



Southcentral Alaska's Water and Microplastics

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A Survey of Water Bodies in Southcentral Alaska

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The views expressed in this report are those of the authors. Participation in this project does not mean an endorsement of the views expressed therein.

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Executive Summary

Plastic is ubiquitous– packaging, clothing, electronics, take out containers, and toys are just a few examples of items commonly made with plastic. Leo Baekeland patented the first fully synthetic plastic a little over a century ago and since then, humans have generated over 7 billion metric tonnes of plastic waste, and recycled less than 10% of it.[6,7] Instead of moderating our plastic use, we're actually increasing it. Globally, we produced 390.7 million metric tons of plastic in 2021, which is 40% more than was produced in 2011.[8]

Marine debris (much of it plastic) coats many of Alaska's shores, and experts predict it will cost over $100 million to clean the pollution up, and more continues to wash up from the massive trash gyres in the Pacific.[9,10] Marine entanglement from trash and fishing gear is common enough in Alaska that multiple stranding hotlines are set up.[11] On land, the Anchorage Chamber of Commerce coordinates an annual city clean up in May, and Anchorage Waterways Council hosts a simultaneous creek cleanup.[12] Similar programs are set up in many other communities across the state, but litter is still a common sight.

Litter and plastic debris are only a portion of the plastic waste in the environment. A recent study in the Atlantic Ocean found that only 1% of the plastic was big enough to be clearly visible with the naked eye and floating near the surface.[13] A large share was micro or nano- pieces smaller than 5mm.[14] When animal and plant based litter enters the environment, microbes including bacteria and fungi will break it down into basic chemical elements like carbon, potassium, nitrogen and other key minerals that in turn feed new life.[15] However, plastic litter is composed of artificial chains of molecules in repeating patterns called polymers, and neither bacteria nor fungi have much success breaking them down into their basic components.[16] Over time, friction and heat will break the plastic into smaller and smaller pieces, but they'll still be plastic and unable to nourish new life for a very long time.[17]

Plastic doesn't just persist in the environment, it threatens wildlife and public health. Larger pieces of plastic are laceration and starvation hazards.[18] The smaller pieces have been found in our rain, air, and human bodies.[19,20,21] Plastic additives include endocrine disrupting chemicals and attract toxins like DDT, PCBs, and heavy metals.[22,23] Those toxic chemicals can bioaccumulate through the food chain, causing problems for animals and humans alike.[24]

As previously mentioned, microplastics enter our environment through a myriad of pathways and move through ocean and atmospheric currents, precipitation, and wind.[25] Litter, illegal dumping, and landfill leakage are all obvious culprits. Microfibers are a prevalent type of microplastic and are introduced to the environment when we wash synthetic clothing.[26,27] Wastewater treatment plants don't fully filter these fibers out and approximately 40% end up in our waterways, oceans, and drinking water.[28] The production of new plastic products uses pellets which are often lost and end up in waterways.[29] Packaging and the process of creating products like bottled water can also cause microplastic contamination.[30]

Our waterways are a prime location to test for microplastics. Alaska's watersheds are largely geographically isolated, with the exception of parts of Southeast which are downstream of Canada. They provide drinking water for residents, habitat for fish and other aquatic life, and are both economically and culturally vital to the state. Southcentral Alaska is home to less than half a million people (the majority of the state's population) and hosts a little under two million visitors annually.[31,32] Microplastic testing in Southcentral Alaska provides additional insight into atmospheric redistribution of microplastics, key fishery exposure, and local information about drinking water.

To better understand the scope of the microplastic problem in Alaska, Alaska Environment Research and Policy Center staff and volunteers sampled 39 water bodies in Southcentral Alaska. We found microplastics in 100% of our samples.

Our project took samples from waterways between June and September of 2023 and tested them for four types of microplastic pollution:

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

Microfibers were by far the most prevalent microplastic found in samples, and were found in 100% of samples. Micro fragments and films showed up in fewer locations, but were present in 20.5% and 33.3% respectively. Alaskans and tourists are almost certainly responsible for some of the microplastic pollution, but distribution patterns indicate some of the microplastic pollution is being swept in from other places as well.

It's clear that the scope of plastic pollution in Southcentral Alaska is extensive. In order to address the environmental and waste crisis being caused by our overreliance on plastics, our leaders at the federal, state, local, and corporate levels should implement policies that will address this problem.

We offer the following recommendations:

Producer Responsibility

Producers are shifting the cost of their waste to consumers and taxpayers.[33] Producer responsibility is a mechanism to shift the costs and management of postconsumer 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 Alaska legislature should pass statewide producer responsibility laws as quickly as possible. Additionally, congress should pass federal measures to make these programs more widespread and shift the burden onto those who are creating the pollution.

Tackle Fast Fashion

To fight synthetic 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 society needs and uses.

