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## **Analysis of recent chlorpyrifos monitoring data in two water quality coalitions of the San Joaquin Valley**

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January 23, 2014 (Revised)

### **Introduction**

Chlorpyrifos has been detected in the surface water of the San Joaquin Valley with concentrations exceeding water quality objectives (Starner and Goh, 2013). DPR has been investigating this issue and is in the process of developing mitigation practices. Starner and Goh (2013) have identified the areas of concern as well as major crops that potentially contributed to chlorpyrifos detections in the San Joaquin Valley. Their analyses were based on data collected between 2006 and 2010. It is possible that the detection hotspots and major uses of chlorpyrifos have changed since 2010. This study examined the recent patterns of chlorpyrifos use and detection.

### **Data sources**

Recent monitoring data on chlorpyrifos were collected for two water quality coalitions in the San Joaquin Valley: the San Joaquin County and Delta Water Quality Coalition (Delta Coalition) and the Westside Water Quality Coalition (Westside Coalition) (Fig 1). The Delta Coalition dataset included surface water samples collected between January 2010 and June 2013; and the Westside Coalition dataset dated from January 2010 to February 2013. The Delta Coalition data were from Scott Hudson of the San Joaquin County Agricultural Commissioner. The Westside Coalition data were from Chris Jimmerson of the Central Valley Regional Water Quality Control Board. The Westside dataset was supplemented by a query of additional monitoring results from the CEDEN database (CEDEN, 2013).

Pesticide use data between 2010 and 2012 were from DPR's pesticide use reporting database (PUR, 2013). Chlorpyrifos use data were queried for areas located within the two coalitions. Crops with the highest use of chlorpyrifos in the study areas were also identified.

### **Results**

#### Delta Coalition

A total of 328 water samples were collected from January 1, 2010, to June 18, 2013, among which 29 (8.8%) had concentrations higher than the water quality objective of 0.015 µg/L. Out of the 29 exceedances, 16 occurred during irrigation season while 13 were associated with storm runoff in winter. Sites with highest exceeding frequencies were mainly located at the Duck-

Littlejohns watershed (Fig. 1, Table 1), accounting for 62% of the exceedances. All five sites in the Duck-Littlejohns watershed had exceeding frequencies above 9%, with the highest being 20%. Monitoring data for the most recent two and half years showed fewer exceedances in the Duck-Littlejohns compared to those in 2010. This reduction in exceedances may be associated with the outreach efforts by the coalitions that promote best management practices to reduce chlorpyrifos runoff. However, Duck-Littlejohns still had the most exceedances among all the watersheds in the coalition (Table 2). In contrast, the exceedances in the San Joaquin Delta watershed increased from 2 to 5, accounting for 31% of all exceedances in the coalition between 2011 and 2013.

Pesticide use data showed that the major crops using chlorpyrifos in the Duck-Littlejohns watershed were walnut, grapes, almond, alfalfa and corn (Table 3). In the San Joaquin Delta watershed, the top use crops were alfalfa, asparagus, walnut and corn. These crops likely would be the candidates for consideration in the development of crop-specific management practices. While storm runoff can occur from any of these crops, irrigation runoff were likely associated with alfalfa, corn and asparagus, which were irrigated by mainly gravity irrigation (Table 4). Gravity irrigation has relatively lower irrigation efficiency and higher runoff potential compared to other irrigation methods. According to the irrigation survey conducted by Department of Water Resources (DWR) in 2010, 93% of alfalfa and 73% of corn fields in the San Joaquin Valley were irrigated with gravity methods. For asparagus, although the exact percentage was not available from the DWR survey, a big portion of asparagus fields in the San Joaquin Delta watershed were likely applied with gravity irrigation (Aegerter *et al.*, 2011).

#### Westside Coalition

A total of 630 water samples were collected from January 1, 2010, to February 18, 2013, among which 52 (8.3%) had concentrations higher than the water quality objective of 0.015 µg/L. Out of the 52 exceedances, over 90% occurred during irrigation season while the rest were associated with storm runoff in winter. Sites with highest exceeding frequencies were mainly located in the Patterson watershed (Fig. 1, Table 5), accounting for 77% of the exceedances. Eight out of the 10 sites in the Patterson watershed had exceeding frequencies above 9%, with the highest being 37%. Monitoring data for the most recent two and a half years showed that the exceedances in the Patterson watershed have been reduced; however, the exceedances there were still the highest among all watersheds in the coalition (Table 2).

Pesticide use data showed that the major crops using chlorpyrifos in the Patterson watershed were walnut, almond, citrus and alfalfa (Table 3). While storm runoff can occur from any of these crops, irrigation runoff, which was the pathway for the majority of the exceedances were likely associated with alfalfa (Table 4). As mentioned in the previous section, 93% of alfalfa field in the San Joaquin Valley were irrigated with gravity methods.

#### **Discussion**

Starner and Goh (2013) conducted similar analysis using surface water monitoring and pesticide use data between 2006 and 2010. They concluded that the areas with frequent chlorpyrifos exceedances in the San Joaquin Valley were the Duck-Littlejohns and Patterson watersheds. The major crops of concern included almond, walnut and alfalfa with alfalfa potentially being the major contributor during irrigation season. The results presented here further confirmed the finding by Starner and Goh (2013) that Duck-Littlejohns and Patterson watersheds should be the areas of focus for reducing chlorpyrifos concentrations in surface water. This analysis also agrees with Starner and Goh (2013) that the major crops of concern were almond, walnut, and alfalfa. In

addition to these crops, grape, corn, citrus and asparagus had major uses of chlorpyrifos in the two coalitions of the San Joaquin Valley.

## **Summary**

Within the Delta Coalition and the Westside Coalition, areas with frequent chlorpyrifos exceedances were the Duck-Littlejohns and Patterson watersheds. In the Duck-Littlejohns watershed, exceedances have been reduced since 2012 likely due to outreach efforts by coalitions. On the contrary, the San Joaquin Delta watershed, one of the watersheds in the Delta Coalition had more exceedances in the last two and a half years compared to 2010. Major crops with high chlorpyrifos use were walnut, almond, grapes, alfalfa, corn, citrus and asparagus. All these crops could potentially contribute to storm runoff of chlorpyrifos in these two coalitions during the rainy season; while alfalfa, corn and asparagus likely were the major contributors for irrigation runoff during the dry season due to their widespread use of gravity irrigation.

## **References**

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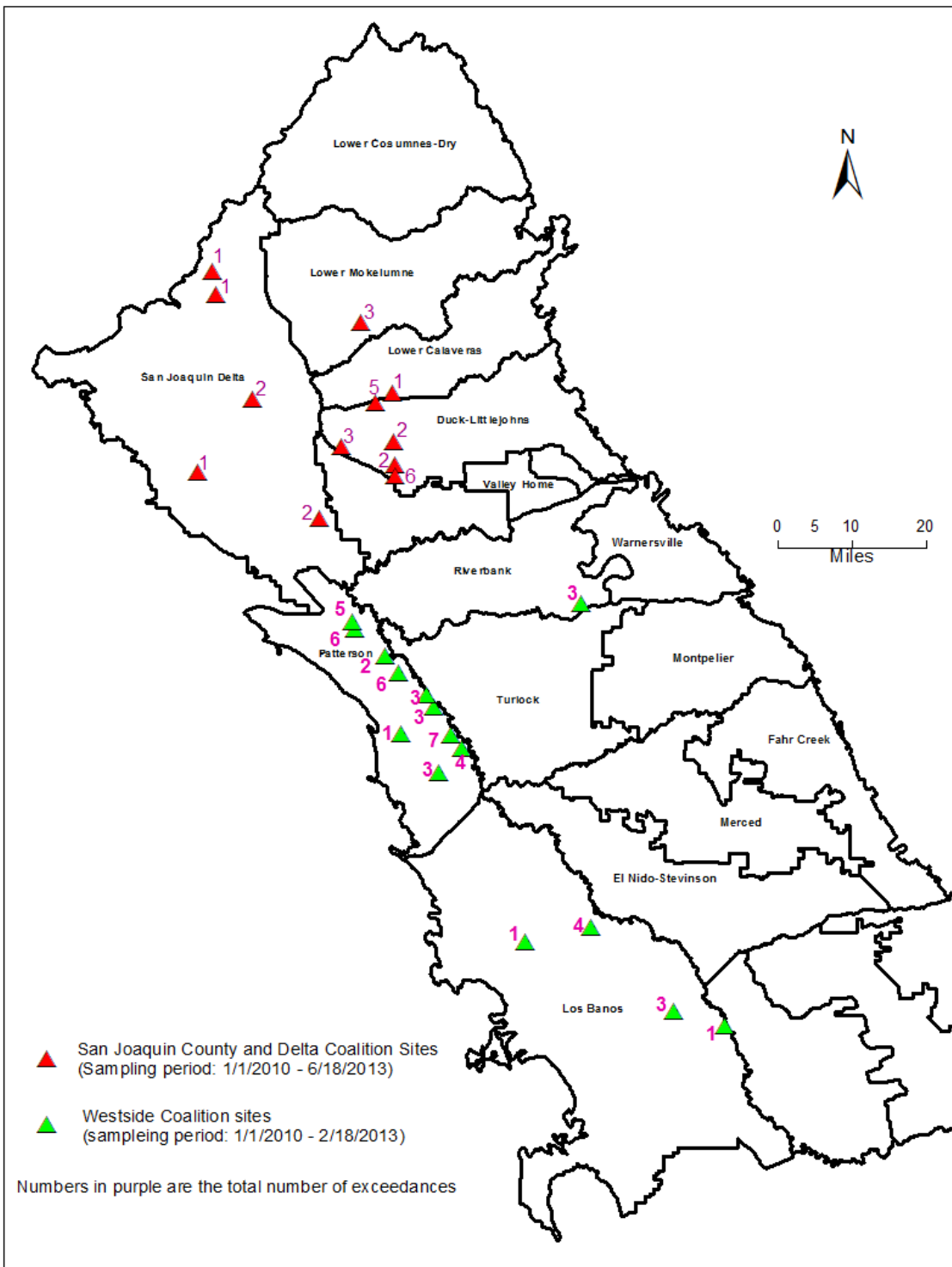


Fig 1. Chlorpyrifos monitoring sites with exceedances in the two coalitions of San Joaquin Valley; numbers in purple show the number of samples with chlorpyrifos concentration exceeding the water quality objective of  $0.015 \mu\text{g/L}$ .

Table 1: Monitoring sites in the San Joaquin County and Delta Coalition with chlorpyrifos samples exceeding the water quality objective of 0.015 µg/L (monitoring data from 1/1/2010 – 6/18/2013)

Station Name	Watershed Name	Exceedance	Total Sample	% of Total Exceedances
Unnamed Drain to Lone Tree Creek @ Jack Tone Rd	Duck-Littlejohns	6	30	20.0%
Bear Creek @ North Alpine Rd	Lower Mokelumne	3	15	20.0%
Duck Creek @ Highway 4	Duck-Littlejohns	5	32	15.6%
French Camp Slough at Airport Way	Duck-Littlejohns	3	27	11.1%
Mormon Slough @ Jack Tone Rd	Lower Calaveras	1	9	11.1%
Lone Tree Creek @ Jack Tone Rd	Duck-Littlejohns	2	19	10.5%
Littlejohns Creek @ Jack Tone Rd	Duck-Littlejohns	2	22	9.1%
Roberts Island Drain @ Holt Rd	San Joaquin Delta	2	24	8.3%
Grant Line Canal @ Clifton Court Rd	San Joaquin Delta	1	12	8.3%
Drain @ Woodbridge Rd	San Joaquin Delta	1	13	7.7%
Terminus Tract Drain @ Hwy 12	San Joaquin Delta	1	21	4.8%
Walthall Slough @ Woodward Ave	San Joaquin Delta	2	44	4.5%

Table 2: Summary of chlorpyrifos samples exceeding the water quality objective of 0.015 µg/L in the watersheds of the San Joaquin County and Delta Coalition

Watershed	Year 2010			Year 2011 – June, 2013		
	Exceedance	Sample	% of Total Exceedances	Exceedance	Sample	% of Total Exceedances
Duck-Littlejohns	11	41	84.6%	7	89	43.8%
San Joaquin Delta	2	49	15.4%	5	65	31.3%
Lower Calaveras	0	0	0.0%	1	9	6.3%
Lower Mokelumne	0	0	0.0%	3	15	18.8%
Total	13	90	100.0%	16	178	100.0%

Table 3: Major crops using chlorpyrifos in watersheds with high exceedances (water quality objective : 0.015 µg/L)

Watershed	Crop	2010	2011	2012	Total	% of total use in the watershed
Duck-Littlejohns	Walnut	5,518	2,720	4,215	12,452	51.6%
	Grapes	3,998	113	1,073	5,184	21.5%
	Almond	1,364	40	1,552	2,956	12.3%
	Alfalfa	837	579	139	1,555	6.4%
	Corn	334	650	557	1,541	6.4%
	Others	287	0	153	440	1.8%
	<b>Total</b>	<b>12,338</b>	<b>4,101</b>	<b>7,689</b>	<b>24,128</b>	<b>100.0%</b>
San Joaquin Delta	Alfalfa	6,483	8,026	5,992	20,502	51.2%
	Asparagus	1,523	2,478	4,701	8,702	21.7%
	Walnut	1,216	2,240	2,688	6,144	15.3%
	Corn	697	1,007	979	2,682	6.7%
	Others	990	542	508	2,040	5.1%
	<b>Total</b>	<b>10,908</b>	<b>14,294</b>	<b>14,868</b>	<b>40,070</b>	<b>100.0%</b>
Patterson	Walnut	5,106	3,090	3,272	11,467	39.5%
	Almond	5,208	4,374	1,809	11,392	39.2%
	Citrus Fruits	952	1,499	631	3,082	10.6%
	Alfalfa	614	750	582	1,946	6.7%
	Corn	403	39	366	809	2.8%
	Others	188	17	124	328	1.1%
	<b>Total</b>	<b>12,472</b>	<b>9,768</b>	<b>6,784</b>	<b>29,024</b>	<b>100.0%</b>

Table 4: Major crops in the San Joaquin Valley and the percent acreage with different irrigation methods; data from 2010 DWR irrigation method survey (unit: percent)

Crop	Gravity	Sprinkler	Low Volume	Other
Corn	73.0	0.5	6.5	20.1
Alfalfa	92.9	1.4	2.8	2.9
Almond & Pistachio	16.8	12.7	68.7	1.8
Other Deciduous	37.6	24.8	37.0	0.6
Other Field Crops	81.3	13.4	5.4	--
Vineyard	28.6	0.8	67.8	2.7

Table 5: Westside Coalition sites with chlorpyrifos samples exceeding the water quality objective of 0.015 µg/L

Station Name	Watershed	Exceedance	Total Sample	% of Total Exceedances
Marshall Road Drain near River Road	Patterson	7	19	36.8%
Blewett Drain at Highway 132	Riverbank	3	11	27.3%
Hospital Creek at River Road	Patterson	5	19	26.3%
Ingram Creek at River Road	Patterson	6	24	25.0%
Del Puerto Creek near Cox Road	Patterson	6	26	23.1%
Orestimba Creek @ River Road	Patterson	4	23	17.4%
Salt Slough at Sand Dam	Los Banos	4	28	14.3%
Poso Slough at Indiana Ave	Los Banos	3	23	13.0%
Ramona Lake near Fig Avenue	Patterson	3	25	12.0%
Orestimba Creek @ Hwy 33	Patterson	3	27	11.1%
Westley Wasteway near Cox Road	Patterson	2	21	9.5%
San Joaquin River at PID Pumps	Patterson	3	40	7.5%
Los Banos Creek at China Camp Road	Los Banos	1	28	3.6%
Delta Mendota Canal at DPWD	Patterson	1	40	2.5%
SJR @ Sack Dam	Los Banos	1	41	2.4%

Table 6: Summary of chlorpyrifos samples exceeding the water quality objective of 0.015 µg/L in the watersheds of the Westside Coalition

Watershed	Year 2010			Year 2011 – June, 2013		
	Exceedance	sample	% of Total Exceedances	Exceedance	sample	% of Total Exceedances
Patterson	20	83	80.0%	20	181	74.1%
Los Banos	4	32	16.0%	5	88	18.5%
Riverbank	1	1	4.0%	2	10	7.4%
Total	25	116	100.0%	27	279	100.0%