Aquatic Macroinvertebrate Communities in Wetland Reserve Easement Lands in the Mississippi Alluvial Valley

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Background

WETLANDS

- Provide **abundant ecological and economic benefits:**
  (Faulkner et al. 2011, Mitsch et al. 2015)
  - Mitigate flooding
  - Improve water quality
  - Combat climate change
  - Biodiversity
- Filter nutrients, sediments, and pollutants
  - Carbon sinks
- From the 1780s to 1980s, **53% of wetlands lost in U.S.**

(Wissinger 1999, Zelder and Kercher 2005)

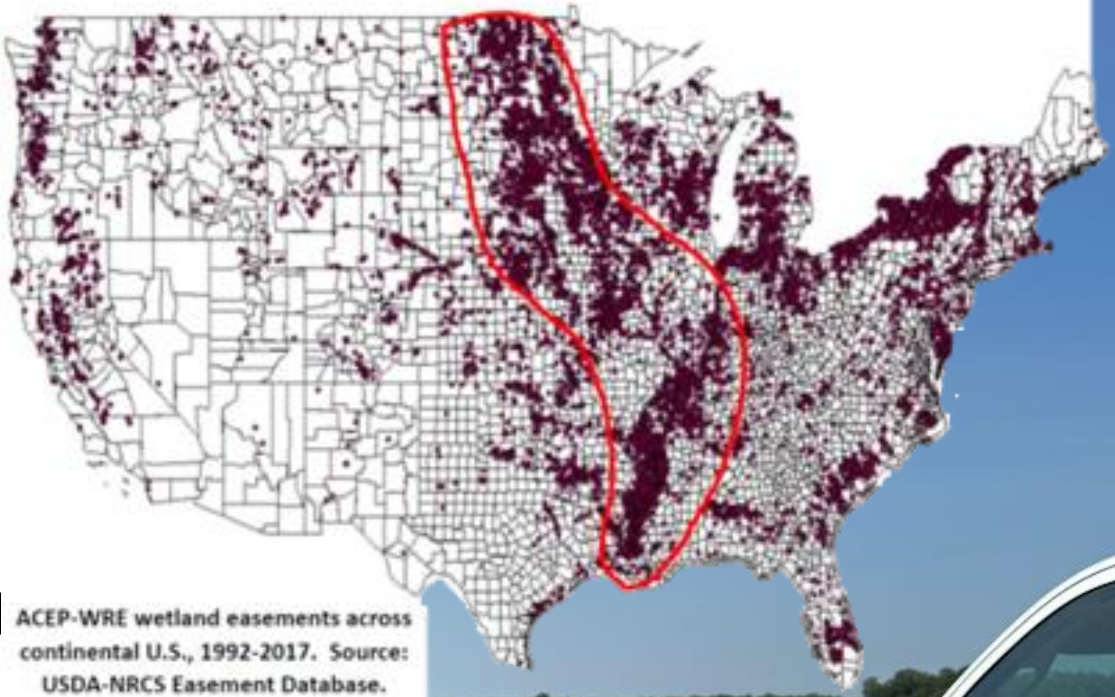
Mississippi Alluvial Valley (MAV)

- MAV 800 km long, spans 7 states
- Historically 10 million ha of bottomland hardwood forest (BLHF) and wetlands
- Land modifications for agriculture led to:
  - ~ 80 % BLHF lost
  - ~ 90 % reduction in flooding
  - Modified hydrology

(Reinecke et al. 1989, Fredrickson 2005, King et al. 2006, Faulkner et al. 2011)

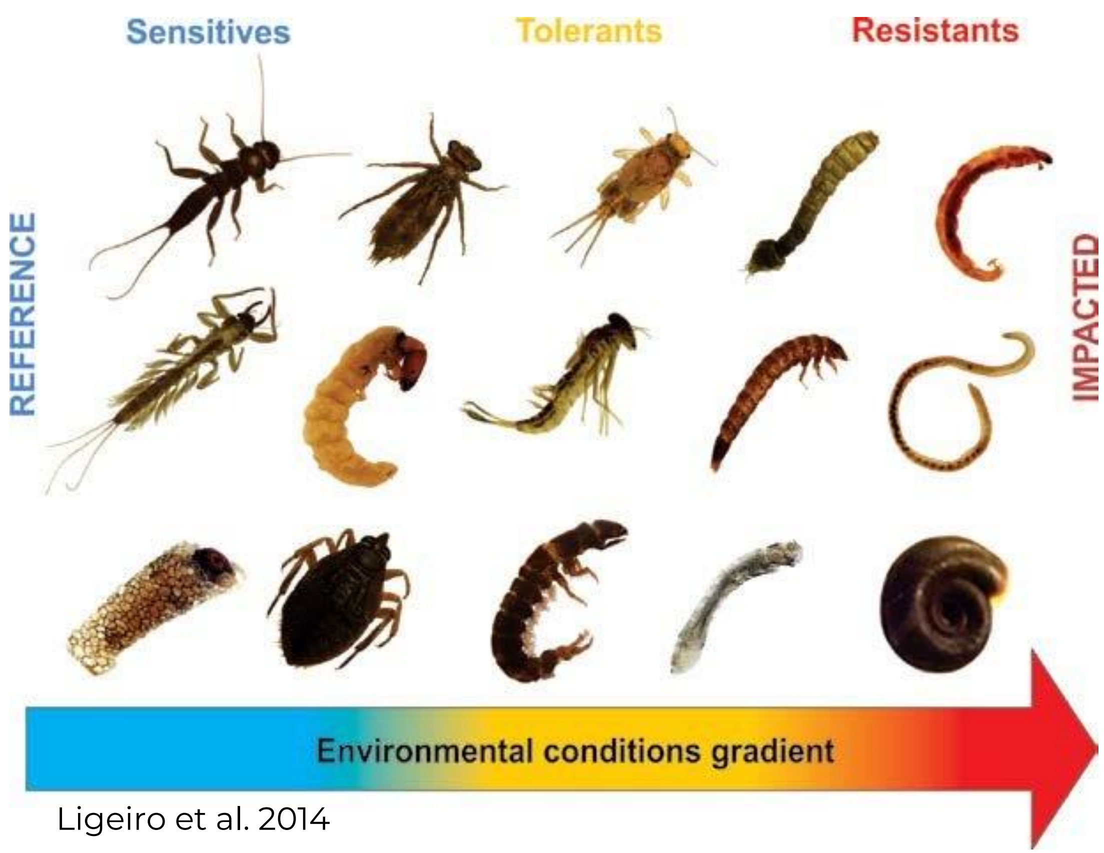
Wetland Reserve Easements (WRE)

