Microplastics in Pennsylvania

A survey of waterways

PennEnvironment Research & Policy Center

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PennEnvironment Research & Policy Center is a statewide non-profit environmental 501(c)(3) organization. We are dedicated to protecting Pennsylvania's air, water, and open spaces. We investigate problems, craft solutions, educate the public and decision makers, and help Americans make their voices heard in local, state, and national debates over the quality of our environment and our lives. For more information about PennEnvironment Research & Policy Center or to download an electronic copy of this report, please visit https://pennenvironmentcenter.org/.

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Executive summary

Plastic is everywhere and in everything. It's used as packaging, it's in food service products, and it's in clothing. All told, Americans generate over 35 million tons of plastic waste every year, 90% of which is landfilled or incinerated.[1] In fact, the U.S. throws out enough plastic every 16 hours to fill the Dallas Cowboys stadium, and that amount is increasing.[2]

Often when talking about plastic pollution, the images that come to mind are turtles snared in bags or straws, massive trash gyres in the Pacific Ocean, or whales washed ashore with hundreds of pounds of plastic waste in their stomachs. So it may not be surprising that 60% of all seabird species have ingested plastic, with that number expected to rise to 99% by the year 2050.[3]

Water sample collection from the Schuylkill River (Photo Credit: Staff)

Studies have also estimated that by 2050 there will be more plastic in our oceans than fish.[4]

Plastic pollution is also an issue that Pennsylvania faces. For example, in a single year, the Philadelphia Water Department removes 44 tons of trash from a 32 mile stretch of the Schuylkill and Delaware rivers, 56% of which was plastic waste.[5] In Pennsylvania, plastic is the most common form of visible litter.[6] In fact, the Department of Transportation spends over $13 million every year cleaning up just roadside litter.[7] The problem is so widespread that nine of the largest cities in Pennsylvania spend over $68.5 million every year on litter and illegal dumping, with $46.7 million of that going toward litter abatement.[8]

But litter alone doesn't capture the full scope of plastic pollution. Research suggests that we could be not counting 99% of the plastic that makes its way into the ocean.[9] That's because plastic doesn't degrade in the environment like an apple or a piece of paper, instead it breaks into smaller and smaller pieces of plastic called microplastics. Microplastic is plastic less than 5mm in length, or smaller than a grain of rice.[10] They've now been found in the deepest depths of the ocean and on the highest mountains in the world.[11, 12]

A growing area of concern regarding our plastic waste is the environmental and public health threat posed by these microplastics. They are severe suffocation and starvation hazards to wildlife and have been found in our air, food, and bodies. [13, 14, 15] Microplastics also attract pollutants that may already exist in the environment at trace levels, accumulating toxins like DDT &

PCBs and delivering them to the wildlife that eat them, often bioaccumulating through the food chain.[16]

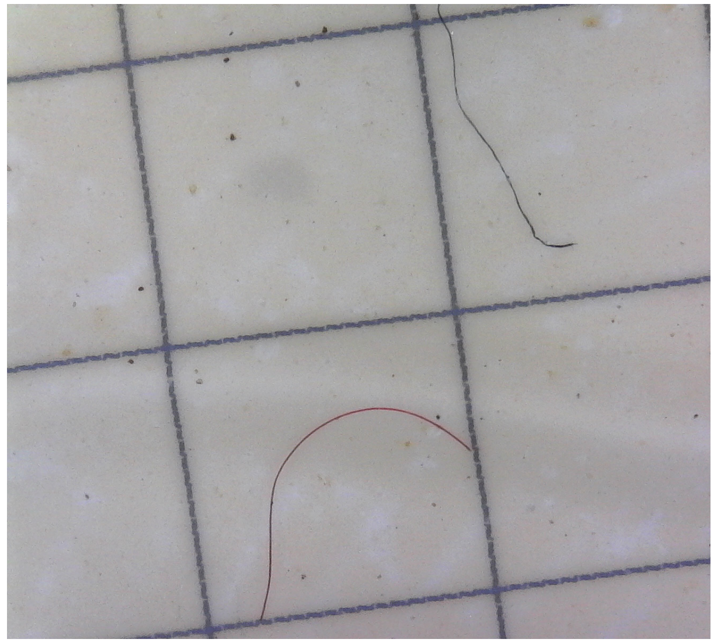
And microplastics don't arrive in the environment from just one source. Plastic littered on roads, in streams, or in the ocean can release tons of microplastics, but plastic waste disposed of in landfills can also release microplastics into the environment through wind, rain, and landfill leachate.[17] The burning of plastic or other waste can also create airborne microplastic particles.[18] Microbeads from cosmetic and personal care products can enter the environment at their manufacture or through sinks and drains.[19] Nurdles, the raw plastic feedstock that are used to make new plastic items, are lost by the millions every year.[20] Synthetic materials in car tires release microplastics onto roads that are swept into stormwater infrastructure.[21]

Clothing and other textiles are also a major source of microplastics. Fibers are one of the most commonly found types of microplastic and they're sourced from synthetic and hybrid materials like fleece.[22] Normal wear and tear will release microplastics into the air, and cleaning these textiles in a washing machine releases millions of microfibers into wastewater infrastructure that treatment plants are unable to fully filter out.[23]

To better understand the scope of the microplastic problem in Pennsylvania, the PennEnvironment Research & Policy Center sampled over 50 of Pennsylvania's most iconic rivers, lakes, and streams. We found microplastics in 100% of our samples.

The project took samples from these waterways over the course of 2020 and tested them for four types of microplastic pollution:

1. Fibers: primarily from clothing and textiles;
2. Fragments: primarily from harder plastics or plastic feedstock;
3. Film: primarily from bags and flexible plastic packaging;
4. Beads: primarily from facial scrubs and other cosmetic products.



Microplastic fibers found in a sample of Philadelphia tap water

The results found were troubling:

- **100% of sites sampled had microfibers;**
- **86.8% of sites sampled had microfragments;**
- **94.3% of sites sampled had microfilm;**
- **Only 1.9% of sites had microbeads.**

It's clear that the scope of plastic pollution in Pennsylvania extends far beyond what was previously thought. Many of the waterways sampled had little to no visual litter at the point of access and have dedicated organizations and volunteers working diligently to regularly clean up litter and trash. Yet despite those efforts, Pennsylvania's most beloved waterways continue to be contaminated with plastic pollution.

In order to address the environmental crisis being caused by plastics, federal, state, and local leaders should implement the following policies:

1. **Congress and the Pennsylvania legislature should pass bills like the federal Break Free From Plastic Pollution Act, which includes strong bans on single-use plastic bags and polystyrene or similar legislation included in the Zero Waste PA state package.**

2. The Pennsylvania General Assembly should repeal the preemption on municipal plastic ordinances and allow local governments to implement policies known to reduce plastic pollution.

3. The General Assembly and Congress should pass bottle deposit requirements and producer responsibility laws, as seen in the Break Free From Plastic Pollution Act, to shift the burden of waste onto those who create the pollution.

4. Communities and legislators should oppose measures that double down on the fossil fuel-to-plastic pipeline and that incentivize the creation of new plastic.

5. State and local governments should pass laws preventing overstock clothing from being sent to landfills so that clothing manufacturers and retailers stop producing more clothing than we could ever need.

6. Cities should develop green infrastructure and stormwater programs to help stem the tide of plastics and microplastics being washed into our waterways and greater environment.

Water samples on the banks of Valley Creek (Photo Credit: Hannah Pittel)

Introduction

Every day, Americans throw away tons of plastic "stuff" -- cups, plates, bags, containers, forks, knives, spoons and more.[24] Sadly, much of this plastic waste never makes it to the trash can and ends up soiling our parks and public lands, where it also washes into our rivers, harming wildlife. Once in our environment, plastic does not biodegrade.[25] Instead, it breaks into smaller and smaller pieces known as microplastics.

Microplastics can enter our environment through a myriad of pathways. Litter, illegal dumping, and what is broadly recognized as plastic waste are all obvious culprits. Microfibers are another prevalent type of microplastics and are introduced into the environment through clothes washing,[26] with wastewater treatment plants unable to fully filter these plastic fibers out, they can end up washed into waterways and ultimately in drinking water.[27, 28] The creation of new plastic products uses small pellets called nurdles which are easily lost and frequently enter waterways.[29] Packaging and the factory processes in the creation of products like bottled water can even cause microplastic contamination.[30]

The small size of microplastics makes it easy for them to be carried by wind and rain and deposited in the environment far from their source. Meaning, plastic disposed of in a landfill can still contaminate waterways.[31]

For a bird or fish, it's easy to mistake these small pieces of plastic for food -- especially when there are billions of pieces of microplastic floating in the waterway. Scientists have found that ingesting even tiny particles of plastic can alter the behavior and metabolism of fish in our lakes and rivers – and people can ingest these pollutants as they make their way up the food chain.[32, 33]

Visible litter floating in Darby Creek (Photo Credit: Staff)

A Widespread Problem

Scientists are still documenting the scope of plastic pollution and investigating its effects in freshwater ecosystems, but microplastics have recently been found in a number of remote environments throughout the world, showing how pervasive the problem has become:

- Microplastics have been found in global and domestic samples of **tap water, sea salt, and beer**;[34]
- Microplastics have been found in a study of some of the most popular **bottled water** brands across several countries that point to contamination from packaging and manufacture;[35]
- U.S. Geological Survey (USGS) researchers found microplastic in 90% of rainwater samples collected from sites in **Rocky Mountain National Park** and the Denver-Boulder urban corridor;[36]
- Researchers at the University of Strathclyde in Scotland found microplastic concentrations in the air of a remote section of the **French Pyrenees Mountains** that were as high as concentrations in Paris;[37]
- Plastic pollution has now been found in isolated marine environments in **the Arctic and Antarctic**;[38]
- Research from the Chinese Academy of Sciences has shown that microplastics in the soil can be taken up by the roots of **wheat and lettuce crops** and transferred to the edible portions of those plants;[39]
- Recent studies from Utah State University and the University of Strathclyde among others have found high concentrations of microplastics in **fog, dust, and ocean air**;[40, 41,]
- In Oregon, a recent study from Portland State University found microplastics in the stomachs of oysters and razor clams off the Oregon Coast. In fact, only two out of the nearly 300 mollusks tested were found to be plastic-free;[42]
- Microplastic pollution has been recorded at the highest elevation on Earth, **Mt Everest**, and the lowest, **the Marianas Trench** at the very bottom of the Pacific Ocean;[43, 44] and
- Microplastics have been found in human fetuses.[45]

A plastic bottle on the banks of the Conestoga (Photo Credit: Staff)

Frighteningly, it's estimated that humans consume roughly a credit card's worth of plastic every week. The effects of this on human, animal, and environmental health are an evolving area of research.[46] _

Research from the National Oceanic and Atmospheric Administration has also shown that microplastic particles can attract heavy metals and chemical contaminants which are then consumed by fish, birds, and humans (among other organisms).[47] These can include PCBs and pesticides which can pose significant health risks when consumed by animals and humans.

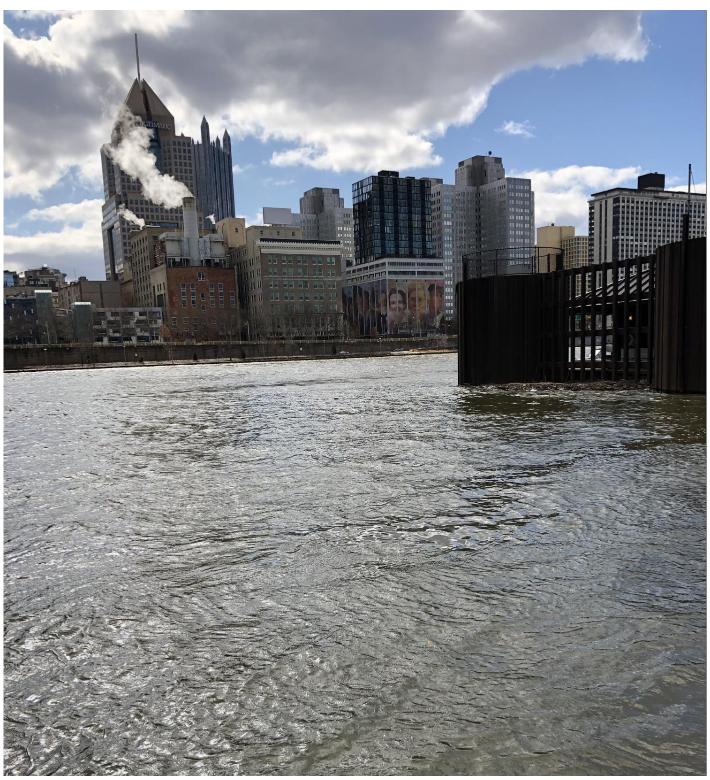
Methodology

Sampling

The goal of this survey was to examine the presence and type of microplastics in waterways across Pennsylvania. The 53 study sites (Table 1) were selected based on a variety of factors intending to capture a range of physical geography, urbanization, and waterbody types. In each region where we sampled, we wanted to capture the iconic waterways that define the region or provide drinking water and recreational activities, from Pittsburgh's Three Rivers to the Delaware River in the east. A full map of where samples were taken can be found at https://pennenvironmentcenter.org

For water sampling and processing, the *Microplastics: Sampling and Processing Guidebook* protocol developed by the National Oceanic and Atmospheric Administration (NOAA), Mississippi State University Extension, Dauphin Island Sea Lab, and Sea Grant was used.[48] To aid in the identification of microplastics, the *Guide to Microplastic Identification* by the Marine & Environmental Research Institute (now Shaw Institute), was also used.[49]

Water samples were collected from the 53 sites in glass quart jars that had been cleaned and triple-rinsed in filtered water from January 2020 to June 2020. Jars were sealed during storage, transport, and before sampling. At each site before collecting samples, jars were triple-rinsed again, this time with the source water. To fill the jars, samplers walked to a water access point with a water depth of approximately two feet (where possible), and drew water samples from this point to avoid collecting sediment. For sites with no access to a depth of two



The City of Pittsburgh seen from the Allegheny River (Photo Credit: Staff)

A volunteer takes samples from Lake Erie at Presque Isle State Park (Photo Credit: Tommy Link)

State Representative Wendy Ullman takes samples from the Tohickon Creek (Photo Credit: Staff)

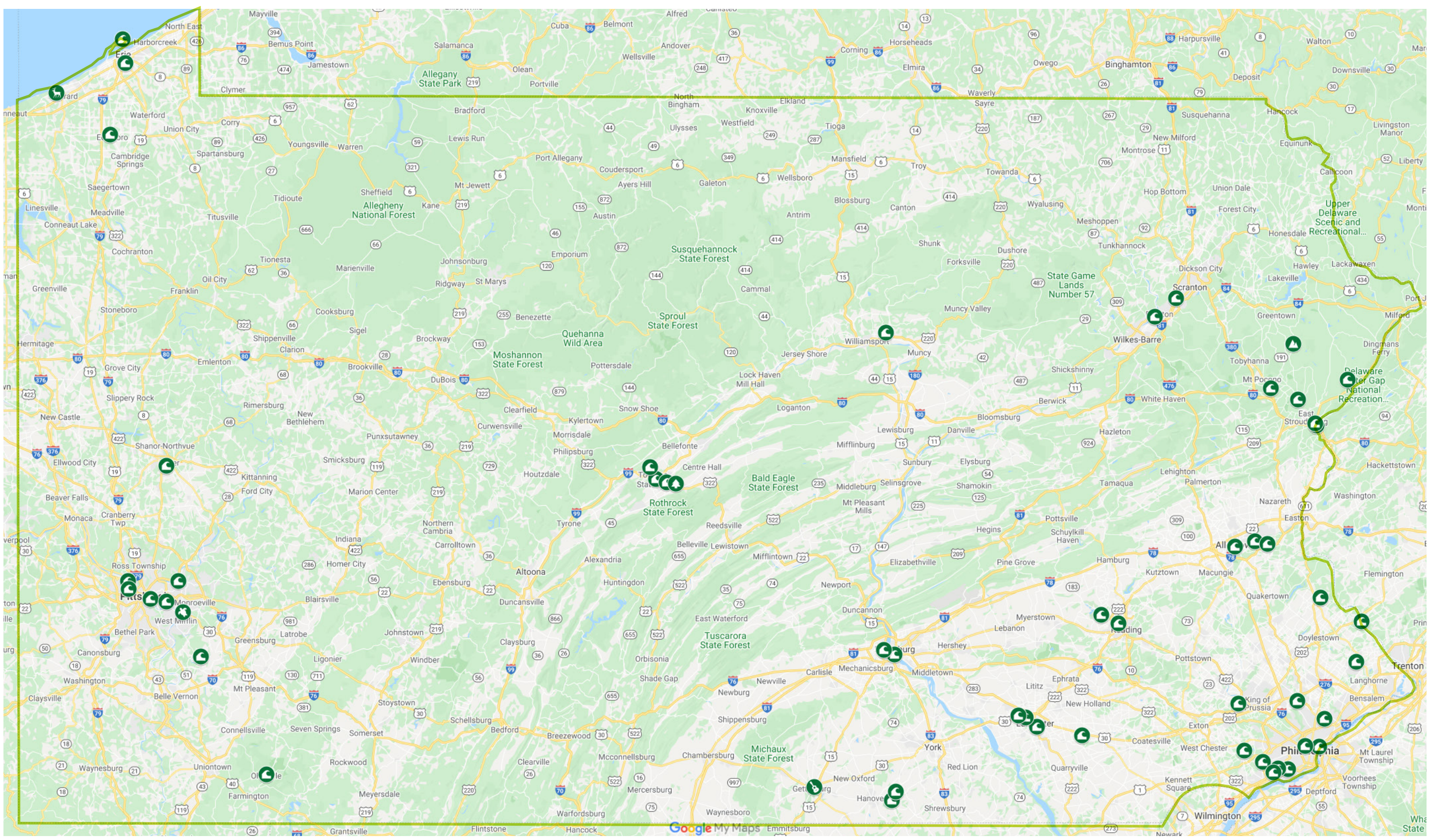
feet, samples were taken at the deepest accessible depth. When taking samples from moving water, samplers sampled upstream from themselves to minimize the potential for contamination. Samplers were instructed to avoid wearing fleece and other synthetic clothing materials to minimize the risk of contamination by clothing fibers.

