NY-NJ HARBOR ESTUARY

PLASTIC COLLECTION REPORT

NY/NJ BAYKEEPER

FEBRUARY 2016

Figure 1. *NY/NJ Baykeeper Plastic Reduction team trawling within New York Harbor*

NY/NJ BAYKEEPER PLASTIC REDUCTION PARTNERS

David Conover, Hudson River Sloop Clearwater, Inc.

Dr. Keith Cooper, Department of Microbiology and Biochemistry, Rutgers University

Dr. Marcus Eriksen, Five Gyres Institute

Dr. Sherri Mason, Chemistry and Environmental Sciences, SUNY Fredonia

James Nickels, Monmouth University's Urban Coast Institute

Dr. Beth Ravit, Department of Environmental Sciences, Rutgers University

NY/NJ BAYKEEPER PLASTIC REDUCTION TEAM

Debbie Mans, Executive Director

Sandra Meola, Communications and Outreach Associate

Meredith Comi, Oyster Restoration Program Director

Mitchell Mickley, Field Technician

Justin Procopio, Field Technician

Frank Steimle, Advisor

Shirin Pillai, Intern

Daniel Kukuyev, Intern

TABLE OF CONTENTS

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 widespread use of personal single-use 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, inadequate waste water treatment, 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 soda can 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 polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), pesticides, and flame retardants (Teuten et al., 2007; Rochman et al., 2013b; Bakir et al., 2014). Such organic pollutants are man-made for industrial purposes and do not break down easily. Thus, if a spill or improper disposal occurs, pollutants can remain in water for decades and latch on to plastic material. Several NY-NJ Harbor Estuary waters, including the Passaic River, Newtown Creek, and Newark Bay, are highly contaminated with such pollutants.

Additionally, plastic is a non-biodegradable material. This means that plastic pieces continuously break down into smaller plastic pieces, never entirely going away. Using the sun's light, this breakdown process is called photodegradation.

Microplastics, plastics smaller than 5 millimeters are a notoriously threatening type of plastic marine debris (Arthur, et al., 2009). Due to their size, aquatic creatures can mistake microplastic for food, harming their digestive systems and overall survival. Not only can fish ingest the plastic itself, but they also ingest pollutants that adhered to the plastic. 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 small, colorful plastics (smaller than 5mm) often marketed as abrasive "scrubbing agents." However, the little beads cause big problems. Microbeads 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's wastewater stream annually (New York State Office for the Attorney General). Fortunately, President Obama signed the Microbead Free Waters Act into law on December 28, 2015, thereby 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 week's worth (12 grams) of face wash. The Five Gyres Institute estimates a total of 360,000 microbeads are present in this scrub.*

OVERVIEW

An estuary is comprised of brackish water (combination of both fresh water and salt water) and forms a transition zone where our rivers and tributaries meet the sea. The NY-NJ Harbor Estuary, one of the most urban estuaries on Earth, encompasses the Ports of NY and NJ, as far north as the Tappan Zee Bridge and as far south as Sandy Hook Bay. Our Estuary is home to a range of habitats including wetlands, shorelines, and coastal forests. A diverse range of bird species, including birds of prey, water birds, and migratory birds call the NY-NJ Harbor their home along with crabs, fish, eel, and clams.

This report provides results on NY/NJ Baykeeper's plastic collection pilot study conducted between March and August 2015 in NY-NJ Harbor Estuary waters.

The goals of the pilot study were to:

- Assess the sizes, types, and concentrations of plastics in NY-NJ Harbor Estuary waters
- Inform NJ and NY lawmakers to influence policy
- Educate the public and encourage behavioral changes
- Identify local sources of plastic and microplastic pollution

Based on NY/NJ Baykeeper's estimates, at least 165 million plastic particles are floating within NY-NJ Harbor Estuary waters at any given time. Approximately 85% of particles counted were microplastics (smaller than 5mm) and the most abundant type of plastic present in samples was foam (38%).

