THE OHIO STATE UNIVERSITY / COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES / SCHOOL OF ENVIRONMENT AND NATURAL RESOURCES

The Role of Taxonomic Verses Functional Macroinvertebrate Diversity as Indices of Nutrient Pollution in Ohio Streams

Krystal Pocock[1], Dr. Lauren M. Pintor[1] & Dr. Mazeika Sullivan[1]

[1)] OSU, School of Environment & Natural Resources

INTRODUCTION

- Converting land from forested to agricultural and/or urban use increases the amount of runoff entering a watershed [1,3,4].
- Runoff carries nutrients directly to streams[2,8,9].
- Excessive nutrients can lead to nuisance algae in streams and harmful algal blooms in larger bodies of water[2,8,9].
- Water quality monitoring provides a "snapshot" of conditions at a single point in time[5].
- Macroinvertebrates are excellent indicators of water quality due to sensitivity to environmental stressors and can more accurately depict the stress a stream system is experiencing over a period of time[5,8].
- Taxonomic and functional indices are often used to quantify macroinvertebrate biodiversity[2,6,7].
- Functional indices have a greater ability to explain the relationship between environmental stressors and macroinvertebrate community composition due to a trait-based approach[2,6,7].

Image 1. Nuisance algae at a study site in Indian Lake watershed.

OBJECTIVES

1. To compare nutrient concentrations and macroinvertebrate biodiversity in streams from three watersheds of differing land use type (e.g., agricultural, mixed use, forested).
2. To quantify and compare estimates of taxonomic and functional diversity of aquatic macroinvertebrates across watersheds of differing land use.

METHODS

STUDY SITES

- Indian Lake
- Hoover Reservoir
- Burr Oak

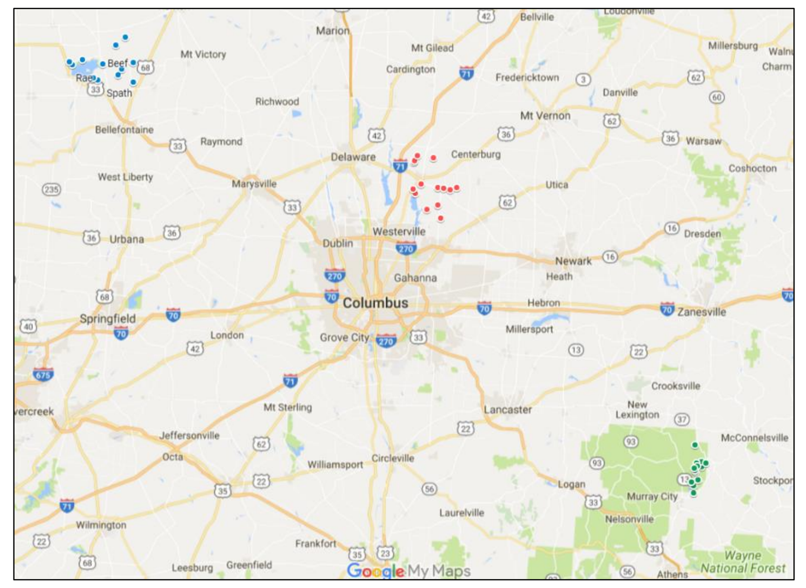
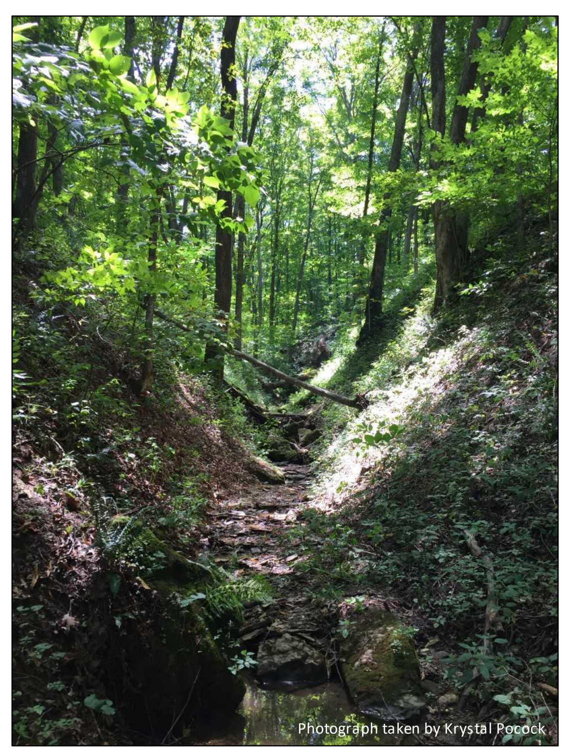


