Targeting Marine Plastic Pollution with Numerical Data Modeling: Predicting Plastic Transport in Massachusetts Bay Through Flow Map Composition

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Marine plastic pollution is an increasingly severe problem today, with over 5.25 trillion pieces of plastic currently in the oceans. Because plastic polymers degrade extremely slowly and only fragment into smaller-sized microplastics, it is imperative that pieces are removed quickly to prevent rapid spreading. To aid plastic pollution cleanup with numerical modeling, this study adapted a passive transport model for oceanic plastic pollution, specifically in Massachusetts Bay, to model plastic distribution over time with greater predictive efficiency and accuracy and lower computational cost. A numerical model modeling passive transport using a novel composition-based advection method, provided by MIT MSEAS, was modified to include initial concentration conditions specific to Massachusetts Bay, including: coastline source; oceanic point source; river discharge (Charles River and Merrimack River), weighted based on river flow output; and combined coastline and river discharge. The model was then applied to Navier-Stokes current simulations of Massachusetts Bay, developed by MIT MSEAS. Results concluded characteristics of plastic flow in the area: i) clear accumulations of plastic around Boston Harbor are present; ii) Cape Cod Bay appears to be self-clearing, with a consistent lack of particles within in it by the end of the 20 days; iii) plastics originating from rivers disperse quickly; iv) point sources tend to remain clustered in travel. Results also suggest that global wind and current patterns influence oceanic plastic distribution. The model can help efficiently target accumulations and sources of oceanic plastic particles. Additional factors can be added to further enhance model accuracy, efficiency, and versatility.

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