Metropolitan Water Reclamation District of Greater Chicago

Welcome to the March Edition of the 2025 M&R Seminar Series

NOTES FOR SEMINAR ATTENDEES

- Remote attendees' microphones are muted at entry to minimize background noise. For attendees in the auditorium, please silence your phones.
- A question and answer (Q/A) session will follow the presentation.
- For remote attendees, please use "**Chat**" only to type questions for the presenter. For other issues, please email Pam to SlabyP@mwrd.org.
  For attendees in the auditorium, please raise your hand and wait for the microphone to ask a verbal question during the Q/A session.
- The presentation slides will be posted on the MWRD website after the seminar.
- This seminar has been approved by the ISPE for one PDH and is pending approval by the IEPA for one TCH. Certificates will be issued only to participants who attend the entire presentation.

Dr. Brian Matthew Ohsowski
Assistant Professor, Loyola University Chicago
School of Environmental Sustainability

Dr. Brian Ohsowski is an Assistant Professor at Loyola University Chicago's School of Environmental Sustainability. At Loyola since 2014, he teaches courses on environmental statistics, ecological restoration, and conservation biology to address the management and preservation of biodiversity and functioning ecosystems. He has 20 years of classroom education and research experience in biostatistics using R. Since 2015, Brian's research focuses on applied land management related to the aquatic and terrestrial ecosystem restoration in the Great Lakes watershed. His lab group, Team *Typha*, focuses on closing the loop of ecological restoration when harvesting wetlands disturbed by clonal invaders. To close this loop, Team *Typha* has been investigating the conversion of harvested invasive plants to biochar to unpack the responses of abiotic soil properties and biotic community to biochar wetland reapplication after invasive plant harvesting in wetlands.

Converting Invasive Hybrid Cattails (*Typha* × *glauca*) into Biochar and its Impact on Water Quality

Dr. Brian Ohsowski – Assistant Professor

March 27, 2025

LOYOLA UNIVERSITY CHICAGO

School of Environmental Sustainability
Lake Shore Campus
1032 W. Sheridan Road | BVM Hall 301 | Chicago, Illinois 60660
Phone 773.508.2130 | LUC.edu/sustainability

Preparing people to lead extraordinary lives

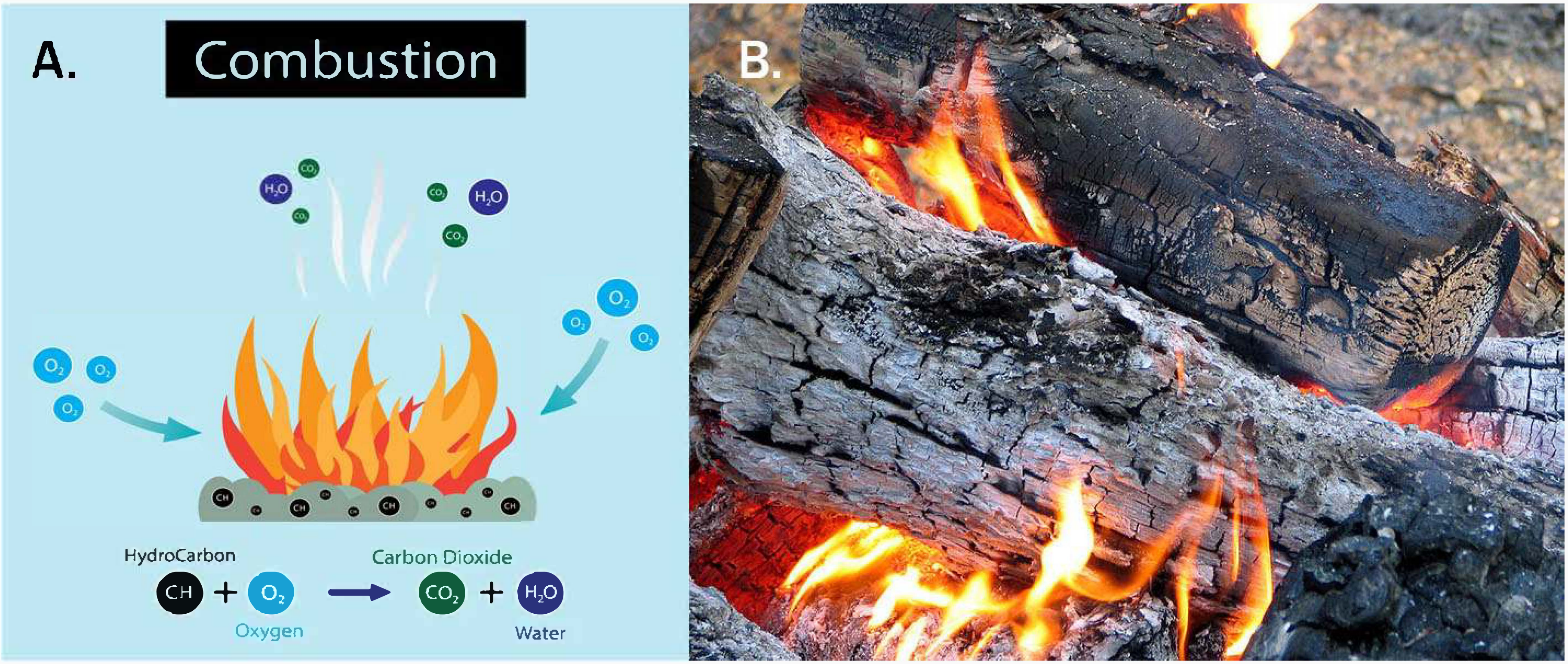
Team *Typha*

Impossible without Collaboration: Graduate Students, Undergraduate Students, Research Associates, Grant Partners at Local, State, and Federal Levels

What is Biochar?

What is Biochar?

If fuel has a continual supply of O_2 and heat ...



Credit: A. Nasky/Shutterstock B. Wikicommons

...complete fuel combustion, smoke, and ash.

What is Biochar?

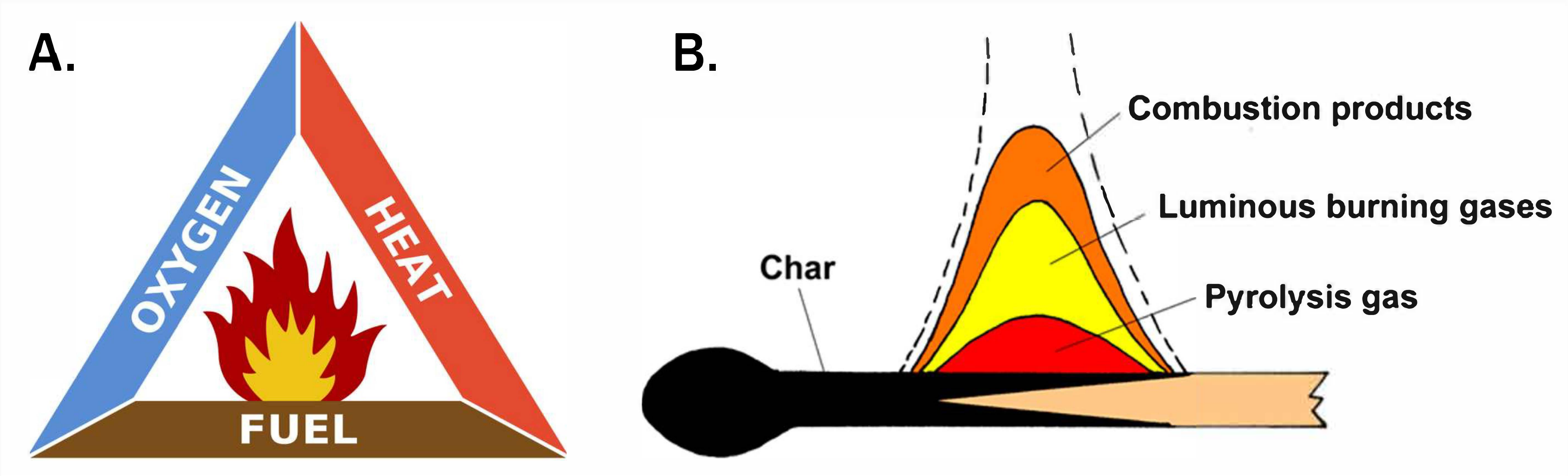
Basic Steps of Burning Wood to Ash

1: Add heat (*pyro*) to fuel

2: Torrefaction = fuel dries and roasts [200–300^{o}C]

3: **Pyrolysis** = fuel *lysis* to **charcoal** & **syngas** [300–650^{o}C]

4: Gasification = fuel combusts, vapors burn, ash [700–850^{o}C]

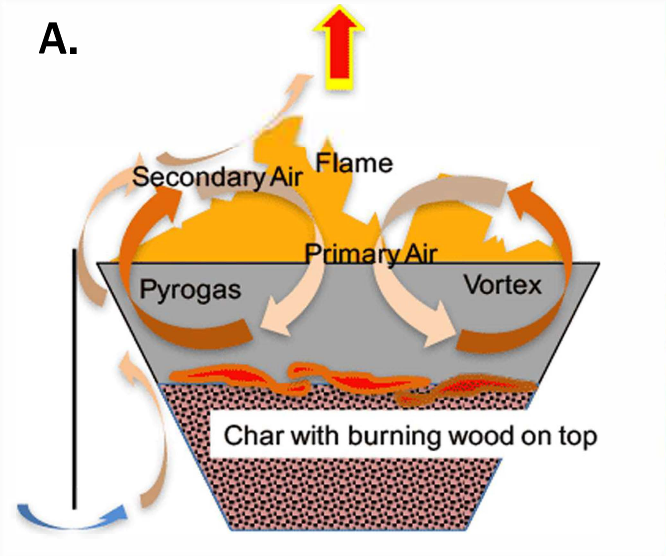


Credit: A. Wikicommons B. International Biochar Initiative

What is Biochar?

