Plastic pollution along the Pacific coast of Costa Rica

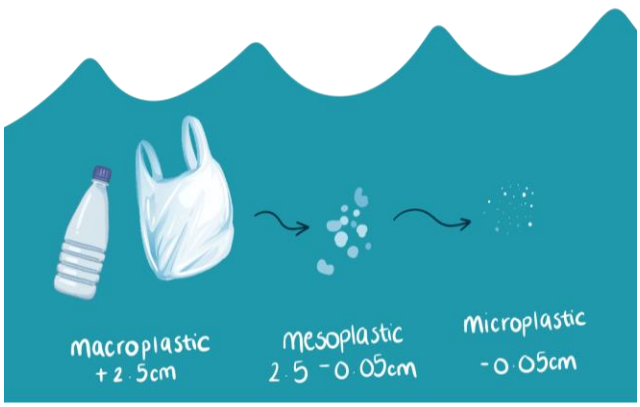
Hannah Gibbs

Plastic pollution comes in many forms, all of which are creating a global crisis threatening ocean health. In order to shed insight into the extent of this issue in Costa Rica I investigated the abundance and distribution of plastics along the Pacific coastline.

A plastic background

In **1907** Leo Baekeland invented the first synthetic plastic[1], beginning a worldwide addiction. Plastics are extremely successful – they are durable, malleable but above all else, they can be discarded. Economically, plastics are cheap compared to alternatives, however plastics are invaluable due to our everyday dependence on them. Tragically, the United Nations Environment Assembly declared that there is an annual dumping of up to **12.7 million tons** of plastic into the ocean every year[2].

The term “plastic pollution” refers to the introduction of synthetic plastics of many kinds into the environment. This encompasses micro-plastics that are less than 5 mm in size and macro-plastics, as well as a range of materials, from polystyrene and polyvinyl chloride (PVC) to different polyesthers.



The study

Prior to joining the Pelican of London, I designed an outline of what I wanted to achieve whilst on board. Given the relatively short duration of the voyage (just 10 days) and the accompanying challenges of doing research on a tall ship, I knew I would most likely have to adapt to unforeseen circumstances. This turned out to be an understatement; the delights of long, indirect flights meant my bags were lost in America for 5 days, delaying the start of my project. However, after hours on hold with customer service, my equipment did eventually appear on deck and my research could commence!

I decided to focus on two different environments within oceanic plastic pollution;

1. In the water column
2. On beaches

Within the water column

To determine the abundance of plastics, I used a plankton net to filter a set volume and depth of the water column. This allowed me to join forces with a fellow scientist on board, Megan, who was using the same equipment to study plankton.

We would lower the plankton net off the side of the RIB down to **6 meters depth**, before pulling the net back up to the surface. This was repeated **3** times so the net passed through **36 meters** of water. This method is called a **Double Oblique Tow.**

The plankton net was then transported back onto the ship so it could be washed down with freshwater from the outside, and the sample collected in a beaker. This sample was 1 liter large and a subsample of 5 ml was used to be examined under the microscope.

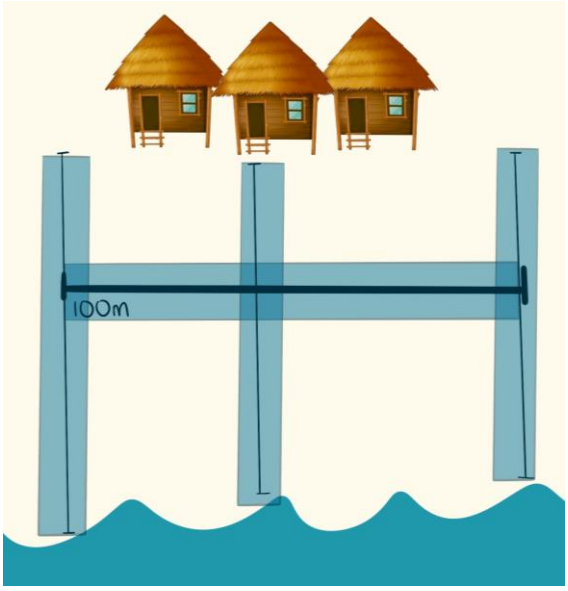
Photos of our method collecting samples from the rib, calculating some statistics and analysis under the microscope.