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 designed to collect floatable debris off the water's surface (Figure 4). 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. 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. Sites sampled were selected on the basis of proximity to Combined Sewer Outfall (CSO) pipes and included the Lower Harbor near Perth Amboy, NJ, the Passaic River, the Morris Canal, the East River, Newtown Creek, the Upper New York Bay, the Arthur Kill, the Lower Newark Bay, and the Upper Newark Bay (Figure 5). The net is towed outside of the boat's wake zone for a duration of approximately 30 minutes at a constant speed of two knots. Due to necessary navigational operations, the distance of each expedition varied slightly based on the state of the tide, wind conditions, and boat traffic (Figure 6). The course of each sampling expedition was not defined; rather, the captain would try to maintain a constant speed for 30 minutes. After 30 minutes, the net was retrieved onto the boat and washed down. The contents within the net were transferred into a bucket and sieved to rinse off and remove large organic material (Figure 7). The samples are preserved in jars using 70% rubbing alcohol (Figure 8).

Figure 4. *Manta trawl net used for plastic collection*

Figure 5. *Starting points of sites sampled within the NY-NJ Harbor Estuary*

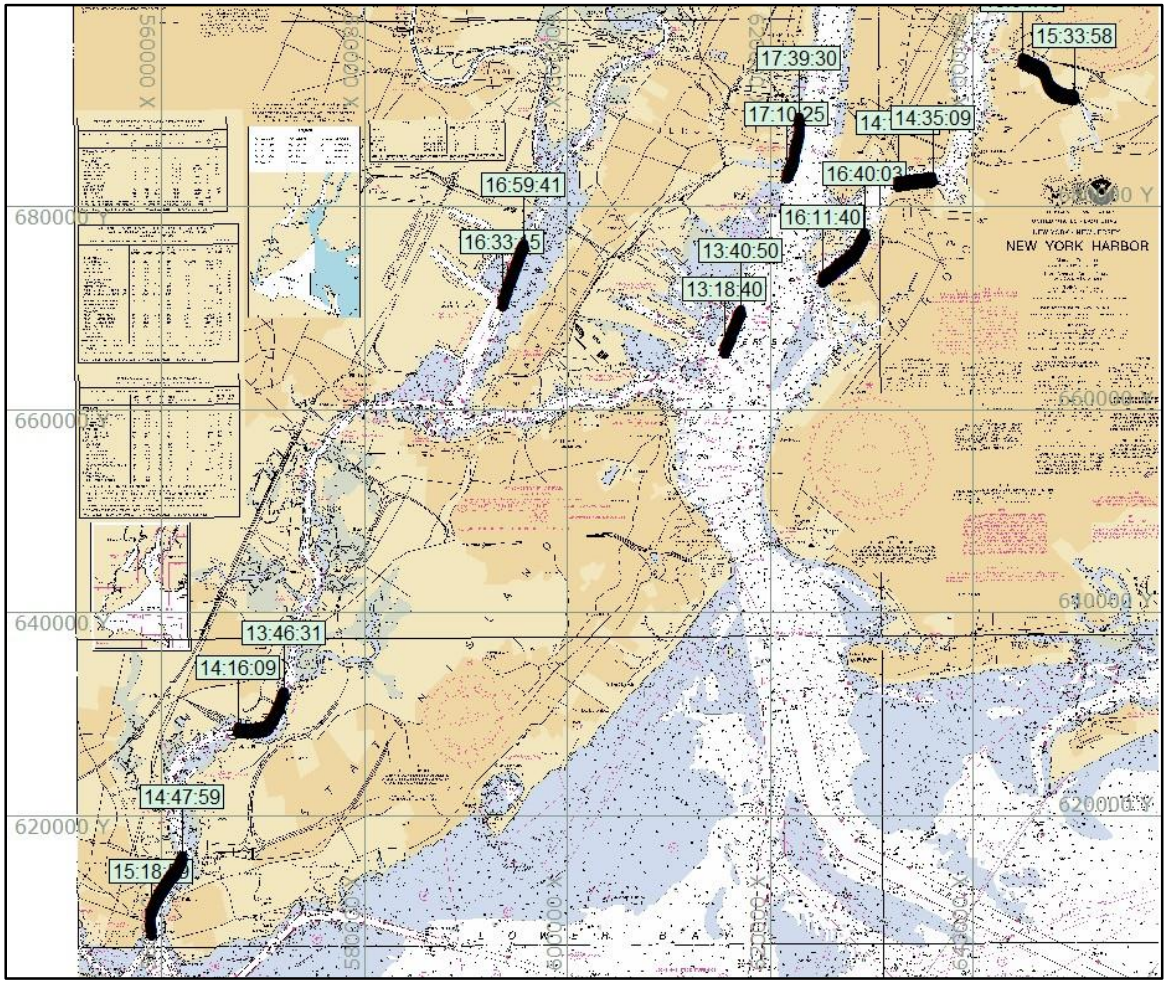

Figure 6. *Distance of plastic sampling sites. Each trawl lasted for a duration of approximately 30 minutes. Not all sampling sites are represented on this map. Photo courtesy of Jim Nickels, Monmouth University's Urban Coast Institute*

