Microplastic Composition in Relation to Wastewater Treatment Plants

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Introduction

- The increasing global production and use of plastic by humans have made plastics ubiquitous in the marine environment. Plastics are a source of chemical pollutants and act as a transport vector of persistent organic pollutants and heavy metals. (Enders et al., 2015)
- Once plastic enters the ocean, it undergoes degradation into smaller fragments via chemical and physical processes. Microplastics are synthetic polymers with dimensions of 0.1 µm-5 mm. The apprehension for the occurrence of microplastics in the marine environment arises since the intake of these compounds can cause toxicity to both humans and other living organisms. (Alvim et al., 2019)
- Hydrodynamic forces determine the horizontal and vertical distribution of microplastics. The plastics' size, density, and shape influence their ability to maintain their neutrally buoyant position in the water column against turbulent displacement thereby also playing a significant role in their distribution (Enders et al., 2015).
- Current research that assesses microplastic distribution in the ocean is focusing on the water column even though the final sink for most microplastics might be the seafloor sediment (Näkki et al., 2019).
- Wastewater treatment plants are a major pathway of microplastics to the marine environment. Our study considered microplastic particle composition in relation to wastewater treatment plants. We predicted that fibers will be most abundant and as we move away from the input source the ratio of microplastic composition would stay the same but decrease in abundance.

Methods

- Sediment samples were washed thoroughly with water through 63-micron and 500-micron sieves to remove large particles
- Microplastics were extracted from the sediment sample retained on the 63-um sieve using NaI (density = 1.70 g/cm^3) and cleaned using a Fenton reaction to remove organic material from the samples
- Suspected particles were visually identified for color and particle type (bead, fiber, film, and fragment)
- Particles were photographed under stereomicroscopy and analyzed in ImageJ. Each microplastic was measured three times then averaged.
- Size was determined with length (l) as the longest dimension and width (w) perpendicular to the length
- We input our measurements into the equation: $s=\sqrt{l\ x\ w}$ to determine the size of each MP and excluded any MP > 5000 um from analysis.
- All data were analyzed in R Studio and plot using the "gplots" package (Warnes et al., 2020)

Results

Figure 1. Sample locations in St. Andrews Bay System, St. Andrews Bay, Florida. Sediment was collected from three reference sites (East Bay, North Bay, West Bay) and from two wastewater treatment plants (Watson Bayou and Lynn Haven). The "x's" display the different stations along a 1 km transect where we collected our sediment samples.