Six quarts were drawn at each site. All jars were labeled with the site name, date, sample number, and initials of the sampler. The jars were then transported to our facilities for analysis.

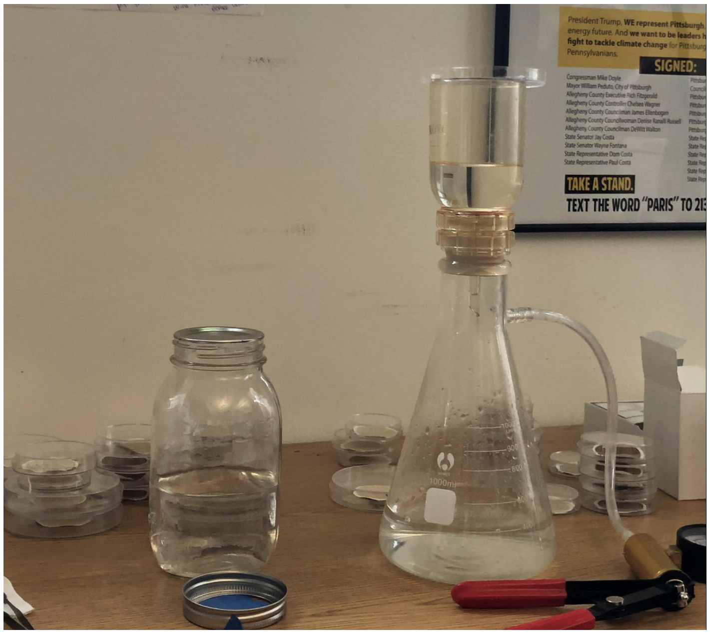
Analysis

All lab materials, including the filter funnel and petri dishes, were rinsed with filtered water between samples to minimize potential contamination from outside sources.

Samples were processed by using a filter flask and hand pump to pass water through 47 mm diameter, 0.45 µm gridded filtered papers. Each 1-quart sample was filtered through its own paper. Some samples with heavy sedimentation had to be broken into multiple filter papers per jar.



Locations of where samples were taken



A Vacuum flask filtering a water sample (Photo Credit: Staff)

The filter paper was then transferred to a petri dish for visual inspection under a digital microscope at 40x magnification. Samples from the Wissahickon Creek were examined at the Academy of Natural Sciences of Drexel University using a dissection microscope at 56x magnification.

To aid in visual identification, additional "squeeze tests" (the use of fine-tipped tweezers or forceps to apply pressure and test durability) were performed on any potential microplastic pieces. Any pieces that could not be positively identified through both a visual and squeeze test were not recorded.

Identified microplastics were categorized into four types:

- **Fibers** from synthetic fabrics and filaments, such as fleece, fishing line and bailing twine;
- **Fragments** from rigid plastics, including polystyrene and clear plastic containers;
- **Film** from plastic bags and food wrappers; and
- **Microbeads** from older cosmetics and personal care products.[50, 51]

Totals for each type of microplastic in each sample from each site were recorded in a data table along with the date the sample was drawn and the names of the sampler and the person performing analysis.

PennEnvironment staff examining a sample with the digital microscope (Photo Credit: Staff)

Quality Control

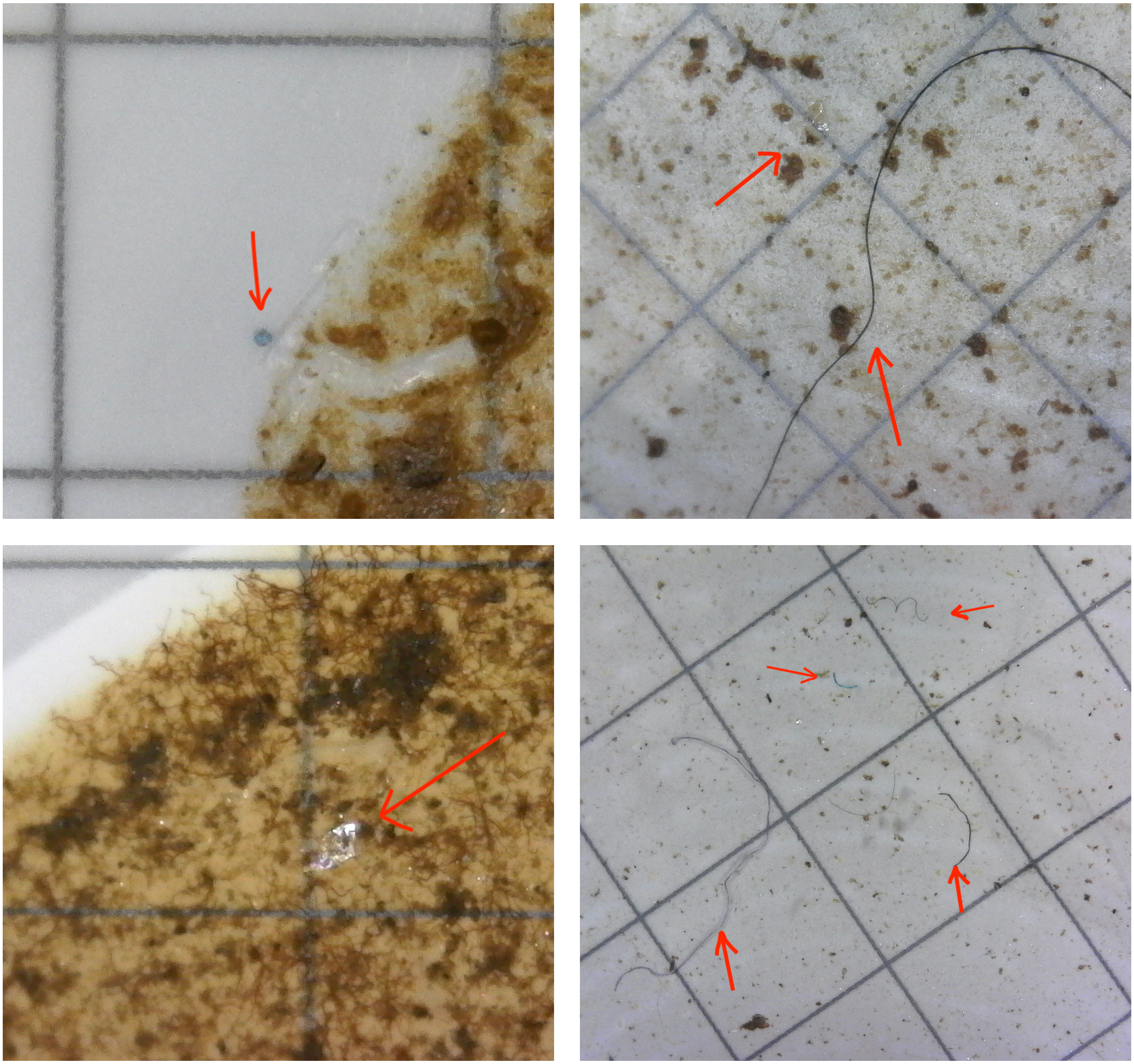
Because of the prevalence of microplastics in the air and on surfaces, steps consistent with the *Microplastics: Sampling and Processing Guidebook* were taken to reduce contamination of the samples. Every jar and lid used in sampling was triple-rinsed with water that had been filtered through 47mm diameter, 0.45 µm gridded paper. After being rinsed, jars were tightly sealed until use.

At the sampling site, the jars and lids were once again triple-rinsed, this time with water from the sampling site. Once filled, samples were immediately sealed and remained so until their analysis. Those taking samples were instructed not to wear fleece or other synthetic clothing to avoid shedding fibers that could contaminate samples.

The filter flask, tweezers, forceps, and other analysis equipment was triple-rinsed with filtered water between samples to reduce contamination. Filter paper remained sealed and packaged until use and was transferred to the filtering set-up with forceps to avoid human contact. Sample jars were sealed in between the transfer of water to the filter apparatus, and the filter funnel was covered by a lid during the process.

Once filtered, filter paper was transferred to a triple-rinsed petri dish by the forceps. The petri dish was then covered and was only uncovered during analysis to allow for squeeze tests.

Examples of Observed Microplastics



Clockwise from left: a microplastic fragment from Connoquenessing Creek, a microplastic fiber and film piece from Neshaminy Creek, multiple microplastic fibers from Codorus Creek, a microplastic film piece from Darby Creek. For scale: grid lines are spaced 3.1 mm apart

Results

Of the 53 sites tested, all 53 (100%) contained one or more types of microplastic.

More specifically, all 53 sites (100%) contained fibers; 46 sites (86.8%) contained fragments; 50 (94.3%) contained film; and microbeads were found at only 1 site (1.9%).

TABLE 1: RESULTS

Site Name	County	Microplastics Present	Observed Microplastics Type			
			Fiber	Fragment	Film	Microbead
Rock Creek	Adams	Yes	•		•	
Allegheny River	Allegheny	Yes	•	•	•	
Chartiers Creek	Allegheny	Yes	•		•	
Monongahela River	Allegheny	Yes	•		•	
Nine Mile Run	Allegheny	Yes	•	•	•	
Ohio River	Allegheny	Yes	•	•	•	
Sewickley Creek	Allegheny	Yes	•	•	•	
Turtle Creek	Allegheny	Yes	•	•	•	
Connoquenessing Creek	Beaver	Yes	•	•	•	
Blue Marsh Lake	Berks	Yes	•	•	•	
Tulpehocken Creek	Berks	Yes	•	•	•	
Delaware River Canal	Bucks	Yes	•		•	•
Neshaminy Creek	Bucks	Yes	•	•	•	
Tohickon Creek	Bucks	Yes	•		•	
Buffalo Run	Centre	Yes	•	•	•	
Cedar Run	Centre	Yes	•	•	•	
Slab Cabin Run	Centre	Yes	•	•	•	
Spring Creek	Centre	Yes	•	•	•	
Valley Creek	Chester	Yes	•	•	•	

TABLE 1: RESULTS (CONTINUED)

Site Name	County	Microplastics Present	Observed Microplastics Type			
			Fiber	Fragment	Film	Microbead
Conodoguinet Creek	Dauphin	Yes	•	•		
Susquehanna River Main Stem	Dauphin	Yes	•	•	•	
Crum Creek	Delaware	Yes	•	•	•	
Muckinipattis Creek	Delaware	Yes	•	•	•	
Ridley Creek	Delaware	Yes	•	•	•	
Stony Creek	Delaware	Yes	•	•	•	
Edinboro Lake	Erie	Yes	•	•	•	
Elk Creek	Erie	Yes	•		•	
Lake Erie	Erie	Yes	•	•	•	
Mill Creek	Erie	Yes	•		•	
Youghiogheny River	Fayette	Yes	•	•	•	
Lackawanna River	Lackawanna	Yes	•	•	•	
Conestoga River	Lancaster	Yes	•	•	•	
Eshleman Run	Lancaster	Yes	•	•	•	
Little Conestoga Creek	Lancaster	Yes	•	•	•	
Millers Run	Lancaster	Yes	•	•	•	
Lehigh River	Lehigh	Yes	•	•	•	
Little Lehigh Creek	Lehigh	Yes	•	•	•	
Saucon Creek	Lehigh	Yes	•	•	•	
Susquehanna River North Branch	Luzerne	Yes	•	•	•	
Loyalsock Creek	Lycoming	Yes	•	•	•	
Brodhead Creek	Monroe	Yes	•	•	•	
Cherry Creek	Monroe	Yes	•	•	•	
Delaware River at Water Gap	Monroe	Yes	•	•	•	
Skytop Mountain Lake	Monroe	Yes	•	•	•	
Swiftwater Creek	Monroe	Yes	•	•	•	
Darby Creek	Philadelphia	Yes	•	•	•	
Lower Delaware River	Philadelphia	Yes	•	•	•	
Schuylkill River	Philadelphia	Yes	•	•	•	
Tookany Creek	Philadelphia	Yes	•	•	•	
Wissahickon Creek	Philadelphia	Yes	•	•	•	
Little Bushkill Creek	Pike	Yes	•	•	•	
Codorus Creek	York	Yes	•	•		
Lake Marburg	York	Yes	•	•		

Policy Recommendations

Given how widespread the threat of plastic and microplastic pollution is, there is no silver bullet solution to address the problem. Multiple policy changes at the local, state, and federal level are needed to combat this problem. Below are several recommendations and a chart of specific fixes.

Phase out single use plastics

Nothing society uses for a few minutes should be able to pollute our environment for hundreds of years. Congress, state governments, and municipalities should pass laws that phase out unnecessary single-use plastics such as polystyrene food service products, single-use plastic bags, and plastic utensils. Cutting off the source of some of the most prevalent forms of plastic pollution will help curtail the tide of microplastics entering the environment. At the state level, this means implementing solutions in the Zero Waste PA legislative package.[52]

Eliminate Pennsylvania's current preemption on local action to address plastic pollution

The Pennsylvania General Assembly should repeal its current legislation preempting local governments from taking steps to address pollution from single-use plastics. Pennsylvania's Act 32 of 2020 indefinitely extended the previous 1-year preemption on local plastic ordinances.[53] Local governments feel the effects of plastic pollution the most, dealing with litter, fielding constituent complaints, and negotiating trash and recycling contracts. Local leaders should have all the tools possible to tackle pollution in their backyards.

Pass "Producer Responsibility" laws

Bottle bills, laws establishing refundable deposits on beverage containers, and other producer responsibility laws are proven effective at keeping waste out of landfills and the environment. Producer responsibility is a mechanism to shift the costs and management of post-consumer waste from local governments and consumers and onto producers themselves, requiring producers of plastic products to design, manage, and finance waste and recycling programs. The General Assembly should pass producer responsibility laws in Pennsylvania. Additionally, Congress should pass federal measures like the *Break Free From Plastic Pollution Act* to make these programs more widespread and shift the burden onto those who create the pollution.

Halt policies that promote increased manufacture & use of single-use plastic

Communities and legislators should oppose measures that double down on the fossil-fuel-to-plastic pipeline. Examples of such measures include HB 732 from the 2019-2020 Pennsylvania legislative session which provides hundreds of millions of taxpayer dollars to subsidize new facilities to convert fracked natural gas into virgin plastics or HB 1808, also from the 2019-2020 session, which provides false solutions to the recycling crisis in the form of "advanced" or "chemical recycling," by making it easier to justify new plastic. State legislators need to reduce plastic production, not incentivize it.

Fight fast fashion

Clothing production and use could spew 22 million metric tons of microplastics into the ocean between 2015 and 2050.[54] To fight textile waste, retailers must stop sending overstock, unsold and unused clothing, to landfills and incinerators. State and local governments should pass laws preventing this practice so that clothing manufacturers and retailers stop producing more clothing than we could ever need.

Develop green infrastructure

A recent study from the San Francisco Estuary Institute found that car tire debris from stormwater runoff may be a significant contributor of microplastic pollution.[55] To keep this debris out of our water, municipalities need to reduce combined sewage overflow and ensure runoff is treated. Green infrastructure projects, such as Philly's *Green City, Clean Waters program*, can reduce the amount of stormwater -- and the plastic it contains -- from washing directly into our waterways.[56]

TABLE 2: POLICY SOLUTIONS

Easing the burden on the overall waste system is imperative to mitigating plastic pollution. Minimizing various waste streams and creating systems to better prevent waste from being created will make it easier to deal with sources of plastic and microplastic pollution.

Reduce	Reuse	Recycle
Ban unnecessary single use plastics such as plastic bags and polystyrene foam (commonly called Styrofoam) food containers.	Pass Right to Repair Laws, giving consumers and independent repair shops the ability to fix their appliances and consumer goods when they break.	Pass Producer Responsibility Laws that make manufacturers responsible for dealing with the waste their products will become.
Require unnecessary single-use plastic accessories such as straws, utensils, and condiment packets, to be given only upon customer request.	Encourage the use of reusable bags and bottles through customer rebates.	Expand curbside recycling and composting efforts.
Oppose the creation of new plastic production infrastructure.	Require sit-down restaurants to use reusable plates and foodware.	Mandate that new products contain a certain percentage of recycled material.
Enact "Pay As You Throw" programs that charge consumers less if they throw out less trash.	Facilitate textile recycling and reuse programs to prevent clothing from becoming waste and disincentivize new clothing manufacture.	Ban food waste from landfills and encourage the creation of a comprehensive composting system.

Appendix

The total plastics counts for each waterway can be viewed on our website.

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