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Study 321. Surface Water Monitoring for Pesticides in Agricultural Areas in the Central Coast and Southern California, 2020

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1. INTRODUCTION

Surface water monitoring in agricultural areas is a priority for the California Department of Pesticide Regulation (CDPR) to assess potential impacts of pesticides from agricultural runoff on California aquatic environments. Initiated in 2008, surface waters of the Central Coast and Imperial Valley represent one of CDPR's long-term environmental monitoring efforts. Annual monitoring data help guide CDPR in the development and implementation of regulatory and non-regulatory mitigation activities. This current project focuses its monitoring efforts on two major agricultural regions of California— the Central Coast and the Imperial Valley. Because a wide variety of commodities are grown in both regions, a wide range of pesticide active ingredients (AI) are used across the landscape. The 2020 monitoring areas include major watershed drainages in Monterey, Santa Barbara, San Luis Obispo and Imperial counties (Deng 2016, 2017, 2018a; Main 2019).

Previous monitoring results for the Central Coast and Southern California are summarized in annual project reports (e.g., Deng 2018b, 2019). Over 37 pesticides including 19 insecticides, 13 herbicides and 5 fungicides were monitored 2017. In 2018, excluding metabolites, there were 55 pesticides monitored including 26 insecticides, 22 herbicides, and 7 fungicides. The most frequently detected insecticides included imidacloprid, methoxyfenozide, chlorantraniliprole, methomyl, bifenthrin, and λ-cyhalothrin. Detection frequencies varied from 28% (λ-cyhalothrin) to 94% (imidacloprid). The frequencies of their concentrations exceeding the associated lowest (chronic or acute) U.S. Environmental Protection Agency (US EPA) aquatic life benchmark values ranged from 16% (methomyl) to 94% (imidacloprid; Deng 2018b). Those specific insecticides can be highly toxic to sensitive aquatic organisms. Many of the insecticidal active ingredients were commonly detected in individual samples or multiple sampling locations from the same watershed. The frequent co-occurrence of insecticides in a given watershed and frequent exceedance of acute aquatic life benchmarks indicate that insecticide uses in the monitored watershed drainages have the potential to cause adverse impacts to non-target aquatic organisms and communities. Herbicides and fungicides that were frequently detected included bensulide, prometryn, azoxystrobin, pyraclostrobin, oxyfluorfen, and diuron (range: 30 to 72%). By comparison, the frequency of US EPA acute aquatic life benchmark exceedances for herbicides and fungicides were low in frequency (<6%). In 2018, CDPR began collecting sediment samples at all 16 monitoring sites that were analyzed for the presence of seven pyrethroids: bifenthrin, cyfluthrin, cypermethrin, fenpropathrin, fenvalerate/esfenvalerate, lambda-cyhalothrin, and permethrin. Detection frequencies were highest for bifenthrin (44%) and lowest for cyfluthrin (6%). Three samples surpassed concentrations >1 toxicity unit (TU) and individual pesticide TUs in all samples with reported concentrations ranged from 0.01 to 11.6. In these focal regions, annual surface water monitoring results in tandem with PUR data indicate that several pesticides continue to increase in use (e.g., neonicotinoids) compared to older chemistries such as organophosphates (e.g., chlorpyrifos, diazinon). Future monitoring efforts will include other neonicotinoid active ingredients such as acetamiprid, clothianidin, and thiamethoxam as new laboratory methods have become available.

Study 321 began in 2019 and is a continuation of CDPR's agricultural monitoring efforts in the Central Coast and Southern California (*see Study 304*). Monitoring sites have been established in previous years (Deng 2017). Priority lists of pesticides recommended for monitoring in each watershed were identified using CDPR's Prioritization Model (Luo et al. 2013, 2014, 2015). As described in section four and five (*see below*), the watershed-based prioritization approach was applied to help refine the pesticide priority list for monitoring in 2020. Monitoring frequency in the Central Coast and Southern California will follow efforts from previous years with no major modifications in 2020. However, future efforts will evaluate the potential expansion to include several new sites for monitoring in 2021.

2. OBJECTIVES

The goals of the project are to assess short-term changes and long-term trends of pesticide occurrence in surface water resulting from agricultural runoff and the potential impact to aquatic environments. Results can be used to assess the efficacy of mitigation efforts and provide information to CDPR managers to determine whether mitigation responses are necessary to address pesticide contamination. Objectives of the project are as follows:

1) Determine occurrences and measure chemical concentrations of high-priority pesticides in aqueous and sediment samples;
2) Identify the factors that influence pesticide sources in agricultural regions such as agricultural practices (e.g., crop type, irrigation type) or mitigation strategies (e.g., use of structural best management practices (BMPs));
3) Test acute toxicity of water samples using lab surrogate species;

4) Analyze chemistry data to evaluate potential impacts on aquatic environments by comparing environmental concentrations with current US EPA aquatic life benchmarks;
5) Analyze spatial correlations between observed pesticide concentrations/detection frequencies and region-specific pesticide use;
6) Assess multiple years of data to characterize patterns and trends in detection frequencies and potential impacts to aquatic organisms.

3. PERSONNEL

The study will be conducted by staff from the Environmental Monitoring Branch, Surface Water Protection Program, under the general direction of Dr. Jennifer Teerlink, Senior Environmental Scientist (Supervisor). Key personnel are listed below:

Project Leader:	Anson Main, Ph.D.
Field Coordinator:	Xin Deng, Ph.D.[1]
Review Scientist:	Robert Budd, Ph.D.
Statistician:	Dan Wang, Ph.D.
Laboratory Liaison:	Sue Peoples
Analytical Chemistry:	Center for Analytical Chemistry, California Department of Food and Agriculture (CDFA)

Questions concerning this monitoring project should be directed to Dr. Anson Main, Environmental Scientist, at (916) 322-0496 or by email at Anson.Main@cdpr.ca.gov.

