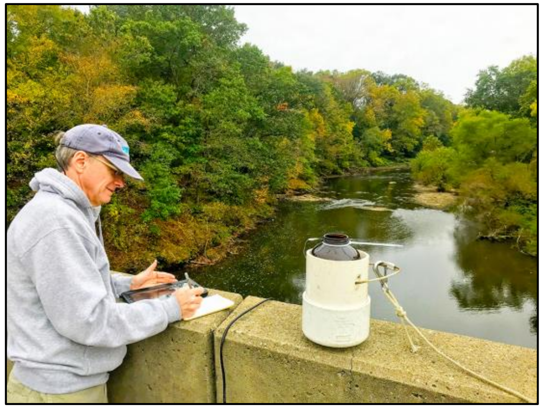
Delaware River Basin Commission

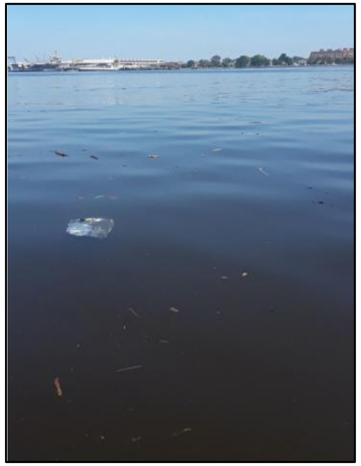
Delaware Estuary Microplastics Monitoring and Cleanup

DRBC Toxics Advisory Committee

January 19, 2022

Jake Bransky
DRBC Aquatic Biologist

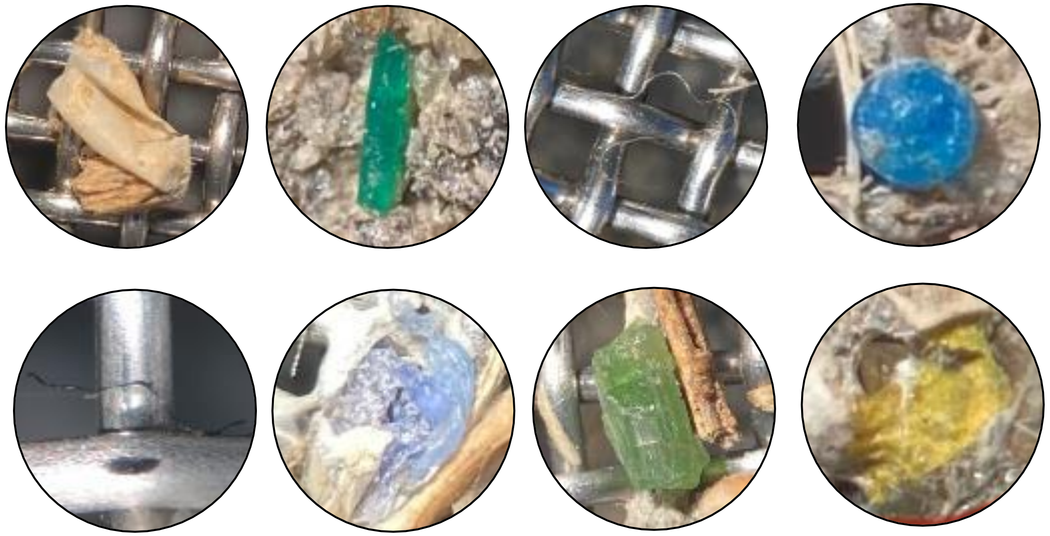




Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

What are Microplastics?

- **Small plastic pieces** less than five millimeters in size.
  - About the size of a sesame seed
- Microplastics include microfibers from synthetic textiles and microbeads in personal care products like face washes and toothpastes.
- Microplastics are also from break down of tires, plastic bags, bottles and fishing line.



Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

What Are the Impacts of Microplastics on Aquatic Life

- Impacts of microplastics are still being studied
- Many species confuse plastic particles for food items
- Consumption of plastic by aquatic life can:
  - Fill stomachs
  - Reduce feeding on nutritious food item
  - Reduce growth
  - Reduce reproductive ability
- New research shows the plastics can increase the transfer of toxic chemicals to aquatic species

This rainbow runner had consumed 17 plastic fragments. Marine plastic pollution plays an unknown role in human exposures to toxic chemicals.

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

What Is Known About Microplastics in the Basin?

USGS
science for a changing world

Microplastics in the Delaware River, Northeastern United States

What are microplastics and where do they come from?

