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# The Impact of Plastic Pollution on Marine Ecosystems: A Study of Microplastics in the Oceans

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## ABSTRACT

Microplastics are small plastic pieces less than five millimeters long which can be harmful to our ocean and aquatic life. Plastic is the most prevalent type of marine debris found in our ocean and Great Lakes. Plastic debris can come in all shapes and sizes, but those that are less than five millimeters in length (or about the size of a pencil eraser) are called "microplastics."

As an emerging field of study, not a lot is known about microplastics and their impacts yet. The NOAA Marine Debris Program is leading efforts within NOAA to research this topic. Standardized field methods for collecting sediment, sand, and surface-water microplastic samples have been developed and continue to undergo testing. Eventually, field and laboratory protocols will allow for global comparisons of the amount of microplastics released into the environment, which is the first step in determining the final distribution, impacts, and fate of this debris.

KEYWORDS-microplastics, ocean, marine, pollution, plastic

## INTRODUCTION

Microplastics come from a variety of sources, including from larger plastic debris that degrades into smaller and smaller pieces. In addition, microbeads, a type of microplastic, are very tiny pieces of manufactured polyethylene plastic that are added as exfoliants to health and beauty products, such as some cleansers and toothpastes. These tiny particles easily pass through water filtration systems and end up in the ocean and Great Lakes, posing a potential threat to aquatic life.

Microbeads are not a recent problem. According to the United Nations Environment Programme, plastic microbeads first appeared in personal care products about fifty years ago, with plastics increasingly replacing natural ingredients. As recently as 2012, this issue was still relatively unknown, with an abundance of products containing plastic microbeads on the market and not a lot of awareness on the part of consumers.[1,2,3]

On December 28, 2015, President Obama signed the Microbead-Free Waters Act of 2015, banning plastic microbeads in cosmetics and personal care products.

Plastic is everywhere. A lot of it ends up in the ocean. Most plastics in the ocean break up into very small particles. These small plastic bits are called "microplastics." Other plastics are intentionally designed to be small. They're called microbeads and are used in many health and beauty products. They pass unchanged through waterways into the ocean. Aquatic life and birds can mistake microplastics for food. Research is being conducted. But there's still much we don't know. In 2015, the U.S. banned the use of microbeads. But microplastics are still a huge problem. You can help keep plastic out of the ocean. Remember: Reduce. Reuse. Recycle.

## DISCUSSION

- Over 400 million tons of plastic are produced every year for use in a wide variety of applications.
- At least 14 million tons of plastic end up in the ocean every year, and plastic makes up 80% of all marine debris found from surface waters to deep-sea sediments.
- Marine species ingest or are entangled by plastic debris, which causes severe injuries and death.
- Plastic pollution threatens food safety and quality, human health, coastal tourism, and contributes to climate change.



- There is an urgent need to explore new and existing legally binding agreements to address marine plastic pollution.

Plastic is a synthetic organic polymer made from petroleum with properties ideally suited for a wide variety of applications including: packaging, building and construction, household and sports equipment, vehicles, electronics and agriculture. Over 400 million tons of plastic are produced every year, half of which is used to create single-use items such as shopping bags, cups and straws. If discarded improperly, plastic waste can harm the environment and biodiversity.

At least 14 million tons of plastic end up in the ocean every year. Plastic debris is currently the most abundant type of litter in the ocean, making up 80% of all marine debris found from surface waters to deep-sea sediments. Plastic is found on the shorelines of every continent, with more plastic waste found near popular tourist destinations and densely populated areas.

The main sources of plastic debris found in the ocean are land-based, coming from urban and stormwater runoff, sewer overflows, littering, inadequate waste disposal and management, industrial activities, tyre abrasion, construction and illegal dumping. Ocean-based plastic pollution originates primarily from the fishing industry, nautical activities and aquaculture.

Under the influence of solar UV radiation, wind, currents and other natural factors, plastic breaks down into small particles called microplastics (particles smaller than 5 mm) or nanoplastics (particles smaller than 100 nm). The small size makes them easy for marine life to ingest accidentally.

Many countries lack the infrastructure to prevent plastic pollution such as: sanitary landfills; incineration facilities; recycling capacity and circular economy infrastructure; proper management and disposal of waste systems. This leads to 'plastic leakage' into rivers and the ocean. The legal and illegal global trade of plastic waste may also damage ecosystems, where waste management systems are not sufficient to contain plastic waste.

Plastic pollution is a widespread problem affecting the marine environment. It threatens ocean health, the health of marine species, food safety and quality, human health, coastal tourism, and contributes to climate change.

#### Impacts on marine ecosystems

The most visible impacts of plastic debris are the ingestion, suffocation and entanglement of hundreds of marine species. Marine wildlife such as seabirds, whales, fish and turtles mistake plastic waste for prey; most then die of starvation as their stomachs become filled with plastic. They also suffer from lacerations, infections, reduced ability to swim, and internal injuries. Floating plastics also help transport invasive marine species, thereby threatening marine biodiversity and the food web.

