Seasonal and Spatial Distributions of Microplastics in St. Andrew Bay, Florida, USA

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Abstract

Microplastic (MP) pollution is an ongoing problem in coastal systems, where wastewater treatment plants (WWTPs) deposit particles daily. This study examined, MP abundances at sites of WWTP outflow and at non-polluted sites over six consecutive seasons to determine seasonal and spatial variations within the St. Andrew Bay system in Northwestern Florida. MPs in the system were dominated by fragments (60.2%), then fibers (32.5%) and films (7.3%), made of predominantly polypropylene (55.3%) and polyethylene (15.4%). MP abundances were highest at one of the WWTP sites, where they increased with increasing distance away from the input source. MPs were nearly one order of magnitude more numerous at the second and third sampling station $(21.51\pm6.37 \text{ and } 34.03\pm11.69 \text{ MP/kg sediment})$ dry weight) compared to the first station $(3.16 \pm 1.59 \text{ MP/kg sediment dry weight})$ across the transect at the Millville WWTP. Furthermore, MPs at WWTP sites were smaller on average than particles at reference sites. The size discrepancies between particles at sites of WWTPs and sites without WWTP inputs likely reflect increased levels of MP fragmentation that occur in waste treatment processes compared to natural deposition processes. Mean MP abundances were also highest in the Winter $(12.41\pm3.56 \text{ MPs/kg sediment dry weight})$ and lowest in the Spring $(2.17\pm0.63 \text{ MPs/kg sediment dry weight})$, largely caused by increased MP deposition by the Millville WWTP and extreme storm events that likely introduced more MPs into the system. Therefore, while WWTPs differentially retain MPs in their removal processes, MP pollution in the St. Andrew Bay system shows similar seasonal dynamics as has been found worldwide. Future research on MP pollution at sites of WWTP outflow should therefore assess the complex seasonal and spatial dynamics associated with MP abundances and compositions in coastal systems, and how differences in WWTP processes affect MP export to coastal systems.

Keywords: Coastal sediment, microplastic pollution, polymer, wastewater treatment plants

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