Ventura Countywide Stormwater Quality Management Program

PYRETHROID INSECTICIDES STUDY

2012 - 2018 FINAL REPORT

PREPARED BY THE:

VENTURA COUNTY WATERSHED PROTECTION DISTRICT

SUBMITTED ON BEHALF OF:

VENTURA COUNTY WATERSHED PROTECTION DISTRICT
COUNTY OF VENTURA
CITY OF CAMARILLO
CITY OF FILLMORE
CITY OF MOORPARK
CITY OF OJAI
CITY OF OXNARD
CITY OF PORT HUENEME
CITY OF SANTA PAULA
CITY OF SIMI VALLEY
CITY OF THOUSAND OAKS
CITY OF VENTURA

December 15, 2018

EXECUTIVE SUMMARY

Monitoring of sediment for pyrethroids, total organic carbon, and toxicity to *Hyalella azteca* was conducted at two sites in the Calleguas Creek, Ventura River, and Santa Clara River watersheds in 2012, 2015, and 2018, as required by Monitoring Program No. CI 7388, as part of the Ventura County Municipal Separate Storm Sewer System National Pollutant Discharge Elimination System Permit, Order No. R4-2010-0108 (Permit).

The most commonly detected pyrethroids were bifenthrin and permethrin. The hypothetical contribution to toxicity was calculated for these pyrethroids based on their concentration, the amount of total organic carbon present in the sample, and a reference concentration known to cause significant toxicity to *Hyalella azteca* in sediment samples. For most samples, the hypothetical and observed toxicity agreed that the concentrations should not result in significant toxicity. However, in one sample, WOOD 2012, there was significant hypothetical and observed toxicity, indicating that bifenthrin was the likely cause of the observed toxicity. This site is in a predominantly agricultural area. In two samples, SCR Up 2015 and VR Down 2015, significant toxicity was observed but hypothetical toxicity was low, indicating that the cause of the toxicity was a pollutant that was not part of this study. Both of these sites are associated with multiple land uses, including urban and agriculture. A field duplicate was collected at CC Down in 2015, and while the sample and its duplicate did not show significant observed toxicity, the duplicate had high hypothetical toxicity, while the original sample did not. The lack of observed toxicity suggests that the high concentration in the duplicate may have been the result of an error or subsampling difference at the chemistry laboratory. This site is located in an agricultural area with upstream urban influences.

Two non-pyrethroid pesticides (pendimethalin and dichloran) were also frequently detected. The reference documents do not include reference concentrations for calculating hypothetical toxicity, but the lack of observed toxicity at sites with higher concentrations of these pesticides indicate that these are not likely a cause for toxicity.

Bifenthrin and permethrin are both used in significant quantities for regulated applications for structural and agricultural pest control in Ventura County but are also known to have unregulated applications for residential and industrial uses, which are not tracked. Due to the presence of significant toxicity in some of the samples that may or may not be attributable to urban contributions of pyrethroids, the recommendation to mitigate urban contributions of pyrethroids in the three sampled watersheds is to continue to target pesticide use in the Ventura Countywide Stormwater Management Program's (Program) education and outreach campaigns. The agricultural contributions are not under the jurisdiction of the Program and would need to be addressed through other avenues.

No trends are apparent over the Permit term, however the impact of the Thomas Fire (over 281,000 acres burnt in December 2017 and January 2018, including much of the Ventura and Santa Clara River watersheds) and the heavy rains and sediment loads following the fire may have affected the composition of the samples in 2018.

INTRODUCTION

Pyrethroid insecticide monitoring of sediments is required by Monitoring Program No. CI 7388, as part of the Ventura County Municipal Separate Storm Sewer System National Pollutant Discharge Elimination System Permit, Order No. R4-2010-0108 (Permit). The Permit specifies that the Principal Permittee (Ventura County Watershed Protection District (District)) shall perform a Pyrethroid Insecticides Study (Study) to accomplish the following objectives:

i. Establish baseline data for major watersheds;
ii. Evaluate whether pyrethroid insecticide concentrations are at or approaching levels known to be toxic to sediment-dwelling aquatic organisms;
iii. Determine if pyrethroids discovered are from urban sources; and
iv. Assess any trends over the permit term.

The first round of sediment monitoring for the Study was conducted in April 2012 by the District at two locations in both the Ventura River and Santa Clara River watersheds. Data from the Calleguas Creek Watershed (CCW) Toxicity Total Maximum Daily Load (TMDL) monitoring program was used to meet the requirements for that watershed, as allowed by the Permit. However, the 2012 TMDL data were unavailable in time for the 2012 report, so 2008-2010 data were included in that report and the 2011 and 2012 data were included in the 2015 report. Two sites in the Calleguas Creek Watershed were added to the District monitoring in 2015 to increase comparability and avoid issues with different detection levels, sampling strategies, and reporting cycles between the TMDL and this Study. Therefore, only TMDL data from 2012 is included in these reports. The second and third rounds of the Study were conducted in April 2015 and May 2018, respectively, by the District at two sites each in the Ventura River, Santa Clara River, and Calleguas Creek watersheds.

The samples were analyzed for total organic carbon (TOC) and eight specific pyrethroid pesticides required by the Permit (bifenthrin, cyfluthrin, cypermethrin, deltamethrin (co-elutes with tralomethrin, which is listed in the Permit if the laboratory is capable of analyzing for it), esfenvalerate (co-elutes with the non-required fenvalerate), lambda-cyhalothrin, and permethrin, as well as several pyrethroid and non-pyrethroid pesticides that are not required by the permit but are standard outputs of the analytical method. All sediment samples were tested for toxicity through a 10-day survival bioassay using 7–10-day old *Hyalella azteca*.

Hypothetical toxicity units (TU_H) were calculated to compare the expected relative toxicity of different samples and pyrethroids. TU_H are calculated by normalizing the sediment pyrethroid concentrations to TOC concentration (to account for hydrophobicity) and then dividing by the *Hyalella azteca* 10-day median lethal concentration (LC50[1]) for each detected pyrethroid, if available. TU_H cannot be calculated for detected analytes without LC50s in the reference documents (e.g. non-pyrethroids such as pendimethalin and dichloran) or for analytes that may be present at levels below the method detection limit (i.e. non-

[1] LC50 is the lethal concentration required to kill 50% of the population.

detects), so their hypothetical contributions to toxicity are unknown. Pollutants other than those analyzed may also be contributing to toxicity, however this study was focused on pyrethroid pollutants.

In 2012, two pyrethroids were detected in the Study samples: bifenthrin (three sites) and permethrin (one site); and one pyrethroid (bifenthrin) was detected in the TMDL samples (two sites). All TU_H were less than one indicating the samples were non-toxic. This was supported by the lack of toxicity seen in the analysis of the sediment samples, except for the two TMDL sites, which had significant toxicity. Two non-pyrethroid pesticides were also detected in the Study samples: pendimethalin (two sites) and dichloran (one site) but were not tested in the TMDL.

In 2015, two of the eight Permit-required pyrethroid pesticides were detected: bifenthrin (three sites) and permethrin (one site). One non-required pyrethroid (fenpropathrin at one site) and two non-pyrethroid pesticides (dichloran at one site and pendimethalin at three sites) were also detected. All TU_H were less than one except for bifenthrin in the CC Down duplicate, however there was not significant toxicity in the measured sample. Some toxicity was observed in 2015 at SCR Up and VR Down. None of the Permit required pyrethroids were detected at SCR up. Bifenthrin was detected in VR Down, however other sites with higher concentrations exhibited no toxicity, and the calculated hypothetical toxicity for VR Down based on the bifenthrin concentration was not toxic.

In 2018, the third round of the study was conducted and pyrethroids were not detected in any of the Study samples. One non-pyrethroid pesticide (Dichloran) was detected at one site. Significant toxicity was not observed in any of the 2018 samples.

Ventura County has been subjected to increased environmental stresses in recent years. In addition to the ongoing severe drought, the Ventura River and Santa Clara River watersheds were heavily impacted by the Thomas Fire, which started on December 4, 2017 and continued through January 9, 2018, burning over 281,000 acres to become the largest fire recorded in California history at that time. The fire burned most of the open space and forest lands in the Ventura River Watershed and a significant amount of open space in the Santa Clara River Watershed, as well as orchards, homes, and other structures from Fillmore to Santa Barbara. Areas that did not burn (especially within the Ojai Valley) were still subject to heavy ash deposition.

The first storm of the 2017/18 wet season occurred in January 2018 and the heavy rain on the burned area resulted in higher than typical runoff and sediment loads, which took many weeks to settle out. Most of the rain for the 2017/18 wet season fell during March, when a series of large storms moved through the area, again increasing runoff and sediment loads. Samples for the 2018 Study were collected in May.

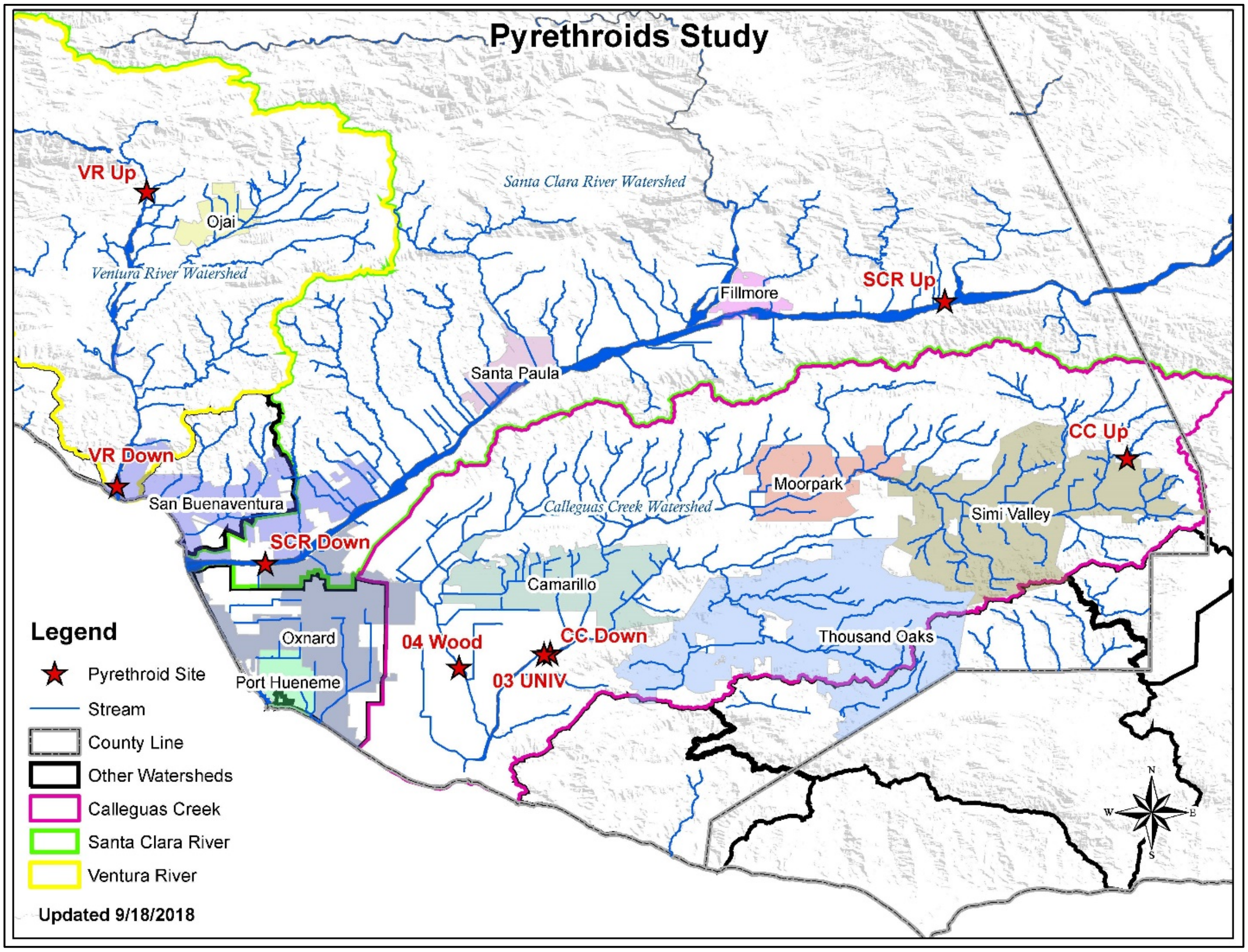
METHOD

The Permit specifies that monitoring is to be conducted every three years for the duration of the Permit (i.e. 2012, 2015, 2018, etc.), after sediment has settled within the water body and safe access can be assured. In-stream sediment samples for chemical analysis and toxicity testing were collected using stainless steel scoops according to methods developed by the USGS and outlined in *Guidelines for Collecting and Processing Samples of Stream Bed Sediment for Analysis of Trace Elements and Organic Contaminants for the National Water Quality Assessment Program (1994)*. When possible, sediment sampling stations encompassed a section of the reach approximately 100 meters in length upstream from water-column sampling stations, but this varied depending on site conditions. Five to ten wadeable depositional zones (low energy areas where fine-grained particles can accumulate) within the reach were targeted (when possible) to obtain a sample representative of the site.

