




ORANGE COUNTY
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Linking Pesticide Detection in Runoff with Water Quality Toxicity

Dr. Ted von Bitner
OC Watersheds
June 1, 2011

Acknowledgements

OC Watersheds

- Joel Magsalin, Project Scientist

Salt Creek Watershed partners

- City of Dana Point
  Lisa Zawaski, *Stormwater Manager*
  Brad Fowler, *Director of Public Works*
- City of Laguna Niguel
  Nancy Palmer, *Stormwater Manager*
- University of California
  Dr. Darren Haver, Director, South Coast Research & Extension Center

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Outline

- Overview of Orange County Stormwater Program
- Case Study: Salt Creek Watershed

  Linking Pesticide Detection and Water Quality Toxicity
- Future Efforts

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Orange County Stormwater Program

Water Quality Monitoring Programs

Cooperative effort between,

County of Orange

Orange County Flood Control District

34 Incorporated Cities

In response to the municipal National Pollutant Discharge System Elimination Program (NPDES)

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Orange County's Monitoring Program

- Pesticides (lab costs $261,000 per year)
  - Organochlorine (DDT, Chlordane, etc.)
  - Auxin Herbicides (2,4 – D, dicamba, etc.)
  - Triazine
  - Carbamates
  - Organophosphorus
  - Pyrethroids

Infrequently detected or in decline

- Toxicity (lab costs $400,000 per year)
  - Coastal streams
  - Estuaries and Wetlands
  - Harbors
  - Marine conservation areas

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What is Toxicity Testing?

- **Definition**: A laboratory based method for measuring mortality rates in test organisms by varying the exposure duration and concentration of toxicants

- **Purpose**: Help evaluate environmental pollutant concentrations that can create an impact on biological species

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Toxicity Test Organisms

Marine: Americamysis *bahia*
(common name, Mysid or Opossum shrimp)

Sensitivity: Pyrethroid and Fipronil Insectides

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Toxicity Test Organisms

Marine; Strongylocentrotus *purpuratus*
(common name, Purple Sea Urchin)

Sensitivity:

Metals (Copper)

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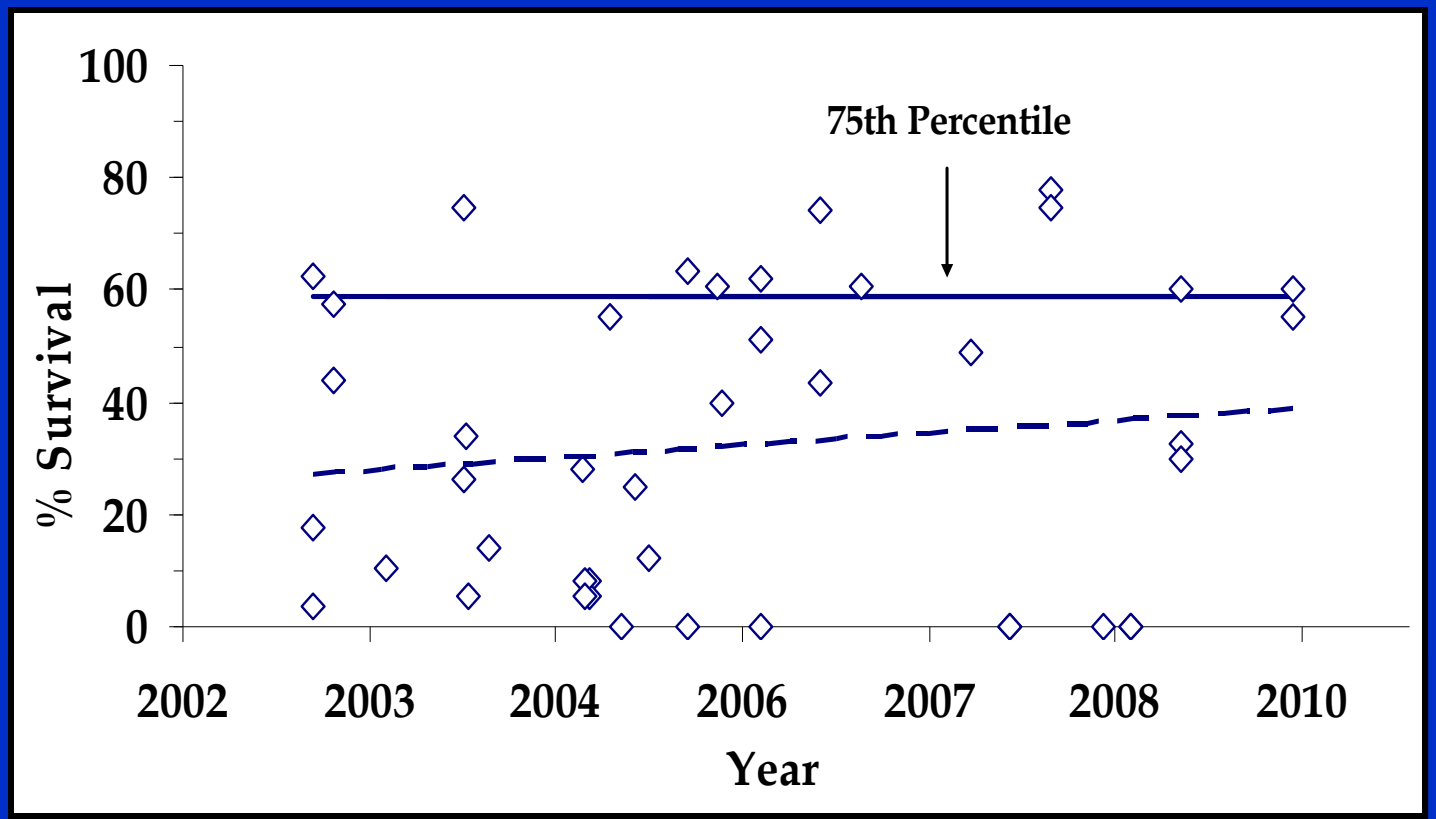
Case Study: Salt Creek

Dana Point Coastal Streams Watershed

Watershed Area = 10.3 square miles

History of Toxicity in Salt Creek Watershed



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Salt Creek Watershed Workgroup

- Working coalition of local government agencies and the University of California
- Collaborative effort started, Spring 2010
- Technical Leads
  - County of Orange
  - University of California
- Outreach and Watershed Management
  - City of Dana Point
  - City of Laguna Niguel
  - University of California

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Workgroup Goals

- To identify, locate, and reduce toxicant(s) to protect Salt Creek and the Niguel State Marine Conservation Area
- Develop a model approach for the Stormwater Program in future source control efforts

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Dana Point Coastal Streams Watershed

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Where do we find pesticides?

In storm drains, creeks, and rivers

Sample Date	Site ID	cyhalothrin (ng L^{-1})	Permethrin cis (ng L^{-1})	Permethrin trans (ng L^{-1})
4/8/2008	AV	√		mv
4/8/2008	SC	√		mv
4/8/2008	SC	√		mv
4/8/2008	SC	√		mv
4/8/2008	WC	√		mv
4/8/2008	WC	√		mv
4/8/2008	WC	√		mv
5/13/2008	AV	√		mv
5/13/2008	SC	√		mv
5/13/2008	SC	√		mv
5/13/2008	SC	√		mv
5/13/2008	WC	√		mv
5/13/2008	WC	√		mv
5/13/2008	WC	√		mv
6/13/2008	SC	√		mv
6/13/2008	SC	√		mv
6/13/2008	SC	√		mv

Study Hypothesis

Is pesticide related toxicity ubiquitous?

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What are the critical factors about pesticide related toxicity?

- (Concentration) presence or absence?
- (Load) amount?
  - Size of area applied
  - Frequency of application
  - Magnitude of application
- (Mechanism) transport pathways?
  - Landscape over-irrigation
  - Application before rain event

Most important,
If measured in terms of realistic context
a toxicity effect

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Study Questions

1. When is toxicity a problem?
2. What is the cause of toxicity?
3. What is the source of the toxicity?
4. How do we control the toxicity?

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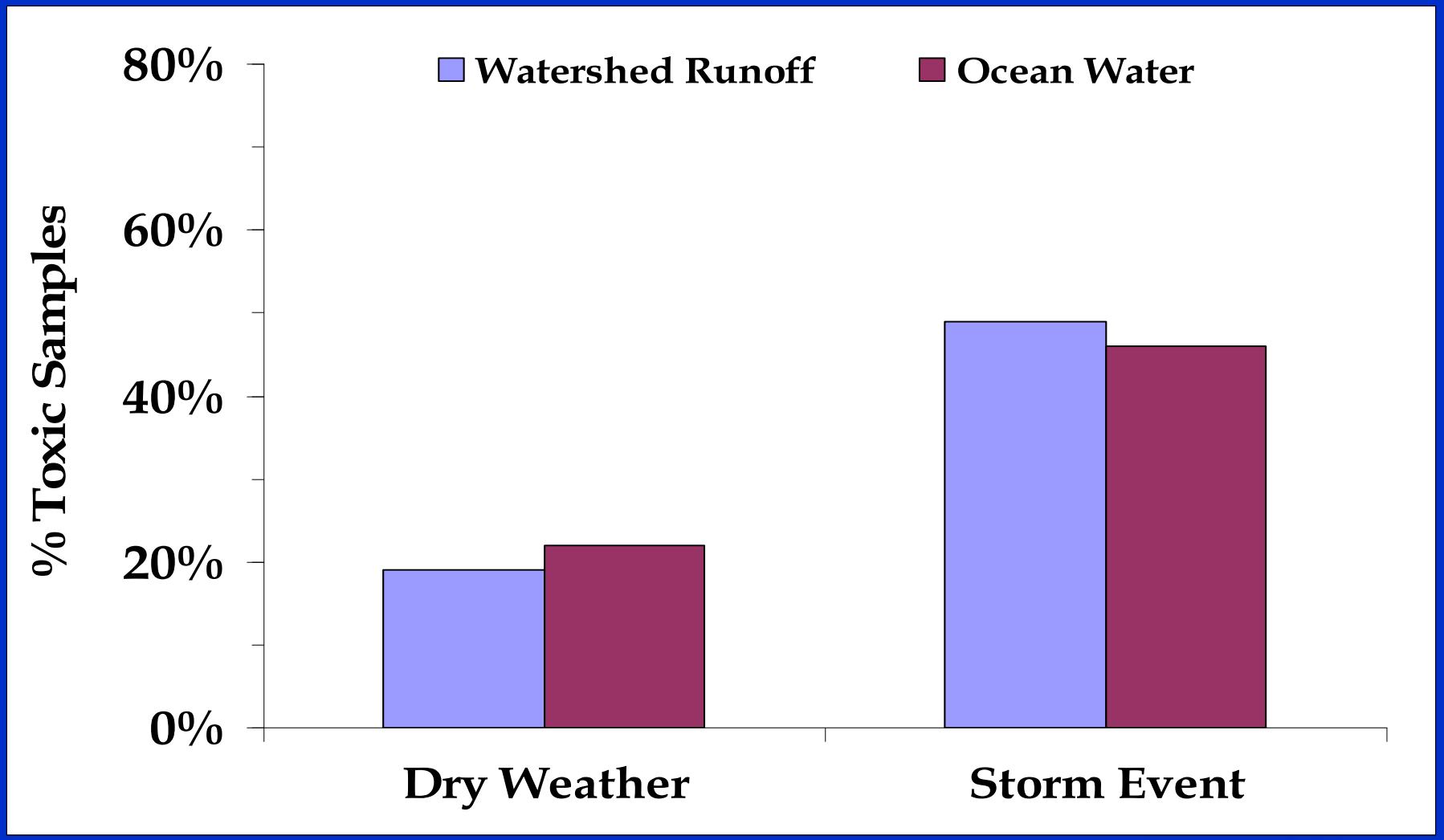
Waterbody Seasonal Conditions



