Annual Climate Variability Effects on Plant Biomass in Tidal Wetlands

Honors College
Randall Research Scholars Program

Abbey Wiggins[1], Jacob Dybiec[1], Shelby Rinehart[1], Julia Cherry[1,2]
1: Department of Biological Sciences, University of Alabama
2: New College, University of Alabama

Sea Grant Mississippi-Alabama

INTRODUCTION

- Tidal wetlands play an essential role in cycling nutrients, sequestering carbon, and stabilizing shorelines[1].
- Plant biomass is an indicator of plant productivity and a common measure of tidal wetland health
- Climatic conditions may influence plant productivity and, thus, biomass levels.
- **<u>Hypothesis</u>: differences in temperature and precipitation are correlated with changes in above- and belowground plant production.**

METHODS

- <u>Design:</u> 13 tidal marshes sampled along the Mississippi-Alabama coastline in late-Summer 2021 and 2022 (Fig. 1). Three 1 x 1 m plots/marsh, sampled once per year
- <u>Biomass</u>: aboveground harvest + belowground soil core (5 cm diameter x 20 cm depth) during peak growing season. Soil cores rinsed; all biomass dried to constant mass at 60º C.
- <u>Climate Data</u>: obtained temperature, precipitation, humidity, and wind speed data from series of proximal weather stations (n = 4)
- <u>Statistics</u>:
  - Differences in biomass: mixed effect models (fixed = X, random = Y)
  - Climate drivers: Principal Components Analysis (PCA) + correlations