[1] Dr. Xin Deng will act as a co-Project Leader for the 2020 sampling season.

4. SELECTION OF PESTICIDES FOR MONITORING

All pesticides selected for monitoring were prioritized following the procedures described in the Monitoring Prioritization Model (Luo et al. 2013, 2014, 2015). The 12-digit hydrologic units (HUC12) on the U.S. Geological Survey (USGS) Watershed Boundary Database tool (USGS, 2018) is used to define the watershed boundary as an input to the prioritization model. The watershed boundary identifies the areas that contribute to the specific HUC12 where the monitoring site is located. The model utilizes pesticide use reporting database to aggregate the total use of each pesticide within each upstream HUC12 and adjusts the total use by factoring in pesticide aquatic dissipation as a function of travel time between each upstream HUC12 and the HUC12 where the monitoring site is located. The model uses the water-sediment DT_{50} (half-life) to account for persistence and/or potential mobility of each pesticide of interest. The model was used to generate a ranked list of pesticides for the watershed contributing to each sampling site. The final *rank score* of a pesticide is the product of the rank in use amount and the rank of toxicity of that pesticide among all pesticides used upstream. Pesticides were then screened to produce final monitoring lists following the general criteria below:

1) Pesticides with final ranking scores ≥ 9 in a priority list for a watershed of interest **will be monitored** as pesticides with this ranking have higher use (use scores ≥ 2) and toxicity (tox scores ≥ 3, the lowest benchmark values ≤ 100 ppb), and thus have higher potential risks to aquatic communities.
2) Pesticides with final scores ≤ 8 and use scores ≥ 2 in a priority list *will be considered for monitoring*. The use criterion includes the top 30% of pesticides with the highest use amounts (i.e., total poundage) among all the pesticides reported to PUR from 2015–2017 for a watershed of interest. Pesticides that are not in the priority lists or have use scores < 2 may be reported when they are concurrently analyzed with other prioritized pesticides in an analytical group.
3) Historical monitoring data, current use trends, availability of analytical methods, and budget constraints are additional factors to help decide a final list for monitoring.

5. STUDY PLAN

5.1. Imperial County

Ambient monitoring will be conducted in Imperial County twice a year in May and October at six established sites. Water samples will be collected in both events and sediment samples will be collected only in October for pyrethroid analysis. Monitoring locations are located in the Alamo River and New River watersheds (Table 1, Figure 1).

The priority lists for monitoring in the New River and Alamo River in May and October were generated using the average pesticide use data from January to March and from August to October from 2015–2017, respectively (Tables 2-5). We focused on these data as they closely mimic the annual agricultural use patterns and likely represent the "worst case" scenario for monitoring. The chemical lists recommended by the model are similar to those in 2019. Chlorantraniliprole will be monitored in May and October despite its low priority score (final score = 4) because the compound was detected frequently (86%) during surface water monitoring in 2018 (Deng 2019).

5.2. Monterey County

Ambient monitoring will be conducted in Monterey County four times a year for routine monitoring (May, July, September), and stormwater monitoring (November) at six established sites. Water samples will be collected during each sampling event for chemical analysis and a subset of water samples from 3 to 5 selected sites will be collected during each sampling event for toxicity testing. Sediment samples will be collected only in September for pyrethroid analysis. Monitoring locations are located in the Salinas River and Tembladero Slough watersheds (Table 6, 7; Figure 2).

The priority lists for monitoring in each watershed were generated using the average pesticide use data from May to November from 2015–2017 (Table 6, 7). The chemical lists recommended by the model are similar to those in 2019 with changes on rankings of a few chemicals due to changes of their use scores from 2015–2017. Notably, the use amounts of chlorpyrifos and diazinon had significantly reduced and so did their ranking scores on the priority list in recent years. Nevertheless, the monitoring results indicated about 12% detections for chlorpyrifos and 2% detections annually for diazinon in 2018 (Deng 2019). We will continue to monitor for chlorpyrifos, but not diazinon in 2020. Pyraclostrobin and prometryn, with final scores <8 will be monitored in the Salinas River Watershed in 2020 due to frequent detections (>50%) in 2018 and their increasing use in recent years. Although glufosinate-ammonium and PCNB are on the priority list in the Salinas River Watershed, they will not be monitored as analytical methods are currently unavailable (Table 6, 7).

5.3. Santa Barbara and San Luis Obispo Counties
Ambient monitoring will be conducted in Santa Barbara and San Luis Obispo counties three times a year in May, July, and September at three established sites and one site added in 2019. Water samples will be collected during each sampling event for chemical analysis and a subset of water samples from three sites will be collected during each sampling period for toxicity testing. Sediment samples will only be collected in September for pyrethroid analysis. Monitoring sites are located in Orcutt Creek and Oso Flaco Creek watersheds (Table 1, Figure 3). The site on Main Ditch at HWY166 was monitored in previous years and was re-added for monitoring in 2019 to replace the 2018 site at Bradley Channel as it dried out during monitoring events in 2018.

The priority lists for monitoring in each watershed were generated using the average use data from May to November from 2015–17 (Table 8, 9). The chemicals recommended by the model for monitoring in the Orcutt Creek Watershed are similar to those in 2019. Chlorpyrifos dropped out of the lists for both watersheds but will be kept on the monitoring list in 2020 as part of the multi-analyte screen. Linuron appears as a medium priority for monitoring at Orcutt Creek (score = 8). However, despite an analytical method available for groundwater, it will not be included for monitoring as there is no method similarly available for surface water.

