EXECUTIVE SUMMARY

Watershed to Whales: Tracking the source and transport of microplastics in the greater Monterey Bay region to inform risk assessments

Plastic pollution has emerged as a defining environmental challenge of the 21st century. Microplastics, defined as particles smaller than five millimeters, are now widespread throughout the world's oceans and coastlines and have become a concern for ecological health, human well-being, and coastal economies. In California, where fisheries, tourism, and ocean recreation play central roles in economic vitality and cultural identity, protecting marine ecosystems from microplastic contamination is a high priority. The Watershed to Whales project was designed to fill a critical knowledge gap: how microplastics travel from land-based sources, through rivers and beaches, into the coastal ocean, and ultimately into the food webs supporting marine wildlife including blue whales.

This project brought together scientists from the California Marine Sanctuary Foundation, the Moore Institute for Plastic Pollution Research, Stanford University's Hopkins Marine Station, California State University Monterey Bay, and Monterey Bay National Marine Sanctuary to conduct the most comprehensive assessment of microplastics in Central California to date.

Background and Justification

Although plastics are widely recognized as a growing pollutant, very little baseline information has existed for central California's river–ocean continuum. Understanding transport pathways and ecological exposure is essential for developing effective management and mitigation strategies. Monterey Bay is a globally significant biodiversity hotspot and the feeding grounds of the largest animals on Earth. Yet the magnitude, chemical composition, and biological interactions of microplastics in this region had not been measured at a scale that reflects environmental reality. Watershed to Whales directly responds to this need by generating coordinated, source-to-sea data that can guide future policy development and pollution reduction efforts.

Summary of Methods, Key Findings, and Preliminary Conclusions

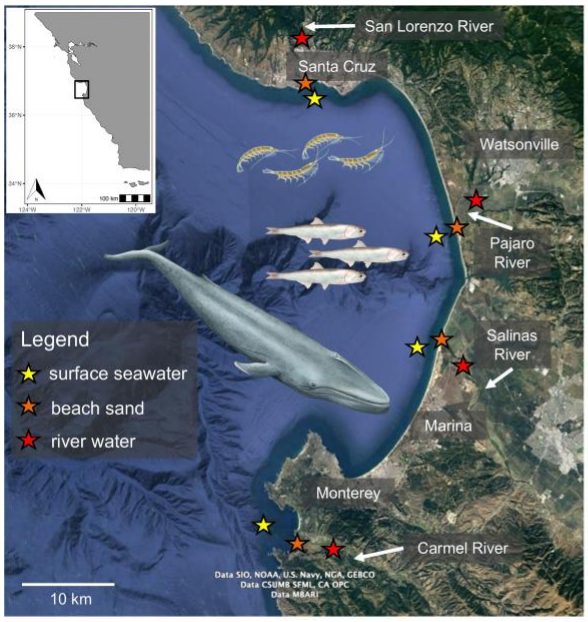
From 2023 to 2025, the project team sampled four major river systems (Salinas, Pajaro, San Lorenzo, and Carmel), beach sands and surface seawater near the mouths of these four rivers, as well as forage fish, krill, and blue whale fecal samples. More than 15,000 liters of river and coastal water and approximately 1,500 liters of beach sand were collected and processed. To date, nearly 25,000 microplastic particles have been identified, making this dataset the largest ever compiled for the Central California coast. Beaches showed the highest concentrations, approximately thirty times higher than river or ocean waters, indicating that beaches act as important long-term sinks and potential exposure zones for wildlife and beachgoers. Fibers were the dominant morphology among larger particles, frequently blue in color and consistent with microfibers shed from textiles such as denim. In contrast, smaller particle size classes contained proportionally fewer fibers. White polystyrene foam fragments were especially abundant at certain beach sites, suggesting localized sources such as food packaging, recreational gear, and marine debris. Rivers exhibited episodic and dynamic particle transport, with deeper river samples occasionally containing more buoyant polymers, indicating the importance of turbulence and storm-driven resuspension.

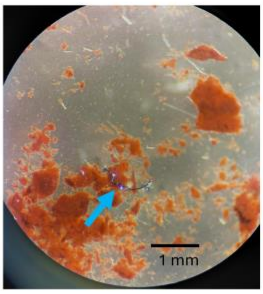
Biota sampling is still underway, but blue whale fecal samples have thus far contained numerous synthetic fibers, demonstrating that microplastic exposure extends into the upper levels of the marine food web. Analyses of forage fish, krill, and additional whale samples are ongoing and will be incorporated before project completion through the no-cost extension period.

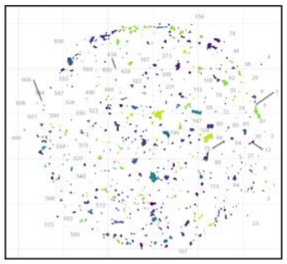
From inland rivers to open-ocean giants, microplastics are now a defining feature of Central California's marine environment. Overall, microplastic presence and concertation in Central California is measurable, widespread, and structured by both environmental transport and human activity patterns. The presence of anthropogenic particles within whales reinforces the potential for microplastics to transfer through food webs, although further work is needed to quantify risks such as food dilution, chemical exposure, or impacts to physiological condition. This project establishes a critical regional baseline for both environmental concentrations and biological interactions.

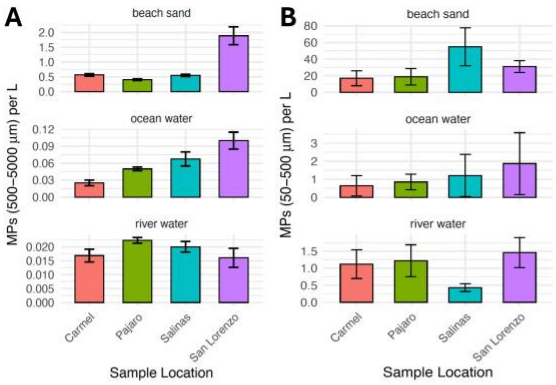
Importance to California's Economy, Environment, and Public Health

The data produced by Watershed to Whales directly support California's efforts to protect coastal heritage and advance a sustainable Blue Economy. Marine wildlife, including species essential to tourism, cultural identity, and ecological functioning, are already interacting with microplastics. Ensuring the continued vitality of coastal resources requires targeted actions to reduce plastic inputs and stormwater contamination, manage high-risk consumer products such as synthetic textiles and polystyrene, and support community-based stewardship. By harmonizing monitoring approaches and applying open-source tools that improve transparency and efficiency, this project positions California to lead in the development of science-based regulations and intervention strategies. Continued collaboration with agency partners and stakeholders will ensure that this work delivers long-term environmental and economic benefits for California's coastal communities.









Proposed toxicity thresholds

Threshold	Food Dilution (particles/L)	Tissue Translocation (particles/L)
1- Investigative monitoring	0.3	60
2- Discharge monitoring	3.0	320
3- Management planning	5.0	890
4- Source control measures	34	4,100