Assessing the Hazards/Risks Herbicides Pose to Fish and Wildlife

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Presentation Outline

- Considerations in assessing hazards/risks:
  - Importance of context in extrapolating laboratory toxicity data to the field

- Example of integrating ecological and operational contexts into toxicity testing
  - Assessing the hazards aquatic herbicides pose to amphibians

- Final thoughts

Why Is Context Important?

Key to Hazard and Risk Assessment

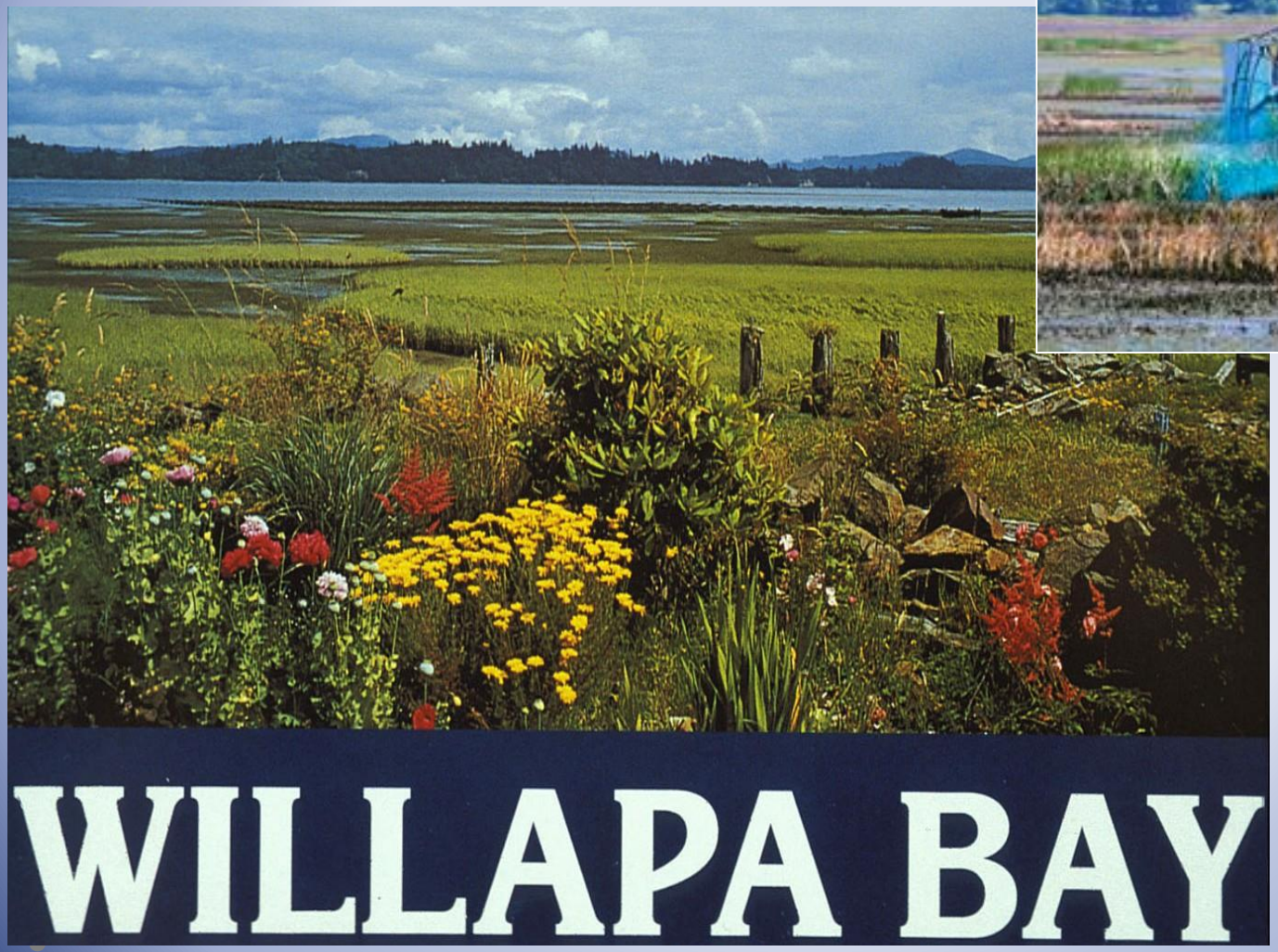
- Environmental exposure
- Environmental, ecological, operational contexts
- Extrapolation of laboratory toxicity data to the field
- Improving design of laboratory toxicity tests

Hazard = Toxicity + Environmental Exposure

Risk = Probability of hazard being realized

These contexts are also critical to evaluating indirect effects

Personal Context



Urban Stream Pesticide Cocktail

		Maximum Concentrations (ppb)		
		(Voss 1999)	(Frans 2004)	LC50
Herbicides	2,4-D	1.00	0.69	>100,000
	Dicamba	---	0.38	28,000
	Dichlobenil	1.20	0.31	6,260
	MCPA	0.40	0.38	>10,000
	MCPP	0.75	0.52	124,800
	Prometon	0.27	0.19	20,000
	Atrazine	0.02	---	24,000
	Simazine	5.00	0.42	>100,000
	Triclopyr	1.30	0.74	>100,000
	Carbaryl	0.05	0.06	1,950
	Diazinon	0.45	0.58	90
	Pentachlorophenol	0.20	0.12	115
	4-nitrophenol	---	0.46	3,800

Concentrations exceed those associated with agriculture

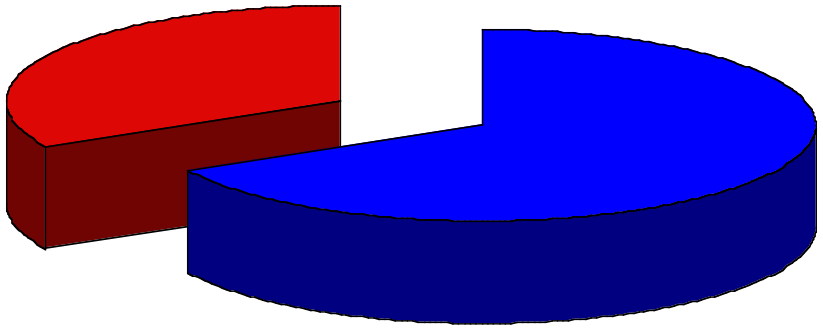
“Thruthiness”

“It used to be, everyone was entitled to their own opinion, but not their own facts. But that’s not the case anymore.
Facts matter not at all. Perception is everything. Its certainty.”
Stephen Colbert, 26 January 2006

Legacy of Agent Orange

Active Ingredients *vs* End Products

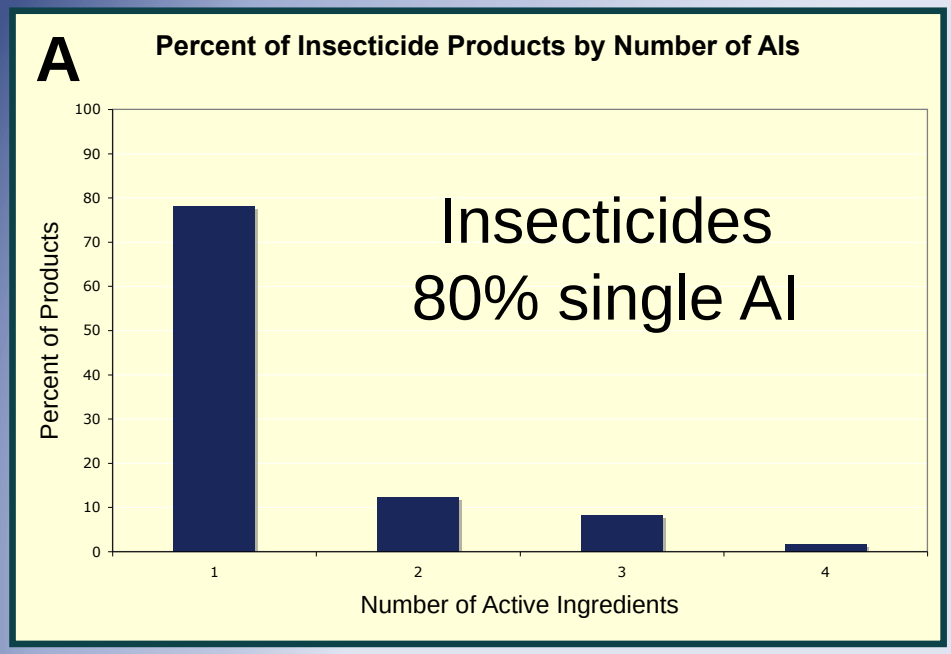
2 billion lbs AI annually

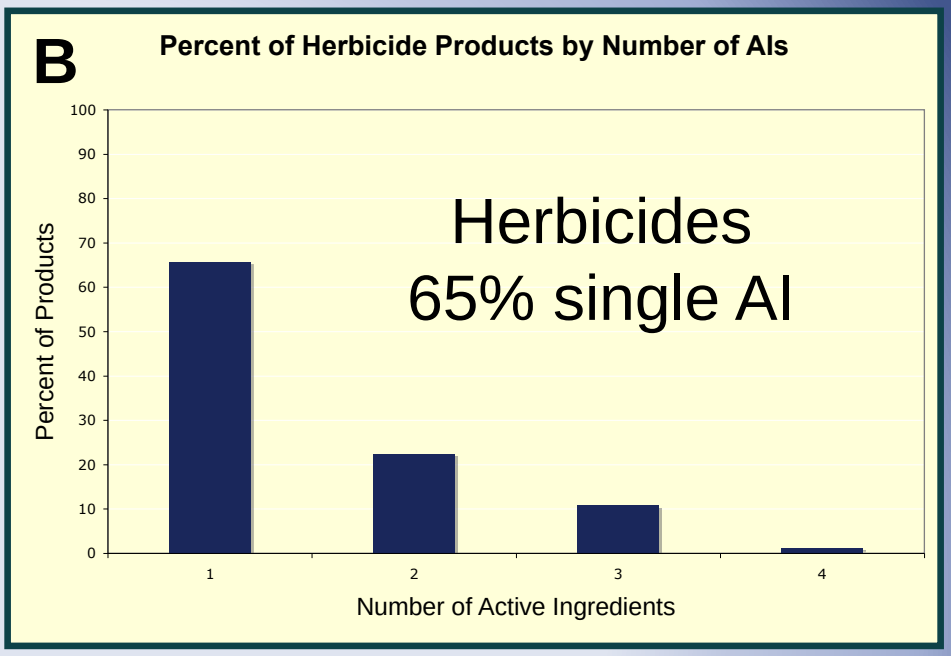


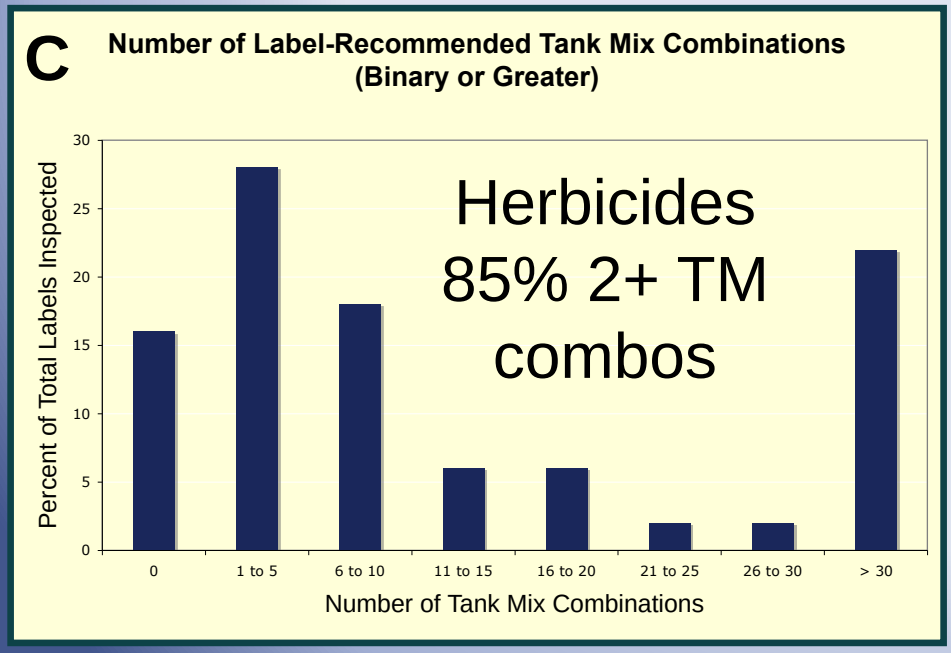
+ Adjuvants and Carriers

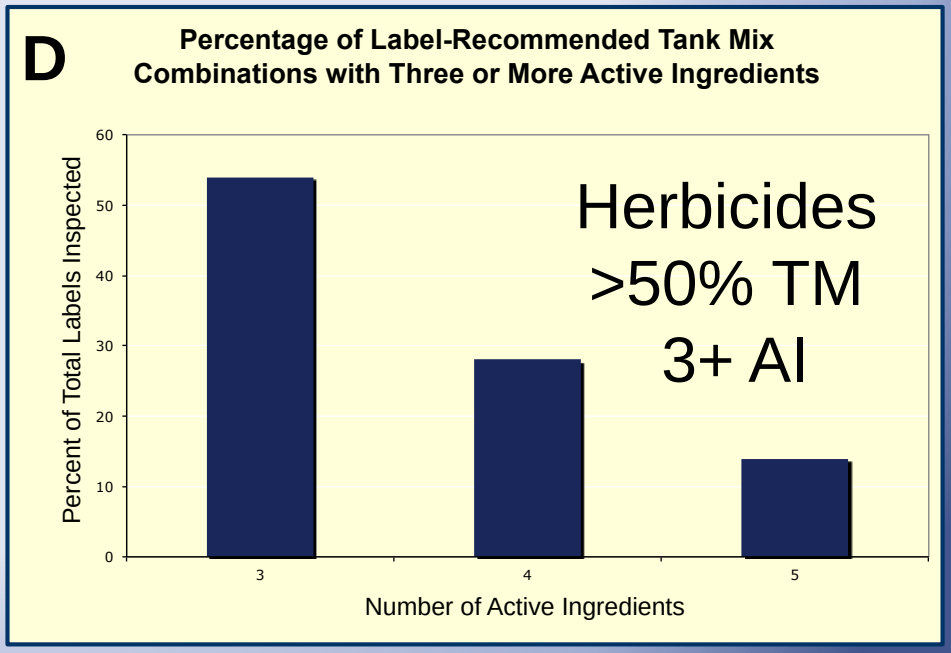
4.1 billion lbs
"inert" ingredients annually

Active Ingredients — Formulations — Tank Mixes









Which Context is Key?

Key to Hazard/Risk Assessment is:

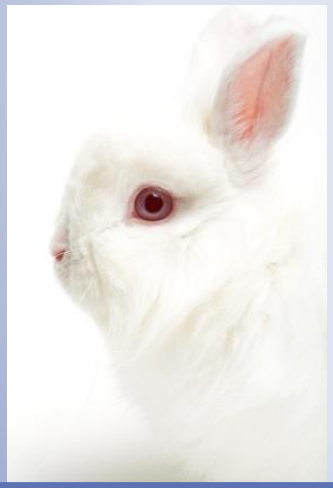
- Environmental exposure
  - Operational practices
    - What, where, when?
  - Species and life stages present
    - Which are most vulnerable
      - Life history
- Example: Toxicity of aquatic herbicides to amphibians

Overview

- Motivation for this work
  - What's the problem?
- Pieces of work
  1. Amphibian phenology and habitat use
  2. Effects of triclopyr on metamorphic northern red-legged frogs (*Rana aurora*)

What's the problem?

Amphibian data are not required in herbicide toxicity testing



Frogs

Tadpoles

(40 CFR § 138)

What's the problem?

