Marine Plastics Research Coordination and Monitoring Network (MP-Net)

Mark Hahn, Neel Aluru, Beckett Colson, Michelle DiBenedetto, Scott Gallager, Mary Gaylord, Houshuo Jiang, Hauke Kite-Powell, Ken Kostel, Larry Madin, Paul Matthias, Anna Michel, Rob Munier, Jordan Pitt, Larry Pratt, Chris Reddy, John Stegeman, Collin Ward

Woods Hole Oceanographic Institution, Woods Hole, MA 02543 U.S.A.

Summary

Pollution of the oceans by plastics, especially microplastics, is a 'wicked problem' (1,2) whose solutions will require cross-disciplinary collaboration and multi-stakeholder engagement. The mission of the proposed Marine Plastics Research Coordination and Monitoring Network (MP-Net) is two-fold: (i) to promote fundamental, solutions-oriented understanding of plastic life-cycles and impacts, and (ii) to enable multi-level, real-time, and continuous observation and monitoring of plastics in the ocean. A Global Marine Plastics Database will compile data on ocean plastics and provide open and equitable access to information about ocean plastics for use in research and mitigation efforts.

Abstract

Inputs of plastic waste to the ocean are immense, global, and increasing. Large macroplastic pieces are transformed into smaller microplastics (<5mm), whose distribution, fate, and impacts on marine ecosystems, food webs, and human health are poorly understood. The complexity of plastics and their transformation products makes plastic pollution a generational challenge requiring innovative approaches, diverse disciplinary expertise, and international coordination. **We propose a Marine Plastics Research Coordination and Monitoring Network (MP-Net) as an international effort to promote fundamental, innovative, solutions-oriented research towards a comprehensive understanding of marine microplastics, while also using plastics research to advance understanding of the oceans.** The research will be complemented by ocean plastics observation and monitoring programs employing multi-level remote sensing and autonomous vehicles. The data will populate a new, open-access Global Marine Plastics Database to support research and mitigation efforts. MP-Net will leverage existing U.S. oceanographic and remote sensing assets and ongoing efforts by NGOs and citizen-scientists. Industry-academic partnerships involving plastics manufacturers, materials scientists, economists, oceanographers, and others will leverage their complementary expertise. MP-Net will engage international microplastics programs in coordinated research efforts. MP-Net activities will promote public understanding, education, and cross-disciplinary training of a diverse community of ocean plastics researchers.

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Challenges addressed

Plastics comprise a complex mixture of materials of various sizes, shapes, polymers, and additives, made even more heterogeneous by biotic and abiotic transformations in the ocean. Such complexity exceeds that of any other class of contaminants on the planet. The possible solutions to ocean plastics pollution are diverse, cross-cutting, and involve numerous trade-offs, making this a “wicked problem” unlike any pollutant problem that we have faced before. Solving this problem will require a comprehensive understanding of the sources and fate of plastics in the ocean and their potential impacts, alone and in combination with other stressors, on ocean ecosystems and human health (**Challenges 1 & 2**), the development of multi-level ocean observing systems to monitor spatial and temporal changes in the distribution of plastics (**Challenge 7**), equitable access to information about plastics pollution for all stakeholders (**Challenge 9**), and overcoming barriers to changing our behavior in relation to the manufacture, use, and disposal of plastic products (**Challenge 10**).

Relevant UN Ocean Decade Challenges

Knowledge and Solutions Challenges

Challenge 1: Understand and map land and sea-based sources of pollutants and contaminants and their potential impacts on human health and ocean ecosystems, and develop solutions to remove or mitigate them.

Challenge 2: Understand the effects of multiple stressors on ocean ecosystems, and develop solutions to monitor, protect, manage and restore ecosystems and their biodiversity under changing environmental, social and climate conditions.

Essential Infrastructure Challenges

Challenge 7: Ensure a sustainable ocean observing system across all ocean basins that delivers accessible, timely, and actionable data and information to all users.