Two sites, an upstream site and a downstream site, were selected on the main stem in the Ventura River, Santa Clara River, and Calleguas Creek watersheds (Figure 1). The upstream site was located higher in the watershed to reduce the influence of urban sources and the downstream site was located low in the watershed to include urban contributions. It was not possible in all cases to exclude upstream sources of agriculture and/or urban runoff, including some sources outside of Ventura County. For the Ventura River watershed, the upstream site (VR Up) is on the Ventura River above the Casitas Municipal Water District’s diversion structure near the north end of Rice Road in Meiners Oaks. The downstream site (VR Down) is on the Ventura River near the Main Street Bridge in Ventura. For the Santa Clara River watershed, the upstream site (SCR Up) is on the Santa Clara River east of Torrey Road near the Los Angeles/Ventura County Line and the downstream site (SCR Down) is on the Santa Clara River near the Victoria Avenue Bridge in Ventura. For the Calleguas Creek watershed, the upstream site (CC Up) is in Las Llajas Canyon above Las Llajas Dam, north of Simi Valley, and the downstream site (CC Down) is on Calleguas Creek at the Camarillo Street (formerly University Drive) Bridge. Factors such as safety, ease of entry, upstream land use, hydrology, and long-term accessibility (including landowner permission) were considered in site selection.

For the first round of the Study (2012), two sites from the Calleguas Creek Watershed (CCW) Toxicity Total Maximum Daily Load (TMDL) monitoring program were used to meet the requirements for that watershed, as allowed by the Permit. The TMDL sites were 03_UNIV (UNIV) – co-located with CC Down, and 04_WOOD (WOOD) – Revolon Slough at Wood Road. To increase comparability between samples, watersheds, and years, and eliminate differences between the Study and the TMDL (e.g. detection levels, sampling strategies, collection methods, reporting cycles, etc.), the TMDL sites were replaced with CC Up and CC Down beginning in 2015.

Figure 1. Pyrethroid Sampling Locations



As described in the Ventura County MS4 Pyrethroid Insecticides Monitoring Quality Assurance Project Plan (QAPP), the top layer (~1 cm) of the most recently deposited sediment was collected with a pre-cleaned stainless-steel scoop as specified in the Permit. The quantity of sediment required for the tests precluded sampling directly into glass jars, so the sediment was deposited in a 24" by 36" 2mm polyethylene bag per site. The bag was closed and the sediment was manually homogenized onsite by squeezing and rotating the bag. Homogenized sediment was placed in two 8 oz wide-mouth glass jars and placed on ice for TOC and pyrethroid analysis. The jars were placed in the freezer at the end of the sampling day for pickup by the chemistry lab courier the following day. The remaining sediment (~ 3 liters) was double- bagged and kept on ice until delivered to the toxicity laboratory.

All sediment samples were analyzed for total organic carbon (TOC) by EPA 9060, pyrethroids by GC/MS NCI-SIM, and toxicity to 7—10-day old *Hyalella azteca*, as described in *Aquatic Toxicity Due to Residential use of Pyrethroid Insecticides*[2]. Water quality field measurements were taken with hand-held probes.

[2] *Aquatic Toxicity Due to Residential Use of Pyrethroid Insecticides*; Weston, D., Holmes, R., You, J., Lydy, M.J (2005). Environ. Sci. Technol.; (Article); 2005; 39(24); 9780 pp.

The stainless-steel trowels used for the Study were cleaned prior to sample collection with Alconox laboratory detergent and tap water, rinsed with distilled water, and air dried. They were then sealed in Ziploc bags until arrival at the site. An equipment blank was collected by the laboratory from one clean, unused stainless-steel trowel by rinsing it with one liter of laboratory grade de-ionized water and analyzing the rinsate for TOC by SM 5310C and pyrethroids by GC/MS NCI-SIM.

RESULTS

Study Equipment Blanks

The 2018 equipment blank analysis detected a small amount of TOC and a detected not quantifiable (DNQ) amount of the pyrethroids bifenthrin and cypermethrin (Table 1). These amounts are similar to those seen in equipment blank samples in previous years of the Study (Table 2) and are insignificant in relation to expected environmental concentrations so a second equipment blank was not submitted for 2018. Several non-pyrethroid constituents were also analyzed by this method but were not detected.

Table 1. Equipment Blank Results 2018

Analyte	2018 Trowel Blank (µg/L, MDL varies)
Allethrin	ND (<0.00085)
Bifenthrin	**0.00085 (DNQ)**
Cyfluthrin	ND (<0.00083)
Cypermethrin	**0.00087 (DNQ)**
Deltamethrin/Tralomethrin	ND (<0.0019)
Dichloran	ND (<0.00080)
Esfenvalerate	ND (<0.00098)
Fenpropathrin (Danitol)	ND (<0.0020)
Fenvalerate	ND (<0.00098)
L-Cyhalothrin	ND (<0.0012)
Pendimethalin	ND (<0.00050)
Permethrin	ND (<0.0050)
Prallethrin	ND (<0.00092)
Sumithrin	ND (<0.0024)
Tefluthrin	ND (<0.00093)
TOC	**0.23 mg/L**

Analyte listed in Permit
Detections
ND = Not Detected
DNQ = Detected Not Quantified

Table 2. Equipment Blank Results 2012 - 2015

Analyte	2015 Initial Trowel Blank (µg/L, MDL varies)	2015 2nd Trowel Blank (µg/L, MDL varies)	2012 Initial Trowel Blank (µg/L, MDL varies)	2012 2nd Trowel Blank (µg/L, MDL varies)
Allethrin	ND (<0.00085)	ND (<0.00085)	ND (<0.00085)	ND (<0.00085)
Bifenthrin	**0.0026**	**0.00091 (DNQ)**	**0.0041**	ND (<0.00079)
Cyfluthrin	ND (<0.00083)	ND (<0.00083)	ND (<0.00083)	ND (<0.00083)
Cypermethrin	ND (<0.00066)	ND (<0.00066)	**0.0026**	ND (<0.00066)
Deltamethrin/Tralomethrin	ND (<0.0019)	ND (<0.0019)	ND (<0.0019)	ND (<0.0019)
Dichloran	ND (<0.00080)	ND (<0.00080)	ND (<0.00080)	ND (<0.00080)
Esfenvalerate	ND (<0.00098)	ND (<0.00098)	ND (<0.00098)	ND (<0.00098)
Fenpropathrin (Danitol)	ND (<0.0020)	ND (<0.0020)		
Fenvalerate	ND (<0.00098)	ND (<0.00098)	ND (<0.00098)	ND (<0.00098)
L-Cyhalothrin	ND (<0.0012)	ND (<0.0012)	ND (<0.0012)	ND (<0.0012)
Pendimethalin	ND (<0.00050)	ND (<0.00050)	**0.0025**	ND (<0.00050)
Permethrin	ND (<0.0050)	ND (<0.0050)	ND (<0.0050)	ND (<0.0050)
Prallethrin	ND (<0.00092)	ND (<0.00092)	ND (<0.00092)	ND (<0.00092)
Sumithrin	ND (<0.0024)	ND (<0.0024)	ND (<0.0024)	ND (<0.0024)
Tefluthrin	ND (<0.00093)	ND (<0.00093)	ND (<0.00093)	ND (<0.00093)
TOC	**0.18 mg/L (DNQ)**	**0.23 mg (DNQ)**	**0.17 mg/L (DNQ)**	N/A

Analyte listed in Permit
Detections
ND = Not Detected
DNQ = Detected Not Quantified

2018 Study

The 2017/18 water year started out very dry, with the first storm of the season occurring in January 2018, followed by a series of storms in March 2018 that dropped 4 – 8 inches of rain across the county. Sampling was conducted on May 8 and 9, 2018, approximately 6 weeks after the March storms. VR Up (Figure 2), VR Down (Figure 3), SCR Up (Figure 4), and CC Down (Figure 7) were flowing, however SCR Down (Figure 5) was damp with small remnant ponds and CC Up (Figure 6) was dry (although there were some sediment deposits from earlier flows).

Figure 2. VR Up

Figure 3. VR Down

Figure 4. SCR Up

Figure 5. SCR Down

Figure 6. CC Up

Figure 7. CC Down

No pyrethroids were detected in the 2018 sediment samples, including the eight pyrethroids specified by the Permit for analysis (bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, l-cyhalothrin, permethrin, and tralomethrin). Dichloran, a non-pyrethroid pesticide, was detected at one site (SCR Down). A field duplicate sample was collected at VR Down and the results agreed with the original sample, with no pyrethroid detections and TOC within allowed limits for relative percent difference.

All samples were subjected to a 10-day survival and growth sediment bioassay using *Hyalella azteca*. The laboratory inadvertently discarded the organisms before collecting the growth data at the end of the initial test period, so the samples were set up and run a second time within hold time for both growth and survival. All samples were non-toxic for both tests, and all samples outperformed the control in measurements of growth.

TOC amounts ranged from 1.43 g/kg in the upstream Calleguas Creek sample (CC Up 2018) to 31.4 g/kg in the downstream Ventura River field duplicate (VR Down 2018 Dup) and this range is similar to previous years, although it varies between sites.

2012-2018 Combined Results

Data from the Calleguas Creek Watershed (CCW) Toxicity Total Maximum Daily Load (TMDL) monitoring program was used to meet the requirements for that watershed in 2012, as allowed by the Permit. However, TMDL site 04_WOOD (WOOD) is not co-located with CC Up, and although TMDL site 03_UNIV (UNIV) is co-located with CC Down, the sample collection methods and protocols for the TMDL are different to this Study. To increase comparability between samples and watersheds, two sites in the Calleguas Creek Watershed were added in 2015 to avoid issues with different detection levels, sampling strategies, and reporting cycles. TMDL data (except for 2012) is not included in this report.

The 2012-2018 laboratory results are grouped by watershed in Table 3, Table 4, and Table 5. Pyrethroids that were detected during the three Study periods (2012, 2015, and 2018) are also grouped by watershed and shown in Figure 8, Figure 9, and Figure 10. Similarly, detected non-pyrethroids for the same period are shown in Figure 11 and Figure 12 (non-pyrethroid pesticides were not detected in any of the Study samples from the Ventura River Watershed, therefore a chart for this data is not included in this report.)

Three pyrethroids were detected during the Study, bifenthrin and permethrin, which were required analytes in the Permit, and fenpropathrin (danitol) which was not required by the Permit but was included in the analytical method. Two non-pyrethroid pesticides, dichloran and pendimethalin, were also detected but were not required by the Permit. These non-pyrethroid analytes were not part of the TMDL analytical method so data is not available for the 2012 TMDL sites.

Table 3. Laboratory Results 2012-2018 – Calleguas Creek Watershed

Analyte	**WOOD**	**CC Up**		**UNIV (co-located with CC Down)**		**CC Down**			**Units**
	2012	**2015**	**2018**	**2012**	**2012 Dup**	**2015**	**2015 Dup**	**2018**	
Allethrin	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
Bifenthrin	2.7	<0.93	<0.85	1^	0.9^	3.3	5.9	<0.93	ng/g
Cyfluthrin	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
Cypermethrin	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
Deltamethrin	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
Dichloran	NS	<0.93	<0.85	NS	NS	<0.93	<0.92	<0.93	ng/g
Esfenvalerate	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
Fenpropathrin (Danitol)	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
Fenvalerate	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
L-Cyhalothrin	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
Pendimethalin	NS	<0.93	<0.85	NS	NS	3.8	2.5	<0.93	ng/g
Permethrin	<5	<0.93	<0.85	<5	<5	3.3	5.4	<0.93	ng/g
Prallethrin	<0.5	<0.93	<0.85	<0.5	<0.5	<0.93	<0.92	<0.93	ng/g
Sumithrin	NS	<0.93	<0.85	NS	NS	<0.93	<0.92	<0.93	ng/g
Tefluthrin	NS	<0.93	<0.85	NS	NS	<0.93	<0.92	<0.93	ng/g
Tralomethrin	NS	<0.93	<0.85	NS	NS	<0.93	<0.92	<0.93	ng/g
TOC	5.6	12.2	1.43	4.4	3.3	12.3	8.27	7.01	g/kg
Toxicity to *H. azteca*, Survival	66.3 SG	95.0	100 100*	75.0 SG	NS	82.5	87.5	95 100*	% Survival
Toxicity to *H. azteca*, Mortality	33.7 SG	5.0	0 0*	25.0 SG	NS	17.5	12.5	5.0 0*	% Mortality
Toxicity to *H. azteca*, Growth	69.4 SG	-565	-304	-7.71	NS	-216	-161	-189	% Effect

TMDL = Samples collected at TMDL sites using TMDL methods. Only applicable to 2012 results.

