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The Presence, Distribution, and Concentration of Microplastics In the Lower Basin of the Chesapeake Bay, USA Near Wastewater Treatment Plants

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Introduction

Microplastics are plastic particles smaller than <5 mm that originate from either gradual photochemical degradation overtime or the deliberate manufacturing of microbeads used in industrial processes. They can enter through wastewater treatment plant (WWTP) effluent, industrial outflow, and household discharge (Fendall & Sewell, 2009; Anderson et al., 2016; Mason et al., 2016). Microplastics have been detected in sediment and surface waters throughout the world, and it is suggested that these particles can be transported via atmospheric deposition (Zhang et al., 2019) and surface water currents (Iwasaki et al., 2017).

The Chesapeake Bay is a large estuarine system, located along the east coast of the United States, whose watershed makes up a total of 166,500 km^2, supporting a population of over 5,000,000. With the rise of anthropogenic development, a greater output of runoff as well as outflow from WWTP's has entered natural river systems of the Chesapeake Bay. With WWTP effluent being a primary identified source of microplastics, there is a strong implication that microplastics are widely present throughout the estuary. However, the occurrence of microplastics has not been studied in the Chesapeake Bay with exception to Yonkos et al.'s study in 2014.

Objectives

The presence and types of microplastics in water and sediment samples from locations near WWTP outfall locations in the lower basin of the Chesapeake Bay Watershed will be examined.

