

Regulations & Their Role in Human & Environmental Risk Management: Microplastics in the Great Lakes

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Background

Microplastics (MP) are the smallest form of plastic litter found in the environment. They can be as large as 1mm or as small as a few micrometers. There are three primary sources of microplastics. The first is personal care products. Microplastic beads are common in creams and lotions meant to exfoliate skin. They can come from synthetic clothing, as plastic fibers are removed during each wash cycle. The last source is from degradation of larger plastic litter. UV radiation and physical abrasion can break down larger plastics into microplastics. Microplastics are being detected and quantified at an increasing rate in aquatic environments [1].

Microplastics are considered harmful due to the negative aesthetic impacts on recreational beaches and the potential risk they pose to humans and the environment.

Recently, legislation has been passed to help mitigate these harmful impacts.



Implications to Ecosystem

Microplastics have the ability to adsorb persistent organic pollutants and release them at higher rates when size is reduced [2].

Human

- Accumulation in wastewater treatment facilities results in increases amounts of MPs in receiving waters even with 70-100% removal
- MP can act as vessels for waterborne pathogens [3]

Environmental

- Settling of MPs into sediments is present throughout the world [4]
- MP consumption causes accumulation in tissues and stomachs of animals
- Larger plastics are pathways to MP formation through breakdown by biota, UV, chemicals, and abrasion to form smaller diameter particles [3]

Laurentian Great Lakes

- Chemical analysis has found PCBs and PAHs on MPs in the LGL [2]
- Average amount of MP in surface waters is 43,000 items/km² [4]
- Nearly 70% of all plastic sampled in the LGL in 2013 was 1/3-1mm [5]

Comparison to Marine Ecosystems

- Marine studies since 1970 while freshwater studies started recently [3]
- Ocean currents accumulate "garbage patches" of buoyant plastics [4]

Wastewater Relevance

Common Sources of Microplastics in Wastewater

- Personal Care Products such as:
 - Lotions
 - Soaps
 - Face and Body Scrubs
 - Toothpaste
 - Clothing
- Synthetic fibers released during washing
- Degradation of plastic bags, bottles, and other large plastics

What Parts of Wastewater Treatment Remove Microplastics?

- All aspects of treatment remove microplastics
- Studies indicate that treatment plants with tertiary treatment are most effective with up to 99.9% removal [6,7] Within the treatment plants, preliminary and primary treatments removed most particles [7]
 - These steps remove up to 88% of microplastics
 - Most microplastic particles float and are able to be removed via solids skimming and in settling tanks

Bottlenecks to Microplastic Removals

- Plastic litter entering storm drains is not treated
 - Litter entering in this way can contribute to Microplastic accumulation through weathering and UV induced photodegradation.
- Floc such as toilet paper can alter the buoyancy of microplastics
- Accumulation of biofilms on particles can also alter the physical properties

Policy Connections

Historically, legislating potentially harmful substances, in the US, has occurred after deleterious effects are recognized; examples include PCBs and DDT. In 2015, 9 states passed legislation to band the sale of products with microplastics. The federal government took note, and passed proactive legislation to limit the sources of MP pollution.

Legislation	Year	Authority	Details [8,9,10,11,12]	
Clean Water Act	1972	EPA	<ul style="list-style-type: none"> • Toxic pollutants list, by family • Priority pollutant list (1977) required chemicals to be specified • 129 as of 2014 	Re-active
Toxic Substances Control Act	1976	EPA	<ul style="list-style-type: none"> • 85,000 chemicals listed • Toxicity of only 200 tested 	Re-active
TSCA update	2015	EPA	<ul style="list-style-type: none"> • Chemicals prioritized for assessment • New chemicals must be safe before placed on the market 	Re-active
Microbead Free Waters Act	2015	FDA	<ul style="list-style-type: none"> • Prohibits manufacture of MP products on July 7, 2017; prohibits sale of MP products on January 1, 2018 • Add one year for pharmaceutical deadlines 	Pro-active

Conclusion

Recent research has brought to light potential human and ecological impacts that result from MP pollution. Federal legislation took a pro-active approach to the emerging contaminant, and regulated it's use in consumer products. Research continues to improve our understanding of MP interactions with wastewater treatment, but evidence points to effective removal, indicating other primary sources of MP pollution.