Figure 7. *Contents of a sampling trawl in Newark Bay, NJ.*

Figure 8. *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 eighteen 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 (Figure 9). The plastic remains unaltered (Figure 10). 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 (Figure 11-12). A buoyancy test was used to confirm if questionable material was plastic. Plastic particles are then categorized into the following and then counted:

- Fragment – unidentified hard piece of plastic
- Foam – also known as polystyrene or "Styrofoam" used to make single use coffee cups, eatery to-go boxes, and packaging peanuts
- Line – fishing line and clothing fibers
- Pellet – plastic spheres such as microbeads from personal care products or pre-production balls of plastic known as nurdles
- Film – flimsy, thin plastic likely from plastic bags and shipping plastic wrap

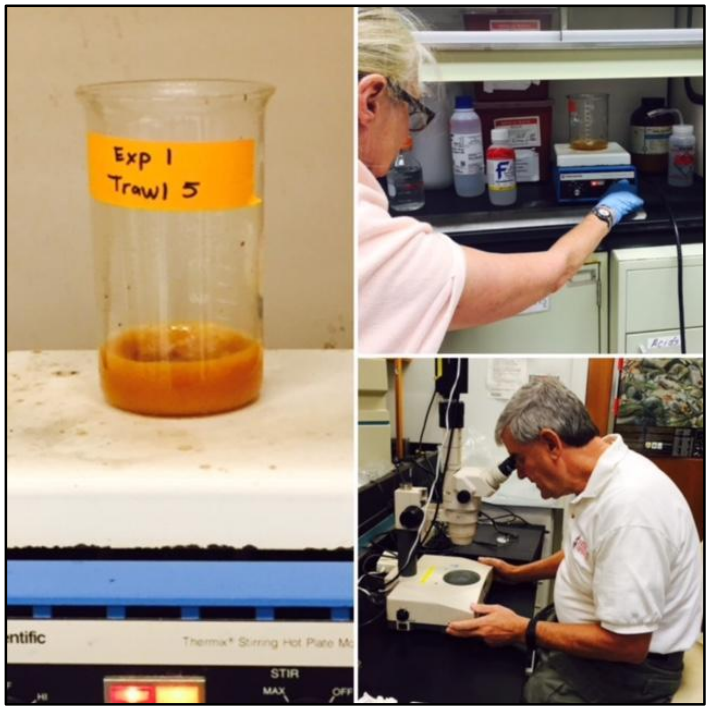

Figure 9. *Samples undergoing oxidation digest and examination under microscope.*

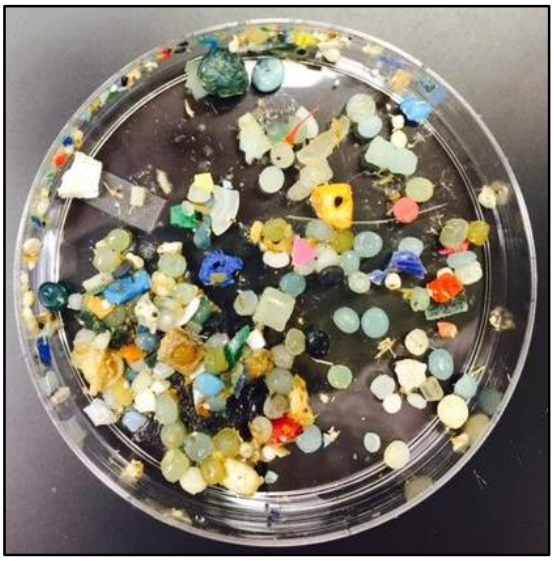

Figure 10. *Plastic sample collected from Newark Bay exhibited pre-production pellets (nurdles) and microplastic fragments. The smallest particles counted were approximately the size of a grain of sand.*

