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DATE: October 3, 2002

SUBJECT: PRELIMINARY RESULTS OF STUDY 205: MONITORING THE OCCURRENCE AND TYPICAL CONCENTRATION OF ESFENVALERATE AND PERMETHRIN PYRETHROIDS IN THE SACRAMENTO AND SAN JOAQUIN WATERSHEDS, WINTER 2002

SCOPE OF THIS MEMORANDUM

This memorandum provides results of water sampling conducted at two sites in the San Joaquin watershed and two sites in the Sacramento watershed by the Department of Pesticide Regulation (DPR) during three storm events. Data presented is from February 19, March 6, and March 7, 2002. Results include chemical analysis conducted by the California Department of Food and Agriculture (CDFA) and bioassays conducted by the California Department of Fish and Game (DFG). Samples were analyzed for the pyrethroids esfenvalerate and permethrin, as well as selected organophosphate (OP) insecticides and herbicides. This memorandum summarizes winter 2002 monitoring results. Due to an unseasonably dry winter, monitoring will likely be repeated in the winter of 2003. This memorandum does not include an in-depth interpretation of the data, which will be provided in the final report.

BACKGROUND

In the Sacramento and San Joaquin valleys there are more than 750,000 acres of almonds, nectarines, peaches, plums and prunes grown (Epstein et al., 2000). As part of integrated pest management, organophosphate insecticides are applied on these tree crops, generally with oil, to control the San Jose scale, the peach twig borer, aphids and other pests. This is done primarily between December and February when trees are dormant, allowing for better pesticide coverage to achieve effective control of pests. The dormant-spray application season coincides with seasonal rainfall, thus increasing the likelihood of OP insecticides to move offsite, dissolved in water or attached to sediment, to surface waters. Various monitoring studies conducted by DPR and the U.S. Geological Survey (USGS) have shown that detections of OPs such as diazinon were observed in surface waters during dormant-spray seasons (Ross et al., 1996; Domagalski et al., 1997; Kratzer, 1998).

Since 1992, the use of OPs during the dormant-spray season has been steadily decreasing, and there are indications that they are being replaced by pyrethroids, specifically esfenvalerate and permethrin, in California (Epstein et al., 2000). The potential for negative environmental impacts to surface waters from esfenvalerate and permethrin use is uncertain. Physico-chemical characteristics indicate a potential for esfenvalerate and permethrin to move offsite with sediment and also the potential to cause acute aquatic toxicity (Table 1). The lack of monitoring data for these pesticides necessitates a need for current monitoring.

Due to their known presence in surface waters, specific OP insecticides that are in use during the dormant season were also monitored. Selected fall-applied herbicides were also monitored to further characterize their concentrations in surface water.

The objective of this monitoring project was to determine if esfenvalerate and permethrin are moving offsite into surface waters in measurable amounts, and if so, what is the typical range of concentrations that may be observed. This data will be used to determine if there is a need for further study. This project will also help further characterize winter runoff of organophosphate insecticides and selected herbicides.

MATERIALS AND METHODS

Site Description

Four monitoring sites were chosen that reflect areas with the heaviest historical applications of esfenvalerate and permethrin through the dormant-spray season (Figures 1-4). The following factors were also considered in evaluating the desirability of these sites for monitoring:

- Previous detections of diazinon during dormant-spray seasons.
- Proximity of monitoring locations to application sites.

Sample Collecting and Handling

All samples were collected using an extended grab pole with a 1-liter amber glass bottle, except for the Wadsworth canal site. For the first storm event only, February 19th, samples were collected from this site using a rope with an encased 1-liter amber glass bottle. Water samples were collected as close to center channel as possible at all sites, and all bottles were sealed with Teflon®-lined lids.

Samples designated for OP chemical analysis were preserved by acidification with 3N hydrochloric acid to a pH of 3.0 to 3.5. Most OP pesticides are sufficiently preserved at this pH (Ross et al., 1996). However, diazinon rapidly hydrolyzes under acidic conditions and so was analyzed using a separate unacidified sample. Samples submitted for herbicide analysis and toxicity tests were not acidified.

For all sites, one 1-liter sample was submitted to DFG for acute toxicity testing. Four 1-liter samples were submitted for chemical analyses: one each for organophosphates, diazinon, permethrin and esfenvalerate, and herbicide analysis. Two 1-liter backups were stored at the field office. All samples were transferred on wet ice and then stored in a 4°C refrigerator until transported (on wet ice) to the appropriate laboratory for analysis.

ENVIRONMENTAL MEASUREMENTS

Water Quality Measurements

Temperature, dissolved oxygen (DO), pH, and electrical conductivity (EC) were measured *in situ* at each sampling site. DO, EC and temperature were measured with a Yellow Springs Instruments (YSI) multi-meter (model 85). Water pH was measured with a YSI pH meter (model 60) or an IQ Scientific Instruments (model IQ150) pH meter depending on the site.

Rainfall Data

Hourly rainfall was obtained for each sampling site from the California Water Resources database (CDEC, 2002). Rainfall data will be used in the analysis of pesticide concentrations with respect to runoff in the final report.

PESTICIDE ANALYSIS AND TOXICITY TESTS

Chemical Analysis

Chemical analysis was performed by the CDFA's Center for Analytical Chemistry. The following methods were used to determine concentrations of pesticides:

- organophosphates - gas chromatography/flame phometric detector (GC/FPD)
- pyrethroids - gas chromatography/electron capture detector (GC/ECD)
- triazines - atmospheric pressure chemical ionization/ liquid chromatography /mass spectrometry/mass spectrometry (APCI/LC/MS/MS)

Comprehensive chemical analytical methods will be provided in the final report. The reporting limit is the lowest concentration of analyte that the method can detect reliably in a matrix blank. Method titles and reporting limits are reported in Table 2.

Quality Control

Quality control (QC) for the chemistry portion of this study was conducted in accordance with Standard Operating Procedure QAQC001.00 (Segawa, 1995) and consisted of a continuing QC program that included the submission of field blanks (10% of analyzed samples) and blind spikes (10% of analyzed samples). Blind spike and continuing QC results for each of the analytical screens are presented in Tables 3-6. The establishment of control limits, spike recoveries, and analysis of QC will be included in the final report.

Toxicity Tests

DFG's Aquatic Toxicology Laboratory performed aquatic toxicity tests. Acute tests were performed in undiluted sample water using 96-hour, static-renewal bioassays with the cladoceran *C. dubia* in accordance with current U. S. Environmental Protection Agency procedures (U.S. EPA, 1993).

RESULTS

Sampling events were planned to occur with storm events that would produce greater than 0.5 inches of rainfall. Due to fiscal constraints, sampling for this study could not begin until after January 15, 2002. Dormant spray applications normally occur from mid-December through February 15, 2002, during the dormant season. Rainfall after January 15, 2002, was unseasonably low. The first significant rain event occurred February 19 for sites 1 and 2 in the Sacramento watershed. The first significant rain event for sites 3 and 4 in the San Joaquin watershed did not occur until March 7. Both of these storm events occurred after a relatively long dry period (> 2 weeks). The magnitude of rainfall that occurred 12 hours prior to the start of sampling and during the sampling events may not have been significant enough to create runoff from agriculture fields. Therefore, this study may be repeated in the 2003 dormant spray season.

