Characteristics of Suspended Solids Affect Bifenthrin Toxicity to Calanoid Copepods of the San Francisco Estuary

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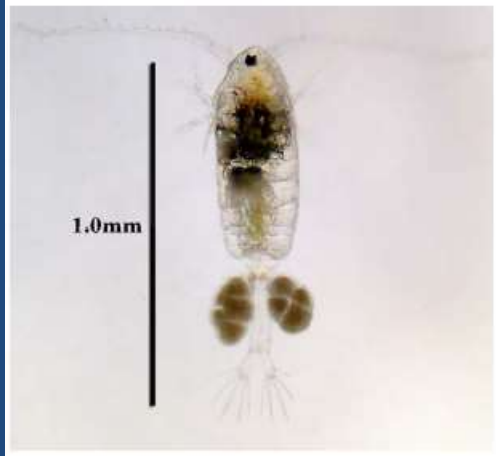
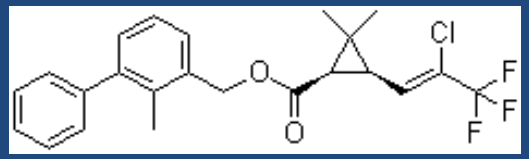
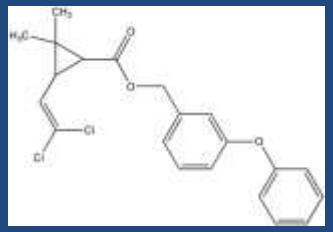
Delta Science Conference