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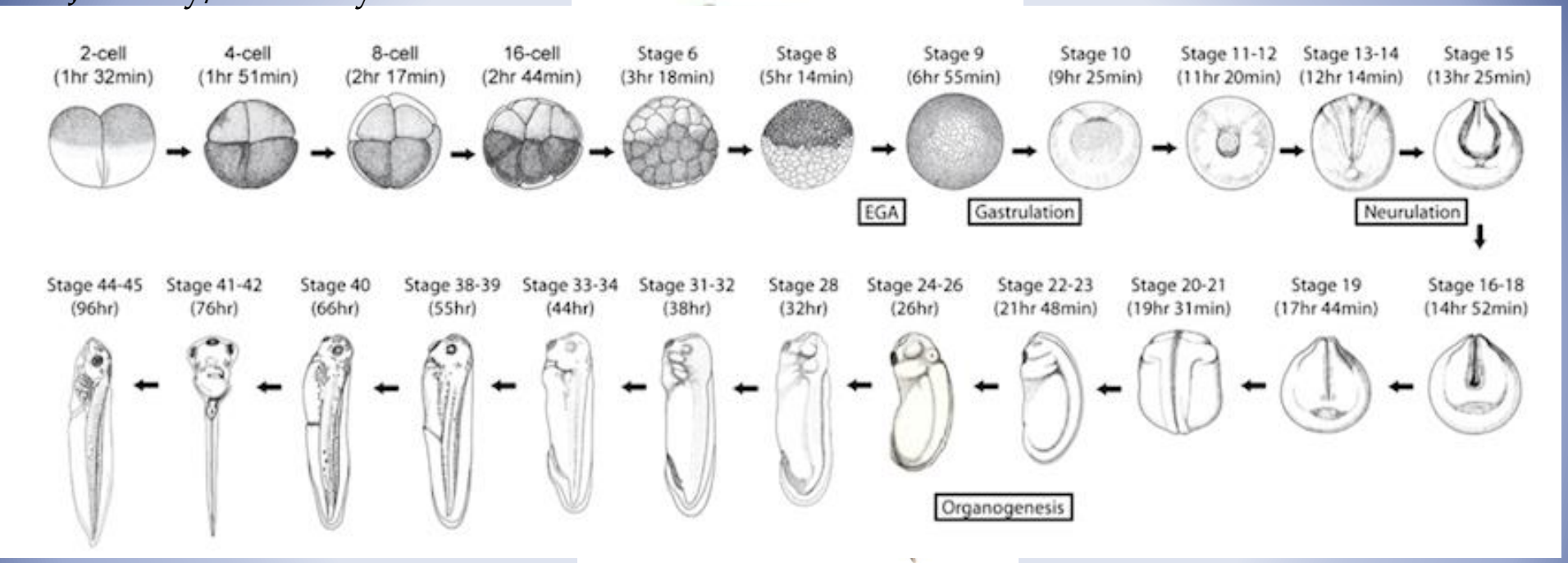
Sparling et al. 2010

Existing amphibian data are not relevant to PNW species

What's the problem?

January/February



March/April

Existing amphibian data are not relevant to PNW life stages

What's the problem?

Different sensitivities to pesticides exist

<

(Bridges 2000)

<

(Harris 2000)

What's the problem?

Roundup

≠

No one studies aquatic formulations

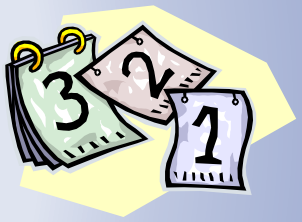
What's the problem?

www.frog-life-cycle.com/

We don't have a complete picture of native amphibian ecology

What's the problem?

Joshua Wallace, FieldHerpFo



We know when and where eggs are laid

What's the problem?

But when and where do they pop those legs out?

What's the problem?

www.frog-life-cycle.com/

Who is at risk of exposure to aquatic weed management?

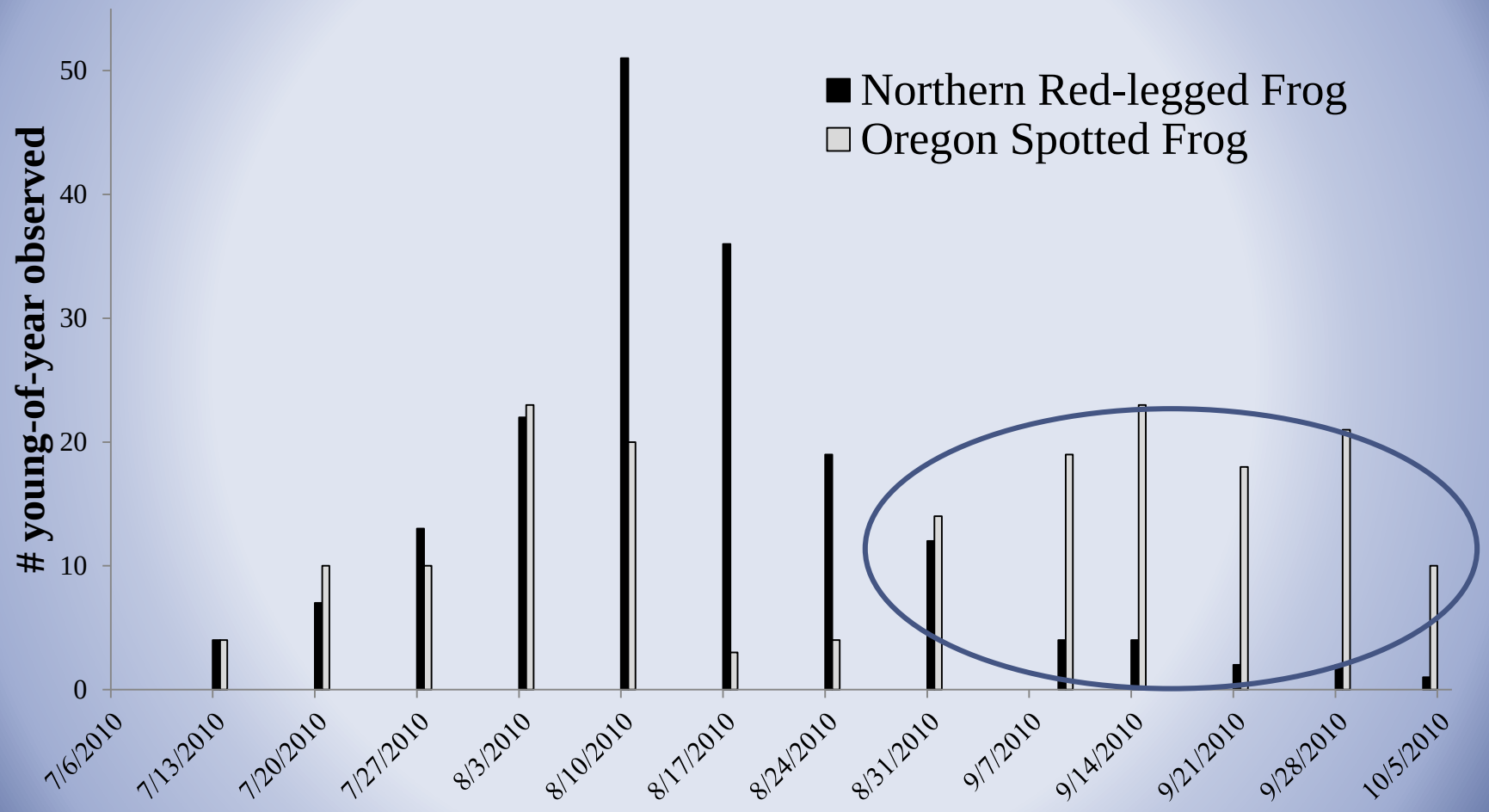
What to do about the problem?

Two Aquatic Weeds Management Fund Grants - Dept. of Ecology

Pieces of Work

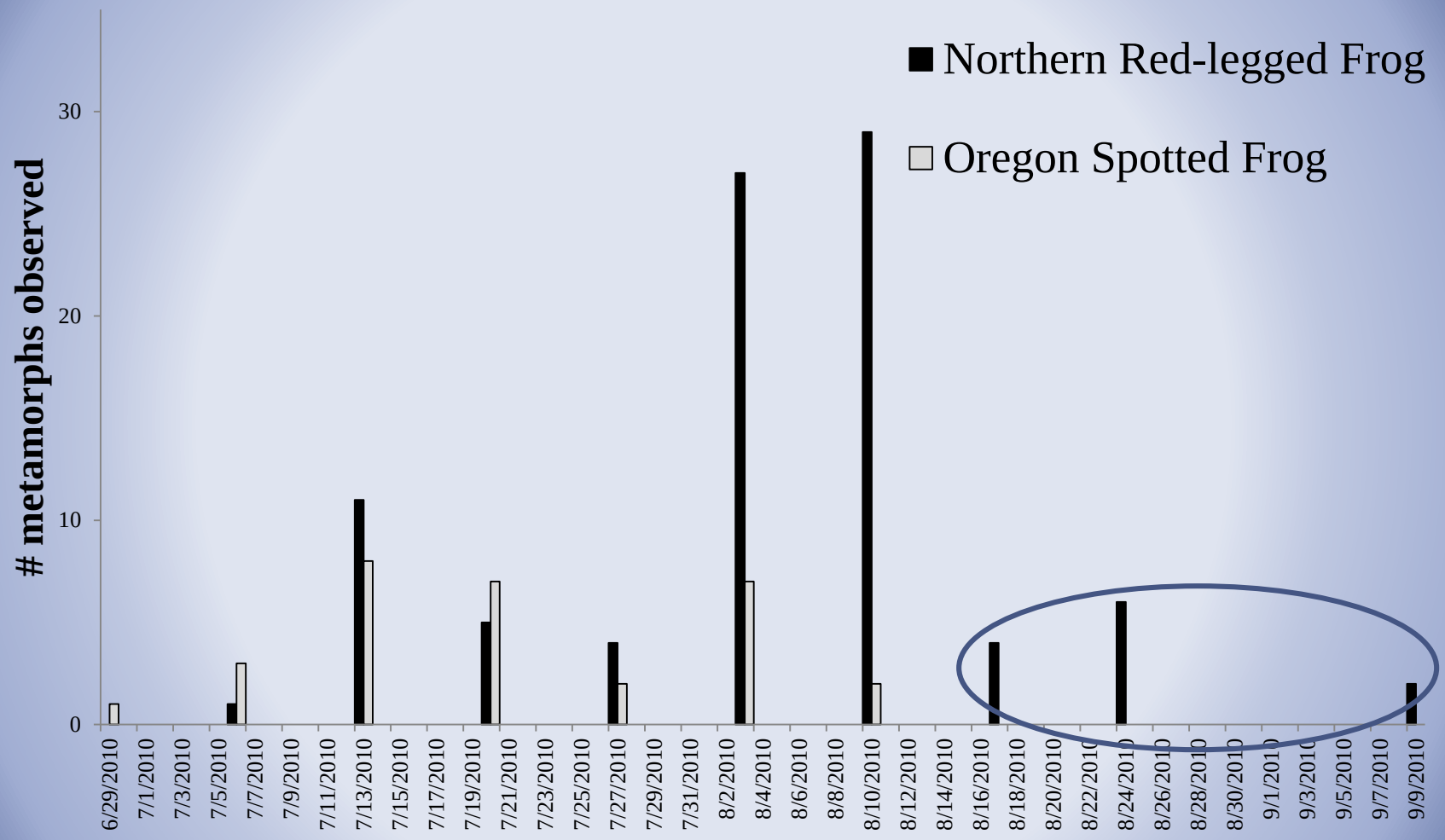
1. Amphibian phenology and habitat use
2. Effects of triclopyr on metamorphic northern red-legged frogs