Choose Natural Fibers

Data from this survey and numerous other studies indicate that synthetic fibers are one of the most ubiquitous forms of microplastic pollution.[34] Retailers and clothing manufacturers should move away from making products containing synthetic plastic fibers, which inevitably contribute to microplastic pollution. Plant and animal based fibers decompose more quickly and when they leach into the environment, there is some evidence they are digestible.[35]

Phase out single-use plastics

Nothing society uses for a few minutes should be able to pollute our environment for hundreds of years. Congress, Alaska state officials, and municipalities should continue to pass laws that phase out unnecessary single-use plastics such as plastic take-out containers, bags, cutlery, and packaging (the largest source of plastic waste in the world).[36] Cutting off the source of some of the most prevalent forms of plastic pollution will help curtail the tide of microplastics entering the environment. Right now, 16 municipalities in Alaska, including Anchorage, have some ban or limitation on plastic bags, but few limits exist on some of the other sources of single use plastics.[37]

Halt policies that promote increased manufacture & incineration of plastic
Communities and legislators in Alaska should oppose proposals to permit bringing facilities online explicitly to make new plastics, or policies that will promote plastics incineration under the guise of "advanced" or "chemical recycling".[38] Incineration does not dispose of microplastics.[39]

Support Reuse
Reusing items can reduce the quantity of plastic we produce and that contaminates our waterways. The state and municipalities can direct and assist reuse.

Support Repair
Repair is also essential to long term use. For example, most electronics contain plastic components; electronic-plastics make up about 5% of municipal waste.[40] Those components make it challenging to safely reclaim and reuse the valuable minerals in the device, and most of the methods leave dangerous pollution behind.[41] If individuals have plenty of options for repair for their electronics through strong Right to Repair laws, they can extend the life of their goods and minimize another source of plastic (and metal) pollution.

Improve Sport Fishing Gear
Alaska is a global hub for sport fishing, and lost or snagged fishing line is one of the sources of microplastic pollution found in Southcentral Alaska, especially in Kenai Lake, Tern Lake, and other heavily fished freshwater. Historically, horse hair, silk, and linen were regularly used for fishing.[42] There are also some microbial polyesters that can be digested by bacteria in aquatic environments, and those are another viable alternative to long lasting plastic gear.[43,44] Anglers, lawmakers, agencies, tackle manufacturers, and guides should work together to transition to better fishing line materials and reinforce skills to better steward fishing holes.

Minimize Loss of Commercial Fishing Gear
Alaska is also a global hub for commercial fishing, and lost gear is regularly found on Alaska shores and in Alaska marine environments. Public education, gear take back programs like the Copper River Watershed Project, introducing some biodegradable elements, and marine spatial management are some of the solutions to limit ghost fishing and lost gear.[45] Elected officials should continue working with agencies, fishermen, and local communities to identify ways to reduce lost plastic gear and maximize repair and repurposing of gear when it's damaged.

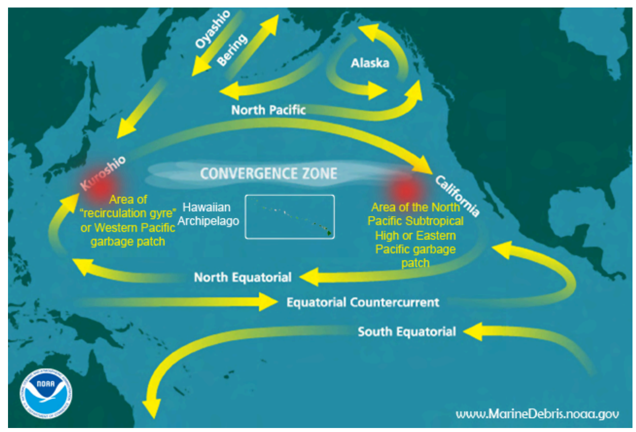
Clean-up

We're spewing plastic into our environment at an alarming rate, and clean-up is a relatively insignificant action compared to turning off the tap, especially because at least some of that cleanup will return to the environment. That said, funding efforts and supporting programs for marine debris clean-up will help our oceans and marine wildlife.[46] Federal legislation like the Don Young Veterans Advancing Conservation Act and other similar policies are worth pursuing.

Introduction

Plastic is everywhere. It's in the disposable cups, plates, bags, containers, cutlery, condiment packages and packaging we throw away everyday. It's in much of our clothing, electronics, and car tires. It also is now in our air, water, soil, and bodies.[47,48]

In just 2021, humans produced approximately 390.7 million metric tons of plastic, which is 40% more than a decade prior.[49] By now, many people have seen photographs of sea turtles and birds tangled up in bags or old fishing nets, the Great Pacific Garbage Patch, and whales washed up on shore with hundreds of pounds of plastic clogging their digestive systems. Approximately 60% of seabird species have ingested plastic and that number is expected to rise to 99% by 2050.[50] One study predicts that by 2050, there will also be more plastic than fish in the sea by weight.[51]



Pacific ocean currents including the garbage patches. Marine Debris Program, NOAA.

Steller sea lions with plastic packing band cutting into neck in Kenai Fjords National Park. ADF&G, NOAA Fisheries.

