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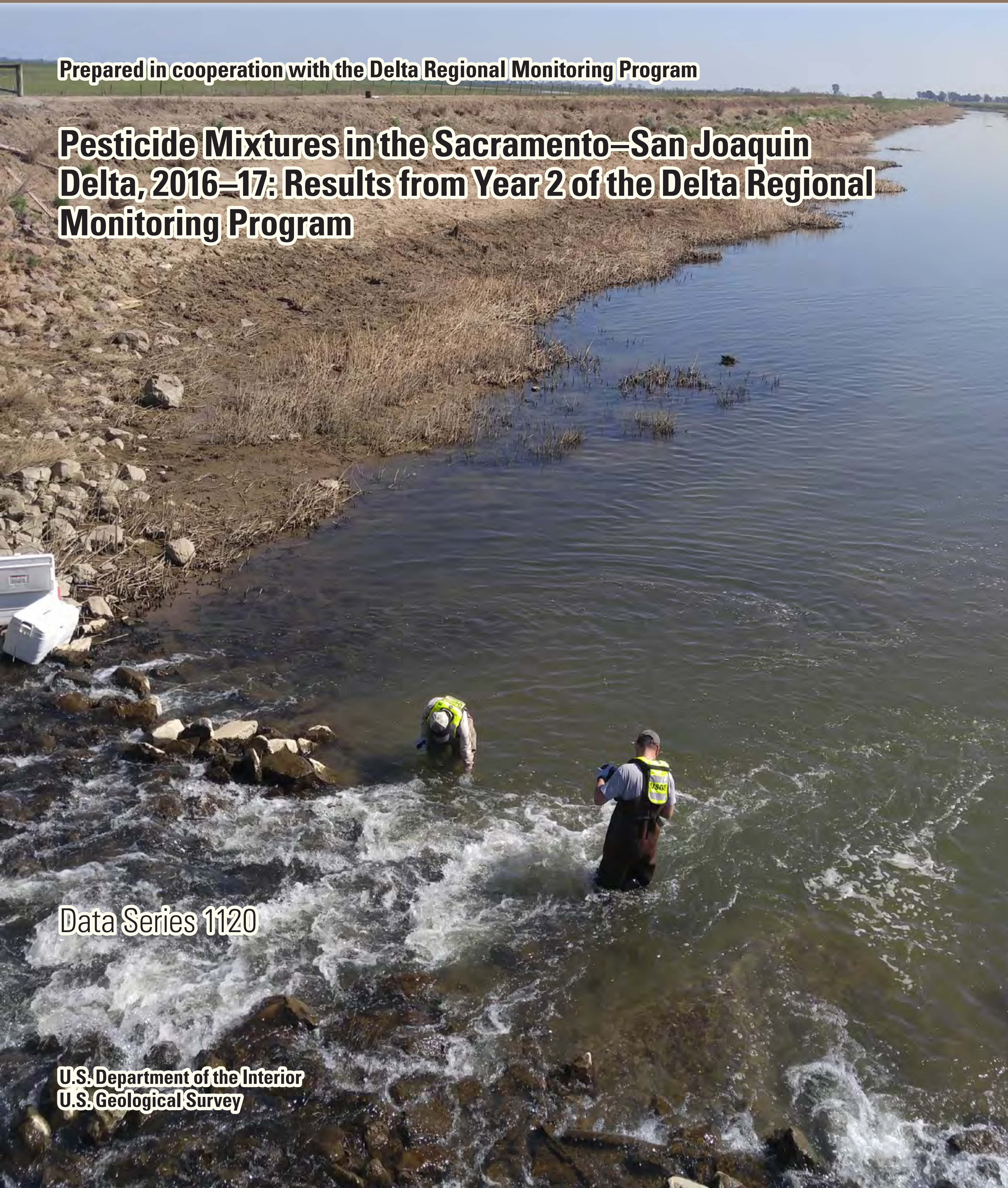
Pesticide Mixtures in the Sacramento–San Joaquin Delta, 2016–17: Results from Year 2 of the Delta Regional Monitoring Program



Data Series 1120

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

Front Cover: Ulatis Creek at Browns Road, photograph taken by Matthew De Parsia, U.S. Geological Survey, March 2017.

Back Cover: Top: New Hope Road near the Mokelumne River, photograph taken by Matthew De Parsia, U.S. Geological Survey, February 2017.
Bottom: San Joaquin River near Vernalis, photograph taken by Matthew De Parsia, U.S. Geological Survey, February 2017.

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DAVID BERNHARDT, Secretary

U.S. Geological Survey
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U.S. Geological Survey, Reston, Virginia: 2019

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Contents

Figures

Tables

Conversion Factors

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
	Volume	
liter (L)	33.81402	ounce, fluid (fl. oz)
	Mass	
milligram (mg)	0.000035	ounce (oz)

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

$$°F = (1.8 \times °C) + 32.$$

Datum

Horizontal coordinate information is referenced to the 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) or 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

±	plus or minus
AHP	Aquatic Health Program Laboratory
Delta RMP	Delta Regional Monitoring Program
DLBLK	detection limit by blank data
DOC	dissolved organic carbon
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
NWQL	National Water Quality Laboratory
OCRL	Organic Chemistry Research Laboratory
PIC	particulate inorganic carbon
POC	particulate organic carbon
POD	pelagic organism decline
QAPP	quality assurance program plan
RPD	relative percent difference
TPC	total particulate carbon
TPN	total particulate nitrogen
USGS	U.S. Geological Survey

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Abstract

The Delta Regional Monitoring Program was developed by the Central Valley Regional Water Quality Control Board in response to the decline of pelagic fish species in the Sacramento–San Joaquin Delta that was observed in the early 2000s. The U.S. Geological Survey, in cooperation with the Delta Regional Monitoring Program, has been responsible for collecting and analyzing surface-water samples for a suite of 154 pesticides and pesticide degradates in surface water and in suspended sediment. Additional 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; and field water-quality indicators (water temperature, specific conductance, dissolved oxygen, pH, and turbidity) were measured at each site.

Five integrator sites on streams draining mixed land-use watersheds were sampled monthly from July 2016 to June 2017. Two sites were sampled in the San Joaquin River watershed and one site was sampled in each of the Mokelumne River, Sacramento River, and Ulatis Creek watersheds.

A total of 53 out of 154 pesticides (18 herbicides, 14 insecticides, 13 fungicides, 7 breakdown products, and 1 synergist) were detected in surface-water samples and 95 percent of samples contained mixtures of 2 or more pesticides. The most frequently detected pesticides were the herbicides hexazinone, metolachlor, and diuron (present in 83 percent, 72 percent, and 67 percent of water samples, respectively), the insecticide methoxyfenozide (present in 83 percent of samples), and the fungicides boscalid and azoxystrobin (present in 67 percent and 58 percent of samples, respectively). Pesticide concentrations detected in water samples ranged from below method detection limits to 1,300 nanograms per liter (ng/L) for the insecticide chlorantraniliprole. A total of 4 pesticides (2 herbicides and 2 insecticides) were detected in suspended-sediment samples and 13 percent of suspended-sediment samples contained at least 1 pesticide. Pesticide concentrations detected in suspended-sediment samples ranged from 4.1 to 750 ng/L, both for the herbicide pendimethalin.

Six samples contained the insecticide imidacloprid at concentrations above the U.S. Environmental Protection Agency (EPA) Aquatic Life Benchmark (10 ng/L) for chronic toxicity to aquatic invertebrates. Three samples contained bifenthrin at concentrations above the EPA Aquatic Life Benchmark (1.3 ng/L) for chronic toxicity to invertebrates. One sample contained cyhalothrin at a concentration above the U.S. Aquatic Life Benchmark (3.5 ng/L) for acute toxicity to invertebrates.

Introduction

This multi-year study was done in cooperation with the San Francisco Estuary Institute Aquatic Science Center as part of the Delta Regional Monitoring Program (Delta RMP), a cooperative effort to better track beneficial-use protections and restoration efforts in the Sacramento–San Joaquin Delta (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 (Feyrer and others, 2007; Sommer and others, 2007). The Aquatic Science Center, a joint powers authority created by the State Water Resources Control Board 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 2016 through June 2017 and a brief comparison with pesticide results from samples collected July 2015 through June 2016, which were published in a previous report (De Parsia and others, 2018). Although monthly pesticide monitoring was suspended in June 2017, the Delta RMP is an ongoing monitoring program with no set end date for data collection or data dissemination.

Water samples for pesticide and toxicity determinations were collected concurrently to determine whether pesticides could contribute to observed toxicity in the Delta. The role of the U.S. Geological Survey (USGS) in the Delta RMP is to collect water samples for the determination of pesticide concentrations, toxicity, and ancillary water quality parameters (dissolved organic carbon, DOC; dissolved copper; particulate organic carbon, POC; particulate inorganic carbon, PIC; total particulate carbon, TPC; and total particulate nitrogen, TPN); to perform the pesticide and ancillary water-quality analyses; and to generate pesticide detection reports. Surface-water samples collected by the USGS for toxicity were used in toxicity analyses by the University of California, Davis Aquatic Health Program Laboratory (AHP).

Purpose and Scope

The purpose of this report is to provide measured concentrations of current-use pesticides and pesticide degradates reported 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.

Pairing pesticide-concentration data from environmental waters with toxicity testing is an important step toward understanding how complex mixtures of pesticides, such as those reported in the Delta, can contribute to toxicity observed in aquatic systems. The Environmental Protection Agency (EPA) provides aquatic life benchmarks for over 500 pesticides. Pesticides measured at concentrations above the EPA aquatic life benchmarks for chronic toxicity to invertebrates were reported where applicable (U.S. Environmental Protection Agency, 2017). Comparisons to EPA toxicity benchmarks were only used to provide context to pesticide concentrations for this report; they were not intended to be an assessment of water quality.

The data collection period from July 2016 through June 2017 represents the second year of the Delta RMP. Results from the July 2015 through June 2016 study period were briefly compared with results from the July 2016 through June 2017 study period.

Sampling Sites

Five sites on important inputs to the Delta were selected by the Delta RMP Technical Advisory Committee to be sampled monthly (fig. 1; table 1). Figure 2 shows land-cover types and watershed boundaries for the five sampling sites. Land cover has been grouped into six broad categories: urban, bare ground, forest, shrub and grasslands, agricultural/cultivated, or wetlands (U.S. Geological Survey, 2014). The watershed for the San Joaquin River at Buckley Cove also encompasses the San Joaquin River near Vernalis watershed. A complete description of the five sites can be found in De Parsia and others (2018).

Precipitation and Hydrologic Conditions

Water year 2017 (October 1, 2016, to September 30, 2017) had above average precipitation, with watersheds in the study area receiving 100–200 percent of their normal yearly precipitation (fig. 3; National Oceanic and Atmospheric Administration, 2018). The above average precipitation in water year 2017 contrasts with the below average precipitation of water year 2016 (October 1, 2015, to September 30, 2016) for the first year of the Delta RMP, in which most watersheds in the study area received 50–100 percent of their normal yearly precipitation (National Oceanic and Atmospheric Administration, 2018). Similar to precipitation, stream flows contrasted strongly between water years 2016 and 2017, as exemplified by the San Joaquin River (fig. 4).

High flows caused by severe storms resulted in levee failures and flooding at multiple locations in the Delta, including levee breaches near two study sites, Mokelumne River at New Hope and San Joaquin River near Vernalis.