Phenology & Habitat



Young-of-year Oregon spotted frogs are present in late summer

Phenology & Habitat



Northern red-legged frog metamorphs are present in late summer

Triclopyr & Northern Red-legged Frogs

ecologyadventure2.edublogs.org/plant/purple-loosestrife/

Triclopyr Tank Mix Methods

Tank mix- labeled rates in 2cm water depth:

Renovate® 3
Specialty Herbicide

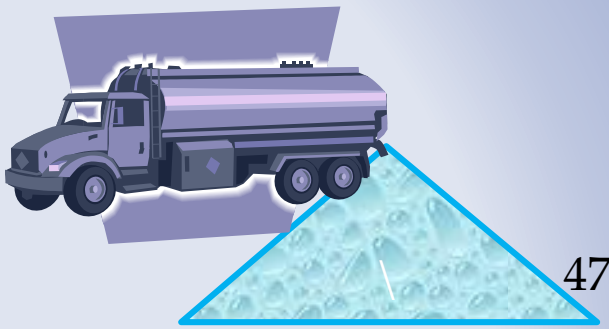
SPECIMEN

SePRO®

Aquatic Sites: For control of emersed, submersed and floating aquatic plants in aquatic sites such as ponds, lakes, reservoirs, non-irrigation canals, seasonal irrigation waters and ditches which have little or no continuous outflow, marshes and wetlands, including broadleaf and woody vegetation on banks and shores within or adjacent to these and other aquatic sites.

For use in New York State, comply with Section 24(c) Special Local Need labeling for Renovate® 3, SLN NY-060001

Active Ingredient
triclopyr: 3,5,6-trichloro-2-pyridinyloxyacetic acid, triethylamine salt 44.4%
Other Ingredients 55.6%



47.1 ppm

+

WILBUR-ELLIS
IDEAS TO GROW WITH®

COMPETITOR®

Modified Vegetable Oil

U.S. Patent No. 5,631,205

CA Reg. No. 2935-50173 WA Reg. No. AW-2935-04001 EPA Est. NO. 2935-TX-2

PRINCIPAL FUNCTIONING AGENTS	% By Wt.
Ethyl Oleate, Sorbitan Alkylpolyethoxylate Ester, Dialkyl Polyoxyethylene Glycol	98%
Constituents Ineffective as spray adjuvant	2%
Total	100%

DIRECTIONS FOR USE

Aquatics: COMPETITOR may be used as an additive with aquatically labeled pesticides. The use rates for COMPETITOR should follow the recommended surfactant rate that is specified on the pesticide product label. If there is no recommended surfactant rate on the pesticide label, COMPETITOR should be used at the rate of 2 to 4 pints per 100 gallons of spray solution.

41.3 ppm

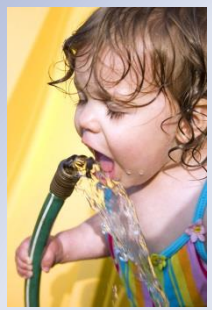
+

HI-LIGHT®

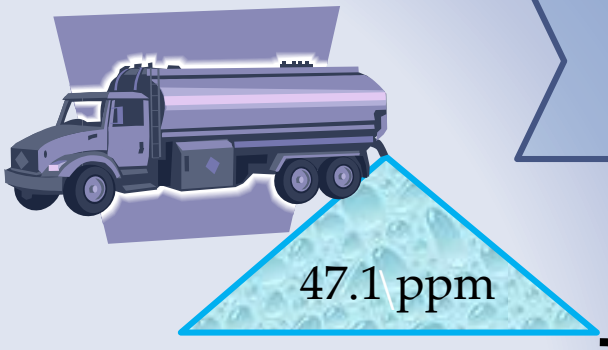
Industrial Strength Spray Pattern Indicator

12.9 ppm

Triclopyr Tank Mix Methods



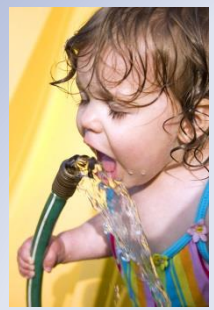
Control (clean water)



96 h
static
renewal

X 15

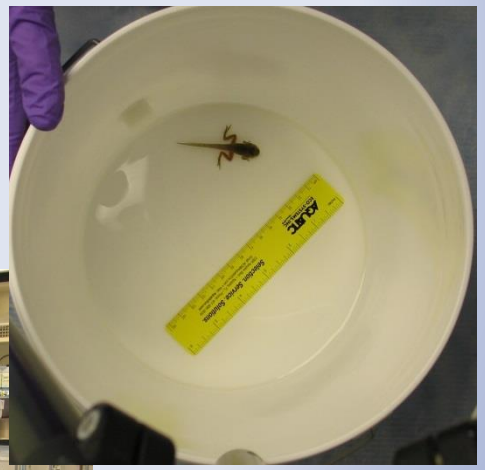
Triclopyr Tank Mix Methods



Control (clean water)

Tank mix
(clean water)

60-d
grow
out

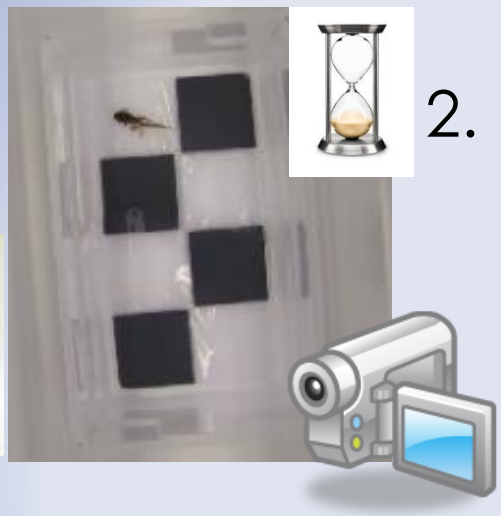


X 15

Triclopyr Tank Mix Methods

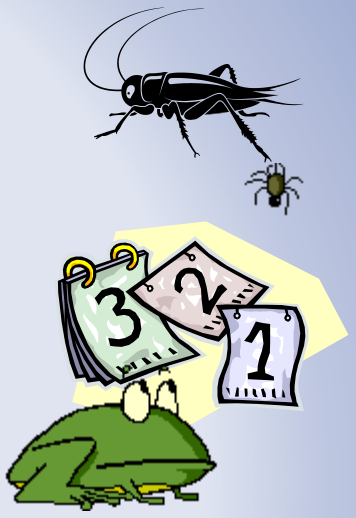
Endpoints:

1.



2.

3.

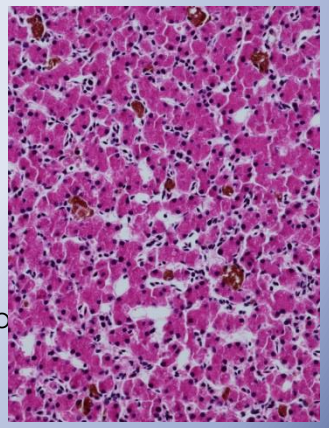


4.

