**Central Coast Regional Water Quality Control Board**
**895 Aerovista Place, Suite 101**
**San Luis Obispo, CA 93401**

# Monitoring Pyrethroid Pesticides in Sediment and Stormwater Runoff in the Gabilan Creek Watershed, Monterey Co., Calif.

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## 1. INTRODUCTION

The Central Coast Regional Water Quality Control Board's (Central Coast Water Board) Surface Water Ambient Monitoring Program (SWAMP-CCAMP) proposes to monitor pyrethroids in sediment and water samples in the Gabilan Creek watershed, which includes the following waterbodies: Gabilan Creek, Natividad Creek, Alisal Creek, Carr Lake, Santa Rita Creek, Salinas Reclamation Canal, Tembladero Slough, Merritt Ditch, Espinosa Slough, and the Old Salinas River (Figures 1 and 2). The study aims to characterize pyrethroid concentrations before, during, and after stormwater runoff events. This monitoring will be conducted in coordination with the Central Coast Water Board's SWAMP- CCAMP, Irrigated Lands Regulatory Program (ILRP), and the Total Maximum Daily Load (TMDL) program.

This monitoring study is a follow-up to existing ambient toxicity and pesticide monitoring conducted by SWAMP-CCAMP, the Cooperative Monitoring Program for irrigated agriculture (CMP), the California Department of Pesticide Regulations' (DPR), and the City of Salinas. These programs either target the growing season or have limited pyrethroid data from the wet weather season or stormwater runoff events. This follow-up monitoring study focuses on concentrations of pyrethroids in stormwater discharges from the subwatersheds of the Gabilan Creek watershed during the winter season (Figure 3); it also monitors sediments prior to the stormwater season and afterwards in the spring.

DPR monitors agricultural streams in the lower Gabilan Creek watershed during the growing season at two locations in the watershed and detected bifenthrin more frequently than any other pyrethroid pesticide (refer to Tables 4 and 5). Bifenthrin binds strongly to sediment, it has long half-life, and is very persistent in the environment. Bifenthrin is used extensively on strawberries, which have little irrigation run-off during the growing season. Therefore, Water Board staff suspects/hypothesizes that bifenthrin could be transported offsite and into streams by stormwater. This monitoring study will evaluate this pathway by monitoring the concentrations of pyrethroids in stormwater and sediments deposited during stormwater runoff events.

This follow-up monitoring study will provide additional information for implementing the TMDLs for sediment toxicity and pyrethroid pesticides for sediments of the Lower Salinas River watershed (specifically, the Gabilan Creek watershed). The Central Coast Water Board adopted the TMDLs on July 14, 2017 and the USEPA approved them on August 9, 2018. The TMDL project addresses widespread sediment toxicity impairments in the watershed that were identified on the 2010 303(d) List of impaired waters (refer to

Figure 2). More recent monitoring conducted in 2017 by the CMP found extensive sediment toxicity and concentrations of pyrethroids at levels that could cause toxicity (refer to Table 7).

## 2. OBJECTIVES

The objectives of this monitoring study in the Gabilan Creek watershed include:

- Determining the concentrations of selected pyrethroid pesticides in stormwater runoff;
- Comparing fall and spring concentrations of selected pyrethroids in water and sediments; and
- Calculating the instantaneous loading of pyrethroids, total suspended solids, and total dissolved solids in stormwater runoff.

## 3. PERSONNEL

Central Coast Water Board staff from the TMDL and SWAMP-CCAMP programs developed this project and will conduct the associated monitoring and data evaluation.

- Project Lead: Peter Meertens (TMDL)
- Monitoring Coordinator: Melissa Daugherty (TMDL and SWAMP-CCAMP)
- Mary Hamilton (TMDL Program Manager)

Supporting agency staff and collaborators:

- Jacqueline Tkac, Lauren Gordon (ILRP)
- Reviewing Scientist: Aniela Burant, Ph.D. (DPR)
- Statistician: TBD
- Collaborators: Bryn Phillips (UC Davis), and Xin Deng, Ph.D. (DPR)

Please direct questions regarding this study to Peter Meertens, Environmental Scientist, at 805-549-3869 or Peter.Meertens@WaterBoards.ca.gov.

