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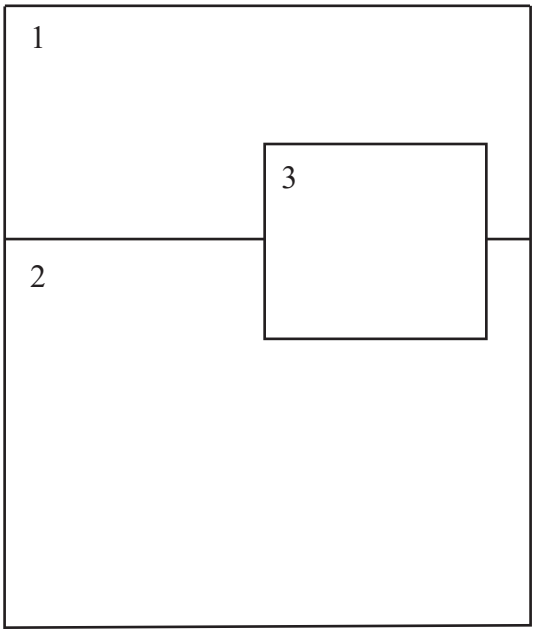
Pesticide Inputs to the Sacramento–San Joaquin Delta, 2015–16: Results from the Delta Regional Monitoring Program

Data Series 1089

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



Cover. **1.** U.S. Geological Survey personnel preparing to collect water samples from Ulatis Creek at Browns Road near Elmira, California.

2. Mokelumne River at New Hope Road at Thornton, California, looking upstream.

3. View of bridge over the San Joaquin River near Vernalis, California.

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Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
micrometer (µm)	0.00003937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
	Area	
square kilometer (km2)	0.3861	square mile (mi2)
	Volume	
milliliter (mL)	0.033814	ounce, fluid (fl. oz)
liter (L)	33.81402	ounce, fluid (fl. oz)
	Flow rate	
milliliter per minute (mL/min)	0.033814	ounce, fluid per minute (fl. oz/min)
	Mass	
milligram (mg)	0.000035	ounce, (oz)
kilogram (kg)	2.20462	pound, (lb)

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

$$°F = (1.8 \times °C) + 32.$$

Datum

North American Datum of 1983 (NAD 83).

Supplemental Information

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Concentrations of chemical constituents in water are given in either milligrams per liter (mg/L), micrograms per liter (µg/L), or nanograms per liter (ng/L). One milligram per liter is equivalent to 1 part per million (ppm); one microgram per liter is equivalent to 1 part per billion (ppb); one nanogram per liter is equivalent to 1 part per trillion (ppt). Concentrations of pesticide compounds in suspended-sediments filtered from 1-liter water samples are provided in ng/L to facilitate the approximation of a whole-water pesticide concentration by summing the dissolved and suspended-sediment concentrations of pesticide compounds.

Abbreviations

AHP	Aquatic Health Program
ASC	Aquatic Science Center
CDPR	California Department of Pesticide Regulation
Delta RMP	Delta Regional Monitoring Program
DOC	dissolved organic carbon
EtOAc	ethyl acetate
EPA	U.S. Environmental Protection Agency
GC/MS	gas chromatography mass spectrometry
LC/MS/MS	liquid chromatography tandem mass spectrometry
LT-MDL	long-term method detection level
MDL	method detection limit
MRL	minimum reporting level
NWIS	National Water Information System
NWQL	National Water Quality Laboratory
OCRL	Organic Chemistry Research Laboratory
PIC	particulate inorganic carbon
±	plus or minus
POC	particulate organic carbon
POD	pelagic organism decline
QAPP	quality assurance program plan
RSD	relative standard deviation
SPE	solid phase extraction
SWRCB	State Water Resources Control Board
TPC	total particulate carbon
TPN	total particulate nitrogen
UCD	University of California, Davis
USGS	U.S. Geological Survey

Pesticide Inputs to the Sacramento–San Joaquin Delta, 2015–16: Results from the Delta Regional Monitoring Program

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Abstract

Emergent hypotheses about causes of the pelagic organism decline in the Sacramento–San Joaquin Delta (Delta) indicate that a more complete understanding of the quality of water entering the Delta is needed. Less than half of all pesticides used in the Delta watershed are measured in samples collected for routine monitoring, and with new pesticides continually being registered for use, the concentrations of unmonitored pesticides in the Delta ecosystem are unknown. In response, a multi-year, cooperative effort to improve monitoring of mercury, nutrients, pathogens, and pesticides was begun by the Delta Regional Monitoring Program (RMP). In July 2015, the U.S. Geological Survey in cooperation with the Delta RMP began measuring concentrations of 154 pesticide compounds in monthly samples of surface water and suspended sediment collected at five major inputs to the Sacramento–San Joaquin Delta from July 2015 to June 2016. In addition to pesticide concentration measurements, field water-quality indicators (water temperature, specific conductance, dissolved oxygen, pH, and turbidity) were measured at each site and samples were collected for the analysis of dissolved organic carbon, dissolved copper, particulate organic carbon, particulate inorganic carbon, total particulate carbon, and total particulate nitrogen. Pesticide concentrations in particulates were measured in collected suspended-sediment samples by gas chromatography with mass spectrometry, whereas concentrations measured in surface-water samples utilized a combination of gas chromatography with mass spectrometry and liquid chromatography with tandem mass spectrometry. Samples were collected from two sites in the San Joaquin River watershed and at one site for each of the Mokelumne River, Sacramento River, and Ulatis Creek watersheds.

All water samples contained mixtures of 2–25 pesticides. Pesticides were detected in 100 percent of surface-water samples. A total of 54 pesticide compounds were detected in water samples during the study period (19 fungicides, 18 herbicides, 9 insecticides, 7 breakdown products, and 1 synergist). The most frequently detected pesticide compounds were the herbicides hexazinone (95 percent) and diuron (73 percent) and the fungicides boscalid (93 percent) and azoxystrobin (75 percent). Pesticide concentrations ranged from below the method detection limits to 2,630 nanograms per liter for the herbicide metolachlor.

A total of 11 pesticide compounds were detected in the suspended sediments filtered from water samples (6 herbicides, 3 insecticides, 1 fungicide, and 1 breakdown product). The most frequently detected compounds were the insecticides permethrin (7 percent) and bifenthrin (5 percent) and the herbicide pendimethalin (5 percent). Pesticide concentrations in the suspended-sediment ranged from below the method detection limit to 265 nanograms per liter for the herbicide pendimethalin.

Introduction

The Sacramento–San Joaquin Delta (Delta) is an area of great importance to humans as both a source and a transport mechanism of freshwater. The Delta is also an area of critical habitat for numerous threatened and endangered species of concern, including Chinook salmon (*Oncorhynchus tshawytscha*) and the Delta smelt (*Hypomesus transpacificus*; Moyle, 2002; Brown and Moyle, 2005; Sommer and Mejia, 2013). In recent years, multiple pelagic species in the Delta have been in sharp decline (Feyrer and others, 2007; Sommer and others, 2007). This phenomenon, termed the pelagic organism decline (POD), is thought to have four causes: (1) previous abundance of pelagic species; (2) changes in habitat, including changes in water quantity and water quality; (3) top-down effects, including predation and losses caused by entrainment in water export pumps; and (4) bottom-up changes in food availability for pelagic species (Baxter and others, 2010). These factors point to the need for a complete and timely understanding of the quality of water entering the Delta.

Studies have indicated that contaminants, including pesticides, may play a role in the POD (Sommer and others, 2007; Werner and others, 2010). In 2014, reported pesticide

use in the Delta watershed was over 50 million pounds of active ingredient (California Department of Pesticide Regulation, 2016). Because year-to-year pesticide use is continually changing, it presents a challenge for resource managers and policy makers trying to understand the fate and effects of these contaminants. Additionally, accurate estimates of pesticide use are difficult to make because only licensed pesticide applicators are required to report pesticide use to the California Department of Pesticide Regulation (CDPR). State regulators do not track household pesticide use and pesticides used in seed coatings.

Previous studies have shown that pesticides associated with agricultural and urban runoff are present in the Delta throughout the year and that the types and concentrations of these pesticides vary based on their use in the upstream watersheds (Dileanis and others, 2002; Kratzer and others, 2002; Zamora and others, 2003; Orlando and Kuivila, 2005; Weston and Lydy, 2010; Zhang and others, 2012; Orlando and others, 2013; Orlando and others, 2014). Finally, less than half of all pesticides applied in the Delta watershed are analyzed for during routine monitoring studies, and new pesticides are continually being registered for use (Kuivila and Hladik, 2008). The concentrations and potential effects of these unmonitored pesticides in the Delta ecosystem are unknown.

This study was conducted in cooperation with the San Francisco Estuary Institute Aquatic Science Center as part of the Delta Regional Monitoring Program (Delta RMP), a multi-year, cooperative effort to better track beneficial-use protections and restoration efforts in the Delta through the monitoring of mercury, nutrients, pathogens, and pesticides (Aquatic Science Center, 2017). The Delta RMP was created by the Central Valley Regional Water Quality Control Board to better coordinate water-quality monitoring in response to the early 2000s decline of pelagic fish species in the Delta. The Aquatic Science Center (ASC), a joint powers authority created by the State Water Resources Control Board (SWRCB) and the Bay Area Clean Water Agencies, is responsible for implementing activities necessary to achieve the goals of the Delta RMP, as well as preparing and publishing results collected for the program (Aquatic Science Center, 2017). Monthly pesticide monitoring for the Delta RMP began in July 2015 and concluded in June 2017; this report contains results for July 2015 through June 2016. Although monthly pesticide monitoring concluded in June 2017, the Delta RMP is an ongoing monitoring program with no set end date for data collection or data dissemination.

Pesticide and toxicity samples were collected concurrently to determine whether pesticides could contribute to observed toxicity in the Delta. The role of the USGS in the Delta RMP is to collect pesticide, toxicity, and ancillary water-quality (dissolved organic carbon, DOC; dissolved copper; particulate organic carbon, POC; particulate inorganic carbon, PIC; total particulate carbon, TPC; and total particulate nitrogen, TPN) samples; perform the pesticide and ancillary water-quality analyses; and to generate pesticide-detection reports. Surface-water samples also were collected by the USGS for toxicity analysis by the University of California, Davis (UCD); ASC plans to publish these toxicity results in a future monitoring report.

Purpose and Scope

This report describes field and laboratory methods used and reports the measured concentrations of pesticides and pesticide degradates found in surface water and in particulates filtered from surface-water samples at five sites that provide surface water input to the Delta. Concentrations of organic carbon, inorganic carbon, nitrogen, and copper also were measured and reported. Constituents with detections above the aquatic-life benchmark for chronic toxicity to invertebrates (U.S. Environmental Protection Agency, 2017) are reported where applicable. The data-collection period of July 2015–June 2016 represents data collected for the first year of the Delta RMP.

Sampling Sites

Five sites were selected to be sampled monthly at inputs to the Delta (fig. 1; table 1). These sites were chosen by the Delta RMP Technical Advisory Committee to capture water at representative inflows to the Delta, to cover an extensive area, and to complement existing monitoring datasets (Aquatic Science Center, 2017). Land-use types and watershed boundaries for the five sampling sites are shown in figure 2. Land use has been grouped into six broad categories: urban, bare ground, forest, shrub and grasslands, agricultural, or wetlands (U.S. Geological Survey, 2014). The watershed boundary for the San Joaquin River at Buckley Cove also includes the San Joaquin River at Vernalis watershed boundary.

Mokelumne River at New Hope Road

The Mokelumne River originates in the western slope of the Sierra Nevada and drains into the San Joaquin River. Samples were collected from a bridge over the Mokelumne River. The site is tidally influenced; therefore, samples were only collected during outgoing tides. The contributing watershed area is approximately 700 square miles (mi^2), and land use is 8 percent agricultural and 2 percent urban (U.S. Geological Survey, 2014). The primary crops grown in the watershed by area are grapes, walnuts, and alfalfa (National Agricultural Statistics Service, 2016).

Sacramento River at Hood

The Sacramento River flows south from its headwaters in northern California and drains into the Delta. Samples at this site were collected 30 feet (ft) from the left bank on the Sacramento River from a monitoring platform maintained by the SWRCB. This site has minimal tidal influence, and although

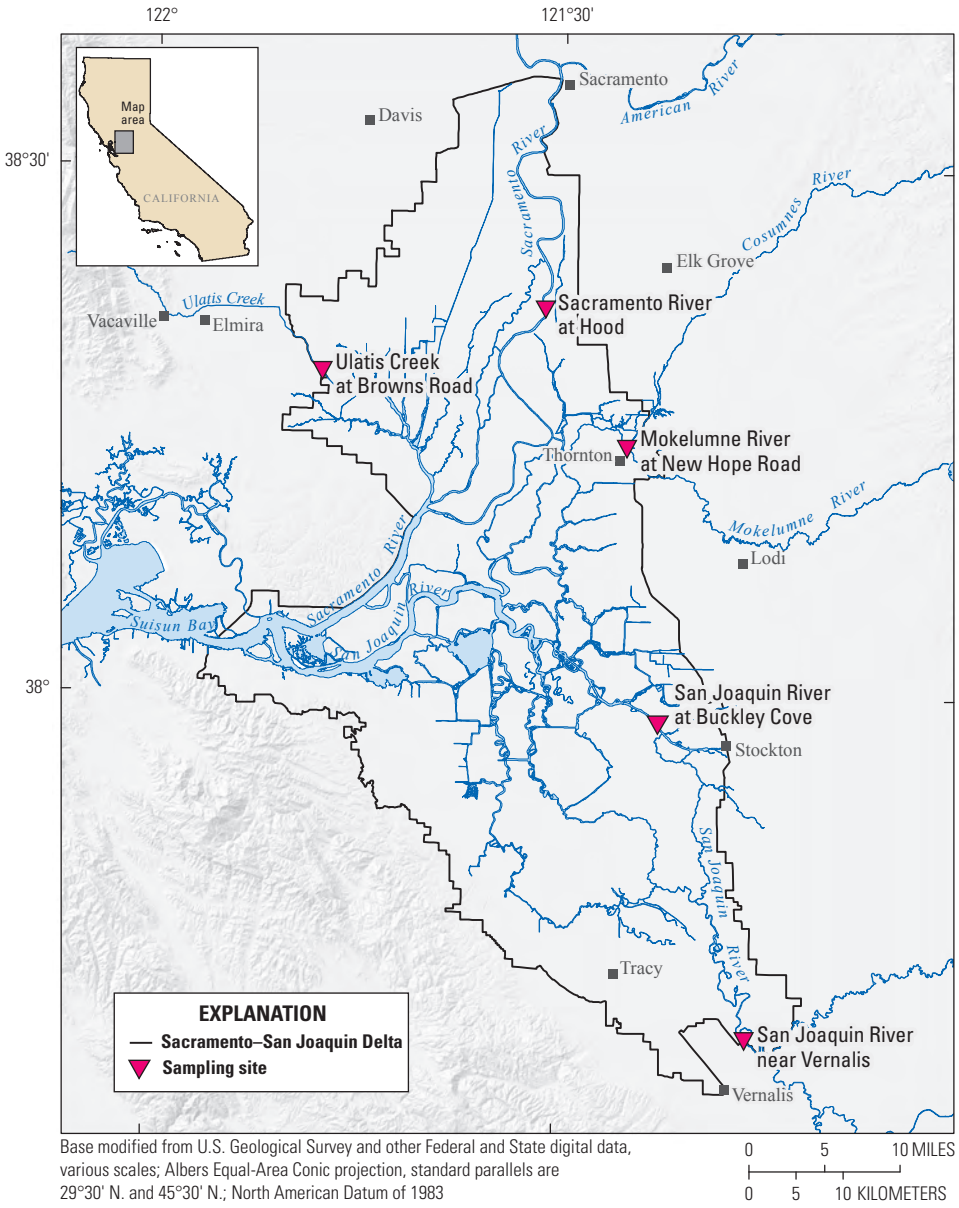

Figure 1. Sampling sites and the legal boundary of the Sacramento–San Joaquin Delta, 2015–16.

Table 1. Surface-water sampling sites located in the Sacramento–San Joaquin Delta, 2015–16.

[Calif., California; dms, degree minute second; ID, identification; USGS, U.S. Geological Survey; °, degree; ', minute; ", second; *, collected from bridge at mid-channel during high-flow events]

USGS station number	USGS station name	Field ID	Latitude1 (dms)	Longtitude1 (dms)	Sample collection point
381411121250901	Mokelumne River at New Hope Road at Thornton, Calif.	Mokelumne River at New Hope Road	38°14'11"	121°25'09"	Bridge, mid-channel
382205121311300	Sacramento River at Hood, Calif.	Sacramento River at Hood	38°22'05"	121°31'13"	Catwalk, mid-channel
375831121223701	San Joaquin River at Buckley Cove near Stockton, Calif.	San Joaquin River at Buckley Cove	37°58'31"	121°22'37"	Wading, bank
11303500	San Joaquin River near Vernalis, Calif.	San Joaquin River near Vernalis	37°40'34"	121°15'59"	Wading, mid-channel*
11455261	Ulatis Creek at Browns Road near Elmira, Calif.	Ulatis Creek at Browns Road	38°18'24"	121°47'41"	Wading, mid-channel*

[1]All locations reference North American Datum of 1983.

