Shore Stewards News
GUIDELINES AND RESOURCES FOR LIVING NEAR WATER | ESTABLISHED 2003

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Microfiber Pollution

Figure 1: *They may seem small, but the microfibers we shed from our clothing may have significant impacts on natural ecosystems.* ***Image Credit:*** *G.A. Wetherbee, A.K. Baldwin, and J.F. Ranville / Public Domain. USGS Report 2019-1048 (link).*

Introduction

When you think of microplastic pollution, what typically comes to mind? A small fragment with jagged edges? Bits of styrofoam? The tiny beads commonly found in cosmetics or hand soaps? These are all common types of **microplastics** (fragments of plastic smaller than 5mm), but scientists are now discovering that the most abundant type of microplastic in our environment is actually **microfibers** from clothing and other synthetic textiles. As scientists refine their collection methods and use smaller mesh for collection, the estimated number of microfibers in the environment increases dramatically. Microfibers are being found not just in our freshwater and marine environments, but in the sedimentary record and in the atmosphere as well.

While textiles in general present a massive source of pollution from production, transportation, and disposal (did you know the average person throws away 80+ pounds of textiles per year?), this newsletter will specifically address *microfiber* pollution in the natural environment. It will cover which fabrics are the worst culprits, how microfibers are released into the environment, the environmental impacts, and what Shore Stewards can do to help reduce the number of loose microfibers generated in our homes.

The fabrics

We don't typically devote much thought to what happens to the fibers shed from our clothing. That's no surprise as most clothing fibers are difficult to see, often narrower in diameter than human hair. Clothing fibers can be shed into the environment through normal wear and through washing, and their small size means that most washing machine filters don't catch them. Fibers from laundry are carried out in the effluent water at the end of each cycle and directly into the sewer or septic system.

There is wide variety in the amount of fibers shed from different fabrics. Comparing estimates across studies is difficult given differences between specific garments, washing conditions (e.g. front- vs. top-loading machines), sampling methods, and measurements used. Estimates from some of these studies are shown in Table 1.

Clothing microfibers shed during washing, by type of fabric and washing machine

Fabric Type	Machine Type	Fibers Released during Single Wash	Study
Polyester	Unspecified	**1,900 fibers** per garment	*Browne et al., 2011*
Polyester-Cotton	Front loading	**137,951 fibers** per 6 kg load	*Napper and Thompson, 2016*
Polyester	Front loading	**496,030 fibers** per 6 kg load	
Acrylic	Front loading	**728,789 fibers** per 6 kg load	
Polyester Fleece	Front loading	**220 mg of fibers** per garment (~0.04% of unwashed garment mass)	*Hartline et al., 2016*
Polyester Fleece	Top loading	**1,906 mg of fibers** per garment (~0.3% of unwashed garment mass)	
Polyester Fleece	Front loading	**110,000 fibers** per garment	*Carney Almroth et al., 2018*
Polyester Knit	Front loading	**900 fibers** per garment	
Polyester (Fleece or Knit)	Top Loading	**161 mg of fibers** per 1 kg of textile (0.0161% of garment mass)	*Vassilenko et al., 2019*
Nylon	Top Loading	**27 mg of fibers** per 1 kg of textile (0.0027% of garment mass)	
Natural (Cotton or Wool)	Top Loading	**165 mg of fibers** per 1 kg of textile (0.0165% of garment mass)	

Table 1: *Estimates (count or mass) of microfibers shed from clothes during washing, as found by various studies conducted between 2011 and 2019. For reference, one kg weighs the same as one liter of water.*

Figure 2: *The central agitator in top-loading washing machines is thought to contribute to higher microfiber releases compared to front-loading washing machines.*

Three primary trends found in this set of studies were:

1. Fleece (synthetic in particular) sheds more microfibers than other fabric types. In general, looser-knit textiles shed more microfibers.
2. Top-loading washing machines cause more shedding than front-loading machines—as much as seven times higher. It's hypothesized that the central agitator increases abrasion and fiber dislodgement.
3. As more studies are done and scientists know to use finer mesh, the number of microfibers detected has increased significantly, from 1,900 microfibers per garment per wash in 2011 to over **100,000 fibers per garment per wash** in 2018 for the highest-shedding fabrics.

How do fibers reach the environment?

To put the numbers above into context, an average household in the United States or Canada is estimated to release **533 million plastic fibers from laundry into wastewater every year**. From there, fibers' paths diverge depending on whether they enter a sewer or septic treatment system.

Wastewater treatment plants

For fibers in the sewer system, their next stop is a wastewater treatment plant. Treatment plants have filters designed to prevent debris from entering the plant, but these filters are often coarse (6mm or larger), meaning microfibers can often pass through. Settling tanks and skimming procedures in most modern plants, however, combine to remove an estimated 95-99% of microplastics before the liquid effluent is released. Unfortunately, even with this efficient removal rate, an estimated **3.5 quadrillion plastic fibers—968 tons—**are released annually in liquid effluent from wastewater treatment plants in the United States and Canada. Studies have found higher concentrations of microfibers downstream or in receiving waters of wastewater treatment plants, indicating they may be a significant source of fibers into aquatic ecosystems.

Biosolids application

To further complicate matters, even the microfibers removed by wastewater treatment plants are not rendered harmless. Many of these microfibers accumulate in the material that settles at the bottom of tanks or in other treatment mechanisms. This material is often treated to create **"biosolids"**, a substance rich in organic matter and nutrients that can be used as fertilizer for agriculture and gardening. Microfibers embedded in the land-applied biosolids can endure all of these treatment processes and wind up in the soil, where they have been detected even 15 years after biosolids application. It is then hypothesized that rainwater runoff and infiltration can carry these fibers into streams and underground aquifers and eventually to the ocean.

