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IDENTIFICATION AND CHARACTERIZATION OF MICROPLASTICS IN FRESHWATER SYSTEMS: A CLOSE LOOK AT THE POQUESSING CREEK- A DELAWARE RIVER TRIBUTARY

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Abstract

Microplastics are accumulating at an alarming rate in waterways all around the world. While marine microplastics have been studied extensively, the distribution, concentration, and characteristics of microplastics in freshwater systems are not well understood. Understanding the presence of microplastics in freshwater is essential for studying their impacts to water resources, human health, and aquatic health. The scientific community is finding that microplastics can carry and release persistent organic pollutants (POPs) and endocrine disruptor chemicals (EDCs) in water, but it is difficult to assess their impacts without having baseline information about their presence in freshwater systems. This research is a step towards identifying and characterizing the types of microplastics present in freshwater systems such as the Delaware River and its tributaries. In this study, surface water samples were collected in the Poquessing Creek via grab sampling. The samples were then purified using the Fenton reaction paired with density separation and analyzed using Fourier Transform Infrared (FTIR) spectroscopy and Scanning Electron Microscopy (SEM). The procedure revealed information on the morphology and composition of microplastics present in the Poquessing Creek. Analysis of samples from the lower, tidal portion of the Poquessing Creek revealed 63 microplastics in the form of fibers, fragments, films, and flakes having variable composition including polyester, polyethylene, and polypropylene. Complete quantification of microplastics was not possible due to the heterogeneity of microparticles present throughout the samples. This research begins to close the knowledge gap on the presence of microplastics in freshwater systems and also attempts to standardize sampling and analysis techniques for assessing freshwater microplastics. Since the types and composition of microplastics in freshwater systems can be characterized, researchers can move towards identifying and assessing their impacts on water resources, human health, and aquatic health.

Keywords

microplastics, fresh water, Delaware River

Disciplines

Environmental Sciences | Physical Sciences and Mathematics

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Summer 2021

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ABSTRACT

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Microplastics are accumulating at an alarming rate in waterways all around the world. While marine microplastics have been studied extensively, the distribution, concentration, and characteristics of microplastics in freshwater systems are not well understood. Understanding the presence of microplastics in freshwater is essential for studying their impacts to water resources, human health, and aquatic health. The scientific community is finding that microplastics can carry and release persistent organic pollutants (POPs) and endocrine disruptor chemicals (EDCs) in water, but it is difficult to assess their impacts without having baseline information about their presence in freshwater systems. This research is a step towards identifying and characterizing the types of microplastics present in freshwater systems such as the Delaware River and its tributaries. In this study, surface water samples were collected in the Poquessing Creek via grab sampling. The samples were then purified using the Fenton reaction paired with density separation and analyzed using Fourier Transform Infrared (FTIR) spectroscopy and Scanning Electron Microscopy (SEM). The procedure revealed information on the morphology and composition of microplastics present in the Poquessing Creek. Analysis of samples from the lower, tidal portion of the Poquessing Creek revealed 63 microplastics in the form of fibers, fragments, films, and flakes having variable composition including polyester, polyethylene, and polypropylene. Complete quantification of microplastics was not possible due to the heterogeneity of microparticles present throughout the samples. This research begins to close the knowledge gap on the presence of microplastics in freshwater systems and also attempts to standardize sampling and analysis techniques for assessing freshwater microplastics. Since the types and composition of microplastics in freshwater systems can be characterized, researchers can move towards identifying and assessing their impacts on water resources, human health, and aquatic health.

1.0 Introduction

In the last few decades, plastic production has doubled almost every decade, resulting in an increase in the amount of plastic waste present in the air, soil, and water. It is estimated that by 2050, annual plastic production will increase to 33 billion tons, with 10% of it ending up in oceans [1]. Plastics, synthetic organic polymers derived from oil, gas, or coal, are found in common household items such as clothes, sponges, and bottles. When plastics break down into smaller particles, they form microplastics (MPs), emerging contaminants of international concern. MPs are plastic debris of various colors and shapes, ranging from 1 μm to 5 mm in size. They can be separated into two categories based on their origin: primary and secondary. Primary MPs, such as microbeads and microfibers, are manufactured for commercial items such as health products, beauty products, and textiles [1]. Secondary MPs originate from fragmentation of larger plastic fragments under the influence of UV radiation, oxidative properties of the atmosphere, and hydrolytic properties of the aquatic environment [1,2]. Primary MPs are mainly dispersed into waterways from industrial or domestic drainage systems, as well as wastewater treatment facilities, while secondary MPs are a result of runoff into water bodies [2].

Although MPs have been found throughout inland and marine waters, freshwater microplastics (fMPs) are less researched and less well understood to date as compared to MPs in marine settings. There are knowledge gaps in areas such as the concentration, characterization, and distribution of fMPs and there is a lack of a standardized data collection and analysis techniques [1,2]. Since rivers are the main conduit of MPs into marine waters, it is crucial to understand where they exist in freshwater settings and in what form [1].

Seventy-five percent of plastics consist of polyethylene (PE), polypropylene (PP), polystyrene (PS), polyethylene terephthalate (PET), polyvinylchloride (PVC), and polyurethane (PU). The various polymer and chemical additives that make up plastics have the potential to threaten aquatic resources due to their toxic nature [1,2]. Microplastics threaten stream health because they can carry toxins from industrial production which leach into water as they degrade and then bioaccumulate in waterways threatening human and aquatic health [3].

This study attempts to examine the quantity and types of fMPs present in freshwater systems in the Philadelphia region, specifically in the Poquessing Creek, a tributary of the Delaware River. Determining the status of fMPs in the Poquessing Creek will not only aid in creating a microplastic profile for the Poquessing Creek, but will also assist in closing the knowledge gaps present in the fMPs research community and could help in determining the distribution of MPs in larger rivers such as the Delaware River. This study builds on sampling methods and sample analysis techniques used by the Philadelphia Water Department in an attempt to create a standardized methodology. Once the distribution, morphology, and characteristics of fMPs are better understood, researchers can more accurately assess their impacts on water resources, human health, and aquatic ecosystems.

2.0 Methods

2.1 Sampling Location and Protocol

The Poquessing Creek is an urban tributary of the Delaware River that flows from northwest Bucks County, Pennsylvania to the Delaware River in Philadelphia. The sampling points were located along the lower, tidal portion of the creek that acts as the border between Bucks and Philadelphia Counties. Samples were collected on the Philadelphia side from a riverfront public park, Glen Foerd on the Delaware (“Glen Foerd”). Figure 1 shows the sampling location in yellow and the three sampling points from where samples were collected.