Using the diameter of the plankton net and the distance the net was towed, we could calculate the water volume sampled. This would allow me to determine the abundance of plastics within a given volume of sea water.

As well as looking at the plastic within the water column, I also observed lots of plastic floating on the water surface. These macro-plastics passing by the ship and the RIB were recorded through taking photos and noting the type of plastic and appearance of the plastics.

On the beaches

In terms of plastic pollution found on beaches, a different method was required. Based on OSPAR's marine litter monitoring survey methodology, the following process was carried out.



Two observers would walk down 1 meter either side of the 100 m transect. Any observed plastics were recorded along the transect and they were categorized by type and size. This was then repeated for three vertical transects from the waters edge to the back of the beach in order to see where plastics were accumulating. After, we would pick up any plastics I found on the beach and disposed of them accordingly.

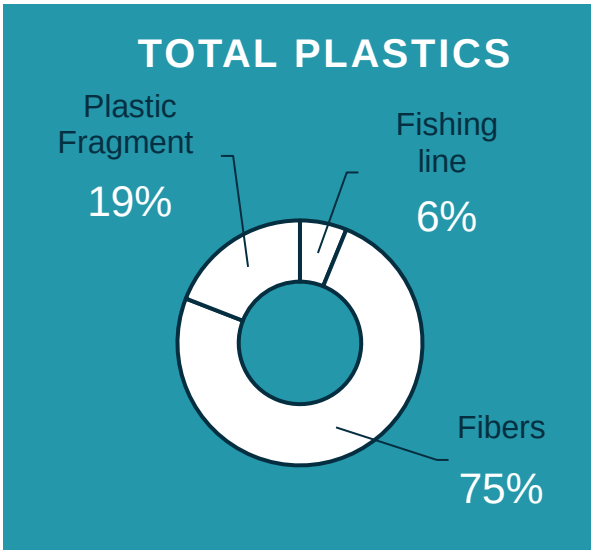
Due to the nature of the Pelican being a sailing vessel, stopping at beaches along the voyage was often not achievable and sadly I only made it to one beach. However, as I was staying in Costa Rica for a further 10 days, I was able to observe more beaches while off the ship. This did mean I didn't have access to my equipment, so I was unable to apply the same method.

Despite this, I felt like I could still gauge valuable insight into the extent of pollution along the visited beaches.

Results

Analysis of the plankton trawls under the microscope revealed that:

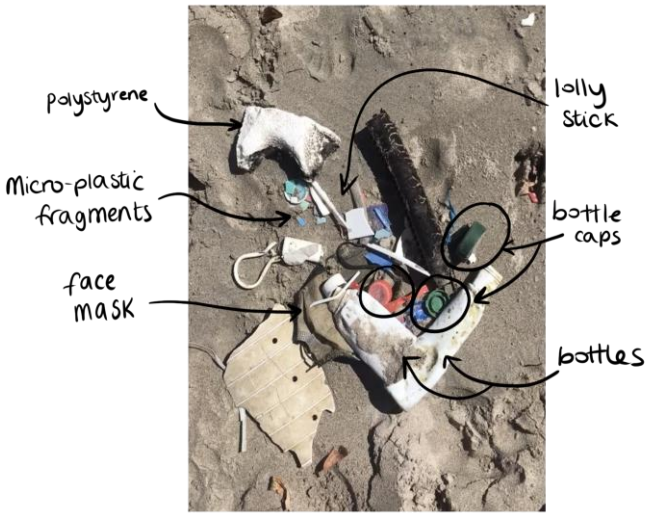
- Synthetic fibers made up 3/4 of the counted micro-plastics
- Plastic fragments accounted for nearly 1/5th
- Fishing line was found in 60% of the recorded sites



