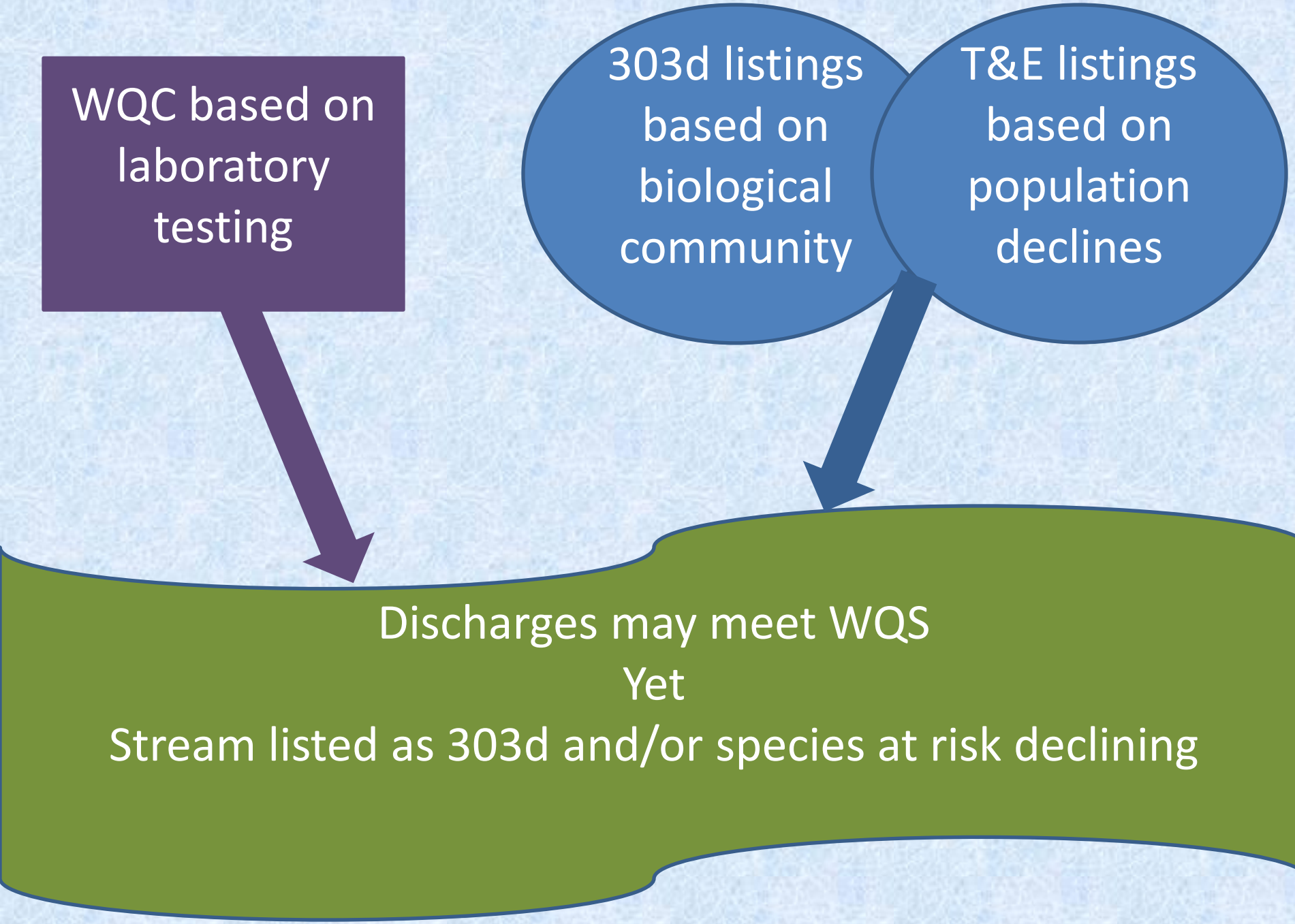
Incorporation of Field or Meso/Microcosm Data to Validate Criteria in Watersheds Supporting Federally Listed Species

Why are the data needed?

How can data be incorporated?

T&E Aquatic Species Nationwide

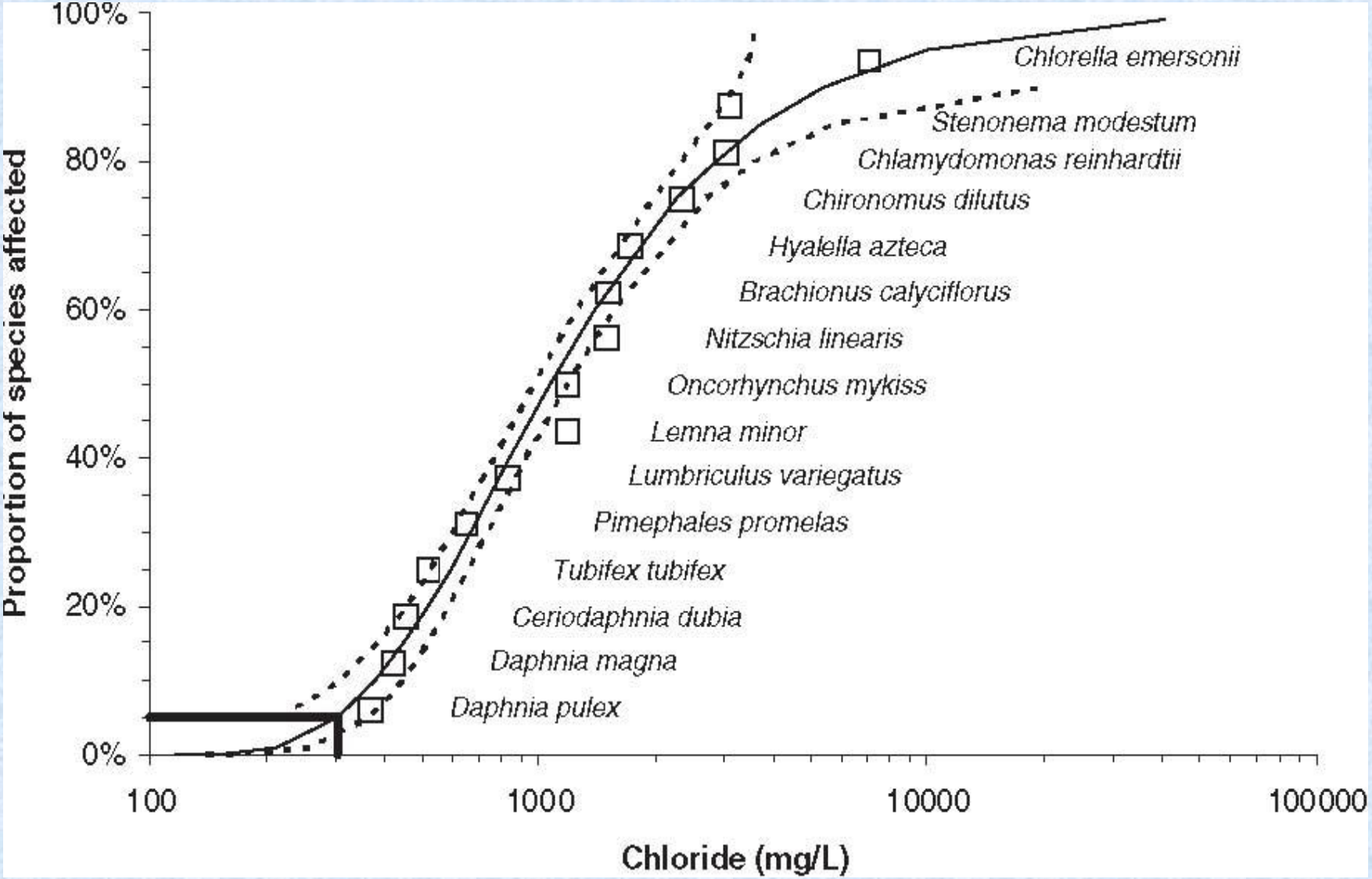

WQC based on laboratory testing
303d listings based on biological community
T&E listings based on population declines
Discharges may meet WQS
Yet
Stream listed as 303d and/or species at risk declining

Potential Factors

- Differences between tested and rare species in species sensitivity distribution (SSD)
- Listed species may be in the 5% not protected by a WQC
- Additional stressors in water bodies
- Contaminant-induced maladaptive behaviors
- Indirect effects on food webs
- Exposure duration (acute vs life long)
- Absence of behavioral endpoints