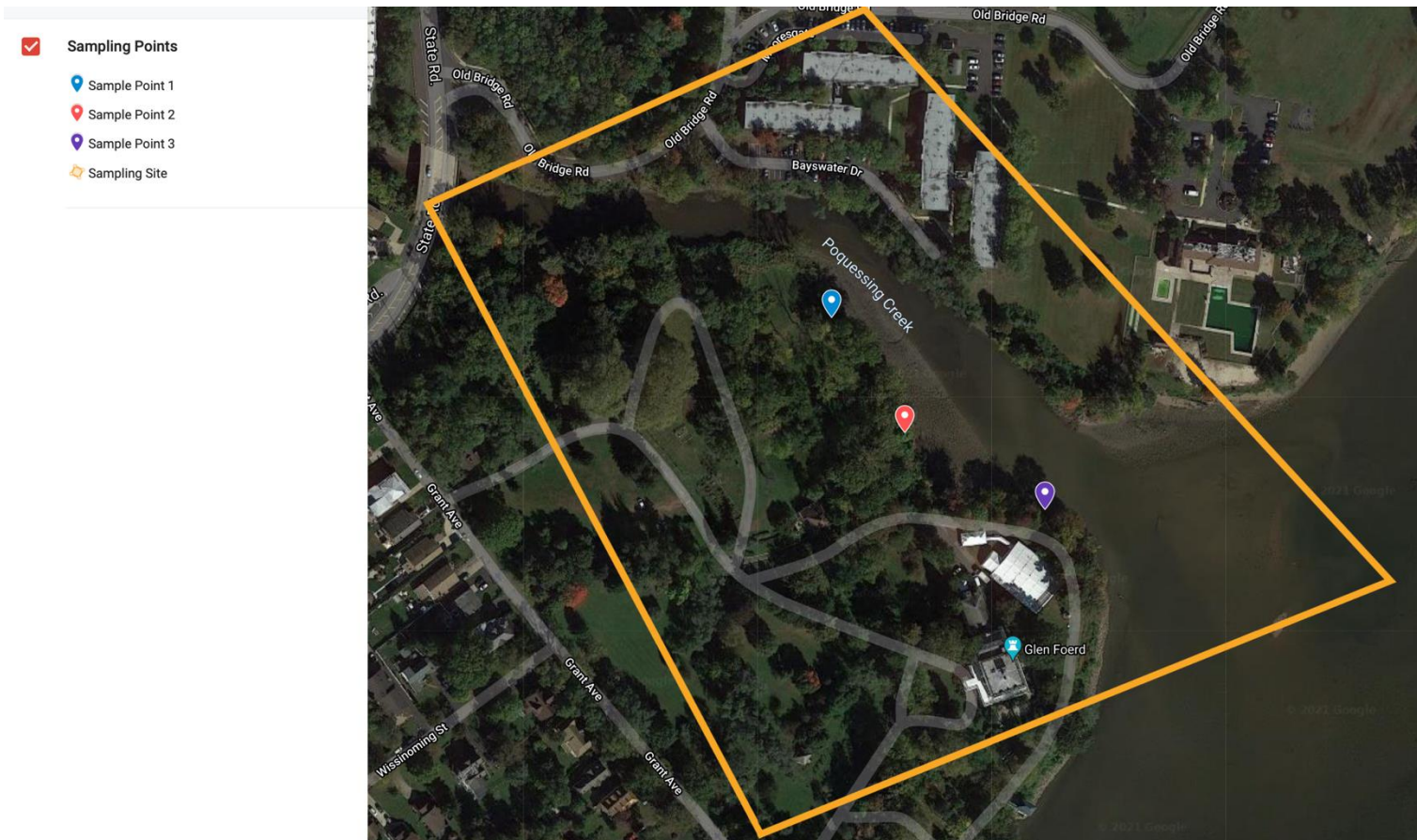


Figure 1: Sampling location as indicated by the yellow outline along with sampling points 1 (blue), 2 (red), and 3 (purple).

The Poquessing Creek was selected as the study site because it is affected by plastic pollution including plastic homeware, plastic bottles, and tires. Figure 2 shows the accumulation of garbage which was collected in the summer of 2019 by Glen Foerd staff and Friends of the Poquessing Watershed volunteers during a routine Poquessing Creek clean up.



Figure 2: Pollution, including macroplastics, collected from the Poquessing Creek in the summer of 2019 (Source- Rupika Ketu).

Table 1: Sampling Dates and Amount

Sample Date	Sampling Point	Sample #	Amount
10/23/2020	1	1	2.5 L
1/7/2021	2	2,3	4 L, 4 L
2/23/2021	3	4,5	4 L, 4 L

Grab samples were collected on three separate occasions, as shown in Table 1. They were collected in amber-colored, 4 L glass bottles with plastic caps, which were rinsed with deionized (DI) water (Nalco Water Deionization System) in the lab prior to collection, and twice again at the sample collection site in the Poquessing Creek. The sample bottles were labeled, and cross-contamination was avoided by keeping the sample bottles tightly sealed during transportation and stored at room temperature in the lab preceding analysis. All samples were processed within a week of collection, except for Sample #1 which was stored at room temperature for about a month.

2.2 Filtration

The surface water samples were processed using the Philadelphia Water Department's (PWD) current methodology for analyzing fMPs. The samples were filtered through various sized stacked sieves (Alfa Aesar USA Std Sieve) which had been cleaned prior using an ultrasonic bath (Branson 5200), dried in an oven at 105° C, and backflushed with compressed air for a few minutes to loosen any particles stuck on the filter meshes. The sieves were inspected, before usage, for contamination using a 7.5x magnification stereomicroscope (Bausch & Lomb). The following sieve sizes were used in different combinations: 355-, 180-, 150-, 106-, 90-, 75-, 53-, and 38- μm . The samples were filtered over 20 minutes to ensure complete particle capture. The sieves were visually inspected for microparticles following filtration.