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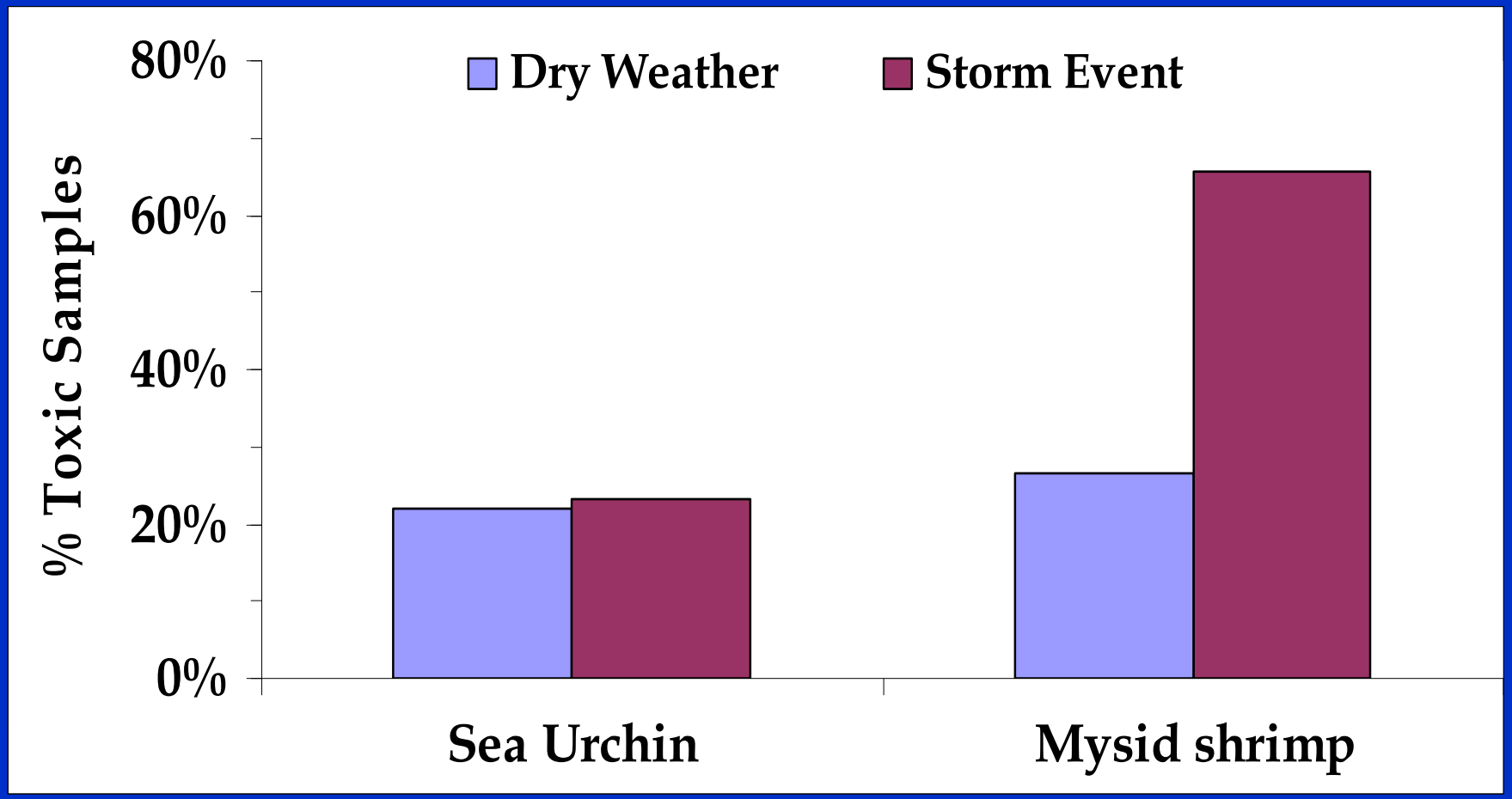
Testing Organism Responses Patterns