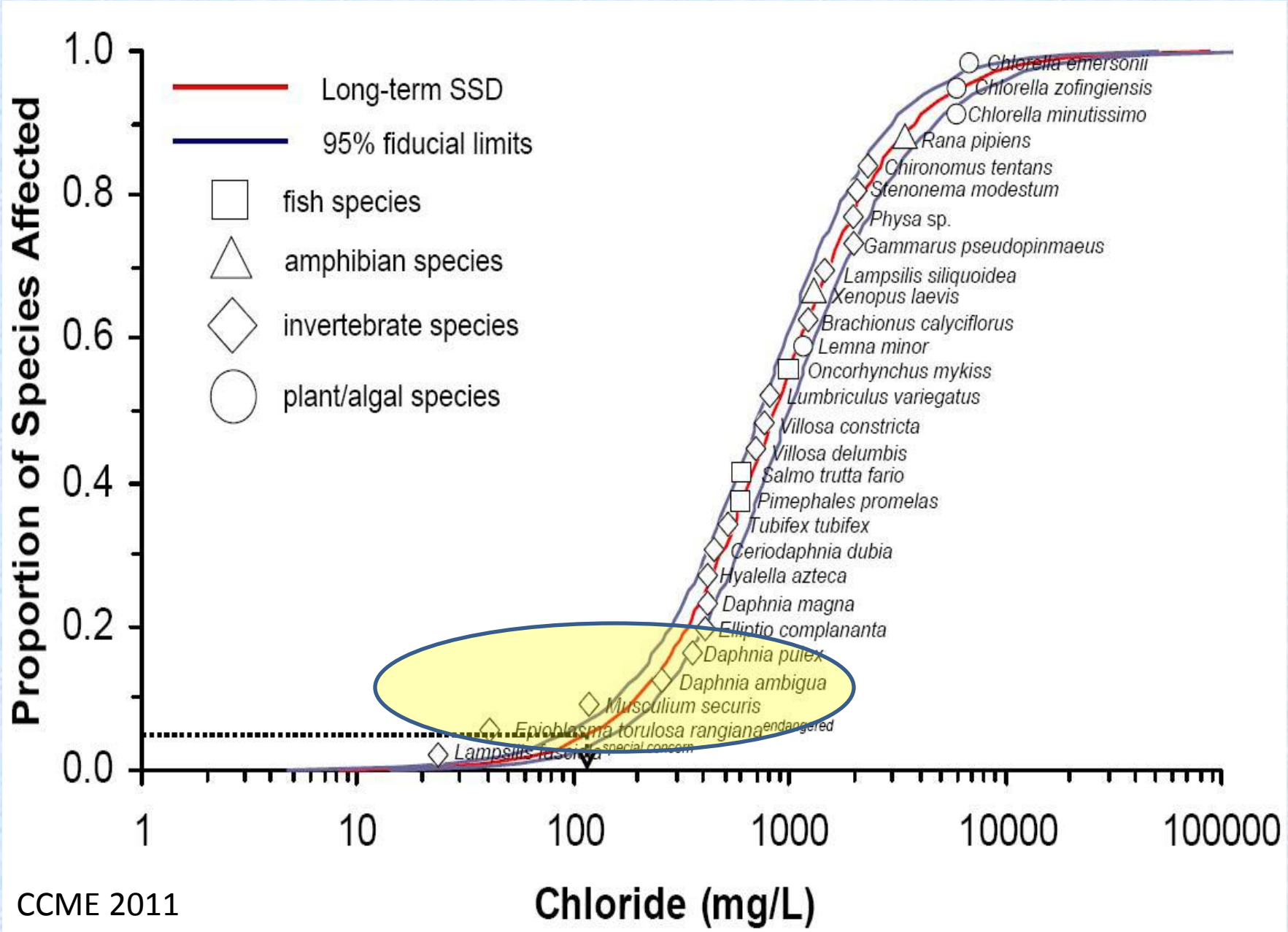
Field, Mesocosm and Microcosm Examples

Tested vs Resident Species



Elphick et al. 2011

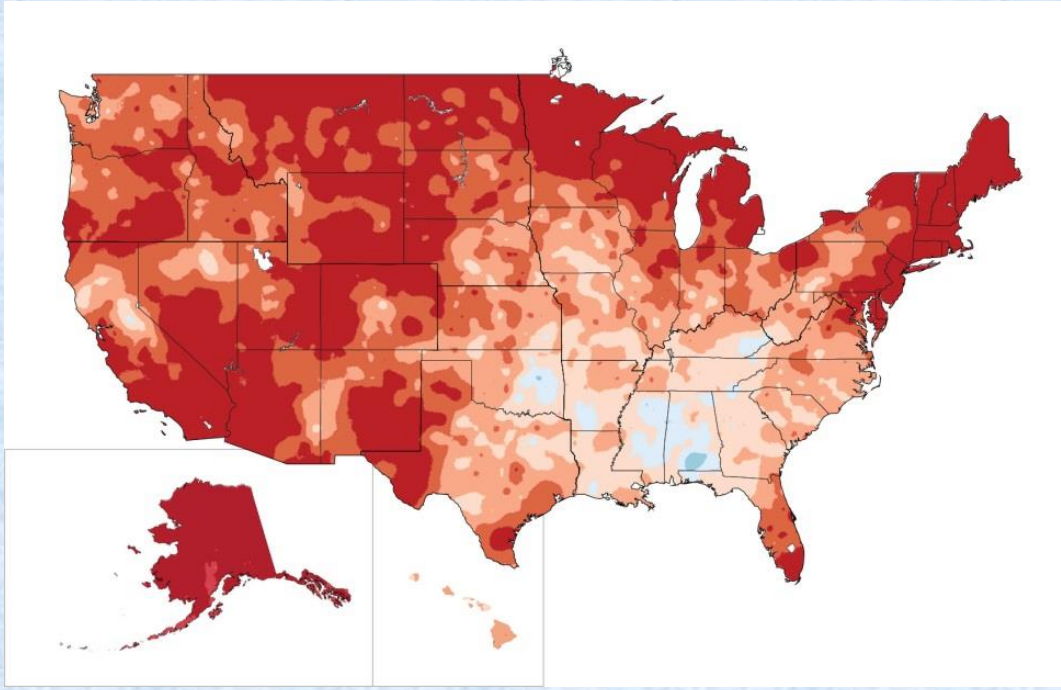
Effect of Including Data for Two Rare Species