Microplastics are a contaminant of increasing concern in aquatic environments. Our understanding of microplastics in freshwater environments has increased dramatically over the past decade, but we still lack information on microplastic occurrence and biological uptake in National Park Service (NPS) waters. Defined as plastic particles less than 5 millimeters (mm) in diameter, microplastics come from a wide variety of sources (see "Microplastic types and possible sources" infographic) and commonly are classified by particle type or morphology, including fibers, pellets/beads, foams, films, fragments, and tire particles. Microplastics reach aquatic environments through diverse pathways, including littering, stormwater runoff, industrial and domestic wastewater, overland application of biosolids, atmospheric deposition, and breakdown of aquatic equipment such as buoys and boats.

Figure 1. U.S. Geological Survey scientists collecting a microplastics sample in the Delaware River at Callicoon, New York.

Microplastic types and possible sources

Pellets/beads: Pre-production pellets, personal care products

Fibers: Synthetic clothing and textiles

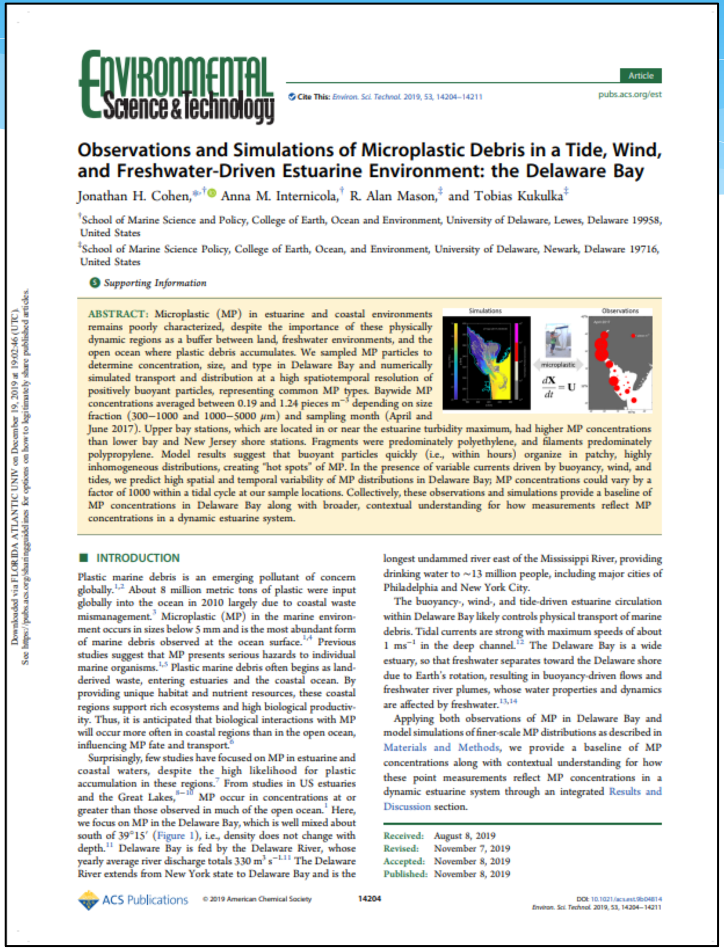
Films: Bags and wrappers

Fragments: Degraded pieces of litter, manufacturing waste material (shavings)

Foams: Styrofoam™ cups and take-out containers, packing material

Tire particles: Tire wear, crumb rubber used on sports fields, rubberized asphalt

https://pubs.er.usgs.gov/publication/fs20203071



Environmental Science & Technology
Article
Cite This: Environ. Sci. Technol. 2019, 53, 14204−14211
pubs.acs.org/est

Observations and Simulations of Microplastic Debris in a Tide, Wind, and Freshwater-Driven Estuarine Environment: the Delaware Bay

Jonathan H. Cohen,*[†] Anna M. Internicola,[†] R. Alan Mason,[‡] and Tobias Kukulka[‡]

[†]School of Marine Science and Policy, College of Earth, Ocean and Environment, University of Delaware, Lewes, Delaware 19958, United States

[‡]School of Marine Science Policy, College of Earth, Ocean, and Environment, University of Delaware, Newark, Delaware 19716, United States

