Breeding In Troubled Waters: *How Chinese tallow Leaf Litter Alters Amphibian Oviposition Site Selection*

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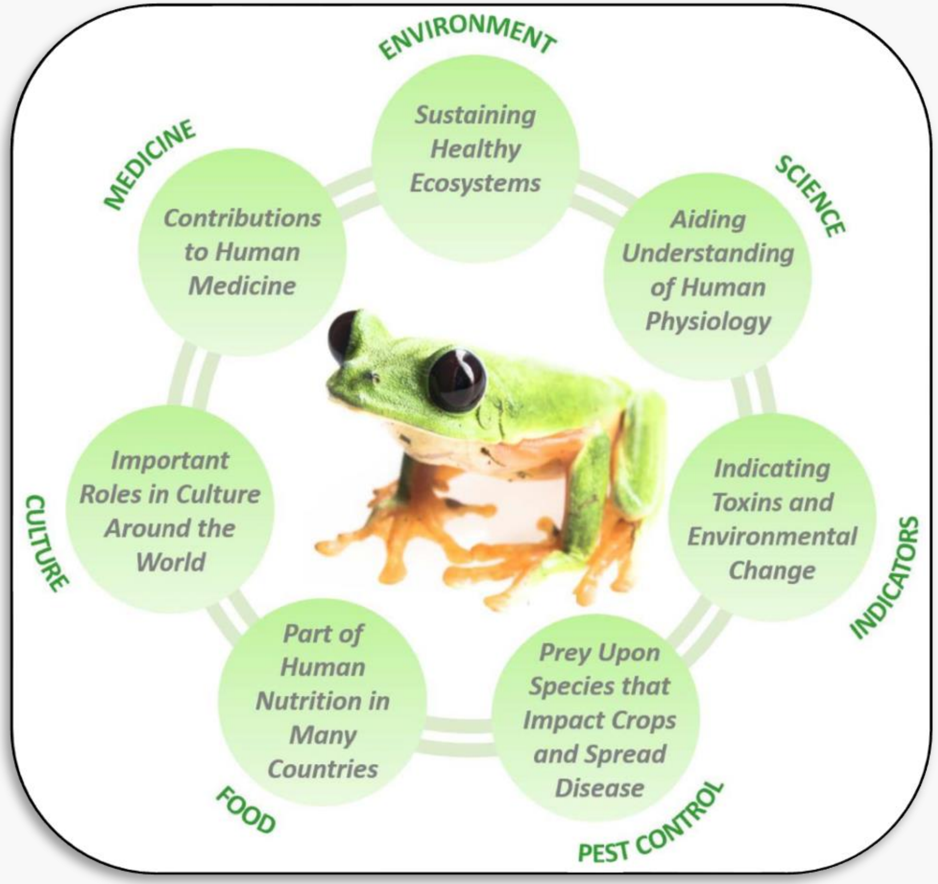
Amphibians: Key Players at Risk

- Critical to food webs
  - As both predators and prey
- Control insect populations
  - Mosquitoes
- Indicators of environmental health and ecosystem change
- Important for nutrient cycling and energy flow
- Traded for food, medicine, and symbolism
  - Important in subsistence, culture, and folklore



AMPHIBIAN SURVIVAL ALLIANCE

Amphibian Ecology:

Life History & Vulnerability

- Moisture-dependent skin and eggs make them sensitive to pollution and dehydration

- Limited dispersal ability—can't escape degraded habitats

- Dual aquatic and terrestrial life stages expose them to multiple threats

- Specialized habitat needs increase extinction risk

Amphibian Reproductive Ecology:
Constraints in Aquatic Environments

- Reproductive success is closely tied to oviposition site selection for many species
- Influences parental fitness, population recruitment, and community structure
- Larvae remain in aquatic environments until metamorphosis
    - ***Site selection is critical***
    - ***Multiple factors influence site selection***

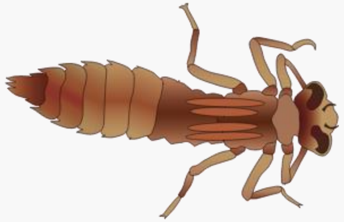

Photo by Brandon Gross

Amphibian Reproductive Ecology:

Biotic Factors Influencing Oviposition

Include the presence of:

Predators



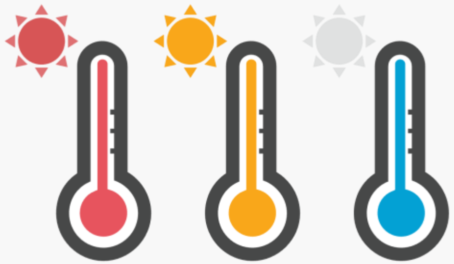
Competitors

Conspecifics

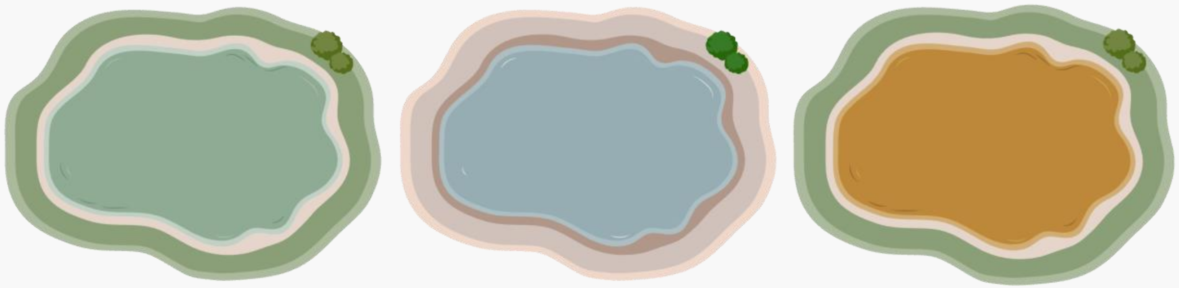
Amphibian Reproductive Ecology:
Abiotic Factors Influencing Oviposition

Include:

Temperature



Water Quality



Hydroperiod

Substrate Quality & Quantity

Complexity in Amphibian Declines

Many species have **small geographic ranges**, making them more vulnerable to local threats

Amphibians are often **habitat specialists** (e.g., stream breeders vs. ephemeral pond breeders)

Limited dispersal ability restricts recolonization after disturbance

High sensitivity to environmental stressors due to permeable skin and complex life cycles

Decline patterns vary by species, life history, and region — no single conservation strategy fits all

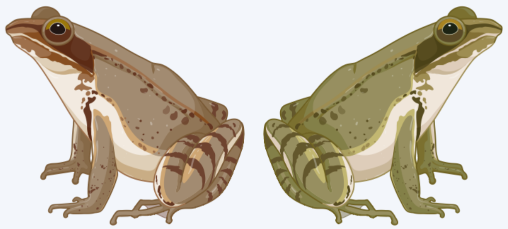
BLAUSTEIN, A.R., KIESECKER, J.M. COMPLEXITY IN CONSERVATION: LESSONS FROM THE GLOBAL DECLINE OF AMPHIBIAN POPULATIONS. ECOLOGY LETTERS 5, 597–608 (2002).

Why One Threat Doesn't Fit All: *Context Matters*

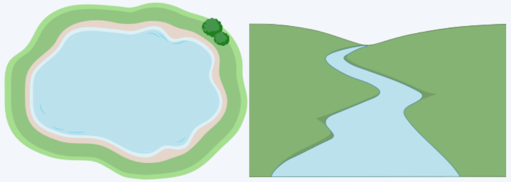
Same Threat, Different Outcomes

Outcome depends on:

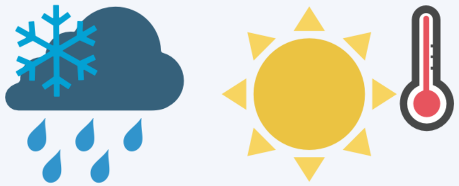
Species



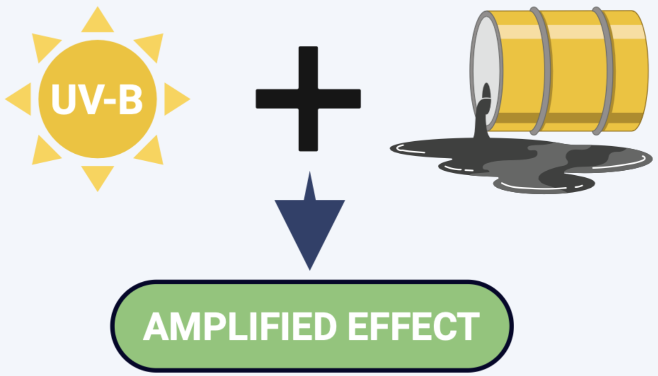
Life History



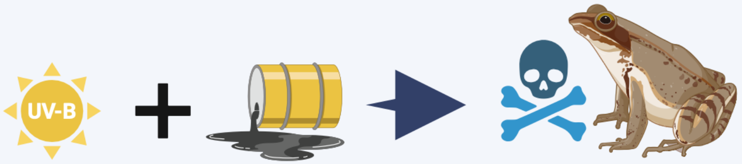
Phenology



Threats Interact & Amplify Effects



Stressors can combine to amplify effects

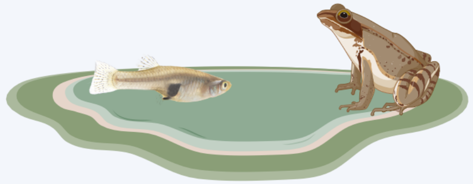


Higher Mortality

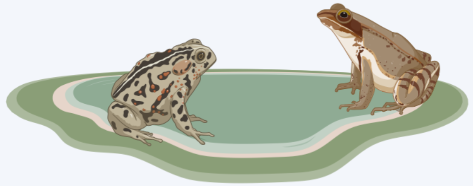
Invasive Species Amplify Stress

May act as:

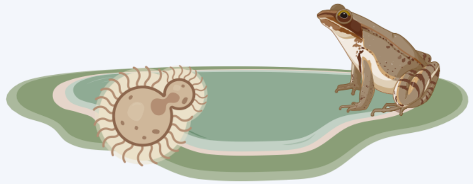
Predators



Competitors



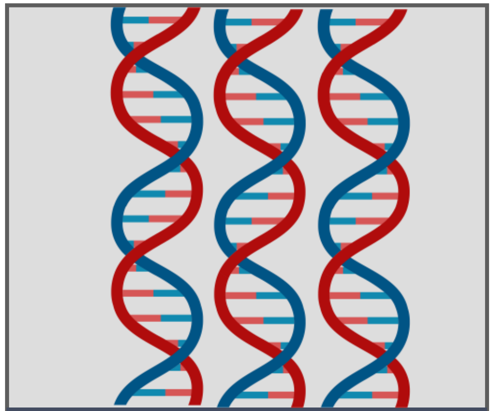
Disease Vectors



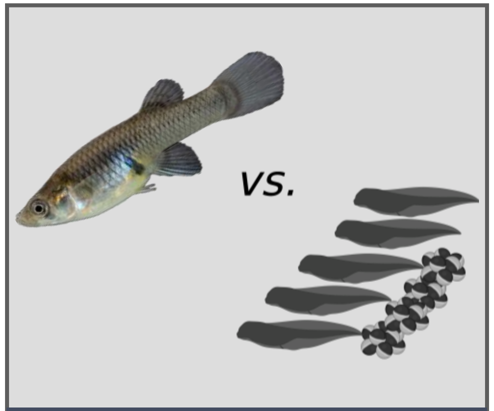
"Stressors don't act in isolation -- outcomes depend on context"

