Manta Mexico Caribe, Microplastic Project

2019 Annual Report

MANTA CARIBBEAN
PROJECT

1. Introduction

Plastic pollution is a global issue that has recently emerged as an area of concern for the health and well being of humans, animals, and the environment. In the world's oceans, plastics enter from primarily land-based sources, such as rivers beaches, and wastewater treatment plants. There are also maritime sources of marine plastic waste, such as discarded fishing gear and equipment (Cole et al., 2011). Plastics are highly durable in the marine environment. Different estimates predict they can persist for anywhere from hundreds to thousands of years. They are, however not immune to degradation. Over time, ultraviolet radiation and other weathering processes cause larger plastics to degrade into microplastics, or plastic particles <5mm in diameter (Barnes et al., 2009). Microplastics were first reported in the open ocean in the 1970s (Carpenter and Smith, 1972) and since then they have been discovered in all types of marine environments (Wright et al., 2013). A 2014 study conducted by the 5 Gyres Institute, a marine plastic research and advocacy organization, estimates that there are more than five trillion pieces of plastic in the ocean, weighing more than 250,000 tons (Eriksen et al., 2014).

Plastic pollution poses a substantial threat to marine wildlife, causing entanglements as well as choking and starvation upon ingestion. This phenomenon has been well documented around the globe for many types of species, from marine mammals to sea turtles and other marine megafauna (Adimey et al., 2014; Butterworth, 2017; Gregory, 2009; Stelfox et al., 2016). These incidents are often either fatal for the animals or the cause of a severe reduction in fitness. Marine plastics and microplastics are also hazardous in a more unexpected way, as they harbor the potential to poison marine wildlife upon ingestion (Simmonds, 2017). Plastic readily absorbs what are known as persistent organic pollutants (POPs). These are chemicals that do not naturally occur in the environment and are resistant to degradation. They include pesticides such as dichlorodiphenyltrichloroethane (DDT) and industrial compounds known as polychlorinated biphenyls (PCBs). When microplastics are ingested, they act as vectors for POPs, which are fat-soluble and accumulate in the fatty tissues of marine animals. While it is currently unknown if these toxins are dangerous at all environmentally relevant concentrations, there has been some evidence of toxic effects in wildlife where concentrations are high. For example, when released into the blood stream, POPs have been shown to cause health problems such as increased rates of cancer and decreased reproductive success in certain species. These problems could potentially have population level implications (Simmonds et al., 2017). POPs are also known to bioaccumulate and biomagnify up the food chain, which means that predators accumulate the toxins of all of their prey before them, with top predators containing the highest levels in their tissues. Considering humans are top predators and regular consumers of seafood, this is potentially a human health issue as well as a conservation issue (Barboza et al., 2018).

For endangered or vulnerable species, microplastics could pose a threat to conservation efforts for wild populations. This includes the giant oceanic manta ray (*Mobula cf. birostris*) (Marshall et al., 2009), a charismatic species present in the Mexican Caribbean and classified as ‘vulnerable’ by the International Union for the Conservation of Nature (IUCN) (Marshall et al., 2018). Oceanic manta rays are filter feeders that primarily consume zooplankton (Germanov et al., 2018). Their small prey and large body size means they must consume large quantities of plankton to survive. This feeding strategy means that microplastics pose a substantial threat to manta ray health because they may filter hundreds to thousands of cubic meters of water daily, which could lead to microplastic ingestion, either directly or through the ingestion of contaminated plankton (Germanov et al., 2018). Currently, the amount of microplastic in the Mexican Caribbean manta ray feeding range is unknown. It is the primary focus of Manta Mexico Caribe’s microplastic project to sample this environment and generate concentrations of microplastics in the region and to further inform the state of this emerging conservation issue.

1. Methods

Throughout the course of this project, there have been four different sampling periods. During August of 2017, nine samples were collected within the Reserva de la Biosfera Caribe Mexicano. During August of 2018, seven samples were collected within the Reserva de la Biosfera Caribe Mexicano. During January of 2019, seven samples were taken along the western coast of Cozumel, within the Parque Nacional Marino Arrecifes de Cozumel. The most recent set of seven samples was taken during August of 2019, again within the Reserva de la Biosfera Caribe Mexicano. This brings the total number of samples to 31, however the first nine samples collected in 2017 are excluded from this analysis because they were processed using different methods by a separate team, rendering them incomparable. For this reason, we will consider the results of samples 10 through 31. All trawl locations can be seen in Figure 1.