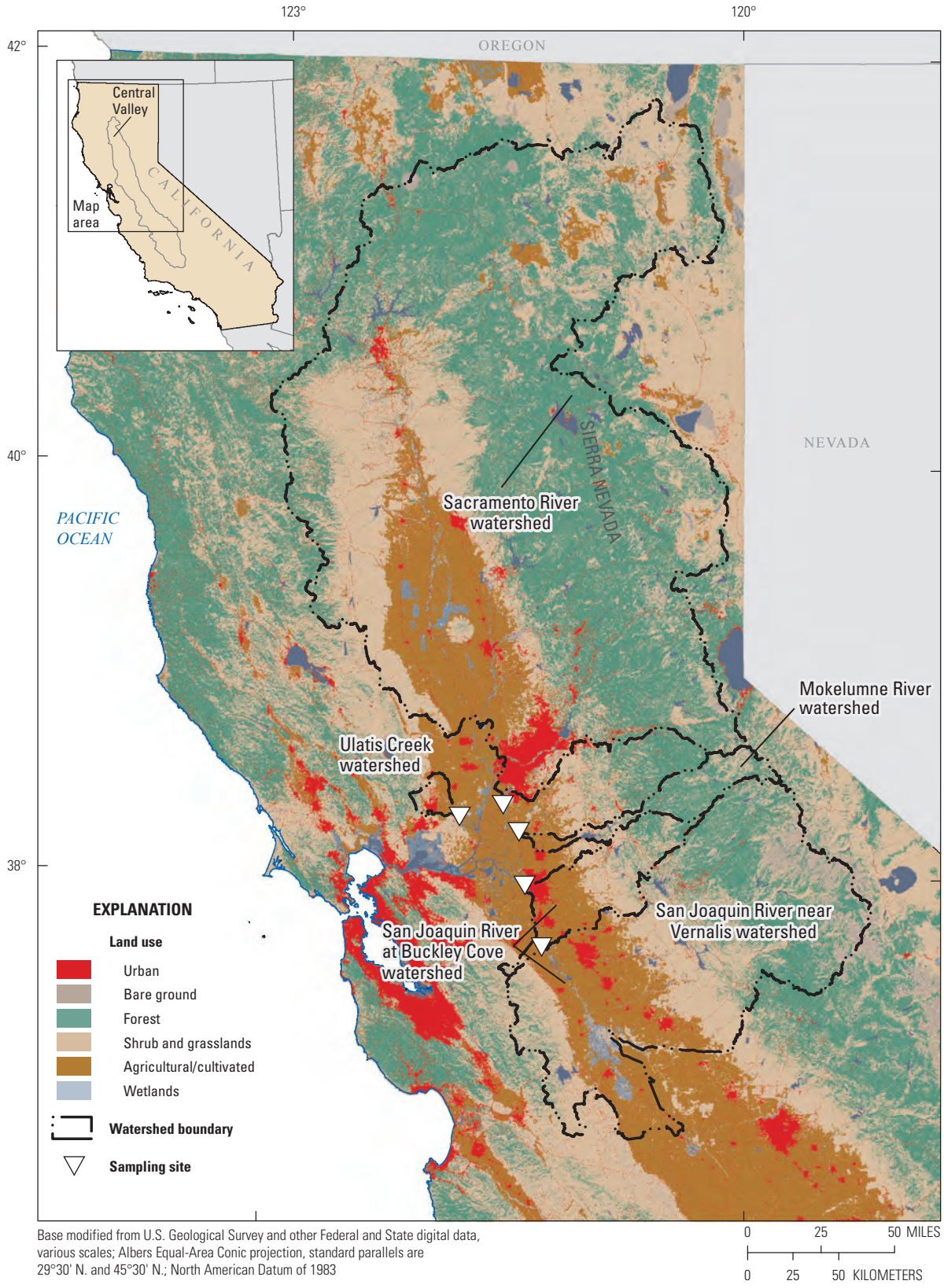

Figure 2. Land-use types and watershed boundaries for sites sampled from July 2015 to June 2016 in the Sacramento–San Joaquin Delta, California.

flows do not regularly reverse directions, sample collection times were limited to outgoing tides to be sure to capture inflows to the Delta only. The watershed area upstream of the sample site encompasses over 23,900 mi^2 of land, of which 11 percent is used for agricultural purposes and 4 percent for urban (U.S. Geological Survey, 2014). The primary crops grown in the watershed by area are rice, almonds, and walnuts (National Agricultural Statistics Service, 2016).

San Joaquin River at Buckley Cove

The San Joaquin River originates in the Sierra Nevada and flows northward through the Central Valley where it enters the Delta near Vernalis, Calif. (fig. 2). San Joaquin River at Buckley Cove is in an urban area, near the city of Stockton, Calif. (population 291,707; U.S. Census Bureau, 2016). Samples were collected from the right bank by wading into the river at this site. This site has a strong tidal influence, and samples were collected during outgoing tides. The watershed area includes the San Joaquin River at Vernalis watershed plus an additional 1,200 mi^2 of land, including 120 mi^2 of urban land. The primary crops grown in the watershed by area are almonds, alfalfa, and walnuts (National Agricultural Statistics Service, 2016).

San Joaquin River near Vernalis

Flows on the San Joaquin River near Vernalis are not tidally influenced; they are highly influenced by dam releases and withdrawals for irrigation upstream of the sample collection point. Samples at this site were collected from a bridge over the San Joaquin River during high-flow conditions and collected by wading into the river during low-flow conditions. The watershed area upstream of the sample site encompasses over 7,300 mi^2 of land; 21 percent of the land is used for agricultural purposes and 5 percent for urban (U.S. Geological Survey, 2014). The primary crops grown in the watershed by area are almonds, alfalfa, and grapes (National Agricultural Statistics Service, 2016).

Ulatis Creek at Browns Road

Ulatis Creek flows eastward from its source in the western margin of the Central Valley through the city of Vacaville, Calif. (population: 92,428; U.S. Census Bureau, 2016) to the valley floor where Ulatis Creek enters the Delta. Samples were collected from a bridge during high-flow conditions and by wading during low-flow conditions. The contributing watershed area is approximately 140 mi^2 with 18 percent of the area used for urban purposes and 44 percent for agriculture (U.S. Geological Survey, 2014). The primary crops grown in the watershed by area are alfalfa, almonds, and walnuts (National Agricultural Statistics Service, 2016).

Procedures and Methods

Surface-water samples for pesticide, water chemistry (organic carbon, inorganic carbon, particulate nitrogen, and copper), and toxicity analyses were collected concurrently at each site. Pesticide samples were analyzed by the USGS at the Organic Chemistry Research Laboratory (OCRL) in Sacramento, Calif. Dissolved and particulate organic carbon, particulate inorganic carbon, particulate nitrogen, and dissolved copper samples were analyzed by the USGS at the National Water Quality Laboratory (NWQL) in Denver, Colo. and toxicity samples were analyzed by the Aquatic Health Program (AHP) at UCD.

Sample Collection

Surface-water samples were collected monthly at all sites from July 2015 to June 2016. Ten sample sets were collected approximately mid-month, and two sample sets were collected following moderate-rainfall events on January 19, 2016, and March 7, 2016. Surface-water samples for pesticide, ancillary water-quality (copper, DOC, PIC, POC, TPC, and TPN), and toxicity analyses were collected concurrently at each site. All water samples were collected as grab samples in accordance with methods described in the USGS National Field Manual (U.S. Geological Survey, variously dated). The study design approved by the Delta RMP called for grab samples because of the large volume of water required for collecting toxicity and pesticide samples together, even in hydrologic conditions that might otherwise dictate integrated sampling techniques. Samples were collected between the high and low tides or ebb tide (for tidally influenced sites), by submerging narrow-mouthed bottles at mid-channel to a depth of 1.5 ft. During low-flow conditions, samples were collected by wading into streams and submerging handheld bottles. In high-flow conditions or for sites with difficult bank access, samples were collected from bridges using weighted-bottle samplers.

Pesticide samples were collected in precleaned, baked glass-amber bottles and transported on ice to the USGS OCRL in Sacramento, Calif., for processing and analysis. Samples for analysis at the USGS NWQL were collected in Teflon™ bottles and transported on ice to the USGS California Water Science Center for processing. Prior to sampling, the Teflon™ bottles were cleaned with tap water and laboratory-grade detergent, rinsed with a 5 percent hydrochloric-acid solution, triple rinsed with ASTM Type-I deionized water, and stored in sealed plastic bags. The Teflon™ bottles were triple rinsed with native water prior to sample collection.

Toxicity samples were collected in precleaned, glass-amber bottles provided by the AHP. Bottles were triple rinsed with native water on-site prior to sample collection. Ten bottles were collected at each site and transported on ice to the AHP for analysis.

Basic water-quality measurements (water temperature, specific conductance, dissolved oxygen, pH, and turbidity) were taken at a depth of 1.5 ft at mid-channel during each

sample collection using a YSI 6920V2 multi-parameter meter. The meter was calibrated using appropriate procedures and standards prior to sample collection as described in the USGS National Field Manual (U.S. Geological Survey, variously dated).

Analytical Methods

Surface-water samples and suspended sediments filtered from surface water for pesticide analysis were analyzed by the USGS at the OCRL in Sacramento, Calif. Copper, DOC, PIC, POC, TPC, and TPN samples were analyzed by the USGS at the NWQL in Denver, Colo. Toxicity samples were analyzed by the AHP at UCD.

Organic Chemistry Research Laboratory, Sacramento, California

Samples for pesticide analysis were analyzed at the OCRL in Sacramento, Calif. One liter of water was extracted for analysis of 25 compounds by liquid chromatography tandem mass spectrometry (LC/MS/MS), and one liter of water was extracted for analysis of 129 compounds by gas chromatography mass spectrometry (GC/MS). All surface-water samples for pesticide analysis were filtered through pre-weighed, baked 0.7-micrometer (μm) glass-fiber filters (Grade GF/F, Whatman, Piscataway, N.J.) to remove suspended material. The filter paper from the GC/MS sample containing the suspended sediments was dried at room temperature overnight, protected from light, then stored in a freezer at –20 degrees Celsius (°C) until extraction. Analysis of pesticides in suspended-material samples was done on resultant filter paper.

Extraction of Pesticides from Surface Water

The extraction procedure and instrumental analysis by LC/MS/MS have been previously described in Hladik and Calhoun (2012). To summarize the method described in Hladik and Calhoun (2012), filtered-water samples were spiked with the recovery surrogate standards, monuron (Chem Service, West Chester, Pennsylvania) and imidacloprid-d_4 (Cambridge Isotope Laboratories, Andover, Massachusetts). Each sample was then passed through an Oasis Hydrophilic Lipophilic Balance (HLB) solid-phase extraction (SPE; 6 milliliters, mL; 500 milligrams, mg; Waters, Milford, Mass.) cartridge that had been cleaned with one column volume of dichloromethane followed by one column volume of acetone and two column volumes of deionized water. During the SPE process, the water samples were pumped through the SPE cartridge at a flow rate of 10 milliliters per minute (mL/min) and the cartridge was then dried under nitrogen until the SPE sorbent was dry. The analytes were eluted with 10 mL of 50:50 DCM:acetone. The eluent was then evaporated to less than 0.5 mL using a gentle stream of dry nitrogen, solvent exchanged into acetonitrile, and further evaporated to 0.2 mL. The internal standard ($^{13}C_3$-caffeine, Cambridge Isotope Laboratories, Andover, Mass.) was then added. The sample extracts were stored in a freezer at –20 °C until analysis (up to 30 days).

The extraction procedure (Hladik and others, 2008, 2009) and instrumental analysis by GC/MS (Hladik and McWayne, 2012) have been previously described. Filtered-water samples were spiked with the recovery surrogate standards $^{13}C_3$-atrazine and d_{14}-trifluralin (Cambridge Isotopes, Andover, Mass.). Each sample was then passed through an Oasis HLB SPE (6 mL, 500 mg, Waters, Milford, Mass.) cartridge that had been cleaned with two column volumes of ethyl acetate (EtOAc), followed by two column volumes of methanol, and two column volumes of deionized water. During this process, the water samples were pumped through the SPE cartridge at a flow rate of 10 mL/min and the cartridge was dried under nitrogen until the SPE sorbent was dry. After extraction, sodium sulfate was added to the sample bottle to remove any residual water, then the bottle was rinsed three times with approximately 2 mL of DCM into a collection tube. The bottle rinse was concentrated to 1 mL under a gentle stream of nitrogen gas. The SPE cartridge was dried under nitrogen until the SPE sorbent was dry, then analytes were eluted with 12 mL of EtOAc into the concentrator tube containing the bottle rinse. The combined bottle rinse and eluent mixture was evaporated to less than 0.2 mL using a gentle stream of dry nitrogen. The internal standard, a mixture of deuterated compounds acenaphthene-d_{10} and pyrene-d_{10} was then added. The sample extracts were stored in a freezer at –20 °C until analysis (up to 30 days).

Extraction of Pesticides from Suspended Sediment

Filter papers were cut up and placed in an Erlenmeyer flask, spiked with the recovery surrogate standards d_{14}-trifluralin, $^{13}C_{12}$-*p,p'*-DDE, and $^{13}C_6$-permethrin (Cambridge Isotopes, Andover, Mass.) and extracted twice with 50 mL of dichloromethane in a sonicator (Branson 5200, Danbury, Conn.) for 5 minutes. The extract was filtered through sodium sulfate, reduced using a Zymark Turbovap II (Hopinkton, Md) to 0.5 mL, then solvent exchanged into EtOAc, and further evaporated to less than 0.2 mL using a gentle stream of dry nitrogen. The internal standard, a mixture of deuterated compounds acenaphthene-d_{10} and pyrene-d_{10} was then added. The sample extracts were stored in a freezer at –20 °C until analysis (up to 30 days).

Instrument Methods

Water extracts for analysis by LC/MS/MS were analyzed on an Agilent (Palo Alto, Calif.) 1260 Infinity coupled to an Agilent 6430 Triple Quad LC/MS with a Zorbax Eclipse XDB-C18 column (2.1 by 150 by 3.5 millimeters, mm; Agilent). The column flow rate was 0.6 mL/min, and the column temperature was 30 °C. Data were collected in the multiple-reaction-monitoring mode. Additional details about the instrument method can be found in Hladik and Calhoun (2012).

Water and filter extracts for analysis by GC/MS were analyzed on an Agilent 7890A gas chromatograph with an Agilent 5975C inert mass-selective detector system using a DB-5MS analytical column (30 meter, m, by 0.25 mm by 0.25 µm; Agilent) for separation with helium as the carrier gas. Data were collected in the selected ion-monitoring mode. Additional details of the GC/MS method can be found in Hladik and others (2008, 2009).

National Water Quality Laboratory, Denver, Colorado

All samples collected for analysis at the NWQL were processed and preserved at the OCRL in Sacramento, Calif., prior to shipment on ice to the NWQL in Denver, Colo.

Copper Methods

Water samples for copper analysis were pumped through a 0.45-µm capsule filter (Pall Versapor WMV High Capacity) using a peristaltic pump and collected in an acid-rinsed 250-mL high-density polyethylene bottle. Prior to sample collection, the capsule filter was rinsed with 2 L of ASTM Type-I deionized water followed by 25 mL of native water; the sample collection bottle was rinsed three times with ASTM Type-I deionized water and once with filtered native water. The sample was then preserved with certified, traceable nitric acid obtained from the NWQL. Copper was analyzed at the NWQL using the method described in Garbarino and others, (2006).

Inorganic Carbon, Organic Carbon, and Nitrogen Methods

Teflon™ filter towers with 25-mm filters were used for DOC, PIC, POC, TPC, and TPN samples. Sample water was passed through filters using gravity or compressed air. Water samples for DOC analysis were filtered through baked 0.3-µm glass-fiber filters (Advantec, Japan) into precleaned, baked 125-mL amber-glass bottles then preserved with certified, traceable sulfuric acid obtained from the NWQL. Particulate analytes (PIC, POC, TPC, and TPN) were collected on three baked 0.3-µm glass-fiber filters (Advantec, Japan) and stored wrapped in aluminum foil. Native water was passed through each filter until the filter appeared to be covered with particulate and the total volume of water that passed through each filter was recorded. Dissolved organic carbon was analyzed at the NWQL using the method described in Brenton and Arnett, (1993). Particulate inorganic carbon, POC, TPC, and TPN were analyzed at the NWQL using U.S. Environmental Protection Agency (EPA) method 440.0 (Zimmerman and others, 1997).

Method Detection Limits and Reporting Levels

Method detection limits (MDLs) for pesticide concentrations in surface water were validated in previous work (Hladik and others, 2008; Hladik and Calhoun, 2012) using the procedure described in 40 CFR 136, appendix B (U.S. Environmental Protection Agency, 1992). Method detection limits for pesticide compounds in suspended sediments filtered from surface water were validated in previous studies by Hladik and others (2009) and Hladik and McWayne (2012). Method detection limits for pesticide concentrations measured in surface water and suspended sediments are listed in table 2. Analytes can sometimes be identified at concentrations less than the MDLs with lower confidence in the numerical value; therefore, concentrations of compounds detected below the MDLs are reported as estimates and coded with an "E."

Method detection limits for DOC and copper were determined by the NWQL by analyzing a series of spiked replicate samples and entering the results into the DQCALC software package following procedures described in ASTM International's Standard Practice D7510-10 (ASTM International, 2010). The method detection limit determined by DQCALC is the lowest concentration at which the chance of a false positive is equal to or less than 1 percent. Reporting levels are reevaluated annually and subject to change, but the reporting level is generally two times the method detection limit. The reporting level is used to control false negative error.

Method detection limits for PIC, POC, TPC, and TPN were determined by the NWQL using the long-term method detection level (LT-MDL) following protocols described in Childress and others (1999). The LT-MDL is used to limit the chance of reporting false positives. Analytes with positive detections, but concentrations measured below the LT-MDL, were flagged with an "E" result-level qualifier. Results with an "E" qualifier have a high certainty of a positive detection, but the exact concentration is uncertain.

Laboratory reporting levels are used to control false negative error and are usually set at two times the LT-MDL. Particulate organic carbon was reported based on the minimum reporting level (MRL). The MRL is the "smallest measured concentration of a constituent that may be reliably reported using a given analytical method" (Timme, 1995). Results below the MRL were flagged with a "<" qualifier. Reporting levels for the analytes measured at the NWQL in this study are listed in table 3.

Table 2. Method detection limits for dissolved pesticides in surface water and on suspended sediments measured by the U.S. Geological Survey Organic Chemistry Research Laboratory.

