Assessing the Impacts of Varying Concentrations of Microplastics on Freshwater Bacterial Diversity

Eri Nakabayashi

Douglas College EAES 2537

Background Information

In times of unprecedented environmental changes, seen in accelerated rates of biodiversity loss, global climate change, and pollution, microplastics (MP) are becoming a growing concern. Due to their inability to decompose, MP can persist in our ecosystems for potentially thousands of years (Parolini et al., 2023). As the global consumption of plastics continues to increase with little to no sign of decline, so does the discharge of these small fragments of plastic. Ranging anywhere from nanometers to millimeters, it has become the most common form of pollutant found in our aquatic and marine ecosystems (National Oceanic and Atmospheric Administration, 2024). As a significant environmental concern, its effects are being actively researched.

Freshwater ecosystems are vital ecosystems that provide habitats and support various ecological processes. Although microscopic, aquatic bacteria within these lakes play a significant role in the maintenance and vitality of the ecosystem (Dubois, 2024). With most research focused on marine ecosystems, the impacts of MP on freshwater bacterial communities remain understudied.

To provide insight into this valuable and understudied topic, I conducted a study to examine the impact of varying low-density polyethylene (LPDE) concentrations, from single-use plastics, on freshwater bacterial community composition. A controlled experiment quantified the alterations.

Hypothesis and Prediction

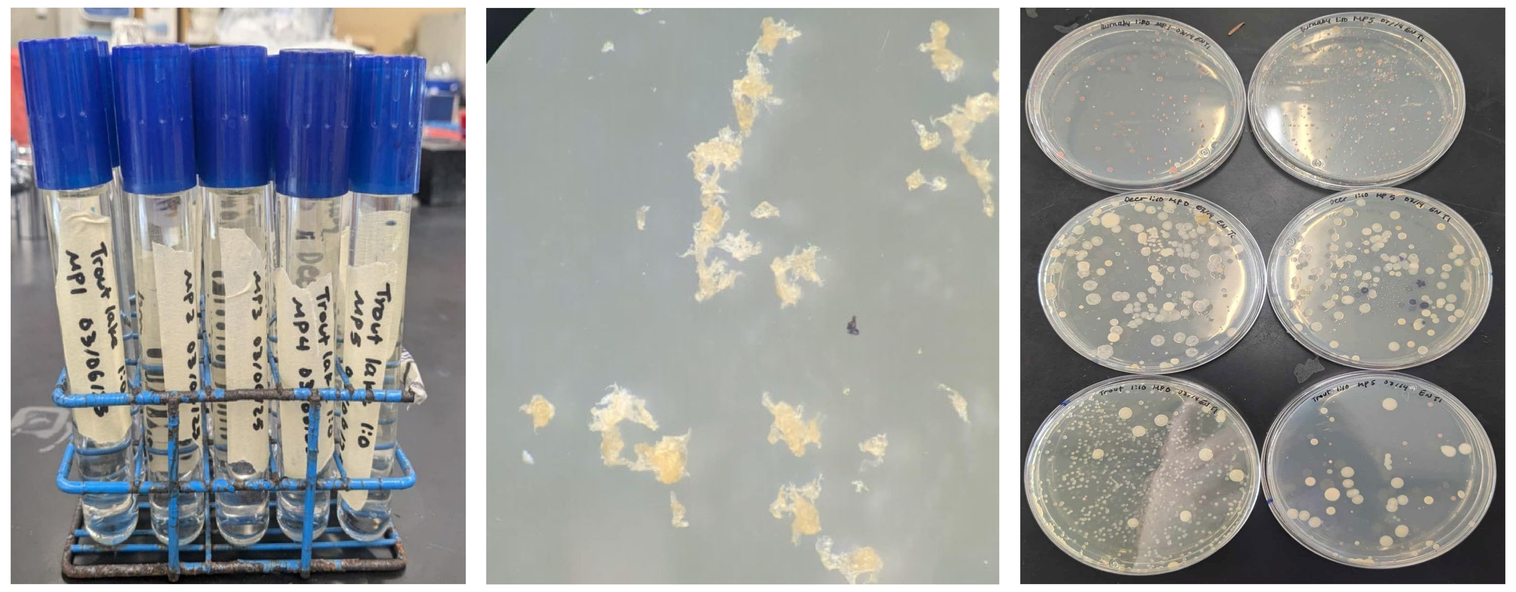
Two hypotheses were tested during this study:

- **Evaluate if varying concentrations of microplastics influence freshwater bacterial community composition.**
- **Observe how the effects of MP alter over time.**

Based on previous studies and research from marine environments, I predict increased MP concentrations will decrease bacterial diversity, abundance, and richness in freshwater ecosystems, and that these effects will continue over time.

Methodology

Freshwater samples from three locations were treated with varying LDPE concentrations. T2 treatments were independent of T1. Following an assimilation period of a week, samples were plated and incubated for a week, and bacterial colonies were counted and characterized by morphology. To determine changes due to LDPE and account for background MP, initial colony counts from the raw sample were subtracted from T1 and T2 counts. Data was collected for change in colony richness, abundance, and diversity.



Figures 1-3: From left to right,
1) The three lake samples, each divided into six test tubes to be exposed to MP. 2) The size of the LDPE MP as seen under a dissection microscope (≈200 μm). 3) Time zero plates taken from the raw samples with no manipulation, diluted to a 1:1 and 1:10 with distilled water.

Results

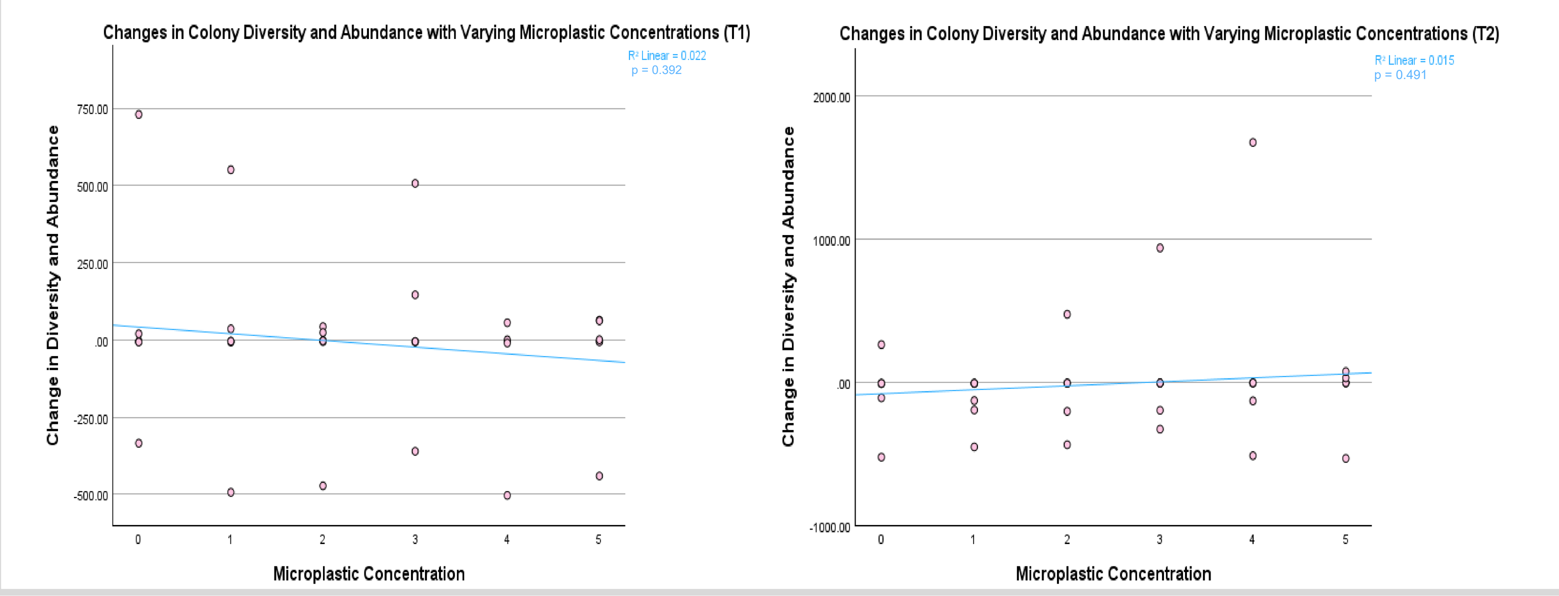


Figure 4 and 5: From left to right,
Two scatterplots illustrating the overall relationship between MP concentrations and bacterial colony abundance and diversity. Both p-values are under the alpha and therefore not statistically significant 4) T1 data with a line of best fit revealing a weak positive trend (p = 0.392). 5) T2 data with a contrasting line of best fit indicating a weak positive trend (0.491).