Foundational Challenges

Challenge 9: Ensure comprehensive capacity development and equitable access to data, information, knowledge and technology across all aspects of ocean science and for all stakeholders.

Challenge 10: Ensure that the multiple values and services of the ocean for human wellbeing, culture, and sustainable development are widely understood, and identify and overcome barriers to behavior change required for a step change in humanity’s relationship with the ocean.

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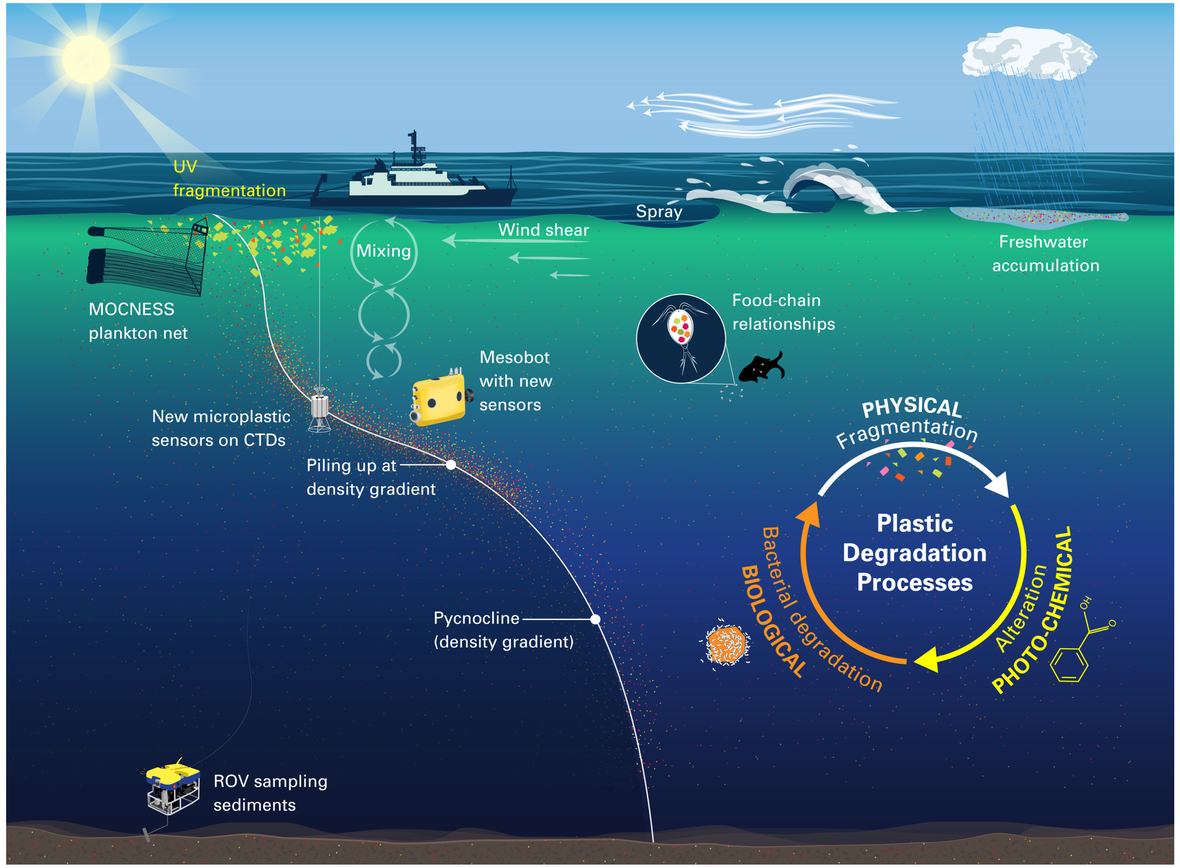
Vision & transformative impact

Plastic pollution of the oceans, especially microplastics, is a 'wicked problem'—global, cross-cutting, multi-dimensional, and poorly defined, with diverse perspectives from numerous stakeholders. Identifying the most effective solutions to this problem will require a Global Action Network approach (3) to promote multi-national, multi-disciplinary collaboration, inter-institutional coordination, and multi-stakeholder engagement.

