California's Surface Water Ambient Monitoring Program

Stream Pollution Trends (SPoT)

Program Review

Watershed Monitoring Council
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MARINE POLLUTION STUDIES LABORATORY GRANITE CANYON

THE UNIVERSITY OF CALIFORNIA DAVIS

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Statewide Programs under the Surface Water Ambient Monitoring Program (SWAMP)

- Bioaccumulation Oversight Group (BOG)
- Perennial Streams Assessment (PSA)
- Reference Condition Management Program (RCMP)
- Stream Pollution Trends Program (SPoT)

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Importance of Surface Water Toxicity Monitoring in California

- Surface water toxicity is pervasive in California
- Between 2001 and 2010, 50% of water and sediment samples collected statewide were toxic
- Evidence suggests toxicity to invertebrates is primarily caused by pesticides – chemistry + TIEs
- A growing number of 303(d) listed water bodies have been listed due to toxicity caused by pesticides
- Water and sediment toxicity is linked to macroinvertebrate community impacts

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SPoT Program Goals

1. Determine long-term trends in stream contaminant concentrations statewide;
2. Relate water quality indicators to land-use characteristics; and
3. Use the network of sites established throughout the state to serve as a backbone for collaboration with local, regional, state & federal monitoring programs

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SPoT – General Design

- Directed design focusing on sediment contaminants and toxicity to *Hyalella azteca.*
- SPoT integrator sites are located at the base of the watersheds to capture influence of land use.
- Trend detection can be accomplished at three scales: statewide, by land use, or individual sites (Goals 1 and 2).
- The statewide network of sites provides context for the findings of local and regional programs (Goal 3).
- Design targets the same sites every year.

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SPoT - Specific Design

	2008-2014
Sites	~100 Annually (60 Tier 1, 40 Tier II)
Toxicity	*Hyalella azteca* (100)
Cold Toxicity	*Hyalella azteca* (40)
Pyrethroids	All
Fipronil	40 Tier II (starting 2013)
PAHs	40 Tier II
PBDEs	40 Tier II
OCs	All
PCBs	All
Metals	All
Microcystin	All (starting 2013)

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Trend Analysis for Toxicity and Chemistry

- Statewide
  - All samples for all years
- Based on Land Use
  - Determined at 5 km scale using National Land Cover Database
  - Urban > 20%, Agriculture > 20%, and Open > 50%
  - Thirteen sites are in more than one category
- Individual Sites
  - Important for Regional Boards and others

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Toxicity Trends – 2008-2012 (23 ºC)

	2008	2009	2010	2011	2012
Number of Sites Tested	92	23	95	100	100
% Non-toxic	83	74	81	85	82
% Toxic	11	17	11	10	9
% Highly Toxic	6	9	8	5	9
% Toxic + % Highly Toxic	17	26	19	15	18

Testing at 15 °C shows a higher incidence of toxicity.

