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BIO376 – Blog Post

# The Great Pacific Garbage Patch the Issues and Solutions

Ocean currents are controlled by the Earth's wind patterns, forces created by the Earth's rotation and its landmasses[1]. Wind pushes the surface water which causes it to move in the direction that the wind is heading. Sometimes they form circular currents due to the Coriolis effect[1]. The earths rotation causes it to shift the surface current by an angle of 45 degrees[1]. In the Northern hemisphere this causes the ocean current to rotate in a clockwise motion[1]. These create large rotating currents commonly known as gyres. The main ocean gyre I want to focus on is the Northern Pacific Gyre which is home to the Great Pacific Garbage Patch (GPGP) as shown in Figure 1. The GPGP is made of two patches the main one focused on in this blog post is the Eastern Garbage Patch[3].

The Great Pacific Garbage patch is an accumulation of marine debris that gets collected in the Northern Pacific Gyre[3]. Marine debris are plastics and other synthetic non-biodegradable materials that somehow find its way into the ocean[4]. These plastics can be anything from everyday single use plastics like bottle caps and straws, to items such as fishing net and rope. Fishing ropes used to be made of natural fibers that would be strengthened by tar or warn canvas, these materials would be able to disintegrate quickly in nature[4]. However, fisheries have switched to nylon and other synthetic fibers although stronger, when left in the ocean won't degrade[4].

What's the importance of this anyway? Why would it matter to us if we don't see it anymore? Well, improper disposal of plastics may eventually find its way into the ocean that can lead to many possible problems. The main problem is that it affects marine species. The problems they face are entanglement, ingestion, suffocation and general debilitation[4]. However, there are also direct effects onto humans that are less recognized and recorded such has global hazards to shipping, fisheries and other maritime activites[4]. In the study by Gregory, M. R. (2009), he stated that the problems with oceanic pollution are more chronic than acute[4], you won't see a big effect immediately but over time the effect will be catastrophic. Gregory states different ways that species are affected by pollution, the three most compelling to me are aesthetic values, entanglement and ghost fishing, and ingestion.

For aesthetic values, its about how unsightly the beach would be. Local beach users and tourists may get a bad emotional reaction to seeing a dirty ocean which leads to financial concern to the city[4]. They may also get harsh public response if pictures of seabirds and marine animals are found entangled in netting[4]. For entanglement and ghost fishing, many animals are drawn to or get stuck in fishing nets/ropes[4]. Once they get entangled in the net it is difficult for them to escape which leads to them drowning or dying from injury or starvation[4]. You often see many cases of animals getting stuck on 6 pack soda rings that tighten to them as they grow which can lead to strangulation[5] as seen in Figure 3. The last point was ingestion. Some of the plastics in the ocean can degrade into smaller pieces that marine species can ingest by accident thinking it was food. This would cause them internal and external wounds, creating skin lesions and stomach ulcers, this would also cause blockage of the digestive tract which would eventually

lead to starvation[4]. It was determined that birds began eating pieces of plastic around the 1960s as they would eat anything resembling food before they died[4]. There was also a huge problem with turtles mistaking plastic bags as jelly fish[4] which could end up getting stuck in their throats as seen in Figure 4.

The next article focuses on the evidence that the Great Pacific Garbage Patch is accumulating more plastics and exactly what those plastics are. In this study by Lebreton, et al. (2018) they characterized and quantified buoyant ocean plastic inside the GPGP. They collected surface trawl samples to obtain a representative distribution of buoyant plastic concentrations[6]. They also performed aerial surveys to determine the surface floating plastic larger than 0.5m[6]. They measured the concentrations of various size plastics and created plastic transport model which helped them create a time-coherent dynamic model of debris accumulation in the GPGP[6] as shown in Figure 5. They determined four different sizes of plastic micro (0.05-0.5cm), meso (0.5-5cm), macro (5-50cm), and megaplastics (>50cm)[6]. They determined that there was 79 thousand tonnes of plastic floating inside the 1.6 million $km^2$ area, microplastics making up a trillion pieces and 6.4k tonnes of it, while macro plastics made 3.2 million pieces and 42k tonnes[6]. This shows that a large problem with plastic waste inside the ocean isn't just the large pieces you see in the ocean but the smaller pieces that float just below it. This is dangerous to ocean species as they may ingest this plastic thinking that it's food.