[GC/MS, gas chromatography mass spectrometry; LC/MS/MS, liquid chromatography/tandem mass spectrometry; ng/L, nanogram per liter; NWIS, National Water Information System]

Compound	NWIS parameter code	Chemical class	Primary pesticide use	Method detection limit (ng/L)	Analytical method
Acetamiprid	68302	Neonicotinoid	Insecticide	3.3	LC/MS/MS
Acibenzolar-*S*-methyl	51849	Unclassified	Fungicide	3.0	GC/MS
Alachlor	65064	Chloroacetanilide	Herbicide	1.7	GC/MS
Allethrin	66586	Pyrethroid	Insecticide	1.0	GC/MS
Atrazine	65065	Triazine	Herbicide	2.3	GC/MS
Azinphos-methyl	65066	Organophosphorus	Insecticide	9.4	GC/MS
Azinphos-methyl oxon	68211	Organophosphorus	Breakdown product	9.4	GC/MS
Azoxystrobin	66589	Strobin	Fungicide	3.1	GC/MS
Benefin (benfluralin)	51643	2,6-Dinitroaniline	Herbicide	2.0	GC/MS
Bifenthrin	65067	Pyrethroid	Insecticide	0.7	GC/MS
Boscalid	67550	Anilide	Fungicide	2.8	GC/MS
Bromoconazole	68315	Azole	Fungicide	3.2	GC/MS
Butralin	68545	2,6-Dinitroaniline	Herbicide	2.6	GC/MS
Butylate	65068	Thiocarbamate	Herbicide	1.8	GC/MS
Captan	68322	Thiophthalimide	Fungicide	10.2	GC/MS
Carbaryl	65069	*N*-Methyl carbamate	Insecticide	6.5	GC/MS
Carbendazim	68548	Benzimidazole	Fungicide	4.2	LC/MS/MS
Carbofuran	65070	*N*-Methyl carbamate	Insecticide	3.1	GC/MS
Chlorantraniliprole	51856	Anthranilic diamide	Insecticide	4.0	LC/MS/MS
Chlorothalonil	65071	Substituted benzene	Fungicide	4.1	GC/MS
Chlorpyrifos	65072	Organophosphorus	Insecticide	2.1	GC/MS
Chlorpyrifos oxon	68216	Organophosphorus	Insecticide	5.0	GC/MS
Clomazone	67562	Unclassified	Herbicide	2.5	GC/MS
Clothianidin	68221	Neonicotinoid	Insecticide	3.9	LC/MS/MS
Coumaphos	51836	Organophosphorus	Insecticide	3.1	GC/MS
Cyantraniliprole	51862	Anthranilic diamide	Insecticide	4.2	LC/MS/MS
Cyazofamid	51853	Azole	Fungicide	4.1	LC/MS/MS
Cycloate	65073	Thiocarbamate	Herbicide	1.1	GC/MS
Cyfluthrin	65074	Pyrethroid	Insecticide	1.0	GC/MS
Cyhalofop-butyl	68360	Aryloxyphenoxy propionic acid	Herbicide	1.9	GC/MS
Cyhalothrin (all isomers)	68354	Pyrethroid	Insecticide	0.5	GC/MS
Cymoxanil	51861	Unclassified	Fungicide	3.9	LC/MS/MS
Cypermethrin	65075	Pyrethroid	Insecticide	1.0	GC/MS
Cyproconazole	66593	Azole	Fungicide	4.7	GC/MS
Cyprodinil	67574	Pyrimidine	Fungicide	7.4	GC/MS
DCPA	65076	Alkyl phthalate	Herbicide	2.0	GC/MS
DCPMU	68231	Urea	Breakdown product	3.5	LC/MS/MS
DCPU	68226	Urea	Breakdown product	3.4	LC/MS/MS
Deltamethrin	65077	Pyrethroid	Insecticide	0.6	GC/MS
Desthio-prothioconazole	51865	Unclassified	Breakdown product	3.0	LC/MS/MS

Table 2. Method detection limits for dissolved pesticides in surface water and on suspended sediments measured by the U.S. Geological Survey Organic Chemistry Research Laboratory.—Continued

[GC/MS, gas chromatography mass spectrometry; LC/MS/MS, liquid chromatography/tandem mass spectrometry; ng/L, nanogram per liter; NWIS, National Water Information System]

Compound	NWIS parameter code	Chemical class	Primary pesticide use	Method detection limit (ng/L)	Analytical method
Desulfinylfipronil	66607	Unclassified	Breakdown product	1.6	GC/MS
Desulfinylfipronil amide	68570	Unclassified	Breakdown product	3.2	GC/MS
Diazinon	65078	Organophosphorus	Insecticide	0.9	GC/MS
Diazoxon	68236	Organophosphorus	Breakdown product	5.0	GC/MS
3,4-Dichloroaniline	66584	Amine	Breakdown product	3.2	LC/MS/MS
3,5-Dichloroaniline	67536	Unclassified	Breakdown product	7.6	GC/MS
Difenoconazole	67582	Azole	Fungicide	10.5	GC/MS
Dimethomorph	68373	Morpholine	Fungicide	6.0	GC/MS
Dinotefuran	68379	Neonicotinoid	Insecticide	4.5	LC/MS/MS
Dithiopyr	51837	Pyridinecarboxylic acid	Herbicide	1.6	GC/MS
Diuron	66598	Urea	Herbicide	3.2	LC/MS/MS
EPTC	65080	Thiocarbamate	Herbicide	1.5	GC/MS
Esfenvalerate	65081	Pyrethroid	Insecticide	0.5	GC/MS
Ethaboxam	51855	Unclassified	Fungicide	3.8	LC/MS/MS
Ethalfluralin	65082	2,6-Dinitroaniline	Herbicide	3.0	GC/MS
Etofenprox	67604	Pyrethroid ether	Insecticide	2.2	GC/MS
Famoxadone	67609	Oxazolidinedione	Fungicide	2.5	GC/MS
Fenamidone	51848	Imidazole	Fungicide	5.1	GC/MS
Fenarimol	67613	Pyrimidine	Fungicide	6.5	GC/MS
Fenbuconazole	67618	Azole	Fungicide	5.2	GC/MS
Fenhexamid	67622	Anilide	Fungicide	7.6	GC/MS
Fenpropathrin	65083	Pyrethroid	Insecticide	0.6	GC/MS
Fenpyroximate	51838	Pyrazole	Insecticide	5.2	GC/MS
Fenthion	51839	Organophosphorus	Insecticide	5.5	GC/MS
Fipronil	66604	Pyrazole	Insecticide	2.9	GC/MS
Fipronil sulfide	66610	Unclassified	Breakdown product	1.8	GC/MS
Fipronil sulfone	66613	Unclassified	Breakdown product	3.5	GC/MS
Flonicamid	51858	Unclassified	Insecticide	3.4	LC/MS/MS
Fluazinam	67636	2,6-Dinitroaniline	Fungicide	4.4	GC/MS
Fludioxonil	67640	Unclassified	Fungicide	7.3	GC/MS
Flufenacet	51840	Anilide	Herbicide	4.7	GC/MS
Flumetralin	51841	2,6-Dinitroaniline	Plant growth regulator	5.8	GC/MS
Fluopicolide	51852	Benzamide pyridine	Fungicide	3.9	GC/MS
Fluoxastrobin	67645	Strobin	Fungicide	9.5	GC/MS
Fluridone	51864	Unclassified	Herbicide	3.7	LC/MS/MS
Flusilazole	67649	Azole	Fungicide	4.5	GC/MS
Flutolanil	51842	Anilide	Fungicide	4.4	GC/MS
Flutriafol	67653	Azole	Fungicide	4.2	GC/MS
Fluxapyroxad	51851	Anilide, pyrazole	Fungicide	4.8	GC/MS
Hexazinone	65085	Triazinone	Herbicide	8.4	GC/MS

Table 2. Method detection limits for dissolved pesticides in surface water and on suspended sediments measured by the U.S. Geological Survey Organic Chemistry Research Laboratory.—Continued

[GC/MS, gas chromatography mass spectrometry; LC/MS/MS, liquid chromatography/tandem mass spectrometry; ng/L, nanogram per liter; NWIS, National Water Information System]

Compound	NWIS parameter code	Chemical class	Primary pesticide use	Method detection limit (ng/L)	Analytical method
Imazalil	67662	Azole	Fungicide	10.5	GC/MS
Imidacloprid	68426	Neonicotinoid	Insecticide	3.8	LC/MS/MS
Indoxacarb	68627	Unclassified	Insecticide	4.9	GC/MS
Ipconazole	52762	Azole	Fungicide	7.8	GC/MS
Iprodione	66617	Dicarboximide	Fungicide	4.4	GC/MS
Kresoxim-methyl	67670	Strobin	Fungicide	4.0	GC/MS
Malaoxon	68240	Organophosphorus	Breakdown product	5.0	GC/MS
Malathion	65087	Organophosphorus	Insecticide	3.7	GC/MS
Mandipropamid	51854	Amide	Fungicide	3.3	LC/MS/MS
Metalaxyl	68437	Xylylalanine	Fungicide	5.1	GC/MS
Metconazole	66620	Azole	Fungicide	5.2	GC/MS
Methidathion	65088	Organophosphorus	Insecticide	7.2	GC/MS
Methoprene	66623	Juvenile hormone mimic	Insect growth regulator	6.4	GC/MS
Methoxyfenozide	68647	Diacylhydrazine	Insecticide	2.7	LC/MS/MS
Methyl parathion	65089	Organophosphorus	Insecticide	3.4	GC/MS
Metolachlor	65090	Chloroacetanilide	Herbicide	1.5	GC/MS
Molinate	65091	Thiocarbamate	Herbicide	3.2	GC/MS
Myclobutanil	66632	Azole	Fungicide	6.0	GC/MS
Napropamide	65092	Amide	Herbicide	8.2	GC/MS
Novaluron	68655	Benzoylurea	Herbicide	2.9	GC/MS
Oryzalin	68663	2,6-Dinitroaniline	Herbicide	5.0	LC/MS/MS
Oxadiazon	51843	Unclassified	Herbicide	2.1	GC/MS
Oxyfluorfen	65093	Diphenyl ether	Herbicide	3.1	GC/MS
p,p’-DDD	65094	Organochlorine	Insecticide, breakdown product	4.1	GC/MS
p,p’-DDE	65095	Organochlorine	Breakdown product	3.6	GC/MS
p,p’-DDT	65096	Organochlorine	Insecticide	4.0	GC/MS
Paclobutrazol	51846	Azole	Plant growth regulator	6.2	GC/MS
Pebulate	65097	Thiocarbamate	Herbicide	2.3	GC/MS
Pendimethalin	65098	2,6-Dinitroaniline	Herbicide	2.3	GC/MS
Penoxsulam	51863	Triazolopyrimidine	Herbicide	3.5	LC/MS/MS
Pentachloroanisole	66637	Organochlorine	Breakdown product	4.7	GC/MS
Pentachloronitrobenzene	66639	Substituted benzene	Fungicide	3.1	GC/MS
Permethrin	65099	Pyrethroid	Insecticide	0.6	GC/MS
Phenothrin	65100	Pyrethroid	Insecticide	1.0	GC/MS
Phosmet	65101	Organophosphorus	Insecticide	4.4	GC/MS
Picoxystrobin	51850	Strobin	Fungicide	4.2	GC/MS
Piperonyl butoxide	65102	Unclassified	Synergist	2.3	GC/MS
Prodiamine	51844	2,6-Dinitroaniline	Herbicide	5.2	GC/MS
Prometon	67702	Triazine	Herbicide	2.5	GC/MS
Prometryn	65103	Triazine	Herbicide	1.8	GC/MS

Table 2. Method detection limits for dissolved pesticides in surface water and on suspended sediments measured by the U.S. Geological Survey Organic Chemistry Research Laboratory.—Continued

[GC/MS, gas chromatography mass spectrometry; LC/MS/MS, liquid chromatography/tandem mass spectrometry; ng/L, nanogram per liter; NWIS, National Water Information System]

Compound	NWIS parameter code	Chemical class	Primary pesticide use	Method detection limit (ng/L)	Analytical method
Propanil	66641	Anilide	Herbicide	10.1	GC/MS
Propargite	68677	Unclassified	Insecticide	6.1	GC/MS
Propiconazole	66643	Azole	Fungicide	5.0	GC/MS
Propyzamide	67706	Amide	Herbicide	5.0	GC/MS
Pyraclostrobin	66646	Strobin	Fungicide	2.9	GC/MS
Pyridaben	68682	Unclassified	Insecticide	5.4	GC/MS
Pyrimethanil	67717	Pyrimidine	Fungicide	4.1	GC/MS
Quinoxyfen	51847	Quinoline	Fungicide	3.3	GC/MS
Resmethrin	65104	Pyrethroid	Insecticide	1.0	GC/MS
Sedaxane	52648	Anilide, pyrazole	Fungicide	5.2	GC/MS
Simazine	65105	Triazine	Herbicide	5.0	GC/MS
Tau-fluvalinate	65106	Pyrethroid	Insecticide	0.7	GC/MS
Tebuconazole	66649	Azole	Fungicide	3.7	GC/MS
Tebupirimfos	68693	Organophosphorus	Insecticide	1.9	GC/MS
Tebupirimfos oxon	68694	Organophosphorus	Breakdown product	2.8	GC/MS
Tefluthrin	67731	Pyrethroid	Insecticide	0.6	GC/MS
Tetraconazole	66654	Azole	Fungicide	5.6	GC/MS
Tetradifon	51651	Unclassified	Insecticide	3.8	GC/MS
Tetramethrin	66657	Pyrethroid	Insecticide	0.5	GC/MS
Thiabendazole	67161	Benzimidazole	Fungicide	3.6	LC/MS/MS
Thiacloprid	68485	Neonicotinoid	Insecticide	3.2	LC/MS/MS
Thiamethoxam	68245	Neonicotinoid	Insecticide	3.4	LC/MS/MS
Thiazopyr	51845	Pyridinecarboxylic acid	Herbicide	4.1	GC/MS
Thiobencarb	65107	Thiocarbamate	Herbicide	1.9	GC/MS
Tolfenpyrad	51866	Pyrazole	Insecticide	2.9	LC/MS/MS
Triadimefon	67741	Azole	Fungicide	8.9	GC/MS
Triadimenol	67746	Azole	Fungicide	8.0	GC/MS
Triallate	68710	Thiocarbamate	Herbicide	2.4	GC/MS
Tribufos	68711	Organophosphorus	Defoliant	3.1	GC/MS
Trifloxystrobin	66660	Strobin	Fungicide	4.7	GC/MS
Triflumizole	67753	Azole	Fungicide	6.1	GC/MS
Trifluralin	65108	2,6-Dinitroaniline	Herbicide	2.1	GC/MS
Triticonazole	67758	Azole	Fungicide	6.9	GC/MS
Zoxamide	67768	Amide	Fungicide	3.5	GC/MS

Table 3. Reporting levels for dissolved and suspended consituents measured by the U.S. Geological Survey National Water Quality Laboratory.

[dl-dqc, detection limit by DQCALC software; lt-mdl, long term-method detection levels; mg/L, milligram per liter; mrl, minimum reporting level; NWIS, National Water Information System; µg/L, microgram per liter]

Analyte	Group	NWIS parameter code	Sample fraction	Reporting level	Reporting threshold type	Parameter unit
Organic carbon	Organics, other	00681	Dissolved	0.23	dl-dqc	mg/L
Inorganic carbon	Inorganics, major, non-metals	00688	Suspended	0.03	lt-mdl	mg/L
Organic carbon	Organics, other	00689	Suspended	0.05	mrl	mg/L
Total carbon	Inorganics, major, non-metals	00694	Suspended	0.05	lt-mdl	mg/L
Copper	Inorganics, minor, metals	01040	Dissolved	0.80	dl-dqc	µg/L
Nitrogen	Nutrient	49570	Suspended	0.030	lt-mdl	mg/L

Quality-Control Methods and Results

A quality assurance program plan (QAPP) was designed by the Aquatic Science Center and approved by the Delta RMP Technical Advisory Committee to ensure data quality (Aquatic Science Center, 2016). Field replicates, field blanks, laboratory matrix spikes, and matrix-spike replicates were used to validate pesticide concentrations measured in the water using GC/MS and LC/MS/MS and in the suspended sediments using GC/MS. Field replicates and blanks were collected and analyzed to validate results for analytes measured at the NWQL.

Pesticide Surrogate Compounds—To assess the efficiency of water sample extraction for the GC/MS and LC/MS/MS analytical methods, $^{13}C_3$-atrazine and d_{14}-trifluralin, and monuron and imidacloprid-d_4, respectively, were used as recovery surrogates for extracts. Mean (plus or minus, ±, standard deviation) recoveries of $^{13}C_3$-atrazine, d_{14}-trifluralin, monuron, and imidacloprid-d_4 were 90±11 percent, 89±14 percent, 83±12 percent, and 91±13 percent, respectively. To assess the efficiency of filter sample extraction, d_{14}-trifluralin, $^{13}C_{12}$-*p,p'*-DDE, and $^{13}C_6$-permethrin were used as recovery surrogates for extracts. Mean (± standard deviation) recoveries of d_{14}-trifluralin, $^{13}C_{12}$-*p,p'*-DDE, and $^{13}C_6$-permethrin were 91±11 percent, 91±7 percent, and 96±11 percent, respectively.

Blanks—Six pesticide field blanks (three for analysis by GC/MS, three for analysis by LC/MS/MS) were collected to verify the cleanliness of pesticide sample collection and processing protocols. Filters from the three pesticide field blanks collected for analysis by GC/MS also were saved and analyzed as suspended-sediment field blanks. No pesticides were detected in any of the pesticide field blanks. Six field blanks (three for copper analysis, three for DOC analysis) were collected for analysis at the USGS NWQL. There were no detections in the copper samples. One DOC blank had a detection at 0.37 milligram per liter (mg/L; reporting level 0.23 mg/L).

Replicates—Seven pesticide field-replicate samples (three for analysis by GC/MS, four for analysis by LC/MS/MS) were collected concurrently to test the reproducibility of results based on field sampling methods (tables 4 and 5, respectively). The relative standard deviations (RSD) of all environmental and replicate pairs fell below the control limit of 25 percent. Filters from the three replicate samples were collected as suspended-sediment replicates; there were no pesticide detections in any of the environmental and replicate suspended-sediment pairs. Six field replicates were collected (three for copper analysis, three for DOC analysis) for analysis at the USGS NWQL. Results from the six replicates analyzed by the NWQL met the QAPP data-quality objective of less than 25 percent RSD (U.S. Geological Survey, 2017).

Matrix Spikes—Nine pesticide matrix-spike samples (four for analysis by GC/MS, five for analysis by LC/MS/MS) and six pesticide matrix-spike replicate samples (three for analysis by GC/MS, three for analysis by LC/MS/MS) were collected to assess pesticide recovery, degradation, sorption, and potential interferences caused by the sampling matrix. The minimum, maximum, and median recoveries and standard deviation of the recoveries are presented in table 6. Recoveries of 151 matrix-spike compounds satisfied the QAPP objectives of 70–130 percent recovery of pesticide matrix-spike compounds. Recoveries of fenthion in 2 samples, mandipropamid in 1 sample, and tebupirimfos oxon in 1 sample exceeded 130 percent recovery of pesticide matrix-spike compounds. All pesticide matrix-spike samples with matrix-spike replicate pairs satisfied the QAPP objective of less than 25 percent relative percent difference between matrix spike and matrix-spike replicate pairs.

Table 4. Pesticide concentrations with measured detections by gas chromatography with mass spectrometry (GC/MS) in environmental and field replicate water samples collected in the Sacramento–San Joaquin Delta, 2015–16.

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. Results in parenthesis ( ) are below method detection limits and are estimates. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; RSD, relative standard deviation; %, percent; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Sample type	Atrazine [65065]	Azoxystrobin [66589]	Boscalid [67550]	Carbaryl [65069]	Clomazone [67562]	Desulfinylfipronil [66607]	Dithiopyr [51837]
Sacramento River at Hood									
07/28/2015	08:45	Environmental	—	84.4	3.8	31.1	10.9	—	7.9
07/28/2015	08:45	Field replicate	—	78.6	3.4	29.4	10.5	—	7.5
—	—	RSD	—	5%	10%	4%	3%	—	3%
San Joaquin River at Buckley Cove									
09/23/2015	10:45	Environmental	8.2	38.0	11.6	—	—	3.1	—
09/23/2015	10:45	Field replicate	8.6	41.8	12.2	—	—	3.3	—
—	—	RSD	3%	7%	4%	—	—	3%	—
Mokelumne River at New Hope Road									
11/10/2015	10:00	Environmental	—	—	14.8	—	—	—	2.3
11/10/2015	10:00	Field replicate	—	—	16.9	—	—	—	2.6
—	—	RSD	—	—	9%	—	—	—	8%

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Sample type	Fipronil [66604]	Fipronil sulfide [66610]	Fluxapyroxad [51851]	Hexazinone [65085]	Metolachlor [65090]	Piperonyl butoxide [65102]	Propanil [66641]	Simazine [65105]
Sacramento River at Hood—Continued										
07/28/2015	08:45	Environmental	25.0	—	—	43.8	13.2	36.3	38.8	—
07/28/2015	08:45	Field replicate	23.6	—	—	40.6	12.1	32.8	37.4	—
—	—	RSD	4%	—	—	5%	6%	7%	3%	—
San Joaquin River at Buckley Cove—Continued										
09/23/2015	10:45	Environmental	—	3.0	22.6	39.0	43.3	6.1	—	6.9
09/23/2015	10:45	Field replicate	—	3.2	24.7	40.3	45.4	6.5	—	7.7
—	—	RSD	—	3%	6%	2%	3%	5%	—	8%
Mokelumne River at New Hope Road—Continued										
11/10/2015	10:00	Environmental	3.1	—	E3.4	15.9	—	14.6	—	—
11/10/2015	10:00	Field replicate	2.9	—	E3.2	17.7	—	13.6	—	—
—	—	RSD	3%	—	4%	8%	—	5%	—	—

Table 5. Pesticide concentrations with measured detections by liquid chromatography tandem mass spectrometry (LC/MS/MS) in environmental and field replicate water samples collected in the Sacramento–San Joaquin Delta, 2015–16.