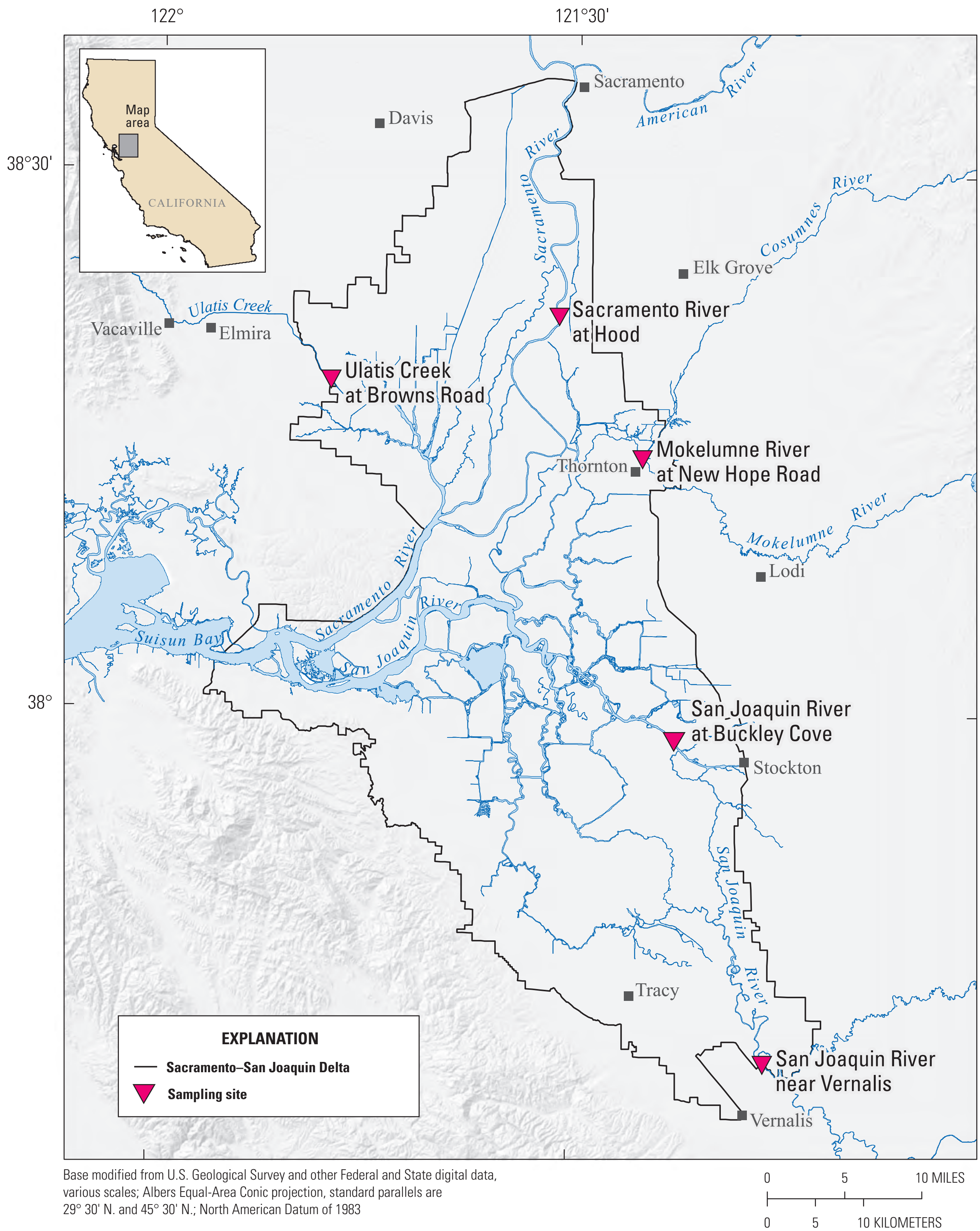

Figure 1. Sampling locations and the legal boundary of the Sacramento–San Joaquin Delta, California, 2016–17.

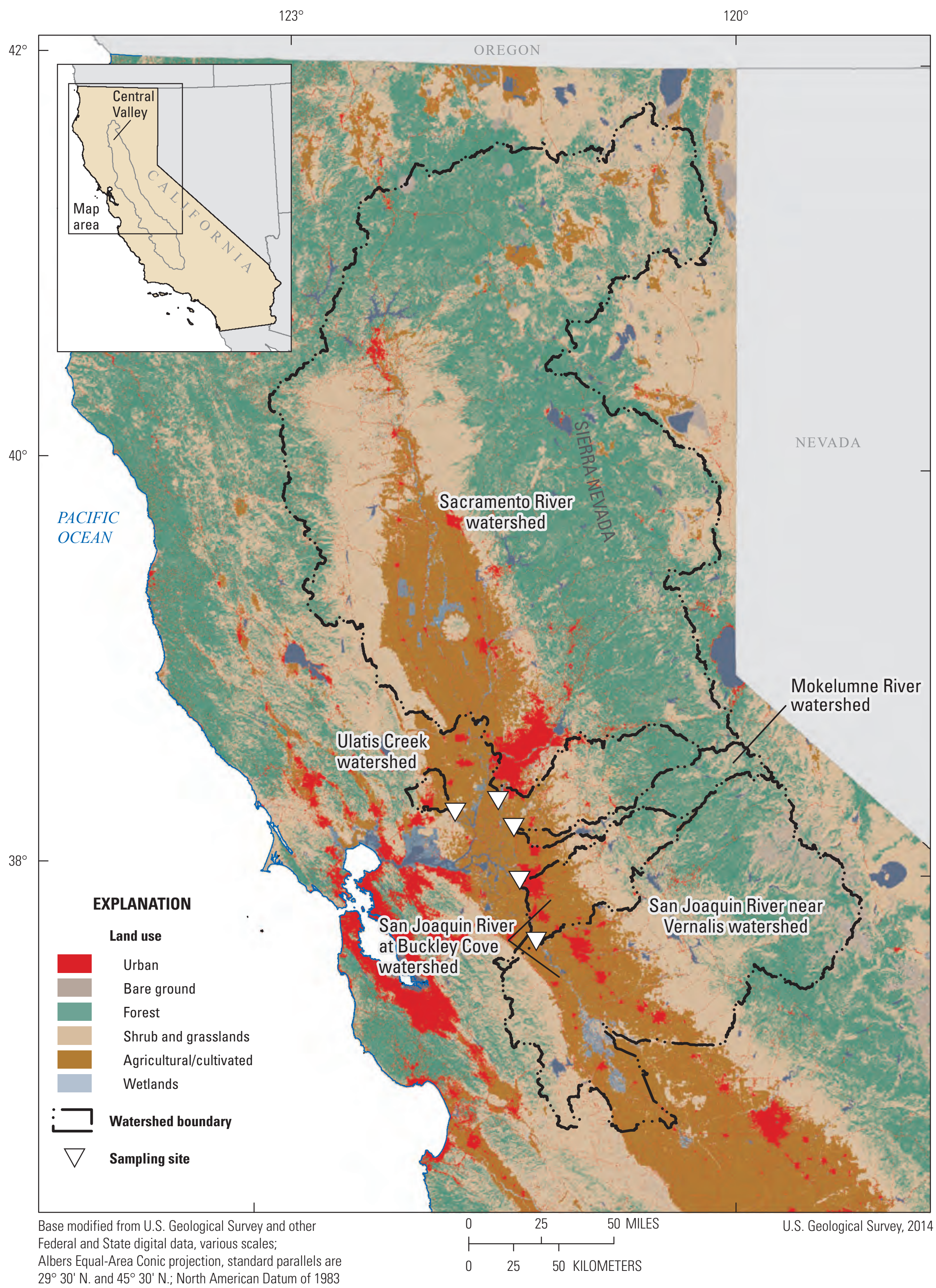

Figure 2. Land-cover types and watershed boundaries for sites sampled from July 2016 to June 2017 in the Sacramento–San Joaquin Delta, California.

Table 1. Surface-water sampling sites in the Sacramento–San Joaquin Delta, California, 2016–17.

[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	Latitude[1] (dms)	Longtitude[1] (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 1983.

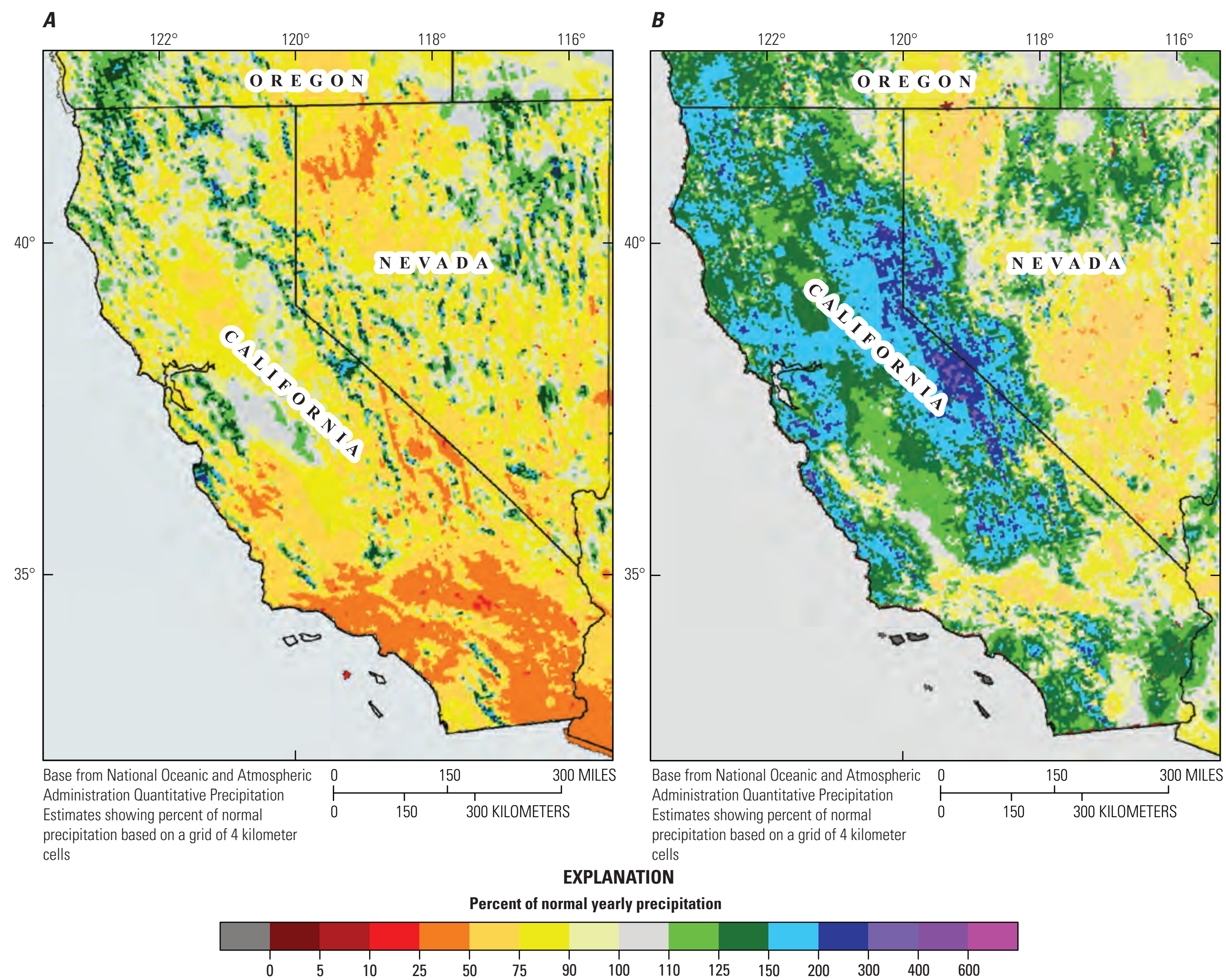

Figure 3. Percent of normal precipitation from *A*, October 1, 2015, to September 30, 2016, and *B*, October 1, 2016, to September 30, 2017.

Figure 4. San Joaquin River near Vernalis, California: A, during base-flow conditions in July 2016, and B, at flood stage in February 2017 (photographs by Matthew De Parsia, U.S. Geological Survey).

Procedures and Methods

Surface-water samples for pesticides, 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, California; 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, Colorado; and toxicity samples were analyzed by the AHP.

Sample Collection and Analysis

Surface-water samples were collected monthly at all sites from July 2016 to June 2017. Ten sample sets were collected approximately mid-month and two targeted sample sets were collected following storms on December 16, 2016, and January 9, 2016. Samples were collected from all five sites in the same day. Surface-water samples for pesticide, ancillary water quality (copper, DOC, PIC, POC, TPC, and TPN), and toxicity analyses were collected over a 20- to 60-minute interval depending on conditions 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, 2006). 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 concurrently, even in hydrologic conditions that might otherwise dictate integrated sampling techniques. Samples were collected between the high and low tide, or on the ebb tide (for tidally influenced sites) by submerging narrow-mouthed bottles at mid-channel to a depth of 1.5 feet (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 pre-cleaned, baked amber-glass bottles and transported on ice to the USGS OCRL in Sacramento, California, for processing and analysis using a combination of liquid chromatography/tandem mass spectrometry (LC/MS/MS) and gas chromatography/mass spectrometry (GC/MS). Samples for analysis at the USGS NWQL (copper, DOC, PIC, POC, TPC, and TPN) were collected in Teflon™ bottles, processed at the USGS California Water Science Center, and shipped on ice to the NWQL. Sample collection and handling methods are described in more detail in De Parsia and others (2018). Analytical methods and method detection limits (MDLs) are described in additional detail in the appendix.

Water samples for toxicity analyses were collected in pre-cleaned amber-glass bottles provided by the AHP. Bottles were triple rinsed with native water on-site before 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 equipped with a YSI 6560 conductivity/temperature sensor, a YSI 6150 dissolved oxygen sensor, a YSI 6561 pH sensor, and a YSI 6136 turbidity sensor. The meter was calibrated using appropriate procedures and standards before sample collection as described in the USGS National Field Manual (U.S. Geological Survey, variously dated).

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 (Jabusch and others, 2018). Field replicates, field blanks, laboratory matrix spikes, and matrix-spike replicates were used to validate pesticide concentrations measured in water and in suspended sediments. Field replicates and blanks were collected and analyzed to validate results for analytes measured at the NWQL.

Blanks

Six pesticide field blanks (three for analysis by GC/MS and 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.

