Pesticides in and around the Delta

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Pesticide Use in the San Francisco Bay watershed

(from Kuivila and Hladik (2008))

	Herbicides	Fungicides	Insecticides	Other
Monitored (at least once)	37	2	30	4
Never monitored	29	30	19	9

160 total pesticides……..54% never monitored in the environment

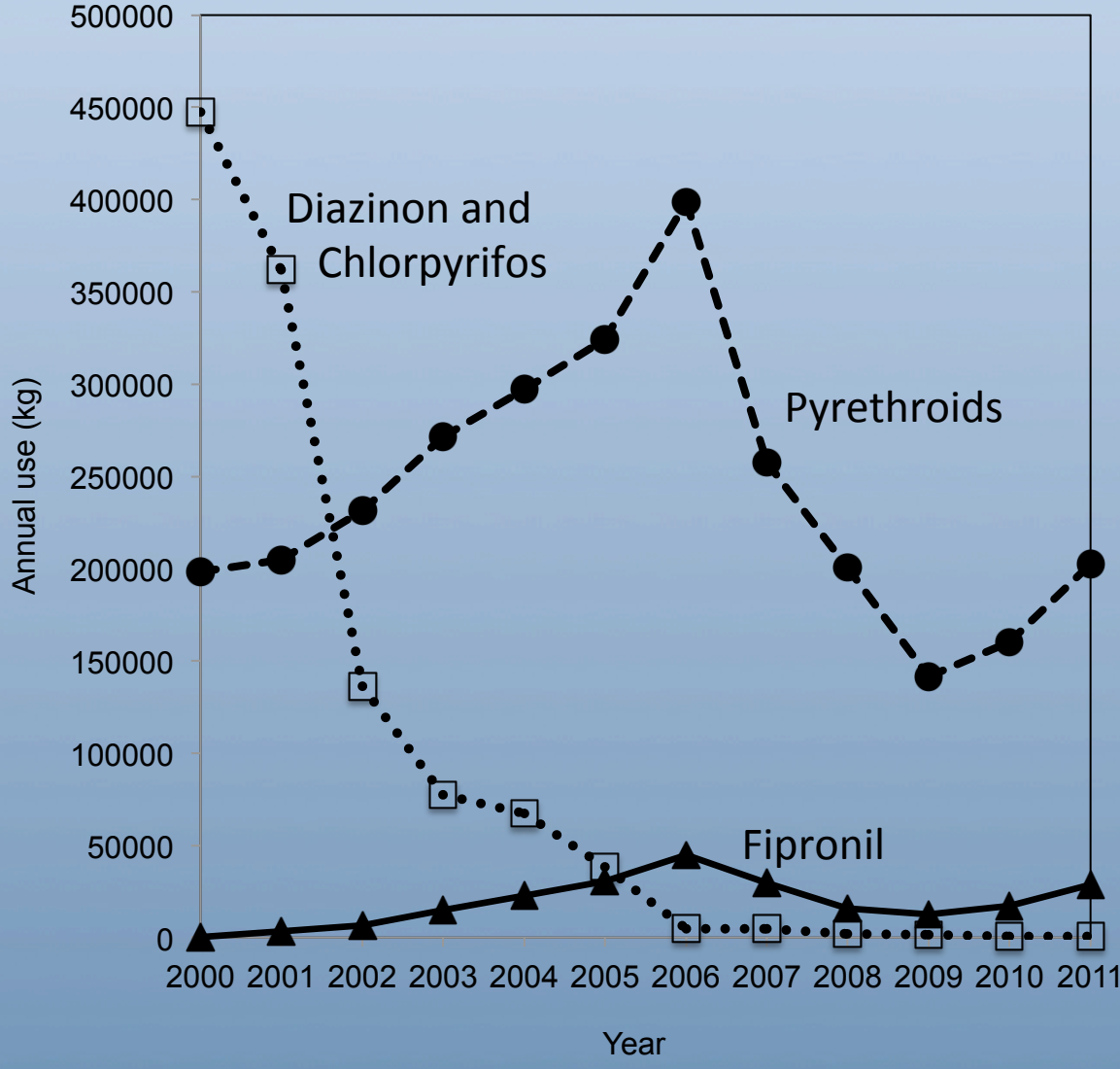
To make matters worse:

1. Environmental degradates, sometimes more toxic than the pesticide applied, are rarely monitored.

2. Pesticides have been approved for use by regulators even when the best analytical labs are not able to measure environmental concentrations exceeding toxic thresholds.

Pesticide use is a moving target

Trends in California non-agric. use of selected insecticides



Sensitivity of toxicity testing species to bifenthrin (a pyrethroid) and fipronil

Concentrations in ng/L (*= highest found by Weston lab)
96-h EC50s except only 96-h LC50 data avail. for Ceriodaphnia dubia

	Ceriodaphnia dubia	Hyalella azteca	Chironomus dilutus
Bifenthrin (High conc. = 106)*	50	3	>253
Fipronil (High conc. = 49)*	17500	728	32

C. dubia data from Yang, et al. (2006) and EPA (2007). Other data from Weston and Jackson (2009), Weston and Lydy (2013) or Weston (unpublished).