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. Results in parenthesis ( ) are below method detection limits and are estimates. **Abbreviations:** E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; RSD, relative standard deviation; %, percent; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Sample type	Carbendazim [68548]	Chlor-antraniliprole [51856]	DCPMU [68231]	DCPU [68226]	3,4-Dichloroaniline [66584]	Diuron [66598]	Fluridone [51864]	Imidacloprid [68426]	Methoxyfenozide [68647]	Thiabendazole [67161]
San Joaquin River at Buckley Cove												
07/28/2015	08:45	Environmental	61.0	5.0	49.5	9.1	9.3	86.5	382.7	E3.2	47.0	—
07/28/2015	08:45	Field replicate	67.9	5.5	52.1	9.8	8.9	87.7	409.7	E3.5	49.1	—
—	—	RSD	8%	6%	4%	5%	4%	1%	5%	6%	3%	—
Ulatis Creek at Browns Road												
09/23/2015	14:15	Environmental	—	36.1	4.0	—	E2.1	5.1	6.7	4.6	5.3	E2.7
09/23/2015	14:15	Field replicate	—	42.5	4.8	—	E2.4	5.7	7.6	5.5	6.1	E3.0
—	—	RSD	—	12%	13%	—	9%	7%	9%	12%	10%	7%
Sacramento River at Hood												
11/10/2015	10:00	Environmental	21.1	—	—	—	3.2	—	—	—	—	—
11/10/2015	10:00	Field replicate	22.2	—	—	—	3.3	—	—	—	—	—
—	—	RSD	4%	—	—	—	2%	—	—	—	—	—
San Joaquin River near Vernalis												
05/18/2016	12:20	Environmental	—	—	—	—	—	7.5	—	—	7.6	—
05/18/2016	12:20	Field replicate	—	—	—	—	—	8.0	—	—	8.1	—
—	—	RSD	—	—	—	—	—	4%	—	—	4%	—

Table 6. Minimum, maximum, and median recovery of compounds in pesticide matrix-spiked water samples with standard deviation.

[Four spiked samples and three spiked replicate samples were analyzed by gas chromatography/mass spectrometry. Compounds noted with ** were analyzed in five spiked samples and three spiked replicate samples by liquid chromatography/tandem mass spectrometry. **Abbreviation**: ±, plus or minus]

Compound	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)	Standard deviation (percent)
Acetamiprid**	74	89	82	±6
Acibenzolar-*S*-methyl	89	122	99	±12
Alachlor	92	113	97	±7
Allethrin	87	113	96	±10
Atrazine	94	101	99	±2
Azinphos-methyl	86	109	93	±8
Azinphos-methyl oxon	82	106	98	±10
Azoxystrobin	88	102	92	±5
Benfluralin	86	97	93	±4
Bifenthrin	83	100	96	±7
Boscalid	91	104	98	±5
Bromuconazole	88	108	100	±8
Butralin	90	111	100	±7
Butylate	79	102	95	±9
Captan	79	104	96	±9
Carbaryl	85	119	105	±12
Carbendazim**	73	98	81	±13
Carbofuran	76	110	95	±13
Chlorantraniliprole**	96	113	106	±5
Chlorothalonil	82	103	96	±8
Chlorpyrifos	87	119	112	±12
Chlorpyrifos oxon	81	115	92	±15
Clomazone	91	104	100	±4
Clothianidin**	79	93	85	±5
Coumaphos	85	114	92	±12
Cyantraniliprole**	94	111	102	±6
Cyazofamid**	78	102	92	±9
Cycloate	82	97	91	±6
Cyfluthrin	97	104	100	±3
Cyhalofop-butyl	85	102	95	±7
Cyhalothrin	91	109	103	±8
Cymoxanil**	71	83	72	±6
Cypermethrin	85	115	91	±11
Cyproconazole	91	106	103	±6
Cyprodinil	77	107	88	±12
3,4-Dichloroaniline**	76	90	84	±6
3,5-Dichloroaniline**	73	90	80	±7
DCPA	87	101	91	±5
DCPMU**	75	97	89	±11
DCPU**	75	99	83	±10
Deltamethrin	93	113	100	±6
Desthio-prothioconazole**	83	118	97	±10
Diazinon	94	113	100	±7
Diazinon oxon	82	117	94	±12
Difenconazole	91	107	93	±6
Dimethomorph	90	108	102	±7
Dinotefuran**	77	112	93	±13
Dithiopyr	97	110	102	±4
Diuron**	92	118	95	±9
EPTC	71	107	91	±16
Esfenvalerate	91	112	97	±8
Ethaboxam**	75	102	93	±10
Ethalfluralin	93	112	98	±7
Etofenprox	85	107	91	±10
Famoxadone	78	113	98	±13
Fenamidone	93	104	98	±4
Fenarimol	89	110	96	±8
Fenbuconazole	92	120	101	±9
Fenhexamide	81	116	96	±13
Fenpropathrin	88	113	93	±11
Fenpyroximate	88	113	101	±9
Fenthion	83	155	97	±27
Fipronil	95	110	105	±5
Desulfinylfipronil	84	109	105	±9
Desulfinylfipronil amide	88	110	105	±9
Fipronil sulfide	93	105	100	±5
Fipronil sulfone	87	102	94	±5
Flonicamid**	72	100	77	±14
Fluazinam	80	105	97	±10
Fludioxinil	96	103	97	±3
Flufenacet	91	114	95	±9
Flumethralin	92	118	103	±8
Fluopicolide	85	110	95	±9
Fluoxastrobin	92	106	97	±5
Fluridone**	89	112	102	±7
Flusilazole	88	122	96	±12
Flutolanil	100	116	105	±5
Flutriafol	95	124	98	±10

Table 6. Minimum, maximum, and median recovery of compounds in pesticide matrix-spiked water samples with standard deviation.—Continued

[Four spiked samples and three spiked replicate samples were analyzed by gas chromatography/mass spectrometry. Compounds noted with ** were analyzed in five spiked samples and three spiked replicate samples by liquid chromatography/tandem mass spectrometry. **Abbreviation**: ±, plus or minus]

Compound	Minimum recovery (percent)	Maximum recovery (percent)	Median recovery (percent)	Standard deviation (percent)
Fluxapyroxad	90	101	97	±4
Hexazinone	82	101	93	±8
Imazalil	76	114	101	±13
Imidacloprid**	77	106	89	±12
Indoxacarb	80	110	103	±12
Ipconazole	90	110	102	±7
Iprodione	82	105	88	±11
Kresoxim-methyl	91	101	96	±4
Malathion	83	115	99	±11
Malathion oxon	83	100	95	±6
Mandipropamid**	85	164	98	±24
Metalaxyl	100	121	103	±7
Metconazole	87	107	97	±7
Methidathion	90	117	105	±9
Methoprene	93	113	101	±6
Methoxyfenozide**	87	104	98	±5
Methyl parathion	94	104	99	±3
Metolachlor	95	104	98	±3
Molinate	75	108	96	±14
Myclobutanil	88	114	96	±9
Napropamide	87	103	92	±6
Novaluron	71	84	78	±6
Oryzalin**	71	100	84	±16
Oxydiazon	95	114	102	±6
Oxyfluorfen	92	104	98	±5
p,p’-DDD	86	101	95	±5
p,p’-DDE	76	92	84	±7
p,p’-DDT	87	100	93	±6
Paclobutrazol	98	107	104	±4
PCA	73	88	79	±6
PCNB	88	105	97	±7
Pebulate	79	106	84	±12
Pendimethalin	96	111	100	±6
Penoxsulam**	74	92	77	±9
Permethrin	81	96	90	±6
Phenothrin	79	97	92	±7
Phosmet	94	101	97	±3
Picoxystrobin	88	103	93	±6
Piperonyl butoxide	90	103	95	±4
Prodiamine	98	111	104	±4
Prometon	72	112	96	±17
Prometryn	89	119	92	±11
Propanil	94	117	101	±8
Propargite	84	106	100	±9
Propiconazole	95	113	100	±6
Propyzamide	86	117	102	±11
Pyraclostrobin	73	92	84	±9
Pyridaben	96	102	101	±2
Pyrimethanil	91	107	101	±6
Quinoxyfen	83	102	95	±8
Resmethrin	80	104	98	±11
Sedaxane	93	103	99	±4
Simazine	85	110	101	±9
Tau-fluvalinate	77	108	101	±12
Tebuconazole	86	106	101	±7
Tebupirimfos	90	107	99	±6
Tebupirimfos oxon	87	146	93	±20
Tefluthrin	70	85	79	±6
Tetraconazole	91	119	98	±9
Tetradifon	97	125	101	±10
Tetramethrin	87	109	101	±9
Thiabendazole**	71	99	81	±11
Thiacloprid**	75	97	78	±10
Thiamethoxam**	77	91	82	±8
Thiazopyr	89	103	97	±5
Thiobencarb	88	105	94	±7
Tolfenpyrad**	84	118	96	±12
Triadimefon	99	118	107	±6
Triadimenol	89	119	97	±12
Triallate	92	103	98	±4
Tribufos	92	109	100	±6
Trifloxystrobin	93	115	98	±8
Triflumizole	96	115	106	±6
Trifluralin	90	103	98	±4
Triticonazole	91	118	96	±9
Zoxamide	84	105	94	±8

Results

A total of 54 out of 154 pesticide compounds were detected in water samples collected during the study, and all samples contained multiple pesticides (table 7). A variety of pesticide types were detected in the water during the study period (19 fungicides, 18 herbicides, 9 insecticides, 7 breakdown products, and 1 synergist). The most frequently detected compounds were the herbicide hexazinone (95 percent) and the fungicides boscalid (93 percent) and azoxystrobin (75 percent). Overall, 14 pesticides were detected in at least half of all samples. Pesticide concentrations ranged from below the MDLs to 2,630 nanograms per liter (ng/L) for the herbicide metolachlor.

Pesticide concentrations measured in suspended sediments filtered from surface water are presented in table 8. Pesticide concentrations in suspended-sediments filtered from 1-liter water samples are presented using surface water parameter codes and units to facilitate the approximation of a whole-water pesticide concentration (table 9). A total of 11 pesticide compounds were detected in the suspended sediments during the study period (6 herbicides, 3 insecticides, 1 fungicide, and 1 breakdown product). Overall, the most frequently detected pesticides in suspended sediments were the insecticides permethrin (7 percent) and bifenthrin (5 percent) and the herbicide pendimethalin (5 percent). Pesticide concentrations in the suspended sediments ranged from below the MDLs to 265 ng/L for the herbicide pendimethalin. Whole-water pesticide concentrations were calculated for compounds with at least one suspended-sediment detection (table 9).

Results for dissolved and suspended constituents measured at the NWQL are provided in table 10 and water quality measurements taken in the field are provided in table 11. Dissolved organic carbon was detected at concentrations from 1.59 to 11.6 mg/L. Particulate inorganic carbon was detected above the MRL of 0.03 mg/L in five samples (8 percent) at concentrations from 0.03 to 0.14 mg/L. Particulate organic carbon was present in 60 samples (100 percent) at concentrations ranging from less than 0.11 to 38.5 mg/L. Total particulate nitrogen was detected above the LT-MDL of 0.03 mg/L in 52 samples (87 percent) at concentrations from 0.031 to 4.59 mg/L. Dissolved copper was detected above the detection limit of 0.8 mg/L in 58 samples (97 percent) at concentrations ranging from 0.81 to 4.4 micrograms per liter (µg/L).

The data presented in this report are publicly available in the USGS National Water Information System web interface (U.S. Geological Survey, 2017). Results for this report were retrieved from NWIS and compiled in April 2017.

Mokelumne River at New Hope Road

A total of 32 pesticides (14 fungicides, 10 herbicides, 4 insecticides, 3 breakdown products, and 1 synergist) were detected in water samples collected at this site; the most frequently detected compounds were boscalid (100 percent) and hexazinone (92 percent). The maximum pesticide concentration measured at this site was 247 ng/L (simazine) in a sample collected on March 7, 2016. A minimum of 2 (October 21, 2015, May 18, 2016, and June 15, 2016) and a maximum of 13 (March 7, 2016) pesticides or pesticide degradates were detected in each water sample (fig. 3). No pesticides or pesticide degradates were detected in the suspended sediments collected at this site. There were no pesticide detections at concentrations above EPA aquatic-life benchmarks at this site (U.S. Environmental Protection Agency, 2017).

Sacramento River at Hood

A total of 33 pesticides (11 herbicides, 11 fungicides, 6 insecticides, 4 breakdown products, and 1 synergist) were detected in the water samples collected at this site. The fungicide azoxystrobin was detected in every sample, and an additional seven pesticides (hexazinone, 3,4-dichloroaniline, boscalid, diuron, piperonyl butoxide, carbendazim, and fipronil) were detected in at least half of the samples collected at this site. The maximum pesticide concentration measured at this site was 348 ng/L for azoxystrobin in the sample collected on August 18, 2015. A minimum of 6 (February 17, 2016) and a maximum of 15 (March 7, 2016) pesticides or pesticide degradates were detected in each water sample (fig. 3). Permethrin was detected in the suspended sediments of the sample collected on March 7, 2016, at a concentration of 19.2 ng/L. This was the only detection of pesticides on suspended sediments from this site.

Bifenthrin was detected in the water sample collected on August 18, 2015 (2.9 ng/L), at a concentration above the aquatic-life benchmark for chronic toxicity to invertebrates of 1.3 ng/L (U.S. Environmental Protection Agency, 2017). The insecticide fipronil was detected at concentrations above the aquatic-life benchmark for chronic toxicity to invertebrates of 11 ng/L in the samples collected on July 28, 2015 (25 ng/L), and November 10, 2015 (12.2 ng/L).

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Acibenzolar-*S*-methyl [51849]	Atrazine [65065]	Azoxystrobin [66589]	Bifenthrin [65067]	Boscalid [67550]	Carbaryl [65069]	Carbendazim [68548]	Chlorantraniliprole [51856]	Chlorothalonil [65071]	Clomazone [67562]	Cyprodinil [67574]
Mokelumne River at New Hope Road												
07/28/2015	09:50	—	—	54.4	—	10.4	—	—	—	—	11.9	—
08/18/2015	09:50	—	—	115	—	21.2	—	—	—	—	—	—
09/23/2015	09:20	—	—	90.1	—	3.5	—	4.3	—	E2.3	—	—
10/21/2015	09:10	—	—	—	—	11.1	—	—	—	—	—	—
11/10/2015	10:00	—	—	—	—	14.8	—	E3.0	—	—	—	—
12/15/2015	14:00	—	—	—	—	E2.5	—	11.6	—	—	—	—
*01/19/2016	09:45	—	—	—	—	9.2	—	E3.1	E3.7	—	—	—
02/17/2016	09:00	—	—	—	—	4.8	—	—	—	—	—	—
*03/07/2016	13:30	—	—	—	—	4.7	—	5.6	—	—	—	—
04/19/2016	09:20	—	—	14.1	—	20.7	—	—	—	6.7	—	9.1
05/18/2016	09:30	—	—	—	—	7.3	—	—	—	—	—	—
06/15/2016	09:15	—	—	—	—	6.4	—	—	—	—	—	—
Sacramento River at Hood												
07/28/2015	08:45	—	—	84.4	—	3.8	31.1	—	—	—	10.9	—
08/18/2015	08:40	—	—	348	2.9	7.5	—	20.6	—	—	4.6	—
09/23/2015	08:30	—	—	19.2	—	—	—	29.4	—	E2.9	—	—
10/21/2015	08:00	—	—	35.9	—	10.6	—	21.1	—	—	—	—
11/10/2015	09:00	—	—	93.9	—	6.3	—	37.9	—	—	—	—
12/15/2015	15:00	—	—	30.3	—	—	—	18.5	—	—	—	—
*01/19/2016	08:30	—	—	32.6	—	—	—	4.2	4.4	—	—	—
02/17/2016	08:00	—	—	28.9	—	—	—	—	—	—	—	—
*03/07/2016	14:20	—	—	7.3	—	3	—	4.4	—	—	—	9.2
04/19/2016	08:20	—	—	15.3	—	13.4	—	—	—	6.8	—	—
05/18/2016	08:30	—	—	11.8	—	7.2	—	—	—	—	135	—
06/15/2016	08:10	—	—	24.5	—	8.9	—	—	—	—	47.6	—
San Joaquin River at Buckley Cove												
07/28/2015	11:10	—	49.3	58.1	—	34.1	—	61	5	—	22.9	—
08/18/2015	11:10	—	21.4	118	—	46	—	58.6	9.3	—	10.7	—
09/23/2015	10:45	—	8.2	38	—	11.6	—	70.7	10.3	—	—	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Acibenzolar-*S*-methyl [51849]	Atrazine [65065]	Azoxystrobin [66589]	Bifenthrin [65067]	Boscalid [67550]	Carbaryl [65069]	Carbendazim [68548]	Chlorantraniliprole [51856]	Chlorothalonil [65071]	Clomazone [67562]	Cyprodinil [67574]
San Joaquin River at Buckley Cove—Continued												
10/21/2015	10:50	—	—	129	—	37.6	—	107	11	—	—	—
11/10/2015	11:30	—	—	66.7	—	28.1	—	33.4	E2.0	—	—	—
12/15/2015	12:20	—	—	14.1	—	6.9	—	20.3	4.7	—	—	—
*01/19/2016	10:50	—	—	11.9	—	118	—	50.1	21.1	—	—	—
02/17/2016	10:10	—	—	5.6	—	67.6	—	8.8	14.4	—	—	—
*03/07/2016	10:15	—	—	3.7	—	24.7	—	35	10.6	—	—	—
04/19/2016	10:40	88.4	—	48.4	—	93.7	—	—	8.9	—	—	—
05/18/2016	10:45	—	—	14.7	—	14.6	—	—	—	—	—	—
06/15/2016	10:50	—	40	33.2	—	28.6	—	7.1	—	—	—	—
San Joaquin River near Vernalis												
07/28/2015	12:15	—	9.7	5.1	—	9.1	—	—	E3.9	—	—	—
08/18/2015	12:50	—	3.9	16	—	17.1	—	—	4	—	—	—
09/23/2015	12:20	—	—	24.5	—	3.7	—	—	4.9	E3.4	—	—
10/21/2015	12:40	—	—	37.7	—	13.4	—	—	5.1	—	—	—
11/10/2015	13:00	—	—	22.2	—	17.9	—	9.2	—	—	—	—
12/15/2015	11:00	—	—	—	—	3.8	—	—	E2.9	—	—	—
*01/19/2016	12:30	—	—	16.5	—	39.4	—	7.5	10.8	—	—	—
02/17/2016	12:00	—	—	—	—	27.5	—	7.6	7.3	—	—	11
*03/07/2016	11:50	—	—	4.2	—	21.8	—	40.7	6.5	—	—	—
04/19/2016	12:45	23.7	—	27.9	—	49.7	—	—	4.1	—	—	—
05/18/2016	12:20	—	—	12.9	—	12.5	—	—	—	—	—	—
06/15/2016	12:40	—	—	14.6	—	15.5	—	—	—	—	—	—
Ulatis Creek at Browns Road												
07/28/2015	14:20	—	14.6	34.7	—	32.6	—	—	150	—	—	—
08/18/2015	15:00	—	5.9	104	—	47.5	—	—	36.1	—	—	—
09/23/2015	14:15	—	4.1	5.9	—	10	—	—	49.5	—	—	—
10/21/2015	15:00	—	—	54.6	—	47.3	20.7	156	12.3	—	—	—
11/10/2015	15:30	—	14.1	—	33.3	66.8	—	—	E2.3	—	—	—
12/15/2015	08:50	—	6.3	—	13.2	23.5	—	57	E2.4	—	—	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Acibenzolar-*S*-methyl [51849]	Atrazine [65065]	Azoxystrobin [66589]	Bifenthrin [65067]	Boscalid [67550]	Carbaryl [65069]	Carbendazim [68548]	Chlorantraniliprole [51856]	Chlorothalonil [65071]	Clomazone [67562]	Cyprodinil [67574]
Ulatis Creek at Browns Road—Continued												
*01/19/2016	15:00	—	—	—	—	82.1	—	E4.0	25.9	—	—	—
02/17/2016	14:10	—	—	—	11.5	46.2	—	—	E3.0	—	—	E4.0
*03/07/2016	08:30	—	—	6.5	—	64.9	—	8	26.9	—	—	—
04/19/2016	15:10	—	10.4	29.1	—	50.4	—	—	E2.5	—	—	—
05/18/2016	14:20	—	—	14.5	—	20.3	—	—	14.4	—	—	—
06/15/2016	14:40	—	—	—	—	25.4	—	—	260	—	—	—