How Invasive Species Threaten Amphibians

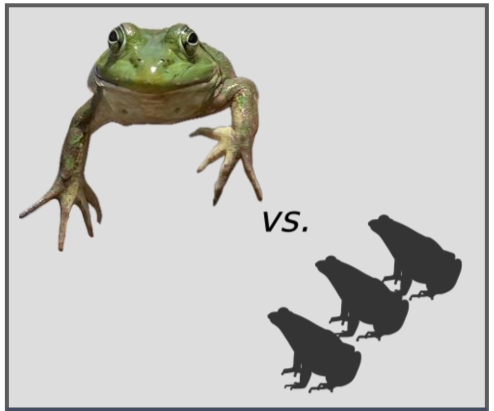
Disease



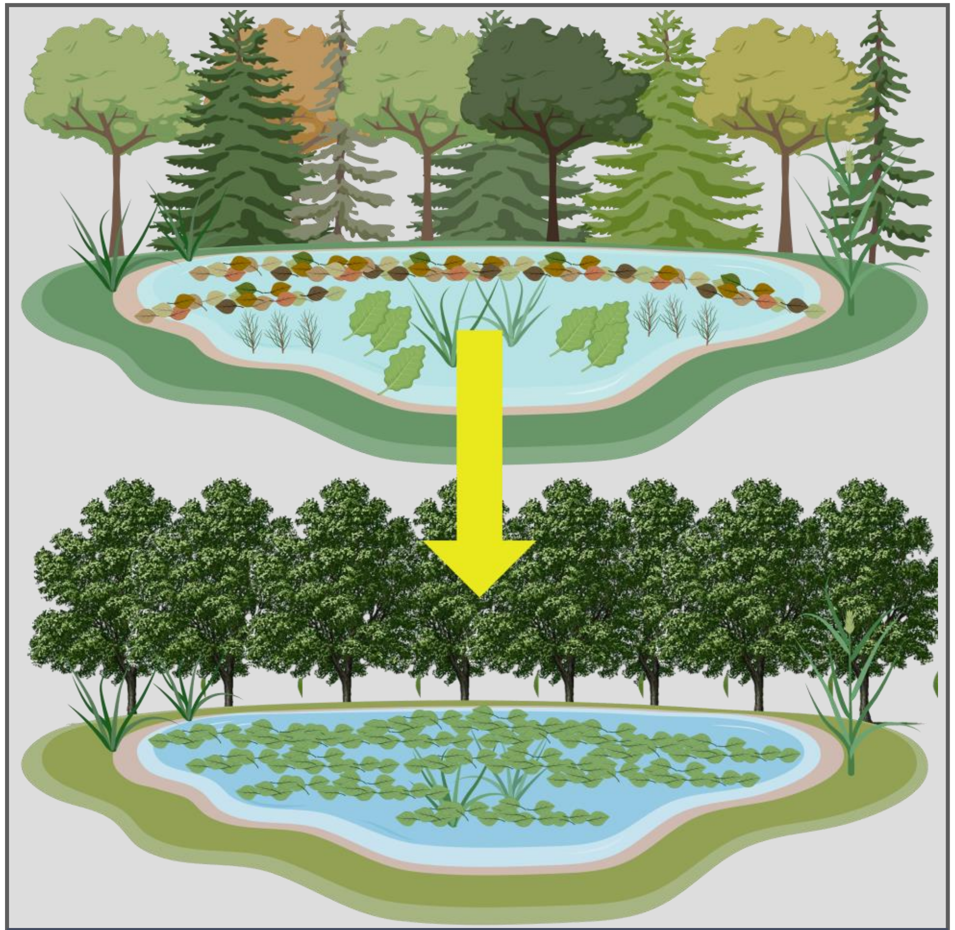
Hybridization



Predation



Competition



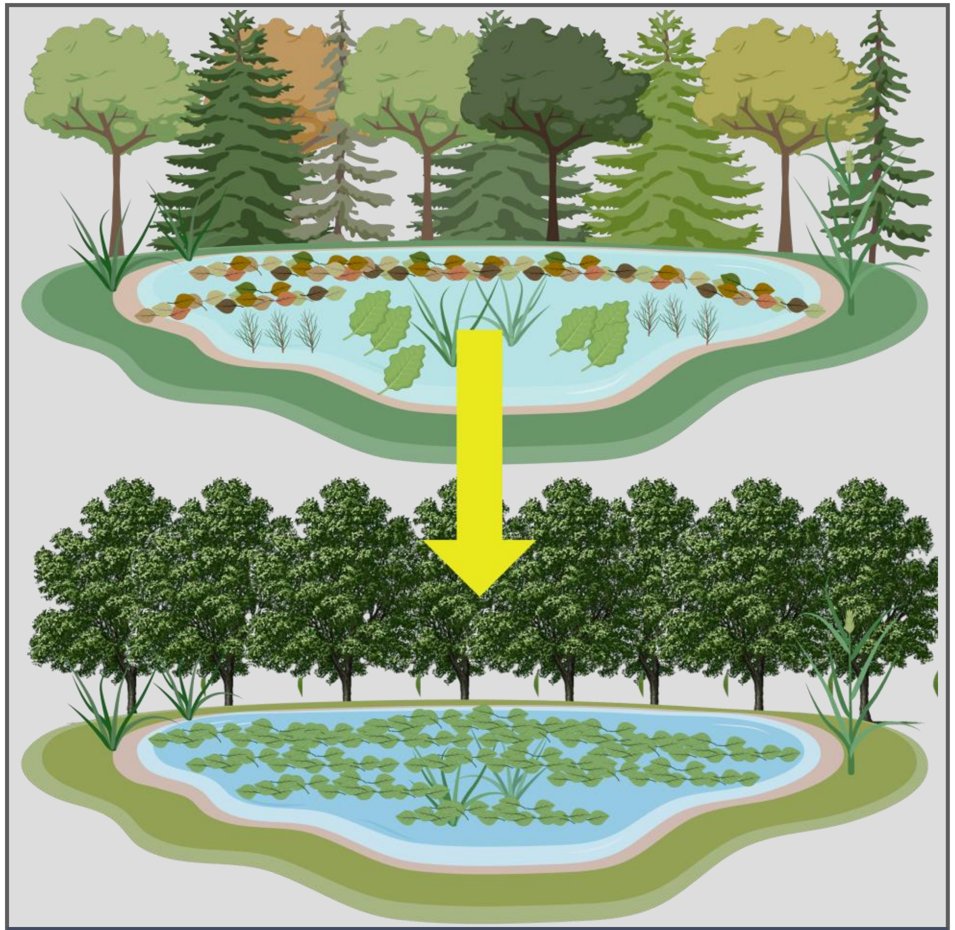
Habitat Alteration

FALASCHI, M., MELOTTO, A., DA SILVA, F.R., ET AL. (2020). INVASIVE SPECIES AND AMPHIBIAN CONSERVATION. *HERPETOLOGICA*, 76(2), 93–105

BLACKBURN, T.M., BELLARD, C., & RICCIARDI, A. (2019). ALIEN VERSUS NATIVE SPECIES AS DRIVERS OF RECENT EXTINCTIONS. *FRONTIERS IN ECOLOGY AND THE ENVIRONMENT*, *17*(4), 203–207.

Invasive Threats to Amphibians: *Habitat Alteration*

- Invasive species can **physically or chemically alter breeding habitats**, making them unsuitable for native amphibians
- Invasive plants may change **water chemistry**, **shade levels**, or **substrate composition**
- Altered habitats can lead to **reduced offspring survival**, slower development, and increased stress
- Changes in plant structure or leaf litter can **impact microclimate**, **nutrient cycling**, and **hydrology**
- These effects can decrease amphibian **growth**, **survival**, and **community diversity**



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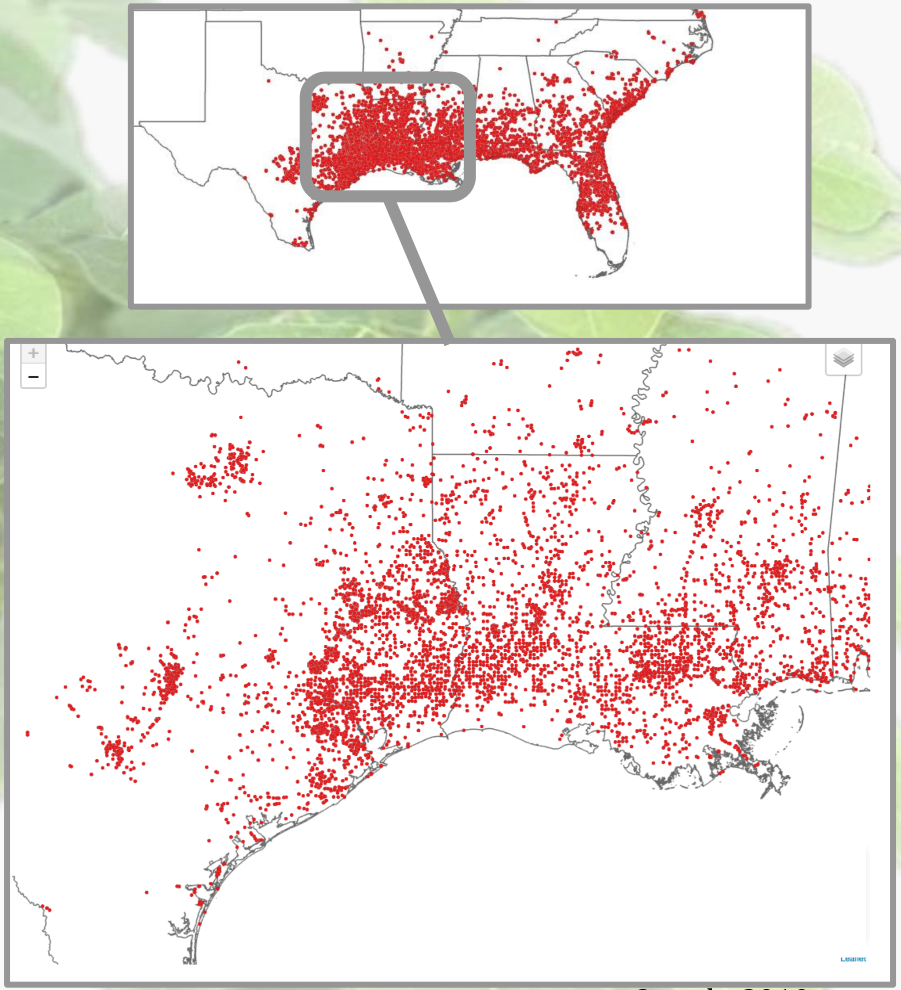
Chinese tallow (*Triadica sebifera*)

- Chinese Tallow is a fast-growing invasive tree
- Native to southeast Asia
- Introduced to U.S. in 1772
  - Savannah, GA
  - Seeds provided by Benjamin Franklin
- Range increased across the Gulf Coast in the 1900s
  - Promoted as an agricultural crop
- Introduced to Texas in 1910
- 1991-2005 population increased by 174%
- 5th most common species recorded



Oswalt, 2010
Pile-Knapp et al., 2023

Chinese Tallow: “*Invasiveness*”

- ***Growth*****-** rapid growth rates and overall larger size (early life stages)
- ***Shade Tolerance*****-** outperforms native trees in both shade and high light conditions
- ***Flood Tolerance*****-** tolerant of floods and subsequent anaerobic soil conditions
- ***Litter Decomposition*****-**
  - Leaves decompose more rapidly
  - Nutrient turnover occurs more rapidly

Effects of Chinese tallow on Amphibians

- Alters water quality conditions
  - Releases tannins and nutrients from rapidly decomposing leaf litter

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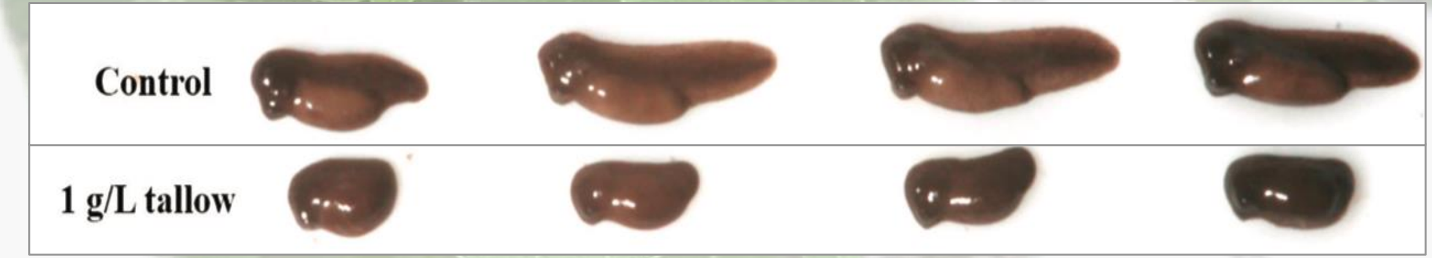
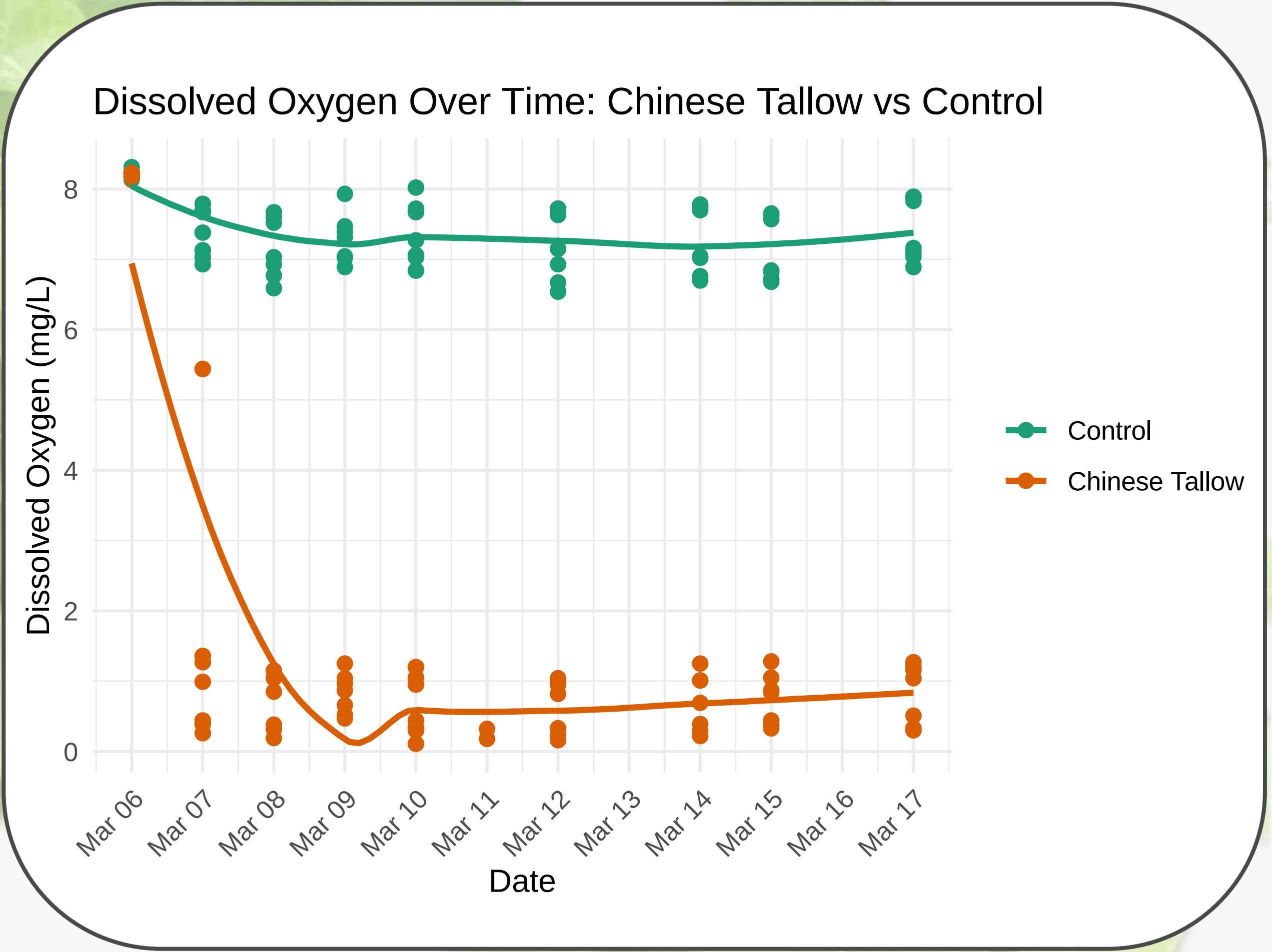
  - Decre etamorphosis
  - Reduc