All samples were collected with a trawl net. Samples were then processed in the laboratory using the protocol of the National Oceanic and Atmospheric Association (NOAA) Marine Debris Program (Masura et al., 2015). Microplastics were identified and counted using microscopy. All 21 samples have been processed and analyzed to date.

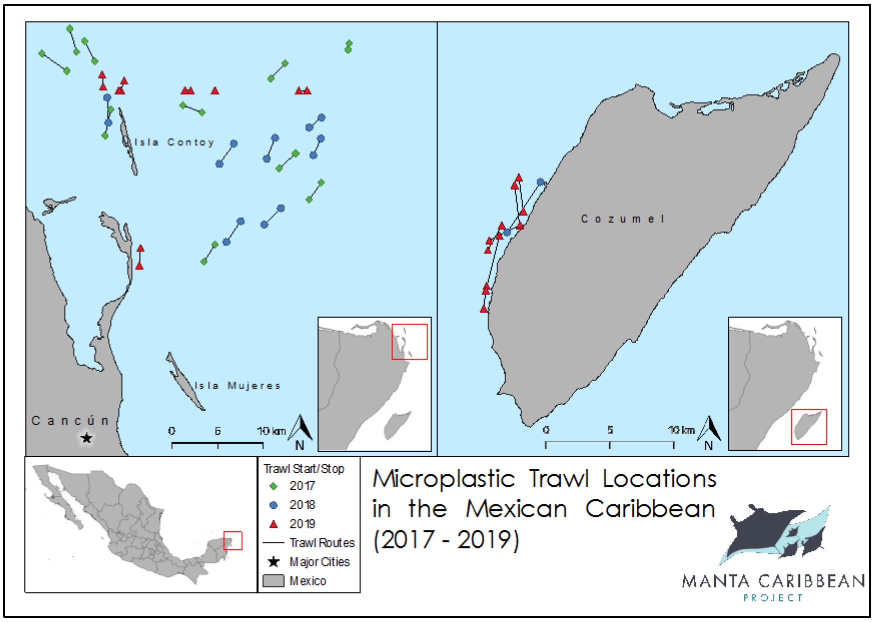

Figure 1: Microplastic trawl locations in the Mexican Caribbean (2017 – 2019)

2.1 Trawling

Samples were collected using a manta trawl, as part of the 5 Gyres TrawlShare Program. A manta trawl has a rectangular aperture that is 16 cm high by 61cm wide. The net is 3 m long and captures particles greater than 335 μm into a collection bag of the same material that is 30 cm x 10 cm (Eriksen et al., 2018). An example can be seen in Figure 2. The manta trawl was pulled behind the boat between distances of 10 m and 15 m. Trawls lasted for 30 minutes at an average speed of 3 knots. For samples 19 through 31 we were able to sample with a flowmeter attached to the mouth of the manta trawl. This is a device that measures the flow rate of water passing through the net and allows us to calculate the volume of water sampled. With a known volume of water we are able to determine a concentration of microplastic particles per cubic meter (pp/m^3). The flowmeter used can be seen in Figure 3.

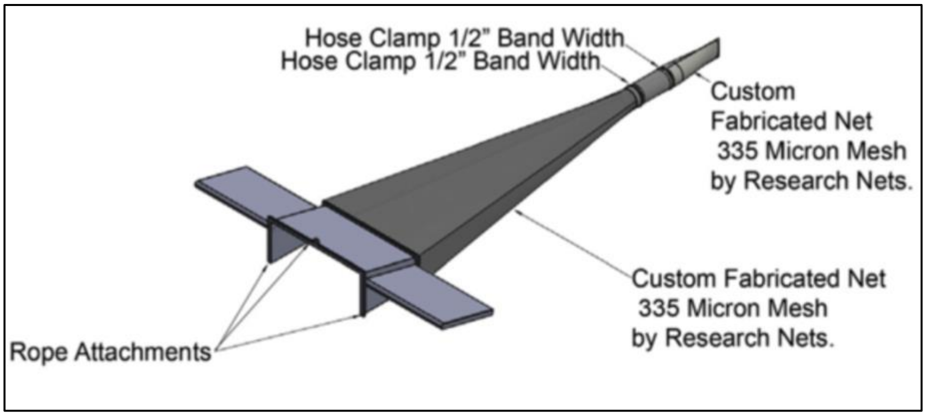

Figure 2: Schematic drawing of a manta trawl (Eriksen et al., 2018).

Figure 3: Flowmeter by General Oceanics, Inc.