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Desulfinylfipronil [66607]	Diazinon [65078]	3,4-Dichloroaniline [66584]	3,5-Dichloroaniline [67536]	3,4-Dichlorophenylurea [68226]	*N*-(3,4-Dichlorophenyl)-*N*-methylurea [68231]	Dithiopyr [51837]	Diuron [66598]	EPTC [65080]
Mokelumne River at New Hope Road—Continued										
07/28/2015	09:50	8.1	—	4.7	—	—	—	—	E1.5	—
08/18/2015	09:50	2.4	—	4.2	—	—	—	—	—	—
09/23/2015	09:20	—	—	7.6	—	—	—	—	—	—
10/21/2015	09:10	—	—	—	—	—	—	—	—	—
11/10/2015	10:00	—	—	—	—	—	—	2.3	—	—
12/15/2015	14:00	—	—	—	—	—	—	7	E2.3	—
*01/19/2016	09:45	—	—	—	—	—	—	14.8	7	—
02/17/2016	09:00	—	—	—	—	—	—	—	E1.8	—
*03/07/2016	13:30	—	89.1	—	—	—	E2.6	17.4	33.7	—
04/19/2016	09:20	—	—	—	—	—	—	2.1	—	—
05/18/2016	09:30	—	—	—	—	—	—	—	—	—
06/15/2016	09:15	—	—	—	—	—	—	—	—	—
Sacramento River at Hood—Continued										
07/28/2015	08:45	—	—	10.5	—	—	—	7.9	E1.6	—
08/18/2015	08:40	—	—	15.3	—	—	—	—	—	—
09/23/2015	08:30	—	—	9	—	—	—	—	4.3	—
10/21/2015	08:00	—	—	3.2	—	—	—	—	—	—
11/10/2015	09:00	—	—	7.8	—	E2.6	4.1	—	8.3	—
12/15/2015	15:00	—	—	5.5	—	—	E2.0	3.5	17.5	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Desulfinylfipronil [66607]	Diazinon [65078]	3,4-Dichloroaniline [66584]	3,5-Dichloroaniline [67536]	3,4-Dichlorophenylurea [68226]	*N*-(3,4-Dichlorophenyl)-*N*'-methylurea [68231]	Dithiopyr [51837]	Diuron [66598]	EPTC [65080]
Sacramento River at Hood—Continued										
*01/19/2016	08:30	—	—	5.7	E1.6	E2.3	E2.9	—	43	—
02/17/2016	08:00	—	—	—	—	—	E2.0	—	5.2	—
*03/07/2016	14:20	—	—	21.1	—	E2.2	9.4	12	134	—
04/19/2016	08:20	—	—	—	—	—	—	—	4.1	—
05/18/2016	08:30	—	—	E2.6	—	—	—	—	—	—
06/15/2016	08:10	—	—	145	—	—	—	—	—	—
San Joaquin River at Buckley Cove—Continued										
07/28/2015	11:10	13.1	—	9.3	—	9.1	49.5	9.4	86.5	—
08/18/2015	11:10	4.9	—	6.2	—	10.3	39.4	2.5	63.6	—
09/23/2015	10:45	3.1	—	4.3	—	5.4	19.5	—	36.5	—
10/21/2015	10:50	4.7	—	—	—	E2.9	8.4	—	13.8	—
11/10/2015	11:30	2.1	—	3.2	—	E2.5	3.5	—	6.7	—
12/15/2015	12:20	2.7	—	—	—	—	4.7	2.9	27.5	—
*01/19/2016	10:50	—	—	5	—	11.8	54.6	14.1	451	—
02/17/2016	10:10	2.8	—	3.9	—	9.7	26.2	22.1	158	—
*03/07/2016	10:15	—	—	5.1	—	15.9	46.4	57.5	313	—
04/19/2016	10:40	—	14.8	3.7	—	4.2	27.7	19.9	60.5	7.3
05/18/2016	10:45	—	5.3	—	—	—	5.5	4	10.2	—
06/15/2016	10:50	—	—	53.1	—	3.8	11.7	—	21.3	33.7
San Joaquin River near Vernalis—Continued										
07/28/2015	12:15	—	—	E1.6	—	—	E2.4	7.2	4.3	—
08/18/2015	12:50	—	—	—	—	—	—	1.9	—	—
09/23/2015	12:20	—	—	—	—	—	—	—	—	—
10/21/2015	12:40	—	—	—	—	—	—	—	—	—
11/10/2015	13:00	—	—	—	—	—	—	3.1	—	—
12/15/2015	11:00	—	—	—	—	—	8.2	14.1	26.3	—
*01/19/2016	12:30	—	7.2	E3.1	—	9.2	27.6	50.4	181	—
02/17/2016	12:00	—	—	E3.0	—	—	9.9	15.2	58.3	—
*03/07/2016	11:50	—	—	3.5	E3.2	8.1	21.9	51	133	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Desulfinylfipronil [66607]	Diazinon [65078]	3,4-Dichloroaniline [66584]	3,5-Dichloroaniline [67536]	3,4-Dichlorophenylurea [68226]	*N*-(3,4-Dichlorophenyl)-*N*-methylurea [68231]	Dithiopyr [51837]	Diuron [66598]	EPTC [65080]
San Joaquin River near Vernalis—Continued										
04/19/2016	12:45	—	—	E2.5	—	E2.9	10.8	6.3	33.1	—
05/18/2016	12:20	—	6	—	—	—	—	3.5	7.5	—
06/15/2016	12:40	—	—	5	—	—	—	—	6	—
Ulatis Creek at Browns Road—Continued										
07/28/2015	14:20	—	—	E2.9	—	—	4.4	15.4	6.4	—
08/18/2015	15:00	—	—	E2.1	—	—	4	5.1	5.1	—
09/23/2015	14:15	—	—	—	—	—	—	—	—	—
10/21/2015	15:00	5.3	—	—	—	3.6	6.6	14.2	18.4	—
11/10/2015	15:30	2.7	—	4	—	—	E2.2	7.6	4.5	—
12/15/2015	08:50	3.2	—	E2.2	—	—	5.4	203	34	—
*01/19/2016	15:00	—	—	—	—	—	7	35.3	44.8	—
02/17/2016	14:10	—	—	3.6	—	5.3	3.8	13.1	6.4	—
*03/07/2016	08:30	—	44.2	—	—	—	5.4	184	37.7	—
04/19/2016	15:10	—	—	4.2	—	3.4	18.7	13	78.8	—
05/18/2016	14:20	—	—	E2.2	—	—	3.5	6.3	11.2	—
06/15/2016	14:40	—	—	6.1	—	—	—	—	3.3	7

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Fenhexamid [67622]	Fipronil sulfide [66610]	Fipronil sulfone [66613]	Fipronil [66604]	Fluridone [51864]	Flusilazole [67649]	Fluxapyroxad [51851]	Hexazinone [65085]	Imazalil [67662]	Imidacloprid [68426]	Indoxacarb [68627]	Iprodione [66617]
Mokelumne River at New Hope Road—Continued													
07/28/2015	09:50	—	—	—	—	4	—	4.8	40.7	—	—	—	—
08/18/2015	09:50	—	—	—	—	4.3	—	23.5	20.3	—	—	—	—
09/23/2015	09:20	17.3	—	—	—	—	—	—	11.5	119	—	—	—
10/21/2015	09:10	—	—	—	—	—	—	—	13.6	—	—	—	—
11/10/2015	10:00	—	—	—	3.1	—	—	E3.4	15.9	—	—	—	—
12/15/2015	14:00	—	—	—	—	—	—	—	E5.8	—	—	—	—
*01/19/2016	09:45	—	—	—	—	—	—	—	E7.9	—	—	—	—
02/17/2016	09:00	—	—	—	—	—	—	—	—	—	—	—	39.2
*03/07/2016	13:30	—	—	—	—	—	—	E2.7	E4.2	—	—	—	33.8

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Fenhexamid [67622]	Fipronil sulfide [66610]	Fipronil sulfone [66613]	Fipronil [66604]	Fluridone [51864]	Flusilazole [67649]	Fluxapyroxad [51851]	Hexazinone [65085]	Imazalil [67662]	Imidacloprid [68426]	Indoxacarb [68627]	Iprodione [66617]
Mokelumne River at New Hope Road—Continued													
04/19/2016	09:20	—	—	—	—	—	—	6.8	17.7	—	—	—	—
05/18/2016	09:30	—	—	—	—	—	—	—	9.9	—	—	—	—
06/15/2016	09:15	—	—	—	—	—	—	—	11.8	—	—	—	—
Sacramento River at Hood—Continued													
07/28/2015	08:45	—	—	—	25	—	—	—	43.8	—	—	—	—
08/18/2015	08:40	—	—	—	6.9	4.5	—	E2.0	22.9	—	E2.3	—	—
09/23/2015	08:30	8.5	—	—	—	—	—	—	11.6	100	—	—	—
10/21/2015	08:00	—	—	—	4.4	—	—	—	20	—	—	—	—
11/10/2015	09:00	—	—	—	12.2	—	—	—	27.2	—	E1.9	—	—
12/15/2015	15:00	—	—	—	—	—	—	—	E8.2	—	—	—	—
*01/19/2016	08:30	—	—	—	—	—	7.5	—	9	—	—	—	—
02/17/2016	08:00	28.1	—	—	—	—	—	—	E7.0	—	E2.2	—	—
*03/07/2016	14:20	—	—	—	—	—	—	—	—	—	9.3	—	6
04/19/2016	08:20	—	—	—	4.6	—	—	—	19.4	—	—	—	—
05/18/2016	08:30	—	—	—	—	—	—	—	14.8	—	—	—	—
06/15/2016	08:10	—	—	—	3.1	—	—	—	17.5	—	—	—	—
San Joaquin River at Buckley Cove—Continued													
07/28/2015	11:10	—	10.8	12.2	13.5	383	—	15.4	132	—	E3.2	—	—
08/18/2015	11:10	—	4.6	3.9	—	293	—	32.4	94.8	—	5.2	—	—
09/23/2015	10:45	—	3	—	—	165	—	22.6	39	—	9.7	—	—
10/21/2015	10:50	—	—	—	—	57	—	35.8	33	—	—	—	—
11/10/2015	11:30	—	—	—	E1.8	9.6	—	21.7	19.2	—	—	—	—
12/15/2015	12:20	—	—	—	—	23.4	—	—	E8.3	—	4.6	—	—
*01/19/2016	10:50	—	—	—	3.4	11.3	—	10	30.7	—	17.8	—	34.6
02/17/2016	10:10	—	—	—	—	16.3	—	11.4	13.5	—	8.9	—	51.1
*03/07/2016	10:15	—	—	—	—	25.6	—	E4.7	16.6	—	7.2	—	42.1
04/19/2016	10:40	—	—	—	4.4	230	—	57.7	54.5	—	60.1	—	—
05/18/2016	10:45	—	—	—	—	208	—	7.2	10.3	—	13.7	—	—
06/15/2016	10:50	—	—	—	—	213	—	11.1	21.2	—	7.3	—	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Fenhexamid [67622]	Fipronil sulfide [66610]	Fipronil sulfone [66613]	Fipronil [66604]	Fluridone [51864]	Flusilazole [67649]	Fluxapyroxad [51851]	Hexazinone [65085]	Imazalil [67662]	Imidacloprid [68426]	Indoxacarb [68627]	Iprodione [66617]
San Joaquin River near Vernalis—Continued													
07/28/2015	12:15	—	—	—	—	4.4	—	—	38.8	—	—	—	—
08/18/2015	12:50	—	—	—	—	—	—	5.8	22.9	—	—	—	—
09/23/2015	12:20	—	—	—	—	—	—	—	11.4	—	—	—	—
10/21/2015	12:40	—	—	—	—	—	—	E4.0	12.9	—	—	—	—
11/10/2015	13:00	—	—	—	E2.4	—	—	6.6	10.9	—	—	—	—
12/15/2015	11:00	12.1	—	—	—	—	—	—	8.9	—	E2.9	—	—
*01/19/2016	12:30	—	—	—	E2.1	—	12.7	—	46.4	—	12.4	—	124
02/17/2016	12:00	—	—	—	—	E2.4	—	6.3	9.5	—	4.3	—	201
*03/07/2016	11:50	—	—	—	—	E2.7	—	E4.3	17.9	—	8.3	—	54.2
04/19/2016	12:45	—	—	—	—	E2.5	—	24.7	33.5	—	11.1	—	—
05/18/2016	12:20	—	—	—	—	—	—	6.9	8.7	—	—	—	—
06/15/2016	12:40	—	—	—	—	—	—	7.9	11.7	—	—	—	—
Ulatis Creek at Browns Road—Continued													
07/28/2015	14:20	—	—	—	—	11.6	—	14.8	67.8	—	12.6	—	—
08/18/2015	15:00	—	—	—	—	6.7	—	32.6	72.2	—	4.6	—	—
09/23/2015	14:15	—	—	—	—	4.5	—	E2.7	—	—	3.9	—	—
10/21/2015	15:00	—	—	—	13.4	5.4	—	13.8	32.9	—	30	—	—
11/10/2015	15:30	—	—	4.7	3.8	E2.1	—	13.3	41.4	—	16	—	—
12/15/2015	08:50	73.1	—	4.6	4.1	—	—	—	14.1	—	21.9	—	—
*01/19/2016	15:00	—	—	—	11	—	—	—	32.2	—	19.5	—	—
02/17/2016	14:10	—	—	—	—	E2.0	—	—	13.2	—	17.8	—	—
*03/07/2016	08:30	—	—	4.8	4	23.3	—	71.4	2,270	—	19.5	72.9	—
04/19/2016	15:10	—	—	—	—	95.8	—	15.2	78.2	—	9.6	—	—
05/18/2016	14:20	—	—	—	—	12.7	—	7.6	112	—	7.8	—	—
06/15/2016	14:40	—	—	—	—	3.8	—	—	86.6	—	6.4	—	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Metalaxyl [68437]	Methoxyfenozide [68647]	Metolachlor [65090]	Myclobutanil [66632]	Oryzalin [68663]	Oxadiazon [51843]	Oxyfluorfen [65093]	Pendimethalin [65098]	Penoxsulam [51863]	Piperonyl butoxide [65102]	Prodiamine [51844]
Mokelumne River at New Hope Road—Continued												
07/28/2015	09:50	—	3.2	14.2	—	—	—	—	—	—	—	—
08/18/2015	09:50	—	11.8	8	15.2	—	—	—	—	—	3.9	—
09/23/2015	09:20	—	—	4.4	—	—	—	—	—	—	—	—
10/21/2015	09:10	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	10:00	—	—	—	—	—	—	—	—	—	14.6	—
12/15/2015	14:00	—	—	—	—	—	—	7.7	—	—	4.1	—
*01/19/2016	09:45	—	—	—	—	—	—	16.7	17.7	—	6.9	—
02/17/2016	09:00	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	13:30	—	6.4	—	—	E2.6	—	6.3	—	—	—	—
04/19/2016	09:20	—	—	—	—	—	—	—	—	—	—	—
05/18/2016	09:30	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	09:15	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Hood—Continued												
07/28/2015	08:45	—	—	13.2	—	—	—	—	—	—	36.3	—
08/18/2015	08:40	—	—	3.9	—	—	—	—	—	—	17.8	—
09/23/2015	08:30	—	—	—	—	—	—	—	—	—	10.2	—
10/21/2015	08:00	—	—	—	—	—	—	—	—	—	4.7	—
11/10/2015	09:00	—	—	—	—	—	—	—	—	—	45	—
12/15/2015	15:00	—	—	—	—	—	—	3.8	—	—	7.4	—
*01/19/2016	08:30	—	3.2	—	—	—	—	—	—	—	—	—
02/17/2016	08:00	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	14:20	—	—	13.6	—	25	—	—	—	—	—	—
04/19/2016	08:20	—	—	—	—	—	—	—	—	—	10.4	—
05/18/2016	08:30	—	—	5.9	—	—	—	—	—	—	—	—
06/15/2016	08:10	—	—	7.1	—	—	—	—	—	—	4.4	—
San Joaquin River at Buckley Cove—Continued												
07/28/2015	11:10	—	47	143	—	—	—	—	—	—	—	—
08/18/2015	11:10	—	48.8	94.5	—	—	—	—	—	—	—	—
09/23/2015	10:45	—	63.9	43.3	—	—	—	—	—	—	6.1	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Metalaxyl [68437]	Methoxyfenozide [68647]	Metolachlor [65090]	Myclobutanil [66632]	Oryzalin [68663]	Oxadiazon [51843]	Oxyfluorfen [65093]	Pendimethalin [65098]	Penoxsulam [51863]	Piperonyl butoxide [65102]	Prodiamine [51844]
San Joaquin River at Buckley Cove—Continued												
10/21/2015	10:50	—	55.8	16.5	—	—	—	—	—	—	8.3	—
11/10/2015	11:30	—	8.1	12.2	—	—	—	—	—	—	20.5	—
12/15/2015	12:20	—	15.7	7	—	—	—	—	—	—	16.8	—
*01/19/2016	10:50	36.9	254	16.2	15.9	17.5	7.7	68.2	53.8	—	32.1	—
02/17/2016	10:10	—	85.4	10.8	—	E4.7	9.8	—	—	—	6	—
*03/07/2016	10:15	—	45.2	42.8	—	16.7	11.5	211	33.4	—	—	—
04/19/2016	10:40	—	74.3	55.6	—	15.1	—	—	—	—	7.2	—
05/18/2016	10:45	—	11.5	42.6	—	—	—	—	—	—	—	—
06/15/2016	10:50	—	21.7	83.5	—	—	—	—	14.4	—	—	—
San Joaquin River near Vernalis—Continued												
07/28/2015	12:15	—	18.9	30.8	—	—	—	—	—	—	—	—
08/18/2015	12:50	—	10.5	5.9	—	—	—	—	—	—	—	—
09/23/2015	12:20	—	16.6	—	—	—	—	—	—	—	—	—
10/21/2015	12:40	—	13.8	3.5	—	—	—	—	—	—	—	—
11/10/2015	13:00	—	5.2	6.4	—	—	—	—	—	—	—	—
12/15/2015	11:00	—	8.5	—	—	—	—	—	—	—	—	—
*01/19/2016	12:30	—	67.2	28.3	—	8.7	—	22.6	46	—	—	—
02/17/2016	12:00	—	28.2	—	—	—	—	—	—	—	—	—
*03/07/2016	11:50	—	36	12.6	—	10.1	—	—	28.9	—	—	—
04/19/2016	12:45	—	14	9	—	—	—	—	—	—	—	—
05/18/2016	12:20	—	7.6	11.8	—	—	—	—	—	—	—	—
06/15/2016	12:40	—	22.8	14.8	—	—	—	—	—	—	—	—
Ulatis Creek at Browns Road—Continued												
07/28/2015	14:20	—	3.8	140	—	—	—	—	—	—	—	—
08/18/2015	15:00	—	5.3	63	—	—	—	—	—	—	—	—
09/23/2015	14:15	17	—	—	—	—	—	—	—	—	—	—
10/21/2015	15:00	—	9	14.5	—	—	—	—	—	—	—	—
11/10/2015	15:30	—	—	20.9	—	—	—	—	—	—	—	—
12/15/2015	08:50	—	—	—	—	—	—	29.7	—	E3.1	—	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Metalaxyl [68437]	Methoxyfenozide [68647]	Metolachlor [65090]	Myclobutanil [66632]	Oryzalin [68663]	Oxadiazon [51843]	Oxyfluorfen [65093]	Pendimethalin [65098]	Penoxsulam [51863]	Piperonyl butoxide [65102]	Prodiamine [51844]
Ulatis Creek at Browns Road—Continued												
*01/19/2016	15:00	—	23.9	114	—	72.6	11	—	99.6	—	—	8.5
02/17/2016	14:10	—	—	—	—	—	—	37.9	—	—	—	—
*03/07/2016	08:30	—	9.4	57.2	—	18.7	50.4	25.7	205	—	—	E3.9
04/19/2016	15:10	—	—	9.1	—	—	—	6.3	33.6	E3.0	—	—
05/18/2016	14:20	—	—	2,630	—	—	—	—	—	—	—	—
06/15/2016	14:40	—	—	178	—	10.9	—	25.8	—	—	—	—