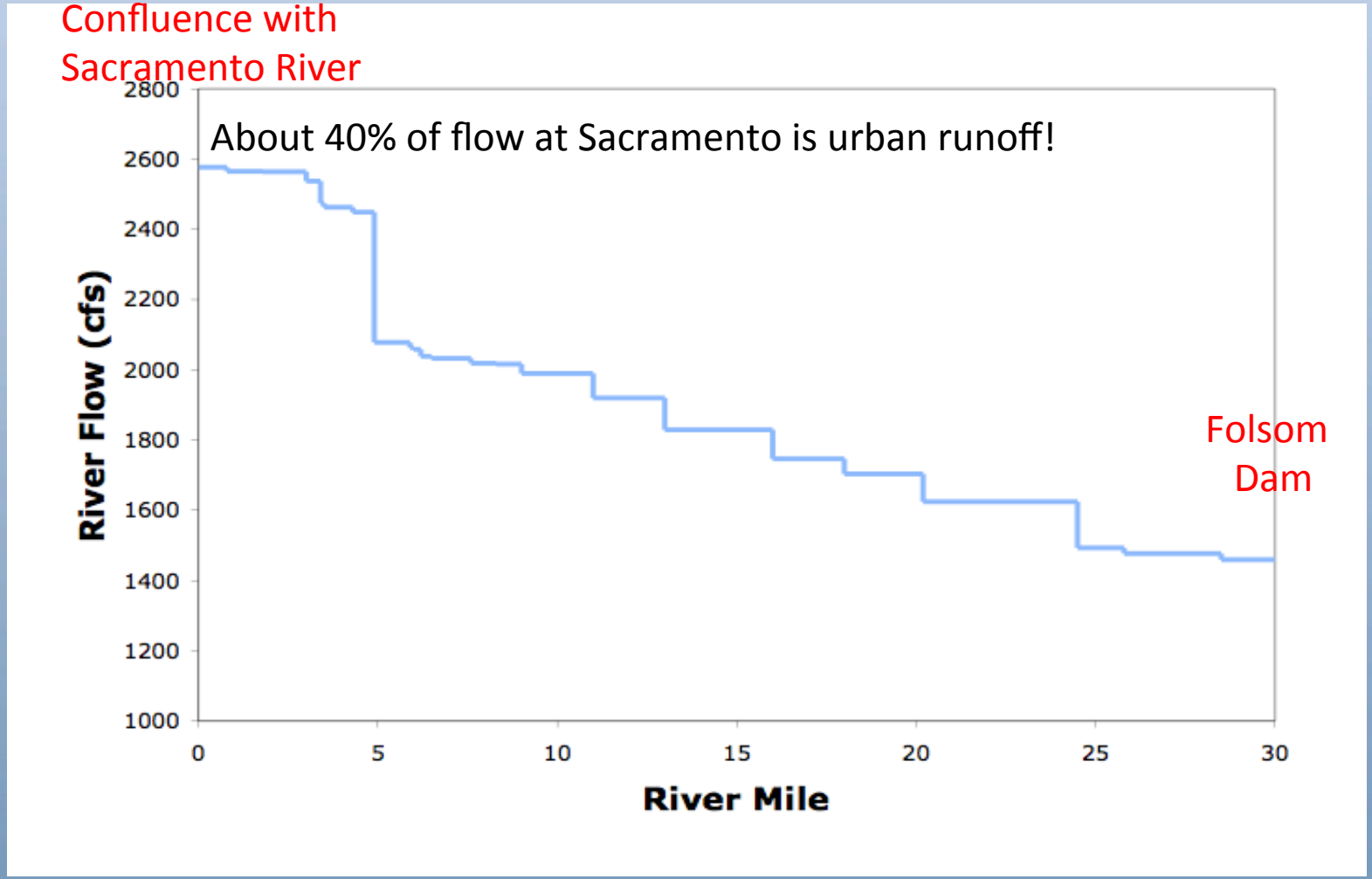
Results to be discussed

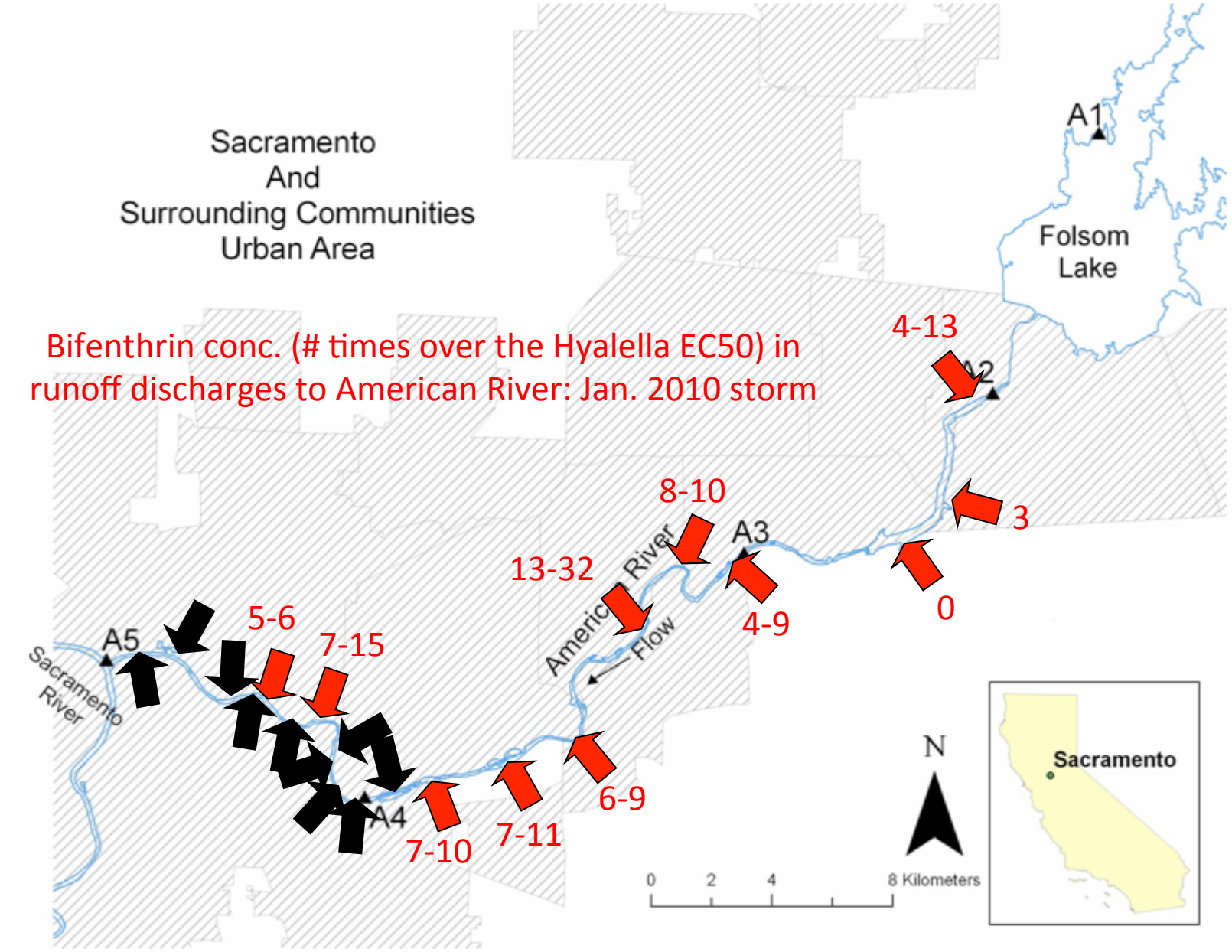
- Pyrethroids in the American River
- Pyrethroids in Cache Slough
- Fipronil in urban creeks
- Evolutionary adaptation to pesticide exposure