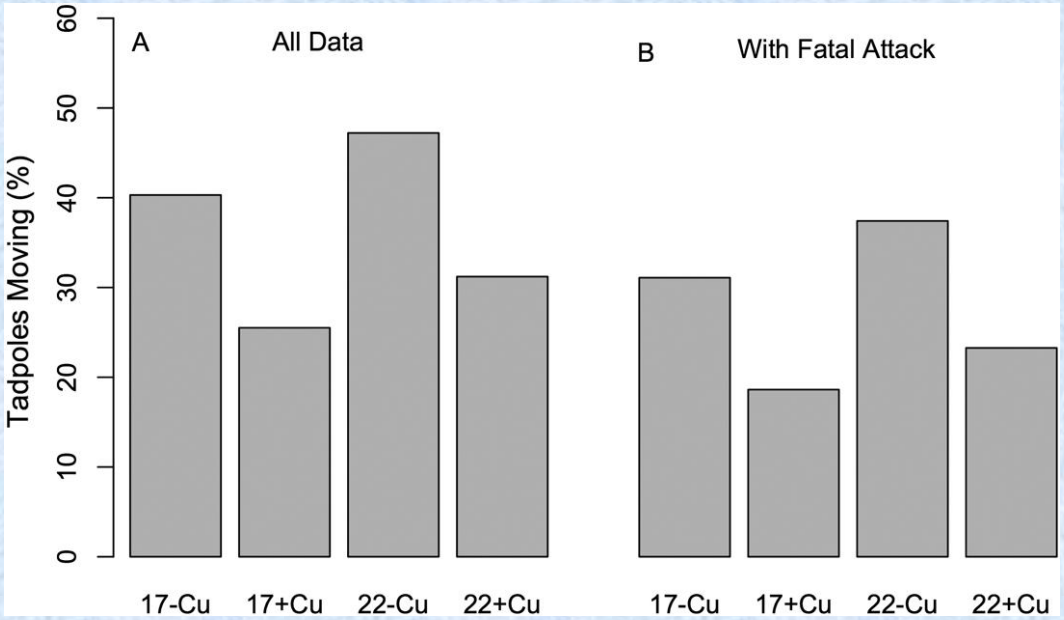


CCME 2011

Additional stressors
Maladaptive behaviors

- Amphibians – worldwide decline sensitive to metals
- Copper – point and non-point sources
- Climate change - warmer waters