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Prometryn [65103]	Propanil [66641]	Propiconazole [66643]	Pyrimethanil [67717]	Quinoxyfen [51847]	Simazine [65105]	Tetraconazole [66654]	Thiabendazole [67161]	Thiamethoxam [68245]	Thiobencarb [65107]	Trifloxystrobin [66660]
Mokelumne River at New Hope Road—Continued												
07/28/2015	09:50	—	—	—	E2.0	—	—	—	—	—	—	—
08/18/2015	09:50	—	—	—	E2.3	—	—	—	—	—	—	—
09/23/2015	09:20	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	09:10	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	10:00	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	14:00	—	—	—	—	—	E4.5	—	—	—	—	—
*01/19/2016	09:45	—	—	—	—	—	19.9	E5.2	—	—	—	—
02/17/2016	09:00	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	13:30	—	—	—	—	—	247	—	—	—	—	—
04/19/2016	09:20	—	—	—	4.9	4.2	E4.3	7.5	—	—	—	7.4
05/18/2016	09:30	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	09:15	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Hood—Continued												
07/28/2015	08:45	—	38.8	—	—	—	—	—	—	—	—	—
08/18/2015	08:40	—	—	—	—	—	—	—	—	—	—	—
09/23/2015	08:30	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	08:00	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	09:00	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	15:00	—	—	—	—	—	—	—	—	—	—	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Prometryn [65103]	Propanil [66641]	Propiconazole [66643]	Pyrimethanil [67717]	Quinoxyfen [51847]	Simazine [65105]	Tetraconazole [66654]	Thiabendazole [67161]	Thiamethoxam [68245]	Thiobencarb [65107]	Trifloxystrobin [66660]
Sacramento River at Hood—Continued												
*01/19/2016	08:30	—	—	—	—	—	5.9	—	—	—	—	—
02/17/2016	08:00	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	14:20	—	—	E3.5	—	—	23.9	—	—	—	—	—
04/19/2016	08:20	—	—	—	—	—	E3.5	—	—	—	—	—
05/18/2016	08:30	—	—	—	—	—	—	—	—	—	21.5	—
06/15/2016	08:10	—	27.6	—	—	—	—	—	—	—	—	—
San Joaquin River at Buckley Cove—Continued												
07/28/2015	11:10	—	—	—	E2.6	—	53.5	—	—	—	—	—
08/18/2015	11:10	—	—	—	E3.0	—	26	—	E3.1	—	—	—
09/23/2015	10:45	—	—	—	—	—	6.9	—	—	3.4	—	—
10/21/2015	10:50	—	—	—	—	—	6.5	—	—	—	—	—
11/10/2015	11:30	—	—	—	—	—	E4.2	—	—	—	—	—
12/15/2015	12:20	—	—	—	—	—	E4.9	—	E3.0	—	—	—
*01/19/2016	10:50	—	—	—	—	—	387	—	—	—	—	—
02/17/2016	10:10	—	—	—	—	—	131	—	—	—	—	—
*03/07/2016	10:15	—	—	—	E2.0	—	192	—	—	—	—	—
04/19/2016	10:40	—	—	38.7	—	—	39.4	—	7.0	—	—	—
05/18/2016	10:45	—	—	—	—	—	5.9	—	5.5	—	—	—
06/15/2016	10:50	—	—	—	—	—	16.5	—	—	—	—	—
San Joaquin River near Vernalis—Continued												
07/28/2015	12:15	—	—	—	—	—	17	—	—	—	—	—
08/18/2015	12:50	—	—	—	—	—	5.3	—	—	—	—	—
09/23/2015	12:20	—	—	—	—	—	E3.3	—	—	—	—	—
10/21/2015	12:40	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	13:00	—	—	23.5	—	—	7.3	—	—	—	—	—
12/15/2015	11:00	—	—	—	—	—	8.4	—	—	—	—	—
*01/19/2016	12:30	—	—	23.4	—	—	30.6	11.6	—	—	—	—
02/17/2016	12:00	—	—	16.4	—	—	23.8	—	—	—	—	—
*03/07/2016	11:50	—	—	E4.8	—	—	21.6	—	—	—	—	—

Table 7. Pesticide concentrations with measured detections in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Prometryn [65103]	Propanil [66641]	Propiconazole [66643]	Pyrimethanil [67717]	Quinoxyfen [51847]	Simazine [65105]	Tetraconazole [66654]	Thiabendazole [67161]	Thiamethoxam [68245]	Thiobencarb [65107]	Trifloxystrobin [66660]
San Joaquin River near Vernalis—Continued												
04/19/2016	12:45	10.2	—	23.5	—	—	10.2	—	—	—	—	—
05/18/2016	12:20	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	12:40	—	—	—	—	—	—	—	—	—	—	—
Ulatis Creek at Browns Road—Continued												
07/28/2015	14:20	—	—	—	—	—	54.5	—	—	—	—	—
08/18/2015	15:00	—	—	—	E2.4	—	29.5	—	E2.7	—	—	—
09/23/2015	14:15	—	—	—	—	—	13.5	—	—	—	—	—
10/21/2015	15:00	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	15:30	—	—	—	—	—	9.5	—	—	—	—	—
12/15/2015	08:50	—	—	—	—	—	—	—	3.9	—	—	—
*01/19/2016	15:00	—	—	34	—	—	6.9	10.3	—	—	—	—
02/17/2016	14:10	—	—	—	—	—	15.3	—	4	—	—	—
*03/07/2016	08:30	—	—	24.8	—	—	209	—	—	—	—	7.7
04/19/2016	15:10	—	—	35.1	—	—	12.6	—	E2.3	—	—	—
05/18/2016	14:20	—	—	—	—	—	159	—	—	25.7	—	—
06/15/2016	14:40	—	—	—	—	—	16.2	—	—	—	—	—

Table 8. Pesticide concentrations with measured detections in suspended sediments filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Bifenthrin [65067]	Cyhalothrin (all isomers) [68354]	DCPA [65076]	Dithiopyr [51837]	Metalaxyl [68437]	Metolachlor [65090]	Oxyfluorfen [65093]	p,p′-DDE [65095]	Pendimethalin [65098]	Permethrin [65099]	Prodiamine [51844]
Mokelumne River at New Hope Road												
07/28/2015	09:50	—	—	—	—	—	—	—	—	—	—	—
08/18/2015	09:50	—	—	—	—	—	—	—	—	—	—	—
09/23/2015	09:20	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	09:10	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	10:00	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	14:00	—	—	—	—	—	—	—	—	—	—	—
*01/19/2016	09:45	—	—	—	—	—	—	—	—	—	—	—
02/17/2016	09:00	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	13:30	—	—	—	—	—	—	—	—	—	—	—
04/19/2016	09:20	—	—	—	—	—	—	—	—	—	—	—
05/18/2016	09:30	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	09:15	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Hood												
07/28/2015	08:45	—	—	—	—	—	—	—	—	—	—	—
08/18/2015	08:40	—	—	—	—	—	—	—	—	—	—	—
09/23/2015	08:30	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	08:00	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	09:00	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	15:00	—	—	—	—	—	—	—	—	—	—	—
*01/19/2016	08:30	—	—	—	—	—	—	—	—	—	—	—
02/17/2016	08:00	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	14:20	—	—	—	—	—	—	—	—	—	19.2	—
04/19/2016	08:20	—	—	—	—	—	—	—	—	—	—	—
05/18/2016	08:30	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	08:10	—	—	—	—	—	—	—	—	—	—	—

Table 8. Pesticide concentrations with measured detections in suspended sediments filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Bifenthrin [65067]	Cyhalothrin (all isomers) [68354]	DCPA [65076]	Dithiopyr [51837]	Metalaxyl [68437]	Metolachlor [65090]	Oxyfluorfen [65093]	p,p'-DDE [65095]	Pendimethalin [65098]	Permethrin [65099]	Prodiamine [51844]
San Joaquin River at Buckley Cove												
07/28/2015	11:10	—	—	—	—	—	—	—	—	—	—	—
08/18/2015	11:10	—	—	—	—	—	—	—	—	—	2.7	—
09/23/2015	10:45	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	10:50	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	11:30	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	12:20	—	—	—	—	—	—	—	—	—	—	—
*01/19/2016	10:50	—	—	—	—	—	—	—	—	51.1	—	—
02/17/2016	10:10	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	10:15	—	—	—	—	—	—	—	—	—	—	—
04/19/2016	10:40	—	—	—	—	—	—	—	—	—	—	—
05/18/2016	10:45	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	10:50	—	—	—	—	—	—	—	—	—	—	—
San Joaquin River near Vernalis												
07/28/2015	12:15	—	—	—	—	—	—	—	—	—	—	—
08/18/2015	12:50	—	—	—	—	—	—	—	—	—	—	—
09/23/2015	12:20	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	12:40	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	13:00	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	11:00	—	—	—	—	—	—	—	—	—	—	—
*01/19/2016	12:30	—	—	86.8	—	E1.0	—	—	—	27.5	—	—
02/17/2016	12:00	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	11:50	—	—	—	—	—	—	—	—	—	—	—
04/19/2016	12:45	4.3	—	—	—	—	—	—	—	—	—	—
05/18/2016	12:20	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	12:40	—	—	—	—	—	—	—	—	—	—	—

Table 8. Pesticide concentrations with measured detections in suspended sediments filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Bifenthrin [65067]	Cyhalothrin (all isomers) [68354]	DCPA [65076]	Dithiopyr [51837]	Metalaxyl [68437]	Metolachlor [65090]	Oxyfluorfen [65093]	p,p'-DDE [65095]	Pendimethalin [65098]	Permethrin [65099]	Prodiamine [51844]
Ulatis Creek at Browns Road												
07/28/2015	14:20	—	—	—	—	—	—	—	—	—	—	—
08/18/2015	15:00	—	—	—	—	—	—	—	—	—	3.2	—
09/23/2015	14:15	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	15:00	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	15:30	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	08:50	—	—	—	—	—	—	—	—	—	—	—
*01/19/2016	15:00	19	—	—	9.6	—	—	23.2	5.6	265	—	9.6
02/17/2016	14:10	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	08:30	3.5	15.2	—	—	—	—	—	—	—	26.4	—
04/19/2016	15:10	—	—	—	—	—	—	E2.9	—	—	—	—
05/18/2016	14:20	—	—	—	—	—	17.8	—	—	—	—	—
06/15/2016	14:40	—	—	—	—	—	4.1	—	—	—	—	—

Table 9. Whole water pesticide concentrations for all compounds with detections in water and suspended sediment filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.

[Table contains concentrations for all compounds with at least one detection in the suspended sediment filtered from environmental water. The whole water concentration is the sum of the suspended-sediment concentration and the dissolved concentration. Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter (ng/L). Whole water concentrations are listed in bold. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Bifenthrin [65067]			Cyhalothrin (all isomers) [68354]			DCPA [65076]			Dithiopyr [51837]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
Mokelumne River at New Hope Road													
07/28/2015	09:50	—	—	—	—	—	—	—	—	—	—	—	—
08/18/2015	09:50	—	—	—	—	—	—	—	—	—	—	—	—
09/23/2015	09:20	—	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	09:10	—	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	10:00	—	—	—	—	—	—	—	—	—	—	2.3	**2.3**
12/15/2015	14:00	—	—	—	—	—	—	—	—	—	—	7	**7**
*01/19/2016	09:45	—	—	—	—	—	—	—	—	—	—	14.8	**14.8**
02/17/2016	09:00	—	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	13:30	—	—	—	—	—	—	—	—	—	—	17.4	**17.4**
04/19/2016	09:20	—	—	—	—	—	—	—	—	—	—	2.1	**2.1**
05/18/2016	09:30	—	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	09:15	—	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Hood													
07/28/2015	08:45	—	—	—	—	—	—	—	—	—	—	7.9	**7.9**
08/18/2015	08:40	—	2.9	**2.9**	—	—	—	—	—	—	—	—	—
09/23/2015	08:30	—	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	08:00	—	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	09:00	—	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	15:00	—	—	—	—	—	—	—	—	—	—	3.5	**3.5**
*01/19/2016	08:30	—	—	—	—	—	—	—	—	—	—	—	—
02/17/2016	08:00	—	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	14:20	—	—	—	—	—	—	—	—	—	—	12	**12**
04/19/2016	08:20	—	—	—	—	—	—	—	—	—	—	—	—
05/18/2016	08:30	—	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	08:10	—	—	—	—	—	—	—	—	—	—	—	—

Table 9. Whole water pesticide concentrations for all compounds with detections in water and suspended sediment filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Table contains concentrations for all compounds with at least one detection in the suspended sediment filtered from environmental water. The whole water concentration is the sum of the suspended-sediment concentration and the dissolved concentration. Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter (ng/L). Whole water concentrations are listed in bold. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Bifenthrin [65067]			Cyhalothrin (all isomers) [68354]			DCPA [65076]			Dithiopyr [51837]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
San Joaquin River at Buckley Cove													
07/28/2015	11:10	—	—	—	—	—	—	—	—	—	—	9.4	**9.4**
08/18/2015	11:10	—	—	—	—	—	—	—	—	—	—	2.5	**2.5**
09/23/2015	10:45	—	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	10:50	—	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	11:30	—	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	12:20	—	—	—	—	—	—	—	—	—	—	2.9	**2.9**
*01/19/2016	10:50	—	—	—	—	—	—	—	—	—	—	14.1	**14.1**
02/17/2016	10:10	—	—	—	—	—	—	—	—	—	—	22.1	**22.1**
*03/07/2016	10:15	—	—	—	—	—	—	—	—	—	—	57.5	**57.5**
04/19/2016	10:40	—	—	—	—	—	—	—	—	—	—	19.9	**19.9**
05/18/2016	10:45	—	—	—	—	—	—	—	—	—	—	4	**4**
06/15/2016	10:50	—	—	—	—	—	—	—	—	—	—	—	—
San Joaquin River near Vernalis													
07/28/2015	12:15	—	—	—	—	—	—	—	—	—	—	7.2	**7.2**
08/18/2015	12:50	—	—	—	—	—	—	—	—	—	—	1.9	**1.9**
09/23/2015	12:20	—	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	12:40	—	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	13:00	—	—	—	—	—	—	—	—	—	—	3.1	**3.1**
12/15/2015	11:00	—	—	—	—	—	—	—	—	—	—	14.1	**14.1**
*01/19/2016	12:30	—	—	—	—	—	—	86.8	—	**86.8**	—	50.4	**50.4**
02/17/2016	12:00	—	—	—	—	—	—	—	—	—	—	15.2	**15.2**
*03/07/2016	11:50	—	—	—	—	—	—	—	—	—	—	51	**51**
04/19/2016	12:45	4.3	—	**4.3**	—	—	—	—	—	—	—	6.3	**6.3**
05/18/2016	12:20	—	—	—	—	—	—	—	—	—	—	3.5	**3.5**
06/15/2016	12:40	—	—	—	—	—	—	—	—	—	—	—	—