Supporting Information

ABSTRACT: Microplastic (MP) in estuarine and coastal environments remains poorly characterized, despite the importance of these physically dynamic regions as a buffer between land, freshwater environments, and the open ocean where plastic debris accumulates. We sampled MP particles to determine concentration, size, and type in Delaware Bay and numerically simulated transport and distribution at a high spatiotemporal resolution of positively buoyant particles, representing common MP types. Baywide MP concentrations averaged between 0.19 and 1.24 pieces m^{-3} depending on size fraction (300−1000 and 1000−5000 μm) and sampling month (April and June 2017). Upper bay stations, which are located in or near the estuarine turbidity maximum, had higher MP concentrations than lower bay and New Jersey shore stations. Fragments were predominately polyethylene, and filaments predominately polypropylene. Model results suggest that buoyant particles quickly (i.e., within hours) organize in patchy, highly inhomogeneous distributions, creating "hot spots" of MP. In the presence of variable currents driven by buoyancy, wind, and tides, we predict high spatial and temporal variability of MP distributions in Delaware Bay; MP concentrations could vary by a factor of 1000 within a tidal cycle at our sample locations. Collectively, these observations and simulations provide a baseline of MP concentrations in Delaware Bay along with broader, contextual understanding for how measurements reflect MP concentrations in a dynamic estuarine system.

Simulations
microplastic
$\frac{dX}{dt} = U$
Observations

INTRODUCTION

Plastic marine debris is an emerging pollutant of concern globally.[1,2] About 8 million metric tons of plastic were input globally into the ocean in 2010 largely due to coastal waste mismanagement.[3] Microplastic (MP) in the marine environment occurs in sizes below 5 mm and is the most abundant form of marine debris observed at the ocean surface.[1,4] Previous studies suggest that MP presents serious hazards to individual marine organisms.[1,5] Plastic marine debris often begins as land-derived waste, entering estuaries and the coastal ocean. By providing unique habitat and nutrient resources, these coastal regions support rich ecosystems and high biological productivity. Thus, it is anticipated that biological interactions with MP will occur more often in coastal regions than in the open ocean, influencing MP fate and transport.[6]

Surprisingly, few studies have focused on MP in estuarine and coastal waters, despite the high likelihood for plastic accumulation in these regions.[7] From studies in US estuaries and the Great Lakes,[8−10] MP occur in concentrations at or greater than those observed in much of the open ocean.[1] Here, we focus on MP in the Delaware Bay, which is well mixed about south of 39°15′ (Figure 1), i.e., density does not change with depth.[11] Delaware Bay is fed by the Delaware River, whose yearly average river discharge totals 330 $m^3 s^{-1}$.[11] The Delaware River extends from New York state to Delaware Bay and is the longest undammed river east of the Mississippi River, providing drinking water to ~13 million people, including major cities of Philadelphia and New York City.

The buoyancy-, wind-, and tide-driven estuarine circulation within Delaware Bay likely controls physical transport of marine debris. Tidal currents are strong with maximum speeds of about 1 ms^{-1} in the deep channel.[12] The Delaware Bay is a wide estuary, so that freshwater separates toward the Delaware shore due to Earth's rotation, resulting in buoyancy-driven flows and freshwater river plumes, whose water properties and dynamics are affected by freshwater.[13,14]

Applying both observations of MP in Delaware Bay and model simulations of finer-scale MP distributions as described in Materials and Methods, we provide a baseline of MP concentrations along with contextual understanding for how these point measurements reflect MP concentrations in a dynamic estuarine system through an integrated Results and Discussion section.

