration in air over its concentration in water at equilibrium. Values reported for diazinon range from 0.049 to 0.072 Pa-m^3/mol (Pascal cubic meter per mole) (Suntio and others, 1988; Howard, 1991; U.S. Department of Agriculture, 2000). Compounds with values less than about 1.2 Pa-m^3/mol are considered low volatility. The Henry's law constants generally accepted for diazinon indicate that once the pesticide is in solution it will tend to remain in solution rather than volatilize to the atmosphere (Lyman and others, 1990; Howard, 1991). Pesticides can also volatilize directly from treated surfaces, such as the trees or soils. Volatilization rates from treated surfaces are complicated by competing processes, such as sorption of the pesticide to the organic matter of the plant or soil, as well as the amount of solar energy input and wind turbulence (Majewski and Capel, 1995). This process is temperature dependent, and is probably of lesser importance in the winter, but may be an important mode of diazinon partitioning to air.

The chemical and physical characteristics of diazinon indicate that storm-water runoff may provide an efficient transport mechanism for the movement of the pesticide from its point of application to streams in the Sacramento River watershed. Data from previous studies and ongoing monitoring programs show that diazinon has been detected frequently in the Sacramento River watershed during the dormant spray season and has been measured at higher concentrations than any other detected pesticide. Toxicity associated with the presence of diazinon and other pesticides also has been measured using standard toxicity tests with the aquatic invertebrate *Ceriodaphnia dubia* (Kuivila and Foe, 1995).

The documented occurrence of diazinon and the occurrence of toxicity has led the California Environmental Protection Agency, through its Central Valley Regional Water Quality Control Board (hereinafter referred to as Regional Board), to add the Sacramento and the Feather Rivers to the 1998 Clean Water Act 303d list of impaired water bodies. Inclusion on the 303d list requires that impairment be addressed by the U.S. Environmental Protection Agency's TMDL (total maximum daily load) program administered by the Regional Board. There is additional interest concerning potential effects of diazinon transported from the Sacramento and San Joaquin River watersheds downstream to the San Francisco Bay–Delta estuary.

In 1998, members of the Sacramento River Watershed Program (SRWP) identified organophosphate (OP) pesticides as a priority issue in the Sacramento River watershed. The SRWP is an inclusive organization made up of stakeholders, a diverse group of citizens representing government agencies, agricultural organizations, and environmental groups, with an interest in water-quality issues in the Sacramento River watershed. The goal of the SRWP is to formulate and implement a technically valid, cost effective, and protective strategy for a watershed-based water-quality management program.

Because the presence of these pesticides in the watershed, at certain levels, appear to cause aquatic toxicity, an OP pesticide management plan to reduce or eliminate that toxicity was developed under the aegis of the SRWP. The California Department of Pesticide Regulation (DPR) and the Regional Board prepared a detailed scope of work for the development of an OP pesticide management plan for the Sacramento and the Feather Rivers. This work plan was reviewed by the Toxics Subcommittee of the SRWP and submitted to the Sacramento Regional County Sanitation District on June 28, 1999. Although a number of monitoring studies have been done in the past or are currently operating, several tasks listed in the management plan call for the development and implementation of additional monitoring studies to fill in gaps in the knowledge base needed to develop an effective OP pesticide management plan.

Purpose and Scope

The first of the monitoring studies to support the development of the OP pesticide management plan and TMDL program was done by the DPR and the U.S. Geological Survey (USGS) during the 1999–2000 dormant spray season. The goal of the monitoring study was to better characterize the occurrence of diazinon in Sacramento Valley streams and determine the sources of the pesticide detected in the Sacramento and the Feather Rivers.

Between January 30 and February 25, 2000, diazinon concentrations were monitored on five consecutive days during each of three winter storms that swept through the Sacramento Valley soon after dormant spray applications had begun. Water samples were collected at 17 sites chosen to represent the effects of upstream land use on a variety of scales, from small tributaries and drains representing local land use to mainstem river sites representing regional effects. The majority of samples were analyzed by ELISA (enzyme-linked immunosorbent assay). Gas chromatography with electron capture detector and thermionic specific detector (GC/ECD/TSD) were used to confirm ELISA results on about 30 percent of the samples. Samples from sites expected to have very low concentrations of pesticides were analyzed by gas chromatography with mass spectrometry (GC/MS) because of that method's lower detection limits.

This report presents pesticide concentrations analyzed in water samples collected during 5-day monitoring periods and the quantity (load) of diazinon transported to the Sacramento River from selected subbasins within the watershed during the same periods. Concentrations and loads are evaluated with regard to the quantity and timing of pesticide applications upstream of the monitoring sites.

Sacramento River Watershed and Environmental Setting

The Sacramento River watershed is shown on figure 1. The Sacramento River is about 370 mi (mile) long and drains more than 27,000 mi^2 (square mile) from its upper reaches near the California–Oregon border to its mouth 50 mi northeast of San Francisco (Kahrl, 1979). On average, over 22 million acre-ft (acre-feet) of water flow from its watershed each year (Webster and others, 2000), making the Sacramento the largest river in California. Water flowing through the Sacramento River watershed supplies a multitude of beneficial uses, including the irrigation of agricultural land, domestic supply, in-stream use for aquatic habitat, and recreation. The watershed is, therefore, a vital resource for the state's economy, the well being of its citizens, and the health of its natural environment. The Feather River, the largest natural tributary of the Sacramento River, originates in the Sierra Nevada and drains much of the eastern area of the Sacramento River watershed. Many smaller tributaries originate in the coastal mountains and in the Sierra Nevada. Winter flow in the watershed is affected by reservoir releases, storm runoff, and diversions to bypass channels used for flood control.

The middle and lower reaches of the Sacramento River flow through the Sacramento Valley, which forms the northern part of California's prominent Central Valley. It is geographically continuous with the San Joaquin Valley to the south, but is defined by its distinct drainage basin. Beginning near the town of Red Bluff at its northern terminus, the valley stretches about 150 mi to the southeast where it merges into the broad expanse of the Sacramento–San Joaquin River Delta south of the Sacramento metropolitan area. The valley is 30 to 45 mi wide in the southern to central parts, but narrows to about 5 mi near Red Bluff. Its elevation decreases almost imperceptibly from 300 ft (feet) at its northern end to near sea level in the delta. The generally flat valley floor occupies about 5,000 mi^2 and is interrupted only by the abrupt profile of the Sutter Buttes, remnants of a volcano that pushed up through the valley floor during the last ice age 1.5 to 2.5 million years ago (Olmstead and Davis, 1961).

The major land uses in the Sacramento River watershed are forestry, agriculture, urban, and mining. Agriculture is the dominant land use on the valley floor followed by urban development. Land use on the valley floor is shown on figure 2. The availability of water during the normally dry summer allows irrigation of a wide variety of crops. Land once occupied by flood basins on either side of the Sacramento River is affected by shallow ground water and silty, poorly draining soils. Much of that area is planted in rice. Row crops and orchards requiring well-drained land are grown on soil derived from alluvial fans and the coarser soils associated with stream channels and elevated natural deposits that built up around the larger rivers and streams. About 2,300 mi^2 in the watershed are devoted to agricultural use. Stone fruit and almond orchards occupy about 290 mi^2, mostly in the northern and central parts of the valley (California Department of Water Resources, 1990, 1994a,b, 1995a,b,c,d, 2000).

Most precipitation in the watershed falls between November through March, with the wettest month on average being January. Mean annual rainfall tends to increase with latitude and elevation from 15 in. (inch) in the Sacramento–San Joaquin Delta to 22 in. at Red Bluff (Rantz, 1969). In the high mountainous areas of the Sierra Nevada, precipitation averages 80 to 90 in. each year, primarily from heavy snowfall during the winter.

Previous Studies

Previous studies of the Sacramento River by the USGS, DPR, and the Regional Board have shown that diazinon is detected more frequently during the dormant spray season than at other times of the year and that the highest observed concentrations are associated with winter storm runoff during the dormant spray season (MacCoy and others, 1995; Ganapathy and others, 1997; Holmes and others, 2000).

During the winters of 1997 through 1999, DPR conducted pesticide and toxicity monitoring at sites along the Sutter Bypass and the Sacramento River (Nordmark, 1998, 1999; Nordmark and others, 1998). In each of the three winters, diazinon was the primary insecticide detected, with most detections occurring in conjunction with rainfall. Other pesticides, including those in other chemical classes such as carbamate and pyrethroid insecticides and triazine herbicides, have been detected in the watershed, but have not been correlated with observed toxicity. The use of

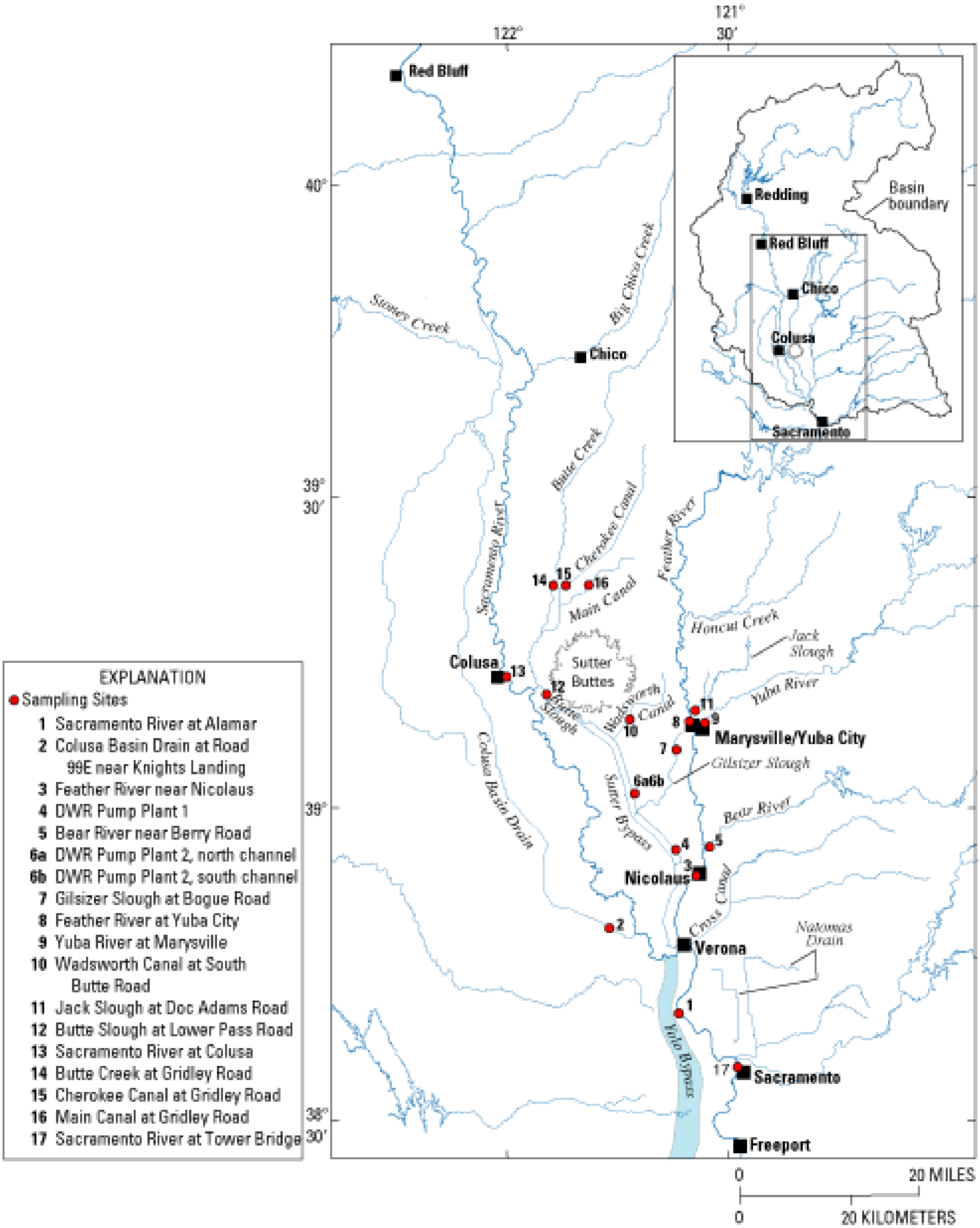


Figure 1. Sampling sites in the Sacramento River watershed, California. DWR, California Department of Water Resources.

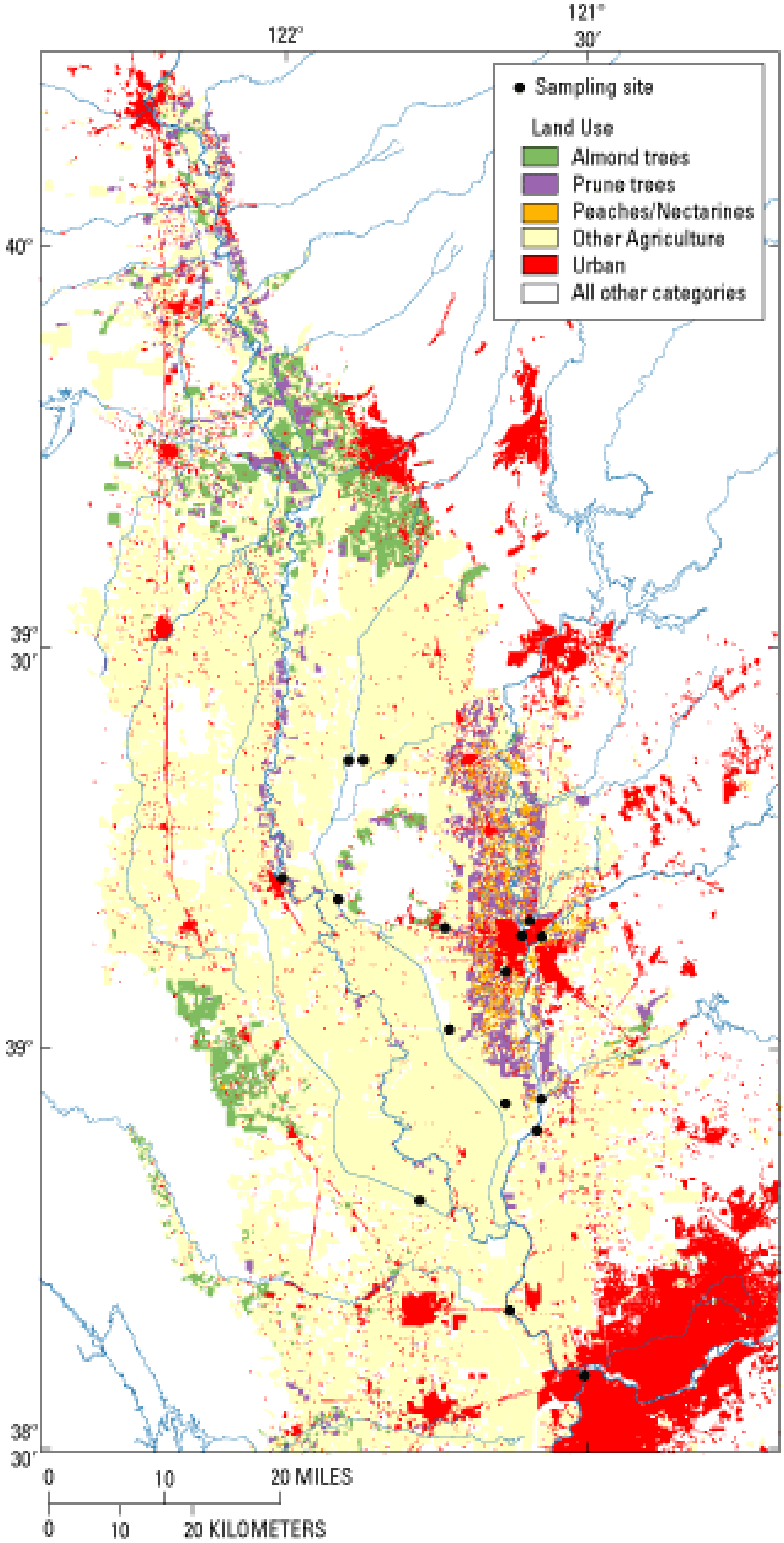


Figure 2. Land use in the Sacramento Valley, California.

pyrethroid pesticides is increasing, however, and warrants further investigation (Epstein and others, 2001). In a study by the Regional Board, acute toxicity to *C. dubia* in conjunction with high diazinon and methidathion concentrations was found at Gilsizer Slough, which drains agricultural and urban areas west of the Feather River and enters the Sutter Bypass (Foe and Sheipline, 1993). An extensive diazinon monitoring study by the Regional Board (Holmes and others, 2000) provided critical information on the occurrence and magnitude of diazinon contamination in the watershed. The results of the study were used to guide the selection of monitoring sites for the 1999–2000 dormant season monitoring program.

Acknowledgments

Monitoring water-quality over a large study area in the relatively brief time period of a winter storm required the efforts of a large field team laboring many hours throughout the day and night in wet and cold weather. Field personnel included Kevin Kelley, Andy Fecko, Jesse Ybarra, and Sainey Ceesay from the California Department of Pesticide Regulation; Michelle McGraw from the California Regional Water Quality Control Board; Steven Gallanthine and Frank Moseanko with the U.S. Geological Survey; and our colleagues from the University of California at Davis: Thomas Kimball, Melvin Whitlock, and Bryan Stafford. Their commitment and endurance was a critical element in the task of collecting the data used in this report.

STUDY DESIGN AND METHODOLOGY

Selection of Sampling Sites

Seventeen sites were chosen to monitor the occurrence and transport of diazinon during the 1999–2000 dormant spray season. Descriptions of individual sites are listed in table 1, and their locations are shown on figure 1. Site selection was based on the need for data from specific areas of the watershed, availability of streamflow data, accessibility during inclement weather, and the safety of field crews collecting samples. Consideration also was given to sites currently or historically monitored for pesticides or toxicity by other programs.

Most sites were located on tributaries and drains where diazinon detections were expected because of upstream pesticide use. Many of the sites (site 3–11, 15, and 16) were located in the Feather River and Butte Creek watersheds owing to a lack of previous water-quality data from that area and the large acreage of almond and stone fruit (prune, peach, and nectarine) orchards. Site 7, Gilsizer Slough at Bogue Road, located downstream of Yuba City was chosen to represent possible urban sources of pesticides. Land use in the watershed upstream of site 7 was predominantly residential or commercial. Although a few acres of walnut orchards were immediately upstream of the site, diazinon is not normally applied to this crop as a dormant spray, and no applications are recorded (California Department of Pesticide Regulation, 2000) for the study period. Site 9, Yuba River at Marysville, is located near the mouth of the Yuba River. Although there is very little agricultural activity or urban development upstream of site 9, the Yuba River is the largest tributary to the Feather River and contributes a significant part of its total streamflow.

A single site (site 2) was chosen to represent pesticide sources in the Colusa Basin Drain (CBD) on the west side of the Sacramento Valley. The CBD flows into the Sacramento River near Knights Landing during low flow in the Sacramento River, but winter runoff from the CBD often is diverted into the Yolo Bypass and enters the Sacramento River near its mouth 85 mi downstream. Previous studies indicate that the CBD was probably not a major source of diazinon to the Sacramento River (Domagalski, 1996).

Three sites (1, 13, and 17) were located on the Sacramento River to evaluate pesticide contamination in the mainstem river environment and diazinon inputs to the San Francisco Bay–Delta estuary. Site 13, Sacramento River at Colusa, was the farthest upstream and chosen to represent all potential sources from the northern part of the watershed. Site 1, Sacramento River at Alamar, included additional sources from the Feather River, Butte Creek, and Natomas Cross Canal watersheds. Additional inputs from agricultural land downstream of Alamar and the northern part of the Sacramento Metropolitan area are combined in the flows at site 17, the site farthest downstream in the study area.

Monitoring began during the first storm that produced runoff after widespread application of dormant sprays had begun. Because dormant sprays are applied over weeks or sometimes months, samples were collected during two additional rainstorms to better characterize pesticide transport during a large part of the application period. Sampling for each storm began just before or at the beginning of rainfall and continued for 5 consecutive days. Each 5-day period allowed sampling of most of the storm related runoff as defined by storm hydrographs.

Individual sites were sampled at three sampling frequencies (table 2). Sites 1, 3, 4, 5, 8, 11, 12, 13, and 17 were sampled once each day throughout each storm monitoring period. Sites 6a, 6b, 7, 10, 14, and 16, which

Table 1. Sites used to monitor the occurrence and transport of diazinon during the 1999–2000 dormant spray season, Sacramento River Basin, California

[DWR, California Department of Water Resources; Hwy, Highway; USGS, U.S. Geological Survey]

Site number	Site name	Latitude (degree/ minute/ second)	Longitude (degree/ minute/ second)	Description
1	Sacramento River at Alamar	38°40′30″	121°37′36″	Located 71 miles upstream of the mouth of the Sacramento River, just upstream of Hwy 5 bridge. Samples collected from pier on left bank.
2	Colusa Basin Drain at Road 99E near Knights Landing	38°48′45″	121°46′23″	Located 2 miles northwest of the town of Knights Landing. Samples collected from bridge over Colusa Basin Drain (USGS site number 11390890).
3	Feather River near Nicolaus	38°54′02″	121°35′01″	Samples collected from a boat in the reach between the Hwy 99 bridge and a point 0.8 miles upstream.
4	DWR Pumping Plant 1	38°55′60″	121°38′01″	DWR pumping plant about 20 miles Northwest of Sacramento along the Sutter Bypass. Samples collected from the bank of north channel. Channel is branch of Gilsizer Slough.
5	Bear River near Berry Road	38°56′22″	121°34′32″	Samples collected 1,000 feet upstream of Bear River mouth by boat. A single sample at extreme high flow was collected from the levee bank about 2 miles upstream of the mouth.
6a	DWR Pumping Plant 2, north channel	39°01′33″	12°43′30″	DWR pumping plant about 25 miles northwest of Sacramento along the Sutter Bypass. Samples collected from pedestrian bridge just upstream of weir. Channel drains area north of Gilsizer Slough.
6b	DWR Pumping Plant 2, south channel	39°01′33″	121°43′30″	Samples collected from single-lane bridge just before the pumping plant. Channel is branch of Gilsizer Slough.
7	Gilsizer Slough at Bogue Road	39°05′54″	121°38′16″	Just south of Yuba City, 1/4 mile west Hwy 99. Samples collected from bridge.
8	Feather River at Yuba City	39°08′37″	121°36′26″	West bank of river beneath Hwy 20 bridge. Alternate site is boat ramp about 3/4 mile south of primary site. Samples collected from right bank.
9	Yuba River at Marysville	39°08′31″	121°34′30″	Just east of Marysville at Simpson Lane. Samples collected from left bank.
10	Wadsworth Canal at South Butte Road	39°09′11″	121°44′00″	Approximately 6 miles west of Yuba City and north of Hwy 20 at South Butte Road. Samples collected from bridge.
11	Jack Slough at Doc Adams Road	39°09′43″	121°35′43″	Just north of Marysville. Samples collected from bank.
12	Butte Slough at Lower Pass Road	39°11′16″	121°54′28″	South east of the Sutter Buttes. Samples collected from bridge.
13	Sacramento River at Colusa	39°12′52″	121°59′58″	In the town of Colusa. Samples collected from bridge (USGS site number 11389500).
14	Butte Creek at Gridley Road	39°21′43″	121°53′30″	Approximately 10.5 miles west of Gridley on Gridley Road. Samples collected from bridge.
15	Cherokee Canal at Gridley Road	39°21′44″	121°52′03″	Approximately 9 miles west of Gridley on Gridley Road. Samples collected from bridge.
16	Main Canal at Gridley Road	39°21′44″	121°49′23″	Approximately 7 miles west of Gridley on Gridley Road. Samples collected from bridge.
17	Sacramento River at Tower Bridge	38°34′30″	121°30′20″	Tower Bridge on Capitol Ave. in downtown Sacramento (USGS site number 383430121302001).

are in small watersheds that had rapid streamflow response to runoff and historically high diazinon use, were sampled multiple times each day of the storm monitoring period to better define peak concentrations and loads. Sites 2, 9, and 15 were monitored to confirm the results of previous studies that determined they are not significant sources of pesticides. Samples at these three sites were collected daily during the first two days of each storm monitoring period, but less frequently thereafter.

Sample Collection Methods

Water samples were collected from bridges at most sites using a US D-77 sampler. Depth integrated samples at a single point in the center of each channel

Table 2. Sampling frequency and source of streamflow data for each sampling site, Sacramento River Basin, California

[DWR, California Department of Water Resources; ELISA, enzyme-linked immunosorbent assay; GC/ECD/TSD, gas chromatography with electron capture detector and thermionic specific detector; GC/MS, gas chromatography with mass spectrometry; NA, not available; USGS, U.S. Geological Survey. —, no sample taken]

Site number	Site name	Sampling frequency for each storm event		Source of discharge data
		Diazinon by ELISA	Pesticide scan by GC/ECD/TSD or GC/MS	
1	Sacramento River at Alamar	1 sample/day × 5 days	1 sample/day × 4 days	USGS gaging station: Sacramento River at Verona, (station number 11425500)
2	Colusa Basin Drain at Road 99E near Knights Landing	1 sample/day × 2 days	—	NA
3	Feather River near Nicolaus	1 sample/day × 5 days	1 sample/day × 5 days	Estimated, using daily instantaneous measurements and routed flow from upstream gages[1]
4	DWR Pumping Plant 1	1 sample/day × 5 days	1 sample/day × 4 days	DWR pumping records
5	Bear River near Berry Road	1 sample/day × 5 days	1 sample/day × 2 days	Estimated, using daily instantaneous measurements and flow from upstream gage[2]
6a	DWR Pumping Plant 2, north channel	3–6 samples/day × 5 days	1 sample/day × 1 day	DWR pumping records and project stream gage
6b	DWR Pumping Plant 2, south channel	3–6 samples/day × 5 days	1 sample/day × 2 days	DWR pumping records
7	Gilsizer Slough at Bogue Road	3–6 samples/day × 5 days	1 sample/day × 1 day	NA
8	Feather River at Yuba City	1 sample/day × 5 days	1 sample/day × 3 days	NA
9	Yuba River at Marysville	1 sample/day × 2 days	1 sample/day × 1 day	USGS gaging station: Yuba River near Marysville (station number 11421000)
10	Wadsworth Canal at South Butte Road	1–7 samples/day × 5 days	1–2 samples/day × 1–3 days	NA
11	Jack Slough at Doc Adams Road	1 sample/day × 5 days	1 sample/day × 3 days	NA
12	Butte Slough at Lower Pass Road	1 sample/day × 5 days	1 sample/day × 3 days	DWR gaging station: Butte Slough near Meridian
13	Sacramento River at Colusa	1 sample/day × 5 days	1 sample/day × 3 days	USGS gaging station: Sacramento River at Colusa (station number 11389500)
14	Butte Creek at Gridley Road	1–6 samples/day × 5 days	1 sample/day × 2 days	NA
15	Cherokee Canal at Gridley Road	1 sample/day × 2 days	1 sample/day × 1 day	DWR gaging station: Cherokee Canal near Richvale
16	Main Canal at Gridley Road	1–6 samples/day × 5 days	1 sample/day × 1 day	NA
17	Sacramento River at Tower Bridge	—	1 sample/day × 5–7 days	DWR gaging station: Sacramento River at I Street

[1]Feather River near Gridley (DWR), Yuba River near Marysville (USGS, station number 1142100), and estimated flow from Bear River near Berry Road.

[2]Bear River near Wheatland (USGS, station number 1142000).

were collected in a 3-L (liter) PTFE (polytetrafluoroethylene) bottle mounted in the sampler (Shelton, 1994). PTFE collection bottles were used to minimize contamination or loss of pesticide due to sorption to container walls. After vigorous mixing, subsamples were poured into baked amber 1-L glass bottles fitted with PTFE-lined caps. At sites 3 and 5 (Feather River near Nicolaus and Bear River near Berry Road) water was collected from a boat at 7 to 10 points (equal width increments) across the channel. The total volume of water collected for each sample exceeded the capacity of a single 3-L bottle so samples at each point in the cross section were mixed in a PTFE lined stainless steel churn splitter (a device for subsampling composite samples), and the glass sample bottles filled from the splitter (Capel and Larson, 1996).

Owing to extreme weather and high flows, sample collection protocol at the Bear River (site 5) was altered for three days during the second storm monitoring period. On February 13, a grab sample was collected from the riverbank after an attempt to access the site by boat was unsuccessful. On February 14 and 15, very high flows and large amounts of debris moving down the channel required the field crew to quickly collect samples from the boat; grab samples were collected by submersing the churn splitter at a single point at the center of the stream.

At sites 1, 8, and 11, grab samples were collected directly in glass sample bottles from piers or the streambank. Bottles were held at the end of a telescoping rod and submerged to about 3 ft while filling. At site 17, a grab sample was collected from a bridge at a point near the center of the channel; the sample was collected in a glass bottle strapped to a weighted cage suspended from a line. An autosampler (ISCO model 6700) was used to collect water at site 6a. The water intake (PTFE tubing with a stainless steel screen) for the autosampler was located midway in width and depth of the rectangular concrete channel at this site. Before each sample was collected, the intake tubing was purged of residual water and the sample then pumped directly into an individual glass bottle mounted in the autosampler.

Immediately after collection, sample bottles were placed in ice or in a refrigerated storage unit at 4°C for delivery to a laboratory. Samples for the USGS laboratory were shipped on ice by overnight freight the day of collection. Samples for the local laboratories were delivered immediately after each 5-day storm monitoring period. Between samples, PTFE collection bottles were rinsed in deionized water. The collection bottles and the churn splitter used at sites 3 and 5 were field washed with a nonphosphate detergent before rinsing with deionized water treated to remove organic constituents. At site 6a, the autosampler bottles were collected several times each day, capped, and stored on ice.

Laboratory Analytical Methods

The majority of samples were analyzed using an ELISA specific for diazinon. Split replicate samples were analyzed by gas chromatography (GC) methods on 30 percent of the samples as a quality control check of the ELISA results.

ELISA analyses were done on 412 unfiltered water samples collected at all sites except Sacramento River at Tower Bridge (site 17). The analyses were performed by the California Department of Food and Agriculture Center for Analytical Chemistry. The reported detection limit for diazinon using ELISA was 30 ng/L (nanogram per liter).

The California Department of Fish and Game Water Pollution Control Laboratory used gas chromatography coupled with an GC/ECD/TSD to determine the concentration of diazinon and methidathion in 107 unfiltered environmental samples. Unfiltered samples were extracted with methylene chloride in a separatory funnel. The extract was dried with sodium sulfate, evaporated using a Kuderna–Danish apparatus, and solvent exchanged into petroleum ether. The extract was concentrated using a micro-snyder apparatus to about 1 mL (milliliter) and adjusted to 2 mL with isooctane before injection into the gas chromatograph. An optional florisil column cleanup procedure to eliminate or reduce interferences is part of the method's standard operating procedure (David Crane, California Department of Fish and Game Water Pollution Control Laboratory, written commun., 2000). For this method, the reported detection limit for diazinon concentration was 20 ng/L.

Thirty-one samples from site 3 (Feather River near Nicolaus) and site 17 (Sacramento River at Tower Bridge) were analyzed by the U.S. Geological Survey National Water Quality Laboratory in Denver, Colorado, using GC/MS operated in the SIM (selective ion monitoring) mode for identification and quantification of 41 pesticides and pesticide metabolites. Water samples were processed through glass fiber filters with a 0.7-µm (micrometer) effective pore diameter and organic compounds isolated by C-18 solid-phase extraction prior to analysis by GC/MS (Zaugg and others, 1995). The USGS laboratory reporting limit for diazinon concentration using this method was 2 ng/L.

Stage and Stream Discharge Measurement

The source of stream stage (water surface elevation) and discharge data for each sampling site is given in table 2. Three of the sampling sites (1, 9, and 13) were near established USGS gaging stations, and sites 12, 15, and 17 were at California Department of Water Resources (DWR) gaging stations, which provided continuous stream discharge data during the monitoring periods. Sites 4, 6a, and 6b were just upstream of DWR pumping plants 1 and 2, which pump water into the Sutter Bypass when the water in the levied bypass is above the elevation of the surrounding land. Water levels were high in the bypass during all monitoring periods, so flows in the channels leading to the pumping plants were only due to operation of the pumps. Pumping records provided discharge data for sites 4 and 6b, as well as partial records for discharge at site 6a. Discharge at site 6a was controlled by two of the six turbine pumps at Pump Plant 2 and a broad crested weir just downstream of the sampling site. To estimate the discharge flowing over the weir, a continuous stage recorder was installed at the site, and a stage-discharge relation (rating) was developed for the weir based on theoretical computations. The channel and weir geometry was measured during a differential level survey of the site. The rating was then calculated using the critical-depth computation model WSPRO (Water Surface Profile Computations) and equations based on dimensional analysis and empirically derived constants (Hulsing, 1967). Stage data and rating were then used to compute a continuous record of streamflow over the weir (Kennedy, 1983). Total discharge was calculated by combining the estimated flow over the weir and flow derived from pumping records. A single instantaneous measurement made during one of the monitoring periods using current meter methods (Rantz and others, 1982) was within 12 percent of the estimated discharge.

Discharge recorded at the USGS gage at Bear River near Wheatland was used to estimate discharge at sampling site 5 located at the mouth of the Bear River 13 mi downstream of the gage. Instantaneous measurements of discharge at the sample site were used to adjust the gage data for local ungaged inputs to the Bear River.

Discharge at site 3, Feather River near Nicolaus, was estimated using measured flow from the gages at Feather River near Gridley (40 mi upstream), Yuba River near Marysville (site 9, 42 mi upstream), and estimated flow from the mouth of the Bear River (2 mi upstream). Data from stage gages at sites on the Feather River at Yuba City, at Live Oak, at Boyd's Landing, and near Nicolaus were used to estimate flood wave travel-time from the upstream gages (Linsley and others, 1958) to site 3. Instantaneous measurements of discharge at site 3 and 5 were made on all sampling days except February 13. An acoustic Doppler current profiler (ADCP) mounted on the sampling boat was used to determine water depth and velocity. Differential GPS (global positioning system) or the bottom tracking function of the ADCP was used to determine horizontal position and cross-section widths. Discharge was calculated using the software program Transect, version 4.0, from RD Instruments, Inc., the maker of the ADCP. The ADCP measures the Doppler frequency shift of reflected sound waves [propagated by the instrument at a frequency of 600 KHz (kilohertz)] to determine the speed and direction of moving water.