What if I'm on septic?

It was initially thought that septic systems did not carry the same risks of releasing microfibers as the sewage system. That understanding appears to be changing as scientific interest has increased into the role of soils as microplastic reservoirs. While it appears that no peer-reviewed studies have yet looked at microfibers in septic tank effluent, the septic industry has become more concerned about the issue. Microfibers' small size means they're resistant to settling in the septic tank and may find themselves in the drainfield (leachfield), where they may eventually clog the soil pores, necessitating system or drainfield maintenance or replacement. If they do not clog the soil pores, the microfibers could be transported by water or soil movement towards groundwater aquifers or the surface, where they may become runoff and re-enter other reservoirs. In many cases in the Puget Sound, septic drainfield pipes are buried only six inches underground, meaning fibers in a saturated drainfield would not have far to travel to reach the surface.

Figure 3: *Septic treatment systems also have the potential to introduce microfibers into the natural environment. While some might be captured in the tank, others could escape into the drainfield (leachfield) pipes, where they could clog soil pores or be carried into ground or surface waters.* ***Image Credit:*** *Shore Stewards Guide for Shoreline Living.*

Impacts of microfibers

Microfibers have become ubiquitous in marine environments. They have been detected around the world: in the guts of freshwater fish in Brazil, mollusks in the Persian Gulf, and zooplankton in Antarctica. They are also showing up in food for human consumption, including shellfish collected from around the Pacific Northwest. New research is starting to shed light on the health effects of these fibers on wildlife, as well as what they might mean for us.

Impacts on aquatic wildlife

Figure 4: *You can start to appreciate how disruptive microfibers could be to microorganisms when they're viewed under a microscope.* ***Image Credit:*** *MakeevaIN / CC-BY-4.0-International. Wikimedia Commons (link).*

There are several ways that microfibers can harm wildlife. Many of their hazards occur because they can be mistaken for food by aquatic plankton and filter feeders (near the base of the food web). The fibers can physically damage small organisms or block the digestive tract if ingested in sufficient quantities. In lower concentrations, ingestion can cause a gradual starvation effect as the fibers don't provide nutritional content. In one study, fibers were shown to be even more dangerous than microplastic beads because, unlike with beads, zooplankton can get tangled up in the fibers, leading to body deformities, difficulty moving, and fewer offspring. Beyond physical damage, ingested microfibers can also leach chemicals into organisms, which can lead to a range of health effects including endocrine disruption, cancer formation, and reduced fertility.

After entering the food web, microfibers and chemicals can concentrate in larger animals as they consume contaminated prey through **bioaccumulation (or biomagnification)**. A variety of marine predators—including birds, fishes, and seals—have been shown to contain microfibers. While specific health impacts are difficult to generalize in large animals, studies have shown reduced nutrient intake in crabs as well as gill and gut tissue damage, endocrine disruption, and neurotoxicity, in fish exposed to microfibers or other microplastics. Fibers represent just one piece of the larger puzzle of microplastic pollution and more research will help determine the exact contribution of microfibers to these health risks.

Impacts on humans

Microfibers have the potential to enter our own bodies through the food we eat, the water we drink, and even the air we breathe. In one study, it was found that U.S. residents could be ingesting upwards of 4,000 microfibers per year just from drinking tap water. The same study also found microfibers in beer and table salt. Microfibers have also been found in seafood sold at market and in fallout from the atmosphere, especially in urban areas.

Can these fibers cause harm to us? Relative to chemicals found in other plastics, research on human risks from microfibers is still early. Preliminary studies suggest ingested microfibers could cause localized immune responses and inflammation in the intestines, but they're unlikely in present-day concentrations to cause more serious harm. Inhaled microfibers, on the other hand, are difficult to clear from the lungs and there's a history of respiratory conditions among workers at textile plants. However, the estimated average daily inhalation of 26-130 microplastics is unlikely to cause significant distress. Research is ongoing into both the ingestion and inhalation of microfibers in recognition of the increasing amounts that we're exposed to and the possibility that underlying health conditions such as asthma could make some people more susceptible to health impacts.

What can you do about microfiber pollution?

Research on microfiber pollution began emerging around a decade ago. You may have noticed that many of the articles used for this newsletter were written just in the past few years, or even the past few months. This is a growing field of research and there are still many unknowns that future research may help address: How exactly are septic systems and drainfields impacted by plastic microfibers? How many fibers are in the environment right now? Are there long-term impacts to environmental and human health? What we do know now is that microfiber pollution is pervasive. After all, we all need clothing. There are some steps, however, that can help reduce the number of fibers generated in our homes.

1. Next time you are in the market for a new washing machine, consider a front-loading machine. Additionally, try using liquid detergent, using shorter cycles, and washing with cold water, as these also reduce fiber loss.
2. Purchase a microfiber filter for your washing machine.
3. Choose clothing made from natural fabrics or fabrics that shed fewer fibers.
4. Wash fabrics less frequently if they don't really need to be washed.
5. Donate or recycle used textiles to keep them out of landfills.

Did you know? Garments that are stained, have holes, or are missing their pair (i.e., clothing that you would not donate to be resold) can be recycled! Inquire about the policies at your local thrift store or find a location for a Northwest Center Blue Bin. As long as they are not wet or mildewy, unsellable items can be placed in a bag or box marked "threadcycle" and placed in the bin. https://bigbluetruck.org/content/collectionlocations

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