2.3 Purification

After the sample was filtered, all stacked sieves were individually subjected to Fenton oxidation in beakers to dissolve organic material using 1% (w/v) Iron Sulfate (FeSO_4) and 30% (v/v) Hydrogen Peroxide (H_2O_2). Each sieve was oxidized by adding 10 mL FeSO_4 followed by 20 mL H_2O_2 . The oxidized sieves were rinsed with DI water, and the washings were separately collected, combined, and treated with a few drops of 1:1 Hydrochloric Acid (HCl)/DI water. This solution was then reserved for further analysis. Meanwhile, the oxidized sieves were dried in an oven at 105° C to prepare for visual inspection under the microscope. The oxidized solutions from the different sieves were pooled into one beaker and an additional 20 mL of H_2O_2 was added to allow the oxidation to proceed. Once the exothermic reaction visually subsided, the solution was heated at about 70°C for 30 minutes to complete the oxidation [4].

The oxidized solution was cooled to room temperature and microplastics were extracted using a density separation protocol where a saturated Zinc Chloride (ZnCl_2) solution with a density of 1.38 g/ml was added to the oxidized solution (6 g ZnCl_2 for every 10 ml of oxidized solution) [5]. The density separation solution was then placed in a separating funnel for approximately 12 hours. Both the top and bottom layers obtained in the density separation protocol were treated with a few drops of 1:1 HCl/water to dissolve inorganic material. All HCl treated solutions (washings, top and bottom layers) were vacuum filtered separately through 0.45- μm pore size filter paper of cellulose mixed ester composition. The filter papers were placed into the oven to dry for about 2 minutes and then transferred to a desiccator prior to visual observation and analysis.

2.4 Particle Analysis

All oxidized sieves, as well as filter papers, were first examined for microparticles under a stereomicroscope (Bausch & Lomb) with 7.5x magnification. Various fine-point tools including tweezers, forceps, and needles were used to “prod” and “feel” the microparticles. Suspected particles with typical microplastic morphologies such as fibers, films, fragments, pellets, beads, and discs were analyzed using optical microscopy and Fourier-transform infrared spectroscopy (FTIR) (Nicolet iN10 MX FTIR imaging microscope).

The microparticles on the filter papers prepared from the 1/7/2021 samples were also analyzed using a Scanning Electron Microscope (SEM) (Quanta 600 ESEM) to visualize these at magnifications up to 1,366x and to perform spot analyses to determine their elemental composition. The compositional data were used to distinguish plastics from non-polymers.

3.0 Results

In total, 63 microparticles were identified as microplastics across all 5 samples. These represent a fraction of the fMPs that were visually identified using “prod and feel” techniques with fine point tools and FTIR analysis. Complete quantification of fMPs in the samples was not possible due to the immeasurable number of microparticles present on the sieves and filter papers. It was too time consuming to count them in an accurate manner and confirm each one with FTIR analysis. Of the 63 identified microplastics, the most common types were fibers (21) and fragments (20). The remaining fMPs were mixes of films and flakes. The most frequently identified polymer was polyester (13) followed by polyethylene (9) and polypropylene (7). Other polymers such as polyethylene terephthalate and polystyrene were also identified, as were alkyd-, epoxy-, and bisphenol A (BPA)- resins. The spectral matches ranged from 65% to 97%. Figure 3 shows a polypropylene flake that was identified as a 97% match.

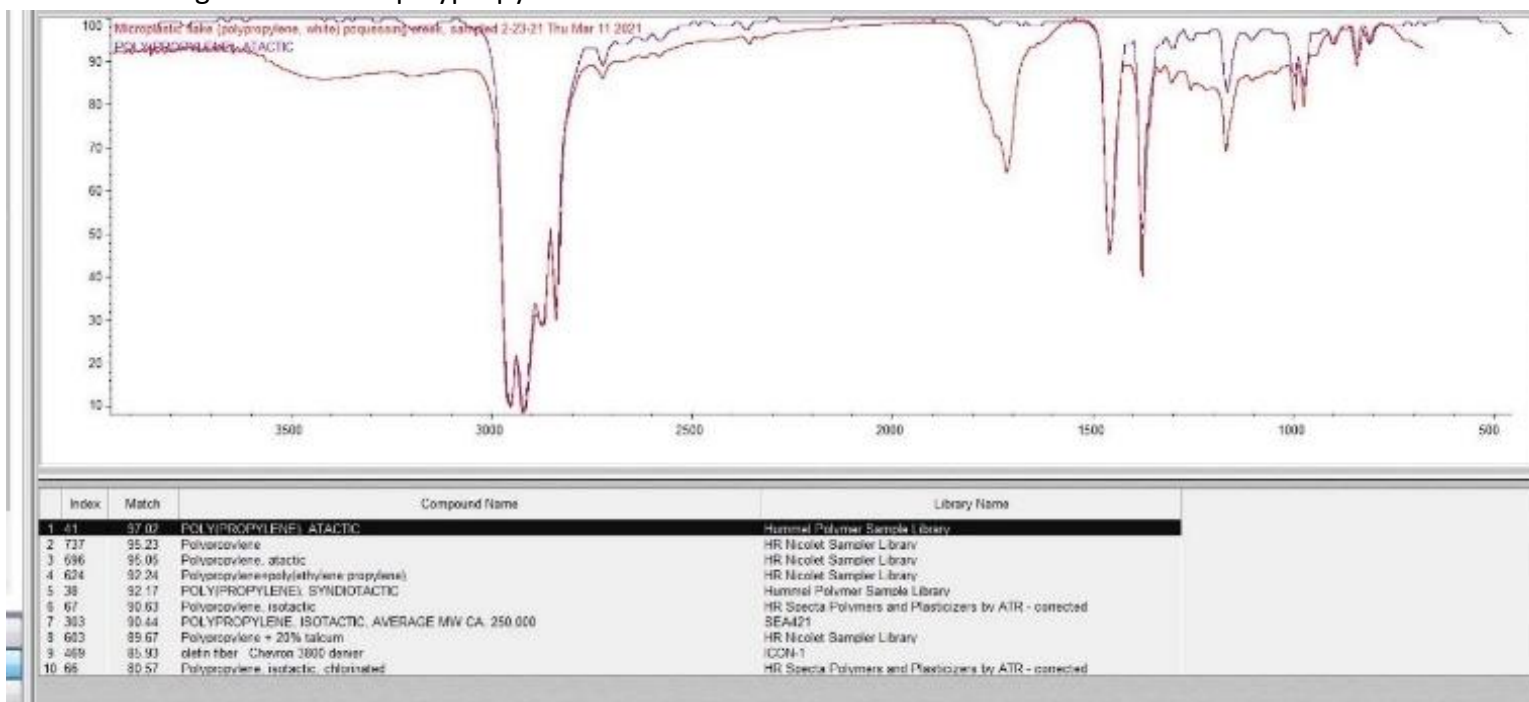


Figure 3: A fMP flake matching polypropylene at 97.02%. The x-axis shows the % transmittance and the y-axis represents the positioning of the peaks and bands. The red spectrum shows the spectrum obtained from FTIR analysis of the flake and the purple spectrum shows the library match. The table at the bottom is indicating that the purple spectrum representing polypropylene is the top match for the flake’s spectrum.

Figures 4 and 5 show the distribution of microplastic polymers and morphologies by sampling point. In Figure 4 one can see that each type of microplastic was present at every point, except

flakes which were found only at points 2 and 3. Figure 5 shows the diversity of polymers present throughout each of the points. Polyester was identified more frequently at points 1 and 2, while polyethylene and polypropylene dominated point 3. Resins were only found at point 3 and polyhexamethylene isophthalate was only present at point 1. The discrepancies seen between point 1 and points 2 and 3 can be attributed to the smaller sample size of 2 L at point 1, as well as atmospheric and hydrological conditions.

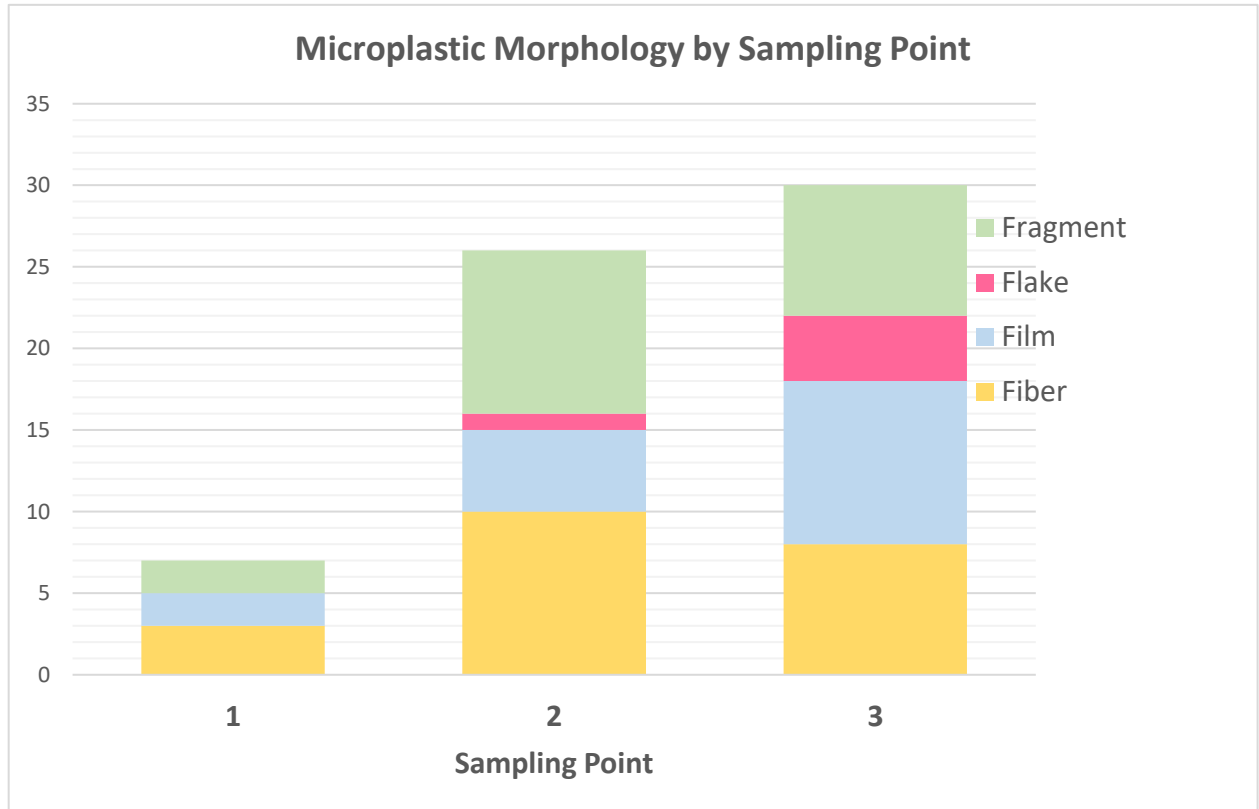


Figure 4: Microplastic morphology by sampling point.