- Helps restore wetlands and BLHFs on marginal farmlands
- Implemented in the 1990 Farm Bill
- Agreement between NRCS and private landowners
- MAV is focal area because of the highly modified landscape
- > 1,092,651 million ha restored nationally as of 2023
- >77,000 ha restored in Mississippi



ACEP-WRE wetland easements across continental U.S., 1992-2017. Source: USDA-NRCS Easement Database.

Macroinvertebrates



Ligeiro et al. 2014

- > 65% of MAV is agricultural use (Gardiner and Oliver 2004)
  - Can cause excessive sedimentation and nutrient loading
- Macroinvertebrates are useful bioindicators
  - Sensitive to stress
  - Rapid responses to disturbances
  - Limited mobility
  - Availability
- Bioindicators can assess watershed health and restoration efforts

Objective

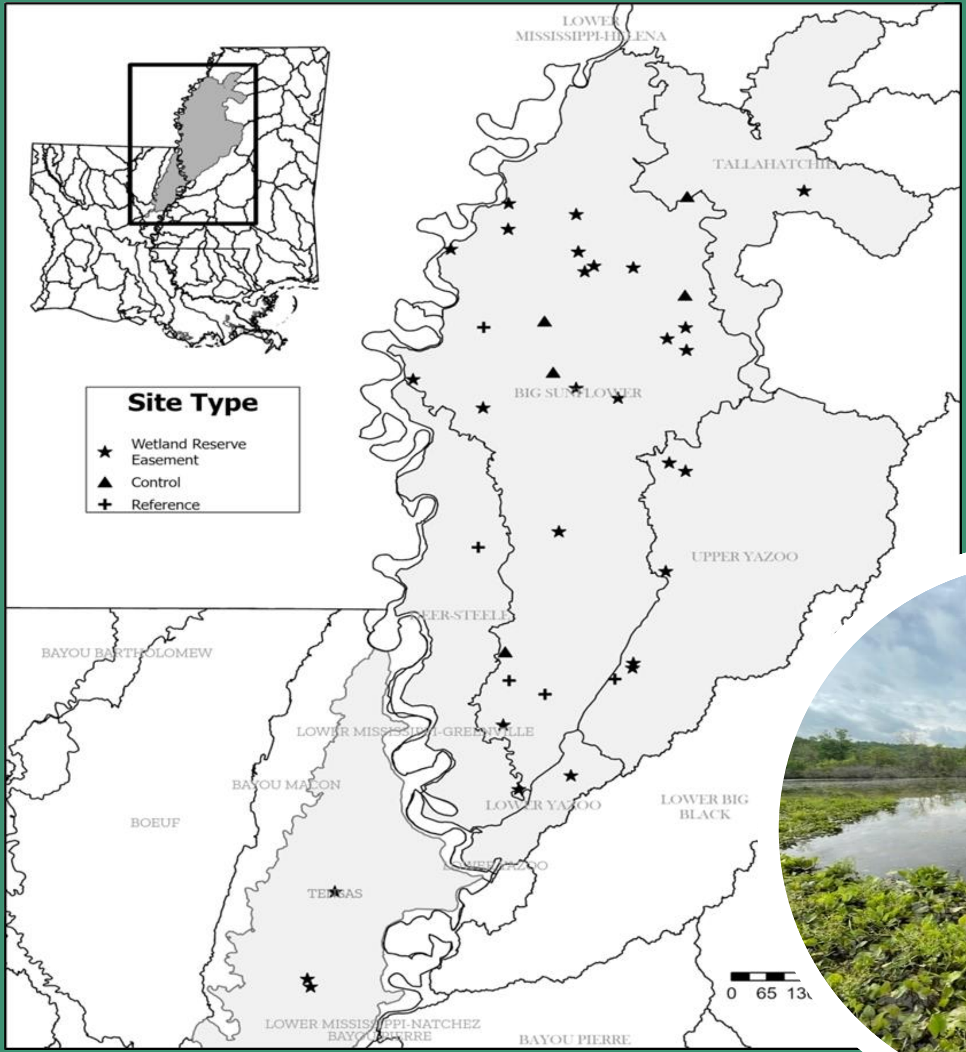
Evaluate aquatic macroinvertebrate abundance, richness, and diversity on Wetland Reserve Easement sites compared to historic reference wetlands and croplands