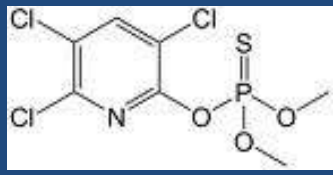


Phytoplankton

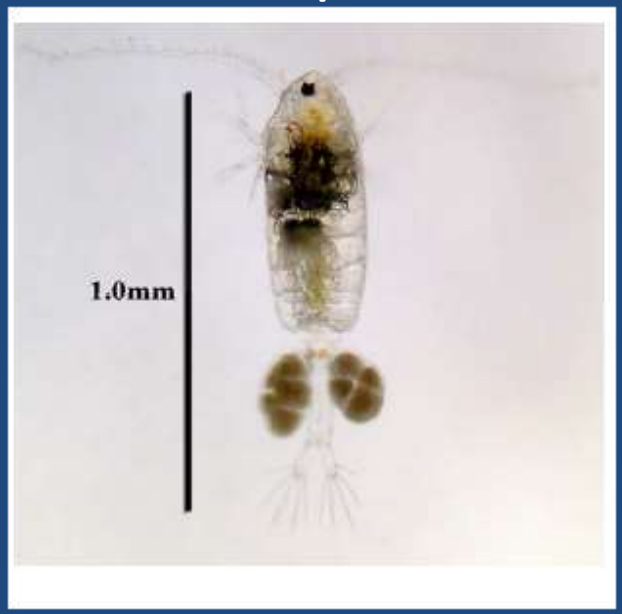


Pesticides





Zooplankton

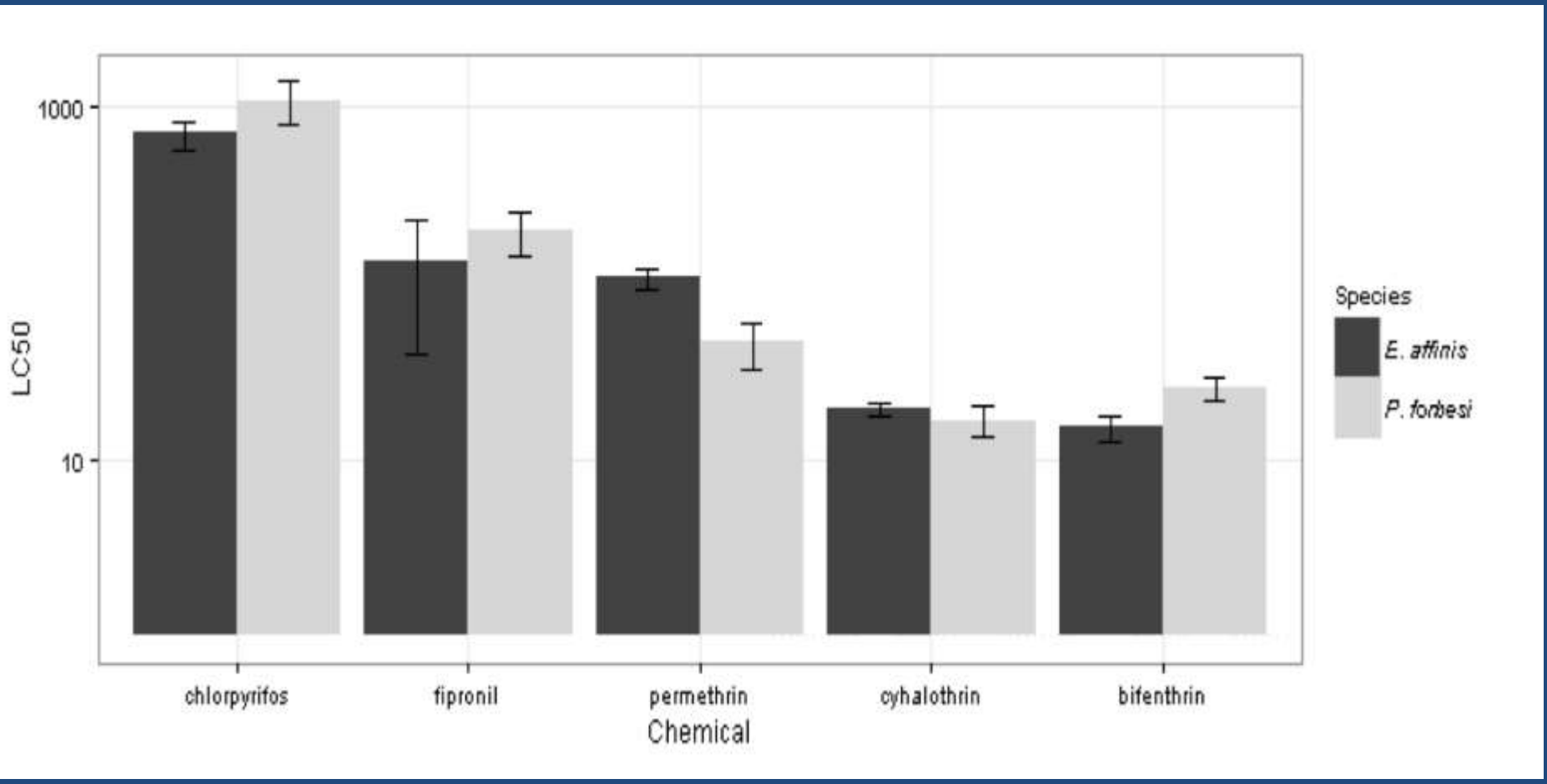


Fish

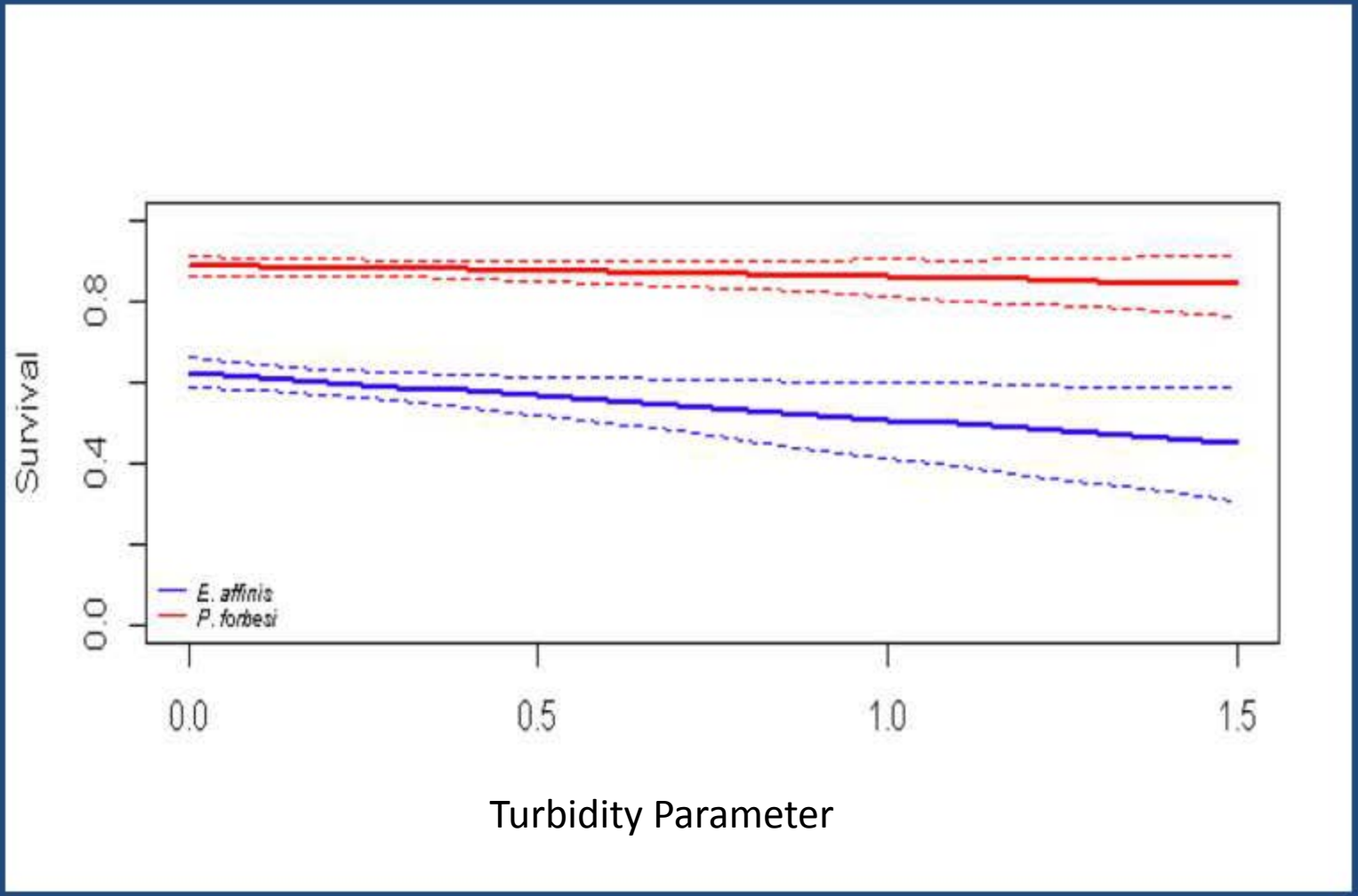
Delta Smelt

Picture fws.gov

Background: Chapter One



Background: Chapter Two



Background: Chapter Three

- Pyrethroids are hydrophobic

  -Readily bind to sediment and particles

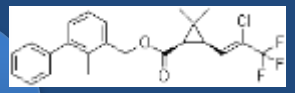
- Bifenthrin