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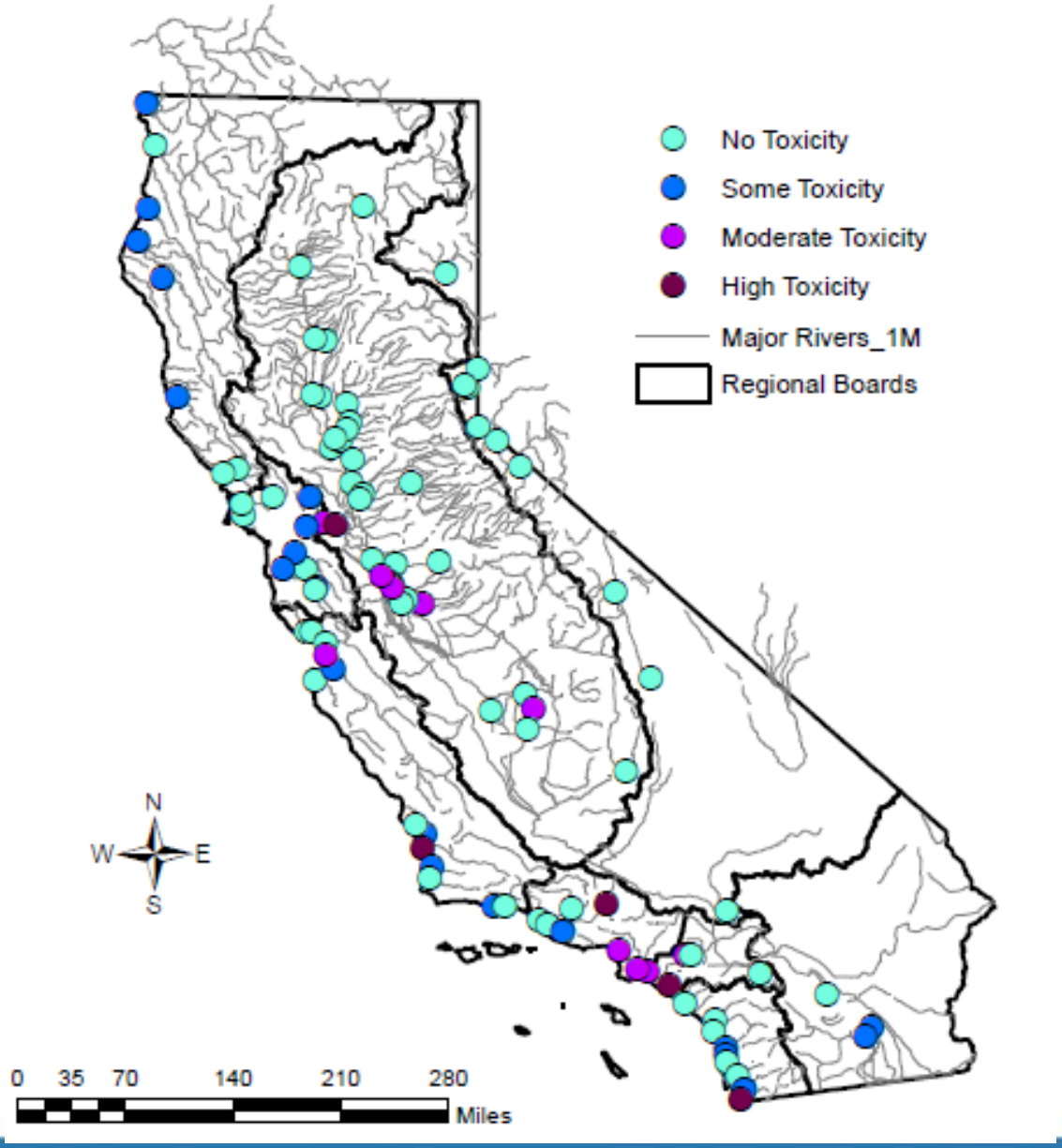
Mean Magnitude of Toxicity 2008 - 2012