Here in Alaska, marine debris lines many shorelines, and it is estimated that it will take at least $100 million to clean it all up, since many of our beaches and shorelines are only accessible by small boats or by foot.[52] Plastic entanglement is a primary anthropogenic killer of humpback and gray whales.[53] In Alaska, steller sea lions get tangled up as well, and over 50% of their neck entanglements are caused by packing bands.[54] About 90% of Alaska's marine pollution is not produced by Alaskans, but instead washes in from around the world.[55] Alaska does have plenty of homegrown plastic pollution though, stemming primarily from litter and lost fishing gear. This problem is made worse by poor recycling infrastructure. Only about 30% of Anchorage households have curbside recycling, and very few plastics are eligible for recycling.[55] The problem is even more stark in smaller communities.[56,57]

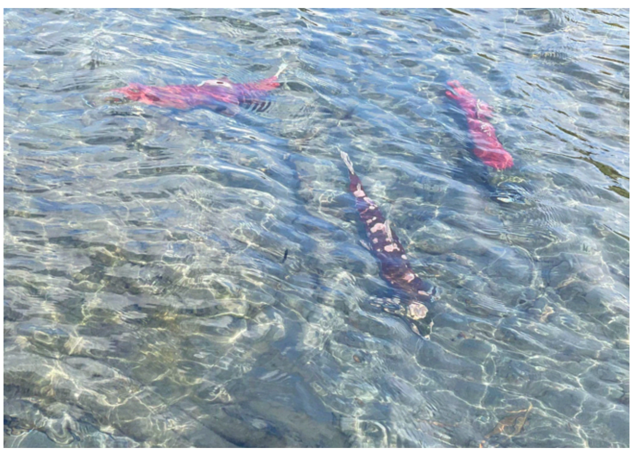
Macroplastic pollution is not the only plastic problem we have though. Recent research indicates that in the Atlantic Ocean only 1% of the plastic pollution is visible and floating on the surface, and the larger share of plastic pollution falls under the classification of micro or nano plastics– 5mm or less in size.[58,59] It's reasonable to assume the Pacific Ocean has a similar distribution. Plastics can take centuries to decompose, but heat and friction from sunshine, weather, and laundering can break plastics into these really small pieces and fibers.[60]

Even when plastics make it to landfills, microplastics can be blown out, hitch a ride with landfill gas, or leach into groundwater and enter the broader environment.[61] When waste is burned, it can release airborne microplastic particles and leave behind bottom ash contaminated with microplastics.[62] Microplastics can also come from car tires and plastic littered on roads, streams or in the ocean. Most new plastics are made from pellets of raw plastic feedstock and millions are lost every year.[63] Packaging and the production of products like bottled water can produce microplastics as well.[64]

Plastics are polymers, which are long chains of atoms in repeating patterns. The chains are longer than those found in nature, which along with the pattern makes it an appealing material–flexible, strong, and light. Plastic recycling is challenging; less than 10% of plastic is recycled even once due to challenges in sorting, contamination, and the economics of recovery. When most plastics are recycled, they degrade in quality and the polymers get shorter. Those lower quality plastics are often used for products that don't need to be quite as strong, like clothing, flower pots, or plastic lumber for park benches.[65]

Clothing and textiles are a particularly significant source of microplastics. Approximately 60% of clothing is made from plastic fibers including nylons, polyesters, acrylics, and fleece. Each time this material is worn or washed, it sheds microfibers into the environment and water. Unfortunately, water treatment facilities are rarely required to filter out microplastics, so an estimated 40% of fibers from washing end up in lakes, rivers, and oceans.[66]

Microplastics are a growing concern for both the environment and public health. They attract pollutants like DDT (Dichlorodiphenyltrichloroethane), PCBs (polychlorinated biphenyl), and heavy metals that exist at trace levels in the environment.[67] DDT is potentially carcinogenic, and has been shown to cause liver and reproductive problems in animals. High doses in humans cause vomiting, seizures, and tremors. It was banned in the U.S in 1972, but is still sometimes used internationally to control mosquitos carrying malaria.[68] PCBs are highly carcinogenic chemicals that used to be used in industrial and consumer products. The U.S banned them in 1976, and they were internationally prohibited in 2001.[69] Heavy metals can cause cellular damage, be carcinogenic, and impact multiple organ systems at a time.[70] Zooplankton and other aquatic organisms will mistake microplastics that have accumulated these pollutants for food, and these toxic chemicals can continue to bioaccumulate through the food chain, and end up in the seafood people eat.[71,72]



Salmon in sampling location Bear Lake, Joi Gross.

