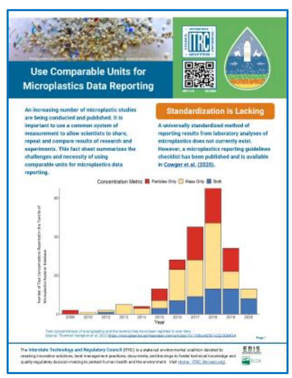
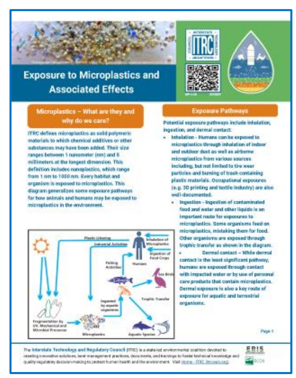
OUTREACH MATERIALS FOR SCIENTISTS AND REGULATORS

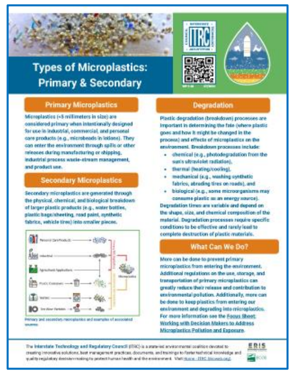
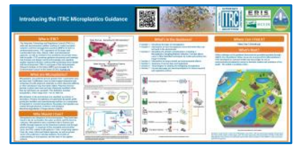
The scientific and regulatory community includes federal, state, and local government technical and regulatory personnel, along with academic researchers interested in increasing their understanding about microplastics. Outreach materials for scientists and regulators should include detailed information described in technical terms, focusing on what is known while acknowledging data gaps. Links to additional information resources from reputable sources, including peer-reviewed research articles, should be included. Although the information is more technical, it should still be presented in an interesting and compelling format.

Types of Materials for Scientists and Regulators

Fact Sheets

The goal of a fact sheet for scientists and regulators is to introduce a potentially complex topic in understandable terms and provide references and links to more detailed information. Regulators, scientists, or others working with the public may also use fact sheets designed for a general audience to educate themselves and provide information to the public. A list of outreach materials for all audiences prepared by the ITRC Microplastics Team can be found in the index.

		
Microplastics Sampling and Analysis Fact Sheet	Use Comparable Units for Microplastics Data Reporting Fact Sheet	Exposure to Microplastics and Associated Effects Fact Sheet

		
Data Gaps and Future Research Needs Fact Sheet	Types of Microplastics – Primary vs Secondary Fact Sheet	Microplastics Poster

Social Media Materials

The scientific and regulatory community may use social media to communicate among themselves about new research findings and technical innovations, and to provide information to a general audience in short but understandable bites. Social media posts for a general audience may be helpful in the second instance.

Posters and Presentations

Posters and presentations are two ways that scientists and regulators communicate information and research results to other scientists and regulators, generally at conferences and meetings. When a presenter speaks to an audience, they are usually accompanied by a visual presentation. Posters are generally set up to convey information visually, with or without a presenter or attendant. ITRC created a poster to provide general information on microplastics and promote the ITRC Microplastics Guidance. The abstract for the poster is:

> **Interstate Technology Regulatory Council (ITRC) Microplastics Outreach Toolkit Abstract Example**
>
> The Interstate Technology and Regulatory Council (ITRC) is a state-led environmental coalition working to create innovative solutions and best management practices (BMPs) for the environmental sector. ITRC produces guidance documents and trainings that broaden and deepen technical knowledge and expedites quality regulatory decision-making while protecting human health and the environment. ITRC is a program of the Environmental Research Institute of the States (ERIS), a 501(c)(3) organization incorporated in the District of Columbia and managed by the Environmental Council of the States (ECOS). ITRC represents all 50 states with membership from state, federal, tribal, and international agencies, as well as members from academia, the private sector, and the public. A recent ITRC activity was to develop a microplastics guidance document. The guidance introduces the topic of microplastics (Section 1), information on how they move and where they can be found in the environment (Section 2), sampling and analysis considerations (Section 3), information on human health and environmental effects (Section 4), a summary of current laws and regulations (Section 5), and

technologies that can be used to abate and mitigate microplastics in the environment (Section 6). Additionally, there is a discussion regarding the current data gaps and recommendations for future research and regulatory actions (Section 7). Online trainings on the guidance document are provided quarterly through USEPA CLU-IN platform. ITRC further developed an outreach toolkit to provide resources for environmental professionals to use in communicating microplastics issues to lawmakers and members of the public. Here is a link to the Microplastics Guidance: https://mp-1.itrcweb.org/.

The poster is included as a resource in this toolkit.

Microplastics Sampling and Analysis

MP-1-14 07/2024

Standardized methods and best practices for sample collection and analysis of microplastics particles and fibers are still being developed. To date, few standard methods have been adopted, and currently there are no regulations governing acceptable levels of microplastics. This fact sheet is an overview of sampling and analysis considerations for study preparations. This fact sheet is not intended to represent technical standard operating procedures.

Data Quality Objectives

Chosen sampling methods should be compatible with study objectives. Data quality objectives for a microplastics study should consider:

1. Sample matrix
2. Identification and measurement of particle mass
3. Identification of microplastic particle quantity, size, and shape
4. Characterization of specific properties of individual microplastic particles
5. Equipment availability and cost

Example of a subset of microplastics collected from a single experiment. The large end of the MP scale is visible to the naked eye.

Sampling Method Tool

ITRC has developed a sampling method tool. The tool outputs the available microplastic sample methods based on the selected inputs for sampling matrix and particle size, and provides additional details, such as equipment needed, advantages and disadvantages, relative cost, and references for additional information.