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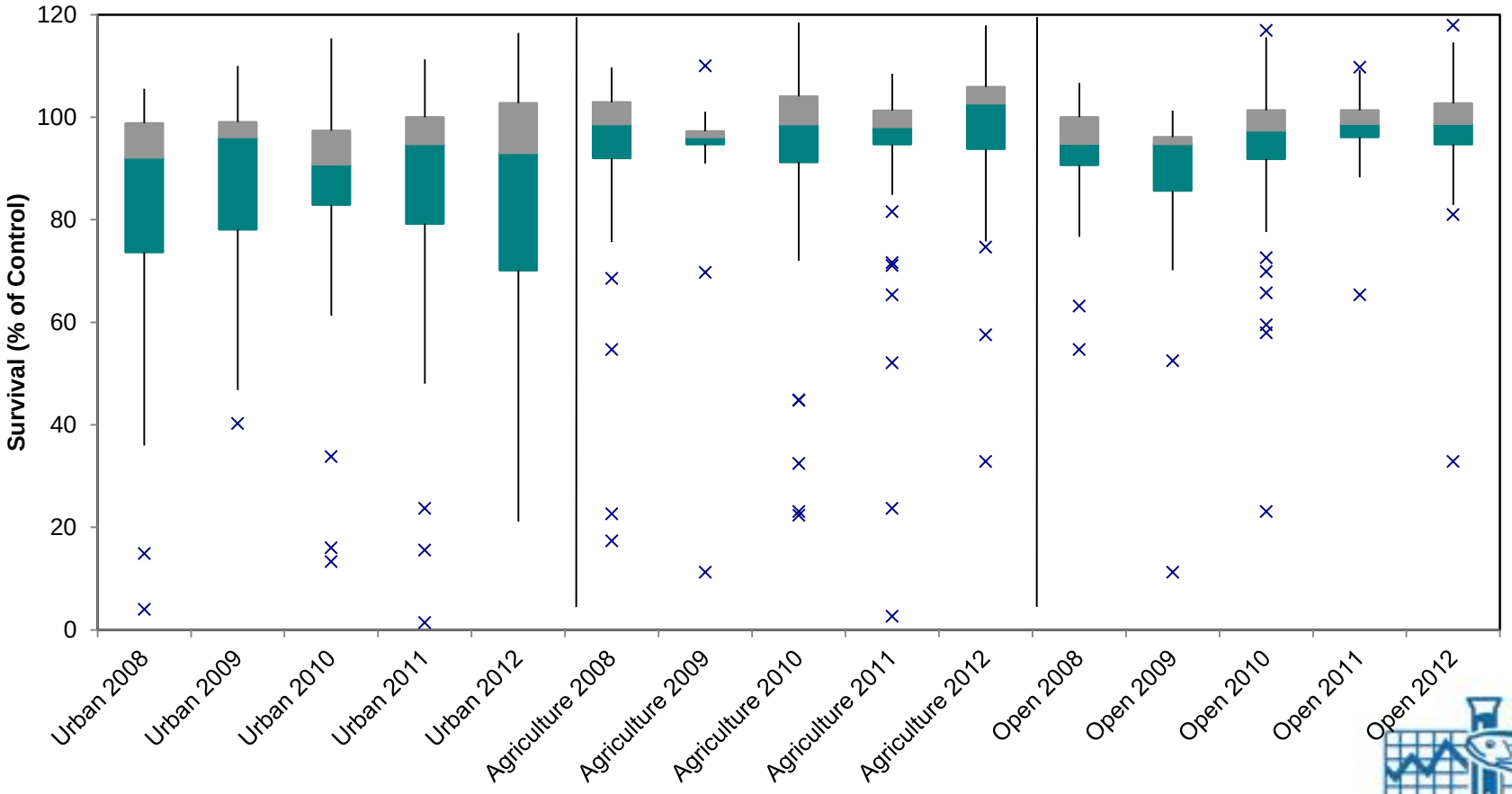
Toxicity Related to Land Use