Three DOC blanks and three copper blanks were analyzed by the NWQL. There were no carbon detections in any of the DOC blanks. A review of inorganic analytical data quality by the USGS Quality Systems Branch identified a positive bias in copper samples analyzed by the NWQL between October 17, 2016, and October 24, 2017. The median bias for blind samples analyzed for copper at the NWQL between October 17, 2016, and May 1, 2017, was 9.0 percent and the median bias for samples analyzed between May 1, 2017, and July 12, 2017, was 7.4 percent (Tedmund Struzeski, U.S. Geological Survey, written commun., 2017). All three copper blanks from the Delta study were analyzed during the interval between October 17, 2016, and October 24, 2017; two of the blanks were analyzed as non-detects, and copper in one blank was measured at a concentration greater than the detection limit of 0.2 micrograms per liter (µg/L), but less than the reporting level of 0.4 µg/L. As of February 2018, the NWQL identified an instrument problem and worked with the instrument manufacturer on a solution. The potential positive bias for copper results is unlikely to have resulted in false-positive results for 59 of the 60 samples collected for copper analysis (minimum concentration 0.88 µg/L, median concentration 1.65 µg/L, maximum concentration 7.8 µg/L). One out of the 60 environmental samples collected—on October 18, 2016, from the San Joaquin River near Vernalis—for copper analysis was measured at 0.37 µg/L and would be most affected by a positive bias in copper results.

Matrix Spikes

Six pesticide matrix-spike samples (three for analysis by GC/MS and three for analysis by LC/MS/MS) and six corresponding pesticide matrix-spike replicate samples (three for analysis by GC/MS and three for analysis by LC/MS/MS) were collected to assess pesticide recovery, degradation, sorption, and potential interferences caused by the sampling matrix. All matrix-spike samples met the QAPP objective of 70–130 percent recovery of pesticide matrix-spike compounds, and less than 25 relative percent difference (RPD) between matrix spike and matrix-spike replicate pairs.

Pesticide Surrogate Compounds

To assess the efficiency of water-sample extraction analytical methods, $^{13}C_3$-atrazine and d_{14}-trifluralin (GC/MS), and monuron and d_4-imidacloprid (LC/MS/MS) were used as recovery surrogates and added to all extracts. Mean (plus or minus, ±, standard deviation) recoveries of $^{13}C_3$-atrazine, d_{14}-trifluralin, monuron, and d_4-imidacloprid were 96±12 percent, 86±9 percent, 94±12 percent, and 86±12 percent, respectively. To assess the efficiency of filter-sample extraction, d_{14}-trifluralin, $^{13}C_{12}$-*p,p'*-DDE, and $^{13}C_6$-*cis*-permethrin were used as recovery surrogates for extracts. Mean (± standard deviation) recoveries of d_{14}-trifluralin, $^{13}C_{12}$-*p,p'*-DDE, and $^{13}C_6$-*cis*-permethrin were 90±10 percent, 89±9 percent, and 89±11 percent, respectively. All samples satisfied the QAPP requirement of 70–130 percent recovery of surrogate compounds.

Replicates

Six pesticide field-replicate samples (three for analysis by GC/MS and three for analysis by LC/MS/MS) were collected at the same time as environmental samples to test the reproducibility of results based on field-sampling methods. Results from the environmental and field-replicate pairs satisfied the QAPP requirement of less than 25 percent RPD between environmental samples and their field-replicate pairs.

Three field-replicate samples were collected for determinations of copper, DOC, and TPC by the NWQL. One TPC environmental and field-replicate sample pair exceeded the QAPP requirement of less than 25 percent RPD with an environmental result of 0.33 milligrams per liter (mg/L) and a field-replicate result of 0.21 mg/L (44 percent RPD). All other environmental and field-replicate pairs satisfied the QAPP requirement of less than 25 percent RPD.

Results

A total of 53 out of the 154 pesticides analyzed for (18 herbicides, 14 insecticides, 13 fungicides, 7 breakdown products, and 1 synergist) were detected in filtered surface-water samples and 98 percent of samples contained at least 1 pesticide (fig. 5; table 2). The most frequently detected pesticides were the herbicides hexazinone, metolachlor, and diuron (fig. 6; present in 83 percent, 72 percent, and 67 percent of samples, respectively), the insecticide methoxyfenozide (present in 83 percent of samples), and the fungicides boscalid and azoxystrobin (present in 67 percent and 58 percent of samples, respectively). Pesticide concentrations ranged from below MDLs to 1,300 nanograms per liter (ng/L) for a detection of the insecticide chlorantraniliprole.

Water samples collected from the San Joaquin River at Buckley Cove, the San Joaquin River near Vernalis, and Ulatis Creek at Browns Road had highest pesticide-detection frequencies in storm samples; water samples from the Mokelumne River at New Hope Road and the Sacramento River at Hood had highest pesticide-detection frequencies in the summer and fall. Pesticide concentrations for most compounds were generally highest in storm samples collected on December 16, 2016, and January 9, 2017. Metolachlor (all sites), fluridone (San Joaquin River at Buckley Cove), and chlorantraniliprole (Ulatis Creek at Browns Road) displayed the opposite trend, with peak pesticide concentrations in the summer and lowest pesticide concentrations during storms. Of the 53 pesticides detected in the second year of the Delta RMP, maximum concentrations for 19 compounds were measured during storm samples collected on December 16, 2016, and January 9, 2017.

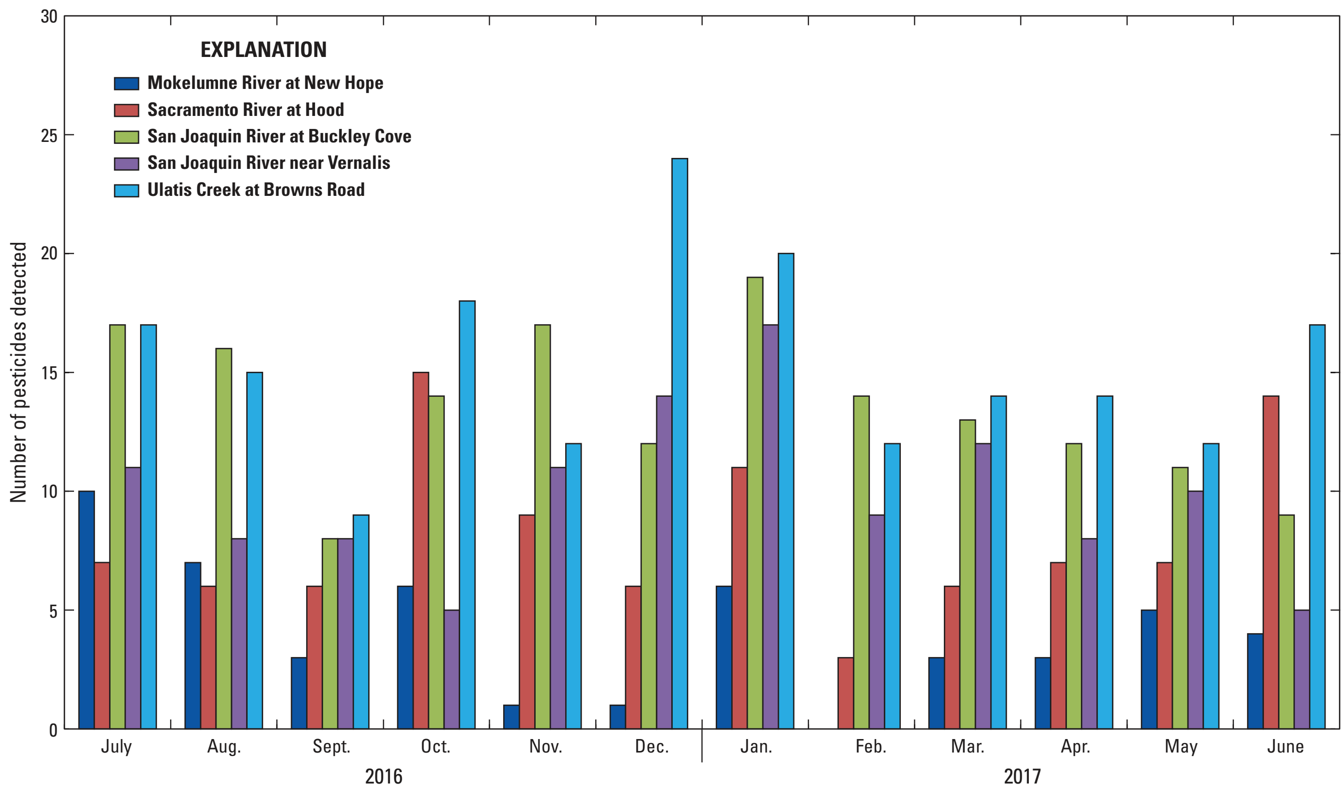

Figure 5. Number of pesticides detected per month in surface-water samples from the Sacramento–San Joaquin Delta, California, 2016–17.

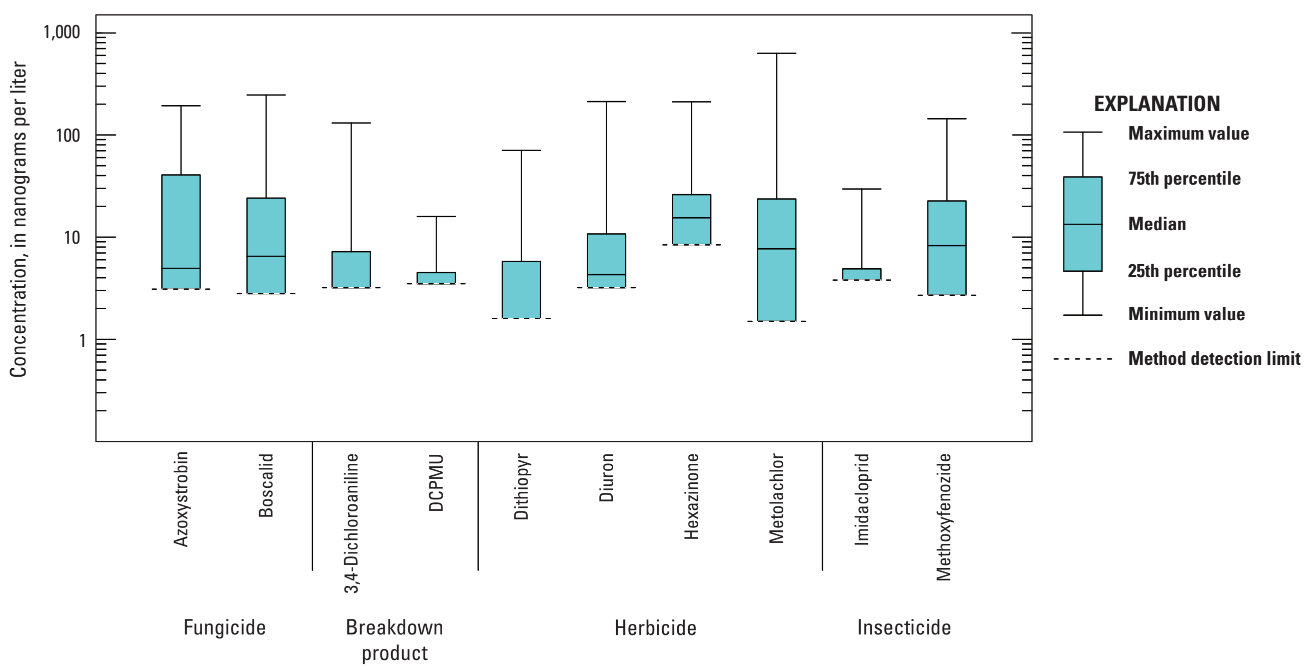

Figure 6. Concentrations of the 10 most frequently detected pesticides in water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17. The box plots were calculated with a sample size of 60 for each of the compounds. Method detection limits are shown with a dashed line and statistics extending below the method detection limits are censored.

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.

