NY-NJ HARBOR ESTUARY

MICROPLASTIC PILOT STUDY REPORT

NY/NJ BAYKEEPER

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Figure 1. *Manta trawl net used for plastic collection along Staten Island, NY shore*

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INTRODUCTION

The mass production of plastics exploded during World War II, birthing an era of single-use products marketed to make everyday life easier. Plastic is durable, cheap, and can be molded into any shape, size, and color, employing the material to meet the demands for convenience for a growing population. The United States quickly became reliant on disposable on-the-go products, contributing to immense societal waste. The addiction to unnecessary personal plastic water bottles, utensils, grocery bags, and take away food containers have translated into a serious marine pollution problem in waters throughout the globe. Wide use of plastics, improper waste management practices, stormwater runoff, and littering translates to plastic smog causing degraded marine habitat, jeopardized wildlife, coastal economic hardships, and threatened human health.

Figure 2. *Washed up plastic debris in Keyport, NJ.*

Negative environmental effects caused by plastic pollution are well documented in marine waters. Plastics like rings and fishing line can trap birds and fish and be ingested affecting growth, reproduction, and survivorship (Gregory 1996; Derraik 2002; Thompson et al., 2004; Fendell & Sewell, 2009; Cole et al., 2011; Law & Thompson 2014). Upon entering a river, lake, or other waterway, plastic acts as a sponge for toxic pollutants present in the water, such as PCBs, PAHs, pesticides, and flame retardants to attach themselves to plastic substrates. Several NY-NJ Harbor waters including the Passaic River, Newtown Creek, and Newark Bay are highly contaminated with such pollutants (Teuten et al., 2007; Rochman et al., 2013b; Bakir et al., 2014).

Additionally, plastic is a non-biodegradable material. Plastic photodegrades, by means of the sun's light, and breaks off into tiny pieces of plastic, becoming microplastic. Microplastics are defined as plastic particles smaller than 5 millimeters, about the size of a grain of sand (Arthur, et al 2009).

Microplastics are a notoriously threatening type of plastic marine debris. Due to their size, aquatic creatures can mistake microplastic for food, ingesting the toxins absorbed by the plastic and harming their digestive systems. Microplastic contamination has been found in finfish and shellfish tissues, indicating that microplastics can enter aquatic and likely human food webs (Browne et al., 2008; Farrell 2013; Lusher et al., 2013; Rochman et al., 2013a; Sanchez et al., 2014; Van Cauwenberghe & Janssen, 2014).

Microbeads are one type of microplastic included in personal care products such as toothpastes and body scrubs. Microbeads are often marketed as abrasive "scrubbing agents" but they travel down drains and end up directly into our waterways since they are too tiny to be removed by existing wastewater treatment processes (Fendall & Sewell, 2009). According to a report released by New York State Attorney General Eric Schneiderman, 19 tons of microbeads are released into New York waterways annually (New York State Office for the Attorney General.) President Obama signed the Microbead Free Waters Act into law on December 28, 2015 banning the manufacturing of rinse-off cosmetic products containing plastic microbeads by January 1, 2018 and the sale of products by 2019. While microbeads within select products have been defeated with federal legislation, they will still continue polluting waterways until 2019 when products are banned from store shelves.

Figure 3. *The small jar on the right shows microbeads contained in just 1 weeks' worth (12 grams) of face wash.*

OVERVIEW

This report provides results on NY/NJ Baykeeper's microplastic collection pilot study conducted between March and August 2015 to assess the quantity, type, and distribution of microplastic marine pollution within the NY-NJ Harbor. NY/NJ Baykeeper's Plastic Reduction Campaign involves a three-pronged approach including education, research, and policy. The beginning research question of the pilot study was to determine if microplastic particles are present in NY-NJ Harbor waters.

The goals of the study were to:

- Measure the concentration of microplastics in NY-NJ Harbor waters
- Document the sizes of types of plastics found including nurdles, polystyrene, and film
- Inform NJ and NY lawmakers and members of the public and identify local sources of microplastic pollution.

COLLECTION METHODOLOGY

Eighteen samples were collected in various locations in the NY-NJ Harbor Estuary using a 333 micron (µm) (0.33 mm) manta trawl. The trawl has a rectangular opening of 16 cm high by 61 cm wide. The net is 3 m long with a 30 x 10 cm^2 collection net made of a 0.33 mm mesh size, with a rectangular opening 16 cm high by 61 cm wide. The net is designed to collect floatable debris off the water's surface (Photo 1). Microplastics are referred to plastic particles smaller than 5 mm. The net is of the same specifications used by the Five Gyres Institute for

international ocean studies and for the groundbreaking work completed in the Great Lakes region. The trawl is towed off a boom outside of the boat's wake zone. Sites sampled were selected on the basis of proximity to Combined Sewer Overflow pipes and included the Lower Harbor near Perth Amboy, NJ, Passaic River, Morris Canal, East River, Newtown Creek, Upper New York Bay, Arthur Kill, Lower Newark Bay, and the Upper Newark Bay. The below image shows the location of trawl starting locations.

Figure 4. *Starting points of all sites sampled within the NY-NJ Harbor Estuary*

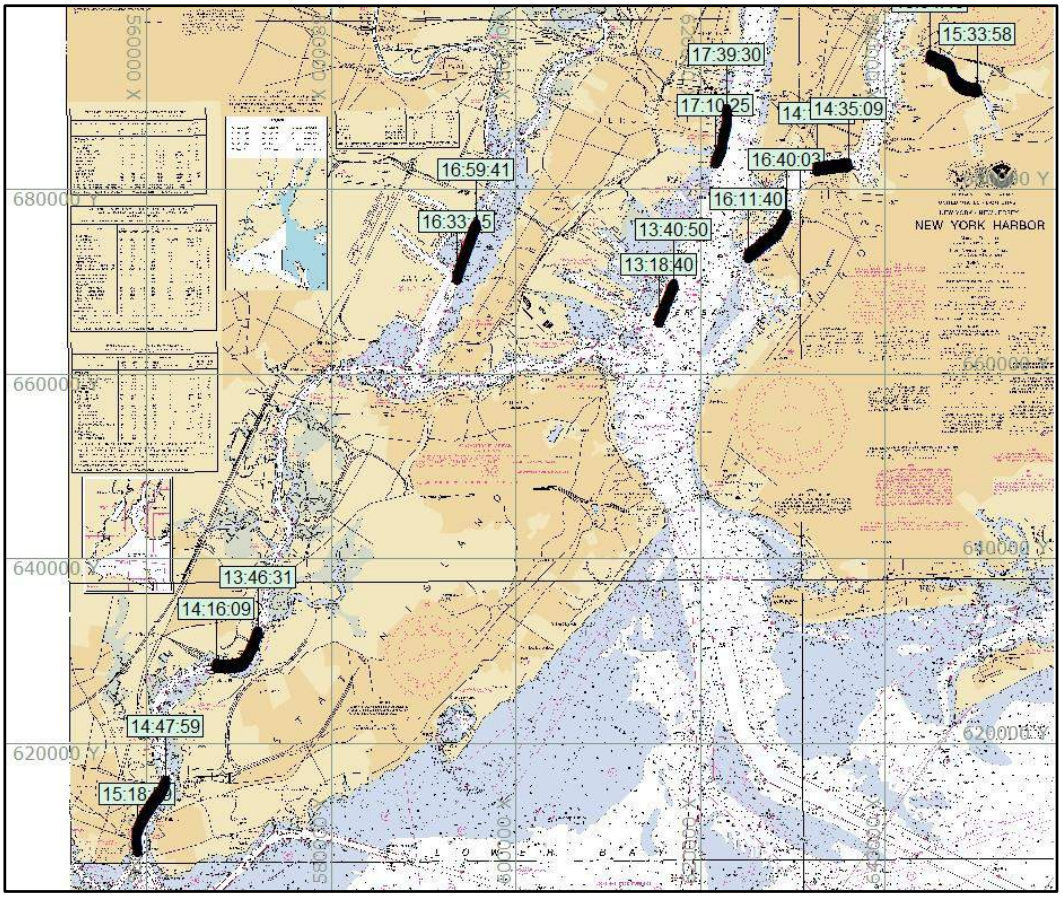

Figure 5. *Distance of plastic sampling sites. Each trawl lasted for a duration of approximately 30 minutes. Photo courtesy of Jim Nickels, Monmouth University's Urban Coast Institute*