In a specialized kiln ...

- recirculated syngas in smoke burns completely
- restricted O_2
- biomass is baked in a “smokeless” fire
- ash greatly reduced



Credit: A. International Biochar Initiative B. Ithaka Institute

Incomplete combustion = ?

What is Biochar?

Credit: Ohsowski, B.

Incomplete combustion = Biochar!

Why Biochar?

Why Biochar?

Worldwide Popularity of "biochar" term Google Search

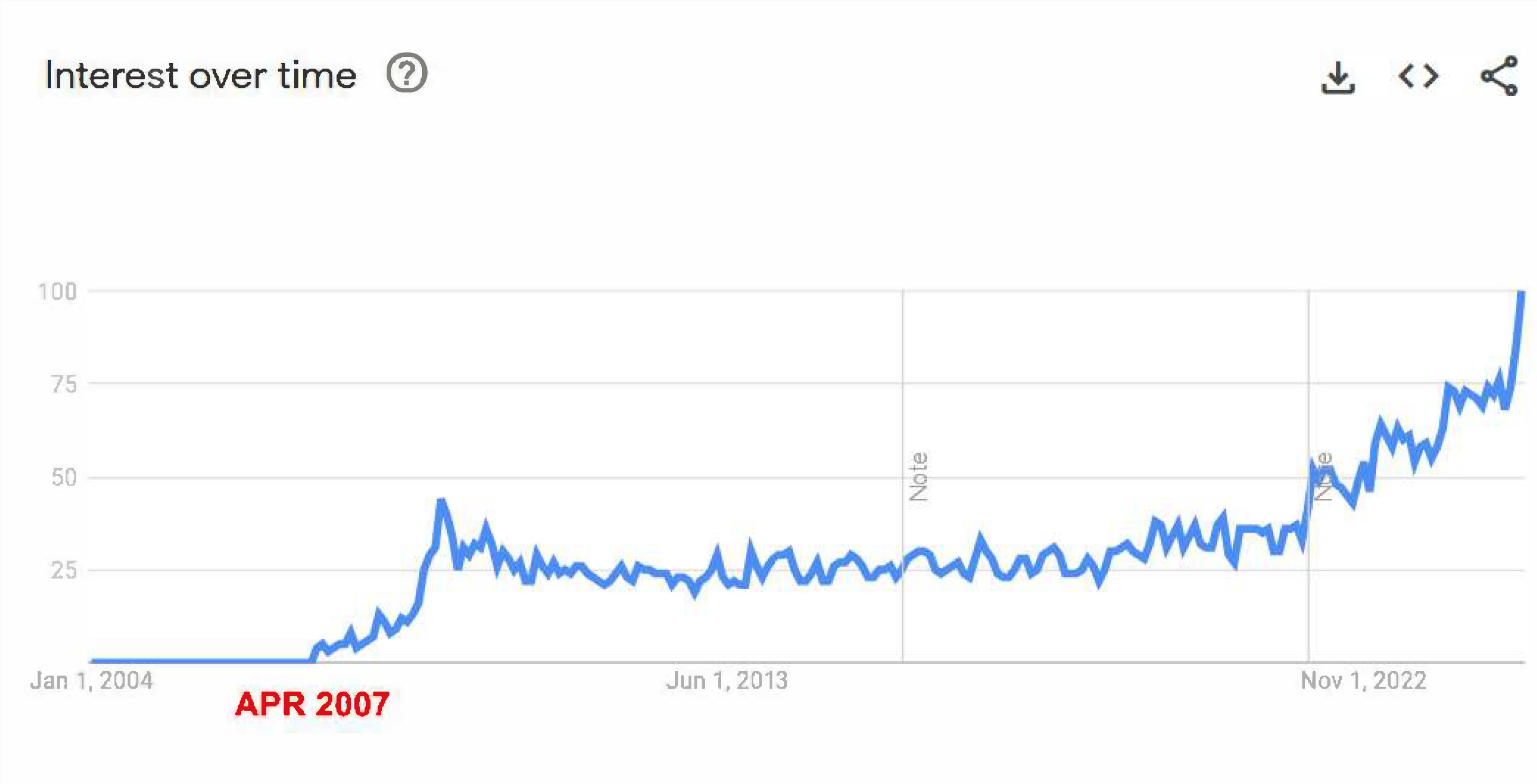


Figure 1: Google Trends: Yearly worldwide interest average for "biochar" search term from 2004 – Present. 100 = peak term popularity; 50 = term is half as popular.

What happened around 2007?

Foundational Publications Gain Attention

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B

Phil. Trans. R. Soc. B (2007) **362**, 187–196
doi:10.1098/rstb.2006.1978
Published online 20 December 2006

Prehistorically modified soils of central Amazonia: a model for sustainable agriculture in the twenty-first century

Bruno Glaser*

Institute of Soil Science and Soil Geography, University of Bayreuth, 95440 Bayreuth, Germany

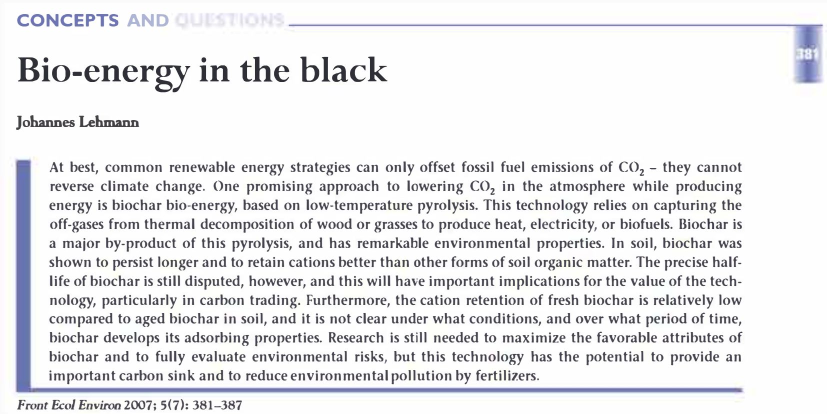
Figure 2: Brazilian nutrient–poor oxisol (left); nearby char–amended oxisol []i.e. Terra Preta de Indio] (right). Photo Credit: Julie Major & Bruno Glaser [International Biochar Initiative]

Compared to adjacent oxisols,

Terra Preta de Indio Soils

- 7000–500 YBP
- 70× more charcoal
- 3× more soil organic matter
- 3× more nitrogen
- 3× more phosphorus

Foundational Publications Gain Attention



CONCEPTS AND QUESTIONS

381

Bio-energy in the black

Johannes Lehmann

At best, common renewable energy strategies can only offset fossil fuel emissions of CO_2 – they cannot reverse climate change. One promising approach to lowering CO_2 in the atmosphere while producing energy is biochar bio-energy, based on low-temperature pyrolysis. This technology relies on capturing the off-gases from thermal decomposition of wood or grasses to produce heat, electricity, or biofuels. Biochar is a major by-product of this pyrolysis, and has remarkable environmental properties. In soil, biochar was shown to persist longer and to retain cations better than other forms of soil organic matter. The precise half-life of biochar is still disputed, however, and this will have important implications for the value of the technology, particularly in carbon trading. Furthermore, the cation retention of fresh biochar is relatively low compared to aged biochar in soil, and it is not clear under what conditions, and over what period of time, biochar develops its adsorbing properties. Research is still needed to maximize the favorable attributes of biochar and to fully evaluate environmental risks, but this technology has the potential to provide an important carbon sink and to reduce environmental pollution by fertilizers.

Front Ecol Environ 2007; 5(7): 381–387

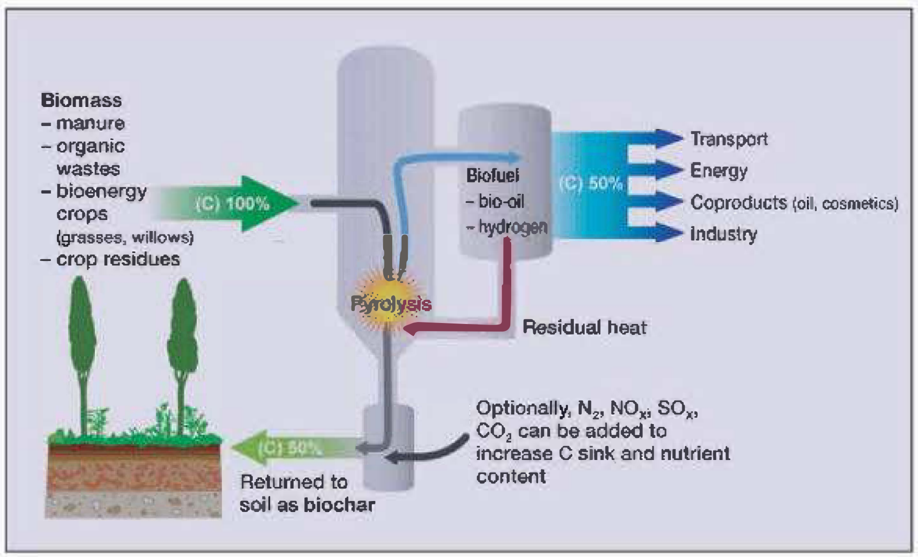


Figure 3: Low-temperature pyrolysis bio-energy with biochar sequestration. Typically, about 50% of the pyrolyzed biomass is converted into biochar and can be returned to soil (Lehmann 2007).

Why Biochar?

One inquiring mind wanted to know.


Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION

RESEARCH ARTICLE

Plant response to biochar, compost, and mycorrhizal fungal amendments in post-mine sandpits

Brian M. Ohsowski[1], Kari Dunfield[2], John N. Klironomos[3], Miranda M. Hart[3,4]

PhD Research site (2009-2013) near London, ON, Canada.

Biochar + Restoration + Research

Biochar: So Many Questions, Some Answers

Biochar: So Many Questions, Some Answers

Research is Growing:

Biochar application to soil is context dependent!

Soil and plant response based on . . .

- Habitat
- Soil classification
- Pyrolysis temperature
- Production equipment
- Land use history
- Co–amendments (compost)
- Pyrolysis speed

Thus, biochar application is not a one–size fits all solution.

Let's explore some established knowns

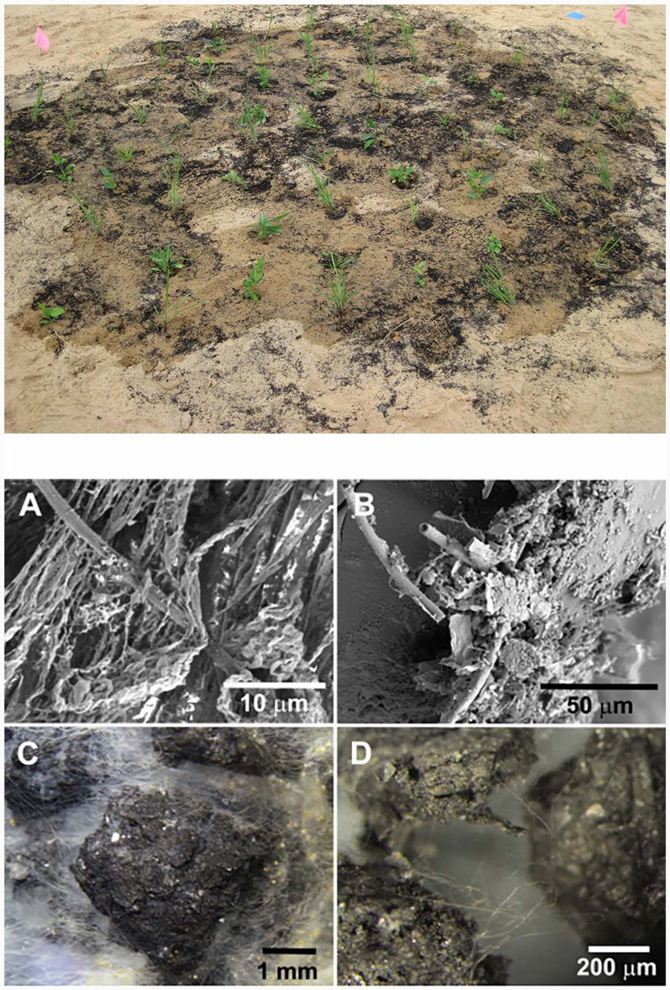


Figure 4: *Top:* Biochar added to post–mine sandpit (Ohsowski 2010); *Bottom:* Arbuscular mycorrhiza colonizing biochar shows 6x P increase to plant (Credit: Hammer et al. 2014)

Soil Benefits (Joseph et al. 2021):

- ↑ carbon
- ↑ water–holding capacity
- ↑ porosity
- ↑ nutrient retention
- ↓ heavy metal availability
- ↑ microbial activity (especially by AM)

Let's explore some established knowns

Figure 5: Tufted Vetch roots associated with biochar chunk in Ontario (Ohsowski 2010)

Plant Benefits (Joseph et al., 2021):

- ↑ crop biomass (especially in sandy & weathered soils)
- ↑ root development
- ↑ disease resistance

Biochar Application to Wetlands: Research Unknowns

Invasive Species Challenges

Great Lakes Coastal Wetland Invasion:

- Aggressive hybrid (*Typha* × *glauca*)
- Clonal growth from rhizomes
- Sites with altered hydrology, sedimentation, & eutrophication
- Tolerates high salinity

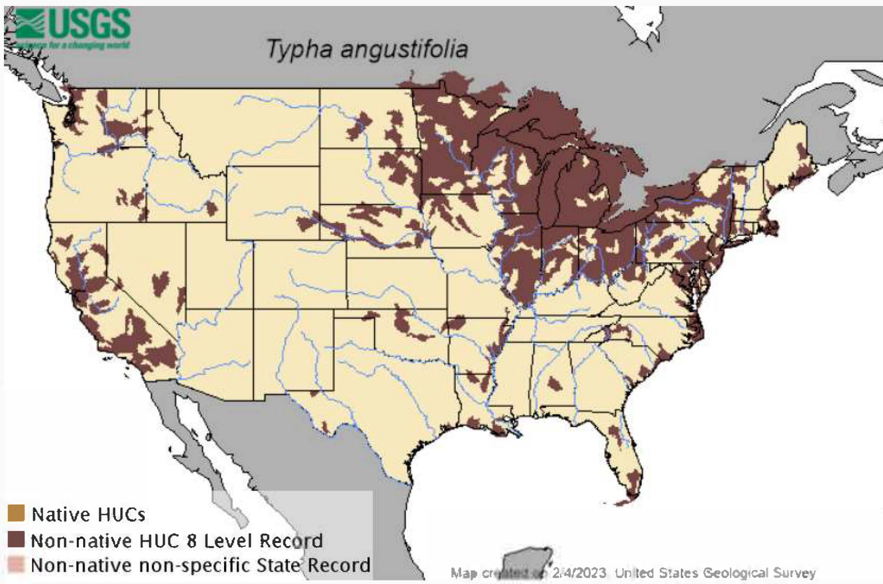


Figure 6: Map Credit: USGS Nonindigenous Aquatic Species Portal (Cao et al., 2023). Photo Credit: Ohsowski 2018

Invasive Species Challenges

frontiers | Frontiers in Plant Science

TYPE Original Research
PUBLISHED 12 March 2024
DOI 10.3389/fpls.2024.1348144

Check for updates

OPEN ACCESS

EDITED BY
Jianping Tao,
Southwest University, China

REVIEWED BY
P. E. Rajasekharan,
Indian Institute of Horticultural Research (ICAR), India
Suresh Chandra Subedi,
Arkansas Tech University, United States

*CORRESPONDENCE
Brian M. Ohsowski
bohsowski@luc.edu

RECEIVED 01 December 2023
ACCEPTED 27 February 2024
PUBLISHED 12 March 2024

Field-based measurement tools to distinguish clonal *Typha* taxa and estimate biomass: a resource for conservation and restoration

Brian M. Ohsowski[1*], Cassidy Redding[1], Pamela Geddes[2] and Shane C. Lishawa[1]

[1]School of Environmental Sustainability, Loyola University Chicago, Chicago, IL, United States,
[2]Department of Biology and Environmental Science Program, Northeastern Illinois University, Chicago, IL, United States

Invasive Species Challenges

The Journal of Wildlife Management 84(7):1326–1337; 2020; DOI: 10.1002/jwmg.21912

Research Article

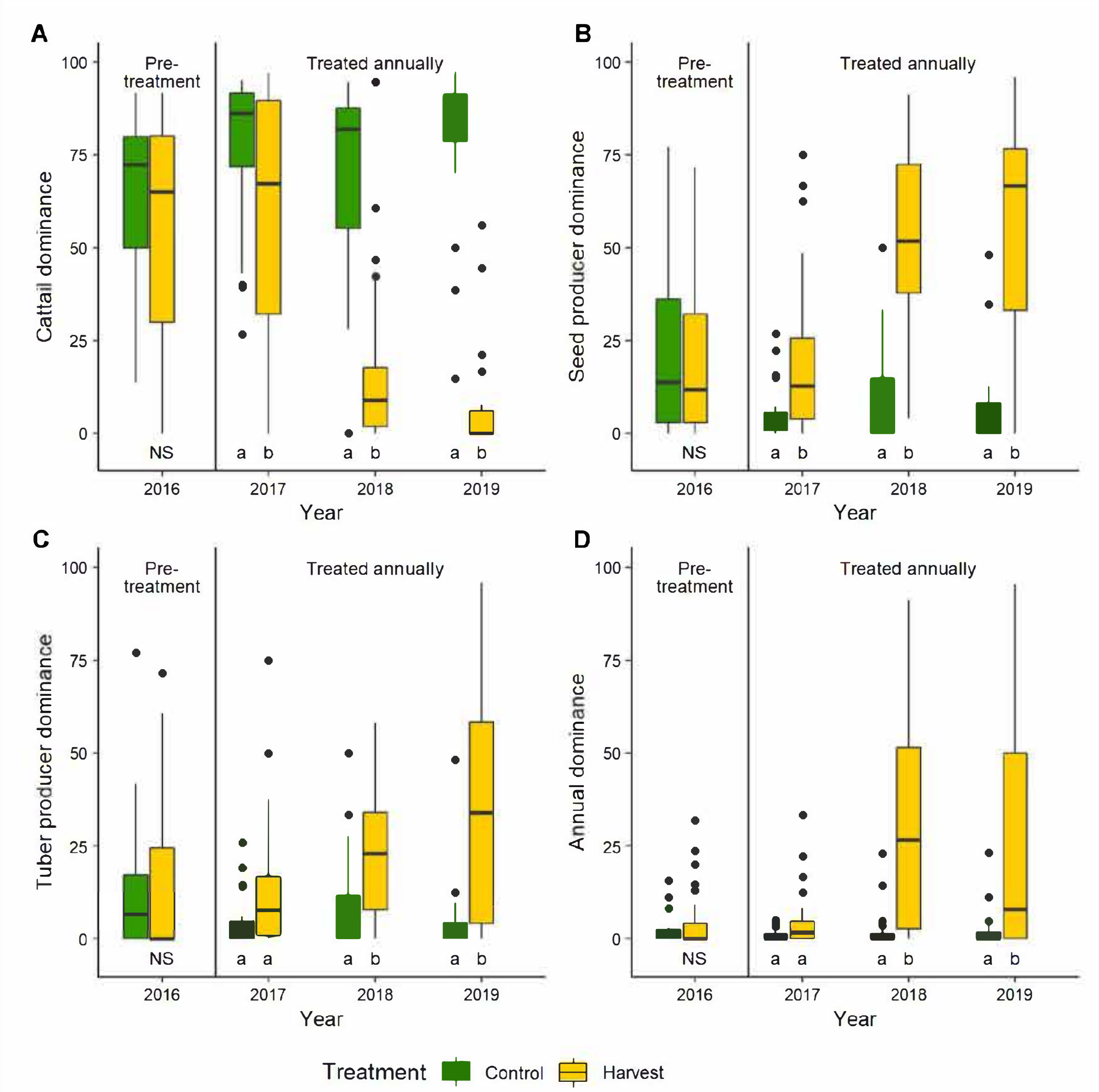
Wetland Waterbird Food Resources Increased by Harvesting Invasive Cattails

SHANE C. LISHAWA,[1] *Loyola University Chicago, 1032 W. Sheridan Road, Chicago, IL 60660, USA*
ERIC M. DUNTON, *U.S. Fish and Wildlife Service, Shiawassee National Wildlife Refuge, 6975 Mower Rd., Saginaw, MI 48601, USA*
DOUGLAS R. PEARSALL, *The Nature Conservancy in Michigan, 101 E. Cesar E. Chavez Avenue, Lansing, MI 48906, USA*
ANDREW M. MONKS, *Loyola University Chicago, 1032 W. Sheridan Road, Chicago, IL 60660, USA*
KURTIS B. HIMMLER, *Loyola University Chicago, 1032 W. Sheridan Road, Chicago, IL 60660, USA*
BRENDAN D. CARSON, *Tufts University, 419 Boston Avenue, Medford, MA 02155, USA*
BRIAN LOGES, *U.S. Fish and Wildlife Service, Division of Natural Resources and Conservation Planning, 364 Wildlife Conservation Road, Brussels, IL 62013, USA*
DENNIS A. ALBERT, *Oregon State University, 1500 SW Jefferson Way, Corvallis, OR 97331, USA*

Photo Credit: Team *Typha*

https://www.youtube.com/watch?v=DOZzOvmM_z8&t=1s

Invasive Species Challenges



Take Home: Harvesting reduces *Typha sp.* dominance (% cover) and increases native plant dominance (% cover) (Lishawa et al. 2020).

Invasive Species Challenges

. . . but nobody wants to deal with the biomass!

Photo Credit: Team *Typha*

Research Needed:

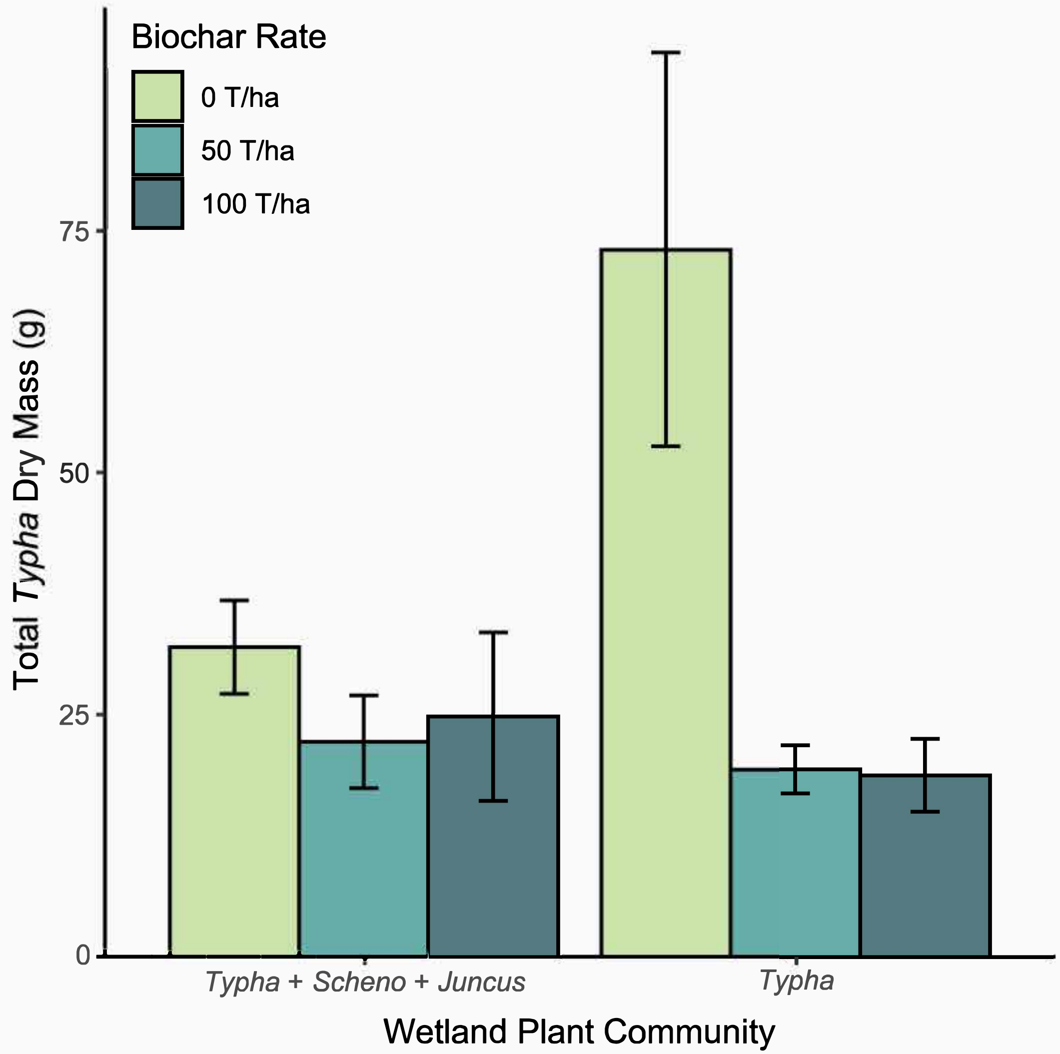
***Typha* + Biochar for increased nutrient removal via harvesting?**

***Typha* Biochar for mass reduction and soil nutrient management?**

Biochar Influence on Wetland Plant Biomass

Biochar Influence on Wetland Plant Biomass

Greenhouse Wetland Mesocosm: Wood–waste Biochar Feedstock

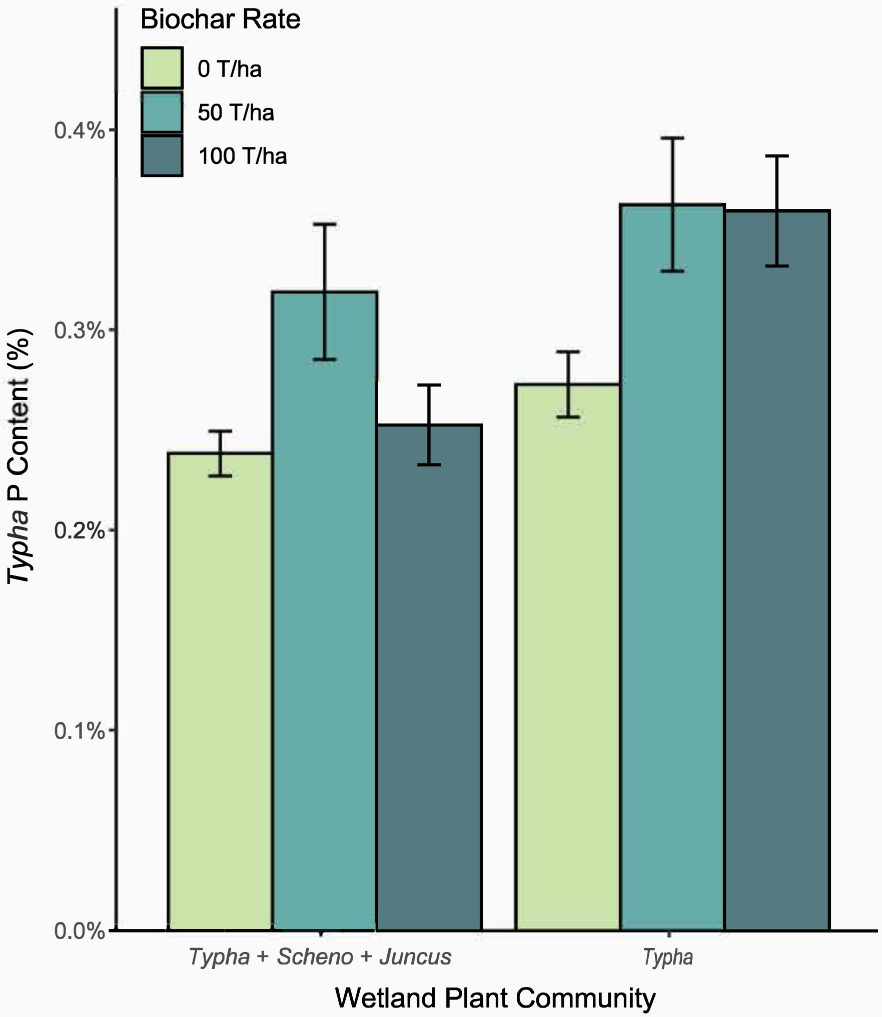


Compared to control...
50T/ha and 100T/ha BC reduced *Typha* growth ($p<0.05$)

Figure 7: *Typha* dry mass (mean grams ± SE) [replication = 5]. *Typha x glauca* grown alone or in mixed community (*Juncus balticus*, *Schenoplectus acutus*). Wood–waste biochar (Wakefield) in 50% Compost / 50% Sand. (McGreal et al., in–prep)

Biochar Influence on Wetland Plant Biomass

Greenhouse Wetland Mesocosm: Wood–waste Biochar Feedstock



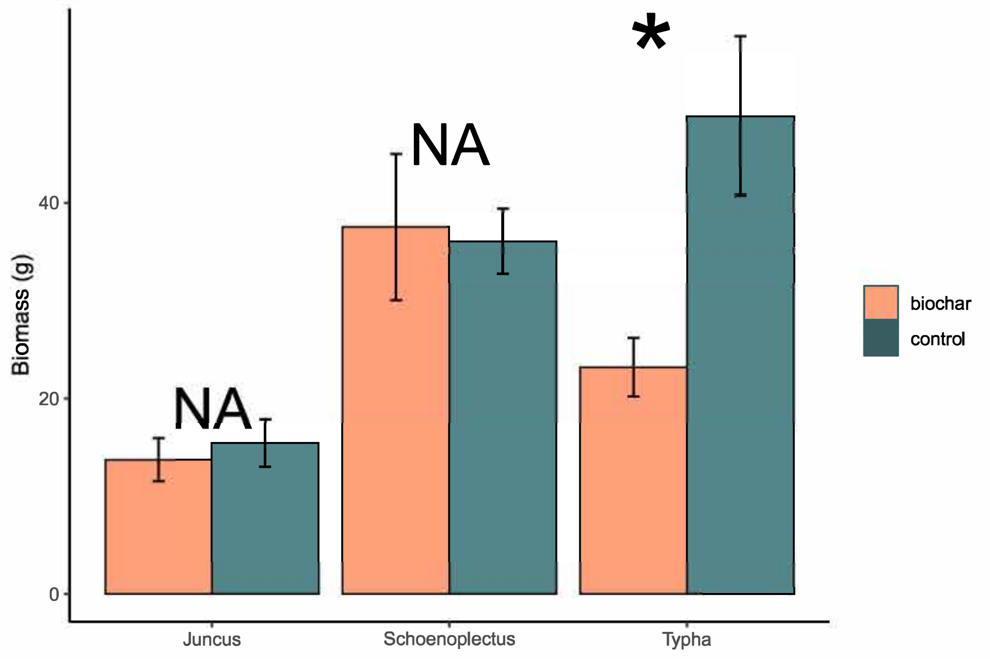
Compared to control...
50T/ha and 100T/ha BC increased *Typha* P% ($p<0.05$)

Typha alone has higher P% than in community ($p<0.05$)

Figure 8: *Typha* total P content (mean % ± SE) [replication = 5]. *Typha x glauca* grown alone or in mixed community (*Juncus balticus*, *Schenoplectus acutus*). Wood–waste biochar (Wakefield) in 50% Compost / 50% Sand. (McGreal et al., in–prep)

Biochar Influence on Wetland Plant Biomass

Greenhouse Wetland Mesocosm: Wood–waste Biochar Feedstock



Compared to control...

Biochar reduced *Typha* biomass ($p<0.05$)

Biochar did not influence native plant biomass ($p>0.05$)

Figure 9: Biomass (mean grams $\pm$ SE) of *Typha × glauca*, *Schoenoplectus acutus*, and *Juncus nodosus* with and without 50 T/ha biochar application [replication = 7]. (Bednard et al., in–prep).

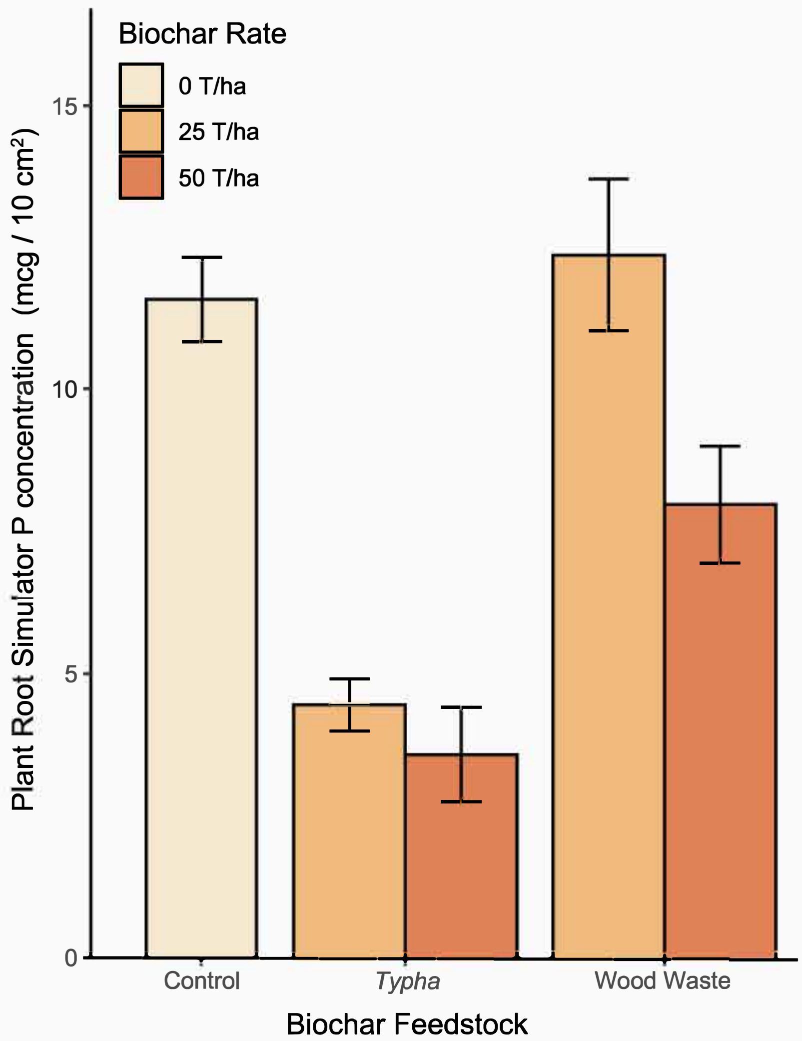
Biochar Feedstock Influence in Wetlands Soils

Biochar Feedstock Influence in Wetlands Soils

Photo Credit: Team *Typha*

Biochar Feedstock Influence in Wetlands Soils

Greenhouse Wetland Mesocosm: *Typha* & Wood Biochar Feedstock



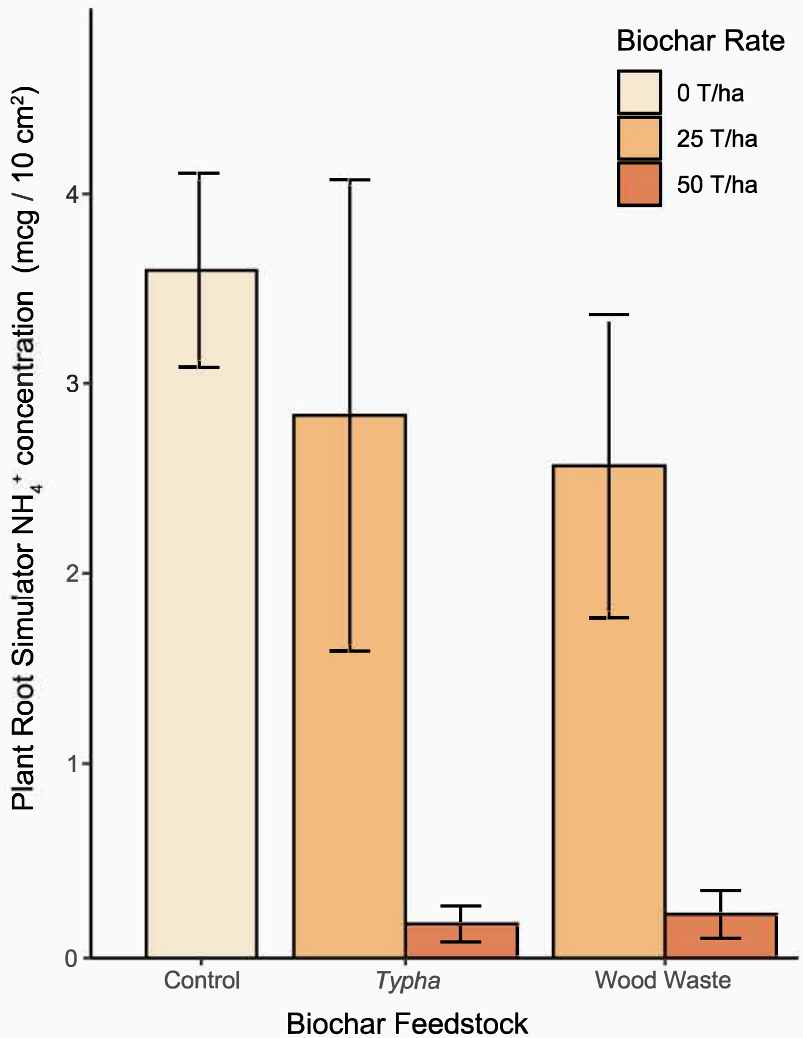
Compared to control...
Typha biochar reduced available P ($p<0.05$)

Typha biochar more effective at reducing available P than wood–waste biochar ($p<0.05$)

Figure 10: PRS probe data of available phosphate ions with wood–waste (Wakefield) and *Typha* biochar [replication = 6]. (Roxo et al., in–prep)

Biochar Feedstock Influence in Wetlands Soils

Greenhouse Wetland Mesocosm: *Typha* & Wood Biochar Feedstock



Compared to control...
50T/ha of *Typha* and wood–waste biochar reduced NH_4^+ ($p<0.05$)

Figure 11: PRS probe data of available ammonium ions with wood–waste (Wakefield) and *Typha* biochar [replication = 6]. (Roxo et al., in–prep)

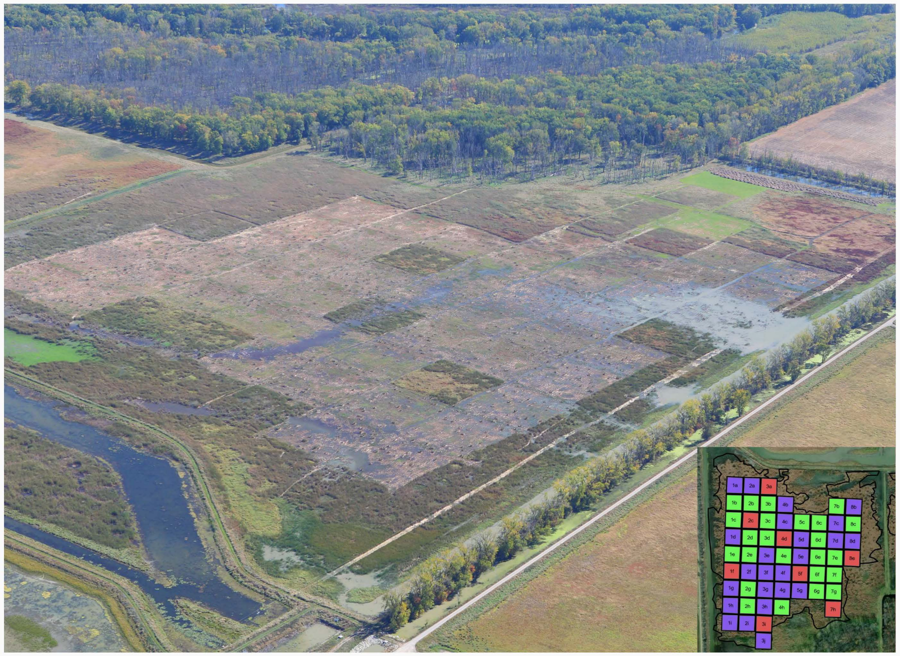
Scaling–up at SNWR: *Typha* Harvesting and Biochar Application

Scaling–up at SNWR: *Typha* Harvesting and Biochar Application

USFWS (GLRI) Co–op Agreement (2023) to Restore *Typha* Invaded Marsh

Plot Size: 1.2 acre

Total Plots: 56



Experimental Design:

Typha Biochar Application Rate (0 T/ha, 20 T/ha, 40 T/ha)

Harvest Frequency (Control, Annual, Triennial)

Scaling–up at SNWR: *Typha* Harvesting and Biochar Application

Phase–I (Summer 2024): *Typha* Biochar Production Testing at SNWR

On–Site Biochar Production Possible!

Scaling–up at SNWR: *Typha* Harvesting and Biochar Application

Phase–II (Spring 2025): Takachar Biochar Production at SNWR

Stream Simulation Study at LUC

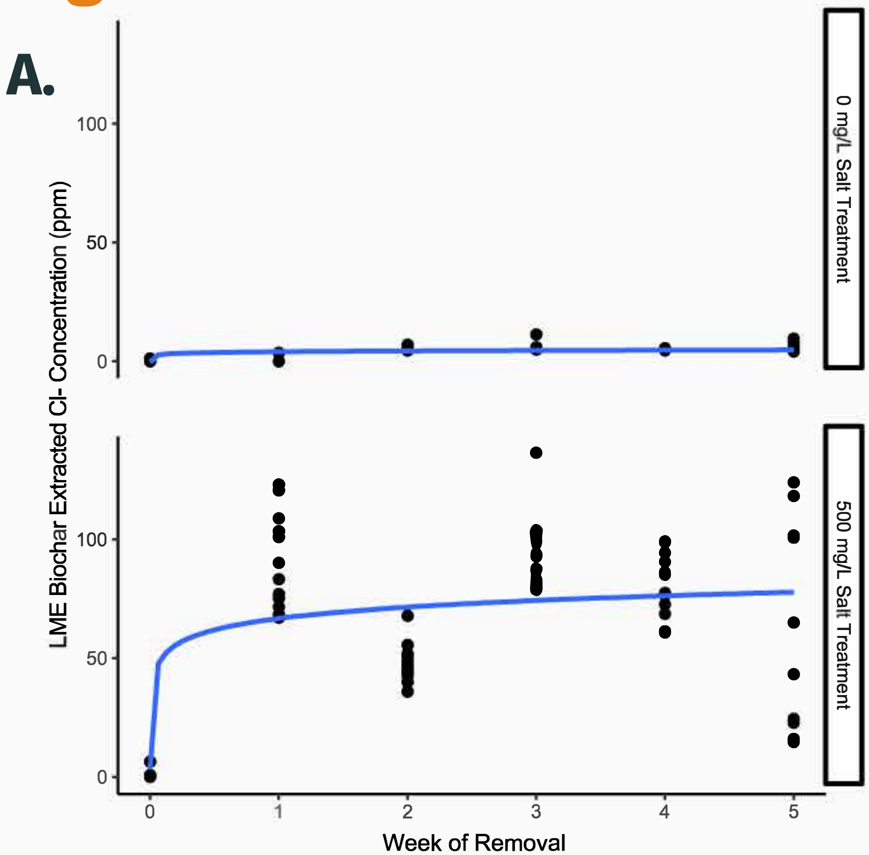
Controlled Stream Simulation Experiment

Five Week Biochar Saturation Curve Estimations for Nitrogen, Phosphorus, and Chloride.