5.

w es/3953-liver-go

6.



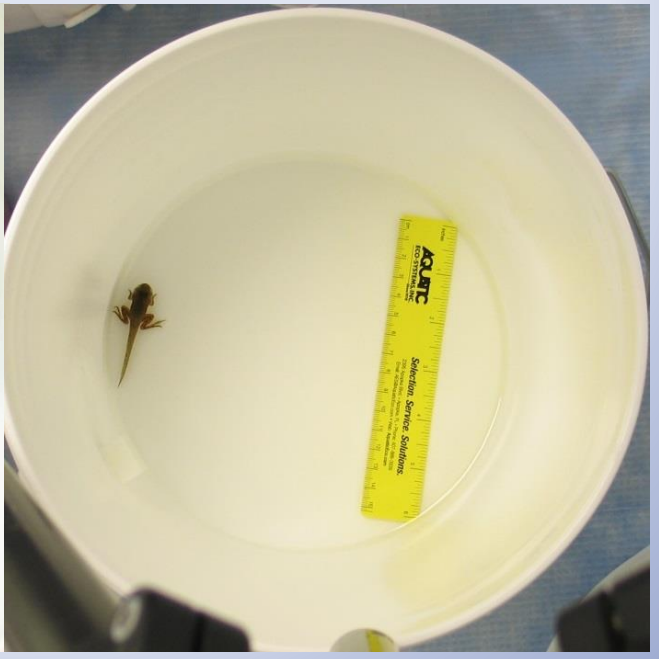
Triclopyr Tank Mix Results

- No treatment-related mortalities
- No gross anomalies in gonad structure
- No treatment-related anomalies in over-all health

Triclopyr Tank Mix Results

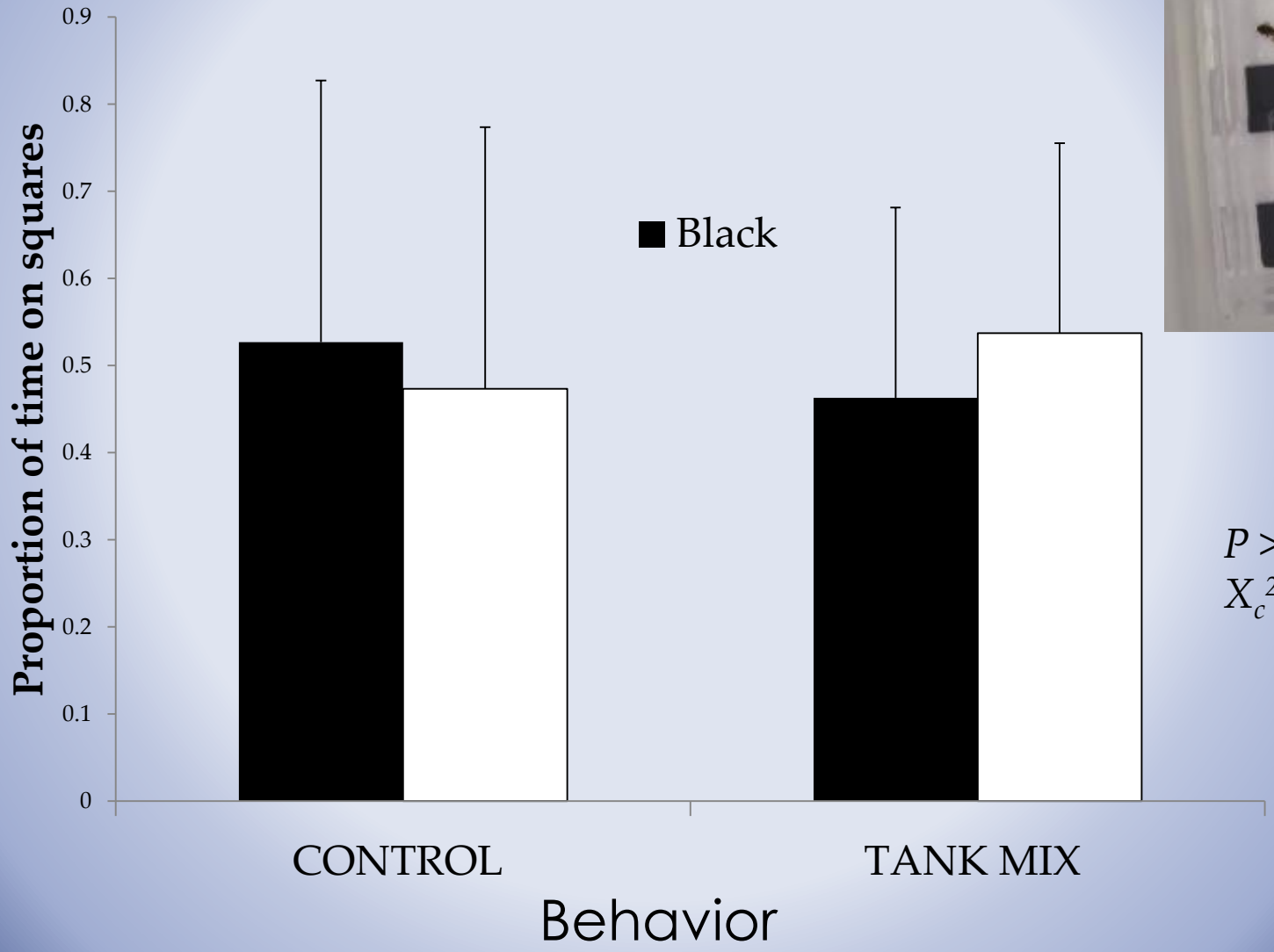
Evidence of stress during exposure.

# Observations	Legs sprawled (n)	Moving (n)
Control	2 (2)	7 (6)
Tankmix	22 (12)	12 (8)
K-S *p*	0.013	1.000



Triclopyr Tank Mix Results

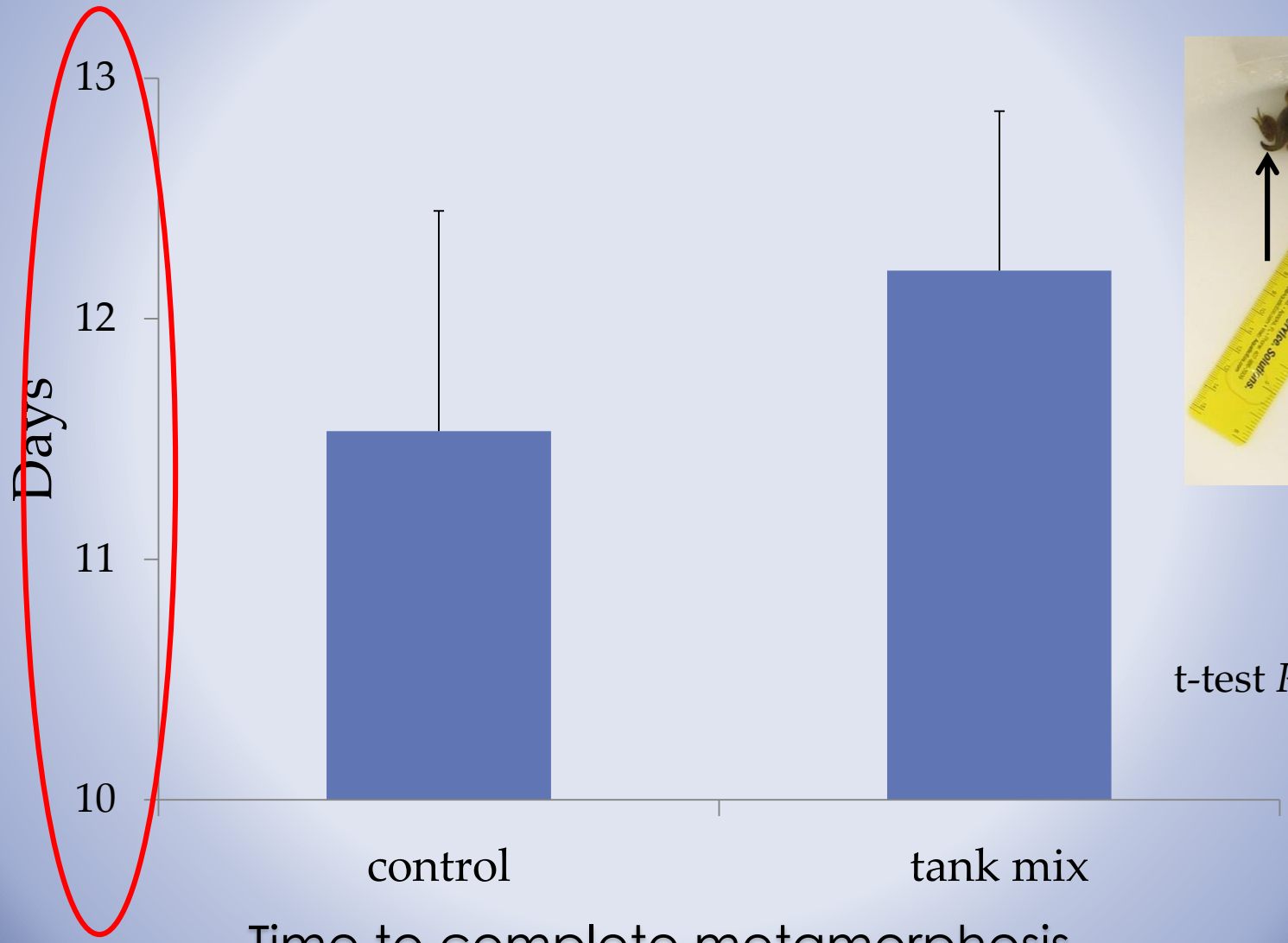
No evidence of color preference



$P > 0.75$

$X_c^2 = 0.10$

Triclopyr Tank Mix Results

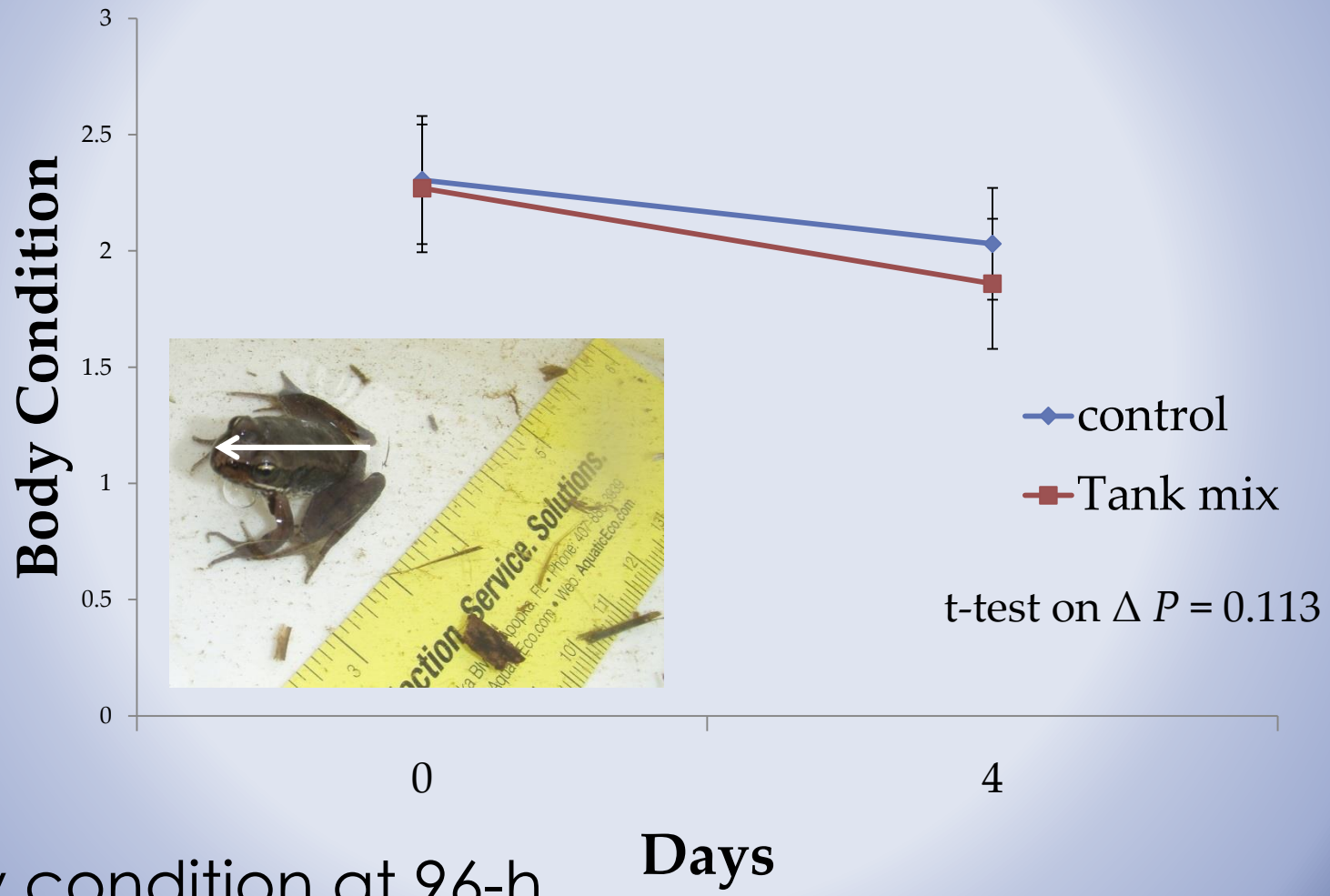


t-test $P = 0.031$

Time to complete metamorphosis

Triclopyr Tank Mix Results

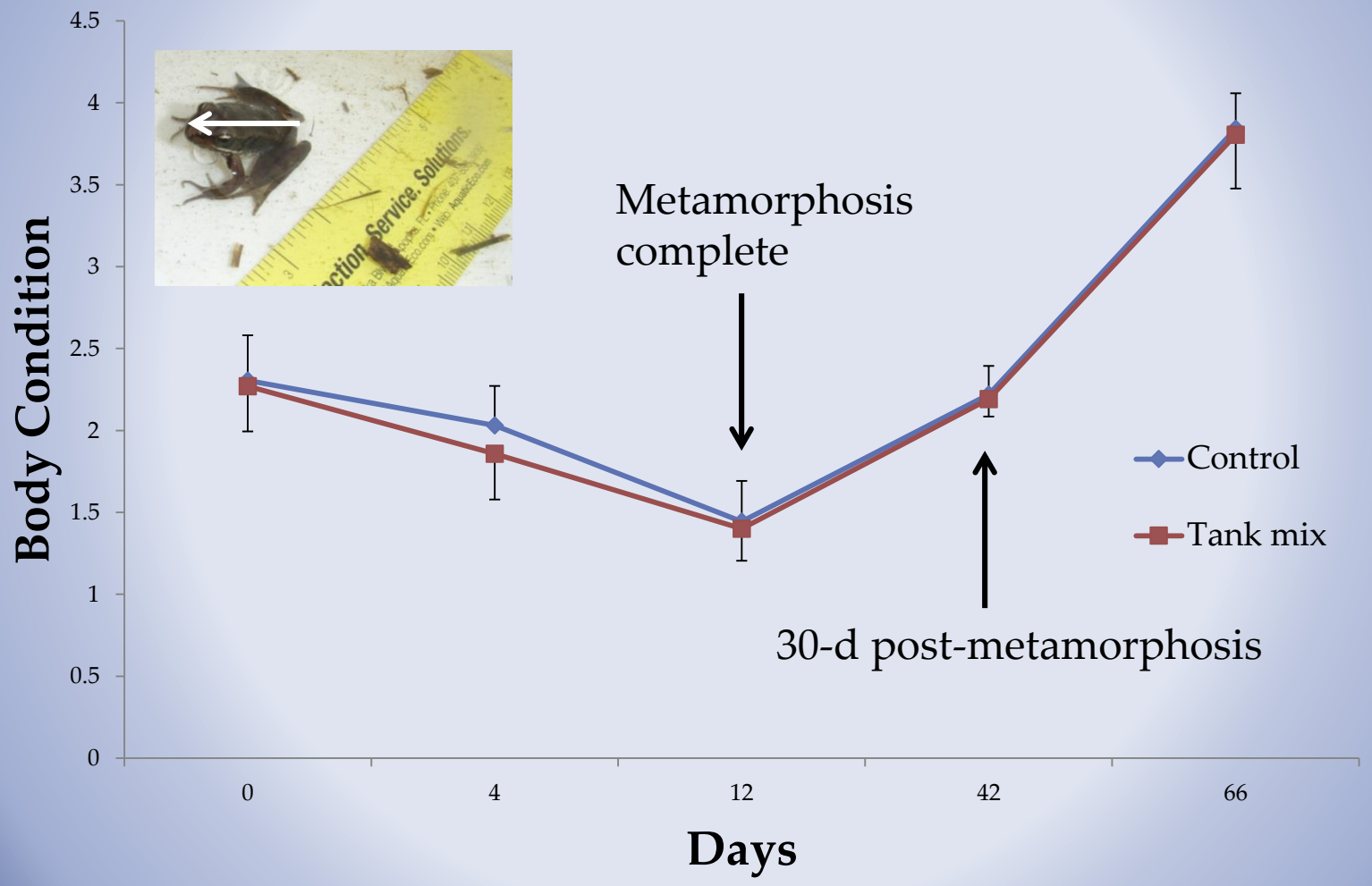
More evidence of stress during exposure?