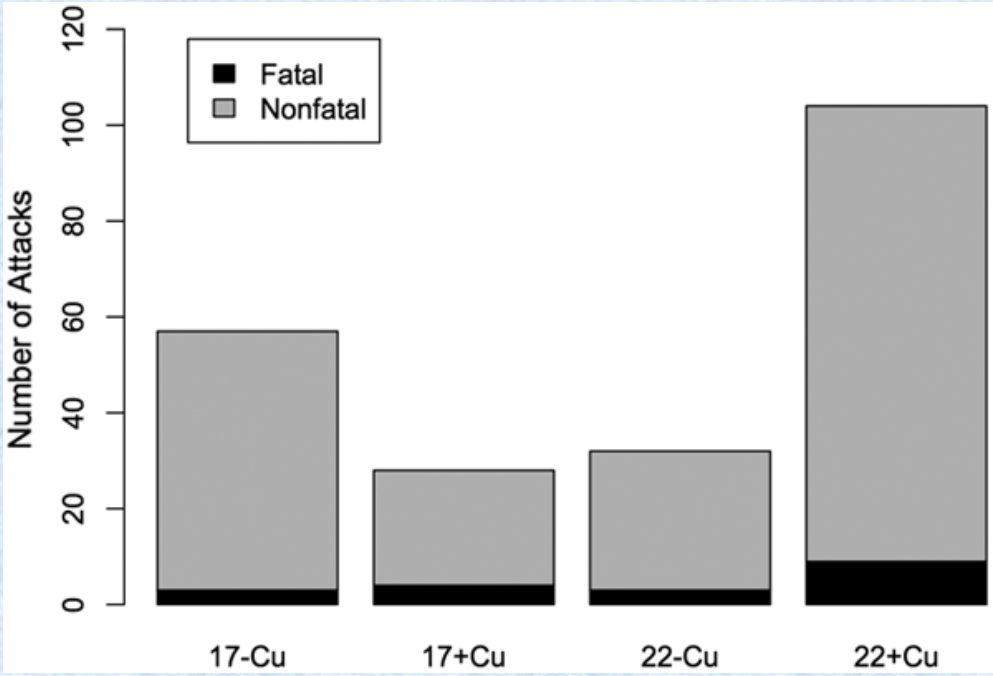


Copper decreased tadpole activity

Increased susceptibility to predation

Temperature increased dragonfly activity

Increased tadpole predation

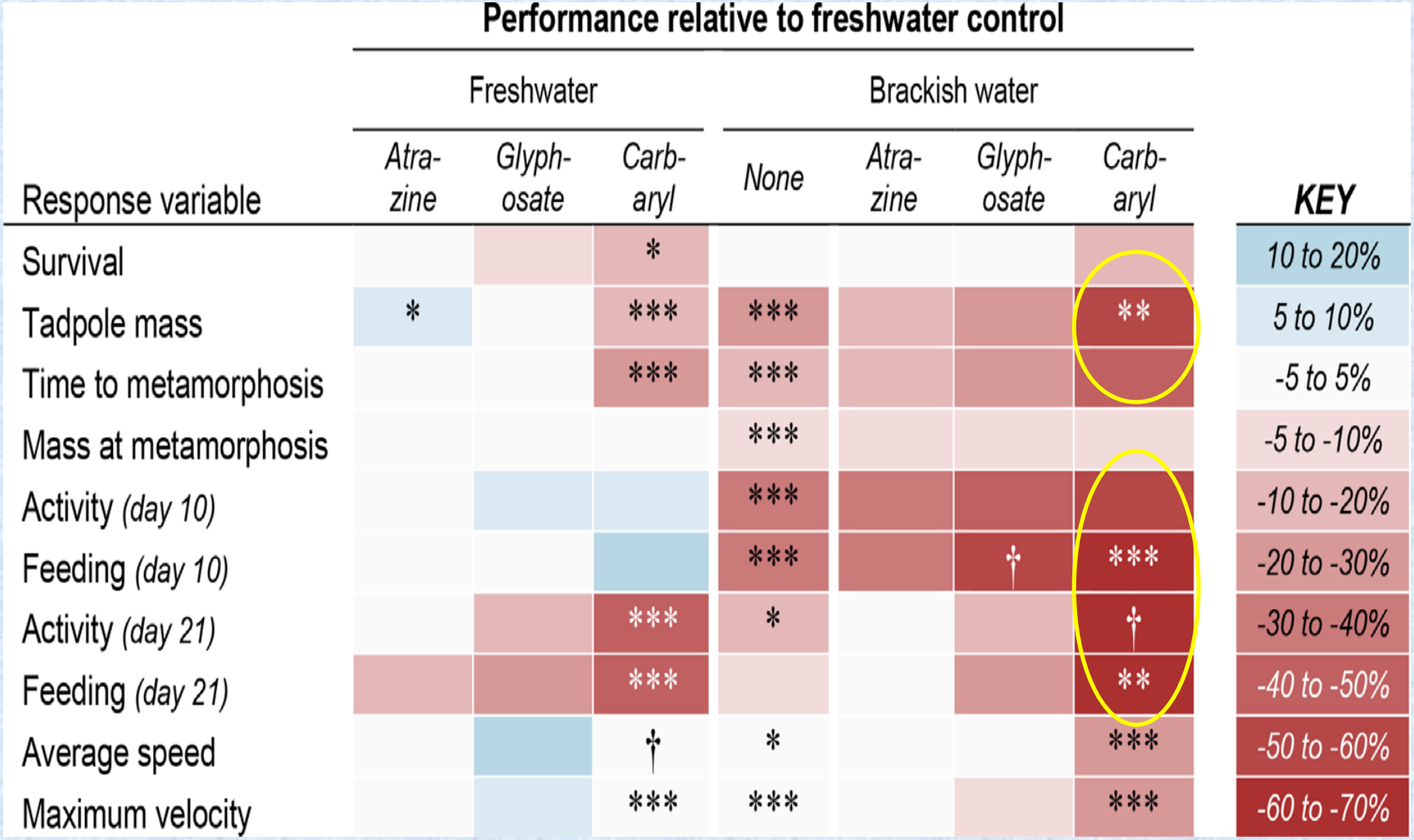


Reeves et al. 2015

Additional stressors
Maladaptive behaviors

- Amphibians
  - 35 listed
  - 43 species in review
  - Sensitive to pesticides
- Carbaryl
  - agricultural/residential
  - widely used
- Salinity
  - sea level rise
  - deicer use
  - irrigation
  - mining/O&G