Environmental Measurements

Site 1 - Wadsworth Canal (Figure 5)

The first sampling event occurred on February 19, 2002. Temperature ranged from 12.7 to 12.9°C. DO ranged from 8.03 to 10.5 mg/l. EC was measured at 596 to 597 µS/cm, and pH ranged from 7.93 to 8.25.

Prior to the start of sampling rainfall for the previous four weeks had been 0.84 inches. Rainfall over the 24 hours prior to the start of sampling was 0.48 inches. This was determined using a rain gauge installed near the site. During the 8-hour sampling event, there was no significant rainfall.

The second sampling event occurred on March 6, 2002. Temperature ranged from 14.1 to 15.2° C. DO ranged from 8.86 to 10.6 mg/l. EC was measured at 595 to 608 µS/cm, and pH ranged from 7.93 to 8.25.

Rainfall for the previous fourteen days was 0.34 inches. Rainfall over the 24 hours prior to the start of sampling was 0.12 inches. During the 10-hour sampling event, rainfall was 0.08 inches.

Site 2: Jack Slough (Figure 6)
The first sampling event occurred on February 19, 2002. Temperature ranged from 11.2 to 11.3°C. DO ranged from 7.8 to 8.63 mg/l. EC was measured at 197.3 to 203.9 µS/cm, and pH ranged from 7.1 to 7.7.

Prior to the start of sampling, rainfall for the previous four weeks had been 0.84 inches. Rainfall over the 24 hours prior to the start of sampling was 0.48 inches. This was determined using a rain gauge installed near the site. During the 8-hour sampling event there was no significant rainfall.

The second sampling event occurred on March 6, 2002. Temperature ranged from 12.5 to 14.1° C. DO ranged from 7.8 to 8.63 mg/l. EC was measured at 183 to 199.8 µS/cm, and pH ranged from 7.2 to 8.9.

Rainfall for the previous fourteen days was 0.34 inches. Rainfall over the 24 hours prior to the start of sampling was 0.12 inches. During the 10-hour sampling event rainfall was 0.08 inches.

Site 3: Westport Drain (Figure 7)
This sampling event occurred on March 7, 2002. Temperature ranged from 15.9 to 17.9°C. DO ranged from 4.66 to 8.44 mg/l. EC was measured at 542 to 920 µS/cm, and pH ranged from 7.2 to 8.4.

Prior to the start of sampling, rainfall for the previous four weeks had been 0.90 inches. There was no significant rainfall 24 hours prior to the start of sampling. During the 8-hour sampling event there was no significant rainfall.

Site 4: Highline canal (Figure 8)
This sampling event occurred on March 7, 2002. Temperature ranged from 14.8 to 15.4°C. DO ranged from 8.7 to 9.01 mg/l. EC was measured at 67.3 to 72.5 µS/cm, and pH ranged from 6.81 to 7.51.

Prior to the start of sampling, rainfall for the previous four weeks had been 0.90 inches. There was no significant rainfall 24 hours prior to the start of sampling. During the 8-hour sampling event, there was no significant rainfall.

Discharge into the canal from Turlock Lake began on March 5, 2002, two days prior to sampling at a flow of approximately 50cfs. On the day of sampling, discharge had been increased to approximately 100cfs. This inflow of fresh water may possibly explain the low EC measurements.

Pesticide Detections

Site 1: Wadsworth Canal (Figure 5)
There were no pesticides detected during the first storm event on February 19, 2002.

During the second storm event on March 6, 2002, the herbicide simazine was detected once (0.156 ppb).

Site 2: Jack Slough (Figure 6)
One OP (diazinon) was detected during the first storm event (February 19). It was detected every hour during the sampling event at a range of 0.084 to 0.162 ppb. The herbicide diuron was also detected during this event. It was detected three times at a range of 0.05 to 0.096 ppb.

At the second sampling event (March 6), again both diazinon and diuron were detected. Detections were reported in each hourly sample at ranges of 0.092 to 0.128 ppb and 0.921 to 2.22 ppb respectively. There were no other pesticide detections.

Site 3: Westport drain (Figure 7)
Due to unseasonably dry conditions this site was only sampled during one storm event (March 7). Diazinon was detected twice (0.119 ppb, 0.79 ppb). The herbicides diuron and bromacil were detected in each hourly sample at ranges of 0.386 to 3.38 ppb and 0.056 to 0.149 ppb, respectively. Norflurazon and Diamino chloro-triazine (DACT) were also detected 3 times each at 0.053 to 0.075 ppb and 0.16 to 0.194 ppb, respectively.

Site 4: Highline canal (Figure 8)
Due to unseasonably dry conditions this site was only sampled during one storm event (March 7). The only detections were three herbicides, diuron, bromacil and norflurazon. All were detected in each hourly sample. Detections ranged from 5.89 to 11.5 ppb for diuron, 1.58 to 3.73 ppb for bromacil, and 0.125 to 0.498 ppb for norflurazon.

Discharge into the canal from Turlock Lake began on March 5, two days prior to sampling at a flow of approximately 50cfs. On the day of sampling discharge had been increased to approximately 100cfs. This inflow of fresh water may have contributed to insecticide concentrations below detection limits.

Toxicity
There was no significant toxicity found in any of the 52 total samples collected.

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Table 1. Esfenvalerate and Permethrin Physical Characteristics and Aquatic Toxicity

Pesticide	K_{oc}	Solubility (mg/l)	Half-life (days)	Half-life (days)	Toxicity *Daphnia Magna* EC50 (ppb)	Toxicity Rainbow Trout 96hr EC50 (ppb)
Esfenvalerate	1000-12,000[a]	0.0002 [a]	14 - 75 [a]	stable [a]	0.15 [c] (48hr)	0.07 [c]
Permethrin	10,471-86,000[a]	0.006 [a]	6 - 106 [a]	3-42 [b]	0.025 - 0.06 [c] (96hr)	2.0 - 11.2 [c]

a–ARSUSDA b–DPR c–U.S.EPA

Acute toxicity (48-hour LC50 ug/L)[1]

Detected pesticides to aquatic macroinvertebrates

Detected Pesticides	Daphnia magna	Ceriodaphnia dubia
Insecticides		
Diazinon	0.96 a – 1.44 b [2, 3]	0.44a
Herbicides		
Bromacil	119,000c – 121,000d	
Norflurazon	15,000e	
Diuron	8,000c – 12,000f	12.1f
Simazine	1100d – >100,000e	

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

2 Number ranges may represent more than 2 individual studies.

3 Numbers underlined are 48-hour EC_{50} values.

SOURCES:

a. CDFG, 1994.
b. DPR, 2001
c. The Pesticide Manual, 1994.
d. U.S. EPA, 1991.
e. Herbicide Handbook, 1994.
f. CDFG, 2000.