## 4. STUDY PLAN

Samples will be collected from eight long term monitoring sites (refer to Table 1 and Figure 3) throughout the Gabilan Creek Watershed, selected based on the results of existing watershed monitoring and land use data. The monitoring site network includes one site at the lower end of each agriculturally dominated subwatershed and above and below of the City of Salinas.

Table 1. Monitoring site codes, descriptions, programs conducting long term monitoring at each location, and type of watershed monitoring sites for planned sample locations.

| Site Code | Site Description (Monitoring Program(s)) | Type |
|---|---|---|
| 309ALG | Salinas Reclamation Canal at La Guardia (CMP) | Alisal Creek Subwatershed Branch |
| 309ALD | Salinas Reclamation Canal at Boronda Road (CCAMP, City of Salinas) | Main Channel |
| 309ESP | Espinosa Slough upstream of Alisal Slough (CMP) | Espinosa Slough Subwatershed Branch |
| 309JON | Salinas Reclamation Canal at San Jon Road (CMP, DPR) | Main Channel |
| 309MER | Merritt Ditch upstream of Highway 183 (CMP) | Merritt Ditch Subwatershed Branch |
| 309NAD | Natividad Creek upstream of the Salinas Reclamation Canal (CMP) | Natividad Creek Subwatershed Branch |
| 309OLD | Old Salinas River at Monterey Dunes Way (CCAMP, CMP) | Main Channel |
| 309TEH | Tembladero Slough at Haro (CMP, DPR) | Main Channel |

## 5. CHEMICAL ANALYSIS

A suite of pyrethroid insecticides will be analyzed in both water and sediment samples. Laboratory QA/QC will follow SWAMP guidelines and will consist of laboratory blanks, matrix spikes, matrix spike duplicates, surrogate spikes, and blind spikes. The monitoring parameters, reporting limits, and monitoring frequency are listed in Table 3. Chemical analysis will be performed by Physis Environmental Laboratories, Inc.

## 6. DATA ANALYSIS

The resulting data will be analyzed and validated in accordance with SWAMP measurement quality objectives (https://www.waterboards.ca.gov/water_issues/programs/swamp/mqo.html). All ambient monitoring data and associated quality control data will be uploaded into the California Environmental Data Exchange Network (CEDEN) database. The resulting data will be analyzed and reported as appropriate, potentially including the following: Comparison of pesticide concentrations to the appropriate thresholds (LC50s, Aquatic Life Benchmarks, TMDL Targets) and calculation of instantaneous pollutant loads.

## 7. TIMETABLE

Field Sampling: October 2018 – May 2019
Chemical Analysis: October 2018 – May 2019
Monitoring Report: June 2019
Data Entry into CEDEN: within 60 days of each sample event

## 8. MONITORING AND LABORATORY BUDGET

The estimated total cost for chemical analysis is $15,150 (Table 2).

Table 2. Monitoring sites, events and monitoring costs for the study.

| Event | Monitoring Sites and Cost/Sample | | | | | | | | | Total Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| | 309ALG | 309ALD | 309ESP | 309JON | 309MER | 309NAD | 309OLD | 309TEH | Dup | |
| Pre-winter sediment and water | $550 | $550 | $550 | $550 | $550 | $550 | $550 | $550 | $550 | $4,950 |
| Stormwater 1 water | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $2,475 |
| Stormwater 2 water only | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $2,475 |
| Stormwater 3 water only | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $275 | $2,475 |
| Post-winter sediment and water | $550 | $550 | $550 | $550 | $550 | $550 | $550 | $550 | $550 | $4,950 |
| Subtotal | | | | | | | | | | $14,850 |
| Lab Reporting Fees | $60/event | | | | | | | | | $300 |
| Total Lab. Costs | | | | | | | | | | $15,150 |

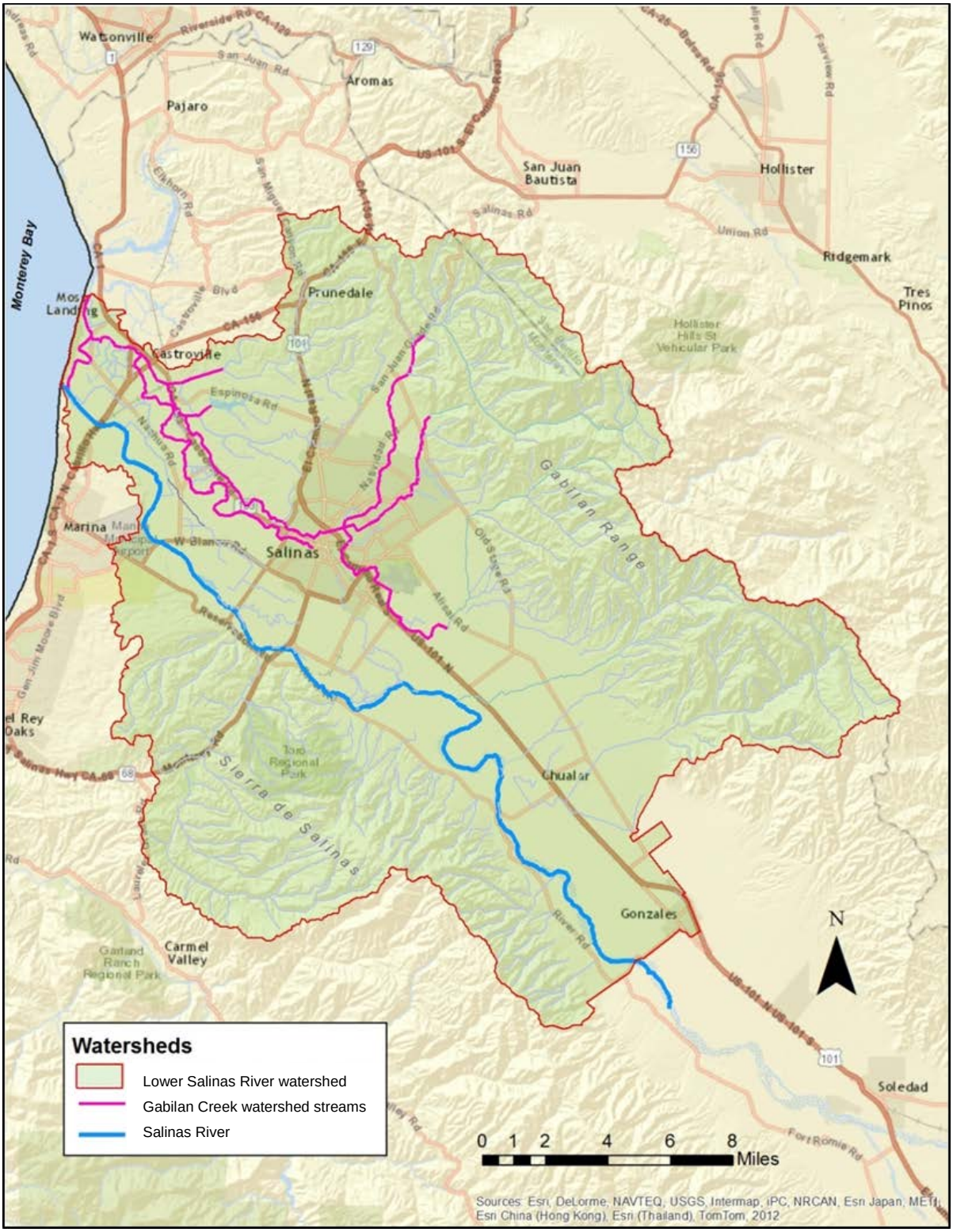


Figure 1. Map of the lower Salinas River watershed and the two major waterbodies, the main stem Salinas River and the streams of the Gabilan Creek watershed.