Analyte listed in Permit

Detected

< Not detected at method detection limit

Dup = Duplicate

^ Detected not quantified

NS = Not sampled

* Samples re-run to include growth

SG = Significant effect compared to control

- Sample performed better than control

Table 4. Laboratory Results 2012-2018 – Santa Clara River Watershed

Analyte	SCR Up			SCR Down			Units
	2012	2015	2018	2012	2015	2018	
Allethrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Bifenthrin	0.78	<0.92	<0.88	0.74	2.6	<0.93	ng/g
Cyfluthrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Cypermethrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Deltamethrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Dichloran	<0.5	<0.92	<0.88	0.54	1.1	2.1	ng/g
Esfenvalerate	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Fenpropathrin (Danitol)	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Fenvalerate	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
L-Cyhalothrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Pendimethalin	0.69	1.4	<0.88	5.4	8.8	<0.93	ng/g
Permethrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Prallethrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Sumithrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Tefluthrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
Tralomethrin	<0.5	<0.92	<0.88	<0.5	<0.94	<0.93	ng/g
TOC	5.4	17	13.3	11	11.4	14.6	g/kg
Toxicity to H. azteca, Survival	98.75	55.0 SG	95.0 100*	96.25	90.0	100 97.5*	% Survival
Toxicity to H. azteca, Mortality	1.25	45.0 SG	5.0 0*	3.75	10.0	0 2.50*	% Mortality
Toxicity to *H. azteca,* Growth	NS	58.06	-226.35	NS	-387.10	-292.00	% Effect

Analyte listed in Permit

Detected

< Not detected at method detection limit

NS = Not sampled

* Samples re-run to include growth

SG = Significant effect compared to control

- Sample performed better than control

Table 5. Laboratory Results 2012-2018 – Ventura River Watershed

Analyte	**VR Up**			**VR Down**				**Units**
	2012	**2015**	**2018**	**2012**	**2015**	**2018**	**2018 Dup**	
Allethrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Bifenthrin	<0.5	<0.83	<0.90	1.2	2.8	<0.99	<0.93	ng/g
Cyfluthrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Cypermethrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Deltamethrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Dichloran	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Esfenvalerate	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Fenpropathrin (Danitol)	<0.5	<0.83	<0.90	<0.5	1.4	<0.99	<0.93	ng/g
Fenvalerate	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
L-Cyhalothrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Pendimethalin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Permethrin	5.3	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Prallethrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Sumithrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Tefluthrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
Tralomethrin	<0.5	<0.83	<0.90	<0.5	<0.82	<0.99	<0.93	ng/g
TOC	22	33.8	13	26	18.8	27.1	31.4	g/kg
Toxicity to H. azteca, Survival	83.75	95.0	100 100*	88.75	20.0 SG	97.5 97.5*	NS	% Survival
Toxicity to H. azteca, Mortality	16.25	5.0	0 0*	11.25	80.0 SG	2.5 2.5*	NS	% Mortality
Toxicity to *H. azteca,* Growth	NS	5.00	-147.58	NS	54.84	-162.08	NS	% Effect

Analyte listed in Permit
< Not detected at method detection limit
* Samples re-run to include growth
- Sample performed better than control

Detected
Dup = Duplicate
NS = Not sampled
SG = Significant effect compared to control

Figure 8. 2012-2018 Detected Pyrethroids - Calleguas Creek Watershed

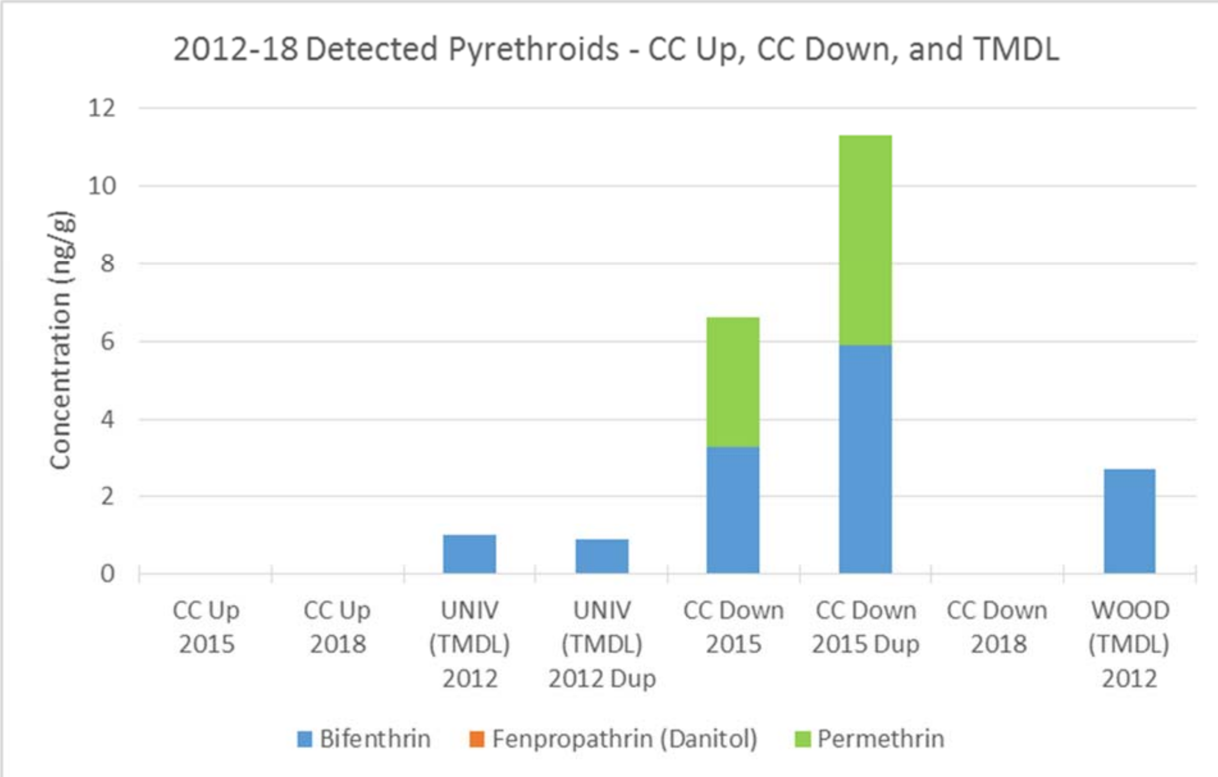


Figure 9. 2012-2018 Detected Pyrethroids - Santa Clara River Watershed

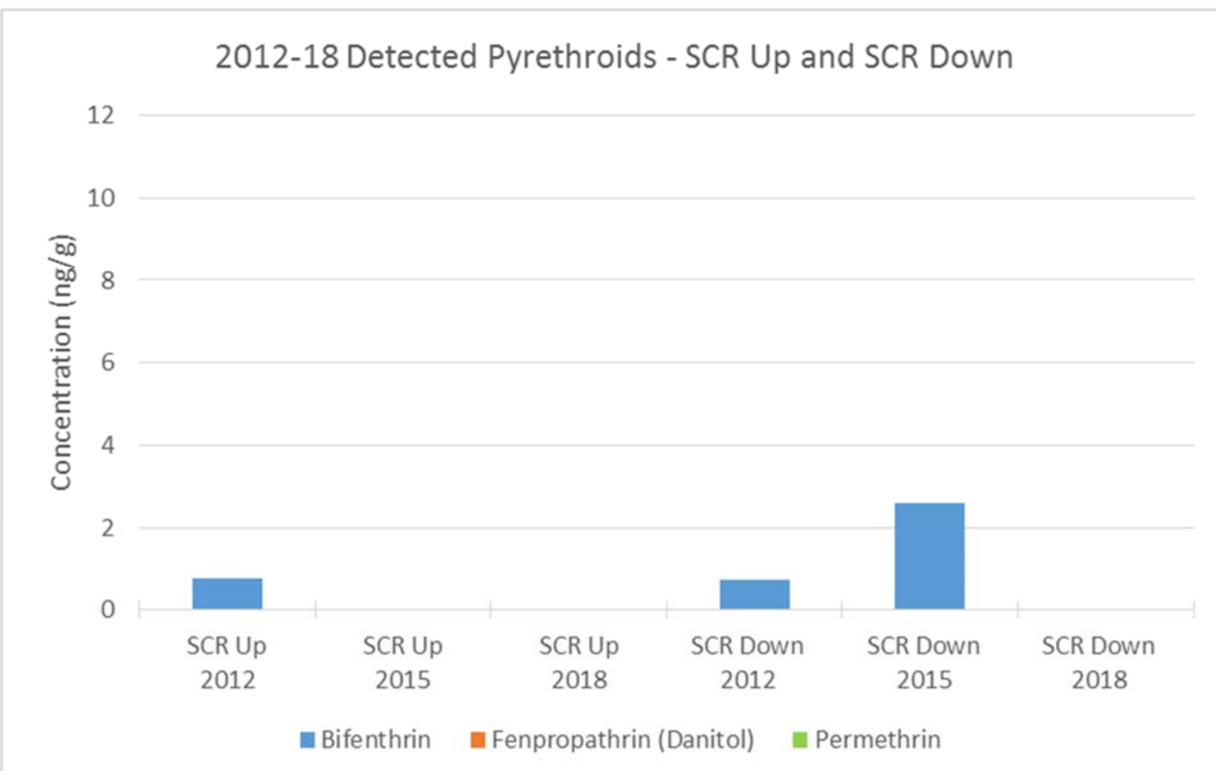


Figure 10. 2012-2018 Detected Pyrethroids - Ventura River Watershed

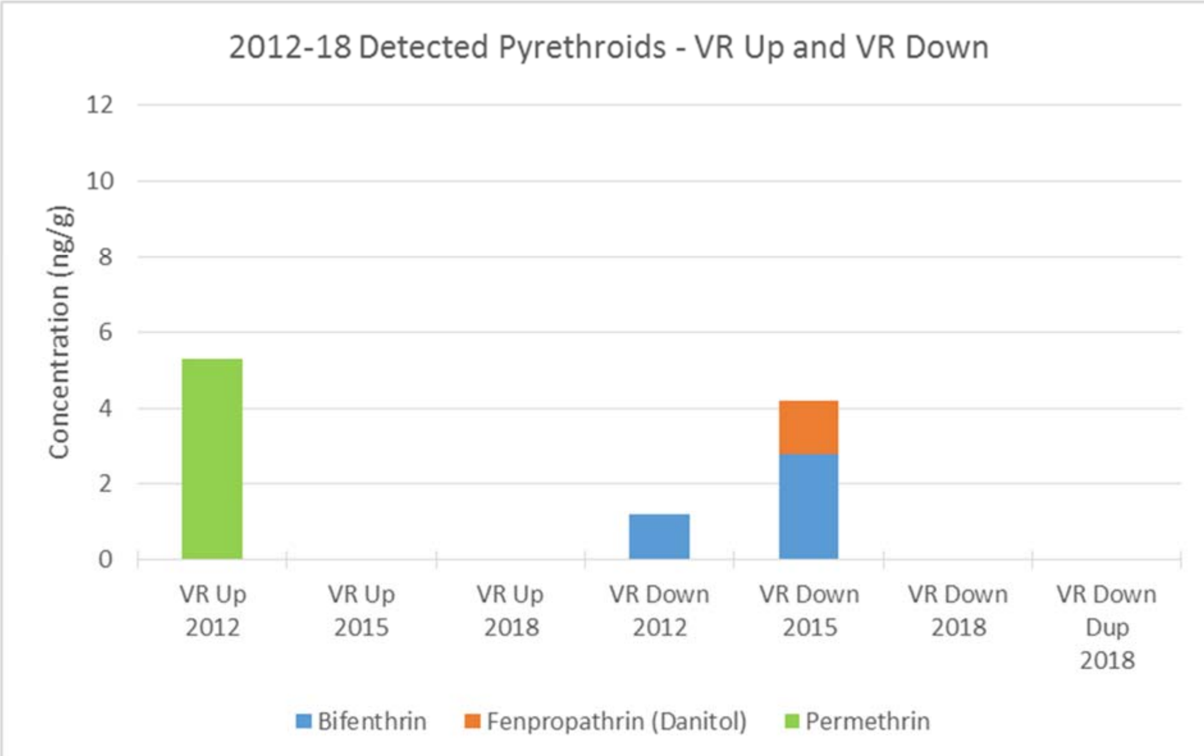


Figure 11. 2012-2018 Detected Non-Pyrethroid Pesticides - Calleguas Creek Watershed