Effects of Chinese tallow on Amphibians

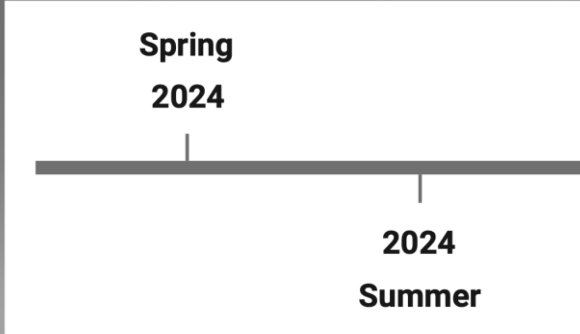
- Effects from rapid leaf litter decomposition may have a greater impact on early-breeding and fast-developing species
- Previous studies were conducted in controlled settings where amphibians were physically introduced



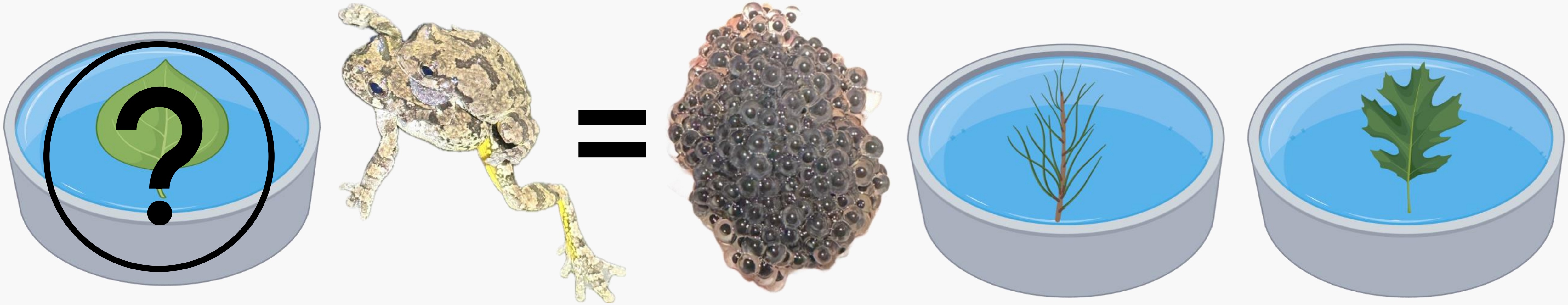
Leaf Litter Concentration and Composition Shape Amphibian Oviposition Site Preferences

Spring-Summer 2024

Research Question

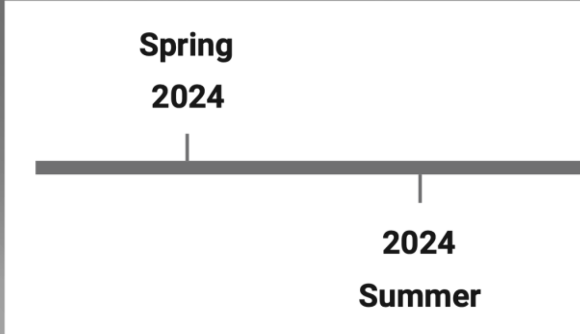


How does Chinese tallow leaf litter influence amphibian oviposition site selection compared to native species leaf litter (Loblolly Pine and Shumard Oak) in east Texas wetlands?



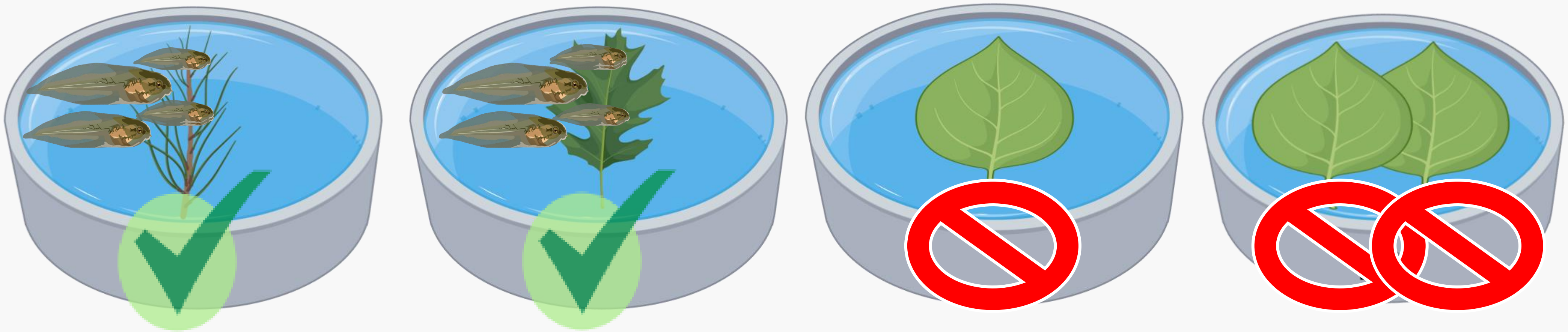
Chinese tallow Leaf Litter ***Oviposition*** ***Native Leaf Litter***

Research Hypothesis



Amphibians prefer oviposition sites with more favorable water quality conditions (higher dissolved oxygen, neutral pH).

Chinese tallow leaf litter, particularly at higher concentrations, will negatively impact water quality, leading to reduced amphibian oviposition.

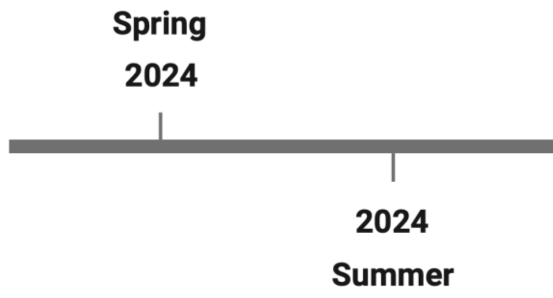


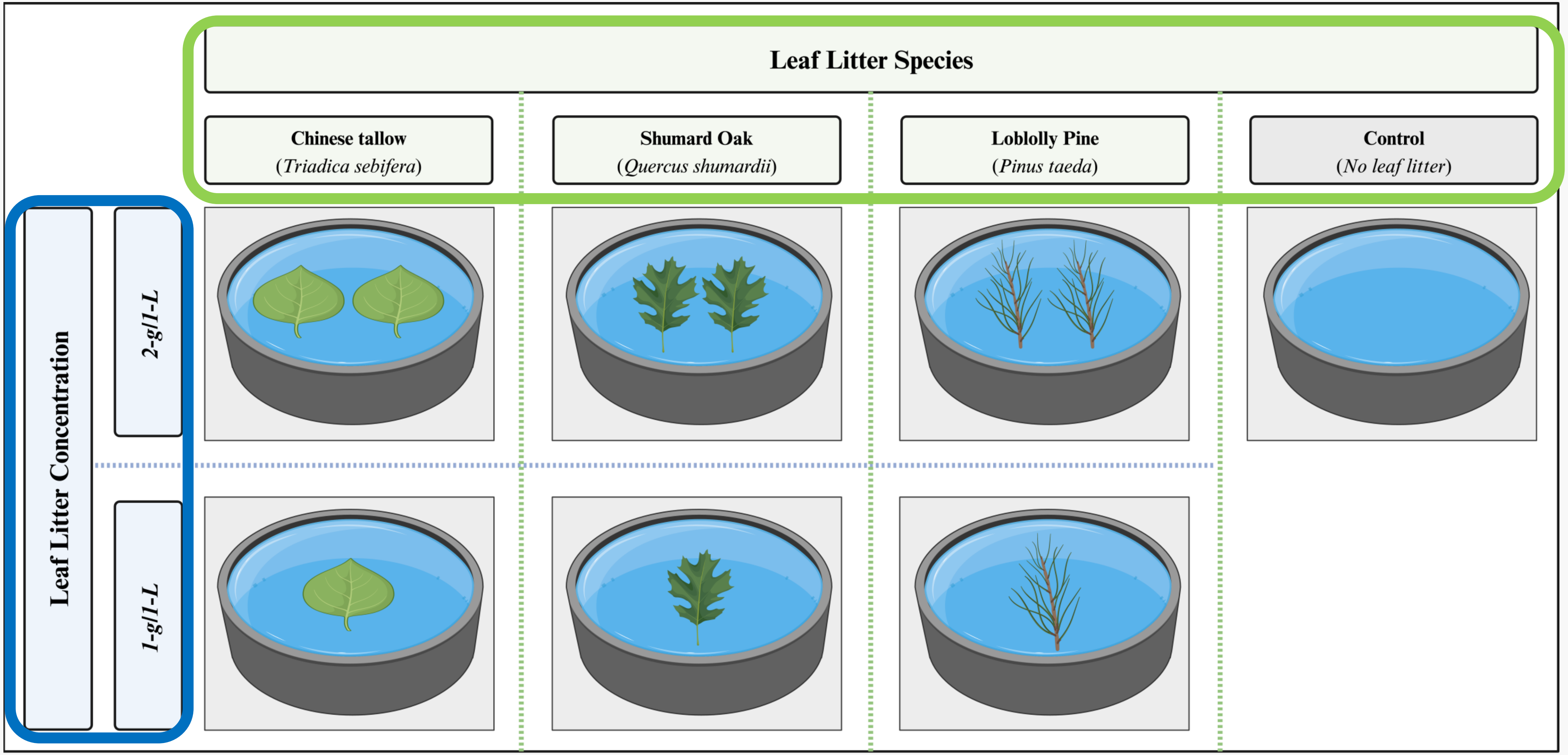
Experimental Venue:
Aquatic Mesocosms

- Mesocosms were used to replicate natural pond environment
- Filled with 800-L aged well water
- Tanks spaced 1-m apart
- Utilized shade covers to prevent unwanted colonization

