Sampling and Quantification of Microplastics and Other Synthetic Particles in the Severn River

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ABSTRACT

The presence of microplastics in rivers, coastal waterways, and open oceans has increased drastically. The Chesapeake Bay has many anthropogenic influences which allow input of plastics in the estuarine waters (Yonkos et al. 2014). Standard field sampling and laboratory analytical methods were employed to identify and quantify resultant microplastics in surface waters of the Severn River located within the Chesapeake Bay watershed. The goal of this project aimed to establish a baseline for follow-on studies regarding microplastics in the Severn River and other similar estuarine and coastal marine ecosystems. Plankton tows were conducted at three locations within and near the Severn River. The results indicated the presence of microplastics at every sampling location collected. The results of this study indicated the presence of microplastics and other synthetic materials in the Severn River. The most common microplastics examined were in the 250-500 µm size fraction. Further work is needed to understand the full impact and extent of microplastic presence in the Severn River and Chesapeake Bay.

METHODS & APPROACH

Figure 1. Map of three microplastic sampling locations within the Severn River and Chesapeake Bay: (A) Round Bay (39° 04.286' N, 76° 35.210' W), (B) Hendrix/USNA (38° 58.986' N, 76°28.583' W), and (C) Deep Water (38° 55.479' N, 76°24.452' W). Plankton tows were conducted at each location at an approximately two knot speed for 1,000 meters. Inset depicts entire Chesapeake Bay with study area highlighted.

Figure 2. (Clockwise from Top Left) Plankton tow being conducted off the side of USNA Edgewater; MIDN Kelly takes environmental parameters of Severn River using a YSI Pro2030; MIDN Syamansoori washing collected sample into cod end of plankton net; Separating samples with 500 µm and 250 µm mesh sieves for microplastic analysis.

Figure 4. (Clockwise from Top Left) MIDN Ebersole monitors the temperature of the chemical digestion; Samples cool waiting for processing; MIDN Ebersole and Kelly prepare samples for gravity separation.

Surface waters were sampled for microplastics at three different locations within the Severn River of the Chesapeake Bay (Figure 1). Two identical plankton tows were conducted at each location using 250 µm plankton nets with 63 µm cod ends towed at approximately two knots for 1,000 meters. After tows were completed, the nets were brought to the lab and gently washed down with fresh water to ensure all solids collected in the cod end. Cod end contents were sieved through 500 µm and 250 µm stacked sieves to separate amassed samples by size fraction. A control sample was also taken for each location to account for potential contamination (Figure 2).

Samples were then placed in a drying oven for approximately 24 hours at 90°C in pre-weighed 250 mL beakers. After drying, the beakers were weighed to find the total biomass of each size fraction (Figure 3). Using laboratory methods outlined by Masura et al. 2015, digestions were conducted on each sample using wet peroxide oxidation (WPO) to remove all organic materials from the sample and gravimetric analysis was then conducted to isolate microplastics (Figure 4).

Following gravimetric density separation, floating solids were placed onto pre-weighed nylon mesh, air dried, and weighed again to attain the weight of microplastics found. After weighing, the samples were examined microscopically (Figure 5).

Figure 3. After sieving, samples were placed in a drying oven. Once removed, dried samples were covered to limit exposure to plastic contamination until digestions.

Table 1. The concentration of microplastics found in each sample was calculated using the 29 cm diameter of the plankton net and the 1,000 m tow to find a total volume of water sampled of 66.05 m³. This number was then used to calculate the concentration of microplastic biomass sampled using the weight of plastics found in each sample.

MICROPLASTIC BIOMASS (g/m³)

Size Fraction <250 µm	Round Bay	#1	1.33×10^{-4}
		#2	8.46×10^{-5}
		Control	5.75×10^{-6}
	Hendrix	#1	2.83×10^{-4}
		#2	2.49×10^{-4}
		Control	4.06×10^{-5}
	Deep Water	#1	7.42×10^{-6}
		#2	3.10×10^{-4}
		Control	1.10×10^{-4}
Size Fraction 250 – 500 µm	Round Bay	#1	6.37×10^{-5}
		#2	1.20×10^{-3}
		Control	1.32×10^{-5}
	Hendrix	#1	2.92×10^{-4}
		#2	4.78×10^{-4}
		Control	5.60×10^{-6}
	Deep Water	#1	4.07×10^{-4}
		#2	7.84×10^{-5}
		Control	9.69×10^{-6}

RESULTS & DISCUSSION

Microplastics were found at each location and size fraction. Of the sampling locations, the site with the greatest average concentration of microplastics was Hendrix/USNA (Table 1). The sample with the greatest concentration of microplastics was collected at Round Bay in the 250-500 µm size fraction with a concentration of 1.20×10^{-3} g/m³ (Table 1). The largest biomass of microplastics sampled was from a 250-500 µm size fraction observed at Round Bay that made up 55.98% of the total biomass sampled and the smallest concentration was measured at the Deep Water location in the <250 µm size fraction which only contained 0.20% of microplastic biomass in the sample (Figure 5). Overall, samples with the greatest percentage of microplastic biomass were typically in the 250-500 µm size fraction. Multiple colors of microplastics were found at each location. Green, orange, blue, pink, black, brown, gray, and white microplastics were all found during microscopic examination (Figure 6). Green plastics and black threads were the most common types of microplastic identified.