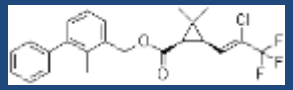
  -Most sensitive pesticide investigated

  -Commonly detected in delta water/sediment

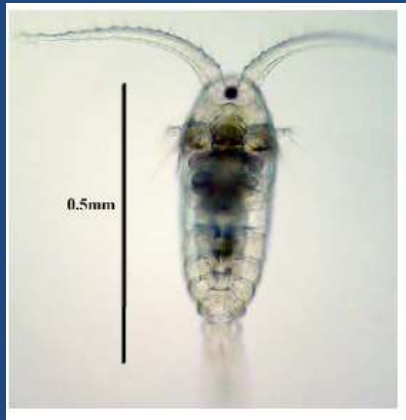
- Partitioning: total=dissolved + bound

TSS





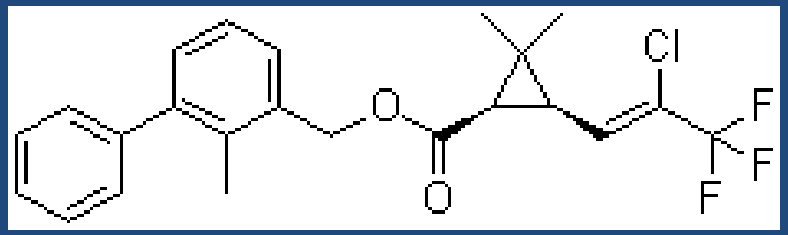
TSS



Questions

- Do particles (TSS) mitigate toxicity of bifenthrin to *E. affinis* and *P. forbesi*?
- Is there an effect of particle type on mitigation?
- Do particle characteristics affect mitigation?
- Species specific effects?

