The Relation of Microbial Biomass Carbon with Denitrification and Nutrient Retention in Restored Floodplain Wetlands

Shrijana Duwadi[1], Robert. S. Brown[1]. Spencer G. Womble[1], Justin N. Murdock[1]

[1] Aquatic Ecology Laboratory, Department of Biology, Tennessee Technological University, Cookeville, Tennessee

Introduction

- Restoration activities have been implemented in the lower Mississippi River basin through the Wetlands Reserve Program (WRP) to enhance essential functions by restoring wetlands.
- Soil can be a significant nutrient sink in wetlands through sequestration and transformations by the soil microbial community; however, our understanding of how soil microbial function recovers during wetland restoration is lacking.
- **Objective**: Assess the relationship between soil microbial biomass and nutrient removal in restored riparian wetlands in western Kentucky.
- **Hypothesis**: Soil nutrient retention and denitrification in restored wetlands will increase with greater microbial biomass carbon (MBC).

Materials and methods

- Thirty sediment cores each were collected from dominant habitats in each of two restored wetlands in western Kentucky in the summer of 2020.
- Sediment cores were incubated and dosed with elevated nitrogen (N) and phosphorus (P) water to estimate maximum potential nutrient retention and denitrification rates.
- Soil nitrate and phosphate uptake rates, and denitrification potential were measured at ~ 6, 24, and 48 hours after incubation.

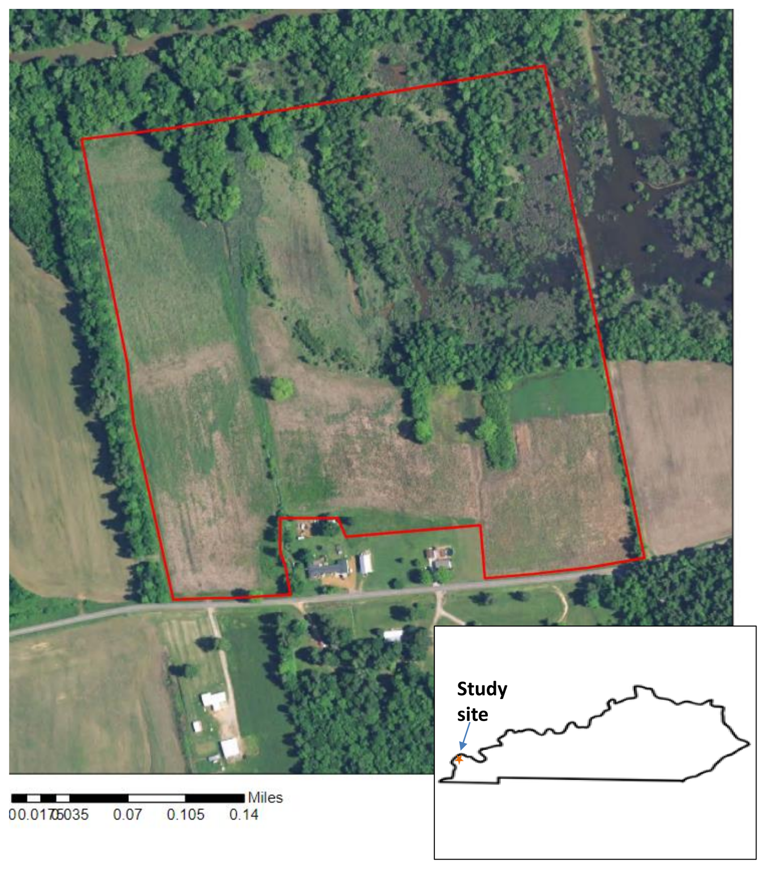

Figure 1. Imagery of a WRP easement in western Kentucky. Red outline indicate easement boundary.

Figure 2. a) Sediment core collection, b) incubation flow through system.

- MBC was determined for top 10 cm by chloroform fumigation-extraction and quantified by assessing the amount of carbon available in the living microorganisms present in the top 10 cm of soil (Horwart and Paul, 1994; Vance et al., 1987).

Figure 3. a) A core section, b) chloroform fumigation, and c) samples subjected to shaking for dissolved carbon extraction.

Results

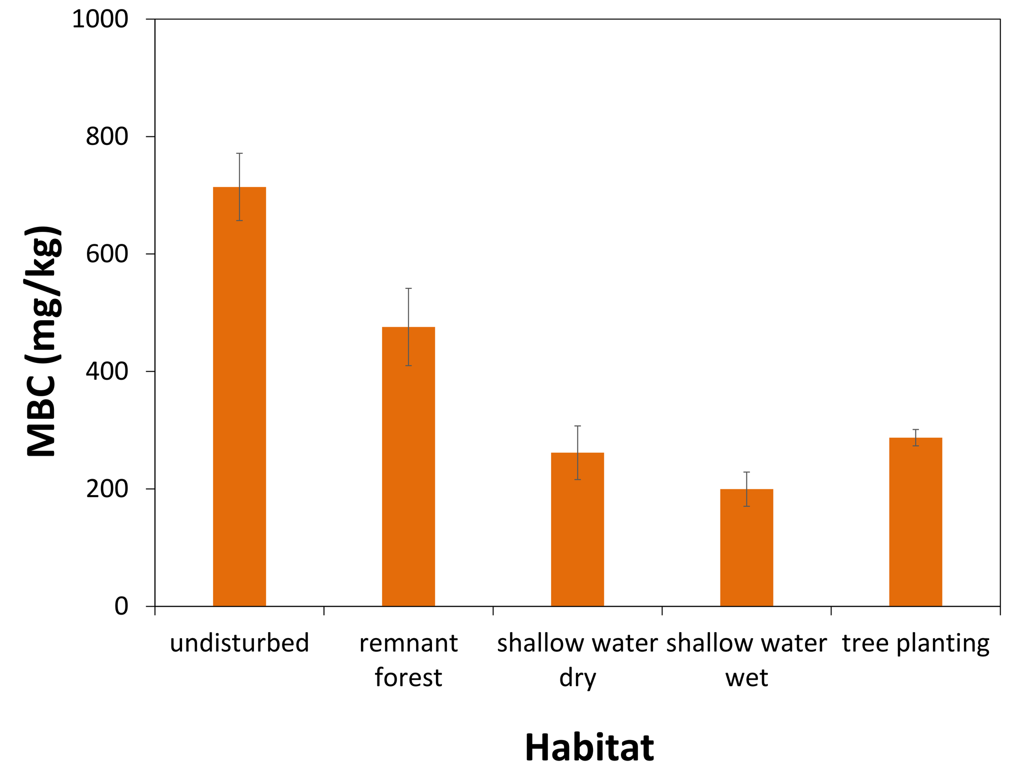

Fig 4. Mean value of MBC across different habitats. Error bars represent standard error of the mean.

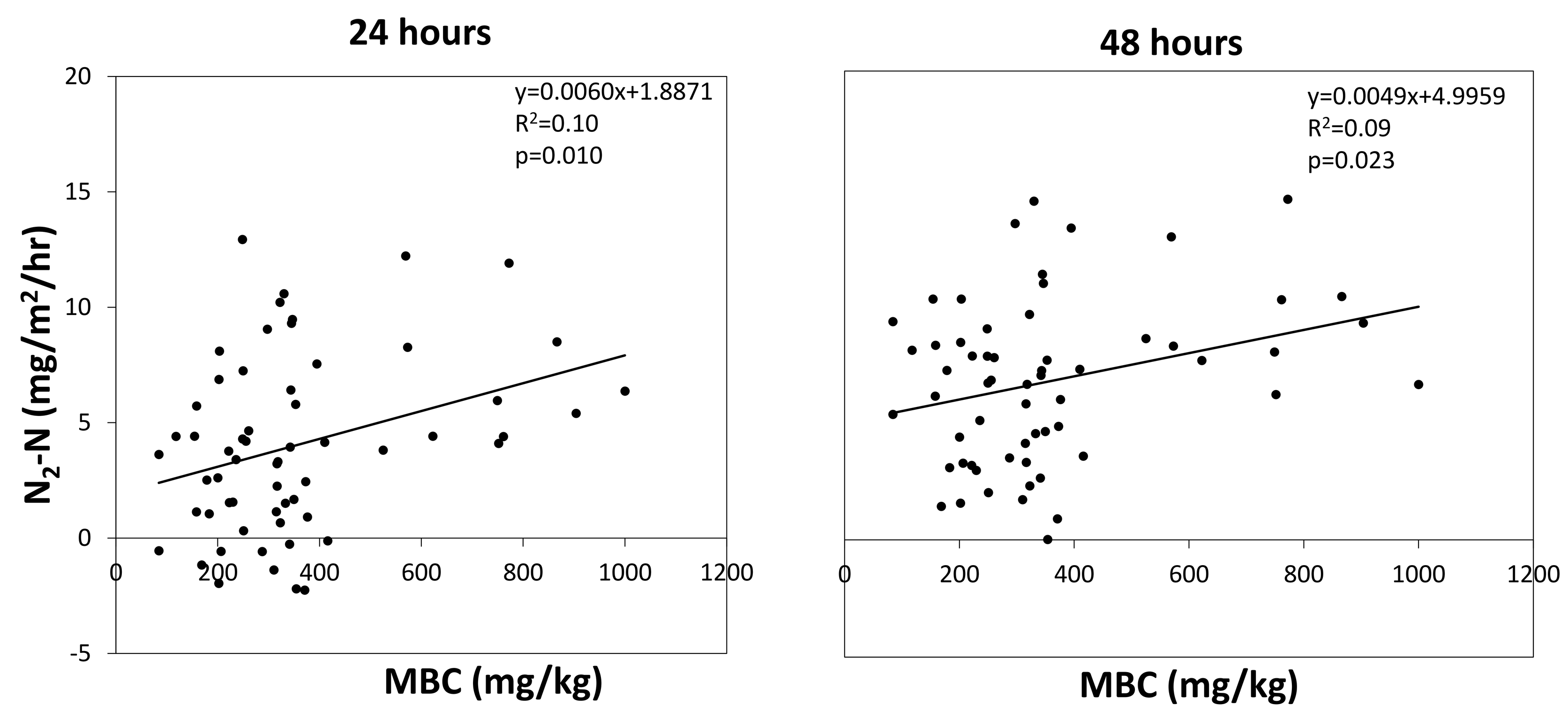

Fig 5. Bivariate fit of potential denitrification rates by MBC at 24 and 48 hours after incubation, respectively.