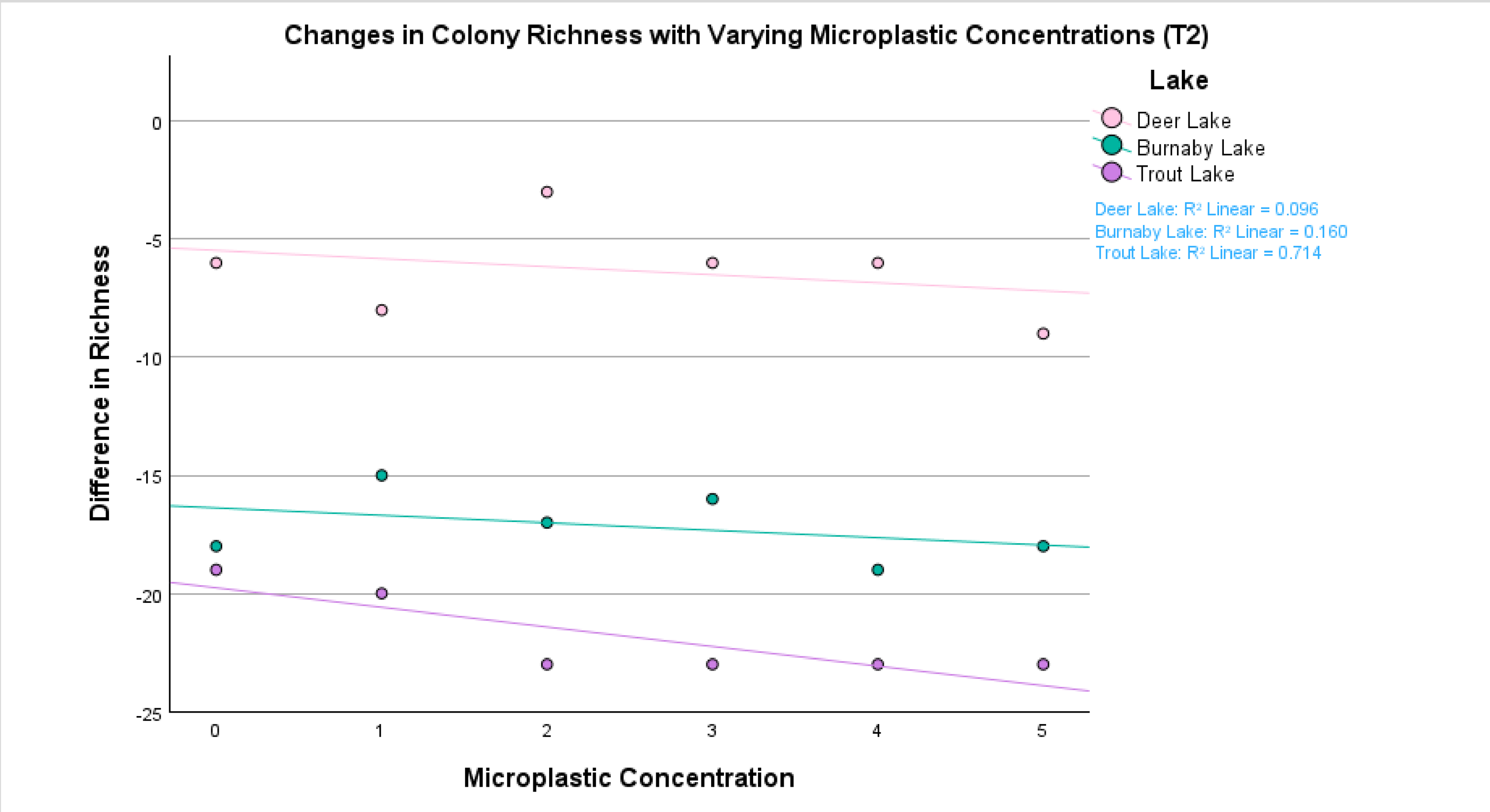


Figure 6: A scatterplot illustrating the relationship between MP concentrations and bacterial richness for three lakes, indicated by color. All lines of best fit indicate varying negative relationship, strongest in Trout Lake (p=0.034).