Prediction

Predicted aquatic macroinvertebrate abundance, richness, and diversity on Wetland Reserve Easement sites would be comparable to reference wetlands and greater than croplands

Methods

STUDY AREA



- 38 sites
  - 28 WREs
  - 5 reference historic wetlands
  - 5 control/crop sites

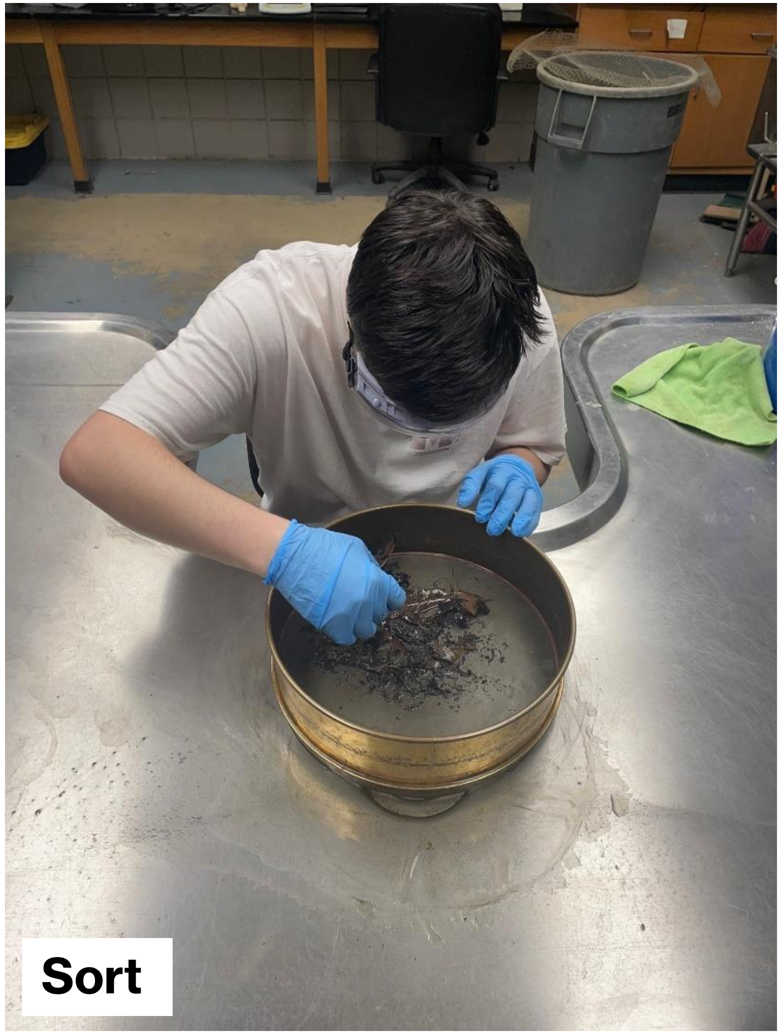
FIELD SAMPLING

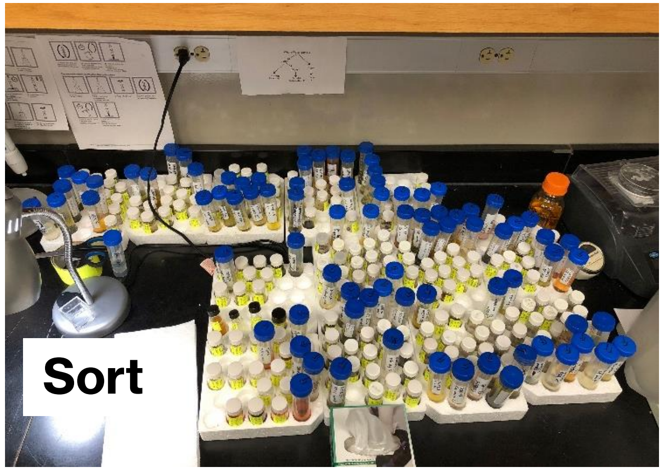
- Sampled in BLHF, emergent wetlands, and agricultural ditches at each property
- Sampled 1x March- May and 1x August 2024
- 7, 1m × 1m squares
  - ≥ 10 m apart
- Preserved with 95% ethanol