Image from Google Maps.



Clockwise, beginning at top left:
Image 2. Hoover Reservoir- mixed use.
Image 3. Indian Lake- agricultural.
Image 4. Burr Oak- forested.

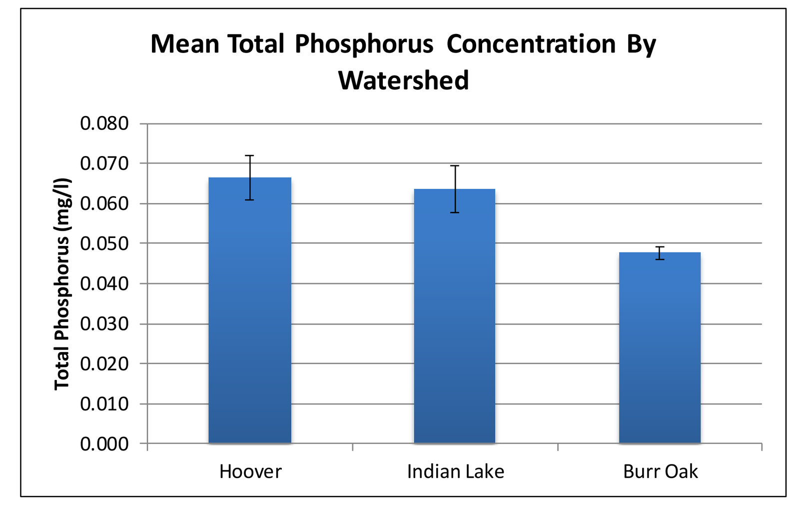
MACROINVERTEBRATE COLLECTION

- Surber samplers, riffle habitat – 90 seconds of effort
- Eckman samplers, no riffle habitat available for sample
- Preserved using 70% ethanol solution.

WATER QUALITY COLLECTION

- Grab water samples were taken at each site in acid washed plastic bottles, placed on ice and frozen upon return to the laboratory.
- Analyzed for total nitrogen and total phosphorus (mg/l).

