



MEXICAN CARIBBEAN MANTA RAY PROJECT | MANTA TRUST

2017 Marine Debris Report

MANTA PROJECT

August 2017

1. INTRODUCTION

Over the past four decades the accumulation of marine debris and microplastics have become more apparent (Wright et al. 2013) and we are now in what is being described as the 'plastic age' (Cózar et al. 2014). The first report of plastic litter in the oceans was in the early 1970s (Andrady 2011), and now the presence of plastics can be found in all major oceans (Thiel et al. 2013). Plastics, like disposable single-use plastics have become the preferred material to other conventional materials such as, glass, metal and paper (Andrady 2011), for cost effectiveness. Marine debris is defined as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment (Gregory & Andrady 2003). Microplastics have been defined as plastics less than 5mm in size by the National Oceanic and Atmospheric Administration (NOAA) (Wright et al. 2013), any particles larger than 5mm in size, can be referred to as a 'mesoplastic' or macroplastic (Gregory & Andrady 2003). The origins of microplastics might be attributed directly or indirectly. For example, introduction of microplastics can be directly from land into the oceans via runoff of exfoliants in cosmetic formulations, or indirectly by weathering breakdown of meso- and macroplastics debris respectively (Andrady 2011). Anthropogenic activities such as tourism, agriculture, aquaculture, fisheries and industry all contribute to marine debris (Thiel et al. 2013). Some marine debris will quickly sink and accumulate in areas they first enter the sea, whereas other will float at the sea surface and may be transported away from its original sources (Thiel et al. 2013).

The size, density, abundance, and colour affect the bioavailability of microplastics (Wright et al. 2013). The factors which influence the physical impacts of microplastics are accumulation, translocation, shape, egestion, population-level effects and transfers to the food chain (Wright et al. 2013). Microplastics can be ingested by low trophic suspension, filter and deposit feeders, detritivores and planktivores (Wright et al. 2013). Microplastics affecting the low trophic level which brings risks to higher trophic level organisms once introduced to the food web (Wright et al. 2013). Furthermore, microplastics may not only affect species at the organism-level but have the capacity to modify population structure (Wright et al. 2013). Ingestion of lethal and sub lethal plastics (Schuyler et al. 2014) by birds and turtles has been widely reported (Andrady 2011).

It has been found that a significant relationship between microplastics abundance and human population-density was found (Wright et al. 2013). So, in coastal areas with seasonal tourism, it would be suggested that there will be an increase in anthropogenic marine debris. Reducing anthropogenic marine debris requires management on a global level (Schuyler et al. 2014). The 5 Gyres institute's

mission is to invest in action against plastic pollution through science. The institute provides trawl equipment and specific protocols for citizen scientists to collect data to update their Global Estimate of Marine Plastic Pollution. The aims of the study are to have a better understanding of the distribution of marine debris, including microplastics and the extent in the marine area of Mexico Caribbean. The surveys completed should highlight local worker's views on marine debris, how often they encounter waste at sea and how marine debris affects themselves as individuals, tourists and other marine organisms.

2. METHODS

2.1 MANTA TRAWL

Study Site

The study areas lie outside of, or near the pre-existing Isla Contoy Reserve and Whale Shark Biosphere Reserve; both are now covered under the newly-appointed Mexican Caribbean Biosphere Reserve (CONANP, 2016). The rapidly growing tourism industry of Mexico's Yucatán coast, in particular, around Cancun and Isla Mujeres, make these study areas of marine debris and microplastic of particular interest (Venegas et al., 2011). This study site experiences seasonal variation in currents and wind (Thiel et al. 2013).

Methods and materials

In association with the 5GYRES Trawlshare program, a Manta Trawl device was deployed opportunistically for one 30-minute interval during each field trip (Figure 1), whenever possible, with an aim to reveal information about the microplastic levels around the Yucatán Peninsula. This was done according to the manufacturer's instructions by towing the device behind the boat whilst moving at a speed of 3 knots maximum. Throughout the months of July and August nine successful trawls were conducted, and one more was conducted but was inflicted with a methodical error, therefore not included in any further analysis (Figure 2).