Table 9. Whole water pesticide concentrations for all compounds with detections in water and suspended sediment filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Table contains concentrations for all compounds with at least one detection in the suspended sediment filtered from environmental water. The whole water concentration is the sum of the suspended-sediment concentration and the dissolved concentration. Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter (ng/L). Whole water concentrations are listed in bold. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Bifenthrin [65067]			Cyhalothrin (all isomers) [68354]			DCPA [65076]			Dithiopyr [51837]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
Ulatis Creek at Browns Road													
07/28/2015	14:20	—	—	—	—	—	—	—	—	—	—	15.4	**15.4**
08/18/2015	15:00	—	—	—	—	—	—	—	—	—	—	5.1	**5.1**
09/23/2015	14:15	—	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	15:00	—	—	—	—	—	—	—	—	—	—	14.2	**14.2**
11/10/2015	15:30	—	33.3	**33.3**	—	—	—	—	—	—	—	7.6	**7.6**
12/15/2015	08:50	—	13.2	**13.2**	—	—	—	—	—	—	—	203	**203**
*01/19/2016	15:00	19	—	**19**	—	—	—	—	—	—	9.6	35.3	**44.9**
02/17/2016	14:10	—	11.5	**11.5**	—	—	—	—	—	—	—	13.1	**13.1**
*03/07/2016	08:30	3.5	—	**3.5**	15.2	—	**15.2**	—	—	—	—	184	**184**
04/19/2016	15:10	—	—	—	—	—	—	—	—	—	—	13	**13**
05/18/2016	14:20	—	—	—	—	—	—	—	—	—	—	6.3	**6.3**
06/15/2016	14:40	—	—	—	—	—	—	—	—	—	—	—	—

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Metalaxyl [68437]			Metolachlor [65090]			Oxyfluorfen [65093]			p,p′-DDE [65095]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
Mokelumne River at New Hope Road—Continued													
07/28/2015	09:50	—	—	—	—	14.2	**14.2**	—	—	—	—	—	—
08/18/2015	09:50	—	—	—	—	8	**8**	—	—	—	—	—	—
09/23/2015	09:20	—	—	—	—	4.4	**4.4**	—	—	—	—	—	—
10/21/2015	09:10	—	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	10:00	—	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	14:00	—	—	—	—	—	—	—	7.7	**7.7**	—	—	—
*01/19/2016	09:45	—	—	—	—	—	—	—	16.7	**16.7**	—	—	—
02/17/2016	09:00	—	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	13:30	—	—	—	—	—	—	—	6.3	**6.3**	—	—	—

Table 9. Whole water pesticide concentrations for all compounds with detections in water and suspended sediment filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Table contains concentrations for all compounds with at least one detection in the suspended sediment filtered from environmental water. The whole water concentration is the sum of the suspended-sediment concentration and the dissolved concentration. Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter (ng/L). Whole water concentrations are listed in bold. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Metalaxyl [68437]			Metolachlor [65090]			Oxyfluorfen [65093]			p,p′-DDE [65095]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
Mokelumne River at New Hope Road—Continued													
04/19/2016	09:20	—	—	—	—	—	—	—	—	—	—	—	—
05/18/2016	09:30	—	—	—	—	—	—	—	—	—	—	—	—
06/15/2016	09:15	—	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Hood—Continued													
07/28/2015	08:45	—	—	—	—	13.2	**13.2**	—	—	—	—	—	—
08/18/2015	08:40	—	—	—	—	3.9	**3.9**	—	—	—	—	—	—
09/23/2015	08:30	—	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	08:00	—	—	—	—	—	—	—	—	—	—	—	—
11/10/2015	09:00	—	—	—	—	—	—	—	—	—	—	—	—
12/15/2015	15:00	—	—	—	—	—	—	—	3.8	**3.8**	—	—	—
*01/19/2016	08:30	—	—	—	—	—	—	—	—	—	—	—	—
02/17/2016	08:00	—	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	14:20	—	—	—	—	13.6	**13.6**	—	—	—	—	—	—
04/19/2016	08:20	—	—	—	—	—	—	—	—	—	—	—	—
05/18/2016	08:30	—	—	—	—	5.9	**5.9**	—	—	—	—	—	—
06/15/2016	08:10	—	—	—	—	7.1	**7.1**	—	—	—	—	—	—
San Joaquin River at Buckley Cove—Continued													
07/28/2015	11:10	—	—	—	—	143	**143**	—	—	—	—	—	—
08/18/2015	11:10	—	—	—	—	94.5	**94.5**	—	—	—	—	—	—
09/23/2015	10:45	—	—	—	—	43.3	**43.3**	—	—	—	—	—	—
10/21/2015	10:50	—	—	—	—	16.5	**16.5**	—	—	—	—	—	—
11/10/2015	11:30	—	—	—	—	12.2	**12.2**	—	—	—	—	—	—
12/15/2015	12:20	—	—	—	—	7	**7**	—	—	—	—	—	—
*01/19/2016	10:50	—	36.9	**36.9**	—	16.2	**16.2**	—	68.2	**68.2**	—	—	—
02/17/2016	10:10	—	—	—	—	10.8	**10.8**	—	—	—	—	—	—
*03/07/2016	10:15	—	—	—	—	42.8	**42.8**	—	211	**211**	—	—	—

Table 9. Whole water pesticide concentrations for all compounds with detections in water and suspended sediment filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Table contains concentrations for all compounds with at least one detection in the suspended sediment filtered from environmental water. The whole water concentration is the sum of the suspended-sediment concentration and the dissolved concentration. Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter (ng/L). Whole water concentrations are listed in bold. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Metalaxyl [68437]			Metolachlor [65090]			Oxyfluorfen [65093]			p,p′-DDE [65095]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
San Joaquin River at Buckley Cove—Continued													
04/19/2016	10:40	—	—	—	—	55.6	**55.6**	—	22.6	**22.6**	—	—	—
05/18/2016	10:45	—	—	—	—	42.6	**42.6**	—	—	—	—	—	—
06/15/2016	10:50	—	—	—	—	83.5	**83.5**	—	—	—	—	—	—
San Joaquin River near Vernalis—Continued													
07/28/2015	12:15	—	—	—	—	30.8	**30.8**	—	—	—	—	—	—
08/18/2015	12:50	—	—	—	—	5.9	**5.9**	—	—	—	—	—	—
09/23/2015	12:20	—	—	—	—	—	—	—	—	—	—	—	—
10/21/2015	12:40	—	—	—	—	3.5	**3.5**	—	—	—	—	—	—
11/10/2015	13:00	—	—	—	—	6.4	**6.4**	—	—	—	—	—	—
12/15/2015	11:00	—	—	—	—	—	—	—	—	—	—	—	—
*01/19/2016	12:30	E1.0	—	**E1.0**	—	28.3	**28.3**	—	—	—	—	—	—
02/17/2016	12:00	—	—	—	—	—	—	—	—	—	—	—	—
*03/07/2016	11:50	—	—	—	—	12.6	**12.6**	—	—	—	—	—	—
04/19/2016	12:45	—	—	—	—	9	**9**	—	—	—	—	—	—
05/18/2016	12:20	—	—	—	—	11.8	**11.8**	—	—	—	—	—	—
06/15/2016	12:40	—	—	—	—	14.8	**14.8**	—	—	—	—	—	—
Ulatis Creek at Browns Road—Continued													
07/28/2015	14:20	—	—	—	—	140	**140**	—	—	—	—	—	—
08/18/2015	15:00	—	—	—	—	63	**63**	—	—	—	—	—	—
09/23/2015	14:15	—	17	**17**	—	—	—	—	—	—	—	—	—
10/21/2015	15:00	—	—	—	—	14.5	**14.5**	—	—	—	—	—	—
11/10/2015	15:30	—	—	—	—	20.9	**20.9**	—	—	—	—	—	—
12/15/2015	08:50	—	—	—	—	—	—	—	29.7	**29.7**	—	—	—
*01/19/2016	15:00	—	—	—	—	114	**114**	23.2	—	**23.2**	5.6	—	**5.6**
02/17/2016	14:10	—	—	—	—	—	—	—	37.9	**37.9**	—	—	—
*03/07/2016	08:30	—	—	—	—	57.2	**57.2**	—	25.7	**25.7**	—	—	—

Table 9. Whole water pesticide concentrations for all compounds with detections in water and suspended sediment filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Table contains concentrations for all compounds with at least one detection in the suspended sediment filtered from environmental water. The whole water concentration is the sum of the suspended-sediment concentration and the dissolved concentration. Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter (ng/L). Whole water concentrations are listed in bold. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Metalaxyl [68437]			Metolachlor [65090]			Oxyfluorfen [65093]			p,p′-DDE [65095]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
Ulatis Creek at Browns Road—Continued													
04/19/2016	15:10	—	—	—	—	9.1	**9.1**	E2.9	6.3	**E9.2**	—	—	—
05/18/2016	14:20	—	—	—	17.8	2,630	**2,650**	—	—	—	—	—	—
06/15/2016	14:40	—	—	—	4.1	178	**182**	—	25.8	**25.8**	—	—	—

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Pendimethalin [65098]			Prodiamine [51844]			Permethrin [65099]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
Mokelumne River at New Hope Road—Continued										
07/28/2015	09:50	—	—	—	—	—	—	—	—	—
08/18/2015	09:50	—	—	—	—	—	—	—	—	—
09/23/2015	09:20	—	—	—	—	—	—	—	—	—
10/21/2015	09:10	—	—	—	—	—	—	—	—	—
11/10/2015	10:00	—	—	—	—	—	—	—	—	—
12/15/2015	14:00	—	—	—	—	—	—	—	—	—
*01/19/2016	09:45	—	17.7	**17.7**	—	—	—	—	—	—
02/17/2016	09:00	—	—	—	—	—	—	—	—	—
*03/07/2016	13:30	—	—	—	—	—	—	—	—	—
04/19/2016	09:20	—	—	—	—	—	—	—	—	—
05/18/2016	09:30	—	—	—	—	—	—	—	—	—
06/15/2016	09:15	—	—	—	—	—	—	—	—	—
Sacramento River at Hood—Continued										
07/28/2015	08:45	—	—	—	—	—	—	—	—	—
08/18/2015	08:40	—	—	—	—	—	—	—	—	—
09/23/2015	08:30	—	—	—	—	—	—	—	—	—
10/21/2015	08:00	—	—	—	—	—	—	—	—	—
11/10/2015	09:00	—	—	—	—	—	—	—	—	—

Table 9. Whole water pesticide concentrations for all compounds with detections in water and suspended sediment filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Table contains concentrations for all compounds with at least one detection in the suspended sediment filtered from environmental water. The whole water concentration is the sum of the suspended-sediment concentration and the dissolved concentration. Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter (ng/L). Whole water concentrations are listed in bold. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Pendimethalin [65098]			Prodiamine [51844]			Permethrin [65099]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
Sacramento River at Hood—Continued										
12/15/2015	15:00	—	—	—	—	—	—	—	—	—
*01/19/2016	08:30	—	—	—	—	—	—	—	—	—
02/17/2016	08:00	—	—	—	—	—	—	—	—	—
*03/07/2016	14:20	—	—	—	—	—	—	19.2	—	**19.2**
04/19/2016	08:20	—	—	—	—	—	—	—	—	—
05/18/2016	08:30	—	—	—	—	—	—	—	—	—
06/15/2016	08:10	—	—	—	—	—	—	—	—	—
San Joaquin River at Buckley Cove—Continued										
07/28/2015	11:10	—	—	—	—	—	—	—	—	—
08/18/2015	11:10	—	—	—	—	—	—	2.7	—	**2.7**
09/23/2015	10:45	—	—	—	—	—	—	—	—	—
10/21/2015	10:50	—	—	—	—	—	—	—	—	—
11/10/2015	11:30	—	—	—	—	—	—	—	—	—
12/15/2015	12:20	—	—	—	—	—	—	—	—	—
*01/19/2016	10:50	51.1	53.8	**105**	—	—	—	—	—	—
02/17/2016	10:10	—	—	—	—	—	—	—	—	—
*03/07/2016	10:15	—	33.4	**33.4**	—	—	—	—	—	—
04/19/2016	10:40	—	—	—	—	—	—	—	—	—
05/18/2016	10:45	—	—	—	—	—	—	—	—	—
06/15/2016	10:50	—	14.4	**14.4**	—	—	—	—	—	—
San Joaquin River near Vernalis—Continued										
07/28/2015	12:15	—	—	—	—	—	—	—	—	—
08/18/2015	12:50	—	—	—	—	—	—	—	—	—
09/23/2015	12:20	—	—	—	—	—	—	—	—	—
10/21/2015	12:40	—	—	—	—	—	—	—	—	—
11/10/2015	13:00	—	—	—	—	—	—	—	—	—

Table 9. Whole water pesticide concentrations for all compounds with detections in water and suspended sediment filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Table contains concentrations for all compounds with at least one detection in the suspended sediment filtered from environmental water. The whole water concentration is the sum of the suspended-sediment concentration and the dissolved concentration. Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanogram per liter (ng/L). Whole water concentrations are listed in bold. **Abbreviations**: E, estimated; hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Pendimethalin [65098]			Prodiamine [51844]			Permethrin [65099]		
		Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water	Suspended sediment	Dissolved	Whole water
San Joaquin River near Vernalis—Continued										
12/15/2015	11:00	—	—	—	—	—	—	—	—	—
*01/19/2016	12:30	27.5	46	**73.5**	—	—	—	—	—	—
02/17/2016	12:00	—	—	—	—	—	—	—	—	—
*03/07/2016	11:50	—	28.9	**28.9**	—	—	—	—	—	—
04/19/2016	12:45	—	—	—	—	—	—	—	—	—
05/18/2016	12:20	—	—	—	—	—	—	—	—	—
06/15/2016	12:40	—	—	—	—	—	—	—	—	—
Ulatis Creek at Browns Road—Continued										
07/28/2015	14:20	—	—	—	—	—	—	—	—	—
08/18/2015	15:00	—	—	—	—	—	—	3.2	—	**3.2**
09/23/2015	14:15	—	—	—	—	—	—	—	—	—
10/21/2015	15:00	—	—	—	—	—	—	—	—	—
11/10/2015	15:30	—	—	—	—	—	—	—	—	—
12/15/2015	08:50	—	—	—	—	—	—	—	—	—
*01/19/2016	15:00	265	99.6	**365**	9.6	8.5	**18.1**	—	—	—
02/17/2016	14:10	—	—	—	—	—	—	—	—	—
*03/07/2016	08:30	—	205	**205**	—	E3.9	**E3.9**	26.4	—	**26.4**
04/19/2016	15:10	—	33.6	**33.6**	—	—	—	—	—	—
05/18/2016	14:20	—	—	—	—	—	—	—	—	—
06/15/2016	14:40	—	—	—	—	—	—	—	—	—

Table 10. Concentrations of dissolved and suspended constituents measured in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. **Abbreviations**: del., result deleted by laboratory; hh:mm, hour:minute; mg/L, milligram per liter; mm/dd/yyyy, month/day/year; <, less than ; µg/L, microgram per liter; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Dissolved organic carbon [00681] (mg/L)	Particulate inorganic carbon [00688] (mg/L)	Particulate organic carbon [00689] (mg/L)	Total particulate carbon [00694] (mg/L)	Dissolved copper [01040] (µg/L)	Total particulate nitrogen [49570] (mg/L)
Mokelumne River at New Hope Road							
07/28/2015	09:50	3.06	—	1.41	1.41	1.3	0.19
08/18/2015	09:50	2.12	—	<0.86	0.86	0.96	0.099
09/23/2015	09:20	2.83	—	<0.61	0.61	1.4	0.069
10/21/2015	09:10	2.13	—	<0.21	0.21	1.1	0.033
11/10/2015	10:00	2.2	—	<0.20	0.2	1.2	0.031
12/15/2015	14:00	2.65	—	<0.30	0.3	0.99	0.049
01/19/2016	09:45	2.94	—	<0.62	0.62	1.4	0.088
02/17/2016	09:00	2.26	—	<0.76	0.76	1.5	0.094
03/07/2016	13:30	2.89	—	<0.42	0.42	2	0.063
04/19/2016	09:20	2.14	—	<0.95	0.95	1.4	0.131
05/18/2016	09:30	del.	—	<0.38	0.38	1.2	0.039
06/15/2016	09:15	2.68	—	<0.51	0.51	1.3	0.06
Sacramento River at Hood							
07/28/2015	08:45	1.81	—	0.36	0.36	1.2	0.049
08/18/2015	08:40	1.81	—	<0.11	0.11	1.7	—
09/23/2015	08:30	1.59	—	<0.11	0.11	1.9	—
10/21/2015	08:00	1.64	—	<0.17	0.17	1.3	—
11/10/2015	09:00	1.78	—	<0.26	0.26	1.3	0.04
12/15/2015	15:00	2.04	—	<0.51	0.51	1.0	0.084
01/19/2016	08:30	4.44	—	<2.11	2.11	2.6	0.254
02/17/2016	08:00	2.65	—	<0.45	0.45	1.9	0.064
03/07/2016	14:20	4.42	—	<2.55	2.55	2.6	0.316
04/19/2016	08:20	1.64	—	<0.50	0.5	1.3	0.086
05/18/2016	08:30	del.	—	<0.15	0.15	1.0	—
06/15/2016	08:10	2.56	—	<0.49	0.49	1.1	0.062
San Joaquin River at Buckley Cove							
07/28/2015	11:10	5.04	—	1.28	1.28	2.0	0.233
08/18/2015	11:10	4.82	—	<0.44	0.44	1.8	0.081
09/23/2015	10:45	4.28	—	<0.43	0.43	1.9	0.08
10/21/2015	10:50	3.54	—	<0.35	0.35	1.5	0.061
11/10/2015	11:30	2.72	—	<0.19	0.19	1.1	—
12/15/2015	12:20	3.35	0.06	1.12	1.18	1.5	0.145
01/19/2016	10:50	7.65	0.03	2.35	2.38	3.3	0.319
02/17/2016	10:10	8.37	—	<0.89	0.89	3.7	0.123
03/07/2016	10:15	7.37	—	<0.54	0.54	4.4	0.075
04/19/2016	10:40	4.8	—	<1.30	1.3	1.9	0.218
05/18/2016	10:45	3.23	—	<1.51	1.51	1.2	0.192
06/15/2016	10:50	3.85	—	<2.17	2.17	1.6	0.303

Table 10. Concentrations of dissolved and suspended constituents measured in environmental water samples collected in the Sacramento–San Joaquin Delta, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. **Abbreviations**: del., result deleted by laboratory; hh:mm, hour:minute; mg/L, milligram per liter; mm/dd/yyyy, month/day/year; <, less than ; µg/L, microgram per liter; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Dissolved organic carbon [00681] (mg/L)	Particulate inorganic carbon [00688] (mg/L)	Particulate organic carbon [00689] (mg/L)	Total particulate carbon [00694] (mg/L)	Dissolved copper [01040] (µg/L)	Total particulate nitrogen [49570] (mg/L)
San Joaquin River near Vernalis							
07/28/2015	12:15	2.6	—	0.79	0.79	0.86	0.178
08/18/2015	12:50	2.27	—	<0.15	0.15	—	—
09/23/2015	12:20	2.55	—	<0.15	0.15	0.92	—
10/21/2015	12:40	2.23	—	<0.18	0.18	0.81	—
11/10/2015	13:00	2.38	—	<0.29	0.29	0.88	0.042
12/15/2015	11:00	2.54	—	<0.29	0.29	—	0.05
01/19/2016	12:30	4.47	—	<1.40	1.4	1.8	0.193
02/17/2016	12:00	4.74	—	<1.48	1.48	1.2	0.236
03/07/2016	11:50	5.08	—	<1.60	1.6	1.6	0.225
04/19/2016	12:45	3.06	—	<2.99	2.99	1.5	0.434
05/18/2016	12:20	2.89	—	<2.90	2.9	0.83	0.461
06/15/2016	12:40	2.77	—	<4.80	4.8	1.0	0.67
Ulatis Creek at Browns Road							
07/28/2015	14:20	8.01	—	0.96	0.96	3.0	0.209
08/18/2015	15:00	7.22	—	<1.66	1.66	2.5	0.29
09/23/2015	14:15	9.97	—	<1.83	1.83	2.3	0.346
10/21/2015	15:00	8.93	—	<1.16	1.16	1.5	0.175
11/10/2015	15:30	4.25	—	<1.25	1.25	1.2	0.186
12/15/2015	08:50	6.32	0.05	1.54	1.59	2.4	0.248
01/19/2016	15:00	7.77	0.14	38.5	38.6	3.8	4.59
02/17/2016	14:10	4.74	—	<1.04	1.04	2.4	0.158
03/07/2016	08:30	9.24	0.13	5.14	5.27	3.9	0.613
04/19/2016	15:10	6.06	—	<4.41	4.41	3.6	0.77
05/18/2016	14:20	6.85	—	<1.69	1.69	3.0	0.255
06/15/2016	14:40	11.6	—	<1.80	1.8	4.2	0.323

Table 11. Water quality field parameters measured in surface-water samples collected in the Sacramento–San Joaquin Delta, California, 2015–16.