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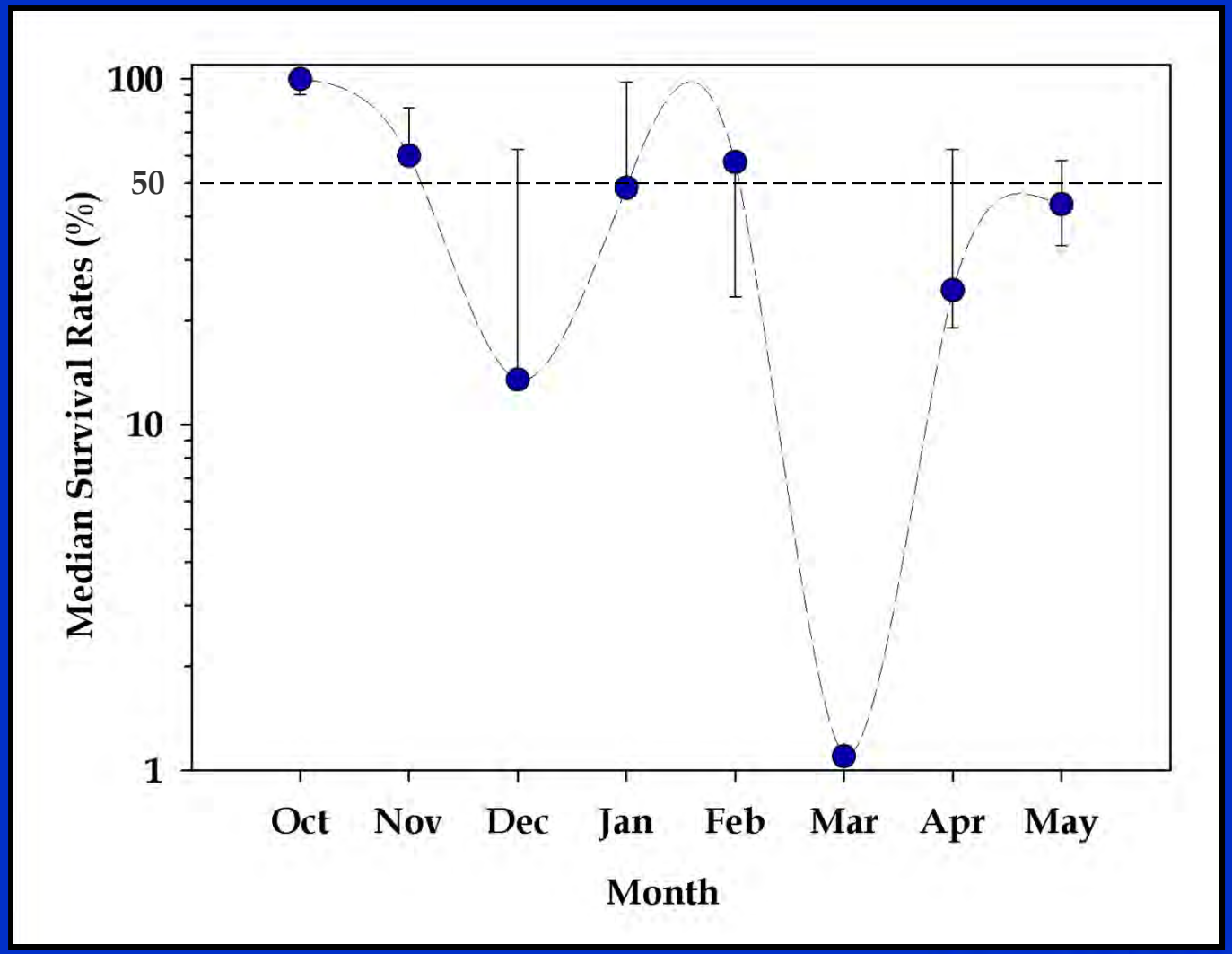
Seasonal Toxicity Patterns