[Numbers in brackets ([ ]) are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter (ng/L). Results with "E" qualifiers are estimates of concentrations measured below the method detection limit. **Abbreviations**: hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	3,4-Dichloro-aniline [66584]	3,4-Dichloro-phenylurea [68226]	Atrazine [65065]	Azoxys-trobin [66589]	Bifen-thrin [65067]	Boscalid [67550]	Carbaryl [65069]	Carben-dazim [68548]	Chlorantra-niliprole [51856]	Chloro-thalonil [65071]
Mokelumne River at New Hope Road											
07/13/2016	09:30	—	—	—	—	—	30.3	—	—	—	—
08/17/2016	09:00	9.1	—	—	28.4	—	8.4	—	—	—	—
09/20/2016	09:10	—	—	—	6.0	—	—	—	—	—	—
10/18/2016	09:15	—	—	—	—	—	37.3	—	6.9	—	—
11/14/2016	09:40	—	—	—	—	—	—	—	—	—	—
12/16/2016	09:30	—	—	—	—	—	—	—	—	—	—
01/09/2017	09:00	—	—	—	—	—	32.1	—	—	—	—
02/28/2017	09:30	—	—	—	—	—	—	—	—	—	—
03/14/2017	09:40	—	—	—	—	—	—	—	—	—	—
04/25/2017	09:40	—	—	—	—	—	4.4	—	—	—	—
05/16/2017	09:20	—	—	10.8	—	—	7.5	—	—	—	—
06/13/2017	09:20	—	—	7.2	—	—	6.2	—	—	—	—
Sacramento River at Hood											
07/13/2016	08:20	67.6	—	—	107	—	—	—	—	—	—
08/17/2016	07:55	37.0	—	—	193	—	—	8.1	—	—	—
09/20/2016	08:10	23.5	—	6.8	—	—	—	—	—	—	—
10/18/2016	08:00	6.7	7.0	—	10.3	—	15.2	—	14.0	—	—
11/14/2016	08:20	38.4	—	—	141	—	—	—	6.9	—	—
12/16/2016	08:15	12.0	—	—	21.8	—	—	—	4.8	—	—
01/09/2017	08:00	10.5	—	—	38.6	—	—	—	5.1	—	—
02/28/2017	08:10	E3.0	—	—	—	—	—	—	17.9	—	—
03/14/2017	08:15	7.5	—	—	—	—	—	—	18.5	—	—
04/25/2017	08:20	7.2	—	—	6.4	—	—	—	—	—	—
05/16/2017	08:15	7.2	—	—	—	—	—	—	—	—	—
06/13/2017	08:00	131	—	—	36.6	—	—	—	60.0	—	7.8
San Joaquin River at Buckley Cove											
07/13/2016	11:05	19.3	4.4	35.7	42.1	—	38.7	—	8.2	—	—
08/17/2016	10:20	10.6	E3.1	7.4	14.8	—	6.8	—	E2.6	E2.0	—
09/20/2016	10:30	10.2	—	—	113	—	—	—	—	—	—
10/18/2016	10:40	6.9	6.2	—	59.5	—	45.9	—	13.4	4.7	—
11/14/2016	11:00	3.3	—	—	48.1	—	27.8	—	6.8	—	—
12/16/2016	10:45	11.2	E2.6	—	52.1	—	—	—	6.8	—	—
01/09/2017	10:30	—	5.1	—	49.4	—	180	—	—	4.3	—
02/28/2017	11:10	—	—	—	—	—	3.1	—	69.5	4.8	—
03/14/2017	10:50	—	—	—	—	—	20.5	—	78.9	E3.7	—
04/25/2017	11:10	—	—	—	3.2	—	6.0	—	32.8	—	—
05/16/2017	11:00	—	—	—	8.7	—	5.0	—	32.8	—	—
06/13/2017	10:45	E2.2	—	—	4.6	—	10.3	—	—	—	—

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

[Numbers in brackets ([ ]) are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter (ng/L). Results with “E” qualifiers are estimates of concentrations measured below the method detection limit. **Abbreviations**: hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	3,4-Dichloro-aniline [66584]	3,4-Dichloro-phenylurea [68226]	Atrazine [65065]	Azoxys-trobin [66589]	Bifen-thrin [65067]	Boscalid [67550]	Carbaryl [65069]	Carben-dazim [68548]	Chlorantra-niliprole [51856]	Chloro-thalonil [65071]
San Joaquin River near Vernalis											
07/13/2016	12:45	E2.8	—	—	25.4	—	27.1	—	—	E2.2	—
08/17/2016	12:00	5.4	—	—	—	—	4.2	—	—	E3.2	—
09/20/2016	12:20	—	—	—	—	—	—	—	—	6.9	—
10/18/2016	12:25	—	—	—	4.5	—	15.8	—	—	—	—
11/14/2016	12:45	E2.1	—	—	26.1	—	11.6	—	—	—	—
12/16/2016	12:15	—	4.2	—	—	—	—	—	—	—	—
01/09/2017	11:55	—	4.0	—	45.8	—	63.6	—	—	E3.4	—
02/28/2017	12:50	—	—	—	E2.2	—	2.9	—	60.4	4	—
03/14/2017	12:40	—	—	—	—	—	21.6	—	47.0	E3.4	—
04/25/2017	13:30	—	—	—	—	—	4.8	—	47.3	—	—
05/16/2017	12:40	—	—	—	4.9	—	2.8	—	47.3	—	—
06/13/2017	13:15	—	—	—	—	—	7.4	—	—	—	—
Ulatis Creek at Browns Road											
07/13/2016	14:30	4.3	—	—	5	11.7	16.2	—	—	1,290	—
08/17/2016	14:10	7.3	—	4.8	106	—	15.5	—	—	252	—
09/20/2016	14:10	4.2	—	—	—	—	15.1	—	—	78.8	—
10/18/2016	14:25	—	8.8	—	12.1	—	66.4	—	23.0	12.5	—
11/14/2016	15:05	4.7	5.2	12.3	—	—	31.0	—	—	—	—
12/16/2016	14:35	—	—	—	45	—	246	—	58.7	113	—
01/09/2017	14:15	—	—	—	50.7	—	108	—	16.5	38.8	—
02/28/2017	16:15	—	—	—	116	—	3.3	—	—	4.6	—
03/14/2017	14:50	—	E2.9	—	—	2.3	26.9	—	68.6	4.1	—
04/25/2017	16:15	—	—	19.1	6.5	3.4	9.6	—	—	—	—
05/16/2017	15:10	—	—	7.7	39.2	—	10.7	—	—	—	—
06/13/2017	15:50	4.9	E2.1	10.8	56.8	—	28.4	—	—	74.7	—

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Chlorpy-rifos [65072]	Cloma-zone [67562]	Clothiani-din [68221]	Cyantra-niliprole [51862]	Cyhalothrin (all isomers) [68354]	Cypro-dinil [67574]	Desulfinylfipro-nil amide [68570]	Desulfinyl-fipronil [66607]	Diazinon [65078]	Difenocon-azole [67582]
Mokelumne River at New Hope Road—Continued											
07/13/2016	09:30	—	—	—	—	—	—	4.7	4.3	—	—
08/17/2016	09:00	—	—	—	—	—	—	—	—	—	—
09/20/2016	09:10	—	—	—	—	—	—	—	—	—	—
10/18/2016	09:15	—	—	—	—	—	—	—	—	—	—
11/14/2016	09:40	—	—	—	—	—	—	—	—	—	—
12/16/2016	09:30	—	—	—	—	—	—	—	—	—	—
01/09/2017	09:00	—	—	—	—	—	—	—	—	—	—
02/28/2017	09:30	—	—	—	—	—	—	—	—	—	—
03/14/2017	09:40	—	—	—	—	—	—	—	—	—	—

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

[Numbers in brackets ([ ]) are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter (ng/L). Results with "E" qualifiers are estimates of concentrations measured below the method detection limit. **Abbreviations**: hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Chlorpyrifos [65072]	Clomazone [67562]	Clothianidin [68221]	Cyantraniliprole [51862]	Cyhalothrin (all isomers) [68354]	Cyprodinil [67574]	Desulfinylfipronil amide [68570]	Desulfinylfipronil [66607]	Diazinon [65078]	Difenoconazole [67582]
Mokelumne River at New Hope Road—Continued											
04/25/2017	09:40	—	—	—	—	—	—	—	—	—	—
05/16/2017	09:20	—	—	—	—	—	—	—	—	—	—
06/13/2017	09:20	—	—	—	—	—	—	—	—	—	—
Sacramento River at Hood—Continued											
07/13/2016	08:20	—	7.1	—	—	—	—	—	—	—	—
08/17/2016	07:55	—	—	—	—	—	—	—	—	—	—
09/20/2016	08:10	—	—	—	—	—	—	—	—	—	—
10/18/2016	08:00	—	—	—	—	—	—	—	6.1	—	—
11/14/2016	08:20	—	—	—	—	—	—	—	—	—	—
12/16/2016	08:15	—	—	—	—	—	—	—	—	—	—
01/09/2017	08:00	—	—	—	—	—	—	—	—	—	—
02/28/2017	08:10	—	—	—	—	—	—	—	—	—	—
03/14/2017	08:15	—	—	—	—	—	—	—	—	—	—
04/25/2017	08:20	—	—	—	—	—	—	—	—	—	—
05/16/2017	08:15	—	14.1	—	—	—	—	—	—	—	—
06/13/2017	08:00	—	179	—	—	—	—	—	—	—	—
San Joaquin River at Buckley Cove—Continued											
07/13/2016	11:05	—	31.0	—	—	—	—	—	4.9	—	—
08/17/2016	10:20	—	4.5	—	—	—	—	—	—	—	—
09/20/2016	10:30	—	—	—	—	—	—	—	—	—	—
10/18/2016	10:40	—	—	—	—	—	—	—	—	—	—
11/14/2016	11:00	—	—	—	—	—	—	—	—	—	—
12/16/2016	10:45	—	—	—	—	—	—	—	—	—	—
01/09/2017	10:30	—	—	—	—	—	—	—	—	—	—
02/28/2017	11:10	—	—	—	—	—	—	—	—	—	—
03/14/2017	10:50	—	—	—	—	—	—	—	—	—	—
04/25/2017	11:10	—	—	—	—	—	—	—	—	—	—
05/16/2017	11:00	—	—	—	—	—	—	—	—	—	—
06/13/2017	10:45	—	—	—	—	—	—	—	—	—	—
San Joaquin River near Vernalis—Continued											
07/13/2016	12:45	—	—	—	—	—	—	—	—	—	—
08/17/2016	12:00	—	—	—	—	—	—	—	—	—	—
09/20/2016	12:20	4.3	—	E2.5	—	—	—	—	—	—	—
10/18/2016	12:25	—	—	—	—	—	—	—	—	—	—
11/14/2016	12:45	—	—	—	—	—	—	—	—	—	—
12/16/2016	12:15	—	—	—	—	—	—	—	—	—	—
01/09/2017	11:55	—	—	—	—	—	—	—	—	—	—
02/28/2017	12:50	—	—	—	—	—	—	—	—	—	—

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

[Numbers in brackets ([ ]) are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter (ng/L). Results with "E" qualifiers are estimates of concentrations measured below the method detection limit. **Abbreviations**: hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Chlorpyrifos [65072]	Clomazone [67562]	Clothianidin [68221]	Cyantraniliprole [51862]	Cyhalothrin (all isomers) [68354]	Cyprodinil [67574]	Desulfinylfipronil amide [68570]	Desulfinylfipronil [66607]	Diazinon [65078]	Difenoconazole [67582]
San Joaquin River near Vernalis—Continued											
03/14/2017	12:40	—	—	—	—	—	—	—	—	—	—
04/25/2017	13:30	—	—	—	—	—	—	—	—	—	—
05/16/2017	12:40	—	—	—	—	—	—	—	—	6.0	—
06/13/2017	13:15	—	—	—	—	—	—	—	—	—	—
Ulatis Creek at Browns Road—Continued											
07/13/2016	14:30	—	—	—	—	9	—	—	—	13.1	—
08/17/2016	14:10	—	—	31.1	E3.4	—	—	—	—	—	—
09/20/2016	14:10	—	—	—	—	—	—	—	—	—	—
10/18/2016	14:25	—	—	—	—	—	—	—	11.3	—	—
11/14/2016	15:05	—	—	—	—	—	—	—	—	—	—
12/16/2016	14:35	—	—	4.5	—	—	—	5.7	—	—	—
01/09/2017	14:15	—	—	E2.9	—	—	—	—	—	—	—
02/28/2017	16:15	—	—	—	—	—	E3.0	—	—	—	57.6
03/14/2017	14:50	—	—	—	—	—	8.0	—	—	—	—
04/25/2017	16:15	—	—	—	—	—	E4.4	—	—	—	—
05/16/2017	15:10	—	—	—	—	—	—	—	—	—	—
06/13/2017	15:50	—	—	—	—	—	—	—	—	—	—

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Dinotefuran [68379]	Dithiopyr [51837]	Diuron [66598]	EPTC [65080]	Fenhexamid [67622]	Fipronil sulfide [66610]	Fipronil sulfone [66613]	Fipronil [66604]	Flonicamid [51858]	Fluridone [51864]	Fluxapyroxad [51851]	Hexazinone [65085]
Mokelumne River at New Hope Road—Continued													
07/13/2016	09:30	—	—	—	—	—	4.3	5.4	—	—	—	15.8	25.2
08/17/2016	09:00	—	—	—	—	—	—	—	—	—	—	5.4	11.5
09/20/2016	09:10	—	—	—	—	—	—	—	—	—	—	—	E7.4
10/18/2016	09:15	—	11.4	9.2	—	—	—	—	—	—	—	—	—
11/14/2016	09:40	—	—	—	—	—	—	—	—	—	—	—	14.9
12/16/2016	09:30	—	11.5	—	—	—	—	—	—	—	—	—	—
01/09/2017	09:00	—	3.6	—	—	—	—	—	—	—	—	—	15.4
02/28/2017	09:30	—	—	—	—	—	—	—	—	—	—	—	—
03/14/2017	09:40	—	—	—	—	—	—	—	—	—	—	—	15.9
04/25/2017	09:40	—	—	—	—	—	—	—	—	—	—	—	17.3
05/16/2017	09:20	—	—	—	—	—	—	—	—	—	—	—	12.7
06/13/2017	09:20	—	—	—	—	—	—	—	—	—	—	—	26.9
Sacramento River at Hood—Continued													
07/13/2016	08:20	—	—	—	—	—	—	—	—	—	—	—	30.4
08/17/2016	07:55	—	—	—	—	—	—	—	—	—	—	—	16.7
09/20/2016	08:10	—	3.1	—	—	—	—	—	—	—	—	—	20.0
10/18/2016	08:00	—	23.5	37.2	—	—	—	8.9	4.5	—	—	13.0	18.9