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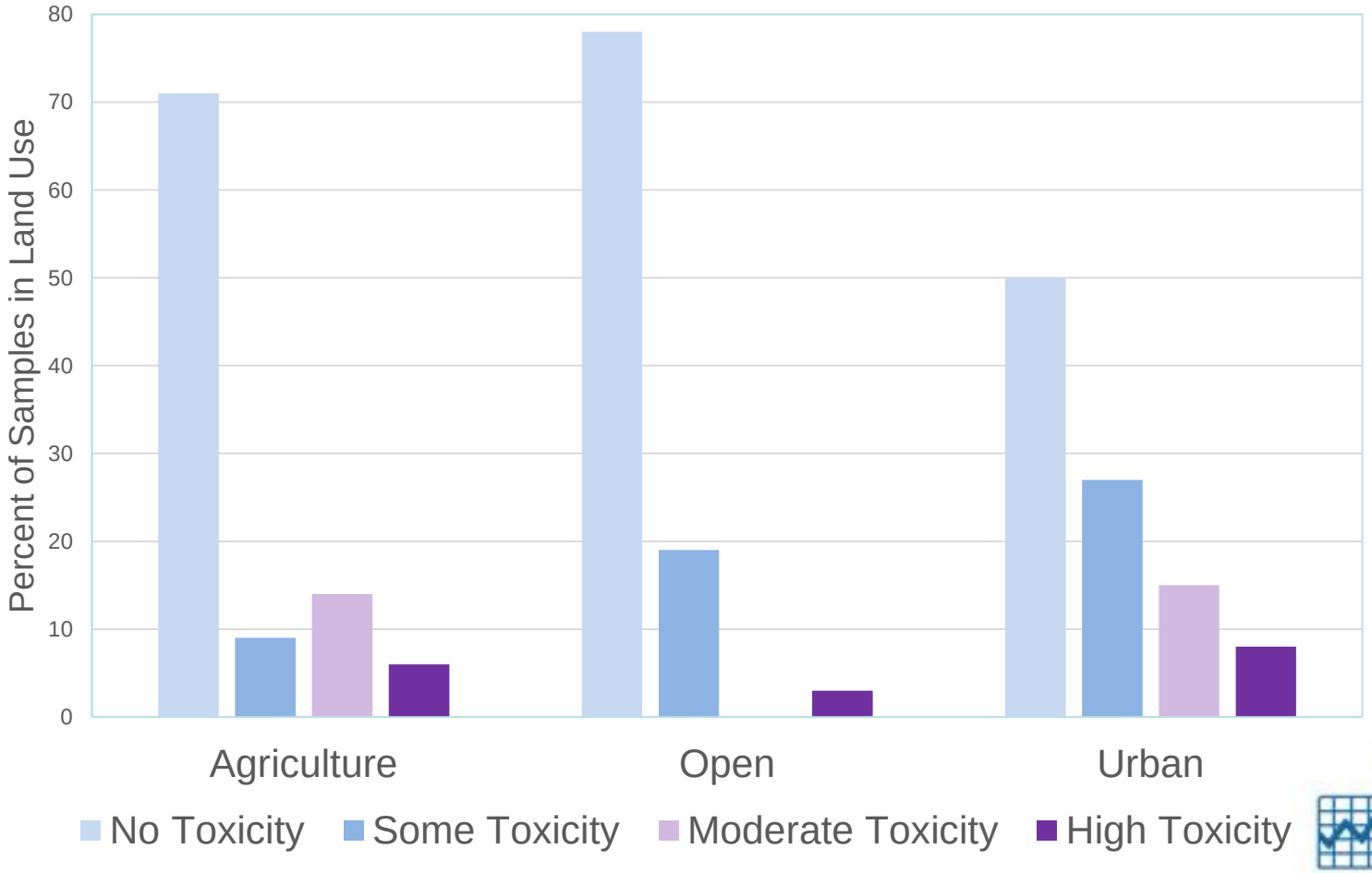

A significant decrease in toxicity (increase in survival) at sites from open watersheds.

