Distribution of Microplastics in the Estuarine Waters around the New York Metropolitan Area and Assessment of their Role as Potential Vectors of Toxic Compounds

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ABSTRACT

- **Microplastic particles and microbeads are plastic polymers that can adsorb organic pollutants from sewage and escape wastewater filtration**
- **In possibly the first assessment of waters around the New York metropolitan area, we obtained samples from 7 sites located primarily around waste water discharge points in the Hudson, East and Harlem Rivers**
- **We developed protocols to detect and quantify microbeads and microplastics and methods to assess their potential toxicity**
- **Based on FTIR spectroscopy and microscopic examination, we concluded that all sites had microplastic particles**
- **The Newtown Creek sample had the largest amount of microplastics**
- **Atenolol, a popular blood pressure drug, was detected in an extract of the microplastics isolated from the Newtown Creek sample**

BACKGROUND

- Microplastic particles and microbeads typically range in size from 5 µm to 1 mm
- They are used in many body and household cleansing products, cosmetics and even toothpaste, and are washed down drains into waste water treatment plants, where they come in contact with a wide range of organic pollutants such as **polycyclic aromatic hydrocarbons** (PAHs), **polychlorinated biphenyls** (PCBs) and even **pharmaceuticals**
- Because of their small size, they usually escape wastewater treatment plant filtration systems and find their way into inland water ways, estuaries, coastal oceans and eventually into the open ocean
- <u>19 tons of microbeads are released into New York every year</u>
- Microplastics pose a threat to estuarine and marine resources, either directly through impacts on internal tissue or indirectly via the toxic compounds that adsorb onto them
- Microplastic debris have been reported since the 1970s, but the size of the microplastic particles have made them difficult to study, making this study fairly new



METHODS

SAMPLING SITES

1. **Westchester County**
2. **125th Street**
3. **79th Street**
4. **Southern Tip of Manhattan**
5. **Newtown Creek**
6. **Ward Island**
7. **Harlem River**

WATER DISCHARGE MEASUREMENTS: 1) Temp 2) Salinity 3) Chlorophyll *a* 4) Turbidity 5) Oxygen Sat. 6) pH

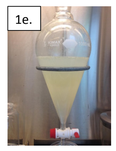
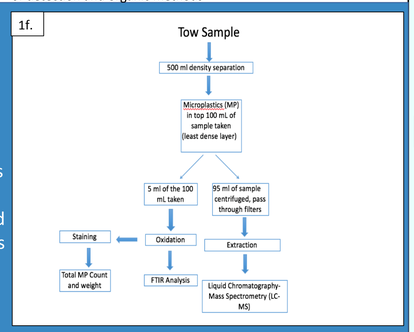


Figure 1a-f: Images of field sampling, Newtown Creek, 125th St. plant, density separation with separatory funnel, and flow chart of detection and organic methods

<u>Detection and Quantification</u>

- Oxidation and staining methods were applied to samples. Aliquots of the samples were filtered onto filters for microscope viewing and counting.
- Due to time constraints, the counts are just part of preliminary data.
- The detection protocol was verified through FTIR spectroscopic analysis with the help of the Columbia University Department of Chemistry