Select your sampling requirements:

Filtering Criteria: Media	**Filtering Criteria: Particle Size Range**
☐ Select all media	☐ No particle size limitations
☐ Surface Water	☐ All Size Fractions
☐ Wastewater	☐ Limited Size Fractions
☐ Stormwater	
☐ Drinking Water	
☐ Groundwater	
☐ Soil	
☐ Sediment	
☐ Biosolids	
☐ Pore Water	
☐ Air	

Screenshot of Sampling Method Tool

Check it out!

Quality Assurance/Quality Control

Quality assurance and quality control are particularly important in microplastics analysis due to the high possibility of contamination and the lack of method standardization. Introduction of contaminants can be through a variety of products, materials, and sources. When sampling for microplastics, it is important to minimize contamination by limiting or eliminating plastic products used for sampling and processing. This also applies to personal protective equipment and clothing worn by and personal care products used by individuals collecting and analyzing samples. Consider nonsynthetic materials, such as cotton shirts and jeans. Additionally, cross contamination must be accounted for by using equipment, laboratory, and field blanks to measure contamination introduced during processing.

Analysis

Analysis of microplastics can be either destructive or nondestructive, and identification can be quantified in mass or count, depending on study objectives. Nondestructive methods (e.g., spectroscopy, such as Fourier transform infrared [FTIR] or Raman) allow physical characteristics including size, shape, and color of microplastics to be characterized. Destructive methods (thermal degradation methods such as pyrolysis-gas chromatography/mass spectrometry) are potentially faster and provide polymer mass, but the process destroys the physical characteristics of the microplastics particles. Method selection is dependent on study objectives.
Microplastics can be detected using several different methods:

Visual methods. Visual examination of a sample with or without magnification, including:

- Naked eye (no magnification)
- Stereo, fluorescence, or scanning electron microscopy

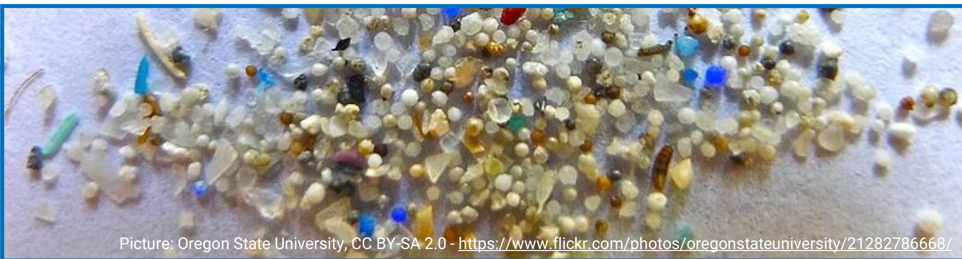
Spectroscopic methods. Capture and assign the characteristics of specific chemical structure of polymers using reference spectra, such as:

- FTIR and focal plane array FTIR
- Laser direct infrared spectroscopy
- Raman

Thermoanalytical/chemical methods. Pyrolyze the sample under inert conditions and specific decomposition products of the individual polymers are detected.

Reporting

A universally standard method of reporting microplastics analyses does not currently exist. This is partially due to the emerging nature of microplastics studies and the wide range of their physical and chemical impacts. Therefore, detailed reporting, including sufficient documentation of the mass or volume of the sampled environmental matrix, laboratory extraction process used, and analysis performed is needed so that conversion to other commonly used units can be performed. Though a standardized method does not yet exist, a highly cited microplastics reporting guidelines checklist has been published and is available in Cowger et al. (2020).



Picture: Oregon State University, CC BY-SA 2.0 - https://www.flickr.com/photos/oregonstateuniversity/21282786668/

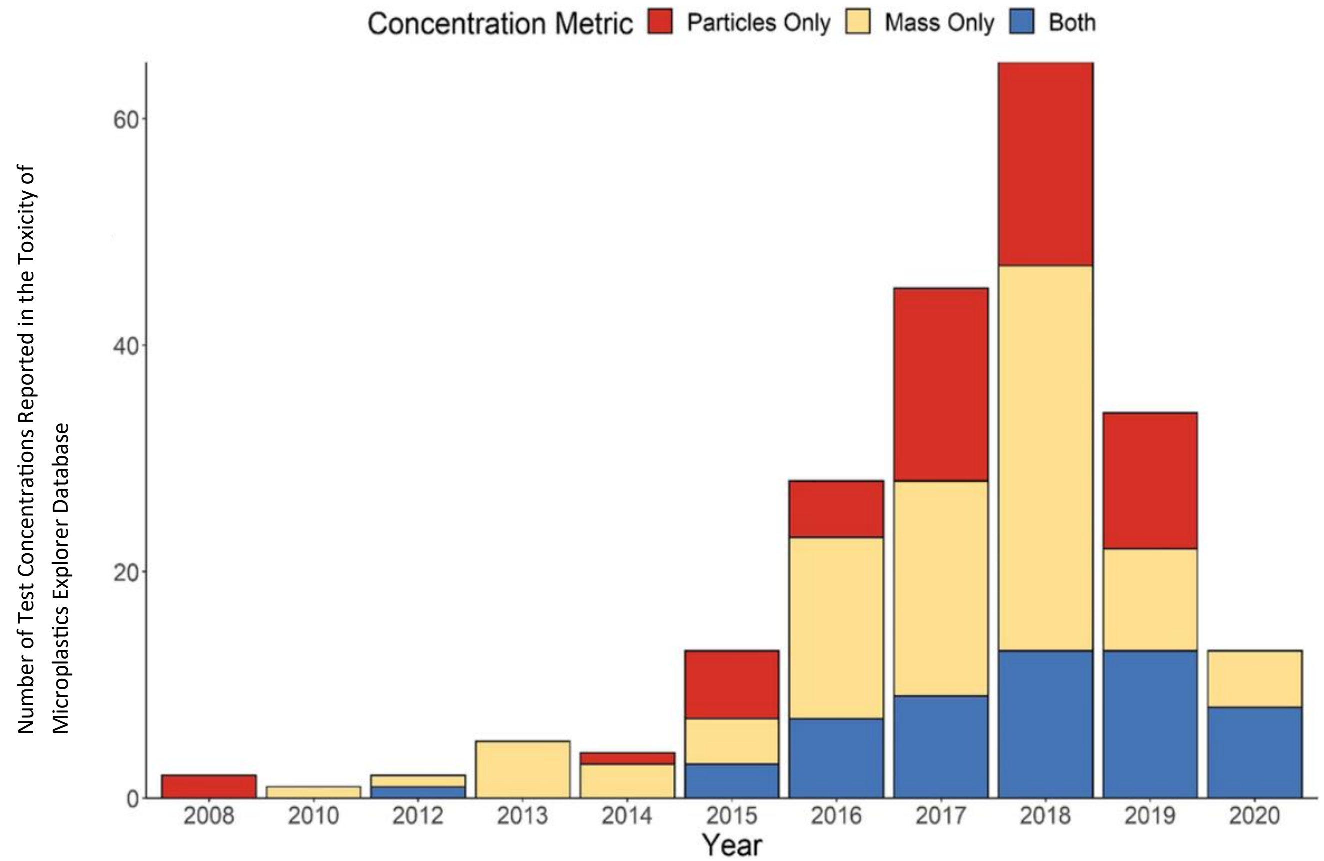
Use Comparable Units for Microplastics Data Reporting