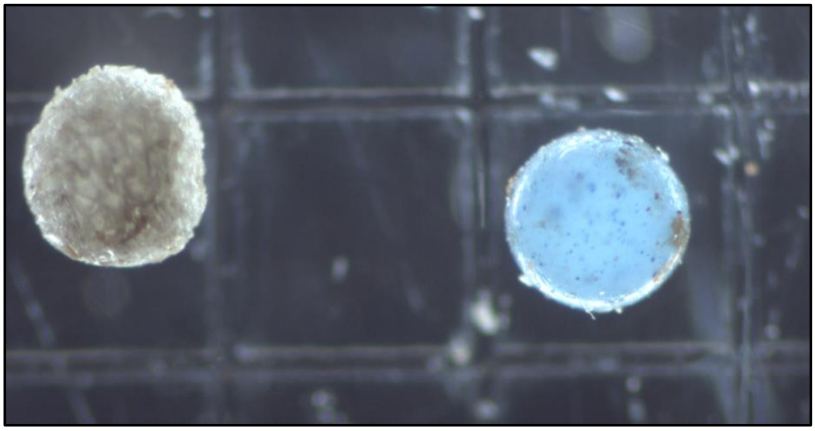

Figure 11. *A blue plastic microbead pictured on the right along with a spherical piece of foam, both measuring less than 5mm.*

Figure 12. *Plastics separated into size categories three size classes (0.355-0.999 mm, 1.00-4.749 mm, and >4.75 mm) after counting.*

RESULTS

The results of the sample analysis show significant concentrations of plastics present in NY-NJ Harbor Estuary waters. 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 (Figure 13).

Based on our estimates, at least 165,840,512 million plastic particles are floating within NY-NJ Harbor Estuary waters at any given time. The average abundance was approximately 256,322 plastic particles/km^2 between all sites sampled. The average plastic quantity per square kilometer sampled in New York waters was approximately twice the average of New Jersey waters. An East River, NYC represents the highest abundance at 556,484 particles/km^2. More sampling is needed to determine if this trend is statistically significant (Figure 14). Of the total 6,932 plastic particles counted, approximately 85% of particles counted were microplastics (smaller than 5mm) and 38% were smaller than 1mm (Figure 15). In one East River New Sample, approximately 58% of particles counted were smaller than 1mm, the size of a grain of sand (Figure 16). The most abundant types of plastics within the samples were foam (38%) and unidentified fragments (31%).

