

On-farm management practices for mitigating toxicity in irrigation run-off

Laura McCalla and Bryn Phillips
University of California Davis – Granite Canyon Lab



Aquatic Toxicity

- Effects of contaminants on aquatic organisms
 - survival rates, development, growth, reproduction, behavior, etc. of sensitive species

fathead minnow



amphipod crustacean



water flea

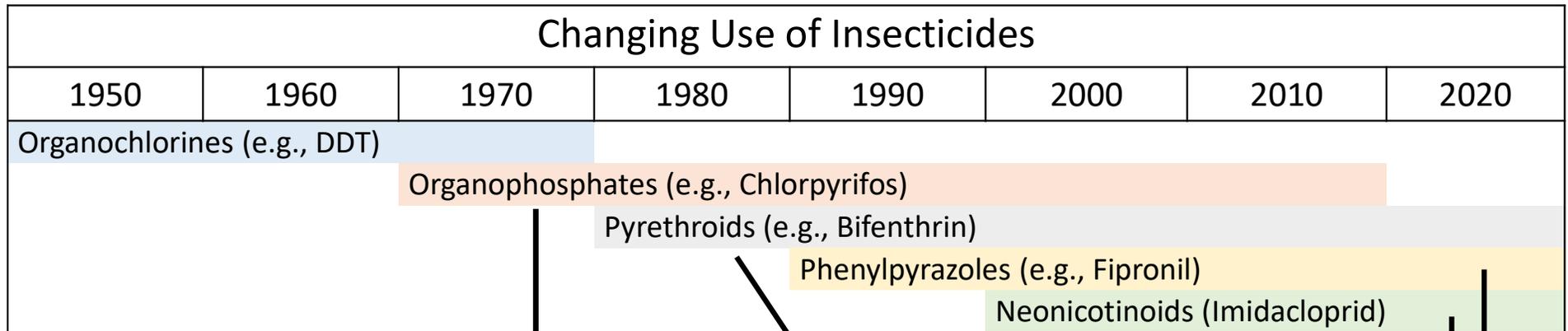


midge fly larva

Solubility & Persistence

Chemical	Log Kow	Koc (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

Insecticide History



fathead minnow



water flea



amphipod crustacean



midge fly larva



Comparative Toxicity

Pesticide 96-Hour LC50 (ng/L)	Chlorpyrifos	Bifenthrin	Fipronil	Imidacloprid
Fathead Minnow	122,000	4,850	398,290	?
Water Flea	54	142	17,700	2,070
Amphipod Crustacean	86	9.3	728	65,430
Midge Fly Larva	290	69	32.5	2,650

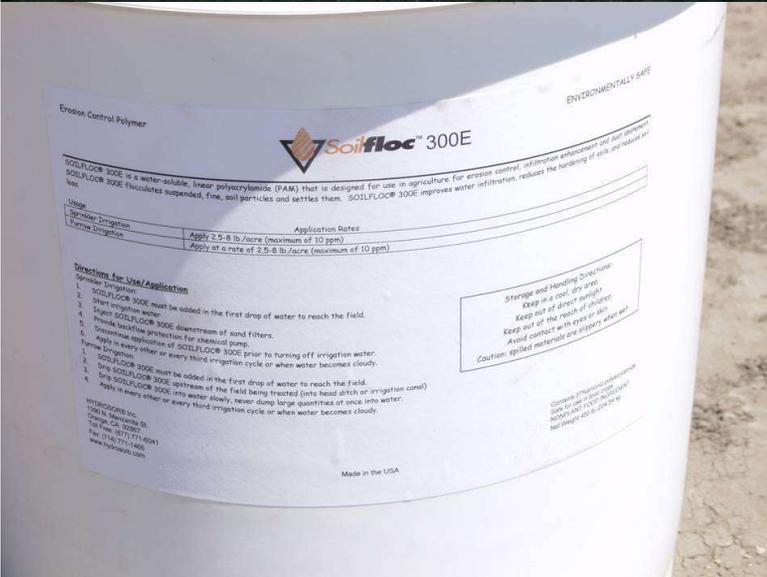
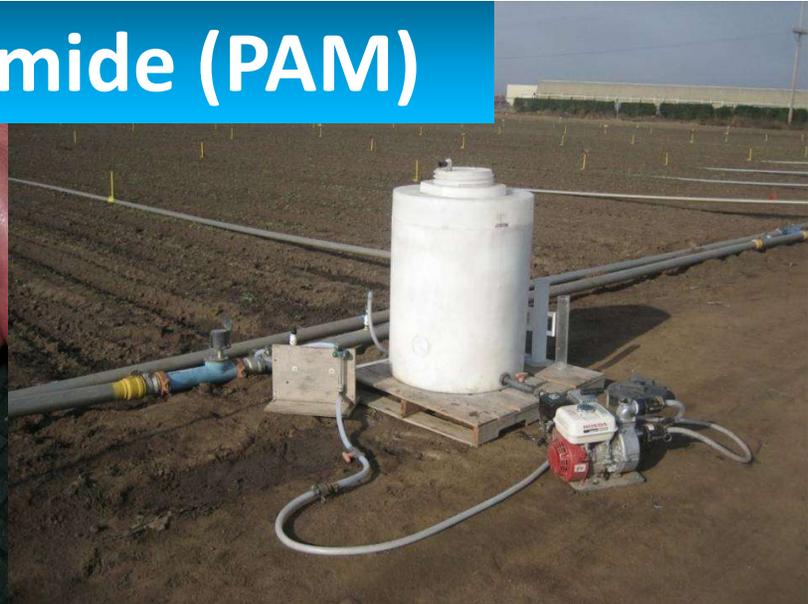
BMP's for runoff treatment:

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

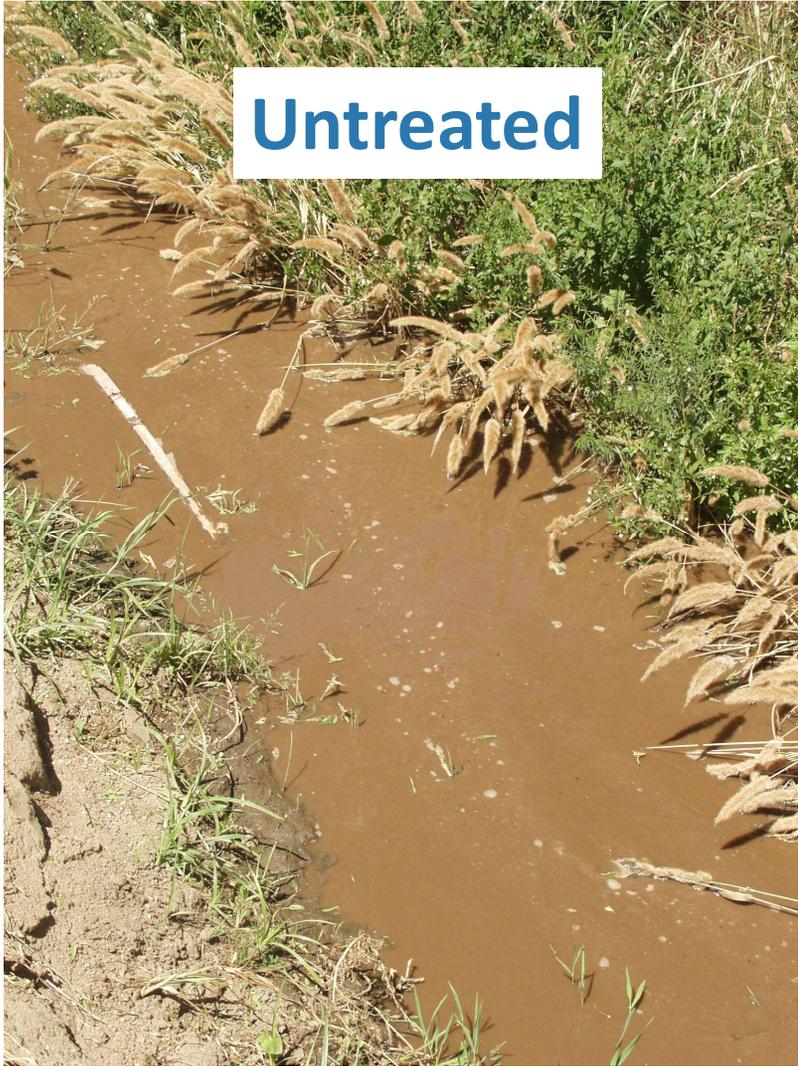
Retention Pond



Polyacrylamide (PAM)



Untreated



PAM-Treated



Vegetated Treatment System (Pennywort)



BMP Effectiveness – Ponds

■ Two-Pond Study

- Upper: 3,452 ft² surface area, 3 ft deep
- Lower: 3,081 ft² surface area, 6.5 ft deep
- Some pyrethroid water reductions up to 100%
- Water reductions of other insecticides: 20 – 90%
- 100% mortality to water fleas
- 100% amphipod mortality at inlet, 72% mortality at outlet





Vegetated Waterways



BMP Effectiveness – Integrated Vegetated Ditch

- 984 ft long ditch
 - Sedimentation basin (100 ft),
vegetated ditch (764 ft),
Landguard organophosphate-A treatment (108 ft)
- Organochlorines reduced >90%, pyrethroids up to 100%,
chlorpyrifos up to 60% in water
- Landguard OP-A enzyme removed more soluble
organophosphate insecticides (diazinon)
- 88% average water flea survival after Landguard OP-A treatment