The study by Bryant, et al. (2016) determined the different microbial communities that flourish in the plastic debris. He determined that there was an increase in net community oxygen production (NCP = gross primary production – community respiration) which means the community was net autotropic compared to bulk seawater which was close to zero[7]. This could be possibly due to the organisms having something to adhere onto creating and environment that could shield them from the harmful UV rays. They used scanning electron microscopy and metagenomic sequencing of plastic attached communities to find few metazoan taxa and more diverse photoautotrophic and heterotrophic protists and bacteria[7]. This showed that the bacteria that inhibit the plastic filled area are different from the surrounding waters[7]. This opens the door to more research to determine if these plastics are useful in anyway and if they can be used to help the plastic problem.

One possible solution to this issue could be to implement mitigation policies as proposed by Lebreton and Andrady (2019)[8]. They performed an experiment that determined where in the world had the most mismanaged plastic waste (MPW)[8]. The current rate of plastic production is at 330 million metric tonne (Mt), it is expected for this rate to double within the next 20 years[8]. They used data distributed by Waste Atlas to determine the per capita municipal solid waste and determined each country's' MPW[8]. From this they determined Southern Asia, specifically China was the top country generating MPW with 18.4 Mt/year[8]. Next, Eastern Africa was the second highest region outside of Asia with 5.89 Mt/year[8]. They suggest that these countries should invest in waste management infrastructures as their GDP grows in the future[8]. These are both regions that are still developing nations, putting sanctions on their growth is difficult place without backlash. This would be like asking them to not follow in our foot-steps and may be seen as a way to keep these countries down. They are trying to become first world countries and to live comfortably as we are.

A more feasible solution would be The Ocean Cleanup. For the past couple of months, I have been following this non-profit organization project called "The Ocean Cleanup" as they

appeared on my Reddit feed. They aim to utilize ocean currents to their advantage by using passive drifting systems that they estimate will clean half of the Great Pacific Garbage Patch in 5 years[9]. They are very transparent about what they're doing including their successes and failures. They upload to their YouTube channel often and keep their website updated. This project was founded by Boyan Slat a 24 year old Dutch aerospace engineering dropout who noticed when he was 16 during a diving trip in Greece that there was more plastic bags in the ocean than fish[10].

In order to get funding, they first crowd-funded a campaign to start Pacific Ocean cleanup trials[9]. From November 2016 to May 2017 they were able to raise 21.7 million USD in donations rounding out their total funding to 31.5 million USD[9]. This money allowed them to begin building and really testing out their system.

This project involves using a 600 meter long floater that has a three meter long skirt attached below. The floater keeps the system buoyant and stop plastic from flowing over it. The skirt prevents smaller particles from escaping underneath. Marine life can swim safely under the skirt. The system takes advantage of three oceanic forces, wind, waves and currents. The plastic and the system are being carried by the current. However, the wind and waves only propel the system due to the floater being above water, this allows it to travel faster than the plastics underneath, catching them. The skirt is longer in the middle of the system to allow it to naturally form a u shape funneling the plastics towards the center. The system is free floating, so it drifts with the winds to the areas of highest plastic concentration. It has anti-collision systems, cameras, sensors and satellite antennas so that its position is always tracked, this allows for a support vessel to come by and take out the plastic when there is too much. This is then transported to land to be recycled. Figure 6 shows the different components of the system. They plan to have at least 60 systems floating in the ocean in order to capture plastics.[9]

As of October 2018 they had sent the first system 001, "Wilson", into the Pacific Garbage Patch. It was determined that Wilson had captured plastic, but it didn't retain it the way they thought it would. There was no massive build up of plastic within the system. They performed many tests to try to determine the problem but ran into a lot of bad weather conditions that prevented them from preforming further testing. Then in January 2019 a piece of Wilson broke off, after getting back that piece they towed it to Hawaii being the nearest shore. This was just one of the many trials they will go through to get a working system. They learned from their mistakes from this trial and will come back with a better working system.[9]

Fishing out plastics out of the ocean with The Ocean Cleanup system is a great idea as it follows the plastic to where its going and is able to grab bigger plastics before they get broken down to even smaller plastics and sink down to the ocean. Although they did fail their first test this is a feasible system with testing and many people backing it. Since this is an ongoing effort to tackle the garbage in the Great Pacific Garbage Patch there is no final answer about whether this will work but the future is looking bright.