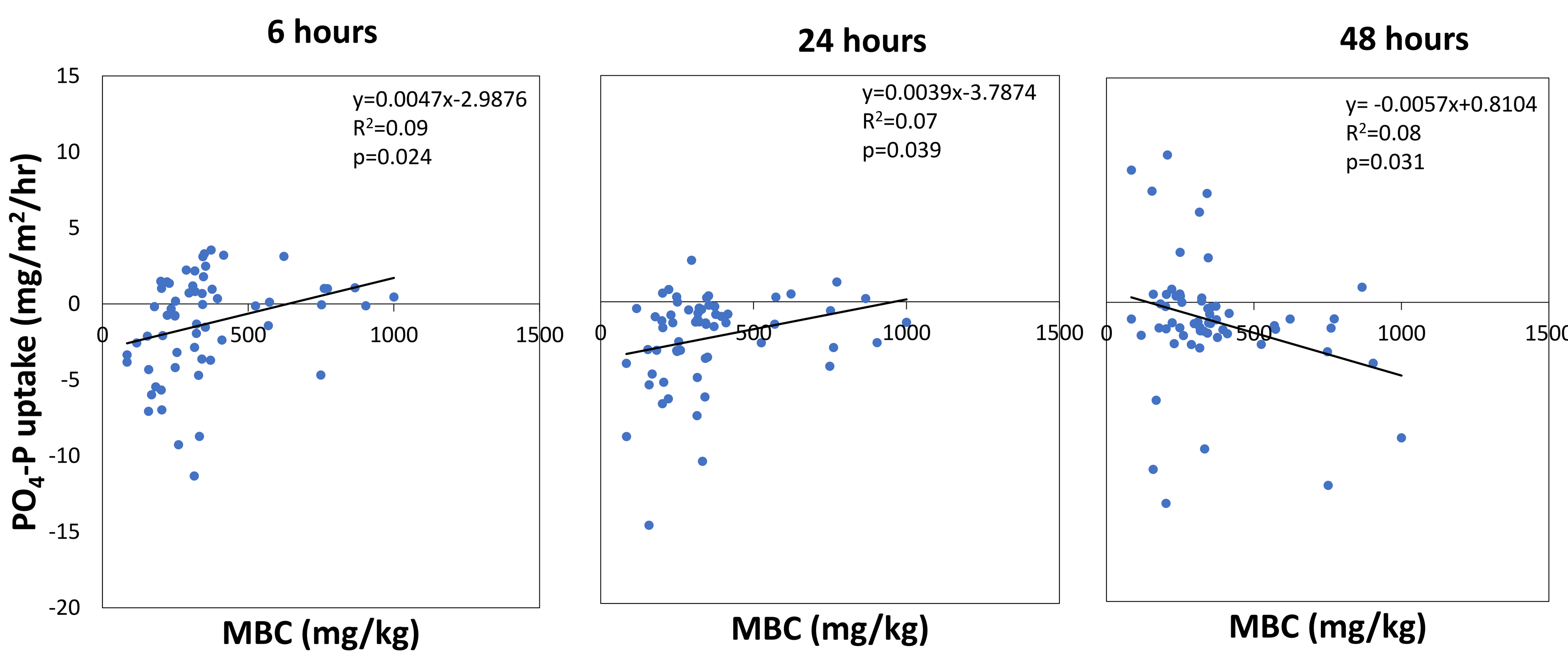

Fig 6. Bivariate fit of PO_4-P uptake by MBC at 6, 24, and 48 hours after incubation, respectively. Negative value means release of nutrient into the water.

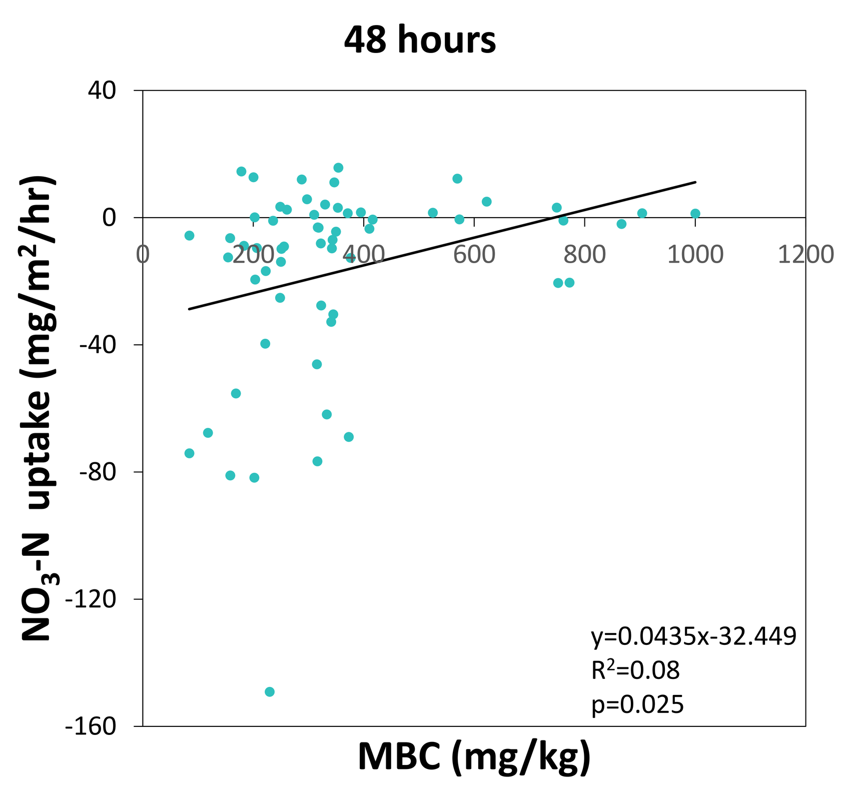

Fig 7. Bivariate fit of NO_3-N uptake by MBC at 48 hours after incubation. Negative value means release of nutrient into the water.

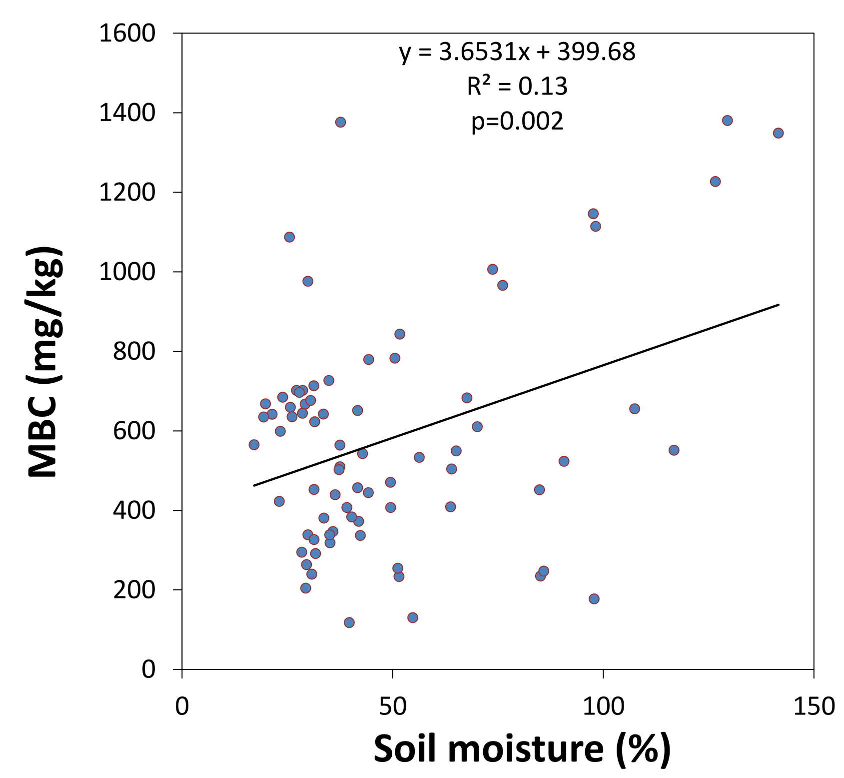

Fig 8. Bivariate fit of MBC by soil moisture.

Summary

- MBC was highest in undisturbed habitat, followed by remnant forest, and lowest in the shallow water areas.
- MBC was strongly correlated with denitrification rates at 24 ($p=0.0104$) and 48 hours ($p=0.0232$) after incubation.
- MBC was also strongly correlated with PO_4-P uptake ($p=0.0239$, 0.0389, and 0.0315) at 6, 24 and 48 hours after incubation, respectively, with NO_3-N uptake ($p=0.0248$) at 48 hours after incubation, and with soil moisture ($p=0.0017$).
- Increasing total soil microorganism biomass may be an important indicator for monitoring improvements in ecological functions in restored wetlands, with potentially important long-term consequences for denitrification and nutrient retention.

Future work:

- Continue sediment core collection to understand role of time since restoration activities in microbe abundance and nutrient removal.
- Evaluate the role of plants and root-zone microbes in belowground nutrient retention.

Literature cited

- Horwart W.R., and Paul, E.A. (1994). Microbial biomass. Methods of soil analysis: Part 2—Microbiological and biochemical properties. Soil Science Society of America, 753-773.
- Vance, E.D., Brookes, P.C., and Jekinson, D.S. (1987). An extraction method of measuring soil microbial biomass carbon. Soil Biology and Biochemistry, 703-707.