There is evidence that even uncontaminated plastic can cause environmental and public health problems. Microplastics break down into nanoplastics over time, pieces that are smaller than 1000n. Research has found that when fish ingest uncontaminated plastic, specifically polystyrene nanoparticles, the plastic can alter their behavior and metabolism. Fish that are exposed to plastics often will feed less, avoid predators less successfully, and experience reduced mobility.[73] Nanoplastics are small enough to enter the livers and embryo walls of fish. In 2018, sea scallops were briefly exposed to nanoplastics, and billions of pieces of nanoplastics were found throughout the scallops' bodies.[74] There is a wide range in how long it will take for different organisms to expel different types and sizes of plastic. Mussels retained plastic particles for over six weeks, crabs closer to four, and sea turtles excreted 85% of foam pieces within 13 days.[75] Another study found that Chinook juvenile salmon excrete about 94% of microplastic polyester fibers (pieces that are bigger than 1000n) that they consumed within 10 days.[76]

Research has also found high levels of microplastics accumulating in Arctic algae. Algae is one of our best carbon sinks, helping us slow global warming. Initial research has indicated that the accumulation of plastic can reduce photosynthesis capacity. Reduced photosynthesis capacity will reduce carbon dioxide storage by Arctic algae.[77]

It's not just animals and algae, there is growing evidence that humans are ingesting and inhaling microplastics. Microplastics have been found in human blood, lungs of living patients, breast milk, and placentas, and inside cells.[78,79,80,81,82] It's not known exactly how microplastics impact health, but it is known that many additives to plastic are toxic along with the dangerous chemicals they can accumulate in the environment. Brominated flame retardants, Bisphenol A (BPA), and phthalates are some common examples of additives to plastic household goods and food packaging that are proven endocrine disrupting chemicals (EDCs) that can damage human health when consumed.[83,84] Endocrine disruptors are linked with hormonal cancers, infertility, genital malformations, metabolic disorders, asthma, and problems with neural development.[85]

A Widespread Problem

Scientists are still documenting the scope of plastic pollution and investigating its effects in freshwater ecosystems and on human health. Nonetheless, there is a growing field of data showing that microplastics are spreading across the planet and becoming more pervasive in our daily lives:

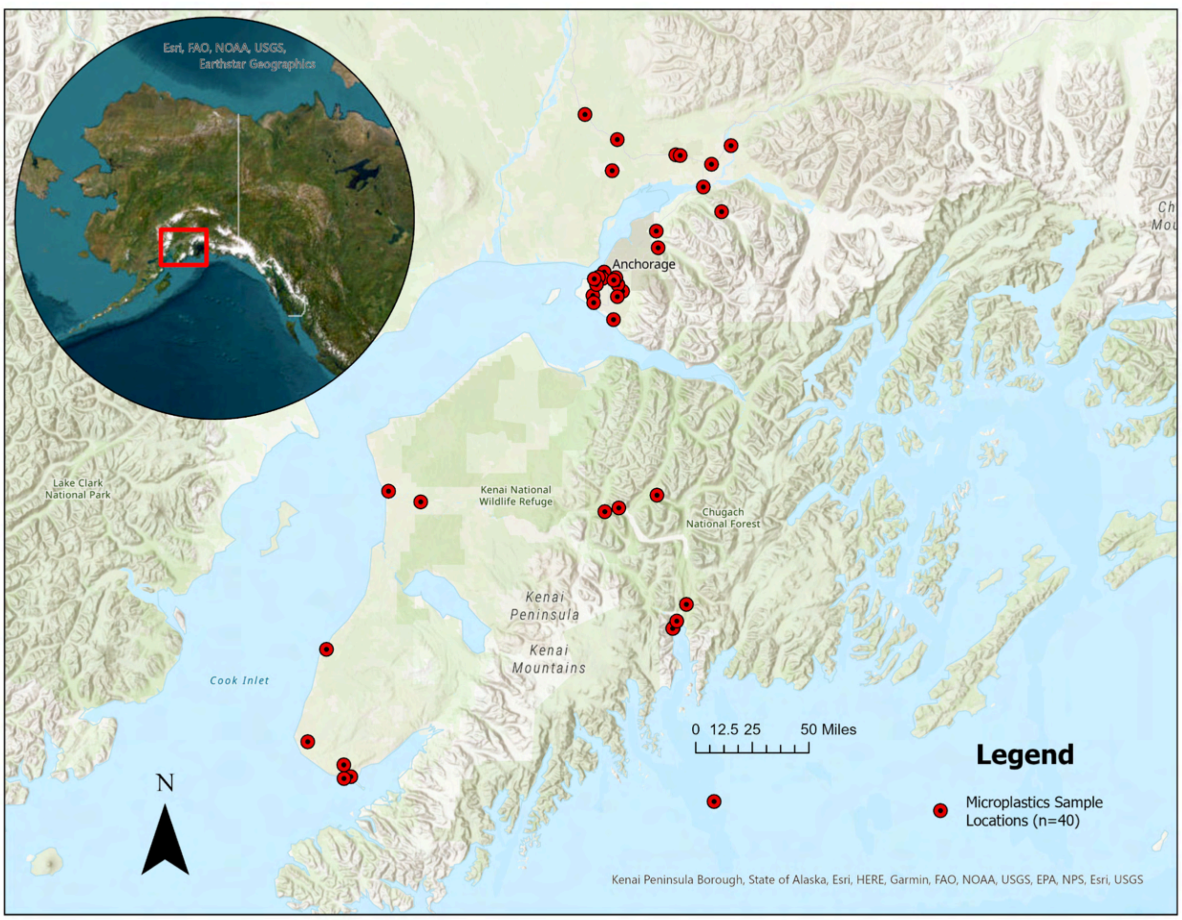
- Microplastics have been found in global and domestic samples of tap water, sea salt, and beer;[86]
- Microplastics have been found in a study of some of the most popular bottled water brands across several countries, which points to contamination from packaging and manufacturing;[87,88]
- U.S. Geological Survey (USGS) researchers found microplastic in 90% of rainwater samples collected from sites in Rocky Mountain National Park and the Denver-Boulder urban corridor;[89]
- Precipitation is estimated to deposit over 1000 metric tons of microplastics on protected land (parks, wildernesses etc) each year;[90]
- A later study in SE Alaska also found microplastics in rainwater samples with between 30-120 pieces of microplastic/square meter/day;[91]
- Researchers from Utah State and Cornell University found that microplastics are taken up by the air and carried around the globe through atmospheric currents;[92]
- Plastic pollution has now been found in isolated marine environments in the Arctic and Antarctic;[93]
- Research from the Chinese Academy of Sciences has shown that microplastics in the soil can be taken up by wheat and lettuce crops;[94]
- Recent studies from Utah State University and the University of Strathclyde have found high concentrations of microplastics in sea mist and ocean air;[95]