Each trawl lasted for a duration of approximately 30 minutes at a constant speed of two knots to effectively operate the net. Due to necessary navigational operations, the distance of each expedition varies slightly based to the state of the tide, wind conditions, and boat traffic. The course of each sampling expedition was not defined; rather, the captain would try to maintain a constant speed for 30 minutes. One sampling event represents data in rainy weather for comparison. The samples are preserved in jars using 70% rubbing alcohol.

Figure 6. *Contents of a sampling trawl in NY Harbor.*

Figure 7. *A water sample collected from Raritan Bay, NJ before lab processing.*

ANALYSIS METHODOLOGY

Analysis methodology was adopted from Dr. Sherri Mason's Great Lakes laboratory protocol and the National Oceanic and Atmospheric Administration's (NOAA) recommendations for quantifying synthetic particles in waters and sediments (Masura, et al 2015). Each of the 18 samples were dried and subject to a wet peroxide oxidation process (WPO) in the presence of an iron (Fe II) catalyst to digest organic material such as twigs and leaves. The plastic remains unaltered. Next, using sieves and a dissecting microscope, plastic was separated into three size classes (0.355-0.999 mm, 1.00-4.749 mm, and >4.75 mm) and then counted. Plastic particles are then categorized into the following: fragment, foamed polystyrene, line, pellet, film, other, and then counted. A buoyancy test was used to confirm if questionable material was plastic.

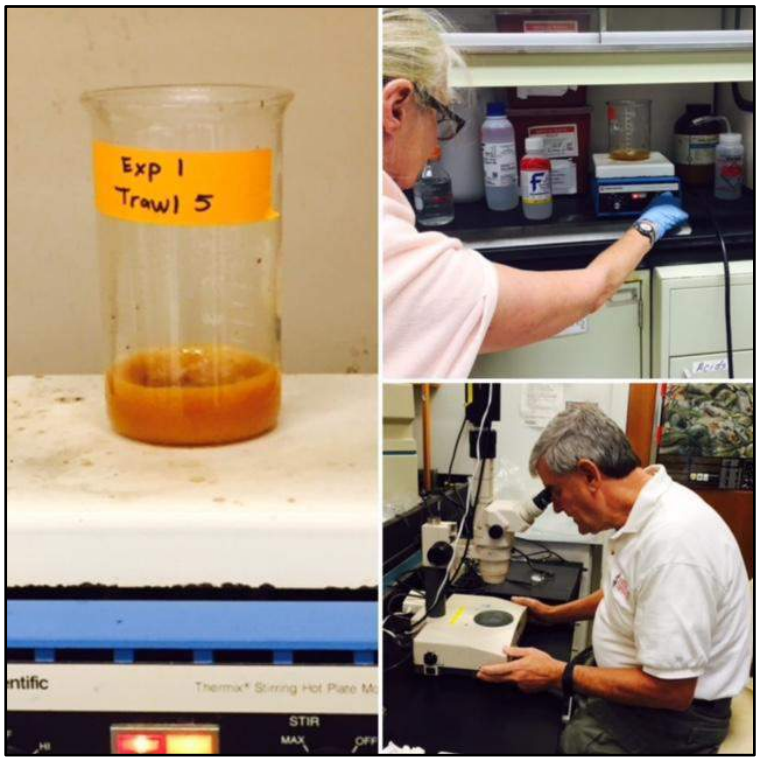

Figure 8. *Samples undergoing oxidation digest and examination under microscope.*

RESULTS

The results of the sample analysis showed that there are in fact microplastics present in NY-NJ Harbor Estuary waters. All samples contained high amounts of plastics. from sampled NY-NJ Harbor waters between March and August 2015. The trawling expeditions uncovered a significant number of pre-production pellets of plastic, also known as nurdles, indicating there is an ongoing influx into Harbor waters. Additionally, the presence of polystyrene foam and blue spherical beads suspected to derive from personal care products were abundant.