MP-1-15 07/2024

An increasing number of microplastics studies are being conducted and published. It is important to use a common system of measurement to allow scientists to share, repeat, and compare results of research and experiments. This fact sheet summarizes the challenges and necessity of using comparable units for microplastics data reporting.

Standardization Is Lacking

A universally standardized method of reporting results from laboratory analyses of microplastics does not currently exist. However, a microplastics reporting guidelines checklist has been published and is available in Cowger et al. (2020).



Test concentrations of microplastics and the metrics they have been reported in over time.
Source: Thornton Hampton et al. 2022 https://microplastics.springeropen.com/articles/10.1186/s43591-022-00040-4

Comparison Between Microplastic Studies Is Difficult

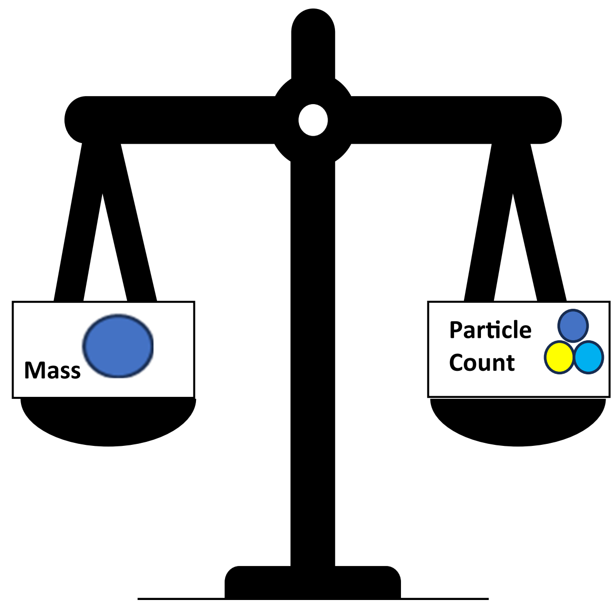
Comparison of data between studies is complicated by variability in how microplastics are defined, a lack of standardized analytical methods, differences in the units used to report the presence of microplastics in various media, and missing particle size data. Microplastics can be quantified in mass, particle count, or both, depending upon project goals.

Units Need to Be Comparable to Be Useful

Many current microplastics analytical methods report results using particle count (per volume or surface area) as the numerical value unit. Particle count allows descriptors of shape and size that support calculation of concentrations of specific types of particles and are therefore easier to link to toxicity studies. Particle size should be reported in all studies.

Another reporting unit is mass per volume (e.g., µg/L) or mass per weight (e.g., mg/kg). These concentration units are commonly used for contaminants in regulatory, monitoring, and toxicological programs. In addition, pyrolysis gas chromatography/mass spectrometry (GC/MS) is increasingly used as an analytical method to identify and quantify small microplastics. This instrument reports microplastics in concentration (mass/volume), not particle count.

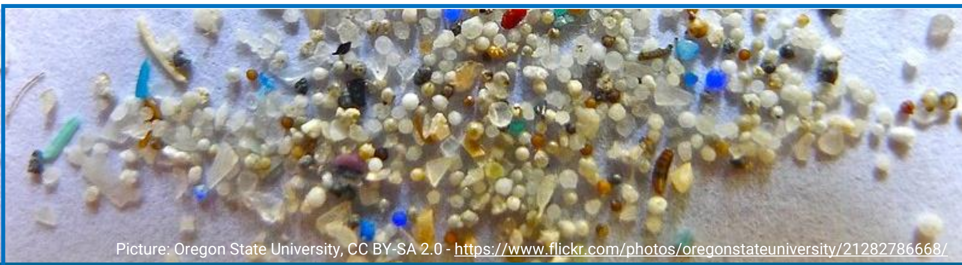
Concentrations in sediment or soil samples containing microplastics should be reported as dry or wet weight. The weight of dry sample particles remains constant, but as water content varies, wet weight will vary; therefore, include a wet:dry ratio if using wet weight so that it can be converted to dry weight based on moisture content.



Note: The mass of one large particle can be equal to the mass of multiple smaller particles. Units need to be comparable to be useful.

Suggested Reporting

To provide maximum usefulness when comparing concentrations to other toxicity studies or environmental concentrations, microplastics concentrations should be reported as both mass (per volume or per unit dry weight) and particle count (per volume or surface area). Microplastic particles that are well-characterized (e.g., detailed characterization of particle size distributions) can allow concentrations to be converted between mass, count, and volume, if the density of the plastic is also reported.



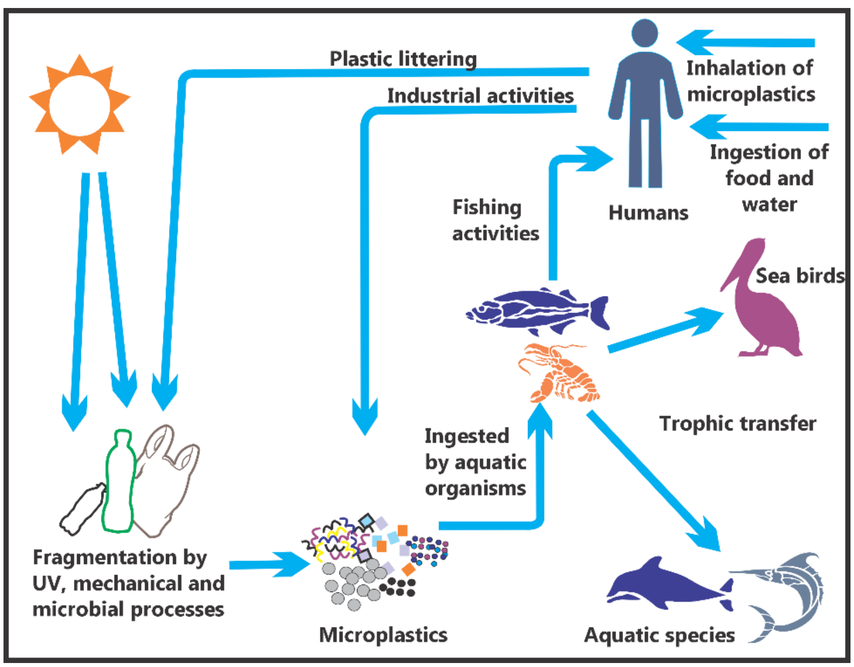
Picture: Oregon State University, CC BY-SA 2.0 - https://www.flickr.com/photos/oregonstateuniversity/21282786668/

Exposure to Microplastics and Associated Effects

MP-1-16 07/2024

Microplastics – What Are They and Why Do We Care?

ITRC defines microplastics as solid polymeric materials to which chemical additives or other substances may have been added. Their size ranges between 1 nanometer (nm) and 5 millimeters at the longest dimension. This definition includes nanoplastics, which range from 1 nm to 1,000 nm. Every habitat and organism is exposed to microplastics. The diagram here generalizes some exposure pathways for how animals and humans may be exposed to microplastics in the environment.



Exposure Pathways

Potential exposure pathways include inhalation, ingestion, and dermal contact:

- Inhalation - Humans can be exposed to microplastics through inhalation of indoor and outdoor dust, as well as airborne microplastics from various sources, including but not limited to tire wear particles and burning of trash containing plastic materials. Occupational exposures (e.g., 3-D printing and textile industry) are also well-documented.
  - Ingestion - Ingestion of contaminated food and water and other liquids is an important route for exposure to microplastics. Some organisms feed on microplastics, mistaking them for food. Other organisms are exposed through trophic transfer, as shown in the diagram.
    - Dermal contact – Although dermal contact is the least significant pathway, humans are exposed through contact with impacted water or by use of personal care products that contain microplastics. Dermal exposure is also a key route of exposure for aquatic and terrestrial organisms.

The Interstate Technology and Regulatory Council (ITRC) is a state-led environmental coalition devoted to creating innovative solutions, best management practices, documents, and trainings to foster technical knowledge and quality regulatory decision-making to protect human health and the environment. Visit Home - ITRC (itrcweb.org).

Exposure to Microplastics and Associated Effects

Challenges in Toxicity Assessment

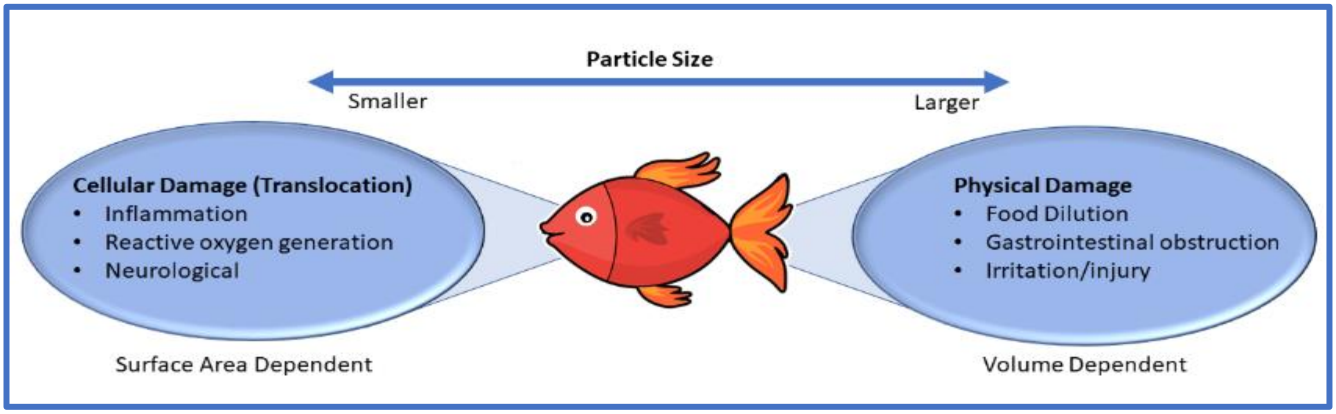
There is a lot of variation in quality and usability of available information on health impacts related to microplastics exposure. Microplastics toxicity can be caused by both physical and chemical properties and the pathogens that may adhere to them. Exposure does not necessarily equal adverse effects.