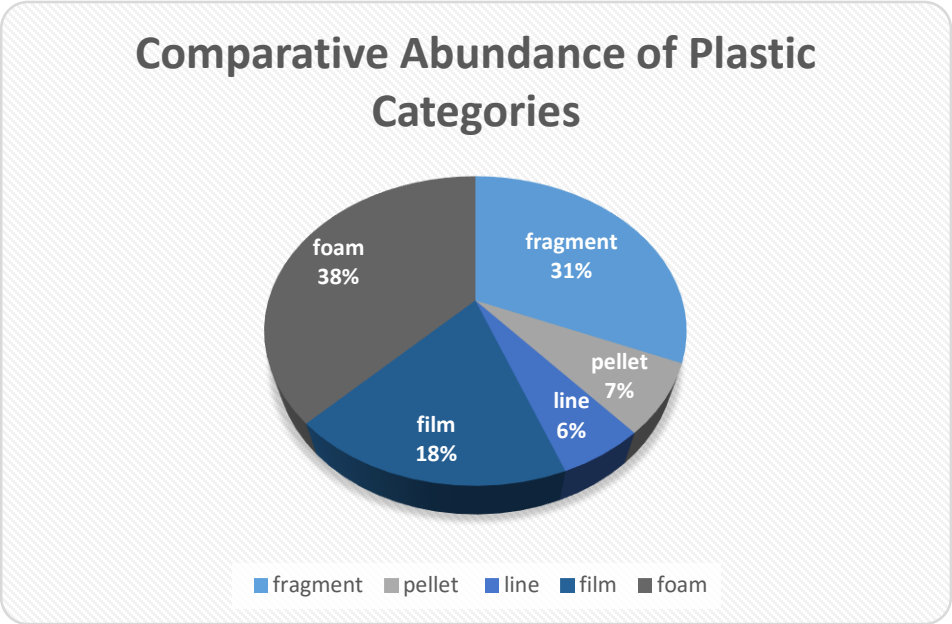

Figure 13. *The most abundant type of plastic observed was foam.*

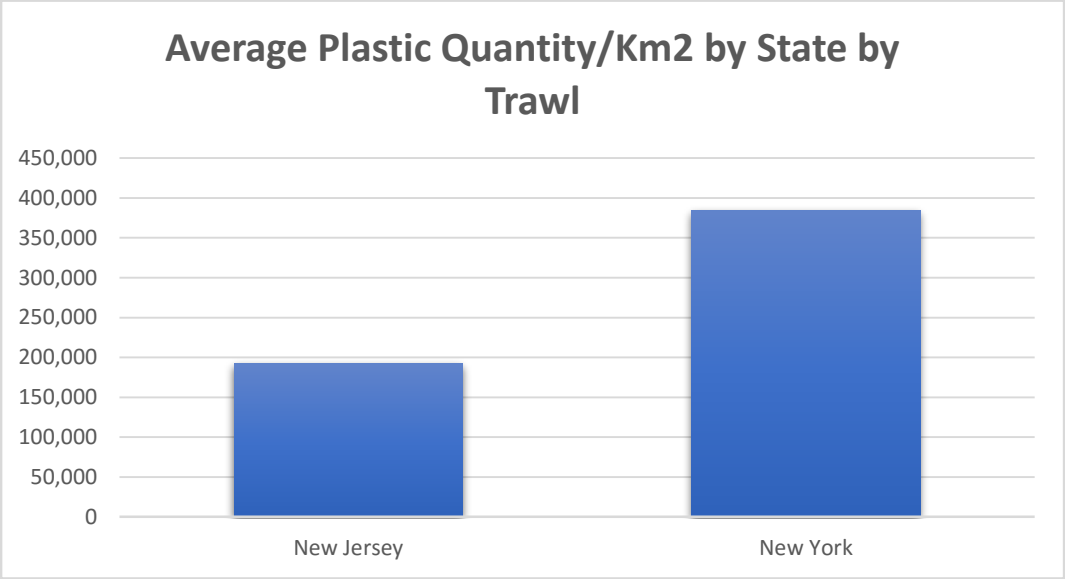

Figure 14. *The average plastic quantity per square kilometer sampled in New York state waters is approximately twice the average sampled in New Jersey waters. More sampling is needed to determine if this trend is statistically significant.*

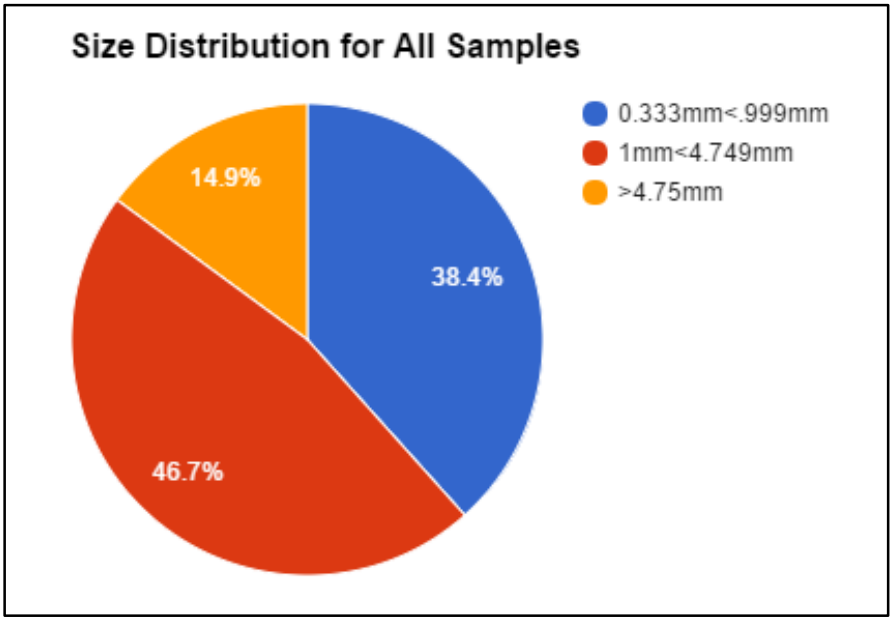

Figure 15. *Approximately 58% of the plastics within a sample taken from the East River, NYC were smaller than 1mm. Approximately 85% of all particles counted were categorized as microplastics (smaller than 5mm).*