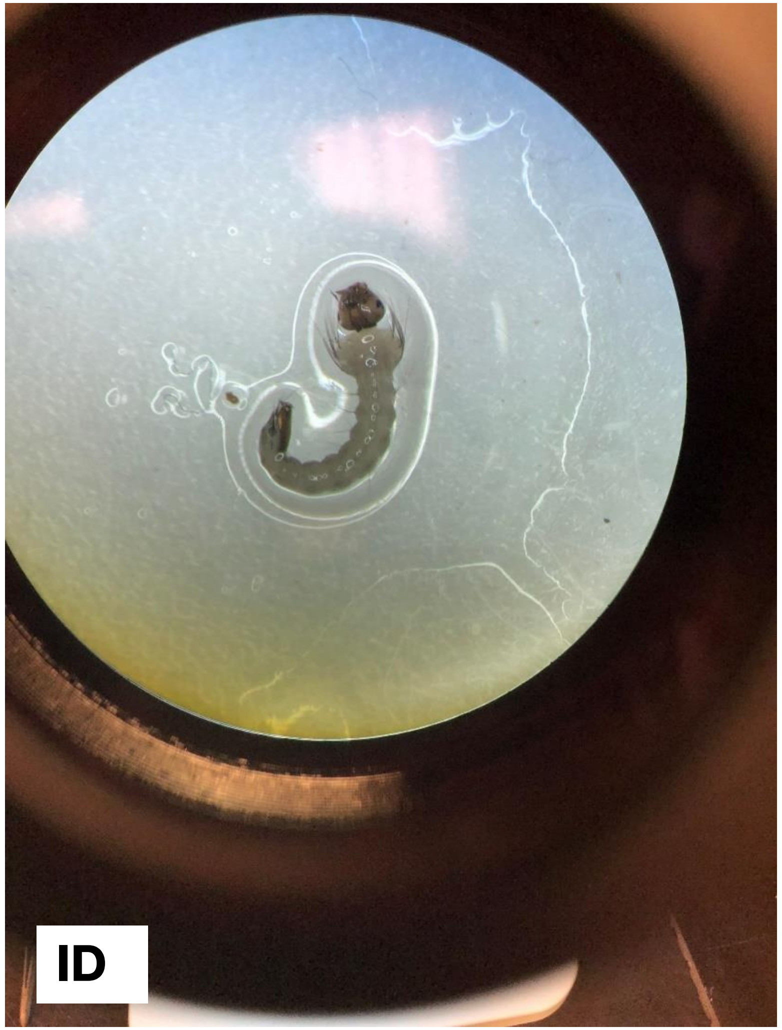
WATER SAMPLING

- Recorded water depth (cm)
- Water Quality Sonde Measurements:
  - water temperature (°C)
  - dissolved oxygen (DO) concentration (mg/L)
  - turbidity (NTU)

LABORATORY







STATISTICAL METHODS

- **Diversity Indices**
  - Evaluating site type and landcover type
    - Kruskal-Wallis and Mann-Whitney U test
- **Non-Metric Multidimensional Scaling (NMDS) and PERMANOVA**
  - Evaluating community comparisons
    - Site type and landcover type

- **Generalized Linear Models (GLMs)**
- Response Variables:
  - Abundance and Richness
- Explanatory Variables:
  - Water Depth
  - Water Temperature
  - Dissolved Oxygen
  - Turbidity
  - Site Type

Results

Spring Abundance

- **Collected 6,309 individuals of 17 unique taxa**

Top 3 taxa
(% abundance):

1. **Amphipoda** (25.6%)

2. **Sphaeriida** (15.2%)

3. **Isopoda** (14.2%)

Late Summer Abundance

- **Collected 6,237 individuals of 21 unique taxa**

Top 3 taxa
(% abundance):

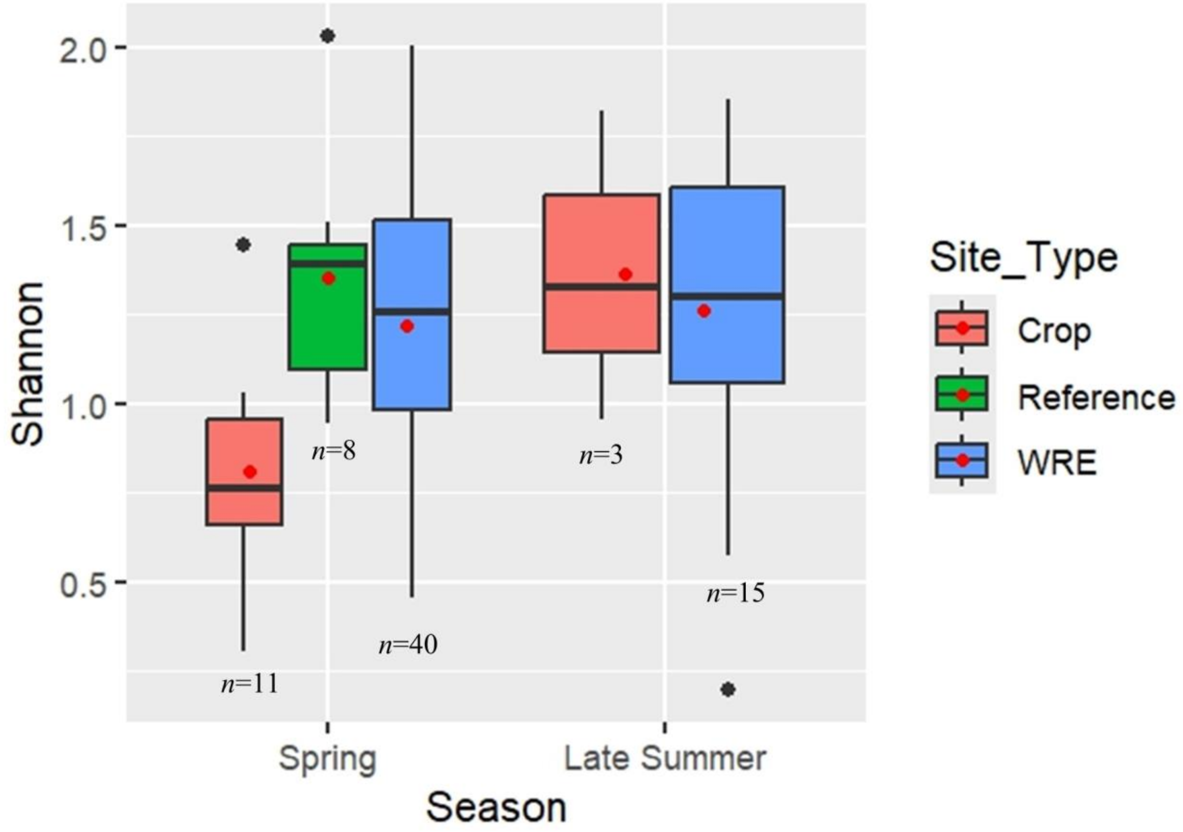
1. **Diptera** (25.6%)

