Microplastic Survey 2019

HUDSON RIVER PK ESTUARY LAB

Brooklyn College The City University of New York

Purpose

Hudson River Park conducts an annual microplastic survey in the surface waters of the Park's Estuarine Sanctuary. This survey has quantified the concentration of microplastics and categorized microplastic types in Park waters. This study currently aims to understand the environmental variables in the Hudson River system and how they impact the presence and type of plastics found in the estuary. During the summer of 2019, the Park collaborated with NOAA to further investigate the categorized plastic types and identify the most common polymer that comprises the plastics found in this survey. Microplastics are pieces of plastic smaller than 5mm in size that can originate from the breakdown of larger plastics or are created deliberately for cosmetic use and other purposes. After four years of conducting the survey, the Estuary Lab has developed a baseline understanding of the concentration, distribution, and identification of microplastics in the Hudson River.

Key Research Questions

1. How is the presence of microplastics impacted by environmental variables such as rain, tides, site and location?
2. What are the exact polymer types of microplastics found in the Hudson River estuary?
3. Are local policy changes on plastic impacting the presence of microplastic types in the lower Hudson?

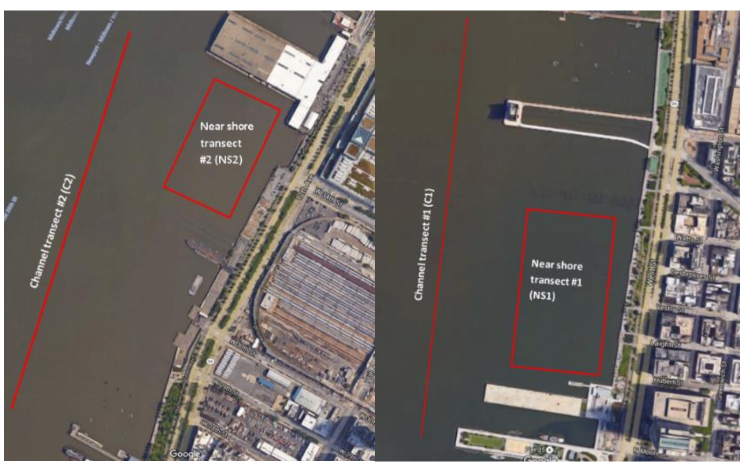


Fig. 1| Map of microplastics sample collection locations.

Methods

- Between June and October, the Park conducts monthly microplastic surveys. Two samples are collected downtown near Vestry Street (site 1) and two samples are collected in midtown town near 34^{th} street (site 2). At each site, a near-shore (NS) sample and a channel (C) sample is taken.
- Samples are collected by attaching a 1-liter bottle to a 0.3mm mesh Neuston net and trawling along the surface of the water for 15 minutes at an average speed of 3-5 knots.
- After the samples have been collected, they are filtered through a series of stacked sieves and dried at 90 °C.
- Organic matter is degraded using a wet peroxide oxidation process. The samples are then divided using salt gradient separation process. Plastics are further separated using a 0.3mm Nitex sieve, creating one sink sample and one float sample.
- All processed samples are counted using a dissecting microscope and categorized into six different categories: These categories include: fragment, foam, line, pellet, film, and nurdles.
- Microplastic concentrations are then statistically analyzed using Microsoft Excel and R Statistics Version 3.5.1.

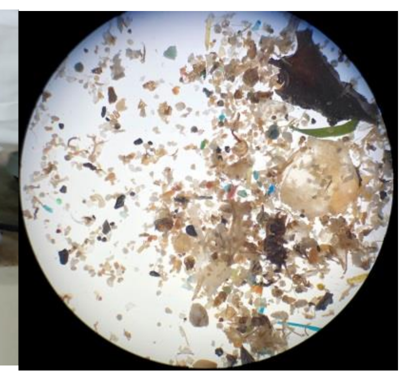


Fig. 2 (Left) **|** Neuston net during microplastic sample collection.
Fig. 3 (middle) **|** Wet peroxide is added to the sample and heated to degrade organic materials.
Fig. 4 (Right) **|** Processed microplastics sample under a microscope featuring a number of microplastic types.

Major Findings

In 2019, the Park found an average concentration of 244,141 microplastics per km² in the Park's estuarine sanctuary. This concentration is 4 times less than in 2018 showing a 71 percent decrease in microplastic concentration. A possible explanation for the decrease in plastic in 2019 as compared to 2018 could be related to the slight decrease in rainfall during the field season in 2019 (Fig. 4). Rain fall in NYC can trigger combined sewage out fall containing plastic litter and untreated waters to enter local waterways. Additionally, though almost no difference was seen in the concentration between 2019 and 2016, there was a 70 percent increase in concentration in 2019 when compared to 2017.