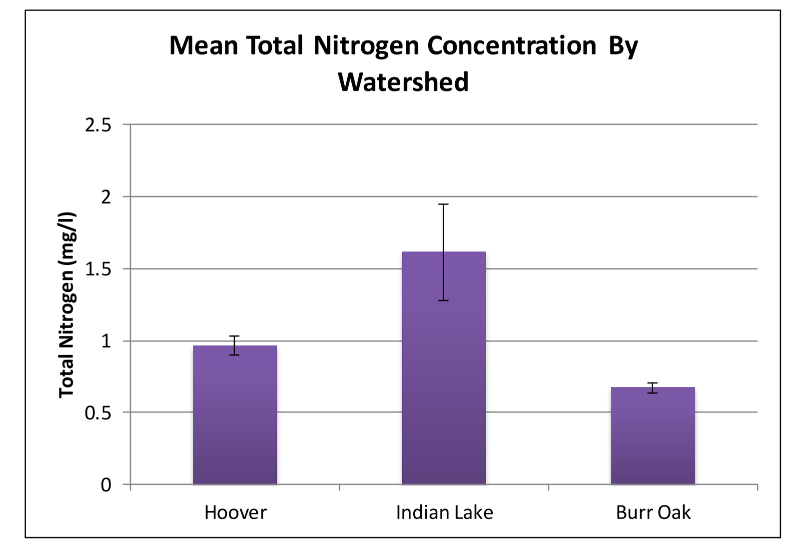
PRELIMINARY RESULTS



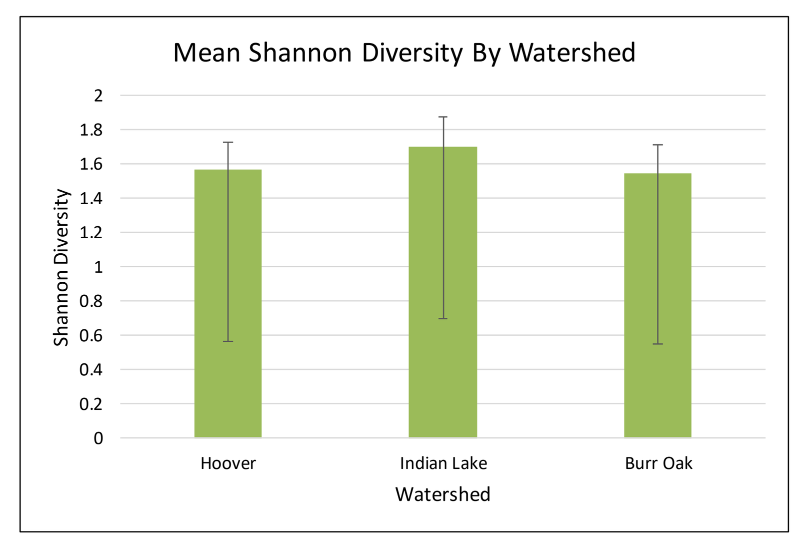
Hoover Watershed- Mean: 0.066, n = 11, SD: 0.018, SE: 0.006. Indian Lake Watershed- Mean: 0.064, n = 11, SD: 0.019, SE: 0.006. Burr Oak Watershed- Mean: 0.048, n = 6, SD: 0.004, SE: 0.0.002.

Figure 1 (left). Mean Total Phosphorus Concentrations By Watershed (mg/l).

Figure 2 (right). Mean Total Nitrogen Concentrations By Watershed (mg/l).



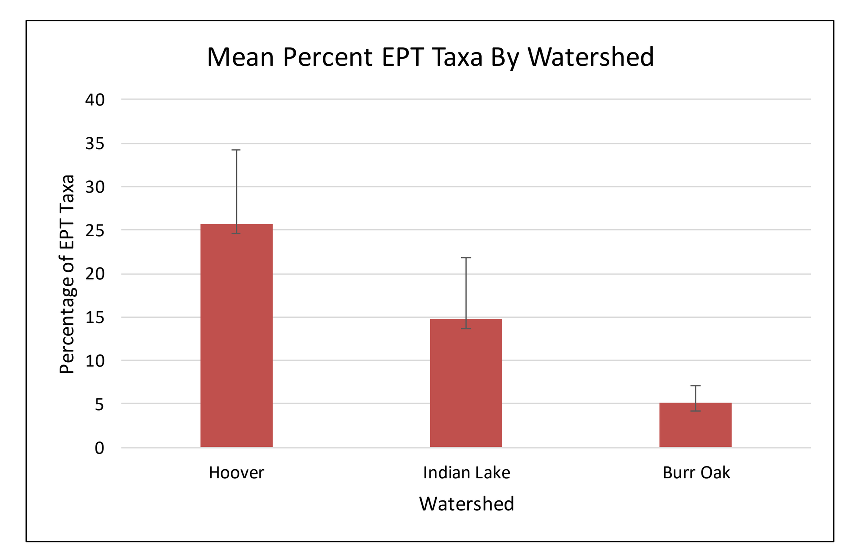
Hoover Watershed- Mean: 0.964, n = 11, SD: 0.214, SE: 0.064. Indian Lake Watershed- Mean: 1.615, n = 11, SD: 1.113, SE: 0.336. Burr Oak Watershed- Mean: 0.674, n = 6, SD: 0.088, SE: 0.036