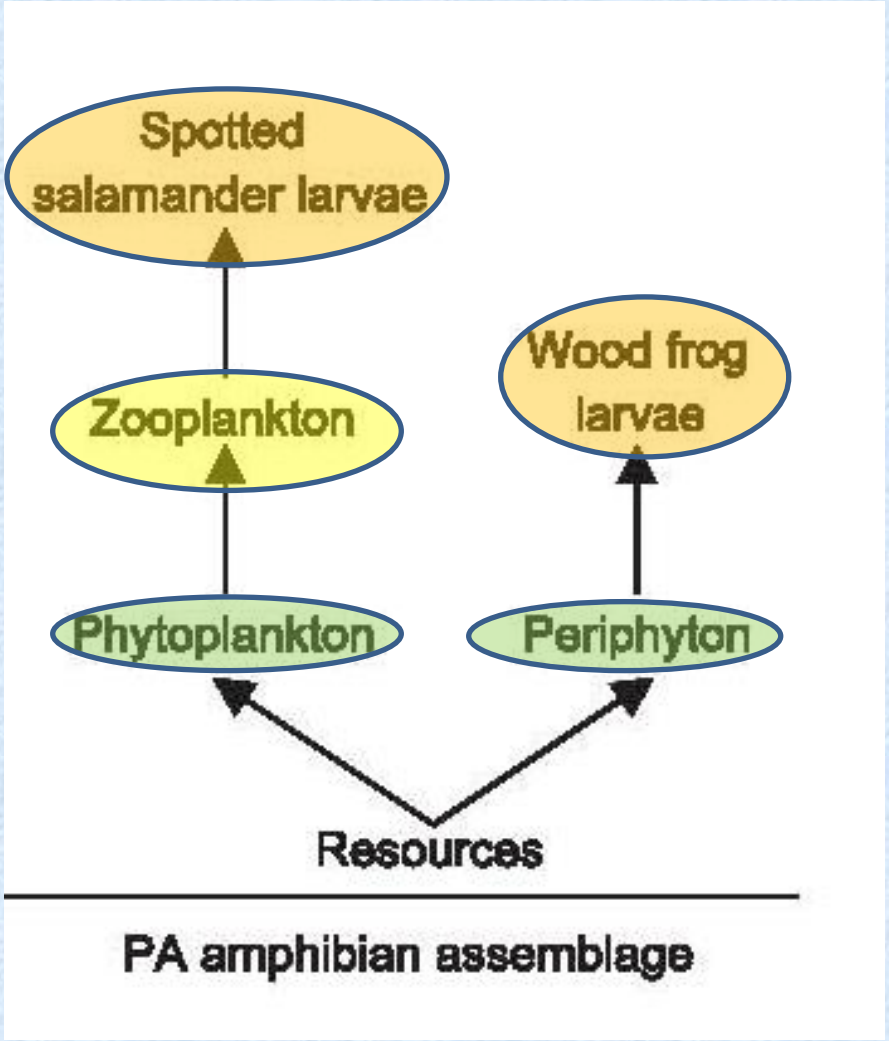
Decreased feeding resulting in slower growth/development
Decreased movement affects predator avoidance and survival