TABLE 2. CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE, CENTER FOR ANALYTICAL CHEMISTRY ORGANOPHOSPHATE AND TRIZINE/HERBICIDE PESTICIDES.

Organophosphate Pesticides Method: GC/FPD		**Organophosphate Pesticides Method: GC/FPD**		**Triazines/Herbicides Method: APCI/LC/MS/MS**	
Compound	**Reporting Limit (µg/L)**	**Compound**	**Reporting Limit (µg/L)**	**Compound**	**Reporting Limit (µg/L)**
Azinphos methyl	0.05	Phosmet	0.05	Atrazine	0.05
Chlorpyrifos	0.04	Thimet (Phorate)	0.05	Bromacil	0.05
Diazinon	0.04	Profenofos	0.05	Diuron	0.05
DDVP (dichlorvos)	0.05	Tribufos	0.05	Hexazinone	0.05
Dimethoate	0.04			Metribuzin	0.05
disulfoton	0.04	**Pyrethroid Pesticides Method: GC/ECD**		Norflurazon	0.05
ethoprop	0.05			Prometon	0.05
Fenamiphos	0.05	**Compound**		Prometryn	0.05
Fonofos	0.04			Simazine	0.05
Malathion	0.04	Esfenvalerate	0.05	AEA	0.05
methidathion	0.05	Permethrin	0.05	ACET	0.05
Methyl Parathion	0.03			DACT	0.05

Table 3. Blind Spike Recoveries

Extraction Date	Sample Number	Screen	Pesticide	Spike Level	Recovery	Percent Recovery	Exceed CL[b]
2/20/2002	183	Esfenvalerate/ Permethrin	Esfenvalerate	0.25	0.228	91.2	
			Permethrin	0.25	0.172	68.8	LWL
2/20/2002	242	Esfenvalerate/ Permethrin	Esfenvalerate	0.30	0.245	81.7	
			Permethrin	0.20	0.147	73.5	LWL
2/21/2002	180	Organophosphate	Malathion	0.25	0.214	85.6	
			Methidathion	0.25	0.210	84.0	
2/21/2002	181	Diazinon	Diazinon	0.30	0.292	97.3	
2/25/2002	182	Herbicide Screen	Simazine	0.20	0.131	65.5	LCL
			Bromacil	0.15	0.127	84.7	
3/8/2002	339	Esfenvalerate/ Permethrin	Esfenvalerate	0.25	0.214	85.6	
			Permethrin	0.35	0.128	36.6	LCL
3/11/2002	336	Organophosphate	Chlorpyrifos	0.25	0.229	91.6	
3/12/2002	337	Diazinon	Diazinon	0.20	0.187	93.5	
3/15/2002	338	Herbicide Screen	ACET metabolite	0.20	0.203	102	

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

Table 4. Continuing Quality Control – Pyrethroid Screen

Extraction Date	Sample Numbers	Percent Recovery	
		Permethrin	Esfenvalerate
2/26/2002	212,221,230,239, (242),252,261,270,103	78.5	96.0
2/26/2002	112,121,130,139,148,157,161, 173,(183),203	76.0	97.5
2/20/2002	1278	85.5	106.0
3/7/2002	1171,1180,1189,1203,1212, 1221,1230,1249,1258,1267	85.5	105.0
3/7/2002	192,279,288,296,1107,1116, 1125,1144,1153,1162	92.0	111.0
3/8/2002	312,321,330,334,(339),347, 356,365,374	78.0	94.5
3/8/2002	403,412,421,430,439,448, 457,466	77.5	93.0
Average Recovery		81.9	100.4
Standard Deviation		5.90	6.86
CV		7.21	6.83
Upper Control Limit		127.0	131.0
Upper Warning Limit		117.0	121.0
Lower Warning Limit		76.0	80.2
Lower Control Limit		65.9	70.0

*Highlighted cells are percent recoveries exceeding control limits

Table 5. Continuing Quality Control – Diazinon analysis

Extraction Date	Sample Numbers	Percent Recovery
		Diazinon
2/21/2002	101,110,119,128,137, 146,156,159,172,(181)	86.0
2/21/2002	201,210,219,228,237, 250,259,268	**110.1**
3/11/2002	190,277,286,1105, 114,1123,1142,1151, 1160,1169	91.5
3/11/2002	1178,1187,1201, 1219,1228,1247, 1256,1265,1274	91.5
3/12/2002	297,301,310,319,328, 332,(337),345,354, 363	95.3
3/12/2002	372,401,410,419,428, 437,446,455,464	88.1
Average Recovery		93.8
Standard Deviation		8.6
CV		9.20
Upper Control Limit		109
Upper Warning Limit		103
Lower Warning Limit		77.6
Lower Control Limit		71.4

Table 6. Continuing Quality Control- Triazines

Extraction Date	Sample Numbers	Percent Recovery Atrazine	Simazine	Diuron	Prometon	Bromacil	Prometryn	Hexazinone	Metribuzin	Norflurazon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
2/21/2002 Spike 1	102,111,120,129,138,147,154, 160, 173	86.5	103.0	76.5	80.0	94.5	65.0	87.0	83.0	79.5	92.0	104.0	78.0	79.5
2/21/2002 Spike 2	102,111,120,129,138,147,154, 160, 173	83.0	88.5	81.5	83.0	91.0	71.5	92.0	88.0	92.0	87.0	111.0	75.0	88.5
2/25/2002 Spike 1	(182),202, 211, 220,229,238, 251,260,269	79.0	83.5	83.5	74.5	82.0	73.5	70.5	76.0	77.5	83.0	100.0	67.5	79.0
2/25/2002 Spike 2	(182),202, 211, 220,229,238, 251,260,269	80.0	89.5	80.5	76.5	94.5	79.5	75.0	80.0	79.5	88.0	100.0	67.5	79.0
3/11/2002 Spike 1	191,278,287,294,1106, 1115, 1124,1143,1152	102.0	112.0	107.0	105.0	103.0	99.0	84.5	88.5	93.5	104.0	110.0	83.0	92.0

Table 6, continued. Continuing Quality Control- Triazines

Date	Numbers	Atropine	Simazine	Diuron	Prometon	Bromacil	Prometryn	Hexazinone	Metribuzin	Norflurazon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
3/11/2002 Spike 2	191,278,287, 294,1106, 1115, 1124,1143 ,1152	99.5	109.0	124.0	99.0	103.0	91.5	91.5	100.0	100.0	109.0	109.0	83.0	89.(
3/13/2002 Spike 1	1161,1175 ,1179, 1188,1202 ,1211,122 0,1229, 1248	84.5	83.5	87.5	89.5	92.5	71.0	85.5	80.5	87.5	86.5	113.0	64.5	78.5
3/13/2002 Spike 2	1161,1175 ,1179, 1188,1202 ,1211,122 0,1229,12 48	97.5	106.0	95.0	106.0	105.0	92.5	87.5	91.0	90.0	110.0	115.0	75.5	88.(
3/15/02 Spike 1	1157,1266 ,1275,302, 211,320, 329,333, (338)	86.5	101.0	102.0	84.5	94.0	70.5	72.0	68.0	82.0	89.5	116.0	84.5	78.5
3/15/02 Spike 2	1157,1266 ,1275,302, 211,320, 329,333, (338)	91.0	91.5	89.0	83.0	94.0	75.5	72.0	73.0	77.0	91.5	113.0	75.0	77.5