There has been an exponential growth in recent years of nonhuman mammalian studies, but variations in study design, exposure concentration, data quality, and data reporting have led to significant data gaps. Currently, there is not enough information to establish toxicity criteria to use in environmental or human health risk assessments.

Human Health Effects

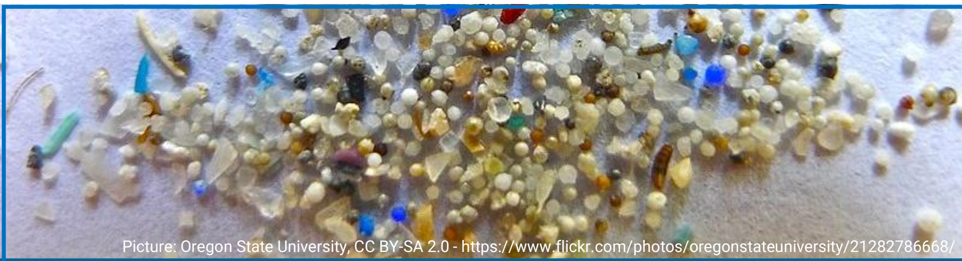
Although the associated risks of exposure remain uncertain, microplastics have been detected in several human tissues, including lungs, placenta, and blood. Microplastics have also been detected in human breast milk and meconium of newborn babies. Currently, there is not sufficient weight-of-evidence to definitively state what the health effects are for humans exposed to microplastics. Additional information regarding potential human health effects can be found in the ITRC Microplastics Guidance Document - https://mp-1.itrcweb.org/human-health-and-ecological-effects.

Ecological Effects



The figure above is a conceptual diagram of aquatic organisms exposed to microplastics. These concepts are expected to be similar for terrestrial organisms. There are two kinds of health effects associated with microplastics, both of which are related to their particle size. The first is that, when the particle size is very small, as shown on the left side of the continuum, it is more capable of causing molecular- and cellular-level damage, such as inflammation and oxidative stress reactions.

The second is that, when the particles are larger, as shown on the right side, the effects are more physical damage, often related to the ingestion route. If microplastics are accidentally or intentionally consumed with food, this can lead to food dilution, or blocking certain portions of the gastrointestinal tract or other types of injury. Even the particle surface (rough or smooth) can make a difference when it comes to causing irritation.



Microplastics Data Gaps & Future Research Needs

MP-1-17 07/2024

The topic of microplastics as emerging contaminants is evolving quickly. As such, it is helpful to keep in mind the areas where additional information is needed to inform potential regulatory initiatives and to provide approaches to mitigation. The ITRC Microplastics Guidance document, published in February 2023, identified future research needs related to fate and transport, sampling and analysis, potential health risks, trophic transfer, and ecological exposure and effects. Potential research areas are listed below and in Section 7 of ITRC's Microplastics Guidance.

Fate and Transport

- Microplastics in groundwater: occurrence, types, concentrations
- Degradation characteristics: What constitutes *fully degraded* microplastics?
- Modeling to include environmental variables, physical and chemical characteristics
- Microplastics in sediment and in relation to aquatic systems
- Occurrence and characteristics of transport in the atmosphere

Sampling and Analysis

- Standardized microplastics reference materials to improve accuracy of extraction and identification methods
- Acceptable blank and reference recovery ranges; replicate numbers and variability
- Affordable instruments for identification/quantification and automated systems, such as use of machine learning
- Develop methods for nanoplastics detection. Nanoplastics may be the most numerous in the environment, and current approaches are not effective for this size range.

Potential Health Risks

- Develop basis for evaluation of effects on humans and assess effects of environmentally relevant concentrations
- Effects with variation in properties (size, morphology), biofilm presence, chemical additives
- Potential for accumulation in body tissues

Trophic Transfer & Ecological Exposure

- Bioaccumulation/biomagnification risks for ecological receptors
- Ecological risks for varying particle characteristics
- Ecological effects of weathered vs. nonweathered particles
- Microplastics as vectors for other pollutants in sediment/water

Mitigation, Abatement, & Management

- Low-cost, sustainable alternatives to plastic
- Economic studies to determine value of plastic waste
- Infrastructure and programs for sustainable plastic waste management (stormwater systems, wastewater treatment, etc.)
- Enhance public education and engagement with disproportionally affected communities

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Picture: Oregon State University, CC BY-SA 2.0 - https://www.flickr.com/photos/oregonstateuniversity/21282786668/

Types of Microplastics: Primary & Secondary

INTERSTATE TECHNOLOGY REGULATORY COUNCIL ITRC

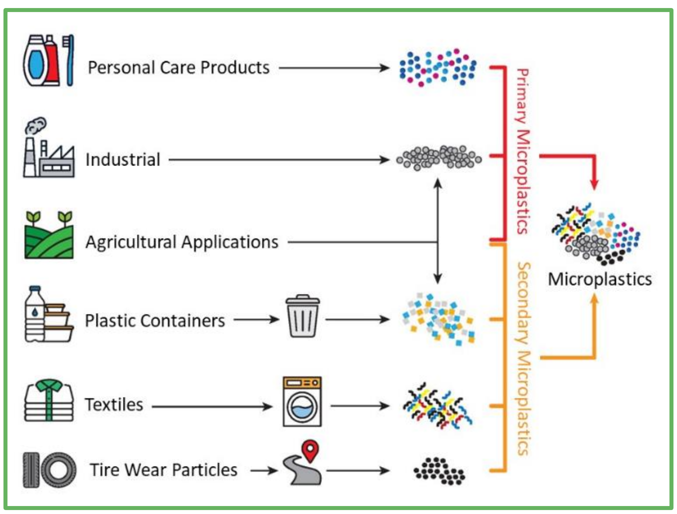
MP-1-18 07/2024

Primary Microplastics

Microplastics (<5 millimeters in size) are considered primary when intentionally designed for use in industrial, commercial, and personal care products (e.g., microbeads in lotions). They can enter the environment through spills or other releases during manufacturing or shipping, industrial process waste-stream management, and product use.

Secondary Microplastics

Secondary microplastics are generated through the physical, chemical, and biological breakdown of larger plastic products (e.g., water bottles, plastic bags/sheeting, road paint, synthetic fabrics, vehicle tires) into smaller pieces.



Primary and secondary microplastics and examples of associated sources.

Degradation

Plastic degradation (breakdown) processes are important in determining the fate (where plastic goes and how it might be changed in the process) and effects of microplastics on the environment. Breakdown processes include:

- chemical (e.g., photodegradation from the sun's ultraviolet radiation)
- thermal (heating/cooling)
- mechanical (e.g., washing synthetic fabrics, abrading tires on roads)
- biological (e.g., some microorganisms may consume plastic as an energy source)

Degradation times vary and depend on the shape, size, and chemical composition of the material. Degradation processes require specific conditions to be effective and rarely lead to complete destruction of plastic materials.

What Can We Do?

More can be done to prevent primary microplastics from entering the environment. Additional regulations on the use, storage, and transportation of primary microplastics can greatly reduce their release and contribution to environmental pollution. Additionally, more can be done to keep plastics from entering our environment and degrading into microplastics. For more information see the Focus Sheet: Working with Decision-Makers to Address Microplastics Pollution and Exposure.

Introducing the ITRC Microplastics Guidance

MP-1-21 07/2024

Who Is ITRC?

The Interstate Technology and Regulatory Council (ITRC) is a state-led environmental coalition working to create innovative solutions and best management practices (BMPs) for the U.S. environmental sector. ITRC represents all 50 states with membership from state, federal, tribal, and international agencies, as well as members from academia, the private sector, and the public. ITRC produces guidance documents and trainings that broaden and deepen technical knowledge and expedites quality regulatory decision making while protecting human health and the environment. ITRC is a program of the Environmental Research Institute of the States (ERIS) and managed by the Environmental Council of the States (ECOS). itrcweb.org

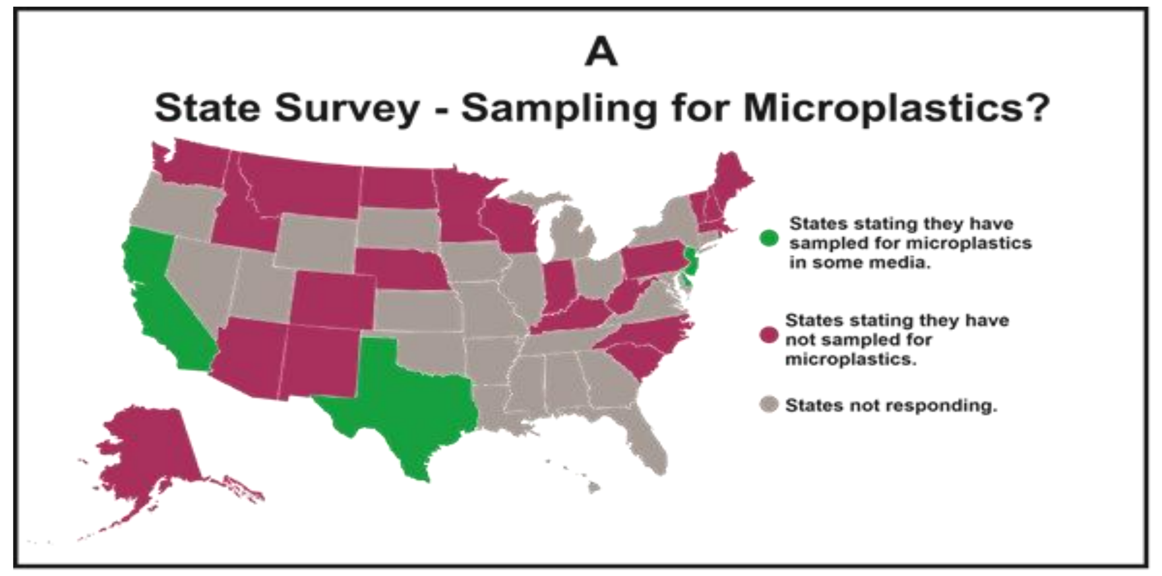
What Are Microplastics?

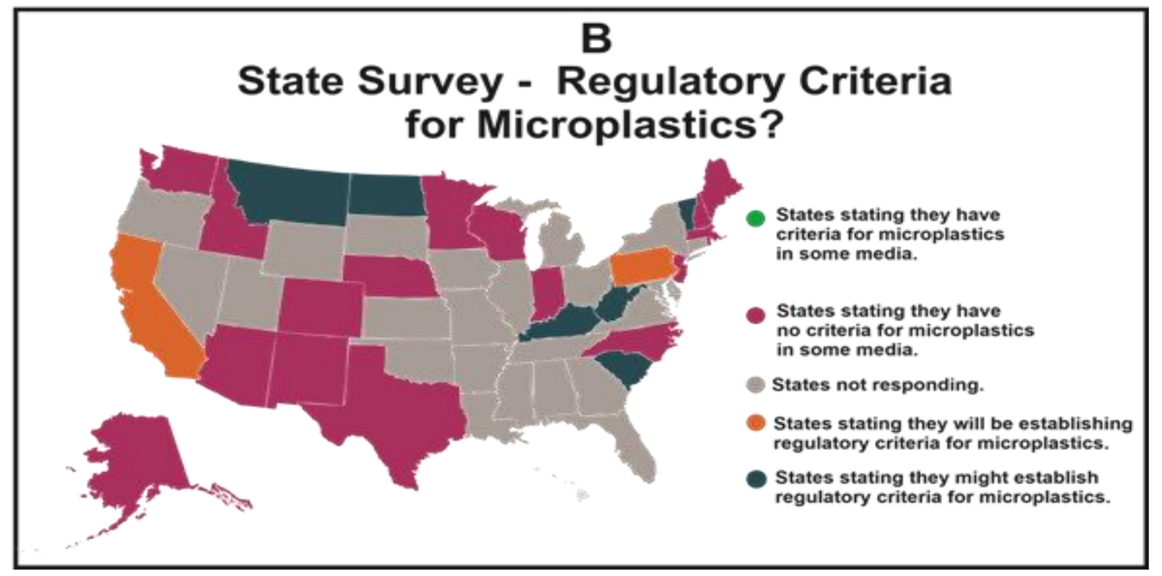
Microplastics are particles that are greater than 1 nanometer (nm) and less than 5 millimeters (mm) in their longest dimension and comprised of solid polymeric materials to which chemical additives or other substances may have been added. Polymers that are derived in nature that have not been chemically modified (other than by hydrolysis) are excluded. This definition includes nanoplastics, which range from 1 nm to 1,000 nm.

Microplastics in the environment are classified as primary or secondary. Primary microplastics are generated by plastic pellet production facilities and manufacturing facilities as a component of industrial or commercial products. Secondary microplastics are created through physical, chemical, and biological alteration/degradation of larger pieces of plastic.

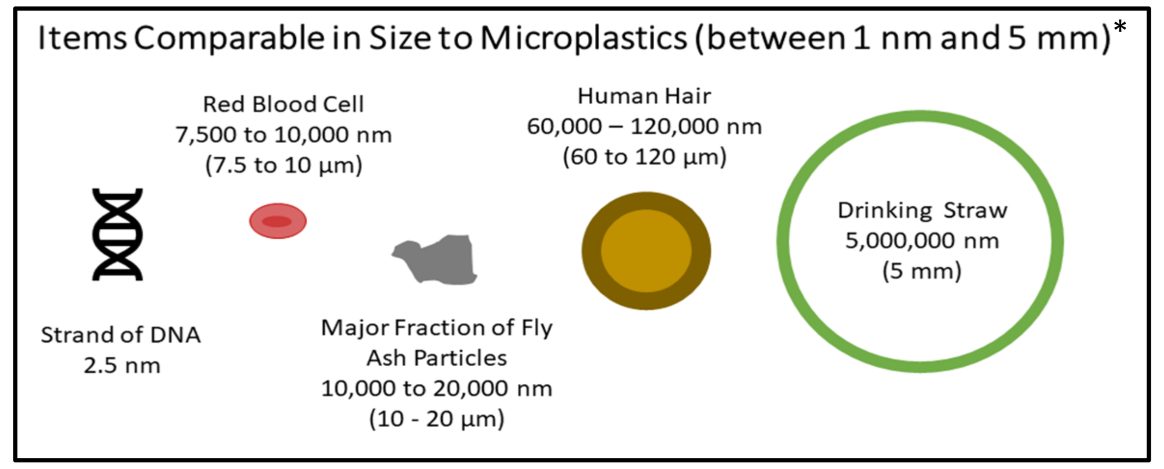
Why Should I Care?

Microplastics are ubiquitous in the environment. They have been found in the air we breathe, the water we drink, and the food we consume. Microplastics pose a potential risk to humans and wildlife through exposure to the chemicals in plastic and through physical impact. In response to this emerging environmental issue, the ITRC created a *Microplastics Team,* comprising experts from city, state, tribal, and federal agencies, as well as the private sector and academia, to develop guidance that provides an understanding of microplastics and the state of the applied science.

