Effects of Land Use Type on Abundance and Type of Microplastic Pollution—a Contaminant of Emerging Concern in Indiana Rivers

A research project funded by the Indiana Water Resources Research Center through the U.S. Geological Survey's 104B annual base grants (section 104 of the Water Resources Research Act of 1984, as amended).

Water quality degradation resulting from human activities represents a threat to environmental and human health. Contaminants of emerging concern, including microplastics (plastic particles <5 mm in size), are understudied in flowing waters of the Midwestern USA including in Indiana. Microplastics can enter rivers and streams through a variety of pathways (e.g., wastewater effluent, breakdown of larger plastic debris, atmospheric deposition) and can negatively impact aquatic organisms through both direct consumption with food and indirect contamination from sorbed toxins. This research quantifies the concentration and types of microplastics found in Indiana watersheds representing a gradient of land use (i.e., agricultural, urban, or forested).

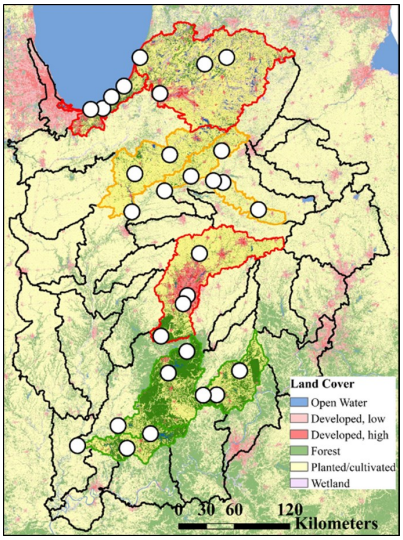

Figure 1. Indiana sampling sites (white circles), watersheds (black outlines), and associated land use. Watersheds outlined in green were targeted primarily as forested watersheds, orange as agricultural watersheds, and red as urban watersheds.

RESEARCH OBJECTIVES

1. Provide Indiana managers, researchers, and decision-makers with a first-ever baseline measurement of the concentration and types of microplastics in major Indiana waterways.

   Information dissemination of this project's results included presentations at statewide and national water symposia, peer-reviewed manuscript development, and the production of a short informational video available to the public.

2. Determine if microplastic concentration or type vary with land use and longitudinal position in the watershed.

   Three watersheds were selected representing each of three major land-use categories (forested, urban, agricultural). Within each watershed, at least three locations were sampled, generally (1) at the lower confluence of the watershed with a larger river to effectively sample the entire watershed, (2) near the midpoint of the watershed, and (3) in a headwater stream or tributary (control). Physical and chemical water quality parameters were collected along with bulk water samples for microplastic analysis. Microplastics were counted and categorized by type in the laboratory.

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RESEARCHER PROFILE

Principal Investigator Dr. Gary Lamberti is a professor in the Department of Biological Sciences and head of the Stream and Wetland Ecology Laboratory at the University of Notre Dame. He is currently serving as a rotating Program Officer in the Division of Environmental Biology of the National Science Foundation.

MAJOR CONCLUSIONS & SIGNIFICANCE

- This project produced a short informative video entitled, "Tiny Plastics, Big Problem?" available at https://iwrrc.org/projects/.
- Microplastics were found in all river systems sampled and land use did not significantly influence microplastic concentration or types in Indiana waterways.
- Microplastic fibers are dominant and ubiquitous across sampling sites, suggesting that microplastics may predominantly be transported through atmospheric deposition.
- When results from this study were compared to results of similar studies in the Great Lakes and their tributaries, microplastics in the Great Lakes are typically larger pieces, whereas tributaries are dominated by fibers.

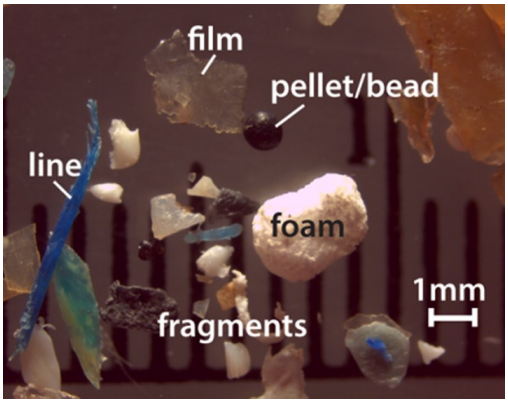

Figure 2. Microscopic images of assorted microplastic particles as characterized by Baldwin et al. 2016 (*Env. Sci. Tech.* 50:10377-10385) for Great Lakes tributaries. "Line" is more commonly referred to as "fiber", the most common microplastic found in our samples.

WHAT DOES THIS MEAN FOR INDIANA?

The sources, pathways, and transport of microplastics remain poorly understood. Our study suggests that atmospheric transport and deposition of fibers may be a hidden source of particulate pollution for inland waters. Further, an emerging public health concern is contaminants that adsorb (hold as a thin layer) to the surface of microplastics that may be transferred up the food web (and potentially to humans via fish consumption) or degrade municipal water quality. While recent legislation has banned the use of plastic microbeads in cosmetics (Microbead-Free Waters Act of 2015, H.R. 1321), microplastics will continue to exist in and impact our waterways due to their multiple sources, mobility, and persistence.

TRAINING THE NEXT GENERATION

One of the missions of the Indiana Water Resources Research Center, and all Water Centers, is to train the next generation of water scientists. This project successfully funded research for two Ph.D. students within Dr. Lamberti's lab and trained three undergraduate researchers and two high school students.

For more information about this project, visit iwrrc.org.

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