Determining Microplastic Concentration in the Water Column in the Spring River Watershed, MO

Author: Tim Peternell
Faculty Mentor: Dr. Teresa Boman, Ms. Melissah Perkins, Dr. Rachel Heth
Department: Biology and Environmental Health
Competition Category: Physical and Biological Science

Introduction

Microplastics are an environmental issue of increasing concern. Microplastics in aquatic environments are harmful to aquatic organisms since they may ingest microplastics because of their small size (Auta et al., 2018). Microplastics may impact humans since microplastics have been found in drinking water (Li et al., 2018). Determining microplastic concentrations is necessary for determining the potential ecological and human impact of microplastics.

This was the first study examining microplastics in the Spring River Watershed, MO. The goal of this study was to determine the baseline concentrations of microplastics in the watershed. This study examined differences in microplastic concentrations between urban/rural and upstream/downstream locations, and the relationship between microplastic concentrations and catchment size, pH, dissolved oxygen (DO), conductivity, and total suspended solids (TSS).

Materials and Methods

Samples were collected at 16 locations throughout the watershed (Figure 1) using a technique used by Dikareva and Simon (2019). Samples were collected using a phytoplankton net. Water was allowed to flow through the net for 20 minutes. After 20 minutes elapsed, the contents of the net were rinsed into glass jars which were capped and double-bagged until processing.

Processing

- Contents of each jar were poured through a 63 µm sieve.
- Contents of the sieve were placed in glass beakers and heated at 60°C until all water was evaporated.
- Organic matter was digested using an aqueous solution of 30% hydrogen peroxide with 20 mL of an aqueous sulfuric acid solution (0.05 M Fe (II) solution, H_2SO_4). The beakers were heated at 75°C until bubbles formed, at which point a reaction occurred. Once the reaction ended, hydrogen peroxide was added 20 mL at a time until the sample reached 200 mL, or all organic matter was removed.
- Samples were vacuum filtered through a 1.2 µm glass fiber filter. The filter was heated at 60°C until dry.
- Filters were examined using a dissecting microscope. Microplastics were determined by shape, size, and color. Particles 5 mm in diameter and smaller were counted.

Statistical Analysis

- T-tests were conducted to test the difference between microplastic concentrations in urban/rural streams and upstream/downstream locations.
- Spearman correlations were used to test the relationship between microplastic concentrations and catchment size, pH, DO, conductivity, and TSS.