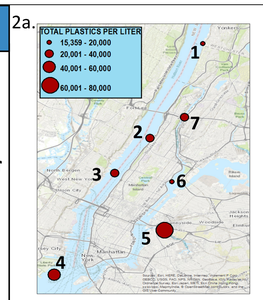
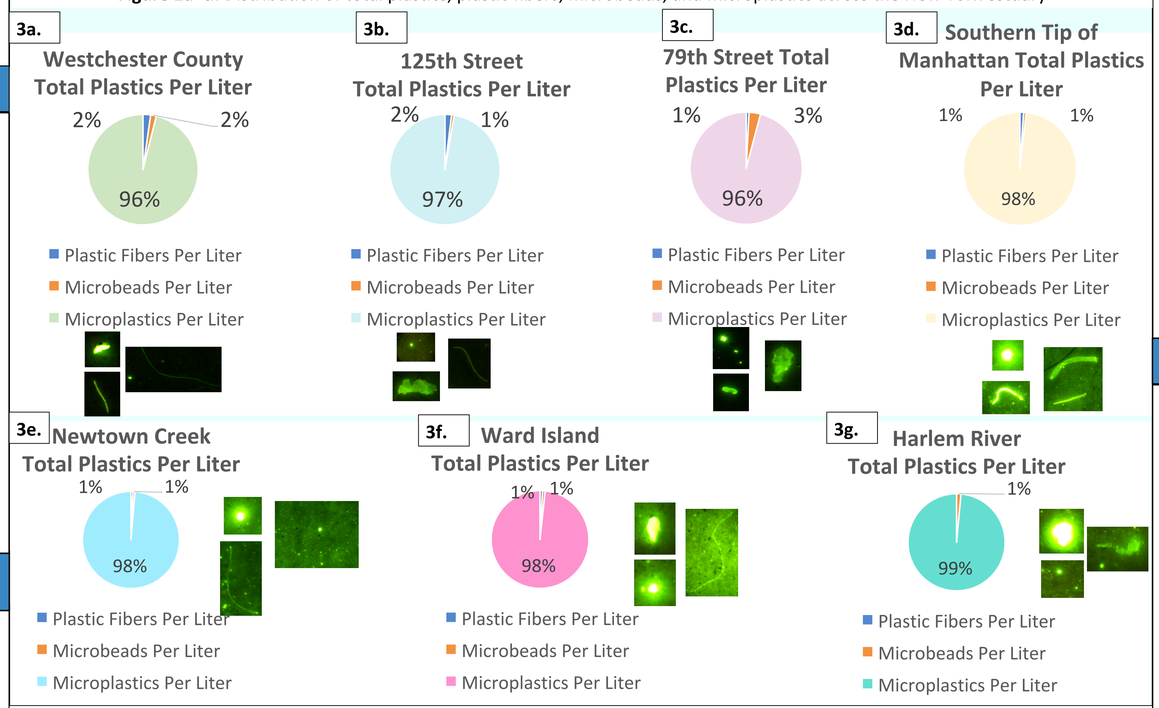
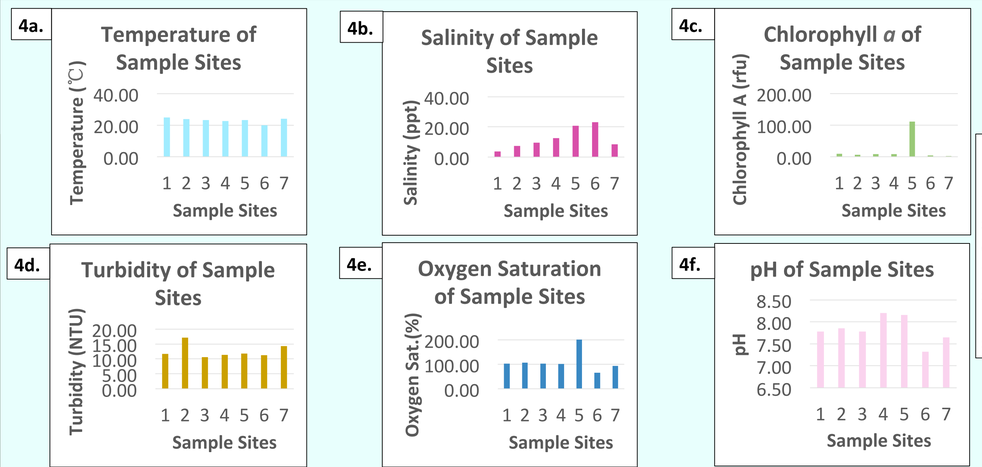


Figure 2a–d: Distribution of total plastics, plastic fibers, microbeads, and microplastics across the New York estuary



Figures 3a-g: Composition of total plastics per liter and various types of plastics detected for sample sites 1-7, respectively.



Figures 4a-f: Measurements of temperature, salinity, chlorophyll *a*, turbidity, oxygen saturation, and pH at all sample sites

Results

- We found a wide range of plastics from plastic fibers and microbeads to microplastic particles in at all sample sites
- Microbeads and plastic fiber strands comprise the least amount of all plastic particles.
- From Westchester to the Southern tip of Manhattan, there is an increasing trend in the amount of total plastics
- Newtown Creek had the largest amount of total plastics
- Preliminary analysis of Newtown Creek microplastics suggests that **atenolol, a popular blood pressure drug**, is one of the adsorbed organics
- FTIR spectroscopic analysis confirms that the water samples had microplastics including polyethylene terephthalate (PET) and polypropylene copolymer (PPC) .
- Newtown Creek (NTC) had the highest amount of pigment chlorophyll *a* and oxygen saturation, and one of the highest salinities and pH.

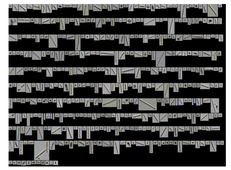


Figure 5: FlowCam data showing heavy diatom chain (phytoplankton) growth in Newtown Creek

CONCLUSIONS

- Microplastics are indeed widespread around the New York metropolitan area, appearing in numerous forms such as microbeads, plastic fibers, and microplastic particles
- FTIR spectroscopic analysis confirms that the protocols that we used are functional and reliable
- Newtown Creek had the highest amount of total microplastics, because it is the largest of NYC's wastewater treatment plants. The amount of microplastics may correlate with the high level of pollution and industrialization there
- The absorbance of the pharmaceutical atenolol suggests that microplastics may be a vector of toxic compounds
- The ingestion of microplastics by estuarine and/or marine organisms may impact the food chain by spreading the toxic compounds
- High levels of diatom chains (phytoplankton) may be a result of the rich amount of nutrients from discharge and pollution in Newtown Creek
- Possible solutions to microplastic pollution may be replacing microplastics with natural products like sugar, boycotting microplastic products, and banning microplastic products. The U.S. microbead ban went into effect on July 1, 2017.

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