Figure 12: Sodium Chloride and fertilizer were added at respective treatment rates: Salt (0.0 mg/L, 500 mg/L), phosphorus (0 mg/L, 0.1 mg/L1, 3.5 mg/L), and nitrogen (0 mg/L, 2.0 mg/L, 20 mg/L).

For five weeks, individual wood–waste biochar bags were removed weekly for chemical analysis.

Significant Increase in Cl^- Biochar Sorption after One Week.



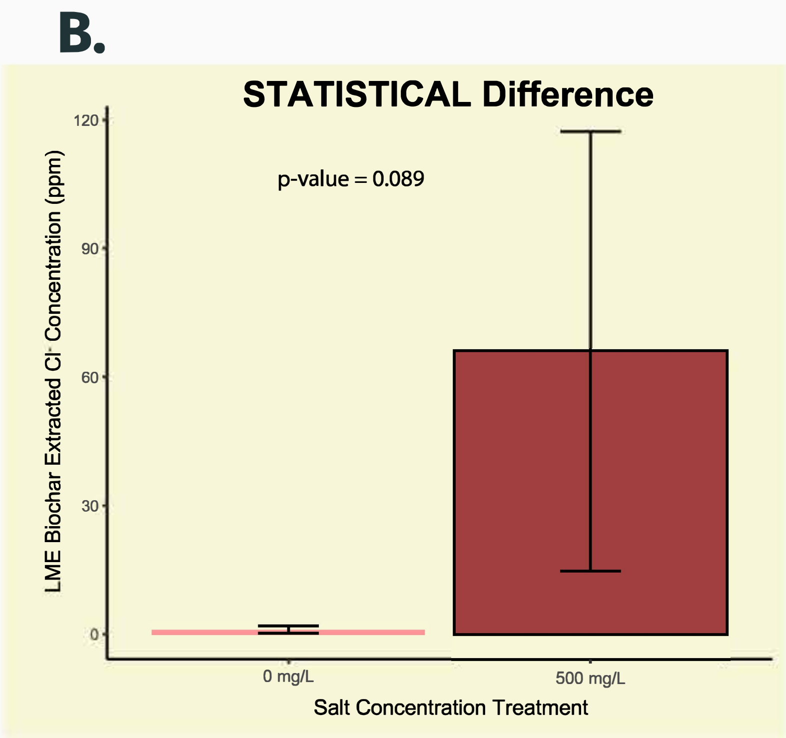


Figure 13: Biochar chloride concentration (ppm) for weekly biochar removal.

Mean$\pm$SE biochar surface extraction in 500mg/L Cl^- Treatment:

66.7 Cl^- mg/L $\pm$ 51.3 Cl^- mg/L

Illinois Tollway Research

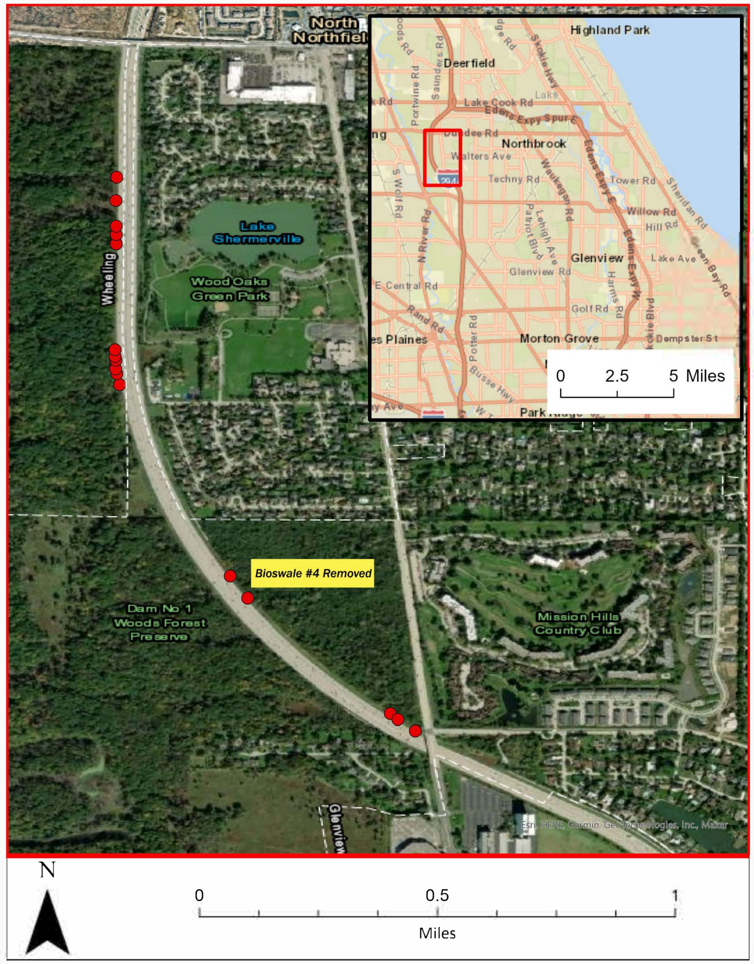


Figure 14: Bioswales selected to employ the Illinois Tollway experiment for Grant RR-22-9261. Five (5) blocked bioswales were chosen along I–294 between Mile Markers 49.9 – 51. Two (2) bioswales located northbound; Three (3)bioswales located southbound. Bioswale #4 removed due to gouged bioswale after mowing equipment accident in the plot.

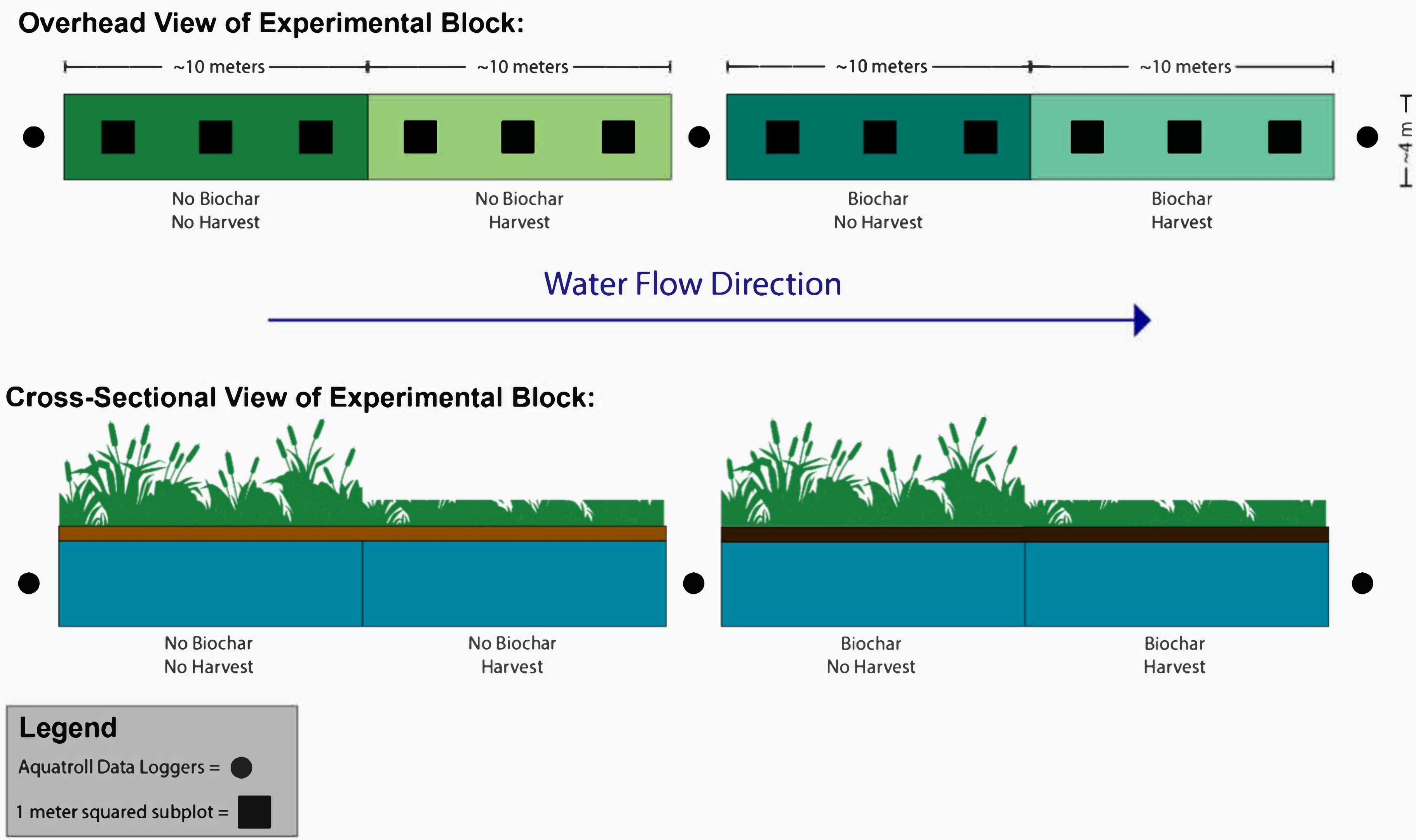


Figure 15: Experimental design of Illinois Tollway experiment for Grant RR-22-9261.

Figure 16: A. Harvest plot establishment (Oct 2022), B. Biochar application (20T/ha) (Oct 2022), C. Probe Installation and Monitoring (Dec 2022 - Present).

Significant Increase in Soil Cl^- ppm w/ Biochar

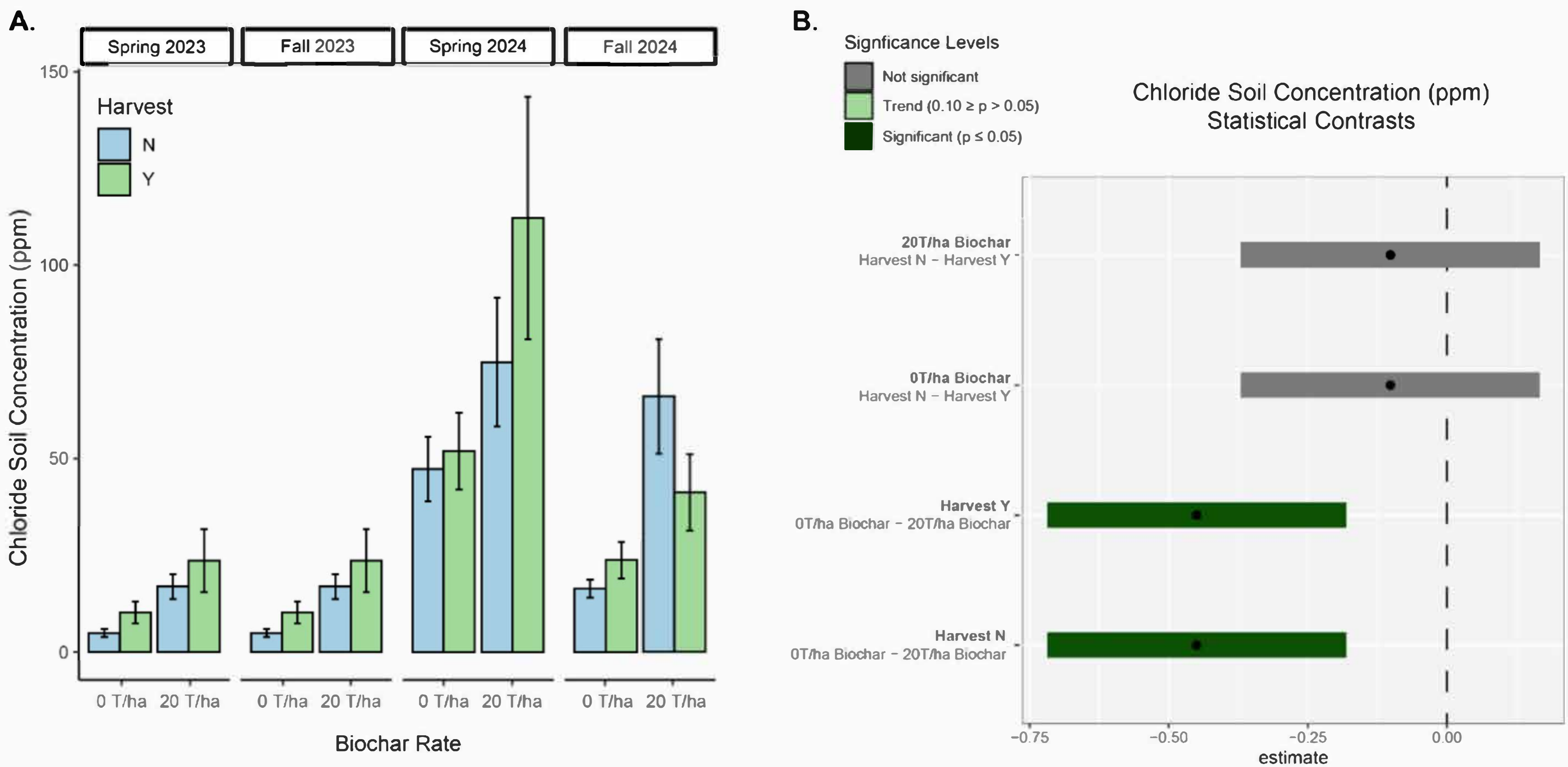


Figure 17: Soil chloride concentration (ppm) in biochar treatments and harvest treatments for 4 IL Tollway bioswales.

Biochar Sorption Time–series in Bioswales

Figure 18: For Task C, large 35 lb biochar sacks were deployed at the end of each bioswale block. Biochar bags will be sampled in five times (AUG 2023, NOV 2023, MAR 2024, SEP 2024, and OCT 2024) to investigate biochar chemical surface adsorption.

Significant Increase in Cl^- ppm w/ biochar time–series

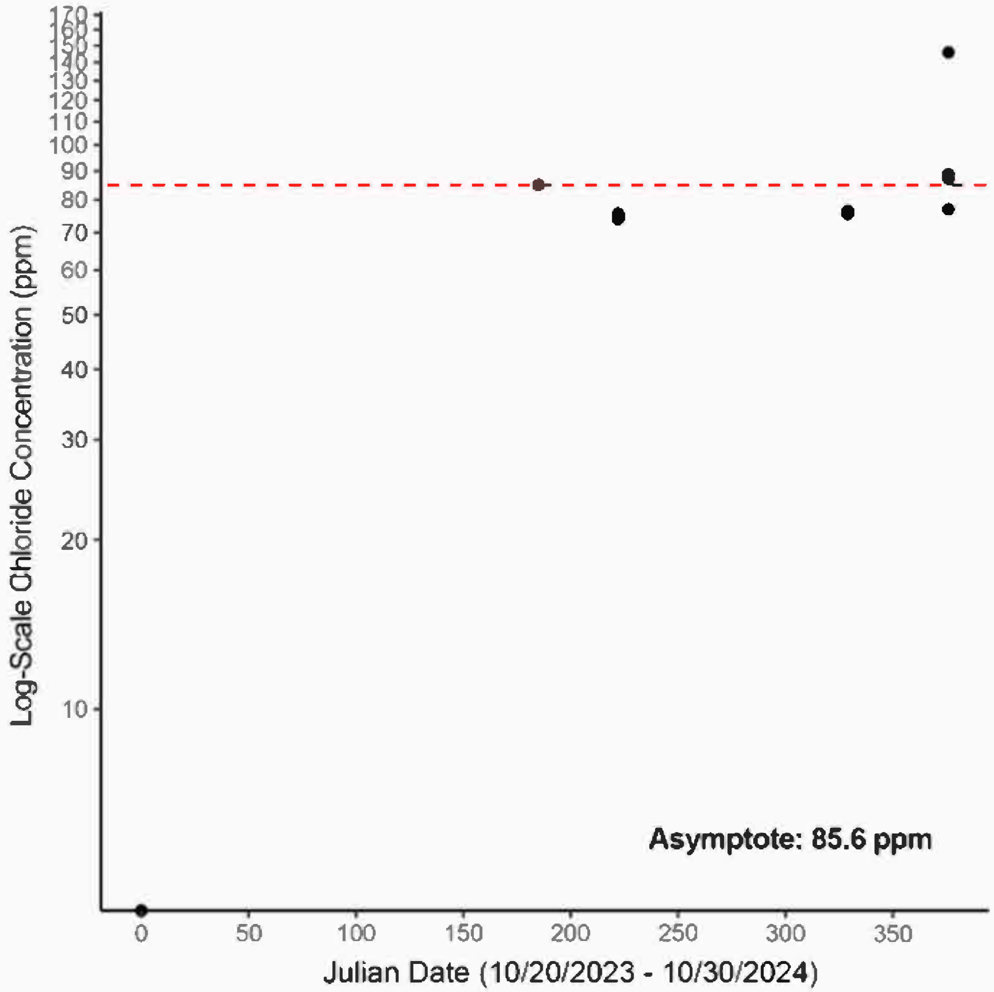


Figure 19: Extractable chloride ions (ppm) for biochar bag saturation curve (replication = 4) deployed in the four bioswales during the experiment. Note the log-scale on the y-axis. Asymptote value estimated by linear mixed effects model average between 10/20/2023 (Day 0) to 10/30/2024 (Day 376).

Thank You MWRD 2025!

Conclusions and reflections ...

Loyola University Chicago

School of Environmental Sustainability

Brian Ohsowski

email: bohsowski@luc.edu