References


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Appendix

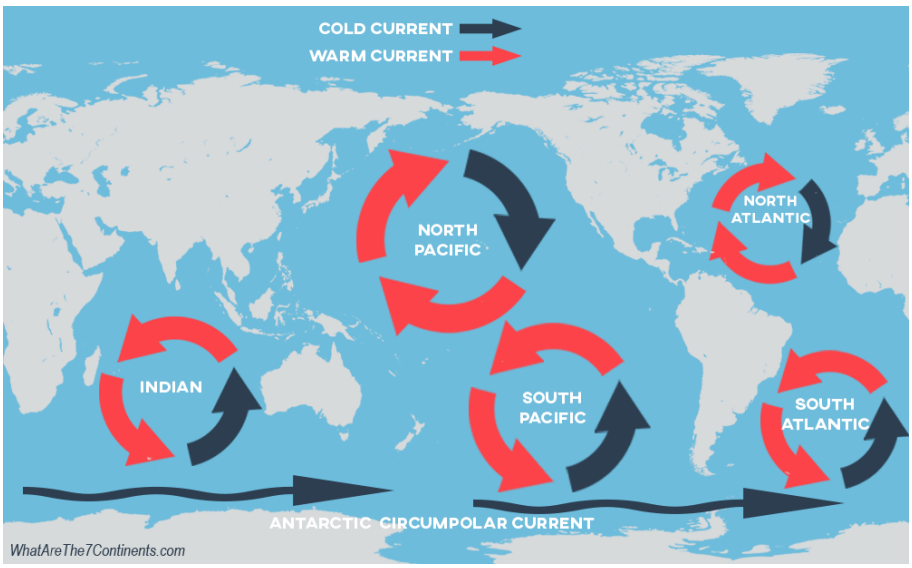



Figure 1: Image of the 5 different Ocean Gyres that help the earth redistribute heat. Focussing mainly on the North Pacific Gyre located between North America and Asia.[2]

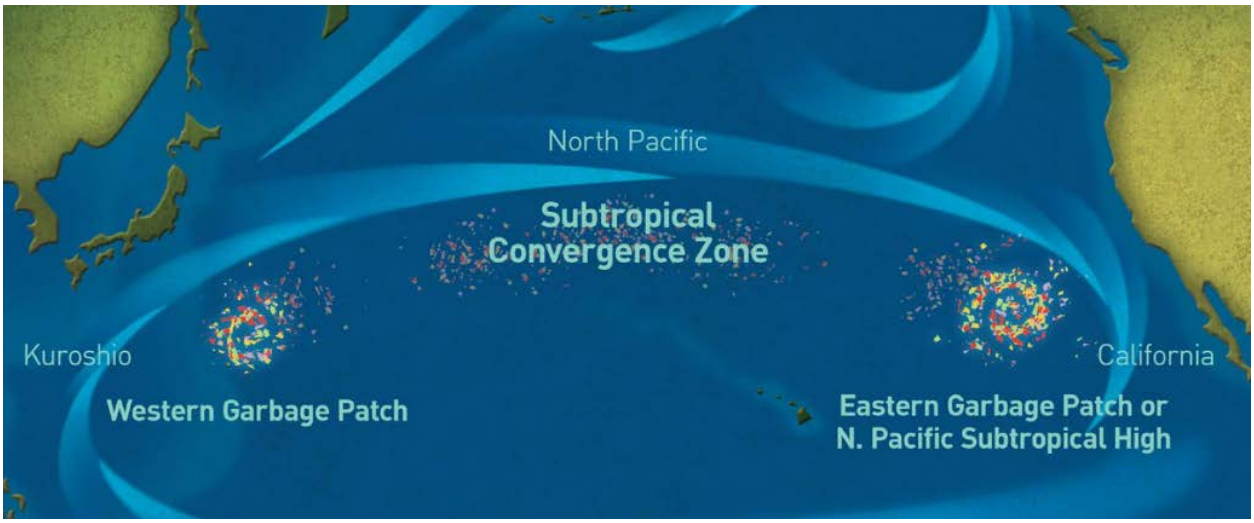



Figure 2: Focusing on the Eastern Garbage Patch. Which is part of the North Pacific Gyre. [3]

