Ten Years of Management Practice Effectiveness Research at the UC Davis Granite Canyon Laboratory

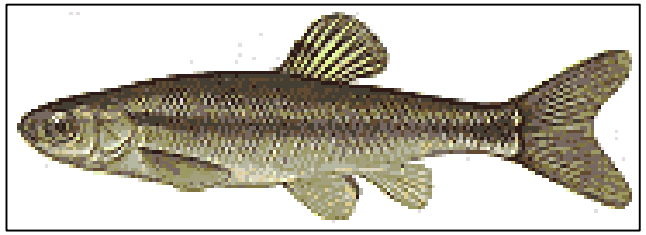
Bryn Phillips, Jennifer Voorhees, Katie Siegler, Laura McCalla, Sylvia Zamudio, Katie Faulkenberry
University of California Davis – Granite Canyon Lab

Michael Cahn, University of California Cooperative Extension

Xin Deng, Rob Budd, Kean Goh, CA Department of Pesticide Regulation

Insecticide History

Changing Use of Insecticides							
1950	1960	1970	1980	1990	2000	2010	2020
Organochlorines (e.g., DDT)							
		Organophosphates (e.g., Chlorpyrifos)					
			Pyrethroids (e.g., Bifenthrin)				
				Phenylpyrazoles (e.g., Fipronil)			
					Neonicotinoids (Imidacloprid)		



fathead minnow

Ceriodaphnia

Hyalella

Chironomus

Comparative Toxicity

Pesticide 96-Hour LC50 (ng/L)	Chlorpyrifos	Bifenthrin	Fipronil	Imidacloprid
Fathead Minnow	122,000	4,850	398,290	?
Ceriodaphnia dubia	54	142	17,700	72,124 µg/L
Hyalella azteca	86	9.3	728	65,430
Chironomus dilutus	290	69	32.5	2,650

Changing Patterns…

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Changing Patterns in Water Toxicity Associated with Current Use Pesticides in Three California Agriculture Regions

Brian S Anderson,† Bryn M Phillips,† Jennifer P Voorhees,† Xin Deng,‡ Jeff Geraci,§ Karen Worcester,‖ and Ron S Tjeerdema†*

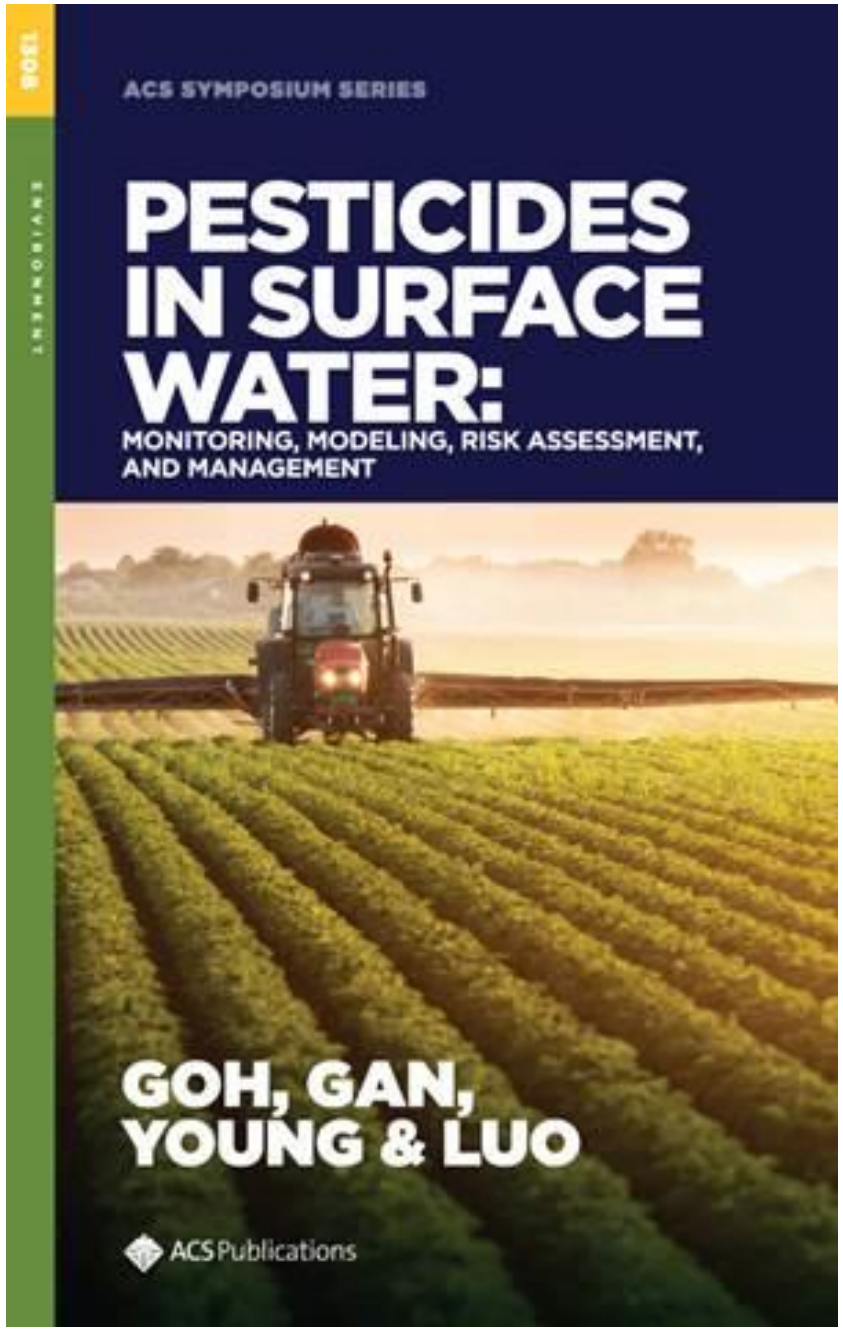
†Granite Canyon Marine Pollution Studies Laboratory, Department of Environmental Toxicology, University of California, Davis, Monterey, California, USA
‡California Department of Pesticide Regulation, Surface Water Protection Program, Sacramento, California, USA
§California Regional Water Quality Control Board – Colorado River Basin Region, Palm Desert, California, USA
‖California Regional Water Quality Control Board – Central Coast Region, San Luis Obispo, California, USA

Solubility & Persistence of Representative Insecticides

Chemical	Log K_{ow}	K_{oc} (mL/g)	Soil Half Life (aerobic)	Water Half Life (photolysis)	Water Half Life (hydrolysis)
DDT	6.0	2,000,000	2 – 15 Years	Weeks – Years	Weeks – Years
Chlorpyrifos	4.7	6,070	7 – 120 Days	21 – 28 Days	35 – 78 Days
Bifenthrin	6.0	240,000	3 – 8 Months	9 – 14 Months	Months – Years
Imidacloprid	0.6	132 - 400	104 – 228 Days	<3 Hours	33 – 44 Days

BMP's for runoff treatment:

- Sediment-Bound Insecticides:
  - Retention ponds
  - Vegetated treatment systems
  - Use of Polyacrylamide (PAM) to reduce suspended sediments
- More Water-Soluble Insecticides:
  - Apply tailwater to non-cropped areas
  - Vegetated treatment systems
  - Enzyme treatment (e.g., Landguard)
  - Carbon filtration



Chapter 26

Best Management Practices for Mitigating Pesticides in Runoff from Vegetable Systems in California

Michael D. Cahn*,[1] and Bryn Phillips[2]

[1]University of California, Cooperative Extension, Monterey County, 1432 Abbott Street, Salinas, California 93901, United States
[2]Department of Environmental Toxicology, University of California, Davis, Granite Canyon Laboratory, 34500 Highway 1, Monterey, California 93940, United States
*E-mail: mdcahn@ucdavis.edu.