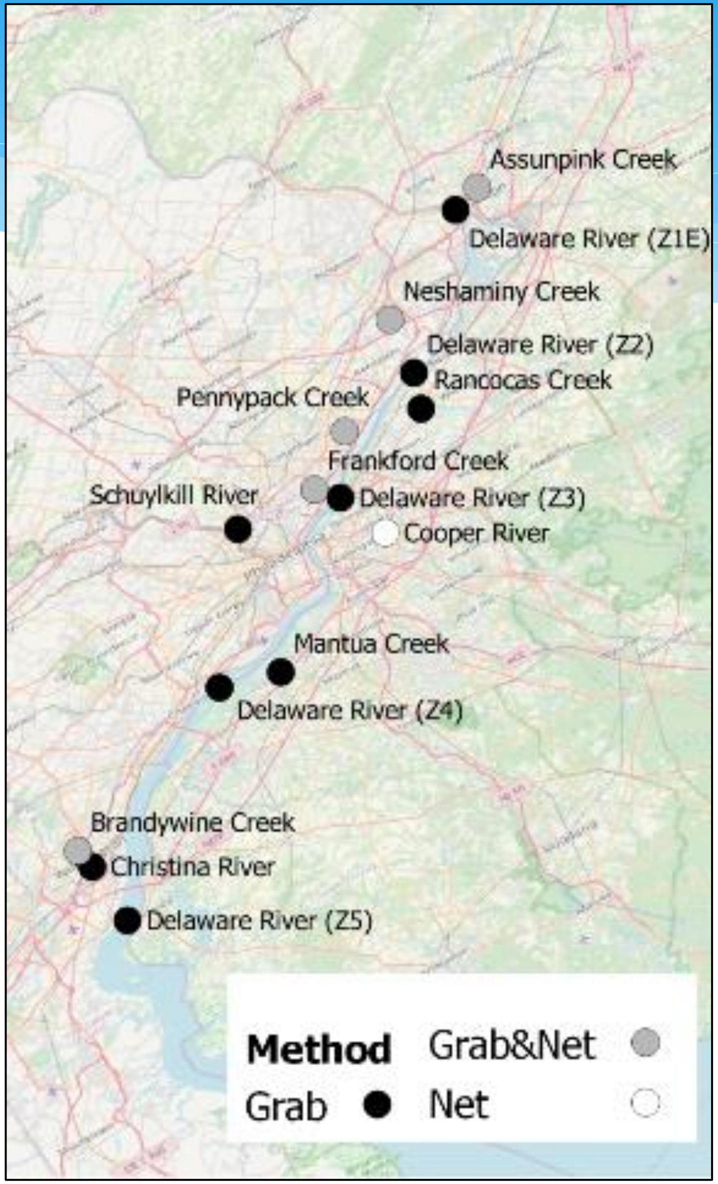
Received: August 8, 2019
Revised: November 7, 2019
Accepted: November 8, 2019
Published: November 8, 2019

https://www.state.nj.us/drbc/library/documents/microplastics-delaware-bay_Cohen-et-al_2019.pdf

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

DRBC Microplastic Study

- DRBC received NFWF funding in 2019 to institute a pilot study on microplastics in the Delaware estuary
- Collect water samples at
  - Four sites in the tidal Delaware River (by boat)
  - One site in non-tidal Delaware River and nine tributary sites (by bridge)
- Use a combination of nets, grab samplers, and Niskin samplers
- Samples analyzed by Temple University – WET Center
  - Plastic concentration, shape, color, size, and composition
- Data would inform models that would allow us to identify high plastic-loading tributaries, which would be targeted for cleanup efforts with partner organizations.

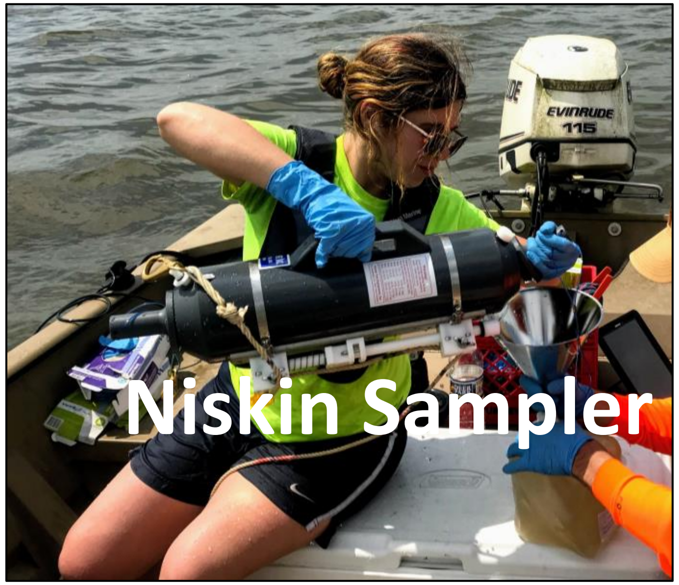


DRBC Sampling Sites

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

How Do We Study Microplastics?