2. **Ephemeroptera** (15.2%)

3. **Hygrophila** (14.2%)

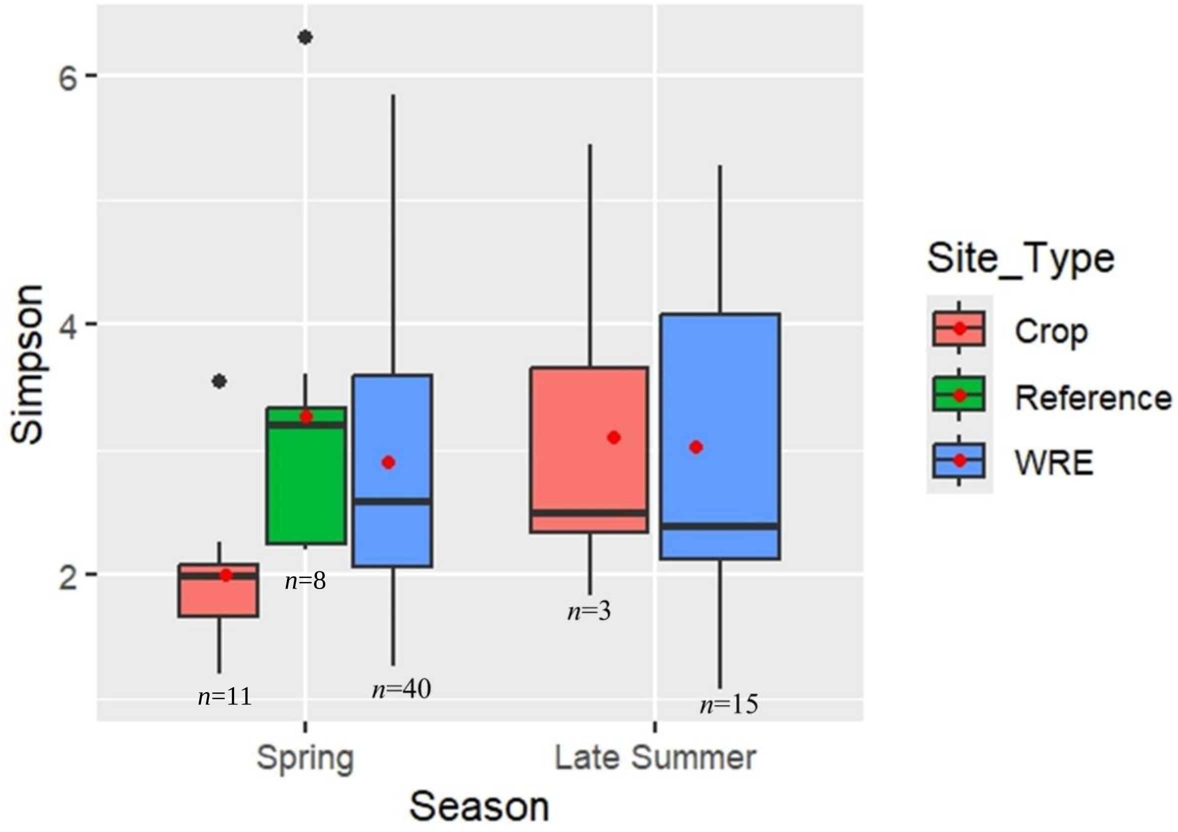
Spring and Late Summer Diversity

Shannon Diversity Index



p= 0.004 p= 0.38

Simpson Diversity Index

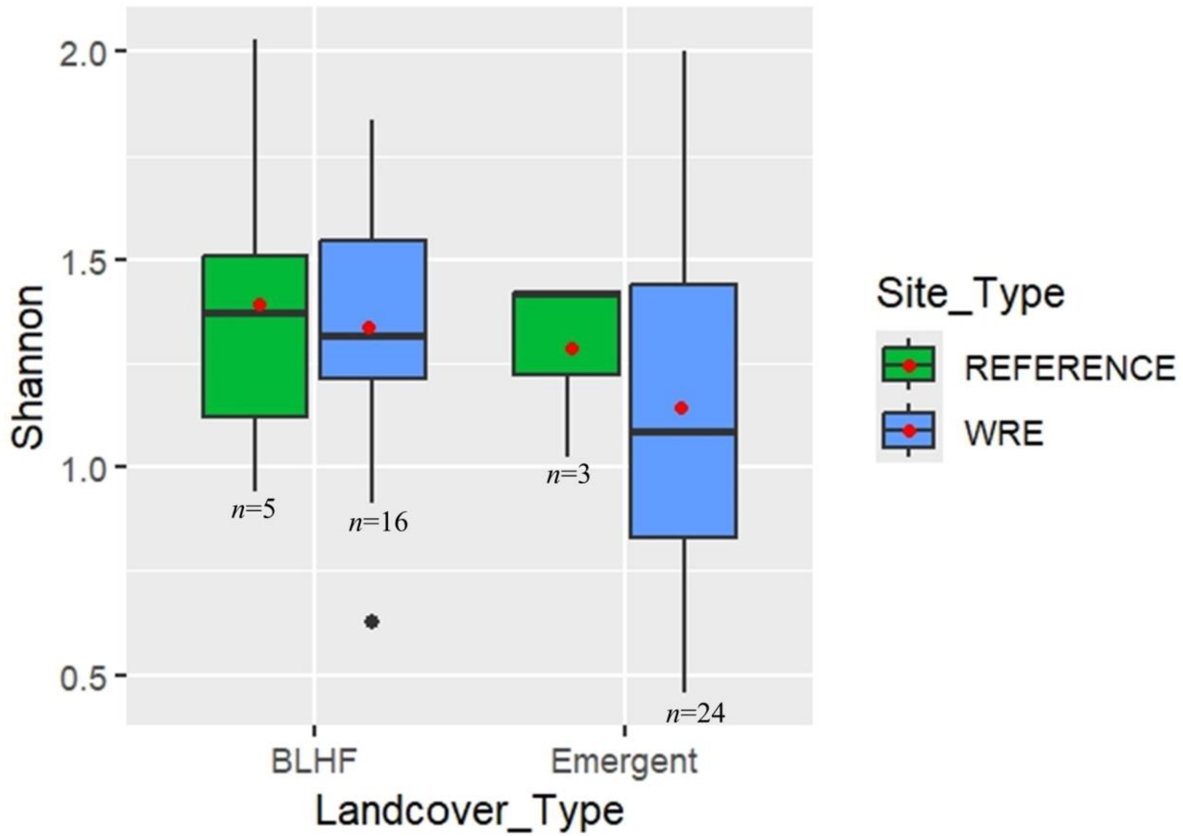


p= 0.01 p= 0.35

Reference sites were not included in late summer due to small sample size (n=1)