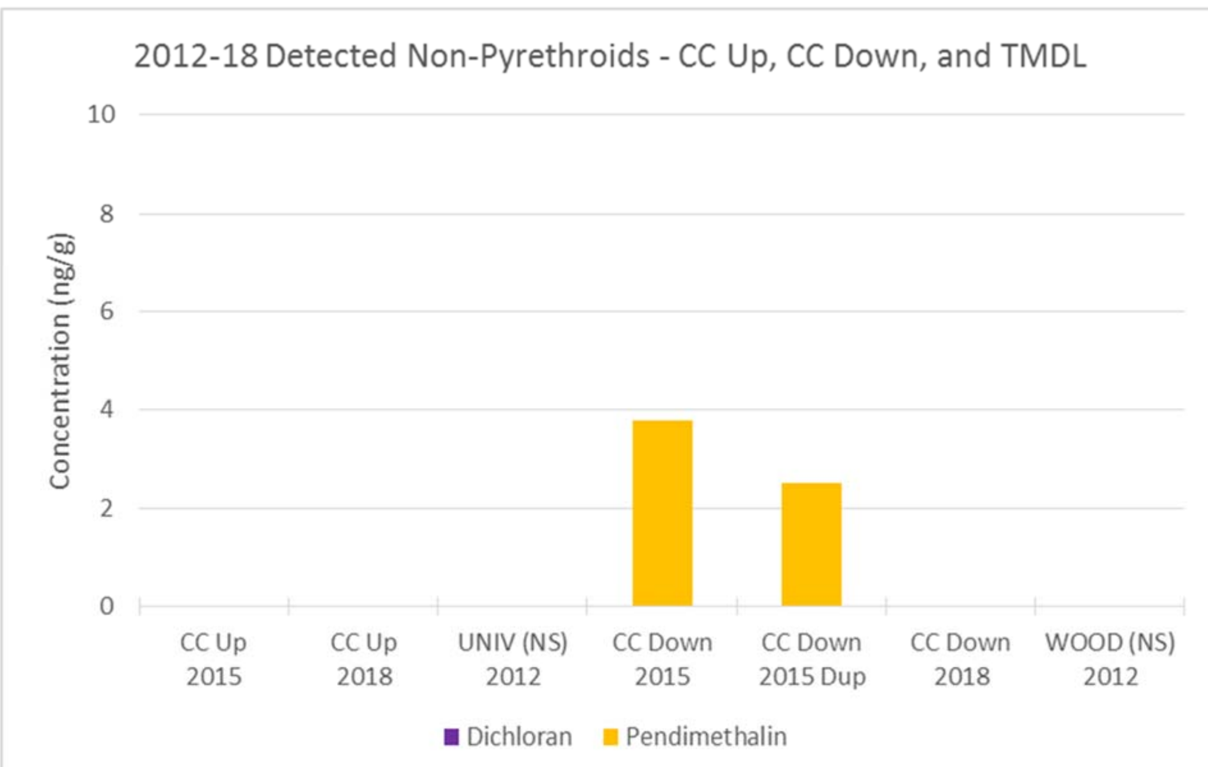
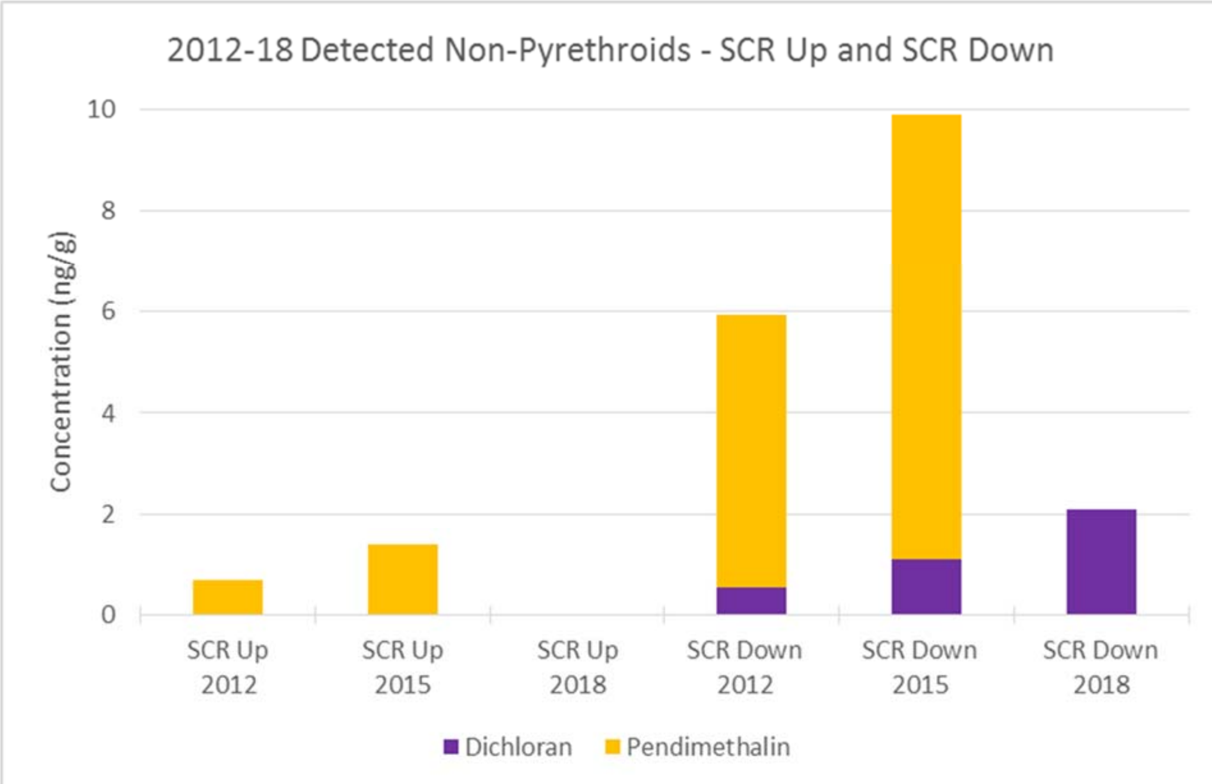


Figure 12. 2012-2018 Detected Non-Pyrethroid Pesticides - Santa Clara River Watershed



Non-pyrethroids were not detected at VR Up or VR Down.

DISCUSSION OF RESULTS

The 2017/18 water year started out very dry, with the first storm of the season occurring in January 2018, followed by a series of storms in March 2018 that dropped 4 – 8 inches of rain across the county. Sampling was conducted on May 8 and 9, 2018, approximately 6 weeks after the March storms. VR Up, VR Down, SCR Up, and CC Down were flowing, however SCR Down was damp with small remnant ponds and CC Up was dry (although there were some sediment deposits from earlier flows)

Equipment Blank

The source of the detected but not quantified (DNQ) amounts of bifenthrin and cypermethrin in the Study's 2018 equipment blank is unknown, but the amounts are similar to those seen in equipment blank samples in previous years of the study, including 2012 when the trowels were new. The laboratory QC was within limits for the equipment blank batches, i.e. bifenthrin and cypermethrin were not detected above the reporting limit of 0.0020 µg/L in the laboratory method blank, and the laboratory control samples and duplicates were all within acceptance limits. The trowels were washed twice since they were last used, once with Citranox after the 2015 sampling, and once with Alconox prior to the 2018 sampling. The source of the contamination is unknown but potential sources could be from air drying, during rinsate collection and/or during analysis at the laboratory. Alconox appears to have worked as well or better than Citranox for bifenthrin removal, and similarly or better than Citranox for cypermethrin removal. The equipment blank is collected by rinsing the trowel with one liter of laboratory grade deionized water and collecting the rinsate for analysis. One liter is used as it is the volume required for the analytical method and collecting extra for a potential re-analysis may dilute the sample, so a replicate is not feasible. The trowels did not contaminate the environmental samples as pyrethroids were not detected at all 2018 sites.

A detectable amount of TOC was measured in the equipment blank at 0.23 mg/L, which is above the reporting limit of 0.10 mg/L. A small DNQ amount of TOC was seen in the method blank (0.0182 mg/L) but these amounts are significantly less than seen in the environmental samples (≥ 1.43 g/kg, equal to 1430 mg/kg) so is not considered to be enough to significantly impact the sediment results (i.e. TOC measured in the equipment blank was at least four orders of magnitude below the environmental samples).

Toxicity

Toxicity levels vary between pyrethroids. Hypothetical toxicity units (TU_H) can be calculated to compare the expected relative toxicity of different samples and pyrethroids. This is done by normalizing the sediment pyrethroid concentrations to TOC concentration to account for hydrophobicity (Table 6 and Figure 13) and then dividing by the *Hyalella azteca* ten day median lethal concentration (LC50[3]) for each detected pyrethroid, if available (Table 7). LC50s for the detected analytes bifenthrin and permethrin were obtained from the study referenced in the Permit, "Aquatic Toxicity Due to Residential Use of Pyrethroid Insecticides (2005) by Weston *et al*. The Study did not include an LC50 for the pyrethroid fenpropathrin

[3] LC50 is the lethal concentration required to kill 50% of the population.

or the non-pyrethroids dichloran and pendimethalin. To complete this Pyrethroid Study, an LC50 for fenpropathrin was obtained from the Los Angeles Regional Water Quality Control Boards study, "Occurrence and Toxicity of Three Classes of Insecticides in Water and Sediment in Two Southern California Coastal Watersheds (2011) by Delgado-Moreno et al. The overall hypothetical pyrethroid toxicity of a sample can be calculated by summing all the pyrethroid TU_H for that sample. TU_H greater than one indicates significant hypothetical toxicity. The non-pyrethroids were also normalized to TOC (Table 6 and Figure 13) but TU_H were not calculated since they are not pyrethroids and do not have LC50s in the Permit-referenced study.

Table 6. Detected Analytes Normalized to TOC – By Watershed

Calleguas Creek Watershed

Analyte	WOOD	CC Up		UNIV (co-located with CC Down)		CC Down			Units
	2012	2015	2018	2012	2012 Dup	2015	2015 Dup	2018	
Bifenthrin	0.48			0.23^	0.27^	0.27	0.71		ng/g
Pendimethalin	NS			NS	NS	0.31	0.30		ng/g
Permethrin						0.27	0.65		ng/g
TOC	5.6	12.2	1.43	4.4	3.3	12.3	8.27	7.01	g/kg