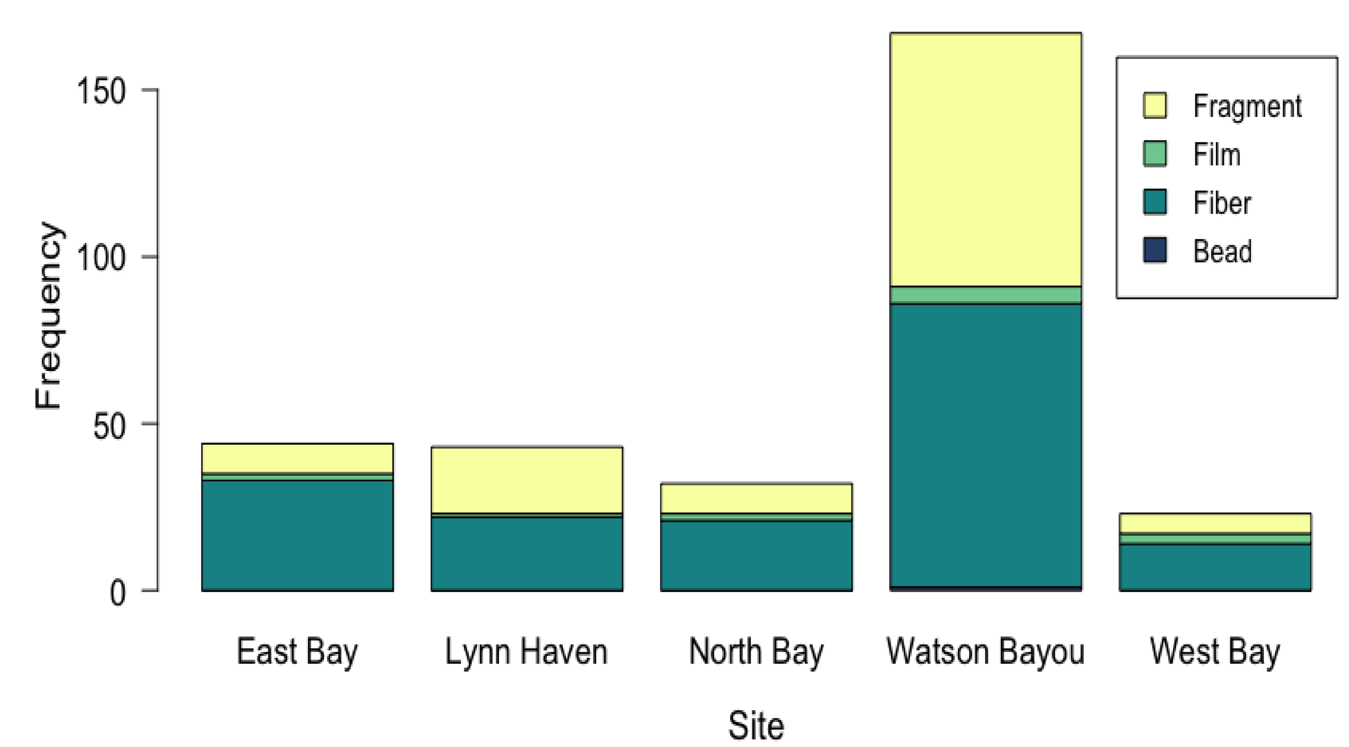

Figure 2. Frequency of microplastic type at each sampling site. The Watson Bayou site (polluted) had a significantly greater number of microfibers (p = 0.00035) and microfragments (p = 0.00021) than any other site. Microfilms were equally abundant across all sites, while fibers were the most abundant particle type overall (56.6%).