Methodology

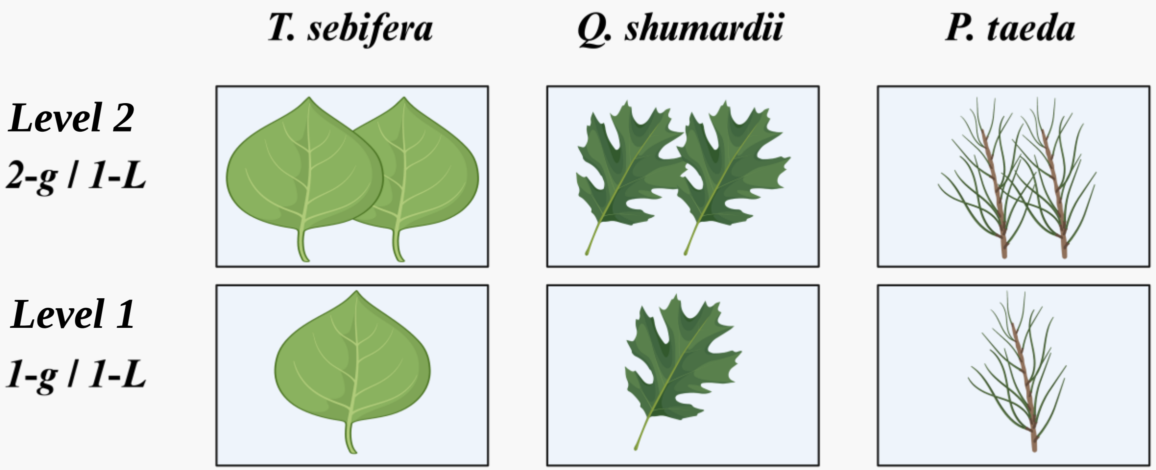
Experimental Design

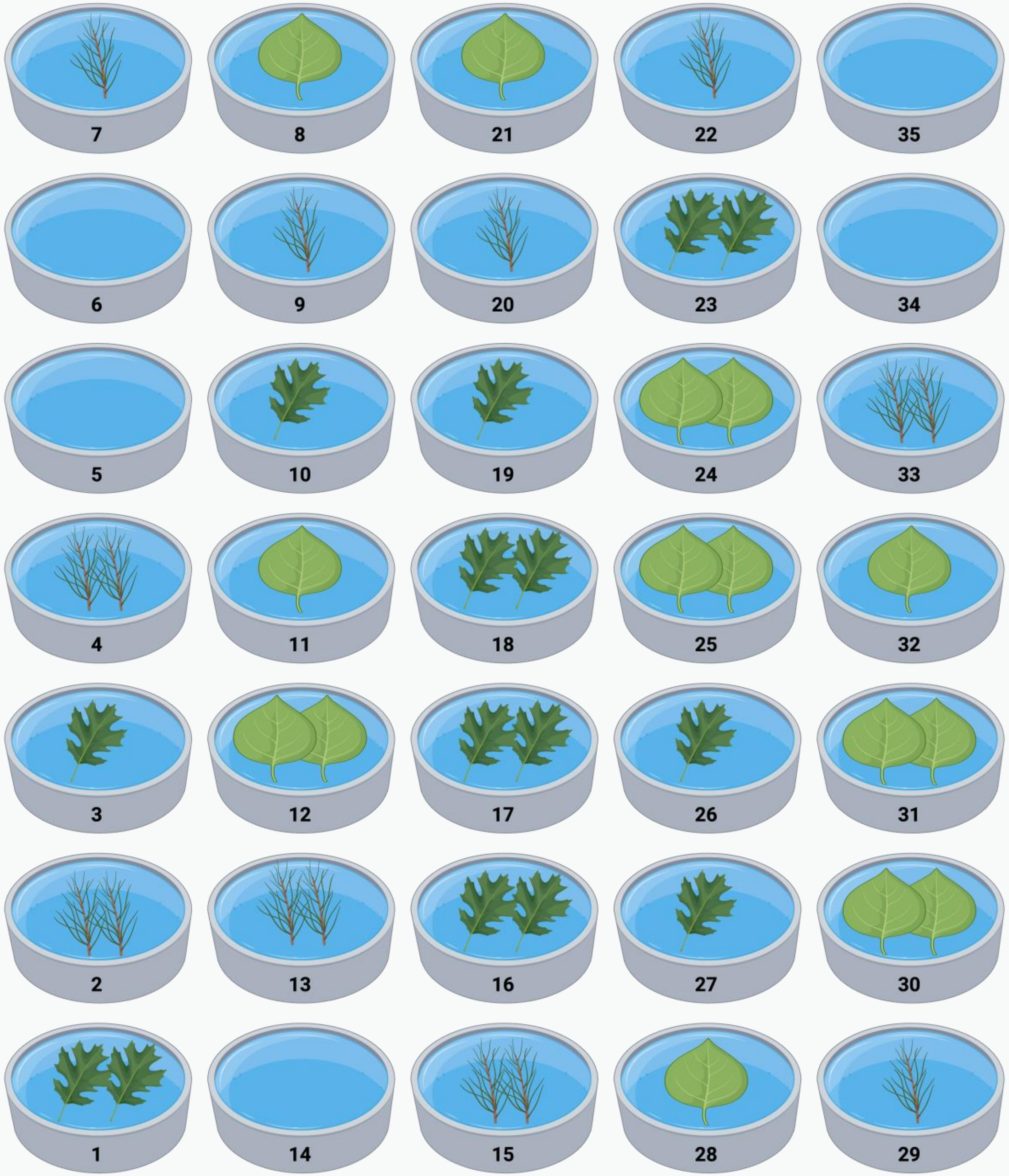




Experimental Design

- Each treatment group replicated 5 times
- Randomly assigned to each experimental unit
- 35 total experimental units





Water Quality Parameters

Recorded weekly:

- Water temperature (ºF)
- pH
- Dissolved Oxygen (mg/L)
- Total Dissolved Solids (mg/L)
- Conductivity (µS/cm)
- Turbidity (FNU)

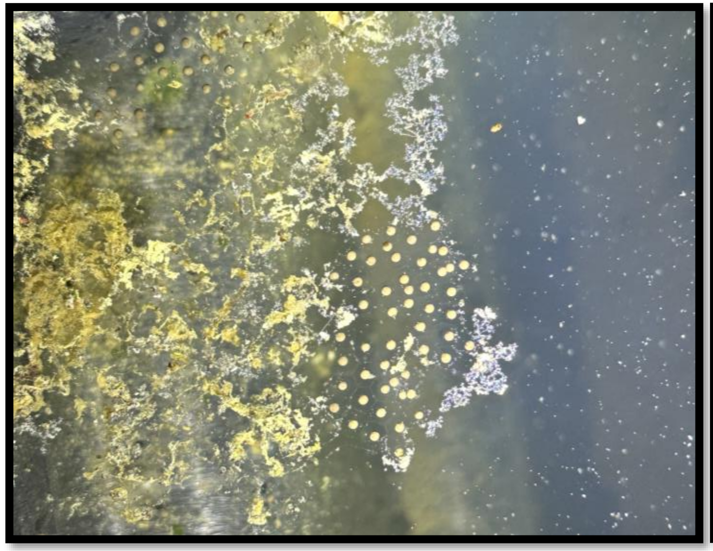
Oviposition Surveys

<u>Nightly (04/17/24 - 05/17/24):</u>

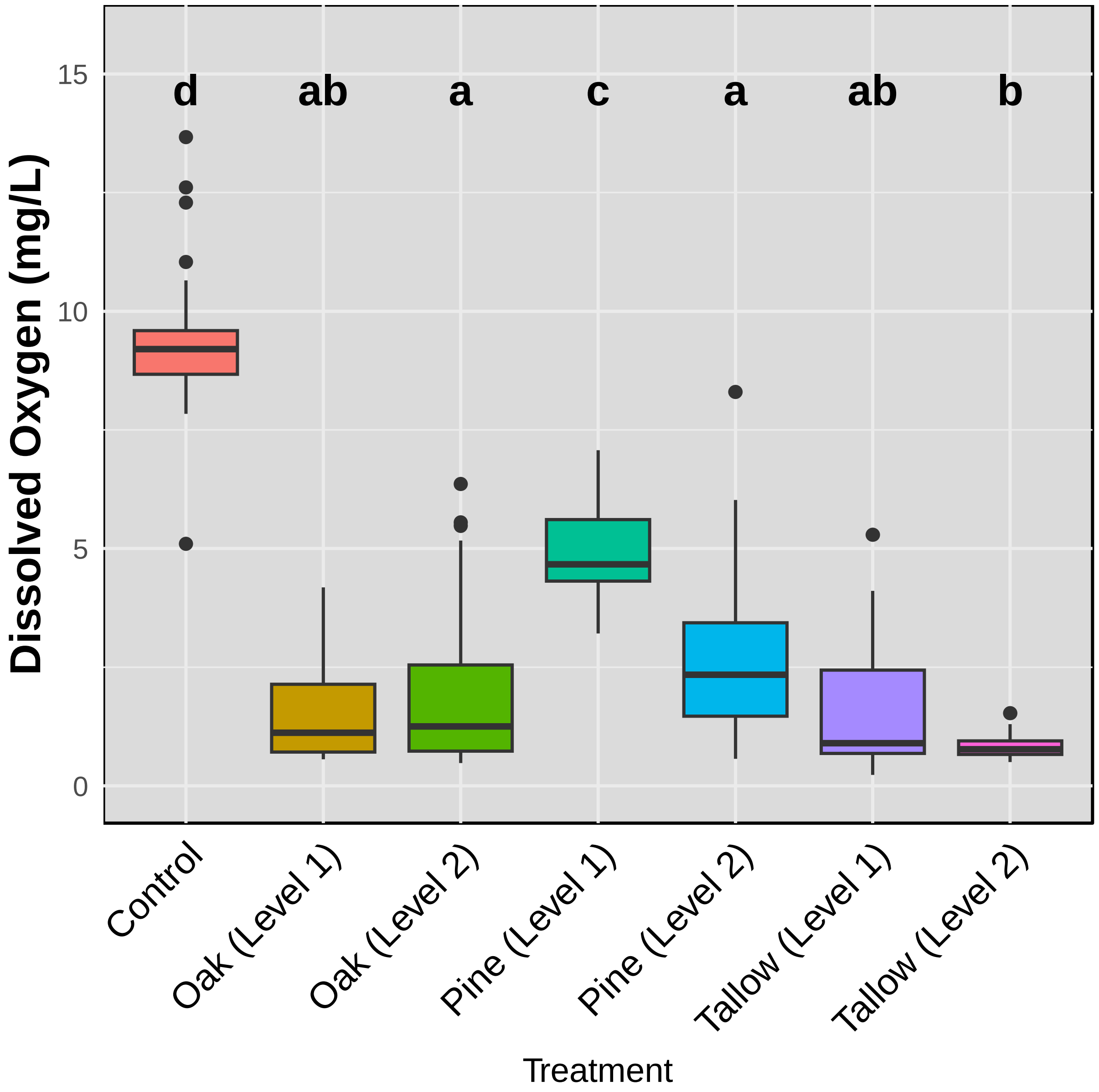
- Adult male and/or female frogs (*count*)
- Amplexic pairs (*count*)
- Eggs (*presence/absence*)
- Tadpoles (*presence/absence*)

<u>Following the end of the breeding period:</u>

- Time-constrained dipnet survey



Results: Water Quality (Dissolved Oxygen)



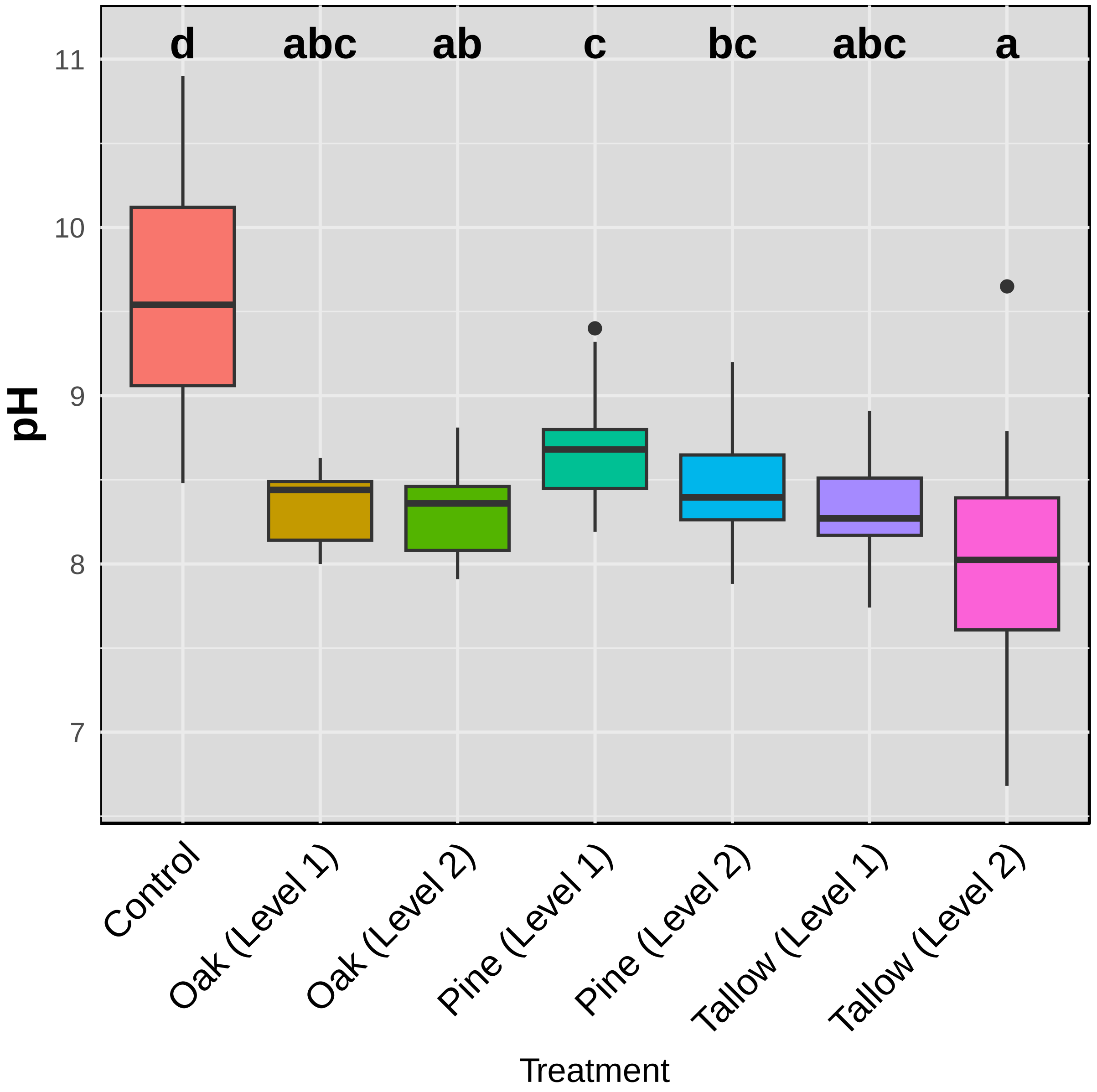
Tallow (Level 1):

- Significantly different from **Pine (Level 1)** and **Control**
- $p < 0.05$

Tallow (Level 2):

- Significantly different from other treatments (except **Tallow (Level 1)** and **Oak (Level 1)**)
- $p < 0.05$

Results: Water Quality (pH)