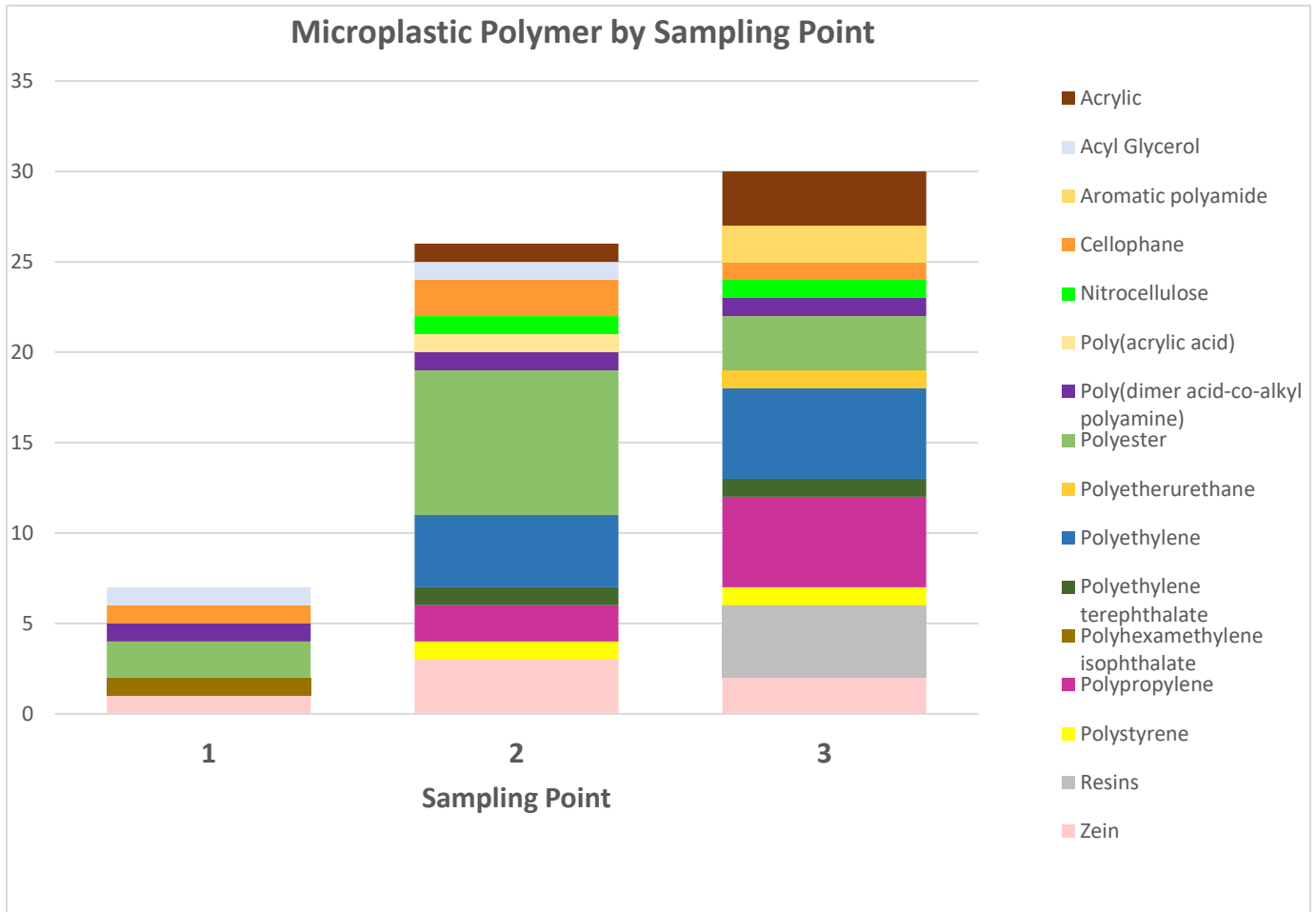


Figure 5: Microplastic polymer by sampling point. All together the samples contained Acrylic, Acyl glycerol, Aromatic polyamide, Cellophane, Nitrocellulose, Poly(acrylic acid), Poly(dimer-co-alkyl polyamine), Polyester, Polyetherurethane, Polyethylene, Polyethylene terephthalate, Polyhexamethylene isophthalate, Polypropylene, Polystyrene, Resins (Alkyd, BPA, Epoxy), and Zein MPs.

The SEM analysis for samples collected at sampling point 2 (1/7/2021) and the associated spot tests of fibers exhibited strong carbon (C) peaks, and smaller oxygen (O) peaks as indicated by Figure 6 and Table 2. Therefore, the isolated fibers could be considered plastic since plastic is carbon-based. Other materials such as non-carbonate minerals do not contain C and organic compounds containing C were removed during the oxidation process with H₂O₂. However, in addition to these peaks, the spot tests also revealed the presence of other metals and non-metals like aluminum (Al), sodium (Na), chlorine (Cl), silicon (Si), and sulfur (S). These may be a result of contamination of minerals in the sample or contamination seeping in during oxidation and density separation protocols with Sodium Chloride (NaCl). The SEM analysis also resulted in detailed images of microparticles resembling fibers. Figure 7 shows these microparticles at 328x, 959x, and 1,366x magnification. The blue arrows in the figures show that these microparticles have additional unknown particles attached to them. It is an important indicator of the potential impurities present in microparticles that can hinder identification results in FTIR.

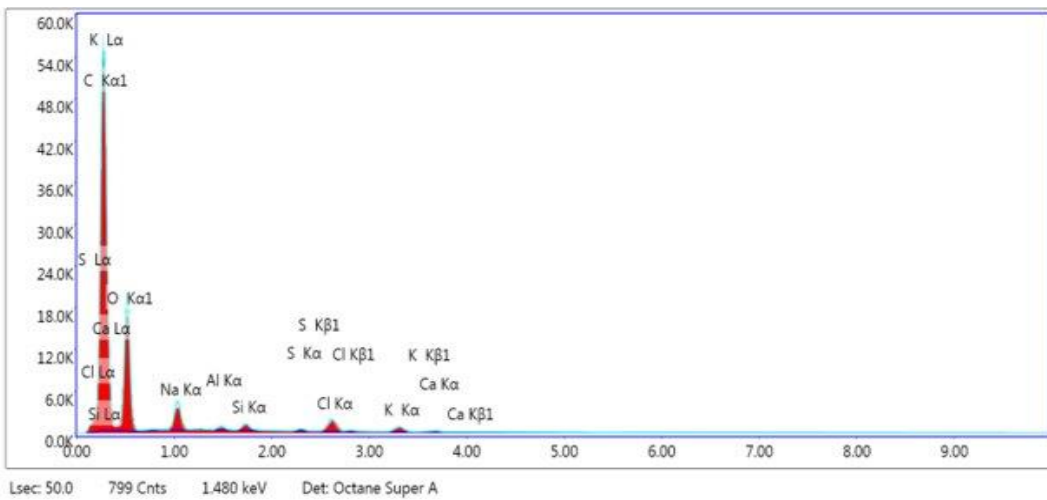


Figure 6: SEM-EDS analysis- Quantitative Results showing elemental peaks.

Table 2: SEM-EDS analysis- Chemical Composition

eZAF Smart Quant Results

Element	Weight %	Atomic %	Net Int.	Error %	Kratio	Z	A	F
C K	65.98	73.71	8525.33	5.80	0.3897	1.0238	0.5769	1.0000
O K	27.75	23.27	2480.57	9.80	0.0561	0.9730	0.2077	1.0000
NaK	2.90	1.70	615.92	6.46	0.0144	0.8774	0.5629	1.0013
AlK	0.27	0.13	95.24	7.02	0.0019	0.8562	0.8229	1.0043
SiK	0.43	0.21	163.43	5.22		0.8735	0.9029	1.0065
S K	0.23	0.10	68.69	8.87	0.0020	0.8529	0.9844	1.0162
ClK	1.39	0.53	358.87	3.00	0.0115	0.8002	1.0018	1.0178
K K	0.81	0.28	163.66	5.64	0.0068	0.8040	1.0140	1.0288
CaK	0.24	0.08	39.70	13.53	0.0020	0.8175	1.0154	1.0359

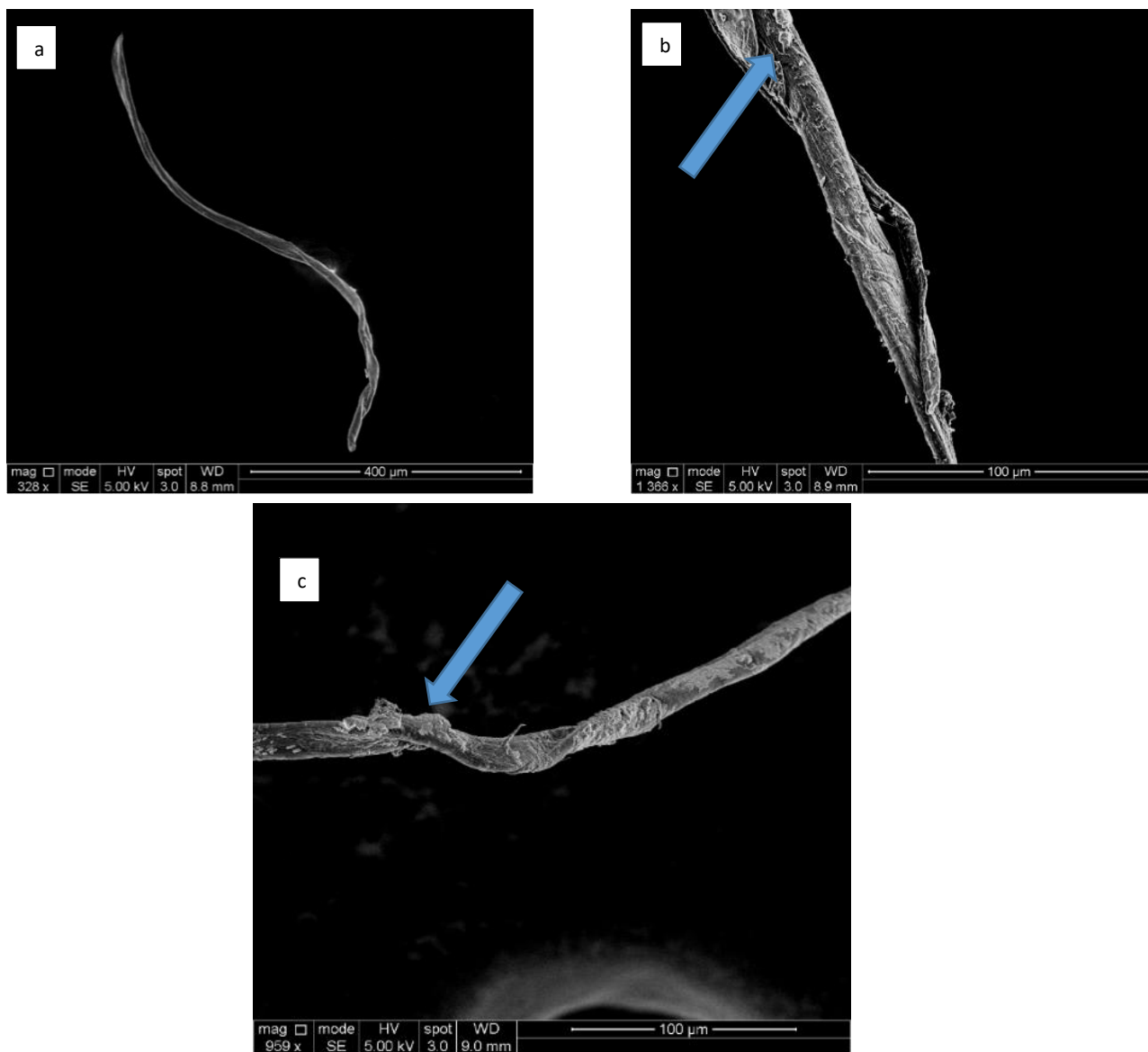


Figure 7: SEM images of microfibers at magnifications (a) 328x (b) 1,366x and (c) 959x (Courtesy of Jaydee Edwards).

It is also worth pointing out that certain non-plastic, cellulose-based fibers may also exhibit similar SEM characteristics. Hence spectroscopic analysis by the Nicolet iN10 MX FTIR microscope was used for further in-depth analysis to differentiate between natural and synthetic cellulose-based fibers. A review of a timely publication, “A practical approach based on FT-IR spectroscopy for identification of semi-synthetic and natural celluloses in microplastic investigation”, helped to closely study the differences in the spectral picture for cellulose-based fibers and plastic fibers. It indicated that cellulose-based fibers such as cellophane may exhibit a

band at approximately 1105cm^{-1} if it is natural, but not when it is semi-synthetic or synthetic [6]. Figure 8 shows the analysis that was performed to distinguish a cellulose-based fiber from a semi-synthetic one. The top spectrum in Figure 8, obtained from the Philadelphia Water Department database, exhibits a band at 1106cm^{-1} , while the bottom spectrum, obtained from a sampled fiber from the Poquessing Creek shows no such band. This indicates that the fiber from the Poquessing Creek is of semi-synthetic origin hence it is a microplastic. This sort of analysis was repeated every time a cellulose-based fiber, such as cellophane, was obtained from the sample.