Table 6, continued. Continuing Quality Control- Triazines

3/19/2002 - Spike 1	346,355,364, 373,402,411, 420,429,438	98.5	93.0	73.0	97.0	101.0	76.0	86.5	99.0	87.0	97.5	105.0	80.0	87.0

Date	Numbers	Atrazine	Simazine	Diuron	Prometon	Bromacil	Prometryn	Hexazinone	Metribuzin	Norflurazon	DEA (Deethyl)	ACET (Deiso)	DACT	Propazine (Surrogate)
3/19/2002 - Spike 2	346,355,364 373,402,411 420,429,438	102.0	103.0	85.5	105.0	105.0	84.5	98.5	99.5	97.5	108.0	101.0	90.0	99.5
3/21/2002 - Spike 1	447,456, 465	89.0	89.5	96.0	91.0	98.0	73.5	102.0	76.5	88.5	96.5	91.5	73.0	84.0
3/21/2002 - Spike 2	447,456, 465	91.5	99.5	88.5	90.5	101.0	72.0	98.5	85.5	89.5	98.5	105.0	67.0	80.5
Average Recovery		90.8	96.6	90.7	90.3	97.0	78.3	86	84.9	87.2	95.8	106.7	76.0	84.3
Standard Deviation		7.98	9.4	13.4	10.69	6.47	9.92	10.35	10.09	7.29	9.05	6.99	7.62	6.55
CV		8.79	9.7	14.8	11.84	6.67	12.68	12.05	11.89	8.36	9.44	6.56	10.03	7.77
Upper Control Limit		105	108	118	106	117	111	121	110	113	116	140	101	115
Upper Warning Limit		98.2	101	109	99.2	111	105	113	103	107	109	128	95.7	107
Lower Warning Limit		72.2	73.2	73.4	73.8	84.9	78.9	76.9	75.0	84.8	79.1	78.3	73.7	72.4
Lower Control Limit		65.8	66.3	64.4	67.4	78.4	72.4	68.1	68.0	79.2	71.7	66.0	68.2	63.8

*Highlighted cells are percent recoveries exceeding control limits

Environmental Measurements and Pesticide Detections

Table 7. Site 1: Wadsworth Canal

Water Quality **Pesticide Detections**

Date	Time	DO	Temp	EC	pH		Simazine (ppb)		
		mg/l	°C	µS/cm					
2/19/2002	10:00	8.34	12.9	597	8.1				
	11:00	8.03	12.8	596	7.93				
	12:00	9.01	12.7	597	8.06				
	13:00	9.59	12.7	596	8.11				
	14:00	9.95	12.7	597	8.14				
	15:00	10.18	12.8	597	8.13				
	16:00	10.5	12.8	597	8.25				
	17:00	9.98	12.8	597	8.24				
3/6/2002	10:30	9.28	14.1	602	8.33				
	11:30				8.22				
	12:30	10.6	15.2	595	8.23		0.156		
	13:30	10.47	15.2	597	8.23				
	14:30	10.44	15.2	597	7.97				
	15:30	10.35	15.2	603	8.32				
	16:30	9.73	15.2	604	8.3				
	17:30	9.71	15.1	606	8.28				
	18:30								
	19:30	8.86	14.9	608	8.25				

Table 8. Site 2: Jack Slough

Water Quality **Pesticide Detections**

Date	Time	DO	Temp	EC	pH		Diazinon	Diuron
		mg/l	°C	µS/cm			ppb	ppb
2/19/2002	10:26	8.63	11.2	203.8	7.3		0.158	
	11.29	8.45	11.2	203.9	7.2		0.162	
	12:30	8.33	11.2	203.1	7.1		0.162	0.05
	13:33	8	11.2	202.6	7.5		0.13	
	14:38	7.8	11.3	202.5	7.4		0.124	
	15:35	8.4	11.3	200.7	7.4		0.133	
	16:35	8.3	11.3	198.1	7.5		0.115	0.05
	17:30	8.25	11.3	197.3	7.7		0.084	0.096
3/6/2002	10:15	7.9	12.5	190.3	7.5		0.097	0.921
	11:20	7.9	12.7	191	7.4		0.096	1.12
	12:20	8	13.1	190.8	7.2		0.12	1.48
	13:25	8.2	13.2	191.3	8.9		0.108	1.02
	14:20	8.4	13.3	190.6	7.2		0.122	1.23
	15:20	8.4	13.4	187	7.2		0.128	2.22
	16:25	8.4	13.6	183	7.4		0.093	1.28
	17:20	8.3	13.9	195	7.2		0.107	0.979
	18:20	7.9	14	198	7.4		0.106	1.21
	19:25	8	14.1	199.8	7.4		0.098	1.75

Table 9. Site 3: Westport Drainage

Water Quality **Pesticide Detections**

Date	Time	DO	Temp	EC	pH		Diazinon	Diuron	Bromacil	Norflurazon	DACT
		mg/l	°C	µS/cm			ppb	ppb	ppb	ppb	ppb
3/7/2002	9:45	4.66	15.9	920	7.2			0.407	0.118	0.055	
	10:45	5.45	16.1	746	7.4			0.446	0.149	0.075	
	11:45	8.12	16.2	743	7.9			0.386	0.112	0.053	
	12:45	8.44	16.9	750	7.9			0.514	0.101		
	13:45	8.33	17.3	758	8.4			0.424	0.066		0.16
	14:45	8.3	17.9	761	8.2			0.393	0.056		0.19
	15:45	8.36	17.8	779	8.2		0.119	2.63	0.103		0.194
	16:45	7.93	17.4	542	8.2		0.079	3.38	0.144		

Table 10. Site 4: Highline Canal

Water Quality **Pesticide Detections**

Date	Time	DO	Temp	EC	pH		Diuron	Bromacil	Norflurazon
		mg/l	°C	µS/cm			ppb	ppb	ppb
3/7/2002	9:46	8.7	14.8	70.2	7.33		11.1	3.73	0.498
	10:44	8.8	14.9	70.8	7.35		11.3	3.20	0.358
	11:43	8.7	15	72.5	7.44		11.5	3.31	0.254
	12:46	8.78	15.1	71.5	7.51		10.5	2.01	0.219
	13:37	8.72	15.2	69.8	7.26		9.05	1.58	0.197
	14:43	8.87	15.2	68.9	6.81		7.11	2.37	0.151
	15:44	9.01	15.3	67.7	6.85		6.44	2.12	0.143
	10:19	8.68	15.4	67.3	7.1		5.89	1.70	0.125

Figure 1.