Figure 1. Manta trawl in action

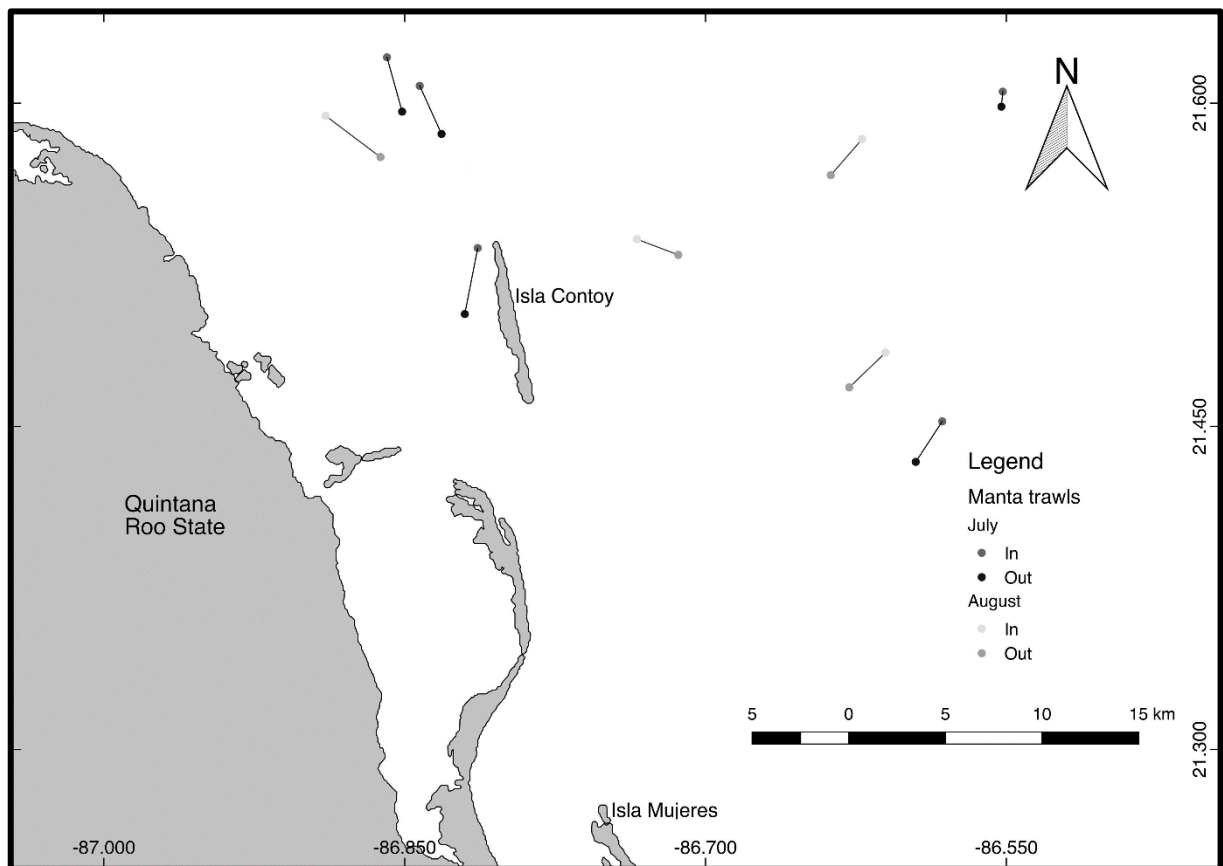


Figure 2. Location of nine manta trawls conducted in the study area from the months of July and August 2017

Upon examination of the collected sample, any sargassum in the sample and the net were rinsed and suspended in water for inspection. Any plastic pieces were categorised as either mesoplastics/macropastics (>5mm) or microplastics (<5mm), using the paper provided by 5GYRES (Figure 3). The plastics were then further categorised as one of the following: fragment, film, foam, pellet or line. The complete samples collected were preserved in containers to be further inspected under microscope in the laboratory. Findings are also anticipated to contribute to a global estimation of marine plastic pollution.