Sample Collection Methods

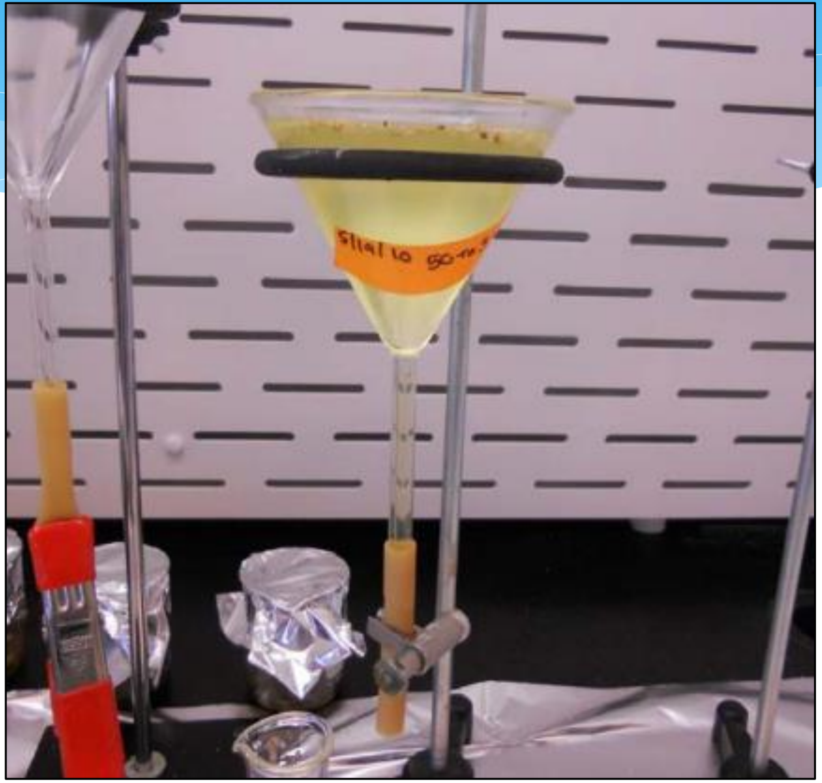


Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

How Do We Study Microplastics?

- Filtering
- Sediment Removal
- Organic Matter Removal

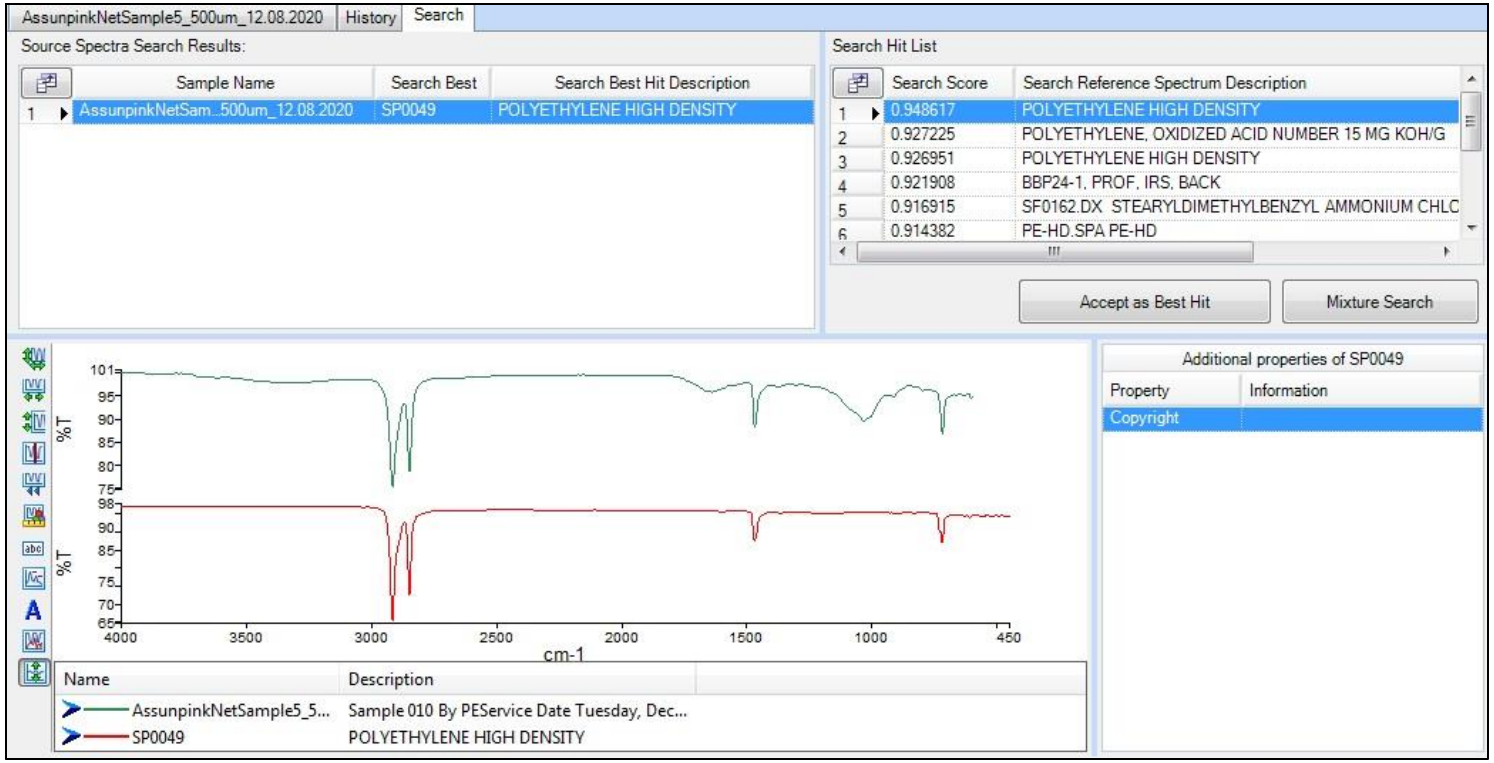
Density Separation (NOAA)