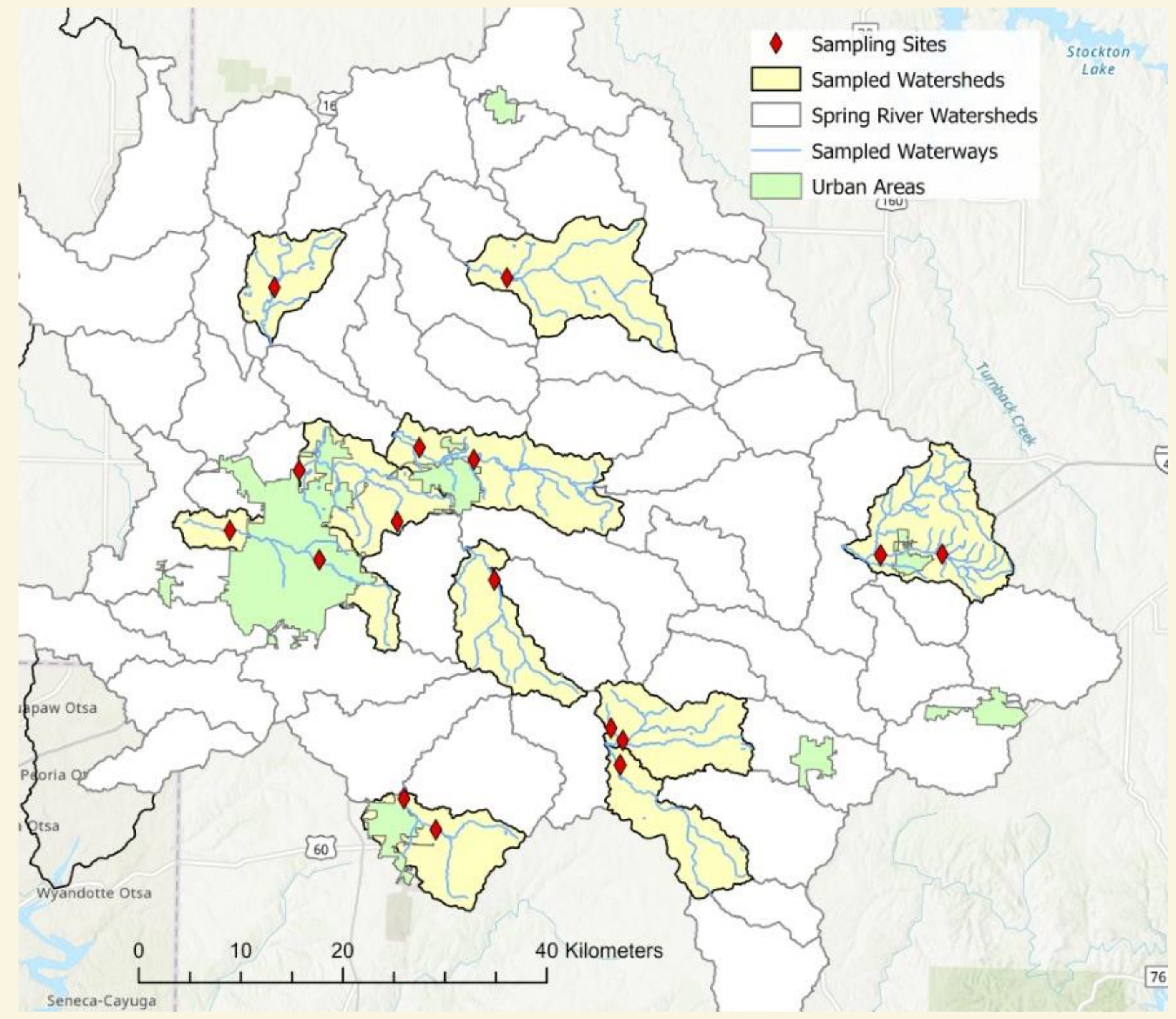

Figure 1: Map of sampling sites, urban areas, and sampled subwatersheds within the Spring River Watershed, MO.

Results

Microplastics were found in all samples, with total particle counts ranging from 2-25 particles. Total microplastic concentrations ranged from 0.3-4.8 particles/m^3.

A total of 146 microplastics were found in all samples. Fibers made up the majority of all microplastics found (Figure 2). Fibers were found in each sample. Black and blue fibers were the most numerous, though other colors such as red and purple were found. Fragments were the second most numerous (Figure 2). All fragments found were blue. Only one film was found in all samples (Figure 2).

The average concentration at urban sites was 2.57 particles/m^3 +/- 1.64, while at rural sites it was 1.88 particles/m^3 +/- 1.51. No significant difference was found (p-value = 0.403). The average concentration at upstream locations was 1.98 particles/m^3 +/- 1.71, while downstream locations was 2.48 particles/m^3 +/- 1.41. No significant difference was found (p-value = 0.63). No significant relationship (p-value > 0.05) was found between catchment size, pH, TSS, DO, and conductivity and microplastic concentrations.

Acknowledgments

Special thanks to Dr. Teresa Boman, Dr. Rachel Heth, and Ms. Melissah Perkins for helping me with this research, and the MSSU Student Research Grant for funding this research. Thank you to Dr. Mary Kilmer for creating the watershed map.

