Intercept the Drift: A Novel NOAA-Data-Driven Lagrangian Model for Marine Debris Interception, Cleanup, and Source Reduction in a Chesapeake Bay Case Study

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My project is a Chesapeake Bay case study simulation built using an existing Lagrangian tracking model, driven by real National Oceanic and Atmospheric Association (NOAA) current and wind data for velocities and coastline boundaries. I released and tracked debris particles over 72 hours from the 8 major pollutant contributing tributaries in the Chesapeake Bay. I first placed 10 interceptor sites by geographic intuition (for example, large cities or at the end of rivers). The simulation demonstrated that these were largely ineffective, with 8 of the 10 sites capturing <10 of the total 1,600 particles released. I also ran 100 random 5-site configurations, which yielded a mean capture rate of 12.0%, only slightly lower than the geographically intuition based sites that captured 15.6% of the debris particles; Geographic intuition is barely better than random placement. The model then found the 5 optimal sites through the regions of highest trajectory density, capturing 56.5% of the debris - a 261% improvement using half the interception devices. While a significant improvement in debris collection was shown, the model still reveals that interception alone is not enough. A three part strategy must be used: optimizing interception, source reduction at tributary mouths, and a targeted beach cleanup in the south-eastern bay. This simulation was run under calm and storm wind conditions, across all four seasons, and used Monte Carlo statistics and confidence intervals to confirm the results are consistent.

Awards Won: