Concentration, transportation, and deposition of microplastics along the Savannah River, Georgia (USA).

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1. Abstract:

Despite extensive research into the transport and fate of oceanic microplastics (MP, <5mm in size), there is comparatively little focus on river systems considered to be pathways for these contaminants. The Savannah River, forming the border between Georgia and South Carolina, provides a unique location to study MP pollution along a variably industrialized river system terminating in the Atlantic Ocean. We investigated spatial variations in MP concentrations along the Savannah River to better understand their transport and deposition in rural to highly developed fluvial systems. Samples of riverbank sediment and suspended particles captured by a <80μm plankton net were collected along a 115 km reach of the river extending from just below the Strom Thurmond Dam to 25km downstream of Augusta, GA. Laboratory MP separation followed NOAA guidelines with a heavy liquid float-sink separation technique and wet peroxide oxidation treatment. Visually identified MPs were counted and photographed using a stereomicroscope; a subset of particles from each sample were examined using a Horiba XploRa Plus confocal microscope system. Average MP concentrations were measured at 3.1 (range: 1.5-4.6) particles/cubic meter in water and 16.8 (range: 6.2-27.4) particles/kg sediment and primarily composed of polyester fibers and polypropylene pellets. Comparison of MP concentrations between sediment samples from the upper bank and water margin suggests that MP particle deposition is dependent on river stage. Preliminary results further indicate that there is no observable relationship between increasing drainage area and MP concentration, suggesting that concentration may be dependent on localized anthropogenic sources rather than cumulative upstream contributions. Measured concentrations of MP in bank sediment in the upper reaches of the Savannah River are an order-of magnitude less than published concentrations at the river's mouth collected over the same sampled cross-sectional area, suggesting tidal action exerts a significant control on MP pollution in coastal and near coastal areas. Future work will focus on quantifying the predicted role of tidally dominated systems in concentrating microplastics around river mouths and identifying river reaches with highly concentrated MP particles for targeted remediation.

2. Background:

Although microplastics (MPs) have been quantified in riverine systems and correlated to urbanization and population density[1], researchers have yet to quantify the natural downriver filtration of MPs from an extended point source. The goal of the REU was to thus identify how a natural riverine buffer extending over 50 kilometers below the city of Augusta, GA, changes the concentration, composition, and depositional location of MPs.

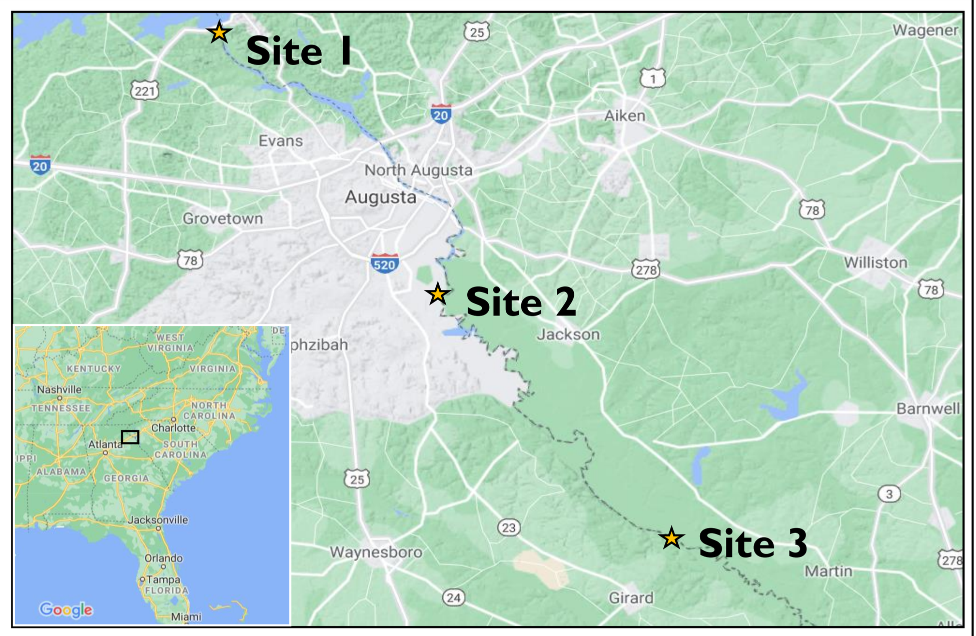

Figure1. Location of sampling sites.