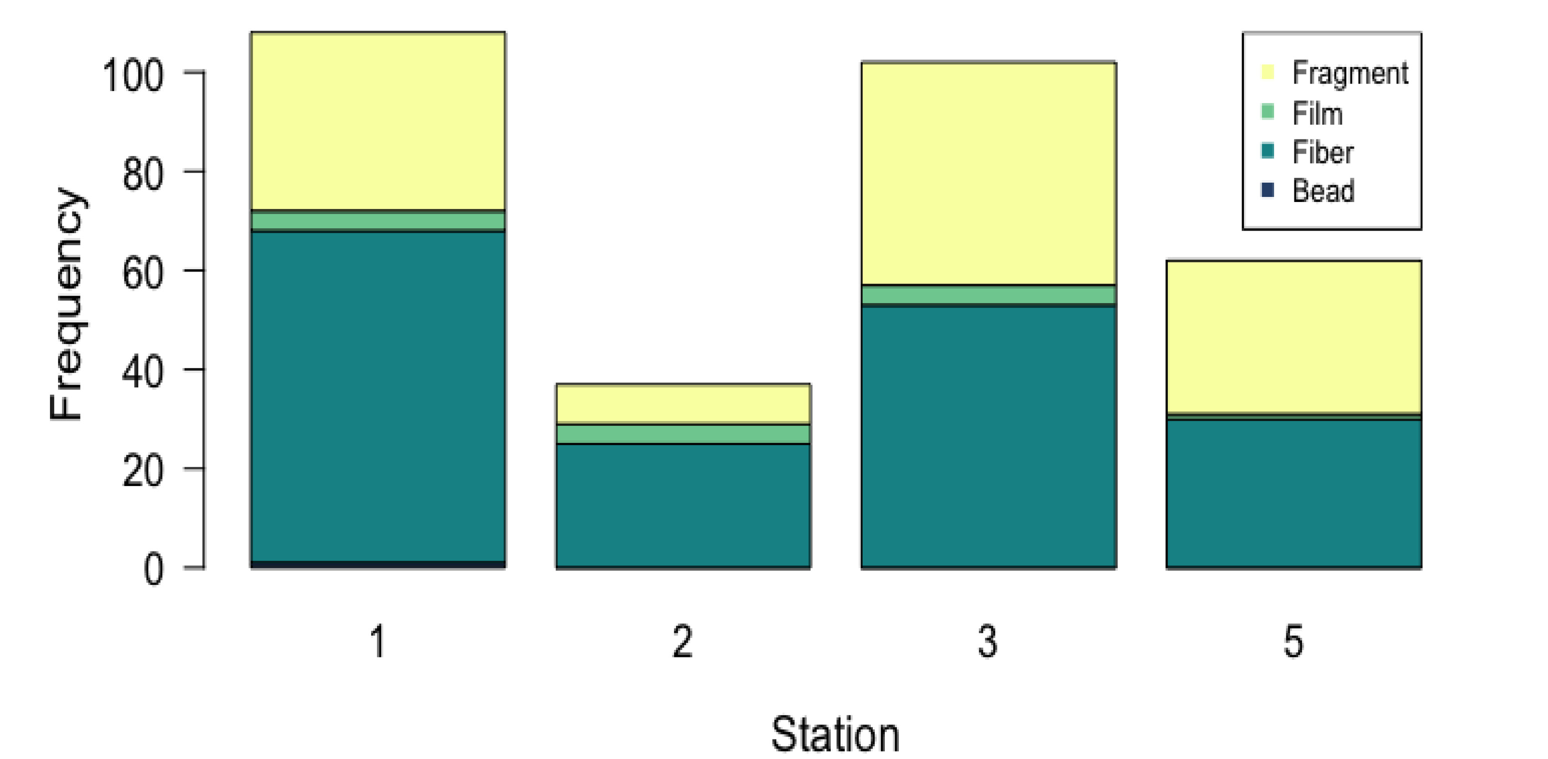

Figure 2. Frequency of microplastic type at each sampling station. All stations are on a transect to establish a distanced gradient within each sampling site. Station 1 is the closest to the input source and station 5 is furthest. When normalized for sampling effort, there was no significant difference in microplastic type across stations (p = 0.23).

Discussion

- Our hypothesis was supported by our data which showed that fiber particles were the most abundant across the embayment. Fiber particles comprise the largest portion of microplastic across all five sites and four stations.
- Fibers are the most common type of microplastic in the St. Andrews Bay System.
- Unpolluted sites showed a mix of all types, whereas polluted sites were majority fiber showing that wastewater effluent contains a majority of microplastics from human clothes.
- As we move away from the input source, the ratio of microplastic type remains pretty similar, when sampling efforts are normalized.
- This study suggests that there is an urgent need for microplastic regulation and implementation of mitigation strategies across the St. Andrews Bay System since microplastics are present across the whole bay.
- Large amounts of fiber in the St. Andrews Bay System suggests need for research on the distribution to quantify the amount present to determine the likelihood of ingestion of fibers by organisms and their effect on the marine food web.

References
1. Alvim, C. B., Mendoza- Roca, J.A., and Bes-Piá, A. (2019). Wastewater treatment plant as microplastics release source – Quantification and identification techniques, Journal of Environmental Management, Volume 255, 2020, 109739, ISSN 0301-4797, https://doi.org/10.1016/j.jenvman.2019.109739. https://www-sciencedirect-com.proxy.lib.fsu.edu/science/article/pii/S0269749118354964
2. Enders, K., Lenz, R., Stedmon, C.A., and Nielsen, T.G. (2015). Abundance, size and polymer composition of marine microplastics ≥10µm in the Atlantic Ocean and their modeled vertical distribution, Marine Pollution Bulletin, Volume 100, Issue 1, 2015, Pages 70-81, ISSN 0025-326X, https://doi.org/10.1016/j.marpolbul.2015.09.027
3. Näkki, P., Setälä, O., and Lehtiniemi, M., (2019). Seafloor sediments as microplastic sinks in the northern Baltic Sea – Negligible upward transport of buried microplastics by bioturbation, Environmental Pollution, Volume 249, 2019, Pages 74-81, ISSN 0269-7491, https://doi.org/10.1016/j.envpol.2019.02.099.
4. Warnes, G. R., Bolker, B., Bonebakker, L., Gentleman, R., Huber, W., Liaw, A., Lumley, T., Maechler, M., Magnusson, A., Moeller, S., Schwartz, M., and Venables, B. (2020). Gplots: Various R Programming Tools for Plotting Data. R package version 3.1.1. https://CRAN.R-project.org/package=gplots