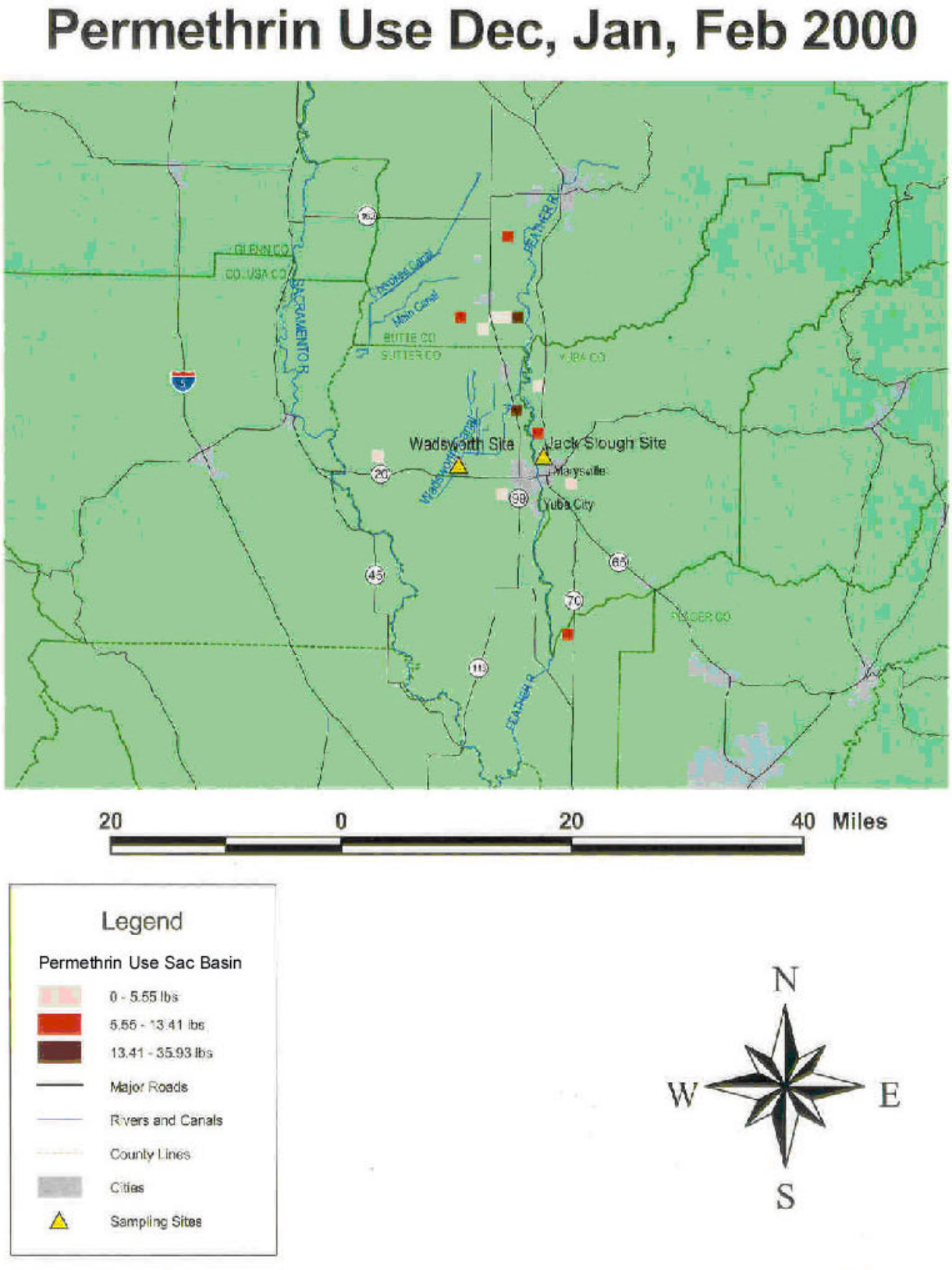

Permethrin Use Dec, Jan, Feb 2000
GLENN CO
COLUSA CO
SACRAMENTO R.
Colusa Canal
Main Canal
BUTTE CO
SUTTER CO
YUBA CO
FEATHER R.
Wadsworth Site
Jack Slough Site
Marysville
Yuba City
PLACER CO
20
0
20
40 Miles
Legend
Permethrin Use Sac Basin
0 - 5.55 lbs
5.55 - 13.41 lbs
13.41 - 35.93 lbs
Major Roads
Rivers and Canals
County Lines
Cities
Sampling Sites
N
W
E
S

Figure 2.