Experimental Design



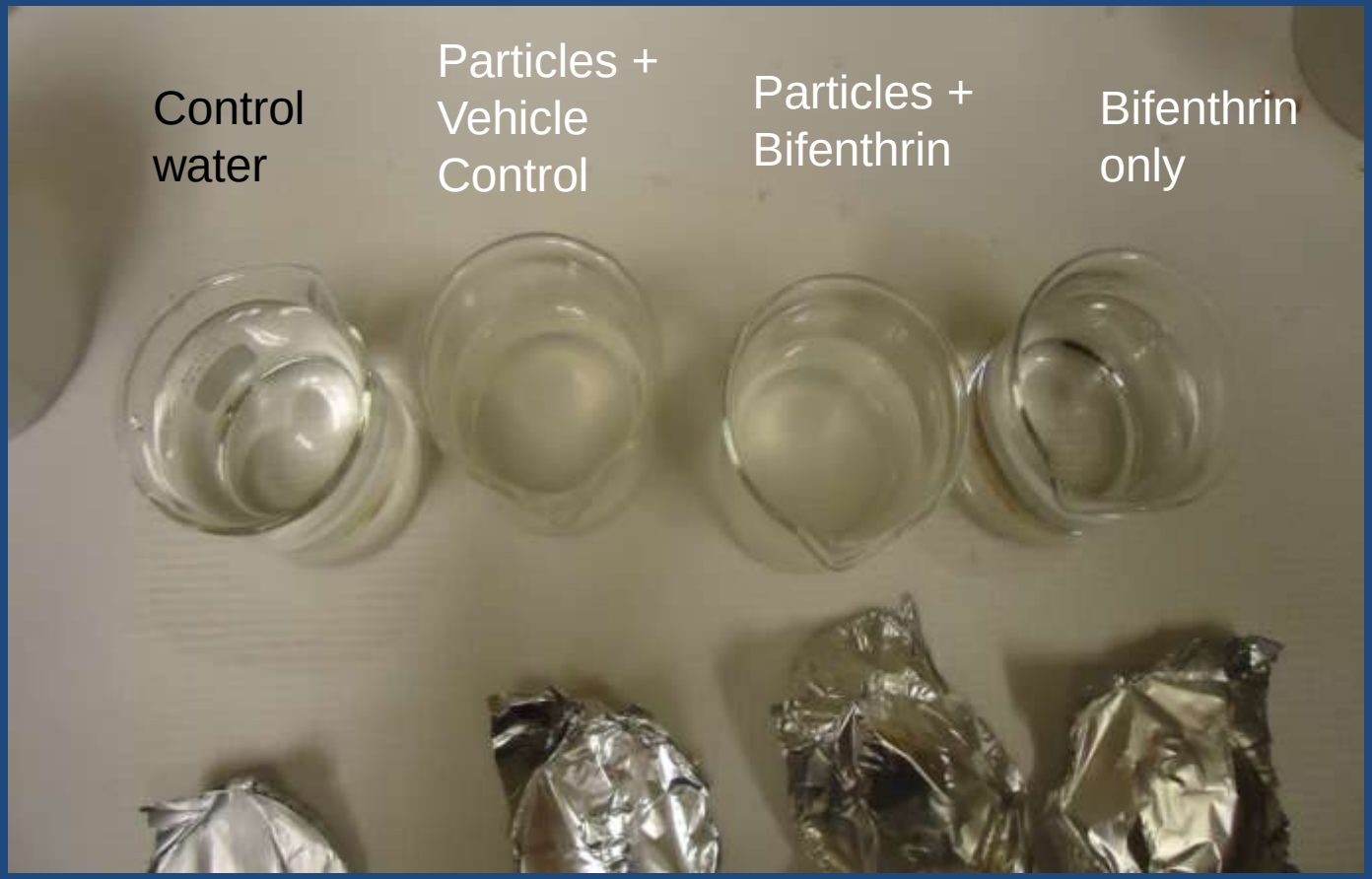
Bifenthrin

Different types of suspended solids

Sacramento – San Joaquin River Delta (SW)

Secondary wastewater treatment (WW)

Experimental Design

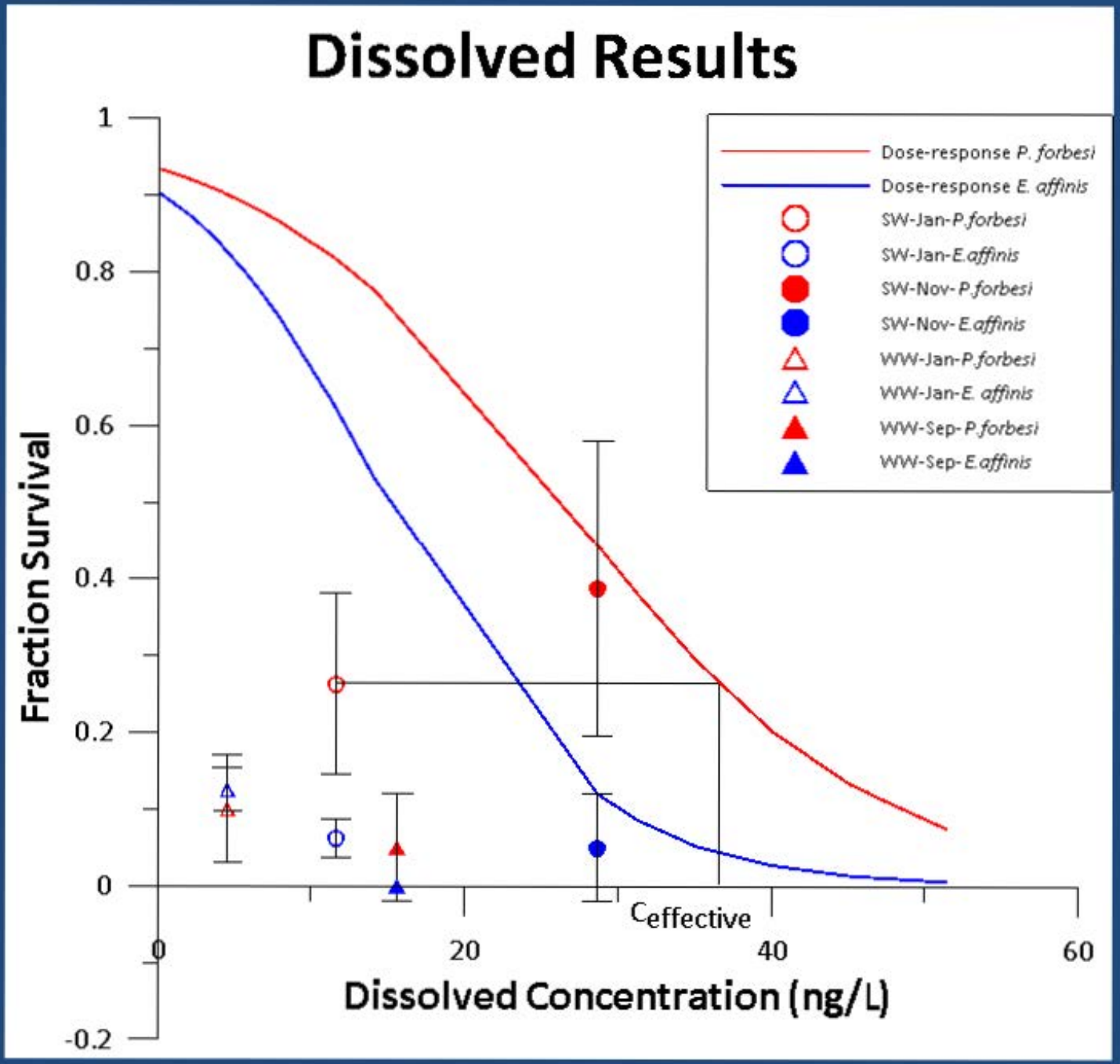


TSS: ~ 5 mg/L
$C_{dissolved}$:~ 5-15 ng/L,
C_{total}: Dependent on particle characteristics
96-hr toxicity test (water change at 48-hrs)

96-hr LC50s for bifenthrin

E. affinis: 15 ng/L
P. forbesi : 26.3 ng/L

Dissolved Results



The “F*” model

Observed toxicity is caused by some interaction between the organisms, particles and bifenthrin

From the previous graph, we know that something beyond dissolved bifenthrin is causing toxicity

A unitless parameter that describes fraction of sorbed chemical that is apparently bioavailable

$$F^* = \frac{M_{sorbed\ but\ bioavailable}}{M_{sorbed}}$$

If F*=0, the dissolved bifenthrin concentration explains observed toxicity

If F*=1, the total bifenthrin concentration explains observed toxicity

If F*>1, then more chemical than is present is needed to cause observed toxicity

$$F^* = \frac{C_{effective} - C_{dissolved}}{C_{total} - C_{dissolved}}$$

$C_{effective}$: A hypothetical $C_{dissolved}$ that would produce observed toxicity

