The inspiration for this research arose out of happenstance and out of personal interest. Microplastics, which are plastics smaller than 5 mm in size, are an ever increasing problem. With the decades-long mass use of plastics, coupled with natural degradation of plastics, plus products that use microplastics, we have a titanic impending environmental problem on our hands. We need to understand how these plastics affect the environment, how they affect our food supplies, and how we can take care of the problem. Several studies have found that microplastics negatively affect the ecosystem, partially due to plastic's ability to absorb and emit toxins. When plastics are ingested by animals, hazardous chemicals in the plastics may leach out and be absorbed into the animal's body (US EPA 1992b). The overall effect of microplastic toxin absorption is not yet fully understood. It is believed that marine organisms consume plastic particles after mistaking them for prey, then allowing the plastics into the food chain to make their way up to larger and larger organisms. Plastics also cause damage to animals through entanglement, malnutrition, suffocation, and decreased mobility (Marine Pollution Bulletin 2016).

Our microplastics characterization and toxicology study is aimed at understanding what is going into the environment, by quantifying the physical size and shape of the plastics. The toxicology study aimed at quantifying the amount and rate of chemical uptake by microplastics. Fluorescence microscopy was used as a tool to enable characterization of microplastics, specifically polyethylene and polypropylene, as sourced from a Neutrogena face scrub and a Crest toothpaste. To study how these plastics absorb and emit toxins, we used UV/Vis spectroscopy to analyze the toxin concentration over time. Characterization and toxicology are good first steps in understanding the long term impact of these plastics on the environment.

We found that Neutrogena microplastics are made out of polyethylene, with two mean area populations centered about 0.1 mm2 and below 0.03 mm2. The shape of these plastics range from irregularly oblong to round. Minimum diameters for the Neutrogena samples had two mean values at 0.4 mm and below 0.05 mm. The maximum diameters were centered about 0.45 mm and below 0.05 mm. The aspect ratio, which is the minimum Feret diameter divided by the maximum Feret diameter, was centered about 0.7. The aspect ratio indicates a shape, where 1 indicates round and close to 0 indicates threadlike. With a mean aspect ratio of 0.7, the Neutrogena plastics were roughly pill shaped.

The Crest toothpaste microplastics were made out of polyethylene, with a mean area population residing below 0.0125 mm2. The shape of these plastics are normally distributed around an oblong shape--roughly oval, as indicated by the mean aspect ratio of 0.7. The minimum and maximum Feret diameters for the sample population were heavily skewed below 0.05 mm2 The Crest microplastics are much smaller than Neutrogena, likely due to the nature of the product's use. Crest's product is used on teeth, and the plastics contained in the toothpaste pose a hazard to ingestion and to gouging enamel. Neutrogena microplastics were more uniformly shaped, also likely due to the product's use. Roughly shaped plastics would gouge the skin.

We conducted a series of toxicology experiments on Neutrogena microplastics using bisphenol-A (BPA). The concentration of BPA that we used is the concentration of BPA in Cayuga Lake: 0.1 mM. The results of the study show that plastic in the presence of a toxin will begin to absorb the toxin within the first hour, leading to a decrease in UV/Vis spectra absorption by (70 ± 15) percent. The absorption of the spectral peaks directly relate to the concentration of BPA in the samples. Less BPA means a lower absorption spectral peak. Future work for the toxicology experiments would use different surface areas of plastic, and different toxins, to see if the effect is similar. Another future experiment would be to make various solutions of BPA with concentrations less than 0.1 mM to see directly how the spectra relate to a concentration.

Knowing the mean areas of these two products plastics allows us to know a range of sizes to look for in the environment. Additionally, we would be able to run more accurate experiments on fish to test what size and shape plastics they would mistake for prey. There are studies that have been conducted that show that animals do mistake these plastics for food, and by such studies, plastics could increase in wildlife via biomagnification. Knowing the sizes and shapes of these plastics helps allow us to find a way to get rid of these plastics.