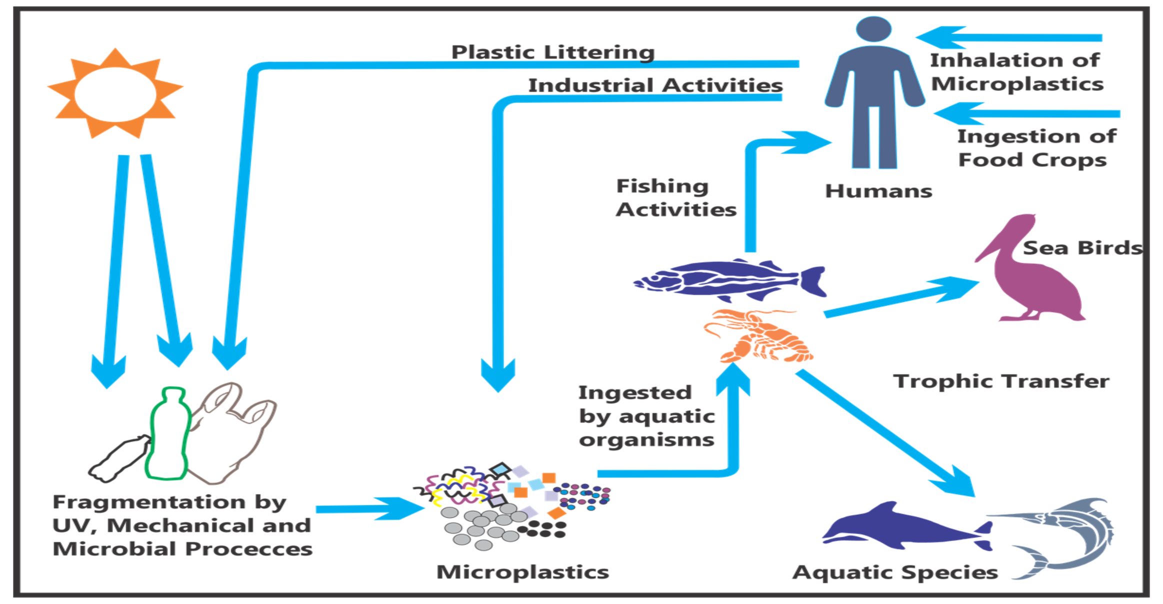




State survey data current as of June 2021



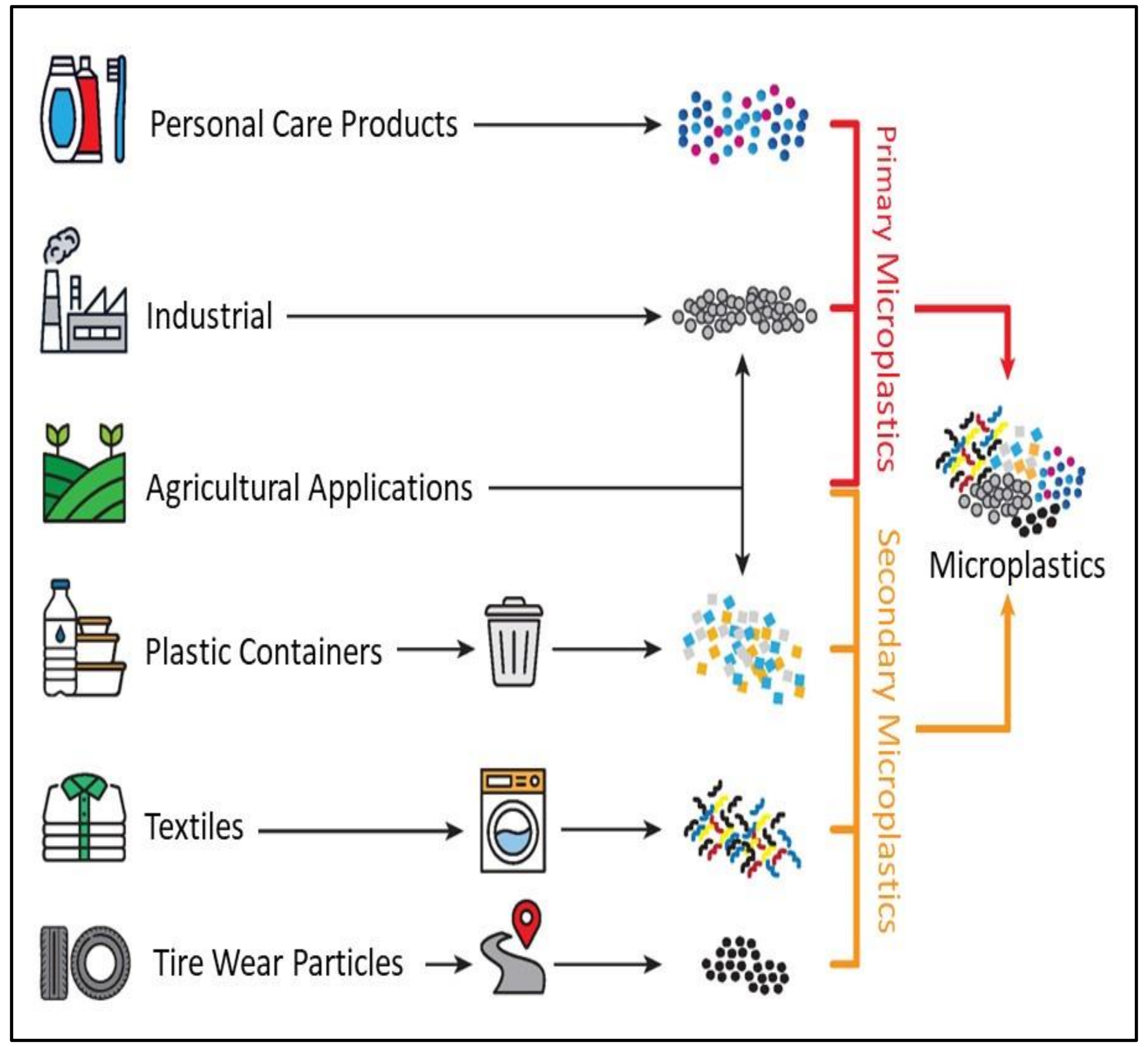
*enlarged to show detail



Examples of how some primary and secondary microplastics sources could result in microplastics entering the food chain at various trophic levels, potentially resulting in environmental and human exposures.

What's in the Guidance?

- Section 1 - Introduces the topic of microplastics
- Section 2 - Information on how microplastics move and where they can be found in the environment
- Section 3 - Sampling and analysis considerations, including a Microplastics Sampling Method Selection Tool that allows users to filter identified techniques by media and particle size range of interest
- Section 4 - Information on human health and environmental effects
- Section 5 - Summary of current laws and regulations
- Section 6 - Technologies for abating and mitigating microplastics
- Section 7 - Current data gaps and recommendations for future research and regulatory actions



Examples of primary and secondary microplastic sources.

Where Can I Find it?

https://mp-1.itrcweb.org/

What's Next?

Online trainings on the guidance document are provided quarterly through USEPA CLU-IN platform (https://www.clu-in.org/conf/itrc/Microplastics/). ITRC developed an outreach toolkit and encourages its use to communicate microplastics issues to decision-makers and members of the public. The toolkit is available online.

Movement of microplastics in surface waters.

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