Measured in study

F* Example
WW-Jan and *E. affinis*

C_{total}=161.8ng/L

$C_{dissolved}$= 4.5ng/L

$C_{effective}$ ~ 38 ng/L

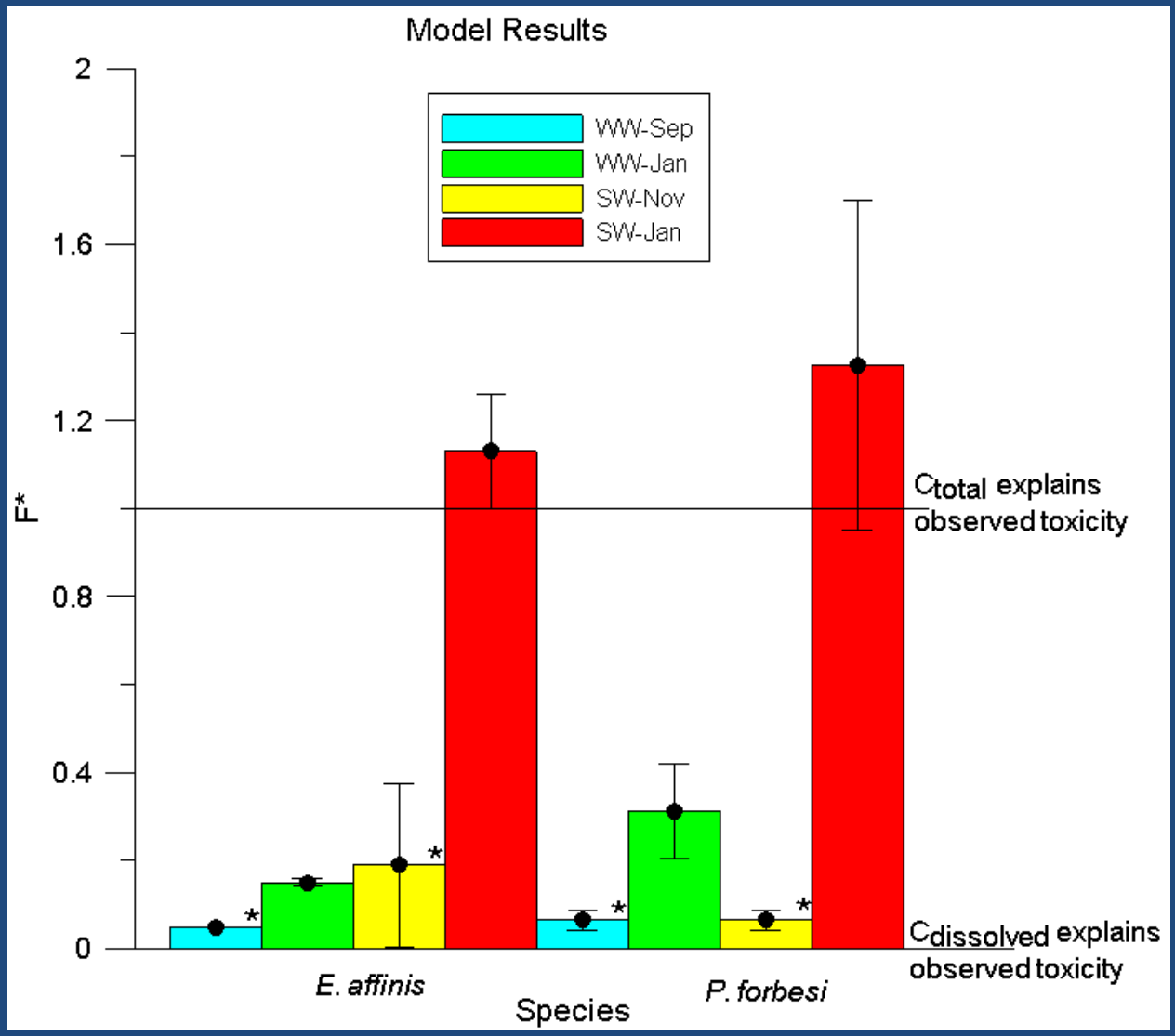
$$F^* = \frac{C_{effective} - C_{dissolved}}{C_{total} - C_{dissolved}}$$