The proposed Marine Plastics Research Coordination and Monitoring Network (MP-Net) will pursue fundamental, solutions-oriented understanding of the plastics problem, including life-cycle assessment of plastics in the marine environment.

This will involve the development and application of innovative approaches to define the physical, chemical, and biological fate of marine plastics (including microplastics) and their potential impacts on marine food webs and ecosystems, and ultimately, human health.



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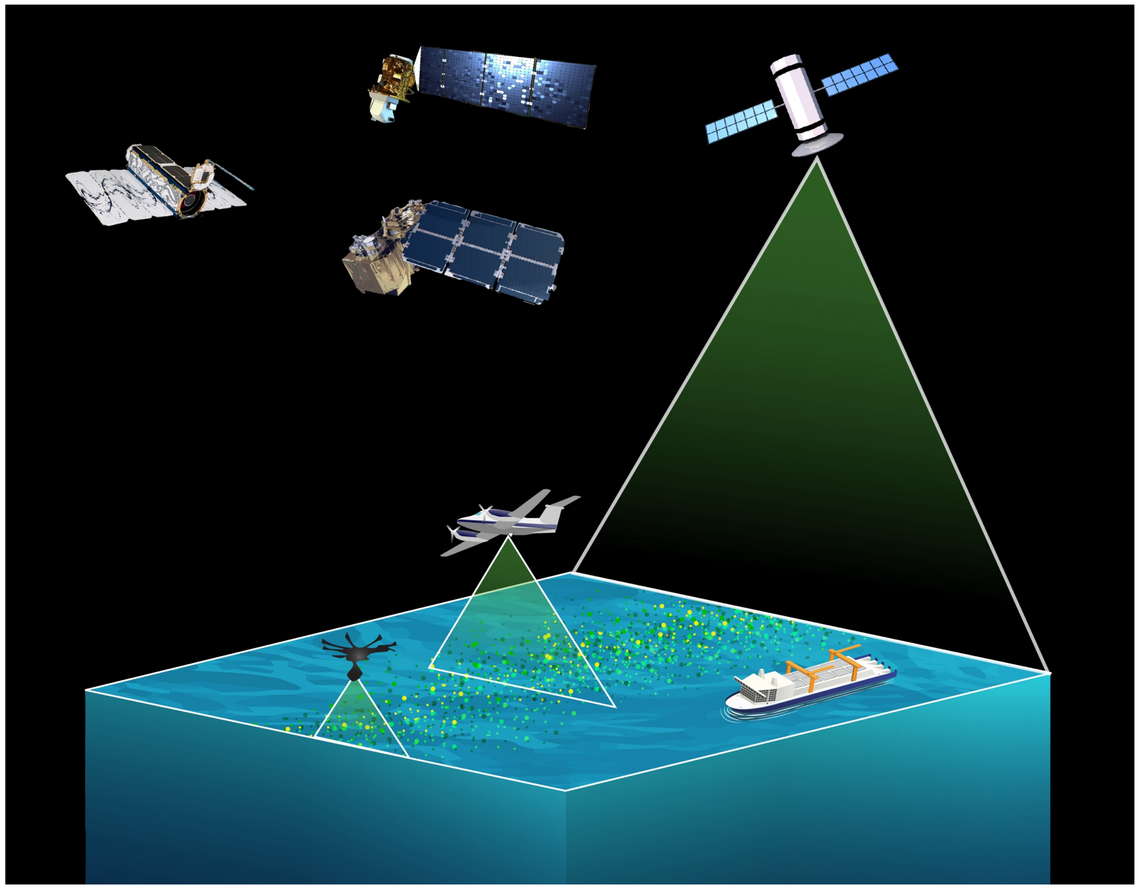
Vision & transformative impact

This coordinated international effort will address ocean plastic sources, transport, distribution, sinks, transformations, and interactions with biota. This will require innovations in sampling, analysis, instrumentation, and modeling; rigorous design of field and laboratory experiments; and harmonization of methods. Sophisticated, multi-level, real-time observation and monitoring technologies will track plastics in the ocean continuously using remote sensing tools and autonomous vehicles. A new Global Marine Plastics Database will collate and provide open and equitable access to information about ocean plastics, for use in research and mitigation efforts.