Mysid shrimp



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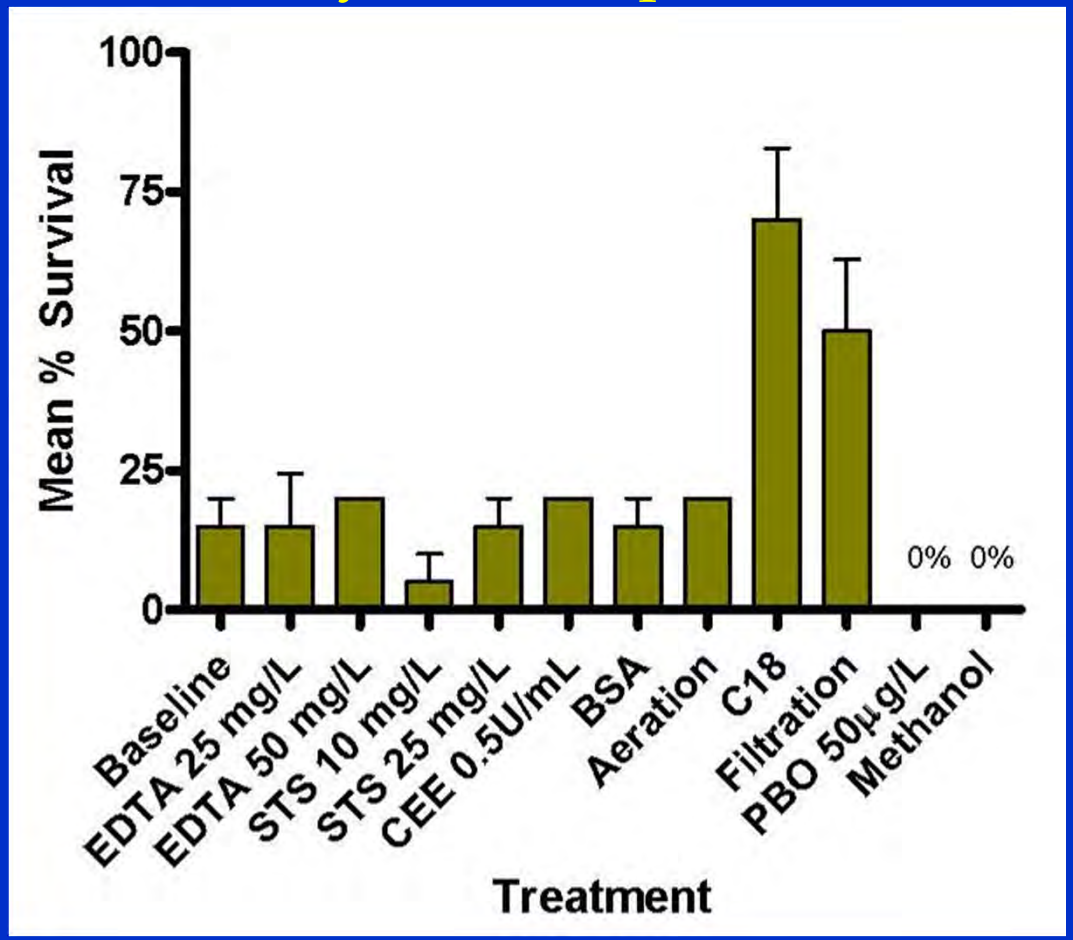
Toxicity Identification Evaluation

Mysid shrimp



Results suggest pyrethroid toxicity

Bifenthrin = 40 ng/L (LC_{50} = 3.97 ng/L)

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Extent of Bifenthrin Data

- Before 2009, lab detection limit $\geq$ 10 ng/L
  - Most samples were non-detects
  - Lab limits 2-4x > LC_{50}
- In 2010, labs achieved 2 ng/L
  - Detected pyrethroids 6 out of 11 sampling events

