Commentary

iMedPub Journals
www.imedpub.com

Journal of Environmental Research

2025
Vol.9 No.1: 01

Microplastic Pollution in Freshwater Ecosystems: Emerging Threats and Remediation Strategies

Hanah Luwis*

Department of Environmental Science, University of California, Berkeley, USA

***Corresponding author:** Hanah Luwis, Department of Environmental Science, University of California, Berkeley, USA; E-mail: hanah.luwis@ley.edu

Citation: Luwis H (2025) Microplastic Pollution in Freshwater Ecosystems: Emerging Threats and Remediation Strategies. J Environ Res Vol.9 No.1: 01.

Received date: January 02, 2025; **Accepted date:** January 18, 2025; **Published date:** January 31, 2025

Introduction

Microplastic pollution has emerged as a pervasive environmental issue, attracting global attention due to its persistence, ubiquity, and potential ecological and human health impacts. Defined as plastic particles smaller than 5 millimeters, microplastics originate from the degradation of larger plastic debris (secondary microplastics) or are manufactured at small sizes for use in consumer products (primary microplastics). While marine ecosystems have been the focus of extensive research, freshwater systems—including rivers, lakes, and reservoirs-are increasingly recognized as critical reservoirs and conduits of microplastics. These ecosystems serve as sources of drinking water, support biodiversity, and provide key ecosystem services, making the presence of microplastics a significant environmental concern. The complex interactions of microplastics with freshwater biota and physicochemical processes highlight the urgency of understanding their sources, impacts, and potential remediation strategies [1].

Description

The sources of microplastics in freshwater ecosystems are diverse and multifaceted. Urban runoff, wastewater effluents, industrial discharges, agricultural activities, and atmospheric deposition contribute to the accumulation of microplastics in rivers and lakes. Synthetic fibers from textiles, microbeads in personal care products, and fragments from plastic packaging are among the most common types of microplastics detected in freshwater environments. Seasonal variations, hydrodynamics, and land-use patterns influence the transport and deposition of microplastics, with higher concentrations often observed near urban centers and wastewater treatment plants. Bioremediation strategies, leveraging microorganisms and enzymes capable of degrading plastics, offer environmentally friendly alternatives but require further optimization and scalability. Public awareness campaigns and community engagement are also essential to reduce littering and enhance participatory monitoring of freshwater microplastic pollution [2].

Microplastics impact freshwater ecosystems at multiple levels, from molecular to community scales. At the organismal level, ingestion of microplastics by fish, invertebrates, and plankton can cause physical damage, impaired feeding, reduced growth, and reproductive toxicity. Microplastics can act as vectors for chemical pollutants, including persistent organic pollutants, heavy metals, and endocrine-disrupting compounds, which adsorb onto particle surfaces and are transferred through trophic levels. Additionally, microplastics can serve as substrates for microbial biofilms, potentially altering microbial community composition and ecosystem functioning. These impacts are compounded by the interactions between microplastics and other environmental stressors, such as nutrient pollution, climate change, and habitat degradation, raising concerns about cumulative effects on freshwater biodiversity and ecosystem services [3].

Human health is also indirectly threatened by microplastics in freshwater ecosystems. Microplastics can contaminate drinking water, recreational waters, and freshwater food sources, including fish and shellfish. The potential for bioaccumulation and biomagnification along food chains increases exposure risks. While the full extent of human health impacts is still under investigation, emerging studies suggest that microplastics may induce oxidative stress, inflammation, and endocrine disruption in mammalian systems. Additionally, microplastics may act as carriers of pathogenic microorganisms, further amplifying health risks. Understanding these pathways is critical for developing evidence-based policies and interventions to protect public health while managing freshwater resources sustainably. Remediation strategies for microplastic pollution in freshwater ecosystems span prevention, removal, and mitigation approaches. Prevention includes reducing plastic production, promoting circular economy principles, improving waste management, and restricting the use of microplastics in consumer products. Removal techniques involve physical, chemical, and biological approaches. Filtration and sedimentation technologies can capture microplastics in wastewater treatment plants, while adsorption using engineered materials and coagulation–flocculation methods show promise for removing microplastics from surface waters [4,5].

Conclusion

Microplastic pollution represents an emerging and complex threat to freshwater ecosystems, with far-reaching ecological and potential human health consequences. Sources of microplastics are diverse, and their persistence, bioaccumulation potential, and role as contaminant vectors underscore the need for urgent research and management. Integrated strategies combining prevention, advanced removal technologies, and innovative bioremediation approaches are essential to mitigate microplastic impacts effectively. Furthermore, interdisciplinary research, standardized monitoring protocols, and robust policy frameworks are required to assess risks, guide remediation efforts, and promote sustainable freshwater management. By addressing microplastic pollution comprehensively, it is possible to safeguard biodiversity, ecosystem services, and public health in freshwater environments for current and future generation.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Khalid N, Aqeel M, Noman A, Hashem M, Mostafa YS, et al. (2021). Linking effects of microplastics to ecological impacts in marine environments. Chemosphere 264: 128541.

2. Dong X, Liu X, Hou Q, Wang, Z. (2023). From natural environment to animal tissues: A review of microplastics (nanoplastics) translocation and hazards studies. Sci Total Environ 855: 158686.

3. Zenker A, Cicero MR, Prestinaci F, Bottoni P, Carere M. (2014). Bioaccumulation and biomagnification potential of pharmaceuticals with a focus to the aquatic environment. J Environ Manag 133: 378-387.

4. Mallik A, Xavier KM, Naidu BC, Nayak BB. (2021). Ecotoxicological and physiological risks of microplastics on fish and their possible mitigation measures. Sci Total Environ 779: 146433.

5. Gaworecki KM, Klaine SJ (2008). Behavioral and biochemical responses of hybrid striped bass during and after fluoxetine exposure. Aquat Toxicol 88: 207-213.