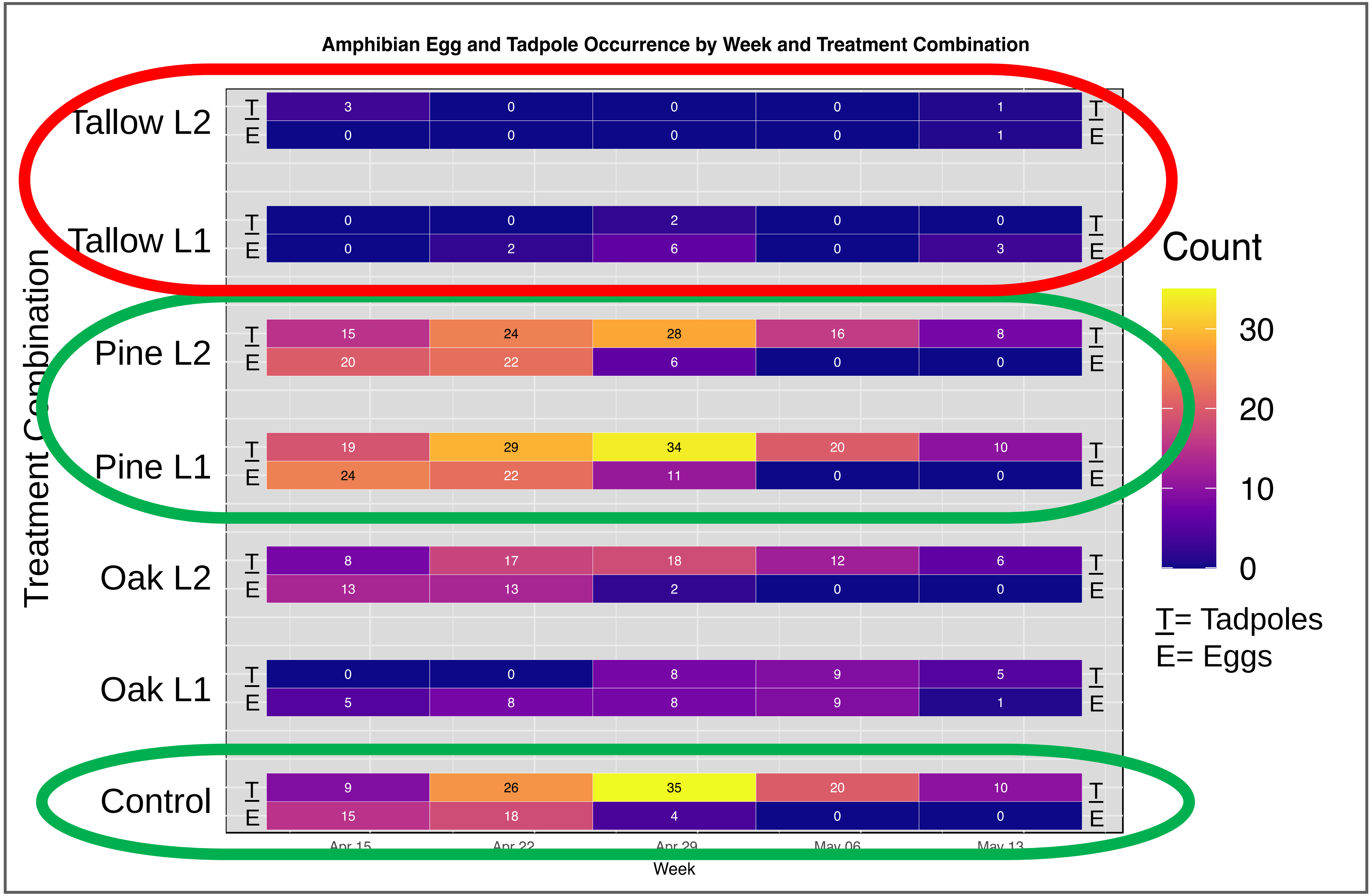
Tallow (Level 1):

- Significantly different from **Pine (Level 2)**
- $p < 0.05$

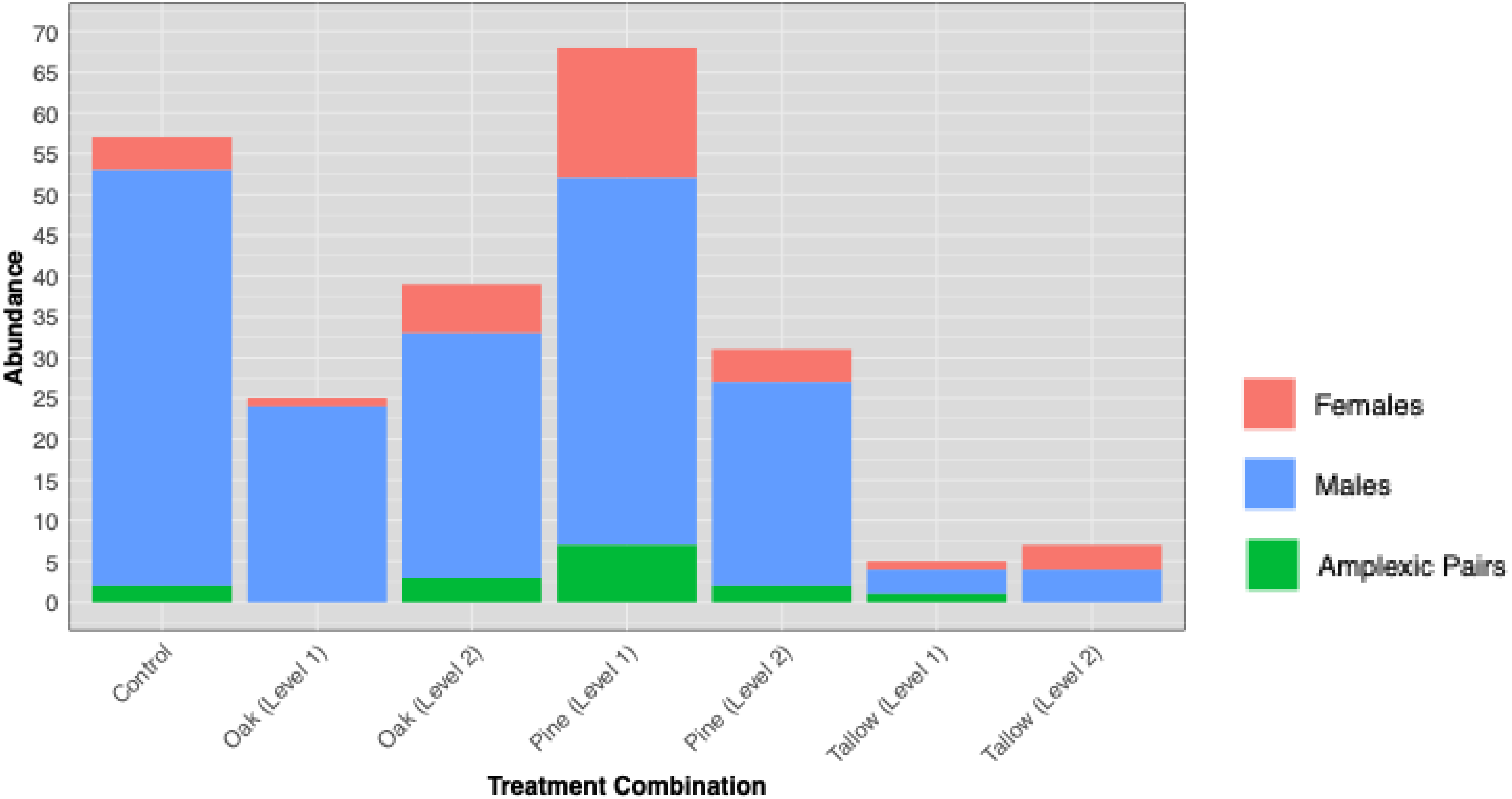
Tallow (Level 2):

- Significantly different from other treatments (except **Tallow (Level 1)**, **Oak (Level 1)**, and **Oak (Level 2)**)
- $p < 0.05$

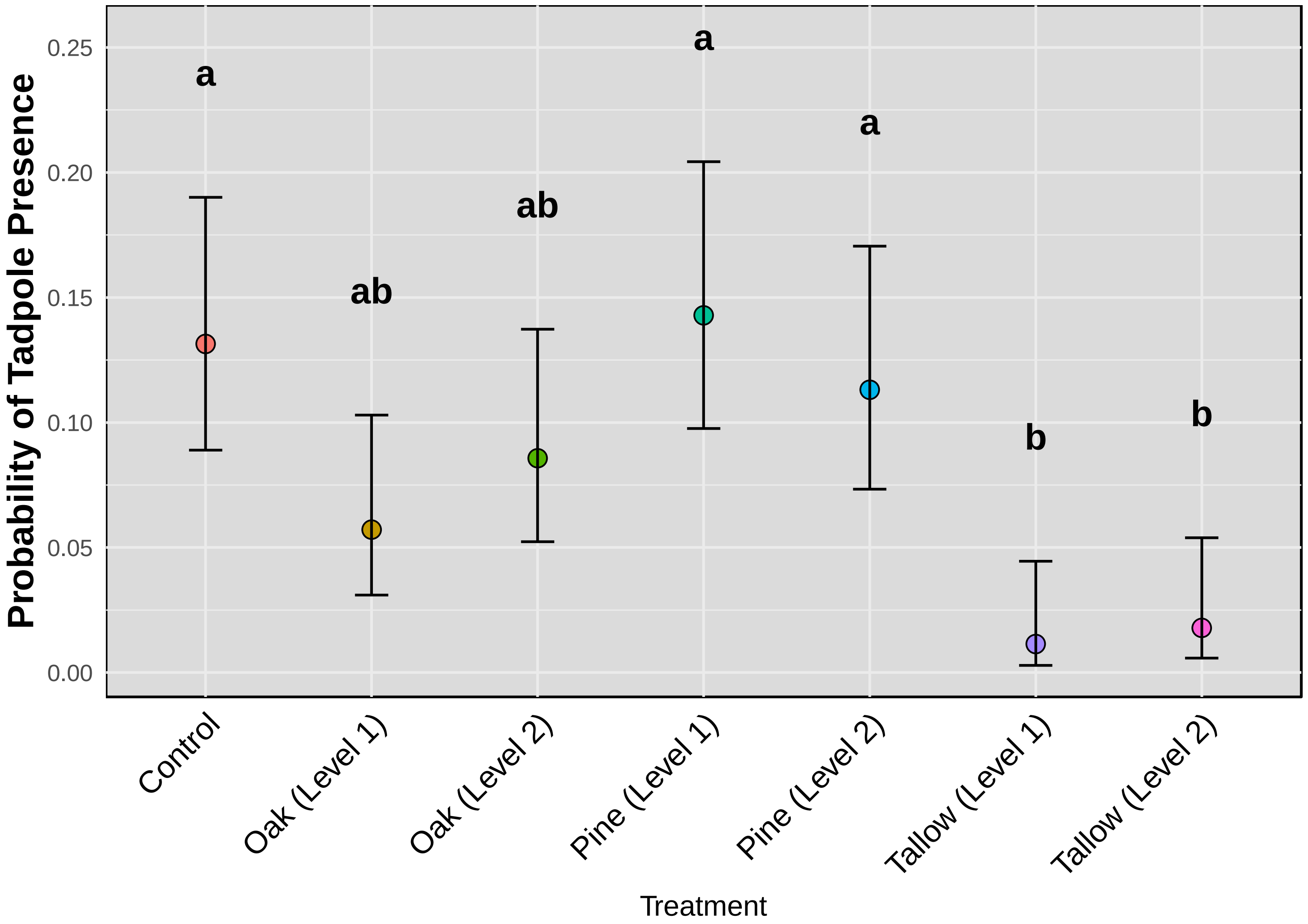
Results: Number of Eggs and Tadpoles Observed per Week



Results: Male & Female Occurrence



Results: Effect of Treatment on Tadpole Presence



Control & Pine (Level 1 & 2):

