NY/NJ Baykeeper STEP (Scientific Teaching to Eliminate Plastics) Microplastics Monitoring Program

Dr. Allison Fitzgerald, Restoration Program

Introduction

The Hudson Raritan Estuary (HRE)

The waters surrounding Staten Island, Manhattan, north NJ, and the rest of the NYC urban area are known as the Hudson Raritan Estuary. This estuary extends down from the freshwater tidal reaches of the Hudson River (Tapanzee Bridge) to Sandy Hook, and encompasses such areas as the Hudson and East rivers, Arthur Kill, Raritan Bay and Newark Bay, and all the tributaries that flow into the estuary. The estuary is of historical importance, as this is where Henry Hudson first sailed into the Americas. The estuary teemed with life then, with abundant fish, bivalve, and crustacean populations as well as healthy salt marshes and coastal communities. However, decades of urbanization, replacement of natural shorelines with armored shorelines (bulkheads), dredging to create shipping lanes, and overfishing of key stocks has led to the environment we observe today.

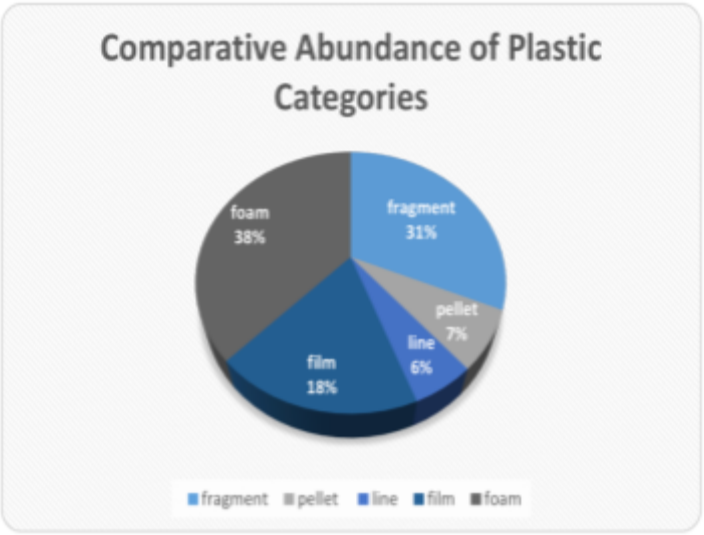
Image courtesy of National Geographic Society. https://www.nationalgeographic.org/maps/hudson-raritan-estuary/

Plastics pollution in the marine environment

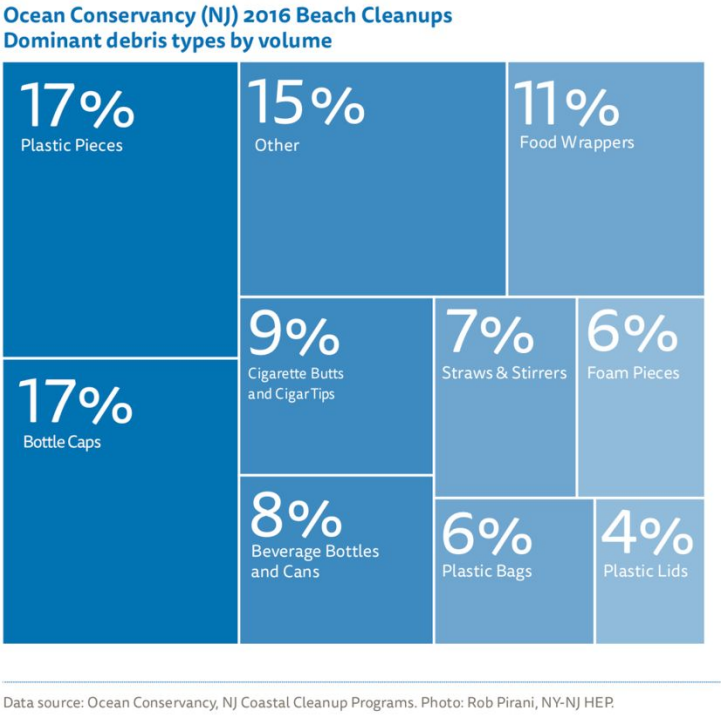
Plastics is now one of the top pollutants in the oceans, and a growing threat to the health and safety of our aquatic ecosystems. Plastics have been found in every ecosystem, from the pristine headwaters of streams to the bottom of the deepest ocean trenches. There are reports of plastic found in all organisms, including plankton and algae at the base of food chains, up to top predators (including humans!). Ingestion of plastic particles is a huge problem to marine life, who often mistake small bits of plastic (microplastics) as food particles and accumulate high concentrations of these microplastics inside their bodies.

How does this plastic get into the estuary? Most microplastics enter the waters as larger pieces of plastic from CSO drains, urban runoff, and point source pollution. Litter from streets nearby the estuary can wash off into the water during storms, or wash into the sewers which can overflow during heavy rains. (not sure what a CSO- Combined Sewer Overflow- is? Check out https://www.nynjbaykeeper.org/campaigns/advocacy/combined-sewer-overflows-csos/ for more information!). These larger particles can breakdown into smaller fragments via photodegradation (from UV rays and heat from sunlight) and also mechanical degradation (from wave action).

A recent study by the NY/NJ Harbor Estuary Program (along with Ocean Conservancy NJ) found that of all beach cleanups performed in the HRE in 2016, 77% of debris found was plastic waste. In 2015, NY/NJ Baykeeper and Rutgers University did a harbor-wide study looking at presence and abundance of microplastics in the water and found that an estimated 165 million pieces of plastic are present in the estuary, with over 85% of that waste being characterized as microplastics (smaller than 5mm size). The most prominent type of plastic Baykeeper found was foam, followed by fragments and films. Coastal areas are known to have higher concentrations of microplastics, as are urban environments; therefore, the extremely urbanized HRE is already at a disadvantage!



NY/NJ Baykeeper Plastics Collection Report, 2016. https://nynjbaykeeper.org/wp-content/uploads/2019/03/NYNJBaykeeper-Plastics-Report-February-2016-2.pdf



How do microplastics affect living organisms in the HRE?

Ingestion of plastic particles has been known to occur in all marine organisms, from the tiniest plankton to the largest whales. A quick google search yields scary results- whales and other large mammals and fish at the top of the food chain are regularly washing up on shore with loads of plastics in their stomachs. Sea turtles, dolphins, and other large animals are prominently displayed in the news when they are entangled in fishing gear and other plastic pollutants (you've probably seen that video of the straw being pulled out of the turtle's nostril!). The WWF estimates that over 100,000 marine mammals are killed by plastic pollution a year!

But, it is the ingestion of small microplastics at the base of the food chain that is of utmost importance. Plastics tend to amplify as the go up the food chain, bioaccumulating at different trophic (feeding) levels. Microplastics (either particles that began small- such as microbeads and microfibers- or fragments of larger plastic debris) can be ingested by zooplankton and small crustaceans which are the food for many bivalves, fish, and mammals are ingesting microplastics. This ingestion is leading to disruptions in food chains and a loss of top predators as

they die from plastic pollution. Organisms may die from the physical effect of the plastic (such as clogged respiratory and feeding structures), or the toxicity effects of the plastic pollution (poisoning due to plastic residue or many contaminants which may sorb to the outside of the plastic particles).

These two figures from Worm et al. (2017) illustrate how microplastics can enter the food chain, and the various effects they have on marine fauna.