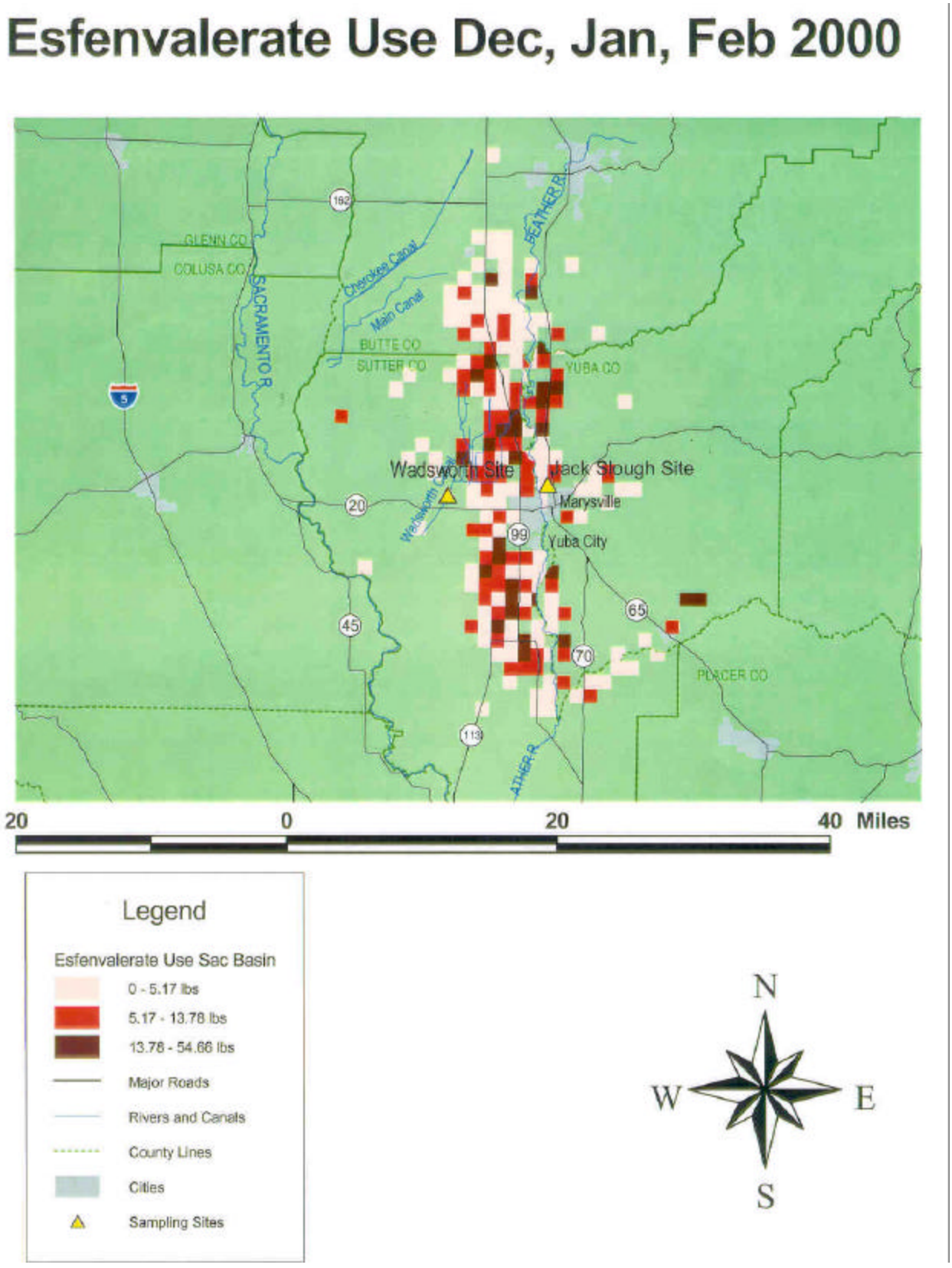

Esfenvalerate Use Dec, Jan, Feb 2000
GLENN CO
COLUSA CO
SACRAMENTO R
Cherokee Canal
Main Canal
BUTTE CO
SUTTER CO
BEAR R
YUBA CO
Wadsworth Site
Jack Slough Site
Marysville
Yuba City
PLACER CO
ATHER R
162
5
20
99
45
65
70
113
20 0 20 40 Miles
Legend
Esfenvalerate Use Sac Basin
0 - 5.17 lbs
5.17 - 13.78 lbs
13.78 - 54.66 lbs
Major Roads
Rivers and Canals
County Lines
Cities
Sampling Sites
N
W
E
S

Figure 3.

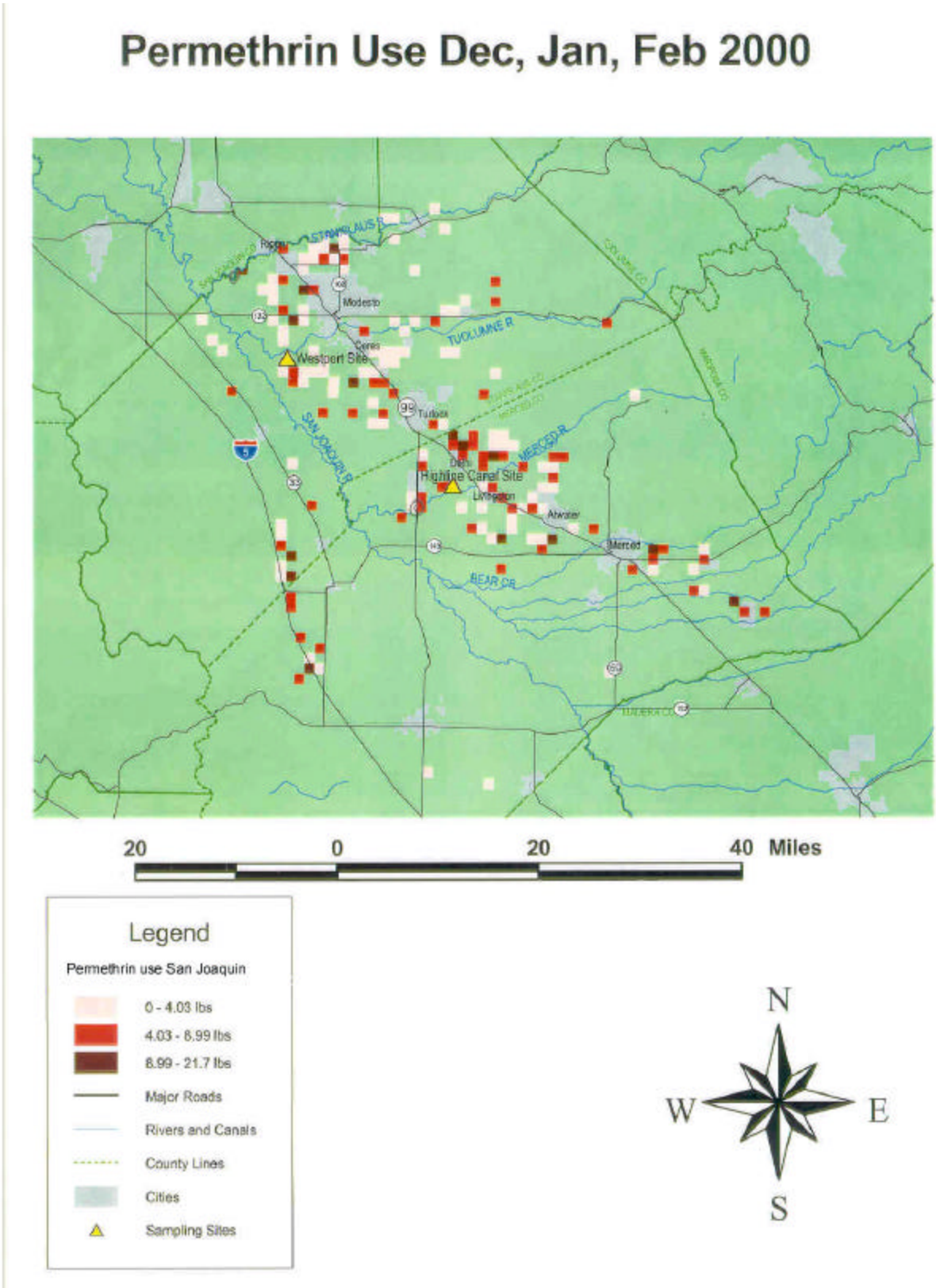

Permethrin Use Dec, Jan, Feb 2000
Modesto
Ceres
Westport Site
Turlock
Delhi
Highline Canal Site
Livingston
Atwater
Merced
TUOLUMNE R
SAN JOAQUIN R
MERCED R
BEAR CR
20
0
20
40 Miles
Legend
Permethrin use San Joaquin
0 - 4.03 lbs
4.03 - 8.99 lbs
8.99 - 21.7 lbs
Major Roads
Rivers and Canals
County Lines
Cities
Sampling Sites
N
W
E
S

Figure 4.