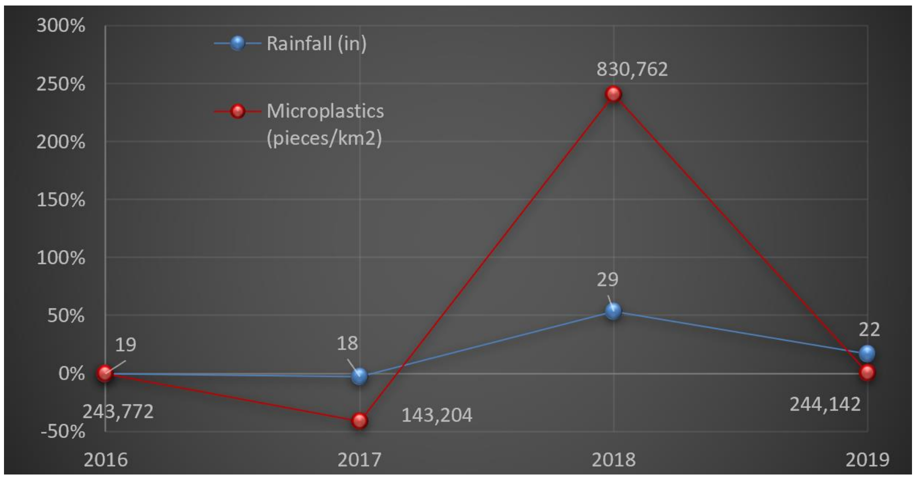


Fig. 4 | Percent change of mean seasonal microplastic concentration versus mean seasonal rainfall in inches, 2016-2019. Sampling season is defined as June-October.

When comparing the concentration of plastics for each site, across all four years, statistical tests showed a significant difference in quantities of plastic found between near-shore (NS) and channel (C) sites (ANOVA $F(1,70) = 5.1$, $p < 0.03$*), with Tukey tests showing that 2018 near-shore concentrations were significantly higher than both channel concentrations in 2016, 2017, and 2019 ($p < 0.002$*) and near-shore concentrations in 2016 and 2017 ($p < 0.03$*). No significant difference in the variation of plastic concentration between sampling sites, in the 2019 field season alone, was found despite the slight variation of plastic concentration observed between nearshore and channel samples during this season, (Fig 5). Additionally, no significant differences in microplastics concentrations were found when comparing microplastics collected during incoming current, outgoing current and sampling location, during the 2019 field season.

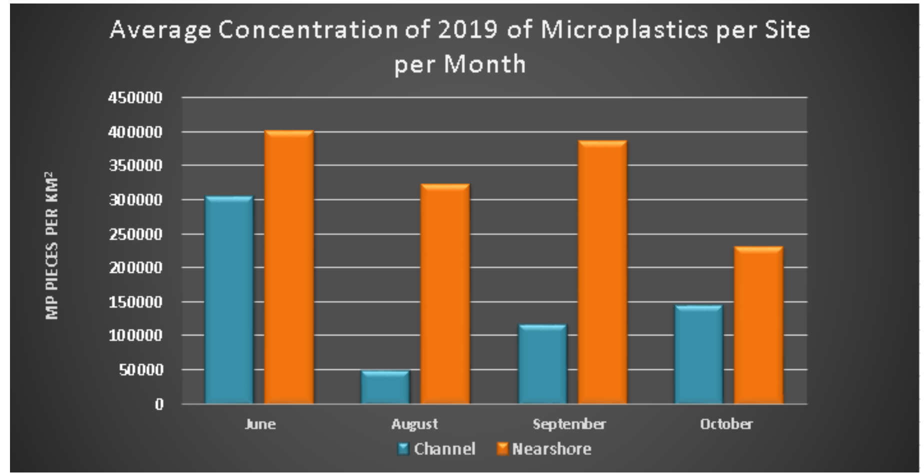


Fig. 5| Average concentration between channel and near shore samples by month.