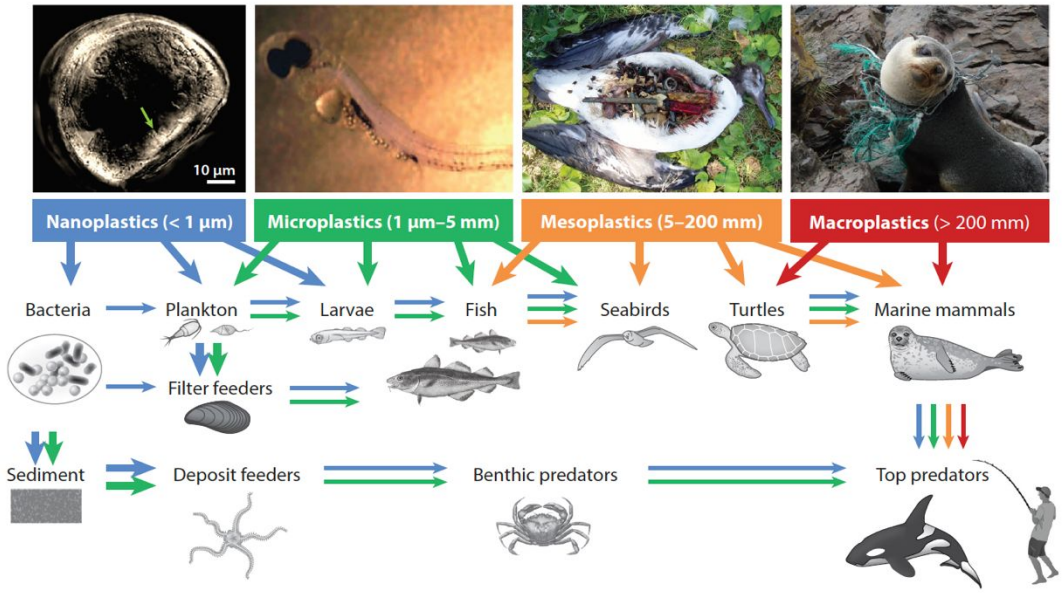


Figure 6

Uptake and possible trophic transfer of plastic pollution in marine food webs. Plastic debris of different size classes has been shown to affect species directly by ingestion or entanglement (*thick arrows*) or indirectly via uptake with food sources (*thin arrows*). Fauna of different sizes and trophic positions will be exposed to particles of different sizes (*blue* to *red*) with some degree of bioaccumulation expected, for both particles themselves (17) and associated chemical pollutants (61, 78). Photographs depict (*left* to *right*) nanoplastic particles taken up by oyster larvae (32), microplastic beads ingested by European perch (14), dead albatross chick with micro- and mesoplastic debris in the stomach (courtesy of Claire Fackler, Marine Photobank), sea lion entangled in macroplastic fishing gear (107).

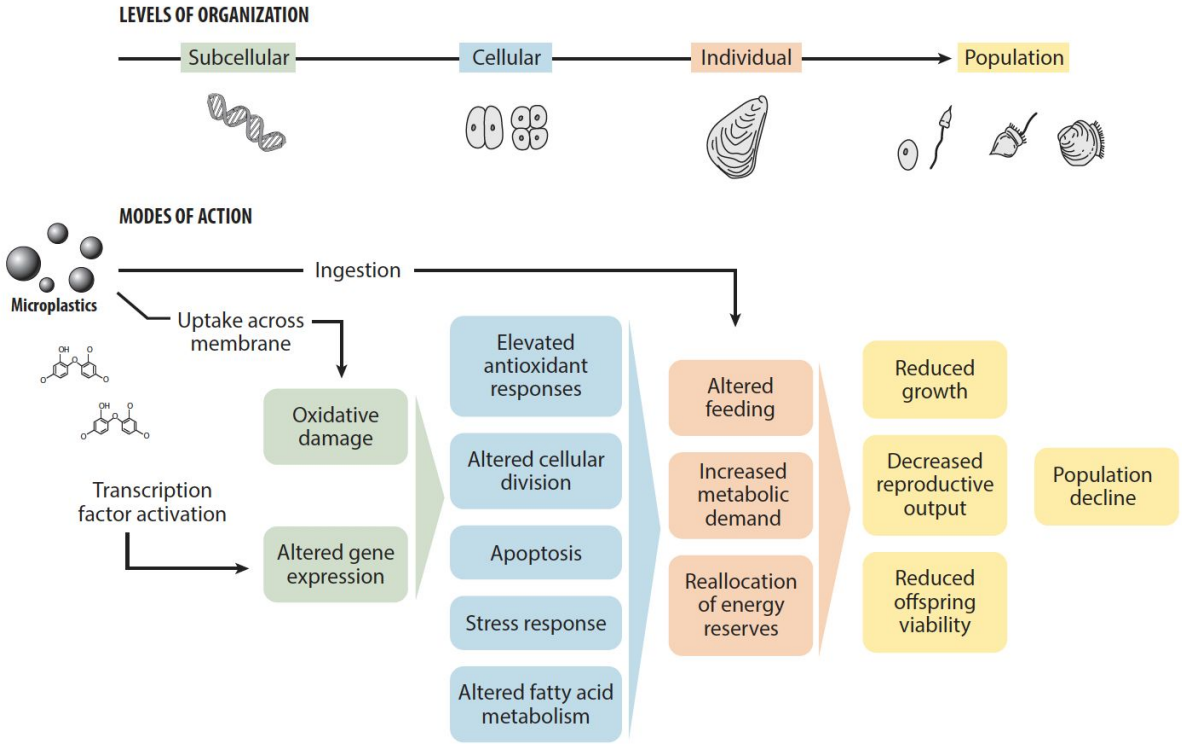


Figure 5

Advocacy and the fight to stop plastics in the HRE

Many citizen science groups around the HRE have joined the fight against plastics. Campaigns aimed at recycling, reducing plastic use, and litter clean-ups are prominent in many areas (including many led by Baykeeper! Check out https://www.nynjbaykeeper.org/campaigns/advocacy/preventing-plastics-pollution/ for plastic reduction tips, and ways you can join our clean ups and advocacy campaigns!). There are several legal initiatives as well, from local governments all the way up to the White House. Microbeads- small plastics that used to be in many cleansers and beauty products- were banned by Presidential order in 2016, and many municipalities around the HRE have plastic bag and product bans in place. Recently, in May 2019 New York State became the second state in the US to have a statewide ban on single-use plastic bags.