5.4. Modifications from 2019
There will be no major modifications to the 2020 sampling sites; however, the sampling timeline will be flexible based on instructions regarding covid-19. Based on previous monitoring efforts, bimonthly sampling in May, July and September captures the worst case scenario during the irrigation season. Maintaining the same sampling schedule in both areas in the Central Coast will further help simplify comparative analyses between the two areas (including previous data years) and reduce the potential for bias introduced by the sampling design. As the inaugural stormwater sampling in 2019 was highly successful, weather permitting, efforts will be made to similarly conduct storm sampling in the Central Coast to capture the first storm runoff in the fall presumably in late-November. This may be expanded to include an additional spring storm event in March of 2021. In addition, as analytical methods for other neonicotinoid AIs and fungicides (e.g., fenhexamid, fenamidone) have become available through the CDFA lab, these AIs will be added to our LC-Screen as priority pesticides for monitoring during 2020.

6. SAMPLING METHOD

6.1. Water and Sediment Sampling

During regular (i.e., irrigation season) monitoring events, water samples will be collected as grab samples directly into 1-liter amber glass bottles by hand or using a pole and then sealed with Teflon-lined lids (Bennett, 1997). We will continue with grab samples for storm monitoring; however, where possible, auto samplers will be used to sample waterbodies over the course of a storm event. Sediment samples will be collected into half-pint Mason Jars using stainless steel scoops from the top 2-cm bed layer. Sediments will be sieved through a 2-mm sieve to remove gravel and plant materials, and homogenized (Mamola, 2005; Ensminger, 2017). Samples will be stored and transported on wet ice or refrigerated at 4°C until analyzed.

6.2. Sample Transport

CDPR staff will transport water and sediment samples to the Center for Analytical Chemistry at California Department of Food and Agriculture for chemical analysis and to the UC Davis Marine Pollution Studies Laboratory following the procedures outlined in CDPR SOP QAQC004.01 (Jones, 1999). A chain-of-custody record will be completed and will accompany each sample.

6.3. Field Measurements

Dissolved oxygen, pH, specific conductivity, TDS, and water temperature will be measured *in situ* during each sampling event with an YSI EXO1 multi-parameter water quality Sonde (Doo and He 2008).

7. LABORATORY ANALYSES

7.1. Chemical Analysis

Chemical analyses will be performed by the Center for Analytical Chemistry, California Department of Food and Agriculture, Sacramento, CA. A total of 24 pesticides on the priority list of each watershed and an additional 13 active ingredients will be analyzed in all water samples collected from all of the sampling sites in 2020. A full scan of over 50 pesticides will be conducted once during 2020 on a subset of water samples collected from sites in the Central Coast (July) and Southern California (October). Table 10, 11, and 12 (LC-Full) present the pesticides and their associated analytical method reporting limits and method detection limits. Twenty-four of the pesticides in the screening groups will be selected from a single liquid chromatograph multi-analyte screen (LC-screen). Seven pyrethroids and six dinitroanilines will also be analyzed. Quality control (QC) will be conducted in accordance with the Standard Operating Procedure QAQC001.00 (Peoples, 2019). Approximately 10% of all samples collected during the 2020 monitoring year will be included for QC. Laboratory QA/QC will follow CDPR guidelines and will consist of laboratory blanks, matrix spikes, matrix spike duplicates, surrogate spikes, and blind spikes (Peoples, 2019). Laboratory blanks and matrix spikes will be included in each extraction set.

7.2. Organic Carbon and Suspended Solid Analyses

Total organic carbon (TOC) and dissolved organic carbon (DOC) in water samples will be analyzed by CDPR staff using a TOC-V CSH/CNS analyzer (Shimadzu Corporation, Kyoto, Japan) (Ensminger 2013a). Before analysis of every sample set, lab blanks and calibration standards will be run to ensure the quality of the TOC and DOC data. Water samples will also be analyzed for suspended sediment (Ensminger 2013b). Similarly, sediment samples collected during September (Central Coast) and October (Imperial Valley) will be analyzed for TOC using the TOC-V CSH/CNS analyzer following the protocol by Goodell (2016).

7.3. Toxicity Analysis

Toxicity analyses will be conducted in collaboration with the Central Coast Regional Water Quality Control Board and the UC Davis Marine Pollution Studies Laboratory (MPSL). Grab water samples collected from a set of selected sampling sites in the Central Coast and Southern California regions will be tested for mortality and growth by the MPSL using *Hyalella azteca, Chironomus dilutus* or *Ceriodaphnia dubia* as surrogate species.

8. DATA ANALYSIS

All data generated by this project will be entered in a Microsoft Office Access database that holds field information, field measurements, and laboratory analytical data. All ambient monitoring analytical data will also be uploaded into the CDPR Surface Water Database (SURF, 2018).

Resulting data will be analyzed and reported as appropriate, potentially including the following:

- Comparison of pesticide concentrations to aquatic toxicity benchmarks, water quality limits, and other toxicity data (CCVRWQCB 2012, US EPA 2018).
- Spatial analysis of data to identify correlations between observed pesticide concentrations and region-specific pesticide uses and geographical features.
- Assessment of multiple years of data to characterize patterns and trends in detection frequencies and exceedances of current aquatic benchmarks.
- Assessment of results to determine potential additional monitoring in regions with similar pesticide use patterns.

9. ESTIMATED TIMETABLE

Field Sampling:	May 2020–November 2020
Chemical Analysis:	May 2020–December 2020
Draft Report:	Late Spring 2021
Data Entry into SURF:	Fall 2021

10. SAMPLING EVENTS

The sampling schedule for each county is provided in Table 13.

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12. TABLES

Table 1. Sampling Site Information for Study 321 in 2020.