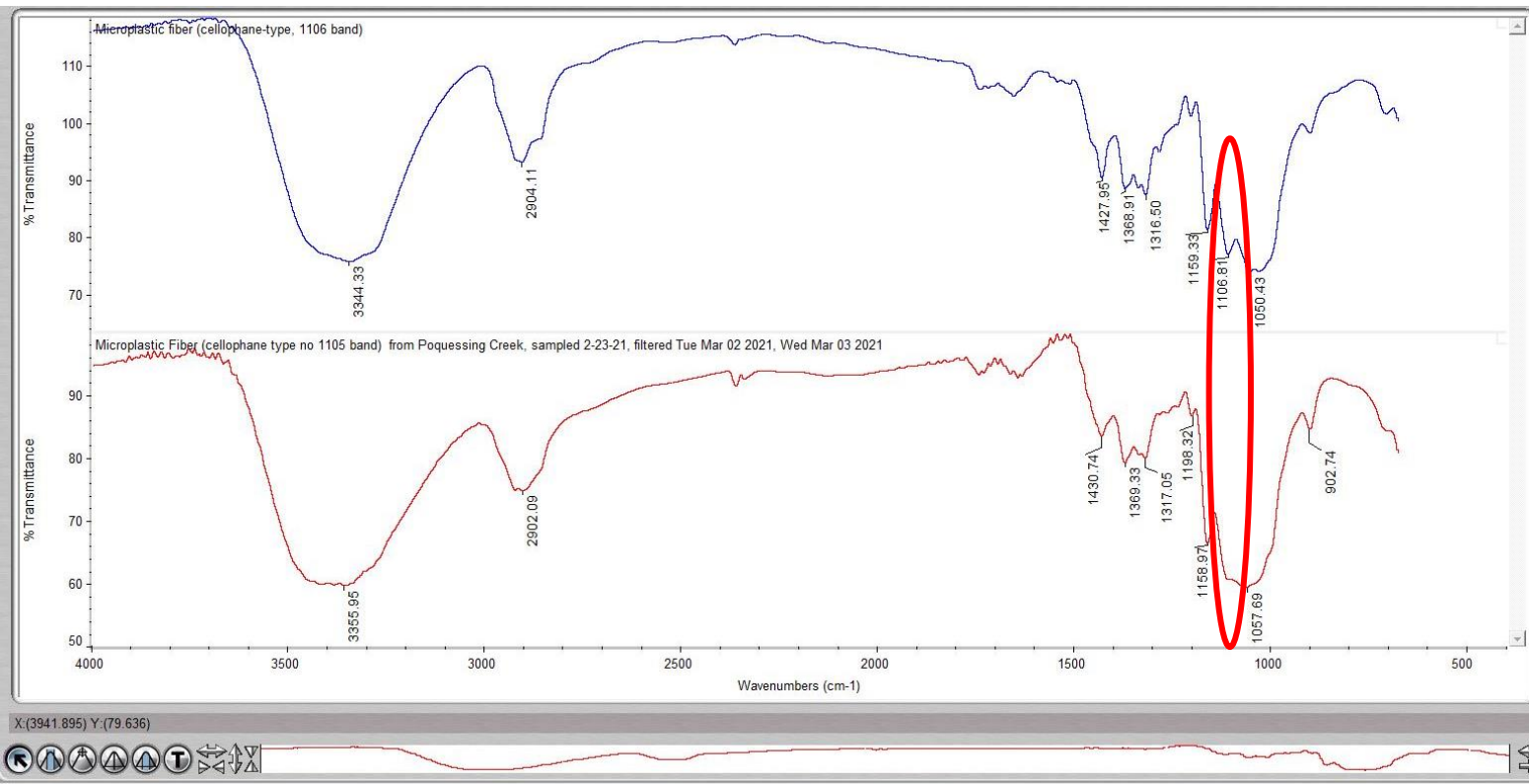


Figure 8: A cellulose-based fiber (top spectrum) vs a semi-synthetic cellophane fiber (bottom). The red circle shows the top spectrum has a band at 1106cm^{-1} while the bottom one does not

Overall, there were more than 15 different microplastic polymers present at the 3 sampling points in the Poquessing Creek in the form of fragments, fibers, flakes, and films. Polymer types and polymer quantities differed from point to point which indicates abiotic factors such as winds, tides, streamflow, entrance points, and source discharge patterns may be playing a role in polymer distribution. The samples were also collected at different times and dates across fall and winter which may also affect which polymers were found and where.

4.0 Discussion

4.1 Possible Sources and Effects

The results of this study, which indicate more than 15 different microplastic polymers in the form of fragments, fibers, flakes, and films were present in the Poquessing Creek, raise questions about the sources and impacts of these microplastics. Microplastics can have various sources. Urban settings potentially contribute the most microplastics to the natural environment because of population density, land use, and wastewater treatment plants (WWTP), along with a high rate of textile uses, packaging, transportation, electronics, buildings, and construction [7, 8]. In a study conducted in the city of Paris, researchers detected fibers from atmospheric fallout, urban runoff, gray water, wastewater, and combined sewer overflows (CSOs). Fragments were mainly detected in urban runoff and CSOs [7]. Microplastic fibers and fragments were also the most frequently detected types of microplastics in the Poquessing Creek and could be coming from sources similar to those in the Paris study. A desktop analysis using Google Maps and the Philadelphia Water Department’s (PWD) Poquessing Creek Watershed Comprehensive Characterization, and 2020 Stormwater Management Program Annual reports revealed that the Poquessing Creek contains multiple stormwater outfalls and is surrounded by impervious surfaces such as highways and residential developments, which can be contributing to urban runoff with high microplastic loads [9, 10]. Between July 2019 and May 2020, regular, in-person observations of the sampling location also revealed plastic bottles, tires, furniture, and other macroplastics regularly running off into the creek. Table 3 shows the various uses and sources of the most frequently identified polymers in the Poquessing Creek.

Table 3: Most Frequently Identified Polymers in the Poquessing Creek and Associated Uses and Possible Sources

Microplastic Polymer	Examples of Uses	Sources
Polyester	Synthetic textiles such as clothing	Litter (urban runoff), domestic washings, WWTP effluents
Polyethylene	Plastic packaging, automotive manufacturing, medical and healthcare supplies, agricultural applications, pipes, wiring, cables, household products, consumer goods	Urban runoff with plastic debris, litter

Polypropylene	Plastic packaging, automotive manufacturing, industrial applications, consumer goods, furniture, flame retardants, medical purposes	Urban runoff with plastic debris, litter
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[Sources: 11, 12, 13, 14, 15, 16]

Many of the microplastics discovered in the Poquessing Creek have also been found to have negative health effects on humans and aquatic life. Endocrine disrupting chemicals such as BPA have been linked to neurodevelopmental problems, impaired fertility, cancer, diabetes, obesity, and coronary heart disease in humans. It has also been shown to cause feminization of fish [17]. Phthalates in the form of polymers such as polyethylene terephthalate and polyhexamethylene phthalates have also been found to be hazardous towards human health because they can interfere with the production, elimination, and binding of hormones in the body. This can lead to changes in how reproductive organs develop and function [18]. Polypropylene particles have also been found to have a cytotoxic effect on peripheral blood mononuclear cells [16]. Studies on marine organisms have also indicated that microplastics disrupt bodily functions. Sea urchins exposed to polyethylene can experience abnormal embryonic development. Microplastics can also cause reproductive and developmental problems in mussels, shellfish, and fish [19]. Other microplastics such as polystyrene and polyethylene also act as endocrine disruptors in adult fish. Microplastics are generally a stressor on aquatic habitats and water resources because they expose aquatic organisms and humans to a large mixture of chemical contaminants [20].