A total of 6,932 plastic particles were recovered. Analysis determined that 38% of the particles were less than 1mm; microplastics visual to the naked eye. Based on our estimates, at least 4.6 million plastic particles per square kilometer (km^2) are floating within NY-NJ Harbor Estuary waters. The average abundance was approximately 256,322 microplastic particles/km^2 between all sites sampled. Approximately 85% of particles counted were microplastics (smaller than 5mm). The most abundant type of plastic within all samples was foam.

Figure 9. *Plastic sample collected from Newark Bay exhibited pre-production pellets (nurdles) and microplastic fragments.*

Figure 10. *Plastics separated into size categories three size classes (0.355-0.999 mm, 1.00-4.749 mm, and >4.75 mm) after counting.*

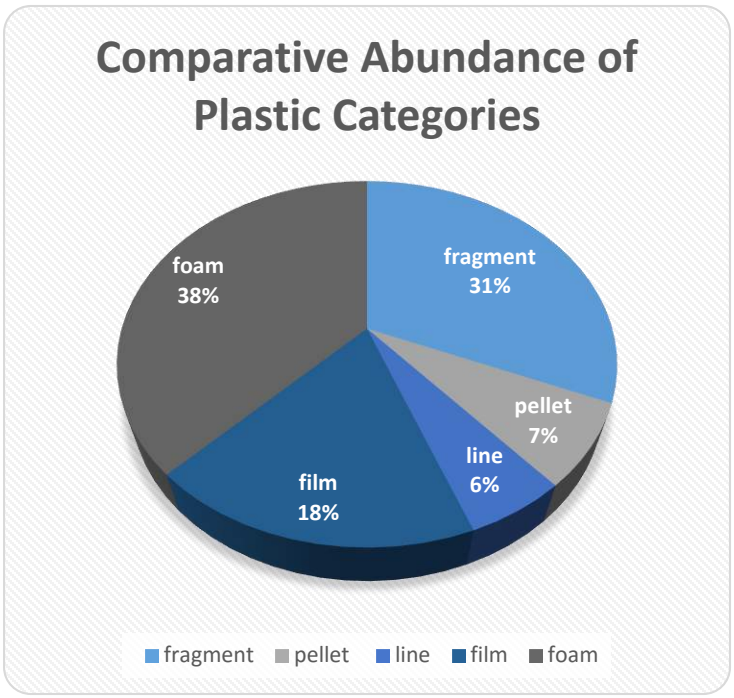

Figure 11. *The most abundant type of plastic observed in our NY-NJ Harbor waters was foam.*