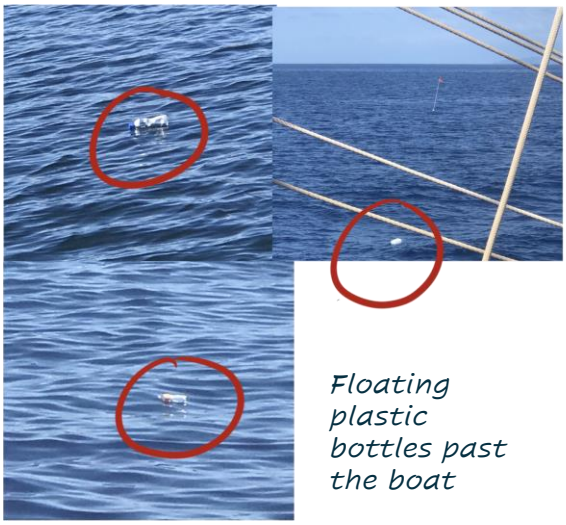
The highest calculated concentration of micro-plastics, of **38,000 per liter**, was recorded at the most northerly site, Bahia Culebra. This was nearly **13 times** larger than concentrations further south at Isla Tortuga. In contrast, the beach survey at Andez resort revealed very limited plastic debris, with just **7** pieces of litter found within the transect area.
This litter had a variety of sources, yet **43%** was identified as food wrappers, indicating domestic sources and potentially poor waste management practices.

Outside of the formal survey, my visits to other beaches further south painted a much more disappointing picture. I found unquantifiable amounts of plastic pollution on Isla Tortuga, consisting of macro-plastics, such as bottles and cans, to thousands of micro-plastic fragments lost in the sand.
I also found some single use face masks, reflecting the environmental impacts from the Corona Virus pandemic.

Locations of studied sites along the Pacific coast. Beach survey highlighted in white line.



I also witnessed lots of floating plastic while under sail, especially concentrated near ports such as Punta Arenas. I collected over **5** plastic bottles while out on one short RIB excursion, along with polystyrene pieces.



Floating plastic bottles past the boat

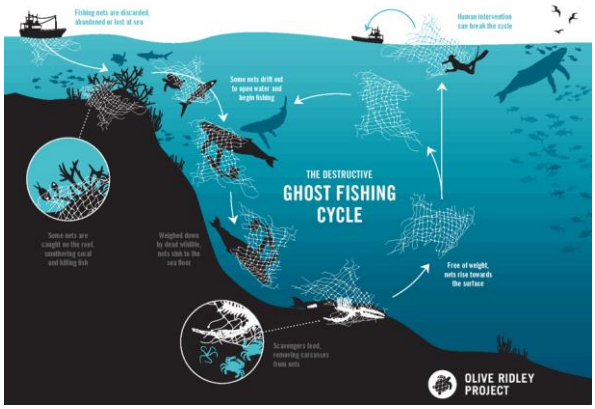
What does this mean?

So, I found that the coastal seas to the west of Costa Rica are polluted with plastics, but what does this mean for ocean health?

As plastics are extremely versatile, so are their impacts on marine wildlife:

Macro-plastics

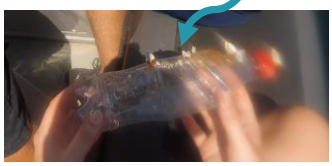
These are larger pieces and ropes, and often entangle marine organisms within them. A prime example are ghost nets. Ghost nets are abandoned fishing nets, discarded into the sea, and they do exactly what they were designed to do; catch fish. These nets trap marine organisms, including sharks, turtles an dolphins. This is a huge threat to ocean biodiversity as endangered species are dying because of this. It has been calculated that up to **40%** of ocean plastic pollution is sourced from the fishing industry[3]. A huge **700** marine species are now known interact with marine debris and at least **17%** of impacted species listed on the IUCN Red List as near threatened or above[4].



Meso-plastics

On a slightly smaller scale, meso-plastics pose the problem of ingestion. Marine organisms mistake plastic pollution for food, the plastic can block their stomachs, throats and other vital organs. This can result in the marine animal starving or choking on the plastic, resulting in their death. Another problem with meso-plastics is the phenomenon **'bio-fouling'.** This is where marine life attaches itself or inhabits objects such as plastic pollution.

I witnessed this multiple times, where barnacles had attached to plastic bottles and crabs were found on polystyrene and foam pieces floating.



Barnacles attached to plastic bottles

This poses a potential problem when trying to remove plastic pollution from the ocean. The one tiny benefit plastic pollution may have, is as refuge for small organisms in an artificial environment, which is very scare in open waters. Removing plastics may have consequences for these animals inhabiting the debris, and should be considered when attempting to clean up the oceans. The "Ocean Clean Up Project" recently began testing a device in the Pacific to try and reduce plastic pollution in the Great Pacific Garbage patch. Data revealed that out of **40,000 kg** of plastic removed, **141 kg** of biological matter was also removed[6]. Although a small proportion in weight, this could be a potential threat to biodiversity and ecosystem health that should be considered.

