

The Final Destination: Plastic in the Open Oceans

Tiani Christian

Faculty Mentor: Steven Petersheim

Editor: Ron Itnyre

Abstract

Plastic is an essential resource for manufacturing given the limitless possibilities that it offers for packaging design, but the single greatest downfall of the material is the threat that unrecycled plastic poses to the environment, specifically marine wildlife. Researchers are working to gain a better understanding of oceanic pollution, but we know that there are at least five giant garbage patches that float in our open oceans today. The paper discusses the problems and possible solutions for this global-marine problem.

Keywords

plastic, environment, recycle, plastic debris, marine crises, wildlife, biodegradability

Introduction

Plastic is an essential resource for manufacturing given the limitless possibilities that it offers for product packaging, medical supplies, construction, and food preservation, but the single greatest downfall of the material is the threat that unrecycled plastic poses to the environment, specifically marine wildlife. Researchers are working to gain a better understanding of oceanic pollution, but we know that there are at least five giant garbage patches that float in our open oceans today. Marine wildlife, from microorganisms to large mammals such as whales, are victims of plastic pollution, most commonly through the ingestion of/or entanglement in plastic debris. A lack of knowledge on the problem causes hesitancy in

finding the most appropriate solution, but it's clear that a reduction in the use of plastic is the first place to seek solutions. Mankind's extensive use and disposal of plastic is largely at fault for the accumulation of plastic debris in the open oceans and beaches, and the harmful effects it has on ocean wildlife, which can be significantly decreased by the general public and corporations working to reduce the amount of garbage that enters the ocean to begin with.

Why Plastic

Versatility is the most important virtue that has attracted manufacturers to the use of plastic since its introduction in the early twentieth century. Plastic was invented as a much-needed alternative for natural resources, the scarcity of which was a growing problem in the late nineteenth century (Science History Institute). Unlike many resources used previously, plastic is very easy to transport from place to place given its light weight, and it has the durability of materials such as metal or glass, which is why its production for commercial purposes has doubled every 11 years since its beginning in the 1950s (Wilcox et al. 11899; Ryan et al. 2000). Unsurprisingly, researchers have discovered that the disturbing amount of plastic found in the marine environment has grown in accordance with the higher production of the material (Wilcox et al. 11899; Ryan et al. 1999). Today it is believed that up to 580,000 pieces of plastic fragments, more than double the amount from 2001, can be found in each square kilometer of the world's oceans, a concentration that never would have been possible before commercial use (Wilcox et al. 11899; Kaiser 1506). It would be difficult for one to argue that the increased use of plastic for manufacturing products, specifically single-use packaging, has no correlation to the increased concentration of plastic debris floating in the oceans.

The durability of plastic is one of the root causes for the buildup of plastic debris. The material is fragile enough to be broken down from large items to small fragments, which is why most of the plastics found in the water are tiny fragments of once larger items (Mole 13). Plastic stands the test of time, however, as it may take decades to centuries to be broken down, if it decomposes at all (Cózar et al. 10239; Ryan et al. 1999). Plastic is broken down through “a combination of photodegradation, oxidation and mechanical abrasion,” but even when the plastic is in direct sunlight, it can

still withstand for decades (Ryan et al. 1999). To further complicate the issue, the ocean can also provide shelter from UV radiation and a low temperature atmosphere ideal for preservation (Ryan et al. 1999). Plastic's durability is an asset to manufacturers, but a crisis for the marine environment.

Problems

Irresponsible disposal of plastic is a root cause for the high concentration of plastic found in the oceans today. According to Ryan et al., the two main reasons that plastic ends up in the water are the dumping of garbage by ships and "land-based sources such as runoffs from rivers, waste water systems, wind-blown litter and recreational litter left off beaches," meaning that both of these can be attributed to the method of disposal of plastic items (2000). Less than 20% of plastic is recycled around the world, both on a corporate and societal level, which begs the question of whether or not this problem would still exist if that percentage were higher (Howard et al.).

Marine Crises

The consequences that have arisen from the increasing levels of plastic pollution are concerning, especially considering the formation of at least five giant garbage patches in the open oceans (Mole 13). A garbage patch is considered an area of ocean that has an especially high concentration of pollution, and they are composed mostly of plastic "particles smaller than 1cm in diameter" (Cózar et al. 10239). The great Pacific garbage patch is the most familiar to the general public, but there is said to be more in the North Atlantic and Pacific Oceans (Cózar et al. 10239; Kaiser 1506). Plastic can be found around the world, even in places that are mostly untouched by humans, which is concerning given the distance that this material is able to travel (Cózar et al. 10239). Cózar et al. explain how the use of "oceanic circulation models" have aided in the discovery that the debris seems to be accumulating in "all five subtropical ocean gyres" in accordance with the ocean's movements (10239). It's possible that these oceanic movements act as "conveyor belts" and collect debris, in which large amounts ultimately end up in the same "central convergence zone" (Cózar et al. 10239). The mobility of plastic in the oceans is becoming more and more of a concern for the future of the marine environments.

Wildlife

Marine wildlife are the primary victims of oceanic pollution, primarily through ingestion of/ or entanglement in plastic and other garbage. The ingestion of plastic affects over 600 species of animals and organisms, especially seabirds, who are most commonly affected by the “mechanical” functions of the body being interrupted (Wilcox et al. 11899; Cozar 10239). Many creatures mistakenly eat the plastic, in which case the item has the ability to cause organ damage or to block the gastrointestinal system (Wilcox et al. 11899). This issue is particularly troublesome given the decreasing populations of seabirds, which are declining much faster than that of other species and could be partially due to the pollution of plastic (Wilcox et al. 11899). In addition, the accumulation of plastic in the gut has been known to cause decreased health or starvation in animals, such as seabirds, due to the lack of available space in the gut for food (Howard et al.; Wilcox et al. 11899). Given that plastic ingestion will reach 99% of seabird species by 2050, one could say that this is an entirely new norm for the health and nutrition of nearly all seabirds (Wilcox et al. 11899).

Entanglement is another significant threat facing ocean creatures today, as becoming entangled in ocean debris can cause bodily harm or death to marine animals such as fish, turtles, and whales. Much of the material in which animals get entangled is fishing gear, both commercial and personal, and it poses a very large threat to those who get caught under or tangled in the gear (NOAA). Immobility caused by entanglement can cause a sea creature to drown or starve, or it could decrease its ability to dodge impending hazards such as boats or predators (NOAA). Entanglement in human-made objects is thought to be the most drastic threat that humans pose to the lives of many whale species (NOAA). Thick pieces of plastic or other items can cause injury to fish or other ocean animals when they become caught, as the items have the ability to cut into flesh, suffocate them, or deform their bodies.

While the danger of ocean plastic is clear to researchers, some objections are being made to the severity of the problem. Biological oceanographer James Leichter points out that “there’s a lot more water than plastic” in the ocean, and that the issue of plastic pollution has too little information to know the true impacts that it might have on the environment (qtd. in Kaiser 1506).

While it is true that there is a serious lack of information about the “scope of the problem” in terms of numbers, the paths by which the plastic travels, and the extent of its effects on the environment, there is much known about the effects it has on animals and marine organisms, as well as the abundance of plastic debris (Law et al. 1185). Researchers are aware that there is a lack of knowledge about the effects and extent of marine pollution, but many are hopeful that gaining a better understanding will increase the likelihood of finding a solution.

Necessity, Recycle, & Biodegradability

The necessity of plastic for manufacturing is another objection that the issue of marine pollution faces. Other materials do not offer the durability and light weight that plastic does, which makes it an irreplaceable resource to companies who manufacture products. While there are many alternatives available that would assist individuals and corporations in reducing plastic use, the reality of replacing plastic with one of its biodegradable counterparts would be complex and nowhere near as efficient (MacDonald). All things considered, it’s possible that biodegradable plastic, which has a tougher plastic component, would not improve the state of the problem at all if it does not make it through a composting system, which would defeat the purpose of biodegradability (MacDonald). Even if all products were biodegradable, less than 20% of plastic is recycled worldwide and many countries do not have the infrastructure to support the recycling such high quantities anyway (MacDonald; Howard et al.) Without discovering an easier alternative for plastic, the amount of effort and money that it would take on a societal and corporate scale would be unlikely, which dulls the chances of biodegradable alternatives replacing traditional plastic all together.

Although the complete discontinuation of plastic is not likely in our near future, there is plenty to be said about the importance of reducing the amount of plastic that enters the ocean. Ryan et al. claim that in order to achieve a decreased level of pollution, educating the general public and “specific user groups” about the importance of proper garbage disposal practices is necessary, as is governmental involvement in legislation efforts, such as banning the dumping of plastic in the waters (2000). For example, the European Parliament has recently voted in favor of a bill which would severely limit the production of single-use plastic items, specifically plastic

eating utensils, straws, containers and cups, and other food and beverage-related plastics all across Europe (Howard et al.). The passing of this bill would likely be powerful enough to modify some of the long-engrained habits of consumers and potentially make a larger impact on efforts to phase out unnecessary plastic items

Solutions

The necessary steps are being taken at a corporate level to reduce the overuse and waste of single-use plastic items such as straws, water bottles and plastic bags. A partnership comprised of 250 organizations (including Coca-Cola, PepsiCo, L’Oreal, and Unilever) who together manufacture 20% of the world’s plastic packaging has banded together under the New Plastics Economy Global Commitment initiative (Howard et al.). The committee seeks to “promote a circular economy for plastic” in which plastic waste will be reused rather than disposed of (Howard et al.). In order to make this a reality, “collection and processing facilities” will need to be established to regulate the recycling process of these items, and with the \$200 million that has been collected from the NPEGC initiative, these facilities are becoming a realistic goal for the future of plastic waste disposal (Howard et al.).

Similarly, 22 aquariums nationwide are involved in the Aquarium Conservation Partnership, which participates in “No Straw November” and similar efforts, such as lobbying and encouraging businesses like United Airlines and the Chicago White Sox to be more stingy with their distribution of straws (Howard et al.). In the past year, the ACP has “eliminated the need for five million straws” in their efforts alone, which would provide an encouraging incentive for other corporations who are looking to make a difference while also benefiting the reputation of their brand (Howard et al.). In addition to funding and driving the initiatives, the partnerships of these organizations are essential to shedding light on the importance of responsible plastic disposal and setting industry standards.

There is still much to learn about the effects and extent of marine pollution, but enough information exists to understand that it is a threat to the environment, as most researchers and environmentalists would agree. Ryan et al. insist that the best way to find a solution is to gather information about the problem in order to implement the most efficient countermeasures (1999). Recent mathematical simulations have aided researchers in predicting

the source of the debris, meaning that it could be possible to find out exactly how much each country contributes to the polluted waters (Mole 13). By analyzing the ocean's currents and other movements, this technology has provided a better understanding of the routes that plastic could travel in one year in the open oceans when leaving from certain points (Mole 13). A better understanding of the sources and fate of the plastic debris floating in the oceans will be a necessary tool in understanding how to combat the problem. For example, it's expected that areas with high amounts of both plastic debris and seabirds are the most threatened by the effects of plastic ingestion, which could help lead protection efforts by identifying problem areas (Wilcox et al. 11902).

Public education and media efforts could provide an additional push to help improve plastic use and recycling habits. Much of the alterations that could be made by the individual are relatively simple, such as carrying a reusable water bottle in place of disposable ones, avoiding use of unnecessary single use plastic items like straws and stir sticks, and signing up for local recycling collection services (Hutchinson). However, stronger actions like beach clean-ups organized by organizations and clubs and citizens supporting bans on single-use plastic items in local government legislations would have a more direct impact on the problem of ocean pollution (Hutchinson). Countless companies have begun to make it a priority to engage in recycling and plastic reduction efforts, but the general public also needs encouragement from corporate brands, media outlets, governments, and educational institutions to modify its daily disposal behaviors. But moreover, the system that allows for the consistent production of plastic needs to be reevaluated and manufacturers should be encouraged, or required, to produce less harmful materials.

Conclusion

The overuse of single-use plastic items has caused an abundance of plastic particles in the oceans, and the increasing concentration of debris in the water is becoming a growing concern for the environmental safety of marine wildlife. Plastic, while offering an ease of transport and durability to manufacturers, poses a severe threat to ocean creatures from microorganisms to whales alike through the mistaken ingestion of plastic particles and entanglement in debris. The irresponsible waste disposal and low recycling rate that most of the world is accustomed to today is another one of the primary contributors to the concerning amount of litter floating in the oceans. If the general public understood the magnitude and impact of marine pollution and the simplicity of the alterations necessary to make a change, a larger transformation could take place, especially if these practices became societal norms. A better understanding of the extent and effects of marine pollution are necessary to finding the most effective solutions. With big-name organizations, governments, environmental and educational institutions, and a growing portion of society participating the efforts to reverse the effects of marine pollution, the future is hopeful for our beloved oceanic environments.

References

- Cózar, Andrés, et al. "Plastic Debris in the Open Ocean." *Proceedings of the National Academy of Sciences of the United States*, vol. 111, no. 28, 2014, pp. 10239-10244.
- Howard, Brian Clark, et al. "A Running List of Action on Plastic Pollution." *National Geographic*, 29 October 2018, <https://www.nationalgeographic.com/environment/2018/07/ocean-plastic-pollution-solution>.
- Hutchinson, Brian. "7 Ways To Reduce Ocean Plastic Pollution Today." *Oceanic Society*, www.oceanicsociety.org/blog/1720/7-ways-to-reduce-ocean-plastic-pollution-today.
- Kaiser, Jocelyn. "The Dirt on Ocean Garbage Patches." *Science, New Series*, vol. 328, no. 5985, 2010, p. 1506.
- Law, Kara Lavender, et al. "Plastic Accumulation in the North Atlantic Subtropical Gyre." *Science, New Series*, vol. 329, no. 5996, 2010, pp. 1185-1188.
- Mole, Beth. "Sea Trash Defies Ocean Boundaries." *Science News*, vol. 186, no. 7, 2014, p. 13.
- MacDonald, James. "Where are the Biodegradable Alternatives to Plastic?" *JSTOR Daily*, 1 September 2018. <https://daily.jstor.org/where-are-the-biodegradable-alternatives-to-plastic/>
- National Oceanic and Atmospheric Administration. "Entanglement of Marine Life: Risks and Response." *Entanglement of Marine Life: Risks and Response*, 2017, www.fisheries.noaa.gov/insight/entanglement-marine-life-risks-and-response.
- Ryan, Peter G., et al. "Monitoring the Abundance of Plastic Debris in the Marine Environment." *Philosophical Transactions: Biological Sciences*, vol. 364, no. 1526, 2009, pp. 1999-2012.

Science History Institute. “The History and Future of Plastics,” *Science History Institute*. <https://www.sciencehistory.org/the-history-and-future-of-plastics>.

Wilcox, Chris, et al. “Threat of Plastic Pollution to Seabirds is Global, Pervasive, and Increasing.” *Proceedings of the National Academy of Sciences of the United States of America*, vol. 112, no. 38, 2015, pp. 11899-11904.