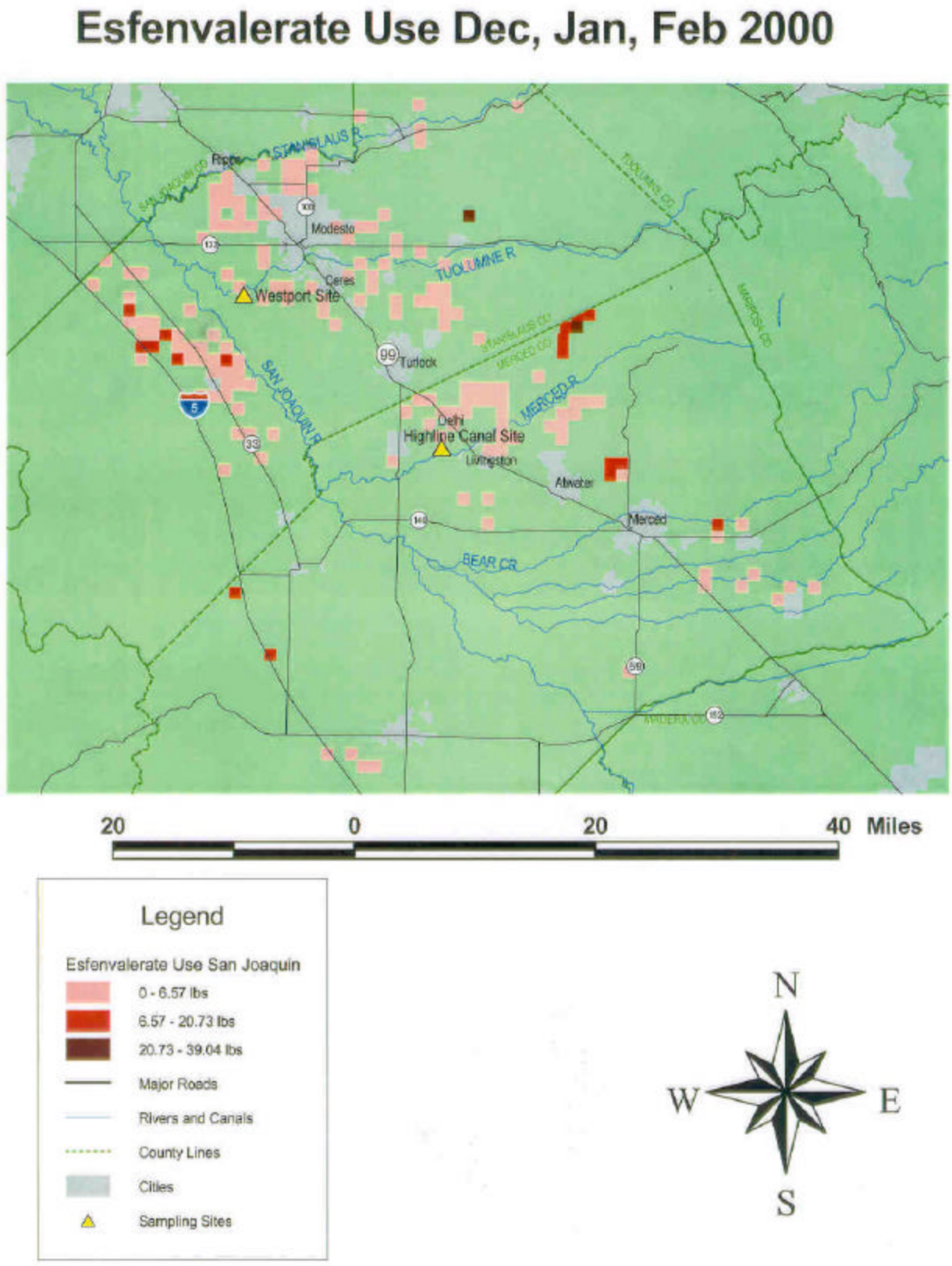
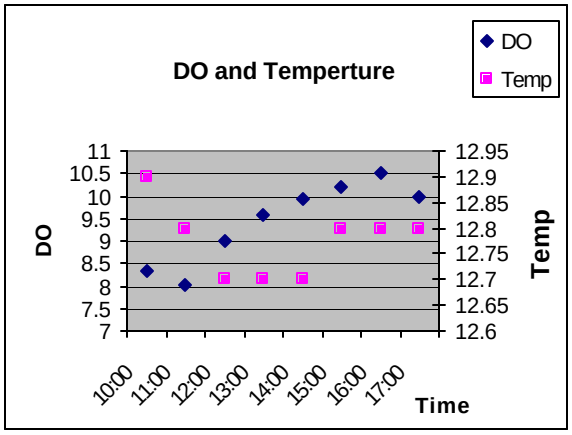
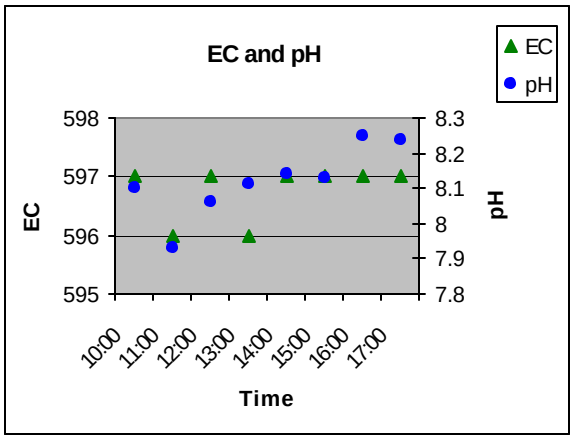

Esfenvalerate Use Dec, Jan, Feb 2000
STANISLAUS R
Ripon
Modesto
Ceres
Westport Site
TUOLUMNE R
Turlock
SAN JOAQUIN R
MERCED R
Delhi
Highline Canal Site
Livingston
Atwater
Merced
BEAR CR
20 0 20 40 Miles
Legend
Esfenvalerate Use San Joaquin
0 - 6.57 lbs
6.57 - 20.73 lbs
20.73 - 39.04 lbs
Major Roads
Rivers and Canals
County Lines
Cities
Sampling Sites
N
W
E
S