- Higher probabilities of tadpole presence

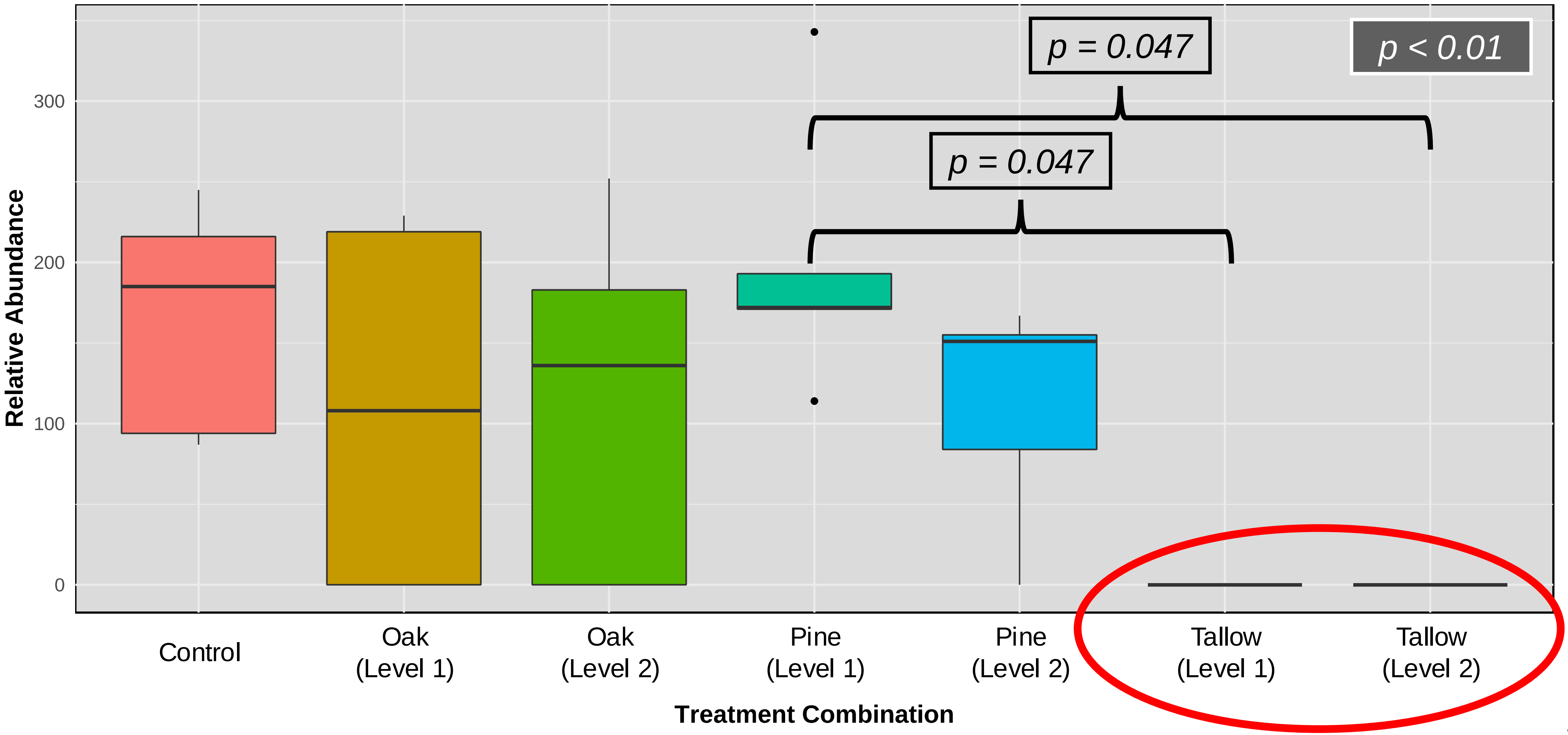
Oak (Level 1 & 2):

- Intermediate effect

Tallow (Level 1 & 2):

- Significantly decreases the probability of tadpole presence

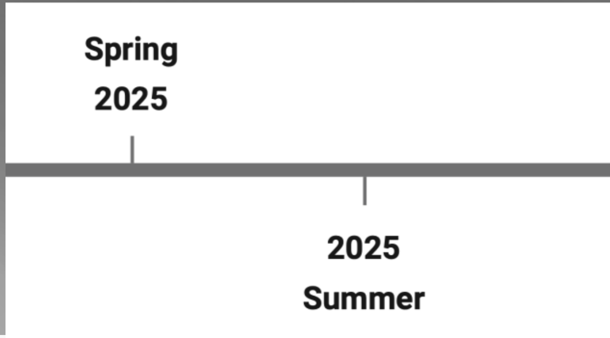
Results: Time-Constrained Dipnet Survey



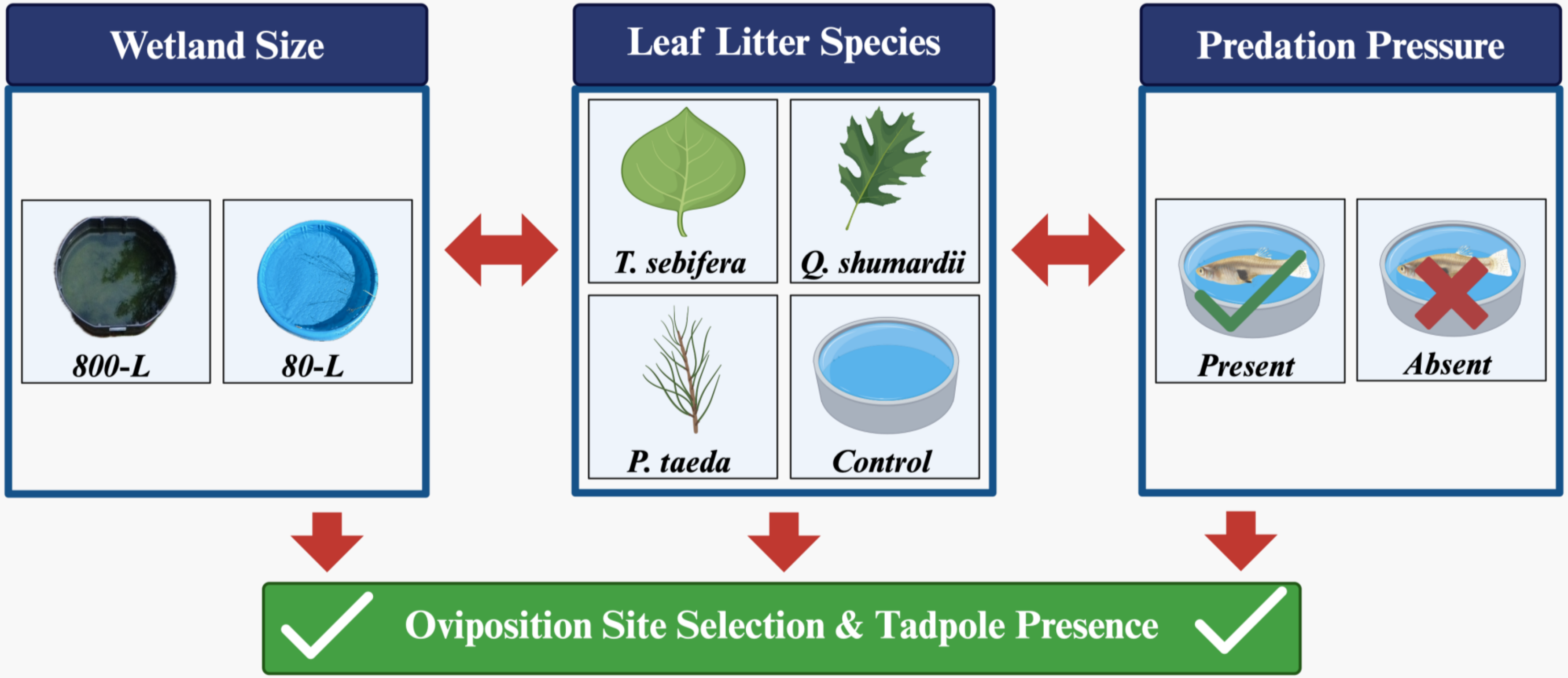
Not All Ponds Are Equal: How Invasive Leaf Litter, Wetland Size, and Predators Shape Amphibian Oviposition

Spring-Summer 2025

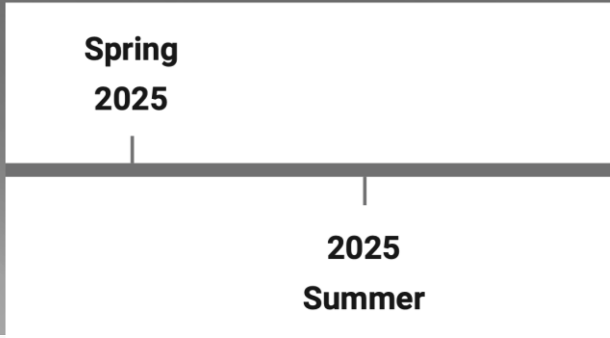
Research Question



How do wetland size, Chinese tallow leaf litter, and predator presence interact to influence amphibian oviposition site selection in east Texas wetlands?



Research Hypotheses



Wetland Size

Hypothesis: *Amphibians prefer larger wetlands due to greater stability*

Prediction: *More eggs and tadpoles will be observed in 800-L mesocosms than in 80-L*

Leaf Litter Species

Hypothesis: *Amphibians will avoid Chinese tallow due to its negative effects on water quality*

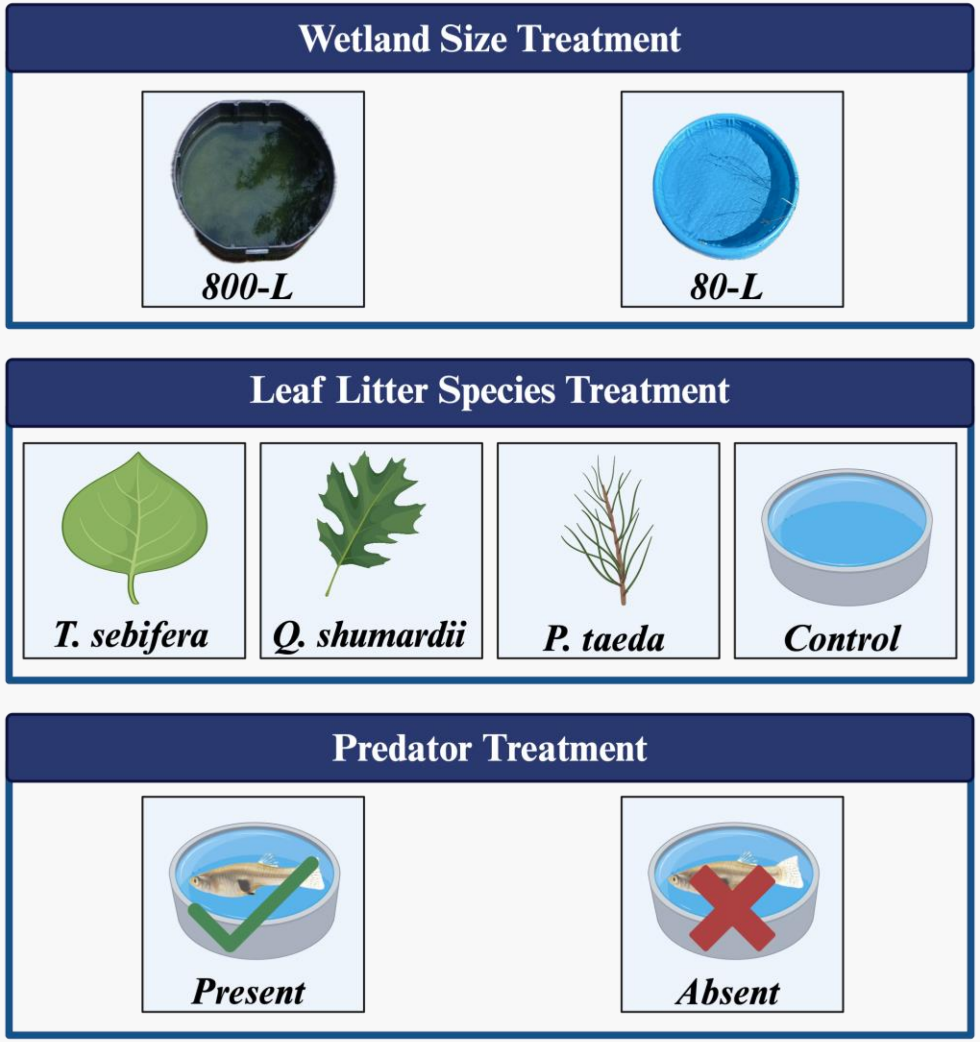
Prediction: *Fewer eggs and tadpoles will be observed in Chinese tallow treatments*

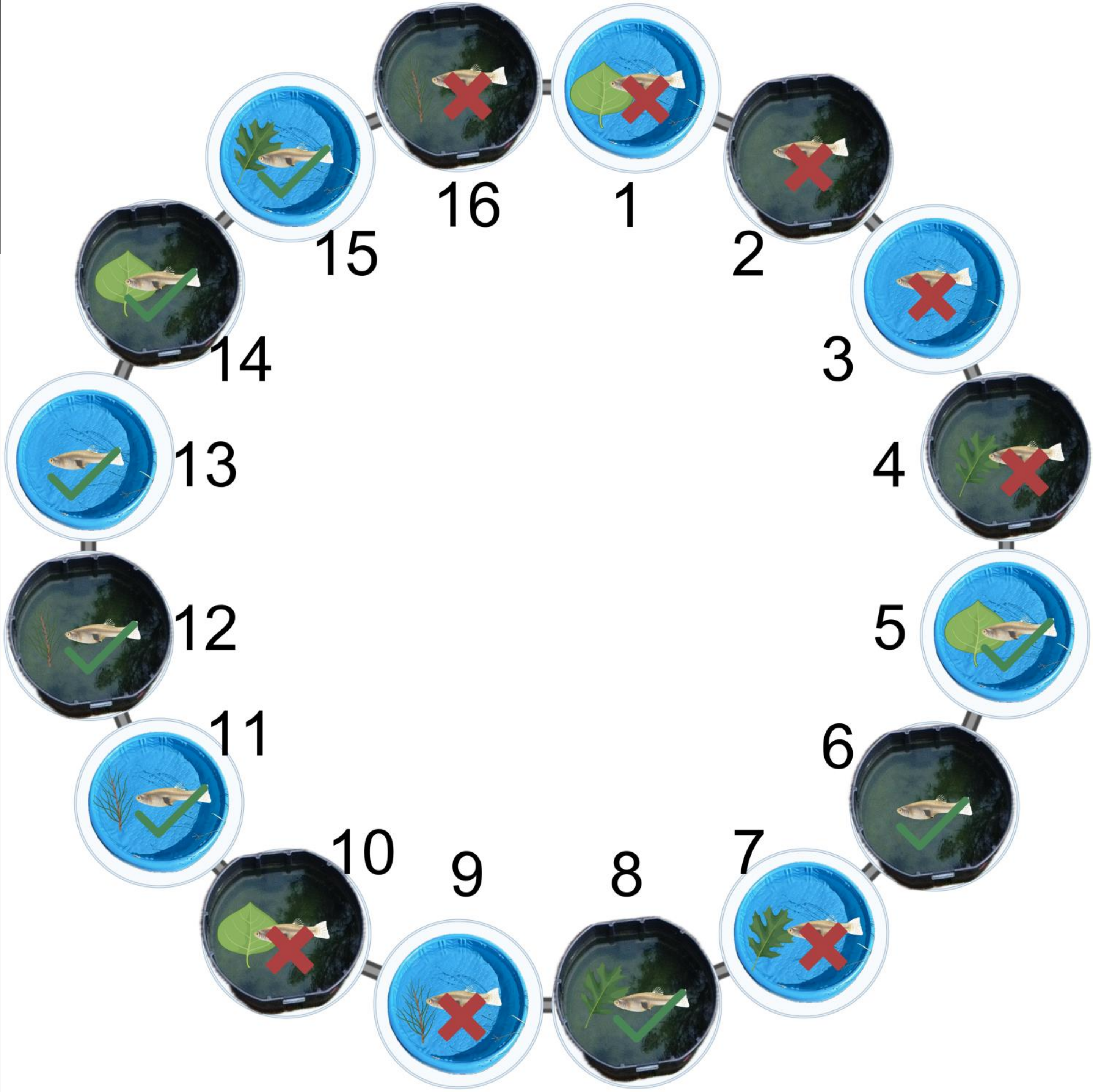
Predation Pressure

Hypothesis: *Amphibians will avoid ovipositing in mesocosms with predators*

Prediction: *Lower oviposition and tadpole presence when predators are present*

Experimental Design

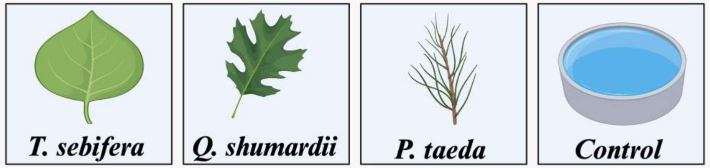




Experimental Design

Wetland Size Treatment

Leaf Litter Species Treatment



Predator Treatment

- 6 total blocks (A-F)
- 16 mesocosms per block
- 96 total mesocosms

Block A

Oviposition Surveys

Nightly (03/23/25 - 06/12/25):

- Adult male and/or female frogs (*count*)
- Amplexic pairs (*count*)
- Eggs (*presence/absence & count*)
  - Gosner Group
- Tadpoles (*presence/absence*)
  - Gosner Group

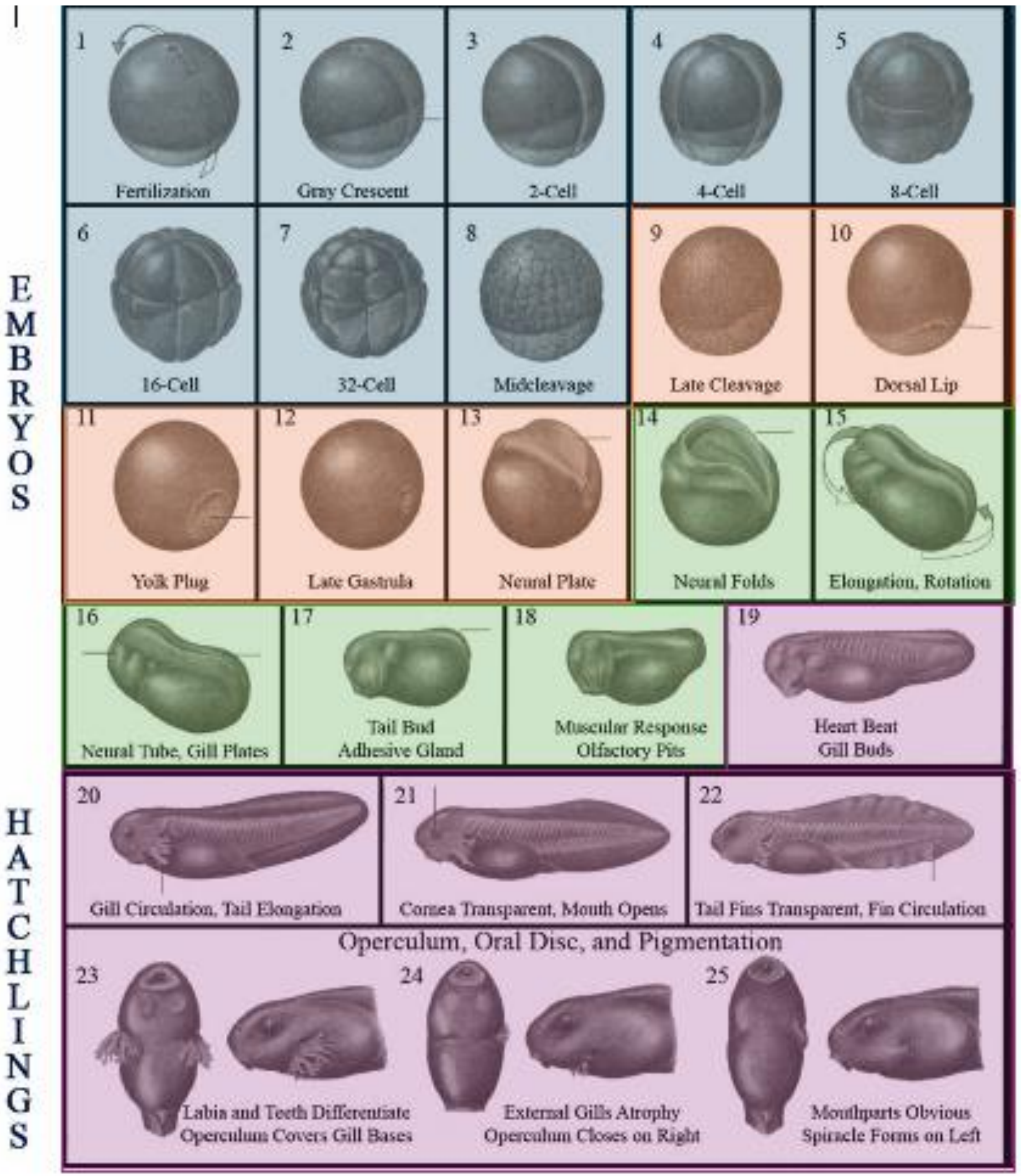
Midpoint & end of breeding period:

- Box/dipnet survey

Oviposition Surveys
Gosner Stage Groups

<u>Eggs</u>

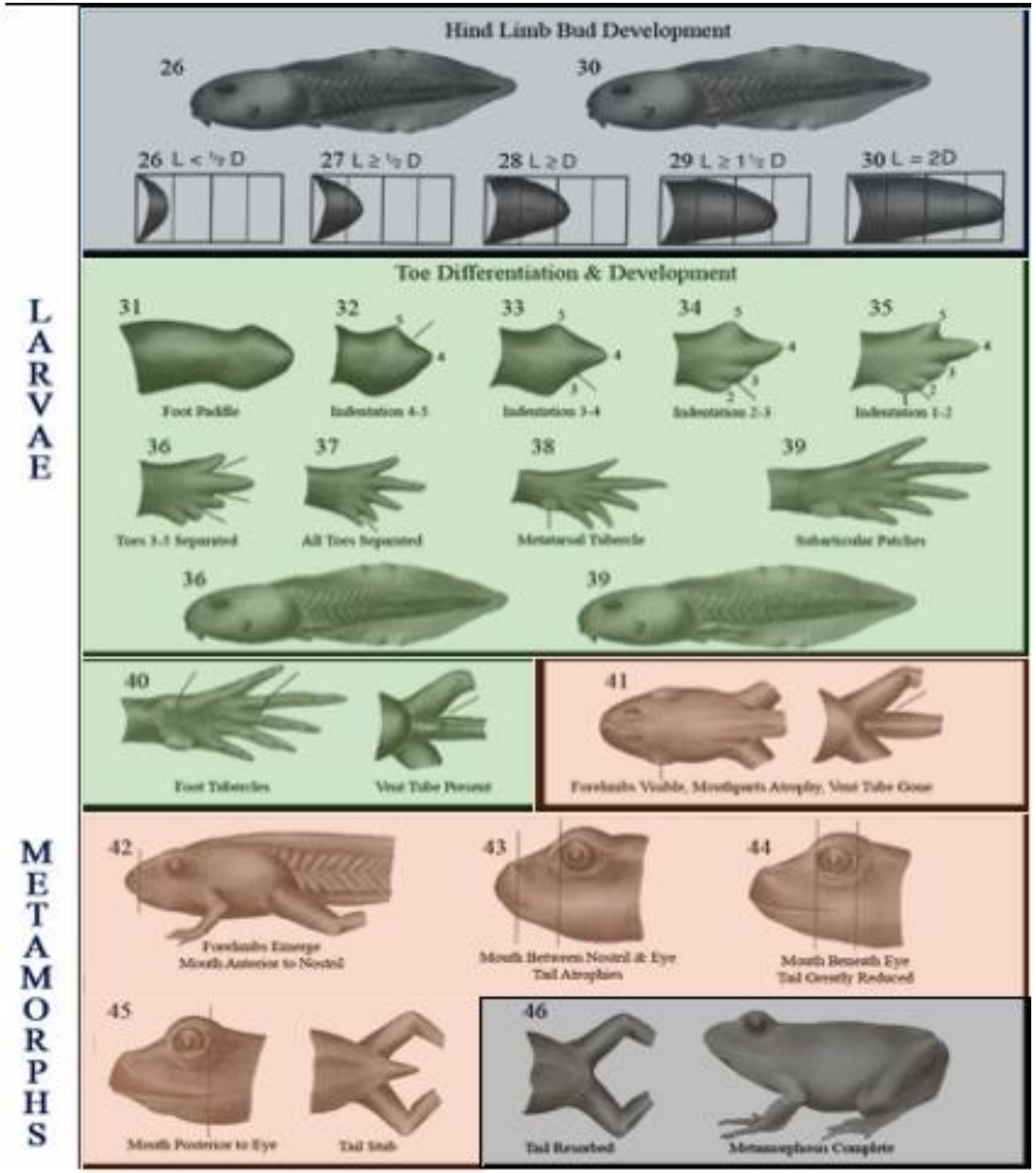
- ***GS 1-8:*** Fresh eggs
- ***GS 9-13:*** Cleavage
- ***GS 14-18:*** Tail bud forms
- ***GS 19-25:*** Frequent movement, jelly thinning, hatching begins



Oviposition Surveys
Gosner Stage Groups

Tadpoles

- ***GS 26-30:*** Hindlimb development
- ***GS 31-40:*** Forelimb development
- ***GS 41-45:*** Approaching metamorphosis
- ***GS 46+:*** Metamorph



From Leaf Fall to Low Oxygen: *Understanding Tallow's Effects*

- Chinese tallow leaves decompose rapidly:
  - Releases high concentrations of secondary compounds and organic matter
    - Such as tannins
  - The rapid release nutrients and secondary compounds:
    - Increased microbial activity
    - High biological oxygen demand reduces dissolved oxygen

Day 1 → Day 2 → Day 4 → Day 7

Oxygen Crash, Predation Risk:
The Cost of Breathing at the Surface

- Differences in water quality observed in Chinese tallow treatments have direct implications for amphibian reproductive success
- Tallow treatments = **Unfavorable water quality conditions**
  - ↓ DO, ↓ pH, ↑ Turbidity
  - Physiological stressful environment

"Air-Gulping Behavior"

Implications

Amphibian Impacts:

- Oviposition site selection is driven by water quality
- Chinese tallow leaf litter reduces DO, pH → **fewer eggs, lower tadpole survival**
- Short-term effects may be stronger in small or ephemeral wetlands with fewer buffering mechanisms