Pyrethroids in the American River

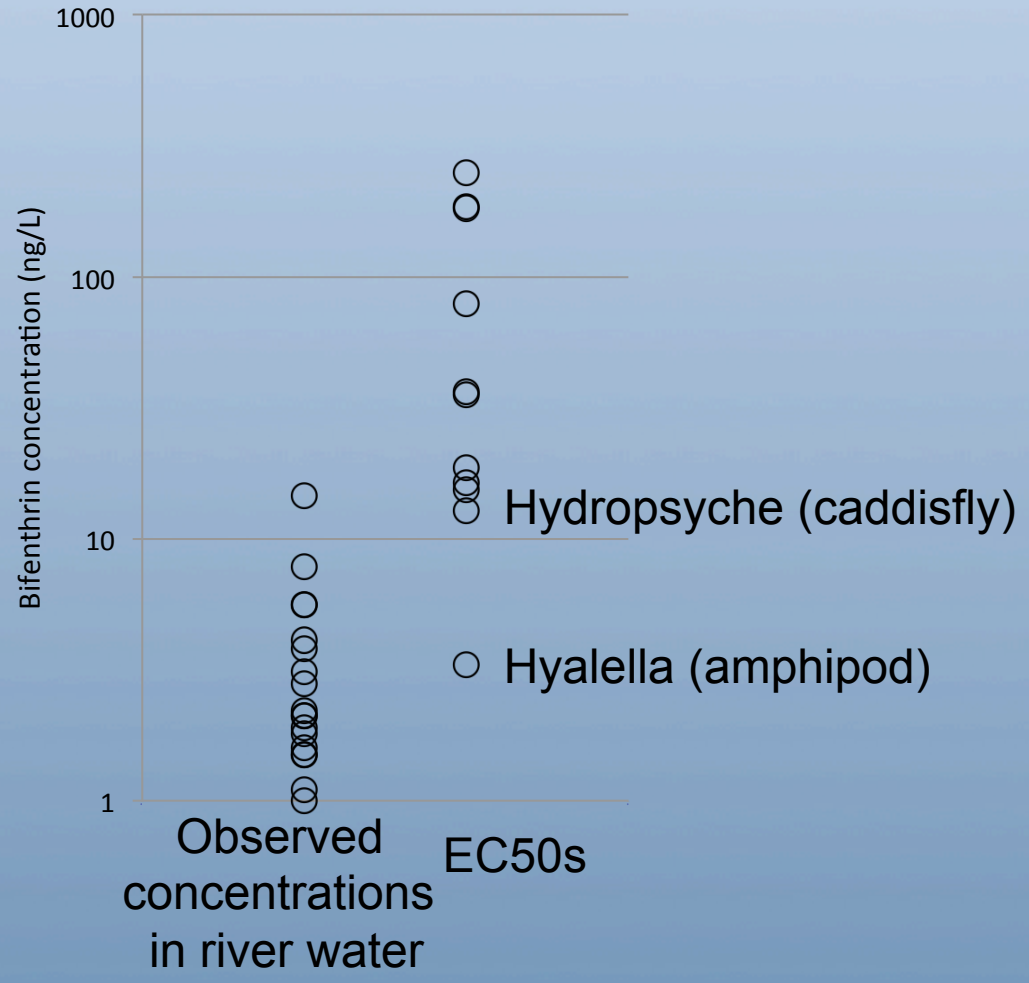
American River Flow

(Jan. 2010 storm producing 3.5 inches over 6 days)




Sacramento
And
Surrounding Communities
Urban Area
Bifenthrin conc. (# times over the Hyalella EC50) in runoff discharges to American River: Jan. 2010 storm
A1
Folsom Lake
A2
A3
A4
A5
Sacramento River
American River
Flow
4-13
8-10
3
13-32
0
4-9
5-6
7-15
6-9
7-11
7-10
N
0 2 4 8 Kilometers
Sacramento

