Global map shows where ocean plastics pose greatest threats

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Plastic pollution poses serious ecological risks far beyond visible garbage pileups. A new Tulane University study maps global ‘risk hotspots,’ showing that even areas with modest plastic levels can threaten marine ecosystems when plastics overlap with dense marine life and pollutants. (Photos by iStock)

As plastic pollution emerges as one of the planet’s most pressing environmental threats, Tulane University scientists have published the first global assessment of where plastics pose the greatest ecological risks to marine ecosystems.

The effort revealed that highest-risk areas aren’t always the “garbage patches” where plastics visibly pile up but often places where plastics overlap with dense

marine life and pollutants. That means even waters with relatively modest plastic levels can face severe ecological threats.

The study, published in *Nature Sustainability*, goes beyond measuring where plastics accumulate. Instead, it maps worldwide "ecological risk hotspots" by evaluating four major pathways of harm for marine life: ingestion, entanglement, transport of toxic pollutants and the leaching of harmful chemicals as plastics break down.

"Plastic pollution in the ocean is widely recognized as a global concern, but the ecological risks it poses remain poorly understood," said lead study author Yanxu Zhang, associate professor of Earth and Environmental Sciences at Tulane School of Science and Engineering. "We wanted to fill this knowledge gap by systematically assessing how plastics interact with marine life and ecosystems through multiple risk pathways."

The team used newly developed computational methods to evaluate risk. By integrating global models of ocean plastics, marine species distribution and pollutant levels, they created a comprehensive new framework for assessing ecological threats.

The findings highlight the need to prioritize cleanup and prevention not only in areas with visible plastic accumulation but also in regions where marine life is most vulnerable, Zhang said.

High-risk zones include the mid-latitude North Pacific and North Atlantic oceans, parts of the North Indian Ocean and coastal East Asia. Nutrient-rich waters with abundant marine life drive risk in some cases, even when plastic levels are not the highest. Coastal areas near busy fishing grounds are particularly vulnerable to entanglement hazards from "ghost gear," the term for abandoned fishing gear in the water, such as gillnets, traps, fishing lines and trawl nets.

The study also identified plastics' role as a "conveyor belt" for pollutants such as the neurotoxic methylmercury and so-called "forever chemicals" (PFOS), two contaminants that can build up in marine food webs and threaten human health. Elevated risks occur in regions where contaminated plastics are most likely to be ingested by marine organisms.

Looking ahead, the researchers modeled future scenarios based on different levels of plastic waste reduction. Without stronger global action, ingestion risk could increase more than threefold by 2060. But coordinated efforts to reduce plastic use and improve waste management — especially in rapidly

developing regions — could substantially lessen the threats.

“By mapping the global distribution of plastic-related ecological risks, we provide a scientific foundation to guide ocean cleanup priorities and policymaking,” Zhang said. “This work comes at a crucial moment, as the world is negotiating a global plastic treaty, and we hope our results can help target interventions where they will have the greatest impact.”

Collaborators on the study include scientists from Nanjing University and South China University of Technology (China), the Scripps Institution of Oceanography at the University of California San Diego (US), Concordia University (Canada) and the Institute of Geological and Nuclear Sciences (New Zealand).

Marine life faces growing threats from plastic waste through entanglement, ingestion and toxic chemical exposure. Tulane researchers identified high-risk zones, including the North Pacific and coastal East Asia.

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Yanxu Zhang, School of Science and Engineering