BMP Effectiveness – Ponds

BMP Effectiveness – Ponds

BMP Effectiveness – Ponds

- **Two-Pond Study** – with pennywort
- **Chemistry**
  - Some pyrethroid reductions up to 100% in water
  - Other pesticide reductions 20 - 90%
- **Toxicity**
  - No toxicity reduction
  - 100% mortality to *Ceriodaphnia*
  - 100% amphipod mortality at inlet, 72% mortality at outlet

Hunt et al. 2008

BMP Effectiveness – Integrated Vegetated Ditch

BMP Effectiveness – Integrated Vegetated Ditch

- **Configuration**
  - Sedimentation Basin (100 ft), Vegetated Section (764 ft), Landguard OP-A Treatment (108 ft)
  - Adjustable volume
- **Chemistry and Toxicity**
  - Organochlorines reduced >90%, pyrethroids up to 100%, chlorpyrifos up to 60% in water
  - Landguard OP-A enzyme removed OPs
  - 88% average *Ceriodaphnia* survival after Landguard OP-A treatment

Anderson et al. 2011, Phillips et al. 2012

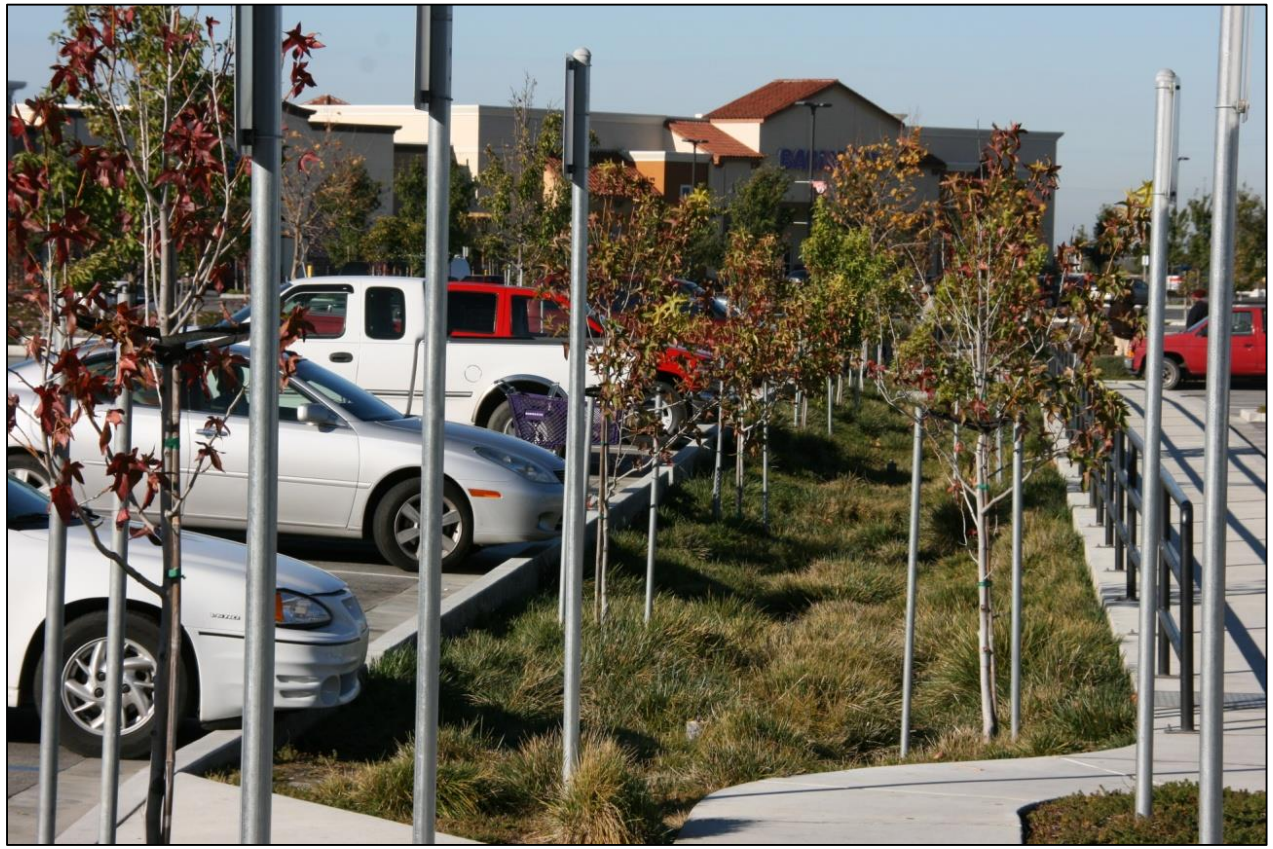
BMP Effectiveness – Integrated Vegetated Ditch

- Organophosphate mitigation tested with simulated chlorpyrifos-spiked irrigation
- Two simulated flow rates: 50 gpm and 100 gpm
- Vegetated with native grass (red fescue), and include installations of compost and granulated activated carbon in mesh enclosures
- Chlorpyrifos load reduced by 98% at low flow, 94% at high flow

Phillips et al. 2017

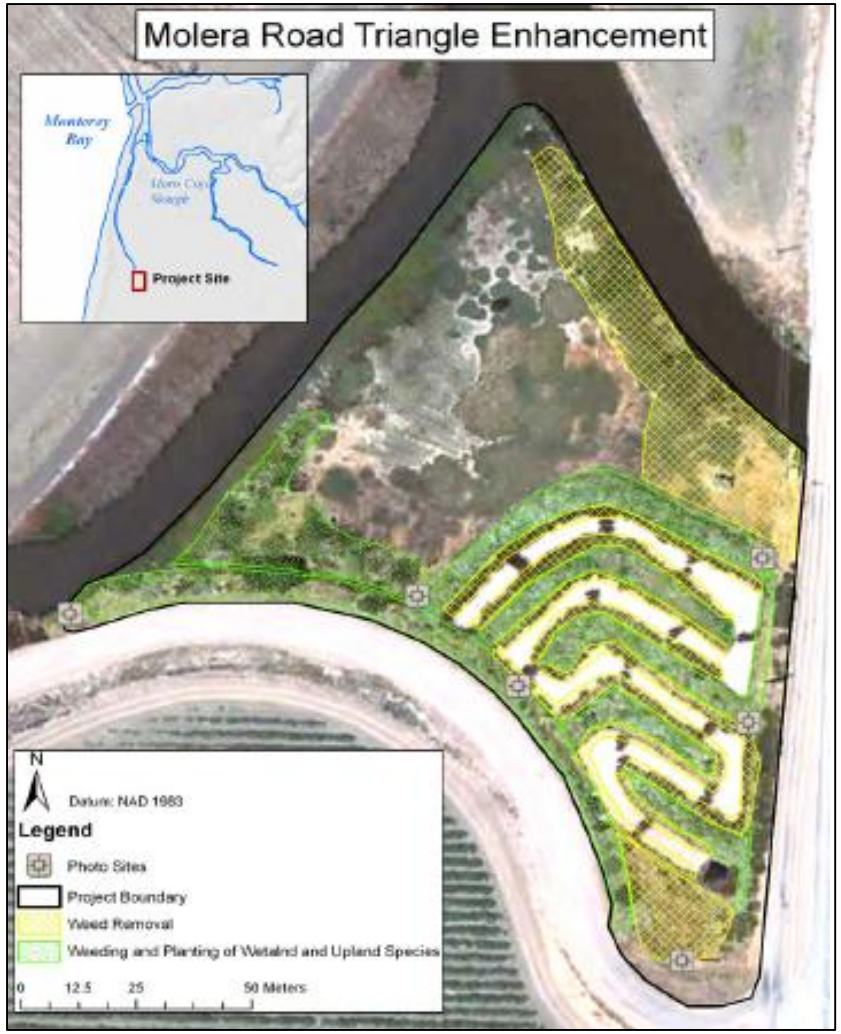
BMP Effectiveness – Bioswales

- Previously constructed bioswales to capture runoff from parking lot or multi-unit residential complex.
- Bioswales reduced toxicity to *Hyalella* and *Chironomus*.
- Pyrethroids reduced by 74%.
- Fipronil treatment inconsistent.
- No imidacloprid detected.
- Could modification increase treatment?



Anderson et al. 2016

Ongoing Projects



Hunt et al. 2008, McCalla et al. 2019

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