Hoover Watershed- Mean: 1.567, n = 11, SD: 0.529, SE: 0.159. Indian Lake Watershed- Mean: 1.698, n = 11, SD: 0.595, SE: 0.179. Burr Oak Watershed- Mean: 1.546, n = 6, SD: 0.398, SE: 0.0.162

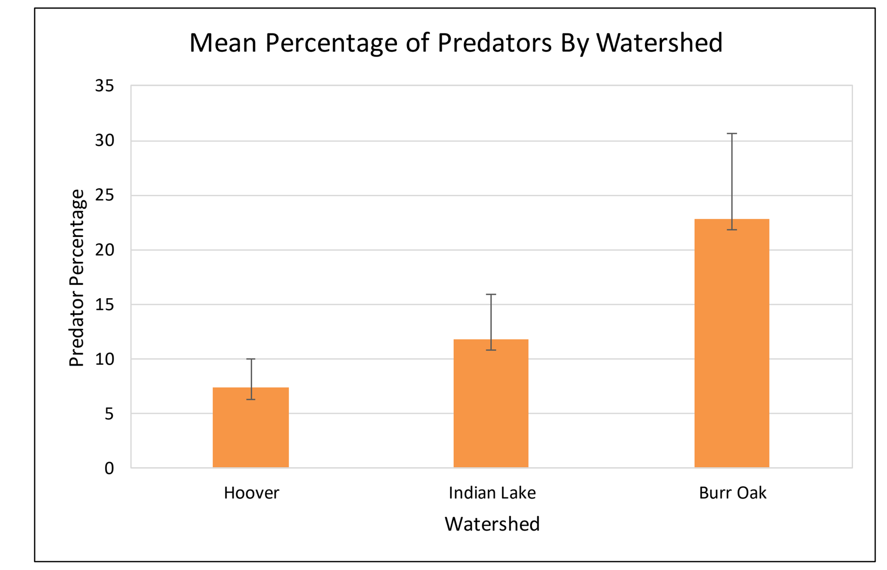
Figure 3 (right). Mean Shannon Diversity By Watershed.

Figure 4 (left). Mean Percentage of EPT (Ephemeroptera, Plecoptera, Trichoperta) Taxa.



Hoover Watershed- Mean: 25.645, n = 11, SD: 28.571, SE: 8.615. Indian Lake Watershed- Mean: 14.700, n = 11, SD: 23.488, SE: 7.082. Burr Oak Watershed- Mean: 5.167, n = 6, SD: 4.830, SE: 1.972

Figure 5 (right). Mean Percentage of Predator Taxa Per Watershed.



Hoover Watershed- Mean: 7.355, n = 11, SD: 8.982, SE: 2.708. Indian Lake Watershed- Mean: 11.855, n = 11, SD: 13.612, SE:4.104. Burr Oak Watershed- Mean: 22.867, n = 6, SD: 18.944, SE: 7.733

DISCUSSION

Preliminary analyses suggest that nitrogen and phosphorus concentrations are highest in Indian Lake and Hoover watersheds and lower in Burr Oak watershed (Figures 1,2). Taxonomy-based indices (e.g. Shannon Diversity) do not appear to vary considerably across all three watersheds (Figure 3). Mean percentage of EPT taxa appear highest in Hoover watershed and lowest in Burr Oak watershed, which differs from expectations of this metric based off of primary land use in each area (Figure 4). In contrast, Burr Oak watershed has a higher percentage of predators taxa than Hoover and Indian Lake Watersheds (Figure 5).