Body condition at 96-h

Triclopyr Tank Mix Results

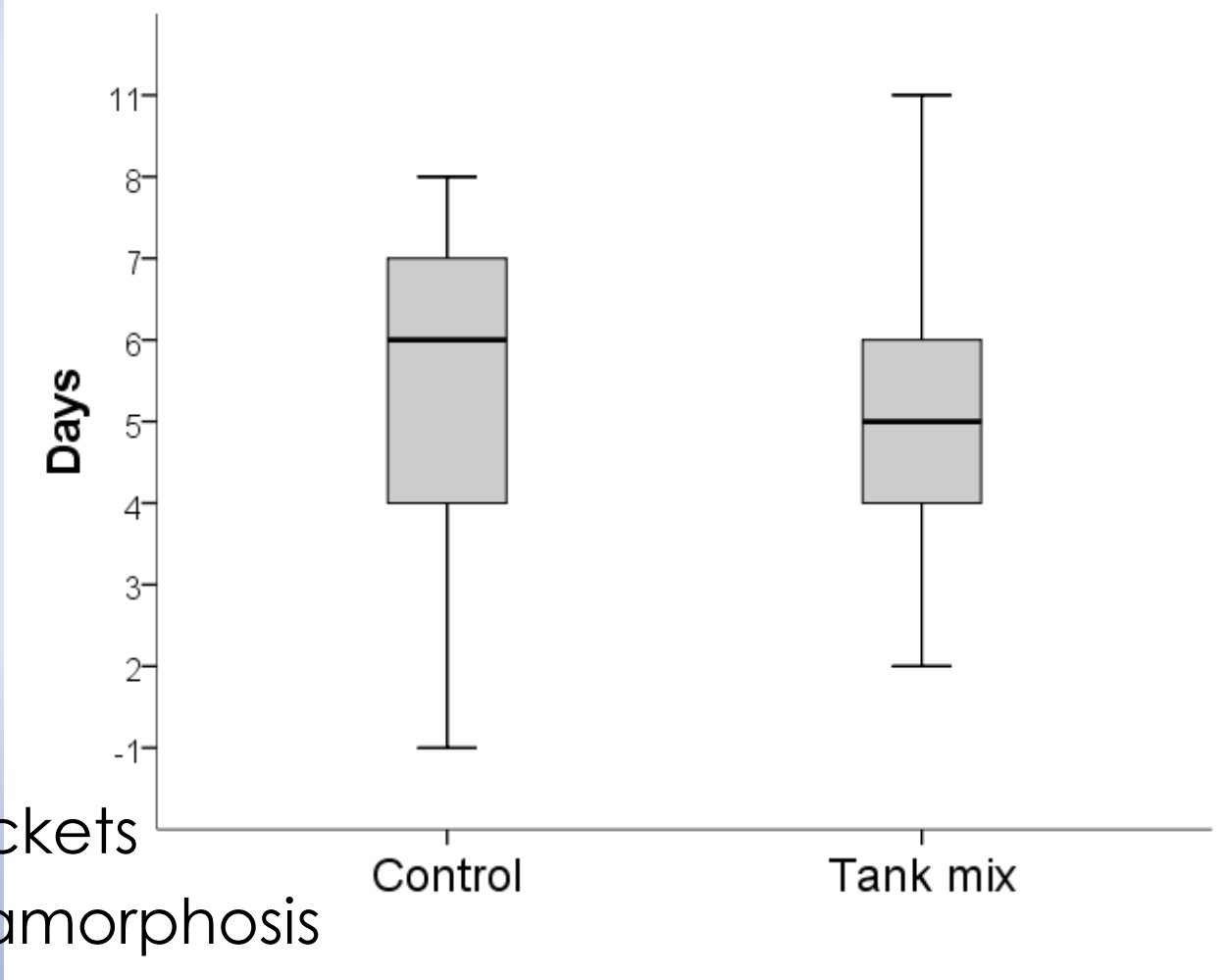
Eventually the controls caught up



Body condition over time

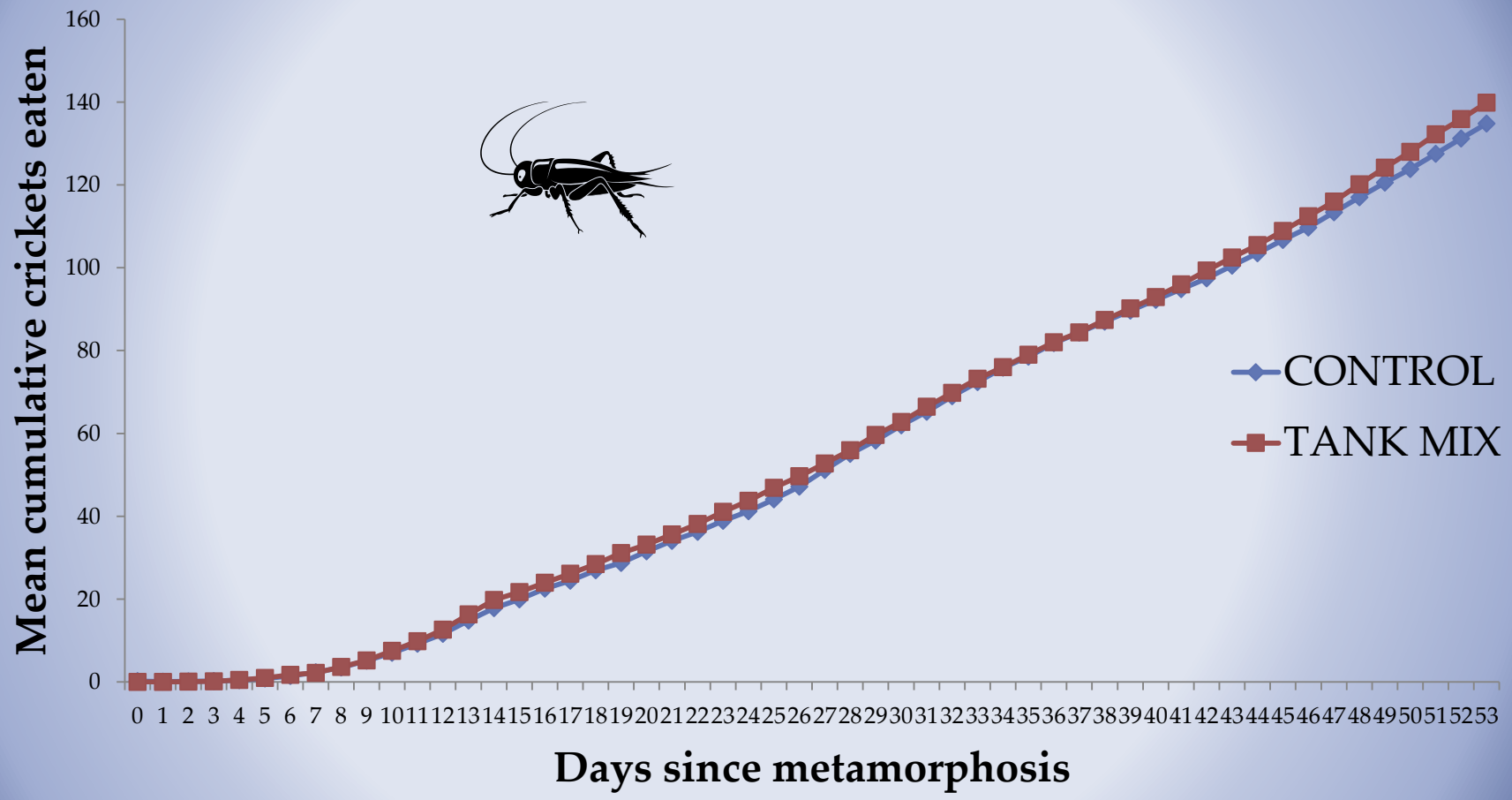
Triclopyr Tank Mix Results

Everyone started eating at the same time



First time eating crickets after metamorphosis

Triclopyr Tank Mix Results

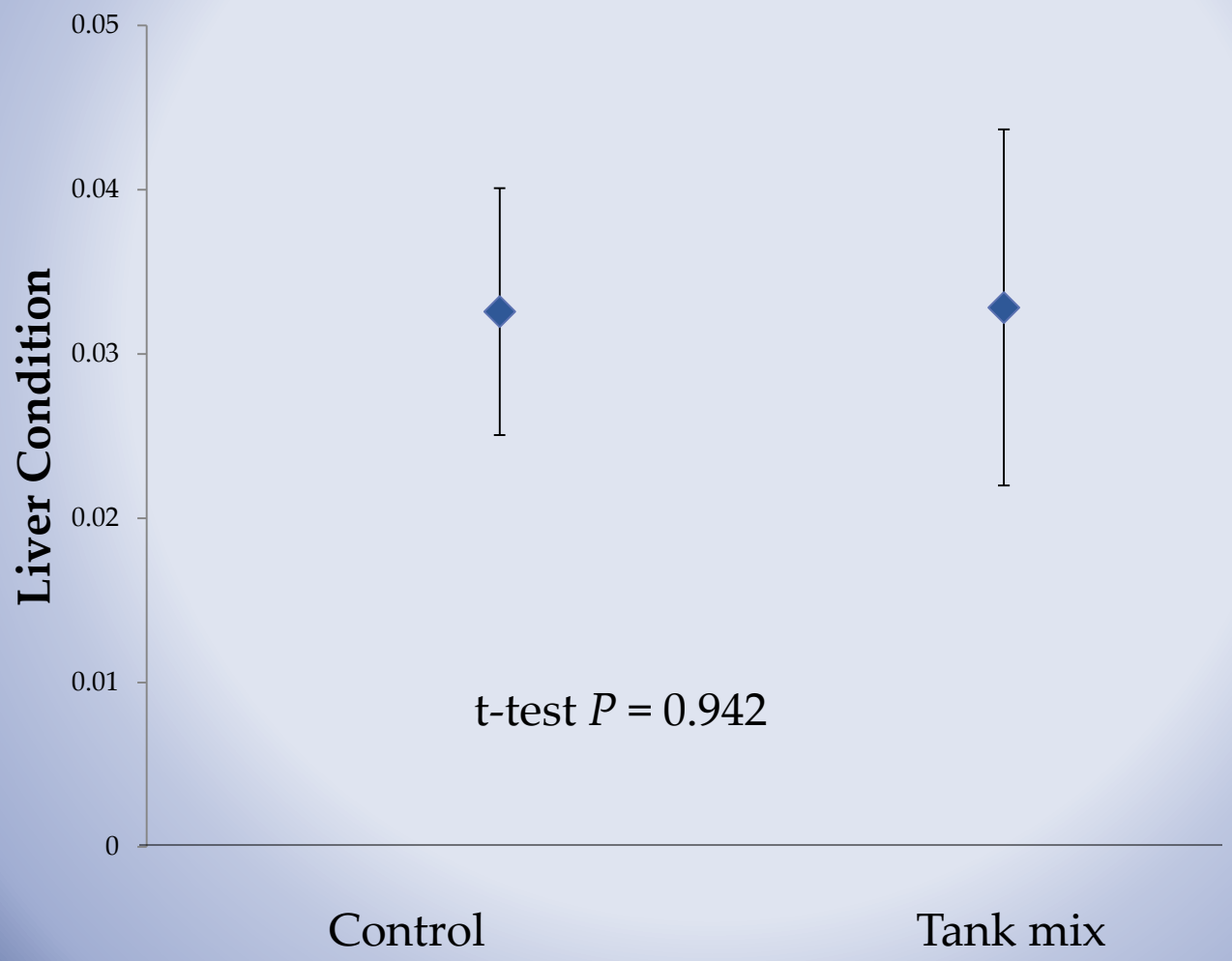


Feeding behavior

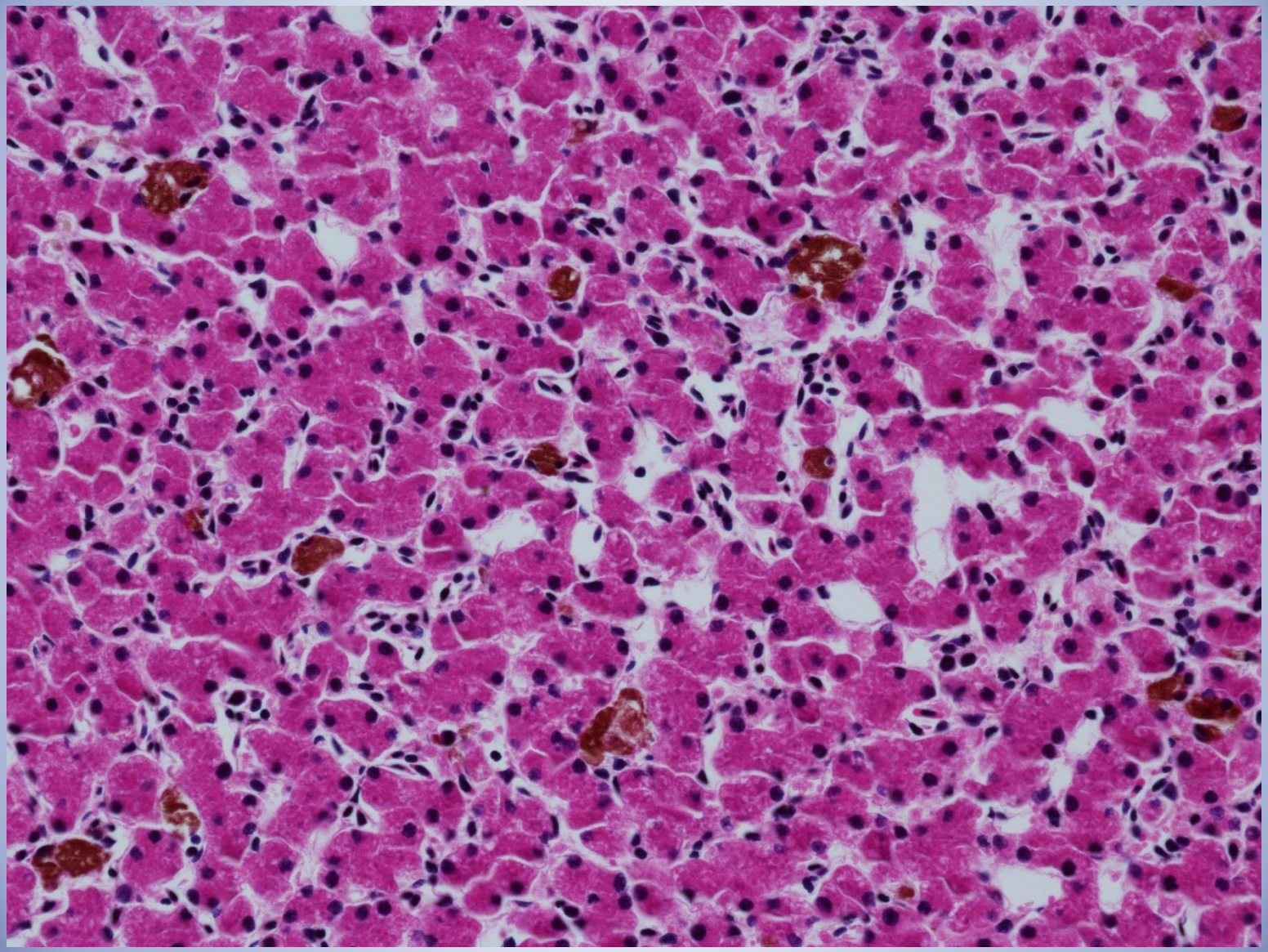
LMM day 53, $P = 0.199$

Triclopyr Tank Mix Results

No difference in liver condition



Triclopyr Tank Mix Results



No difference in liver histology

Triclopyr Tank Mix Conclusions

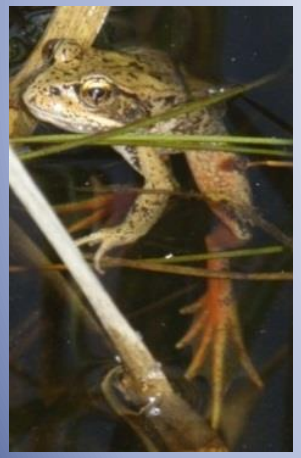
- Minimal effects observed
- Stress during exposure – what is real exposure in field?
- Data recording minimal observed effects from herbicide tank mixes are important in conservation work
  - Provides support for managers working with protected or invasive species
  - Informs policy and fills data gaps

Final Thoughts

- Presence of pesticides in surface waters does not necessarily translate to hazard
- Incorporating ecological processes into toxicity testing can improve our ability to inform policy and the public
- "Effects" sell! … but "no effects" can be just as important in supporting habitat management decision-making
- There are risks associated with "no action"

Final Thoughts

- We, as users of herbicides, must do our part to minimize non-target effects
- IPM = Adaptive Management
  - Uncertainty drives the process, but does not paralyze it
    - Unfortunately, AM is the exception and not the rule



Associated journal papers are available in the *Archives of Environmental Contamination and Toxicology* (King) and *Environmental Toxicology and Chemistry* (King, Yahnke)

Questions?