Only stage (water-surface elevation) data was available for sites 7, 8, 10, 11, 14, and 16. Stage gages at sites 8, 10, and 14, are operated by DWR as part of their flood control network. Stage recording equipment was installed at sites 7, 11, and 16, for the duration of the monitoring study. Backwater conditions at high flows preclude determining stream discharge using simple stage-discharge relation at all these sites, with the exception of site 8, which required periodic discharge measurements to compute discharge. Neither flow nor stage data were available for site 2 at the Colusa Basin Drain.

Load Calculation Methods

Diazinon loads are the quantity of diazinon (mass) flowing past a sampling site over a specific period. Concentrations are dependent on both the mass of material and its dilution at the point of sampling. Load calculations effectively remove the effect of dilution and allow direct comparison of the quantity of diazinon transported downstream from different sites.

Instantaneous loads at the time of sampling were calculated by multiplying the measured concentration by the stream discharge at the time of sample collection and a unit conversion term. For example:

$$\text{Concentration}\left(\frac{\text{ng}}{\text{L}}\right) \times \text{Discharge}\left(\frac{\text{ft}^3}{\text{s}}\right) \times$$

$$5.4 \times 10^{-6} = \text{Load}\left(\frac{\text{lb}}{\text{d}}\right)$$

Total loads during each 5-day storm monitoring period were calculated for sites where a continuous record of stream discharge was available. At every hour or 15-minute interval throughout each storm monitoring period, loads were calculated using recorded discharge and estimates of concentration derived from a linear interpolation between known concentrations. At sites 1, 3, 4, 5, 13, and 17, where one sample was collected each day (table 2), concentrations were interpolated between daily sample values. At sites on smaller streams and canals where concentrations and flows were expected to change rapidly, multiple samples were collected each day, and concentrations were interpolated between samples collected 4 to 8 hours apart. Total loads were then estimated by summing the hourly or 15-minute loads over the entire storm. All load values are presented in units of pounds per day.

Quality Assurance and Quality Control

The reliability of field and laboratory methods used in this study was assessed using a variety of blanks, spiked samples, and analysis of split samples by separate laboratories using different methods of analyses.

Possible contamination of environmental samples during the entire process from sample collection to laboratory analysis was evaluated by analyzing blanks made from deionized water that had passed through sampling equipment and collection bottles before being poured into sample bottles and stored alongside environmental samples. Twelve blanks were made at random times throughout the monitoring period and analyzed by ELISA. Diazinon was not detected in any of these blank samples.

Another 50 blanks were prepared by pouring deionized water directly into sample bottles at the same time that environmental samples were being processed in the field. These blanks were used to evaluate possible contamination from all sources, except sampling equipment and collection bottles. Diazinon concentrations in all of these randomly distributed samples were below reported detection levels of the ELISA analysis (less than 30 ng/L). Blanks accompanied 15 percent of all environmental samples submitted for analysis. Data from blank analyses indicated no sample contamination resulting from site to site carryover or other possible sources.

The bias and variability of laboratory analyses were evaluated using spiked samples. Blind spikes were made by adding a known quantity of diazinon to split replicates of environmental samples before submitting them for analysis along with regular samples. These samples were not identified as spikes to the analyst and, thus, were treated in the same manner as regular environmental samples. Diazinon concentrations were 100 or 500 ng/L in 14 spiked replicates analyzed by ELISA. Percentage recovery of diazinon ranged from 111 to 161 percent with an average of 130 percent. In four blind spikes analyzed by GC/ECD/TSD, diazinon spike concentrations were set at 100, 500, or 1000 ng/L. Recovery ranged from 53 to 102 percent with an average of 87 percent. Deviations from 100 percent recovery represent bias and variability of laboratory methods, as well as matrix effects caused by the interference of organic materials other than the analyte that may be present in the samples.

Reagent spikes are used in the laboratory to monitor the system performance of the analytical process. They are analyzed between small sets of environmental samples to determine instrument calibration and function. The California Department of Fish and Game laboratory analyzed 19 reagent spikes using GC/ECD/TSD during their analysis of environmental samples for this project. These spikes were made by adding diazinon to American River water producing concentrations of 100, 200, or 500 ng/L. Diazinon recoveries from these spikes averaged 85 percent with a standard deviation of 11percent. Along with environmental samples, the USGS laboratory analyzed 54 reagent spikes using GC/MS. These spikes were made by adding diazinon to laboratory reagent water. Recoveries averaged 98 percent with a standard deviation of 18 percent.

A single split replicate analysis of an environmental sample was submitted for analysis by ELISA. Diazinon concentration was 542 ng/L in the environmental sample and 502 ng/L in the replicate. These values are within the range of acceptable variation (control limits) determined by the laboratory.

Seven split replicate samples were analyzed by both GC/ECD/TSD and GC/MS. All samples were above reported detection limits or laboratory reporting limits. Concentration values between the two methods showed relatively little difference in all but one sample. The average difference was 11 percent. The coefficient of determination (R^2) for a linear regression of the paired data was 0.88. Split replicates of 110 environmental samples were analyzed by both ELISA and GC/ECD/TSD methods. Samples with diazinon concentrations above reported detection limits for both methods (87 sample pairs) were used to compare the two methods. A significant and consistent bias was observed between the two methods of analyses over the entire range of measured concentrations (fig. 3). Concentration values from ELISA analyses were significantly and consistently higher than values from GC/ECD/TSD analyses. The difference in mean concentration between the two methods was statistically significant (Mann–Whitney test, $p<0.001$). The coefficient of determination for a linear regression of the entire data set of paired values was 0.98, indicating a good correlation and a consistent bias between the two analyses. The regression trend line in figure 3 illustrates the positive bias of the ELISA values: an unbiased analysis would plot close to the 1:1 line on the graph. The difference between concentrations measured by ELISA and gas chromatography averaged 85 (median 83) percent above GC/ECD/TSD analysis values over the entire range of observed concentrations. At concentrations of 80 ng/L or less, the relative difference between the ELISA and GC/ECD/TSD analysis tended to be slightly lower, averaging about 60 percent.

The large bias observed during this study was not apparent in an extensive method performance evaluation completed prior to the study (Sullivan and Goh, 2000), although there was some positive bias between ELISA tests and confirmatory gas chromatography analyses on runoff water samples. Sullivan and Goh (2000) hypothesized that the bias they observed in runoff water might be due to cross-reaction with diazoxon, or an unknown metabolite in the water matrix, but considered this hypothesis as unlikely because of the low persistence of diazoxon in water and the lack of detections of this compound in other runoff studies. Also, diazoxon has not been detected in surface water in the study area (Domagalski, 1996) or in municipal wastewater treatment plant effluent with detectable diazinon concentrations (U.S. Environmental Protection Agency, 1999). Bias in ELISA analyses was not evident in a 1994 study of dormant spray season diazinon sources in which water samples collected in the same general study area were analyzed

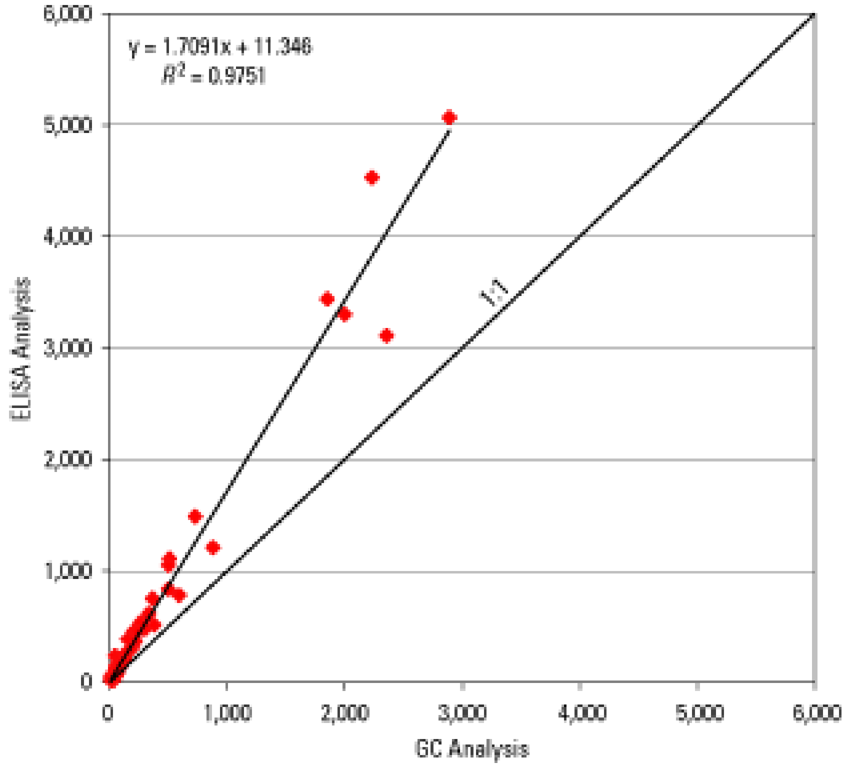


Figure 3. Concentrations of diazinon in split replicate samples analyzed by enzyme-linked immunosorbent assay (ELISA) and gas chromatography (GC) methods. Diazinon concentrations in nanogram per liter.

by both ELISA and GC/MS analysis (Holmes and others, 2000).

There is no clear explanation of the observed bias between the two analytical methods used in this study. Although recovery rates for GC/ECD/TSD analyses tended to be less than 100 percent, the recovery rate alone does not account for the large discrepancy between ELISA and GC analyses. The higher than expected concentrations provided by the ELISA analysis may be due to factors such as interference caused by the physical presence of particulate matter in the unfiltered samples used in the analysis or chemical cross-reactions with compounds other than the targeted pesticide.

For the purposes of this study, GC/ECD/TSD and GC/MS analyses are considered the more accurate method when interpreting data. ELISA methods for diazinon are relatively new, and GC/ECD/TSD and GC/MS methods have been widely used and proven over the years. GC/ECD/TSD and GC/MS methods had been chosen as a confirming analysis for the ELISA tests in the quality assurance/quality control plan of the approved study design. Finally, the confirming analysis of spiked samples provides confidence in the GC/ECD/TSD analysis versus the ELISA tests.

HYDROLOGIC CONDITIONS DURING THE STUDY

Although the total rainfall for the 1999–2000 dormant spray season was near average, precipitation during individual months departed from normal seasonal patterns, as shown in the precipitation data at Marysville, California (fig. 4). December and most of January were unusually dry. Dormant sprays may damage trees if humidity in the orchards is low, so the dry weather hindered pesticide application in the early part of the season. Winter storms began to move into the valley in late January, bringing that month's rainfall totals to near normal, and February was unusually wet. The city of Marysville, which is centrally located in the study area and receives an average of 3.15 in. of rain in February, received 10 in. of rain in February 2000. Marysville's daily precipitation during the storm monitoring periods is shown on figure 5.

Flows in the smaller tributaries generally reflect local storm runoff during the winter after irrigation decreases, and flows in the Sacramento, the Feather, the Yuba, and the Bear Rivers tend to be dominated by releases from reservoirs above the valley floor. Large volumes of water were released from reservoirs on these rivers in February in response to storm runoff in

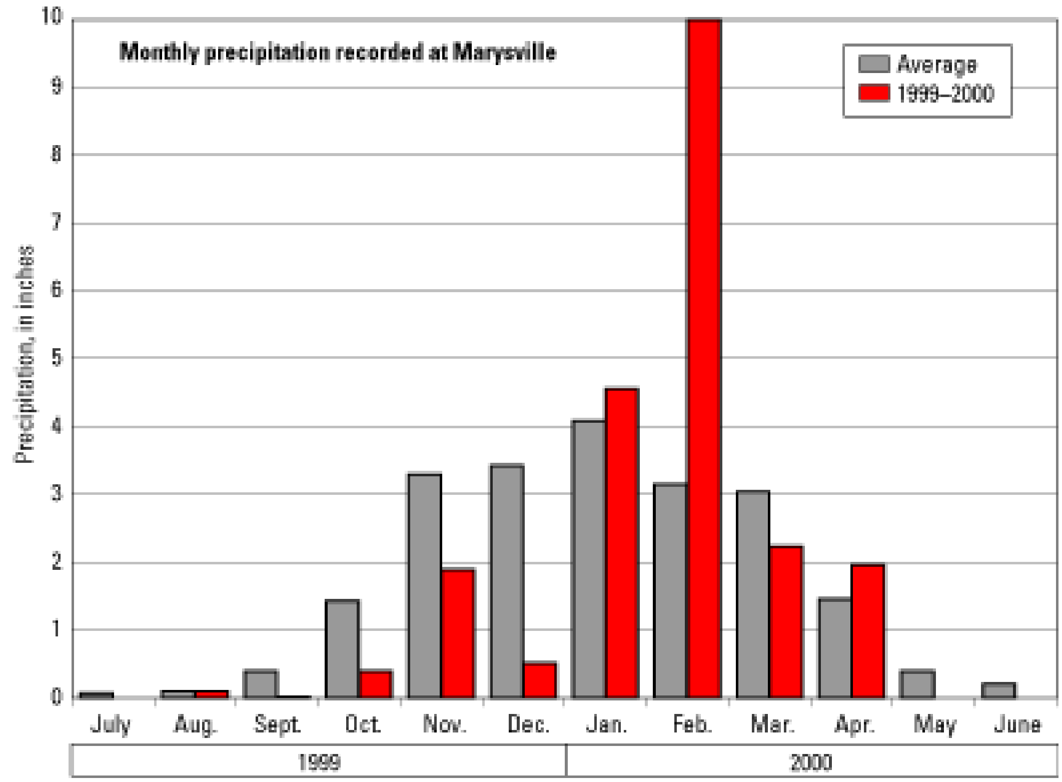


Figure 4. Monthly precipitation at Marysville, California, during the monitoring period. Average values are based on data colllected from 1961 to 1990.

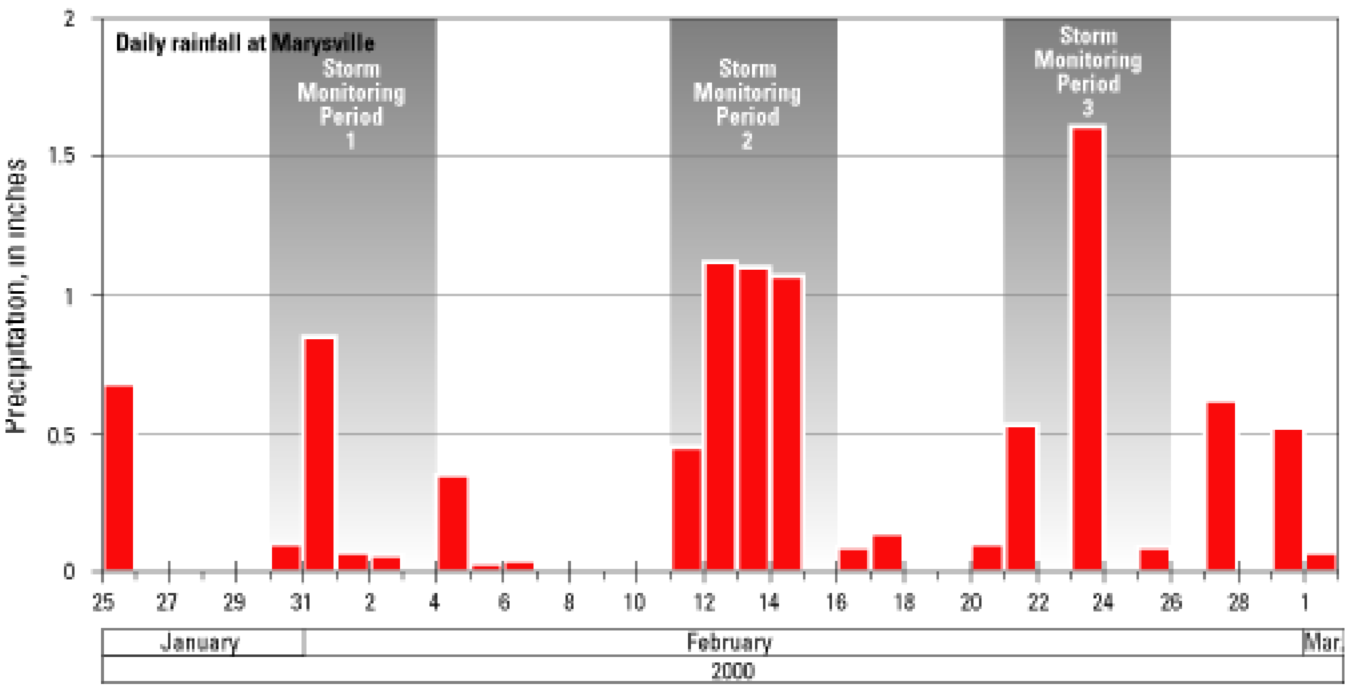


Figure 5. Daily rainfall at Marysville, California, during the monitoring period.

the upper watersheds. Reservoir releases are determined by downstream flood and reservoir management concerns and, thus, may not always correspond well to actual storm runoff patterns.

OCCURRENCE AND TRANSPORT OF DIAZINON

In California, the location and quantity of agricultural and commercial pesticide applications must be reported to DPR. Data from DPR's Pesticide Use Database (California Department of Pesticide Regulation, 2000) show that from late 1995 through the spring of 1999, between 76,700 and 96,000 pounds active ingredient (lb a.i.) of diazinon (fig. 6) were applied each year during the dormant spray season in the 10 counties that occupy the Sacramento Valley. The average quantity of diazinon applied during that period was 82,900 lb. The greatest use occurred during January and February; January had the highest use with 56 to 66 percent of the total seasonal application (statistics derived from California Department of Pesticide Regulation, 2000).

Diazinon Use During the Winter of 1999–2000

Records from pesticide applicators sent to DPR for December 1999 to March 2000 (California Department of Pesticide Regulation, 2000) indicate that diazinon use in the Sacramento Valley during the 1999–2000 dormant spray season was considerably lower than in previous years (fig. 6, table 3). The current records document 49,500 lb a.i. of diazinon applied in the Sacramento Valley by registered applicators, an amount 60 percent of the average application of the previous four dormant spray seasons. Much of the decrease was due to a reduction of use in almond orchards, where applications were only 20 percent of the amount applied the previous winter (table 3). Diazinon use in prune orchards was 83 percent of the previous years level, also slightly lower. The decrease may be partly due to recent low market prices for these commodities; increased production may not offset the cost of the pesticide applications. Another possible explanation is product substitution, whereby growers switch to a different pesticide. Epstein and others (2001) have documented the recent trend of growers switching from diazinon and other organophosphate insecticides to pyrethroid insecticides for dormant spraying.

The majority of diazinon use was from late January through February. To determine diazinon use within individual subbasins during this period, pesticide-use data were incorporated into a geographic information system (GIS) coverage of the study area, and the data were segregated into those subbasins having known or defined boundaries. Bar charts and maps (figs. 7–13) show the daily application amounts of diazinon during the dormant spray season for selected subbasins in the Sacramento River watershed.

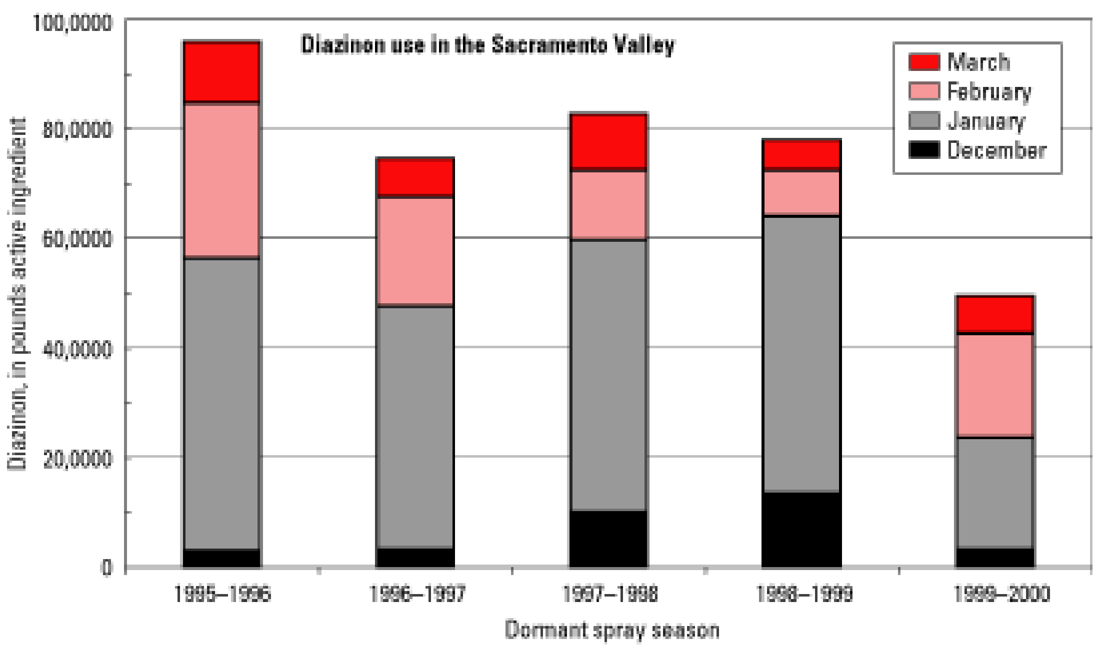


Figure 6. Diazinon use in the Sacramento Valley, California, during dormant spray seasons from 1995 to 2000. Counties applicable are Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba (California Department of Pesticide Regulation, 2000).

Table 3. Diazinon applications reported for selected crops and other uses in the Sacramento Valley, California

[Diazinon use is in pounds active ingredient. Counties applicable are Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba (California Department of Pesticide Regulation, 2000)]

Crop	Diazinon use		
	1998–1999 dormant spray season	1999–2000 dormant spray season	Percent of previous year
Prune	30,000	25,000	83
Almond	29,800	5,980	20
Peach	7,290	8,720	120
Structural	6,480	4,930	76
Other uses	2,930	3,670	125
Apple	1,230	700	57
Walnut	250	50	20
Cherry	84	520	619
Total	78,064	49,570	63

Between December 1 and the first significant rain of the season on January 24, only 6,950 lb a.i. had been applied to the drainage basin above site 17 (Sacramento River at Tower Bridge). After the January 24 storm, conditions for dormant spraying improved and diazinon applications increased. Between January 25 and the end of the monitoring period on February 25, 32,900 lb a.i. had been applied. At the tail end of the dormant spray season, between the end of the monitoring period and March 31, an additional 7,200 lb a.i. of diazinon were applied.

Pesticide applications upstream of monitoring sites that have defined drainage boundaries are summarized in table 4 for five time periods related to storm monitoring periods. Period 1 includes all applications made in December. Period 2 includes all applications made between January 1 and the end of the first monitoring period on February 3. Periods 3 and 4 include applications made after the previous monitored storm through the end of the second and third monitored storms. Period 5 covers the time between the third monitored storm and the end of the dormant spray season. Rainfall did occur during application period 4; however, only 18 percent of the total diazinon application of the entire dormant spray period occurred during that period.

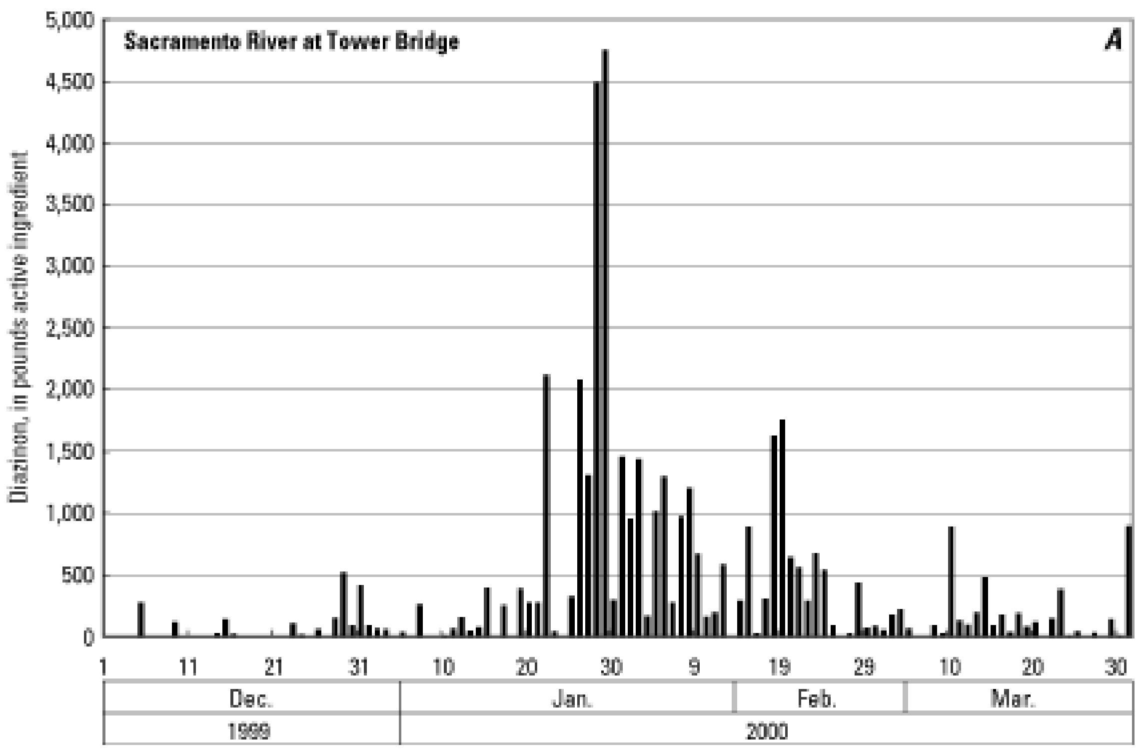


Figure 7. Diazinon use upstream of Sacramento River at Tower Bridge (site 17), California. (***A***) Daily diazinon use. See figure 1 and table 1 for site location. *Continued.*

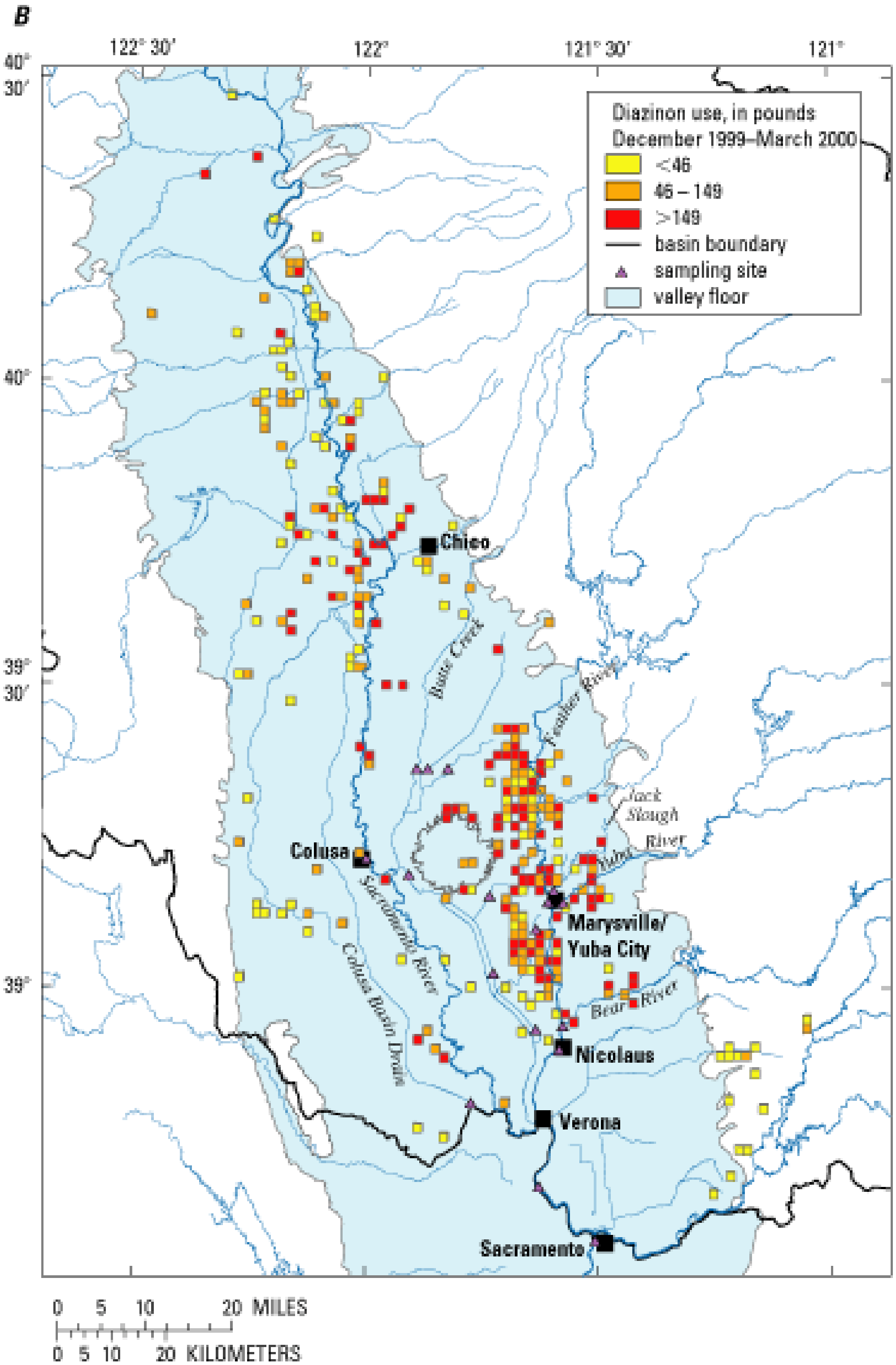


Figure 7. Diazinon use upstream of Sacramento River at Tower Bridge (site 17), California. (***B***) Areal distribution of applications. See figure 1 and table 1 for site location. <, less than; >, greater than.

Maps in figures 7 through 13 show the areal distribution of registered diazinon applications within the selected subbasins from December to March. Application quantities are plotted at the section level of the Public Lands Survey System.

Concentrations of Diazinon Observed During Storms

Diazinon concentrations measured in this study (fig. 14) are plotted along with stream discharge or stage (that is, water surface elevation) when no discharge was available. Sites 2 and 9 are not included because neither discharge nor stage was available for site 2 (Colusa Basin Drain at Road 99E near Knights Landing), and site 9 (Yuba River at Marysville) had no detectable pesticides in samples. As noted earlier, positive bias was observed in the ELISA analyses relative to GC methods in this study and, therefore, ELISA data probably overestimate actual concentrations in the environment. Because the bias is consistent, the data is useful in comparing the relative differences among samples collected at different times during a storm monitoring period and the relative difference among sites.

With few exceptions, the highest concentrations were observed during the first storm runoff of the dormant spray season, even though the first storm was not the largest in terms of total rainfall. This "first flush" washed off pesticides that had accumulated since the beginning of the dormant spray season, and the period before the first storm was the period of the largest diazinon applications (table 4). Another factor influencing the high concentrations during the first storm was the relatively low flows in the Sacramento, the Feather, and the Bear Rivers; low reservoir releases resulted in less dilution of agricultural and urban runoff than during later storms. The two exceptions to this trend were site 4 (DWR Pump Plant 1) and site 16 (Main Canal at Gridley Road). Because the boundaries of the basins upstream of these sites have not been defined, it is unclear whether low concentrations observed during the first storm monitoring period are due to low applications in the basins or characteristics of the basins that delayed transport from sources to monitoring sites.

Box plots of data aggregated by storm (fig. 15) show that, overall, the concentrations during the first and second storm monitoring periods were similar.

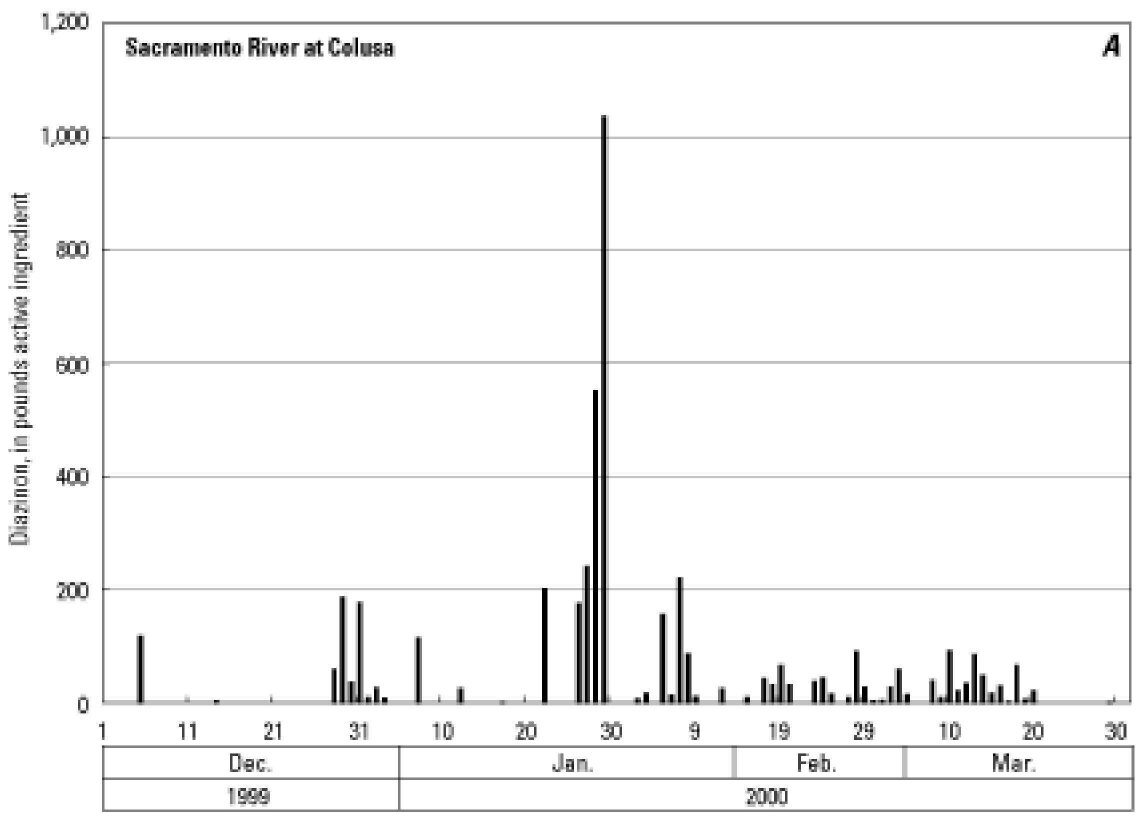


Figure 8. Diazinon use upstream of Sacramento River at Colusa (site 13), California. (***A***) Daily diazinon use. See figure 1 and table 1 for site location. *Continued.*

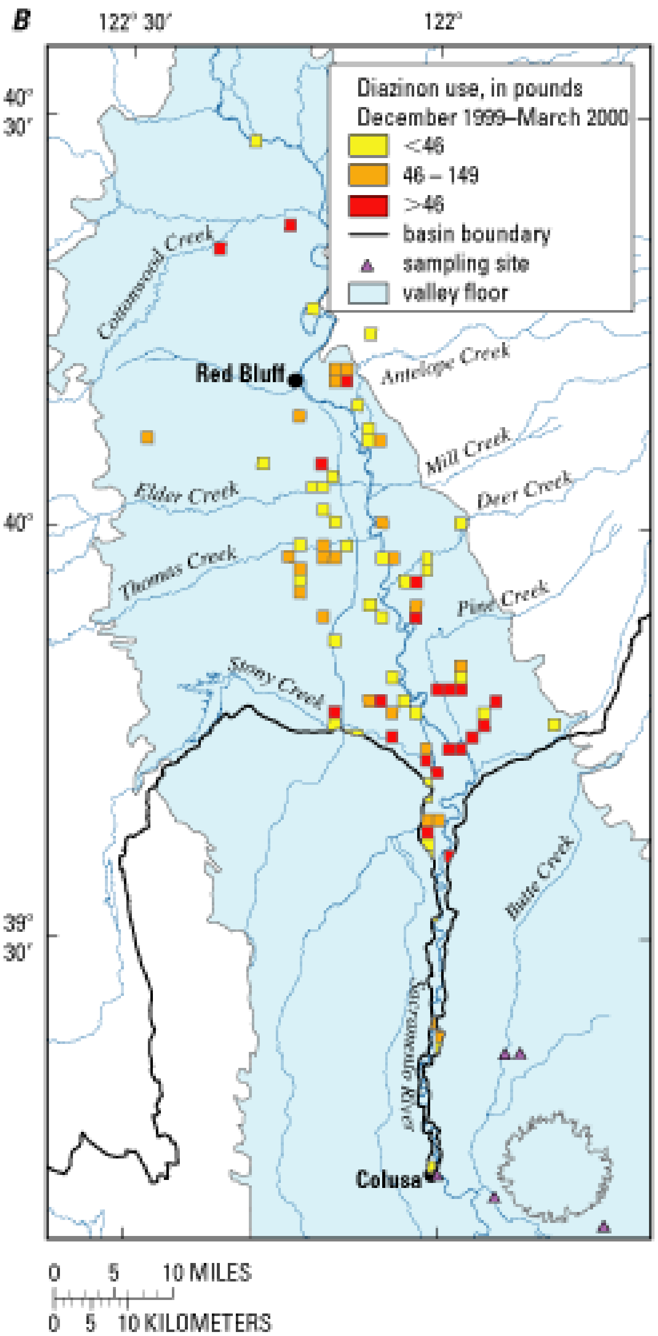


Figure 8. Diazinon use upstream of Sacramento River at Colusa (site 13), California. (***B***) Areal distribution of applications. See figure 1 and table 1 for site location. <, less than; >, greater than.

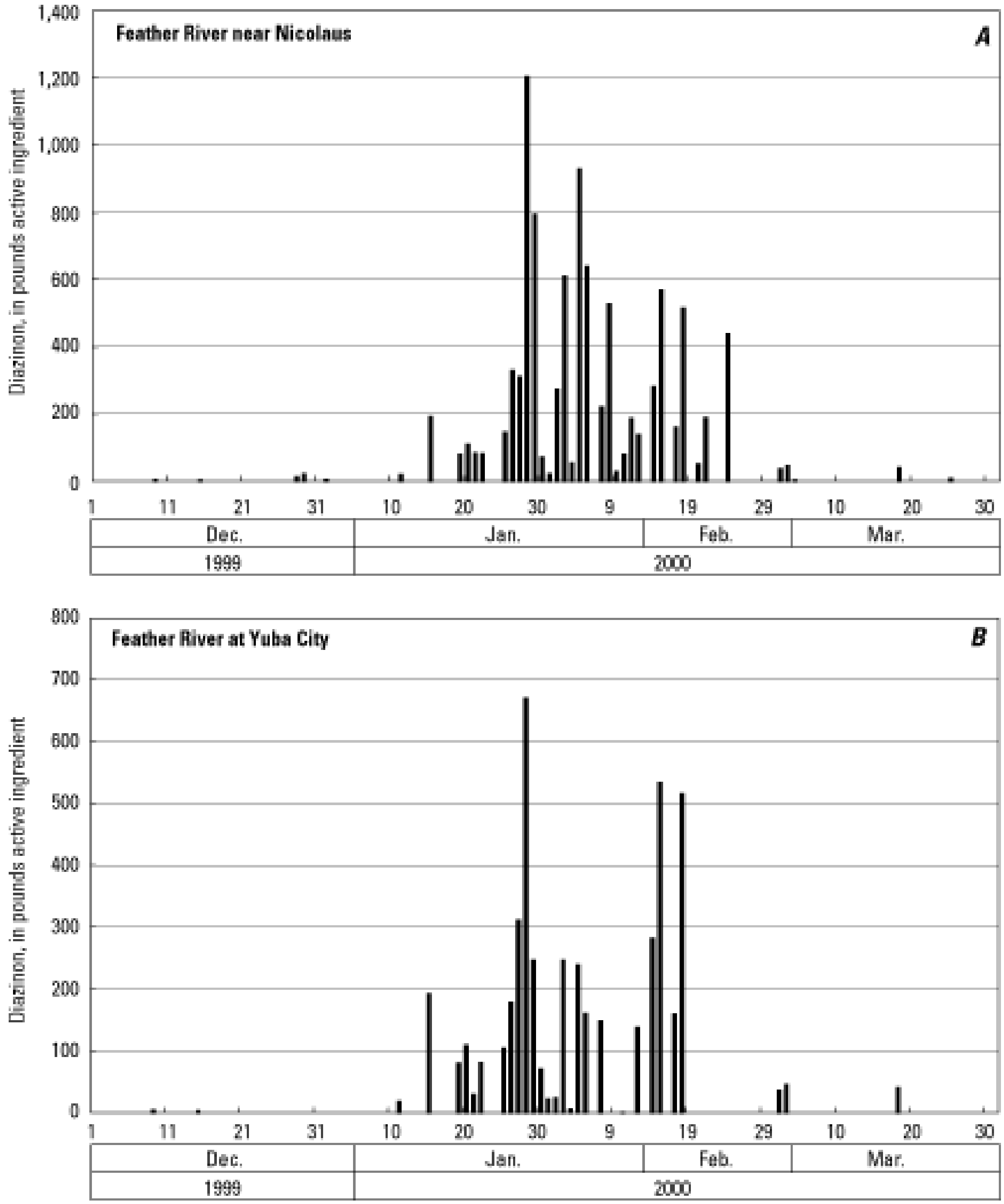


Figure 9. Diazinon use upstream of the Feather River near Nicolaus (site 3) and the Feather River at Yuba City (site 8), California. Daily diazinon use upstream of (***A***) Feather River near Nicolaus (site 3) and (***B***) Feather River at Yuba City (site 8). See figure 1 and table 1 for site location.

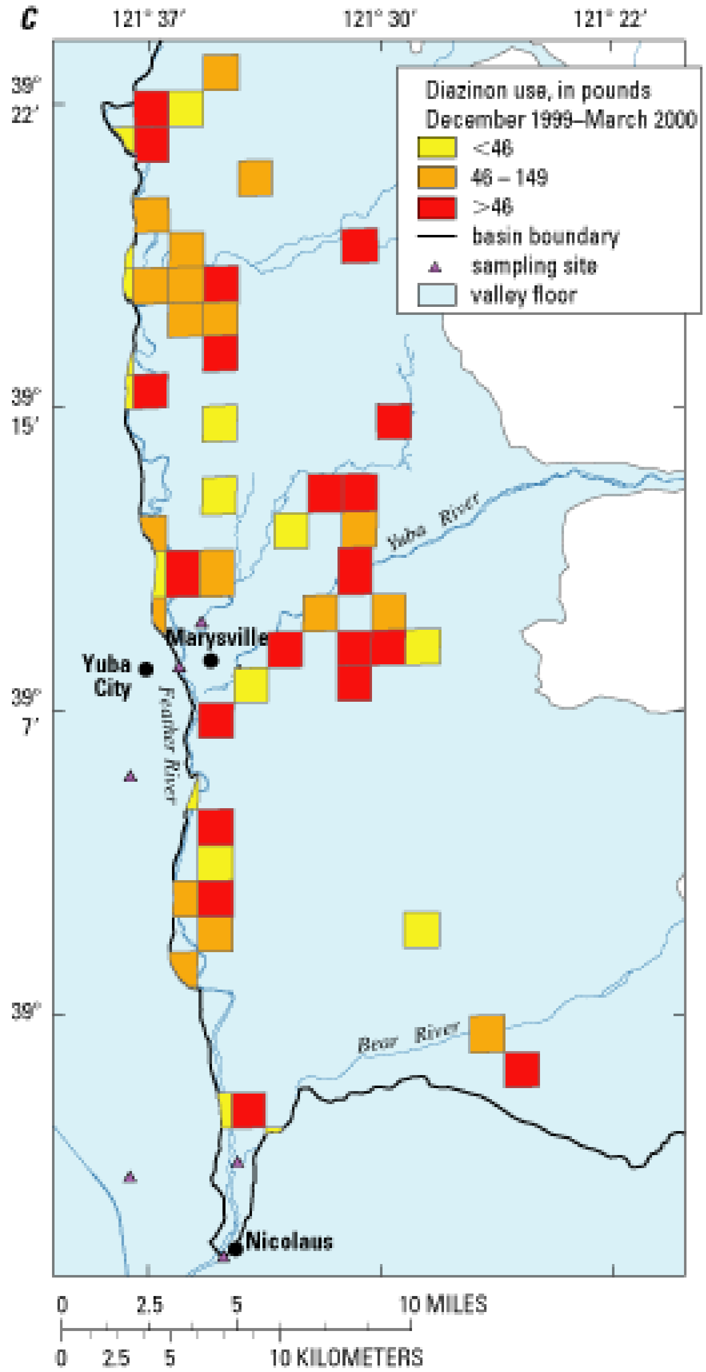


Figure 9. Diazinon use upstream of the Feather River near Nicolaus and the Feather River at Yuba City, California. (***C***) Areal distribution of applications. See figure 1 and table 1 for site location. <, less than; >, greater than.

Median concentrations in samples analyzed by ELISA (fig. 15*A*) were 174, 159, and 55 ng/L for storms monitoring period 1, 2, and 3, respectively. Median concentrations of samples analyzed by gas chromatography methods (fig. 15*B*) were 57, 44, and 22, for storms monitoring periods 1, 2, and 3, respectively.

Box plots of data collected at each site are shown on figures 16*A* (ELISA) and 16*B* (GC methods). Sites receiving mostly agricultural or urban drain water had the highest concentrations of diazinon. A hazard assessment of diazinon by the California Department of Fish and Game reported that freshwater organisms

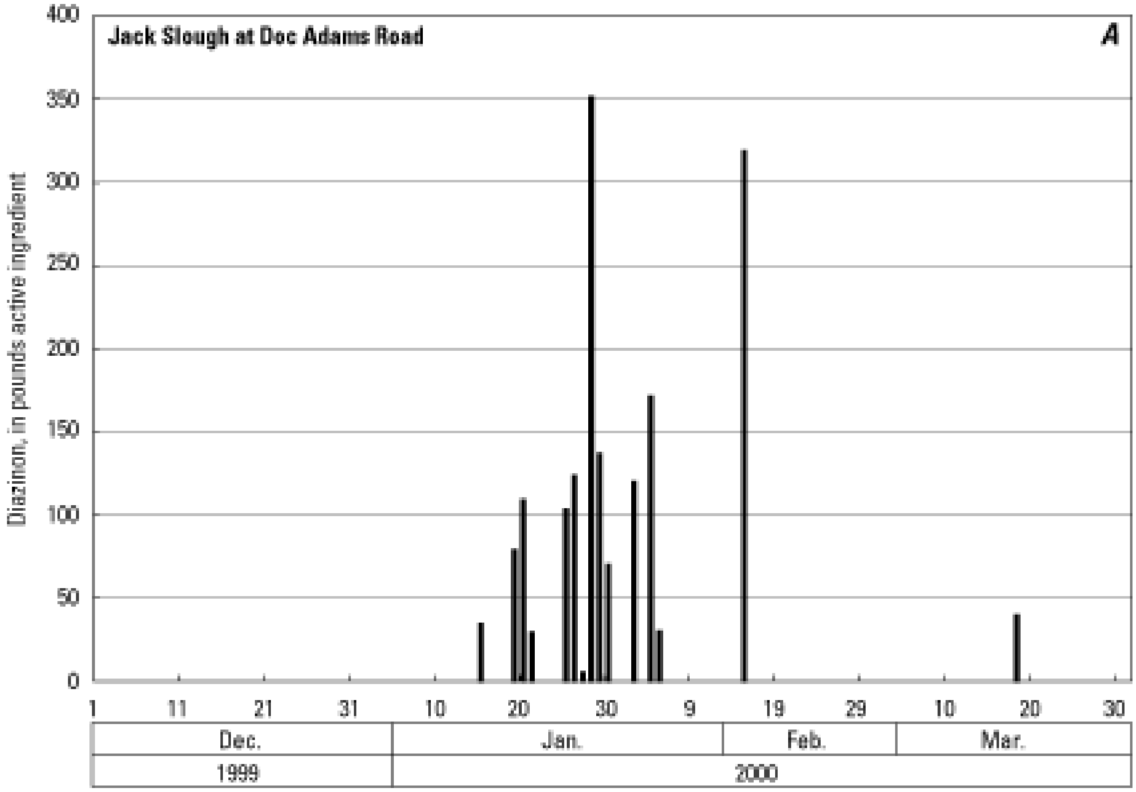


Figure 10. Diazinon use upstream of Jack Slough at Doc Adams Road (site 11), California. (***A***) Daily diazinon use. See figure 1 and table 1 for site location. *Continued.*

should not be adversely affected by exposure to diazinon if the 4-day average aquatic concentration did not exceed 40 ng/L, or if the 1-hour average did not exceed 80 ng/L more than one time every 3 years (Menconi and Cox, 1994). All samples collected at agricultural sites 6b, 10, 11, and 16, as well as site 7, which drains the Yuba City urban watershed, were above 80 ng/L (GC analyses). Out of a total of 138 samples analyzed by gas chromatography methods, 55 percent were over 40 ng/L, and 30 percent were greater than 80 ng/L.

The median concentration of diazinon in the 16 samples analyzed by GC/MS at site 17 (Sacramento River at Tower Bridge) was 27 ng/L with a range of 12 to 67 ng/L. The USGS Toxic Contaminants Hydrology Program did extensive monitoring at site 17 from 1991 through 1994 (MacCoy and others, 1995). Samples for that study were collected once or twice daily during periods of high flow. During the three dormant spray seasons (December through March of these years), median concentrations were 23, 37, and 39 ng/L, with maximum concentrations of 155, 393, and 253 ng/L, respectively.

The median concentration of diazinon in samples collected at site 3 (Feather River near Nicolaus) and analyzed by GC/MS was 36 ng/L with a maximum of 130 ng/L. In 1994, a dormant spray monitoring study directed by the Regional Board (Holmes and others, 2000) included a site adjacent to site 3. Eleven samples from three storms (including the first storm of the dormant spray season) from the Regional Board site were analyzed by GC/MS; the median concentration was 180 ng/L with a maximum concentration of 782 ng/L. These comparisons suggests that diazinon concentrations observed during the 1999–2000 dormant spray season were lower than previous years, perhaps because of the relatively low diazinon use compared with the earlier period.

Measured and Estimated Loads at Monitoring Sites

Storm loads using ELISA analyses were calculated for sites 1, 3, 4, 5, 6a, 6b, 12, and 13 (fig. 17 and table 5). Because these loads were derived from samples analyzed by ELISA, they are presented here only for site-to-site and storm-to-storm comparison. At sites 3 (Feather River near Nicolaus) and 17 (Sacramento River at Tower Bridge), a sufficient number of samples were analyzed by GC/MS (table 6) to estimate loads based on those analyses. These loads are estimates of the actual mass transport of diazinon passing through the rivers at those two sites (table 6).

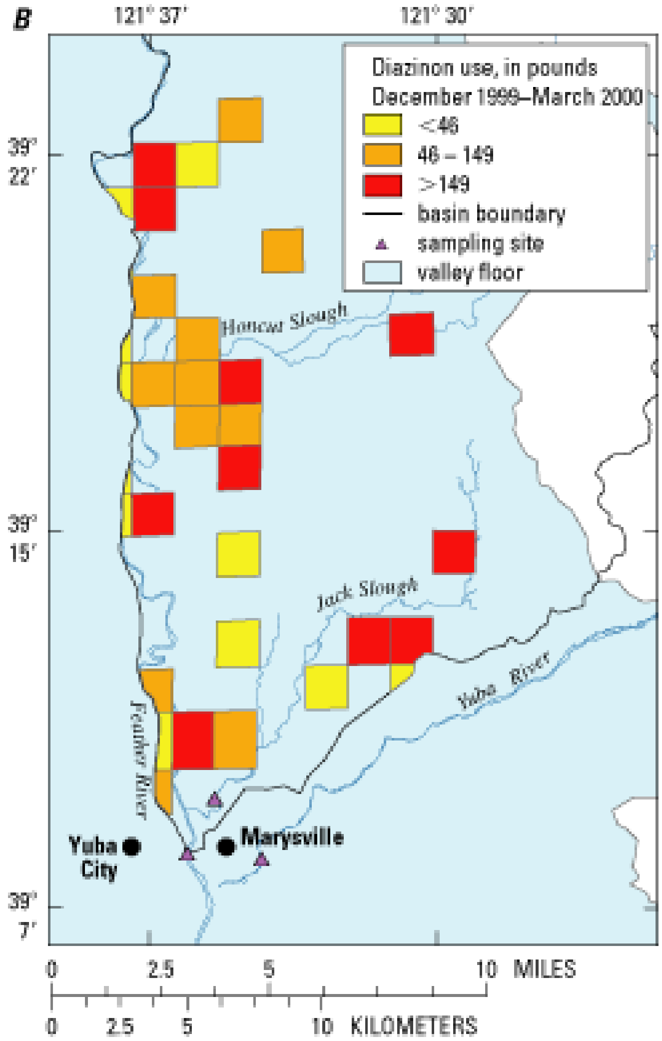
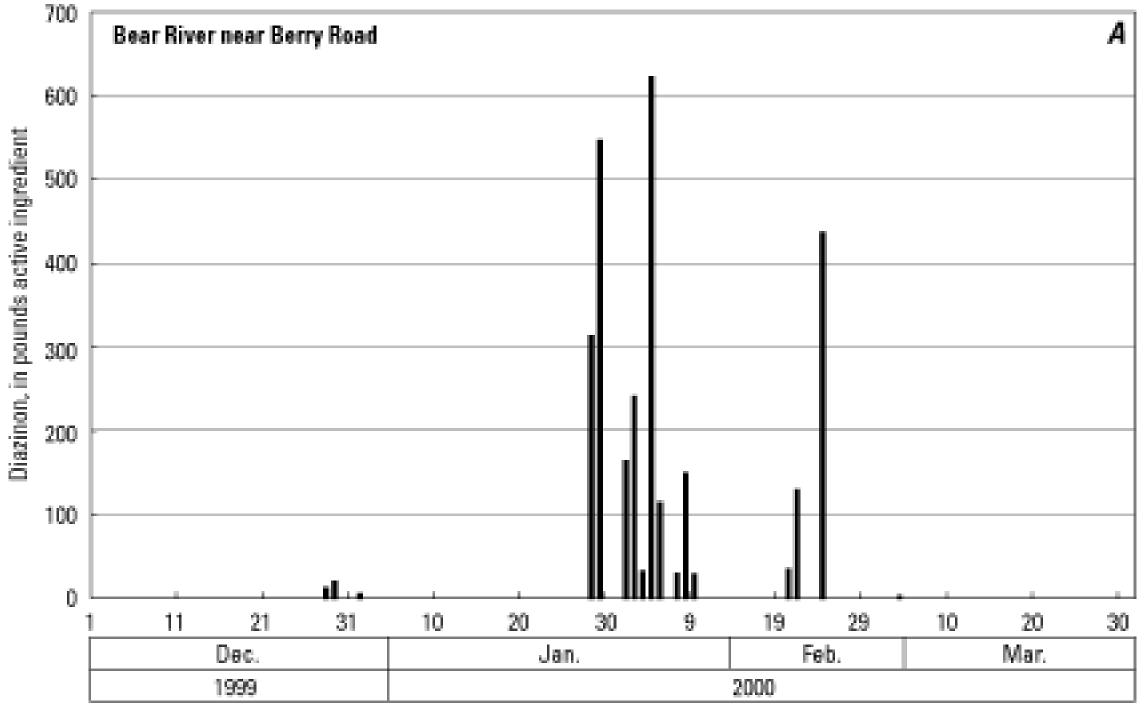


Figure 10. Diazinon use upstream of Jack Slough at Doc Adams Road (site 11), California. (***B***) Areal distribution of applications within the subbasin. See figure 1 and table 1 for site location. <, less than; >, greater than.

Estimated total loads in the Sacramento River at the mouth of the Feather River during the three monitored storms was about 176 lb (pound) using ELISA data (table 5). The value was derived by summing the estimated loads entering that reach from sites 13, 3, 4, 6a, 6b, and 12. The watershed upstream of site 13 (Sacramento River at Colusa) appears to contribute about 50 percent of the total diazinon load to the Sacramento River at the Feather River. About 25 percent of the total storm load appeared to come from the Feather River. Butte Slough contributed about 17 percent and the two DPR pumping plants on the Sutter Bypass added about 6 percent of the total mass of diazinon. A large part of the water flowing through Butte Slough during the second and third storms (86 percent of the volume) was Sacramento River water that had been diverted to the slough by way of the Moulton and Colusa weirs located upstream of Colusa (site 13). An unknown part of the loads from Butte slough during those periods may have originated in the upper reaches of the Sacramento River.

The estimated storm loads at site 1 (Sacramento River at Alamar) are consistently lower than the sum of estimated loads upstream by 26, 16, and 25 percent for storms monitoring periods 1, 2, and 3, respectively. Although some flows were diverted from the Sacramento River to the Yolo Bypass 10 mi upstream of Alamar, the diversions during the first and second storm periods do not appear sufficient to account for all the difference. Streamflow records indicate that only about 5 percent of the flow was diverted during the first two storms. Diversions increased substantially during the third storm period to about one half the flow at Alamar. Another source of error that could lead to underestimating loads at Alamar relates to the timing of sample collections. As a pulse of material entrained in flowing water moves down channel, it tends to attenuate and elongate because of differences in



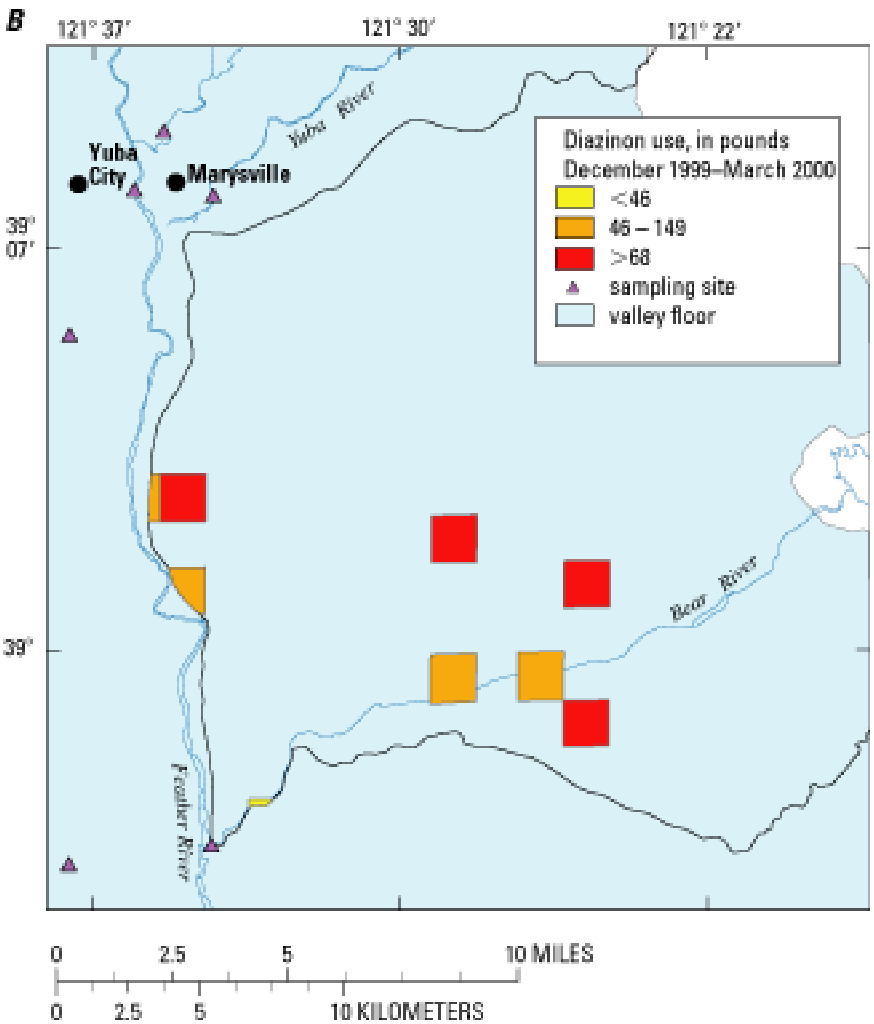


Figure 11. Diazinon use upstream of Bear River near Berry Road (site 5), California. (***A***) Daily diazinon. (***B***) Areal distribution of applications within the subbasin. See figure 1 and table 1 for site location. <, less than; >, greater than.

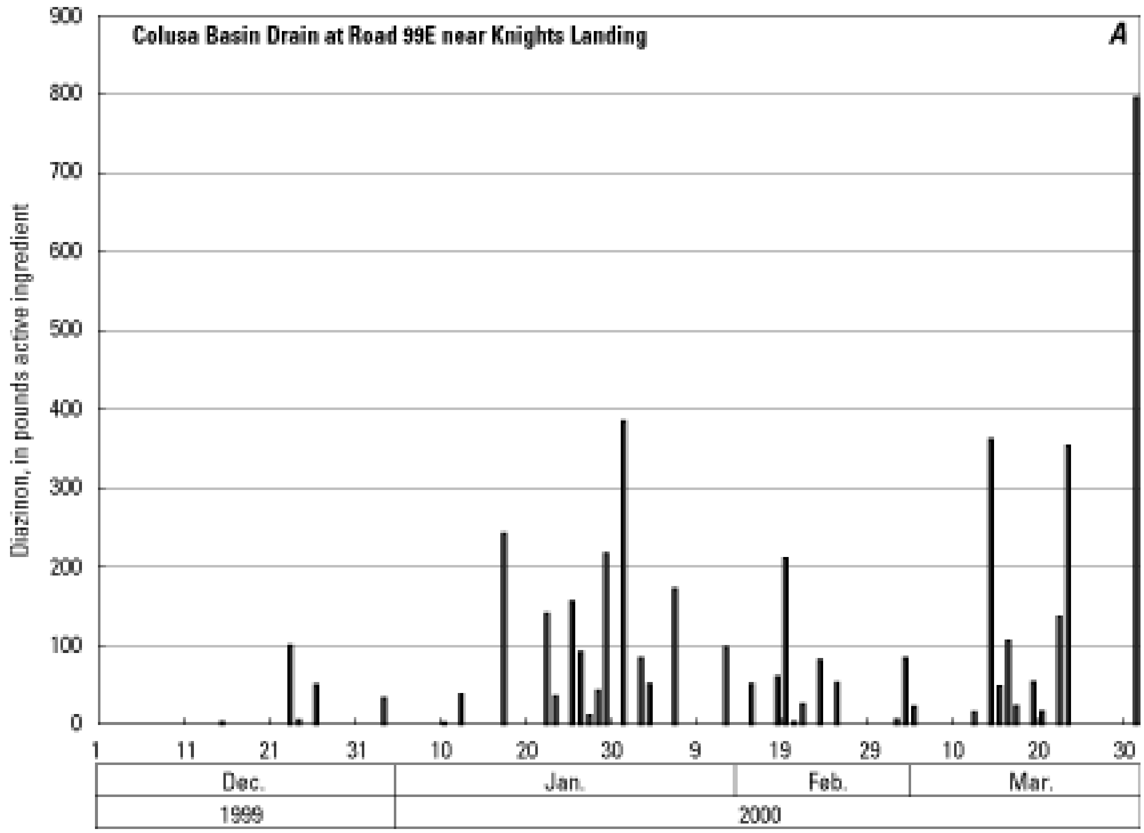


Figure 12. Diazinon use upstream of Colusa Basin Drain at Road 99E near Knights Landing (site 2), California. (***A***) Daily diazinon use. See figure 1 and table 1 for site location. *Continued.*

water velocity throughout the channel. In the case of storm runoff, streamflow also tends to lag because of the effect of channel storage as water levels rise and fall. The mass of diazinon that passed by upstream sites in each 5-day storm monitoring period may have taken more than 5 days to pass through the lower sites. The convention of assigning a 50 percent concentration of the detection limit to samples below the detection limit when computing loads for this study may also have contributed to underestimating or overestimating loads, particularly during the last storm monitoring period when diazinon concentrations in many samples from the Sacramento River were below the relatively high detection limits of the ELISA analysis.

Estimates of actual storm loads using data from GC/MS analyses are available for two sites; 35 lb of diazinon passed site 3 on the Feather River, and 132 lb passed site 17 on the Sacramento River (table 6). The latter represents the contribution from all sources upstream of the city of Sacramento, minus an unknown part of the upstream loads diverted to the Yolo Bypass.

Relation of Loads to Diazinon Use

In general, diazinon loads were greater in subbasins that had greater diazinon use. Figure 18 shows the relation between use and total loads for the three storm monitoring periods in the four subbasins where both pesticide use and loads were known. The loads shown are the sum of the three monitored storms based on ELISA analyses.

Estimates of the fraction of applied diazinon transported as storm loads to the Feather and the Sacramento Rivers were calculated by dividing loads calculated using GC/MS data at sites 3 and 17 by the mass of diazinon applied upstream in the period before and during the storm monitoring periods (table 6). Although there was some agricultural use of diazinon in December applications (period 1 in table 4), this period was not included in the analysis because the amount applied was relatively small and sufficient time had elapsed for significant degradation and loss of applied diazinon prior to the first monitored storm at the end of January.

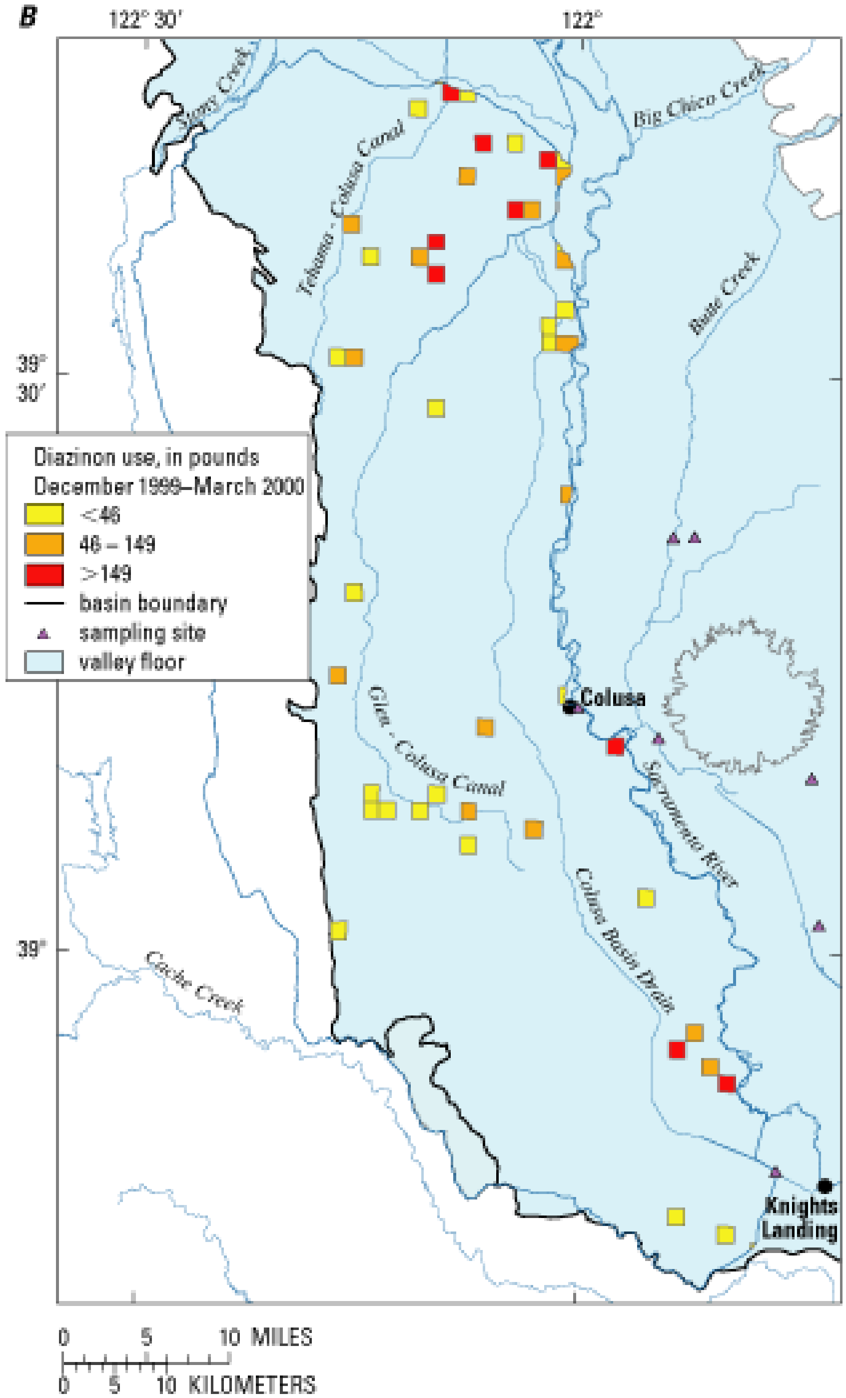


Figure 12. Diazinon use upstream of Colusa Basin Drain at Road 99E near Knights Landing (site 2), California. (***B***) Areal distribution of applications within the subbasin. See figure 1 and table 1 for site location. <, less than; >, greater than.

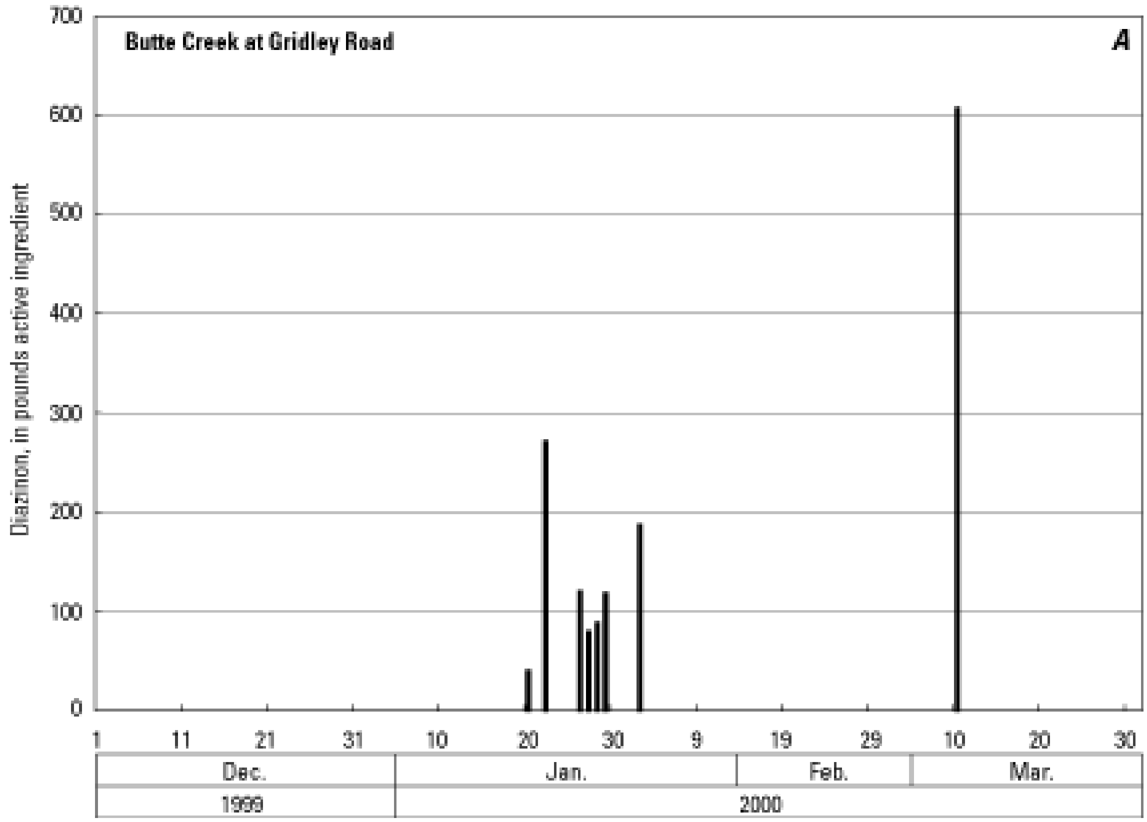


Figure 13. Diazinon use upstream of Butte Creek at Gridley Road (site 14), California. (***A***) Daily diazinon use. See figure 1 and table 1 for site location. *Continued*.

Diazinon transported to the Feather River (site 3) during the three storm monitoring periods ranged between 0.25 and 0.49 percent of the applied pesticide with a total for the monitoring period of 0.38 percent. Diazinon transported to the Sacramento River at Tower Bridge (site 17) ranged from 0.19 to 0.85 percent in individual storms with a total for the monitoring period of 0.40 percent. Because some of the load was diverted to the Yolo Bypass upstream of Sacramento, the fraction may be slightly higher than this estimate suggests.

Estimates of the percentage of applied diazinon transported from application areas to the Sacramento and the Feather Rivers are similar to the estimates of 0.5 to 1.7 percent of applied diazinon transported to the Sacramento River based on data collected in 1993 (Kuivila and Foe, 1995). These estimates are higher than Kratzer (1999) reported for rivers in the San Joaquin Valley. Kratzer (1999) estimated that about 0.05 percent of the total applied diazinon was transported to the San Joaquin River during two storms monitored in 1994. The values derived for the Sacramento Valley, however, are consistent with estimates from other parts of the United States. Estimates of diazinon fluxes to seven rivers in the Mississippi River Basin during 1991 were between 0.08 and 20 percent with a median of 0.13 percent (Larson and others, 1995). The high values in some of those rivers may have resulted from significant urban use that was not accounted for in pesticide use records, or from possible illegal use and spills.

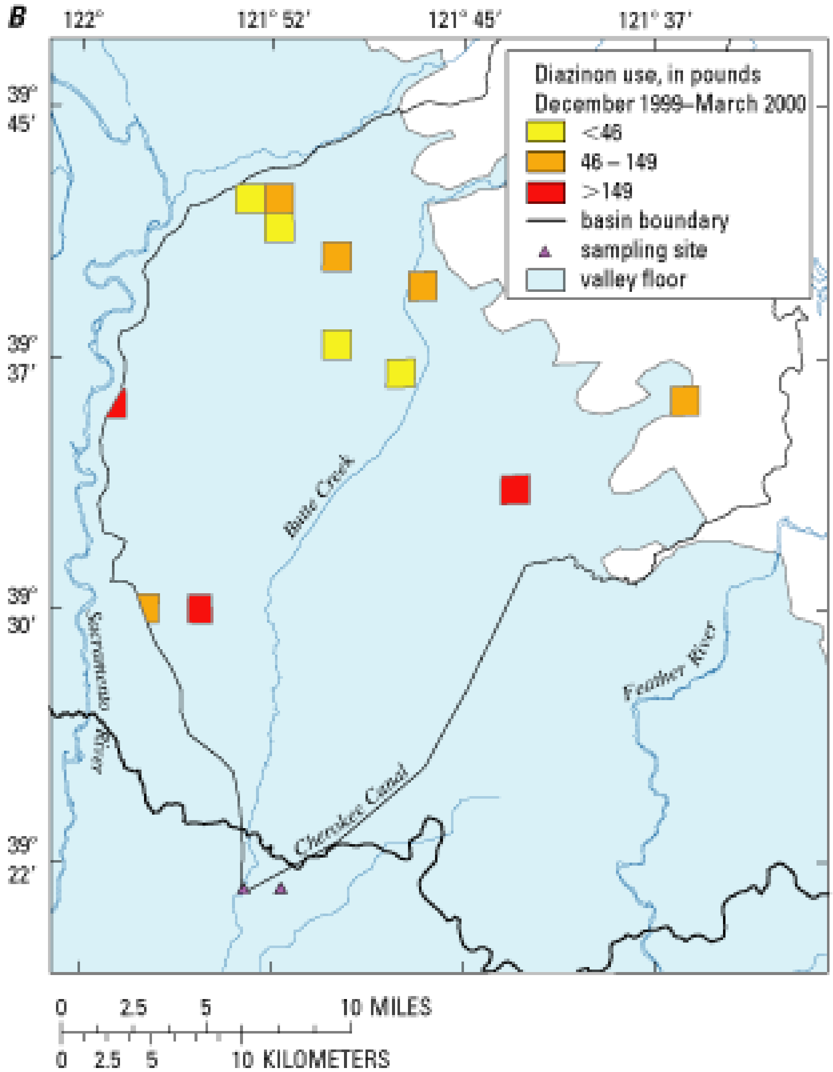


Figure 13. Diazinon use upstream of Butte Creek at Gridley Road (site 14), California. (***B***) Areal distribution of applications within the subbasin. See figure 1 and table 1 for site location. <, less than; >, greater than.

Table 4. Diazinon use in selected subbasins during five application periods in the 1999–2000 dormant spray season, Sacramento River Basin, California

[Pounds applied are active ingredient. Basin area and area applied are in square miles]

Sites	Basin area	Period 1 (12/1/99–12/31/99)		Period 2 (1/1/00–2/3/00)		Period 3 (2/4/00–2/15/00)		Period 4 (2/16/00–2/25/00)		Period 5 (2/26/00–2/29/00)	
		Pounds applied	Area applied (in basin)	Pounds applied	Area applied (in basin)	Pounds applied	Area applied (in basin)	Pounds applied	Area applied (in basin)	Pounds applied	Area applied (in basin)
Bear River	574	32	2.0	1,300	7.1	940	6.0	600	1.7	2	1.0
Butte Creek	589	0	0.0	905	9.4	0	0.0	0	0.0	607	1.4
Colusa Basin Drain	1,630	158	4.0	1,530	15.9	320	3.4	433	6.9	2,020	16.9
Jack Slough	73	0	0.0	1,160	8.0	520	3.5	0	0.0	40	1.1
Feather River at Nicolaus	5,880	40	2.4	4,370	30.3	3,670	17.4	1,350	4.0	130	4.4
Feather River at Yuba	3,930	8	0.4	2,380	17.8	1,500	7.1	674	2.0	120	3.1
Sacramento River at Colusa	122,300	1,280	8.8	5,310	30.2	1,140	13.4	591	7.7	1,550	28.3
Sacramento River at Verona	21,440	1,830	25.8	21,700	152	7,440	57.8	6,440	44.2	5,140	69.5
Sacramento River at Tower Bridge	23,640	1,830	25.8	21,700	154	7,460	60.4	6,440	47.2	5,180	74.1

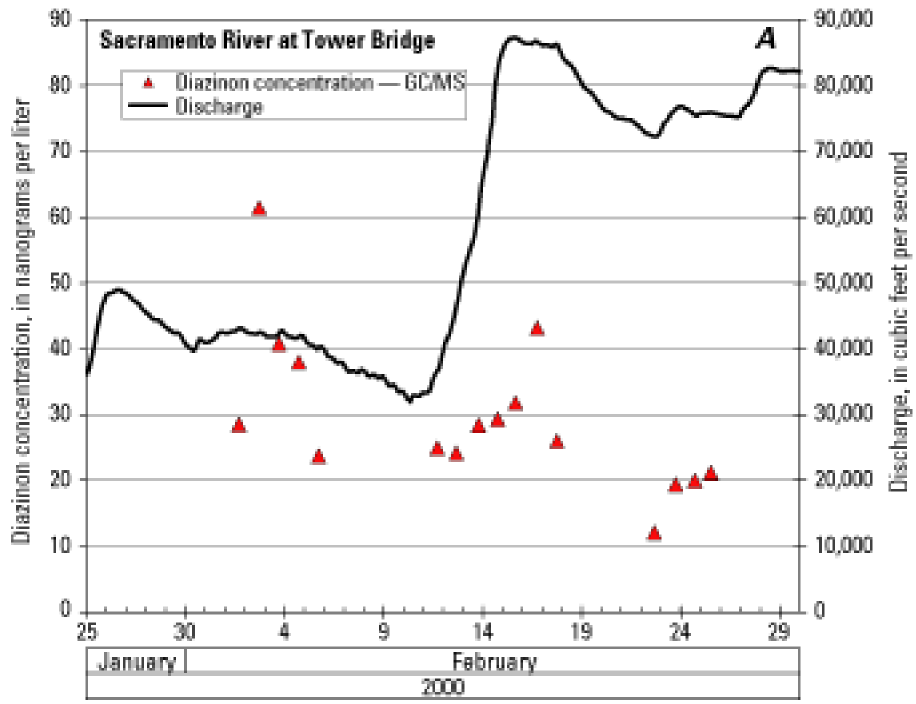


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. (***A***) Gas chromatography with mass spectrometry (GC/MS) and discharge at the Sacramento River at Tower Bridge (site 17). See figure 1 and table 1 for site location. *Continued.*

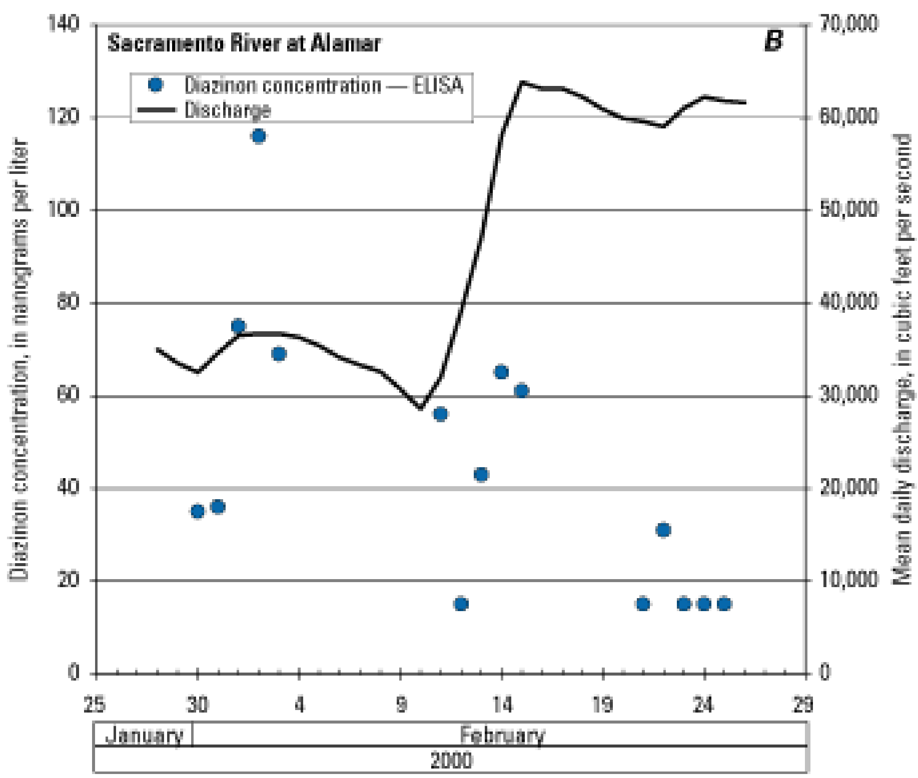


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. (***B***) Enzyme-linked immunosorbent assay (ELISA) and discharge at the Sacramento River at Alamar (site 1). See figure 1 and table 1 for site location. *Continued.*

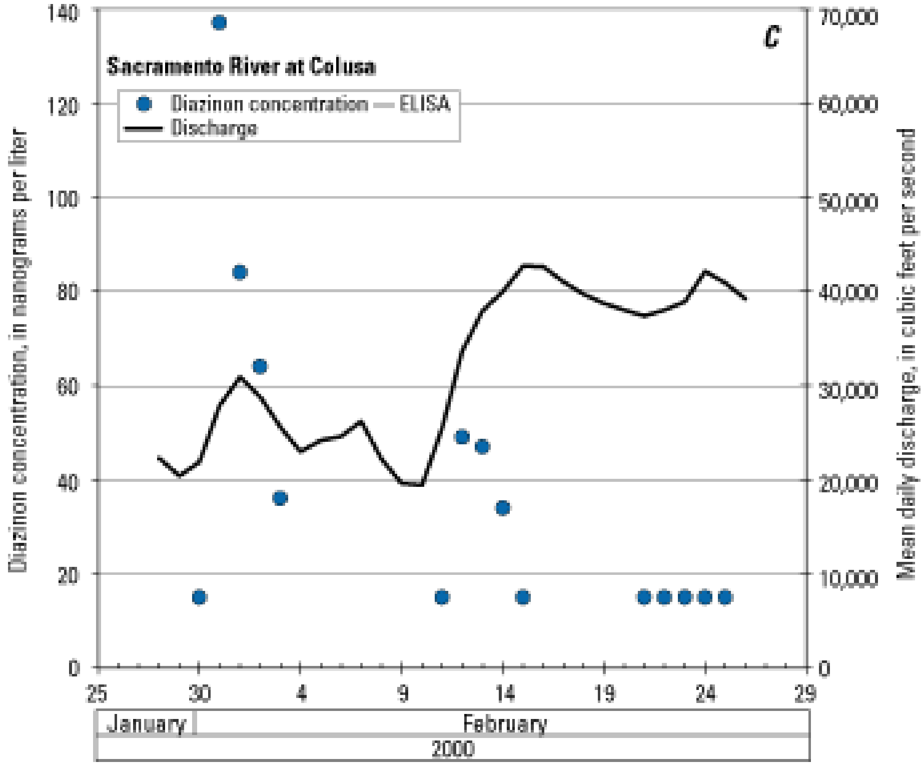


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. (***C***) Enzyme-linked immunosorbent assay (ELISA) and discharge at the Sacramento River at Colusa (site 13). See figure 1 and table 1 for site location. *Continued.*

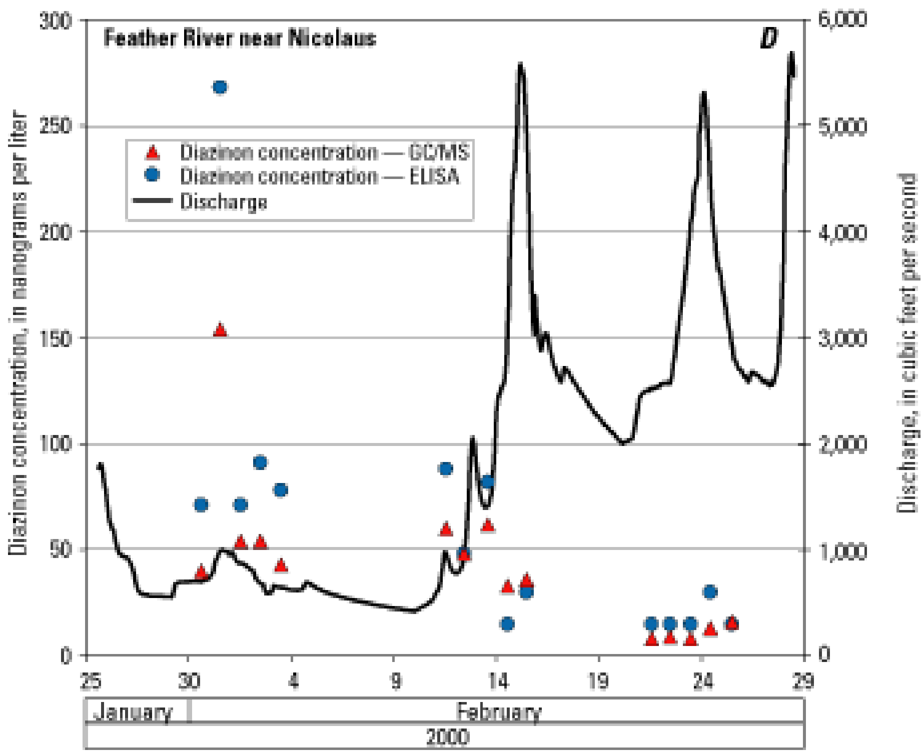


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. (***D***) Enzyme-linked immunosorbent assay (ELISA) and gas chromatography with mass spectrometry (GC/MS) and discharge, Feather River near Nicolaus (site 3). See figure 1 and table 1 for site location. *Continued.*

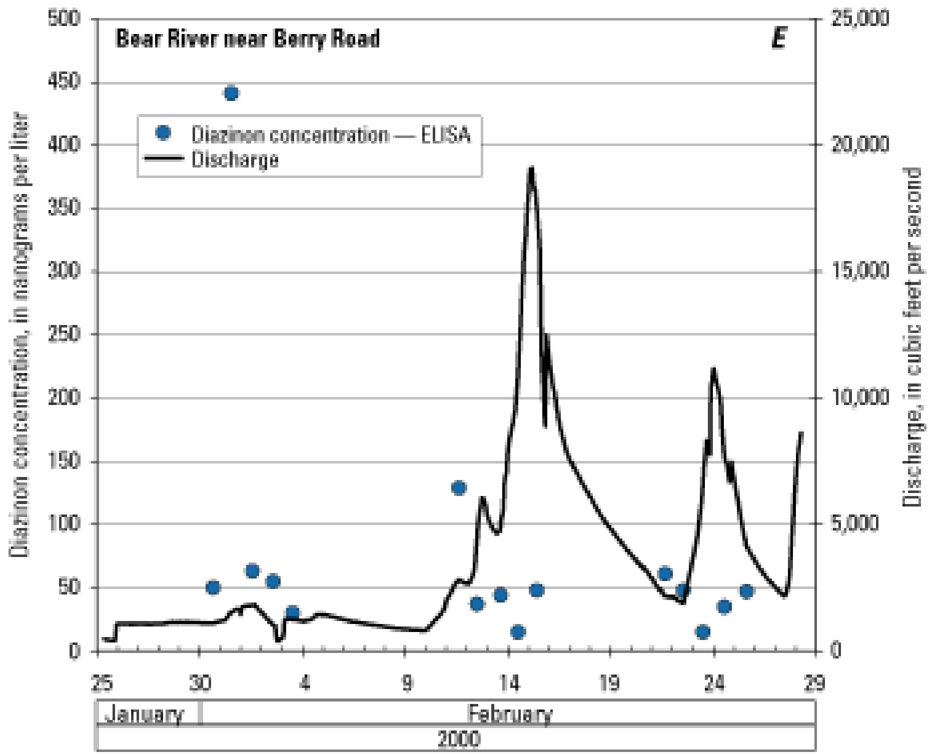


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. (***E***) Enzyme-linked immunosorbent assay (ELISA) and discharge at Bear River near Berry Road (site 5). The gap between February 4 and 11 indicates no data available. See figure 1 and table 1 for site location. *Continued.*

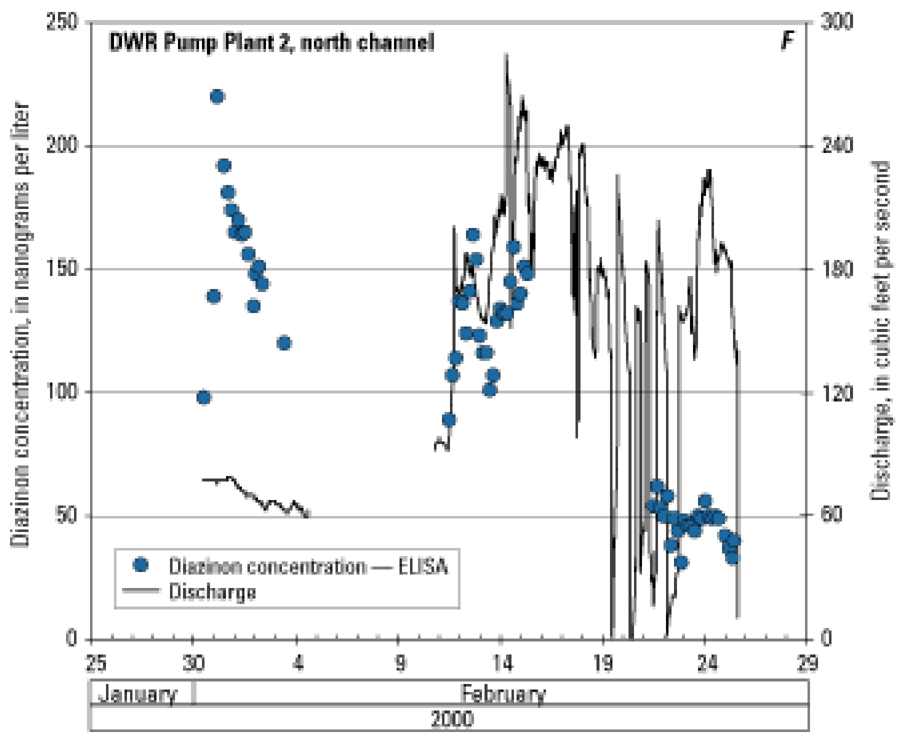


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. ***(F)*** Enzyme-linked immunosorbent assay (ELISA) and discharge at California Department of Water Resources (DWR) Pump Plant 2, north channel (site 6a). The gap between February 4 and 11 indicates no data available. See figure 1 and table 1 for site location. *Continued.*

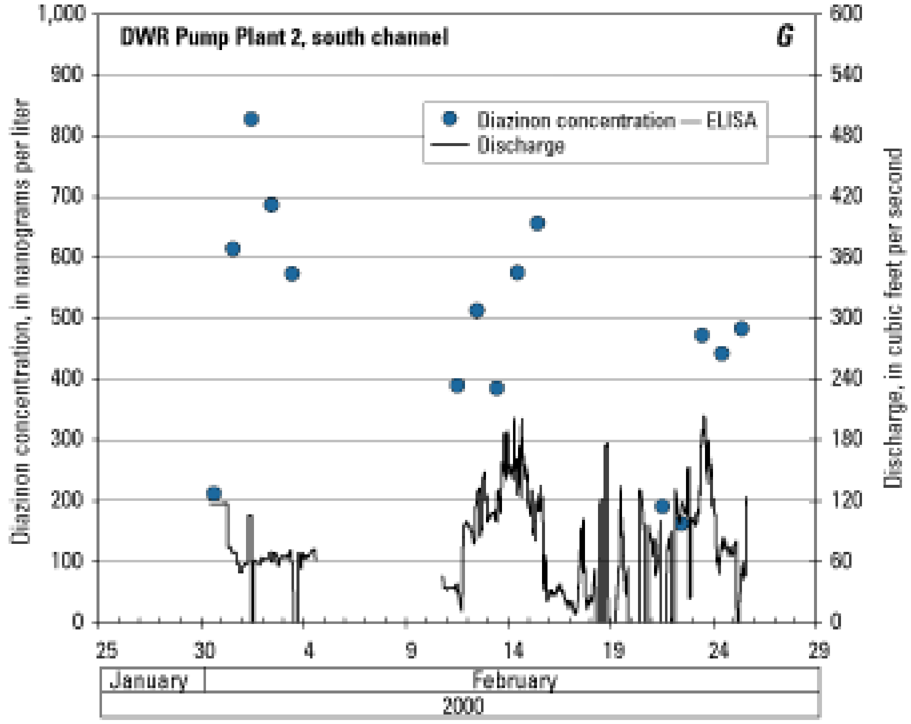


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. ***(G)*** Enzyme-linked immunosorbent assay (ELISA) and discharge at California Department of Water Resources (DWR) Pump Plant 2, south channel (site 6b). The gap between February 4 and 11 indicates no data available. See figure 1 and table 1 for site location. *Continued.*

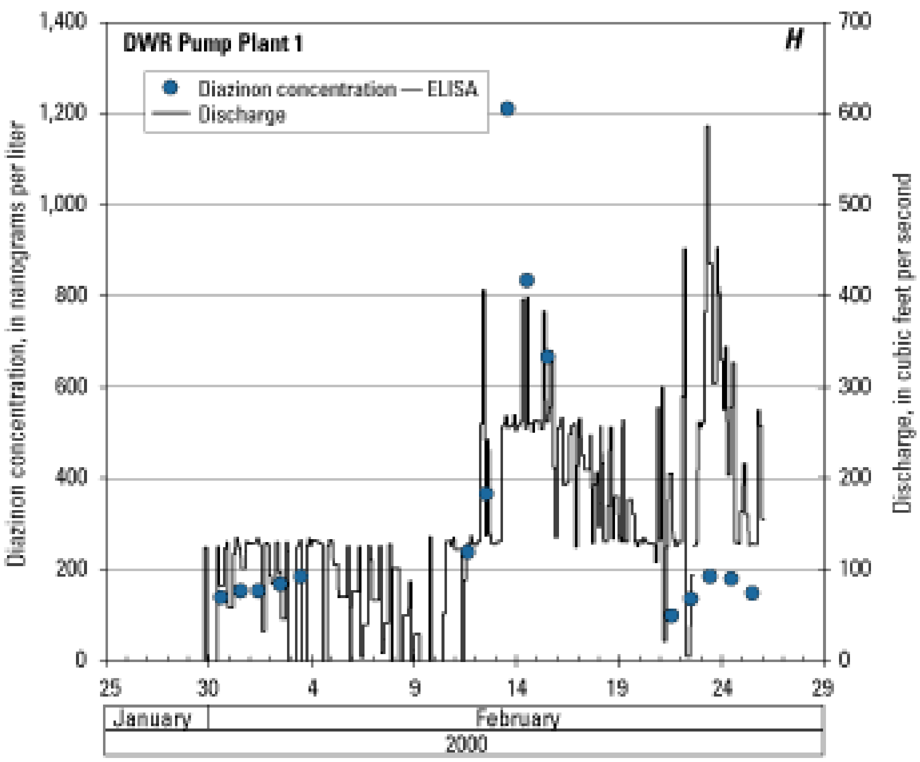


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. ***(H)*** Enzyme-linked immunosorbent assay (ELISA) and discharge at California Department of Water Resources (DWR) Pump Plant 1 (site 4). See figure 1 and table 1 for site location. *Continued.*

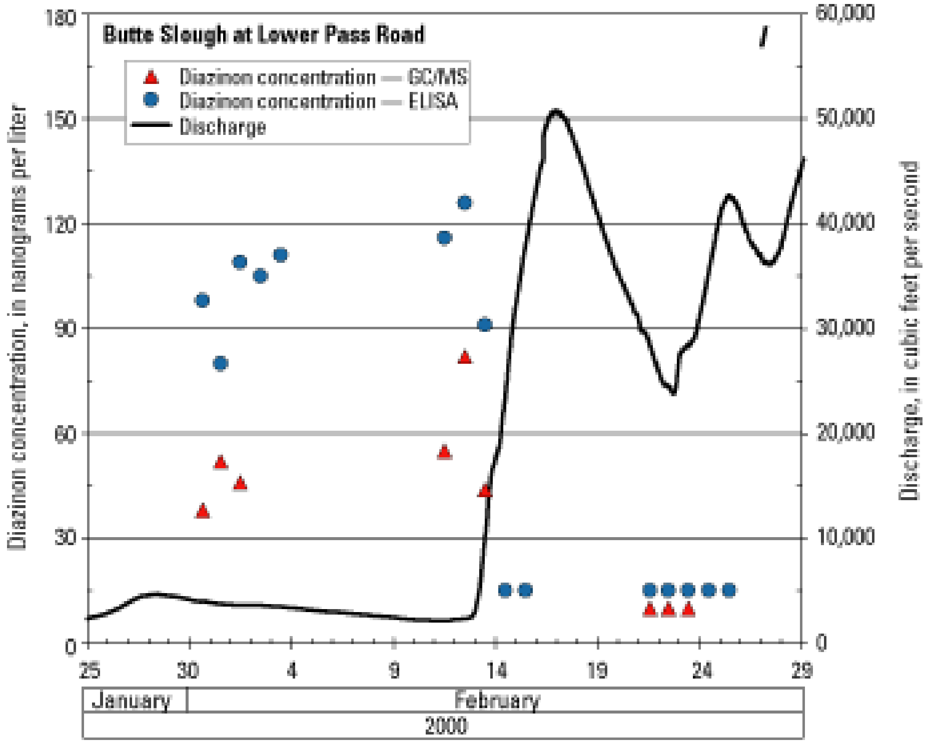


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. ***(I)*** Enzyme-linked immunosorbent assay (ELISA) and gas chromatography with mass spectrometry (GC/MS) and discharge at Butte Slough at Lower Pass Road (site 12). See figure 1 and table 1 for site location. *Continued.*

.

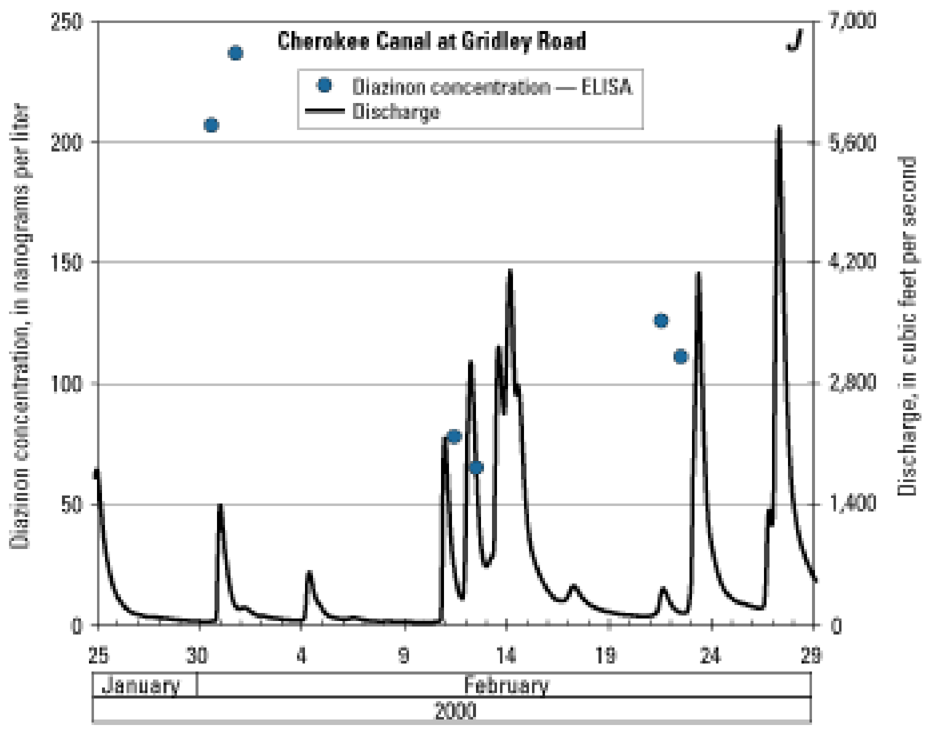


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. (***J***) Enzyme-linked immunosorbent assay (ELISA) and discharge at Cherokee Canal at Gridley Road (site 15). See figure 1 and table 1 for site location. *Continued.*

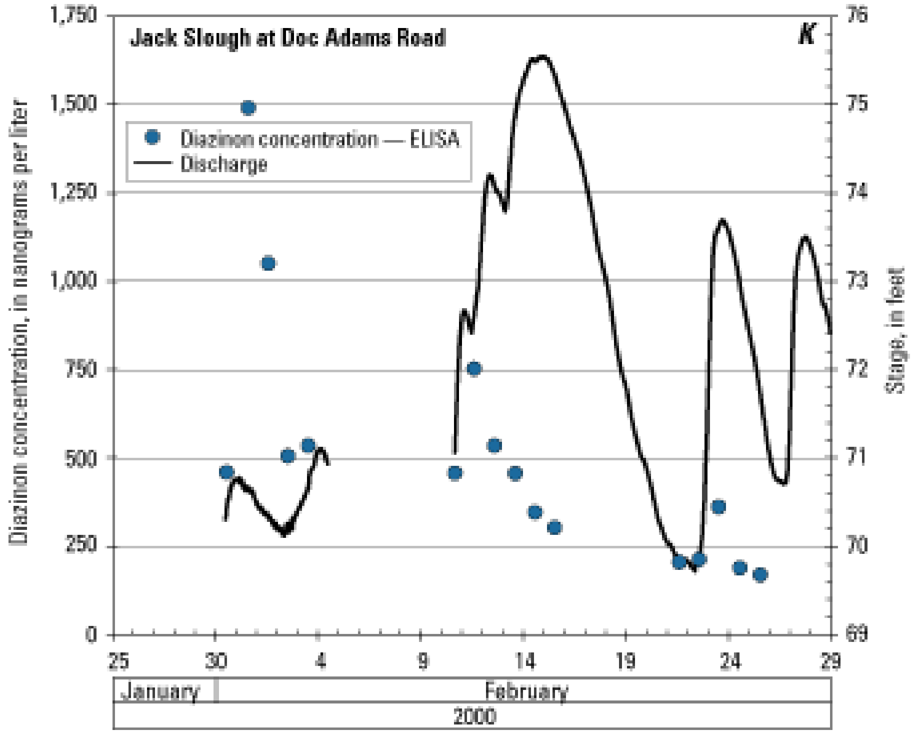


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. (***K***) Enzyme-linked immunosorbent assay (ELISA) and stage at Jack Slough at Doc Adams Road (site 11). The gap between February 4 and 11 indicates no data available. See figure 1 and table 1 for site location. *Continued*.

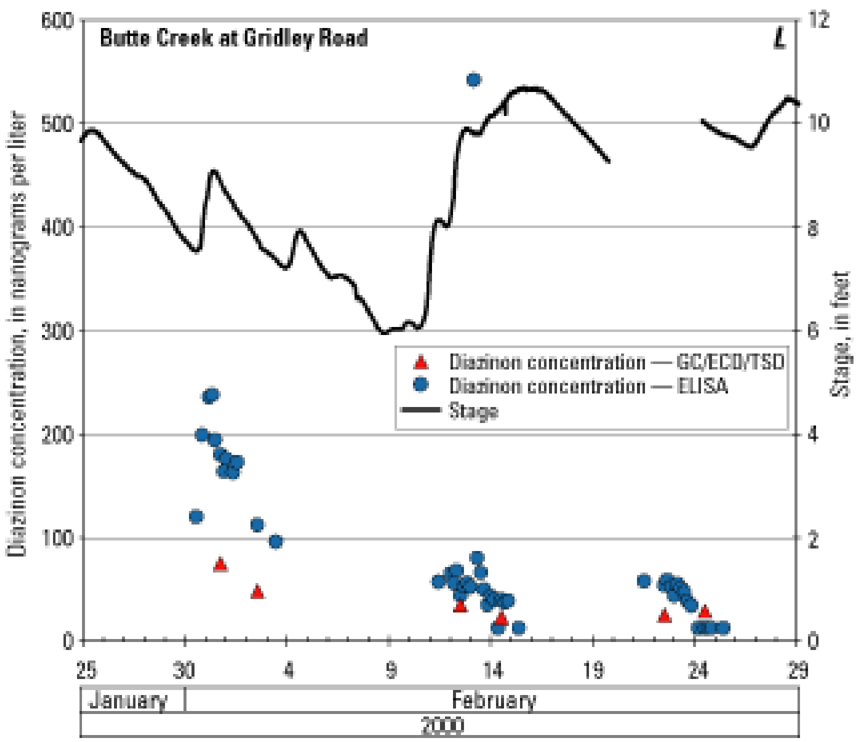


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. ***(L)*** Enzyme-linked immunosorbent assay (ELISA) and gas chromatography with electron capture detector and thermionic specific detector (GC/ECD/TSD) and stage at Butte Creek at Gridley Road (site 14). The gap between February 19 and 24 indicates no data available. See figure 1 and table 1 for site location. *Continued*.

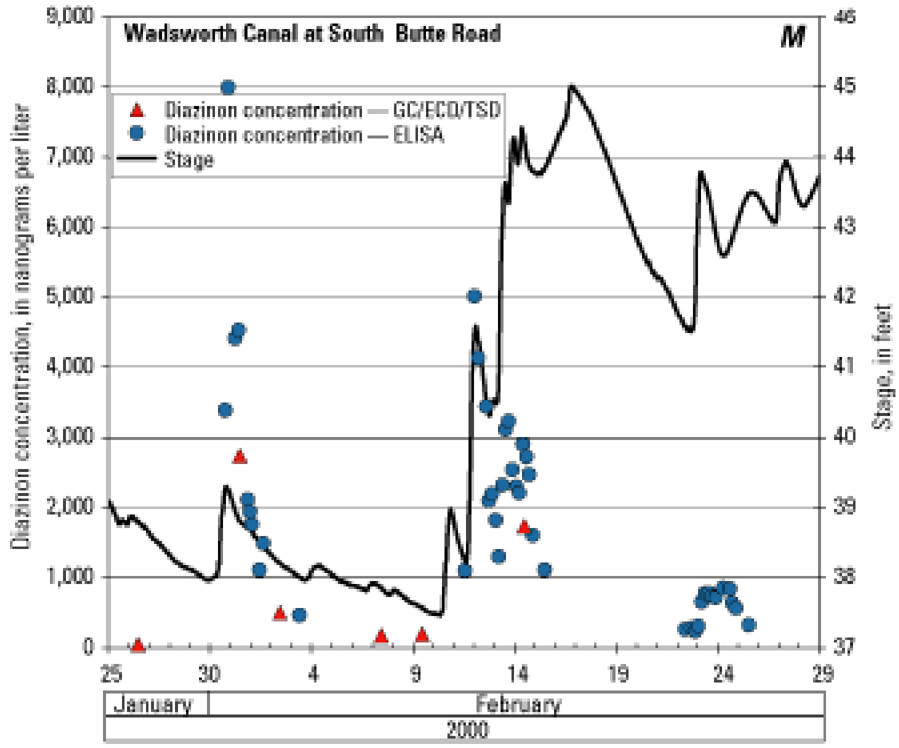


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. ***(M)*** Enzyme-linked immunosorbent assay (ELISA) and gas chromatography with electron capture detector and thermionic specific detector (GC/ECD/TSD) and stage at Wadsworth Canal at South Butte Road (site 10). See figure 1 and table 1 for site location. *Continued.*

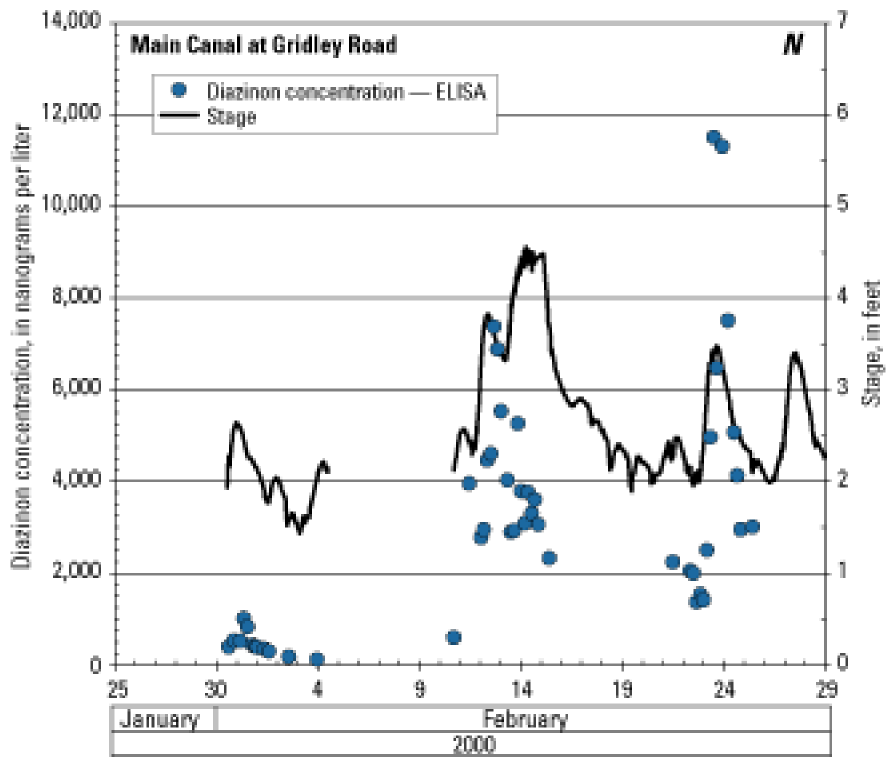


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. ***(N)*** Enzyme-linked immunosorbent assay (ELISA) and stage at Main Canal at Gridley Road (site 16). The gap between February 4 and 11 indicates no data available. See figure 1 and table 1 for site location. *Continued.*

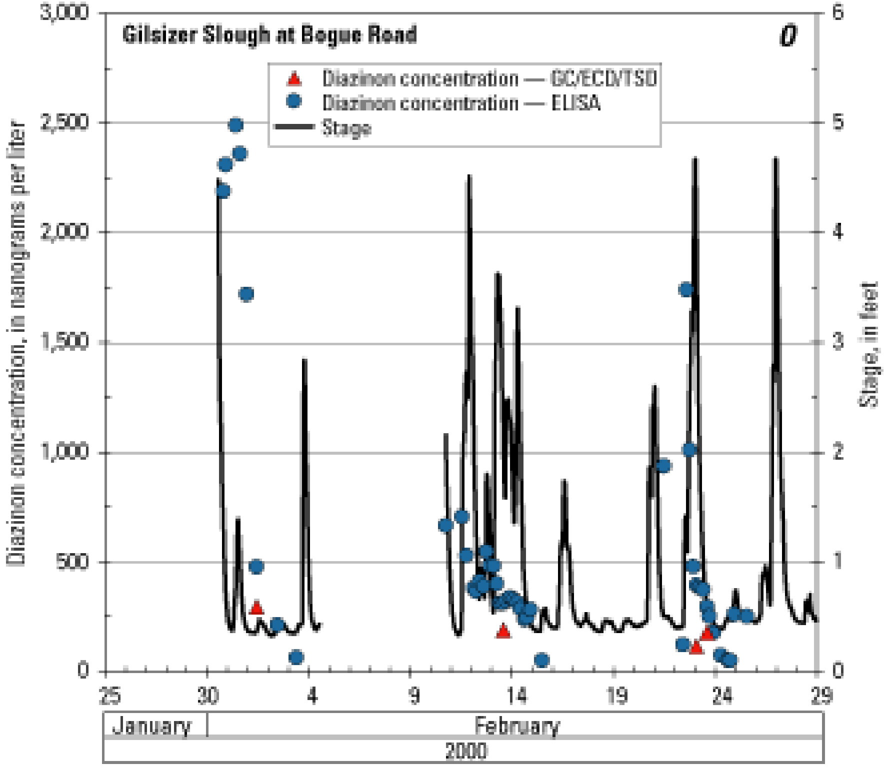


Figure 14. Diazinon concentrations at the sampling sites in the Sacramento River Basin, California. ***(O)*** Enzyme-linked immunosorbent assay (ELISA) and gas chromatography with electron capture detector and thermionic specific detector (GC/ECD/TSD) and stage at Gilsizer Slough at Bogue Road (site 7). The gap between February 4 and 11 indicates no data available. See figure 1 and table 1 for site location.

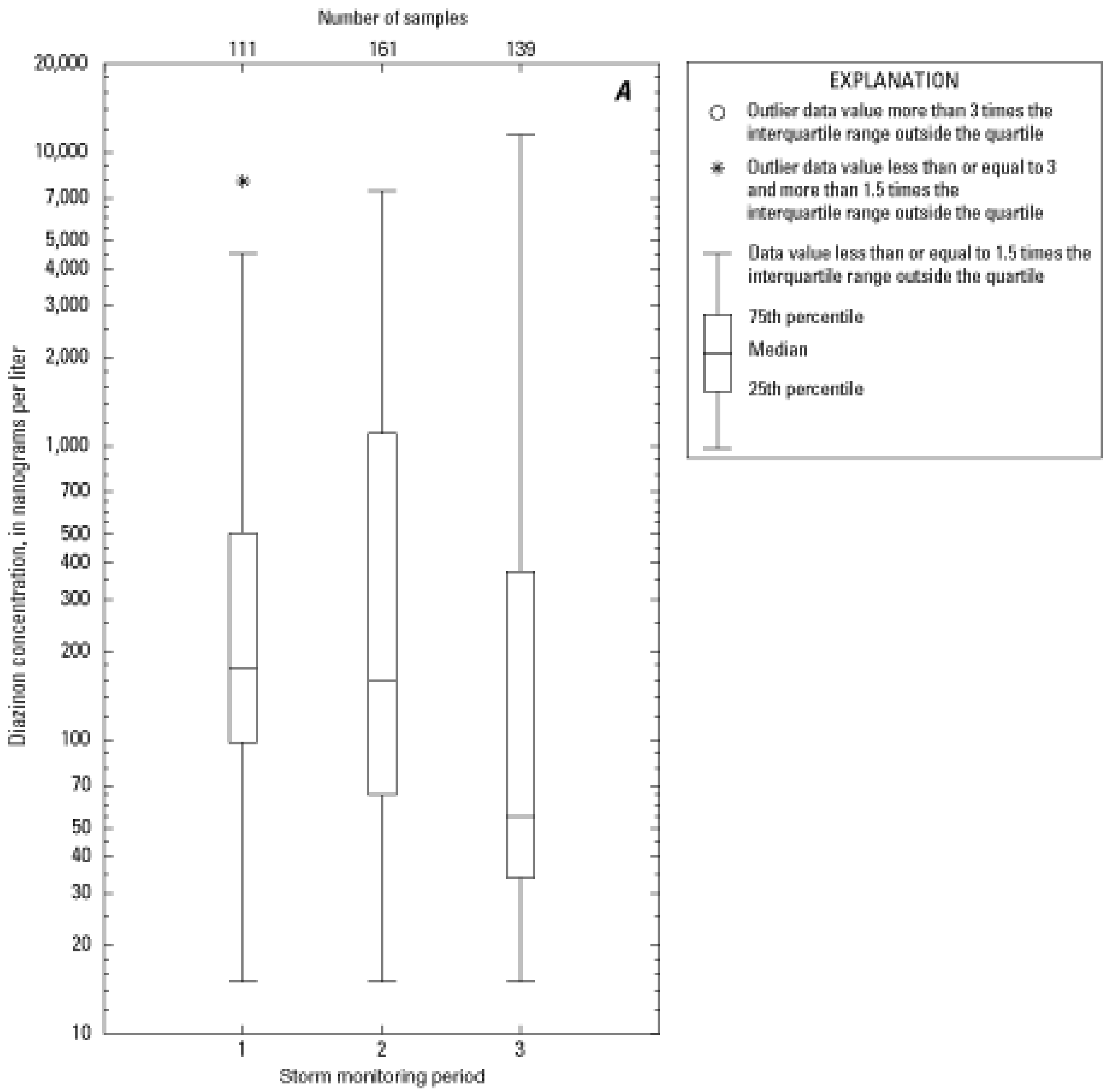


Figure 15. Box plots of diazinon concentration for each sampling monitoring period, Sacramento River Basin, California. (***A***) Enzyme-linked immunosorbent assay (ELISA). *Continued*.

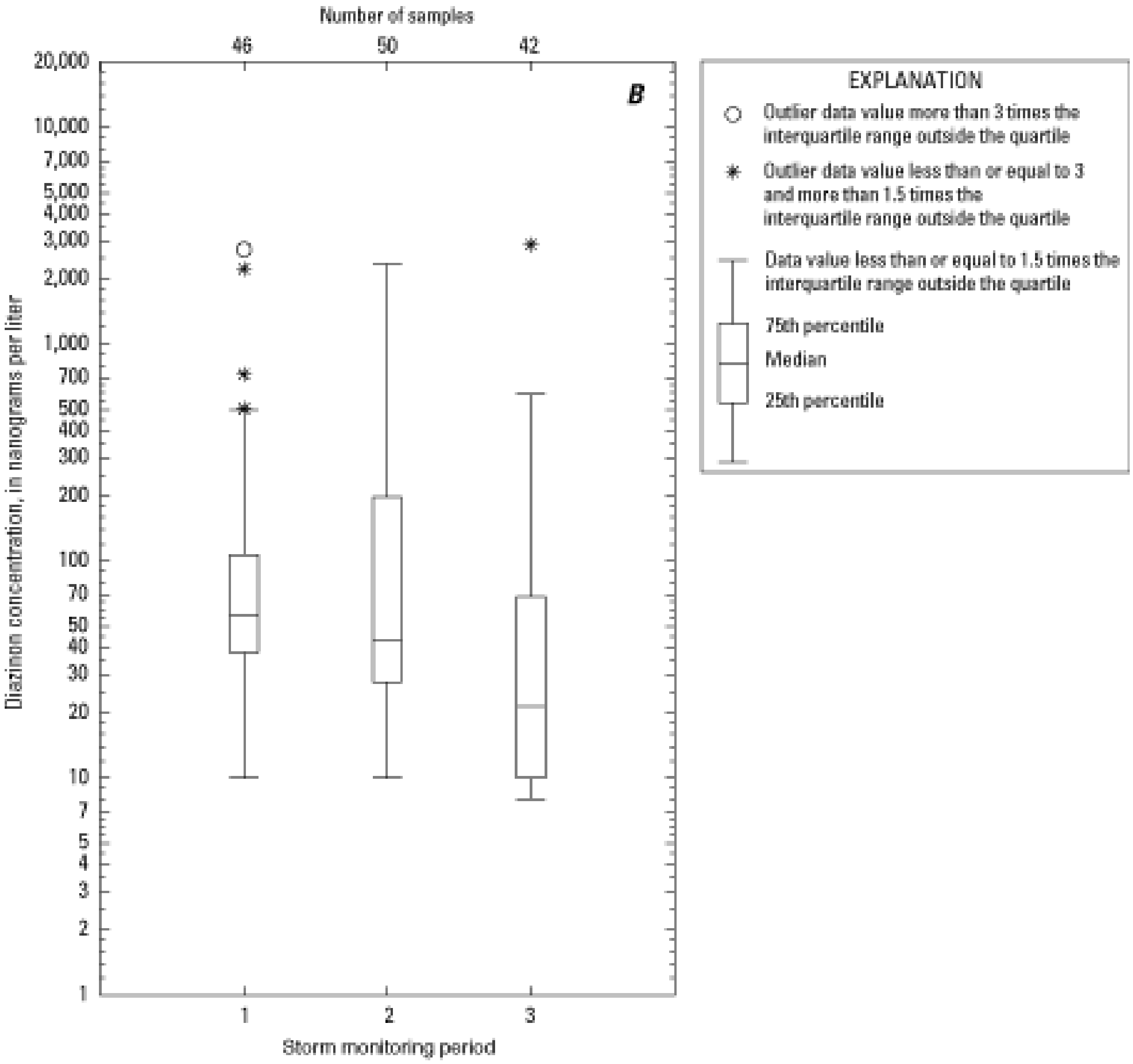


Figure 15. Box plots of diazinon concentration for each sampling monitoring period, Sacramento River Basin, California. ***B***/ Gas chromatography with electron capture detector and thermionic specific detector (GC/ECD/TSD) and gas chromatography with mass spectrometry (GC/MS).

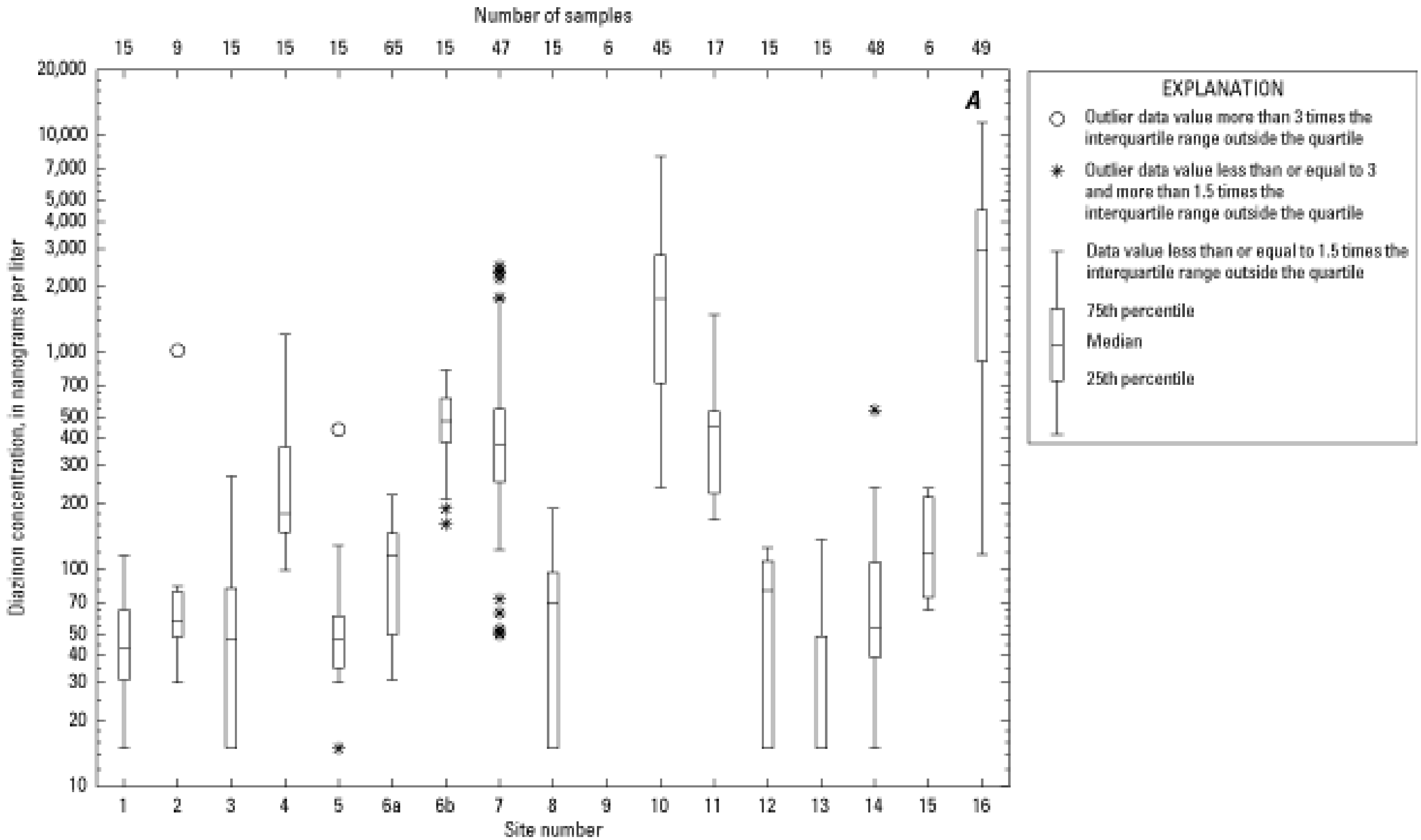


Figure 16. Box plots of diazinon concentration for each sampling site, Sacramento River Basin, California. (***A***) Enzyme-linked immunosorbent assay (ELISA). There were no diazinon detections above the reporting limit for site 9. *Continued.*

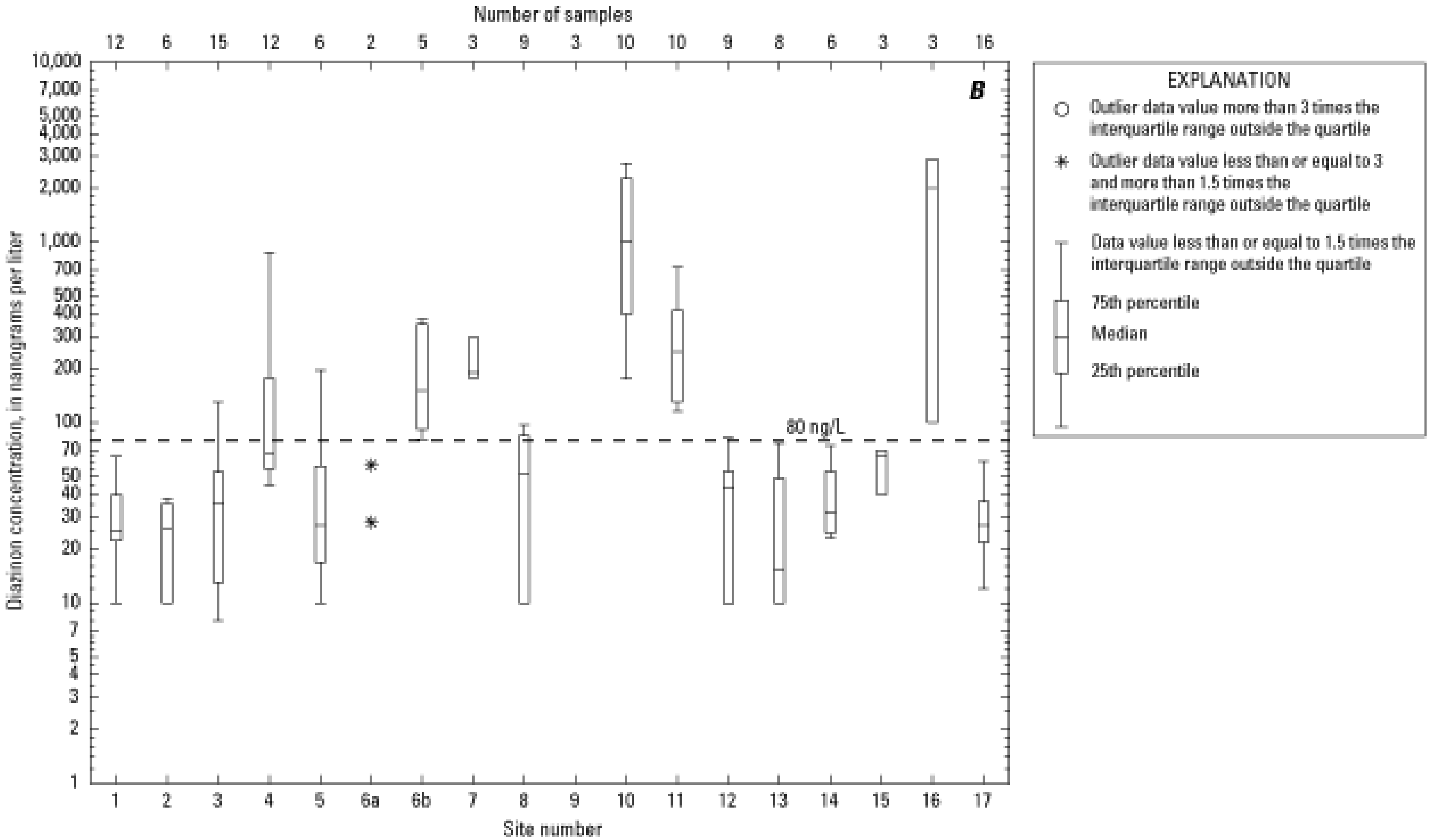


Figure 16. Box plots of diazinon concentration for each sampling site, Sacramento River Basin, California. (***B***) Gas chromatography with electron capture detector and thermionic specific detector (GC/ECD/TSD) and gas chromatography with mass spectrometry (GC/MS) for each sampling site. There were no diazinon detections above the reporting limit for site 9. ng/L, nanogram per liter.

Table 5. Storm loads of diazinon calculated using data from samples analyzed by enzyme-linked immunosorbent assay (ELISA), Sacramento River Basin, California

[All values are in pounds. DWR, California Department of Water Resources]

Site number	Site name	Storm monitoring period 1 (1/30–2/3/00)	Storm monitoring period 2 (2/11–2/15/00)	Storm monitoring period 3 (2/21–2/25/00)
1	Sacramento River at Alamar	56	52	28
3	Feather River at Nicolaus	18	17	12
4	DWR Pumping Plant 1	0	4	1
5	Bear River near Berry Road	5	6	4
6a	DWR Pumping Plant 2, north channel	0	1	0
6b	DWR Pumping Plant 2, south channel	1	1	1
12	Butte Slough at Lower Pass Road	8	11	10
13	Sacramento River at Colusa	49	29	13

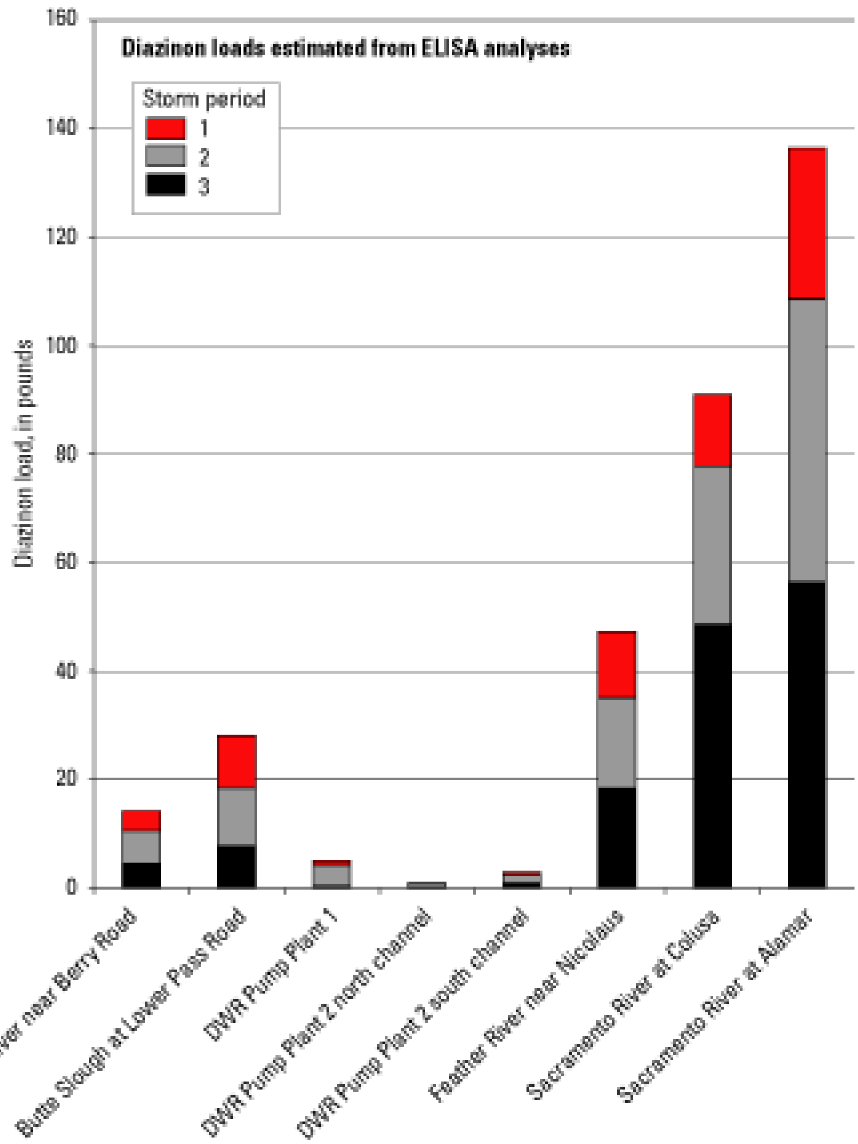


Figure 17. Storm loads using data from samples analyzed by enzyme-linked immunosorbent assay (ELISA).

Table 6. Diazinon use and storm loads calculated using data from samples analyzed by gas chromatography with mass spectrometry (GC/MS), Sacramento River Basin, California

Site	Pesticide use and storm loads		
	Storm monitoring period 1 (Applications from January 1 to February 3)		
	Pesticide use in pounds	**Load in pounds**	**Load as a percentage of use (load/use) x 100**
Feather River near Nicolaus	4,370	11	0.25
Sacramento River at Tower Bridge	20,100	39	0.19
	Storm monitoring period 2 (Applications from February 4 to 15)		
	Pesticide use in pounds	**Load in pounds**	**Load as a percentage of use (load/use) x 100**
Feather River near Nicolaus	3,670	18	0.48
Sacramento River at Tower Bridge	7,140	61	0.85
	Storm monitoring period 3 (Applications from February 16 to 25)		
	Pesticide use in pounds	**Load in pounds**	**Load as a percentage of use (load/use) x 100**
Feather River near Nicolaus	1,350	7	0.49
Sacramento River at Tower Bridge	6,010	33	0.54
	Total (Applications from January 1 to February 25)		
	Pesticide use in pounds	**Load in pounds**	**Load as a percentage of use (load/use) x 100**
Feather River near Nicolaus	9,390	35	0.38
Sacramento River at Tower Bridge	33,250	132	0.40

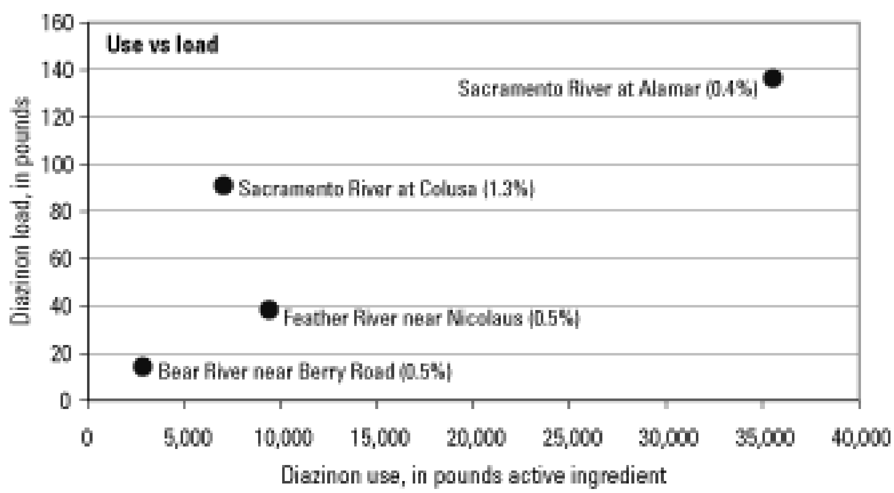


Figure 18. Diazinon loads in relation to use in four subbasins, Sacramento River Basin, California. Numbers in parentheses are percentages based on ratios of load to use upstream. Diazinon loads are based on enzyme-linked immunosorbent assay (ELISA) data. %, percent.

