Plastic waste inputs from land into the ocean

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Summary

The peer-reviewed Jambeck et al. study quantifies, for the first time, the input of plastic waste from land into the ocean, and offers a roadmap for developing ocean-scale solutions to the problem of plastic marine pollution.

While plastic waste in the ocean gyres (the so-called "garbage patches") has been known since 1972, this is the first study to rigorously quantify how much plastic is entering the ocean from land-based sources. These quantities are large and suggest that recent estimates of how much plastic is currently floating in the ocean vastly underestimate how much enters the ocean on a yearly basis. Today's study highlights the critical need to address adequate waste management infrastructure in the regions of the world where plastic discharges are greatest, as well as other mitigation strategies, if oceans are to be protected from the negative impacts of plastic on ocean life.

Key findings:

- The amount of plastic waste entering the oceans from land each year exceeds 4.8 million tons (Mt), and may be as high as 12.7 Mt - or nearly **one to three orders of magnitude greater than the reported mass of plastic in high-concentration ocean gyres**.
- Quantities of plastic entering the ocean are growing rapidly with the global increase in population and plastics use, with **the potential for cumulative inputs of plastic waste into the ocean as high as 250 Mt by 2025.**
- Discharges of plastic are spread around the globe from the 192 countries with coastal borders considered in the study, but the largest quantities are estimated to be coming from a relatively small number of countries in Asia and other middle income, rapidly developing countries. **The top 20 countries account for 83% of the mismanaged plastic waste available to enter the ocean.**
- Reducing the amount of mismanaged waste by 50% in these top 20 countries would result in a **nearly 40% decline in inputs of plastic to the ocean.**

The new research was led by an 8-member team of scientists working together at the National Center for Ecological Analysis and Synthesis at the University of California, Santa Barbara. The study was led by Dr. Jenna Jambeck, an environmental engineer at the University of Georgia, with contributions from experts in oceanography, waste management and plastics materials science.

The research suggests that solutions to the growing problem of plastic pollution are achievable, given sufficient resources and commitment. Investments in improved waste management practices on land, particularly in fast growing and developing nations, are critical and will lead to substantial reductions in the amount of plastic waste entering the oceans. Furthermore, a

reduction in plastics use and improved recycling of plastics in developed countries is an important complement to the infrastructure improvements needed in developing economies.

Other facts about plastics in the ocean:

- The pace of scientific publications investigating marine debris, including plastics in the ocean, is growing rapidly; 2013 has been the most prolific year to date, with nearly 130 studies published on ecological impacts alone[1].

- Rivers are primary vectors for plastics and other debris to enter the ocean[2].

- Plastics do not biodegrade in the ocean, but merely fragment into smaller and smaller pieces as a result of weathering and exposure to ultraviolet light[3].

- Plastic debris has been found in all areas of the ocean, from the ocean gyres to the deep sea, on coastal shores and frozen in Arctic sea ice[4].

- There is a large discrepancy between the amount of plastic entering the ocean annually, as calculated by Jambeck and colleagues, and the amount estimated to be floating in ocean gyres worldwide (ranging from 7,000 to 270,000 tons[5]). The fate of this "missing plastic" is an area of ongoing research.

- Impacts by plastic debris on more than 660 species have been documented[6], including from entanglement and ingestion. Species impacted range from the smallest of zooplankton to the largest whales, including fish destined to the seafood market.

- Plastics can concentrate toxic chemicals from seawater up to 1 million fold. Ingestion of these contaminated plastic particles may deliver these chemicals to the ocean animals which eat them, potentially resulting in negative effects on their health and survival[5].

- A direct link between plastics input to the ocean and human health through consumption of contaminated seafood has not yet been made. However, a recent study by Van Cauwenberghe and Janssen (2014) found microplastics in commercially grown shellfish destined for consumers[6]. Seafood toxicity from plastics is an area of active research.

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[1] Rochman et al (2014, in review). The ecological impacts of marine debris: unraveling the demonstrated evidence from what is perceived. 25 pages.

[2] Lechner et al. (2014). The Danube so colourful: A potpourri of plastic litter outnumbers fish larvae in Europe's second largest river. Environ. Pollut. 188, 177–181; Jang et al. (2014). Estimation of the annual flow and stock of marine debris in South Korea for management purposes. Mar. Pollut. Bull.

[3] Barnes et al. (2009). Accumulation and fragmentation of plastic debris in global environments Philosophical Transactions B. DOI: 10.1098/rstb.2008.0205

[4] Obbard et al. (2014). Global warming releases microplastic legacy frozen in Arctic Sea ice. Earth's Future, 2: 315–320. doi: 10.1002/2014EF000240

[5] Cózara et al. (2014). Plastic debris in the open ocean. PNAS. Vol. 111(28): 10239–10244. Eriksen et al. (2014). Plastic pollution in the world's oceans. PLoS ONE 9(12): e111913. doi:10.1371/journal.pone.0111913

[5] Rochman, et al. (2013). Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress. Sci. Rep. 3.; Rochman et al. (2014). Early warning signs of endocrine disruption in adult fish from the ingestion of polyethylene with and without sorbed chemical pollutants from the marine environment. Sci. Total Environ. 493, 656–661.

[6] Van Cauwenberghe and Janssen (2014). Microplastics in bivalves cultured for human consumption. Environ. Pollut. 193, 65–70.