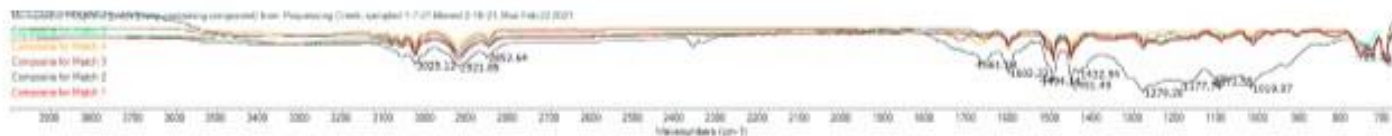
4.2 Study Limitations

A few challenges were encountered while conducting this study. The excessive quantities of sediments and minerals in samples prevented the quantification of the number of microplastics. The presence of a large number of minerals in water samples also hindered running FTIR scans for every microparticle. It was not possible to visually differentiate between MPs and non-plastic microparticles even under 7.5x magnification. Additionally, multi-component analyses of some samples showed lower spectral matches compared to the initial library match, which suggests that these may not be pure polymers, but mixtures of additives or emulsifiers as well. For example, one polystyrene fragment initially showed a 67% match, but as Figure 9 indicates, a multi-component analysis of this sample indicated it was a mixture of polystyrene and phenolic resin.

SEM images revealed contaminants attached to MP fibers suggesting the need for improving purification techniques (Figure 7). The use of ZnCl₂ provided a less turbid oxidation solution and was less time consuming in comparison to earlier efforts using NaCl. Many microparticles were also lost between the transfer from the sieve or filter paper to the gold slide due to their miniscule sizes, lack of extremely fine point tools, and human error further preventing analysis. Blank samples of DI water also revealed approximately 5 fibers/L, which posed contamination threats as did clothing. The FeSO₄ and H₂O₂ ratios were also altered to determine whether the changes would remove naturally occurring cellophane fibers, but they still commonly occurred throughout the samples. Lastly, zein was a recurring polymer present in the sample, but it is

unclear whether it should be considered a MP. Zein is a prolamin (plant storage protein) derived from corn and more recently has been used as a coating in pharmaceuticals. It is described as a biopolymer, but it was still present in the samples after oxidation [21].

Multi-Component Search Results



Match	Title	Cumulative	Composite%	
1	56.03	Polystyrene	42.19	45.69
		1h-pyrrole, 1-(2-furanylmethyl)-	50.70	30.84
		Phenolic resin	56.03	23.47
2	55.34	Polystyrene	42.19	49.23
		1h-pyrrole, 1-(2-furanylmethyl)-	50.70	35.80
		METHYL 4-METHOXYBENZOATE, 99%	55.34	14.97
3	55.20	POLYSTYRENE STANDARD, TYPICAL MW 50,000	40.39	46.83
		1h-pyrrole, 1-(2-furanylmethyl)-	49.76	30.77
		Phenolic resin	55.20	22.40
4	55.00	POLYSTYRENE STANDARD, TYPICAL MW 2,500	39.83	44.52
		1h-pyrrole, 1-(2-furanylmethyl)-	48.52	30.82
		DIPHENYL CARBAZONE; PHENYL AZOFORMIC ACID 2- PHENYLHYDRAZIDE	55.00	24.66
5	54.73	Polystyrene	42.19	40.05
		diphenylmethane	48.73	28.04
		Phenolic resin	54.73	31.91

Figure 9: Multi-component analysis of a polystyrene fragment. An initial FTIR analysis revealed this polystyrene fragment to be a 67% match, but the first match from this multi-component analysis table reveals the fragment is a combination of polystyrene, 1-h pyrrole/1-(2-furanylmethyl)-, and phenolic resin. The spectra at the top of the image represent the matches from the table.

4.3 Future Recommendations

1. Semi-synthetic vs natural cellophane fibers should be explored as there is no consensus on whether semi-synthetic fibers are considered MPs. However, the state of California’s definition of MPs in drinking water states: “Microplastics in Drinking Water are defined as solid polymeric materials to which chemical additives or other substances may have been added, which are particles which have at least three dimensions that are greater than 1nm and less than 5,000 micrometers (µm). Polymers that are derived in nature that have not been chemically modified (other than by hydrolysis) are excluded” [22]. In these findings semi-synthetic cellophane fibers were present more than any other polymer, however, each one was not recorded due to the uncertainty of the material’s nature.
2. Visual identification of microplastic particles as a standalone technique presents a high risk of incorrect identification, since this is prone to human error 20-70% of the time [23,

24]. Hence methods for identifying and characterizing MPs should always be paired with physical and analytical techniques. While this research was in progress, Environment America released a study titled “Microplastics in Philadelphia, a survey of waterways” which indicated the presence of MPs Philadelphia’s waterways. Samples were collected from Darby Creek, Lower Delaware River, Schuylkill River, Tookany Creek, and Wissahickon Creek. Surprisingly, the methods in the study only relied on a visual identification technique using a 40x magnification digital microscope [25]. Although the study showed the presence of MPs, it did not attempt to look at the complex diversity of microplastics which would include composition and/or the presence of additives. Such data becomes critical for toxicity studies.

3. Since MPs are present in freshwater systems, the next step is to determine dose-related toxicity. This is especially crucial in areas such as the Poquessing Creek since it flows into the Delaware River, a source of drinking water for millions. There are studies that have documented the impacts of plastics and plastic additives on humans and aquatic health. Scientists and toxicologists studying these impacts have begun to determine the dosage at which MPs become harmful [16, 17, 18 19, 20]. As the Swiss physician and chemist Paracelsus once said, “All things are poison, and nothing is without poison; the dosage alone makes it so a thing is not a poison” [26].

5.0 Conclusion

In this study, microplastics were extracted from five water samples taken from the Poquessing Creek using a suite of filtration, purification, and analytical techniques. Through visual identification and FTIR analysis it was confirmed that there were fibers, fragments, films, and flakes present in the form of multiple polymers including polyester, polyethylene, and polypropylene. It is now apparent that microplastics are present at high levels in freshwater systems such as the Poquessing Creek and can be contributing to loads in the larger Delaware River. The body of literature on the discovery of microplastics in freshwater, marine water, and aquatic habitats keeps growing. The hazards of these plastic polymers are also widely documented and continue to come to light. These new discoveries call for action to regulate the production and use of plastics while encouraging researchers to uncover their presence and impacts so that we can maintain healthy waterways for aquatic life and human use and consumption.

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