SUMMARY AND CONCLUSIONS

Part of the diazinon applied to orchards and urban areas during the winter in the Sacramento Valley of California is transported to streams and agricultural drains in storm runoff. In the winter of 2000, diazinon concentrations in the Sacramento River and selected tributaries ranged from below analytical detection levels to 2,890 ng/L (nanogram per liter) with a median of 44 ng/L. The highest concentrations were in small streams draining either agricultural or urban areas. Of the samples analyzed by gas chromatography methods, 30 percent of the samples had concentrations greater than 80 ng/L, the value being considered by California as its criterion maximum concentration for the protection of aquatic habitat. Concentrations were highest in small tributaries and canals draining subbasins with predominantly agricultural land use and in Gilsizer Slough, a channel draining Yuba City. All samples collected in the Sacramento River were below 80 ng/L, but one sample collected in the Feather River exceeded the guideline.

The majority of samples were analyzed by ELISA (enzyme-linked immunosorbent assay) with GC/ECD/TSD (gas chromatography with electron capture detector and thermionic specific detector) used to confirm ELISA results on 30 percent of the samples. Concentrations from ELISA analyses were consistently higher than duplicate samples analyzed by gas chromatography methods. The observed bias in the ELISA diazinon concentrations does not allow direct comparison to regulatory standards, and load calculations using the ELISA analyses would be similarly biased. Load estimates, using the data generated by gas chromatography methods, indicate that about 25 percent of the diazinon in the lower Sacramento River is introduced from the Feather River Basin. The source of over half the total load measured above Sacramento appears to have originated in the part of the drainage basin upstream of Colusa.

About 42,500 pounds of diazinon were reported applied to agricultural land in the Sacramento Valley just before and during the monitoring period. About 0.4 percent of the applied pesticide appeared to be transported to the lower Sacramento River during the period of monitoring. A similar percentage of applied diazinon was estimated to have entered the Feather River from upstream sources.

Diazinon use in the study area during the year 1999–2000 dormant spray season was unusually low, about 60 percent of the average of the previous four years. Peak concentrations observed during the study were lower than those recorded in previous monitoring studies. Concentrations and loads may be greater during years of more average use.

REFERENCES CITED

California Department of Pesticide Regulation, 2000, Pesticide use data for 1995–2000 [digital data]: California Department of Pesticide Regulation, Sacramento, California.

California Department of Water Resources, 1990, Land use data for Yolo county, California, for 1989 [digital data]: California Department of Water Resources, Division of Planning, Statewide Planning Branch, Land and Water Use, Sacramento, California.

———1994a, Land use data for Colusa county, California, for 1993 [digital data]: California Department of Water Resources, Division of Planning, Statewide Planning Branch, Land and Water Use, Sacramento, California.

———1994b, Land use data for Glenn county, California, for 1993 [digital data]: California Department of Water Resources, Division of Planning, Statewide Planning Branch, Land and Water Use, Sacramento, California.

———1995a, Land use data for Butte county, California, for 1994 [digital data]: California Department of Water Resources, Division of Planning, Statewide Planning Branch, Land and Water Use, Sacramento, California.

———1995b, Land use data for Placer county, California, for 1994 [digital data]: California Department of Water Resources, Division of Planning, Statewide Planning Branch, Land and Water Use, Sacramento, California.

———1995c, Land use data for Sacramento county, California, for 1994 [digital data]: California Department of Water Resources, Division of Planning, Statewide Planning Branch, Land and Water Use, Sacramento, California.

———1995d, Land use data for Tehama county, California, for 1994 [digital data]: California Department of Water Resources, Division of Planning, Statewide Planning Branch, Land and Water Use, Sacramento, California.

———2000, Land use data for Sutter county, California, for 1990 [digital data]: California Department of Water Resources, Division of Planning, Statewide Planning Branch, Land and Water Use, Sacramento, California.

Capel, P.D., and Larson, S.J., 1996, Evaluation of selected information on splitting devices for water samples: U.S. Geological Survey Water-Resources Investigations Report 95-4141, 103 p.

Domagalski, J.L., 1996, Pesticides and pesticide degradation products in stormwater runoff: Sacramento River Basin, California: Journal of the American Water Resources Association, v. 32, no. 5, p. 953–964.

Epstein, L., Bassein, S., Zalam, F.G., and Wilhoit, L.R., 2001, Changes in pest management practice in almond orchards during the rainy season in California, U.S.A., Agriculture, Ecosystems and Environment, v. 31, p. 111–120.

Foe, C. and Sheipline, R., 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.

Ganapathy, C., C. Nordmark, K. Bennett, A. Bradley, H. Feng, J. Hernandez, and J. White, 1997, Temporal distribution of insecticide residues in four California rivers. California EPA, Department of Pesticide Regulation, Environmental Hazards Assessment Program. EH97-06. November 1996.

Giddings, J.M., Hall Jr., L.W., and Solomon, K.R., 2000, Ecological Risks of Diazinon from Agricultural Use in the Sacramento–San Joaquin River Basins, California, Risk Analysis, v. 20, p. 545–572.

Holmes, R., de Vlaming, V., and Foe, C., 2000, Sources and concentrations of diazinon in the Sacramento watershed during the 1994 orchard dormant spray season: Report by the Central Valley Regional Water Quality Control Board dated July 2000, 94 p.

Howard, P.H., ed., 1991, Pesticides, v. 3 *of* Handbook of environmental fate and exposure data for organic chemicals: Lewis Publishers, Chelsea, Michigan, 684 p.

Hulsing, H., 1967, Measurement of peak discharge at dams by indirect method: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, chapter A5, 29 p.

Kahrl, W.L., ed., 1979, The California water atlas: Prepared by the Governor's Office of Planning and Research in cooperation with the California State Department of Water Resources, 113 p.

Kennedy, E.J., 1983, Computation of continuous records of streamflow: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A13, 53 p.

Kratzer, C.R., 1999, Transport of diazinon in the San Joaquin River Basin, California: Journal of the American Water Resources Association, v. 35, no. 2, p. 379–395.

Kuivila, K.M., and Foe, C.G., 1995, Concentrations, transport, and biological effects of dormant spray pesticides in the San Francisco Estuary, California: Journal of Environmental Toxicology and Chemistry, v. 14, no. 7, p. 1141–1150.

Larson, S.J., Capel, P.D., and Majewski, M.S., 1997, Pesticides in surface waters—Distribution, trends, and governing factors: Ann Arbor Press, Pesticides in the Hydrologic System series, v. 3, 373 p.[Available from CRC Press.]

Larson, S.J., Capel, P.D., Goolsby, D.A., Zaugg, S.D., and Sandstrom, M.W., 1995, Relations between pesticide use and riverine flux in the Mississippi River Basin: Chemosphere, v. 31, no. 5, p. 3305–3321.

Linsley, R.K., Kohler, M.A., and Paulhus, J.L., 1958, Hydrology for engineers: McGraw-Hill, New York, 340 p.

Lyman, W.J., Reehl, W.F., and Rosenblatt, D.H., 1990, Handbook of chemical property estimation methods—Environmental behavior of organic compounds: American Chemical Society, Washington, DC.

MacCoy, D., Crepeau, K.L., and Kuivila, K.M., 1995, Dissolved pesticide data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991–94: U.S. Geological Survey Open File Report 95-110, 27 p.

Majewski, M.S., Capel, P.D., 1995, Pesticides in the atmosphere—Distribution, trends, and governing factors: Ann Arbor Press, Pesticides in the Hydrologic System series, v. 1, 214 p. [Available from CRC Press.]

Menconi, M., and Cox, C., 1994, Hazard assessment of the insecticide diazinon to aquatic organisms in the Sacramento–San Joaquin River system: California Department of Fish and Game, Pesticide Investigations Unit, Environmental Services Division, Administrative Report 94-2 Rancho Cordova, CA.

Nordmark, C.E., 1998, Preliminary results of acute and chronic toxicity testing of surface water monitored in the Sacramento River watershed; Winter 1997–98: Memorandum to Don Weaver, Environmental Hazards Assessment Program, California Environmental Protection Agency, Department of Pesticide Regulation, July, 1998. Accessed on April 25, 2002 at URL http://www.cdpr.ca.gov/docs/empm/pubs/memos.htm.

———1999, Preliminary results acute and chronic toxicity testing of surface water monitored in the Sacramento River Watershed; Winter 1998–99: Memorandum to Don Weaver, Environmental Hazards Assessment Program, California Environmental Protection Agency, Department of Pesticide Regulation, May 26, 1999.

Nordmark, C.E., Bennett, K.P., Feng, H, Hernandez, J., and Lee, P., 1998, Occurrence of aquatic toxicity and dormant spray pesticide detection in the Sacramento River Watershed, Winter 1996–97: California Environmental Protection Agency, Department of Pesticide Regulation, Environmental Hazards Assessment Program, EH98-01, February 1998.

Olmstead, F.H., and Davis, G.H., 1961, Geologic features and ground water storage capacity of the Sacramento Valley, California: U.S. Geological Survey Water-Supply Paper 1497, 241 p.

Rantz, S.E., 1969, Mean annual precipitation in the California region: U.S. Geological Survey Basic Data Compilation, scale 1:1,000,000, 2 sheets.

Rantz, S.E., and others, 1982, Measurement and computation of streamflow: Volume 1, Measurement of stage and discharge: U.S. Geological Survey Water Supply Paper 2175, 284 p.

Shelton, L.R., 1994, Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program, U.S. Geological Survey Open File Report 94-455, 42 p.

Smith, J.A., Witkowski, P.J., and Fusillo, T.V., 1987, Manmade organic compounds in the surface waters of the United States—A review of current understanding: U.S. Geological Survey Open File Report 87-209, 181 p.

Sullivan, J., and Goh, K.S., 2000, Evaluation and validation of a commercial ELISA for diazinon in surface waters: Journal of Agricultural Food Chemistry, v. 48, no. 9, p. 4071–4078.

Suntio, L.R., Shiu, W.Y., Mackay, D., Seiber, J.N., and Glotfelty, D.E., 1988, Critical review of Henry's law constants for pesticides: Review of Environmental Contaminants and Toxicology, v. 103, p. 1–59

U.S. Department of Agriculture, 2000, Pesticide properties database: Accessed October 24, 2000 at http://www.arsusda.gov.

U.S. Environmental Protection Agency, 1999, Toxicity reduction evaluation guidance for municipal wastewater treatment plants: U.S. Environmental Protection Agency report EPA/833B-9/002, 159 p.

Webster, M.D., Anderson, S.W., Rockwell, G.L., Smithson, J.R., and Freibel, M.F., 2000, Water resources data, California—water year 1999. Volume 4. Northern Central Valley basins and the Great Basin from Honey Lake Basin to the Oregon State Line: U.S. Geological Survey Water Data Report CA-99-4, 405 p.

Zalom, F.G., Van Steenwyk, R.A., Bentley, W.J., Coviello, R., Rice, R.E., Barnett, W.W., Pickel, C., Barnes, M.M., Teviotdale, B.L., Gubler, W.D., and McKenry, M.V., 1995, Almond pest management guidelines. University of California, Division of Agriculture and Natural Resources, UCPMG Publication 1.

Zaugg, S.D., Sandstrom, M.W., Smith, S.G., and Fehlberg, K.M., 1995, Methods of analysis by the U.S. Geological Survey National Water Quality Laboratory—determination of pesticides in water by C-18 solid-phase extraction and capillary-column gas chromatography/mass spectrometry with selected ion monitoring, U.S. Geological Survey Open-File Report 95-181, 49 p.

Appendix 1, Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California

[ELISA, enzyme-linked immunosorbent assay; GC/ECD/TSD, gas chromatography with electron capture detector and thermionic specific detector; GC/MS, gas chromatography with mass spectrometry; ng/L, nanogram per liter; <, less than ; —, no data available]

				Diazinon			
Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	ELISA (ng/L)	GC/ECD/TSD (ng/L)	GC/MS (ng/L)	Methidathion (ng/L)
1	Sacramento River at Alamar	1	01/30/2000 1100	35	25	—	—
1	Sacramento River at Alamar	1	01/31/2000 1045	36	25	—	—
1	Sacramento River at Alamar	1	02/01/2000 1310	75	38	—	—
1	Sacramento River at Alamar	1	02/02/2000 1250	116	65	—	—
1	Sacramento River at Alamar	1	02/03/2000 1250	69	—	—	—
1	Sacramento River at Alamar	2	02/11/2000 1610	56	25	—	—
1	Sacramento River at Alamar	2	02/12/2000 1405	43	39	—	—
1	Sacramento River at Alamar	2	02/13/2000 1450	43	40	—	—
1	Sacramento River at Alamar	2	02/14/2000 1315	65	42	—	—
1	Sacramento River at Alamar	2	02/15/2000 1340	61	—	—	—
1	Sacramento River at Alamar	3	02/21/2000 1500	<30	23	—	—
1	Sacramento River at Alamar	3	02/22/2000 1325	31	<20	—	—
1	Sacramento River at Alamar	3	02/23/2000 1400	<30	<20	—	—
1	Sacramento River at Alamar	3	02/24/2000 1250	30	22	—	—
1	Sacramento River at Alamar	3	02/25/2000 1205	32	—	—	—
2	Colusa Basin Drain	1	01/30/2000 1315	52	<20	—	—
2	Colusa Basin Drain	1	01/31/2000 1200	30	20	—	—
2	Colusa Basin Drain	1	02/03/2000 0925	1,020	—	—	—
2	Colusa Basin Drain	2	02/11/2000 1405	58	<20	—	—
2	Colusa Basin Drain	2	02/12/2000 0920	61	33	—	—
2	Colusa Basin Drain	2	02/15/2000 0930	84	—	—	—
2	Colusa Basin Drain	3	02/21/2000 1120	52	35	—	—
2	Colusa Basin Drain	3	02/22/2000 1030	46	38	—	—
2	Colusa Basin Drain	3	02/25/2000 0855	74	—	—	—
3	Feather River near Nicolaus	1	01/30/2000 1430	71	35	40	—
3	Feather River near Nicolaus	1	01/31/2000 1230	268	105	154	—
3	Feather River near Nicolaus	1	02/01/2000 1250	71	45	54	—
3	Feather River near Nicolaus	1	02/02/2000 1150	91	52	54	—
3	Feather River near Nicolaus	1	02/03/2000 1130	78	—	43	—
3	Feather River near Nicolaus	2	02/11/2000 1240	88	70	60	—
3	Feather River near Nicolaus	2	02/12/2000 1030	48	35	35	—
3	Feather River near Nicolaus	2	02/13/2000 1420	82	55	63	—
3	Feather River near Nicolaus	2	02/14/2000 1300	<30	26	33	—
3	Feather River near Nicolaus	2	02/15/2000 1040	34	—	36	—
3	Feather River near Nicolaus	3	02/21/2000 1240	<30	—	8	—
3	Feather River near Nicolaus	3	02/22/2000 1030	<30	—	9	—
3	Feather River near Nicolaus	3	02/23/2000 1020	<30	—	9	—
3	Feather River near Nicolaus	3	02/24/2000 1010	30	—	13	—
3	Feather River near Nicolaus	3	02/25/2000 1050	<30	20	16	—
4	DWR Pump Plant 1	1	01/30/2000 1430	139	48	—	—
4	DWR Pump Plant 1	1	01/31/2000 1255	153	65	—	168

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
4	DWR Pump Plant 1	1	02/01/2000 0930	153	55	—	—
4	DWR Pump Plant 1	1	02/02/2000 1150	168	70	—	—
4	DWR Pump Plant 1	1	02/03/2000 1150	185	—	—	—
4	DWR Pump Plant 1	2	02/11/2000 1500	238	45	—	660
4	DWR Pump Plant 1	2	02/12/2000 1245	366	215	—	389
4	DWR Pump Plant 1	2	02/13/2000 1340	1,210	878	—	145
4	DWR Pump Plant 1	2	02/14/2000 1220	834	500	—	402
4	DWR Pump Plant 1	2	02/15/2000 1230	666	—	—	—
4	DWR Pump Plant 1	3	02/21/2000 1355	99	55	—	95
4	DWR Pump Plant 1	3	02/22/2000 1220	135	57	—	58
4	DWR Pump Plant 1	3	02/23/2000 1030	185	96	—	1,580
4	DWR Pump Plant 1	3	02/24/2000 1145	180	98	—	504
4	DWR Pump Plant 1	3	02/25/2000 1200	148	—	—	—
5	Bear River	1	01/30/2000 1600	50	—	—	—
5	Bear River	1	01/31/2000 1310	441	195	—	—
5	Bear River	1	02/01/2000 1420	63	—	—	—
5	Bear River	1	02/02/2000 1330	55	38	—	—
5	Bear River	1	02/03/2000 1240	30	—	—	—
5	Bear River	2	02/11/2000 1430	129	—	—	—
5	Bear River	2	02/12/2000 1130	37	<20	—	—
5	Bear River	2	02/13/2000 1530	44	—	—	—
5	Bear River	2	02/14/2000 1220	<30	26	—	—
5	Bear River	2	02/15/2000 1010	48	—	—	—
5	Bear River	3	02/21/2000 1530	61	—	—	—
5	Bear River	3	02/22/2000 1210	48	28	—	—
5	Bear River	3	02/23/2000 1200	<30	—	—	—
5	Bear River	3	02/24/2000 1240	35	20	—	—
5	Bear River	3	02/25/2000 1430	47	—	—	—
6a	DWR Pump Plant 2, north	1	01/30/2000 1200	98	—	—	—
6a	DWR Pump Plant 2, north	1	01/30/2000 2000	139	—	—	—
6a	DWR Pump Plant 2, north	1	01/31/2000 0400	220	—	—	—
6a	DWR Pump Plant 2, north	1	01/31/2000 1200	192	—	—	—
6a	DWR Pump Plant 2, north	1	01/31/2000 1630	181	—	—	—
6a	DWR Pump Plant 2, north	1	01/31/2000 2030	174	—	—	—
6a	DWR Pump Plant 2, north	1	02/01/2000 0030	165	—	—	—
6a	DWR Pump Plant 2, north	1	02/01/2000 0430	170	—	—	—
6a	DWR Pump Plant 2, north	1	02/01/2000 0830	164	—	—	—
6a	DWR Pump Plant 2, north	1	02/01/2000 1230	165	—	—	—
6a	DWR Pump Plant 2, north	1	02/01/2000 1630	156	—	—	—
6a	DWR Pump Plant 2, north	1	02/01/2000 2030	135	—	—	—
6a	DWR Pump Plant 2, north	1	02/02/2000 0030	148	—	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
6a	DWR Pump Plant 2, north	1	02/02/2000 0430	151	—	—	—
6a	DWR Pump Plant 2, north	1	02/02/2000 0830	144	—	—	—
6a	DWR Pump Plant 2, north	1	02/03/2000 1025	120	58	—	—
6a	DWR Pump Plant 2, north	2	02/11/2000 1201	89	—	—	—
6a	DWR Pump Plant 2, north	2	02/11/2000 1601	107	—	—	—
6a	DWR Pump Plant 2, north	2	02/11/2000 2001	114	—	—	—
6a	DWR Pump Plant 2, north	2	02/12/2000 0001	137	—	—	—
6a	DWR Pump Plant 2, north	2	02/12/2000 0401	136	—	—	—
6a	DWR Pump Plant 2, north	2	02/12/2000 0801	124	—	—	—
6a	DWR Pump Plant 2, north	2	02/12/2000 1201	141	—	—	—
6a	DWR Pump Plant 2, north	2	02/12/2000 1601	164	—	—	—
6a	DWR Pump Plant 2, north	2	02/12/2000 2001	154	—	—	—
6a	DWR Pump Plant 2, north	2	02/13/2000 0001	123	—	—	—
6a	DWR Pump Plant 2, north	2	02/13/2000 0401	116	—	—	—
6a	DWR Pump Plant 2, north	2	02/13/2000 0801	116	—	—	—
6a	DWR Pump Plant 2, north	2	02/13/2000 1201	101	—	—	—
6a	DWR Pump Plant 2, north	2	02/13/2000 1601	107	—	—	—
6a	DWR Pump Plant 2, north	2	02/13/2000 2001	129	—	—	—
6a	DWR Pump Plant 2, north	2	02/14/2000 0001	134	—	—	—
6a	DWR Pump Plant 2, north	2	02/14/2000 0401	132	—	—	—
6a	DWR Pump Plant 2, north	2	02/14/2000 0801	132	—	—	—
6a	DWR Pump Plant 2, north	2	02/14/2000 1201	145	—	—	—
6a	DWR Pump Plant 2, north	2	02/14/2000 1601	159	—	—	—
6a	DWR Pump Plant 2, north	2	02/14/2000 2001	136	—	—	—
6a	DWR Pump Plant 2, north	2	02/15/2000 0001	140	—	—	—
6a	DWR Pump Plant 2, north	2	02/15/2000 0401	151	—	—	—
6a	DWR Pump Plant 2, north	2	02/15/2000 0801	148	—	—	—
6a	DWR Pump Plant 2, north	2	02/15/2000 1105	116	—	—	—
6a	DWR Pump Plant 2, north	3	02/21/2000 1230	54	—	—	—
6a	DWR Pump Plant 2, north	3	02/21/2000 1630	62	—	—	—
6a	DWR Pump Plant 2, north	3	02/21/2000 2030	53	—	—	—
6a	DWR Pump Plant 2, north	3	02/22/2000 0030	50	—	—	—
6a	DWR Pump Plant 2, north	3	02/22/2000 0430	58	—	—	—
6a	DWR Pump Plant 2, north	3	02/22/2000 0830	38	—	—	—
6a	DWR Pump Plant 2, north	3	02/22/2000 1230	49	—	—	—
6a	DWR Pump Plant 2, north	3	02/22/2000 1630	44	—	—	—
6a	DWR Pump Plant 2, north	3	02/22/2000 2030	31	—	—	—
6a	DWR Pump Plant 2, north	3	02/23/2000 0030	48	—	—	—
6a	DWR Pump Plant 2, north	3	02/23/2000 0430	46	—	—	—
6a	DWR Pump Plant 2, north	3	02/23/2000 0830	46	—	—	—
6a	DWR Pump Plant 2, north	3	02/23/2000 1230	44	—	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
6a	DWR Pump Plant 2, north	3	02/23/2000 1630	50	—	—	—
6a	DWR Pump Plant 2, north	3	02/23/2000 2030	49	—	—	—
6a	DWR Pump Plant 2, north	3	02/24/2000 0030	56	—	—	—
6a	DWR Pump Plant 2, north	3	02/24/2000 0430	50	—	—	—
6a	DWR Pump Plant 2, north	3	02/24/2000 0830	49	—	—	—
6a	DWR Pump Plant 2, north	3	02/24/2000 1230	50	—	—	—
6a	DWR Pump Plant 2, north	3	02/24/2000 1630	49	—	—	—
6a	DWR Pump Plant 2, north	3	02/25/2000 0030	42	—	—	—
6a	DWR Pump Plant 2, north	3	02/25/2000 0430	37	—	—	—
6a	DWR Pump Plant 2, north	3	02/25/2000 0830	33	—	—	—
6a	DWR Pump Plant 2, north	3	02/25/2000 1025	40	28	—	—
6b	DWR Pump Plant 2, south	1	01/30/2000 1530	211	—	—	—
6b	DWR Pump Plant 2, south	1	01/31/2000 1348	614	330	—	525
6b	DWR Pump Plant 2, south	1	02/01/2000 1100	827	—	—	—
6b	DWR Pump Plant 2, south	1	02/02/2000 1100	686	—	—	—
6b	DWR Pump Plant 2, south	1	02/03/2000 1050	573	—	—	—
6b	DWR Pump Plant 2, south	2	02/11/2000 1240	389	150	—	—
6b	DWR Pump Plant 2, south	2	02/12/2000 1115	513	375	—	550
6b	DWR Pump Plant 2, south	2	02/13/2000 1050	385	—	—	—
6b	DWR Pump Plant 2, south	2	02/14/2000 1050	575	—	—	—
6b	DWR Pump Plant 2, south	2	02/15/2000 1035	656	—	—	—
6b	DWR Pump Plant 2, south	3	02/21/2000 1245	190	103	—	—
6b	DWR Pump Plant 2, south	3	02/22/2000 1120	162	81	—	—
6b	DWR Pump Plant 2, south	3	02/23/2000 1110	472	—	—	—
6b	DWR Pump Plant 2, south	3	02/24/2000 1050	442	—	—	—
6b	DWR Pump Plant 2, south	3	02/25/2000 0955	483	—	—	—
7	Gisizer Slough at Bogue Road.	1	01/30/2000 1900	2,190	—	—	—
7	Gisizer Sl at Bogue Road.	1	01/30/2000 2210	2,310	—	—	—
7	Gisizer Slough at Bogue Road.	1	01/31/2000 0615	1,780	—	—	—
7	Gisizer Slough at Bogue Road.	1	01/31/2000 1010	2,490	—	—	—
7	Gisizer Slough at Bogue Road.	1	01/31/2000 1455	2,360	—	—	—
7	Gisizer Slough at Bogue Road.	1	01/31/2000 2235	1,720	—	—	—
7	Gisizer Slough at Bogue Road.	1	02/01/2000 1020	476	295	—	62
7	Gisizer Slough at Bogue Road.	1	02/02/2000 1105	213	—	—	—
7	Gisizer Slough at Bogue Road.	1	02/03/2000 0910	63	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/11/2000 1303	704	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/11/2000 1805	529	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/12/2000 0210	380	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/12/2000 0545	367	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/12/2000 0940	412	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/12/2000 1445	388	—	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
7	Gisizer Slough at Bogue Road.	2	02/12/2000 1757	547	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/12/2000 2137	482	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/13/2000 0205	480	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/13/2000 0540	400	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/13/2000 0915	312	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/13/2000 1355	313	190	—	—
7	Gisizer Slough at Bogue Road.	2	02/13/2000 1720	324	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/13/2000 2145	338	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/14/2000 0140	329	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/14/2000 0605	314	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/14/2000 1000	287	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/14/2000 1440	238	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/14/2000 1750	243	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/14/2000 2145	283	—	—	—
7	Gisizer Slough at Bogue Road.	2	02/15/2000 1150	51	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/21/2000 1115	937	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/22/2000 0945	123	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/22/2000 1400	1,740	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/22/2000 1730	1,010	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/22/2000 2150	479	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/23/2000 0125	393	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/23/2000 0530	382	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/23/2000 0955	374	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/23/2000 1413	294	178	—	—
7	Gisizer Slough at Bogue Road.	3	02/23/2000 1705	252	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/23/2000 2144	177	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/24/2000 0625	73	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/24/2000 1445	53	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/24/2000 1735	50	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/24/2000 2155	260	—	—	—
7	Gisizer Slough at Bogue Road.	3	02/25/2000 1310	252	—	—	—
7	Gisizer Slough at Bogue Road.		02/10/2000 1800	665	—	—	—
8	Feather River at Yuba City	1	01/30/2000 1150	88	48	—	—
8	Feather River at Yuba City	1	01/31/2000 1505	177	92	—	—
8	Feather River at Yuba City	1	02/01/2000 1230	191	97	—	—
8	Feather River at Yuba City	1	02/02/2000 1345	86	—	—	—
8	Feather River at Yuba City	1	02/03/2000 1330	97	—	—	—
8	Feather River at Yuba City	2	02/11/2000 1400	82	52	—	—
8	Feather River at Yuba City	2	02/12/2000 1345	60	52	—	—
8	Feather River at Yuba City	2	02/13/2000 1345	122	78	—	—
8	Feather River at Yuba City	2	02/14/2000 1300	65	—	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
8	Feather River at Yuba City	2	02/15/2000 1220	70	—	—	—
8	Feather River at Yuba City	3	02/21/2000 1550	<30	<20	—	—
8	Feather River at Yuba City	3	02/22/2000 1250	<30	<20	—	—
8	Feather River at Yuba City	3	02/23/2000 1215	<30	<20	—	—
8	Feather River at Yuba City	3	02/24/2000 1245	34	—	—	—
8	Feather River at Yuba City	3	02/25/2000 1230	<30	—	—	—
9	Yuba River at Marysville	1	01/30/2000 1740	<30	<20	—	—
9	Yuba River at Marysville	1	01/31/2000 1410	<30	—	—	—
9	Yuba River at Marysville	2	02/11/2000 1430	<30	<20	—	—
9	Yuba River at Marysville	2	02/12/2000 1350	<30	—	—	—
9	Yuba River at Marysville	3	02/21/2000 1500	<30	<20	—	—
9	Yuba River at Marysville	3	02/22/2000 1430	<30	—	—	—
10	Wadsworth Canal	1	01/30/2000 1815	3,390	—	—	—
10	Wadsworth Canal	1	01/30/2000 2145	7,990	—	—	—
10	Wadsworth Canal	1	01/31/2000 0540	4,410	—	—	—
10	Wadsworth Canal	1	01/31/2000 0940	4,530	2,230	—	805
10	Wadsworth Canal	1	01/31/2000 1118		2,740	—	—
10	Wadsworth Canal	1	01/31/2000 2033	2,110	—	—	—
10	Wadsworth Canal	1	01/31/2000 2300	1,940	—	—	—
10	Wadsworth Canal	1	02/01/2000 0135	1,760	—	—	—
10	Wadsworth Canal	1	02/01/2000 1025	1,110	506	—	331
10	Wadsworth Canal	1	02/01/2000 1500	1,490	—	—	—
10	Wadsworth Canal	1	02/02/2000 1040		504	—	—
10	Wadsworth Canal	1	02/03/2000 1000	465	—	—	—
10	Wadsworth Canal	2	02/07/2000 1030		175	—	—
10	Wadsworth Canal	2	02/09/2000 1049		193	—	—
10	Wadsworth Canal	2	02/11/2000 1335	1,100	—	—	—
10	Wadsworth Canal	2	02/12/2000 0145	5,010	—	—	—
10	Wadsworth Canal	2	02/12/2000 0520	4,130	—	—	—
10	Wadsworth Canal	2	02/12/2000 0910	2,940	—	—	—
10	Wadsworth Canal	2	02/12/2000 1420	3,440	1,850	—	235
10	Wadsworth Canal	2	02/12/2000 1740	2,100	—	—	—
10	Wadsworth Canal	2	02/12/2000 2110	2,190	—	—	—
10	Wadsworth Canal	2	02/13/2000 0130	1,820	—	—	—
10	Wadsworth Canal	2	02/13/2000 0521	1,300	—	—	—
10	Wadsworth Canal	2	02/13/2000 0935	2,320	—	—	—
10	Wadsworth Canal	2	02/13/2000 1330	3,110	2,355	—	105
10	Wadsworth Canal	2	02/13/2000 1655	3,230	—	—	—
10	Wadsworth Canal	2	02/13/2000 2125	2,540	—	—	—
10	Wadsworth Canal	2	02/14/2000 0206	2,300	—	—	—
10	Wadsworth Canal	2	02/14/2000 0535	2,210	—	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