2.2 Sampling Locations

Trawl locations within the Reserva de la Biosfera Caribe Mexicano during August of 2018 and 2019 were determined with the aim to sample near manta ray feeding sites, but far enough away as to not endanger any animals with the trawl net. During each field expedition the team began the trawl by travelling 0.5-1km away from each feeding site until no animals were observed. Trawl locations off the coast of Cozumel, within the Parque Nacional Marino Arrecifes de Cozumel, were determined due to a desire to sample throughout the entire reserve. Trawls will continue in this location until an adequate number of samples is collected to draw definitive conclusions about microplastic contamination in this area.

2.3. Isolation and Extraction of Microplastics

Following collection, each sample was rinsed thoroughly through a stacked arrangement of three stainless steel mesh sieves (2 mm, 1 mm, 0.3 mm). All solids less than 2 mm and greater than 0.3mm were retained and kept in a drying oven at 70℃ until dry. Then, all organic material was chemically dissolved using Wet Peroxide Oxidation. Finally, microplastics were extracted by filtration through a 0.3 mm sieve. They were then confirmed under a dissecting microscope and total counts were taken.

3. Results and Discussion

The samples collected contained three types of microplastic particles. They were 'fragments', 'fibers' and 'foam'. Fragments are secondary microplastics that have fragmented from their larger primary source, as opposed to primary microplastics that are manufactured as microbeads. They can be identified by their irregular shape (Hidalgo-Ruz et al., 2012). Fibers are defined as long, filamentous particles that are equally thick throughout their entire length, as with clothing fibers, fishing line or synthetic ropes (Qui et al., 2016). Foam particles are secondary particles broken down from larger styrofoam pieces.

For the majority of samples, fragments were the most abundant particles. This was true for all, except five samples (numbers 10, 11, 12, 18, and 19), whose most abundant particle type was fibers. For the remaining samples, fibers were the second most abundant particle type. Finally, foam particles were the least abundant particle type, only present in samples 19 and 20. These results can be seen in Figure 4.

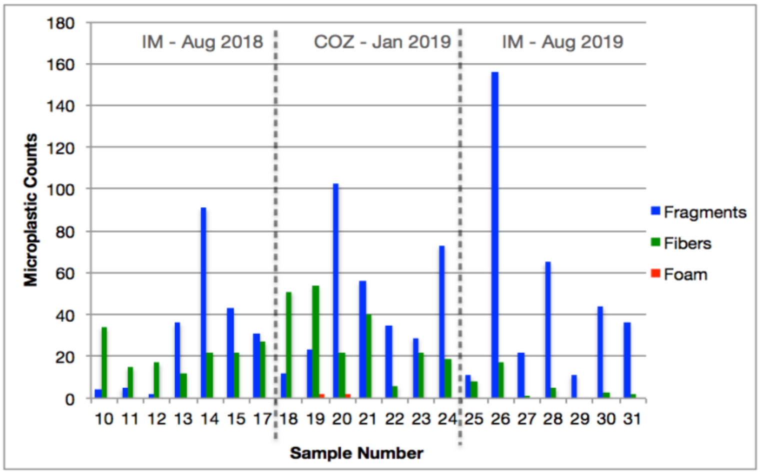

Figure 4: Total microplastic counts by particle type (fragment, fiber, and foam)
Samples 10 through 17 and 25 through 31 were collected from the Reserva de la Biosfera Caribe Mexicano near Isla Mujeres (IM), while samples 18 through 24 were collected within the Parque Nacional Marino Arrecifes de Cozumel off the western coast of Cozumel (COZ).

Microplastic presence was also considered by concentration of total microplastic particles per cubic meter. This calculation could be made for samples 19 through 31, due to the presence of a flowmeter. The concentrations in Cozumel ranged from 0.140 to 0.488 pp/m3, with a mean concentration of 0.307 +/- 0.12 (mean +/- SD). The Concentrations near Isla Mujeres ranged from 0.053 to 0.999 pp/m3, with a mean concentration of 0.311 +/- 0.32 (mean +/- SD). These results can be seen in Figures 5 and 6.