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Connections to existing infrastructure, technology, and partnerships

Numerous components of U.S. scientific infrastructure and programs might be leveraged to facilitate MP-Net activities. Federal efforts include the NOAA Marine Debris Program and U.S.EPA's Trash-Free Waters program. NASA assets and scientists provide world-class remote sensing capabilities that could be deployed for multi-level, global monitoring of ocean plastics. The NSF-NIH Oceans and Human Health program (4) could contribute to assessing health impacts of marine plastic pollution.

The substantial U.S. ocean science infrastructure—scientists, ships, buoys, underwater vehicles (both remotely operated and autonomous), and ocean observatories—would provide critical plastics research and observational capabilities. Oceanographic research programs such as WHOI's Ocean Twilight Zone project (5) could be engaged to incorporate plastics assessment in their work. Numerous non-profit, non-governmental organizations and coastal communities are engaged in education and advocacy around the marine plastics issue and provide an opportunity to initiate and expand citizen-science efforts in support of MP-Net.

Beyond ocean sciences

A key goal of MP-Net would be to engage stakeholders who can provide expertise that is critical to solving the ocean plastics problem. Industries involved in producing and manufacturing plastic materials have unique expertise and tools that can inform research and monitoring efforts as well as science-based prevention and mitigation activities. MP-Net will engage and enhance existing industry efforts such as the Alliance to End Plastic Waste. Similarly, collaborations with materials scientists, waste management professionals, and social scientists will facilitate new perspectives on the issue. Engaging biomedical and public health researchers will enhance understanding of potential human health impacts.

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Opportunities for international collaboration and capacity-building

Opportunities for international participation and collaboration

The problem of ocean plastics pollution does not recognize national boundaries, making international cooperation and collaboration an essential element in the search for solutions. The plastics problem has galvanized citizens, scientists, governments, and organizations around the world. The current sense of urgency in addressing this problem provides numerous opportunities for engagement on a global scale. MP-Net would provide a mechanism for connecting multi-national research, assessment, and monitoring efforts such as the North Atlantic Microplastics Centre, International Pellet Watch, No Plastic Waste initiative, Global Rivers Observatory, and GESAMP programs. Identified solutions will be communicated to diverse stakeholders worldwide, including ocean-dependent communities.

Inspiring the next generation of ocean scientists

Solving the ocean plastics problem is a long-term, trans-generational effort that requires capacity-building and holds great potential to motivate existing and future generations of ocean scientists worldwide. Communication of accurate information about the problem will shape public understanding. Enhanced access to cross-disciplinary education and training will produce a more diverse community of researchers who can work across disciplines, linking ocean science to areas such as materials science, waste management, economics, and public health. The Global Marine Plastics Database will provide equitable access to knowledge and data about ocean plastics to facilitate research and mitigation efforts around the world.

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Woods Hole Oceanographic Institution, Woods Hole, MA 02543 U.S.A.

Collaborators

North Atlantic Microplastic Centre

Dr. Hans Kleivdal
https://namc.no

BOSTON COLLEGE
THE GLOBAL OBSERVATORY ON POLLUTION AND HEALTH

Dr. Philip Landrigan
https://tinyurl.com/6wydcxk6

International Pellet Watch

Dr. Hideshige Takada
http://pelletwatch.org

SEA Semester
S·E·A

Dr. Kara Lavender Law
https://www.sea.edu

Join us!

Contact: mhahn@whoi.edu
https://microplastics.whoi.edu

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