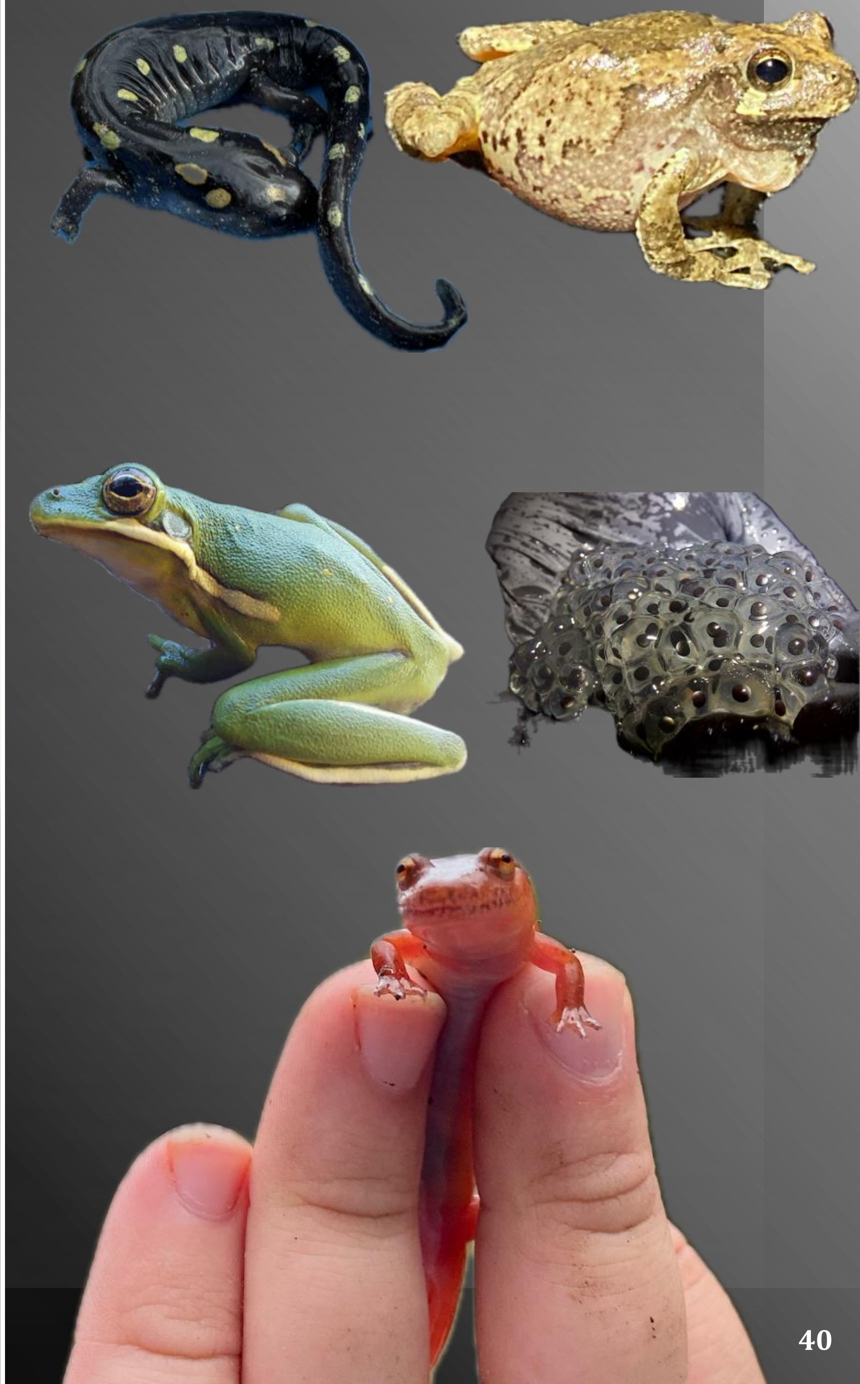
Ecosystem-Level Effects:

- **Monospecific** tallow stands reduce habitat complexity
- Loss of **connectivity** limits gene flow and amphibian movement
- Altered **nutrient cycling** may affect downstream aquatic systems

Amphibians & Invasive Species: *Conservation Outlook*

- Invasive species are a **persistent and growing threat** to amphibians
- Impacts are **highly variable**, requiring **tailored, site-specific strategies**
- Amphibian responses offer insights for **adaptive management**
- Continued research is essential to guide **evidence-based interventions**

A hopeful future depends on integrating ecology, restoration, and public action



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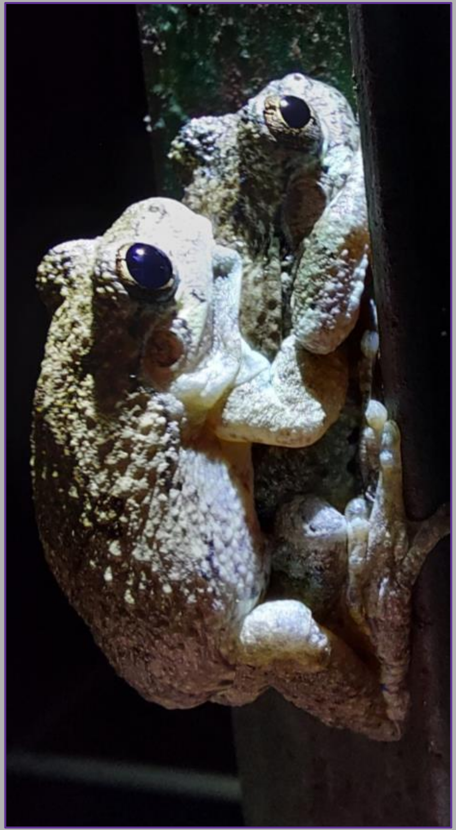

Questions?

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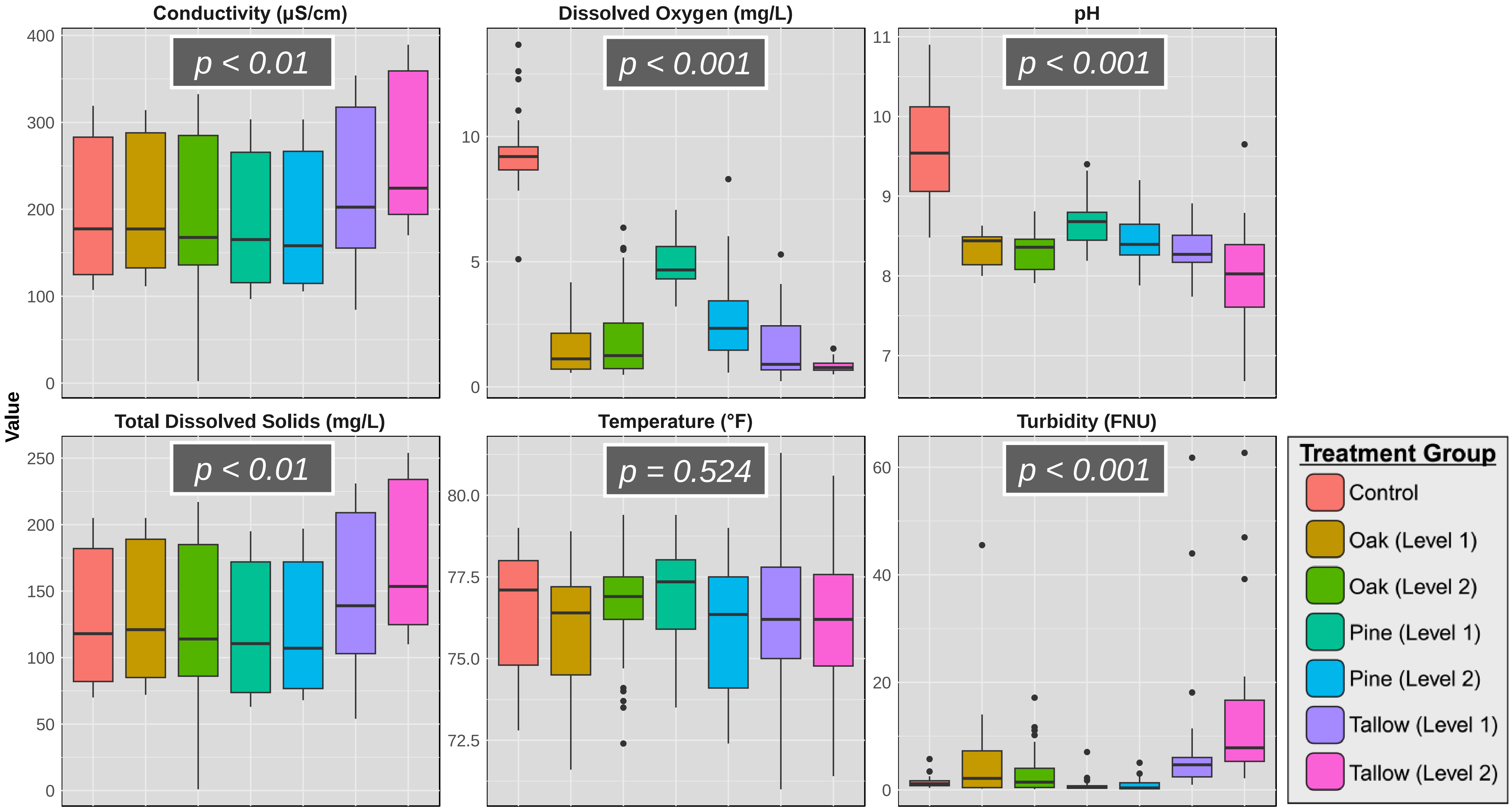
THE UNIVERSITY OF TEXAS SYSTEM

Future Research

Future studies should explore how natural phenological cycles, habitat conditions, and behavioral mechanisms interact to shape oviposition site selection in the presence of Chinese tallow

- Align experiments with natural phenology
  - Leaf fall and breeding periods
- Examine climate-driven shifts in amphibian reproductive strategies
- Investigate behavioral responses to leaf litter treatments
  - Active avoidance vs. delayed arrival
- Assess trade-offs between site selection, larval survival, habitat quality, and predation risk

Results: Effect of Treatment on Water Quality



Statistical Analysis

Water Quality:

- One-way ANOVA and Tukey Kramer post-hoc tests

Oviposition Site Selection:

- Generalized Linear Models (GLMs) with a binomial distribution were used to analyze tadpole presence
    - Predictor: Treatment combination (leaf litter species & concentration)
    - Response: Proportion of nights tadpoles were present per week

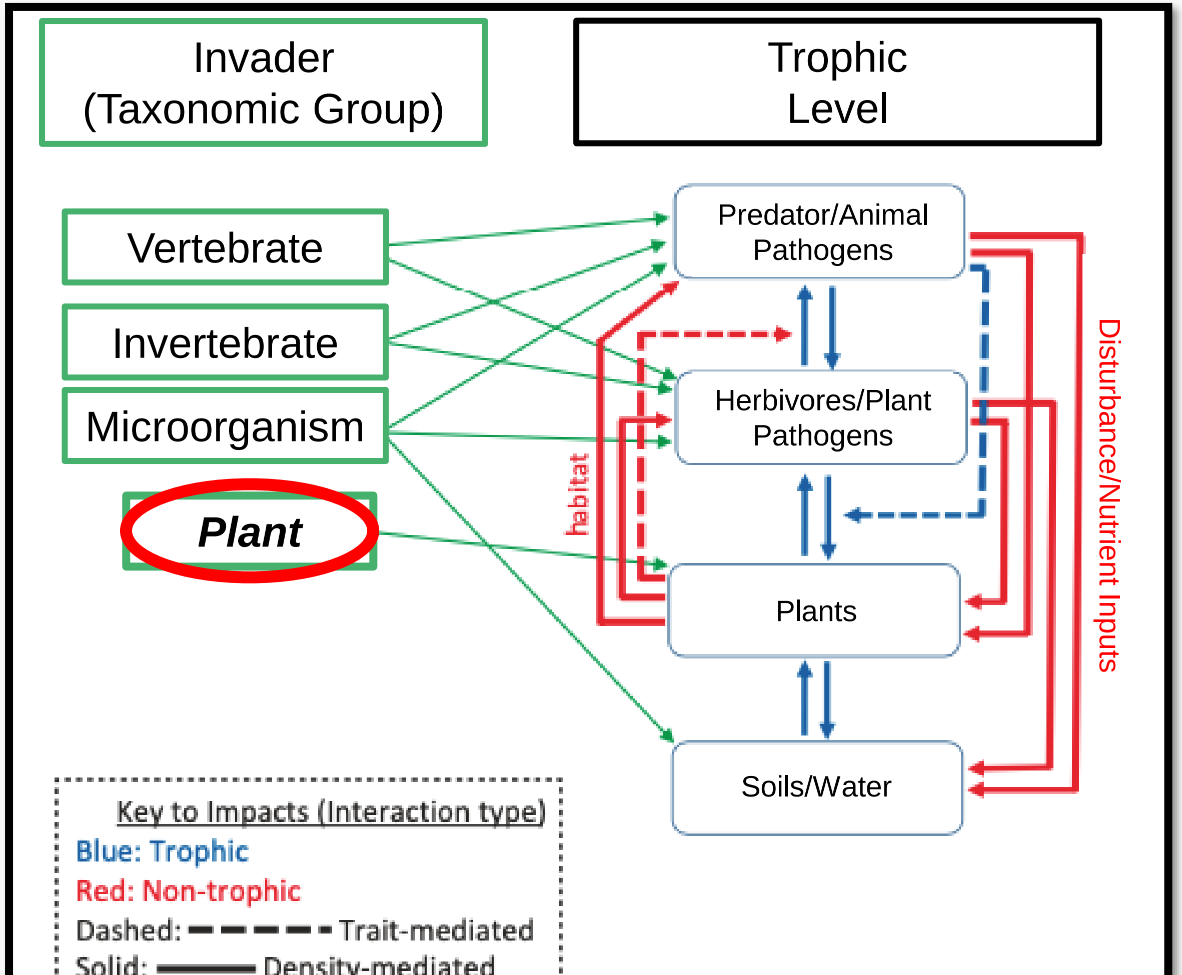
Time-Constrained Dipnet Survey:

- Kruskal-Wallis and Dunn’s post-hoc tests

Invasive Plant Species

Multifaceted impacts on both **trophic** and **non-trophic** levels:

- Compete for moisture, sunlight, nutrients, and space
- Decrease overall plant diversity
- Degrade wildlife habitat
- Degrades water quality



Mayfield III et al., 2021

Chinese tallow (*Triadica sebifera*)

- Native to SE Asia
- Introduced to U.S. in 1772
  - Savannah, GA
  - Seeds provided by Benjamin Franklin
- Range increased across the Gulf Coast in the 1900s
  - USDA- Office of Foreign Seed and Plant Introduction
  - Promoted as an agricultural crop