BMP Effectiveness – Integrated Vegetated Ditch

- Low volume vs high volume runoff
 - Higher water volume = more plant coverage, greater retention time
 - Organochlorines reduced up to 100%, some pyrethroids up to 100% in water
 - Landguard OP-A dose & mixing time
 - Upper vegetated application
 - Organophosphate concentrations & toxicity removed



BMP Effectiveness – Integrated Vegetated Ditch

- Chlorpyrifos mitigation:
 - Native grass vegetated: 1,800 ft long, ~2 to 3% slope
 - 6.5 ft compost and GAC filters in 500 ft sections
 - Two simulated flow rates: 50 gpm and 100 gpm
 - Chlorpyrifos load reduced by 98% at low flow, 94% at high flow
 - GAC in vegetated ditch removed additional 4-8%, depending on flow

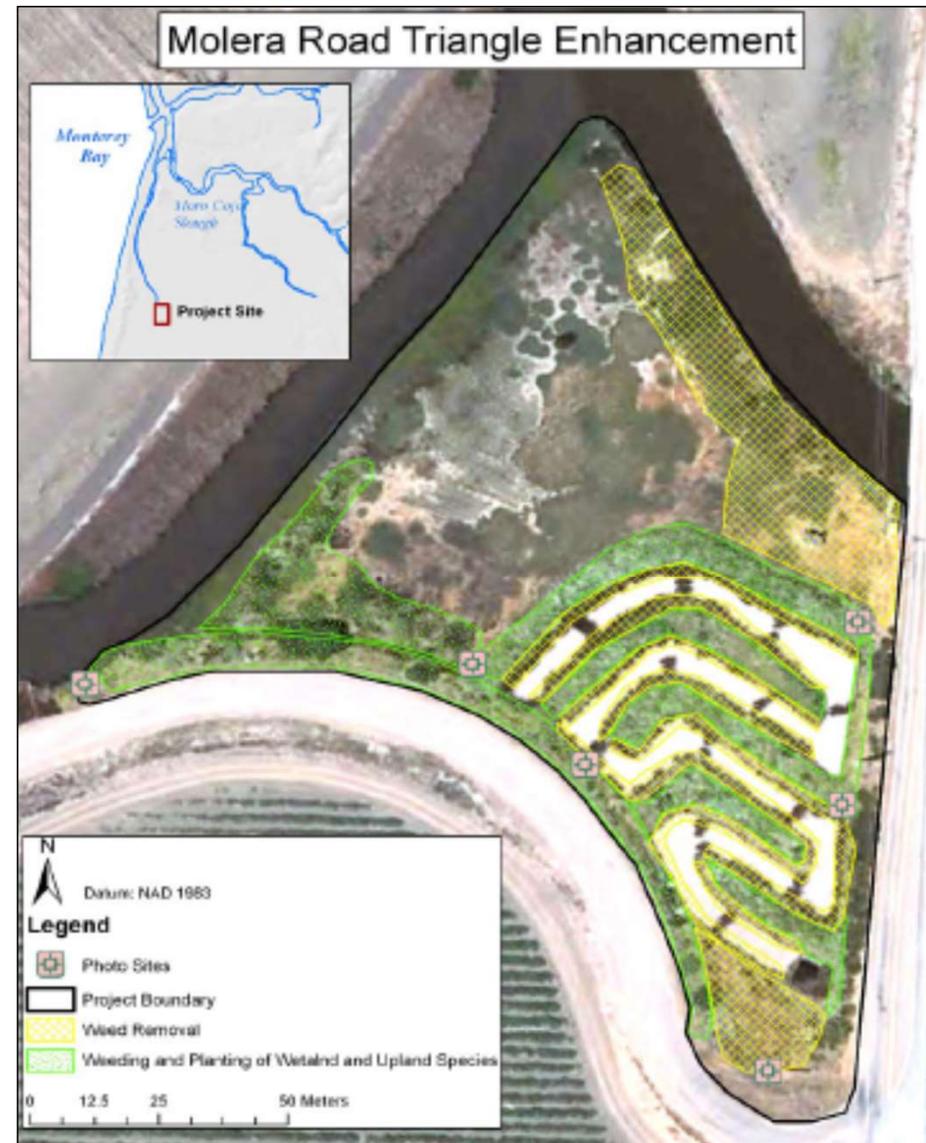


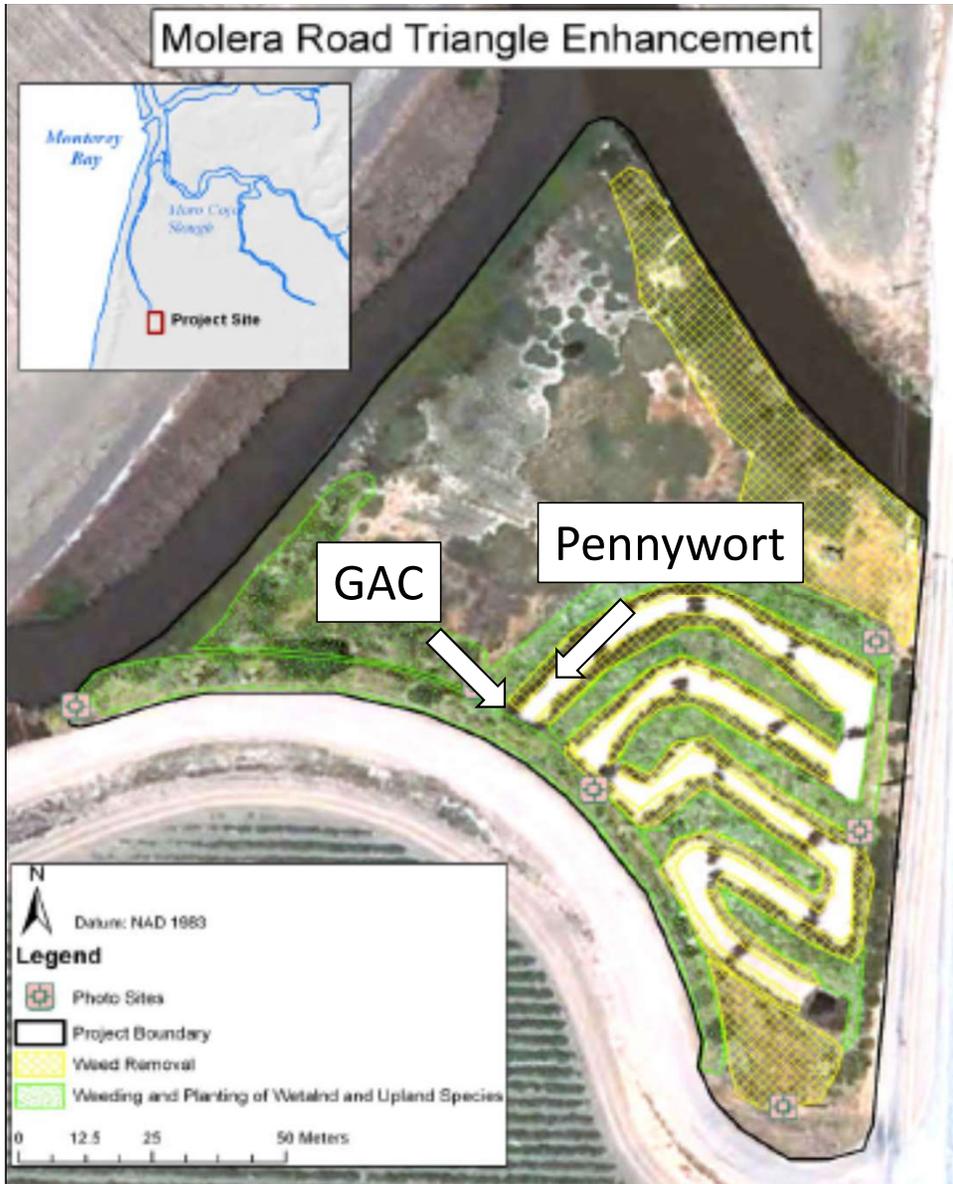
Vegetated System – Concerns

- Food Safety
 - Mammal presence (pathogen vectors)
 - Vegetation choice & fencing
- Cost & Maintenance
 - Installation
 - ~\$10,100 (grading, seeding, irrigating, & maintaining)
 - Mesh filter material: ~\$100 per 130 ft roll
 - New carbon costs & contaminated carbon disposal: ~\$500
 - Activated carbon = ~\$2 per lb

Wetland-Scale Treatment

- Molera Road Triangle Enhancement
 - First section: 1.65 acres
 - Second section: 1.45 acres marsh wetland
 - Long residence time = decreases in pyrethroids, organochlorines, & organophosphates
 - 100% water flea survival at outlet
 - Sediment toxicity to amphipods removed





Aerial Views



Summary: On-Farm Management

- Retention Pond
- Polyacrylamide (PAM)
- Integrated vegetative treatment system
 - Sedimentation basin
 - Vegetated ditch
 - Polishing step:
 - GAC (or Biochar?)
 - Enzyme treatment