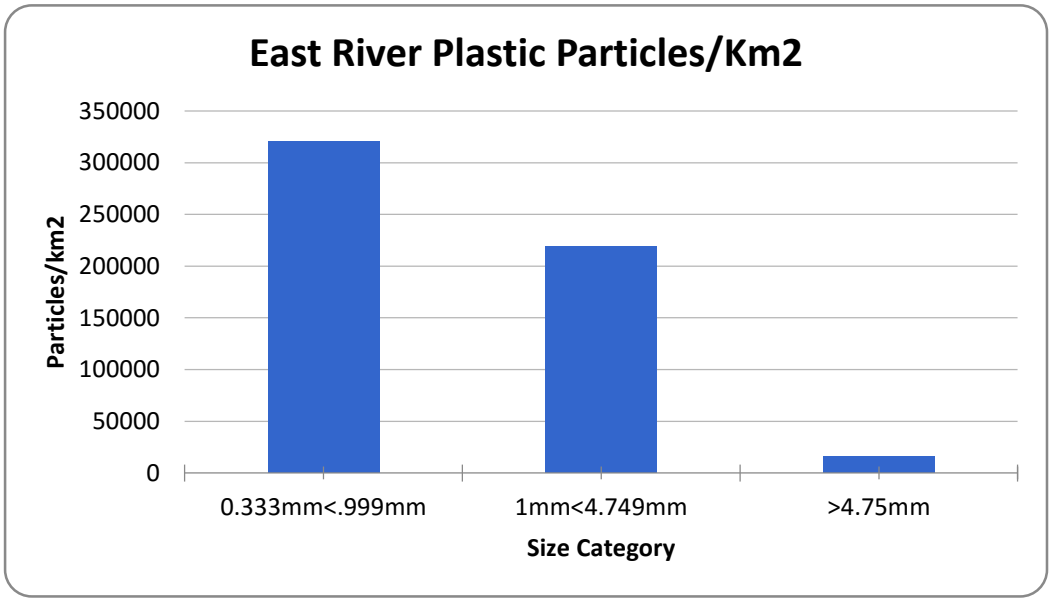

Figure 16. *Approximately 58% of the plastics within a sample taken from the East River, NYC were smaller than 1mm. This sample represents the highest particle count/km2 at 556,484.*

DISCUSSION

NY/NJ Baykeeper is the first organization to complete a plastic research within NY-NJ Harbor Estuary waters. Prior to our sampling, no other group was pursuing plastic research within one of the most urban estuaries on earth so we chose to dive in head first in hopes of improving our watershed. The intention of this study was to increase public awareness and influence behavioral changes and policy initiatives, in addition to providing a first look at quantifying and categorizing plastic marine debris.

The results from this pilot study are startling. Eighty-five percent of plastic particles present in samples are categorized as microplastics. When just one large piece of plastic such as a single use spoon, water bottle, or plastic bag enters our waterways and breaks down, the harmful impacts to wildlife and our own well-being from the numerous pieces of plastics used daily are unfathomable

Policy initiatives, consumer education, and behavioral change must occur as soon as possible to reduce the ever-growing plastic smog exhibited not only in the NY-NJ Harbor Estuary, but throughout our oceans.

Although results from this pilot study portray a significant amount of plastic particles present (approximately 165 million), the current study size of eighteen 30-minute trawls is limiting to estimate the total amount of plastic present within the NY-NJ Harbor Estuary. Additionally, while it appears that twice as much plastic is present in New York waters than New Jersey waters, more sampling, to resume in Spring 2016, is needed to determine definitive results.

NEXT STEPS

Going forward, NY/NJ Baykeeper will collaborate with study partners to continue collecting water column samples, analyze, and compare results. We will analyze what the potential impacts are of microplastics entering the human food web, what the effects of these materials are on the estuary's wildlife, 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 million 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 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, such as Klean Kanteen and Love Bottle.
- Carry reusable utensils with you. When ordering take-out, opt-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. Check out Glass Dharma for durable glass straws.
- Dispose of cigarette butts in a receptacle. The filter is composed of plastic.
- 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. Check out NY/NJ Baykeeper's Plastic Free Personal Care Product Guide. When in doubt, check the product label for polyethylene or polypropylene. If the product contains either of these ingredients, it contains plastic microbeads.