References

- [Picture, Top Left] http://kahlee93.weebly.com/uploads/5/0/0/5/50056413/2838290_orig.jpg
 [Picture, Top Right] <http://askthegreen.org/wp-content/uploads/2016/04/5vrespenny.jpeg>
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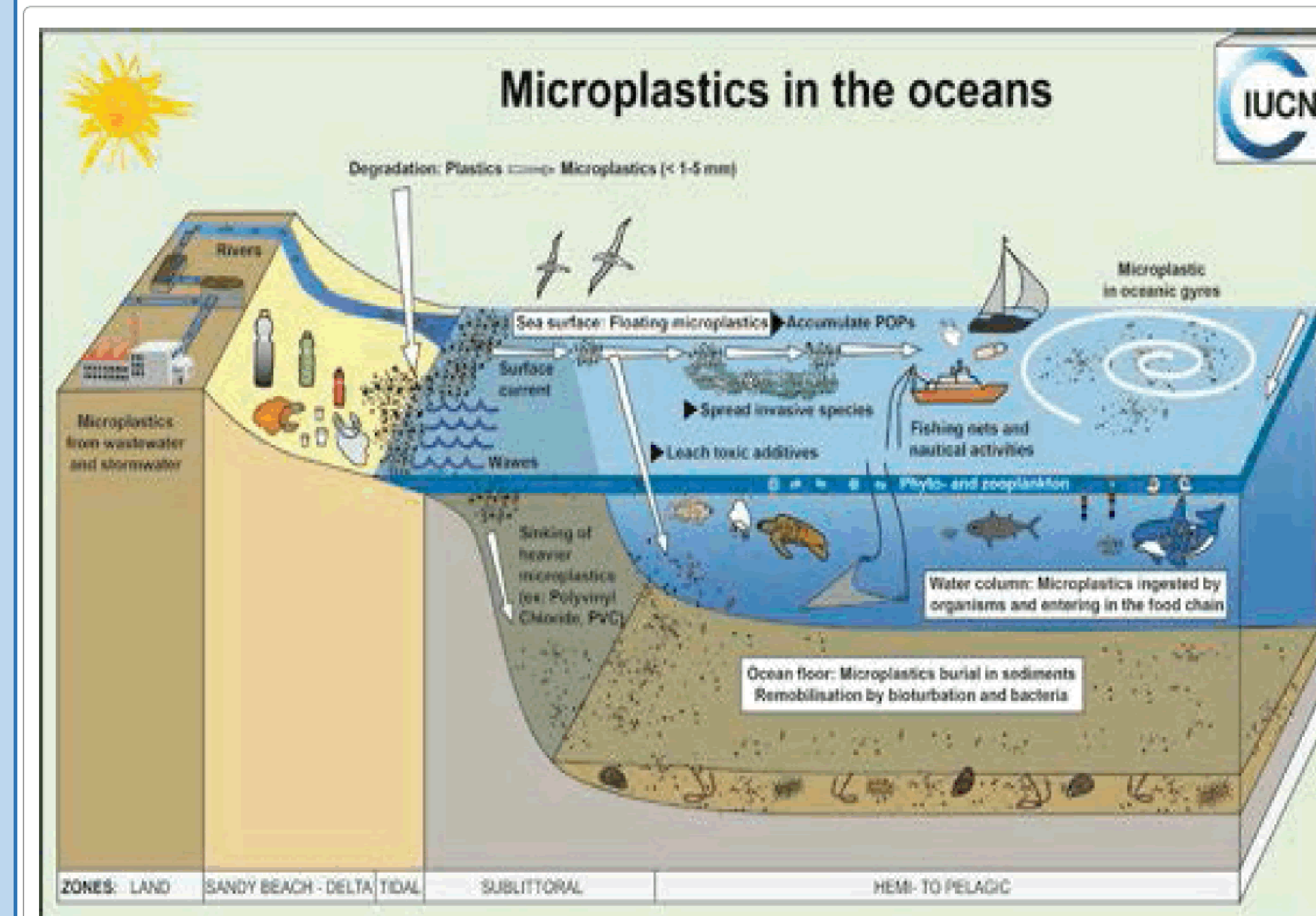


Figure 4: Schematic drawing showing the main sources and movement pathways for plastics debris in the oceans (Source: Florian Thevenon) [1].