County	Site ID	Location	Watershed	Latitude	Longitude	Site Type
Imperial	Imp_Newriv27	New River at HWY S27/Keystone Road	New River	32.9136	-115.60646	Main stem
Imperial	Imp_Lack	New River at Lack Road	New River	33.0999	-115.64876	Main stem
Imperial	Imp_Rice3	Rice Drain III at Weinert Road	New River	32.8691	-115.651	Tributary
Imperial	Imp_Rutherford	Alamo River at Rutherford Road	Alamo River	33.0447	-115.48829	Main stem
Imperial	Imp_Garst	Alamo River at Garst Road	Alamo River	33.199	-115.59696	Main stem
Imperial	Imp_Holtville	Holtville Main Drain at HWY 115	Alamo River	32.9309	-115.40611	Tributary
Monterey	Sal_Quail	Quail Creek at HWY 101; Spence and Potter Roads	Salinas River	36.6092	-121.56269	Tributary
Monterey	Sal_Chualar	Chualar Creek at Chualar River Road	Salinas River	36.5584	-121.52964	Tributary
Monterey	Sal_Davis	Salinas River at Davis Road	Salinas River	36.647	-121.70219	Main stem
Monterey	Sal_Hartnell	Alisal Creek at Hartnell Road	Tembladero Slough	36.6435	-121.57836	Tributary
Monterey	Sal_SanJon	Rec Ditch at San Jon Road	Tembladero Slough	36.7049	-121.70506	Tributary
Monterey	Sal_Haro	Tembladero Slough at Haro Street	Tembladero Slough	36.7596	-121.75433	Main stem
San Luis Obispo	SM_OFC	Oso Flaco Creek at Oso Flaco Creek Road	Oso Flaco Creek	35.0164	-120.58755	Tributary
Santa Barbara	SM_Solomon	Solomon Creek at HWY 1	Orcutt Creek	34.9414	-120.5742	Tributary
Santa Barbara	SM_Orcutt	Orcutt Creek at West Main Street	Orcutt Creek	34.9576	-120.63244	Main stem
Santa Barbara	SM_Main[1]	Main Ditch at HWY 166	Main Ditch	34.95474	-120.48501	Tributary

[1]SM_Main was a replacement site for SM_Bradley which stopped being monitored in 2018.

Table 2. Pesticide Prioritization for Surface Water Monitoring in Alamo River in Imperial County. Ranking of Pesticides Based on Average Use Data from January through March of 2015–2017.

Chemical	Use score	Tox score	Final score	Monitoring inclusion
PENDIMETHALIN	5	4	20	Yes
TRIFLURALIN	5	4	20	Yes
MALATHION	3	6	18	Yes.
CHLORPYRIFOS	3	6	18	Yes
DIMETHOATE	4	3	12	Yes
PERMETHRIN	2	6	12	Yes
ATRAZINE	2	5	10	Yes
FENPROPATHRIN	2	5	10	Yes
MANCOZEB	3	3	9	No[1]
2,4-D	4	2	8	No*
METHOMYL	2	4	8	Yes

Alamo River drainage area = 1,264 km^2

[1]Analytical method not currently available; *not prioritized for monitoring due to limited use at other sites

Table 3. Pesticide Prioritization for Surface Water Monitoring in New River in Imperial County. Ranking of Pesticides Based on Average Use Data from January through March of 2015–2017.

Chemical	Use score	Tox score	Final score	Monitoring inclusion
PENDIMETHALIN	5	4	20	Yes
CHLORPYRIFOS	3	6	18	Yes
MALATHION	3	6	18	Yes
MANCOZEB	5	3	15	No[1]
IMIDACLOPRID	3	5	15	Yes
LAMBDA-CYHALOTHRIN	2	7	14	Yes
DIMETHOATE	4	3	12	Yes
TRIFLURALIN	3	4	12	Yes
METHOMYL	3	4	12	Yes
PERMETHRIN	2	6	12	Yes
ATRAZINE	2	5	10	Yes
OXYFLUORFEN	2	5	10	Yes
BENSULIDE	4	2	8	Yes
LINURON	2	4	8	No[1]

New River drainage area = 1,729 km^2

[1]Analytical method not currently available.

Table 4. Pesticide Prioritization for Surface Water Monitoring in Alamo River in Imperial County. Ranking of Pesticides Based on Average Use Data from August through October of 2015–2017.

Chemical	Use score	Tox score	Final score	Monitoring inclusion
CHLORPYRIFOS	5	6	30	Yes
IMIDACLOPRID	4	5	20	Yes
TRIFLURALIN	3	4	12	Yes
ESFENVALERATE	2	6	12	Yes
PERMETHRIN	2	6	12	Yes
MALATHION	2	6	12	Yes
CYPERMETHRIN	2	5	10	Yes
METHOXYFENOZIDE	3	3	9	Yes
PENDIMETHALIN	2	4	8	Yes

Alamo River drainage area = 1,264 km^2

Table 5. Pesticide Prioritization for Surface Water Monitoring in New River in Imperial County. Ranking of Pesticides Based on Average Use Data from August through October of 2015–2017.

Chemical	Use score	Tox score	Final score	Monitoring inclusion
IMIDACLOPRID	5	5	25	Yes
CHLORPYRIFOS	4	6	24	Yes
TRIFLURALIN	3	4	12	Yes
PENDIMETHALIN	3	4	12	Yes
PERMETHRIN	2	6	12	Yes
ESFENVALERATE	2	6	12	Yes
CYPERMETHRIN	2	5	10	Yes
OXYFLUORFEN	2	5	10	Yes
BENEFIN	3	3	9	Yes
METHOXYFENOZIDE	3	3	9	Yes
BENSULIDE	4	2	8	Yes
METHOMYL	2	4	8	Yes
LINURON	2	4	8	No[1]
CHLORANTRANILIPROLE	2	4	8	Yes

New River drainage area = 1,729 km^2

[1]Analytical method not currently available.

Table 6. Pesticide Prioritization for Surface Water Monitoring in Salinas River in Monterey County. Ranking of Pesticides Based on Average Use Data from May through November of 2015–2017.

Chemical	Use score	Tox score	Final score	Monitoring inclusion
METHOMYL	5	4	20	Yes
PARAQUAT DICHLORIDE	4	5	20	No*
MALATHION	3	6	18	Yes
PERMETHRIN	3	6	18	Yes
IMIDACLOPRID	3	5	15	Yes
OXYFLUORFEN	3	5	15	Yes
LAMBDA-CYHALOTHRIN	2	7	14	Yes
GLUFOSINATE-AMMONIUM	4	3	12	No[1]
PYRACLOSTROBIN	3	4	12	Yes
BIFENTHRIN	2	6	12	Yes
BENSULIDE	5	2	10	Yes
CARBARYL	2	5	10	Yes
PCNB	3	3	9	No[1]
CYPRODINIL	3	3	9	Yes
FENAMIDONE	3	3	9	Yes
PROMETRYN	2	4	8	Yes
CHLORANTRANILIPROLE	2	4	8	Yes

Salinas River drainage area = 11,082 km^2

*No longer prioritized for monitoring due to frequently low detections in previous years.

[1]Analytical method not currently available.

Table 7. Pesticide Prioritization for Surface Water Monitoring in Tembladero Slough in Monterey County. Ranking of Pesticides Based on Average Use Data from May through November of 2015–2017.

Chemical	Use score	Tox score	Final score	Monitoring inclusion
MALATHION	4	6	24	Yes
PERMETHRIN	3	6	18	Yes
NALED	3	6	18	No[1]
METHOMYL	4	4	16	Yes
PCNB	4	3	12	No[1]
PYRACLOSTROBIN	3	4	12	Yes
BIFENTHRIN	2	6	12	Yes
IMIDACLOPRID	2	5	10	Yes
CARBARYL	2	5	10	Yes
OXYFLUORFEN	2	5	10	Yes
CYPRODINIL	3	3	9	Yes
FLUPYRADIFURONE	3	3	9	Yes
PENDIMETHALIN	2	4	8	Yes
PROMETRYN	2	4	8	Yes

Tembladero Slough drainage area = 291 km^2

[1]Analytical method not currently available.

Table 8. Pesticide Prioritization for Surface Water Monitoring in Orcutt Creek in Santa Barbara County. Ranking of Pesticides Based on Average Use Data from May through November of 2015–2017.

Chemical	Use score	Tox score	Final score	Monitoring inclusion
MALATHION	5	6	30	Yes
IMIDACLOPRID	4	5	20	Yes
OXYFLUORFEN	4	5	20	Yes
METHOMYL	4	4	16	Yes
PROMETRYN	3	4	12	Yes
PERMETHRIN	2	6	12	Yes
BIFENTHRIN	2	6	12	Yes
NOVALURON	2	6	12	No*
FENPROPATHRIN	2	5	10	Yes
PYRACLOSTROBIN	2	4	8	Yes
TRIFLURALIN	2	4	8	Yes
LINURON	2	4	8	No[1]
CHLORANTRANILIPROLE	2	4	8	Yes

Orcutt Creek drainage area = 301 km^2

*Not currently monitored as this is a plant growth regulator.

[1]Analytical method not currently available.

Table 9. Pesticide Prioritization for Surface Water Monitoring in Oso Flaco Creek in San Luis Obispo County. Ranking of Pesticides Based on Average Use Data from May through November of 2015–2017.

Chemical	Use score	Tox score	Final score	Monitoring inclusion
MALATHION	5	6	30	Yes
IMIDACLOPRID	4	5	20	Yes
OXYFLUORFEN	3	5	15	Yes
NOVALURON	2	6	12	No*
PERMETHRIN	2	6	12	Yes
BIFENTHRIN	2	6	12	Yes
FENPROPATHRIN	2	5	10	Yes
CYPRODINIL	3	3	9	Yes
PROPYZAMIDE	4	2	8	No[1]
PYRACLOSTROBIN	2	4	8	Yes
METHOMYL	2	4	8	Yes
CHLORANTRANILIPROLE	2	4	8	Yes

Oso Flaco Creek drainage area = 51 km^2

*Not currently monitored as this is a plant growth regulator.

[1]Analytical method not currently available.

Table 10. Reporting Limit and Method Detection Limit for Pesticides Monitored in 2020. All analytes listed in the LC screen are part of the condensed (i.e., LC-short) pesticide screen.

Analytic Screen*	Pesticide	Method Detection Limit (µg/L)	Reporting Limit (µg/L)
LC	Acetamiprid	0.004	0.02
LC	Atrazine	0.004	0.02
LC	Azoxystrobin	0.004	0.02
LC	Bensulide	0.004	0.02
LC	Chlorantraniliprole	0.004	0.02
LC	Chlorpyrifos	0.004	0.02
LC	Clothianidin	0.004	0.02
LC	Cyprodinil	0.004	0.02
LC	Dimethoate	0.004	0.02
LC	Diuron	0.004	0.02
LC	Fenamidone	0.004	0.02
LC	Fenhexamid	0.005	0.02
LC	Fludioxonil	0.004	0.02
LC	Imidacloprid	0.004	0.01
LC	Indoxacarb	0.004	0.02
LC	Malathion	0.004	0.02
LC	Methomyl	0.004	0.02
LC	Methoxyfenozide	0.004	0.02
LC	Prometryn	0.004	0.02
LC	Pyraclostrobin	0.004	0.02
LC	Quinoxyfen	0.004	0.02
LC	Simazine	0.004	0.02
LC	S-Metolachlor	0.004	0.02
LC	Thiamethoxam	0.004	0.02
LC	Trifloxystrobin	0.004	0.02
DN/OX	Benfluralin (*Benefin*)	0.014	0.05
DN/OX	Ethalfluralin	0.015	0.05
DN/OX	Oxyfluorfen	0.010	0.05
DN/OX	Pendimethalin	0.012	0.05
DN/OX	Prodiamine	0.012	0.05
DN/OX	Trifluralin	0.014	0.05
PY	Bifenthrin	0.00091	0.001
PY	Lambda-cyhalothrin	0.00174	0.002
PY	Permethrin	0.00105	0.002
PY	Cyfluthrin	0.00146	0.002
PY	Cypermethrin	0.00154	0.005
PY	Fenpropathrin	0.00132	0.005
PY	Fenvalerate/esfenvalerate	0.00166	0.005

*LC = liquid chromatography multi-analyte screen; DN/OX = dinitroanilines and oxyfluorfen; PY = pyrethroids in water

Table 11. Reporting Limit and Method Detection Limit for Pesticides Monitored in Sediment in 2020.

Analytic Screen	Pesticide	Method Detection Limit (ng/g dry wt)	Reporting Limit (ng/g dry wt)
Pyrethroids	Bifenthrin	0.1083	1
Pyrethroids	Lambda-cyhalothrin	0.1154	1
Pyrethroids	Permethrin	0.1159	1
Pyrethroids	Cyfluthrin	0.1830	1
Pyrethroids	Cypermethrin	0.1070	1
Pyrethroids	Fenpropathrin	0.1094	1
Pyrethroids	Esfenvalerate/fenvalerate	0.1430	1

Table 12. Reporting Limit and Method Detection Limit for Pesticides Monitored in 2020. The LC-Full Screen will be conducted at a subset of sampling locations throughout the year.

Analytic Screen*	Pesticide	Method Detection Limit (µg/L)	Reporting Limit (µg/L)
LC	Abamectin	0.004	0.02
LC	Acetamiprid	0.004	0.02
LC	Atrazine	0.004	0.02
LC	Azoxystrobin	0.004	0.02
LC	Bensulide	0.004	0.02
LC	Boscalid	0.004	0.02
LC	Bromacil	0.004	0.02
LC	Carbaryl	0.004	0.02
LC	Chlorantraniliprole	0.004	0.02
LC	Chlorpyrifos	0.004	0.02
LC	Clothianidin	0.004	0.02
LC	Cyprodinil	0.004	0.02
LC	Diazinon	0.004	0.02
LC	Diflubenzuron	0.004	0.02
LC	Dimethoate	0.004	0.02
LC	Diuron	0.004	0.02
LC	Ethoprop	0.004	0.02
LC	Etofenprox	0.004	0.02
LC	Fenamidone	0.004	0.02
LC	Fenhexamid	0.005	0.02
LC	Fludioxonil	0.004	0.02
LC	Hexazinone	0.004	0.02
LC	Imidacloprid	0.004	0.01
LC	Indoxacarb	0.004	0.02
LC	Isoxaben	0.004	0.02
LC	Kresoxim-methyl	0.004	0.02
LC	Malathion	0.004	0.02
LC	Mefenoxam	0.004	0.02

Analytic Screen*	Pesticide	Method Detection Limit (µg/L)	Reporting Limit (µg/L)
LC	Methidathion	0.004	0.02
LC	Methomyl	0.004	0.02
LC	Methoxyfenozide	0.004	0.02
LC	Metribuzin	0.004	0.02
LC	Norflurazon	0.004	0.02
LC	Oryzalin	0.004	0.02
LC	Oxadiazon	0.004	0.02
LC	Prometon	0.004	0.02
LC	Prometryn	0.004	0.02
LC	Propanil	0.004	0.02
LC	Propargite	0.004	0.02
LC	Propiconazole	0.004	0.02
LC	Pyraclostrobin	0.004	0.02
LC	Pyriproxyfen	0.004	0.015
LC	Quinoxyfen	0.004	0.02
LC	Simazine	0.004	0.02
LC	S-Metolachlor	0.004	0.02
LC	Tebuconazole	0.004	0.02
LC	Tebufenozide	0.004	0.02
LC	Tebuthiuron	0.004	0.02
LC	Thiabendazole	0.004	0.02
LC	Thiacloprid	0.004	0.02
LC	Thiamethoxam	0.004	0.02
LC	Thiobencarb	0.004	0.02
LC	Trifloxystrobin	0.004	0.02
LC	Atrazine-d5	0.004	0.02
LC	Imidacloprid-d4	0.004	0.02
LC	Fipronil	0.004	0.01
LC	Fipronil Amide	0.004	0.01
LC	Fipronil Sulfide	0.004	0.01
LC	Fipronil Sulfone	0.004	0.01
LC	Desulfinyl Fipronil	0.004	0.01
LC	Desulfinyl Fipronil Amide	0.004	0.01

Table 13. Number of Samples Collected for Pesticide Analyses by County or Counties from May–November, 2020. Numbers under each month represent the total number of samples collected for each analyte or analyte group. One grab sample for each analyte or analyte group will be collected from one site.

Analyte Group*	Location[1]	May	July	September	October	November	Total samples (*n*)[2]
LC-Screen	Imperial	6			4		10
LC-Full	Imperial				2		2
DN/OX	Imperial	6			6		12
PY-Water	Imperial	6			6		12
PY-Sediment	Imperial				6		6
LC-Screen	Central Coast	10	5	10			25
LC-Full	Central Coast		5			6	11
DN/OX	Central Coast	10	10	10		6	36
PY-Water	Central Coast	10	10	10		6	36
PY-Sediment	Central Coast			10			10
Overall		**30**	**30**	**40**	**24**	**18**	**160**

*LC-Screen = Liquid chromatograph multi-analyte screen (24 AIs); LC-Full = includes 47 analytes; DN/OX = Dinitroaniline & Oxyfluorfen; PY = Pyrethroid.
[1]Central Coast = Monterey, Santa Barbara and San Luis Obispo counties.
[2]10% of the equivalent total samples collected will be used for QA/QC.

13. FIGURES

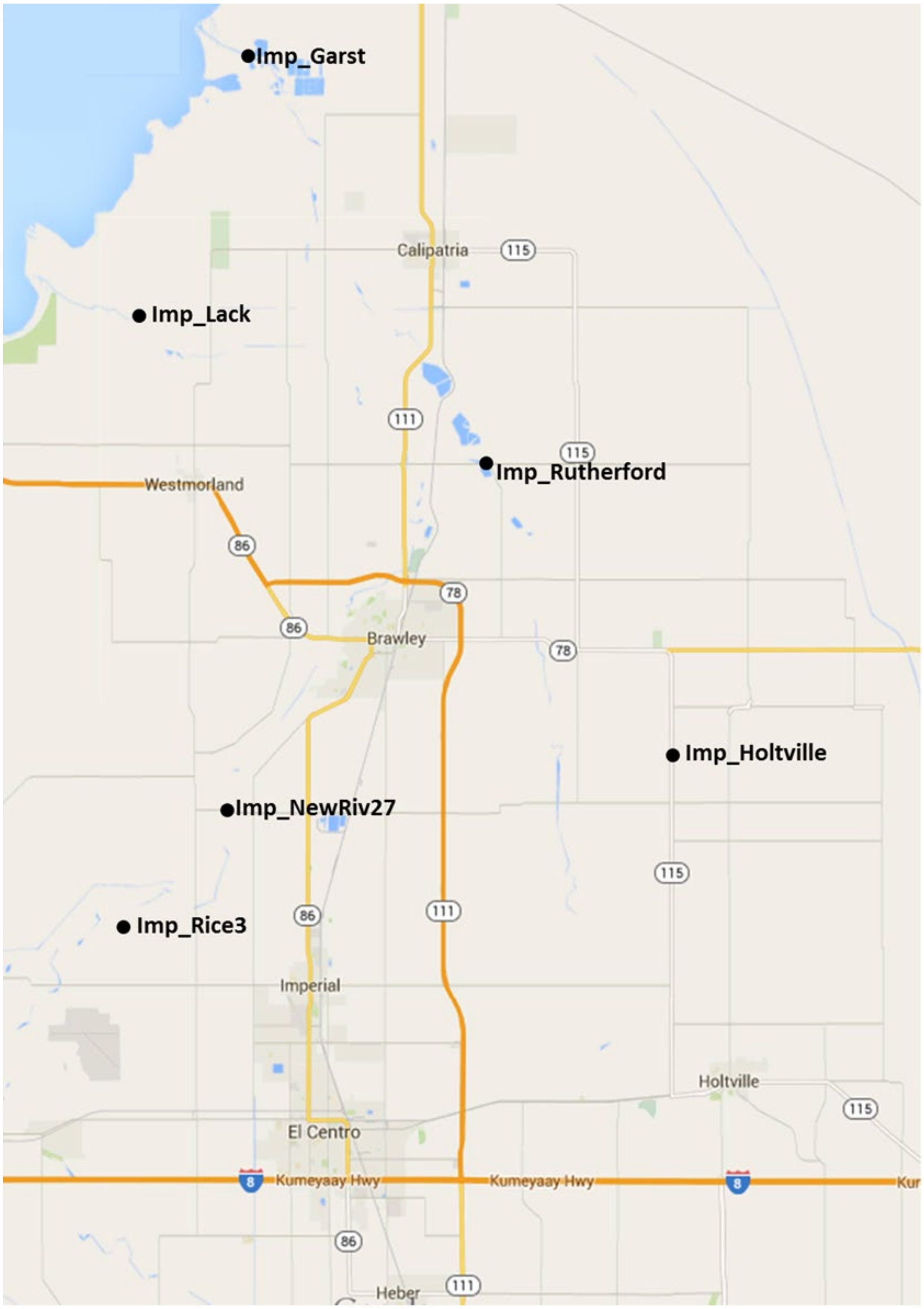

Figure 1. Monitoring Sites in Alamo River and New River in Imperial County.

