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5/25/15

Oceans and Beaches of Plastic: The Impact of Plastic Pollution on Marine Life and Ourselves

January 10, 1992: The fourth day of the journey in the container that was packed with thousands of other small plastic ducks, frogs, turtles, and beavers. At some point during the day, or possibly during the night (the duck cannot quite remember when), the slow, comforting sway of the cargo ship suddenly became a series of violent rolls. The cargo ship was viciously jerked from side to side. The sound of straps snapping echoed across the containers. Containers slammed into each other and broke open while falling into the water below. Boxes floated on the ocean's surface and were soon torn apart by the powerful waves. The duck cannot remember at what point she became separated from the plastic turtle, beaver, and frog with whom she had been packed, but she soon realized that she was alone floating across the ocean to an unknown location, her fate uncertain and in the hands of the unpredictable ocean. She was tossed about vigorously for some time before she finally came to a halt and floated gently across the water on her way to an unforeseeable fate. She was one tiny, plastic duck floating alone in the vast expanse of the ocean. This is no work of fiction. This is the story told in the book *Moby Duck* by Donovan Hohn, which chronicles Hohn's adventures as he follows the peripatetic trail of the lost plastic bath toys, from their initial spill off the cargo ship the Evergreen *Ever Laurel* just south of the Aleutians, near the international date line, along the divergent paths they take while riding the North Pacific Subtropical and Subpolar Gyres. In doing so he illustrates the almost indestructible nature of plastic and the effects large amounts of plastic waste can have on the oceans.

The duck is alone in one small patch of the ocean, which covers 71% of the Earth's surface, contains 97% of the planet's water, and is known to be one of the most diverse habitats in the world. There is a great chance that the duck could run into something that human eyes have never glimpsed, as ninety-five percent of the ocean has yet to be explored by humans.[1] Her travels could very well lead her to the unknown.

What is known is that the ocean provides needed resources for both marine life and humans. Humans rely on the ocean both as a source of food and oxygen,[2] yet despite our reliance on the ocean, we are destroying it with plastic waste. It is estimated that 8 million metric tons of plastic waste enter the ocean each year.[16] As plastic does not break down into its component elements but rather into microscopic pieces called nurdles,[3] it can affect the ocean's ecosystem for up to five hundred years. Plastic pollution's effects span the entire food chain, from plankton to humans. In some places in the ocean, there is sixty times as much plastic as there is plankton.[4] When microplastics such as nurdles "and other trash collect on or near the surface of the ocean, they block sunlight from reaching plankton and algae below."[5] When plankton and algae are threatened, the result is a domino effect up the food chain. Declining plankton populations mean that animals that eat plankton, such as small fish, will face an existential threat. The decline of small fish would leave less food for predators, such as sharks and tuna. Plastic pollution not only affects plankton populations, but also the diets of those fish that eat the plankton. Microplastics can easily be mistaken for plankton and eaten by fish. The consumption of plastics by fish is extremely dangerous to both fish and humans because many plastics absorb harmful chemicals. When a human consumes a fish that has ingested plastics full of toxic chemicals, the chemicals pose a serious health risk to the human. Many chemical substances present in plastics, such as bisphenol-A, are known to be carcinogenic in much smaller amounts than previously thought by

scientists.[4] Plastic consumption by fish can ultimately be prevented by eliminating plastic pollution from the ocean. People need to strive to use less plastic and dispose of the plastic that they do use properly.

Over time, a large mass of mostly plastic waste has gathered in the ocean to form the Great Pacific Garbage Patch and other garbage patches around the world. Despite the image that these titles generate, the patches are not solid islands of plastic. The Great Pacific Garbage Patch, in particular is made up of a large amount of plastic spread across the North Pacific Subtropical Convergence zone,[6] which "is created by the interaction of the California, North Equatorial, Kuroshiro, and North Pacific currents. These four currents move in a clockwise direction around an area of 20 million square kilometers (7.7 million square miles)."[5] Many marine animals that pass through this area, such as seals and turtles, are killed from either ingesting plastic or becoming entangled in plastic nets left behind by fishing boats. Sea birds, for example, will scoop up and eat larger pieces of plastic or feed them to their young. Most animals cannot digest the plastic and "starve on a full stomach."[4] Additionally, coral has been found to consume plastic along with the food that it regularly intakes, which includes a variety of plankton such as phytoplankton, floating plankton, zooplankton, and bacterioplankton. Researchers have found that corals are consuming microplastics at the same rate that they would consume the various types of plankton they typically eat. The coral is unable to excrete the plastic it is consuming and slowly begins to die. Continued pollution of the ocean through plastic debris can lead to the destruction and elimination of the most diverse of ocean habitats, the coral reef. While corals do grow, to some extent, from photosynthesis, they need the nutrients provided by the food they consume in order to survive.[7] The Great Pacific Garbage Patch and other garbage patches affect

all forms of marine life, from plankton to fish to corals. Should the patches continue to grow, it will have a catastrophic effect on the life in the ocean.

Plastic waste in the ocean not only affects marine life but also the lives of shore birds. Sitting between the west coast of the United States and the east coast of Japan, Midway Island is home to roughly two thousand albatross for part of the year. The birds come to the island to nest. Midway is home to the albatross, a few members of the Fish and Wildlife Service every few weeks, and tens of thousands of pounds of plastic waste.[6] Waste washes up on its shores from both the Western and Eastern Garbage Patches. The plastic that washes up on the shore poses a threat to the albatross as smaller pieces will be mistaken for sources of food and eaten or fed to young chicks by their parents. Since the birds cannot digest the plastic, they slowly die.

Plastic pollution in the oceans also affects islands and coastal areas. Plastic sand is a phenomenon occurring on some beaches as the plastic trash that collects on them photodegrades and turns into something that resembles colored sand. A prime example is Kamilo Beach in Hawaii, which is littered with little bits of degraded plastic. This causes walking on the shore to feel more like walking on plastic than on sand.[3] When large amounts of waste are dumped into the ocean, there is a real chance that some of that waste will wash-up onto the shores of islands and coastal areas and, over time, mix with the sand, creating plastic sand. These degraded pieces of plastic are then cycled through the environment, possibly lasting for centuries.

Animals and coastal areas are not the only entities that suffer the effects of plastic pollution; humans are also affected by plastic waste that washes up on the shores of coastal areas. There are many beach communities that face the problem of having to clean up plastic waste. The process of removing trash, including plastic waste, can be very costly for local governments. The city of Long Beach, California, for example, faces problems with annual beach cleanups due to garbage

that washes up on its shores. Beach cleanup in Long Beach costs roughly 2.2 million dollars per year.[8] This is money that could be spent on conservation education and programs, such as the Marine Conservation Research Institute of the Aquarium of the Pacific, located in Long Beach, which is devoted to expanding scientific knowledge related to the Pacific Ocean.[9] The beach cleanups in Long Beach are not casual endeavors, with a hand full of volunteers picking up large pieces of trash. Actually, the city needs to fund large, expensive machinery in order to clean the beaches, again, by spending money that could be used to create more environmental programs and fund other environmental projects. Plastic waste does not only affect our environment and our health, but for beach towns, it can also affect their economy. When a town like Long Beach has to decide whether to cut funding from education, or other public services, in order to have enough money in its budget not to improve but rather simply maintain the state of its beaches, it is not an easy decision, and it is a decision that should not be necessary.

How did plastic pollution become such an extreme hazard to the health of the oceans and the life within them? Undoubtedly, the modern convenience culture has had a tremendous impact on the proliferation of plastic in the ocean. People strive to make their lives a little easier by manufacturing products that are efficient and easy to use. Products such as single-use coffee cups allow a person to brew just enough coffee for themselves in the comfort of their own home. Using a single-use coffee cup saves time and energy, as it prevents a trip to the nearest café. These cups, however, are nonrecyclable and nonbiodegradable, and now present a large waste problem, as more of them are being used and then thrown away by coffee drinkers.[10] Single-use plastic bottles are another convenient item for consumers. They allow the user to enjoy a drink of their choice without requiring the user to carry the bottle around when they are finished with the drink. Single-use bottles often allow for easy, grab-and-go storage. We live in a time where any

product that requires minimal effort to use and saves time and money will fly off the shelves. This way of life has contributed to our plastic addiction. Plastics are easy to manufacture, durable, and affordable. Plastics can be molded into a seemingly endless variety of shapes and sizes. Plastics are ubiquitous! They are used to make lightweight, portable phones and computers. Car fenders are also made of plastic to make them more resistant to denting. Plastic packaging keeps food fresh longer and protects it from exposure to harmful bacteria from those who have touched the food before you buy it. Plastics are also used in home materials such as windows, insulation, and air conditioners. The versatility of plastic has made it difficult for people not to use it on a daily basis.[11]

This situation may seem grim, but there are several ways to reduce its severity and eliminate plastic pollution in our waterways. One of the easiest ways to prevent plastic pollution of our waterways is to make sure this trash does not end up on the beach in the first place.[8] One way of doing this is banning the use of plastic bags in stores. An average of 100 billion plastic bags are used in the United States annually. Plastic bags are only used for 12 minutes on average and can take up to 1000 years to decay.[12] There are several cities across the United States that have or are considering laws regarding the use of plastic shopping bags. One example is the city of Bisbee, Arizona. Bisbee was the first city in Arizona to place a ban on plastic bags.[12] Additionally, many businesses encourage and try to promote the use of reusable bags. Target and Whole Foods, for example, both give customers a five-cent discount for each reusable bag that they use.[13] If we are unable to reimagine the throwaway culture we have created, the price we will pay for our frenzied search for convenience will be the continued degradation of the ocean environment.

Another proposed solution to plastic pollution is the manufacture of environmentally friendly plastics. There are three different types of environmentally friendly plastics: bioplastics,

biodegradable plastics, and eco/recycled plastics. Bioplastics are made from materials such as corn starch. The theory behind using more natural materials is that the plastics will breakdown more quickly than plastics made out of chemicals such as polyethylene. When bioplastics degrade, they produce almost 70% less greenhouse gases than traditional or biodegradable plastics, making bioplastics less toxic to the environment. Biodegradable plastics are made from the same chemicals as traditional plastics, with added chemicals that allow the plastics to break down more quickly than they normally would. Eco/recycled plastics are items, such as benches, that have been made using recycled plastic items such as milk jugs or water bottles. Recycled plastics are not made into newer versions of the same item, but rather into something completely different. While creating environmentally friendly plastics is a step in the right direction, there are still some disadvantageous effects of using these products. Biodegradable plastics can still release harmful amounts of greenhouse gases into the environment when they decompose. The processes of manufacturing used plastic items into new products can often use more energy than it would take to simply manufacture new plastic.[14] The production of bioplastics would also use valuable food resources and would not be able to meet the global demand for plastic.[4] Environmentally friendly plastics may provide a short-term solution to the issue of plastic pollution, but in the long term we need to find a more sustainable and less harmful solution.

Additionally, social media is a powerful tool that can be harnessed to raise awareness for problems such as plastic pollution and encourage the use of creative and environmentally friendly replacements for plastics. Currently, there are some online campaigns that have been created in order to raise awareness about plastic pollution. The Klean Kanteen water bottle company has launched a campaign in which users of their stainless steel products can take a pledge to go single-use free for thirty days, which will hopefully lead to a lifetime of refusing

single-use products. There is also a reusable water bottle that is collapsible; this allows the user to simply store the bottle in their pocket or in a small bag when they are finished with their drink.[15] This water bottle, which goes by the name of Hydaway, was funded by a Kickstarter campaign, which exceeded its fundraising goal in just one month.[15] This exhibits public interest in being more environmentally conscious and taking positive action with regard to reducing plastic consumption. Furthermore, there is a Twitter campaign that is devoted to eliminating plastic pollution in the oceans through education and awareness by the name of "Breaking Plastics." These are just a few examples that highlight the power of social media in bringing about positive change. Using social media in this way helps people become more aware of their impact on the world around them and the actions they can take to protect the ocean environment.