Soil Sieve (https://www.humboldtmfg.com/)

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

How Do We Study Microplastics?



FTIR Analysis Output

- Samples analyzed for plastic concentration, shape, color, size, and composition
- FTIR spectroscopy used to determine composition

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

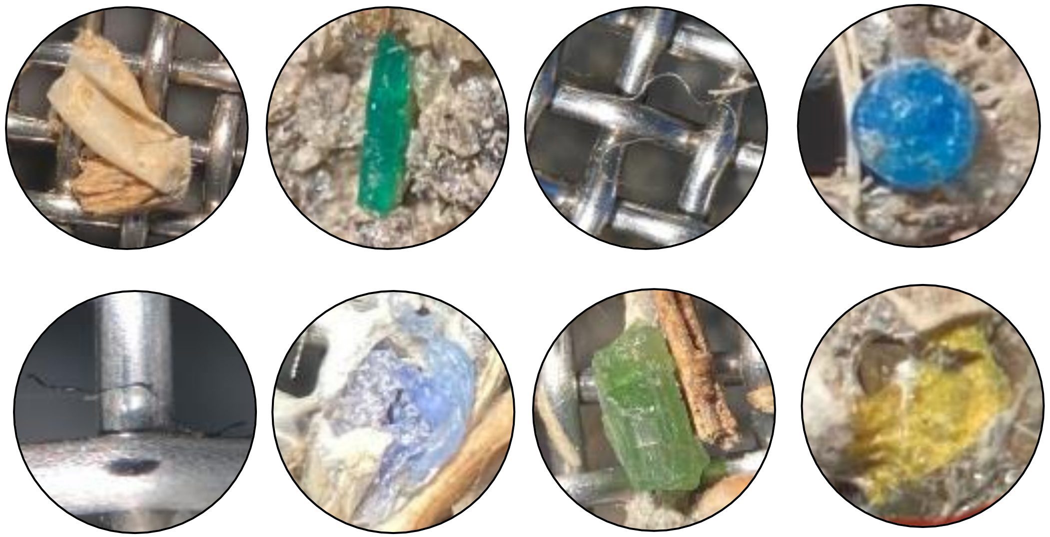
Preliminary Results

- Collected a total of 18 grab samples and 6 net samples
- Plastics found in all samples
- Plastics also found in all blanks

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Results Summary

- Plastics found in all locations using all collection methods
- Grab sampler collected higher concentration of plastics than net sampler
  - Driven by fibers
- Disentangling differences in results between collection methods is important before future studies
- Efforts should be made to standardize collection methodologies



Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

How Can We Help?

Consider using the following to conserve water & reduce plastic waste:

- Refillable coffee mug
- Refillable water bottle
- Reusable bags
- Say “no thanks” to the straw (or BYO)
- BYO carryout containers
- Participate in volunteer cleanup efforts in your local watershed

- DRBC staff and members of the public participated at two cleanup events in 2021
  - Frankford Creek
  - Mainstem Delaware River at Palmyra Cove

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Questions?

NOAA

Contact:

Jake Bransky
DRBC Aquatic Biologist
jacob.bransky@drbc.gov

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA