GROUP PROJECT BRIEF

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BREN SCHOOL UC SANTA BARBARA

Characterizing the ecological risk to the tidewater goby from pyrethroid use

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Fish Kills in Ormond Lagoon Watershed

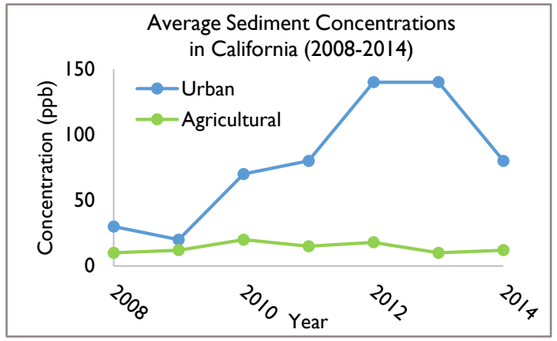
In the past three years, there have been two incidences of fish kills in the Oxnard and Port Hueneme regions of California in waters hydrologically connected to tidewater goby critical habitats. Tidewater gobies are small fish found in California's lagoons and were listed as endangered under the Endangered Species Act in 1994. These die-off events have been linked to high concentrations of pyrethroids, an insecticide used heavily in California and found to be toxic to aquatic organisms.

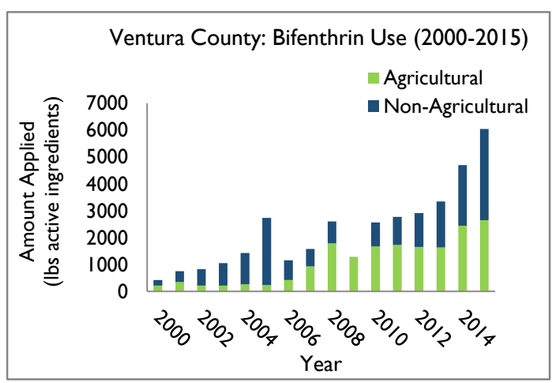
Background

Pyrethroids: Chemical Properties

- Strong affinity for soil and other organic material
- Highly hydrophobic; low solubility in water
- Resistant to degradation

Due to these chemical properties, pyrethroids are transported during erosion, irrigation, and runoff events into creeks and estuaries where they continue to persist in the sediments.





Pyrethroids: Application Rates

Coastal California

- Non-agricultural (72%) application rates are higher than agricultural (28%) application rates
- Structural pest control accounts for 93% of all non-agricultural application

Ventura County

- Since 2000, bifenthrin application in Ventura County has increased more than 10-fold
- In 2015, agricultural (56%) and non-agricultural (44%) application rates were fairly even

Sampling in Ormond Lagoon 5

- More pyrethroids were found at higher concentrations following a rain event which agrees with the model results
- The highest concentrations were found downstream of strawberry agriculture
- Results indicate that personal use of pyrethroids for home and yard pest control is a significant contributor to toxicity

Watershed specific BMPs 6

In order to reduce pyrethroid laden runoff into waterways across coastal California watersheds, best management practices can be implemented based on sector (urban vs. agricultural) and type (behavioral vs. structural).

	Urban	Agricultural
Behavioral	• Communication system • Apply earlier in dry season • Apply granules over liquid • Pyrethroid substitutes such as boric acid	• Integrated Pest Management • Polyacrylamide • Pyrethroid substitutes that are less toxic to fish
Structural	• Bioswales • Vegetative filter strips	• Sediment basins • Vegetative filter Strips

Conclusions

- Current pyrethroid use is likely adversely affecting tidewater gobies
- Sources of pyrethroid contamination across California are watershed specific
- In Ormond Lagoon, strawberry production contributes the most pyrethroids
- In the Calleguas watershed, which contains Ormond Lagoon, over 13,000 pounds of pyrethroids are applied annually
- There are six other coastal California watersheds with tidewater goby critical habitat that apply even greater annual loads of pyrethroids
- More proactive pesticide management by state and federal governments is recommended to minimize ecological risk from pyrethroids

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Further Information
More information can be found at our website: https://tidewatergoby.weebly.com. You can also contact us directly at gp-gogobies@bren.ucsb.edu

Objectives & Approach

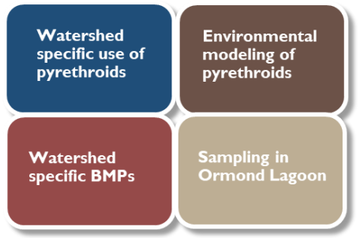
PROJECT OBJECTIVES

- Characterize pyrethroid use in coastal California
- Calculate and project pyrethroid hotspots for tidewater goby critical habitat throughout coastal California
- Recommend best management practices
- Estimate expected environmental concentrations in Ormond Lagoon