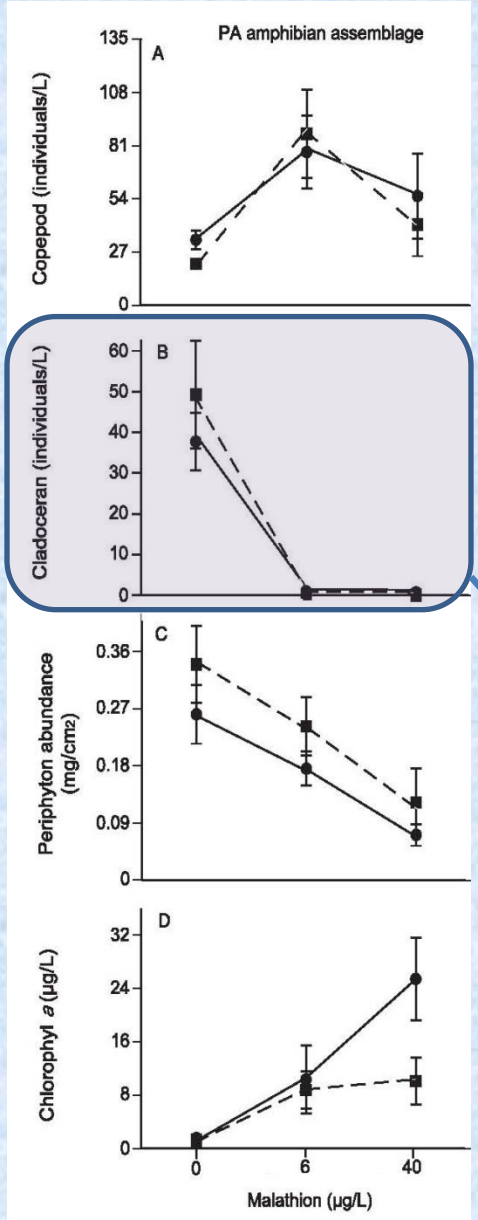
Wood and Welch 2015

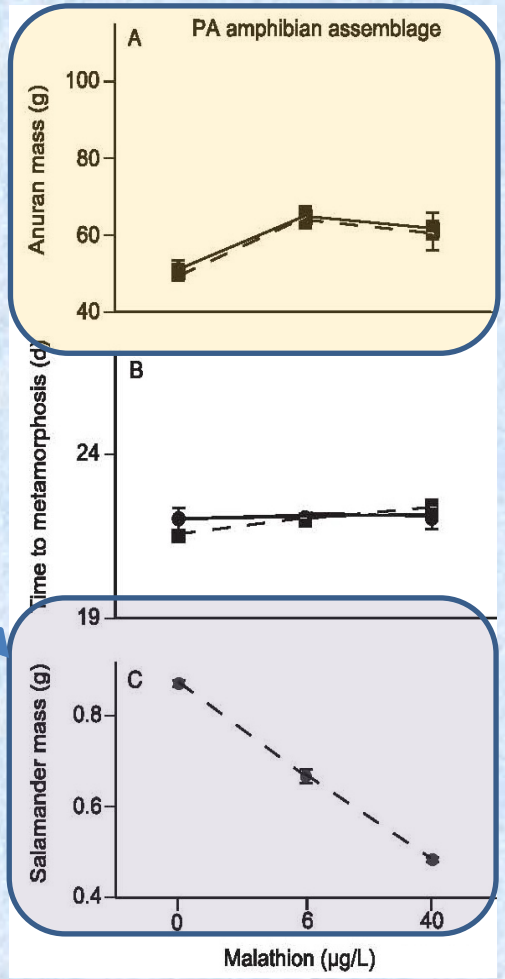
Indirect Effects via Food Webs

- Amphibians –
  under represented in lab
  suited to mescosms
- Low dose pesticide exposure relevant to environment
- Simple Food Web –
  different sensitivities
  evident interactions



Hua and Relyea 2012





Selective toxicity in prey
Perturbs food web balance

Selective indirect effects in predators without direct toxicity

Annual exposures could eliminate entire populations

Hua and Relyea 2012

Exposure Duration and Endpoints

- Freshwater mussels
  - under represented in lab
  - Uniquely sensitive to some chemicals
  - Sessile; complex life history; long lived
- Metal mixtures –
  - typical environmental exposure
- Sediments & Pore Water
  - relevant to filter feeders that burrow
- Lab Testing & Field Surveys-
- -combination warranted to understand toxicity

Correspondence of laboratory testing and field survey

	Field impact	Field no impact
Lab toxic	33%	0%
Lab nontoxic	27%	40%

Potential Factors for Discrepancy:
Lifetime exposure of mussels
Effects on reproduction not assessed

Critical population reductions for rare species

Besser et al. 2009 and Roberts et al. 2009

Why are the data needed?

- Water quality critical to T&E aquatic species
- 274 aquatic species under review for T&E
- Difficult logistics for lab testing T&E species
- Lifetime and full life cycle exposure effects
- Indirect toxicity via food web perturbations
- Ubiquity of environmental stressors including climate changes

How can data be incorporated?

- Incorporate laboratory toxicity data for T&E species or closely related surrogates into SSDs
- Include mesocosm/*in situ* studies with T&E species in SSDs
- prioritize chronic studies and sublethal endpoints in setting WQC
- Consider field monitoring data encompassing T&E distributions in assessing the need for WQC revisions

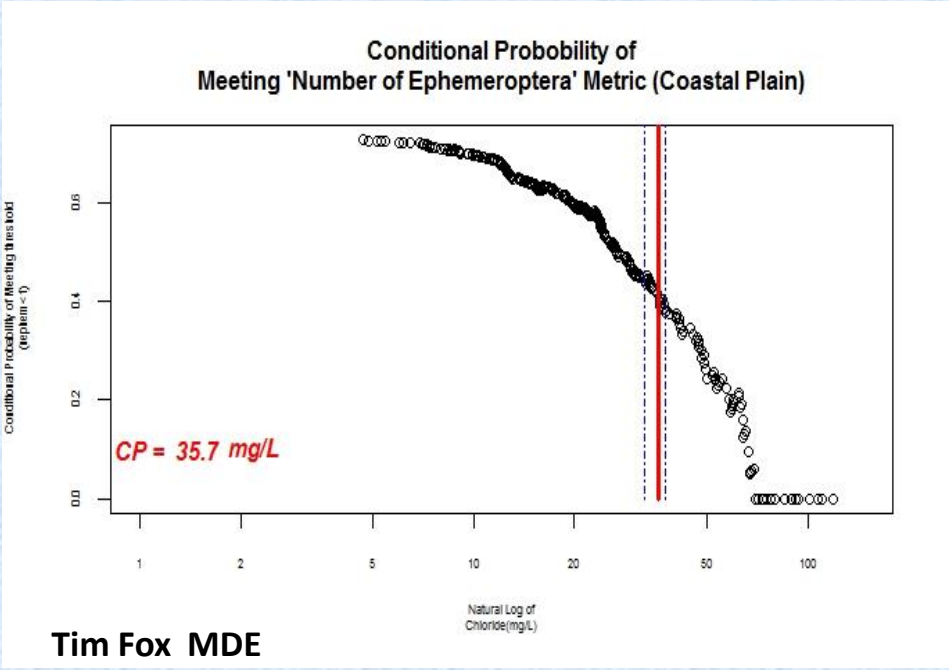
T&E Toxicity Data in SSD

- derive unique WQC for watersheds with sensitive taxa (e.g., ammonia)
- select surrogates for testing in consultation with T&E species experts (e.g., FWS, NOAA, academics)
- add weight to quality studies with T&E species in deriving WQC

T&E Mesocosm/*In Situ* Studies

- Enables testing species difficult to sustain in lab
- Allows for extended exposures
- Enables testing of mixtures/other stressors
- Incorporates behavioral responses
- Facilitates assessment of indirect effects
- Used for EPA pesticide approvals
- Evaluation guidance available from other countries

T&E in Field Monitoring Data



Tim Fox MDE

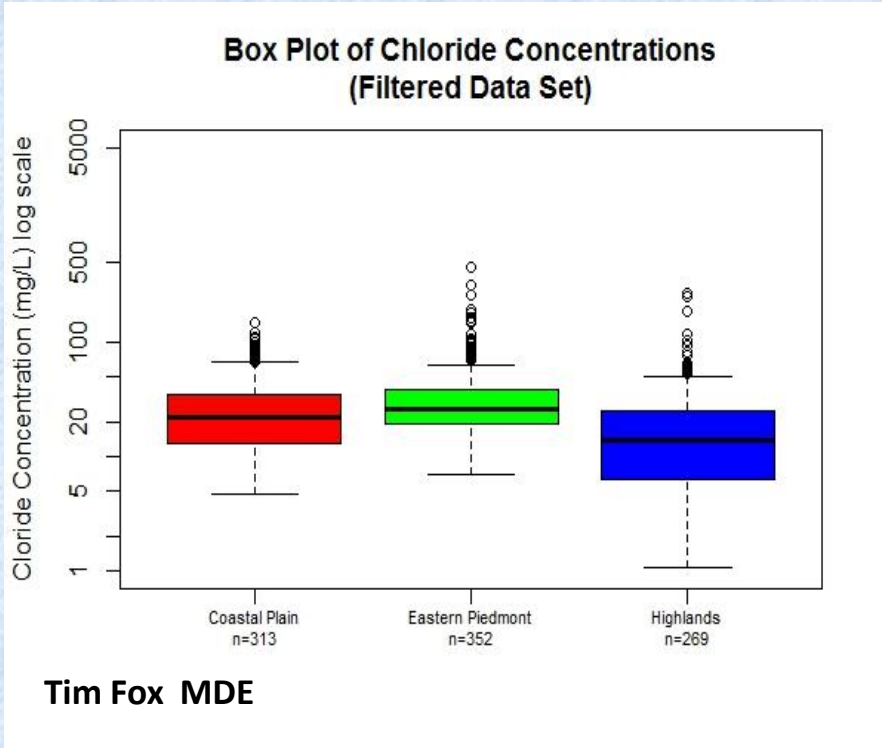
Demonstrated to be effective for:

-conductivity (e.g., Appalachians)

-chloride (e.g., Maryland)

Signals failure of WQC to protect sensitive species

Useful for documenting effectiveness of revisions to WQC or state standards



Tim Fox MDE

Captures effects of:

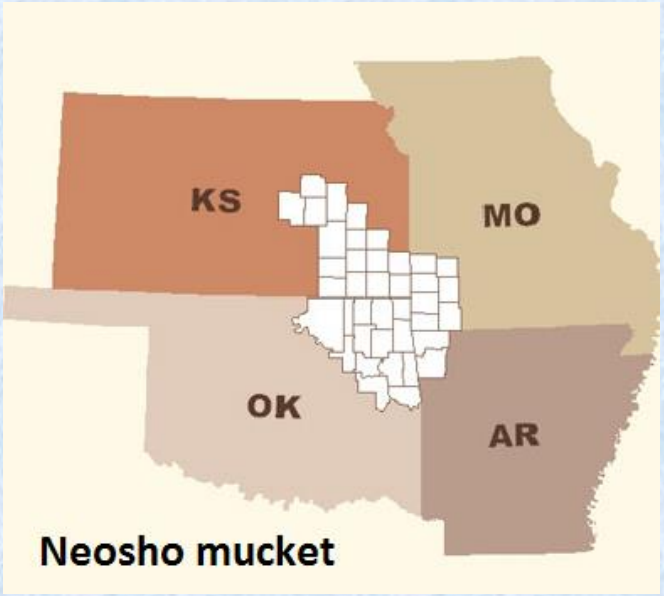
long term exposures

multiple life stages

multiple stressors

Indirect effects

Federal Strategy



- T&E species ranges cross state boundaries
- States provide inconsistent protection
- Inefficient and ineffective protection at the permit-specific level
- Federal review of toxicity data for laboratory and field studies needed to ensure standardization

Acknowledgements

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