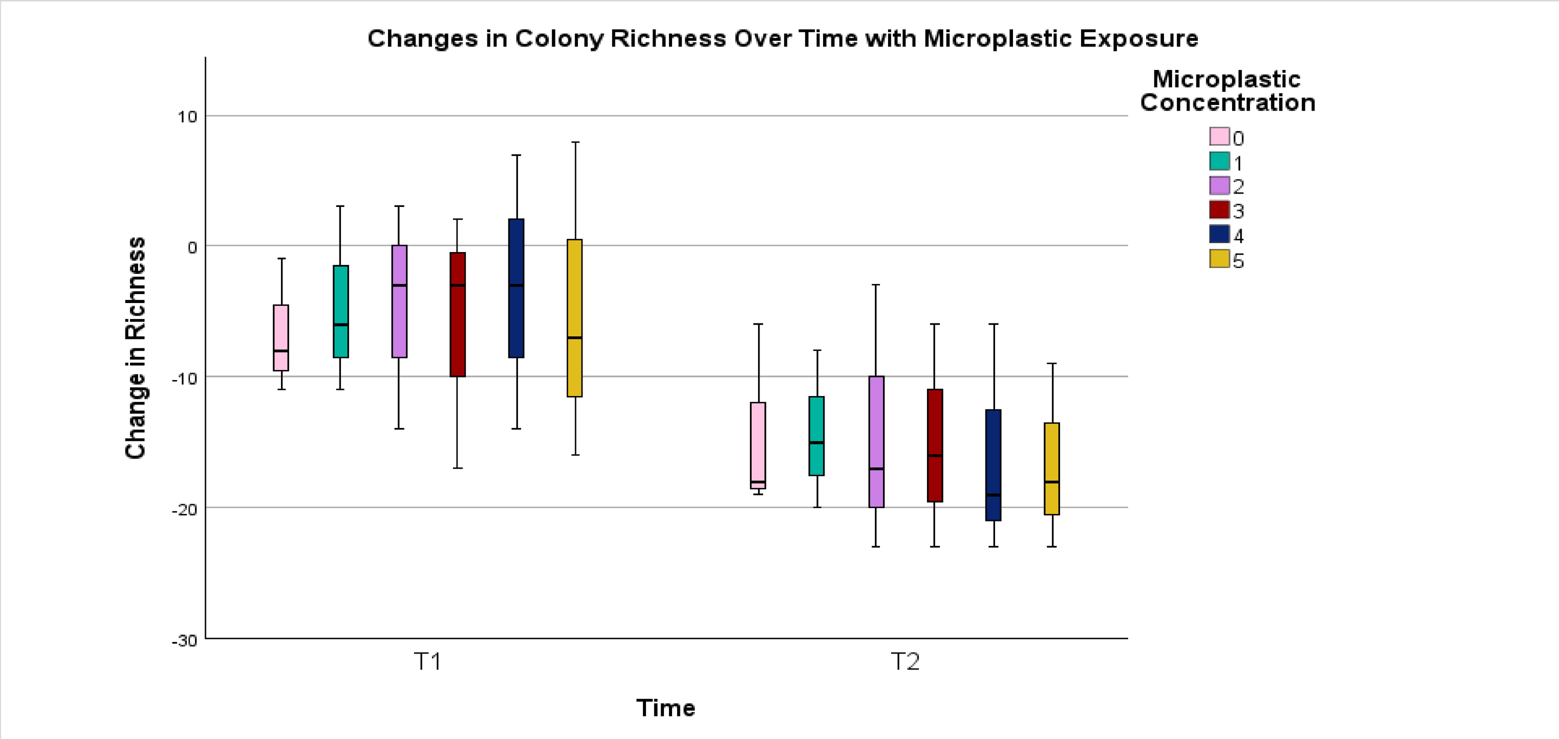


Figure 7: A box-plot illustrating the mean colony richness over two weeks at different MP concentrations. Shows a clear decrease in mean and variability however, the interaction between MP concentration and time on colony richness was not statistically significant (p = 0.997).

Discussion

The results supported a small part of my first hypothesis.

- Overall, my data indicates that increased MP concentrations have no significant or consistent effect on freshwater bacterial diversity and abundance, with a p-value of 0.392 and 0.491 seen in Figures 4 and 5.
- While only statistically significant in Trout Lake (p = 0.034), colony richness was shown to decrease with increased MP concentrations in all three lakes, as seen in Figure 6.
- The effects of MP concentrations over time were far from statistically significant with a p-value of 0.997, however, there is a visual trend within the data of the mean colony richness per MP concentration decreasing over the observed time points (Figure 7).

Despite the lack of statistical significance within my study, it is important to consider the limitations of this experiment. The long-term ecological impacts of MP input into freshwater ecosystems is a new field that must continue to be actively researched. Further research to manipulate longer exposure times, different MP types, and observing community succession is crucial in understanding the potential detrimental impacts of MP pollution on freshwater ecosystems and subsequently, bacterial health.

The implications of this research topic are vital as global plastic consumption is only increasing with time. While significant evidence to support my hypotheses was not found within the parameters of my experiment, we cannot conclude that MP does not affect bacterial communities. Input of MP into freshwater ecosystems should continue to be monitored and researched as to how it affects the bacterial community; which acts as the foundation for many habitats and the ecosystem services that keep them healthy and resilient.