Figure 3: Red-eared slider turtle that had got stuck within six-pack soda holder. After removal of the plastic in 1993 the turtle has been thriving for 22 years as of 2015.[5]

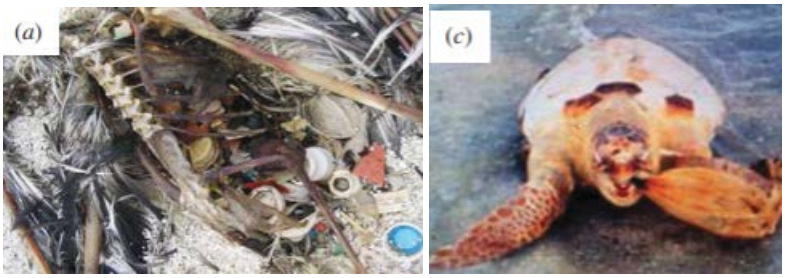
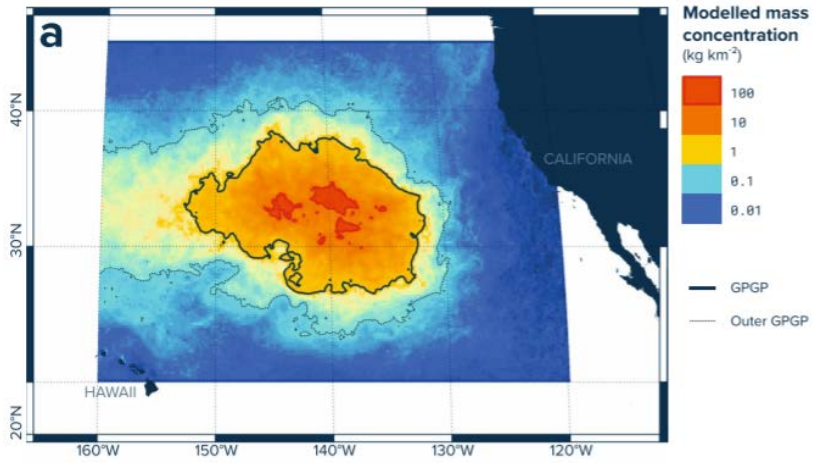



Figure 4: Examples of ingestion: (A) picture of Laysan albatross with many plastic bottle caps stuck in its stomach. (C) Sea turtle with plastic bag stuck in its throat.



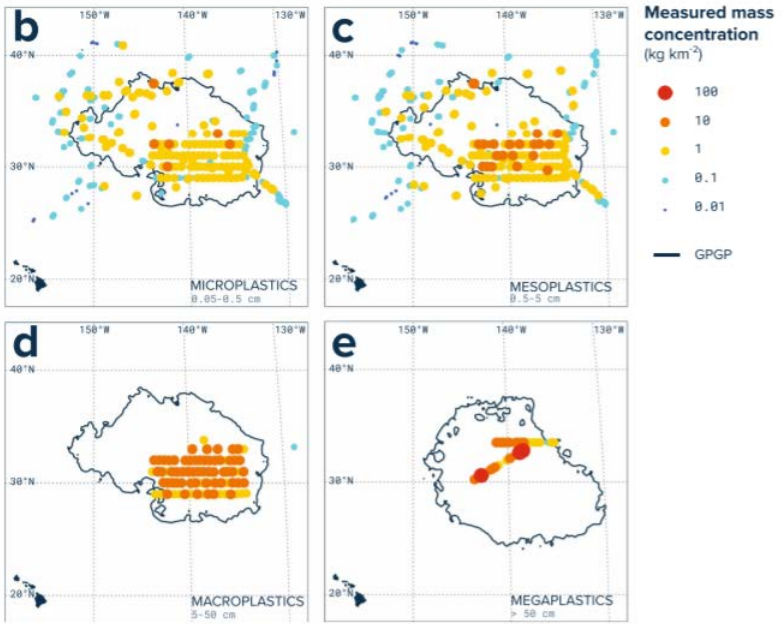



Figure 5: Show casing the different sizes of plastics and their distribution within the GPGP.[6]