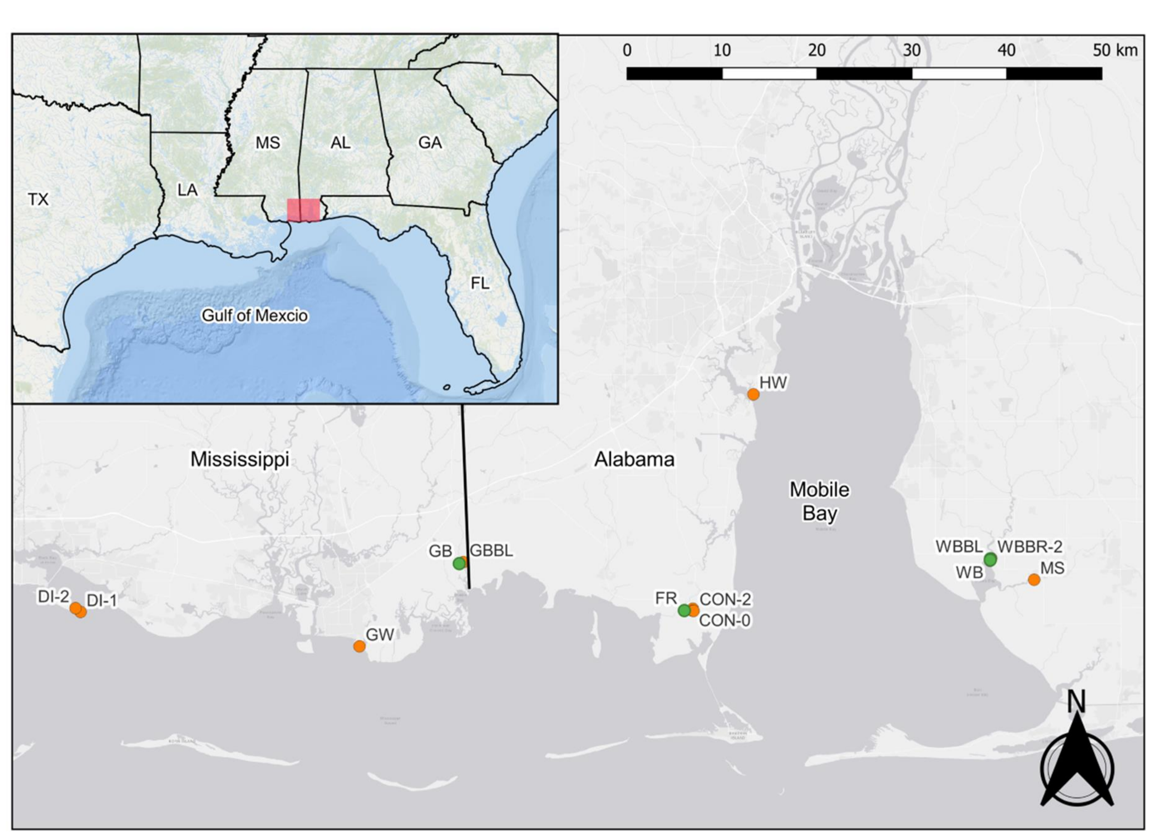

Figure 1. Location of marsh study sites along the Mississippi-Alabama coastline

RESULTS

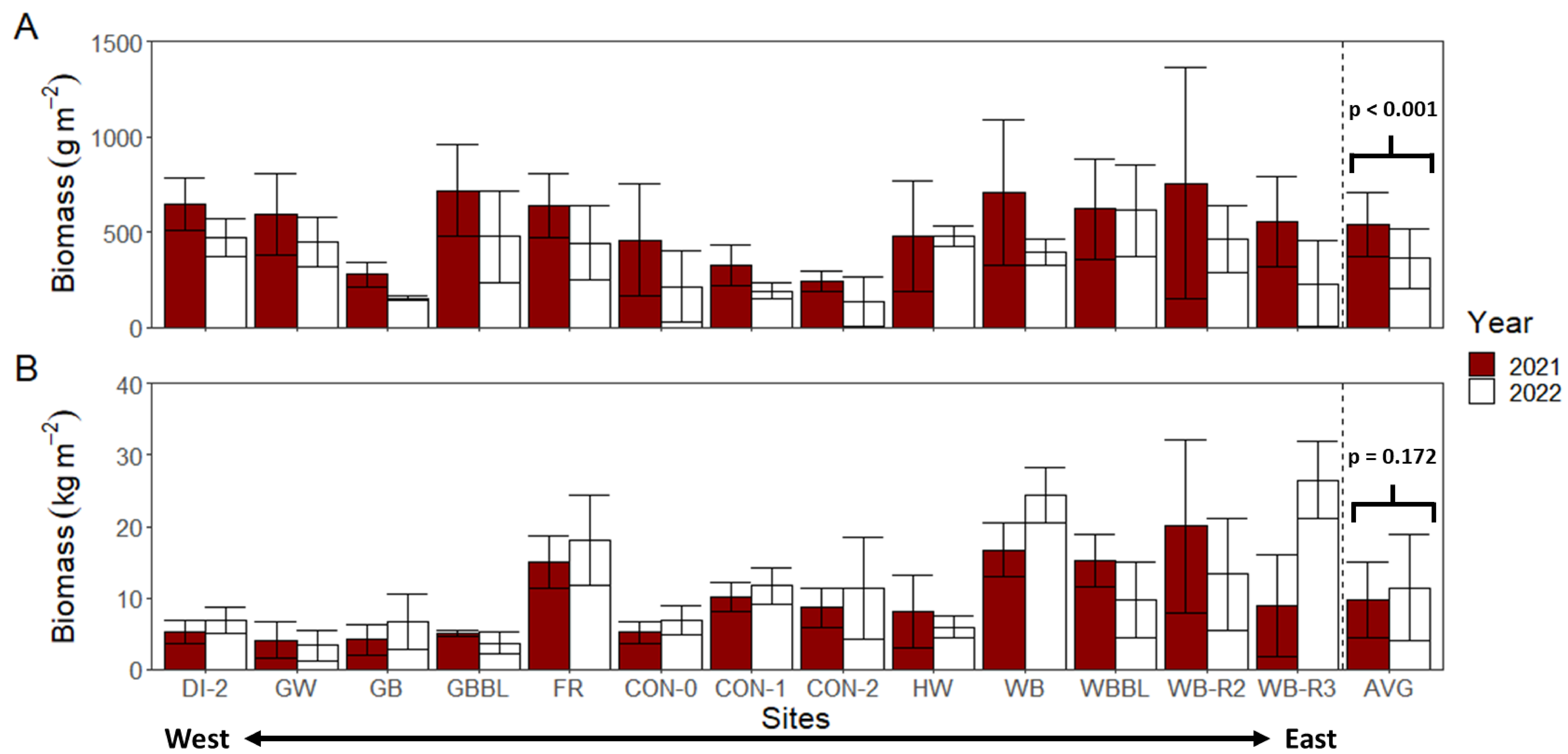

Figure 2. (**A**) Aboveground biomass and (**B**) belowground biomass from 2021 and 2022 plotted by site (mean ± 1 SD). Sites codes correspond to Deer Island (DI-2), Greenwood Island (GW), and Grand Bay (GB, GBBL) in Mississippi and Fowl River (FR, CON-0, CON-1, CON-2), Helen Wood (HW), and Weeks Bay (WB, WBBL, WB-R2, WB-R3) in Alabama. Sites are oriented from west to east along the x-axis, and the average biomass for each year is plotted to the right of the dashed line.