Bifenthrin in American River vs. 96-h EC50s of salmonid prey taxa



Pyrethroids in Cache Slough

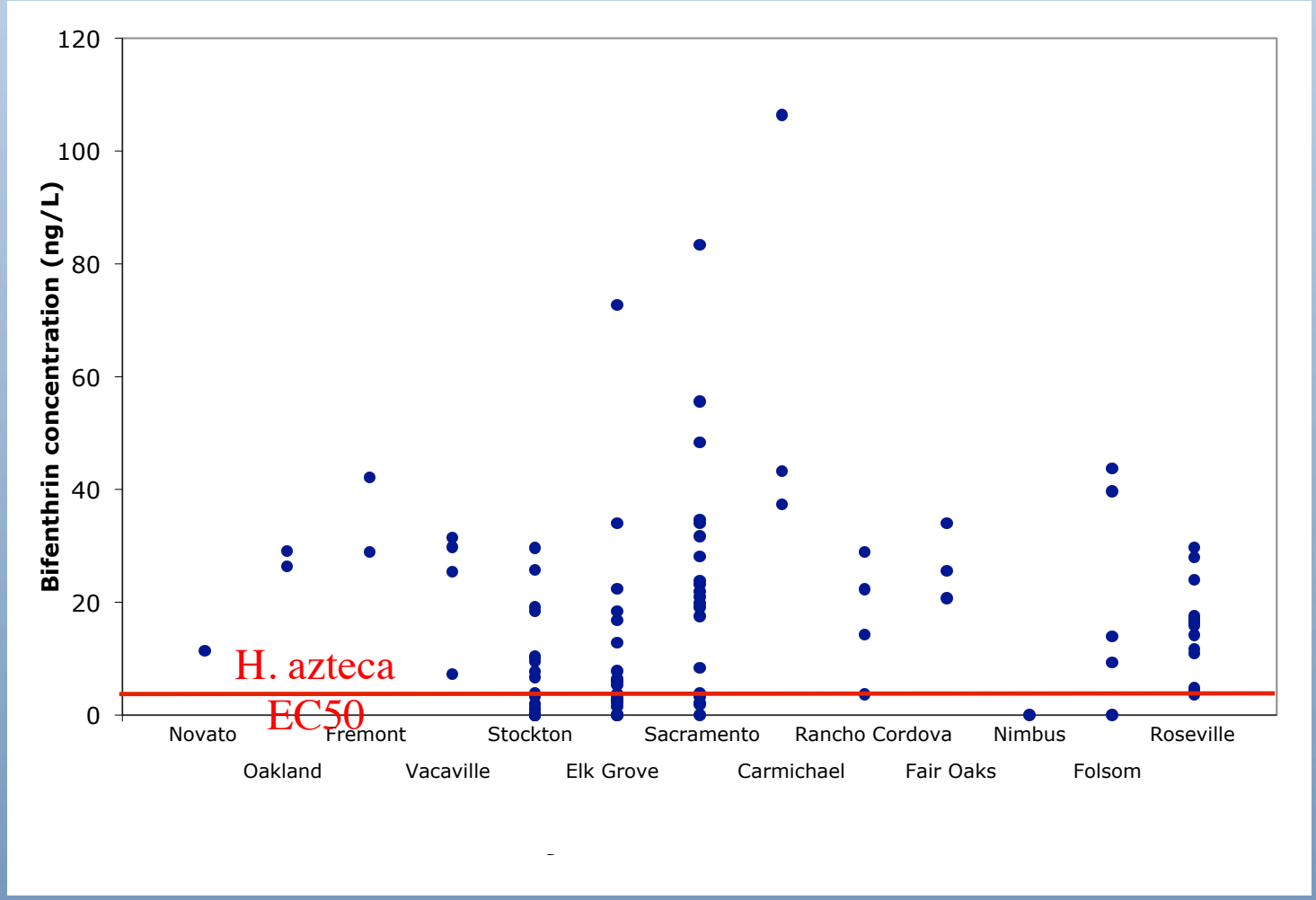
1. Ulatis Creek carries Vacaville urban pesticides, supplemented with agric. inputs, 13 miles to Cache Slough.

2. Two-thirds of samples within Cache and Lindsey Sloughs (red-circled area), following four winter storms, were acutely toxic to Hyalella.

3. The substances responsible for toxicity were the pyrethroids bifenthrin, and on one occasion, cyhalothrin.

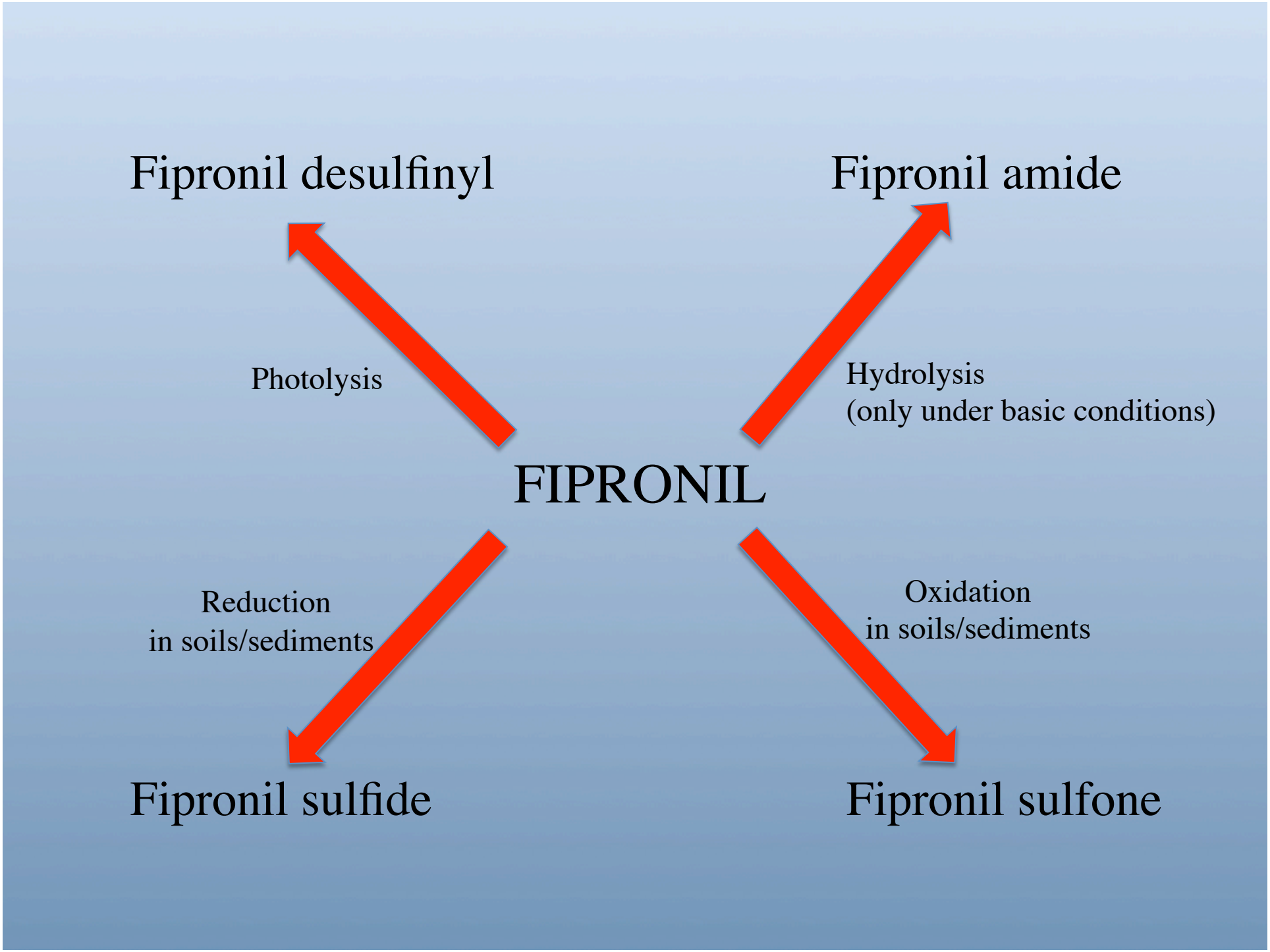
4. The highest bifenthrin concentration observed (7 ng/L) may be at the LC50 for the copepod Eurytemora affinis (important delta smelt prey species) if in situ temperatures considered.

All our urban runoff data collected 2006-2010



Fipronil in urban creeks

Fipronil is used around homes for control of ants and termites. No agricultural use in California.


Fipronil desulfinyl
Fipronil amide
Photolysis
Hydrolysis
(only under basic conditions)
FIPRONIL
Reduction
in soils/sediments
Oxidation
in soils/sediments
Fipronil sulfide
Fipronil sulfone

Waterways from which we have fipronil data

Greater Sacramento
- American River
- Arcade Creek
- Carmichael Creek
- Hinkle Creek
- Morrison Creek
- Kaseberg Creek
- Pleasant Grove Creek
- Chicken Ranch/Strong Ranch Sloughs
- Buffalo Creek

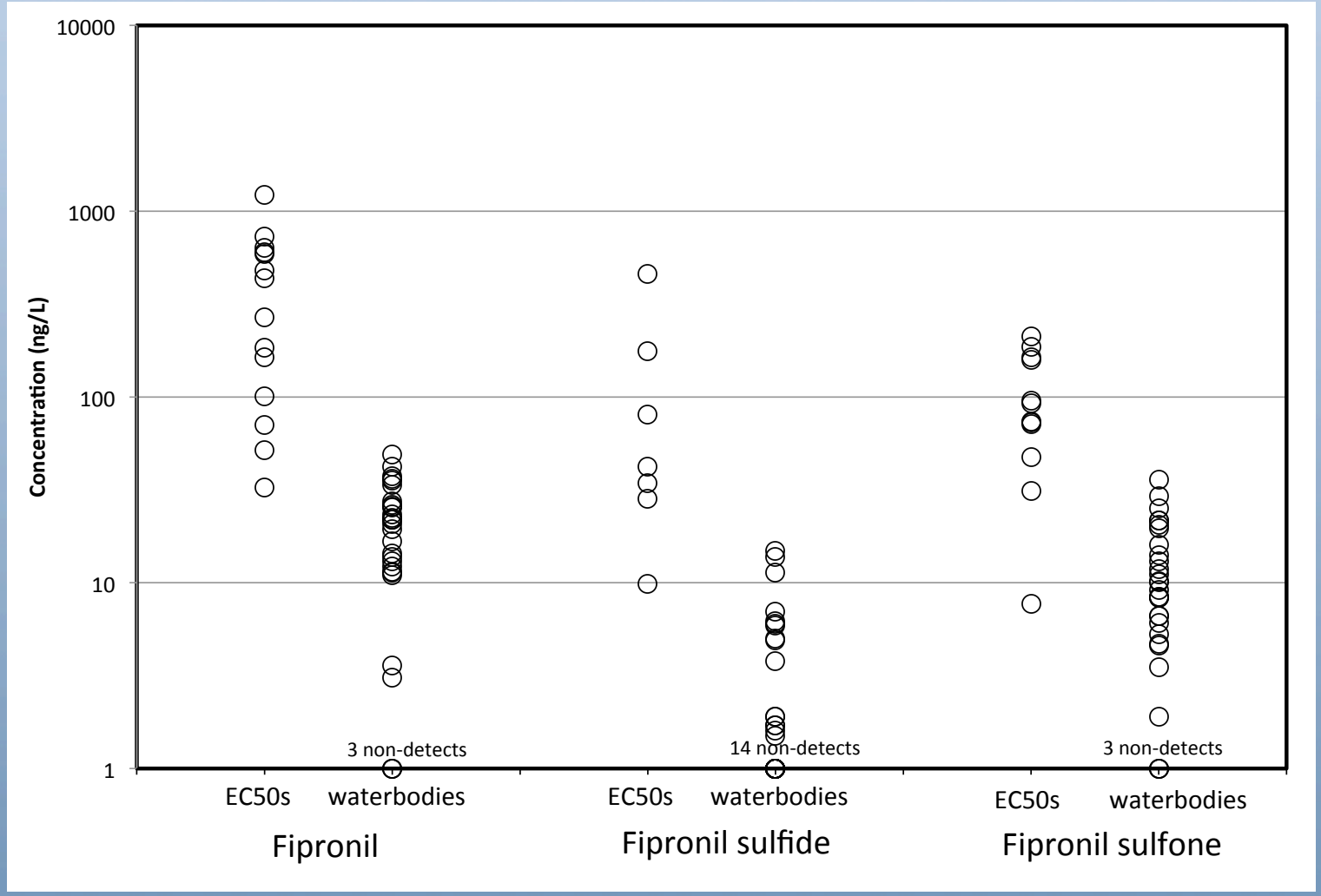
Yuba City
- Gilsizer Slough

Vacaville/Fairfield
- New Alamo Creek
- Ulatis Creek
- McCoy Creek
- Ledgewood Creek
- Laurel Creek