^ DNQ

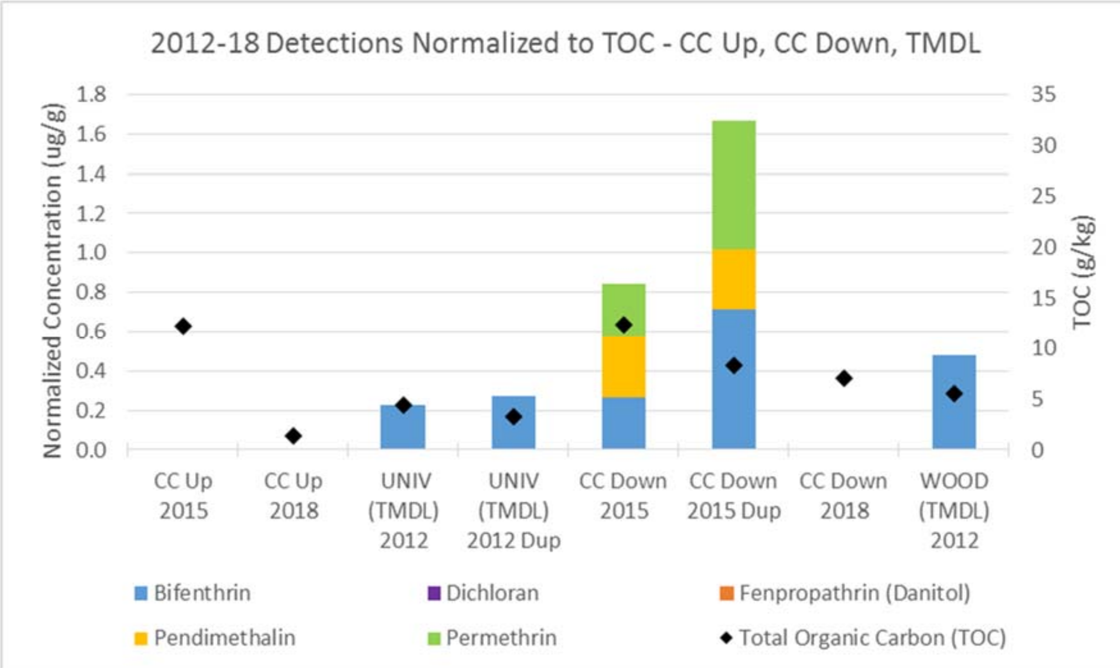
Santa Clara River Watershed

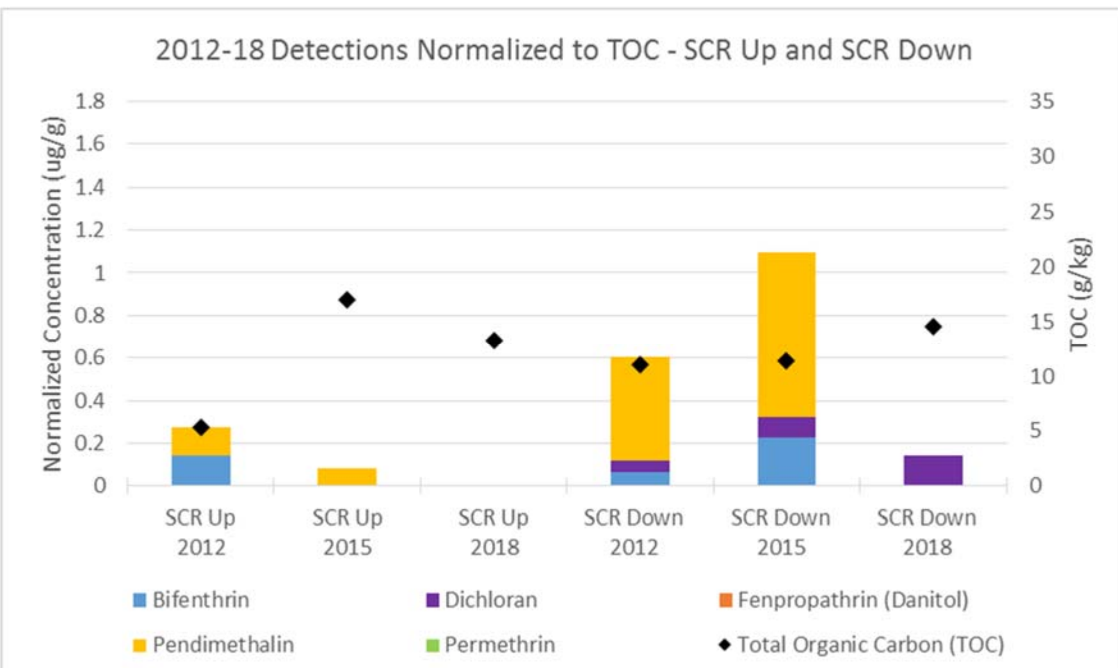
Analyte	SCR Up			SCR Down			Units
	2012	2015	2018	2012	2015	2018	
Bifenthrin	0.14			0.07	0.23		ng/g
Dichloran				0.05	0.10	0.14	ng/g
Pendimethalin	0.13	0.08		0.49	0.77		ng/g
TOC	5.4	17	13.3	11	11.4	14.6	g/kg

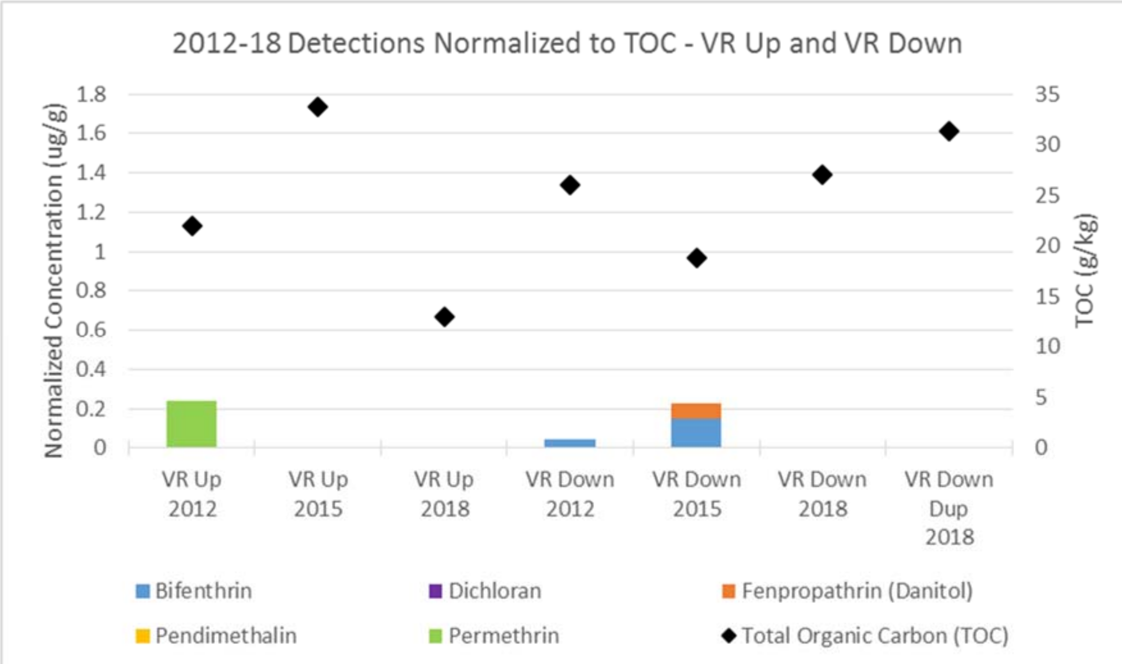
Ventura River Watershed

Analyte	VR Up			VR Down				Units
	2012	2015	2018	2012	2015	2018	2018 Dup	
Bifenthrin				0.05	0.15			ng/g
Fenpropathrin (Danitol)					0.07			ng/g
Permethrin	0.24							ng/g
TOC	22	33.8	13	26	18.8	27.1	31.4	g/kg

Figure 13. Detected Analytes Normalized to TOC – By Watershed







Dichloran, fenpropathrin, and pendimethalin not required by Permit. Dichloran and pendimethalin not analyzed for TMDL samples.

Table 7. Hypothetical Toxicity Units Vs. Observed Toxicity – By Watershed

Calleguas Creek Watershed									
Analyte	LC50 (ug/g TOC)	Units	WOOD	CC Up		UNIV	CC Down		
			2012	2015	2018	2012	2015	2015 Dup	2018
Bifenthrin	0.52	TU_H	0.927			0.437^	0.516	1.372	
Fenpropathrin (Danitol)	1.1	TU_H							
Permethrin	10.83	TU_H					0.025	0.060	
Summed Hypothetical TU_H		TU_H	0.927			0.437^	0.541	1.432	
Significant Observed Toxicity			Yes	No	No	Yes	No	No	No

^ DNQ

Santa Clara River Watershed								
Analyte	LC50 (ug/g TOC)	Units	SCR Up			SCR Down		
			2012	2015	2018	2012	2015	2018
Bifenthrin	0.52	TU_H	0.278			0.129	0.439	
Fenpropathrin (Danitol)	1.1	TU_H						
Permethrin	10.83	TU_H						
Summed Hypothetical TU_H		TU_H	0.278			0.129	0.439	
Significant Observed Toxicity			No	Yes	No	No	No	No

Ventura River Watershed								
Analyte	**LC50 (ug/g TOC)**	**Units**	**VR Up**			**VR Down**		
			2012	**2015**	**2018**	**2012**	**2015**	**2018**
Bifenthrin	0.52	TU_H				0.089	0.286	
Fenpropathrin (Danitol)	1.1	TU_H					0.068	
Permethrin	10.83	TU_H	0.022					
Summed Hypothetical TU_H		TU_H	0.022			0.089	0.354	
Significant Observed Toxicity			No	No	No	No	Yes	No

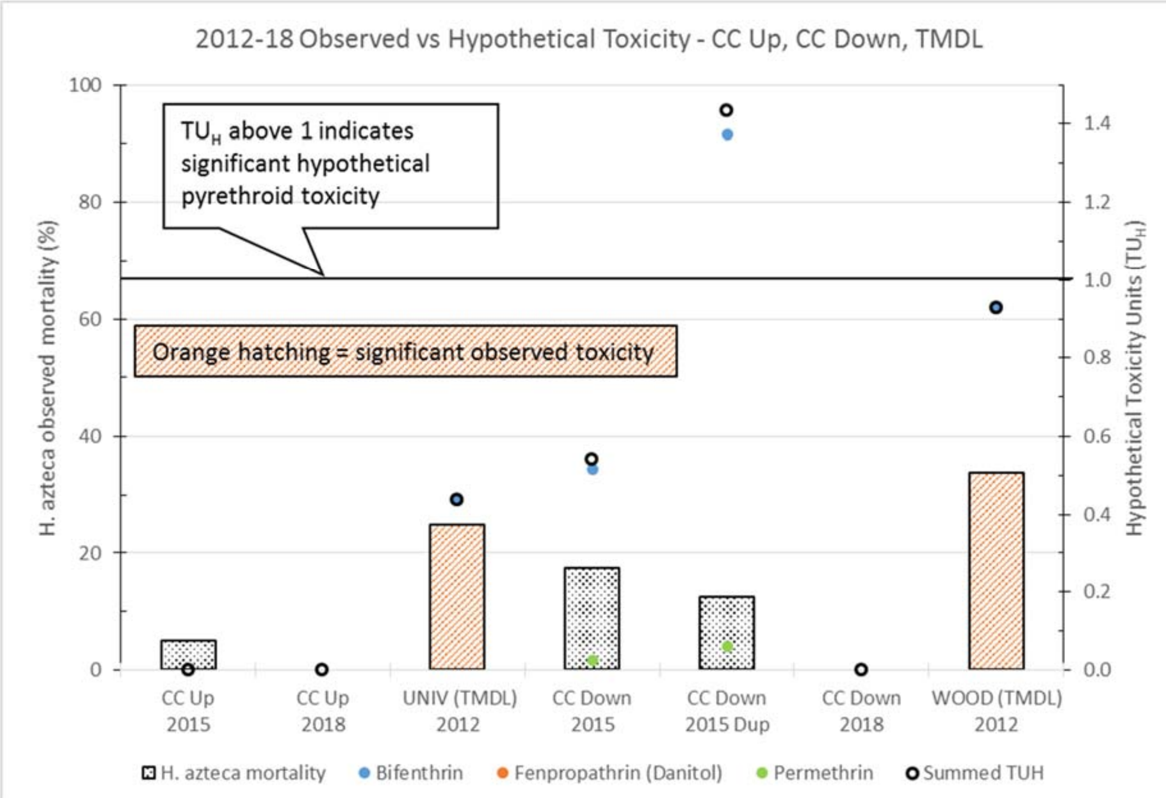
No pyrethroids were detected in the 2018 Study samples, so all TU_H for 2018 are equal to zero and toxicity due to pyrethroids is not expected. This was supported by the lack of toxicity observed in the sediment samples for both survival and growth.

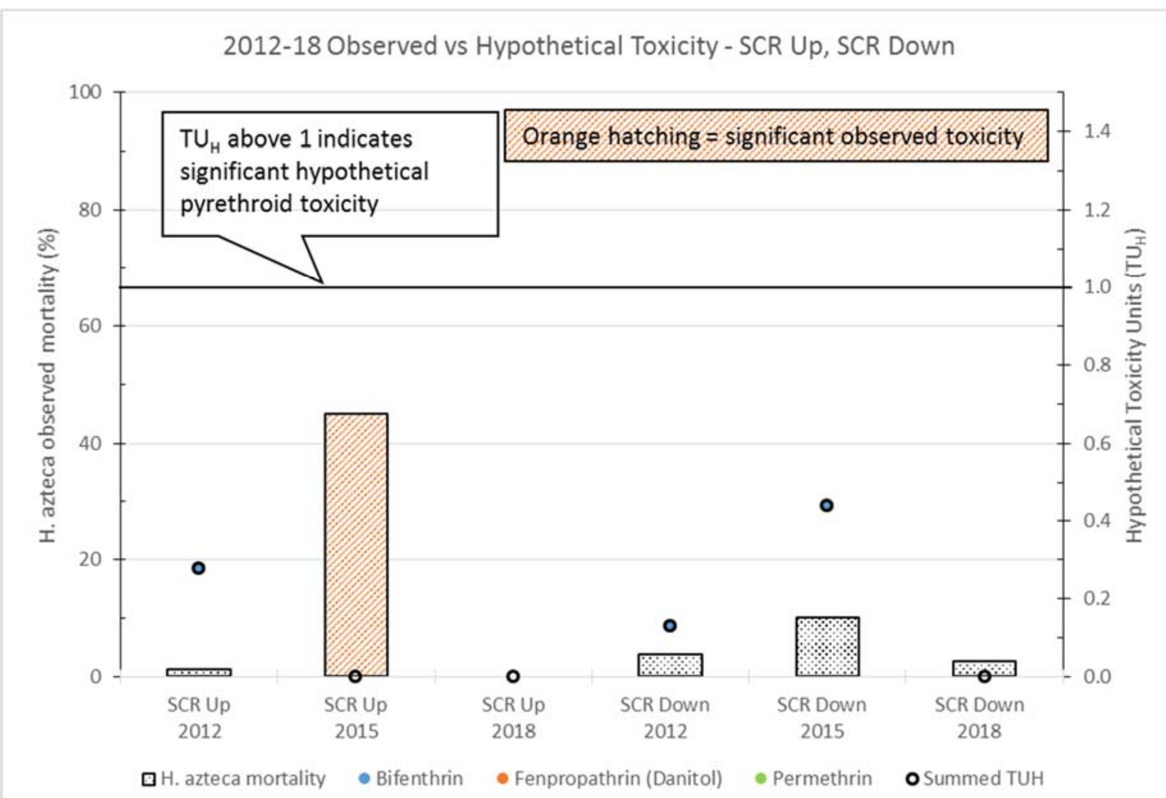
The 2012-2018 results are summarized by watershed in the figures below, showing their measured toxicity (% mortality) as compared to their hypothetical pyrethroid toxicity units. In some cases, e.g. UNIV (2012), SCR Up (2015), and VR Down (2015), significant toxicity was observed but the TU_H were low, in which case a different contaminant is likely the cause of the observed toxicity. At WOOD (2012), pyrethroids may have contributed to or been the cause of the toxicity observed in the sample, since the pyrethroid TU_H is close to 1. For CC Down Dup (2015), the TU_H were high but the observed toxicity was not, which may be due to other factors such as antagonistic effects with other components in the sample or subsample differences (e.g. differences in concentrations of TOC and pyrethroids). Subsample differences seem a likely cause since CC Down (2015) had a similar observed toxicity but a lower TU_H mostly due to higher TOC and lower bifenthrin concentrations.

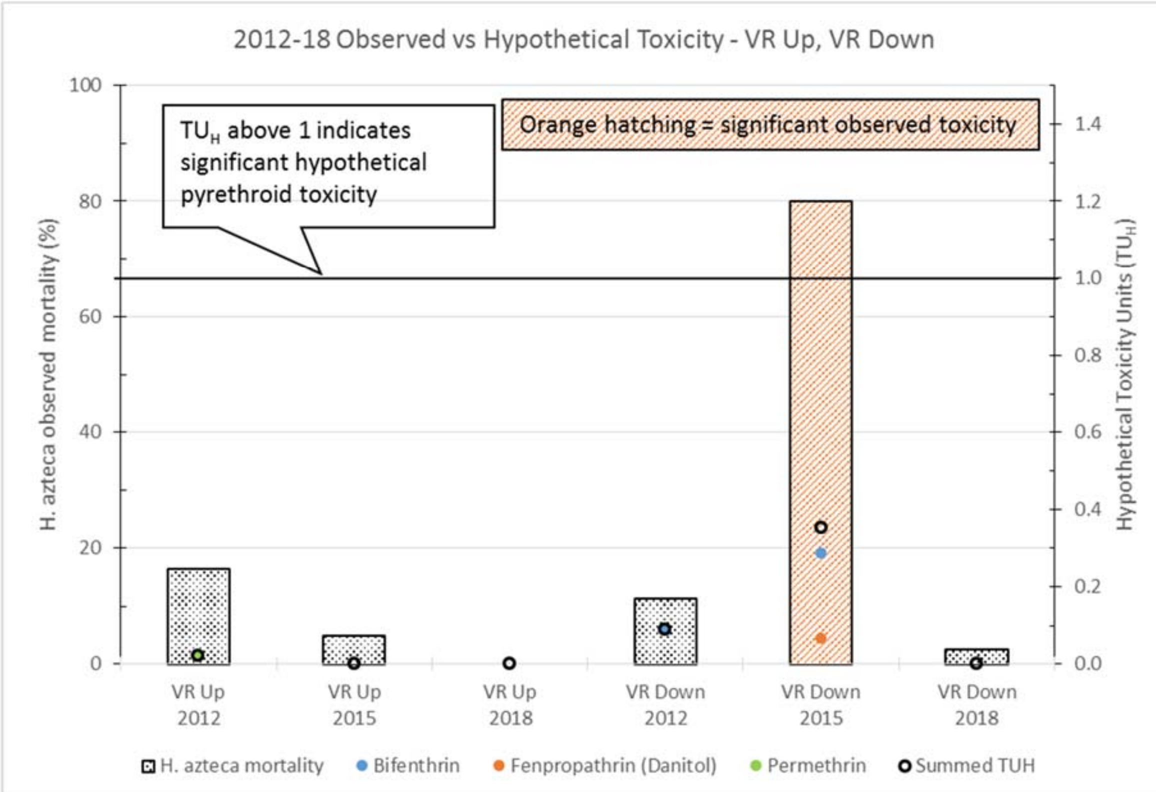
Except for the CC Down Dup (2015), the TU_H for the Study samples were all less than one (Table 7) and so pyrethroid toxicity is not expected to be an issue for these samples according to this evaluation method. For the CC Down Duplicate, even though the TU_H was greater than one, the measured toxicity units were not above one, which means that significant toxicity was not observed in the *H. azteca* test.

The study referenced in the Permit does not contain an LC50 for dichloran or pendimethalin, however the lack of toxicity in the environmental sample infers a TU_H of less than one for these analytes. The TU_H were not correlated with the observed toxicity, possibly due to the presence of unanalyzed constituents in the samples.

Figure 14. Hypothetical Toxicity Units Vs. Observed Toxicity – By Watershed







Pyrethroid pesticides were more prevalent in the downstream samples for most analytes/watersheds.

POTENTIAL PESTICIDE SOURCES

The application of pesticides for residential, industrial, and commercial use is not tracked, except for structural pest control by certified applicators. Many pesticides have both general use (lower concentrations and/or small areas) and restricted use (higher concentrations and/or large-scale applications) formulations. General use pesticides can be applied by anyone however restricted use pesticides applications require California Department of Pesticide Regulation (CDPR) Certified Pesticide Applicators.

The pounds of pesticides applied annually for agriculture and structural pest control is tracked by the CDPR. The *Annual Pesticide Use Report Indexed by Chemical* (PUR) for Ventura County summarizes the annual reported pesticide use for regulated applications, including agriculture (e.g. food and ornamental), structural pest control, and other purposes (e.g. animal premise, golf course turf, landscape maintenance, public health, regulatory pest control, rights of way, vertebrate control, etc.). These reports typically become available two years after the year referenced, so 2017 and 2018 were unavailable for this Study report. The pounds used for regulated uses of the detected pesticides in this Study are summarized in Table 8.

Table 8. Ventura County Pesticide Use (Pounds) Reported to California Department of Pesticide Regulation (DPR)

	2011					2012				
Pesticide	**Total Pounds**	**Agriculture**	**Structural**	**Other**	**Major crop - pounds**	**Total Pounds**	**Agriculture**	**Structural**	**Other**	**Major crop - pounds**
Bifenthrin	2771.79	1732.74	1005.79	33.26	Strawberry 1499	2911.63	1673.06	1211.49	27.08	Strawberry 1364
Permethrin	4742.67	3635.45	1059.45	47.77	Celery 2162	4625.02	2060.4	2515.73	48.89	Celery 873
Fenpropathrin (Danitol)**	969.21	969.21	0	0	Strawberry 849	788.71	788.08	0	0.63	Strawberry 595
Dichloran*,**	22733.97	22733.97	0	0	Celery 21916	15545.81	15545.81	0	0	Celery 14854
Pendimethalin*,**	2788.84	2627.32	0	161.52	Strawberry 2515	5983.35	5739.14	0	244.21	Strawberry 5140

	2013					2014				
Pesticide	**Total Pounds**	**Agriculture**	**Structural**	**Other**	**Major crop - pounds**	**Total Pounds**	**Agriculture**	**Structural**	**Other**	**Major crop - pounds**
Bifenthrin	3350.01	1635.33	1684.09	30.59	Strawberry 1253	4699.88	2453.05	2133.09	113.74	Strawberry 1413
Permethrin	4678.32	2408.77	2201.2	68.35	Celery 1142	3807.76	2755.71	933.95	118.1	Celery 945
Fenpropathrin (Danitol)**	1668.9	1668.9	0	0	Strawberry 1307	1820.92	1820.92	0	0	Strawberry 1215
Dichloran*,**	19557.51	19557.51	0	0	Celery 18984	19983.11	19983.11	0	0	Celery 19347
Pendimethalin*,**	11899.69	11862.37	0	37.32	Strawberry 10855	12617.4	12557.56	0	59.84	Strawberry 11255

	2015					2016				
Pesticide	**Total Pounds**	**Agriculture**	**Structural**	**Other**	**Major crop - pounds**	**Total Pounds**	**Agriculture**	**Structural**	**Other**	**Major crop - pounds**
Bifenthrin	6048.4	2657.4	3362.52	28.48	Strawberry 1615	3239.03	2003.42	1123.58	112.03	Strawberry 1068
Permethrin	3222.6	2503.93	660.79	57.88	Container plants 906, Celery 657	2865.9	2193.48	612.48	59.94	Celery 721
Fenpropathrin (Danitol)**	2131.63	2130.85	0	0.78	Strawberry 1852	1831.09	1831.09	0	0	Strawberry 1250
Dichloran*,**	18702.35	18702.35	0	0	Celery 18146	17521.95	17521.95	0	0	Celery 17400
Pendimethalin*,**	11350.8	11296.26	0	54.54	Strawberry 8854	12068.51	11978.68	0	89.83	Strawberry 10089

* Not analyzed by TMDL ** Analytes not required by Permit

Other - Includes animal premise, golf course turf, landscape maintenance, public health, regulatory pest control, rights of way, vertebrate control, unknown

Data from Pesticide Use Annual Summary Reports at https://www.cdpr.ca.gov/docs/pur/purmain.htm, indexed by Chemical and restricted to Ventura County

E.g "Department of Pesticide Regulation 2015 Annual Pesticide Use Report Indexed by Chemical - Ventura County"

There is approximately a two-year delay for the California Department of Pesticide Regulation Annual Pesticide Use Reports (PUR) to become available online. This means that 2011 and 2012 PUR were unavailable for the 2012 Study report, 2014 and 2015 PUR were unavailable for the 2015 Study report, and 2017 and 2018 PUR were unavailable for the 2018 Study Report.

Five pesticides (three pyrethroids and two non-pyrethroids) were detected by the laboratory's pyrethroid analytical method during the Study. Bifenthrin and permethrin are pyrethroid insecticides that have both agricultural and urban and general and restricted use applications. Bifenthrin and permethrin are both used in significant quantities for regulated applications for structural and agricultural pest control in Ventura County but are also known to have unregulated applications for residential and industrial uses, which are not tracked. The pyrethroid insecticide fenpropathrin and the non-pyrethroid fungicide dichloran are agricultural pesticides without urban uses. The non-pyrethroid herbicide pendimethalin is used for agricultural and urban uses. Fenpropathrin, dichloran, and pendimethalin are not used for structural pest control in Ventura County.

Bifenthrin is used as a restricted use pesticide in orchards, nurseries, and buildings (e.g. structural pest control). Some products with lower concentrations are available for unrestricted residential use for indoor and outdoor insect control. Bifenthrin was detected at all Study sites except CC Up and VR Up at least once from 2012-2018. All the sites at which bifenthrin was detected (TMDL sites in 2012, CC Down in 2015, VR Down in 2012 and 2015, SCR Up in 2012, and SCR Down in 2012 and 2015) have both urban and agricultural influences but are in predominantly agricultural areas. In contrast, CC Up doesn't have urban or agricultural influences and VR Up has a small amount of agriculture and low-density housing. WOOD 2012 is a predominantly agricultural site and given its location within the Oxnard Plain, an area notable for its large crops of strawberries, peppers, and leafy green vegetables, the source of the bifenthrin is likely agricultural, however there are upstream discharges from urban areas.

Permethrin is a restricted use pesticide for crop and wide area applications (e.g. nurseries, sod farms) but is also a general use pesticide for residential (e.g. indoor and outdoor spaces, pets) and industrial applications. According to the United States Environmental Protections Agency's "Reregistration Eligibility Decision (RED) for Permethrin (December 2007)", approximately 70% of permethrin is used in non-agricultural settings and approximately 30% is used on food/feed crops in agricultural settings. The RED states that approximately 55% of the non-agricultural applications are made by professionals, 41% by homeowners on residential areas, and 4% on mosquito abatement areas. Permethrin was only detected at VR Up in 2012, which is downstream of a small amount of agriculture and low-density housing, and at ME-CC in 2015, which has both urban and agricultural influences. The TMDL permethrin detection limit of 5 ng/g is above/near the quantities measured in the 2015 CC Down samples, so the higher TMDL detection limit may have obscured the presence of similar concentrations of permethrin in the TMDL samples. The CDPR reports show that the regulated use of permethrin in Ventura County is predominantly for row crops and structural pest control, however according to the Environmental Health Tracking Program (www.cehtp.org/pesticidetool), which uses CDPR data, there were no applications near VR Up, so the source may be from unregistered residential users but the data is inconclusive at this time.

