

Author's Commentary: The Marine Pollution Problem

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Introduction

Lightweight, inexpensive, durable, and infinitely variable, plastic defines the modern age. However, the very qualities that make plastic indispensable make it an environmental problem.

Today, plastic waste is found throughout the world's oceans, from the coast to the depths to the center of the open sea far from land. The best-known accumulation of trash is the "Great Pacific Garbage Patch," located in the North Pacific Central Gyre (NPCG), a vast swathe of ocean that stretches between the west coast of North America and the east coast of Asia.

Bordered by four major currents, the NPCG slowly rotates clockwise, pulling water in towards the center. Plastic debris from North America and Asia that does not sink or degrade becomes trapped in the NPCG. While larger pieces of plastic such as fishing nets and disposable drink bottles are found in the NPCG, most of the plastic debris is small. This is because as plastic items are exposed to ultraviolet light, they become brittle and are broken into smaller and smaller pieces by the movement of the ocean. This process is known as photodegradation.

The environmental impacts of small pieces of plastic debris are poorly understood. Larger pieces of debris, such as lost fishing gear, can entangle and drown oceanic animals such as seals and turtles. Seabirds and turtles eat plastic debris, and turtle death has been linked to intestinal blockage from plastic bags. However, effects on the organisms at the base of the food chain, such as phytoplankton, zooplankton, and small fishes, remain less studied but may be more

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significant due to the high proportion of plastic debris that is less than 3 mm in diameter. Small particles of plastic are readily ingested by filter-feeding and deposit-feeding invertebrates, and plastic resin pellets accumulate high levels of persistent organic pollutants such as PCBs and DDT. Plastic debris also serves as a “raft” for benthic invertebrates such as barnacles, and has already been responsible for at least one exotic species introduction in the Atlantic.

The “Great Pacific Garbage Patch” has captured the public imagination, leading to a great deal of coverage in the popular media. While detectable amounts of plastic debris were documented in the NPCG as early as 1972, the public awareness of this issue is due in large part to Capt. Charles Moore and the nonprofit organization he founded to combat marine debris, the Algalita Marine Research Foundation. However, relatively little is known about the extent and environmental effects of the plastic debris. Since a robust scientific understanding of the problem is necessary to seeking a solution, the “Great Pacific Garbage Patch” was the topic for this year’s problem in the Interdisciplinary Contest in Modeling (ICM)[®].

Formulation and Intent of the Problem

The goal of this year’s ICM problem was for student teams to model one aspect of the marine debris issue in the NPCG. Because the issue encompasses physical oceanography, ecology, and waste management, there were many potential issues to choose from. Teams were asked to focus on one critical aspect of the problem of oceanic marine debris, and to model the important behavior and phenomena. The end result was to be in the form of a 10-page report to the leader of an expedition setting off to study marine debris.

Suggested tasks included:

- Create a monitoring plan, with the option of including other oceanic gyres such as the North Atlantic Gyre and South Pacific Gyre.
- Characterize the extent, distribution, and density of debris.
- Describe the photodegradation of debris.
- Model the impact of banning polystyrene takeout containers.
- Pursue any relevant topic of the team’s choosing that included modeling.

Models were evaluated based on the team’s understanding of the nature of the problem, their use of realistic parameters, and their approach to describing either the existing problem or a proposed solution.

This year’s ICM problem is based on ongoing research by a variety of organizations and scientists, particularly the Algalita Marine Research Foundation, the Sea Education Association, Project Kaisei, and Scripps Institution of Oceanography. Most work has focused on understanding the abundance and distribution of plastic particles in the NPCG. Future work will focus on the impacts and mitigation of marine debris.

About the Author



Miriam Goldstein is a fourth-year Ph.D. student in Biological Oceanography at the Scripps Institution of Oceanography at the University of California San Diego, CA. For her dissertation work, she is studying the effect of plastic debris on zooplankton communities and invasive species transport. She was the principal investigator on the 20-day Scripps Environmental Accumulation of Plastic Expedition (SEAPLEX) that investigated plastic debris in the North Pacific Gyre in August 2009. Miriam holds an M.S. in Marine Biology from Scripps and a B.S. in Biology from Brown University. She is originally from Manchester, NH.