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annote="Method to study toxicolgy absorbtion from an experiment that is testing a high efficiency polymer filter. We will model our methods after theirs, and also look to use similar toxins that their paper uses, such as BPA and estrogen. They also correct their UV/Vis data to the zero absorbance at 600 nm. From their method, they use a 45 nm syringe filter, and I'd like to follow up on whether those filters can be reused or if they are single use only. I'd also like to know if their experiments protect against evaporation of the toxin solution used, as for my experiment evaporation would be a large contribution to error."
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title = {Are we eating plastic-ingesting fish?},
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}

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annote="Methods for plastic removal from products using sieves and vacuum filtration, as well as exhaustive washing. They used a nikon camera to take images and also used FTIR analysis to identify types of plastics. They used a gridded Petri dish to facilitate particle counting, and suspended toothpaste particles in t-butanol. I'd like to know if other types of plastics can be suspended in a solution other than water. I'd also like to know if they used multiple ways to try to separate the plastics, or if they only used sieves and vacuum filtration."
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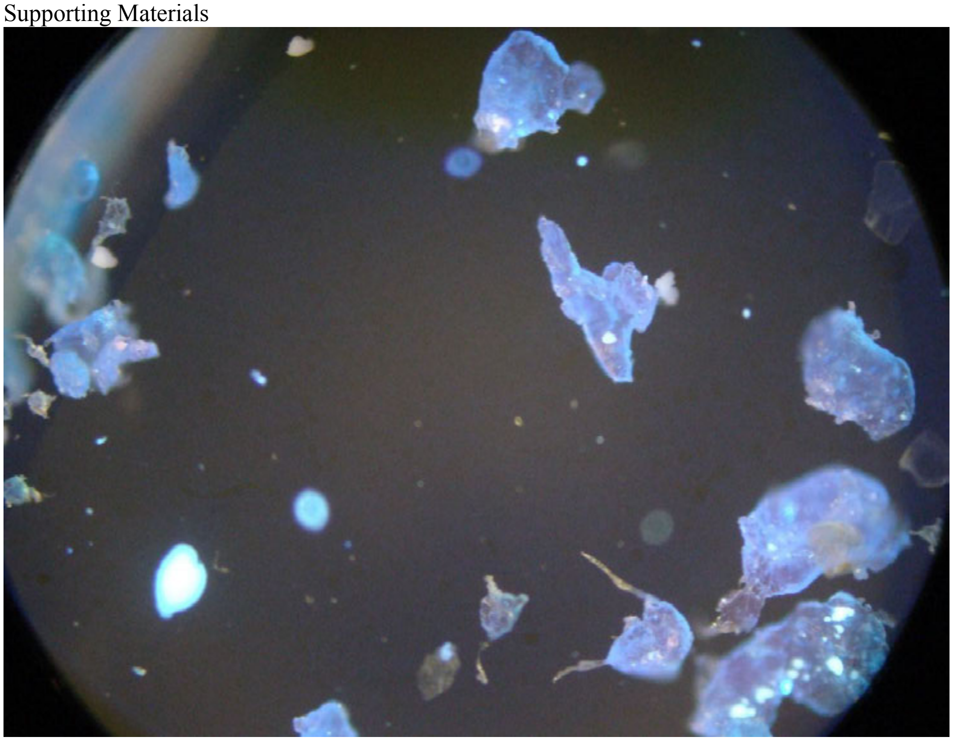
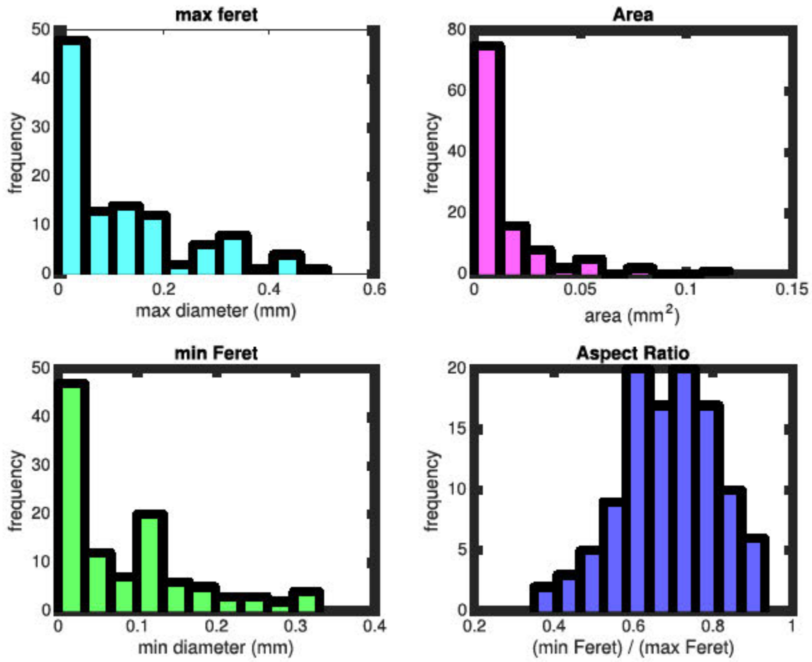
}