- In Alaska, a recent study found 85% of Pollock sampled in the Bering Sea had ingested microplastics;[96]
- 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;[97,98]
- Microplastics from plastic bottles, polystyrene containers, and LDPE film have been found in samples of human blood;[98]
- Microplastics have been found deep in the lung tissue of cadavers, demonstrating that the plastic does not pass through our bodies but lingers.[100]

Methodology

Sampling

The goal of this survey was to examine the presence and type of microplastics in surface waters in Southcentral Alaska. Thirty-nine sampling sites were chosen, ranging from urban ponds to tap water to bays and rivers. A map with the sampling locations is available through this link.



Sampling was undertaken between the beginning of June and the end of September 2023 by organizational staff and trained volunteers adhering to a consistent protocol based on best practices and earlier reports including the Microplastics: Sampling and Processing Guidebook protocol developed by NOAA, Mississippi State University Extension, Dauphin Island Sea Lab, and Sea Grant.[101] Approximately 3 liters of water were collected in glass mason jars at each sampling site. Collectors rinsed the mason jars and lids in source water a minimum of three times before collecting a sample of water flowing toward them (if water had movement). Some samples were collected from shore if it was deep enough, and some samples were collected after taking a few steps into the water. The Resurrection Bay sample was taken from a large boat using grappling hooks and tape. Samples were labeled with the source location and photographs were taken of each location. The jars were stored at room temperature until analysis within three weeks.

Analysis

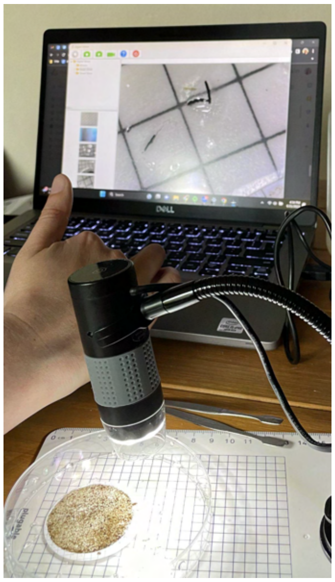
Filter flasks attached to vacuum pumps.

Analysis was performed on a rolling basis. All lab materials, including the filter funnel, petri dishes, forceps, and tweezers were rinsed with filtered water between samples to minimize potential contamination from outside sources. Jars containing samples were kept sealed until they were filtered, and filters remained closed in their packaging or petri dishes until they were analyzed under the microscope.

The samples were filtered through .45 micron (pore size) and 47mm (diameter) filters using electric vacuum pumps. Some samples with heavy sediment needed multiple filters. For sources with particularly heavy sediment, some sediment was left in the sampling jars after settling out, and only the top ⅚ of the water sample ran through the filter.

The filter was then transferred to a graduated observation stage for visual inspection under a digital microscope at 50-200x magnification. Visual identification of microplastics was guided by earlier reports, literature, and protocols including the Shaw Institute's Guide to Microplastic Identification.[102]

To aid in visual identification, additional "squeeze tests" (the use of fine-tipped tweezers or forceps to apply pressure and test durability) were performed. A hot needle test was performed to triple-confirm a fragment found in the Chester Creek sample. Any pieces that could not be positively identified were not recorded.



Digital microscope and sample

Identified microplastics were categorized into four types:

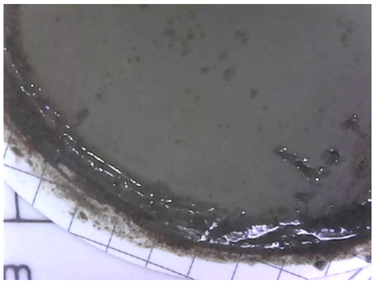
- Fibers from synthetic fabrics and filaments, such as fleece, polyesters, fishing line and baling twine;
- Fragments from rigid plastics, including polystyrene and clear plastic containers
- Film from plastic bags and food wrappers; and
- Microbeads from older cosmetics and personal care products.