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

[Numbers in brackets ([ ]) are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter (ng/L). Results with "E" qualifiers are estimates of concentrations measured below the method detection limit. **Abbreviations**: hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Dinotefuran [68379]	Dithiopyr [51837]	Diuron [66598]	EPTC [65080]	Fenhexamid [67622]	Fipronil sulfide [66610]	Fipronil sulfone [66613]	Fipronil [66604]	Flonicamid [51858]	Fluridone [51864]	Fluxapyroxad [51851]	Hexazinone [65085]
Sacramento River at Hood—Continued													
11/14/2016	08:20	—	—	7.5	—	—	—	—	4.9	—	—	—	28.6
12/16/2016	08:15	—	—	14.7	—	—	—	—	—	—	—	—	—
01/09/2017	08:00	—	6.8	11.0	—	—	—	—	—	—	—	E4.6	55.3
02/28/2017	08:10	—	—	—	—	—	—	—	—	—	—	—	E7.8
03/14/2017	08:15	—	—	—	—	—	—	—	—	—	—	—	15.5
04/25/2017	08:20	—	2.1	—	—	—	—	—	—	—	—	—	17.9
05/16/2017	08:15	—	—	—	—	—	—	—	3.8	—	—	—	12.3
06/13/2017	08:00	—	—	E2.1	—	—	—	—	4.2	—	—	—	31.9
San Joaquin River at Buckley Cove—Continued													
07/13/2016	11:05	—	—	19.8	—	—	—	—	—	—	436	17.5	45.0
08/17/2016	10:20	—	—	20.8	—	—	—	—	—	—	185	E3.2	17.0
09/20/2016	10:30	—	—	12.7	—	—	—	—	—	—	143	—	21.3
10/18/2016	10:40	—	—	36	—	—	4.5	—	—	—	130	26.4	—
11/14/2016	11:00	—	7.3	39	—	—	—	4.0	3.5	—	26.2	13.5	13.7
12/16/2016	10:45	—	—	32.6	—	—	—	—	—	—	61.9	—	—
01/09/2017	10:30	5.1	12.7	137	—	—	—	—	—	—	E2.2	19.6	84.5
02/28/2017	11:10	—	2.5	13.7	—	—	—	—	—	—	—	—	14.6
03/14/2017	10:50	—	4.2	8.3	—	—	—	—	—	—	E2.2	—	14.3
04/25/2017	11:10	E3.0	4.1	7.5	—	—	—	—	—	—	9.5	—	9.6
05/16/2017	11:00	E3.0	3.7	7.5	—	—	—	—	—	—	9.5	—	8.5
06/13/2017	10:45	—	—	E2.0	—	—	—	—	—	—	12.0	—	15.5
San Joaquin River near Vernalis—Continued													
07/13/2016	12:45	—	—	5.5	—	—	—	—	—	—	6.1	12.4	27.7
08/17/2016	12:00	—	—	E2.4	—	—	—	—	—	E2.3	—	—	E4.7
09/20/2016	12:20	—	—	E3.1	—	—	—	—	—	—	E3.1	—	E5.8
10/18/2016	12:25	—	—	5.7	—	—	—	—	—	—	E2.7	—	—
11/14/2016	12:45	—	5.0	5.3	—	—	—	—	—	—	9.3	5.1	19.3
12/16/2016	12:15	—	7.7	152	7.6	—	—	—	—	—	5.4	—	16.7
01/09/2017	11:55	—	3.0	212	—	—	—	—	—	—	—	36.0	31.4
02/28/2017	12:50	—	—	10.5	—	—	—	—	—	—	—	—	—
03/14/2017	12:40	—	4.5	7.8	—	—	—	—	—	—	—	—	16.7
04/25/2017	13:30	—	4.1	3.9	—	—	—	—	—	—	—	—	10.2
05/16/2017	12:40	—	3.5	3.9	—	—	—	—	—	—	—	—	E7.5
06/13/2017	13:15	—	—	E2.3	—	—	—	—	—	—	—	—	12.0
Ulatis Creek at Browns Road—Continued													
07/13/2016	14:30	—	—	—	—	25.8	—	—	—	—	5	E3.0	26.9
08/17/2016	14:10	—	—	3.2	—	—	—	—	—	—	E3.2	21.6	29.5
09/20/2016	14:10	—	—	—	—	—	—	—	—	—	E3.0	—	38.7

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

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Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Dinotefuran [68379]	Dithiopyr [51837]	Diuron [66598]	EPTC [65080]	Fenhexamid [67622]	Fipronil sulfide [66610]	Fipronil sulfone [66613]	Fipronil [66604]	Flonicamid [51858]	Fluridone [51864]	Fluxapyroxad [51851]	Hexazinone [65085]
Ulatis Creek at Browns Road—Continued													
10/18/2016	14:25	17.3	29.1	48.2	—	—	—	14.1	—	—	4.1	19.4	—
11/14/2016	15:05	—	6.9	9.0	—	—	—	—	—	—	E2.9	—	21.5
12/16/2016	14:35	4.7	70.6	44.7	—	—	—	—	7.7	9.6	—	42.4	29.3
01/09/2017	14:15	—	16.3	7.8	—	—	—	—	—	—	—	38.0	211
02/28/2017	16:15	—	3.6	4.6	—	—	—	—	—	—	E2.5	—	—
03/14/2017	14:50	—	6.7	5.6	—	—	—	—	—	—	4.5	—	12.7
04/25/2017	16:15	—	28.4	4.0	—	—	—	—	—	—	—	—	12.1
05/16/2017	15:10	—	14.1	4.0	—	—	—	—	—	—	—	—	14.6
06/13/2017	15:50	—	8.4	5.5	—	—	—	—	—	—	4.5	10.2	29.1

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Imidacloprid [68426]	Iprodione [66617]	Methoxyfenozide [68647]	Metolachlor [65090]	*N*-(3,4-Dichlorophenyl)-N′-methylurea [68231]	Napropamide [65092]	Oryzalin [68663]	Oxadiazon [51843]	Oxyfluorfen [65093]	Pendimethalin [65098]
Mokelumne River at New Hope Road—Continued											
07/13/2016	09:30	—	—	3.3	—	—	—	—	—	—	—
08/17/2016	09:00	—	—	13.7	4.3	—	—	—	—	—	—
09/20/2016	09:10	—	—	4.7	—	—	—	—	—	—	—
10/18/2016	09:15	4.6	—	11.9	—	—	—	—	—	—	—
11/14/2016	09:40	—	—	—	—	—	—	—	—	—	—
12/16/2016	09:30	—	—	—	—	—	—	—	—	—	—
01/09/2017	09:00	—	—	4.6	—	—	—	—	—	4.2	—
02/28/2017	09:30	—	—	—	—	—	—	—	—	—	—
03/14/2017	09:40	—	—	6.6	—	—	—	—	—	—	—
04/25/2017	09:40	—	—	7.4	—	—	—	—	—	—	—
05/16/2017	09:20	—	—	7.4	6.1	—	—	—	—	—	—
06/13/2017	09:20	—	—	E2.4	—	—	—	—	—	—	—
Sacramento River at Hood—Continued											
07/13/2016	08:20	—	—	17.1	6.7	—	—	—	—	—	—
08/17/2016	07:55	—	—	21.4	5.1	—	—	—	—	—	—
09/20/2016	08:10	—	—	9.2	—	—	—	—	—	—	—
10/18/2016	08:00	6.7	—	—	—	6.7	—	—	—	—	—
11/14/2016	08:20	—	—	27.6	—	—	—	—	—	—	—
12/16/2016	08:15	E2.6	—	6.0	—	—	—	—	—	—	—
01/09/2017	08:00	5.2	—	—	15.7	—	—	—	—	6.3	—
02/28/2017	08:10	—	—	—	—	—	—	—	—	—	—
03/14/2017	08:15	E1.5	—	E2.1	3.1	—	—	—	—	—	—
04/25/2017	08:20	—	—	2.7	2.7	—	—	—	—	—	—
05/16/2017	08:15	—	—	2.7	5.5	—	—	—	—	—	—
06/13/2017	08:00	—	—	E2.1	16.9	—	—	—	—	—	—

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

[Numbers in brackets ([ ]) are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter (ng/L). Results with "E" qualifiers are estimates of concentrations measured below the method detection limit. **Abbreviations**: hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Imidacloprid [68426]	Iprodione [66617]	Methoxyfenozide [68647]	Metolachlor [65090]	*N*-(3,4-Dichlorophenyl)-N′-methylurea [68231]	Napropamide [65092]	Oryzalin [68663]	Oxadiazon [51843]	Oxyfluorfen [65093]	Pendimethalin [65098]
San Joaquin River at Buckley Cove—Continued											
07/13/2016	11:05	E3.3	—	56.4	74.2	12.9	—	—	—	—	—
08/17/2016	10:20	—	—	38.1	25.5	8.9	—	—	—	—	—
09/20/2016	10:30	—	—	26.3	13.9	4.7	—	—	—	—	—
10/18/2016	10:40	4	—	126	34.2	9.4	—	—	—	—	—
11/14/2016	11:00	8.3	—	101	11.6	5.5	—	—	—	—	—
12/16/2016	10:45	E3.2	—	34.3	15.0	4.3	—	—	—	29.0	—
01/09/2017	10:30	9.3	—	103	63.6	15.9	—	251	—	38.6	80.0
02/28/2017	11:10	E2.4	13.9	22.5	9.4	E2.6	—	—	—	—	—
03/14/2017	10:50	E2.9	23.4	13.7	7.1	E2.5	—	—	—	—	—
04/25/2017	11:10	—	—	11.7	9.4	E2.7	—	—	—	—	—
05/16/2017	11:00	—	—	11.7	20.4	E2.7	—	—	—	—	—
06/13/2017	10:45	3.8	—	7.2	38.3	—	—	—	—	—	—
San Joaquin River near Vernalis—Continued											
07/13/2016	12:45	—	—	25.2	39.5	—	—	—	—	—	—
08/17/2016	12:00	—	—	12.5	21.9	—	—	—	—	—	—
09/20/2016	12:20	—	—	58.4	9.2	—	—	—	—	—	—
10/18/2016	12:25	—	—	44.7	—	—	—	—	—	—	—
11/14/2016	12:45	—	—	22.7	3.6	—	—	—	—	—	—
12/16/2016	12:15	17.1	—	12.5	13.8	13.5	37.6	—	—	—	24.1
01/09/2017	11:55	29.1	—	30.1	37.1	10.4	—	8.8	—	22.2	42.1
02/28/2017	12:50	—	12.7	14.9	—	E2.6	—	—	—	—	—
03/14/2017	12:40	E2.2	26.6	12.7	4.0	E2.9	—	—	—	—	—
04/25/2017	13:30	—	—	11.1	8.3	E2.3	—	—	—	—	—
05/16/2017	12:40	—	—	11.1	10.0	E2.3	—	—	—	—	—
06/13/2017	13:15	—	—	7.0	26.0	—	—	—	—	—	—
Ulatis Creek at Browns Road—Continued											
07/13/2016	14:30	3.9	—	4.1	63.5	4.1	—	—	—	7.6	—
08/17/2016	14:10	10.8	—	—	206	3.6	—	—	—	—	—
09/20/2016	14:10	4.1	—	3.2	16.3	—	—	—	—	—	—
10/18/2016	14:25	28.2	—	6.5	40.2	13.5	—	—	24.0	—	—
11/14/2016	15:05	29.6	—	—	5.0	4.7	—	—	—	—	—
12/16/2016	14:35	28.5	—	144	257	6.1	201	330	79.4	48.4	148
01/09/2017	14:15	7.9	—	59.6	123	E3.1	17.7	86.4	20.5	75.4	175
02/28/2017	16:15	E3.7	—	—	2.6	—	—	—	—	—	—
03/14/2017	14:50	6.9	—	—	5.5	E2.9	—	—	—	—	—
04/25/2017	16:15	6.8	—	2.8	10.3	4.7	—	—	—	—	—
05/16/2017	15:10	6.8	—	2.8	247	4.7	—	—	—	—	290
06/13/2017	15:50	8.3	—	E2.6	629	6.1	—	—	—	—	—

