13. Recommendations

The International Community

Plastic production and consequent waste is a global problem requiring international action. Microplastics (MPs) come almost entirely from degradation of macroplastics, so the control of MPs requires the reduction of plastic manufacturing and the reduction of plastic waste.

- Strengthen and enforce existing and proposed international treaties to reduce plastic production and disposal.
- More strongly administer MARPOL 73/78, the International Convention for the Prevention of Pollution from Ships, for example to reduce apparent releases of waste from Asian ships.
- Adopt and implement the five areas of recommendations of the G7 Oceans Plastic Charter and work to have others join to achieve the goal of zero plastic waste.
- Strongly support the proposed global treaty aimed at curbing plastic pollution, which will be discussed at the U.N. Environment Assembly in February 2022.
- Continue to conform to the Convention for the Protection of the Marine Environment of the North-East Atlantic (the 'OSPAR Convention') along with all of the contracting parties (Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden, and the UK). Work to establish similar regulations for the rest of the world's oceans.
- Encourage the European Commission's EU Plastics Strategy to reduce or eliminate intentionally added microplastics under its Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH) regulatory program.
- Incentivize improving global waste management to reduce plastics pollution by the worst waste generators, currently China, Indonesia, the Philippines, Vietnam, and Sri Lanka.

Recommendations for the Federal Government

Plastic production and plastic waste require federal action. Microplastics (MPs) come almost entirely from degradation of macroplastics, so the control of MPs requires the reduction of plastic production and its consequent waste.

- Ban future permits for new plastic manufacturing plants.
- Require Extended Producer Responsibility (EPR) for all plastics in order to shift the legal and financial responsibility to the manufacturers of plastics.
- Expand the Microbead-Free Waters Act of 2015 to ban manufactured microbeads in all consumer products, not just cosmetics and Over The Counter (OTC) pharmaceuticals.
- If genuine recycling becomes an important part of solving plastics pollution in the future, enact an approach like the European Commission's 2018 Europe-wide-plastics recycling plan. The European Commission has a set date of 2030 by which all plastic packaging must be recyclable. It also raises the extent of recycling to 55% of all packing material compared to the current European level of 30%. In the U.S., this rate is now less than 10%.
- Federal agencies like the National Science Foundation (NSF) and National Institutes of Health (NIH) should prioritize research on plastics and MPs and make special funding available to study them and their hazards.

Recommendations for State Governments

Plastic production and plastic waste require state action. Microplastics (MPs) come almost entirely from degradation of macroplastics, so the control of MPs requires the reduction of plastic manufacturing and the reduction of plastic waste.

- Ban any future permits for newly proposed plastic manufacturing plants.
- Require Extended Producer Responsibility (EPR) for all plastics in order to shift the legal and financial responsibility to the manufacturers of plastics.
- Ban plastic uses in all packaging, including for food and other products.
- Container redemption laws should be enacted in the 40 states that do not currently have them. Only ten states currently have container redemption laws. These are California, Connecticut, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont.
- Fund educational campaigns that will help make the public more aware of the importance of implementing the "Four Rs," which are "refuse, reduce, reuse, and recycle."

- Enact state laws, like the one in California that monitors the distribution and levels of plastics and microplastics in the environment. You cannot manage what you do not measure.
- Ban all remaining single use plastics that have not already been included in earlier state bans.
- Schools need to educate children about the importance of reducing the use of plastics. Children have a strong influence among their peers, parents, and community and can make a difference in reducing plastic uses.

Recommendations for Towns and Cities

- Ban any future permits for newly proposed plastic manufacturing plants.
- Ban as many single use plastics products as your town can pass.
- Test municipal drinking water for microplastics and retrofit treatment to eliminate them in drinking water.
- Recycle only those plastic products made from the two plastic polymers that are able to be successfully recycled: PET and HDPE (numbers 1 and 2). Ensure that they are actually recycled and not disposed as waste or exported.
- Do not collect plastic containers in categories 3–7, which are not recycled, but which give consumers the false belief that they are.
- Provide adequate numbers of street receptacles to prevent littering.
- Conduct street sweeping twice a month to help remove tire wear particles (TWPs) and macroplastics.
- Install hoods in all street catch basins to trap floatables, which are mainly plastics. Clean basins at least annually or whenever needed as they become full.
- Install end of pipe litter traps or other measures to capture plastics transported by runoff.
- Evaluate microplastics in treated sewage and upgrade treatment to reduce them.

Recommendations for Corporations

Corporations play a major role in causing plastics pollution and need to take a number of measures to help control the problem.