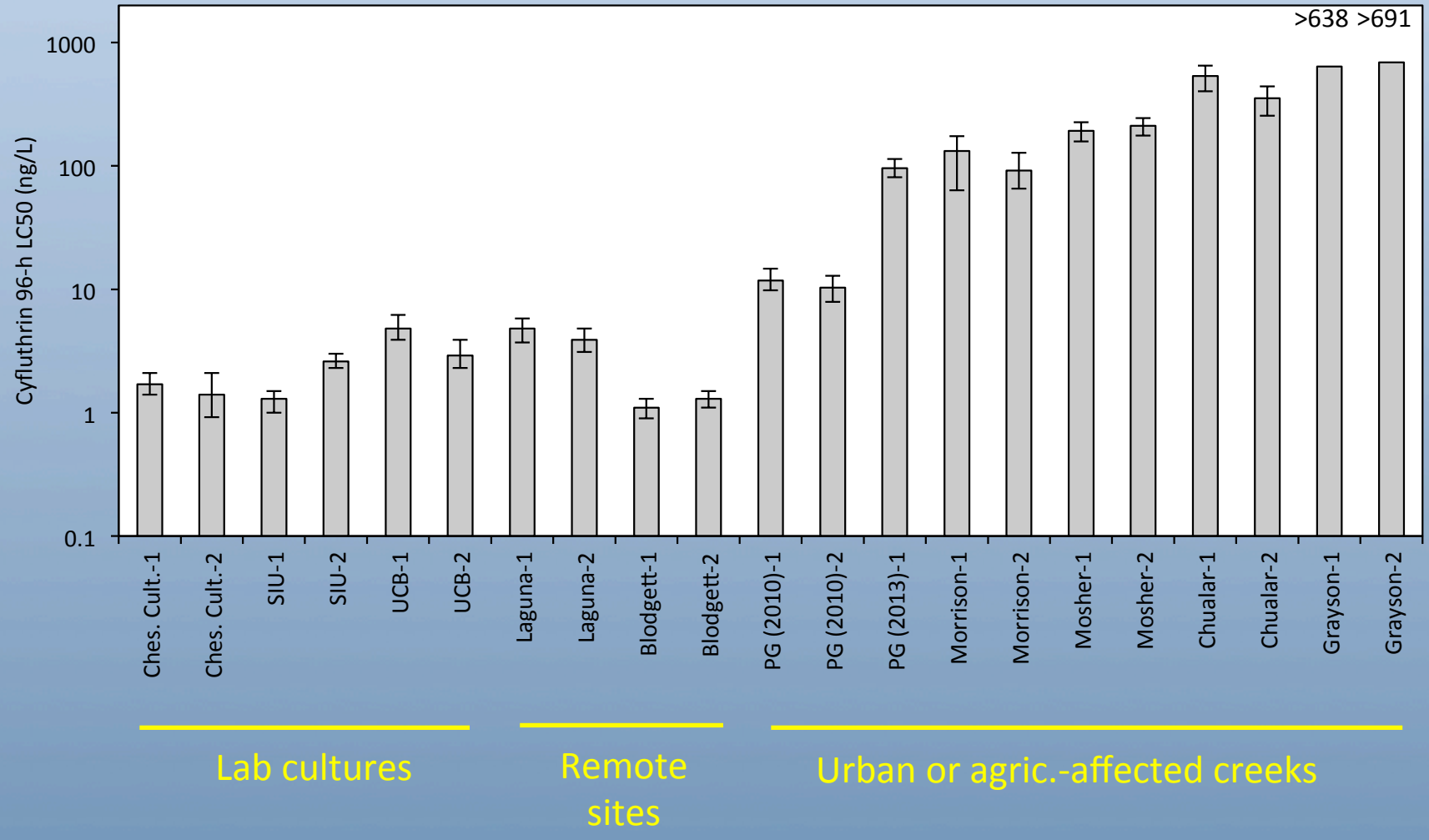
Orinda
- Lauterwasser Creek
- Moraga Creek