Figure 3. 5GYRES Manta trawl measurement grid used to categorize the size of the plastics found

Data Analysis

The data was analysed with description and presented in graphical form using Microsoft Excel with reference to the different sea states (Beaufort Scale) was observed whilst on the boat.

2.2 MARINE DEBRIS SURVEY

Study Site

The surveys were collected at tourist centres and dive shops situated on Isla Mujeres and the crew members of the boats that took our team out for our field trips.

Methods and Materials

A marine debris survey was designed to collect anecdotal knowledge regarding the marine debris situation from members of the local community employed by the tourism industry. Questions were designed to obtain local knowledge of marine debris levels in Mexico's Yucatán coastal region and any observed impact on the local charismatic marine species.

Data Analysis

The received responses were then categorised to be more concise categories. The question of how often the participant went out on the boat, it was assumed each time was on a separate day. The data was presented in graphical form using Microsoft Excel and in tables to display the number of mentions specific answers got.

3. RESULTS

3.1 MANTA TRAWL

There were nine successful attempts of the 'manta trawl' from July and August, where plastic and other debris were found in all trawls except for one (date: 19/07/2017). Aside from the specific plastics mentioned in the protocol the other debris found were fabric and paint. Plastic in fragment form was found more often than any other kind of plastic (Figure 4). There was a larger total count of microplastic (plastic under 5mm in size) than mesoplastic (plastic over 5mm in size) (Figure 5). From the total microplastic pieces (<5mm) collected, 61% was found in Blue water, 32% was found in Green water and 7% in Isla Contoy. Of the nine efforts of trawling, three different sea states (using the Beaufort Scale) were observed: (1) light air, (2) light breeze, (3) gentle breeze. The sample that was conducted in a sea state 3 had no plastic or other debris in it (Figure 6).