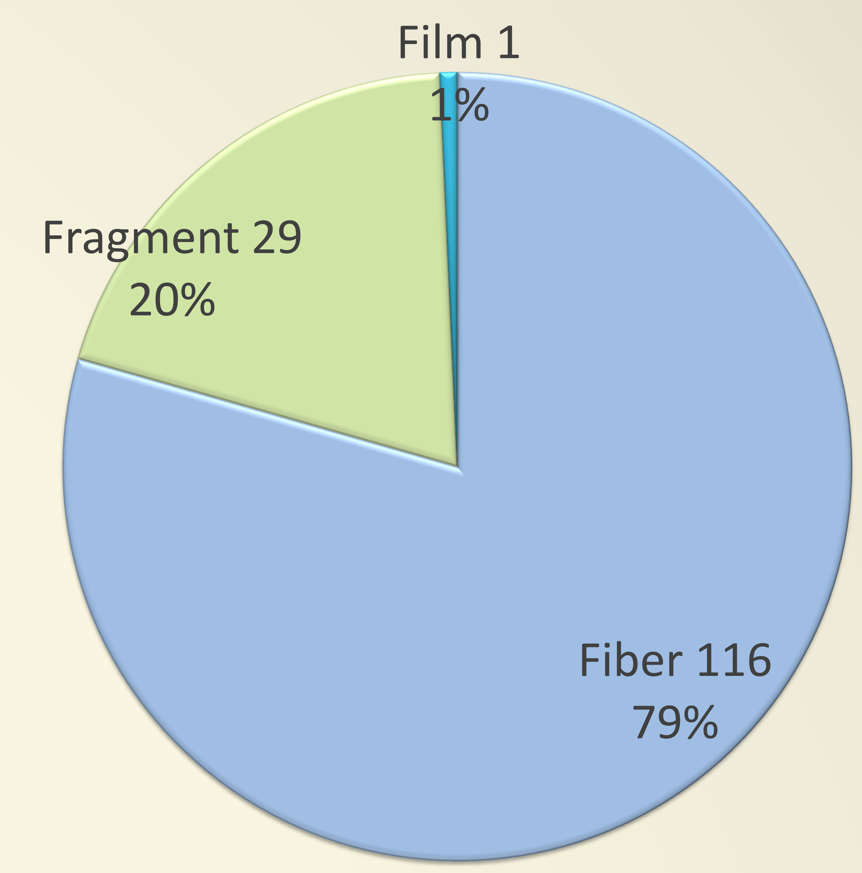

Figure 2: Summary of overall microplastic total organized by type for the microplastic types in the Spring River Watershed, MO.

Conclusions

This study accomplished its goal of determining baseline concentrations of microplastics in the Spring River Watershed, MO. Microplastic concentrations found in the watershed were lower than those found in studies of other waterbodies, though comparison is difficult because of differences in methods and materials. The findings of this study point to a greater need to determine the sources of microplastics in the Spring River Watershed.

Fibers were the most prevalent type of microplastic found. Synthetic clothing is common, and fibers may be released from synthetic clothing when it is washed (Kapp & Miller, 2020). These fibers may enter waterways from wastewater treatment facilities or on-site sewage systems.

Microplastics were found in streams that were expected to be pristine. The existence of microplastics in these streams points to contamination of streams from airborne microplastics and runoff from surrounding soil. These potential sources of microplastics were not examined in this study, though future studies should examine these sources.

Though no significant relationships were found in this study, the goal of this study was accomplished. The findings of this study will aid future researchers who are studying microplastics in the Spring River Watershed.

References

Auta, H., Emenike, C., & Fauziah, S. (2017). Distribution and importance of microplastics in the marine environment: A review of the sources, fate, effects, and potential solutions. *Environment International, 102,* 165-176, doi:10.1016/j.envint.2017.02.013

Dikareva, N., & Simon, K. (2019). Microplastic pollution in streams spanning an urbanisation gradient. *Environmental Pollution, 250*, 292-299. doi: 10.1016/j.envpol.2019.03.105

Kapp, K., & Miller, R. (2020). Electric clothes dryers: An underestimated source of microfiber pollution. *PLoS One, 15,* e0239165, doi: 10.1371/journal.pone.0239165

Li, J., Liu, H., & Chen, J. (2018). Microplastics in freshwater systems: A review on occurrence, environmental effects, and methods for microplastics detection. *Water Research, 137,* 362-374. doi:10.1016/j.watres.2017.12.056