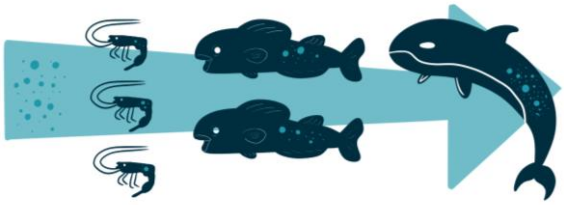
Ocean boon collecting surface layer plastics floating in a gyre.

Micro-plastics

Even smaller still, micro-plastics have perhaps the largest impact on ocean health, and on human health too. Micro-plastics are ingested by marine organisms as well, but can undergo a process called **'bio-accumulation'**.

> "the net accumulation of a contaminant in or on an organism[7]"

Small organisms at the base of the food chain ingest micro-plastics, mistaking them for food. Small fish then consume a lot of these small organisms, and with their prey ingest the micro-plastics lodged within thsee organisms. This process occurs throughout the food web, with plastics increasing in concentration the higher up the food chain.



The build-up of plastics can be very dangerous within marine organisms, not only because they have no food value and can lead to malnutrition or starvation, the chemicals within or adhering to the plastics can potentially have toxic effects on organisms, including humans. As we are avid fish consumers, it is estimated the average European dietary exposure to micro-plastics is **11,000** a year! Mussels have been found to contain **0.36** plastic particles ger gram of tissue. So, the more we pollute the oceans with plastic, the more damage we are causing to the marine environment and to ourselves.

Next steps

Costa Rica has put in places several measures to attempt to reduce their plastic pollution and consumption. In **2017,** during the UN global conference, they pledged to discourage single use plastics and “reduce marine pollutants” by **2025**. They have also ran a social media campaign #ChaoPlásticoDesechable (Goodbye Disposable Plastic) to raise public awareness and engagement with the issue. Plastic pollution is a global issue, our oceans are all interconnected with currents so if one country releases plastic into the ocean it affects the entire world. The majority of plastic on the beaches had been washed onto shore and may not have originated from Costa Rica.

In order to reduce plastic pollution, we need global co-operation from all governments, enforcing policy change reducing dependence on single use plastics.

However, the floating plastics most likely came from local pollution brought to sea by river sources and the fishing industry. Making simple swaps away from plastic dependency can help reduce pollution and make our oceans a cleaner place, while the reduction of plastics pollution from the fishing industry is a more difficult task..

References

1. Science History Institute. 2021. History and Future of Plastics. [online] Available at: <https://www.sciencehistory.org/the-history-and-future-of-plastics> [Accessed 12 October 2021].
2. United Nations Environment Assembly. Towards a pollution-free planet. Report No. UNEP/EA.3/L.19 (United Nations, 2017)
3. Lebreton, L., Slat, B., Ferrari, F., Sainte-Rose, B., Aitken, J., Marthouse, R., Hajbane, S., Cunsolo, S., Schwarz, A., Levivier, A., Noble, K., Debeljak, P., Maral, H., Schoeneich-Argent, R., Brambini, R. and Reisser, J., 2018. Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic. Scientific Reports, 8(1).
4. Gall, S. and Thompson, R., 2015. The impact of debris on marine life. Marine Pollution Bulletin, 92(1-2), pp.170-179.
5. Olive Ridley Project. 2022. *Ghost Fishing: A Cycle of Devastation | Olive Ridley Project*. [online] Available at: <https://oliveridleyproject.org/what-are-ghost-nets/ghost-fishing-cycle-of-devastation> [Accessed 24 January 2022].
6. The ocean clean up project. 2022. *The ocean clean up project*. [online] Available at: <https://theoceancleanup.com/oceans/> [Accessed 24 January 2022].
7. Poppenga, R., 2007. Avian toxicology. *Veterinary Toxicology*, pp.663-688.
8. Van Cauwenberghe, L. and Janssen, C., 2014. Microplastics in bivalves cultured for human consumption. *Environmental Pollution*, 193, pp.65-70.