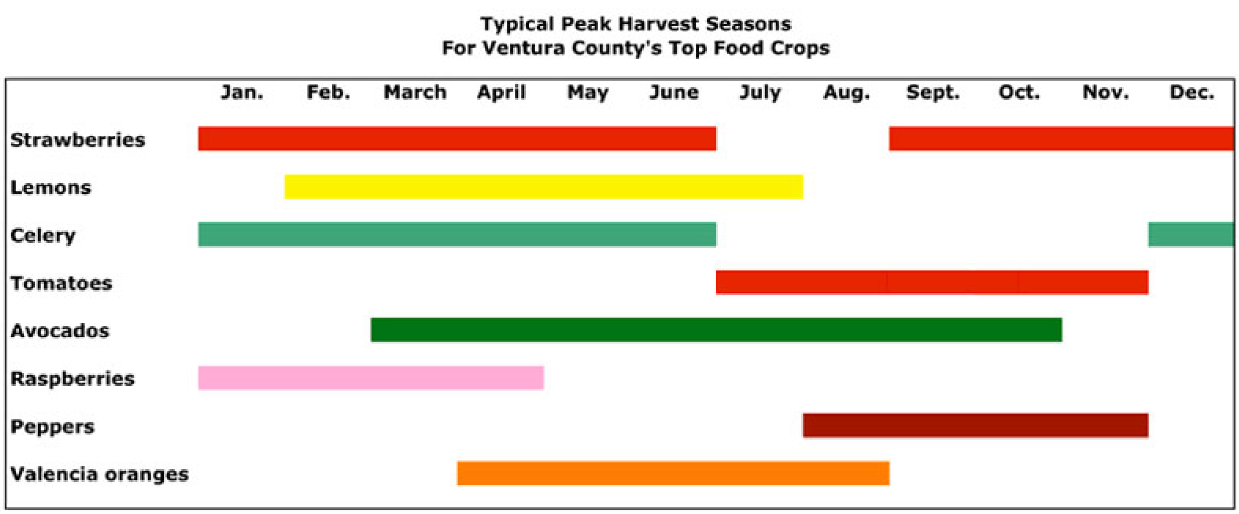
Fenpropathrin is a pyrethroid insecticide that is registered for multiple crops but its restricted use designation makes it unlikely to have an urban source, however it can be used to treat Asian citrus psyllid infestations (as can cyfluthrin, which was not detected), which have become a problem in Ventura County. It was only detected once during the Study, at VR Down in 2015.

Dichloran is a (non-pyrethroid) general use fungicide with no residential uses [DCNA (Dicloran) Reregistration Eligibility Decision (RED) Fact Sheet (EPA 738-F-06-013, July 2006)], therefore the detected dichloran is not from an urban source. Dichloran was only detected at one site, SCR Down, and was detected during all three study years (2015, 2015, and 2018).

Pendimethalin is a (non-pyrethroid) general use selective herbicide used to control broadleaf weeds and grassy seed species in agricultural and non-agricultural settings. Pendimethalin was predominantly detected in the Santa Clara River Watershed at SCR Up and SCR Down in 2012 and 2015, but it was also detected at CC Down in 2015. It is unknown if the detection of this non-pyrethroid is related to an urban source, but its concentrations tended to be higher at the downstream sites, where agriculture is a more direct influence.

The PUR are summarized by calendar year, however samples for this Study were collected in April/May so the previous year's applications are also relevant. Strawberry and celery are among the top 10 crops grown in Ventura County, and are also the major crops on which the five detected pesticides (3 pyrethroids and 2 non-pyrethroids) are applied. Additionally, as seen in Figure 15, the strawberry and celery growing seasons lead into the sampling period. This suggests that the pesticides could have an agricultural source, however it does not exclude an urban source for those pesticides which have urban uses.

Figure 15. Peak Harvest Seasons



(Chart obtained from http://www.farmbureauvc.com/new/images/typical-peak.jpg)

PESTICIDE USE TRENDS

According to the CDPR website (https://www.cdpr.ca.gov/docs/pur/pur16rep/16sum.htm#trends), "Since 1990, the reported pounds of pesticides applied and acres treated have fluctuated from year to year. These fluctuations can be attributed to a variety of factors, including changes in planted acreage, crop plantings, pest pressures, and weather conditions. An increase or decrease in use from one year to the next or in the span of a few years may not necessarily indicate a general trend in use, but rather variations related to changes in weather, pricing, supply of raw ingredients, or regulations. Regression analyses on use over the last twenty years do not indicate a significant trend of either increase or decrease in total pesticide use." These factors, combined with differences in rainfall and runoff intensities and amounts could all contribute to the variations in concentrations seen in the Study.

The 2017 and 2018 PUR data were not released by CDPR in time for inclusion in this report, so the comparison of analytical data to pesticide application amounts to look for trends are limited to the 2011-2016 period. The multiple factors that can affect fluctuations and the lack of PUR data for 2017 and 2018, combine to prevent drawing conclusions from any apparent trends. However, some possible trends from the current available data are visible in Figure 16, Figure 17, Figure 18, Figure 19, and Figure 20, and are described below.

Figure 16. 2011-2016 Bifenthrin Use in Ventura County (CDPR)

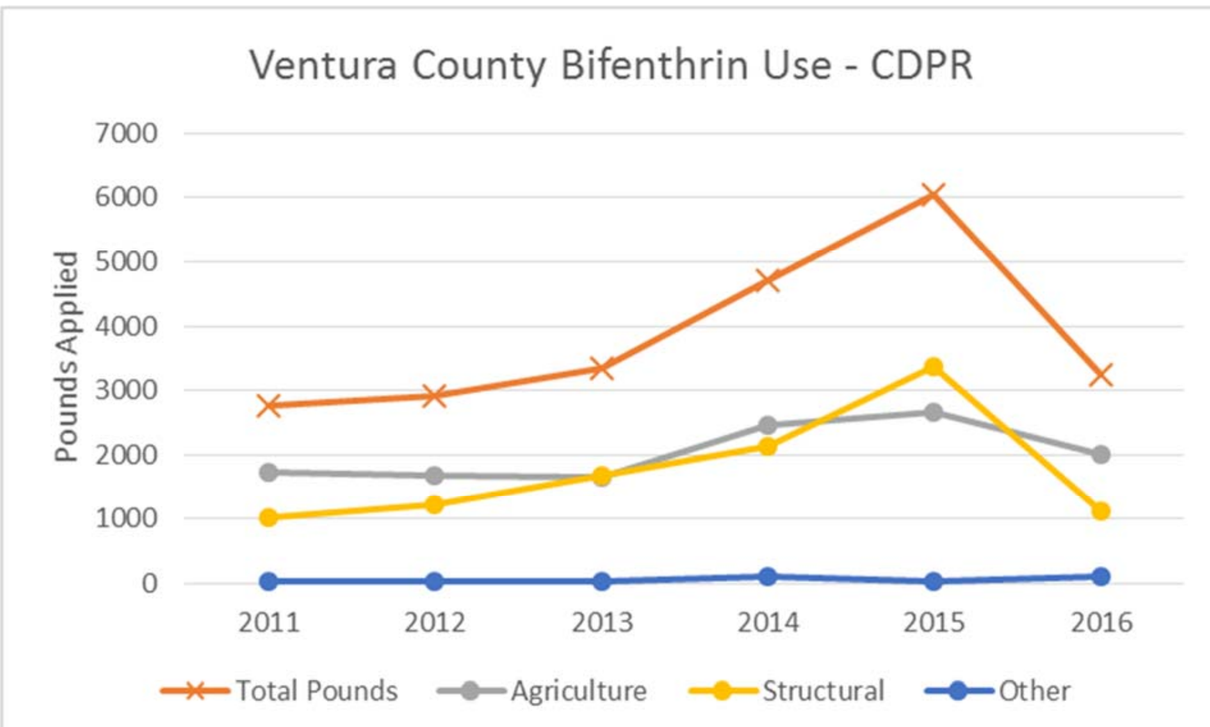


Figure 17. 2011-2016 Permethrin Use in Ventura County (CDPR)

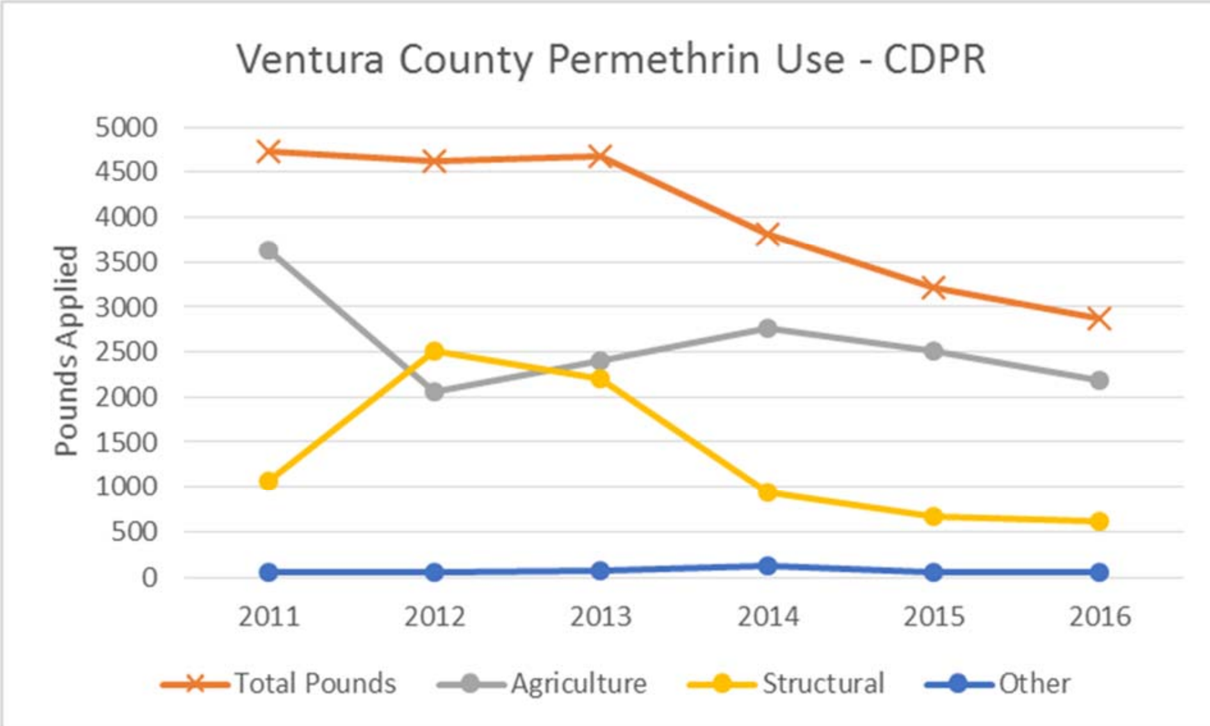


Figure 18. 2011-2016 Fenpropathrin (Danitol) Use in Ventura County (CDPR)

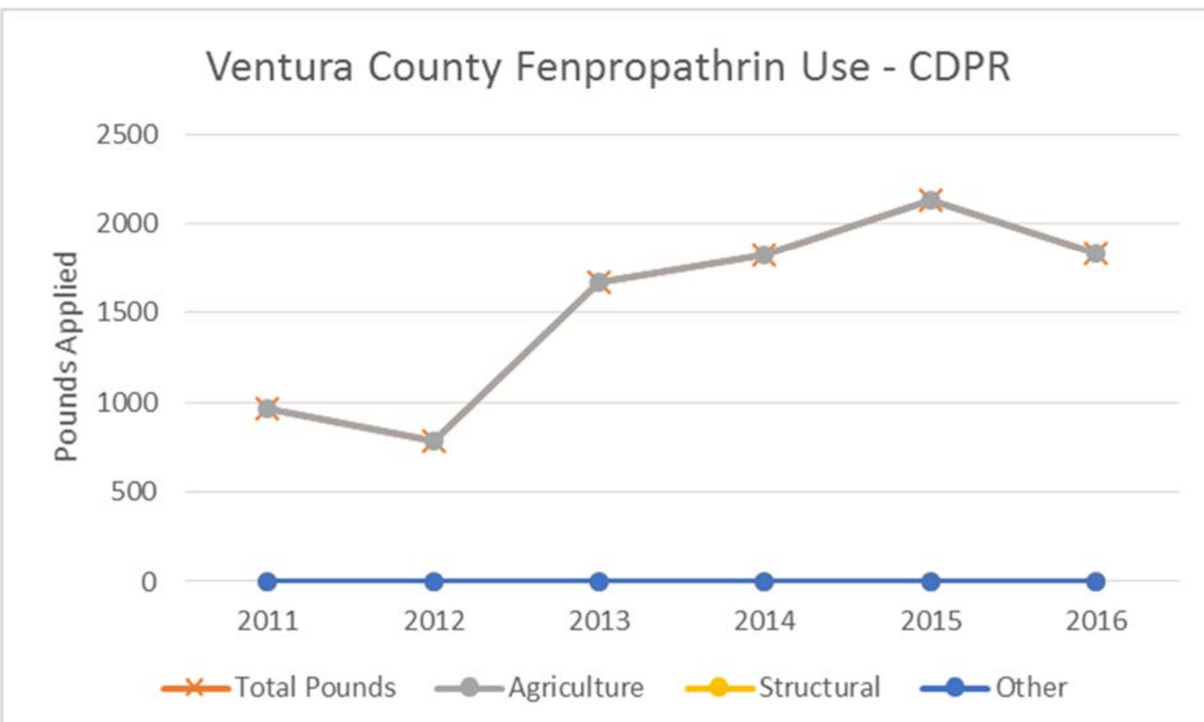


Figure 19. 2011-2016 Dichloran Use in Ventura County (CDPR)