Totals for each type of microplastic in each sample from each site were recorded in the Data Table along with the date the sample was drawn and the names of the sampler and the person performing analysis. For a breakdown of this data see our Appendix.

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 collection jar was glass and the lids were tinplate with a silicone ring. All but three sets of sample jars were rinsed in filtered water prior to transport to the testing locations (noted in the data table), and tripled-rinsed with source water from the collection site, downstream of where samples were to be collected (if water was moving). The sample jars that weren't rinsed with filtered water prior to transport were rinsed with source water a total of five times prior to collection of a sample. Those taking samples strived to avoid wearing synthetic clothing while sampling, and to ensure clothing did not contact the source water. The only exception to this was when collecting a sample from the Kenai River. For that sample collection, waders with a fleece underneath were worn during sampling.

The filter flask, tweezers, forceps, and other analysis equipment were rinsed with filtered water between samples to reduce contamination. Filter paper remained sealed and packaged until use and



Thick sediment from the bottom of the Knik River sample.

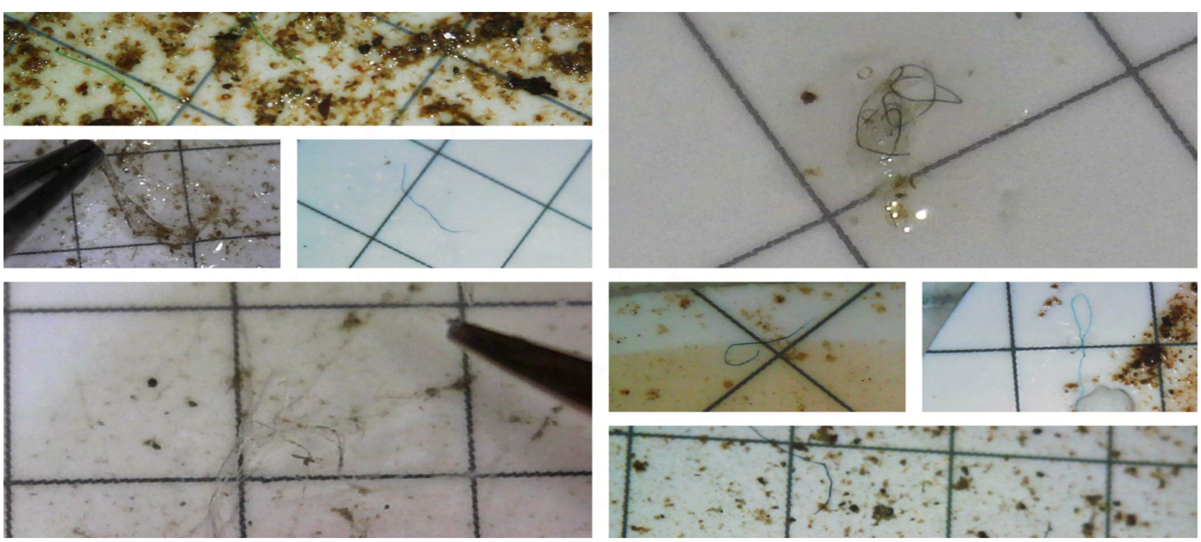
was transferred to the filtering set-up with forceps to avoid human contact. Sample jars were sealed in between transfer of water to the filter apparatus. Once filtered, filter papers were transferred to a triple-rinsed petri dish by the forceps for keeping until analysis. Filtered water was run through the filter and examined as a control sample and no microplastics were present.

Some samples had significant sediment. For those, the top half of each liter mason jar was poured through the filter first, and then new filters were used for the sediment heavy bottom half of the samples. It is likely that some microplastics were missed in the examination of those samples.

The team sampled one location twice. The initial sample of Cottonwood Creek had dozens of small red plastic fibers, possibly due to one specific piece of red plastic trash, and not representative of the average water in the creek. A second sample was taken a few weeks later in the same spot. Microplastics were still identified, but at a volume more comparable to other water sources.

The Resurrection River sample was only two liters of water, rather than three, so the number of microplastics may be underrepresented.

Examples of Observed Microplastics



Pictures of microfibers taken under microscope. Moving left to right, top to bottom: fibers from Lake Wasilla, fiber wrapped around a film from Sand Lake, film from Tern Lake, fiber from tap water in the U-Med neighborhood of Anchorage, fibers (likely fishing line fragments) from Kenai Lake, fiber from the Little Susitna, fiber from University Lake, fibers from Kepler Lake.

Results

To better understand the scope of the microplastic problem in Alaska, Alaska Environment Research and Policy Center staff and volunteers sampled 39 water bodies in Southcentral Alaska. We found microplastics in 100% of our samples.