Photo from http://www.janewithers.com/selfridges-project-ocean-2/

Cool links to follow for updates on plastic pollution and how you can help!

https://www.nationalgeographic.com/environment/2018/07/ocean-plastic-pollution-solutions/
https://www.nynjbaykeeper.org/campaigns/advocacy/preventing-plastics-pollution/
https://www.cnn.com/2019/04/16/health/ocean-plastic-study-scn/index.html

https://response.restoration.noaa.gov/marine-debris

Sources of information for this handout, and good articles to read about research in microplastics:

- Botterell et al., 2018. Bioavailability and effects of microplastics on marine zooplankton: A review. *Environmental Pollution.* 245 (98-110).
- Worm et al., 2017. Plastic as a persistent marine pollutant. *Annual Review of Environmental Resources*. 42 (1-26).
- Wesch et al., 2016. Towards the suitable monitoring of ingestion of microplastics by marine biota: A review. *Environmental pollution.* 218 (1200-1208).
- NY/NJ Baykeeper. 2015. NY-NJ Harbor Estuary Plastic Collection Report.

What are we going to do today?

During today's sampling, we are going to sample both the beach and aquatic environments. We will collect samples, sort them into different plastic size classes and groups, and discuss the potential impacts of these specific plastics on the biota in the waters off Staten Island.

1. Litter survey on the beach:

Walking in parallel transect across the beach, pick up and catalog all debris found (*see data sheet handed out)
Place all plastic debris in garbage bags to be taken to appropriate trash disposal and recycling locations by Baykeeper

Discussion questions:

A. What was the most abundant trash seen on the beach? Was it plastic, or another type of waste?

B. What was the most abundant plastic type observed on the beach? What size is most of that trash (microplastic, larger whole piece of plastic, or large fragment of a larger plastic)

C. Did the abundance of plastic change as you moved up the beach (away from the water)? Do you think the tides and water flow impact plastics in the estuary and on the shoreline?

D. What types of animals may be most affected by the types of plastic found in the litter survey?

2. Plastics in the water

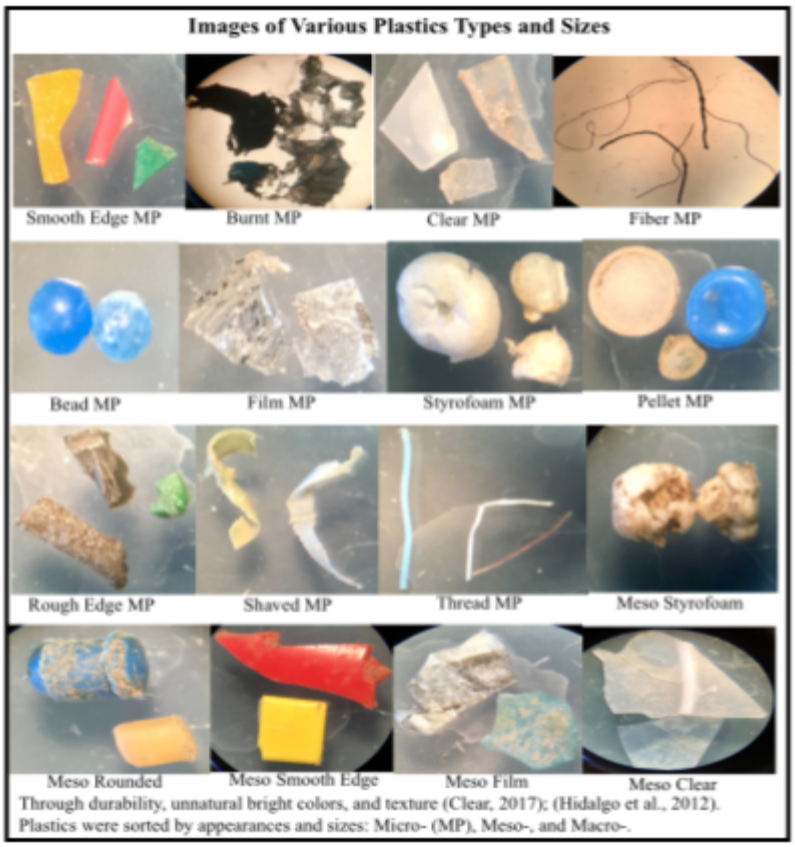
Using various collection methods, we will take several samples for plastics in the water and catalog the type and abundance of plastics found.