Table 3. Monitoring parameters, reporting limits (RL), and monitoring frequency

| Parameters and Tests | MDL | RL | Units | Monitoring Frequency |
|---|---|---|---|---|
| **Photo Monitoring** | | | | |
| Upstream and downstream photographs at monitoring locations | | | | All sample events |
| **Physical Parameters – Water Sampling** | | | | |
| Flow (field measure) (CFS) following SWAMP field SOP | | .25 | | All sample events |
| pH (field measure) | | 0.1 | | ” |
| Electrical Conductivity (field measure) (µS/cm) | | 2.5 | | ” |
| Dissolved Oxygen (field measure) (mg/L) | | 0.1 | | ” |
| Temperature (field measure) $^{o}$C) | | 0.1 | | ” |
| Turbidity (NTU) | | 0.5 | | ” |
| Total Dissolved Solids (mg/L) | | 10 | | ” |
| Total Suspended Solids (mg/L) | | 0.5 | | ” |
| | | | | |
| **Pyrethroid Pesticides (EPA 625-MRM) – Water Sampling** | | | | |
| Allethrin | 0.50 | 2.0 | ng/L | All sample events |
| Bifenthrin | 0.50 | 2.0 | ng/L | ” |
| Cyfluthrin | 0.50 | 2.0 | ng/L | ” |
| Lambda-cyhalothrin | 0.50 | 2.0 | ng/L | ” |
| Cypermethrin | 0.50 | 2.0 | ng/L | ” |
| Danitol (Fenpropathrin) | 0.30 | 2.0 | ng/L | ” |
| Deltamethrin/Tralomethrin | 0.50 | 2.0 | ng/L | ” |
| Esfenvalerate | 0.50 | 2.0 | ng/L | ” |
| Fenvalerate | 0.50 | 2.0 | ng/L | “ |
| Fluvalinate | 0.50 | 2.0 | ng/L | “ |
| Permethrin, cis | 2.00 | 4.0 | ng/L | “ |
| Permethrin, trans- | 1.00 | 2.0 | ng/L | “ |
| Prallethrin | 0.50 | 2.0 | ng/L | “ |
| **Pyrethroid Pesticides (EPA 8270D-NCI) Sediment Sampling** | | | | |
| Allethrin | 0.28 | 0.9 | ng/g | Fall and spring events |
| Bifenthrin | 0.22 | 0.7 | ng/g | “ |
| Cyfluthrin | 0.25 | 0.8 | ng/g | “ |
| Lambda-cyhalothrin | 0.23 | 0.7 | ng/g | “ |
| Cypermethrin | 0.28 | 0.9 | ng/g | “ |
| Danitol (Fenpropathrin) | 0.21 | 0.7 | ng/g | “ |
| Deltamethrin/Tralomethrin | 0.29 | 0.9 | ng/g | “ |
| Esfenvalerate | 0.28 | 0.9 | ng/g | “ |
| Fenvalerate | 0.25 | 0.8 | ng/g | “ |
| Fluvalinate | 0.23 | 0.7 | ng/g | “ |
| Permethrin, cis | 0.17 | 0.6 | ng/g | “ |
| Permethrin, trans- | 0.22 | 0.7 | ng/g | “ |
| Prallethrin | 0.28 | 0.9 | ng/g | “ |
| Total Organic Carbon | | | | |

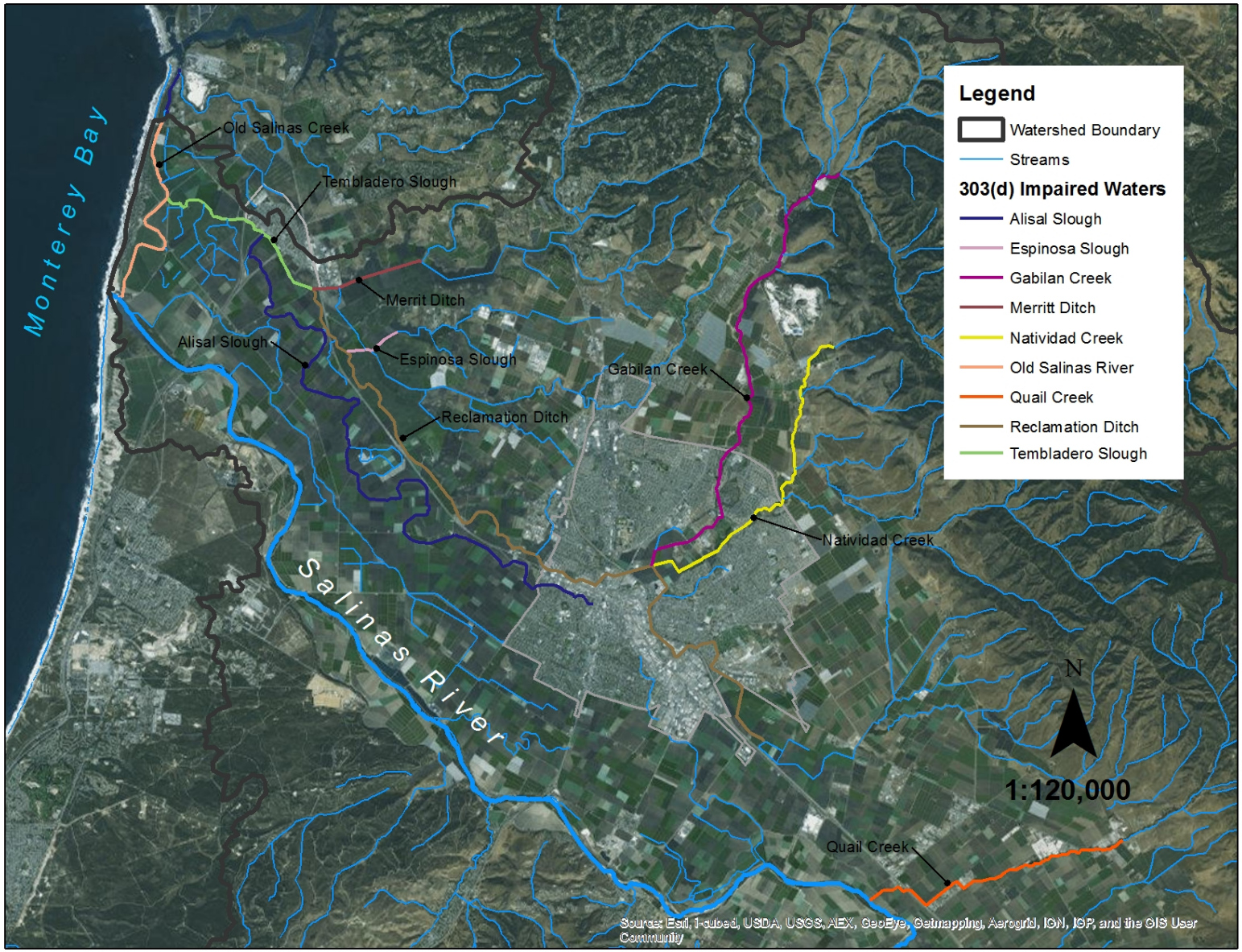


Figure 2. Map of waterbodies (light blue) and sediment toxicity impaired surface waters on the 2010 303(d) List in the lower Salinas River watershed.

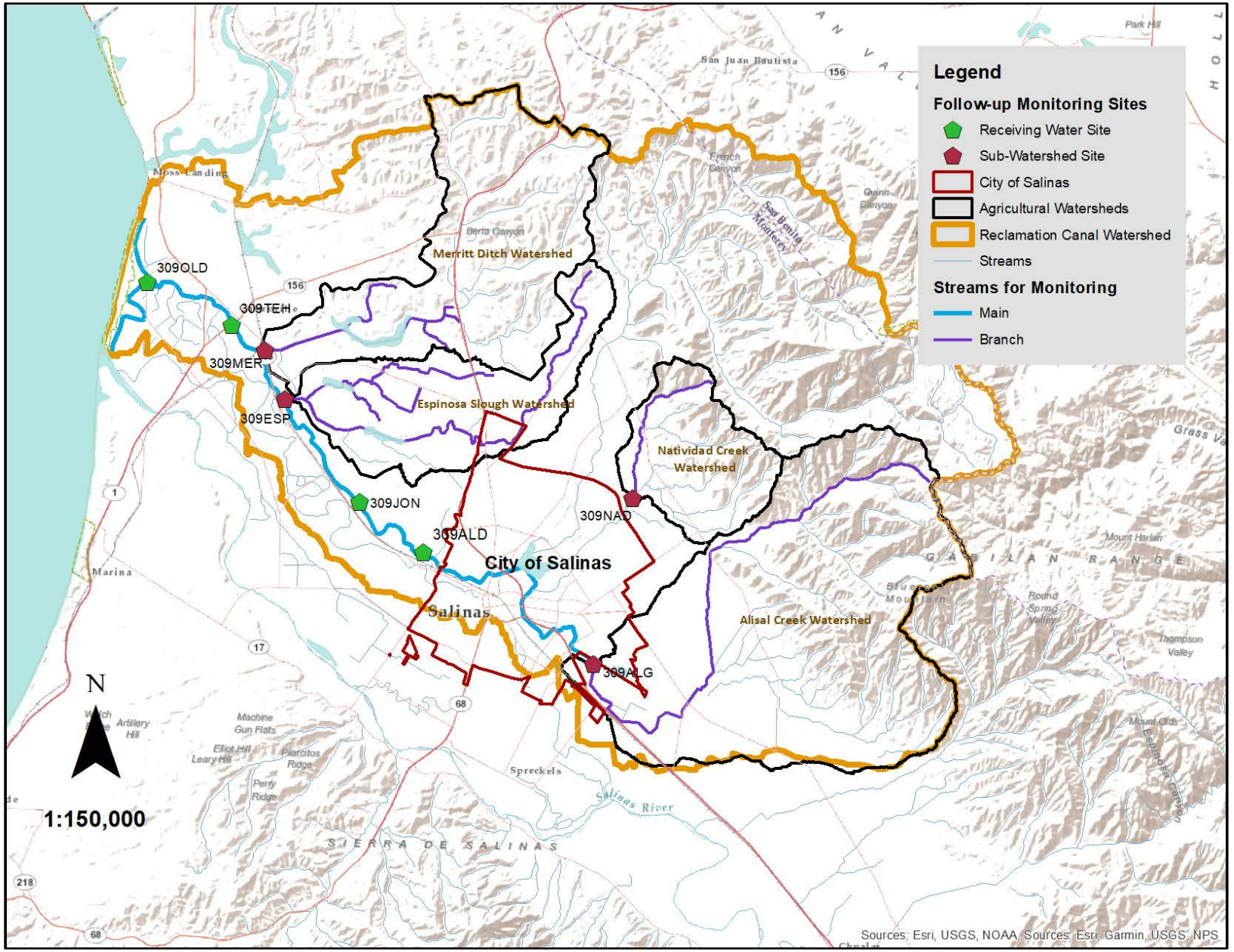


Figure 3. Map agricultural subwatersheds for follow-up monitoring in the Gabilan Creek watershed.

Table 4. DPR pyrethroid detections in water and exceedances of U.S.EPA Aquatic Life Benchmark. DPR monitoring of central coast agricultural watersheds from 2011 to 2015.

| Pesticide | Chemical Class | Type of Use | Samples | Detection | Detection Freq | Exceedance | % Exceed |
|---|---|---|---|---|---|---|---|
| bifenthrin | Pyrethroid | Insecticide | 98 | 41 | 42% | 42 | 100% |
| lambda cyhalothrin | Pyrethroid | Insecticide | 98 | 20 | 20% | 21 | 21% |
| permethrin | Pyrethroid | Insecticide | 98 | 19 | 19% | 23 | 23% |
| esfenvalerate | Pyrethroid | Insecticide | 98 | 3 | 3% | 0 | 0% |
| cypermethrin | Pyrethroid | Insecticide | 98 | 1 | 1% | 0 | 0% |
| cyfluthrin | Pyrethroid | Insecticide | 98 | 1 | 1% | 1 | 1% |

Table 5. DPR pyrethroid samples and detections from waterbodies in the lower Salinas River watershed from 2011 to 2015.

| Waterbody | DPR Site ID | Pesticide | # of Samples | # of detections |
|---|---|---|---|---|
| Alisal Creek | 27_70 | bifenthrin | 11 | 10 |
| Alisal Creek | 27_70 | lambda cyhalothrin | 11 | 4 |
| Alisal Creek | 27_70 | permethrin | 11 | 6 |
| Chualar Creek | 27_8 | bifenthrin | 11 | 2 |
| Chualar Creek | 27_8 | lambda cyhalothrin | 11 | 2 |
| Chualar Creek | 27_8 | permethrin | 11 | 2 |
| Old Salinas River | 27_50 | bifenthrin | 2 | 2 |
| Reclamation Canal | 27_10 | bifenthrin | 8 | 8 |
| Reclamation Canal | 27_10 | lambda cyhalothrin | 8 | 6 |
| Reclamation Canal | 27_10 | permethrin | 8 | 3 |
| Quail Creek | 27_7 | bifenthrin | 11 | 8 |
| Quail Creek | 27_7 | lambda cyhalothrin | 11 | 6 |
| Quail Creek | 27_7 | permethrin | 11 | 7 |
| Tembladero Slough | 27_66 | bifenthrin | 11 | 9 |
| Tembladero Slough | 27_58 | bifenthrin | 3 | 2 |

Table 6. Sediment toxicity monitoring data (2004 to 2013)

| **Waterbody Name** | 2010 303(d) List (2004 to 2006) | | Additional Monitoring (2006 to 2013) | | Total | |
|---|---|---|---|---|---|---|
| | **Exceedances*** | **Samples** | **Exceedances*** | **Samples** | **Exceedances*** | **Samples** |
| **Alisal Creek** | 1 | 2 | 1 | 1 | **2** | **3** |
| **Alisal Slough** | 2 | 3 | 1 | 6 | **3** | **9** |
| **Blanco Drain** | 0 | 2 | 2 | 7 | **2** | **9** |
| **Chualar Creek** | | | 5 | 9 | **5** | **9** |
| **Espinosa Slough** | 2 | 2 | 6 | 6 | **8** | **8** |
| **Gabilan Creek** | 4 | 5 | 2 | 2 | **6** | **7** |
| **Merrit Ditch** | 2 | 2 | 5 | 6 | **7** | **8** |
| **Natividad Creek** | 5 | 5 | 6 | 6 | **11** | **11** |
| **Old Salinas River** | 7 | 8 | 3 | 3 | **10** | **11** |
| **Quail Creek** | 2 | 2 | 9 | 9 | **11** | **11** |
| **Reclamation Canal** | 8 | 9 | 15 | 16 | **23** | **25** |
| **Salinas River (Lower)** | 1 | 5 | 2 | 21 | **3** | **26** |
| **Tembladero Slough** | 3 | 3 | 17 | 19 | **20** | **22** |
| | **Total** | | | | **111** | **159** |

Source: Data compiled for TMDLs for sediment toxicity and pyrethroids in sediment in the lower Salinas River watershed.

* Exceedances of TMDL toxicity targets and 303(d) List impairment toxicity criteria.

Table 7. Results of invertebrate bioassays in sediment samples and corresponding pesticide concentrations and Toxicity Units, from CMP 2017

| Site ID | Site Description | Month (2017) | *H. azteca* %Survival | *H. azteca* %Growth | Bifenthrin (ng/g) | Bifenthrin oc. (ug/g) | Bifenthrin toxic units | Pyrethroid toxic units | Chlorpyrifos toxic units | Total Toxic Units | TOC (%) Dry Wgt. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pesticide Criteria | | | | | 12.9 LC50 | 0.52 LC50 | 1.0 TU | | | | |
| | | April | 88.61 | 46.18 | *duplicate sample result* | | | | | | |
| | | Sept. | *dry* | | | | | | | | |
| **309ALG** | Reclamation Canal above Salinas | April | **0** | **0** | 2.87 | 0.12 | 0.24 | 0.61 | 0.00 | 0.61 | 2.34 |
| | | Sept. | 81.25 | **29.04** | 1.05 | 0.05 | 0.09 | 0.09 | 0.00 | 0.09 | 2.20 |
| **309ASB** | Alisal Slough | April | *disconnected* | | | 0.11 | | | | | |
| | | Sept. | **23.08** | **31.19** | 2.6 | | 0.22 | 0.41 | 0.00 | 0.41 | 2.32 |
| **309BLA** | Blanco Drain | April | **68.75** | **21.4** | 6.19 | 0.24 | 0.46 | 1.11 | 0.00 | 1.11 | 2.57 |
| | | Sept. | 100 | **60.68** | *nd* | | 0.00 | 0.00 | 0.00 | 0.00 | 1.32 |
| **309CCD** | Chualar Creek | April | **15.71** | **19.29** | 5.18 | 0.25 | 0.47 | 1.16 | 0.00 | 1.16 | 2.11 |
| | | Sept. | **10.26** | **3.26** | *nd* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 |
| **309ESP** | Espinosa Slough | April | **43.75** | 87.86 | 7.78 | 0.35 | 0.67 | 0.69 | 0.00 | 0.69 | 2.22 |
| | | Sept. | **0** | **0** | 1.41 | 0.12 | 0.23 | 0.23 | 0.07 | 0.30 | 1.16 |
| **309GAB** | Gabilan Creek | April | **0** | **0** | 0.48 | 0.04 | 0.08 | 0.08 | 0.05 | 0.12 | 1.22 |