Microfibers were by far the most prevalent microplastic found in samples with identification in 100% of samples. Micro fragments and films showed up in fewer locations, but were present in 20.5% and 33.3% respectively. It is important to note that our visual inspection methods may not detect all plastics in the samples, in particular clear or white plastics, those that are too small to visually detect using our scopes, or those that were obscured by sediment. Therefore, we believe our counts are an underestimate of the true prevalence of microplastics.

The concentration of microplastics (MP) in our water samples ranged from .33 to more than 50 MP/liter with an average of 4.8±8.8 MP/liter. While there are no standard methods of MP sampling, analysis, and detection, and there are studies indicating variance in concentration over space and time, we can make rough comparisons of these results with similar studies.[103] For example, Barrow et al.'s citizen science study detected 11.8 MP/liter in marine surface waters from around the world.[104] Nagorski at al. found an average of 17 MP/liters from water in non-glacial lakes, 3 MP/liter in non-glacial stream water, and less than a particle per liter in supraglacial streams and proglacial lakes in southeast Alaska.[105] Su et al. found 3.4-25.8 MP/L in Taihu Lake, which is in one of the most developed areas of China.[106]

Alaskans and tourists are almost certainly responsible for some of the microplastic pollution, but distribution patterns indicate some of the microplastic pollution is being swept in from other places as well. Our results show that popular fishing and recreation spots including Kenai Lake and Tern Lake have some of the highest concentrations of microplastics, and many of the pieces appear to be pieces of fishing line. On the other hand, microplastic concentrations are not consistently lower in more rural locations, indicating some non-local sources. When comparing samples within Anchorage city limits, where the largest population resides, to outside of the city, Anchorage had fewer microplastics/liter of water tested. Overall, locations that were not right in an urban area had a higher average number of microplastics/liter, but also had some samples with less than one piece per liter.

It's clear that the scope of plastic pollution in Southcentral Alaska is extensive. In order to address the environmental and waste crisis being caused by our overreliance on plastics, both local and global action is necessary. Our leaders at the federal, state, local, and corporate levels must implement policies that will address this problem.

Table 1: Results

Location	Microplastics? (Yes:Y or No:N)	Fibers (Y/N)	Beads (Y/N)	Fragments (Y/N)	Films (Y/N)
Resurrection River	Y	Y	N	Y	N
Ninilchik River	Y	Y	N	N	Y
Kenai River	Y	Y	N	N	N
Ship Creek	Y	Y	N	N	N
Eagle River	Y	Y	N	N	N
Knik	Y	Y	N	N	Y
Matanuska	Y	Y	N	N	N
Little Susitna	Y	Y	N	N	N
Anchor Point	Y	Y	N	N	N
Cooper's Creek	Y	Y	N	N	N
Campbell Creek	Y	Y	N	N	N
Chester Creek	Y	Y	N	Y	N
Cottonwood Creek Pt.2	Y	Y	N	N	N
Seward Lagoon	Y	Y	N	N	N
Second Lake	Y	Y	N	N	N
Bear Lake	Y	Y	N	N	N
Beluga Lake	Y	Y	N	N	Y
Sports Lake	Y	Y	N	Y	N
Kenai Lake	Y	Y	N	N	Y
Tern Lake	Y	Y	N	N	Y
Sand Lake	Y	Y	N	N	Y
Campbell Lake	Y	Y	N	N	N
University Lake	Y	Y	N	N	Y

Fish Creek Park	Y	Y	N	N	N
Westchester Lagoon	Y	Y	N	Y	Y
Lower Fire Lake	Y	Y	N	N	N
Wasilla Lake	Y	Y	N	N	N
Kelper Lake	Y	Y	N	Y	Y
Big Lake	Y	Y	N	N	Y
Nancy Lake	Y	Y	N	N	N
Bridge Creek Reservoir	Y	Y	N	N	Y
Eklutna	Y	Y	N	N	N
Resurrection Bay	Y	Y	N	N	N
Bishop Beach (Kachemak Bay)	Y	Y	N	Y	N
Lyn Ary (Cook Inlet)	Y	Y	N	Y	N
Potter's Marsh	Y	Y	N	N	N
Mountain View Tap Water	Y	Y	N	Y	Y
U-Med Tap Water	Y	Y	N	N	N
Abbot Loop Tap Water	Y	Y	N	N	Y

Basic Data Table
Extended Data Table

Policy Recommendations

Given how widespread the threat of plastic and microplastic pollution is, there is no silver bullet solution to address this pervasive problem. Fortunately, we know it's possible. Plastic has only been widely used for the last 50-60 years, so there are viable alternatives for most uses.[107] Multiple policy changes all over the globe are needed to combat this problem. The United States is not the biggest producer of plastic globally, but it is the biggest producer of plastic waste, so there is a lot to do at the local, state, and federal level.[108] Right now, there are a handful of municipalities in Alaska with plastic bag bans, but there are no statewide policies to address plastic pollution.[109] Below are several recommendations.