Stockton
- Smith Canal
- Mosher Slough

Comparison of observed conc. in urban creeks compared to toxic thresholds

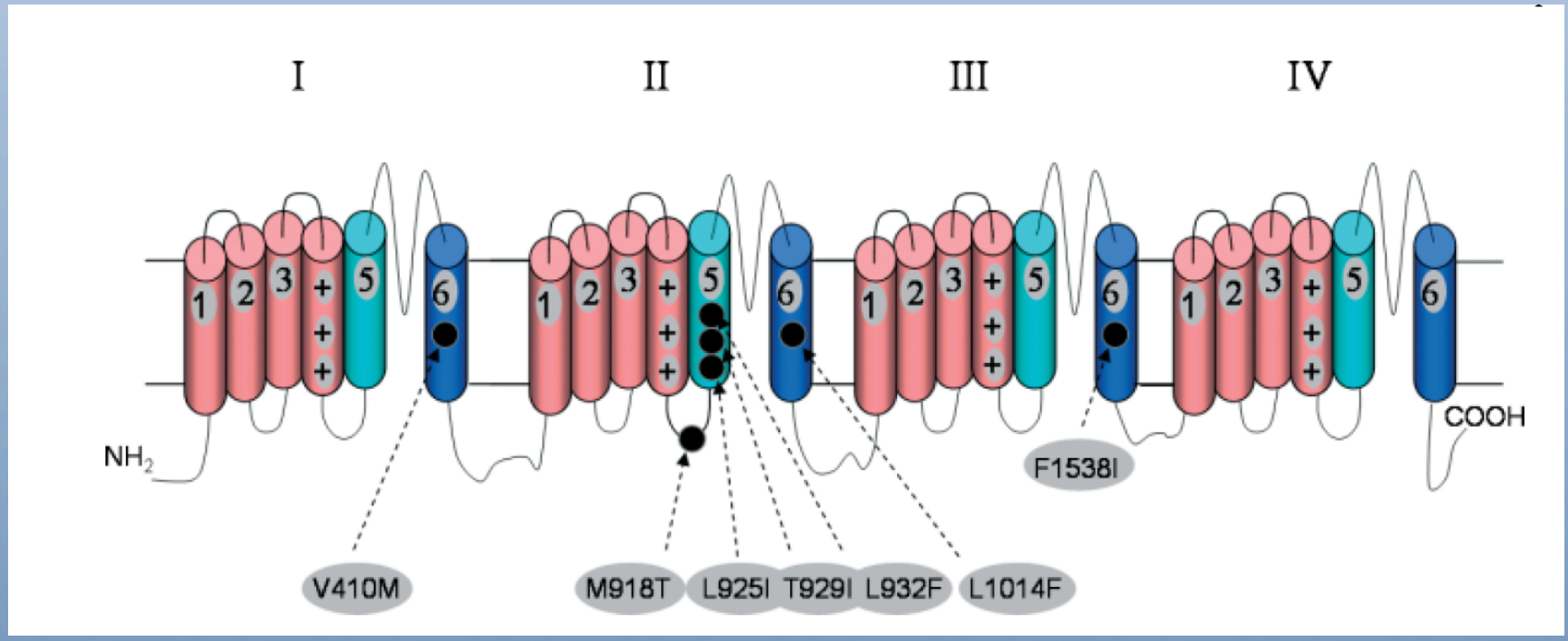


We and others have found locations from which sediment and/or water are highly toxic due to pyrethroid insecticides when tested with H. azteca in the lab, yet the sites contain a thriving wild population of H. azteca.


>638 >691
Cyfluthrin 96-h LC50 (ng/L)
1000
100
10
1
0.1
Ches. Cult.-1
Ches. Cult.-2
SIU-1
SIU-2
UCB-1
UCB-2
Laguna-1
Laguna-2
Blodgett-1
Blodgett-2
PG (2010)-1
PG (2010)-2
PG (2013)-1
Morrison-1
Morrison-2
Mosher-1
Mosher-2
Chualar-1
Chualar-2
Grayson-1
Grayson-2
Lab cultures
Remote sites
Urban or agric.-affected creeks

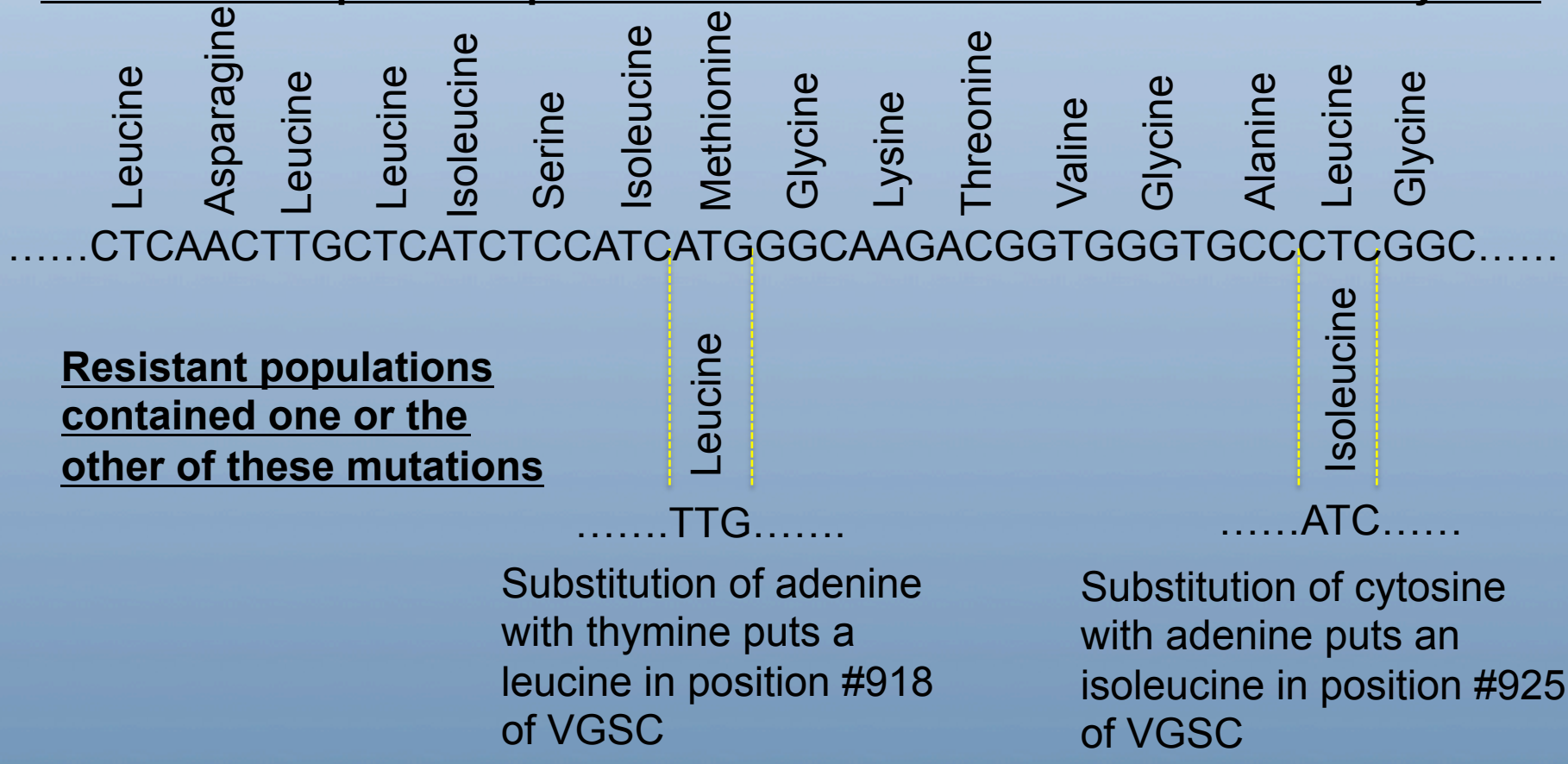
Pyrethroids target the voltage gated sodium channel, interfering with sodium transport and causing uncontrolled firing of neurons. Resistance in agricultural pests often achieved by mutations in the target site.

