Talking SHIF: Human Impact on Creek Health (59-24)

Cora Paul, Clare Bunton, Jovaughn Carver, Kathy Garneau, Keelin A. Markou, Diamond Norlien, Brianna Salome, Steve Bertman, Steve Kaczmarek, Heather Petcovic, Lauri E. Mackelburg-Davis

Introduction

Human activity can have detrimental effects on freshwater ecosystems (Zhang, 2020). Given the importance of freshwater to human health, understanding water quality, and factors that influence it, is necessary to properly manage this resource. Stream health can be assessed in various ways, including macroinvertebrate populations (EPA, 2016), chemical concentrations, and the habitat structure surrounding the water source (Doi, 2013). Multiple sources contribute to chemically unbalanced freshwater ecosystems, including non-point agricultural, industrial, and urban runoff (EPA, 2017; KRWC, 2021). Work by previous *Pathways to Science Teaching* student cohorts suggest that water chemistry and macroinvertebrate populations vary with location along Portage Creek (Kalamazoo County), and that observed variation may be related to land use. Doi (2013) studied 109 river systems in Japan, concluding that areas with increased human interactions showed a decrease in river health and biodiversity.

The current study examines how chemical parameters and macroinvertebrate diversity vary with land use across nine tributaries of the Kalamazoo River. **The hypotheses tested are:**

- **More human impact on the land use along a river results in a greater decrease of macroinvertebrate biodiversity.**
- **More human impact on land use along a river results in a greater decrease of pollution-sensitive macroinvertebrates.**
- **More human impact on land use along a river will increase observed changes in pH and conductivity.**

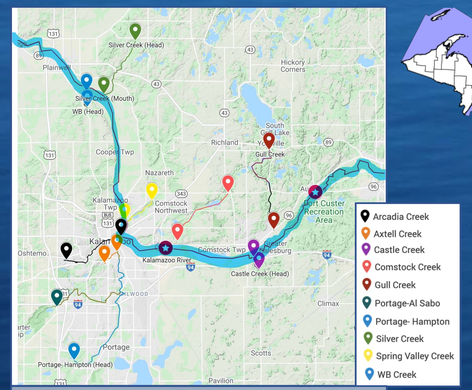


Figure 1. Sampling locations within the Kalamazoo River watershed.

Methods

Overview

The river health of nine tributaries of the Kalamazoo River with a variety of different land uses from rural to urban were investigated from 5/24/21-6/4/21 (Figure 1).

Scaled Human Impact Factor (SHIF)

GIS software using land use zoning data in Kalamazoo County was used to create screenshots (.56 mi x .56 mi) of each creek from the headwaters to the mouth. The percentage of each zoning category was estimated from each screenshot. An impact value was generated for each category:

- Parks/Conversations = 10
- Agriculture = 20
- Government = 50
- Residential = 60
- Commercial = 70
- Industrial = 95

A numerical, Scaled Human Impact Factor (SHIF) for each creek was calculated by multiplying the impact value by the zoning percentage (Figure 2).

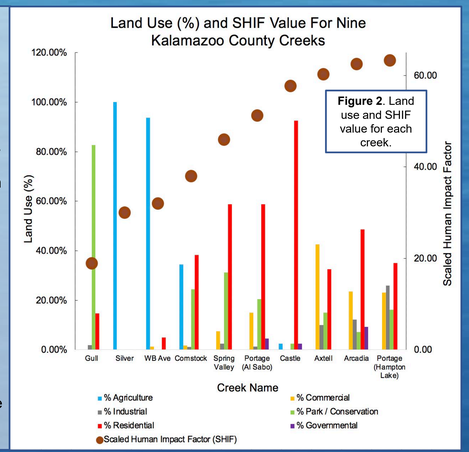


Figure 2. Land use and SHIF value for each creek.

Figure 3. Photographs of fieldwork at the mouth of Portage Creek. A. Macroinvertebrate collection. B. Water chemistry testing. C & D. Macroinvertebrate identification.

Water Chemistry

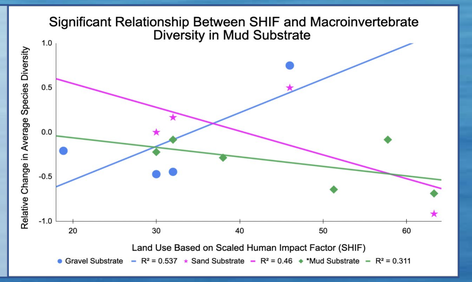
Two PC-60 multi-parameter testers (Apera) were used to determine average (N=3) pH, conductivity (mS/cm), TDS (ppm), salinity (ppt), and temperature (C). (Figure 3).

Macroinvertebrates

Standardized samples (N=3) of each identifiable substrate (gravel, sand, mud) at each site were collected by dragging a .43 m long net. Individual species were identified and populations of each species found were estimated as follows: if 1-10 individuals = exact number, < 50 = 35 individuals, > 50 = 75 individuals, > 100 = 150 individuals. (Figure 3).

Results

Figure 4. Scatterplot demonstrating the relationship between the relative change in average species diversity and land use based on SHIF for various substrates. A relative change was calculated from the headwaters to mouth of creeks with comparable substrates. *The slope of the trendline for the mud substrate was significantly different from zero [$F_{(1,5)}$14.92; p<0.05].



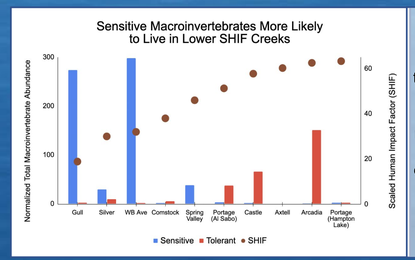
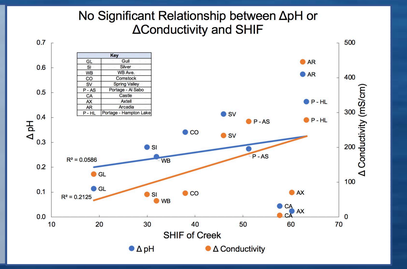


Figure 5. Graph demonstrating the total number of sensitive and tolerant macroinvertebrates found at the mouth and headwaters of nine Kalamazoo County creeks, normalized by samples taken based on the substrate types found at each location. Creeks are organized in order of least human impacted to most human impacted, from left to right, using SHIF.

Figure 6. Graph demonstrating the change in pH and the change in conductivity for nine Kalamazoo County creeks in order of increasing numerical SHIF from left to right. Standard deviation for testing: pH is +/- 0.197 and conductivity is +/- 69.397.



Conclusions

There is no statistically significant relationship between land use along a creek and change in macroinvertebrate biodiversity in gravel and sand substrates. There is a significant relationship between land use along a creek and change in macroinvertebrate biodiversity in mud substrate ($F_{(1,5)}$14.92; p<0.05).

A higher number of sensitive macroinvertebrates are found in rivers associated with lower SHIF values. Additionally, a higher number of tolerant macroinvertebrates are found in rivers with higher SHIF values. Together these data suggest a relationship between fewer pollution-sensitive organisms and increased abundance of tolerant organisms with human impacted land use.

There was no significant correlation between human impact on land use and observed changes in pH and conductivity.

Future studies would benefit by replicate sampling at rivers and a more thorough evaluation of land use, possibly by using remotely sensed satellite data. By extending the area studied into other watersheds, a greater range of human impact would be provided.

Figure 7. Group photo of preservice educators and program coordinator at the mouth of Portage Creek.

References & Acknowledgements

References are available on request.

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