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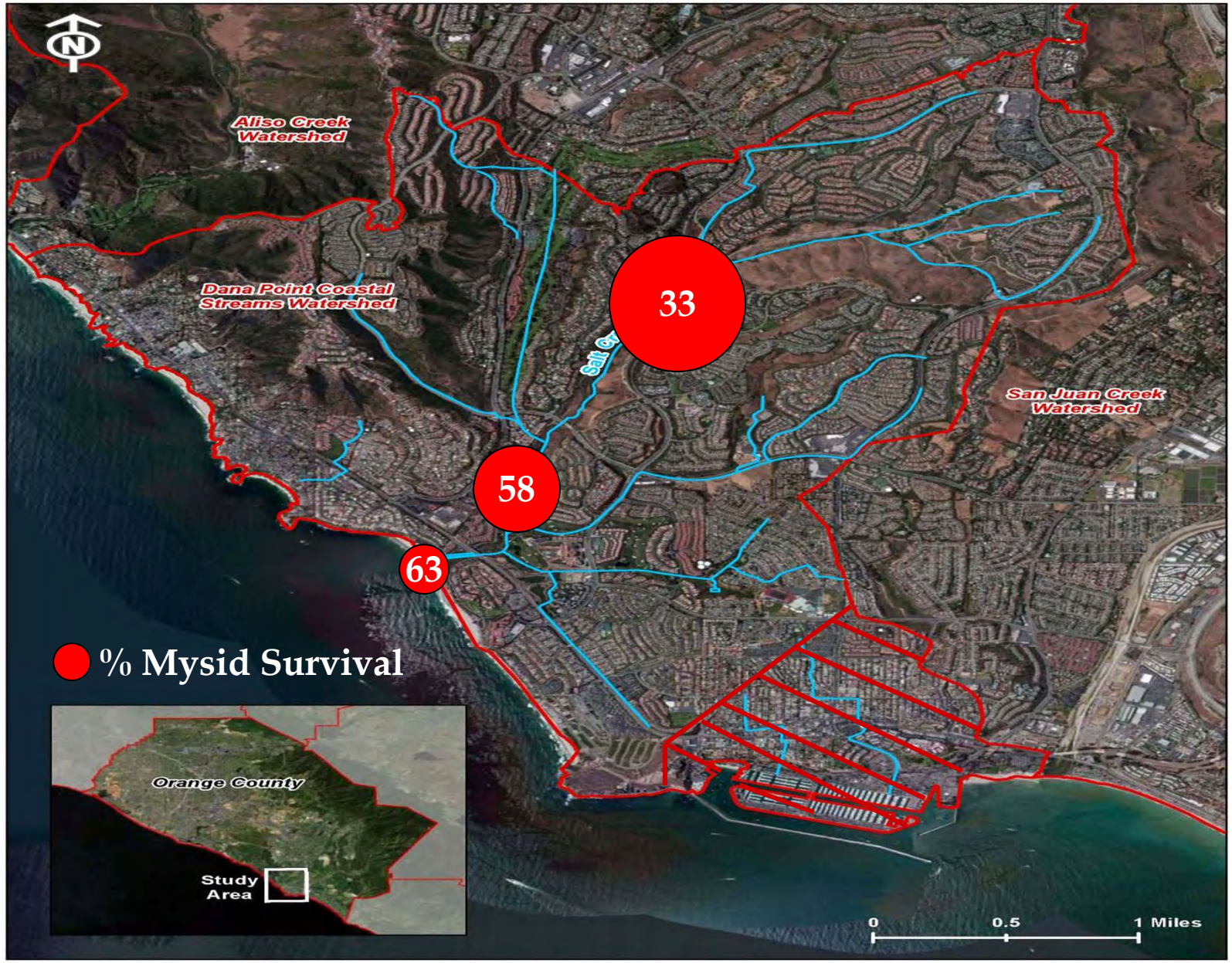
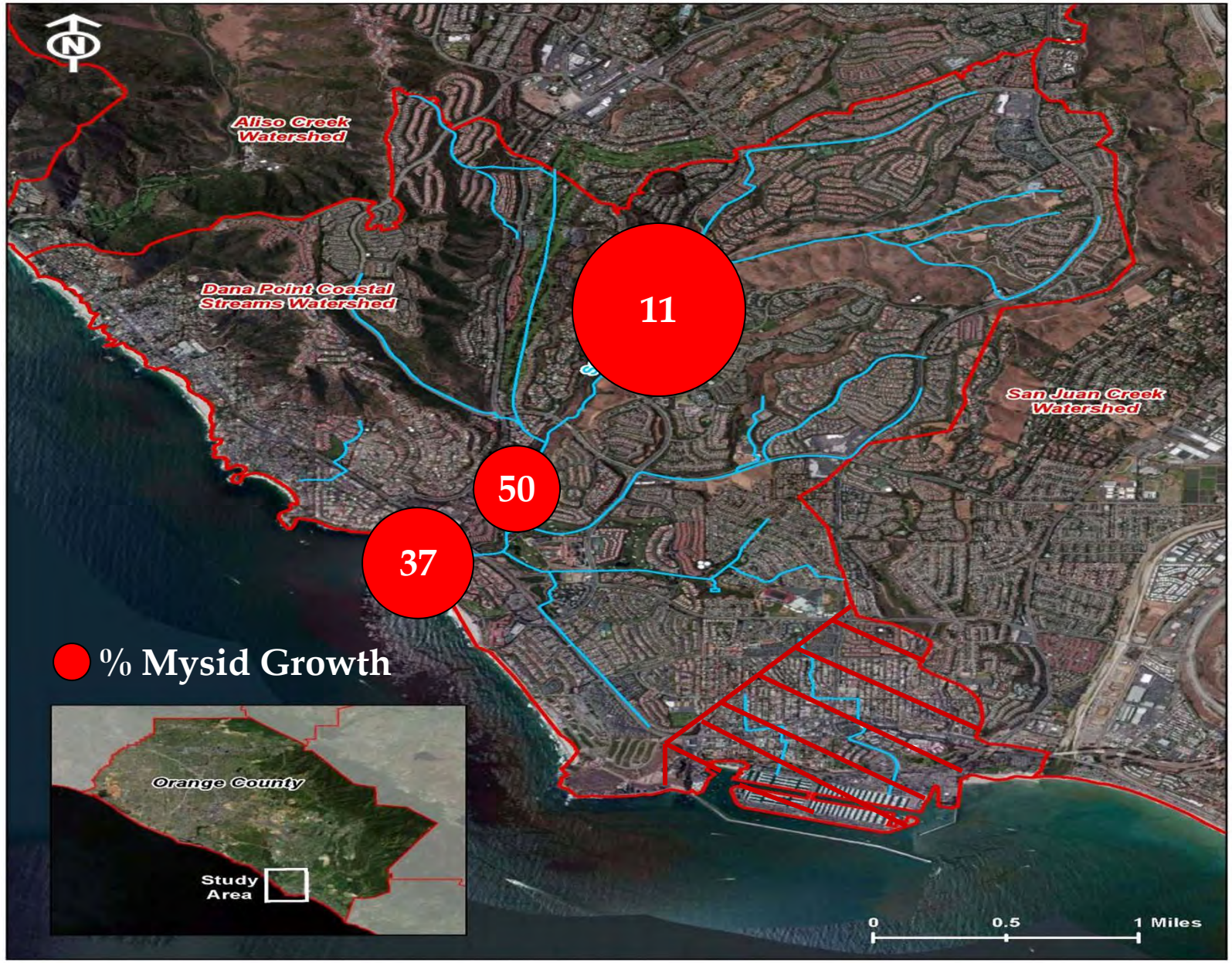
Synoptic Storm Event Source ID