#### Impacts on food and human health

Microplastics have been found in tap water, beer, salt and are present in all samples collected in the world's oceans, including the Arctic. Several chemicals used in the production of plastic materials are known to be carcinogenic and to interfere with the body's endocrine system, causing developmental, reproductive, neurological, and immune disorders in both humans and wildlife. Recently, microplastics were found in human placentas but more research is needed to determine if this is a widespread problem.

Toxic contaminants also accumulate on the surface of plastic as a result of prolonged exposure to seawater. When marine organisms ingest plastic debris, these contaminants enter their digestive systems, and over time accumulate in the food web. The transfer of contaminants between marine species and humans through consumption of seafood has been identified as a health hazard, and research is ongoing.[4,5,6]



#### Impacts on tourism

Plastic waste damages the aesthetic value of tourist destinations, leading to decreased income from tourism. It also generates major economic costs related to the cleaning and maintenance of the sites. The build-up of plastic litter on beaches can have a negative impact on a country's economy, wildlife, and the physical and psychological wellbeing of people.

#### Impacts on climate change

Plastic production contributes to climate change. If plastic waste is incinerated, it releases carbon dioxide and methane (from landfills) into the atmosphere, thereby increasing emissions.

### RESULTS

Efforts should be made to adhere to and strengthen existing international legislative frameworks that address marine plastic pollution. The most important are the 1972 Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (the London Convention), the 1996 Protocol to the London Convention (the London Protocol) and the 1978 Protocol to the International Convention for the Prevention of Pollution from Ships (MARPOL).

Regional and national governments should also explore national legislative frameworks on Extended Producer Responsibility. These are emerging as innovative, low-cost solutions, as are policies to promote circular economies.

Governments, research institutions and industries need to work collaboratively to redesign products, and rethink their use and disposal to reduce microplastic waste from pellets, synthetic textiles and tyres. Consumers and society must shift to more sustainable consumption patterns. This will require solutions which go beyond waste management and consider the whole lifecycle of plastic products; from design to infrastructure, and household use.

More funding for research and innovation should be made available to provide policymakers, manufacturers and consumers with the evidence needed to implement technological, behavioural and policy solutions to address marine plastic pollution.

Methodologies to identify, measure and address marine plastic pollution sources and plastic leakage are available, including from IUCN.

The world is drowning under the weight of plastic pollution, with more than 430 million tonnes of plastic produced annually. Two-thirds are short-lived products that soon become waste, filling the ocean and, often, working their way into the human food chain.

At this year's World Environment Day on 5 June, the issue of plastic pollution will be front and center. One of the most damaging and long-lived legacies of the plastic pollution crisis is microplastics, a growing threat to human and planetary health.

These tiny plastic particles are present in everyday items, including cigarettes, clothing and cosmetics. United Nations Environment Programme (UNEP) research shows that continuous use of some of these products increases microplastics' accumulation in the environment.

Microplastics, which can be up to five millimetres in diameter, enter the ocean from marine plastic litter breaking down, run-off from plumbing, leakage from production facilities and other sources.

When ingested by marine life such as birds, fish, mammals and plants, microplastics have both toxic and mechanical effects, leading to issues including reduced food intake, suffocation, behavioral changes and genetic alteration.



In addition to entering the food chain through seafood, people can inhale microplastics from the air, ingest them from water and absorb them through the skin. Microplastics have been found in various human organs, and even in the placenta of newborn babies.

UNEP's 2021 report *From Pollution to Solution* warned that chemicals in microplastics "are associated with serious health impacts, especially in women". These can include changes to human genetics, brain development and respiration rates, among other health issues.

"The impacts of hazardous chemicals and microplastics on the physiology of both humans and marine organisms is still nascent and must be prioritized and accelerated in this Decade of Ocean Science for Sustainable Development," said Leticia Carvalho, Head of the Marine and Freshwater Branch at UNEP.

"However, action limiting their spread and prevalence will undoubtedly be beneficial to our long-term health and the well-being of marine ecosystems and beyond," she added.

#### Cigarette filters

Microplastics known as cellulose acetate fibres comprise the majority of cigarette filters. With six trillion cigarettes consumed by one billion smokers annually, these fibres reach every corner of the world. Cigarette butts are the most common plastic litter on beaches, making marine ecosystems highly susceptible to microplastic leakages.

When they break down, cigarettes release microplastics, heavy metals and many other chemicals that impact ecosystems' health and services.

#### Clothing and textiles

Plastics – including polyester, acrylic and nylon – comprise approximately 60 per cent of all clothing material. Due to abrasion, clothing and textiles with these materials shed microplastics known as microfibrils when washed or worn. According to a 2020 UNEP report that maps the global textile value chain, around 9 per cent of annual microplastic losses to the ocean come from clothes and other textiles.