FUTURE DIRECTION

Additional analyses are underway to examine and compare additional taxonomic, functional and trait-based metrics. Next, we will examine correlations between macroinvertebrate diversity indices and nutrient (TP and TN) concentrations to investigate variability among stream reaches both within and across watersheds. Data from Qualitative Habitat Index Evaluations (QHEI) will be explored along with stream velocity measurements in an attempt to understand whether variability in diversity metrics may also be explained by physical characteristics of stream reaches.

BIBLIOGRAPHY

1. Camargo, J. A., Alonso, A., & De La Puente, M. (2004). Multimetric Assessment of Nutrient Enrichment in Impounded Rivers Based on Benthic Macroinvertebrates. *Environmental Monitoring and Assessment*, *96*(1–3), 233–249. https://doi.org/10.1023/B:EMAS.0000031730.78630.75
2. Delong, M. D., & Brusven, M. A. (1998). Macroinvertebrate Community Structure Along the Longitudinal Gradient of an Agriculturally Impacted Stream. *Environmental Management*, *22*(3), 445–457. https://doi.org/10.1007/s002679900118
3. Johnson, R. C., Jin, H.-S., Carreiro, M. M., & Jack, J. D. (2013). Macroinvertebrate community structure, secondary production and trophic-level dynamics in urban streams affected by non-point-source pollution: Macroinvertebrate response to urban non-point-source pollution. *Freshwater Biology*, *58*(5), 843–857. https://doi.org/10.1111/fwb.12090
4. Smith, A. J., Bode, R. W., & Kleppel, G. S. (2007). A nutrient biotic index (NBI) for use with benthic macroinvertebrate communities. *Ecological Indicators*, *7*(2), 371–386. https://doi.org/10.1016/j.ecolind.2006.03.001
5. Song, M.-Y., Leprieur, F., Thomas, A., Lek-Ang, S., Chon, T.-S., & Lek, S. (2009). Impact of agricultural land use on aquatic insect assemblages in the Garonne river catchment (SW France). *Aquatic Ecology*, *43*(4), 999–1009. https://doi.org/10.1007/s10452-008-9218-3
6. Vandewalle, M., de Bello, F., Berg, M. P., Bolger, T., Dolédec, S., Dubs, F., … Woodcock, B. A. (2010). Functional traits as indicators of biodiversity response to land use changes across ecosystems and organisms. *Biodiversity and Conservation*, *19*(10), 2921–2947. https://doi.org/10.1007/s10531-010-9798-9
7. Verberk, W. C. E. P., van Noordwijk, C. G. E., & Hildrew, A. G. (2013). Delivering on a promise: integrating species traits to transform descriptive community ecology into a predictive science. *Freshwater Science*, *32*(2), 531–547. https://doi.org/10.1899/12-092.1
8. Wallace, J. B., & Webster, J. R. (1996). The Role of Macroinvertebrates in Stream Ecosystem Function. *Annual Review of Entomology*, *41*(1), 115–139. https://doi.org/10.1146/annurev.en.41.010196.000555
9. Wang, L., Robertson, D. M., & Garrison, P. J. (2007). Linkages Between Nutrients and Assemblages of Macroinvertebrates and Fish in Wadeable Streams: Implication to Nutrient Criteria Development. *Environmental Management*, *39*(2), 194–212. https://doi.org/10.1007/s00267-006-0135-8

ACKNOWLEDGEMENTS

Many thanks to my advisor and mentor, Dr.. Lauren Pintor of The Ohio State University's School of Environment and Natural Resources, for her continued support, guidance, and patience throughout the research process. Thanks also goes to Dr. Kay Stefanik for help with data collection, logistics, and advice. Thanks to The Office of Undergraduate Research and Creative Inquiry for providing me with a Summer Undergraduate Research Fellowship which allowed the project to be completed. Thanks also goes to STRIVE and Pintor lab groups for providing the equipment, resources, and laboratory space necessary to complete the project and to The Olentangy River Wetland Research Park for extensive use of the facility and its resources.