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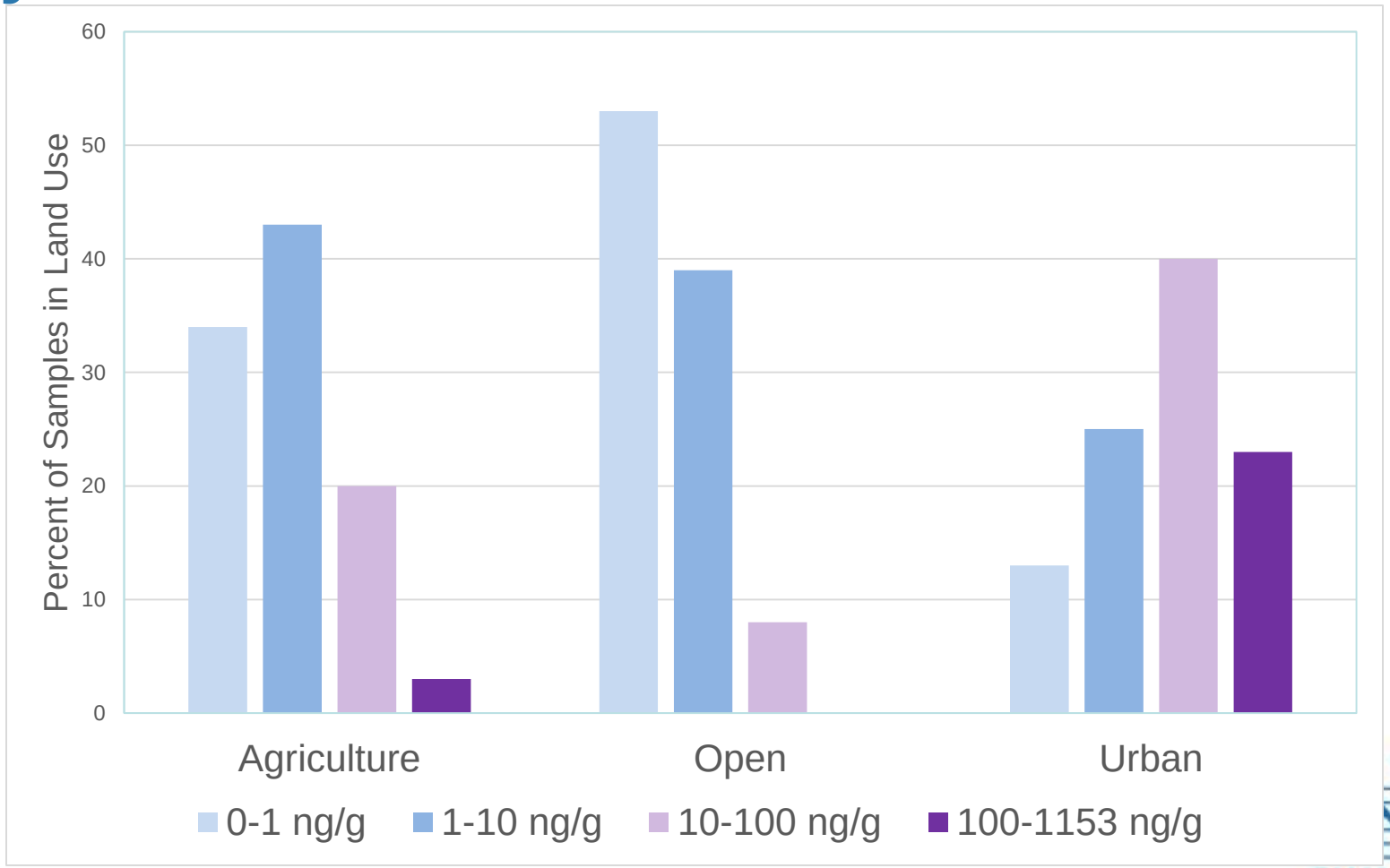
Pyrethroid Pesticides Related to Land Use



Significant increase in Pyrethroids statewide (likely driven by a significant increase in at urban sites).

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Trends

Variable	Statewide	Urban	Agriculture	Open	Individual Sites
Survival	=	=	=	↑	4↑
Pyrethroids	↑	↑	=	=	3↑ 1↓
DDT	↓	↓	↓	↓	10↓
PCB	↓	↓	↓	↓	1↑
PAH	=	=	=	↓	1↑ 2↓
PBDE	=	=	=	=	1↓
Cd, Cu, Pb, Zn	=	=	=	=	1↑ 1↓

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Evaluation of Chemical Thresholds

Chemical	Type	Concentration
Pyrethroid Pesticides		
Bifenthrin	LC50	12.9
Bifenthrin	LC50	0.52
Cyfluthrin	LC50	13.7
Cyfluthrin OC	LC50	1.08
Cyhalothrin, Lambda	LC50	5.6
Cyhalothrin, Lambda OC	LC50	0.45
Cypermethrin	LC50	14.9
Cypermethrin OC	LC50	0.38
Deltamethrin/Tralomethrin	LC50	9.9
Deltamethrin/Tralomethrin OC	LC50	0.79
Esfenvalerate/Fenvalerate	LC50	41.8
Esfenvalerate/Fenvalerate OC	LC50	1.54
Fenpropathrin	LC50	177
Fenpropathrin OC	LC50	8.9
Permethrin	LC50	201
Permethrin OC	LC50	10.9
Organochlorine Pesticides		
Sum DDT	LC50	11000
Sum DDT OC	LC50	367
Total Chlordane	PEC	17.6
Endrin	LC50	4400
Endrin OC	LC50	147
Dieldrin	LC50	2000
DDD (o,p')	LC50	1300
DDE (o,p')	LC50	8300
Heptachlor Epoxide	PEC	16
Methoxychlor	LC50	85.8

Chemical	Type	Concentration
Organophosphate Pesticides		
Chlorpyrifos	LC50	399
Chlorpyrifos OC	LC50	1.77
Diazinon	LC50	1085
Diazinon OC	LC50	54.6
PAHs		
Sum PAH	LC50	1800
Anthracene	PEC	845
Benz(a)anthracene	PEC	1050
Benzo(a)pyrene	PEC	1450
Chrysene	PEC	1290
Fluoranthene	LC50	1077
Fluorene	PEC	536
Naphthalene	PEC	561
Phenanthrene	PEC	1170
Pyrene	PEC	1520
PCBs		
Sum PCB	LC50	400
Metals		
Arsenic	LC50	532
Cadmium	PEC	4.98
Chromium	PEC	111
Copper	LC50	260
Lead	PEC	128
Mercury	PEC	1.06
Nickel	LC50	521
Zinc	PEC	459

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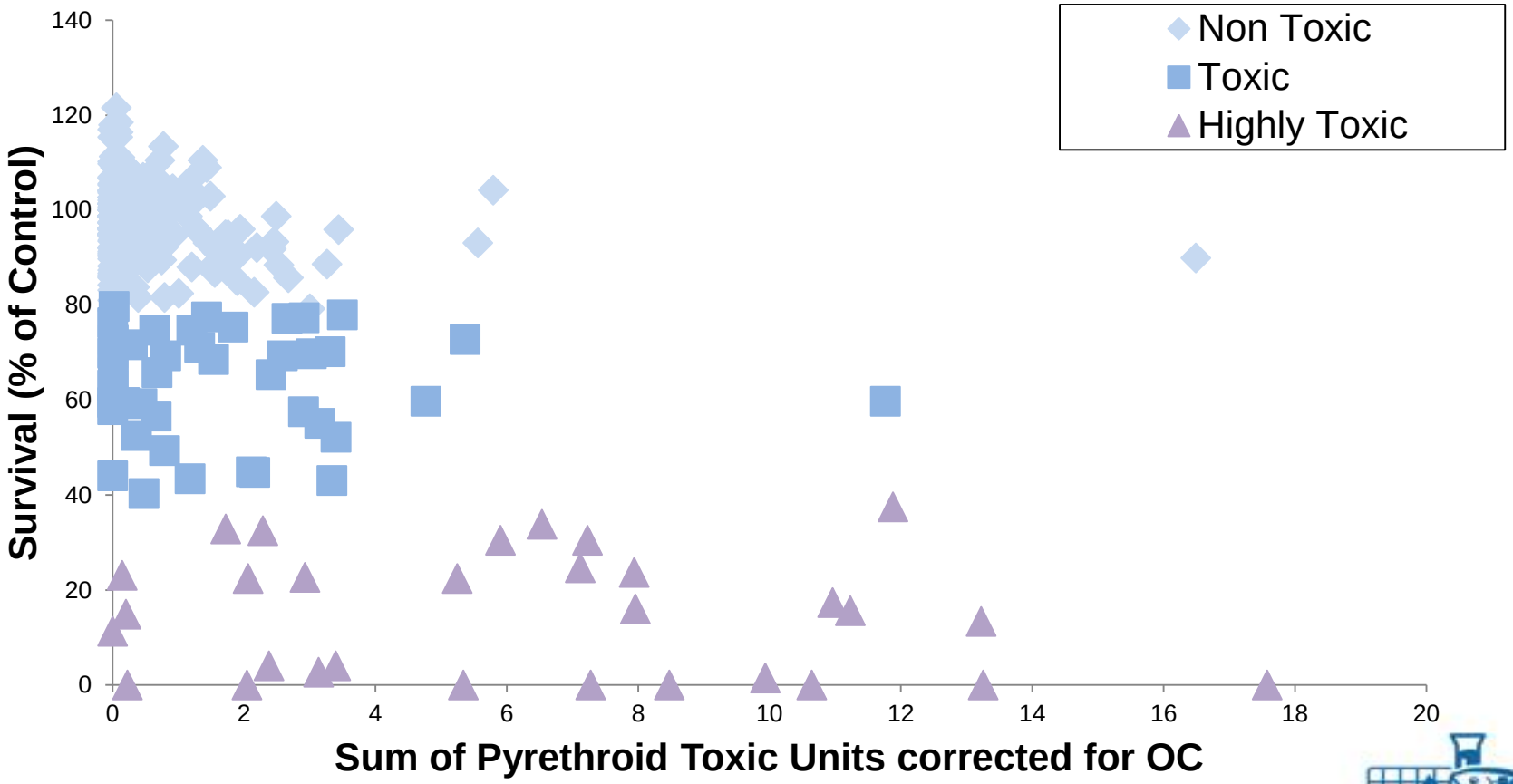
Relationship Between Toxicity and Pyrethroids



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SPoT Adaptations

- Power analysis provided a range of estimates for the time it would take for trends to appear.
  - Estimates were based on the variability of the measurement, but significant trends have been noted (statewide, by land use, and at individual sites)
  - There are sites that could be visited, and analytes that could be measured, less often.
- As new chemicals emerge, and usage increases, SPoT is adapting to monitor trends.

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Contaminants of Emerging Concern

- Fipronil:
  - Started measuring parent compound and degradates in 2013
  - *Hyalella* test organism not as sensitive as *Chironomus* (EC50s = 213-728 ng/L and 7.7-32.5 ng/L, respectively)
  - Addition of *Chironomus* toxicity testing at Tier II sites to provide relevant information about toxicity of fipronil
- Imidacloprid:
  - Not measuring this chemical in SPoT sediments because highly soluble
  - *Hyalella* not as sensitive as *Chironomus*
  - Beginning collaborations between Regional SWAMP programs and DPR to assess potential toxicity

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Region 3 *Hyalella* and *Chironomus* Tests

	Hyalella		*Chironomus*	
Sample	Mean	SD	Mean	SD
Alisal Slough	38	8	0	0
Chualar Creek	0	0	73	4
Main St. Ditch	94	5	92	10
Orcutt Creek	50	20	48	14
Oso Flaco Creek	0	0	42	34
Quail Creek	0	0	2	4
Rec Ditch III	30	10	4	8
Solomon Creek	98	4	0	0
Tembladero Slough	59	9	83	12

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Collaborations and Connections

- Collaborations
  - DPR - Intensive Site Study
  - CSUMB – Cyanotoxin Measurements
  - DPR and SWAMP pesticide monitoring (Regions 3 and 7)
- Connections
  - Stormwater Coalitions – SMC and RMC
  - Individual Sites – Klamath River, Santa Margarita River
- Overlap
  - PSA and Regional Bioassessment Sites

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Intensive Sampling Study - DPR

- Goal: to determine the effectiveness of new pesticide regulations for professional applicators.
- Four Urban sites chosen for more intensive monitoring starting in 2013 (two DPR and two SPoT).
- Previously, these sites have exhibited significant toxicity and toxic concentrations of pyrethroid pesticides.
- The study should provide additional information at a higher resolution.

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Cyanotoxin Monitoring - CSUMB

- Cyanotoxins may associate with depositional sediments (e.g., Kudela et al. Solid Phase Adsorption Toxin Tracking = SPATT samplers)
- Monitor microcystin-LR in sediment interstitial water at all 100 SPoT stations – minor cost to SPoT
- ELISA (Envirologix microcystin-LR QuanitPlate kit)
  - Detections in 77% of sediment samples in 2013
  - Detections in 9% of interstitial water samples
  - Also have Cyanotoxin data for the intensive sites
  - LC/MS Collaboration with King County WA lab for ELISA confirmation