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System parameter codes. **Abbreviations**: hh:mm, hour:minute; mg/L, milligram per liter; mm/dd/yyyy, month/day/year; NTU, nephelometric turbidity units; °C, degrees Celsius; µS/cm, microsiemens per centimeter; —, data not collected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Water temperature [00010] (°C)	Specific conductance [00095] (µS/cm)	Dissolved oxygen [00300] (mg/L)	pH [00400]	Turbidity [63675] (NTU)
Mokelumne River at New Hope Road						
07/28/2015	9:50	24.2	122	8.0	8.2	—
08/18/2015	9:50	25.1	130	7.9	7.9	11
09/23/2015	9:20	20.6	187	8.2	7.8	6.6
10/21/2015	9:10	16.7	54	8.7	7.4	4.5
11/10/2015	10:00	12.4	52	9.9	7.2	6.6
12/15/2015	14:00	9.1	57	10.6	7.7	3.0
01/19/2016*	9:45	14.6	53	—	7.3	7.6
02/17/2016	9:00	14.0	59	9.3	7.6	7.6
03/07/2016*	13:30	13.6	55	9.3	7.6	—
04/19/2016	9:20	17.9	52	8.4	7.2	830
05/18/2016	9:30	18.9	52	8.3	7.4	0.0
06/15/2016	9:15	18.2	53	8.4	7.2	0.0
Sacramento River at Hood						
07/28/2015	8:45	23.7	132	7.2	7.2	—
08/18/2015	8:40	24.9	169	7.1	7.5	6.7
09/23/2015	8:30	20.9	172	8.1	7.5	7.6
10/21/2015	8:00	18.9	160	8.5	7.3	6.6
11/10/2015	9:00	13.4	178	9.2	7.0	5.9
12/15/2015	15:00	10.5	182	10.0	7.5	9.8
01/19/2016*	8:30	9.8	142	10.2	7.3	90
02/17/2016	8:00	13.4	190	9.6	7.5	14
03/07/2016*	14:20	13.0	140	9.2	7.3	76
04/19/2016	8:20	16.8	127	9.2	7.0	1.0
05/18/2016	8:30	19.2	108	8.6	7.2	0.0
06/15/2016	8:10	19.9	113	8.3	7.0	2.1
San Joaquin River at Buckley Cove						
07/28/2015	11:10	26.3	1,370	8.8	8.2	—
08/18/2015	11:10	26.0	1,360	6.2	7.7	16
09/23/2015	10:45	23.0	1,410	7.5	7.7	12
10/21/2015	10:50	21.4	860	8.1	7.8	5.6
11/10/2015	11:30	15.9	366	8.7	7.6	6.5
12/15/2015	12:20	11.1	592	11.1	7.9	22
01/19/2016*	10:50	11.1	409	9.1	7.4	68
02/17/2016	10:10	13.4	606	7.2	7.3	11
03/07/2016*	10:15	15.7	672	8.7	7.5	—
04/19/2016	10:40	20.6	878	9.4	7.5	0.1
05/18/2016	10:45	21.0	276	8.7	7.5	6.6
06/15/2016	10:50	23.7	624	7.8	7.3	4.8

Table 11. Water quality field parameters measured in surface-water samples collected in the Sacramento–San Joaquin Delta, California, 2015–16.—Continued

[Numbers in brackets are U.S. Geological Survey (USGS) National Water Information System parameter codes. **Abbreviations**: hh:mm, hour:minute; mg/L, milligram per liter; mm/dd/yyyy, month/day/year; NTU, nephelometric turbidity units; °C, degrees Celsius; µS/cm, microsiemens per centimeter; —, data not collected; *, storm sample]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Water temperature [00010] (°C)	Specific conductance [00095] (µS/cm)	Dissolved oxygen [00300] (mg/L)	pH [00400]	Turbidity [63675] (NTU)
San Joaquin River near Vernalis						
07/28/2015	12:15	25.3	962	9.0	7.9	—
08/18/2015	12:50	26.6	668	8.6	7.8	6.6
09/23/2015	12:20	21.9	706	8.6	7.7	5.0
10/21/2015	12:40	18.7	453	7.5	7.5	12
11/10/2015	13:00	13.4	299	8.3	7.3	7.2
12/15/2015	11:00	8.8	476	10.2	7.8	6.4
01/19/2016*	12:30	12.3	449	8.4	7.4	24
02/17/2016	12:00	15.5	975	8.7	7.6	12
03/07/2016*	11:50	16.0	751	8.0	7.7	4.6
04/19/2016	12:45	17.4	382	10.1	7.9	18
05/18/2016	12:20	19.4	322	12.0	8.4	1.7
06/15/2016	12:40	21.2	433	14.1	8.6	7.0
Ulatis Creek at Browns Road						
07/28/2015	14:20	25.2	695	7.1	7.9	—
08/18/2015	15:00	24.0	763	8.2	8.0	14
09/23/2015	14:15	20.9	1,050	7.2	7.8	16
10/21/2015	15:00	18.2	930	5.6	7.7	14
11/10/2015	15:30	13.8	1,030	10.2	8.1	22
12/15/2015	8:50	7.3	805	9.8	7.7	8.4
01/19/2016*	15:00	12.9	134	8.7	7.7	730
02/17/2016	14:10	16.6	1,120	11.0	8.2	7.2
03/07/2016*	8:30	12.1	208	9.5	7.2	160
04/19/2016	15:10	23.3	819	—	8.8	2.4
05/18/2016	14:20	24.4	811	9.0	8.1	0.0
06/15/2016	14:40	19.0	1,040	9.4	8.2	11

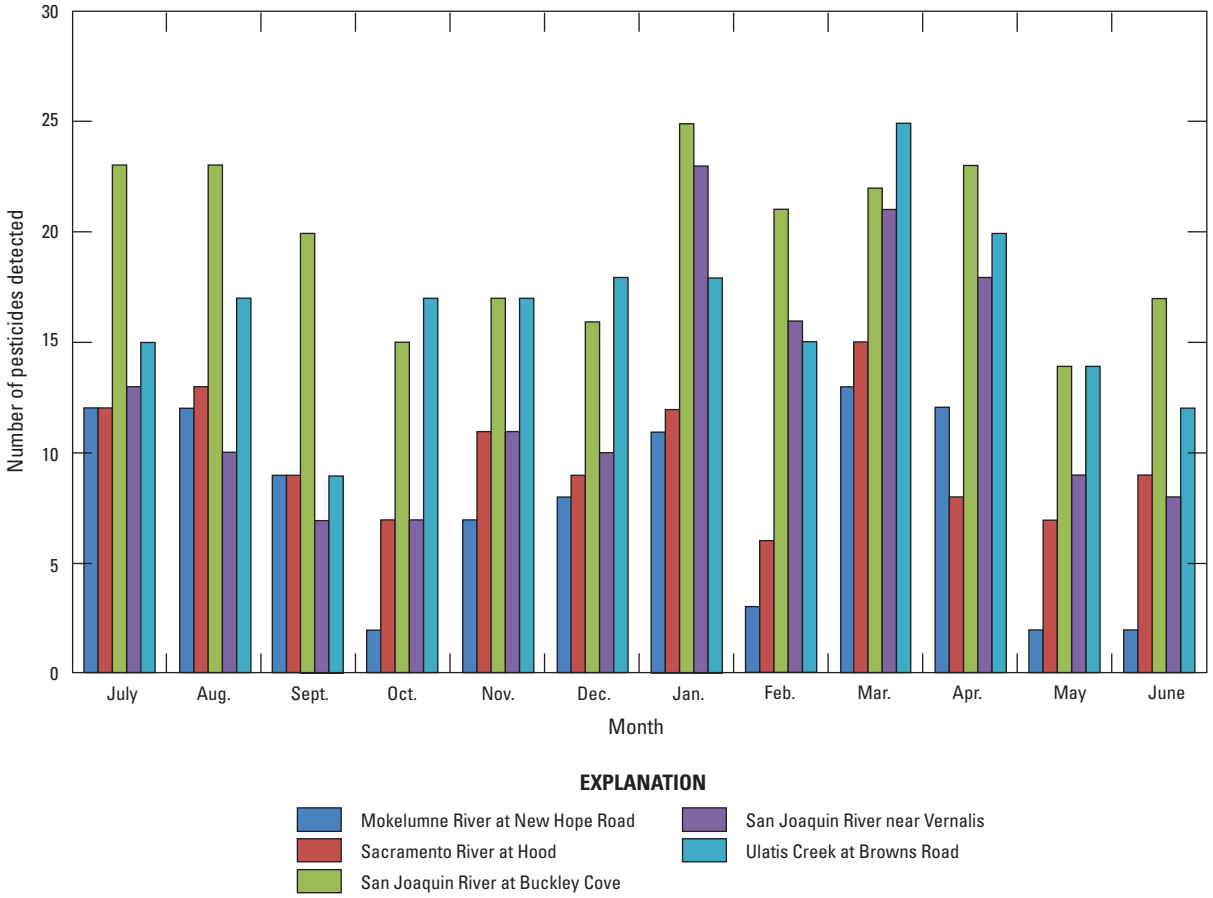

Figure 3. Numbers of pesticides detected per month in surface-water samples from July 2015 to June 2016 in the Sacramento–San Joaquin Delta, California.

San Joaquin River at Buckley Cove

A total of 37 pesticides (13 herbicides, 11 fungicides, 6 insecticides, 6 breakdown products, and 1 synergist) were detected in the water samples from this site. Nine pesticides were detected in every sample from this site (azoxystrobin, boscalid, DCPMU, diuron, fluridone, hexazinone, methoxyfenozide, metolachlor, and simazine), and nine additional pesticides (fluxapyroxad, carbendazim, chlorantraniliprole, DCPU, imidacloprid, 3,4-dichloroaniline, dithiopyr, piperonyl butoxide, and desulfinylfipronil) also were detected in at least 50 percent of the samples. The maximum pesticide concentration measured at the site was 451 ng/L for diuron in the sample collected on January 19, 2016. A minimum of 14 (May 18, 2016) and a maximum of 25 (January 19, 2016) pesticides or pesticide degradates were detected in each water sample (fig. 3). Pendimethalin was detected in the suspended sediments of the sample collected on January 19, 2016 (51.1 ng/L), and permethrin was detected in the suspended sediments collected on August 18, 2015 (2.7 ng/L).

The insecticide fipronil was detected (13.5 ng/L) in the water sample collected on July 28, 2015, at a concentration above the aquatic-life benchmark for chronic toxicity to invertebrates of 11 ng/L. Imidacloprid was detected in the water samples collected on January 19, 2016 (17.8 ng/L), April 19, 2016 (60.1 ng/L), and May 18, 2016 (13.7 ng/L), at concentrations above the aquatic-life benchmark for chronic toxicity to invertebrates of 10.0 ng/L (U.S. Environmental Protection Agency, 2017).

San Joaquin River Near Vernalis

A total of 32 pesticides (12 fungicides, 11 herbicides, 5 insecticides, and 4 breakdown products) were detected in the water samples collected from San Joaquin River near Vernalis. Three pesticides (methoxyfenozide, hexazinone, and boscalid) were detected in every sample from this site, and nine additional pesticides (azoxystrobin, metolachlor, simazine, chlorantraniliprole, dithiopyr, diuron, fluxapyroxad, DCPMU, and 3,4-dichloroaniline) were detected in at least half of the samples. The maximum pesticide concentration measured at this site was 201 ng/L for iprodione in the sample collected on February 17, 2016. A minimum of 7 (September 23, 2015, and October 21, 2015) and a maximum of 23 (January 19, 2016) pesticides or pesticide degradates were detected in each water sample (fig. 3). Imidacloprid was detected in the water samples collected on January 19, 2016 (12.4 ng/L), and April 19, 2016 (11.1 ng/L), at concentrations above the aquatic-life benchmark for chronic toxicity to invertebrates of 10.0 ng/L (U.S. Environmental Protection Agency, 2017).

Four pesticides were detected in the suspended sediments of water samples collected at San Joaquin River near Vernalis. The herbicides DCPA and pendimethalin were detected in the sample collected on January 19, 2016, at concentrations of 86.8 and 27.5 ng/L, respectively. The fungicide metalaxyl was detected at an estimated concentration of 1.0 ng/L in the sample collected on January 19, 2016. The insecticide bifenthrin was detected at a concentration of 4.3 ng/L in the sample collected on April 19, 2016.

Ulatis Creek at Browns Road

A total of 40 pesticides (14 herbicides, 12 fungicides, 9 insecticides, and 5 breakdown products) were detected in water samples collected from Ulatis Creek at Browns Road. Three pesticides were detected in every sample (boscalid, chlorantraniliprole, and imidacloprid), and 11 additional pesticides were detected in at least half of the samples. The maximum concentration measured at Ulatis Creek was 2,630 ng/L for the herbicide metolachlor in the sample collected on May 18, 2016. A minimum of 9 (September 23, 2015) and a maximum of 25 (March 7, 2016) pesticides or pesticide degradates were detected in each water sample (fig. 3).

Bifenthrin was detected in the samples collected on November 10, 2015 (33.3 ng/L), December 15, 2015 (13.2 ng/L), and February 17, 2016 (11.5 ng/L), at concentrations above the aquatic-life benchmark for chronic toxicity to invertebrates of 1.3 ng/L. Fipronil was detected at concentrations at or above the aquatic-life benchmark for chronic toxicity to invertebrates of 11 ng/L in the samples collected on October 21, 2015 (13.4 ng/L), and January 19, 2016 (11 ng/L). Imidacloprid was detected at concentrations above the aquatic-life benchmark for chronic toxicity to invertebrates of 10.0 ng/L in seven water samples at this site (U.S. Environmental Protection Agency, 2017).

Pesticides were detected in the suspended sediments of six samples collected at Ulatis Creek. A total of nine pesticides were detected (bifenthrin, cyhalothrin, dithiopyr, metolachlor, oxyfluorfen, *p,p'*-DDE, pendimethalin, permethrin, and prodiamine); the most frequently detected compounds being the herbicides metolachlor and oxyfluorfen (17 percent each) and the insecticides bifenthrin and permethrin (17 percent each). The storm sample collected on January 19, 2016, contained the most pesticides (six) and generally had the highest concentrations. The highest concentrations measured in the suspended sediment were 265 ng/L for pendimethalin, 26.4 ng/L for permethrin, and 23.2 ng/L for oxyfluorfen.

Summary

This study was conducted as part of the Sacramento–San Joaquin Delta (Delta) Regional Monitoring Program, which is a cooperative effort to better track beneficial-use protections and restoration efforts through the monitoring of mercury, nutrients, pathogens, and pesticides in the Delta. The U.S. Geological Survey (USGS) was responsible for collecting, analyzing, and reporting pesticide concentration data in the Delta. Samples were collected monthly at five major inputs to the Delta from July 2015 to June 2016 and analyzed for a suite of 154 pesticides and pesticide degradates, dissolved organic carbon, particulate organic carbon, particulate inorganic carbon, particulate nitrogen, and dissolved copper by the USGS. Ten samples were collected approximately mid-month, and two samples were collected following moderate-rainfall events.

Thirty-two quality-assurance and quality-control samples (replicates, blanks, and matrix spikes) were collected to validate measurements taken on environmental water samples. Twenty-seven quality-control samples satisfied quality assurance program plan requirements for the study; one blank sample analyzed for dissolved organic carbon was measured at a concentration above the reporting level, and four pesticide matrix-spike samples each contained one compound that was measured at over 130 percent recovery.

A total of 54 pesticides were detected in water samples collected during the study period (19 fungicides, 18 herbicides, 9 insecticides, 7 breakdown products, and 1 synergist). All samples contained mixtures of pesticides ranging from 2 to 25 pesticides per sample. Overall, 14 pesticides were detected in at least half of all samples. Pesticide concentrations ranged from below method detection limits listed in table 2 to 2,630 nanograms per liter for the herbicide metolachlor.

A total of 11 pesticides were detected in suspended sediments filtered from the water samples collected during the study period (6 herbicides, 3 insecticides, 1 fungicide, and 1 breakdown product). Overall, the most frequently detected pesticides on suspended sediments were permethrin (7 percent), pendimethalin (5 percent), and bifenthrin (5 percent). Pesticide concentrations in the suspended sediments ranged from below the method detection limits to 265 nanograms per liter for pendimethalin.

Bifenthrin, fipronil, and imidacloprid were measured at concentrations above their respective U.S. Environmental Protection Agency (EPA) aquatic-life benchmarks for chronic toxicity to invertebrates. The EPA aquatic-life benchmarks are listed only to give context to measurements; instantaneous concentrations above chronic criteria do not constitute an assessment of water quality.

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