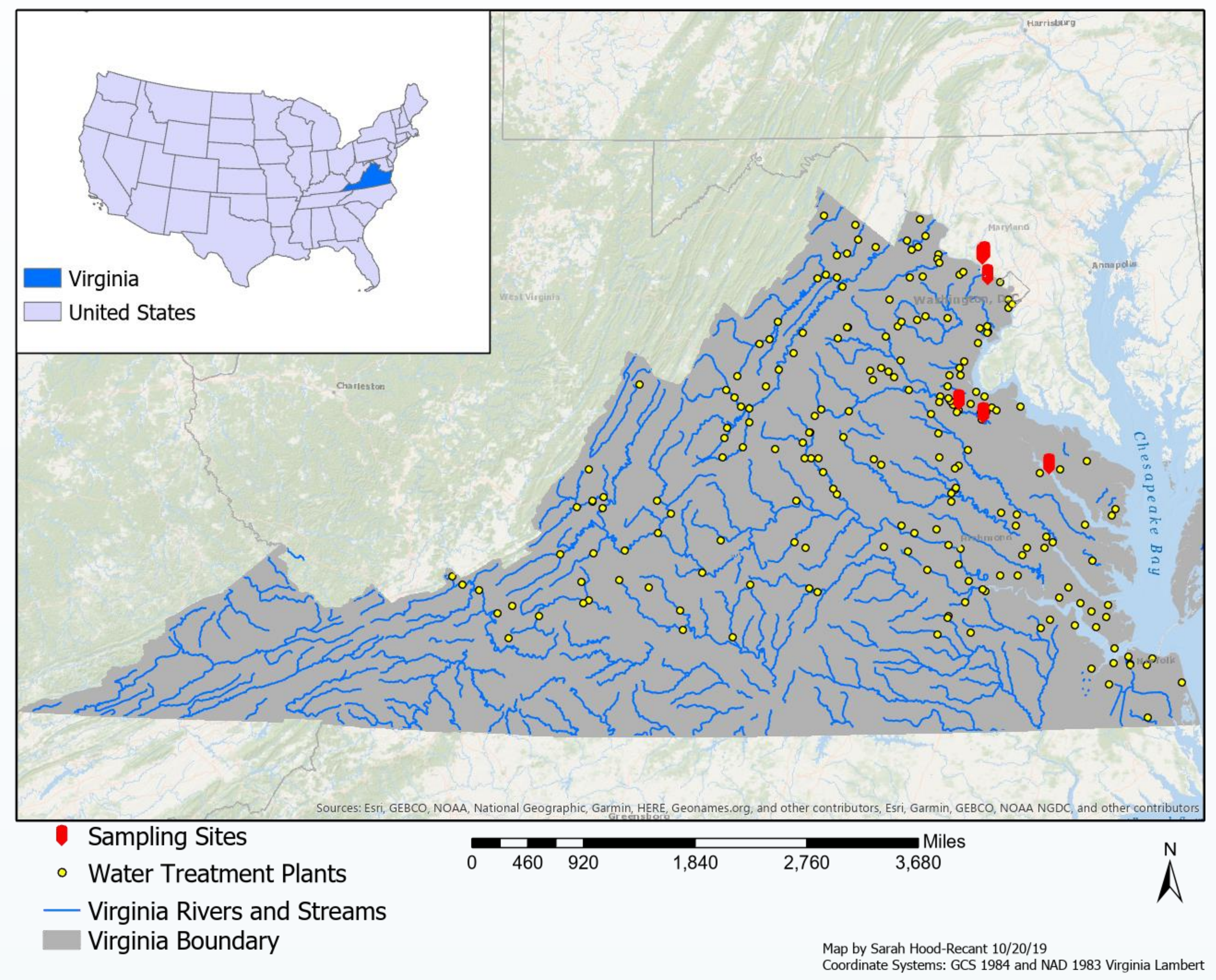
Hypotheses

Microplastics were expected to be found at the outfall site of WWTPs and accumulate in greater quantities downstream from the location as an indicator of suspension and sedimentation of microplastics overtime as effluent travels through fluvial systems.

Materials and Methods

- Sediment and water samples were collected along the Rappahannock and Potomac Rivers, Virginia, USA upstream, at, and downstream from outfall points of WWTP. Sediment samples were collected using a Van Veen grab sampler/manual push coring device. Surface water samples were obtained by dip sampling.
- To extract microplastics from sediment samples, an organic matter digestion and density separation protocol was followed, using Fenton's reagent (H_2O_2, $FeSO_4$, H_2SO_4) and NaCl. The supernatant of the mixture as well as water samples collected were filtered through 8-micron filter papers using vacuum filtration.
- Filter papers were examined using an Olympus SZ-CTV Microscope and Fisher Scientific Micromaster Microscope. Microplastics were recorded based on color, shape, sample type, and location.

Results



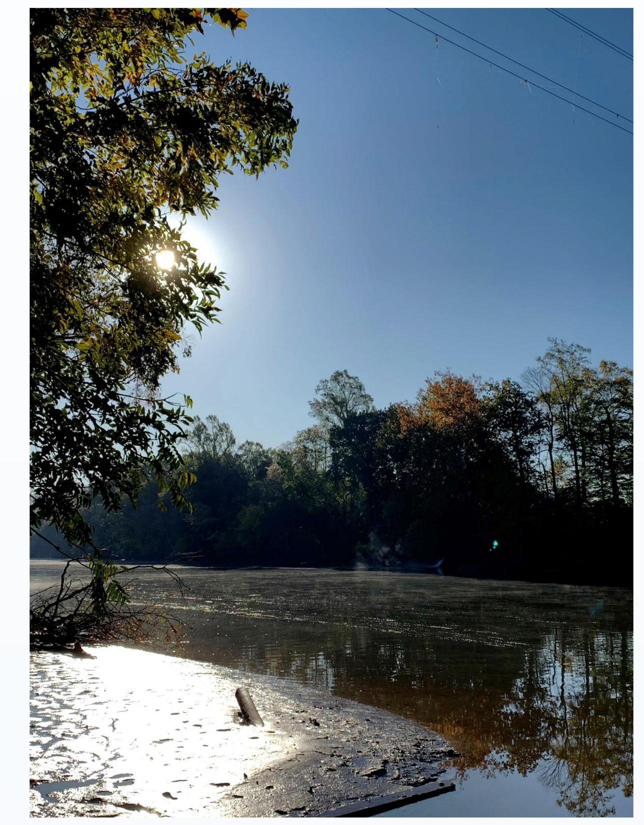


Image 1 – Little Falls Boat Ramp, Virginia, USA. Served as the WWTP outfall sampling site for Rappahannock River.

Image 2 – Hick's Boat Landing, Virginia, USA. Served as one of the downstream sampling sites for Rappahannock River.

Microplastic Type	Count
Bead/Sphere	46
Filament/Fiber	64
Fragment	1

Table 1 – Types of microplastics found in sediment collected at Little Falls WWTP Outfall. Total amount of sediment sampled: 394.8g

Microplastic Type	Count
Bead/Sphere	0
Filament/Fiber	104
Fragment	5

Table 2 – Types of microplastics found in surface water collected at Little Falls WWTP Outfall. Total amount of water sampled: 3.4 L.

Sample Type	Abundance
Sediment	14 per 50g dry sediment
Water	3 per 100 mL sample

Table 3 – Abundances of microplastics in sediment and water at Little Falls WWTP Outfall per 50g dry mass (sediment) or 100 mL sample (water).

Image 3 – Microplastic fiber found in sediment collected at Little Falls WWTP Outfall.

Image 4 – Microplastic fragment found in sediment collected at Little Falls WWTP Outfall.

Image 5 – Microplastic fiber found in surface waters collected at Little Falls WWTP Outfall.

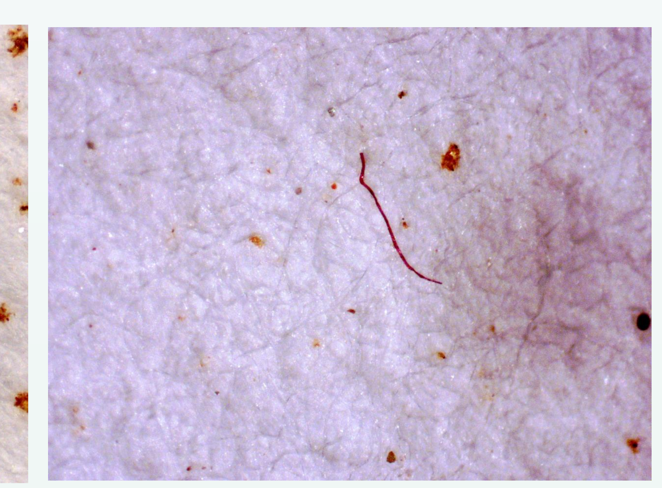


Image 6 – Microplastic fiber found in surface waters collected at Little Falls WWTP Outfall.

Microplastic Type	Count
Bead/Sphere	252
Filament/Fiber	41
Fragment	1

Table 4 – Types of microplastics found in sediment collected from Hick's Boat Landing. Total amount of sediment sampled: 242.4g.

Microplastic Type	Count
Bead/Sphere	1
Filament/Fiber	93
Fragment	5

Table 5 – Types of microplastics found in surface water collected from Hick's Boat Landing. Total amount of water sampled: 2.5 L.

Sample Type	Abundance
Sediment	61 per 50g dry sediment
Water	4 per 100 mL sample

Table 6 – Abundances of microplastics in sediment and water at Hick's Boat Landing per 50g dry mass (sediment) or 100 mL sample (water).

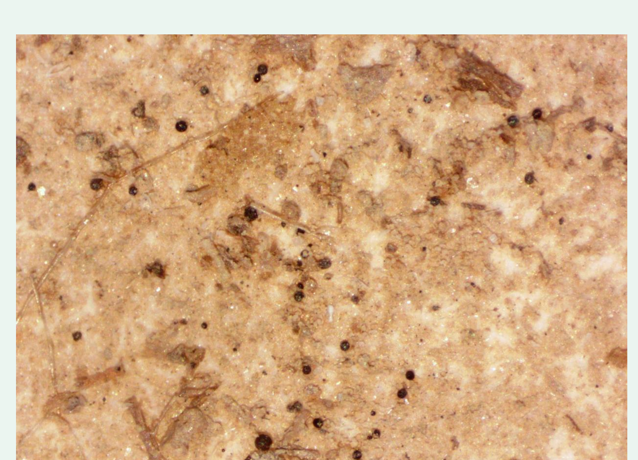


Image 7 – Microplastic beads found in sediment collected at Hick's Boat Landing.

Image 8 – Microplastic fragment found in sediment collected at Hick's Boat Landing.

Image 9 – Microplastic fiber found in surface waters collected at Hick's Boat Landing.

Image 10 – Microplastic fiber found in surface waters collected at Hick's Boat Landing.

Results (cont.)

Microplastics were detected in both sediment and water extractions. Particles were primarily identified as filaments or fibers and bead/spheres, though fragments were also found. The common colors of the found particles were black and blue. Microplastics were more present in water and sediment samples collected at Hick's Boat Landing, which is located downstream of the Little Falls WWTP.

Conclusions

The detection of microplastics in the form of fibers/filaments implies the major source of microplastic pollution is textile fibers, which may release filaments upon washing. The presence of microbeads brings implications to facial scrubs and industrial processes being an additional source of microplastic pollution. A greater presence of plastic particles in sediment downstream of a WWTP suggests that microplastics require a greater suspension time in water for biofilm formation to induce sedimentation.

Future Studies

This study will be continued to a) further determine the extent of microplastic pollution in the Rappahannock River, USA and b) investigate the distribution of microplastics in the Potomac River, USA. Sediment cores will be processed to evaluate whether a temporal distribution of microplastics is relevant to this study area.

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Acknowledgements

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