Figure 5. Site 1: Wadsworth Canal

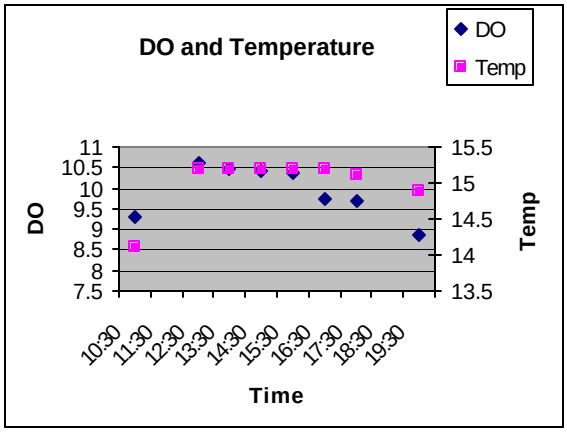
February 19, 2002

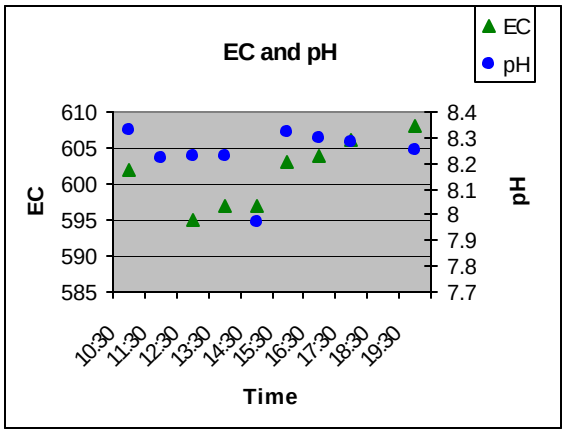




No pesticide detections

March 6, 2002





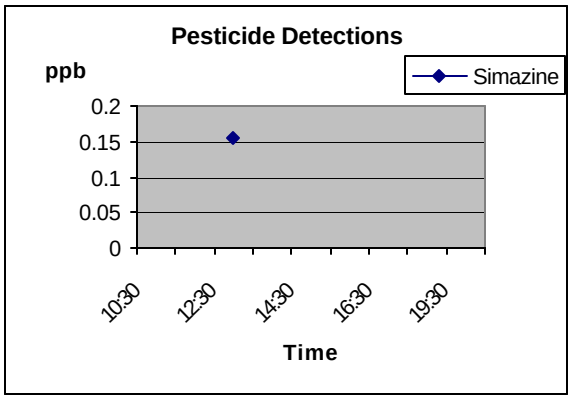
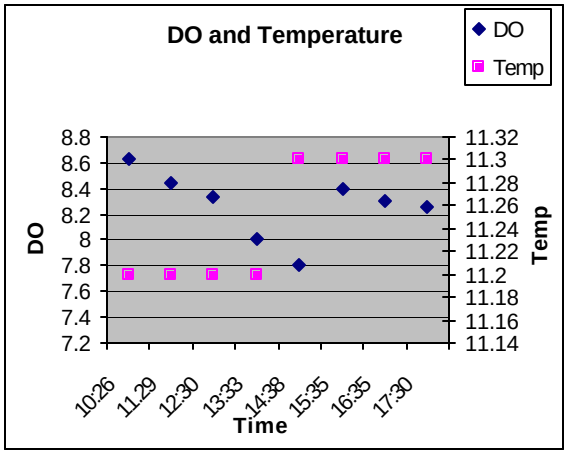
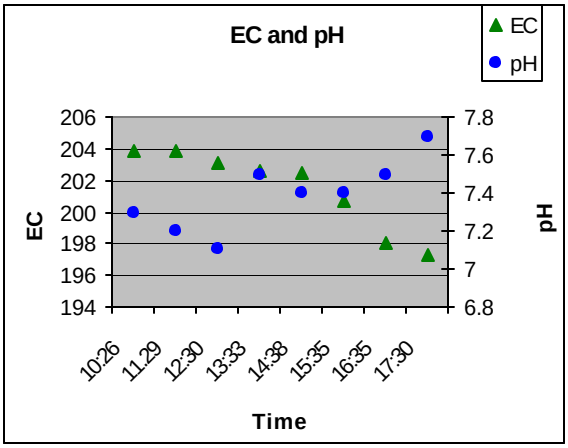
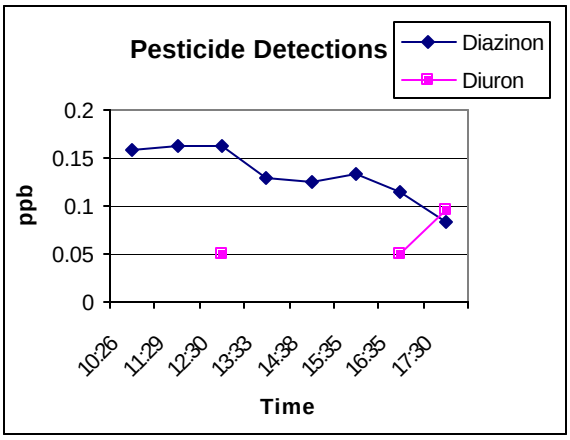


Figure 6. Site 2: Jack Slough

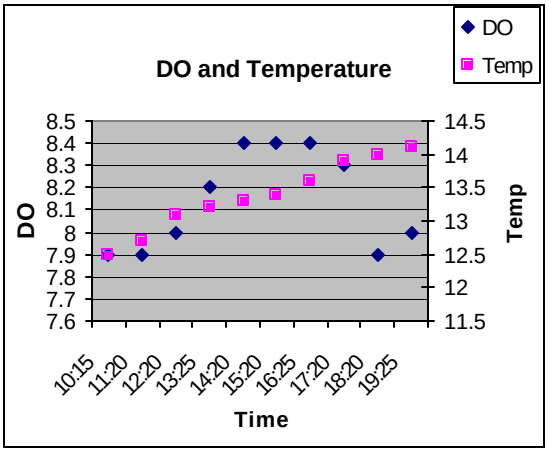
February 19, 2002

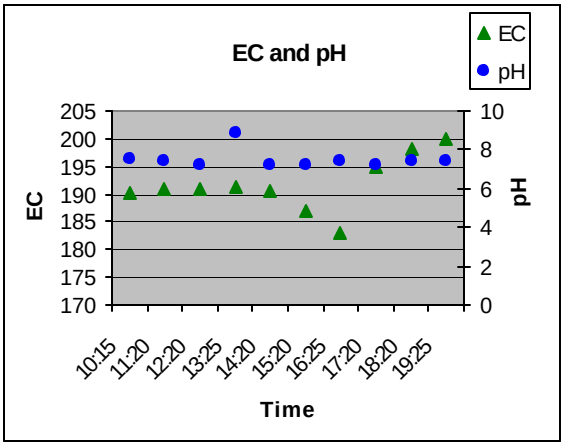


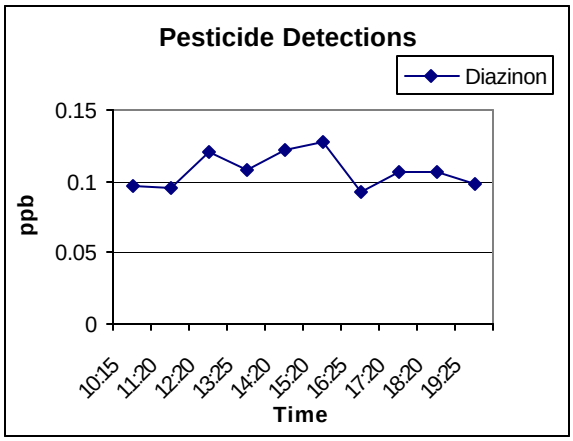




March 6. 2002







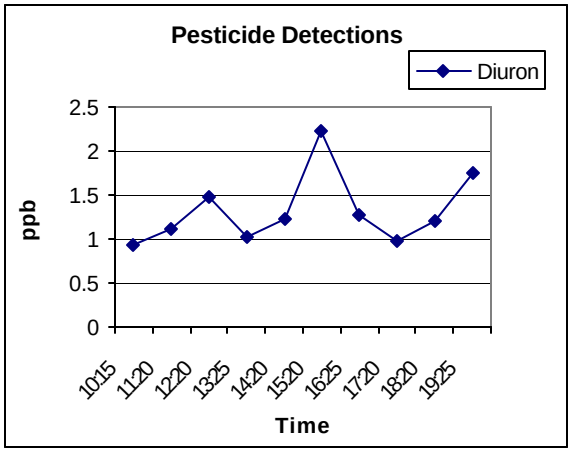


Figure 7. Site 3: Westport Drain March 7, 2002 Site 4: Highline Canal