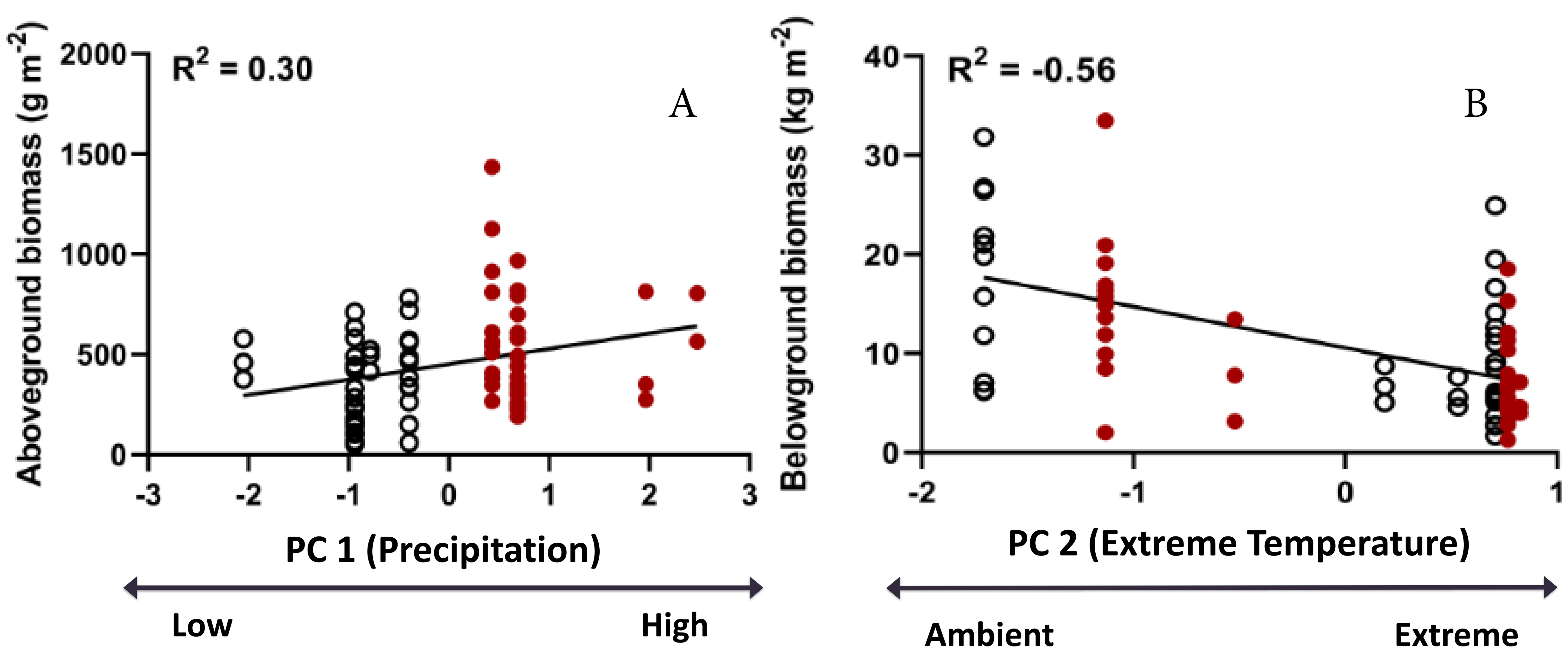

Figure 3. Relationships between (**A**) PC1 (precipitation) and aboveground biomass and (**B**) PC2 (extreme temperatures) and belowground biomass. Correlation coefficients are listed in the top left of each graph; $p = 0.008$ and $p < 0.001$ for **A** and **B**, respectively.

MAJOR FINDINGS

- Aboveground biomass decreased (Fig. 2A) and belowground biomass increased (Fig. 2B) between 2021 and 2022.
- PCA: first 2 components explained ~75% of variation in climate data.
  - Component 1: Precipitation
  - Component 2: Extreme Temperature
- Aboveground biomass was significantly positively correlated with precipitation (Fig. 3A).
- Belowground biomass was significantly negatively correlated with extreme temperature (Fig. 3B)
- Other relationships were explored and found to be insignificant.

DISCUSSION

- Climate conditions are becoming more variable and extreme (i.e., more frequent storm surges, fluctuation between wet and dry years, extreme temperatures) and sea-level rise is accelerating[2].
- Plant responses to climatic variation are tissue-specific (Fig. 3). Therefore, models of the impacts of climate change on marsh resiliency should take these differences into account
- While variation in precipitation and temperature may not drive marsh loss in isolation, they may exacerbate the impacts of other stressors (i.e., sea-level rise, eutrophication, increased storm intensity, etc.)[3].

ACKNOWLEDGEMENTS

We would like to thank Cherry Lab volunteers for their assistance in sample processing. This work is a leveraged project of a MS-AL Sea Grant to Cherry and Mortazavi (NOAA Award NA18OAR4170080).

REFERENCES

1. Barbier, Edward B., et al. "The value of estuarine and coastal ecosystem services." Ecological Monographs 81.2 (2011): 169-193.
2. Simas, T., J. P. Nunes, and J. G. Ferreira. "Effects of global climate change on coastal salt marshes." Ecological Modelling 139.1 (2001): 1-15.
3. Hanson, Alana, et al. "Responses of *Spartina alterniflora* to multiple stressors: changing precipitation patterns, accelerated sea level rise, and nutrient enrichment." Estuaries and Coasts 39 (2016): 1376-1385.