APPROACH

1. Developed a geospatial representation of pyrethroid use at the watershed level for coastal California.

4. Identified best management practices to reduce ecological risk from pyrethroid application.

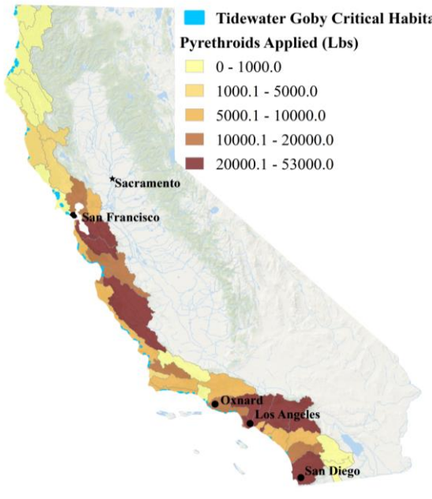


2. Estimated expected environmental concentrations of pyrethroids in Ormond Lagoon, utilizing EPA's Pesticide in Water Calculator model.

3. Collected samples to calculate current pyrethroid levels before and after precipitation events to support modeling efforts.

Pyrethroid use along the coast of California

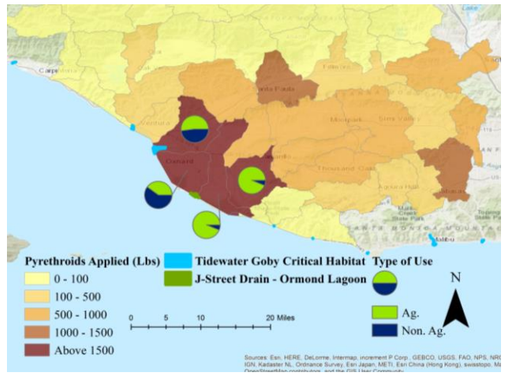
Utilizing the California Department of Pesticide Regulation's Pesticide Use Reporting (PUR) data, total pyrethroid use was estimated for the coastal watersheds of California. The PUR program requires all licensed pesticide applicators– therefore excluding personal use of products sold at home improvement stores– to report their pesticide use. Agricultural use is reported to the square mile and daily level while non-agricultural use is only reported to the county and monthly level. Our team relied on population data provided by the U.S Census to estimate non-agricultural use at the watershed scale.



1

There is high spatial variability of pyrethroid use across coastal watersheds. Many areas with concentrated use (SF Bay, Salinas, LA) drain into tidewater goby critical habitat.

There is also watershed specific seasonality of pyrethroid applications which has important implications for the tidewater goby. For example, many watersheds have a spike in application loads right before the rainy season begins.

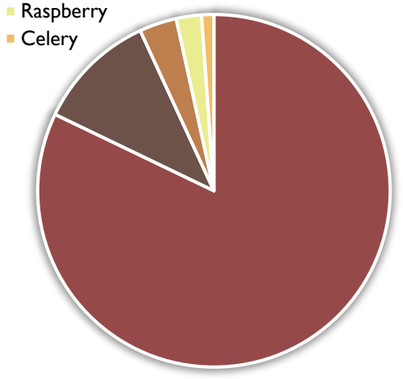


2

In Oxnard, the areas with the highest rates of application are concentrated nearest Ormond Lagoon. Smaller watershed unit analysis shows the variability in location of use, and the type (Ag. or Non Ag.)

Environmental modeling of pyrethroids

Sources of Bifenthrin in Ormond Lagoon



Key Results

60% of all aquatic species are affected by peak permethrin concentrations

83% of acutely toxic bifenthrin concentrations occur Nov-Feb

Environmental pyrethroid concentrations are highest during spawning season

The acute LC50 of bifenthrin for *Hyalella Azteca* is exceeded on over 99% of days modeled

Acutely toxic concentrations of individual pyrethroids are likely to occur simultaneously

Acutely toxic concentrations occur directly as a results of precipitation events.

3

Strawberry production and pest control applications on impervious surfaces are the largest contributors of pyrethroids to the Ormond Lagoon Watershed. Bifenthrin and permethrin from these sources were identified as causing the most ecological risk to tidewater gobies.

4

Current pyrethroid use is likely adversely affecting tidewater gobies. Modeled results indicate both acute direct toxicity and negative indirect effects via diminished prey abundance.