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

[Numbers in brackets ([ ]) are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter (ng/L). Results with "E" qualifiers are estimates of concentrations measured below the method detection limit. **Abbreviations**: hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Penox-sulam [51863]	Piperonyl butoxide [65102]	Prodi-amine [51844]	Propanil [66641]	Propicon-azole [66643]	Pyrimeth-anil [67717]	Quinoxy-fen [51847]	Sima-zine [65105]	Thiaben-dazole [67161]	Thiameth-oxam [68245]	Thioben-carb [65107]
Mokelumne River at New Hope Road—Continued												
07/13/2016	09:30	—	—	—	—	—	—	6.4	13.9	—	—	—
08/17/2016	09:00	—	—	—	—	—	—	—	—	—	—	—
09/20/2016	09:10	—	—	—	—	—	—	—	—	—	—	—
10/18/2016	09:15	—	—	—	—	—	—	—	—	—	—	—
11/14/2016	09:40	—	—	—	—	—	—	—	—	—	—	—
12/16/2016	09:30	—	—	—	—	—	—	—	—	—	—	—
01/09/2017	09:00	—	—	—	—	—	—	—	12.0	—	—	—
02/28/2017	09:30	—	—	—	—	—	—	—	—	—	—	—
03/14/2017	09:40	—	—	—	—	—	—	—	E4.9	—	—	—
04/25/2017	09:40	—	—	—	—	—	—	—	—	—	—	—
05/16/2017	09:20	—	—	—	—	—	—	—	—	—	—	—
06/13/2017	09:20	—	—	—	—	—	—	—	—	—	—	—
Sacramento River at Hood—Continued												
07/13/2016	08:20	—	9.3	—	—	—	—	—	—	—	—	—
08/17/2016	07:55	—	—	—	—	—	—	—	—	—	—	—
09/20/2016	08:10	—	3.5	—	—	—	—	—	—	—	—	—
10/18/2016	08:00	—	10.7	—	—	—	—	—	—	—	—	—
11/14/2016	08:20	—	12.9	—	—	8.4	—	—	—	—	—	—
12/16/2016	08:15	—	—	—	—	—	—	—	—	—	—	—
01/09/2017	08:00	—	—	—	—	—	—	—	10.0	—	—	—
02/28/2017	08:10	—	—	—	—	—	—	—	—	—	—	—
03/14/2017	08:15	—	—	—	—	—	—	—	—	—	—	—
04/25/2017	08:20	—	—	—	—	10.5	—	—	—	—	—	—
05/16/2017	08:15	—	3.4	—	—	—	—	—	—	—	—	—
06/13/2017	08:00	8.6	15.1	—	16.4	—	—	—	—	—	—	65.2
San Joaquin River at Buckley Cove—Continued												
07/13/2016	11:05	—	—	—	—	—	—	—	21.5	—	—	—
08/17/2016	10:20	—	—	—	—	—	—	—	—	4.9	—	—
09/20/2016	10:30	—	—	—	—	—	—	—	—	—	—	—
10/18/2016	10:40	—	—	—	—	—	—	—	—	—	—	—
11/14/2016	11:00	—	17.4	—	—	—	—	—	65.3	—	—	—
12/16/2016	10:45	—	—	—	—	—	—	—	28.6	—	—	—
01/09/2017	10:30	—	13.9	—	—	—	—	—	148	—	—	—
02/28/2017	11:10	—	—	—	—	E2.4	E2.6	—	6.9	—	—	—
03/14/2017	10:50	—	—	—	—	—	—	—	E3.2	—	—	—
04/25/2017	11:10	—	—	—	—	—	—	—	6.9	—	—	—
05/16/2017	11:00	—	—	—	—	—	—	—	—	—	—	—
06/13/2017	10:45	—	—	—	—	—	—	—	—	—	—	—

Table 2. Pesticide detections with measured concentrations in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

[Numbers in brackets ([ ]) are U.S. Geological Survey (USGS) National Water Information System (NWIS) parameter codes. Concentrations are in nanograms per liter (ng/L). Results with “E” qualifiers are estimates of concentrations measured below the method detection limit. **Abbreviations**: hh:mm, hour:minute; mm/dd/yyyy, month/day/year; —, not detected]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Penox-sulam [51863]	Piperonyl butoxide [65102]	Prodi-amine [51844]	Propanil [66641]	Propicon-azole [66643]	Pyrimeth-anil [67717]	Quinoxy-fen [51847]	Sima-zine [65105]	Thiaben-dazole [67161]	Thiameth-oxam [68245]	Thioben-carb [65107]
San Joaquin River near Vernalis—Continued												
07/13/2016	12:45	—	5.2	—	—	—	—	—	—	—	—	—
08/17/2016	12:00	—	—	—	—	—	—	—	—	—	—	—
09/20/2016	12:20	—	—	—	—	—	—	—	—	—	—	—
10/18/2016	12:25	—	—	—	—	—	—	—	—	—	—	—
11/14/2016	12:45	—	—	—	—	—	—	—	28.7	—	—	—
12/16/2016	12:15	—	—	—	—	—	—	—	277	—	6.4	—
01/09/2017	11:55	—	10.1	—	—	—	—	—	174	—	—	—
02/28/2017	12:50	—	—	—	—	E2.7	—	—	—	—	—	—
03/14/2017	12:40	—	—	—	—	—	—	—	E4.4	—	—	—
04/25/2017	13:30	—	—	—	—	—	—	—	—	—	—	—
05/16/2017	12:40	—	—	—	—	—	—	—	—	—	—	—
06/13/2017	13:15	—	—	—	—	—	—	—	—	—	—	—
Ulatis Creek at Browns Road—Continued												
07/13/2016	14:30	—	—	—	—	—	—	—	11.0	—	—	—
08/17/2016	14:10	—	—	—	—	—	—	—	17.0	—	—	—
09/20/2016	14:10	—	—	—	—	—	—	—	13.0	—	—	—
10/18/2016	14:25	—	—	—	—	—	—	—	39.0	—	—	—
11/14/2016	15:05	—	—	—	—	—	—	—	—	5.1	—	—
12/16/2016	14:35	—	—	18.7	—	282	—	—	—	—	—	—
01/09/2017	14:15	—	—	—	—	161	—	—	—	—	4.9	—
02/28/2017	16:15	—	—	—	—	7.7	4.3	—	—	—	—	—
03/14/2017	14:50	—	—	—	—	—	—	—	—	E2.9	—	—
04/25/2017	16:15	—	—	—	—	40.5	—	—	10.6	—	—	—
05/16/2017	15:10	—	—	—	—	—	—	—	11.5	—	—	—
06/13/2017	15:50	—	—	—	—	—	—	—	18.1	—	25.5	—

A total of 4 out of 129 pesticides (2 herbicides and 2 insecticides) were detected in suspended-sediment samples and 13 percent of suspended-sediment samples contained at least 1 pesticide (table 3). Pesticide concentrations in suspended sediments filtered from 1-liter water samples were presented using surface-water parameter codes and units to facilitate the approximation of a whole-water pesticide concentration. Pesticide concentrations in suspended sediments ranged from 4.1 to 750 ng/L, both for the herbicide pendimethalin. Results from field measurements and ancillary water-quality measurements collected by the NWQL are provided in tables 4 and 5, respectively.

The data presented in this report are publicly available in the USGS National Water Information System web interface (U.S. Geological Survey, 2018). Results for this report were retrieved from the National Water Information System and compiled in January 2018.

Mokelumne River at New Hope Road

A total of 16 pesticides were detected in water samples collected at this site (8 herbicides, 4 fungicides, 2 insecticides, 1 breakdown product, and 1 synergist). The median number of pesticides detected was 4, a minimum of no compounds were detected in the sample collected on February 28, 2017, and a maximum of 10 compounds were detected in the sample collected on July 13, 2016. There were no pesticides detected in suspended-sediment samples. There were no pesticide detections at concentrations above EPA aquatic life benchmarks in samples collected from this site.

Table 3. Pesticide detections with measured concentrations in suspended sediments filtered from environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.

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

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Bifenthrin [65067]	Cyhalothrin (all isomers) [68354]	Metolachlor [65090]	Pendimethalin [65098]
Mokelumne River at New Hope Road					
07/13/2016	09:30	—	—	—	—
08/17/2016	09:00	—	—	—	—
09/20/2016	09:10	—	—	—	—
10/18/2016	09:15	—	—	—	—
11/14/2016	09:40	—	—	—	—
12/16/2016	09:30	—	—	—	—
01/09/2017	09:00	—	—	—	—
02/28/2017	09:30	—	—	—	—
03/14/2017	09:40	—	—	—	—
04/25/2017	09:40	—	—	—	—
05/16/2017	09:20	—	—	—	—
06/13/2017	09:20	—	—	—	—
Sacramento River at Hood					
07/13/2016	08:20	—	—	—	—
08/17/2016	07:55	—	—	—	—
09/20/2016	08:10	—	—	—	—
10/18/2016	08:00	—	—	—	—
11/14/2016	08:20	—	—	—	—
12/16/2016	08:15	—	—	—	—
01/09/2017	08:00	—	—	—	7.1
02/28/2017	08:10	—	—	—	—
03/14/2017	08:15	—	—	—	—
04/25/2017	08:20	—	—	—	—
05/16/2017	08:15	—	—	—	—
06/13/2017	08:00	—	—	—	—
San Joaquin River at Buckley Cove					
07/13/2016	11:05	—	—	—	—
08/17/2016	10:20	—	—	—	—
09/20/2016	10:30	—	—	—	—
10/18/2016	10:40	—	—	—	—
11/14/2016	11:00	—	—	—	—
12/16/2016	10:45	—	—	—	—
01/09/2017	10:30	—	—	—	14.6
02/28/2017	11:10	—	—	—	—
03/14/2017	10:50	—	—	—	—
04/25/2017	11:10	—	—	—	—
05/16/2017	11:00	—	—	—	—
06/13/2017	10:45	—	—	—	—
San Joaquin River near Vernalis					
07/13/2016	12:45	—	—	—	—
08/17/2016	12:00	—	—	—	—
09/20/2016	12:20	—	—	—	—
10/18/2016	12:25	—	—	—	—
11/14/2016	12:45	—	—	—	—
12/16/2016	12:15	—	—	—	—
01/09/2017	11:55	—	—	—	4.1
02/28/2017	12:50	—	—	—	—
03/14/2017	12:40	—	—	—	—
04/25/2017	13:30	—	—	—	—
05/16/2017	12:40	—	—	—	—
06/13/2017	13:15	—	—	—	—
Ulatis Creek at Browns Road					
07/13/2016	14:30	6.7	8.3	—	—
08/17/2016	14:10	—	—	—	—
09/20/2016	14:10	—	—	—	—
10/18/2016	14:25	—	—	—	—
11/14/2016	15:05	—	—	—	—
12/16/2016	14:35	—	—	—	754
01/09/2017	14:15	—	—	—	52.1
02/28/2017	16:15	—	—	—	—
03/14/2017	14:50	—	—	—	—
04/25/2017	16:15	—	—	—	—
05/16/2017	15:10	—	—	4.6	34.8
06/13/2017	15:50	—	—	19.2	—

Table 4. Water-quality field parameters measured in surface-water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.

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

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Water temperature (°C) [00010]	Specific conductance (µS/cm) [00095]	Dissolved oxygen (mg/L) [00300]	pH [00400]	Turbidity (NTU) [63680]
Mokelumne River at New Hope Road						
07/13/2016	09:30	23.8	60	7.8	7.8	0.1
08/17/2016	09:00	24.3	95	7.7	7.9	0
09/20/2016	09:10	22.0	65	7.9	7.7	0
10/18/2016	09:15	15.3	62	8.3	6.6	—
11/14/2016	09:40	14.1	51	8.9	7.3	—
12/16/2016	09:30	12.8	49	9.7	7.3	—
01/09/2017	09:00	11.5	46	9.2	7.5	6.9
02/28/2017	09:30	9.9	42	10.9	7.3	6.2
03/14/2017	09:40	10.8	45	10.8	7.4	5.4
04/25/2017	09:40	11.6	42	10.1	7.1	1.2
05/16/2017	09:20	13.7	42	9.5	6.9	1.7
06/13/2017	09:20	16.0	43	8.9	6.9	2.7
Sacramento River at Hood						
07/13/2016	08:20	21.2	107	8.7	7.5	3.2
08/17/2016	07:55	21.6	129	7.9	8.0	0.9
09/20/2016	08:10	19.8	154	8.3	7.3	0
10/18/2016	08:00	16.2	126	8.0	6.8	—
11/14/2016	08:20	15.6	180	8.2	7.4	—
12/16/2016	08:15	10.6	97	10.3	7.1	70
01/09/2017	08:00	9.3	97	10.5	7.3	33
02/28/2017	08:10	8.9	66	11.8	6.4	26
03/14/2017	08:15	12.3	121	10.4	7.3	30
04/25/2017	08:20	13.1	84	10.3	7.2	8.8
05/16/2017	08:15	15.2	88	9.8	7.1	13
06/13/2017	08:00	16.5	115	8.9	7.2	9.5
San Joaquin River at Buckley Cove						
07/13/2016	11:05	25.4	571	8.7	7.7	1.3
08/17/2016	10:20	24.9	350	6.0	7.8	14
09/20/2016	10:30	23.3	361	7.0	7.7	0
10/18/2016	10:40	19.7	820	7.8	7.0	—
11/14/2016	11:00	17.8	399	7.3	7.5	—
12/16/2016	10:45	11.4	441	10.1	7.7	0.4
01/09/2017	10:30	11.3	244	8.4	7.5	28
02/28/2017	11:10	11.8	156	9.4	7.2	47
03/14/2017	10:50	15.1	174	9.4	7.4	5.7
04/25/2017	11:10	15.6	155	10.6	7.8	2
05/16/2017	11:00	15.4	141	9.1	7.4	3.8
06/13/2017	10:45	18.8	97	8.5	7.3	5.5