- Corporations that currently manufacture plastics must not create any new plastic manufacturing facilities and must reduce the amount of plastic from existing plants.
- Corporations need to support Extended Producer Responsibility (EPR) for all plastics that will shift the legal and financial responsibility to the manufacturers of plastics.
- Discontinue using plastic in the packaging of products. Many products are so heavily packaged in plastic that they require sharp tools to open them.
- Replace food storage and kitchen product lines with ones based on glass or other inert materials like stainless steel.
- Industry should avoid harming vulnerable infants with their plastic products. This should include making things like infants' feeding and water bottles from less harmful plastic resins and with lower amounts of additives, and using materials like shatterproof glass in place of plastic.
- Work to replace all conventional plastics with biodegradable and compostable plastics. Compostable plastics are broken down rapidly by microbes into nutrient-rich biomass, leaving behind no toxins or residue. Compostables are well-defined and governed by the U.S. Standard ASTM D6400-99, European Standard EN 13432, Canadian BNQ 9011-911/2007, and Japanese JBPA/2011.
- As industry moves to biodegradable and compostable plastics and other alternatives, it should use less hazardous polymers and include fewer additives.
- Industry should adopt a Circular Economy (CE) approach. This means incorporating used products as raw materials for making new ones. When manufacturing products, industry should Reuse-Repair-Refurbish-Remanufacture and then Repurpose.
- Produce plastics from biologically sourced raw materials, such as starch, cellulose, lignin and bioethanol. Use of these so-called bioplastics, which amount to about 1% of the current market, will reduce the dependence on fossil fuels, even if they will not reduce plastic waste.

- Industry is encouraged to work together in groups like the Alliance to End Plastic Waste (AEPW), which pledges to invest up to 1.5 billion dollars over the next five years on projects to keep plastic trash out of the ocean. The AEPW is an industry-funded, NGO, and non-profit organization composed of 28 companies. Founding members include BASF, Chevron Phillips Chemical, ExxonMobil, Dow Chemical, Mitsubishi Chemical Holdings, Proctor & Gamble, and Shell. Any such enterprise will need to be closely monitored by outsiders to ensure it is not simply a vehicle for greenwashing the members' public images.

Recommendations for Individuals

Individuals can help solve this problem by using less plastic whenever possible.

- Practice the Four Rs concepts: refuse, reduce, reuse, and recycle.
- Choose reusable products over single use ones.
- Select alternative materials to plastics, like glass, especially for storing food and microwaving.
- Reuse, recycle, and repurpose plastics at the end of their normal useful life.
- Encourage others to use the Four Rs through your social networks.
- Bring small reusable mesh bags to the grocery to hold produce.
- Buy bulk foods and put them in your own reusable containers.
- Choose products packaged in non-plastic containers, from eggs to milk to dishwasher detergent.
- Do not line trash cans or wastepaper baskets with plastic bags.
- Keep a reusable metal or glass water bottle – not plastic.
- Opening and closing plastic water bottles multiple times generates MPs that you will later ingest. Therefore avoid opening and closing plastic beverage bottles.
- Avoid polyester fleece fabrics, which release the greatest amounts of fiber MPs. Instead, use natural fiber fabrics or blends.

- Consumers can reduce MP fiber release from laundry by avoiding high water-volume washes, transitioning to appliances that use a lower water-volume, and ensuring that full wash loads are used. A device called the Lint LUV-R captures nearly 90% of microfibers from the wash.
- Consider keeping a plastics diary. Once a year, weigh all the plastics you discard during one week. Strive to waste less the next year.
- Never use products that contain manufactured microbeads.
- Pick up plastic litter. A single bottle has the potential to break down into more than a trillion MPs.

Recommendations for Future Research

There remain many unanswered questions about MPs and how they may harm human health. These should be immediate priorities for the research community.

- Increase research on small MPs (<100 microns). These are the most abundant and most likely to harm people and other animals.
- Study MPs that have been naturally or artificially aged. These are likely to carry more toxic substances and pathogens than are virgin particles.
- Establish standard protocols for sample collection, treatment, and analysis so that results of different investigators can be fairly intercompared. The National Academies of Science (NAS) should convene a committee to generate a report providing guidance on this topic.
- Investigators need to adopt clean techniques (filtered air laboratories and the like) to avoid sample contamination and erroneous results.
- Researchers need to guard against self-contamination of their samples with plastic additives that are almost ubiquitous in the human environment.
- Government, industrial, and academic researchers should monitor MPs in foods, beverages, and various environmental compartments (air, water, soils) with a view to their impact on human health.
- Researchers should close knowledge gaps that are impediments to conducting reliable risk assessments on human exposure to MPs, intake and translocation of smaller MPs and nanoplastics, chemical and microbiological hazards, and human health impacts.

- Research is needed on identifying the presence of microplastics in the human body in various tissues and organs.
- Scientists need to expand the range of organisms studied to allow greater generality of research findings.
- More investigations are needed with real world (lower) levels and long exposure times, rather than high-level exposure for short periods, as is commonly done at present. This shift in approach will require increased research funding by federal agencies.
- Additional study is needed to evaluate the health risk to vulnerable populations, like children and the immunocompromised.
- More research is needed on technologies to reduce plastic and MP pollution, especially safe substitutes for conventional plastics (biodegradable and compostable forms).
- We also need a better understanding of the fate and lifetime of plastics in the environment and where they wind up.
- Scientists can also contribute to strategies to achieve a more sustainable, circular economy, where materials normally considered waste by one industry can be repurposed as raw materials in another.

We recommended that all stakeholders from science, policy, and industry, to governments and individuals all work together. It will require action at all levels and by every sector to solve the global problem of plastics pollution and its impacts on human and ecosystem health.