To conclude the narrative with which we started: The little plastic duck has survived several long months at sea; though her yellow color has faded, she is intact. Looking ahead of her, she sees land. She, like some of the other plastic toys with whom she started her journey, is bound towards a shoreline. As she approaches the shore of the island in sight, she sees more and more plastic waste. When she finally washes ashore, the duck lands in a heap of trash that seems to be mostly made of plastic. On this isolated island, she may sit for many years surrounded by the plastic waste that was deposited into the ocean by humans, which can only be prevented from growing in size by people becoming more aware of the impact of plastic on the oceans and what they can do in order to prevent the situation from becoming worse.

Notes

[1] National Oceanic and Atmospheric Administration http://www.noaa.gov/ocean.html

[2] Salon http://www.salon.com/2014/07/19/why_our_brains_love_the_ocean_science_explains_what_draws_humans_to_the_sea/

[16] The New York Times http://time.com/3707112/plastic-in-the-ocean/

[3] Moby Duck by Donovan Hohn

[4] It's a Plastic World http://itsaplasticworld.com

[5] National Geographic Education http://education.nationalgeographic.com/education/encyclopedia/great-pacific-garbage-patch/?ar_a=1

[6] Plastic Paradise Documentary

[7] The Guardian http://www.theguardian.com/environment/2015/feb/25/corals-face-slow-starvation-from-ingesting-plastics-pollution-experts-find

[8] Suja Lowenthal Tedx Talk https://www.youtube.com/watch?v=ElvXUt0BHWQ

[9] Aquarium of the Pacific Website http://www.aquariumofpacific.org/mcri

[10] The New York Times http://www.nytimes.com/2010/08/04/business/energy-environment/04coffee.html?_r=0

[11] Plastic Resource®: http://dwb4.unl.edu/Chem/CHEM869E/CHEM869ELinks/www.plasticsresource.com/plastics_101/uses/uses.html

[12] AZ Central http://www.azcentral.com/story/news/local/tempe/2015/03/17/tempe-wants-sack-plastic-bags/24937719/

[13] Target Corporate Website: https://corporate.target.com/corporate-responsibility/environment/sustainable-living and Whole Foods website: http://www.wholefoodsmarket.com/mission-values/environmental-stewardship/doing-green-thing

[14] Explain That Stuff http://www.explainthatstuff.com/bioplastics.html

[15] Refinery29: http://www.refinery29.com/hydaway-collapsible-water-bottles?utm_source=email&utm_medium=editorial&utm_content=everywhere&utm_campaign=150521-no-foundation-experiment#.1jllam:delQ

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Reflection

I wrote this essay because I am passionate about environmental conservation. As a teen volunteer at the Reid Park Zoo, I work to educate the public about wildlife and conservation. The teen volunteers also raise money through special events to support several different conservation groups including the Hyderabad Tiger Conservation Society (HiTyCoS) and Wildlife SOS in India, the Tarangire Elephant Research Project in Tanzania, and the Pantanal Giant Armadillo Project in Brazil. Living in Arizona, we do not see many of the problems related to ocean conservation, but we still do our best to educate the public about it when we can. More recently, the Reid Park Zoo has partnered with the Monterey Bay Aquarium's Seafood Watch® program to encourage our visitors to make seafood dining choices that encourage sustainable fishing and farming choices.

As I was writing this essay, I was continuously researching the issue of plastic pollution in the oceans and possible solutions to the problem. I also read the book *Moby Duck* by Donovan Hohn as part of my research. The author is able to display the effects that plastic has on the ocean ecosystems and the efforts of those trying to remove it from the ocean.

Ocean conservation is equally important as land conservation, and I believe that everyone, no matter where they live, can make a difference in the lives of marine animals. If more people are educated about the issue, they can see the impact they have and be inspired to take action.