Supporting Materials

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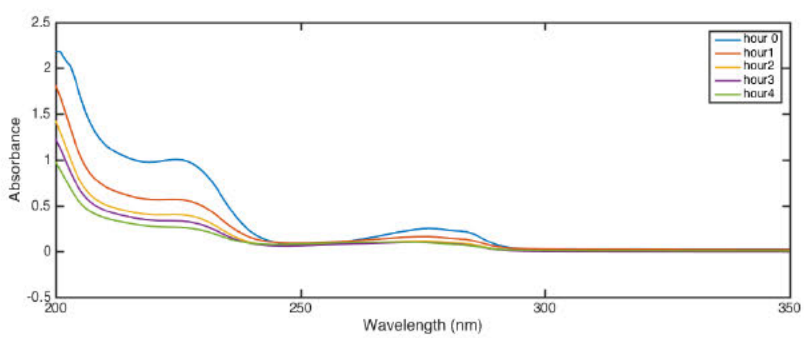
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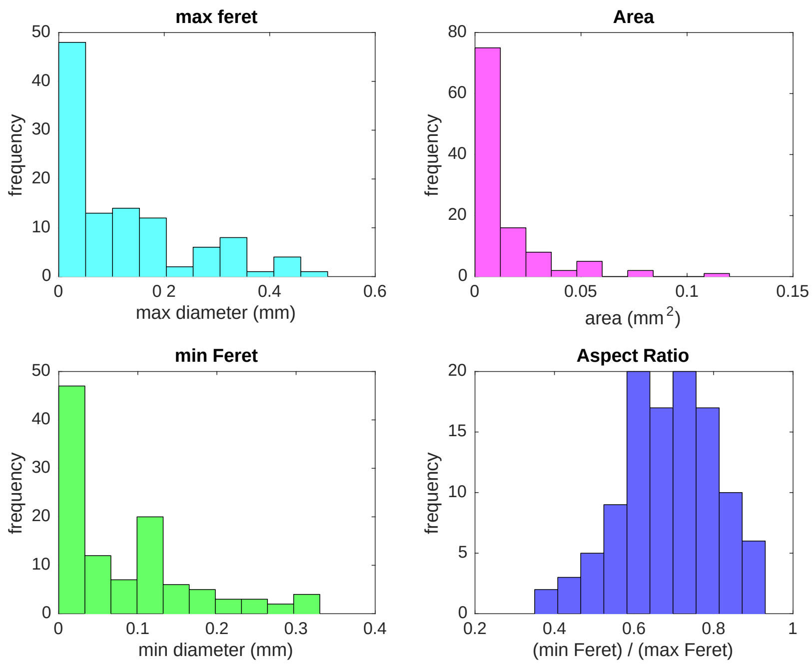
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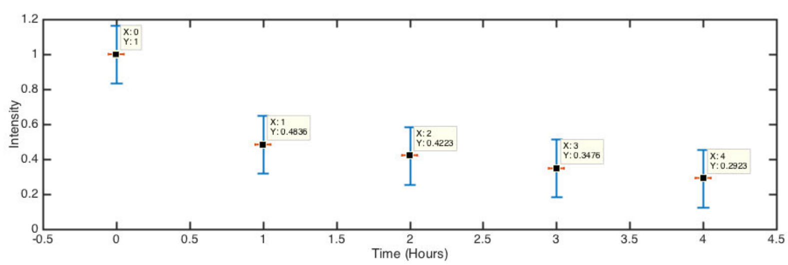
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