$$F^* = \frac{38 - 4.5}{161.8 - 4.5}$$

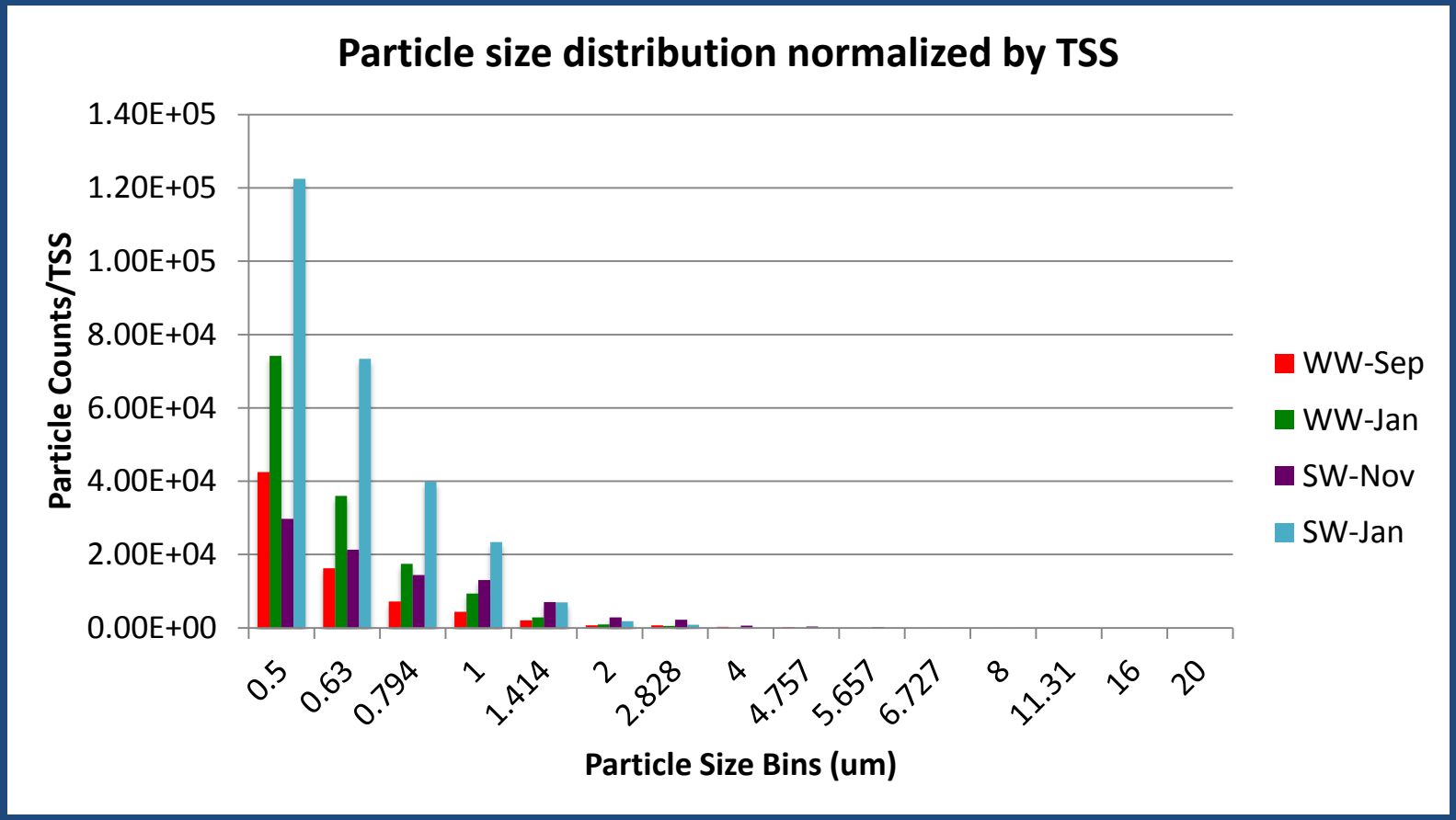
$$\frac{33.5}{157.3}$$

$$F^* = 0.21$$

Model Results

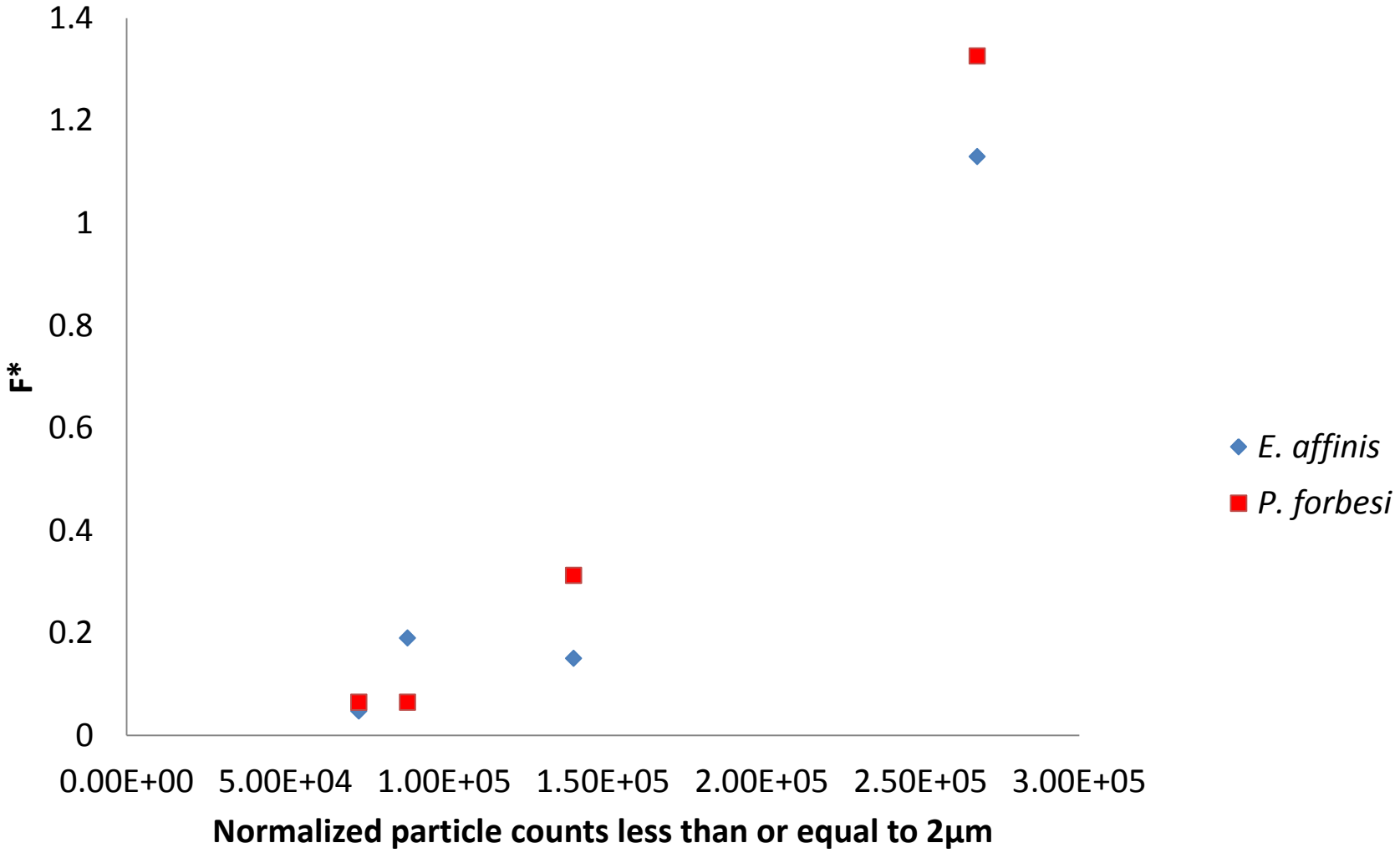


Water Quality



Water Quality				
Parameter	WW-Sep	WW-Jan	SW-Nov	SW-Jan
TSS	5.7	6.1	5.5	5.2
TOC	2.7	2.6	0.8	0.6
DOC	0.7	0.7	0.3	0.1

F* Correlation



Why particle size?

- Increase ingestion of particles sorbed with bifenthrin
- Decrease in food availability
- Change in feeding behaviors
- Physical effects of particles

Answers: Particles and bifenthrin

- Do particles (TSS) mitigate toxicity of bifenthrin to *E. affinis* and *P. forbesi*?
  - Yes, dissolved concentration is a better predictor of toxicity compared to total concentration
- Is there an effect of particle type on mitigation?
  - NO, dependent on particle characteristics
- Do particle characteristics affect mitigation?
  - Particle size
- Species specific effects?
  - Not observed in this study

Acknowledgements

- Aquatic Health Program
  - Rae Porter-Blackwell, Elizabeth Siemion
- CA Department of Pesticide Regulation
  - Dr. Kean Goh

Particle Control Survival