Davies et al. (2008) *Pest Manag Sci. 64:1126–1130*

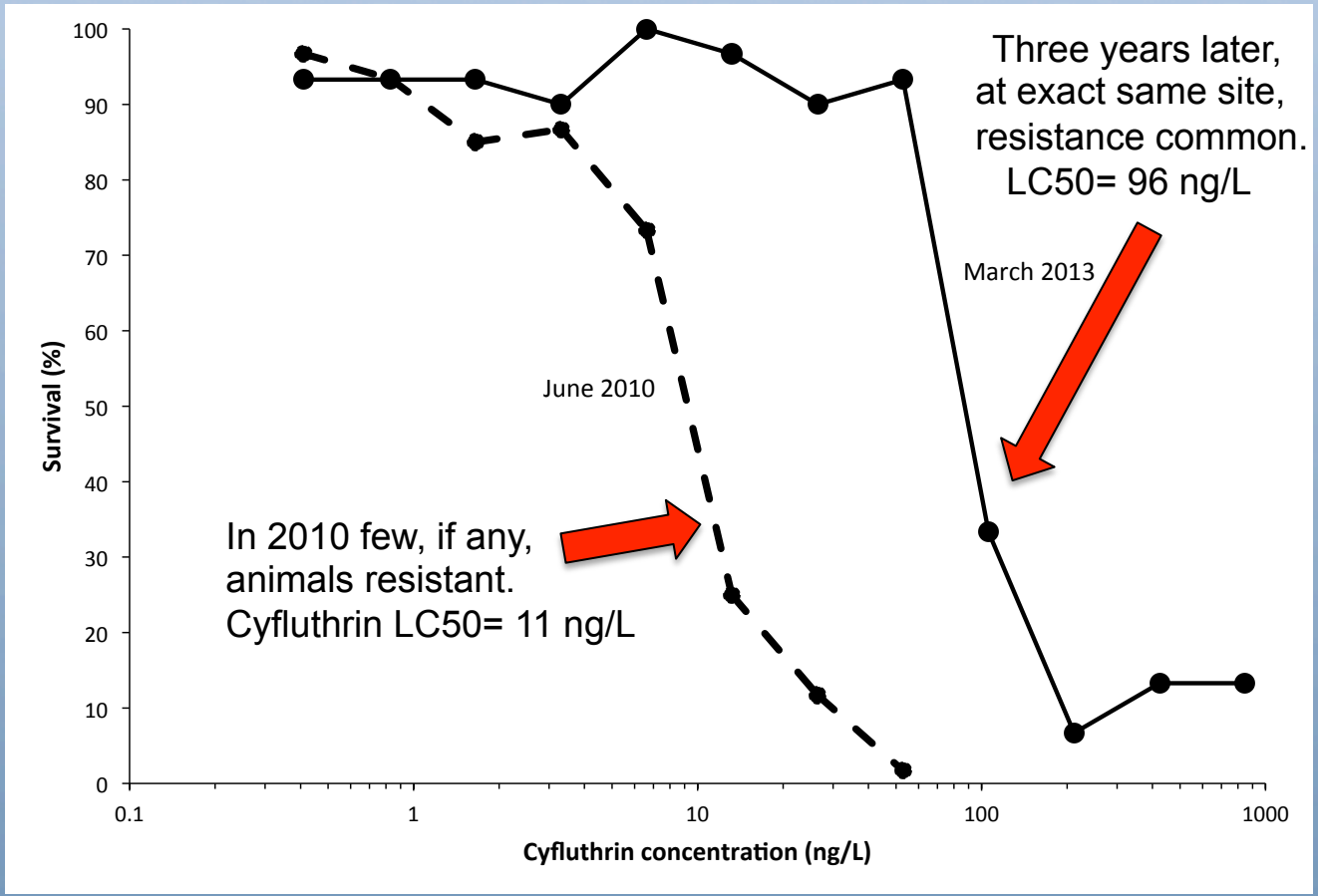


The resistant populations have achieved resistance by mutations in the voltage-gated sodium channel gene (vgsc).

Amino acid sequence in positions 911-926 of VGSC in non-resistant Hyalella



Pyrethroid sensitivity at a site depends on the time of sampling



For further details:

American River:

Weston and Lydy (2012)
Environ. Toxicol. and Chem. 31:1579-1586.

Cache Slough:

Weston, Asbell, Lesmeister, Teh, and Lydy (2014)
Environ. Toxicol. and Chem. 33:920-929.

Fipronil in urban creeks:

Weston and Lydy (2013)
Environ. Sci. and Technol. 48:1290-1297.

Pyrethroid resistance in Hyalella:

Weston, Poynton, Wellborn, Lydy, Blalock, Sepulveda, and Colbourne (2013)
Proc. Nat. Acad. Science 110:16532-16537.