To reduce these losses, experts recommend re-wearing clothes more often and washing them less often. When purchasing new outfits, opting for sustainably sourced natural materials can decrease or eliminate the threat of microplastic leakage – though doing so may come with other environmental trade-offs.

In the long term, UNEP and other UN agencies participating in the UN Alliance for Sustainable Fashion will continue to drive coordinated action in the industry. They will also campaign for government action to transition towards a sustainable and circular textile value chain with minimal microplastics. UNEP is working on a roadmap that highlights key actions stakeholders can take, as well as guidance for improving communication measures to drive behavioural change.[7,8,9]

### CONCLUSION

According to Elisa Tonda, UNEP's Head of the Consumption and Production Unit, engaging all stakeholders is necessary to shift the textile industry towards circularity and to address microplastics releases from textiles.

"Policymakers need to implement stronger governance and policies, as well as create a policy environment which incentivizes the design of sustainable fabrics and clothing and promotes a more standardized approach to the determination of releases from different textile products and suitable alternatives," said Tonda. "Brands should strengthen their efforts in designing sustainable clothing and take responsibility for their products at end-of-life," she added



## Cosmetics

Cosmetics and personal care products are other staples of grooming routines that can be loaded with microplastics. These products often contain primary microplastics, which are intentionally manufactured and added, often to provide texture - from hand sanitizer and soap to toothpaste and deodorant.

Plastic particles from these products can be absorbed into the skin or, in the case of products like lipstick or lip balm, directly ingested. Microplastics that remain on the skin are eventually washed down the drain and could make their way to the ocean.

According to UNEP's Global Chemicals Outlook II report, significant amounts of microplastics from cosmetics and other sources are more likely to enter waterways in areas with inadequate wastewater treatment facilities.

The report noted that some exfoliating agents contain more than 10 per cent microbeads - a type of primary microplastic. Furthermore, in a recent study, the Plastic Soup Foundation's Beat the Microbead campaign found that 83 per cent of 138 sanitizer and hand gel brands contained microplastics.

Reducing use, purchasing products with minimal packaging and examining ingredient lists are a few ways consumers can limit their potential exposure to microplastics, according to Madhuri Prabhakar, the foundation's Microplastics Campaigner.

Prabhakar added that generating a "future-proof definition for microplastics," will be essential in lobbying governments and businesses for change and potential bans or restrictions.

UNEP's Clean Seas Campaign's interactive "What's in your bathroom?" project showcases the prevalence of plastic in common personal care products to encourage consumers to opt for environmentally friendly alternatives.

Businesses and manufacturers also have a responsibility to decrease primary microplastic use. Meaningfully addressing the issue requires action beginning from the product design phase, according to UNEP's Assessment Report on Issues of Concern.

## Turning the tide

Through this new focus, Clean Seas Campaign aims to drive change for consumers, policymakers and businesses alike.

Its partnerships with various organizations and businesses can encourage lifestyle and industry changes and lead to greater impetus for essential research. It can also bolster our limited knowledge of microplastics' true impacts on human health and help to identify the best paths forward.

Given their pervasiveness in everyday household items, finding answers to microplastics' complex threats is a critical and pressing challenge.

Countries and businesses can join the Clean Seas campaign, as well as the New Plastics Economy Global Commitment to make ambitious pledges and commitments to combat all aspects of marine litter and plastic pollution. Individuals can also take the Clean Seas pledge to reduce their plastic footprint. Together, we can make the changes necessary to reduce the impacts of plastics and microplastics on environmental and human health.

There are 5,250 billion\* plastic particles floating on the surface on the world's seas and oceans, equivalent to 268,940 metric tons of waste. These fragments move with the currents before washing up on beaches, islands, coral atolls or one of the five great ocean gyres. As early as 2010, Tara Expeditions Foundation was one of the first bodies to undertake a scientific examination of microplastic pollution in the oceans, an issue previously subject to very limited scientific study. Tara wanted to use its ocean study programs to understand the impact of this pollution on marine life. In 2014, Tara conducted a seven-month expedition in the Mediterranean Sea to improve understanding of the consequences in a semi-enclosed sea. The expedition highlighted the fact that microplastics are heavily colonized by bacteria. Research into sea-borne plastic has since become an integral part of Tara's work. Excessive consumption of plastics, and the



waste this generates, has a massive impact on the natural world and the marine environment in particular. In this knowledge, Tara conducts scientific studies to improve our understanding of the risks to humans and marine ecosystems. Faced with the gravity of the situation Tara is convinced that, if we are to avoid plastics ending up in the oceans, the solutions lie on land. This involves a collective re-engineering of how we produce and consume, for example banning single-use plastic bags.[10,11,12]

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