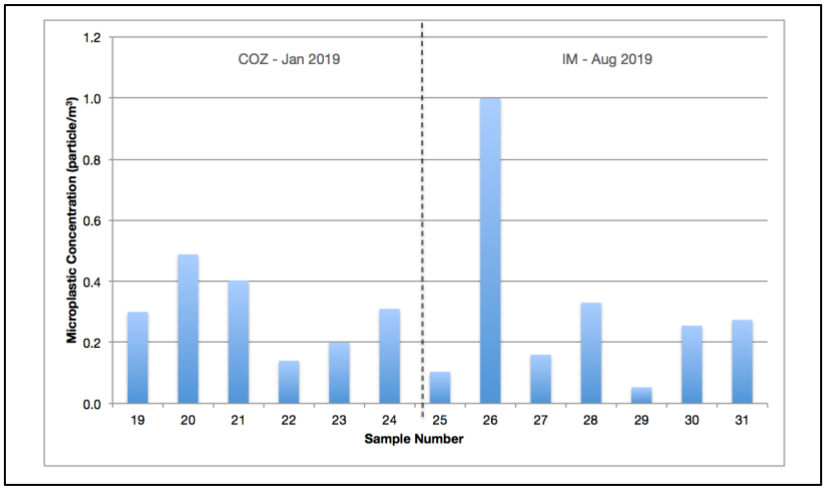

Figure 5: Concentration of microplastic particles per cubic meter
Samples 19 through 24 were collected within the Parque Nacional Marino Arrecifes de Cozumel off the western coast of Cozumel (COZ), while samples 25 through 31 were collected from the Reserva de la Biosfera Caribe Mexicano near Isla Mujeres (IM).

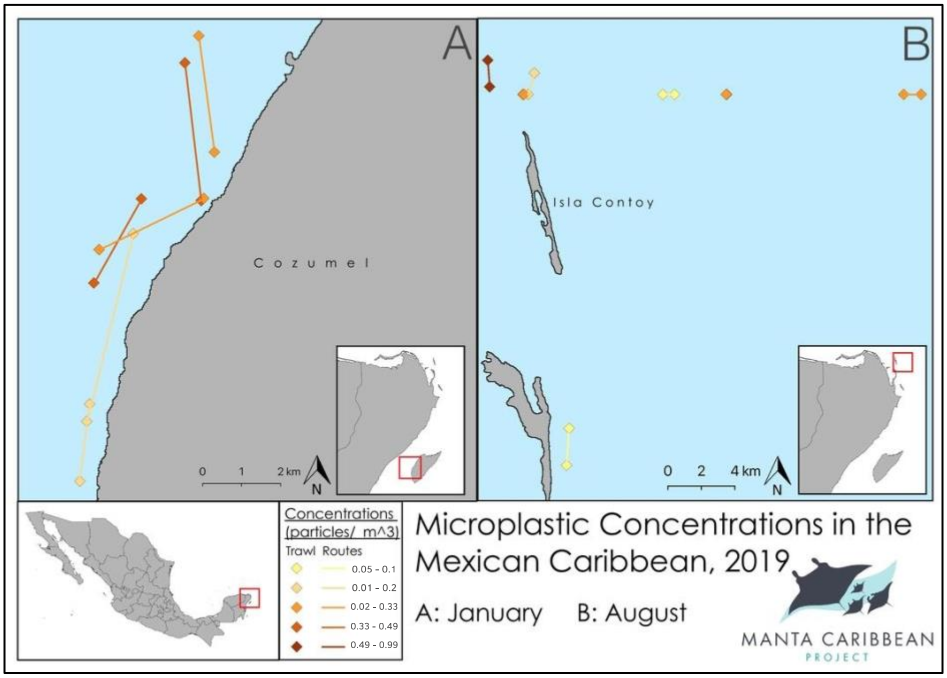

Figure 6: Microplastic concentrations in the Mexican Caribbean, 2019
Map A depicts the concentrations within the Parque Nacional Marino Arrecifes de Cozumel and Map B depicts the concentrations within the Reserva de la Biosfera Caribe Mexicano

As of this point in our project, the sample size is still too small to draw any statistically significant conclusions about microplastic concentrations in the Mexican Caribbean, though so far our data indicate that mean concentrations are similar between both study areas. This project, however, is a continued effort through 2020, and with more data we will be able to draw more concrete conclusions about the state of microplastic pollution in the Mexican Caribbean. Manta Mexico Caribe is dedicated to increasing our knowledge of environmental conditions, whether natural or anthropogenic, so we can better protect manta rays and all marine life. In the future, we hope to replicate our efforts throughout the region and continue documenting microplastic contamination in the Mexican Caribbean.

4. Acknowledgments

We would like to thank 5 Gyres Institute for allowing the use of their manta trawl, the Universidad de Quintana Roo and Dr. Luis Mejia for allowing the use of his laboratory and the Comisión Nacional de Áreas Naturales Protegidas (CONANP) for granting the permits needed and offering general support for this research.

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