Producer Responsibility
Producers are shifting the cost of their waste to consumers and taxpayers.[110] Producer responsibility is a mechanism to shift the costs and management of postconsumer waste from local governments and consumers and onto producers themselves, requiring producers of plastic products to design, manage, and finance waste and recycling programs. Right now, very little plastic is actually recycled, and part of that is because plastics have to be separated out for effective recycling, and there are thousands of different polymer permutations.[111] When manufacturers are responsible for end of life during design, they can do things like choose actually recyclable materials, choose compostable options, or entirely eliminate a plastic component. The Alaska legislature should pass statewide producer responsibility laws as quickly as possible. Additionally, congress should pass federal measures to make these programs more widespread and shift the burden onto those who are creating the pollution.

Tackle Fast Fashion
To fight synthetic 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 society needs and uses. Societally, we should normalize and celebrate wearing our clothes for longer periods of time, mending them when they tear, buying used, and altering existing pieces rather than buying new.

Choose Natural Fibers
Data from this survey and numerous other studies indicate that synthetic fibers are one of the most ubiquitous forms of microplastic pollution.[112] They are also the microplastics that are most often found in rain samples and more remote environments. Retailers and clothing manufacturers should move away from making products containing synthetic plastic fibers, which inevitably contribute to microplastic pollution. Plant and animal based fibers decompose far more quickly and when they leach into the environment, there is evidence that they are digestible.[113]

Phase out single-use plastics
Nothing society uses for a few minutes should be able to pollute our environment for hundreds of years. Congress, Alaska state officials, and municipalities should continue to pass laws that phase out unnecessary single-use plastics such as plastic take-out containers, bags, cutlery, and packaging (the largest source of plastic waste in the world).[114] Cutting off the source of some of the most prevalent forms of plastic pollution will help curtail the tide of microplastics entering the environment. Right now, 16 municipalities in Alaska, including Anchorage, have some ban or limitation on plastic bags, but few limits exist on some of the other sources of single use plastics.[115]

Halt policies that promote increased manufacture & incineration of plastic

Communities and legislators in Alaska should oppose proposals to permit bringing facilities online explicitly to make new plastics, or policies that will promote plastics incineration under the guise of "advanced" or "chemical recycling".[116] Incineration does not dispose of microplastics.[117]

Support Reuse

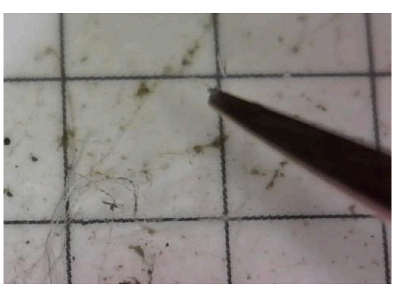
Reusing items can reduce the quantity of plastic we produce and that contaminates our waterways. There are many innovative ways to increase reuse- permitting customers to bring their own reusable containers for to-go food and bulk food, having universal reusable to-go containers in a town with collection bins for washing and redistribution by trash cans and in hotels, having delivery customers opt-in to including cutlery and sauce packets rather opt-out, provide grants for small restaurants to upgrade their kitchens to accommodate cleaning reusable containers etc. The state and municipalities can direct and assist reuse.

Support Repair

Repair is also essential to long term use. For example, most electronics contain plastic components–electronic-plastics make up about 5% of municipal waste. Those components make it challenging to safely reclaim and reuse the valuable minerals in the device, and most of the methods leave dangerous pollution behind.[118] If individuals have plenty of options for repair for their electronics through strong Right to Repair laws, they can extend the life of their goods and minimize another source of plastic pollution. Repair should also be supported and culturally reinforced for other goods.

Improve Sport Fishing Gear

Alaska is a global hub for sport fishing, and lost or snagged fishing line is one of the sources of microplastic pollution found in Southcentral Alaska, especially in Kenai Lake, Tern Lake, and other heavily fished freshwater. Historically, horse hair, silk, and linen were regularly used for fishing.[119] There are also some microbial polyesters that can be digested by bacteria in aquatic environments, and those are another viable alternative to long lasting plastic gear.[120,121] Anglers, lawmakers, agencies, tackle manufacturers, and guides should work together to transition to better fishing line materials and reinforce skills to better steward fishing holes.



Sample from Kenai Lake.

Minimize Loss of Commercial Fishing Gear

Alaska is also a global hub for commercial fishing, and lost gear is regularly found on Alaska shores and in Alaska marine environments. Public education, gear take back programs like the Copper River Watershed Project, introducing some biodegradable elements, and marine spatial management are some of the solutions to limit lost gear and ghost fishing (when lost gear catches marine life).[122,123] Elected officials should continue working with agencies, fishermen, and local communities to identify ways to reduce lost plastic gear and maximize repair and repurposing of gear when it's damaged.

Clean-up

We're releasing plastic into our environment at an alarming rate, and clean-up is a relatively insignificant action compared to turning off the tap, especially because at least some of that cleanup will return to the environment. That said, funding efforts and supporting programs for marine debris clean-up will help our oceans. Federal legislation like the Don Young Veterans Advancing Conservation Act and other similar policies are worth pursuing.

Appendix

Basic Data Table

Extended Data Table

Full Map

Detailed Procedure

Notes

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