CONCLUSIONS & FUTURE WORK

- Results indicate that microplastics and other synthetic materials exist in the Severn River in varying quantities with the greatest concentration of plastic found in the 250-500 µm size fraction sampled.
- The presence of plastic in bodies of water is a large concern due to a variety of reasons (e.g. biomagnification, chemical leaching). This study serves as a baseline for future microplastic examination in the Severn River.
- Further research on this topic is encouraged, as well as the expansion of the sampling area and number of replicates. Collecting samples from a greater number of sites may give more insight into areas experiencing greater plastic accumulation. Future studies should also take great care to avoid any outside plastic contamination of the samples (e.g. rubber gloves, hose).

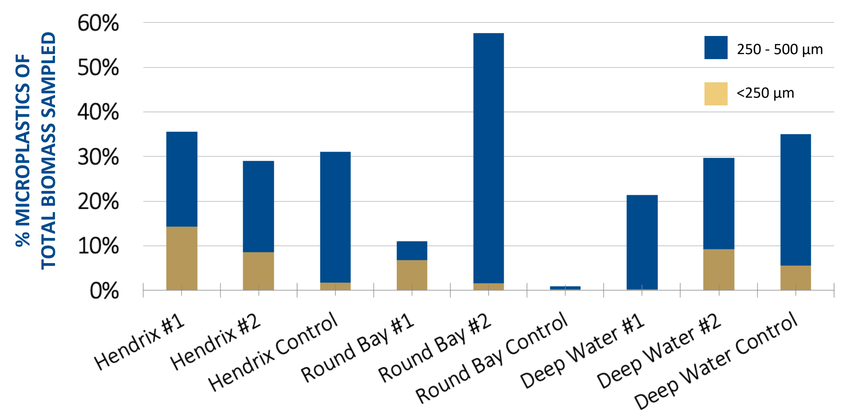

Figure 5. The percentage of microplastics per total biomass of each sample (grams) graphed for both the 250-500 µm and <250 µm size fractions. Sampling sites as well as the correlated controls are labeled.

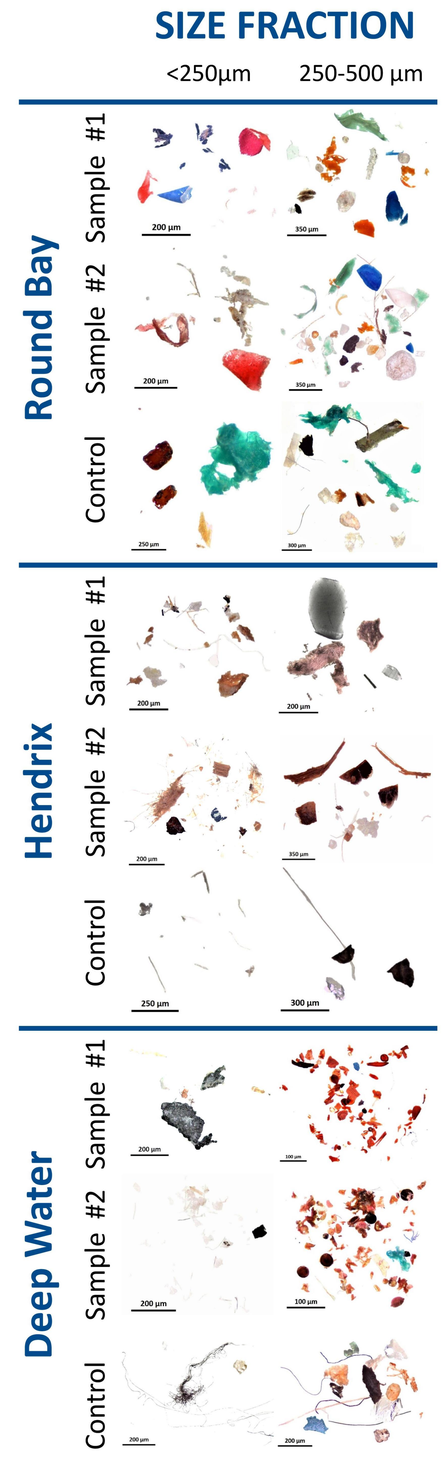

Figure 6. Photographs of microplastics found in each size fraction at different sampling locations.

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