Similar to the result of 2018, the most common type of microplastic identified in 2019's samples were fragments (Fig. 6). Fragments are formed as larger pieces of plastic are broken down. The second most common type seen this year was foam. This continues to be consistent with the Park's marine debris study, where foam is the dominant marine debris found in shoreline clean ups. A decrease in the presence of foam is expected, in future sampling of the estuary, due to the Styrofoam ban passed in January of 2019. A decrease in pellets is also expected in connection to the 2018 and 2019 summer implementation of the FDA Microbead-Free Waters Act of 2015 (Center for Food Safety and Applied Nutrition, 2017).

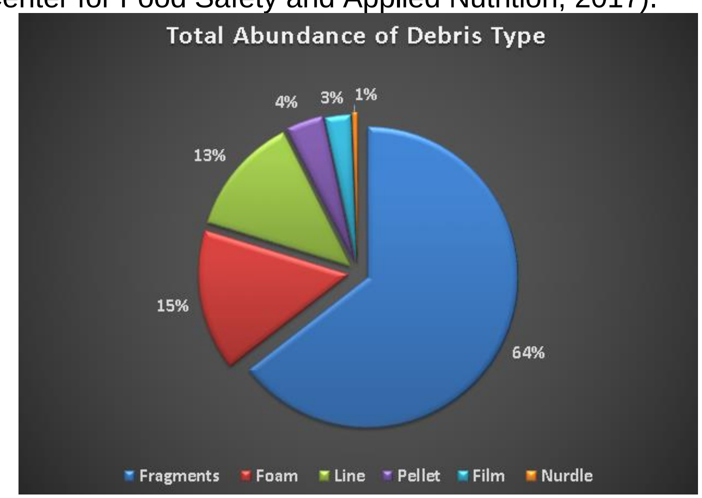


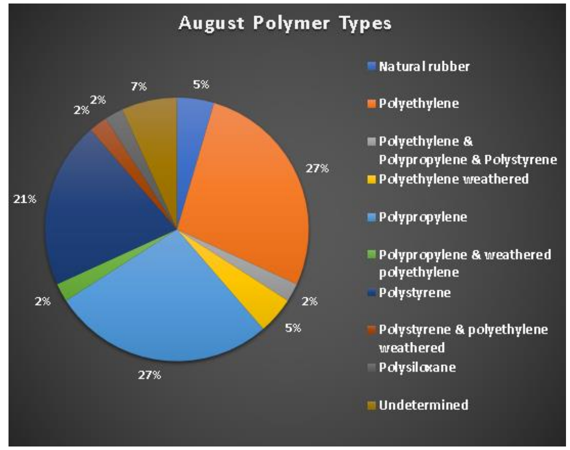
Fig. 6 | Total debris types across all samples.

Collaborative Research

In conjunction with statistical analyses, the Park collaborated with a research chemist, Dr. Ashok Deshpande from NOAA, to conduct chemical analysis on the microplastics categorized through microscopic analysis in this study. This collaboration aimed to accurately identify microplastic polymer types and investigate their chemical composition. Additionally, this analysis sought to investigate the presence of plastic additives or other chemicals that are typically used to strengthen or improve the properties of plastics when they are created (Tanaka, 2020).

Chemical analysis using gas chromatography and mass spectrometry (GC-MS) was conducted on archived samples from August and October of 2018. 15 samples from each site and location were chosen for the analysis amounting to 60 samples. These samples contained a variation of categorized and sorted microplastic types such as fragments, foam, line, nurdles and pellets. To investigate the polymer's composition each sample was loaded on to a quartz tube with a platinum coil and injected into a pyrolyzer. The sample underwent thermal degradation at 750 °C for 3 seconds. Once the sample was degraded, the GC-MS analyzed the plastic, displaying the elements that were present in the sample and allowing for polymer determination (Fig 9,10 and11), (Hooker, 2019).

Polyethylene, polypropylene and polystyrene dominated the chemical composition of most plastics in samples collected in August 2018, with some plastics being composed of more than one polymer type (Fig 7). Although there was a larger variety of polymer compounds found in the August samples, there were similar findings in the October samples. Some differences found in the October samples included the unexpectedly large percentage of undeterminable polymer compounds that were also found to be almost equal to the amount of polystyrene (Fig 8). Fragments are largely composed of polyethylene and polypropylene whereas styrofoam is composed of polystyrene. The presence of these polymer types are consistent with the categorized microplastics found in this study and their abundance is consistent with our



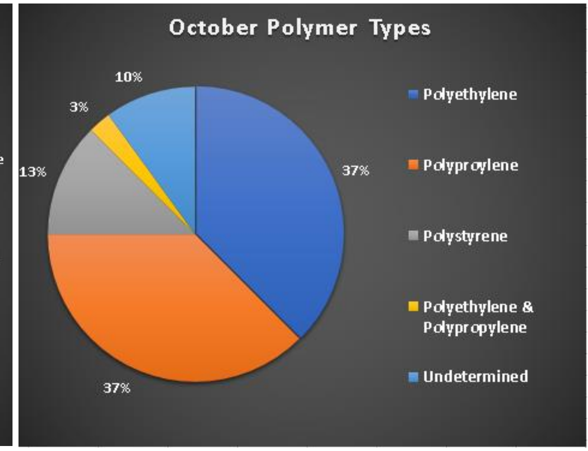


Fig. 7 | The percentage of polymer types found in August 2018 samples.
Fig. 8 | The percentage of polymer types found in October of 2018 samples.

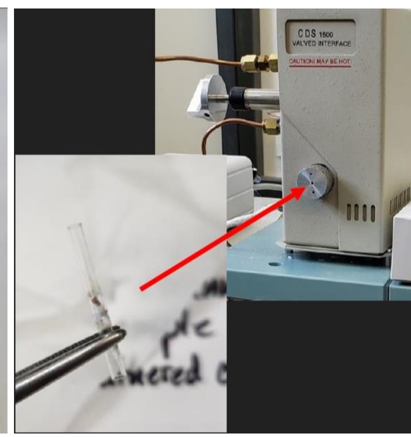




Fig. 9 (Left) **|** A quartz tube with a platinum coil being heated to clean it before loading the sample.
Fig. 10 (Middle)**|** Plastic sample being injected in to the pyrolyzer.
Fig. 11 (Right) **|** Plastic sample undergoing thermal degradation for 750 °C and analyzed using of GC-MS.

Take Aways

The results of this year's study suggest that there is a pattern that explains the presence of microplastics in the river, that is related to the water's proximity to shore and CSO locations. The prevalence of fragments in our microplastic samples indicates that larger plastics are not being disposed of properly; instead, these plastics are ending up in local waterways after CSO events, triggered by rain fall, where they continue to degrade into smaller pieces due to UV and salt exposure. Although no significant correlation between rain fall and microplastic concentration was found, it is likely that this year's field season's decreased rain fall affected the presence of microplastics in the estuarine system. Continuing to collect information on microplastics in the Hudson River creates a deeper understanding of how the estuarine system and the city's sewer system are connected. This information is valuable in creating an overarching understanding of the health of the River. By monitoring the annual fluctuations in plastic concentration in the River, the Park is able to track how natural and anthropogenic environmental impacts alter the conditions of the Hudson River.

Fig. 7 | A Park field scientist keeping the Neuston net submerged during a microplastics trawl.

Fig. 8 | Park staff counting and categorizing processed microplastic samples using dissecting microscopes.

Future Directions

Microplastics research is still a field of study in which data is lacking, particularly in the Hudson River. The Park wants to continue creating strong records of microplastics concentrations in the Estuarine Sanctuary. The Park intends to continue collaborating with new research partners in effort to analyze samples using different methods that will help gain a deeper understanding of plastic compounds, their derivative types and their additives. Hudson River Park also aims to narrow down sources of contamination and create goals towards rehabilitation.

References:

1.) Center for Food Safety and Applied Nutrition. (2017, November 03). The Microbead-Free Waters Act: FAQs. Retrieved from https://www.fda.gov/Cosmetics/GuidanceRegulation/LawsRegulations/ucm531849.htm

2.) Department of Environmental Conservation. (n.d.). Combined Sewer Overflow (CSO). Retrieved from https://www.dec.ny.gov/chemical/48595.html

3.) Hooker, C, Deshpande, A (2019). Microplastics: What's Swimming in the Hudson River Besides Fish? [PowerPoint slides].

4.) Mayor Announces Ban On Single-Use Styrofoam Products Beginning 2019. (2018, June 13). Retrieved from https://www1.nyc.gov/office-of-the-mayor/news/295-18/mayor-de-blasio-ban-single-use-styrofoam-products-new-york-city-will-be-effect

5.) Tanaka, K., Takada, H., Ikenaka, Y., Nakayama, S. M., & Ishizuka, M. (2020). Occurrence and Concentrations of Chemical Additives in Plastic Fragments on a Beach on the Island of Kauai, Hawaii. *Marine pollution bulletin*, *150*, 110732.