Manta trawl being held off a dock in the Passiac River, NJ. 2018

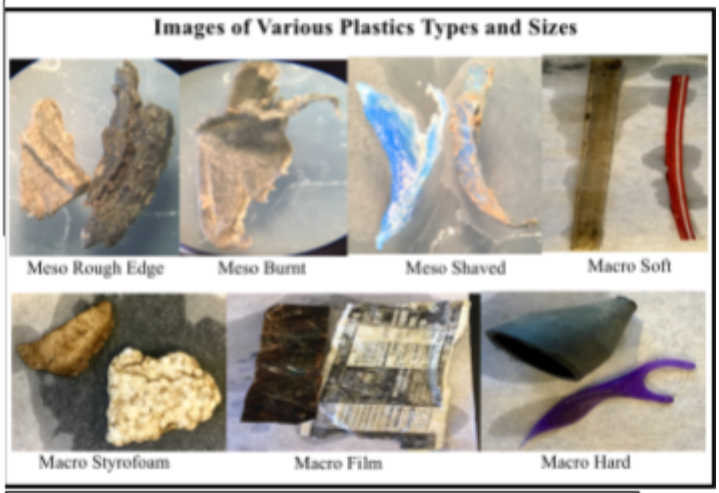
How are plastics captured in marine environments? There are several methods used to collect plastics. We could take a dip sample- when a jar is rinsed in the water and then filled with sample. The sample is then filtered through an appropriately sized sieve (usually 300µm or less to capture microplastics) and size characterized using light microscopes or hand lenses. Another method is to use a Manta trawl, a large net that captures surface particles by being trawled into a current (or held off a dock or in moving water) to allow the water to flow through a mesh net (330µm to capture most microplastics).

Once captured, particles are divided into different size classes and separated based on what material they are made up of.

Array of larger macro-plastics found in a manta trawl sample from the Passaic River. Though the trawl is mainly used to sample microplastics, anything larger than 330□m is retained in the net and could be sampled.



Through durability, unnatural bright colors, and texture (Clear, 2017); (Hidalgo et al., 2012). Plastics were sorted by appearances and sizes: Micro- (MP), Meso-, and Macro-.



Photos courtesy of the Fitzgerald Lab, NJCU.

Discussion questions:

A. What types of plastics did you find in the water sample? What was most abundant?

B. Do you feel the Manta trawl captured an accurate picture of what plastics are in the water? Why or why not?

Wrap up: Post- trip questions and activities.

Thank you so much for collecting this data with us! A huge part of advocating for legal change is having DATA to back up your conclusions. By collecting the abundance and types of plastics around the HRE, Baykeeper is creating a database of information that can be used to help ignite change in plastic pollution around the HRE.

Some activities you can do with the data to reinforce data analysis and conclusions relevant to today's activities:

1. Create a graph of the types of plastic found on the beach. How does this compare to other studies done in the HRE? (Such as the Hudson Riverkeeper's 2018 survey, https://www.riverkeeper.org/blogs/docket/plastic-pollution-data-sweep-2018/).

2. Create a graph and data table from your Manta trawl or dip sample. What types of plastic were most commonly found? Does this compare to what NY/NJ Baykeeper found in their 2015-2016 survey of the HRE? (full report available here https://nynjbaykeeper.org/wp-content/uploads/2019/03/NYNJBaykeeper-Plastics-Report-February-2016-2.pdf)

3. Do some research about the smallest plastic polluters, nanoplastics. These are a growing area of concern, as these small particles (commonly called microfibers) are small enough to be able to slip through the Manta trawl's net and most sieves used. Microfibers, which commonly come from your clothing and enter the water via laundry machine outputs and sewer systems, are smaller than 5mm and often not caught by the wastewater treatment filters in place now. Head to https://www.5gyres.org/plastic-fashion to start looking into this global problem, and what can be done about preventing future microfiber pollution.