Conclusion

- Increasing the MP concentration did not have a significant effect on bacterial diversity or abundance.
- However, a significant decrease in colony richness within Trout Lake was observed with increasing MP concentrations.
- Although statistically insignificant, a weak negative relationship was observed in the colony richness of the other two lakes.
- Additionally, time and MP concentrations did not have a statistically significant effect on each other.

Future research can provide insight on:

- How MP affects bacteria, subsequently impacting key ecosystem services such as nutrient cycling.
- The effects of certain MP types and sizes on bacterial diversity and function.

References

Dubois, A.-M. (2024, November 20). Understanding the microbiome to better protect lakes and predict lake health. Institut National de La Recherche Scientifique. https://inrs.ca/en/news/understanding-the-microbiome-to-better-protect-lakes-and-predict-lake-health/

National Oceanic and Atmospheric Administration. (2024, June 16). What are microplastics? Noaa.gov; National Ocean Service. https://oceanservice.noaa.gov/facts/microplastics.html

Parolini, M., Stucchi, M., Ambrosini, R., & Romano, A. (2023). A global perspective on microplastic bioaccumulation in marine organisms. Ecological Indicators, 149(1), 110179. https://doi.org/10.1016/j.ecolind.2023.110179

Acknowledgements

I would like to thank Dr. Jessie Clasen for her guidance and involvement in my research. I would also like to thank professor Maite Maldonado and graduate student Lori Waugh from the University of British Columbia for providing the LPDE samples.