				Diazinon			
Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	ELISA (ng/L)	GC/ECD/TSD (ng/L)	GC/MS (ng/L)	Methidathion (ng/L)
10	Wadsworth Canal	2	02/14/2000 0940	2,900	—	—	—
10	Wadsworth Canal	2	02/14/2000 1111	NA	1,738	—	—
10	Wadsworth Canal	2	02/14/2000 1350	2,720	—	—	—
10	Wadsworth Canal	2	02/14/2000 1720	2,470	—	—	—
10	Wadsworth Canal	2	02/14/2000 2125	1,600	—	—	—
10	Wadsworth Canal	2	02/15/2000 1125	1,110	—	—	—
10	Wadsworth Canal	3	02/22/2000 0918	266	—	—	—
10	Wadsworth Canal	3	02/22/2000 1450	290	—	—	—
10	Wadsworth Canal	3	02/22/2000 1700	282	—	—	—
10	Wadsworth Canal	3	02/22/2000 2125	238	—	—	—
10	Wadsworth Canal	3	02/23/2000 0103	307	—	—	—
10	Wadsworth Canal	3	02/23/2000 0505	654	—	—	—
10	Wadsworth Canal	3	02/23/2000 0920	773	—	—	—
10	Wadsworth Canal	3	02/23/2000 1400	778	591	—	80
10	Wadsworth Canal	3	02/23/2000 1640	729	—	—	—
10	Wadsworth Canal	3	02/23/2000 2123	715	—	—	—
10	Wadsworth Canal	3	02/24/2000 0605	847	—	—	—
10	Wadsworth Canal	3	02/24/2000 1420	839	—	—	—
10	Wadsworth Canal	3	02/24/2000 1700	641	—	—	—
10	Wadsworth Canal	3	02/24/2000 2130	565	—	—	—
10	Wadsworth Canal	3	02/25/2000 1245	323	—	—	—
11	Jack Slough	1	01/30/2000 1320	459	208	—	—
11	Jack Slough	1	01/31/2000 1410	1,490	727	—	—
11	Jack Slough	1	02/01/2000 1400	1,050	499	—	—
11	Jack Slough	1	02/02/2000 1245	505	—	—	—
11	Jack Slough	1	02/03/2000 1230	534	—	—	—
11	Jack Slough	2	02/10/2000 1600	457	—	—	—
11	Jack Slough	2	02/11/2000 1430	752	365	—	—
11	Jack Slough	2	02/11/2000 1500		397	—	—
11	Jack Slough	2	02/12/2000 1430	534	258	—	—
11	Jack Slough	2	02/13/2000 1445	456	236	—	—
11	Jack Slough	2	02/14/2000 1340	346	—	—	—
11	Jack Slough	2	02/15/2000 1300	302	—	—	—
11	Jack Slough	3	02/21/2000 1430	205	116	—	—
11	Jack Slough	3	02/22/2000 1330	213	118	—	—
11	Jack Slough	3	02/23/2000 1250	261	134	—	275
11	Jack Slough	3	02/24/2000 1315	189	—	—	—
11	Jack Slough	3	02/25/2000 1300	169	—	—	—
12	Butte Slough at Lower Pass Road	1	01/30/2000 1520	98	38	—	—
12	Butte Slough at Lower Pass Road	1	01/31/2000 1245	80	52	—	—
12	Butte Slough at Lower Pass Road	1	02/01/2000 1130	109	46	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
12	Butte Slough at Lower Pass Road	1	02/02/2000 1135	105	—	—	—
12	Butte Slough at Lower Pass Road	1	02/03/2000 1130	111	—	—	—
12	Butte Slough at Lower Pass Road	2	02/11/2000 1200	116	55	—	—
12	Butte Slough at Lower Pass Road	2	02/12/2000 1200	126	82	—	—
12	Butte Slough at Lower Pass Road	2	02/13/2000 1130	91	44	—	—
12	Butte Slough at Lower Pass Road	2	02/14/2000 1115	<30	—	—	—
12	Butte Slough at Lower Pass Road	2	02/15/2000 1110	<30	—	—	—
12	Butte Slough at Lower Pass Road	3	02/21/2000 1340	<30	<20	—	—
12	Butte Slough at Lower Pass Road	3	02/22/2000 1130	<30	<20	—	—
12	Butte Slough at Lower Pass Road	3	02/23/2000 1100	<30	<20	—	—
12	Butte Slough at Lower Pass Road	3	02/24/2000 1115	<30	—	—	—
12	Butte Slough at Lower Pass Road	3	02/25/2000 1115	<30	—	—	—
13	Sacramento River at Colusa	1	01/30/2000 1620	<30	<20	—	—
13	Sacramento River at Colusa	1	01/31/2000 1045	137	77	—	—
13	Sacramento River at Colusa	1	02/01/2000 1000	84	60	—	—
13	Sacramento River at Colusa	1	02/02/2000 0945	64	—	—	—
13	Sacramento River at Colusa	1	02/03/2000 0950	36	—	—	—
13	Sacramento River at Colusa	2	02/11/2000 1030	<30	<20	—	—
13	Sacramento River at Colusa	2	02/12/2000 1100	49	23	—	—
13	Sacramento River at Colusa	2	02/13/2000 1020	47	27	—	—
13	Sacramento River at Colusa	2	02/14/2000 1000	34	—	—	—
13	Sacramento River at Colusa	2	02/15/2000 0940	<30	—	—	—
13	Sacramento River at Colusa	3	02/21/2000 1220	<30	<20	—	—
13	Sacramento River at Colusa	3	02/22/2000 1035	<30	<20	—	—
13	Sacramento River at Colusa	3	02/23/2000 1015	<30	—	—	—
13	Sacramento River at Colusa	3	02/24/2000 0950	<30	—	—	—
13	Sacramento River at Colusa	3	02/25/2000 1005	<30	—	—	—
14	Butte Creek near Gridley	1	01/30/2000 1315	120	—	—	—
14	Butte Creek near Gridley	1	01/30/2000 2015	199	—	—	—
14	Butte Creek near Gridley	1	01/31/2000 0420	236	—	—	—
14	Butte Creek near Gridley	1	01/31/2000 0810	238	—	—	—
14	Butte Creek near Gridley	1	01/31/2000 1215	194	—	—	—
14	Butte Creek near Gridley	1	01/31/2000 1740	180	75	—	—
14	Butte Creek near Gridley	1	01/31/2000 2125	164	—	—	—
14	Butte Creek near Gridley	1	02/01/2000 0030	176	—	—	—
14	Butte Creek near Gridley	1	02/01/2000 0830	163	—	—	—
14	Butte Creek near Gridley	1	02/01/2000 1325	173	—	—	—
14	Butte Creek near Gridley	1	02/02/2000 1300	112	48	—	—
14	Butte Creek near Gridley	1	02/03/2000 1103	96	—	—	—
14	Butte Creek near Gridley	2	02/11/2000 1010	57	—	—	—
14	Butte Creek near Gridley	2	02/12/2000 0038	65	—	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
14	Butte Creek near Gridley	2	02/12/2000 0420	56	—	—	—
14	Butte Creek near Gridley	2	02/12/2000 0805	68	—	—	—
14	Butte Creek near Gridley	2	02/12/2000 1215	44	35	—	—
14	Butte Creek near Gridley	2	02/12/2000 1635	53	—	—	—
14	Butte Creek near Gridley	2	02/12/2000 2015	56	—	—	—
14	Butte Creek near Gridley	2	02/13/2000 0016	52	—	—	—
14	Butte Creek near Gridley	2	02/13/2000 0410	542	—	—	—
14	Butte Creek near Gridley	2	02/13/2000 0810	80	—	—	—
14	Butte Creek near Gridley	2	02/13/2000 1220	66	—	—	—
14	Butte Creek near Gridley	2	02/13/2000 1550	50	—	—	—
14	Butte Creek near Gridley	2	02/13/2000 2010	35	—	—	—
14	Butte Creek near Gridley	2	02/14/2000 0015	43	—	—	—
14	Butte Creek near Gridley	2	02/14/2000 0422	40	—	—	—
14	Butte Creek near Gridley	2	02/14/2000 0825	<30	—	—	—
14	Butte Creek near Gridley	2	02/14/2000 1225	40	23	—	—
14	Butte Creek near Gridley	2	02/14/2000 1620	37	—	—	—
14	Butte Creek near Gridley	2	02/14/2000 2020	39	—	—	—
14	Butte Creek near Gridley	2	02/15/2000 0920	<30	—	—	—
14	Butte Creek near Gridley	3	02/21/2000 1240	58	—	—	—
14	Butte Creek near Gridley	3	02/22/2000 0810	44	—	—	—
14	Butte Creek near Gridley	3	02/22/2000 1220	54	25	—	—
14	Butte Creek near Gridley	3	02/22/2000 1600	59	—	—	—
14	Butte Creek near Gridley	3	02/22/2000 2020	52	—	—	—
14	Butte Creek near Gridley	3	02/23/2000 0008	44	—	—	—
14	Butte Creek near Gridley	3	02/23/2000 0415	55	—	—	—
14	Butte Creek near Gridley	3	02/23/2000 0810	51	—	—	—
14	Butte Creek near Gridley	3	02/23/2000 1210	47	—	—	—
14	Butte Creek near Gridley	3	02/23/2000 1535	39	—	—	—
14	Butte Creek near Gridley	3	02/23/2000 2021	34	—	—	—
14	Butte Creek near Gridley	3	02/24/2000 0440	<30	—	—	—
14	Butte Creek near Gridley	3	02/24/2000 1220	<30	29	—	—
14	Butte Creek near Gridley	3	02/24/2000 1605	<30	—	—	—
14	Butte Creek near Gridley	3	02/24/2000 2020	<30	—	—	—
14	Butte Creek near Gridley	3	02/25/2000 1005	<30	—	—	—
15	Cherokee Canal	1	01/30/2000 1345	207	70	—	—
15	Cherokee Canal	1	01/31/2000 1815	237	—	—	—
15	Cherokee Canal	2	02/11/2000 1035	78	40	—	—
15	Cherokee Canal	2	02/12/2000 1235	65	—	—	—
15	Cherokee Canal	3	02/21/2000 1305	126	65	—	—
15	Cherokee Canal	3	02/22/2000 1230	111	—	—	—
16	Main Canal	1	01/30/2000 1445	389	—	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
16	Main Canal	1	01/30/2000 2045	523	—	—	—
16	Main Canal	1	01/31/2000 0450	520	—	—	—
16	Main Canal	1	01/31/2000 0833	1,010	—	—	—
16	Main Canal	1	01/31/2000 1240	823	—	—	—
16	Main Canal	1	01/31/2000 1840	437	—	—	—
16	Main Canal	1	01/31/2000 2145	404	—	—	—
16	Main Canal	1	02/01/2000 0045	385	—	—	—
16	Main Canal	1	02/01/2000 0910	346	—	—	—
16	Main Canal	1	02/01/2000 1400	291	—	—	—
16	Main Canal	1	02/02/2000 1330	172	100	—	—
16	Main Canal	1	02/03/2000 2323	117	—	—	—
16	Main Canal	2	02/10/2000 1645	596	—	—	—
16	Main Canal	2	02/11/2000 1105	3,950	—	—	—
16	Main Canal	2	02/12/2000 0055	2,770	—	—	—
16	Main Canal	2	02/12/2000 0435	2,950	—	—	—
16	Main Canal	2	02/12/2000 0820	4,460	—	—	—
16	Main Canal	2	02/12/2000 1255	4,600	—	—	—
16	Main Canal	2	02/12/2000 1650	7,380	—	—	—
16	Main Canal	2	02/12/2000 2025	6,880	—	—	—
16	Main Canal	2	02/13/2000 0040	5,530	—	—	—
16	Main Canal	2	02/13/2000 0430	4,720	—	—	—
16	Main Canal	2	02/13/2000 0830	4,030	—	—	—
16	Main Canal	2	02/13/2000 1235	2,890	—	—	—
16	Main Canal	2	02/13/2000 1610	2,920	—	—	—
16	Main Canal	2	02/13/2000 2025	5,260	—	—	—
16	Main Canal	2	02/14/2000 0055	3,780	—	—	—
16	Main Canal	2	02/14/2000 0445	3,080	—	—	—
16	Main Canal	2	02/14/2000 0850	3,760	—	—	—
16	Main Canal	2	02/14/2000 1300	3,300	1,999	—	60
16	Main Canal	2	02/14/2000 1630	3,600	—	—	—
16	Main Canal	2	02/14/2000 2035	3,060	—	—	—
16	Main Canal	2	02/15/2000 0950	2,320	—	—	—
16	Main Canal	3	02/21/2000 1320	2,240	—	—	—
16	Main Canal	3	02/22/2000 0825	2,050	—	—	—
16	Main Canal	3	02/22/2000 1245	2,000	—	—	—
16	Main Canal	3	02/22/2000 1615	1,370	—	—	—
16	Main Canal	3	02/22/2000 2040	1,540	—	—	—
16	Main Canal	3	02/23/2000 0020	1,410	—	—	—
16	Main Canal	3	02/23/2000 0420	2,500	—	—	—
16	Main Canal	3	02/23/2000 0835	4,960	—	—	—
16	Main Canal	3	02/23/2000 1235	11,500	—	—	—

Appendix 1. Table 1. Concentrations of diazinon and methidathion in water samples, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date and time (month/day/year 24-hour time)	Diazinon ELISA (ng/L)	Diazinon GC/ECD/TSD (ng/L)	Diazinon GC/MS (ng/L)	Methidathion (ng/L)
16	Main Canal	3	02/23/2000 1555	6,470	—	—	—
16	Main Canal	3	02/23/2000 2030	11,300	—	—	—
16	Main Canal	3	02/24/2000 0515	7,510	—	—	—
16	Main Canal	3	02/24/2000 1240	5,070	2,890	—	—
16	Main Canal	3	02/24/2000 1620	4,130	—	—	—
16	Main Canal	3	02/24/2000 2030	2,950	—	—	—
16	Main Canal	3	02/25/2000 1025	3,010	—	—	—
17	Sacramento River at Tower Bridge	1	02/01/2000 1700	—	—	29	—
17	Sacramento River at Tower Bridge	1	02/02/2000 1710	—	—	61	—
17	Sacramento River at Tower Bridge	1	02/03/2000 1700	—	—	41	—
17	Sacramento River at Tower Bridge	1	02/04/2000 1700	—	—	38	—
17	Sacramento River at Tower Bridge	1	02/05/2000 1700	—	—	24	—
17	Sacramento River at Tower Bridge	2	02/11/2000 1715	—	—	25	—
17	Sacramento River at Tower Bridge	2	02/12/2000 1600	—	—	24	—
17	Sacramento River at Tower Bridge	2	02/13/2000 1900	—	—	28	—
17	Sacramento River at Tower Bridge	2	02/14/2000 1730	—	—	29	—
17	Sacramento River at Tower Bridge	2	02/15/2000 1530	—	—	32	—
17	Sacramento River at Tower Bridge	2	02/16/2000 1730	—	—	43	—
17	Sacramento River at Tower Bridge	2	02/17/2000 1757	—	—	26	—
17	Sacramento River at Tower Bridge	3	02/22/2000 1545	—	—	12	—
17	Sacramento River at Tower Bridge	3	02/23/2000 1735	—	—	19	—
17	Sacramento River at Tower Bridge	3	02/24/2000 1635	—	—	20	—
17	Sacramento River at Tower Bridge	3	02/25/2000 1150	—	—	21	—

Appendix 1. Table 2. Pesticide concentrations in samples analyzed by the U.S. Geological Survey's National Water-Quality Laboratory using gas chromatography with mass spectrometry (GC/MS), Sacramento River Basin, California

[μg/L, microgram per liter; E, estimated; <, less than]

Site name	Date	Time	2,6-Diethylaniline (μg/L)	Acetochlor (μg/L)	Alachlor (μg/L)	Alpha-BH (μg/L)	Atrazine (μg/L)	Benfluralin (μg/L)	Butylate (μg/L)	Carbaryl (μg/L)
Feather River near Nicolaus	01/30/00	1430	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	01/31/00	1230	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/01/00	1250	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/02/00	1150	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/03/00	1130	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	E0.0048
Feather River near Nicolaus	02/11/00	1240	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	E0.010
Feather River near Nicolaus	02/13/00	1420	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/14/00	1300	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/15/00	1040	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/21/00	1240	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/22/00	1030	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/23/00	1020	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/24/00	1010	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Feather River near Nicolaus	02/25/00	1050	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Sacramento River at Tower Bridge	02/01/00	1700	<0.003	<0.002	<0.002	<0.002	E0.003	<0.002	<0.002	<0.003
Sacramento River at Tower Bridge	02/02/00	1710	<0.003	<0.002	<0.002	<0.002	<0.004	<0.002	<0.002	E0.005
Sacramento River at Tower Bridge	02/03/00	1700	<0.003	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	E0.004
Sacramento River at Tower Bridge	02/04/00	1700	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	E0.005
Sacramento River at Tower Bridge	02/05/00	1700	<0.003	<0.002	<0.002	<0.002	E0.003	<0.002	<0.002	<0.003
Sacramento River at Tower Bridge	02/11/00	1715	<0.003	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	E0.007
Sacramento River at Tower Bridge	02/12/00	1600	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	E0.005
Sacramento River at Tower Bridge	02/13/00	1900	<0.003	<0.002	<0.002	<0.002	E0.003	<0.002	<0.002	E0.005
Sacramento River at Tower Bridge	02/14/00	1730	<0.003	<0.002	<0.002	<0.002	0.004	<0.002	<0.002	E0.006
Sacramento River at Tower Bridge	02/15/00	1530	<0.003	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	E0.005
Sacramento River at Tower Bridge	02/16/00	1730	<0.003	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	E0.008
Sacramento River at Tower Bridge	02/17/00	1757	<0.003	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	<0.003
Sacramento River at Tower Bridge	02/22/00	1545	<0.003	<0.002	<0.002	<0.002	E0.003	<0.002	<0.002	<0.003
Sacramento River at Tower Bridge	02/23/00	1735	<0.003	<0.002	<0.002	<0.002	E0.003	<0.002	<0.002	E0.005
Sacramento River at Tower Bridge	02/24/00	1635	<0.003	<0.002	<0.002	<0.002	<0.001	<0.002	<0.002	<0.003
Sacramento River at Tower Bridge	02/25/00	1150	<0.003	<0.002	<0.002	<0.002	E0.003	<0.002	<0.002	E0.004

Appendix 1. Table 2. Pesticide concentrations in samples analyzed by the U.S. Geological Survey's National Water-Quality Laboratory using gas chromatography with mass spectrometry (GC/MS), Sacramento River Basin, California—*Continued*

Site name	Date	Time	Carbofuran (µg/L)	Chlorpyrifos (µg/L)	Cyanazine (µg/L)	DCPA (µg/L)	Desethyl-atrazine (µg/L)	Diazinon surrogate (percent)	Diazinon (µg/L)	Dieldrin (µg/L)
Feather River near Nicolaus	01/30/00	1430	<0.010	<0.004	<0.004	<0.002	<0.002	104	0.040	<0.001
Feather River near Nicolaus	01/31/00	1230	<0.010	<0.004	<0.004	<0.002	<0.002	103	0.154	<0.001
Feather River near Nicolaus	02/01/00	1250	<0.010	<0.004	<0.004	<0.002	<0.002	107	0.054	<0.001
Feather River near Nicolaus	02/02/00	1150	<0.010	<0.004	<0.004	<0.002	<0.002	110	0.054	<0.001
Feather River near Nicolaus	02/03/00	1130	E0.0226	<0.004	<0.004	<0.002	<0.002	98	0.043	<0.001
Feather River near Nicolaus	02/11/00	1240	<0.015	E0.004	<0.004	E0.002	<0.002	106	0.060	<0.001
Feather River near Nicolaus	02/13/00	1420	E0.007	0.006	<0.004	<0.002	<0.002	109	0.063	<0.001
Feather River near Nicolaus	02/14/00	1300	E0.004	E0.004	<0.004	<0.002	<0.002	104	0.033	<0.001
Feather River near Nicolaus	02/15/00	1040	<0.003	<0.004	<0.004	<0.002	<0.002	106	0.036	<0.001
Feather River near Nicolaus	02/21/00	1240	E0.003	<0.004	<0.004	<0.002	<0.002	90.8	0.008	<0.001
Feather River near Nicolaus	02/22/00	1030	E0.004	<0.004	<0.004	<0.002	<0.002	89.5	0.009	<0.001
Feather River near Nicolaus	02/23/00	1020	E0.003	<0.004	<0.004	<0.002	<0.002	92.4	0.009	<0.001
Feather River near Nicolaus	02/24/00	1010	<0.003	<0.004	<0.004	<0.002	<0.002	102	0.013	<0.001
Feather River near Nicolaus	02/25/00	1050	<0.003	<0.004	<0.004	E0.001	<0.002	101	0.016	<0.001
Sacramento River at Tower Bridge	02/01/00	1700	<0.013	<0.004	<0.004	<0.002	<0.002	109	0.029	<0.001
Sacramento River at Tower Bridge	02/02/00	1710	E0.011	0.004	<0.004	<0.002	<0.002	104	0.061	<0.001
Sacramento River at Tower Bridge	02/03/00	1700	E0.011	E0.003	<0.004	<0.002	<0.002	99	0.041	<0.001
Sacramento River at Tower Bridge	02/04/00	1700	E0.011	<0.004	<0.004	<0.002	<0.002	101	0.038	<0.001
Sacramento River at Tower Bridge	02/05/00	1700	E0.008	<0.004	<0.004	E0.002	<0.002	101	0.024	<0.001
Sacramento River at Tower Bridge	02/11/00	1715	E0.010	<0.004	<0.004	E0.002	<0.002	97.1	0.025	<0.001
Sacramento River at Tower Bridge	02/12/00	1600	<0.010	<0.004	<0.004	<0.002	<0.002	91.8	0.024	<0.001
Sacramento River at Tower Bridge	02/13/00	1900	<0.003	E0.003	<0.004	E0.001	<0.002	90.5	0.028	<0.001
Sacramento River at Tower Bridge	02/14/00	1730	<0.003	0.005	<0.004	E0.002	<0.002	90.1	0.029	<0.001
Sacramento River at Tower Bridge	02/15/00	1530	E0.006	<0.004	<0.004	<0.002	<0.002	87.4	0.032	<0.001
Sacramento River at Tower Bridge	02/16/00	1730	<0.008	0.004	<0.004	E0.002	<0.002	108	0.043	<0.001
Sacramento River at Tower Bridge	02/17/00	1757	<0.003	E0.003	<0.004	E0.002	<0.002	106	0.026	<0.001
Sacramento River at Tower Bridge	02/22/00	1545	E0.004	<0.004	<0.004	<0.002	<0.002	90.7	0.012	<0.001
Sacramento River at Tower Bridge	02/23/00	1735	E0.006	<0.004	<0.004	E0.002	<0.002	92	0.019	<0.001
Sacramento River at Tower Bridge	02/24/00	1635	E0.007	<0.004	<0.004	<0.002	<0.002	103	0.020	<0.001
Sacramento River at Tower Bridge	02/25/00	1150	E0.007	<0.004	<0.004	<0.002	<0.002	105	0.021	<0.001

Appendix 1. Table 2. Pesticide concentrations in samples analyzed by the U.S. Geological Survey's National Water-Quality Laboratory using gas chromatography with mass spectrometry (GC/MS), Sacramento River Basin, California—*Continued*

Site name	Date	Time	Disulfoton (µg/L)	EPTC (µg/L)	Ethalfluralin (µg/L)	Ethoprop (µg/L)	Fonofos (µg/L)	HCH surrogate (percent)	Lindane (µg/L)	Linuron (µg/L)
Feather River near Nicolaus	01/30/00	1430	<0.017	<0.002	<0.004	<0.003	<0.003	91.2	<0.004	<0.002
Feather River near Nicolaus	01/31/00	1230	<0.017	<0.002	<0.004	<0.003	<0.003	88.3	<0.004	<0.002
Feather River near Nicolaus	02/01/00	1250	<0.017	<0.002	<0.004	<0.003	<0.003	90.6	<0.004	<0.002
Feather River near Nicolaus	02/02/00	1150	<0.017	<0.002	<0.004	<0.003	<0.003	95.8	<0.004	<0.002
Feather River near Nicolaus	02/03/00	1130	<0.017	<0.002	<0.004	<0.003	<0.003	106	<0.004	<0.002
Feather River near Nicolaus	02/11/00	1240	<0.017	<0.002	<0.004	<0.003	<0.003	94.6	<0.004	<0.002
Feather River near Nicolaus	02/13/00	1420	<0.017	<0.002	<0.004	<0.003	<0.003	104	<0.004	<0.002
Feather River near Nicolaus	02/14/00	1300	<0.017	<0.002	<0.004	<0.003	<0.003	99.1	<0.004	<0.002
Feather River near Nicolaus	02/15/00	1040	<0.017	<0.002	<0.004	<0.003	<0.003	100	<0.004	<0.002
Feather River near Nicolaus	02/21/00	1240	<0.017	<0.002	<0.004	<0.003	<0.003	74.4	<0.004	<0.002
Feather River near Nicolaus	02/22/00	1030	<0.017	<0.002	<0.004	<0.003	<0.003	78.8	<0.004	<0.002
Feather River near Nicolaus	02/23/00	1020	<0.017	<0.002	<0.004	<0.003	<0.003	73.3	<0.004	<0.002
Feather River near Nicolaus	02/24/00	1010	<0.017	<0.002	<0.004	<0.003	<0.003	81.8	<0.004	<0.002
Feather River near Nicolaus	02/25/00	1050	<0.017	<0.002	<0.004	<0.003	<0.003	97.3	<0.004	<0.002
Sacramento River at Tower Bridge	02/01/00	1700	<0.017	<0.002	<0.004	<0.003	<0.003	95.4	<0.004	<0.002
Sacramento River at Tower Bridge	02/02/00	1710	<0.017	<0.002	<0.004	<0.003	<0.003	107	<0.004	<0.002
Sacramento River at Tower Bridge	02/03/00	1700	<0.017	<0.002	<0.004	<0.003	<0.003	109	<0.004	<0.002
Sacramento River at Tower Bridge	02/04/00	1700	<0.017	<0.002	<0.004	<0.003	<0.003	110	<0.004	<0.002
Sacramento River at Tower Bridge	02/05/00	1700	<0.017	<0.002	<0.004	<0.003	<0.003	98.1	<0.004	<0.002
Sacramento River at Tower Bridge	02/11/00	1715	<0.017	<0.002	<0.004	<0.003	<0.003	102	<0.004	<0.002
Sacramento River at Tower Bridge	02/12/00	1600	<0.017	<0.002	<0.004	<0.003	<0.003	92.3	<0.004	<0.002
Sacramento River at Tower Bridge	02/13/00	1900	<0.017	<0.002	<0.004	<0.003	<0.003	91.8	<0.004	<0.002
Sacramento River at Tower Bridge	02/14/00	1730	<0.017	<0.002	<0.004	<0.003	<0.003	92.5	<0.004	<0.002
Sacramento River at Tower Bridge	02/15/00	1530	<0.017	<0.002	<0.004	<0.003	<0.003	90.4	<0.004	<0.002
Sacramento River at Tower Bridge	02/16/00	1730	<0.017	<0.002	<0.004	<0.003	<0.003	99	<0.004	<0.002
Sacramento River at Tower Bridge	02/17/00	1757	<0.017	<0.002	<0.004	<0.003	<0.003	97.2	<0.004	<0.002
Sacramento River at Tower Bridge	02/22/00	1545	<0.017	<0.002	<0.004	<0.003	<0.003	74.4	<0.004	<0.002
Sacramento River at Tower Bridge	02/23/00	1735	<0.017	<0.002	<0.004	<0.003	<0.003	71.8	<0.004	<0.002
Sacramento River at Tower Bridge	02/24/00	1635	<0.017	<0.002	<0.004	<0.003	<0.003	102	<0.004	<0.002
Sacramento River at Tower Bridge	02/25/00	1150	<0.017	<0.002	<0.004	<0.003	<0.003	102	<0.004	<0.002

Appendix 1. Table 2. Pesticide concentrations in samples analyzed by the U.S. Geological Survey's National Water-Quality Laboratory using gas chromatography with mass spectrometry (GC/MS), Sacramento River Basin, California—*Continued*

Site name	Date	Time	Malathion (µg/L)	Methyl-azinhos (µg/L)	Methyl parathion (µg/L)	Metolachlor (µg/L)	Metribuzin (µg/L)	Molinate (µg/L)	Napropamide (µg/L)	*p,p'*-DDE (µg/L)
Feather River near Nicolaus	01/30/00	1430	<0.005	<0.001	<0.006	<0.002	<0.004	0.025	<0.003	<0.006
Feather River near Nicolaus	01/31/00	1230	<0.005	<0.001	<0.006	<0.002	<0.004	0.026	<0.003	<0.006
Feather River near Nicolaus	02/01/00	1250	<0.005	<0.001	<0.006	<0.002	<0.004	0.030	<0.003	<0.006
Feather River near Nicolaus	02/02/00	1150	<0.005	<0.001	<0.006	<0.002	<0.004	0.025	<0.003	<0.006
Feather River near Nicolaus	02/03/00	1130	<0.005	<0.001	<0.006	0.005	<0.004	0.021	<0.003	<0.006
Feather River near Nicolaus	02/11/00	1240	E0.004	<0.001	<0.006	0.004	<0.004	0.023	<0.003	<0.006
Feather River near Nicolaus	02/13/00	1420	<0.005	<0.04	<0.006	<0.006	<0.004	0.009	<0.003	<0.006
Feather River near Nicolaus	02/14/00	1300	<0.005	<0.001	<0.006	<0.002	<0.004	0.007	<0.003	<0.006
Feather River near Nicolaus	02/15/00	1040	<0.005	<0.001	<0.006	0.006	<0.004	0.009	<0.003	<0.006
Feather River near Nicolaus	02/21/00	1240	<0.005	<0.001	<0.006	<0.002	<0.004	<0.010	<0.003	<0.006
Feather River near Nicolaus	02/22/00	1030	<0.005	<0.001	<0.006	<0.002	<0.004	<0.010	<0.003	<0.006
Feather River near Nicolaus	02/23/00	1020	<0.005	<0.001	<0.006	<0.002	<0.004	<0.004	<0.003	<0.006
Feather River near Nicolaus	02/24/00	1010	<0.005	<0.001	<0.006	<0.002	<0.004	0.008	<0.003	<0.006
Feather River near Nicolaus	02/25/00	1050	<0.005	<0.001	<0.006	<0.002	<0.004	0.008	<0.003	<0.006
Sacramento River at Tower Bridge	02/01/00	1700	<0.005	<0.001	<0.006	0.005	<0.004	0.012	<0.003	<0.006
Sacramento River at Tower Bridge	02/02/00	1710	<0.005	<0.001	<0.006	0.007	<0.004	0.010	<0.003	<0.006
Sacramento River at Tower Bridge	02/03/00	1700	<0.005	<0.001	<0.006	0.006	<0.004	0.010	<0.003	<0.006
Sacramento River at Tower Bridge	02/04/00	1700	<0.005	<0.001	<0.006	0.007	<0.004	0.009	<0.003	<0.006
Sacramento River at Tower Bridge	02/05/00	1700	<0.005	<0.001	<0.006	E0.004	<0.004	0.011	<0.003	<0.006
Sacramento River at Tower Bridge	02/11/00	1715	<0.005	<0.001	<0.006	0.007	<0.004	0.009	<0.003	<0.006
Sacramento River at Tower Bridge	02/12/00	1600	<0.005	<0.001	<0.006	0.006	<0.004	0.011	<0.003	<0.006
Sacramento River at Tower Bridge	02/13/00	1900	<0.005	<0.001	<0.006	0.006	<0.004	0.007	<0.003	<0.006
Sacramento River at Tower Bridge	02/14/00	1730	<0.005	<0.001	<0.006	0.006	<0.004	0.006	<0.003	<0.006
Sacramento River at Tower Bridge	02/15/00	1530	<0.005	<0.001	<0.006	0.005	<0.004	0.009	<0.003	<0.006
Sacramento River at Tower Bridge	02/16/00	1730	<0.005	<0.001	<0.006	0.011	<0.004	0.009	<0.003	E0.0014
Sacramento River at Tower Bridge	02/17/00	1757	<0.005	<0.001	<0.006	0.005	<0.004	0.008	<0.003	<0.006
Sacramento River at Tower Bridge	02/22/00	1545	<0.005	<0.001	<0.006	0.004	E0.0030	0.007	<0.003	<0.006
Sacramento River at Tower Bridge	02/23/00	1735	E0.004	<0.001	<0.006	0.008	<0.004	0.011	<0.003	<0.006
Sacramento River at Tower Bridge	02/24/00	1635	<0.005	<0.001	<0.006	0.005	<0.004	0.010	<0.003	<0.006
Sacramento River at Tower Bridge	02/25/00	1150	<0.005	<0.001	<0.006	0.006	<0.004	0.009	<0.003	<0.006

Appendix 1. Table 2. Pesticide concentrations in samples analyzed by the U.S. Geological Survey's National Water-Quality Laboratory using gas chromatography with mass spectrometry (GC/MS), Sacramento River Basin, California—*Continued*

Site name	Date	Time	Parathionn (µg/L)	Pebulate (µg/L)	Pendimethalin (µg/L)	Permithrin (µg/L)	Phorate (µg/L)	Prometon (µg/L)	Pronamide (µg/L)	Propachlor (µg/L)
Feather River near Nicolaus	01/30/00	1430	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	01/31/00	1230	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/01/00	1250	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/02/00	1150	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/03/00	1130	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/11/00	1240	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/13/00	1420	<0.004	<0.004	0.008	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/14/00	1300	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/15/00	1040	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/21/00	1240	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/22/00	1030	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/23/00	1020	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/24/00	1010	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Feather River near Nicolaus	02/25/00	1050	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/01/00	1700	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/02/00	1710	<0.004	<0.004	<0.008	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/03/00	1700	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/04/00	1700	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/05/00	1700	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/11/00	1715	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/12/00	1600	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/13/00	1900	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/14/00	1730	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/15/00	1530	<0.004	<0.004	0.008	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/16/00	1730	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/17/00	1757	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/22/00	1545	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/23/00	1735	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/24/00	1635	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007
Sacramento River at Tower Bridge	02/25/00	1150	<0.004	<0.004	<0.004	<0.005	<0.002	<0.018	<0.003	<0.007

Appendix 1. Table 2. Pesticide concentrations in samples analyzed by the U.S. Geological Survey's National Water-Quality Laboratory using gas chromatography with mass spectrometry (GC/MS), Sacramento River Basin, California—*Continued*

Site name	Date	Time	Propanil (µg/L)	Propargite (µg/L)	Simazine (µg/L)	Tebuthiuron (µg/L)	Terbacil (µg/L)	Terbufos (µg/L)	Thiobencarb (µg/L)	Triallate (µg/L)	Trifluralin (µg/L)
Feather River near Nicolaus	01/30/00	1430	<0.004	<0.013	0.012	<0.010	<0.007	<0.013	0.009	<0.001	<0.002
Feather River near Nicolaus	01/31/00	1230	<0.004	<0.013	0.060	<0.010	<0.007	<0.013	0.011	<0.001	<0.002
Feather River near Nicolaus	02/01/00	1250	<0.004	<0.013	0.026	<0.010	<0.007	<0.013	0.011	<0.001	<0.002
Feather River near Nicolaus	02/02/00	1150	<0.004	<0.013	0.031	<0.010	<0.007	<0.013	0.010	<0.001	<0.002
Feather River near Nicolaus	02/03/00	1130	<0.004	<0.013	0.033	<0.010	<0.007	<0.013	0.009	<0.001	0.006
Feather River near Nicolaus	02/11/00	1240	<0.004	<0.013	0.062	<0.010	<0.007	<0.013	0.009	<0.001	<0.002
Feather River near Nicolaus	02/13/00	1420	<0.004	<0.013	0.051	<0.010	<0.007	<0.013	0.007	<0.001	<0.002
Feather River near Nicolaus	02/14/00	1300	<0.004	<0.013	0.031	<0.010	<0.007	<0.013	0.006	<0.001	<0.002
Feather River near Nicolaus	02/15/00	1040	<0.004	<0.013	0.034	<0.010	<0.007	<0.013	0.007	<0.001	<0.002
Feather River near Nicolaus	02/21/00	1240	<0.004	<0.013	0.006	<0.010	<0.007	<0.013	<0.002	<0.001	<0.002
Feather River near Nicolaus	02/22/00	1030	<0.004	<0.013	0.006	<0.010	<0.007	<0.013	E0.003	<0.001	<0.002
Feather River near Nicolaus	02/23/00	1020	E0.004	<0.013	0.015	<0.010	<0.007	<0.013	E0.003	<0.001	<0.002
Feather River near Nicolaus	02/24/00	1010	<0.004	<0.013	0.017	<0.010	<0.007	<0.013	E0.004	<0.001	<0.002
Feather River near Nicolaus	02/25/00	1050	<0.004	<0.013	0.011	<0.010	<0.007	<0.013	E0.004	<0.001	<0.002
Sacramento River at Tower Bridge	02/01/00	1700	<0.004	<0.013	0.013	<0.010	<0.007	<0.013	0.007	<0.001	E0.002
Sacramento River at Tower Bridge	02/02/00	1710	<0.004	<0.013	0.023	<0.010	<0.007	<0.013	0.007	<0.001	0.006
Sacramento River at Tower Bridge	02/03/00	1700	<0.004	<0.013	0.019	<0.010	<0.007	<0.013	0.007	<0.001	0.006
Sacramento River at Tower Bridge	02/04/00	1700	<0.004	<0.013	0.012	<0.010	<0.007	<0.013	0.008	<0.001	0.006
Sacramento River at Tower Bridge	02/05/00	1700	<0.004	<0.013	0.014	<0.010	<0.007	<0.013	0.006	<0.001	E0.002
Sacramento River at Tower Bridge	02/11/00	1715	<0.004	<0.013	0.013	E0.008	<0.007	<0.013	0.005	<0.001	0.006
Sacramento River at Tower Bridge	02/12/00	1600	<0.004	<0.013	0.019	0.012	<0.007	<0.013	0.006	<0.001	E0.001
Sacramento River at Tower Bridge	02/13/00	1900	<0.004	<0.013	0.019	0.014	<0.007	<0.013	0.004	<0.001	E0.002
Sacramento River at Tower Bridge	02/14/00	1730	<0.004	<0.013	0.023	0.012	<0.007	<0.013	<0.002	<0.001	E0.001
Sacramento River at Tower Bridge	02/15/00	1530	0.009	<0.013	0.028	E0.0066	<0.007	<0.013	0.007	<0.001	E0.001
Sacramento River at Tower Bridge	02/16/00	1730	<0.004	<0.013	0.030	<0.010	<0.007	<0.013	0.007	<0.001	E0.003
Sacramento River at Tower Bridge	02/17/00	1757	<0.004	<0.013	0.040	E0.005	<0.007	<0.013	0.006	<0.001	E0.002
Sacramento River at Tower Bridge	02/22/00	1545	<0.004	<0.013	0.01	E0.008	<0.007	<0.013	0.005	<0.001	E0.002
Sacramento River at Tower Bridge	02/23/00	1735	<0.004	<0.013	0.011	E0.010	<0.007	<0.013	0.007	<0.001	E0.003
Sacramento River at Tower Bridge	02/24/00	1635	<0.004	<0.013	0.024	E0.007	<0.007	<0.013	0.006	<0.001	<0.002
Sacramento River at Tower Bridge	02/25/00	1150	<0.004	<0.013	0.027	<0.010	<0.007	<0.013	0.006	<0.001	<0.002

Appendix 1. Table 3. Field measurements, Sacramento River Basin, California

[Temperature at site 3 to nearest 0.5 degree. DWR, California Water Resources; °C, degrees Celsius; mg/L, milligram per liter; µS/cm, microsiemen per centimeter at 25°C; —, no data available]

Site no.	Site name	Storm monitoring period number	Date / Time (month/day/year hour/minute)	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific conductance (µS/cm)	pH
1	Sacramento River at Alamar	1	01/30/2000 1100	10.2	10.6	62	9.7
1	Sacramento River at Alamar	1	01/31/2000 1045	9.7	10.2	148	7.6
1	Sacramento River at Alamar	1	02/01/2000 1310	10.0	12.4	144	7.7
1	Sacramento River at Alamar	1	02/02/2000 1250	10.9	9.9	141	7.6
1	Sacramento River at Alamar	1	02/03/2000 1250	10.2	10.8	146	7.7
1	Sacramento River at Alamar	2	02/11/2000 1610	10.9	9.6	154	7.6
1	Sacramento River at Alamar	2	02/12/2000 1405	10.5	10.2	129	7.8
1	Sacramento River at Alamar	2	02/13/2000 1450	10.6	10.2	123	7.6
1	Sacramento River at Alamar	2	02/14/2000 1315	10.9	10.6	101	7.5
1	Sacramento River at Alamar	2	02/15/2000 1340	12.3	10.1	116	7.3
1	Sacramento River at Alamar	3	02/21/2000 1500	11.6	9.9	123	7.7
1	Sacramento River at Alamar	3	02/22/2000 1325	11.2	9.8	125	7.6
1	Sacramento River at Alamar	3	02/23/2000 1400	10.5	9.3	120	7.7
1	Sacramento River at Alamar	3	02/24/2000 1250	10.3	9.3	106	7.2
1	Sacramento River at Alamar	3	02/25/2000 1205	10.0	9.5	113	7.4
2	Colusa Basin Drain	1	01/30/2000 1315	10.5	7.9	777	7.6
2	Colusa Basin Drain	1	01/31/2000 1200	10.0	7.7	784	7.9
2	Colusa Basin Drain	1	02/03/2000 0925	11.3	7.4	770	7.7
2	Colusa Basin Drain	2	02/11/2000 1405	12.5	7.3	871	8.7
2	Colusa Basin Drain	2	02/12/2000 0920	11.8	7.7	851	7.9
2	Colusa Basin Drain	2	02/15/2000 0930	11.8	7.5	450	7.4
2	Colusa Basin Drain	3	02/21/2000 1120	13.3	8.0	633	7.6
2	Colusa Basin Drain	3	02/22/2000 1030	12.8	7.4	690	7.5
2	Colusa Basin Drain	3	02/25/2000 0855	10.2	7.4	451	7.4
3	Feather River near Nicolaus	1	01/30/2000 1430	11.0	11.9	—	—
3	Feather River near Nicolaus	1	01/31/2000 1230	10.0	11.5	95	—
3	Feather River near Nicolaus	1	02/01/2000 1250	10.8	9.8	95	7.4
3	Feather River near Nicolaus	1	02/02/2000 1150	11.0	9.0	92	7.4
3	Feather River near Nicolaus	1	02/03/2000 1130	10.5	—	98	7.4
3	Feather River near Nicolaus	2	02/11/2000 1240	—	—	101	7.3
3	Feather River near Nicolaus	2	02/15/2000 1040	—	—	62	—
3	Feather River near Nicolaus	3	02/22/2000 1030	—	—	73	—
3	Feather River near Nicolaus	3	02/23/2000 1020	—	—	72	—
3	Feather River near Nicolaus	3	02/24/2000 1010	10.0	—	69	—
3	Feather River near Nicolaus	3	02/25/2000 1050	9.0	—	75	—
4	DWR Pump Plant 1	1	01/30/2000 1430	10.9	8.5	450	7.9
4	DWR Pump Plant 1	1	01/31/2000 1255	10.5	7.9	407	7.7
4	DWR Pump Plant 1	1	02/01/2000 0930	10.5	6.4	574	7.2
4	DWR Pump Plant 1	1	02/02/2000 1150	11.7	8.0	560	7.7
4	DWR Pump Plant 1	1	02/03/2000 1150	12.2	—	440	7.4
4	DWR Pump Plant 1	2	02/11/2000 1500	11.2	6.7	583	7.6
4	DWR Pump Plant 1	2	02/12/2000 1245	10.3	7.9	506	7.8
4	DWR Pump Plant 1	2	02/13/2000 1340	11.3	9.3	497	7.7

Site no.	Site name	Storm monitoring period number	Date / Time (month/day/year hour/minute)	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific conductance (μS/cm)	pH
4	DWR Pump Plant 1	2	02/14/2000 1220	13.1	8.5	429	7.8
4	DWR Pump Plant 1	2	02/15/2000 1230	12.7	7.0	481	7.3
4	DWR Pump Plant 1	3	02/21/2000 1355	14.9	7.9	750	7.8
4	DWR Pump Plant 1	3	02/22/2000 1220	12.3	8.1	728	8.7
4	DWR Pump Plant 1	3	02/23/2000 1030	9.7	8.4	390	7.0
4	DWR Pump Plant 1	3	02/24/2000 1145	10.4	7.0	490	7.0
4	DWR Pump Plant 1	3	02/25/2000 1200	11.7	6.4	554	7.5
5	Bear River	1	01/30/2000 1600	10.3	11.1	—	—
5	Bear River	1	01/31/2000 1310	10.1	11.0	105	
5	Bear River	1	02/01/2000 1420	10.9	9.3	98	7.3
5	Bear River	1	02/02/2000 1330	11.7	8.0	108	7.3
5	Bear River	1	02/03/2000 1240	10.3	—	100	7.3
5	Bear River	2	02/12/2000 1130	—	—	73	—
5	Bear River	3	02/22/2000 1210	—	—	79	—
5	Bear River	3	02/23/2000 1200	—	—	62	—
5	Bear River	3	02/24/2000 1240	—	—	63	—
5	Bear River	3	02/25/2000 1430	—	—	69	—
6a	DWR Pump Plant 2, north	1	02/03/2000 1025	13.6	5.3	404	7.4
6a	DWR Pump Plant 2, north	2	02/15/2000 1105	12.1	6.5	258	7.2
6a	DWR Pump Plant 2, north	3	02/25/2000 1025	11.4	6.3	364	7.1
6b	DWR Pump Plant 2, north	1	01/30/2000 1530	12.4	5.8	259	7.4
6b	DWR Pump Plant 2, north	1	01/31/2000 1348	11.2	7.8	4	7.7
6b	DWR Pump Plant 2, north	1	02/01/2000 1100	11.7	5.8	398	7.2
6b	DWR Pump Plant 2, north	1	02/02/2000 1100	11.9	4.8	417	7.5
6b	DWR Pump Plant 2, north	1	02/03/2000 1050	12.4	5.0	454	7.6
6b	DWR Pump Plant 2, north	2	02/11/2000 1240	12.3	6.4	437	7.9
6b	DWR Pump Plant 2, north	2	02/12/2000 1115	10.9	4.2	253	7.6
6b	DWR Pump Plant 2, north	2	02/13/2000 1050	11.1	8.3	249	7.2
6b	DWR Pump Plant 2, north	2	02/14/2000 1050	12.3	8.4	224	7.7
6b	DWR Pump Plant 2, north	2	02/15/2000 1035	12.3	5.8	306	6.5
6b	DWR Pump Plant 2, north	3	02/21/2000 1245	14.1	7.0	450	7.9
6b	DWR Pump Plant 2, north	3	02/22/2000 1120	12.7	7.2	522	7.9
6b	DWR Pump Plant 2, north	3	02/23/2000 1110	11.4	7.4	450	7.4
6b	DWR Pump Plant 2, north	3	02/24/2000 1050	10.4	5.8	331	6.5
6b	DWR Pump Plant 2, north	3	02/25/2000 0955	11.2	6.5	408	7.1
7	Gisizer Slough at Bogue Road	1	01/31/2000 1010	13.2	8.5	428	8.3
7	Gisizer Slough at Bogue Road	1	01/31/2000 1455	12.6	8.6	121	7.8
7	Gisizer Slough at Bogue Road	1	02/02/2000 1105	14.2	6.7	912	8.3
7	Gisizer Slough at Bogue Road	1	02/03/2000 0910	12.4	6.5	872	8.3
7	Gisizer Slough at Bogue Road	2	02/11/2000 1303	13.0	9.5	305	8.5
7	Gisizer Slough at Bogue Road	2	02/12/2000 0210	9.8	9.6	52	8.0
7	Gisizer Slough at Bogue Road	2	02/12/2000 0940	10.2	8.9	161	7.5
7	Gisizer Slough at Bogue Road	2	02/12/2000 1445	12.4	7.6	247	8.0
7	Gisizer Slough at Bogue Road	2	02/12/2000 1757	11.8	9.1	155	7.8
7	Gisizer Slough at Bogue Road	2	02/12/2000 2137	11.8	8.8	128	7.8
7	Gisizer Slough at Bogue Road	2	02/13/2000 0205	11.7	8.7	94	7.7
7	Gisizer Slough at Bogue Road	2	02/13/2000 0915	10.3	11.1	34	7.8
7	Gisizer Slough at Bogue Road	2	02/13/2000 1355	11.0	10.1	54	7.3

Appendix 1. Table 3. Field measurements, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date / Time (month/day/year hour/minute)	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific conductance (μS/cm)	pH
7	Gisizer Slough at Bogue Road	2	02/13/2000 1720	11.8	10.0	93	7.7
7	Gisizer Slough at Bogue Road	2	02/13/2000 2145	12.0	9.8	57	7.7
7	Gisizer Slough at Bogue Road	2	02/14/2000 1000	13.0	9.4	58	7.6
7	Gisizer Slough at Bogue Road	2	02/14/2000 1440	15.2	8.4	262	7.8
7	Gisizer Slough at Bogue Road	2	02/14/2000 1750	13.9	8.1	314	8.0
7	Gisizer Slough at Bogue Road	2	02/14/2000 2145	12.6	6.3	525	8.1
7	Gisizer Slough at Bogue Road	2	02/15/2000 1150	15.5	8.5	932	7.6
7	Gisizer Slough at Bogue Road	3	02/21/2000 1115	14.9	9.6	268	7.7
7	Gisizer Slough at Bogue Road	3	02/22/2000 0945	12.8	9.3	987	8.3
7	Gisizer Slough at Bogue Road	3	02/22/2000 1400	12.9	9.8	174	7.8
7	Gisizer Slough at Bogue Road	3	02/22/2000 1730	12.0	7.9	86	7.9
7	Gisizer Slough at Bogue Road	3	02/22/2000 2150	—	—	—	7.7
7	Gisizer Slough at Bogue Road	3	02/23/2000 0955	10.3	8.5	143	7.2
7	Gisizer Slough at Bogue Road	3	02/23/2000 1705	14.9	5.3	498	8.3
7	Gisizer Slough at Bogue Road	3	02/24/2000 1445	15.7	7.7	992	8.4
7	Gisizer Slough at Bogue Road	3	02/24/2000 1735	14.9	8.1	971	8.4
7	Gisizer Slough at Bogue Road	3	02/24/2000 2155	13.2	7.3	795	8.4
7	Gisizer Slough at Bogue Road	3	02/25/2000 1310	18.0	10.0	908	8.2
8	Feather River at Yuba City	1	01/30/2000 1150	10.3	10.4	116	7.4
8	Feather River at Yuba City	1	01/31/2000 1505	10.2	10.9	122	7.5
8	Feather River at Yuba City	1	02/01/2000 1230	10.4	12.1	112	7.7
8	Feather River at Yuba City	1	02/02/2000 1345	11.0	10.2	115	7.1
8	Feather River at Yuba City	1	02/03/2000 1330	11.0	9.9	116	6.9
8	Feather River at Yuba City	2	02/11/2000 1400	10.9	10.6	—	7.3
8	Feather River at Yuba City	2	02/12/2000 1345	10.3	9.7	131.1	6.6
8	Feather River at Yuba City	2	02/13/2000 1345	10.1	10.4	98	6.5
8	Feather River at Yuba City	2	02/14/2000 1300	11.3	10.1	78	7.5
8	Feather River at Yuba City	2	02/15/2000 1220	12.2	9.6	83	7.4
8	Feather River at Yuba City	3	02/21/2000 1550	10.7	11.6	103	6.9
8	Feather River at Yuba City	3	02/22/2000 1250	9.6	11.5	99	7.4
8	Feather River at Yuba City	3	02/23/2000 1215	9.3	11.7	97	7.6
8	Feather River at Yuba City	3	02/24/2000 1245	9.1	10.9	95	8.3
8	Feather River at Yuba City	3	02/25/2000 1230	9.1	12.0	99	8.4
9	Yuba River at Marysville	2	02/11/2000 1430	10.1	10.9	87	7.9
9	Yuba River at Marysville	2	02/12/2000 1350	9.5	8.2	81	7.7
9	Yuba River at Marysville	3	02/21/2000 1500	11.0	12.1	65	7.8
9	Yuba River at Marysville	3	02/22/2000 1430	9.5	10.9	68	7.5
10	Wadsworth Canal	1	01/31/2000 0940	10.4	7.7	340	7.8
10	Wadsworth Canal	1	01/31/2000 1118	11.0	7.6	333	7.9
10	Wadsworth Canal	1	02/01/2000 1500	12.7	8.6	406	7.7
10	Wadsworth Canal	1	02/02/2000 1040	12.5	7.8	451	7.5
10	Wadsworth Canal	1	02/03/2000 1000	12.9	7.7	496	8.0
10	Wadsworth Canal	2	02/07/2000 1030	13.2	7.4	495	7.4
10	Wadsworth Canal	2	02/09/2000 1049	14.6	7.8	552	7.6
10	Wadsworth Canal	2	02/11/2000 1335	12.2	8.0	412	7.9
10	Wadsworth Canal	2	02/12/2000 0145	10.6	9.5	207	7.9
10	Wadsworth Canal	2	02/12/2000 0910	10.2	8.4	232	7.8
10	Wadsworth Canal	2	02/12/2000 1420	9.5	9.4	248	7.8

Appendix 1. Table 3. Field measurements, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date / Time (month/day/year hour/minute)	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific conductance (µS/cm)	pH
10	Wadsworth Canal	2	02/12/2000 1740	10.4	8.7	257	7.8
10	Wadsworth Canal	2	02/12/2000 2110	10.7	8.6	252	7.7
10	Wadsworth Canal	2	02/13/2000 0130	10.8	8.4	257	7.7
10	Wadsworth Canal	2	02/13/2000 0935	10.4	9.8	172	7.6
10	Wadsworth Canal	2	02/13/2000 1330	10.7	9.7	162	7.7
10	Wadsworth Canal	2	02/13/2000 1655	10.9	9.2	153	7.8
10	Wadsworth Canal	2	02/13/2000 2125	11.3	9.5	128	7.6
10	Wadsworth Canal	2	02/14/2000 0940	12.1	8.8	135	7.6
10	Wadsworth Canal	2	02/14/2000 1111	12.4	8.6	136	7.3
10	Wadsworth Canal	2	02/14/2000 1350	13.1	8.9	145	7.4
10	Wadsworth Canal	2	02/14/2000 1720	13.5	7.6	155	7.5
10	Wadsworth Canal	2	02/14/2000 2125	13.6	7.1	171	7.6
10	Wadsworth Canal	2	02/15/2000 1125	12.2	7.7	217	7.6
10	Wadsworth Canal	3	02/22/2000 0918	13.3	9.2	439	7.9
10	Wadsworth Canal	3	02/22/2000 1450	12.8	9.2	444	8.0
10	Wadsworth Canal	3	02/22/2000 1700	12.6	7.6	439	8.0
10	Wadsworth Canal	3	02/22/2000 2125	12.0	7.1	345	7.9
10	Wadsworth Canal	3	02/23/2000 0920	9.6	10.1	177	—
10	Wadsworth Canal	3	02/23/2000 1640	11.5	7.5	216	7.7
10	Wadsworth Canal	3	02/24/2000 1420	11.2	8.3	335	7.5
10	Wadsworth Canal	3	02/24/2000 1700	11.4	7.7	345	7.7
10	Wadsworth Canal	3	02/24/2000 2130	11.9	7.8	356	—
10	Wadsworth Canal	3	02/25/2000 1245	12.4	8.9	390	7.6
11	Jack Slough	1	01/30/2000 1320	10.5	8.2	147	7.5
11	Jack Slough	1	01/31/2000 1410	9.8	9.0	133	7.6
11	Jack Slough	1	02/01/2000 1400	11.1	9.1	134	7.6
11	Jack Slough	1	02/02/2000 1245	11.7	8.2	144	7.1
11	Jack Slough	1	02/03/2000 1230	12.0	7.8	148	7.4
11	Jack Slough	2	02/11/2000 1430	10.4	8.3	112	6.9
11	Jack Slough	2	02/12/2000 1430	9.4	8.7	97.3	6.8
11	Jack Slough	2	02/13/2000 1445	10.1	9.6	89	6.7
11	Jack Slough	2	02/14/2000 1340	12.8	8.3	79	7.5
11	Jack Slough	2	02/15/2000 1300	12.1	8.1	82	7.8
11	Jack Slough	3	02/21/2000 1430	13.7	8.5	145	6.9
11	Jack Slough	3	02/22/2000 1330	12.1	8.6	137	6.9
11	Jack Slough	3	02/23/2000 1250	9.6	9.7	88	7.2
11	Jack Slough	3	02/24/2000 1315	10.2	8.7	94	7.1
11	Jack Slough	3	02/25/2000 1300	10.8	9.2	104	7.8
12	Butte Slough at Lower Pass Road	1	01/30/2000 1520	10.7	7.5	209	7.3
12	Butte Slough at Lower Pass Road	1	01/31/2000 1245	10.1	8.2	218	7.5
12	Butte Slough at Lower Pass Road	1	02/01/2000 1130	10.2	9.0	215	7.6
12	Butte Slough at Lower Pass Road	1	02/02/2000 1135	10.4	7.4	214	7.3
12	Butte Slough at Lower Pass Road	1	02/03/2000 1130	11.2	6.8	219	7.5
12	Butte Slough at Lower Pass Road	2	02/11/2000 1200	12.2	7.3	264	7.0
12	Butte Slough at Lower Pass Road	2	02/12/2000 1200	10.8	7.8	248	6.7
12	Butte Slough at Lower Pass Road	2	02/13/2000 1130	10.1	11.0	160	6.7
12	Butte Slough at Lower Pass Road	2	02/14/2000 1115	10.7	11.3	125	7.4
12	Butte Slough at Lower Pass Road	2	02/15/2000 1110	10.4	10.5	103	7.4

Appendix 1. Table 3. Field measurements, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date / Time (month/day/year hour/minute)	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific conductance (μS/cm)	pH
12	Butte Slough at Lower Pass Road	3	02/21/2000 1340	11.0	10.5	146	7.2
12	Butte Slough at Lower Pass Road	3	02/22/2000 1130	10.5	10.9	144	7.3
12	Butte Slough at Lower Pass Road	3	02/23/2000 1100	10.2	11.0	141	7.7
12	Butte Slough at Lower Pass Road	3	02/24/2000 1115	9.4	10.9	132	7.6
12	Butte Slough at Lower Pass Road	3	02/25/2000 1115	9.6	11.2	128	7.6
13	Sacramento River at Colusa	1	01/30/2000 1620	11.2	10.9	135	7.6
13	Sacramento River at Colusa	1	01/31/2000 1045	10.0	11.7	131	7.8
13	Sacramento River at Colusa	1	02/01/2000 1000	10.6	13.0	115	8.0
13	Sacramento River at Colusa	1	02/02/2000 0945	10.4	11.3	123	7.4
13	Sacramento River at Colusa	1	02/03/2000 0950	10.6	11.3	128	7.3
13	Sacramento River at Colusa	2	02/11/2000 1030	10.4	5.1	139	7.6
13	Sacramento River at Colusa	2	02/12/2000 1100	10.4	10.3	158	6.4
13	Sacramento River at Colusa	2	02/13/2000 1020	10.1	8.3	115	7.2
13	Sacramento River at Colusa	2	02/14/2000 1000	12.0	11.2	111	7.6
13	Sacramento River at Colusa	2	02/15/2000 0940	10.9	10.9	106	8.2
13	Sacramento River at Colusa	3	02/21/2000 1220	11.8	11.3	146	7.3
13	Sacramento River at Colusa	3	02/22/2000 1035	10.9	11.2	143	7.7
13	Sacramento River at Colusa	3	02/23/2000 1015	10.5	11.3	146	7.6
13	Sacramento River at Colusa	3	02/24/2000 0950	9.8	11.2	129	7.5
13	Sacramento River at Colusa	3	02/25/2000 1005	10.8	11.9	133	8.4
14	Butte Creek near Gridley	1	01/30/2000 1315	9.8	8.8	210	7.6
14	Butte Creek near Gridley	1	01/31/2000 1215	9.2	9.0	161	8.1
14	Butte Creek near Gridley	1	02/01/2000 1325	9.5	9.8	180	7.6
14	Butte Creek near Gridley	1	02/02/2000 1300	10.8	9.0	198	7.6
14	Butte Creek near Gridley	1	02/03/2000 1103	11.5	8.4	212	7.6
14	Butte Creek near Gridley	2	02/11/2000 1010	10.9	9.3	149	7.7
14	Butte Creek near Gridley	2	02/12/2000 0038	10.1	9.5	176.0	8.1
14	Butte Creek near Gridley	2	02/12/2000 0805	9.6	9.2	144.6	8.0
14	Butte Creek near Gridley	2	02/12/2000 1215	9.5	9.3	—	7.7
14	Butte Creek near Gridley	2	02/12/2000 1635	9.7	9.3	128	7.8
14	Butte Creek near Gridley	2	02/12/2000 2015	9.5	9.1	133	7.7
14	Butte Creek near Gridley	2	02/13/2000 0016	9.5	9.4	136	7.8
14	Butte Creek near Gridley	2	02/13/2000 0810	9.5	10.0	138	8.0
14	Butte Creek near Gridley	2	02/13/2000 1220	9.6	10.1	136	7.6
14	Butte Creek near Gridley	2	02/13/2000 1550	9.5	10.1	130	7.7
14	Butte Creek near Gridley	2	02/13/2000 2010	9.7	9.9	115	7.7
14	Butte Creek near Gridley	2	02/14/2000 0825	10.4	9.8	100.0	8.2
14	Butte Creek near Gridley	2	02/14/2000 1225	11.3	8.9	98.5	7.6
14	Butte Creek near Gridley	2	02/14/2000 1620	11.9	8.9	99.4	7.6
14	Butte Creek near Gridley	2	02/14/2000 2020	11.7	7.9	96	7.7
14	Butte Creek near Gridley	2	02/15/2000 0920	10.3	9.2	89	7.4
14	Butte Creek near Gridley	3	02/21/2000 1240	11.6	10.4	168	7.6
14	Butte Creek near Gridley	3	02/22/2000 0810	12.1	6.3	159	7.6
14	Butte Creek near Gridley	3	02/22/2000 1220	11.5	—	161	7.8
14	Butte Creek near Gridley	3	02/22/2000 1600	11.0	9.1	165	7.7
14	Butte Creek near Gridley	3	02/22/2000 2020	10.6	6.9	169	7.9
14	Butte Creek near Gridley	3	02/23/2000 0810	9.3	10.8	126	7.5
14	Butte Creek near Gridley	3	02/23/2000 1535	10.1	8.3	113	7.7

Appendix 1. Table 3. Field measurements, Sacramento River Basin, California—*Continued*

Site no.	Site name	Storm monitoring period number	Date / Time (month/day/year hour/minute)	Temperature (°C)	Dissolved Oxygen (mg/L)	Specific conductance (µS/cm)	pH
14	Butte Creek near Gridley	3	02/24/2000 1220	9.6	9.3	117	7.3
14	Butte Creek near Gridley	3	02/24/2000 1605	9.5	9.5	122	7.7
14	Butte Creek near Gridley	3	02/24/2000 2020	9.3	9.2	127	7.7
14	Butte Creek near Gridley	3	02/25/2000 1005	9.5	9.2	136	7.3
15	Cherokee Canal	2	02/11/2000 1035	9.0	11.2	—	7.4
15	Cherokee Canal	2	02/12/2000 1235	9.9	9.2	—	7.7
15	Cherokee Canal	3	02/21/2000 1305	13.3	8.8	169	7.8
15	Cherokee Canal	3	02/22/2000 1230	12.3	7.5	143	7.6
16	Main Canal	1	01/30/2000 1445	9.5	7.3	250	7.8
16	Main Canal	1	01/31/2000 1240	10.1	6.9	245	7.7
16	Main Canal	1	02/01/2000 1400	12.2	8.1	259	7.6
16	Main Canal	1	02/02/2000 1330	12.4	7.0	282	7.6
16	Main Canal	1	02/03/2000 2323	12.0	5.6	238	7.7
16	Main Canal	2	02/11/2000 1105	11.4	5.5	308	7.7
16	Main Canal	2	02/12/2000 0055	10.8	7.6	243	7.7
16	Main Canal	2	02/12/2000 0820	9.4	7.4	186	7.6
16	Main Canal	2	02/12/2000 1255	9.6	8.0	200	7.7
16	Main Canal	2	02/12/2000 1650	10.5	7.5	215	7.7
16	Main Canal	2	02/12/2000 2025	10.9	7.8	225	7.7
16	Main Canal	2	02/13/2000 0040	10.9	7.3	234	7.7
16	Main Canal	2	02/13/2000 0830	10.5	7.9	235	7.7
16	Main Canal	2	02/13/2000 1235	10.6	8.5	195	7.7
16	Main Canal	2	02/13/2000 1610	10.8	8.5	171	7.6
16	Main Canal	2	02/13/2000 2025	11.2	8.4	161	7.7
16	Main Canal	2	02/14/2000 0850	12.2	8.2	168	7.6
16	Main Canal	2	02/14/2000 1300	13.0	8.2	175	7.7
16	Main Canal	2	02/14/2000 1630	14.8	7.4	180	7.5
16	Main Canal	2	02/14/2000 2035	14.7	6.3	188	7.5
16	Main Canal	2	02/15/2000 0950	10.9	7.7	219	7.3
16	Main Canal	3	02/21/2000 1320	13.6	8.3	327	7.7
16	Main Canal	3	02/22/2000 0825	12.5	7.0	355	7.8
16	Main Canal	3	02/22/2000 1245	12.2	7.2	362	7.8
16	Main Canal	3	02/22/2000 1615	12.2	7.8	363	7.7
16	Main Canal	3	02/22/2000 2040	11.4	6.9	350	7.8
16	Main Canal	3	02/23/2000 0835	9.1	9.1	198	7.9
16	Main Canal	3	02/23/2000 1555	12.9	6.9	211	7.7
16	Main Canal	3	02/24/2000 1240	10.4	7.8	306	7.7
16	Main Canal	3	02/24/2000 1620	12.0	7.9	319	7.7
16	Main Canal	3	02/24/2000 2030	12.0	7.6	322	7.7

Appendix 2. Blank sample data analyzed by enzyme-linked immunosorbent assay (ELISA), Sacramento River Basin, California

[FB, field blank; RB, rinse blank; <, less than]

Site no.	Site name	Date/Time	Sample type	Diazinon, in nanograms per liter	Storm monitoring period
1	Sacramento River at Alamar	1/30/00 1100	FB	<30	1
1	Sacramento River at Alamar	2/11/00 1610	FB	<30	2
1	Sacramento River at Alamar	2/21/00 1500	FB	<30	3
1	Sacramento River at Alamar	2/22/00 1325	FB	<30	3
2	Colusa Basin Drain	1/30/00 1315	FB	<30	1
2	Colusa Basin Drain	2/11/00 1405	FB	<30	2
2	Colusa Basin Drain	2/22/00 1030	FB	<30	3
3	Feather River near Nicolaus	1/31/00 1230	FB	<30	1
3	Feather River near Nicolaus	2/12/00 1030	FB	<30	2
3	Feather River near Nicolaus	2/22/00 1030	FB	<30	3
4	DWR Pump Plant 1	1/31/00 1255	FB	<30	1
4	DWR Pump Plant 1	2/12/00 1245	FB	<30	2
4	DWR Pump Plant 1	2/22/00 1220	FB	<30	3
5	Bear River	1/30/00 1600	FB	<30	1
5	Bear River	1/31/00 1310	RB	<30	1
5	Bear River	2/11/00 1430	FB	<30	2
5	Bear River	2/12/00 1130	RB	<30	2
5	Bear River	2/21/00 1530	FB	<30	3
5	Bear River	2/22/00 1210	RB	<30	3
7	Gilsizer Slough at Bogue Road	1/30/00 1900	FB	<30	1
7	Gilsizer Slough at Bogue Road	2/11/00 1303	FB	<30	2
7	Gilsizer Slough at Bogue Road	2/21/00 1115	FB	<30	3
8	Feather River at Yuba City	1/31/00 1505	FB	<30	1
8	Feather River at Yuba City	2/11/00 1400	FB	<30	2
8	Feather River at Yuba City	2/12/00 1345	FB	<30	2
8	Feather River at Yuba City	2/22/00 1250	FB	<30	3
9	Yuba River at Marysville	1/31/00 1410	FB	<30	1
9	Yuba River at Marysville	2/12/00 1350	FB	<30	2
9	Yuba River at Marysville	2/22/00 1430	FB	<30	3
10	Wadsworth Canal	1/31/00 940	FB	<30	1
10	Wadsworth Canal	2/12/00 1420	FB	<30	2
10	Wadsworth Canal	2/22/00 1450	FB	<30	3
11	Jack Slough	1/30/00 1320	FB	<30	1
11	Jack Slough	2/11/00 1430	FB	<30	2
11	Jack Slough	2/21/00 1430	FB	<30	3
12	Butte Slough at Lower Pass Road	1/30/00 1520	FB	<30	1
12	Butte Slough at Lower Pass Road	2/1/00 1130	RB	<30	1
12	Butte Slough at Lower Pass Road	2/11/00 1200	FB	<30	2
12	Butte Slough at Lower Pass Road	2/12/00 1200	RB	<30	2
12	Butte Slough at Lower Pass Road	2/21/00 1340	FB	<30	3
12	Butte Slough at Lower Pass Road	2/22/00 1130	RB	<30	3
13	Sacramento River at Colusa	1/31/00 1045	FB	<30	1
13	Sacramento River at Colusa	2/12/00 1100	FB	<30	2
13	Sacramento River at Colusa	2/22/00 1035	FB	<30	3
14	Butte Creek near Gridley	1/30/00 1315	FB	<30	1
14	Butte Creek near Gridley	2/11/00 1010	FB	<30	2

Appendix 2. Blank sample data analyzed by enzyme-linked immunosorbent assay (ELISA), Sacramento River Basin, California—*Continued*

Site no.	Site name	Date/Time	Sample type	Diazinon, in nanograms per liter	Storm monitoring period
14	Butte Creek near Gridley	2/21/00 1240	FB	<30	3
15	Cherokee Canal	1/31/00 1815	FB	<30	1
15	Cherokee Canal	2/12/00 1235	FB	<30	2
15	Cherokee Canal	2/22/00 1230	FB	<30	3
16	Main canal	1/30/00 1445	FB	<30	1
16	Main canal	1/31/00 1840	RB	<30	1
16	Main canal	2/11/00 1105	FB	<30	2
16	Main canal	2/12/00 1255	RB	<30	2
16	Main canal	2/22/00 1245	RB	<30	3
6a	Pump Plant 2, north	2/13/00 1201	FB	<30	2
6b	Pump Plant 2, south	1/31/00 1348	FB	<30	1
6b	Pump Plant 2, south	1/31/00 1348	RB	<30	1
6b	Pump Plant 2, south	2/12/00 1115	FB	<30	2
6b	Pump Plant 2, south	2/12/00 1115	RB	<30	2
6b	Pump Plant 2, south	2/22/00 1120	FB	<30	3
6b	Pump Plant 2, south	2/22/00 1120	RB	<30	3