Table 4. Water-quality field parameters measured in surface-water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

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

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Water temperature (°C) [00010]	Specific conductance (µS/cm) [00095]	Dissolved oxygen (mg/L) [00300]	pH [00400]	Turbidity (NTU) [63680]
San Joaquin River near Vernalis						
07/13/2016	12:45	25.7	642	19.7	8.9	4.1
08/17/2016	12:00	25.4	475	9.1	7.9	23
09/20/2016	12:20	23.6	643	9.3	8.0	1.9
10/18/2016	12:25	17.4	274	8.0	7.4	—
11/14/2016	12:45	17.5	710	7.8	7.6	0
12/16/2016	12:15	12.4	824	9.2	7.8	7
01/09/2017	11:55	11.5	122	8.5	7.5	14
02/28/2017	12:50	11.5	143	9.5	7.3	16
03/14/2017	12:40	14.3	122	9.2	7.3	9.9
04/25/2017	13:30	14.3	101	9.3	7.4	3.6
05/16/2017	12:40	14.3	83	9.2	7.2	13
06/13/2017	13:15	16.7	78	8.9	7.2	10
Ulatis Creek at Browns Road						
07/13/2016	14:30	25.6	1,060	7.5	7.8	14
08/17/2016	14:10	21.9	716	6.3	8.0	3.2
09/20/2016	14:10	21.3	1,050	4.8	7.8	0.8
10/18/2016	14:45	19.0	635	8.3	7.3	—
11/14/2016	15:05	17.5	1,090	8.5	8.1	—
12/16/2016	14:35	11.9	246	9.3	7.7	180
01/09/2017	14:15	12.0	208	9.3	7.7	200
02/28/2017	16:15	15.0	787	11.1	8.3	3.1
03/14/2017	14:50	19.6	888	19.4	8.8	0.3
04/25/2017	16:15	20.8	858	15.7	8.7	0.3
05/16/2017	15:10	18.9	896	15.1	8.7	0.1
06/13/2017	15:50	24.7	712	15.5	8.6	0.1

Table 5. Concentrations of dissolved and suspended constituents measured in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.

[hh:mm, hours:minutes; mg/L, milligrams per liter; mm/dd/yyyy, month/day/year; n, below the reporting level, but at or above the detection level; µg/L, micrograms per liter; <, less than]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Dissolved organic carbon (mg/L) [00681]	Particulate inorganic carbon (mg/L) [00688]	Particulate organic carbon (mg/L) [00689]	Total particulate carbon (mg/L) [00694]	Dissolved copper (µg/L) [01040]	Total particulate nitrogen (mg/L) [49570]
Mokelumne River at New Hope Road							
07/13/2016	09:30	2.31	<0.03	<0.47	0.47	1.3n	0.059
08/17/2016	09:00	no data	<0.03	<0.57	0.57	0.99n	0.086
09/20/2016	09:10	3.74	<0.03	<0.38	0.38	1.3n	0.042
10/18/2016	09:15	3.96	<0.03	<0.33	0.33	2.0	0.044
11/14/2016	09:40	2.1	<0.03	<0.15	0.15	1.4	<0.030
12/16/2016	09:30	2.03	<0.03	<0.44	0.44	0.97	0.06
01/09/2017	09:00	2.8	<0.03	<0.83	0.83	1.5	0.107
02/28/2017	09:30	2.34	<0.03	<0.52	0.52	1.2	0.064
03/14/2017	09:40	1.99	<0.03	<0.35	0.35	1.3	0.035
04/25/2017	09:40	1.87	<0.03	<0.33	0.33	1.4	0.047
05/16/2017	09:20	1.88	<0.03	<0.31	0.31	1.1	0.039
06/13/2017	09:20	2.2	<0.03	<0.43	0.43	2.5	0.053
Sacramento River at Hood							
07/13/2016	08:20	1.69	<0.03	<0.54	0.54	1.2n	0.073
08/17/2016	07:55	1.55	<0.03	<0.42	0.42	1.1n	0.061
09/20/2016	08:10	2.11	<0.03	<0.30	0.3	1.4n	0.034
10/18/2016	08:00	2.73	<0.03	<0.40	0.4	1.7	0.058
11/14/2016	08:20	2.47	<0.03	<0.34	0.34	1.7	0.043
12/16/2016	08:15	2.99	0.04	3.1	3.14	1.7	0.366
01/09/2017	08:00	3.01	<0.03	<0.55	0.55	1.8	0.088
02/28/2017	08:10	1.67	<0.03	<0.52	0.52	1.2	0.065
03/14/2017	08:15	1.58	<0.03	<0.87	0.87	2.9	0.141
04/25/2017	08:20	1.5	<0.03	<0.66	0.66	1.3	0.089
05/16/2017	08:15	1.46	<0.03	<0.29	0.29	1.6	0.035
06/13/2017	08:00	2	<0.03	<0.44	0.44	2.2	0.069
San Joaquin River at Buckley Cove							
07/13/2016	11:05	3.85	<0.03	<0.77	0.77	2.0	0.135
08/17/2016	10:20	3.57	<0.03	<0.76	0.76	1.5n	0.139
09/20/2016	10:30	3.58	<0.03	<1.09	1.09	1.3n	0.189
10/18/2016	10:40	4.33	<0.03	<0.93	0.93	2	0.153
11/14/2016	11:00	3.7	<0.03	<0.30	0.3	1.8	0.039
12/16/2016	10:45	3.35	<0.03	<0.26	0.26	1.9	0.036
01/09/2017	10:30	7.85	<0.03	<1.66	1.66	3.4	0.26
02/28/2017	11:10	4.24	<0.03	<1.74	1.74	1.7	0.211
03/14/2017	10:50	3.36	<0.03	<0.40	0.4	1.3	0.06
04/25/2017	11:10	2.81	<0.03	<0.61	0.61	2.1	0.085
05/16/2017	11:00	2.62	<0.03	<0.47	0.47	1.3	0.074
06/13/2017	10:45	2.94	<0.03	<0.53	0.53	1.9	0.079

Table 5. Concentrations of dissolved and suspended constituents measured in environmental water samples collected in the Sacramento–San Joaquin Delta, California, 2016–17.—Continued

[hh:mm, hours:minutes; mg/L, milligrams per liter; mm/dd/yyyy, month/day/year; n, below the reporting level, but at or above the detection level; µg/L, micrograms per liter; <, less than]

Sample date (mm/dd/yyyy)	Sample time (hh:mm)	Dissolved organic carbon (mg/L) [00681]	Particulate inorganic carbon (mg/L) [00688]	Particulate organic carbon (mg/L) [00689]	Total particulate carbon (mg/L) [00694]	Dissolved copper (µg/L) [01040]	Total particulate nitrogen (mg/L) [49570]
San Joaquin River near Vernalis							
07/13/2016	12:45	2.87	0.04	5.61	5.66	1.0n	0.794
08/17/2016	12:00	1.89	<0.03	<1.49	1.49	0.88n	0.23
09/20/2016	12:20	2.8	<0.03	<1.80	1.8	0.91n	0.305
10/18/2016	12:25	3.14	<0.03	<0.78	0.78	0.37n	0.112
11/14/2016	12:45	3.87	<0.03	<0.94	0.94	1.3	0.109
12/16/2016	12:15	3.55	<0.03	<0.92	0.92	1.2	0.121
01/09/2017	11:55	3.92	0.03	0.84	0.87	2.1	0.154
02/28/2017	12:50	4.32	<0.03	<0.79	0.79	1.4	0.112
03/14/2017	12:40	3.46	<0.03	<0.48	0.48	1.3	0.072
04/25/2017	13:30	2.63	<0.03	<0.53	0.53	3.9	0.091
05/16/2017	12:40	2.49	<0.03	<0.56	0.56	1.1	0.088
06/13/2017	13:15	2.72	<0.03	<0.81	0.81	3.5	0.11
Ulatis Creek at Browns Road							
07/13/2016	14:30	no data	<0.03	<1.53	1.53	3.8	0.275
08/17/2016	14:10	7.37	<0.03	<0.56	0.56	2.7	0.089
09/20/2016	14:10	7.1	<0.03	<1.44	1.44	2.3	0.202
10/18/2016	14:45	8.73	<0.03	<1.03	1.03	2.6	0.162
11/14/2016	15:05	4.53	<0.03	<1.88	1.88	4.1	0.225
12/16/2016	14:35	8.85	0.3	5.04	5.34	4.1	0.668
01/9/2017	14:15	6.74	<0.03	<5.14	5.14	5.6	0.75
02/28/2017	16:15	2.58	<0.03	<0.46	0.46	1.1	0.069
03/14/2017	14:50	3.09	<0.03	<1.06	1.06	1.9	0.192
04/25/2017	16:15	2.72	<0.03	<0.30	0.3	2.2	0.059
05/16/2017	15:10	6.55	<0.03	<1.09	1.09	7.8	0.189
06/13/2017	15:50	8.91	<0.03	<0.46	0.46	4.6	0.084

Sacramento River at Hood

A total of 30 pesticides were detected in water samples collected at this site (11 herbicides, 7 fungicides, 7 breakdown products, 4 insecticides, and 1 synergist). The median number of pesticides detected was 7, a minimum of 3 compounds were detected in the sample collected on February 28, 2017, and a maximum of 15 compounds were detected in the sample collected on October 17, 2016. The herbicide pendimethalin was the only pesticide detected in suspended-sediment samples. There were no pesticide detections at concentrations above EPA aquatic life benchmarks in samples collected from this site.

San Joaquin River at Buckley Cove

A total of 31 pesticides were detected in water samples collected at this site (11 herbicides, 8 fungicides, 6 breakdown products, 5 insecticides, and 1 synergist). The median number of pesticides detected was 14, a minimum of 8 compounds were detected in the sample collected on September 20, 2016, and a maximum of 19 compounds were detected in the sample collected on January 9, 2017. The herbicide pendimethalin was the only pesticide detected in suspended-sediment samples. There were no pesticide detections at concentrations above EPA aquatic life benchmarks in samples collected from this site.

San Joaquin River near Vernalis

A total of 29 pesticides were detected in water samples collected at this site (11 herbicides, 8 insecticides, 6 fungicides, 3 breakdown products, and 1 synergist). The median number of pesticides detected was 10, a minimum of 5 compounds were detected in samples collected on October 18, 2016, and June 13, 2017, and a maximum of 17 compounds were detected in the sample collected on January 9, 2017. The herbicide pendimethalin was the only pesticide detected in suspended-sediment samples. Imidacloprid was detected in the samples collected on December 12, 2016 (17 ng/L), and January 9, 2017 (29 ng/L), at concentrations above the aquatic life benchmark for chronic toxicity to invertebrates of 10 ng/L (U.S. Environmental Protection Agency, 2017).

Ulatis Creek at Browns Road

A total of 41 pesticides were detected in water samples collected at this site (13 herbicides, 12 insecticides, 10 fungicides, and 6 breakdown products). The median number of pesticides detected was 15, a minimum of 9 compounds were detected in the sample collected on September 20, 2016, and a maximum of 24 compounds were detected in the sample collected on December 16, 2016. A total of four pesticides were detected in suspended-sediment samples (two insecticides and two herbicides; table 3).

Imidacloprid was detected in the samples collected on August 17, 2016 (11 ng/L), October 18, 2016 (28 ng/L), November 14, 2016 (30 ng/L), and December 16, 2016 (29 ng/L), at concentrations above the aquatic life benchmark for chronic toxicity to invertebrates of 10 ng/L (U.S. Environmental Protection Agency, 2017). Bifenthrin was detected in the samples collected on July 13, 2016 (12 ng/L), March 14, 2017 (2.3 ng/L), and April 25, 2017 (3.4 ng/L), at concentrations above the aquatic life benchmark for chronic toxicity to invertebrates of 1.3 ng/L (U.S. Environmental Protection Agency, 2017). Cyhalothrin was detected in the sample collected on July 13, 2016 (9 ng/L), at a concentration above the aquatic life benchmark for acute toxicity invertebrates of 3.5 ng/L (U.S. Environmental Protection Agency, 2017).

Comparison of Year 1 and Year 2 Results

The number of total pesticide detections and compounds detected by pesticide class were similar between Years 1 and 2 of the study period. In Year 1 a total of 54 out of 154 current-use pesticides were detected in water samples (De Parsia and others, 2018), and in Year 2 a total of 53 out of 154 current-use pesticides were detected in water samples. Year 1 had 18 herbicides, 9 insecticides, 19 fungicides, 7 breakdown products, and 1 synergist detected. Year 2 had 18 herbicides, 14 insecticides, 13 fungicides, 7 breakdown products, and 1 synergist detected. Method detection limits for pesticide compounds did not change between Year 1 and Year 2.

Slight differences were seen in pesticide concentrations between Years 1 and 2 of the study period. The range in pesticide concentrations was larger in Year 1 than in Year 2. Pesticide concentrations in Year 1 ranged from below the MDLs to 2,700 ng/L (maximum concentration was for the herbicide metolachlor), and concentrations in Year 2 ranged from below the MDLs to 1,300 ng/L (maximum concentration was for the insecticide chlorantraniliprole). Maximum concentrations were larger in Year 1 than in Year 2 for 17 of the 20 most frequently detected compounds.