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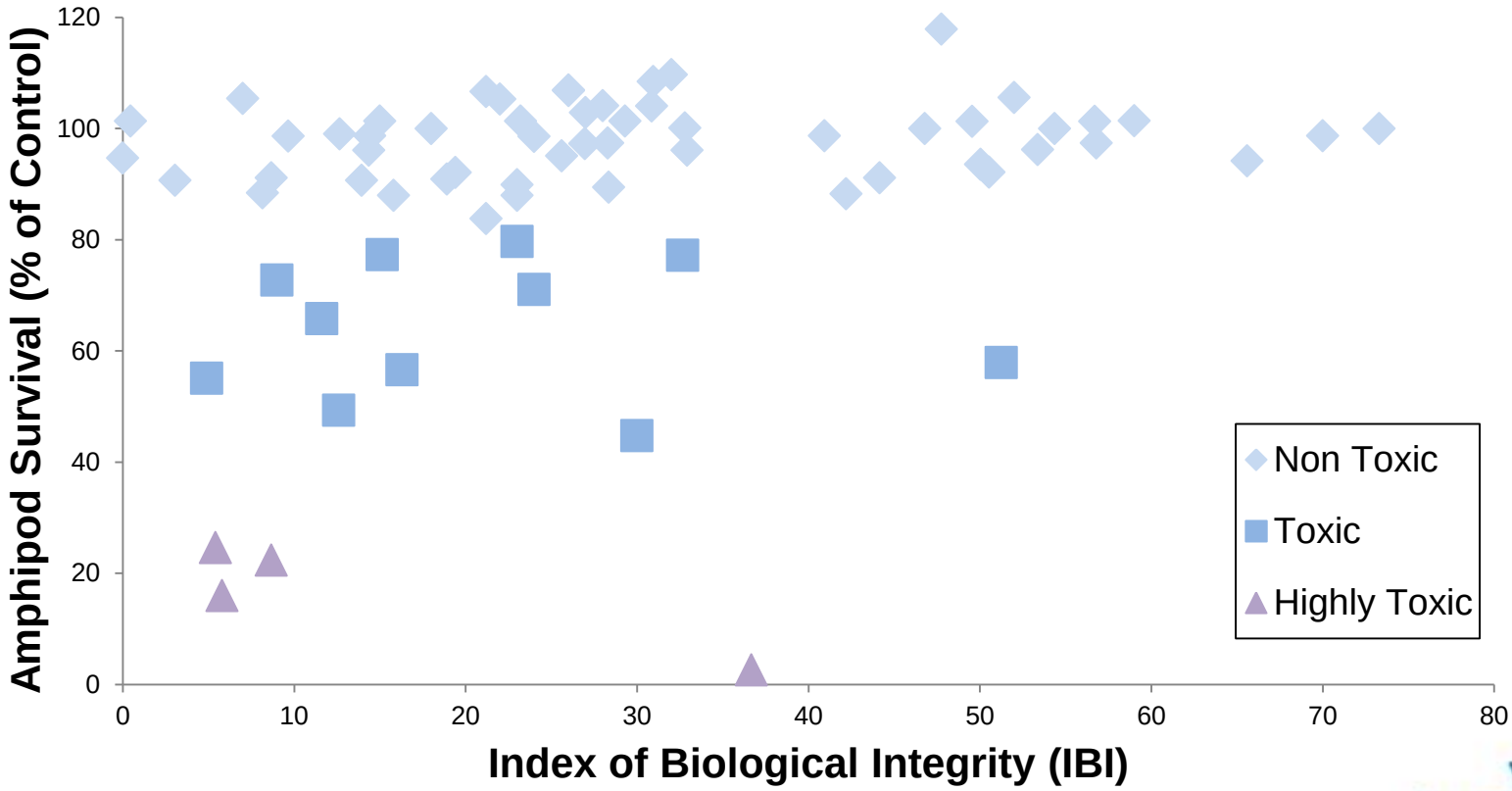
SPoT Indicators in Relation to Stream Ecology



This analysis also revealed a significant negative correlation between IBI and contaminant concentrations, particularly pyrethroid pesticides.

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PSA and Regional Bioassessment

- SPoT would like to create a list of targeted sites that share sediment toxicity, sediment chemistry, and bioassessment
- Sites would provide data and create hypotheses for causal assessments
- Tools for causal assessments
  - CSCI (California Stream Condition Index) – index that compares observed macroinvertebrate community what would be expected under ideal conditions
  - SPEAR (SPEcies At Risk) – index that accounts for sensitivity and life cycle of benthic macroinvertebrates

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Thank you.

Questions?

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http://www.waterboards.ca.gov/water_issues/programs/swamp/spot/

www.granitecanyon.org

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