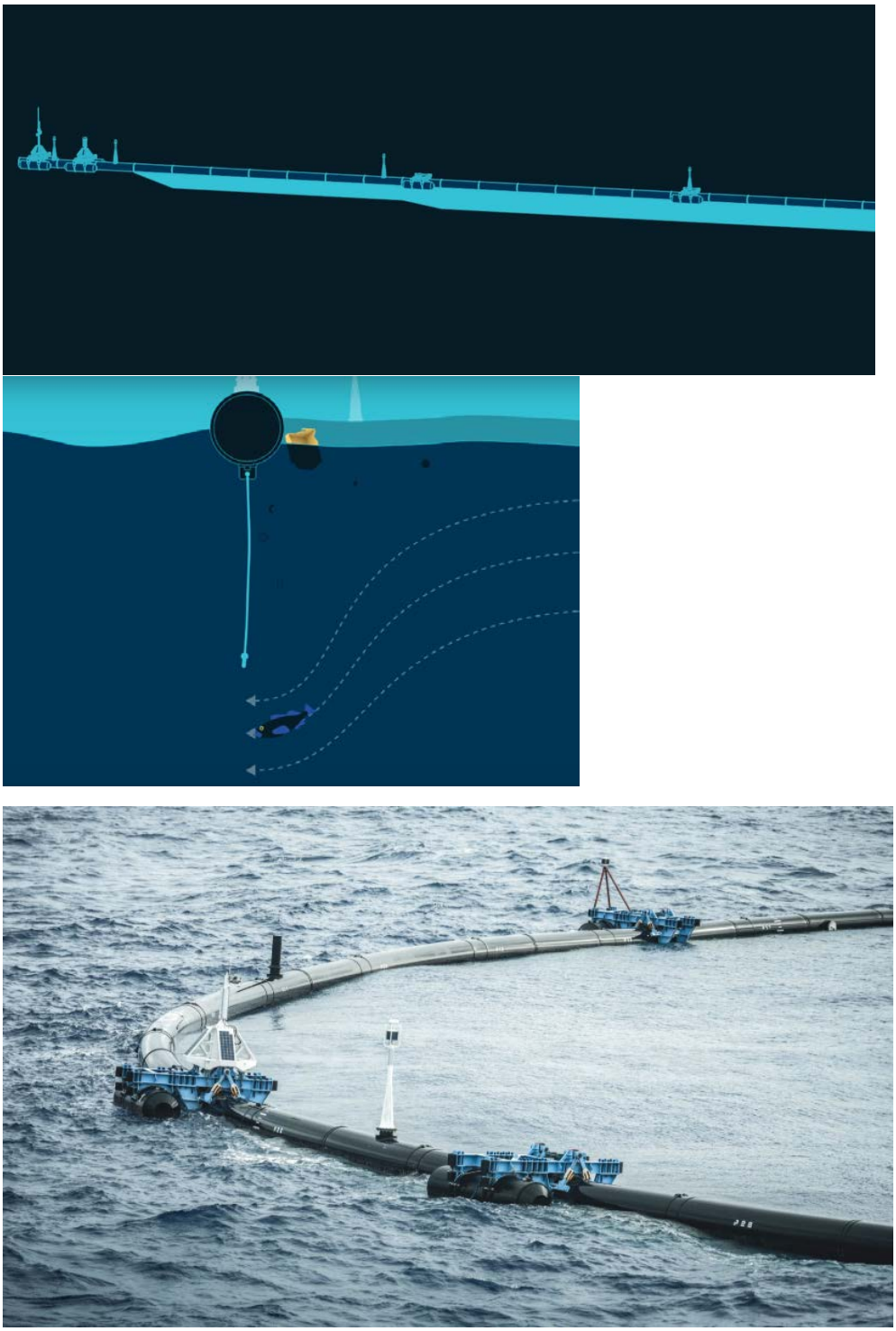


Figure 6: Following pictures are the diagrams of the system 001 and the system in the field. [9]