

## The Triple Threat: Microplastic, Nanoplastic, and Macroplastic Pollution and Their Cumulative Impacts on Marine Ecosystem

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**Abstract :** The increasing amount of plastic pollution in maritime settings poses a substantial risk to the functioning of ecosystems and the preservation of biodiversity. This comprehensive analysis combines the most recent data on the environmental effects of pollution from macroplastics, microplastics, and nanoplastics within marine ecosystems. Our goal is to provide a comprehensive understanding of the cumulative impacts that plastic waste accumulates on marine life by outlining the origins, processes, and ecological repercussions connected with each size category of plastic debris. Microplastics and nanoplastics have more sneaky effects that are controlled by chemicals. These effects can get through biological barriers and affect the health of cells and the whole body. Compared to macroplastics, which primarily contribute to physical harm through entanglement and ingestion by marine fauna, microplastics, and nanoplastics are associated with non-physical effects. The review underlines a vital need for research that crosses disciplinary boundaries to untangle the intricate interactions that the various sizes of plastic pollution have with marine animals, evaluate the long-term ecological repercussions, and identify effective measures for mitigating the effects of plastic pollution. Additionally, we urge governmental interventions and worldwide cooperation to solve this pervasive environmental concern. Specifically, we identify significant knowledge gaps in the detection and effect assessment of nanoplastics. To protect marine biodiversity and preserve ecosystem services, this review highlights how urgent it is to address the broad spectrum of plastic pollution.

**Keywords :** macroplastic pollution, marine ecosystem, microplastic pollution, nanoplastic pollution

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