Watershed Toxicity Patterns



Watershed Toxicity Patterns



Toxicity Confirmation

Mysid shrimp, November 2010 (TIE event)

Survival = 55%

Growth = 64%

Bifenthrin = 40 ng/L

Mysid shrimp, February 2011 (Confirmation Sample)

Survival = 55%

Growth = 56%

Bifenthrin = 3.3 ng/L

Pyrethroids may not be the only toxicant

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Toxicity of Fipronil Insecticides

- Mysid shrimp
  - Fipronil LC_{50} = 140 ng/L
  - Degradation products more toxic than parent compound
    - Fipronil sulfone = 6.6x more toxic
    - Fipronil sulfide = 1.9x more toxic

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Fipronil Insecticides in Upper Salt Creek Watershed

Concentrations (ng/L)

LC50	4/8/08	5/13/08	6/13/08	11/26/08	5/5/09	8/1/09
140	trace	391	175	148	99.0	518

Source: DPR Report Study 249, 2008-09

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Next Steps

- Continue watershed study
  - Fipronil vs Pyrethroid
- Watershed outreach
  - HOAs
  - professional applicators
- Need to begin engaging stakeholders
  - Collaborative (not redundant) source control effort
    - *Whole Effluent Toxicity (WET) policy, SWRCB 2010*
  - Economic impact
    - Salt Creek Special Study **≈ $ 20,000**
    - *Clean Water Act 303(d) listing* **≈ $???**

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Questions?

Theodore.VonBitner@ocpw.ocgov.com
(714) 955 - 0680

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