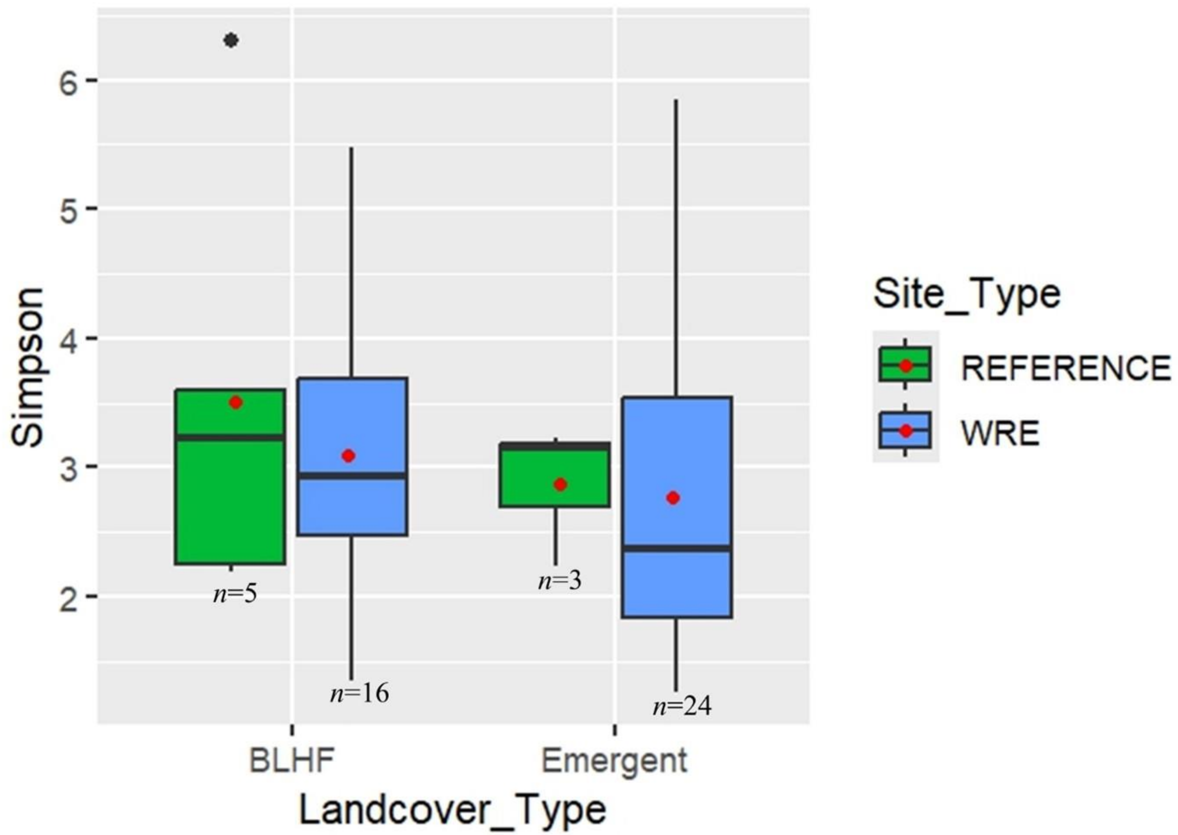
Spring Landcover Diversity

Shannon Diversity Index



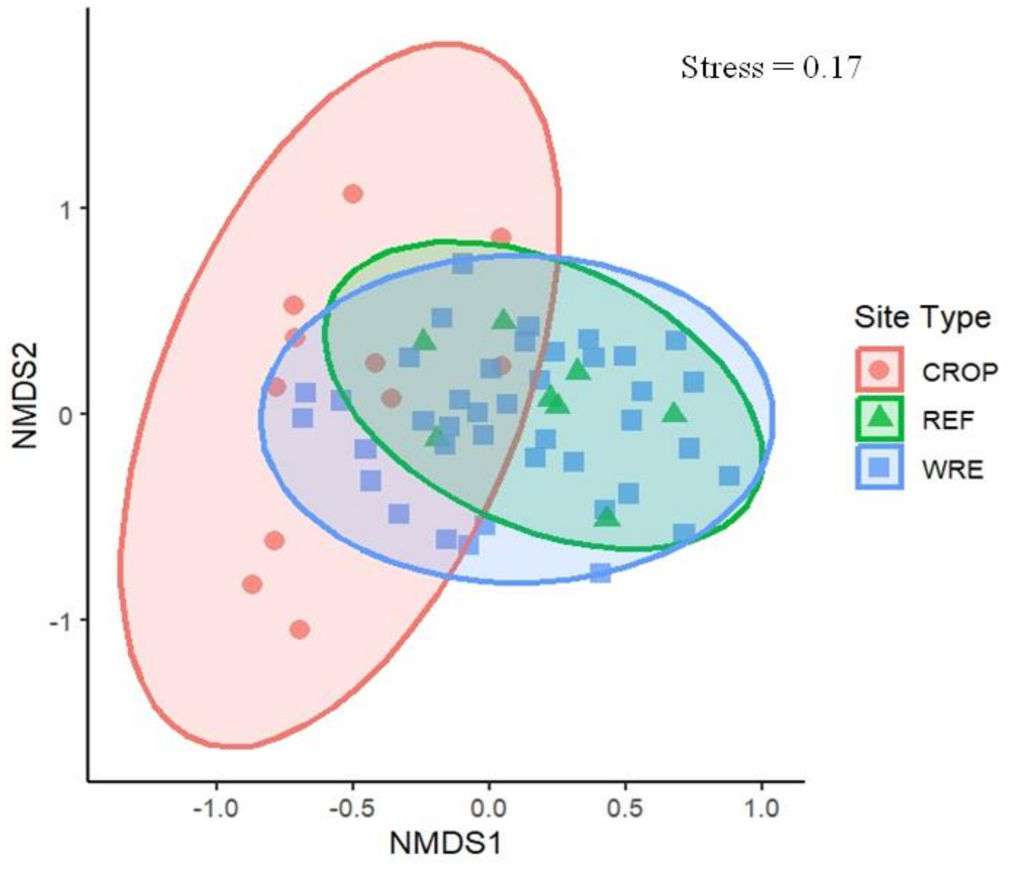
p=0.53

Simpson Diversity Index



p=0.62

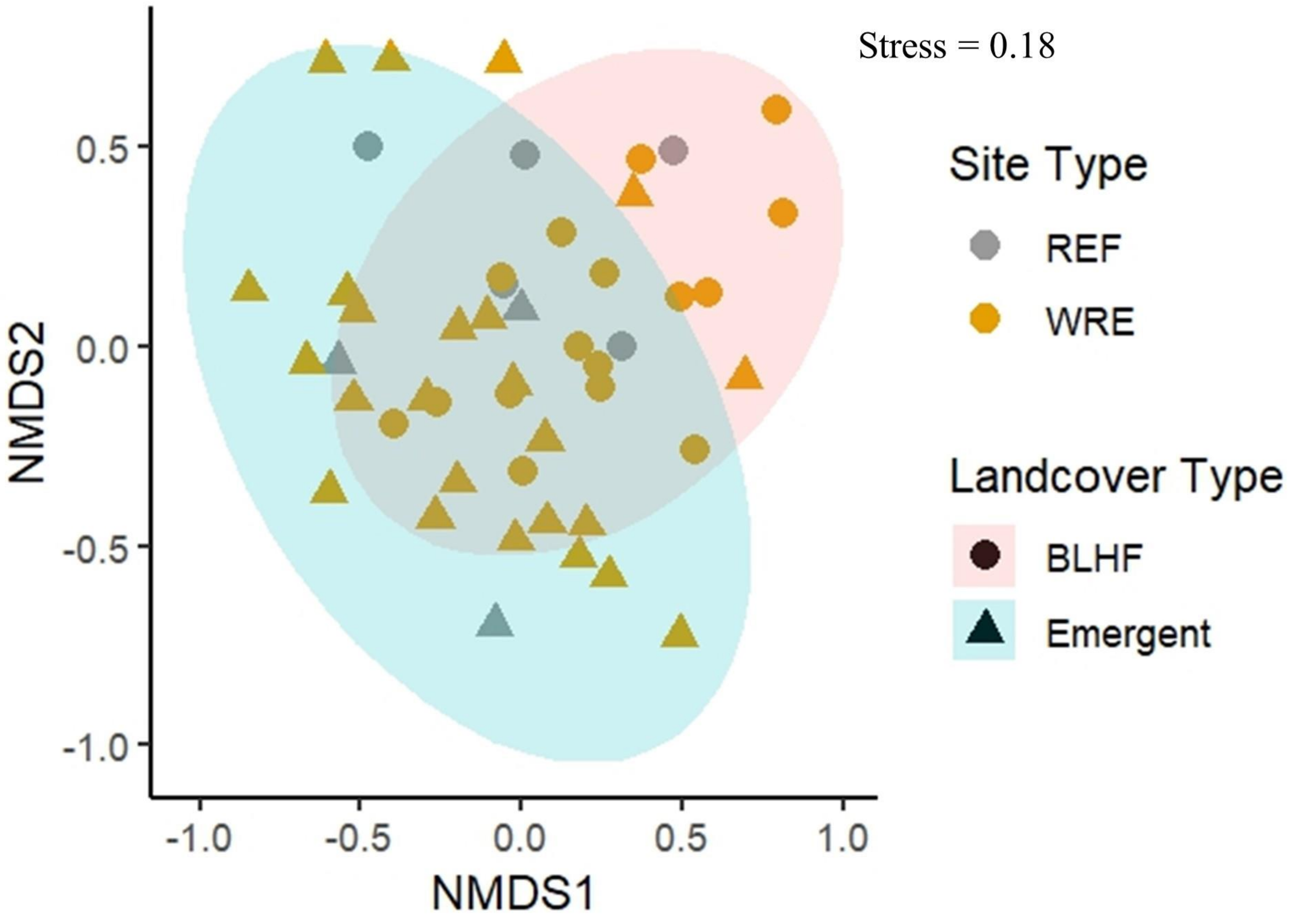
Spring Community Comparisons



p=0.001

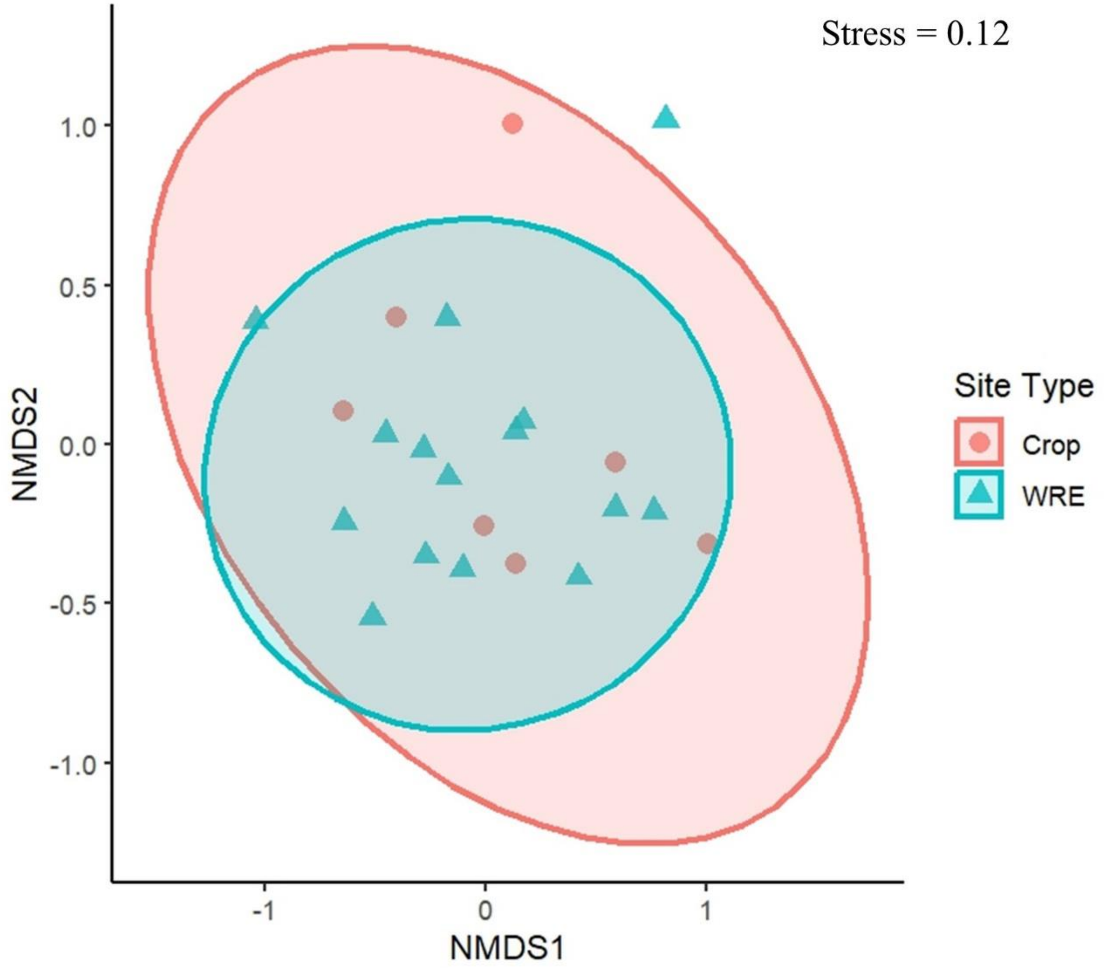
Pairwise Comparisons	p-Values
Crop vs. WRE	**0.002**
Crop vs. Reference	**0.01**
Reference vs. WRE	0.37

Spring Community Comparisons



p=0.001

Late Summer Community Comparisons



p=0.11

Reference sites were not included in late summer due to small sample size (n=1)

Spring Environmental Analysis

GLMs

Abundance

- Water Depth
  - $\boxed{P=0.0005}$
- Dissolved Oxygen
  - P=0.30
- Turbidity
  - $\boxed{P=0.03}$
- Site Type
  - P=0.69

Richness

- Water Depth
  - $\boxed{P=0.009}$
- Dissolved Oxygen
  - P=0.06
- Turbidity
  - P=0.24
- Site Type
  - $\boxed{P=0.004}$

Late Summer Environmental Analysis

GLMS

Abundance

- Water Temperature
  - $\boxed{P=0.001}$
- Turbidity
  - $\boxed{P=0.04}$

Richness

- Water Temperature
  - P=0.58
- Turbidity
  - P=0.46

Conclusions

- Comparable abundance, richness, and diversity between WRE and reference sites in spring
- Differences in assemblages in landcover types in spring

- Shallower water depth and lower turbidity were the primary drivers in abundance and richness
- Vegetation identified as possible component of water characteristics supporting communities

Acknowledgements

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Questions?