Total pesticide concentrations measured on suspended sediments filtered from surface water varied between Years 1 and 2. A total of 11 pesticide compounds were detected in the suspended sediments during the Year 1 study period (6 herbicides, 3 insecticides, 1 fungicide, and 1 breakdown product), and a total of 4 pesticide compounds were detected in the suspended sediment during the Year 2 study period (2 herbicides and 2 insecticides). In Year 1, the most frequently detected pesticides were bifenthrin (5 percent), pendimethalin (5 percent), and permethrin (7 percent). In Year 2, the most frequently detected pesticides were metolachlor (3 percent) and pendimethalin (10 percent). The range in pesticide concentrations in the suspended sediments was smaller in Year 1 than in Year 2. The Year 1 pesticide concentrations ranged from below the MDLs to 270 ng/L (maximum concentration was for the herbicide pendimethalin). The Year 2 pesticide concentrations ranged from below the MDLs to 750 ng/L (maximum concentration was for the herbicide pendimethalin).

For each year, there were pesticide detections in filtered water samples that exceeded aquatic life benchmarks (U.S. Environmental Protection Agency, 2017). In Year 1, three compounds exceeded aquatic life benchmarks: bifenthrin, fipronil, and imidacloprid. Bifenthrin and imidacloprid also exceeded aquatic life benchmarks in Year 2. Over the course of this study, bifenthrin exceeded its aquatic benchmark (1.3 ng/L) 6 times, fipronil exceeded its aquatic benchmark (11 ng/L) 5 times, and imidacloprid exceeded its aquatic benchmark (10 ng/L) 17 times. The maximum concentration for each compound was 33, 25, and 60 ng/L for bifenthrin, fipronil, and imidacloprid, respectively.

Summary

This study was done as part of the Delta Regional Monitoring Program (RMP), a cooperative effort to better track beneficial-use protections and restoration efforts through the monitoring of mercury, nutrients, pathogens, and pesticides in the Sacramento–San Joaquin Delta (Delta). The July 2016 to June 2017 study period marks the second year of pesticide sample collection and analysis for the Delta RMP. The U.S. Geological Survey (USGS), working in cooperation with the San Francisco Estuary Institute, was responsible for collecting, analyzing, and reporting pesticide-concentration data in the Delta. Samples were collected monthly at 5 major inputs to the Delta from July 2016 to June 2017 and analyzed for a suite of 154 current-use pesticides and pesticide degradates, dissolved organic carbon, particulate organic carbon, particulate inorganic carbon, particulate nitrogen, and dissolved copper by the USGS. From each site, 10 samples were collected approximately mid-month and 2 samples were collected following storms.

Thirty-eight quality-assurance and quality-control samples were collected and analyzed to validate measurements taken on environmental samples. Two analytical values, copper in one field blank and total particulate carbon in one pair of replicate samples, did not meet data-quality standards defined in the study's quality-assurance program plan; all measurements for the other 36 quality-assurance and quality-control samples satisfied the targets for the quality-assurance program plan.

A total of 53 out of 154 pesticides (18 herbicides, 14 insecticides, 13 fungicides, 7 breakdown products, and 1 synergist) were detected in filtered surface-water samples and 98 percent of samples contained at least 1 pesticide. Seven pesticides were detected in at least half of the water samples collected during the July 2016 to June 2017 study period. A total of 4 pesticides (2 herbicides and 2 insecticides) were detected in suspended-sediment samples and 13 percent of suspended-sediment samples contained at least 1 pesticide. The maximum pesticide concentration detected in a water sample was 1,300 nanograms per liter (ng/L) for the insecticide chlorantraniliprole and the maximum concentration detected in a suspended-sediment sample was 750 ng/L for the herbicide pendimethalin.

The total number of pesticides detected in the July 2015 to June 2016 study period of the Delta RMP was similar to the total number of pesticides detected in the July 2016 to June 2017 study period, but the pesticide class breakdown changed from Year 1 to Year 2. The main changes from Year 1 to Year 2 were a decrease in the number of fungicides detected and an increase in the number of insecticides detected. Maximum concentrations were generally higher in Year 1 than Year 2. Pesticide-detection frequencies were higher in Year 1 than Year 2 for all but two of the most frequently detected compounds (detection frequency of metolachlor and methoxyfenozide increased from Year 1 to Year 2).

Bifenthrin and imidacloprid were detected in filtered water samples at concentrations above the U.S. Environmental Protection Agency (EPA) aquatic life benchmarks for chronic toxicity to invertebrates and cyhalothrin was detected at a concentration greater than the aquatic life benchmark for acute toxicity to invertebrates. Comparisons to EPA toxicity benchmarks were only used to provide context to pesticide concentrations for this report; they were not intended to be an assessment of water quality.

Although the EPA does provide aquatic life benchmarks for over 500 pesticides, the effects of mixtures of those pesticides are often unknown and difficult to study. Pairing pesticide-concentration data from environmental waters with toxicity testing is an important step toward understanding how complex mixtures of pesticides, such as those reported in the Delta, can contribute to toxicity observed in aquatic systems. Further study is necessary to determine whether pesticides are contributing to toxicity observed in the Delta.

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Appendix A

This appendix contains brief descriptions and citations for the analytical methods and method detection limits (MDLs) used in this study. More detailed descriptions of the following methods can be found in U.S. Geological Survey Data Series Report 1089.

Analytical Methods

Pesticide concentrations in surface water were measured by the U.S. Geological Survey Organic Chemistry Research Laboratory (OCRL) using two methods: (1) liquid chromatography/tandem mass spectrometry (LC/MS/MS) and (2) gas chromatography/mass spectrometry (GC/MS). Twenty-five compounds were analyzed using the LC/MS/MS method described in Hladik and Calhoun (2012) and 129 compounds were analyzed using the GC/MS methods described in Hladik and others (2008, 2009) and Hladik and McWayne (2012). Pesticide concentrations for 129 compounds in suspended sediment were measured by the OCRL using the GC/MS methods described in Hladik and others (2008, 2009) and Hladik and McWayne (2012).

Dissolved organic carbon, DOC; particulate inorganic carbon, PIC; particulate organic carbon, POC; total particulate carbon, TPC; total particulate nitrogen, TPN; and copper analyses were performed by the U.S. Geological Survey National Water Quality Laboratory (NWQL). Dissolved organic carbon was analyzed at the NWQL using the method described in Open-File Report 92–480 (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 (Zimmermann and others, 1997). Copper was analyzed at the NWQL using the method described by Garbarino and others (2006).

Method Detection Limits and Reporting Levels

Method detection limits 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 A–1. 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 are coded with an “E”.

Detection limits for PIC, POC, TPC, and TPN were determined by the NWQL using long-term method detection levels (LT-MDL) following protocols described in Childress and others (1999). The LT-MDL is used to limit the chance of reporting false positives. Laboratory reporting levels (LRL) are used to control false negative errors and are usually set at two times the LT-MDL. 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. 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 “less than” (<) qualifier. Reporting levels and detection limits for the analytes measured at the NWQL in this study are listed in table A–2.

The NWQL changed its method detection and reporting level methodologies for DOC and copper analyses during the July 2016 to June 2017 study period of the Delta Regional Management Program (RMP; table A–2). Detection limits for DOC results from October 1, 2014, to March 6, 2017, and copper results from October 1, 2014, to September 30, 2016, were determined by the NWQL using the DQCALC software package (ASTM International, 2010). Detection limits for DOC results from March 6, 2017, to present and copper results from October 1, 2016, to present were determined using blank data (DLBLK).

The detection limit determined by DQCALC is calculated by analyzing a series of spiked replicate samples; it provides the lowest concentration at which the chance of a false positive is equal to or less than 1 percent (ASTM International, 2010). The DLBLK also provides the lowest concentration at which the chance of a false positive is less than or equal to 1 percent, but the DLBLK is determined by analyzing a series of blanks (U.S. Geological Survey, 2015). Reporting levels for analyses that use DQCALC and DLBLK are re-evaluated annually and subject to change, but the reporting level is generally two times the detection limit. The reporting level is used to control false negative error. For a full description of NWQL detection limits and reporting levels see the National Water Quality Laboratory Technical Memorandum 15.02 (U.S. Geological Survey, 2015).

Table A–1. Method detection limits for dissolved pesticides in surface water and on suspended sediments measured by the U.S. Geological Survey Organic Chemistry Research Laboratory.

[Parent compounds for breakdown products are provided in parantheses. **Abbreviations**: GC/MS, gas chromatography/mass spectrometry; LC/MS/MS, liquid chromatography/tandem mass spectrometry; ng/L, nanograms 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 (azinphos-methyl)	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 (diuron)	3.5	LC/MS/MS
DCPU	68226	Urea	Breakdown product (diuron)	3.4	LC/MS/MS
Deltamethrin	65077	Pyrethroid	Insecticide	0.6	GC/MS

Table A–1. 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

[Parent compounds for breakdown products are provided in parantheses. **Abbreviations**: GC/MS, gas chromatography/mass spectrometry; LC/MS/MS, liquid chromatography/tandem mass spectrometry; ng/L, nanograms per liter; NWIS, National Water Information System]

Compound	NWIS parameter code	Chemical class	Primary pesticide use	Method detection limit (ng/L)	Analytical method
Desthio-prothioconazole	51865	Unclassified	Breakdown product (prothioconazole)	3.0	LC/MS/MS
Desulfinylfipronil	66607	Unclassified	Breakdown product (fipronil)	1.6	GC/MS
Desulfinylfipronil amide	68570	Unclassified	Breakdown product (fipronil)	3.2	GC/MS
Diazinon	65078	Organophosphorus	Insecticide	0.9	GC/MS
Diazoxon	68236	Organophosphorus	Breakdown product (diazinon)	5.0	GC/MS
3,4-Dichloroaniline	66584	Amine	Breakdown product (diuron)	3.2	LC/MS/MS
3,5-Dichloroaniline	67536	Unclassified	Breakdown product (vinclozolin)	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 (fipronil)	1.8	GC/MS
Fipronil sulfone	66613	Unclassified	Breakdown product (fipronil)	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

Table A–1. 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

[Parent compounds for breakdown products are provided in parantheses. **Abbreviations**: GC/MS, gas chromatography/mass spectrometry; LC/MS/MS, liquid chromatography/tandem mass spectrometry; ng/L, nanograms per liter; NWIS, National Water Information System]

Compound	NWIS parameter code	Chemical class	Primary pesticide use	Method detection limit (ng/L)	Analytical method
Fluxapyroxad	51851	Anilide, pyrazole	Fungicide	4.8	GC/MS
Hexazinone	65085	Triazinone	Herbicide	8.4	GC/MS
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 (malathion)	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	Breakdown product (p,p’-DDT)	4.1	GC/MS
p,p’-DDE	65095	Organochlorine	Breakdown product (p,p’-DDT)	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 (pentachlorophenol)	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

Table A–1. 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

[Parent compounds for breakdown products are provided in parantheses. **Abbreviations**: GC/MS, gas chromatography/mass spectrometry; LC/MS/MS, liquid chromatography/tandem mass spectrometry; ng/L, nanograms per liter; NWIS, National Water Information System]

Compound	NWIS parameter code	Chemical class	Primary pesticide use	Method detection limit (ng/L)	Analytical method
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
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 (tebupirimfos)	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 A–2. Reporting levels and detection limits for dissolved and suspended constituents measured by the U.S. Geological Survey National Water Quality Laboratory.

[dlblk, detection limit by blank data; dldqc, detection limit by DQCALC software; lt-mdl, long term-method detection levels; mg/L, milligrams per liter; mm/dd/yyyy, month/day/year; mrl, minimum reporting level; n/a, not available; NWIS, National Water Information System; µg/L, micrograms per liter; —, reporting threshold is current]

Analyte	Group	NWIS parameter code	Sample fraction	Detection limit	Reporting level	Reporting threshold type	Parameter unit	Start date (mm/dd/yyyy)	End date (mm/dd/yyyy)
Organic carbon	Organics, other	00681	Dissolved	0.23	0.46	dldqc	mg/L	10/01/2014	03/06/2017
Organic carbon	Organics, other	00681	Dissolved	0.23	0.46	dlblk	mg/L	03/06/2017	—
Inorganic carbon	Inorganics, major, non-metals	00688	Suspended	0.03	0.06	lt-mdl	mg/L	10/01/2011	—
Organic carbon	Organics, other	00689	Suspended	n/a	0.05	mrl	mg/L	08/13/2012	—
Total carbon	Inorganics, major, non-metals	00694	Suspended	0.05	0.10	lt-mdl	mg/L	11/01/2011	—
Copper	Inorganics, minor, metals	01040	Dissolved	0.8	1.60	dldqc	µg/L	10/01/2014	09/30/2016
Copper	Inorganics, minor, metals	01040	Dissolved	0.2	0.4	dlblk	µg/L	10/01/2016	—
Nitrogen	Nutrient	49570	Suspended	0.030	0.060	lt-mdl	mg/L	10/01/2013	—

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