3. Approach:

- A total of 17 sediment and dragnet water samples were collected from three sites along the Savannah River in July 2021 (Figure 1).
  - Water samples were collected with an 80 micrometer-mesh plankton net towed along the thalweg of the channel.
  - Sediment samples were collected every 0.5 meters along a perpendicular transect extending from the water line.
- Samples were processed in accordance with the NOAA guidelines[2] for the separation and microscopic analysis of microplastic particles (Figure 2).
- Contamination minimized by:
  - Covering samples and operating under a fume hood during processing.
  - Wearing nitrile gloves when handling samples and using non-plastic implements.
  - Collecting blanks in the field and during processing for analysis of contamination.

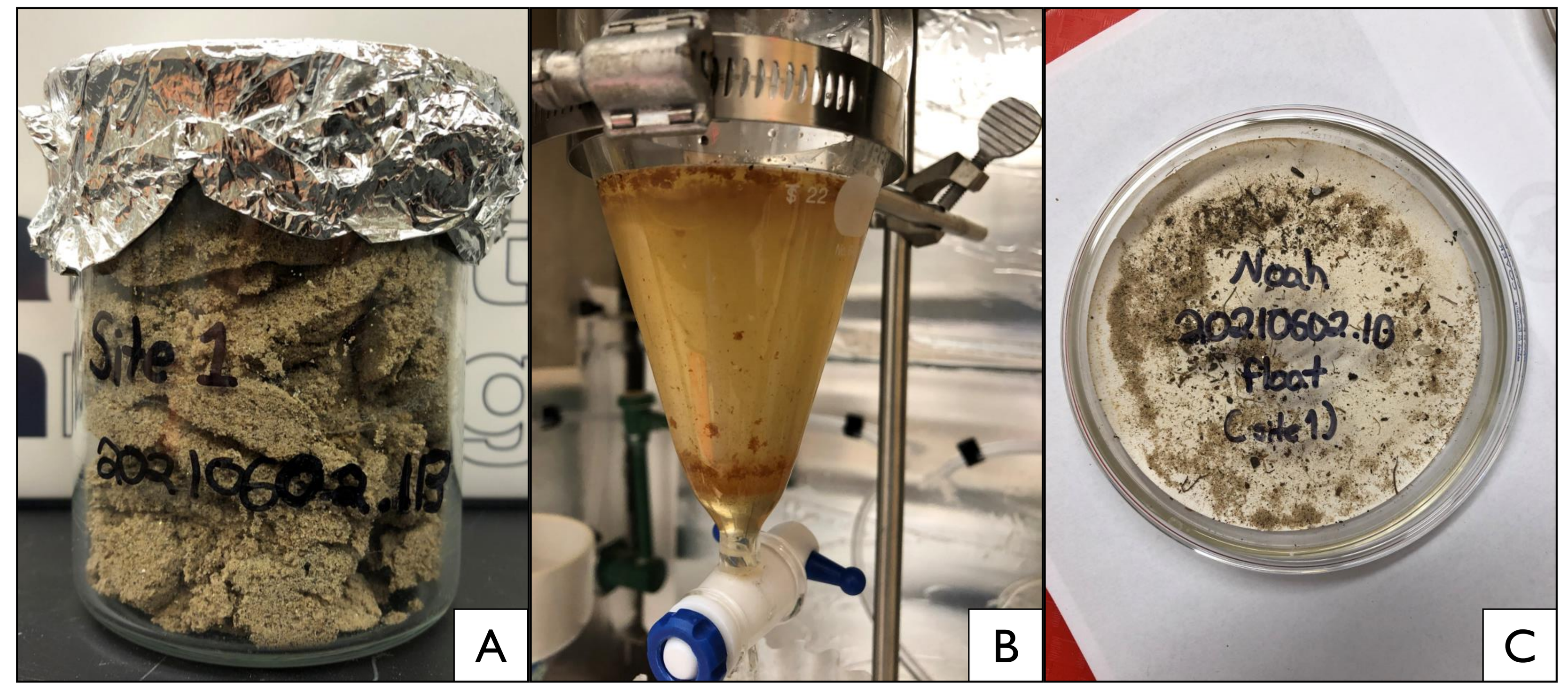

Figure 2. Unprocessed sediment sample (tile A) placed in the density separation funnel with high-density sodium metatungstate (tile B) to collect the floating microplastics on a paper filter for analysis (tile C).

4. Processing / Microplastic Recovery Efficiency:

- Spiked pure quartz sand with microspheres to create varying microplastic concentrations.
- Samples were run through the density separation technique and plastics recovered.
- Overall recovery efficiency varies between 75% and 95%.
- At observed levels, procedure operates at a 94% to 97% efficiency (Figure 3).

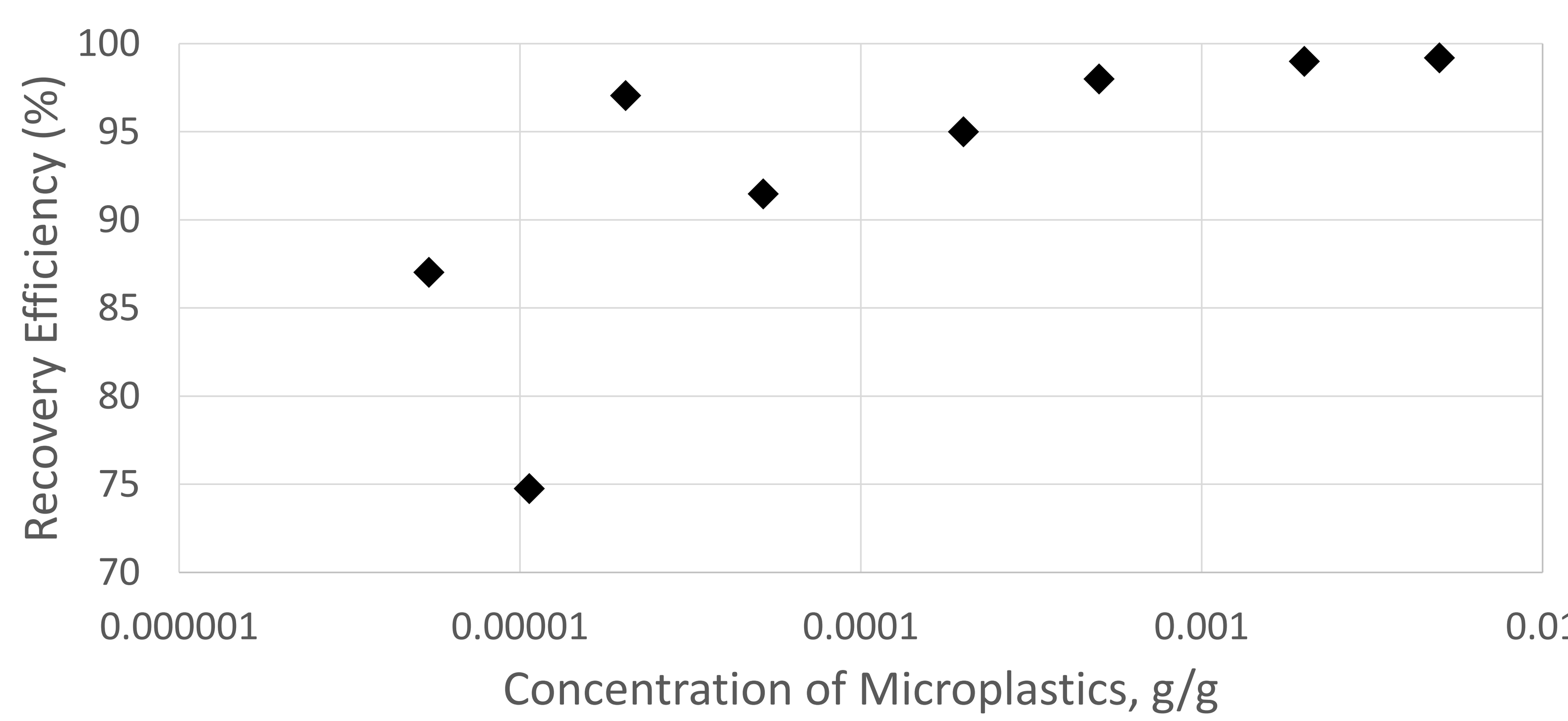

Figure 3. Recovery efficiency of the density-separation technique. Concentration of microplastics is reported in grams microplastic per gram sediment

Figure 4. Collecting bank samples along the Savannah River, looking upriver. Collection apparatus and scale card shown. Taken June 6th, 2021.

5. Conclusions:

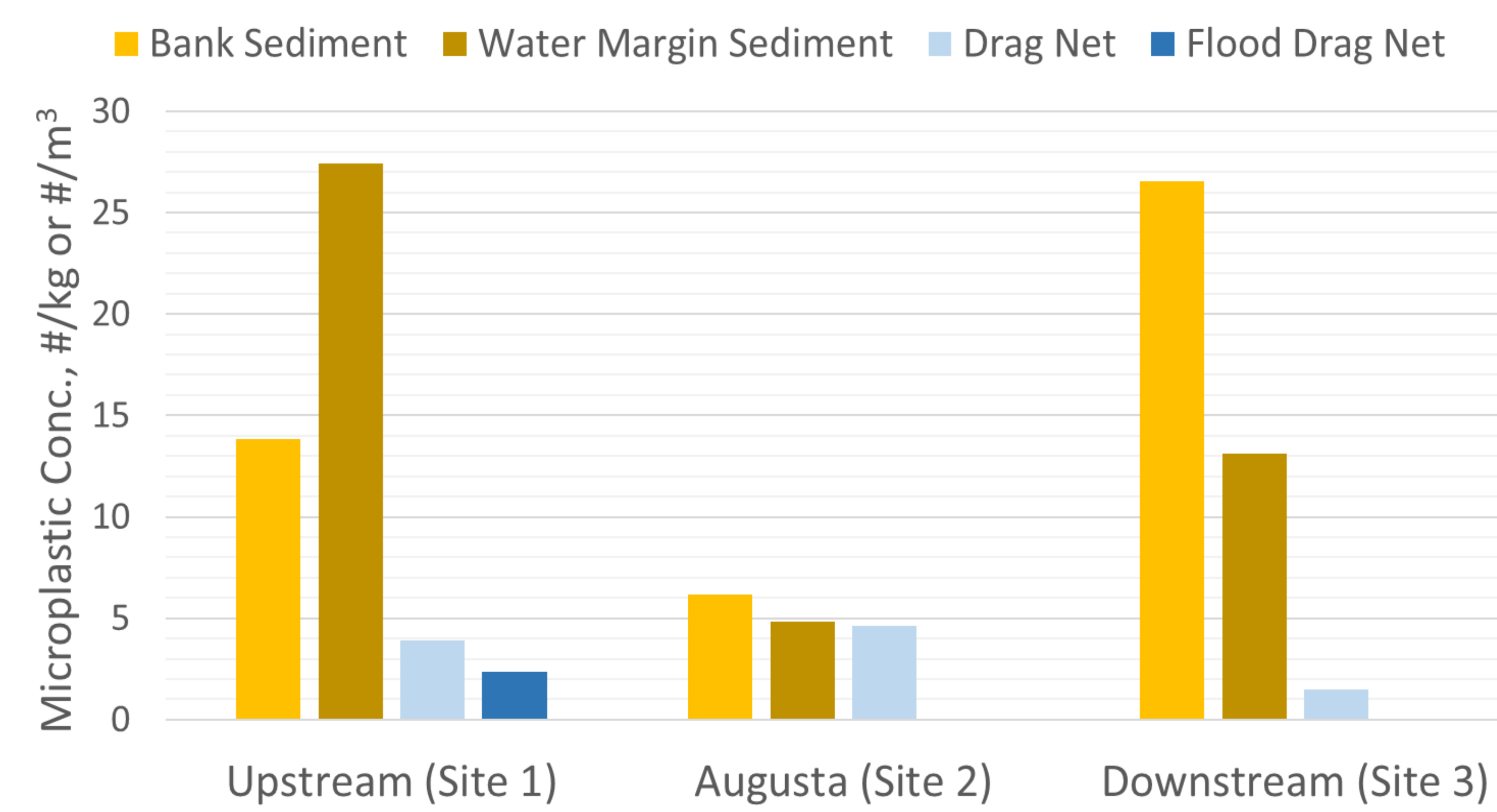

Figure 5. Microplastic concentrations at each location. Concentration reported in units of number of microplastics per kilogram (sediment samples) and number of microplastics per cubic meter (water samples). Flow direction is from left to right.

- No observable relationship between increasing drainage area and MP concentration, suggesting that concentration may be dependent on localized anthropogenic sources rather than cumulative upstream contributions.
- MP concentrations in the surface water only slightly decreased following a controlled flood event; the turbulent release may have suspended trapped MPs, or the released water may have contained a similar concentration of microplastics.

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References: [1] Kataoka, T., Nihei, Y., Kudou, K., & Hinata, H. (2019). Assessment of the sources and inflow processes of microplastics in the river environments of Japan. Environmental Pollution, 244, 958–965. DOI: 10.1016/j.envpol.2018.10.111; [2] Masura, J., Baker, J. E., 1959-, Foster, G. D. (Gregory D., Arthur, C., & Herring, C. (2015). Laboratory methods for the analysis of microplastics in the marine environment: Recommendations for quantifying synthetic particles in waters and sediments (noaa:10296). https://repository.library.noaa.gov/view/noaa/10296.