Cleaning up plastic already in our waters:

One of the most effective methods of cleaning up the plastic pollution already present in our waterways is participating in shoreline cleanups. Removing plastic debris before it washes into the ocean reduces the harm it will cause marine life when carried out to deeper Harbor waters and the ocean. Encourage others to never litter, always recycle, and make it a habit to go plastic-free. Contact NY/NJ Baykeeper or your local environmental organization for ways you can help.

Our world's oceans are expected to contain 1 metric ton of plastic for every 3 metric tons of fish by 2025, and by 2050, more plastics than fish by weight (Ellen MacArthur Foundation). 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 enjoy.

REFERENCES

Arthur, C., Baker, J., & Bamford, H., Eds. Proceedings of the International Research Workshop on the Occurrence, Effects, and Fate of Microplastic Marine Debris. Sept 9-11, 2008. NOAA Technical Memorandum NOS-OR&R-30, 2009.

Bakir, A., Rowland, S.J., Thompson, R.C. 2014. Transport of persistent organic pollutants by microplastics in estuarine conditions. Estuarine, Coastal, & Shelf Science 140:14-21.

Browne, M.A., Dissanayake, Galloway, /t.S., Lowe, D.M., Thompson, R.C. 2008. Ingested microscopic plastic translocates to the circulatory system of the mussel, *Mytilus edulis* (L). Environmental Science & Technology 42(13):5026-5031.

Cole, M., Lindeque, P., Halsband, C., Galloway, T.S. 2011. Microplastics as contaminants in the marine environment: A review. Marine Pollution Bulletin 62:2588-2597.

Derraik, J.G.B. 2002. The pollution of the marine environment by plastic debris debris: a review. Marine Pollution Bulletin 44:842-852.

Ellen MacArthur Foundation. 2016. The New Plastics Economy: Rethinking the future of plastics. World Economic Forum.

Farrell, P., Nelson, K. 2013. Trophic level transfer of Microplastic: *Mytilus edulis* (L.) to *Carcinus maenas* (L.). Environmental Pollution 177:1-3.

Fendall, L.S., Sewell, M.A. 2009. Contributing to marine pollution by washing your face: Microplastics in facial cleansers. Marine Pollution Bulletin 58:1225-1228.

Gregory, M.R. 1996. Plastic 'scrubbers' in hand cleansers: a further (and minor) source for marine pollution identified. Marine Pollution Bulletin 32:867-871.

Lusher, A.L., McHugh, M., Tompson, R.C. 2013. Occurance of microplastics in the gastrointestinal track of pelagic and demersal fish from the English Channel. Marine Pollution Bulletin 67(1-2):94-99.

Masura, J., et al. 2015. Laboratory methods for the analysis of microplastics in the marine environment: recommendations for quantifying synthetic particles in waters and sediments. NOAA Technical Memorandum NOS-OR&R-48.

New York State Office for the Attorney General, "Discharging Microbeads to Our Waters: An

Examination of Wastewater Treatment Plants in New York," April 2015, http://www.ag.ny.gov/pdfs/2015_Microbeads_Report_FINAL.pdf

Rochman, C.M., Hah, E., Kurobe, T., Teh, S.J. 2013a. Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress Scientific Reports 3:1-7.

Rochman, C.M., Hoh, E., Hentschel, B.T., Kaye, S. 2013b. Long-term field measurements of sorption of organic contaminants to five types of plastic pellets: implications for plastic marine debris. Environmental Science & Technology 47:1646-1654.

Sanchez, W., Bender, C., Porcher, J-M. 2014. Wild gudgeons (*Gobio gobio*) from French rivers are contaminated by microplastics: Preliminary study and first evidence. Environmental Research 128: 98-100.

Teuten, E.L., Rowland, S.J., Galloway, T.S., Thompson, R.C. 2007. Potential for plastics to transport hydrophobic contaminants. Environmental Science & Technology 41(22):7759-7764.

Van Cauwenberghe, L. & Janssen, C.R.2014. Microplastics in bivalves cultured for human consumption. Environmental Pollution 193:65-70.