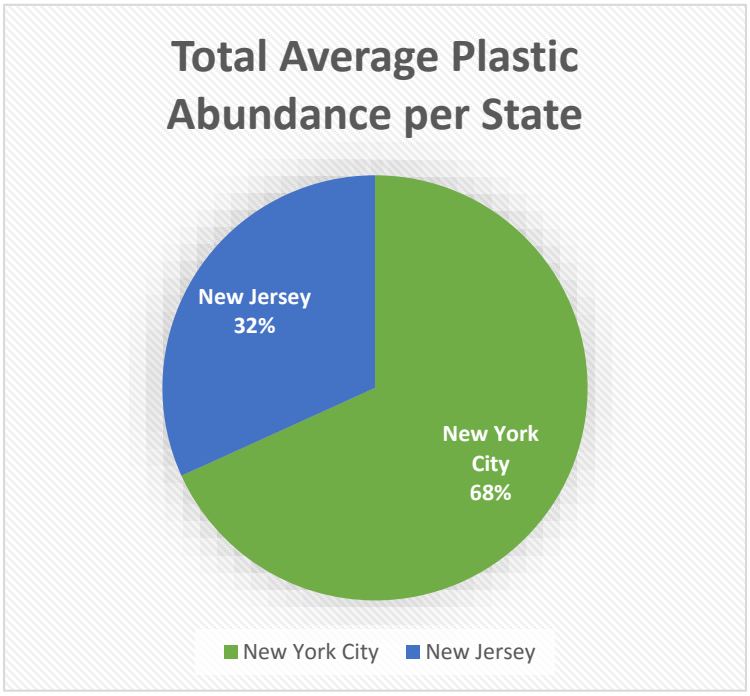

Figure 12. *More than twice as many plastic particles are present in New York City Harbor waters than New Jersey Harbor waters, according to results.*

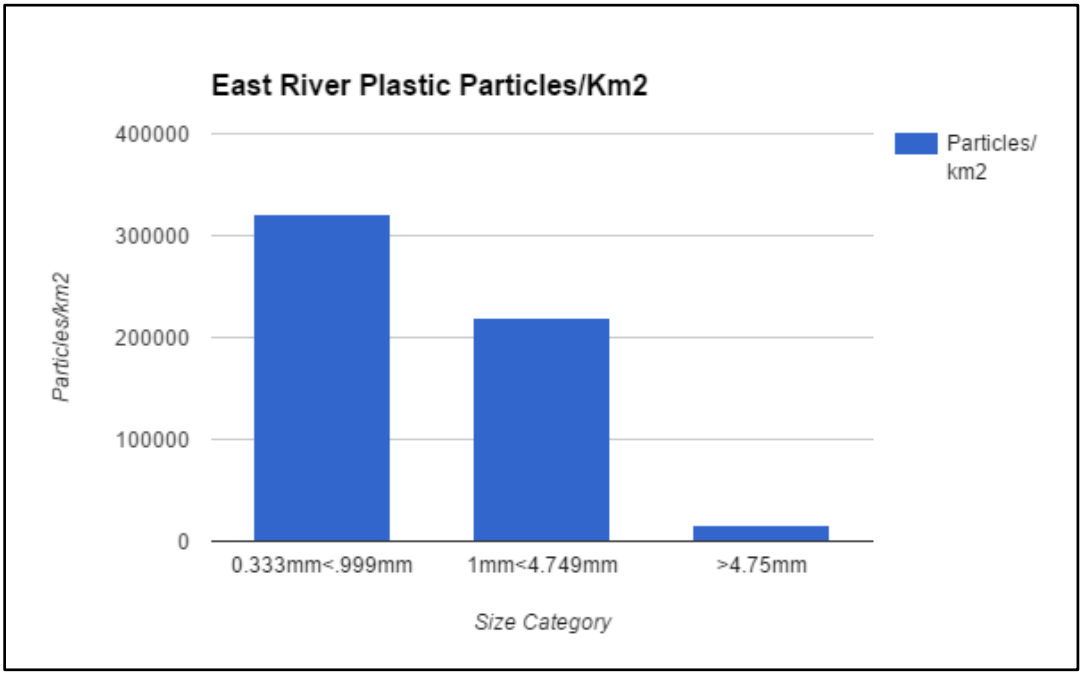

Figure 13. *Approximately 58% of the plastics within an East River, NYC sample were smaller than 1mm.*

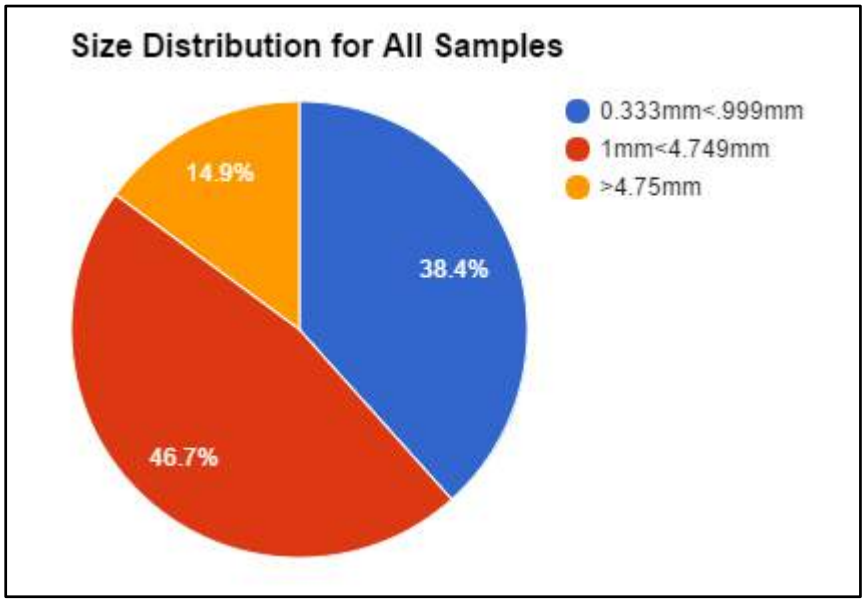

Figure 14. *Approximately 85% of all particles counted were categorized as microplastics (smaller than 5mm).*

DISCUSSION

The intention of this pilot study was to increase public awareness, behavioral changes, and policy initiatives, in addition to providing a first look at quantifying and categorizing plastic marine debris in the NY-NJ Harbor Estuary. While there are several published surveys on the world's oceans and Great Lakes region, there is no published data on NY-NJ Harbor Estuary waters pertaining to plastic pollution.

Results from this pilot study signify that there is a significant amount of plastic particles present, especially in New York City waters. Thus, the data suggests that as population density increases so does plastic pollution. The majority of particles present were smaller than 5mm and the most abundant types of plastics within the samples were foam and unidentified fragments. Foam can derive from consumer single use coffee cups or to-go boxes, packaging peanuts, cooling containers, and industrial product waste.

It should be noted that 18 samples of 30 minute trawls are a small sample size to estimate the total amount of plastic present within the NY-NJ Harbor Estuary. The results may be a function of where sampling occurred, weather, and tidal flow. More sampling will provide definitive results.

NEXT STEPS

Going forward, NY/NJ Baykeeper will collaborate with partners to continue collecting water column samples and conduct analysis and comparing results with partners. Ultimately, next steps include analyzing what the potential impacts are of microplastics entering the human food web, what the effects of these materials are on the estuary's fauna, and the interaction between plastic and persistent contaminants of concern in the NY-NJ Harbor Estuary.

REDUCING PLASTIC POLLUTION

With a population of more than eight billion individuals and thousands of to-go coffee shops and restaurants, New York City has a serious single-use plastic pollution problem that must change. The quickest change starts with you, the consumer. To reduce and eventually eliminate plastic pollution at its source, we must simply stop relying on plastic products for everyday convenience and switch to reusable and natural alternatives.

Simple switches to a plastic free lifestyle include:

- Bring reusable bags to the grocery store.

- Shop products sold in bulk at the grocery store. Check out EcoBags, ECO Lunchboxes, and EcoDitty for a great selection of produce bags, lunch bags, sandwich bags, and more
- Use a reusable glass or stainless steel bottle or mug. We suggest brands such as Klean Kanteen and Love Bottle.
- Carry reusable utensils with you. When ordering take-out, op-out of plastic utensils
- Ask your server to wrap your leftovers in aluminum foil instead of using polystyrene foam boxes.
- Say no to plastic straws at restaurants. Check out Glass Dharma for durable glass straws.
- Use fewer garbage bags by composting food waste and paper.
- Check out all natural personal care products that do not include plastic microbeads. Such products are better for your health and our waterways. NY/NJ Baykeeper has developed a Plastic Free Personal Care Product Guide found here.

In terms of cleaning up the plastic pollution already present in our waterways, one of the most effective methods you can help with are shoreline cleanups. Removing plastic debris before it washes into the ocean reduces the harm it will cause marine life. Contact NY/NJ Baykeeper or your local organization for ways you can help.

No one wants to live in a world where there is more plastic in our waters than fish. Together, we can all make a difference to protect, preserve, and restore our waterways for future generations to come.

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