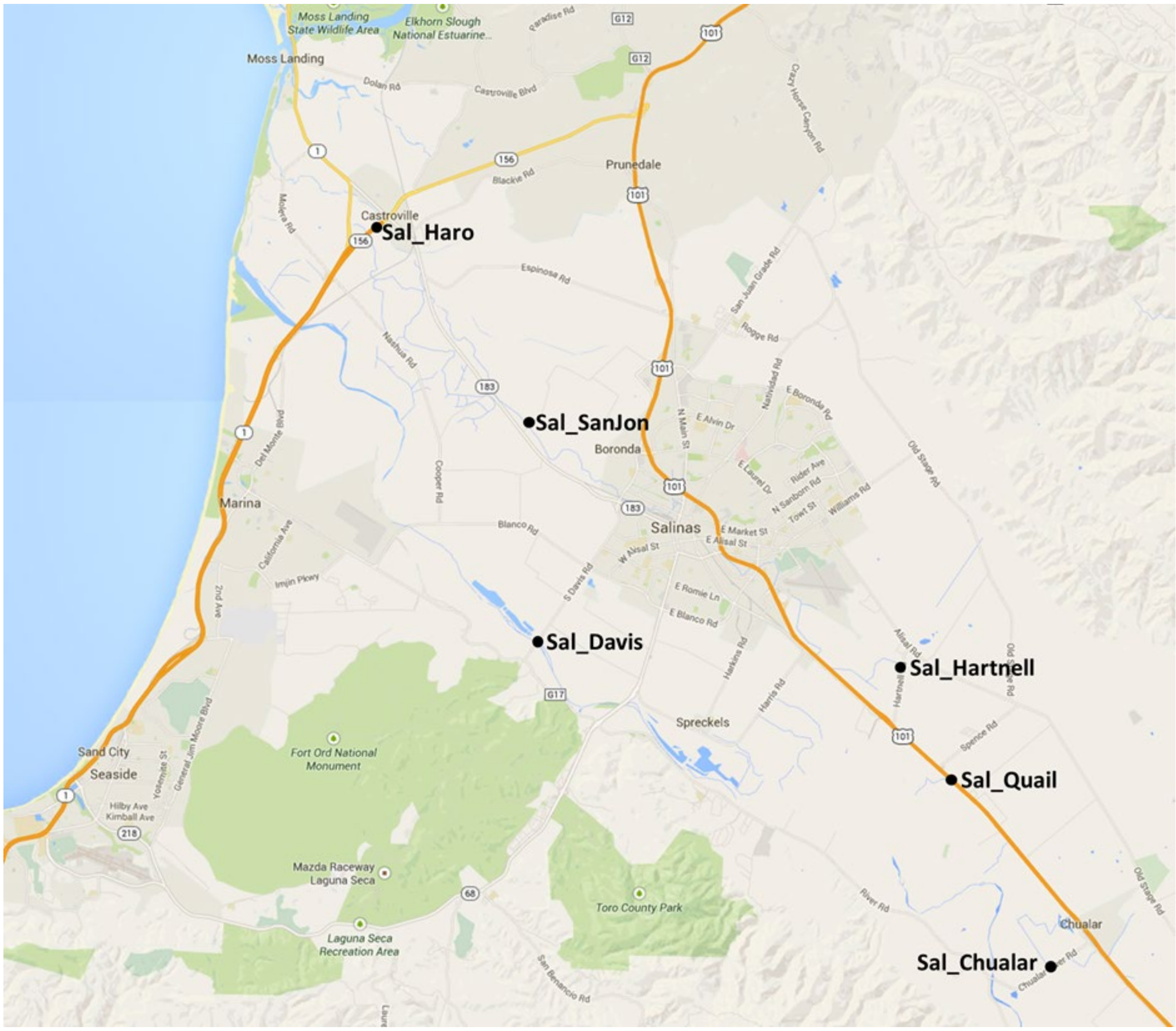

Figure 2. Monitoring Sites in Salinas River and Tembladero Slough in Monterey County

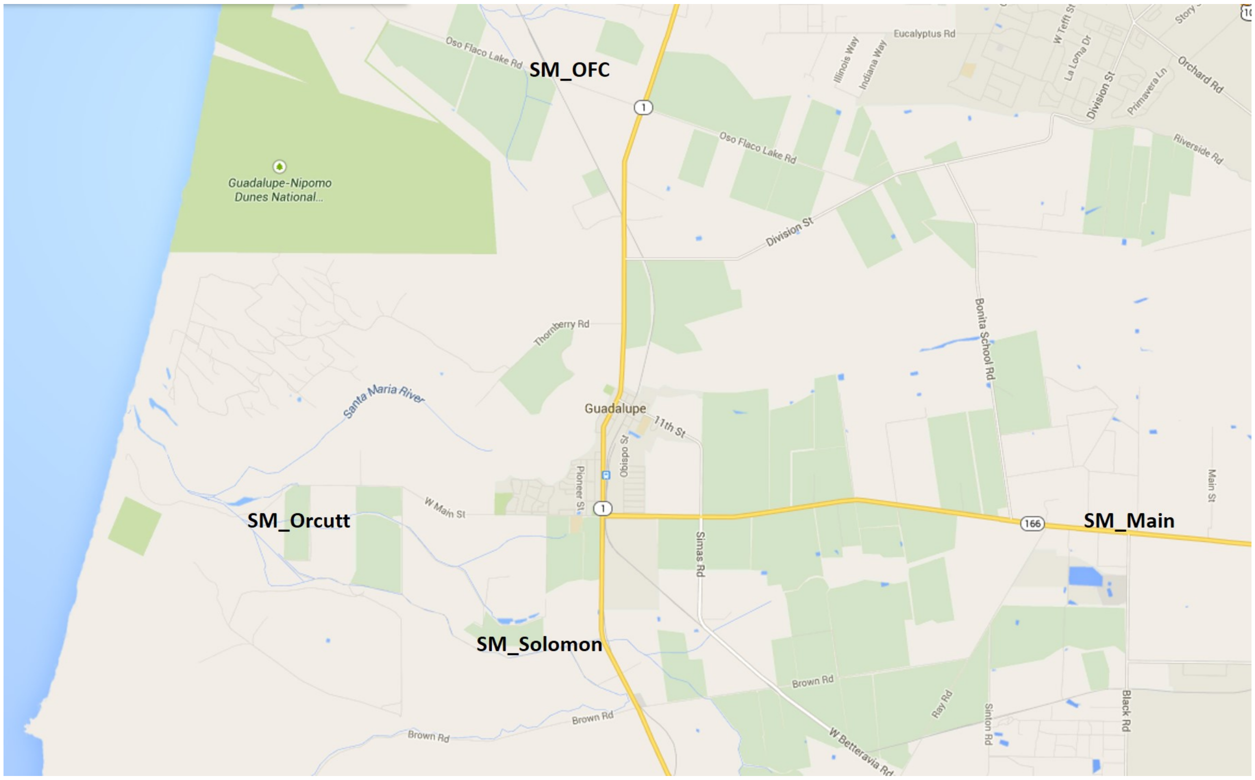

Figure 3. Monitoring Sites in Orcutt Creek and Oso Flaco Creek in Santa Barbara and San Luis Obispo Counties.