| Site ID | Site Description | Month (2017) | *H. azteca* %Survival | *H. azteca* %Growth | Bifenthrin (ng/g) | Bifenthrin oc. (ug/g) | Bifenthrin toxic units | Pyrethroid toxic units | Chlorpyrifos toxic units | Total Toxic Units | TOC (%) Dry Wgt. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pesticide Criteria | | | | | 12.9 LC50 | 0.52 LC50 | 1.0 TU | | | | |
| | | Sept. | *disconnected* | | | | | | | | |
| **309GRN** | Salinas River (Mid) | July | 94.87 | 97.32 | *nd* | | 0.00 | 0.00 | 0.38 | 0.38 | 0.24 |
| | | Sept. | **75.64** | 75.54 | *nd* | | 0.00 | 0.00 | 0.00 | 0.00 | 0.55 |
| **309JON** | Reclamation Canal below Salinas | April | *no sediment* | | | | | | | | |
| | | Sept. | *no sediment* | | | | | | | | |
| **309MER** | Merrit Ditch | April | **26.25** | **77.46** | 12.18 | 0.35 | 0.68 | 0.68 | 0.00 | 0.68 | 3.45 |
| | | Sept. | **67.95** | **35.95** | *nd* | | 0.00 | 0.00 | 0.04 | 0.04 | 2.54 |
| | | Sept. | 84.62 | **23.74** | *duplicate sample result* | | | | | | |
| **309MOR** | Moro Cojo Slough | April | 100 | 87.46 | *nd* | | 0.00 | 0.00 | 0.00 | 0.00 | 2.6 |
| | | Sept. | 102.04[c] | | *nd* | | 0.00 | 0.00 | 0.00 | 0.00 | 0.45 |
| **309NAD** | Natividad Creek | April | **10** | **34.88** | 1.25 | 0.21 | 0.40 | 0.91 | 0.32 | 1.23 | 0.6 |
| | | Sept. | **0** | **0** | 1.39 | 0.22 | 0.42 | 0.52 | 0.00 | 0.52 | 0.64 |
| **309OLD** | Old Salinas River | April | **0** | **0** | 441.98 | 17.00 | 32.69 | 38.09 | 0.00 | 38.09 | 2.6 |
| | | Sept. | **0** | **0** | 6.54 | 0.31 | 0.60 | 0.60 | 0.00 | 0.60 | 2.11 |
| **309QUI** | Quail Creek | April | *disconnected* | | | | | | | | |
| | | Sept. | **67.95** | **35.85** | *nd* | | 0.00 | 0.00 | 0.00 | 0.00 | 1.37 |
| **309RTA** | Santa Rita Creek | July | **3.95** | **3.93** | *nd* | | 0.00 | 12.46 | 0.00 | 12.46 | 0.01 |
| | | Sept. | *dry* | | | | | | | | |

| Site ID | Site Description | Month (2017) | *H. azteca* %Survival | *H. azteca* %Growth | Bifenthrin (ng/g) | Bifenthrin oc. (ug/g) | Bifenthrin toxic units | Pyrethroid toxic units | Chlorpyrifos toxic units | Total Toxic Units | TOC (%) Dry Wgt. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pesticide Criteria | | | | | 12.9 LC50 | 0.52 LC50 | 1.0 TU | | | | |
| **309SAC** | Salinas River (Lower) @ Chualar Bridge | April | 114.26 | 114.41 | *nd* | | 0.00 | 0.00 | 0.00 | 0.00 | 0.53 |
| **309SAG** | Salinas River @ Gonzales River Road Bridge | Sept. | 82.5 | 96.21 | *nd* | | 0.00 | 0.00 | 0.00 | 0.00 | 0.76 |
| **309SSP** | Salinas River (Lower) @ Spreckles Gage | July | **70.51** | 103.55 | *nd* | | 0.00 | 0.00 | 0.08 | 0.08 | 1.09 |
| | | Sept. | 92.5 | 97.04 | *nd* | | 0.00 | 0.00 | 0.00 | 0.00 | 0.06 |
| **309TEH** | Tembladero Slough | April | **0** | **0** | 19.57 | 0.90 | 1.73 | 3.24 | 0.03 | 3.27 | 2.17 |
| | | April[b] | **0** | **0** | *duplicate sample result* | | | | | | |
| | | Sept. | **31.65** | **51.17** | 0.83 | 0.05 | 0.09 | 0.09 | 0.00 | 0.09 | 1.69 |
| | | Sept. | 97.5 | 99.85 | *nd* | | 0.00 | 0.38 | 0.62 | 1.00 | 0.10 |

oc – samples results are organic carbon normalized
TOC – Total Organic Carbon
Exceedances of *Hyalella azteca* toxicity thresholds highlighted in red