Assessing Biochar's Influence on Soil Nutrients and Native Plants in Great Lakes Coastal Wetlands

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Research Question: How is Great Lake Coastal Wetland (GLCW) native plant biomass, tissue chemistry, and soil chemistry affected by practically feasible rates of biochar application in a wetland d mesocosm greenhouse experiment?

Introduction

Native species in Great Lakes Coastal Wetlands (GLCWs) are threatened by rampant invasion of aggressive species such as *Typha angustifolia*. Eutrophication from nitrogen (N) and phosphorus (P) negatively impact freshwater systems by creating a favorable environment for aggressive clonal wetland invasives. [1,2] An emerging mitigation strategy to address invasion via pollutant and macronutrient capture is the application of the soil amendment product, biochar. Unpublished research suggests that biochar application to wetland soils growing *Typha* will suppress growth and reduce available N and P. However, prior to real world application, more research is needed to understand the potential impact of biochar application on native plant communities in GLCWs.

This project addresses how 2 common GLCW native species, *Schoenoplectus acutus* and *Juncus nodosus*, respond under the stress of biochar compared to the invasive cattail, *Typha angustifolia*. The experiment was designed to assess if plant survival, total biomass, soil, and plant nutrient content were impacted by biochar application. Experimental conditions replicate GLCW ecosystems in which biochar is utilized to inhibit the spread of invasive species. Project results can subsequently be used to inform land managers about the survivorship of native wetland plants, allowing them to mitigate invasion without harming native species.

Hypotheses

My hypotheses addressed biochar's impact on both plant tissue and biomass and are as follows:
1. GLCW native plant biomass will be reduced, but survival will not be impacted.
GLCW plants have evolved under low nutrient conditions, so a practically feasible application rate in a mesocosm greenhouse experiment is expected to reduce plant growth without impacting survival rates.
2. Nutrient concentrations in plant tissues will be reduced comparative to the controls.
Biochar is expected to adsorb nutrients in the soil solution and reduce plant available ions, thus it is expected that nutrient concentrations will be reduced in plant tissues exposed to biochar

Figure 1. Experimental native plants post-collection before being moved to greenhouse

Results

Results are to follow on printed poster (including graphs)

Figure 2. Experimental mesocosm setup of project post-biochar application in Loyola's School of Environmental Sustainability greenhouse

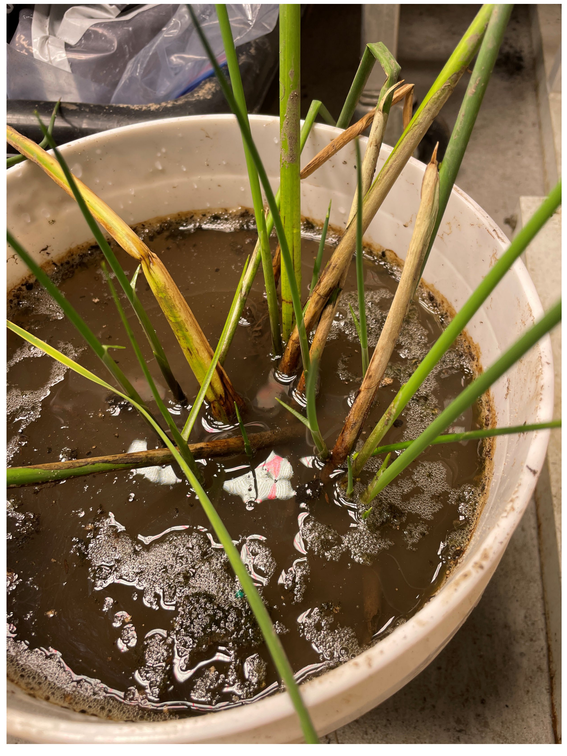

Figure 3. *Schoenoplectus acutus* in its experimental pot under conditions intended to mimic those in eutrophic wetlands

Methods

My experiment was conducted in two phases: *Phase I: Rhizome Collection and Plug Growth* and *Phase II: Greenhouse Experiment*.
During *Phase 1*
Rhizomes of two native species - *Schoenoplectus acutus* and *Juncus nodosus* - and one invasive species - *Typha angustifolia* - were collected and maintained for 6 weeks before being transported to a greenhouse for Phase II.
During *Phase II*
Rhizomes were planted and grown in experimental mesocosms in a greenhouse. To simulate moderate nutrient conditions of *Typha* invaded wetlands, rhizomes were grown in a 25% compost / 75% sand wetland soil as a mesocosm substrate in two (2) gallon buckets. Following soil addition, commercially available wood-derived biochar from Wakefield Biochar was mixed in respective pots at rates of 0 T/ha and 50T/ha.

After 12 weeks, plant survival, total biomass, and plant nutrient content were assessed. To collect total biomass, plants were removed from the buckets, roots were washed of sediments, dried at 60°C, and weighed. In the coming weeks, subsamples of dried plants will be grinded and subsequent plant tissue cations and anions will be chemically analyzed via Ion Chromatography. All data will be analyzed using a Two-Way ANOVA in R.

Project Takeaway and Future Directions

My project goals are to collect impactful and interpretable data regarding biochar's effect on native plant communities under saturated soil conditions.
This research will inform the future application of biochar use beyond an agricultural or wastewater treatment application. I intend to identify if and how biochar will influence native plant community growth in an ecosystem when used to combat *Typha* invasion in eutrophic wetlands. If native plant impact is minimal, biochar's application in wetland systems to manage nutrients and invasive *Typha* in GLCWs could be significant to reduce *Typha* growth while minimally impacting native plant species.

Acknowledgements

I am very grateful to my research team for making this project possible. Thank you to my mentors Dr. Brian Ohsowski, Shane Lishawa, and Sam Schurkamp, as well as all of my fellow team members for supporting me during this process. I am also appreciative of Loyola's School of Environmental Sustainability for providing me with space to carry out my project and to the College of Arts and Sciences for providing me the opportunity to engage in undergraduate research.

References

1. Bansal, S., Lishawa, S.C., Newman, S., Tangen, B.A., Wilcox, D., Albert, D., Anteau, M.J., Chimney, M.J., Cressey, R.L., DeKeyser, E. and Elgersma, K.J. (2019). Typha (Cattail) invasion in North American wetlands: Biology, regional problems, impacts, ecosystem services, and management. *Wetlands,* 39, 645-684.

2. Kim, D.K., Yang, C., Parsons, C.T., Bowman, J., Theÿsmeÿer, T. and Arhonditsis, G.B. (2021). Eutrophication management in a Great Lakes wetland: examination of the existence of alternative ecological states. *Ecosphere,* 12(2), *p.e03339.*