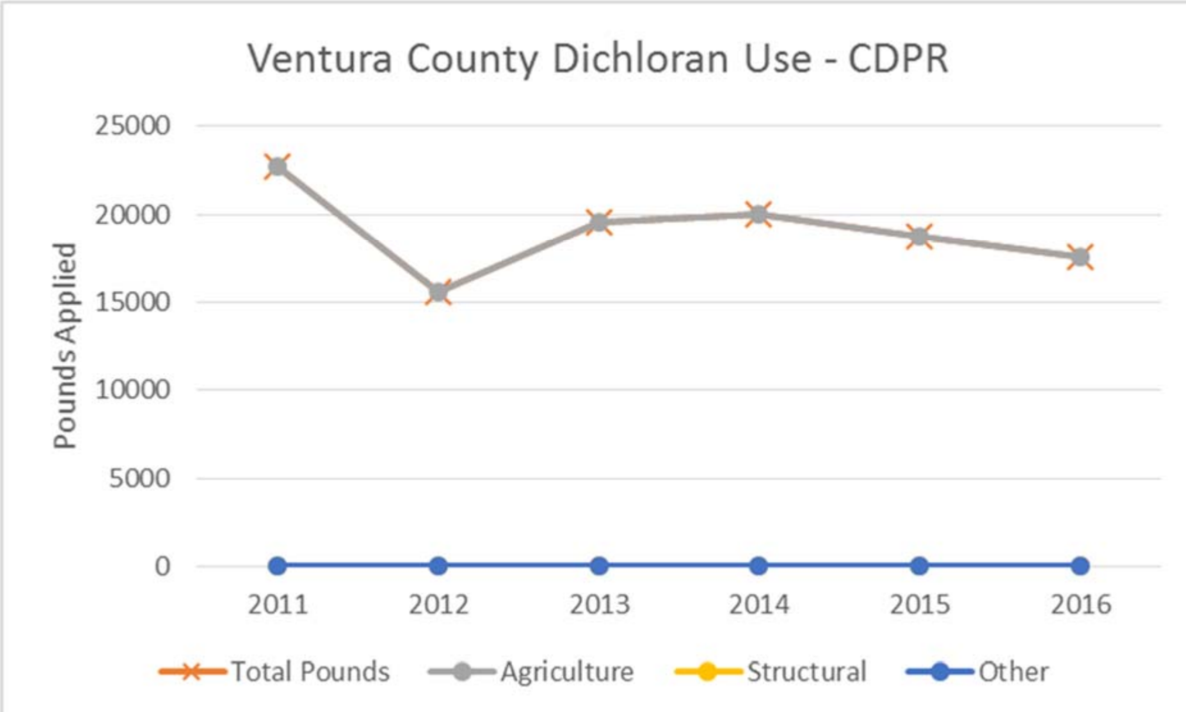
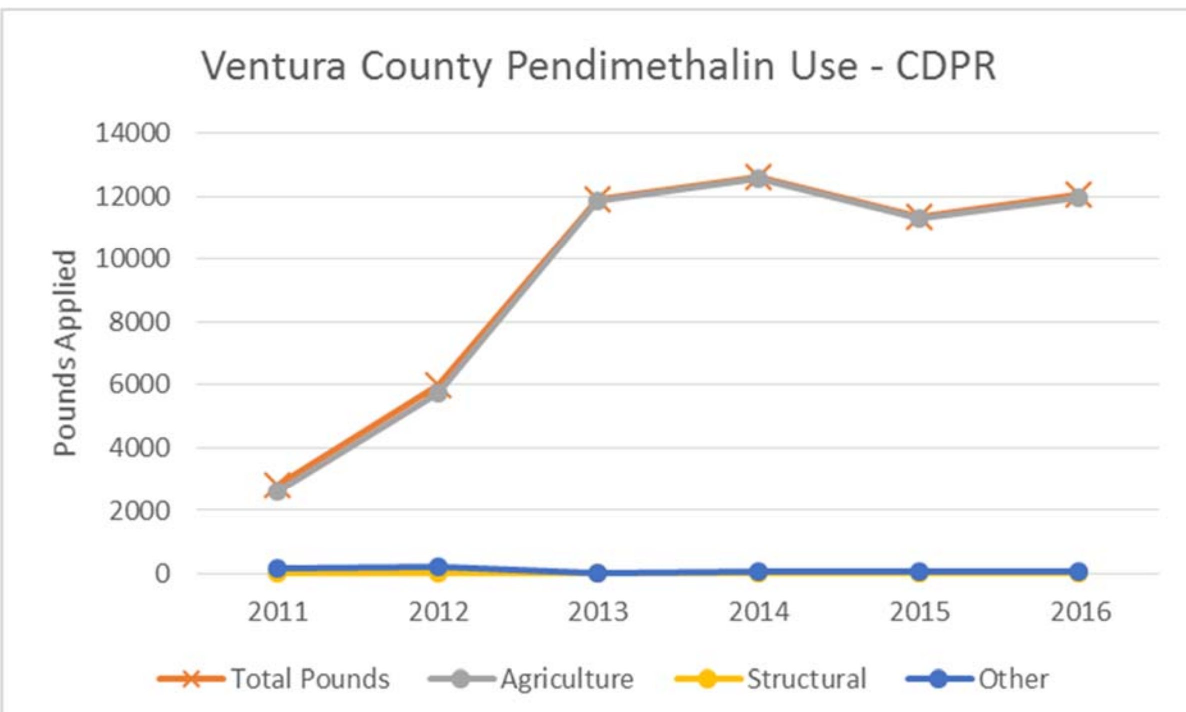


Figure 20. 2011-2016 Pendimethalin Use in Ventura County (CDPR)



The 2011-2016 PUR show dichloran and pendimethalin (non-pyrethroids) are used in larger quantities (pounds) for regulated applications (primarily agriculture) in the County than the pyrethroids bifenthrin, permethrin, and fenpropathrin, however this was not typically reflected in the monitoring data (i.e. quantities and frequencies of detection). These five pesticides are all applied to strawberry or celery as their major crop, and these are among the top ten crops in Ventura County and are mainly grown in the lower regions of each watershed.

According to the 2011-2016 PUR, bifenthrin, fenpropathrin, and pendimethalin use appear to be trending upward since 2011 (although bifenthrin use decreased in 2016). Bifenthrin use (according to CDPR) was highest in 2015, which correlates with the concentrations measured at downstream sites. Bifenthrin structural use increased in the county between 2012 and 2015, and briefly exceeded agricultural use in 2015. Permethrin use appears to be decreasing (largely due to decreased use for structural pest control use) and dichloran use appears to be staying relatively stable over the 2011-2016 period. The 2017 and 2018 data are unavailable to see if the trend continues.

PESTICIDE REDUCTION EFFORTS

Integrated Pest Management Programs

A model integrated pest management (IPM) program was drafted through the Public Agencies Activities Subcommittee and used as a template by the Permittees to develop their own plans by November 2009. This standardized protocol was amended in February 2014 at the amended version is posted on Program's website at: http://www.vcstormwater.org/index.php/publications/manuals/pesticide-application-protocol.

The prevention of pesticides from harming non-target organisms is the primary goal of the Permittees IPM program. The intent is to focus on preventing pesticides, fertilizers, and herbicides from entering the storm drain system and discharging to receiving waters. This protocol is applicable to 1) the outdoor use of pesticides, herbicides, and fertilizers; 2) the use of pesticides and fertilizers where the materials may come into contact with precipitation; 3) the use of pesticides, herbicides, and fertilizers where these materials may come into contact with runoff (natural or induced); and 4) the use of pesticides, herbicides, or fertilizers anywhere where they may be directly or indirectly discharged to a storm drainage system.
An effective IPM program includes the following elements:

- Pesticides are used only if monitoring indicates they are needed according to established guidelines.
- Treatment is made with the goal of removing only the target organism.
- Pest controls are selected and applied in a manner that minimizes risks to human health, beneficial, non-target organisms, and the environment.
- The use of pesticides, including organophosphates and pyrethroids do not threaten water quality.
- Partner with other agencies and organizations to encourage the use of IPM.

- Adopt and verifiably implement policies, procedures, and/or ordinances requiring the minimization of pesticide use and encouraging the use of IPM techniques (including beneficial insects) in the Permittees' overall operations and on municipal property.

- Policies, procedures, and ordinances shall include commitments and timelines to reduce the use of pesticides that cause impairment of surface waters by implementing the following procedures:

    - Quantify pesticide use by its staff and hired contractors.

    - Prepare and annually update an inventory of pesticides used by all internal departments, divisions, and other operational units.

    - Demonstrate reductions in pesticide use.

The protocol is applicable to any Permittee staff and contracted services that apply pesticides, fertilizers, or herbicides. Such staff commonly include, park, public works, purchasing, building/grounds maintenance, hazardous materials, and pesticide application staff. It is not applicable to the indoor use of pesticides, herbicides or fertilizers, but is applicable to the consequential outdoor handling, mixing, transport, or disposal of materials related to indoor use. This protocol also does not apply when another NPDES permit and/or abatement orders are in effect at the selected site. Furthermore, this protocol is not intended to replace federal or state requirements or provide complete directions for applying, handling, transporting, mixing, or storing pesticides, fertilizers, or herbicides.

Spanish Language Pesticide Outreach

Public Outreach and Education on Pesticide Use

Ventura County's Community for a Clean Watershed (CCW) is the Program's public outreach effort, and it regularly targets pesticide use in its campaigns. CCW has developed creative materials to promote the safe and correct use of outdoor pesticides. The animated "More, Better" television commercial graphically demonstrates how using too much pesticide results in runoff into the storm drains, eventually making it into the Watershed where it adversely affects plants and animals. The radio spot was a humorous adaptation of the television ad, featuring the two animated characters as they defend their house against garden pests and inadvertently poison the watershed. An animated web banner corresponded with both broadcast media while the transit shelters took a more direct approach showing a snail and telling residents "Don't kill an ocean just to keep pests out of your garden."

Newspaper Advertisement

In 2010, coinciding with the spring planting season, CCW ran a five-week campaign on television and radio, as well as animated web banners and transit shelter posters. A similar campaign was run in spring 2016 for four weeks, utilizing the thirty second radio spot, digital web banner, and six transit shelters showing the snail poster. The radio spot was also run for four weeks on Pandora in January – February 2017.

In February 2016, April 2016, and twice in January 2017, CCW sent out e-blasts targeting 100,000 homeowners in Ventura County each time. The e-blast promoted the Program's rain barrel and compost bin truckload sale and included links to the Program's "Yard Care Watershed Protection Tips" brochure and "Pesticides, Herbicides, & Fertilizer Application Best Practices" BMP sheet.

Retail Partnership Brochures: Nurseries and Gardeners

"Watershed Protection Tips for Gardeners" pamphlets were created in 2010 to encourage residents to follow best practices in their homes and yards when gardening and dealing with pests. These brochures were distributed to targeted retail stores and numerous outreach events across the county to reach the population that is likely involved in the activities. The colorful pamphlet defines the Watershed, explains the storm drain system, how and why polluted water is damaging, and gives both overall and topic-specific tips for how to keep the Watershed clean. The pamphlet covers plant selection, irrigation, fertilizer and pesticide practices, integrated pest management, and proper yard maintenance. The pamphlet was updated in 2016 to include pictures of drought tolerant plants and an updated link to Integrated Pest Management resources.

The Program also created a best management practices fact sheet covering commercial pesticide, herbicide, & fertilizer application and a poster covering best management practices for nurseries. These were distributed during stormwater business inspections. All the materials are also posted on the CCW website www.cleanwatershed.org.

2010 Gardening Retail Partnership Brochure

2016 Gardening Retail Partnership Brochure

RECOMMENDATIONS

Urban use of pesticides remains one of the priority pollutants for the Program. Through maintaining a strong public outreach effort to educate the public on the use and handling of pesticides coupled with household hazardous waste collections providing proper disposal of unwanted products, the Program expects to reduce the pesticide contamination in stormwater discharge. The results of this study, and the previous studies in 2012 and 2015, do not directly show a link between pyrethroids and significant toxicity in the samples, therefore the instances of measured toxicity could be from other pesticides or other pollutants. The Program is committed to reducing all pollutants in MS4 runoff and through the continued implementation of the Program, these other potential causes of toxicity will be addressed.

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