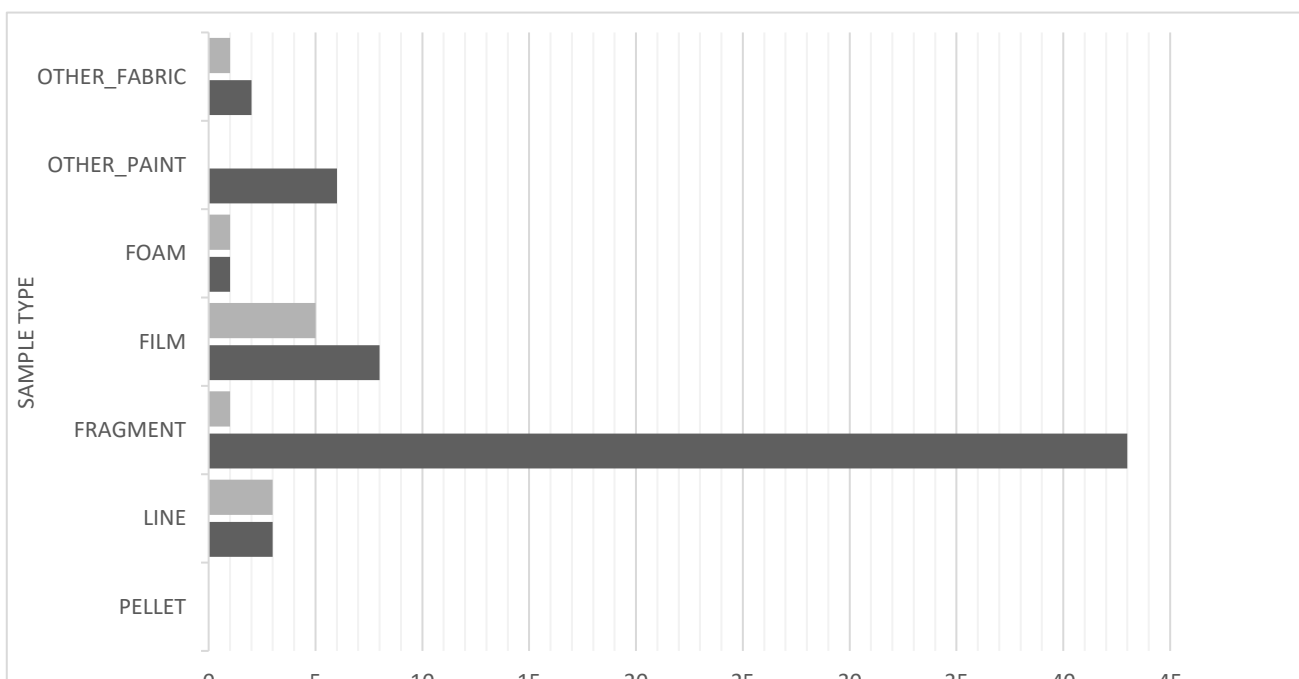


Figure 4. Total count of the quantity, type and size of debris found in the samples from the nine 'manta trawls' conducted in the study area

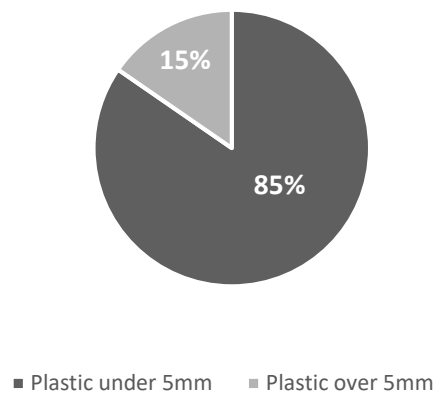


Figure 5. Proportion of pieces of microplastic (plastic under 5mm in size) and mesoplastic (plastic over 5mm in size) found in the samples of the nine 'manta trawls'

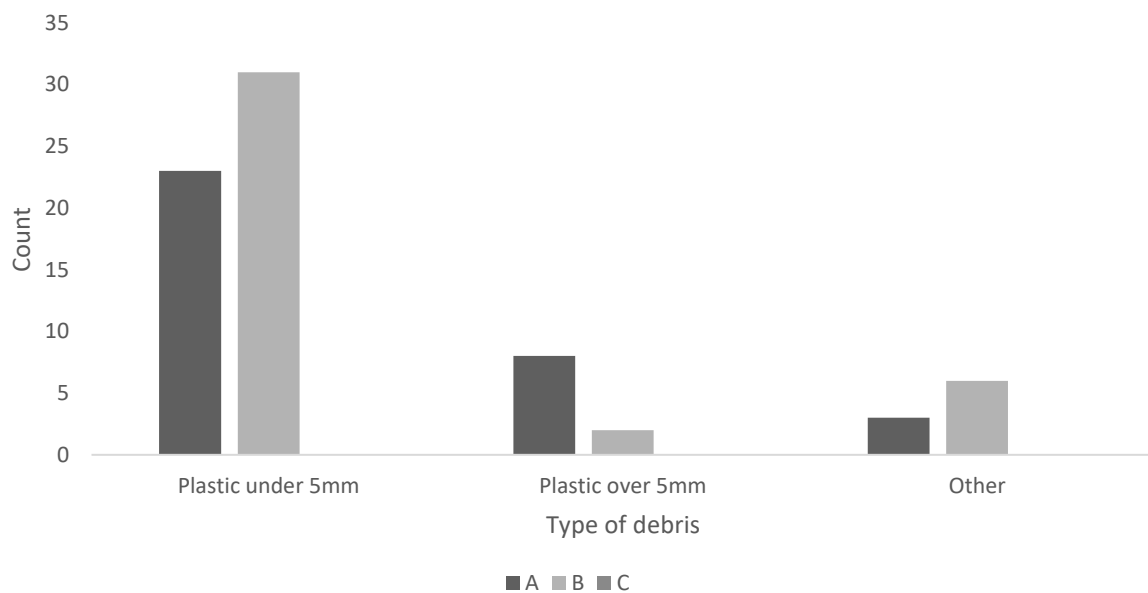


Figure 6. Total count of pieces of microplastic (plastic under 5mm in size), mesoplastic (plastic over 5mm in size), and other debris in regard to the sea state. Where the letters represent the following: A - sea state 1, light air; B - sea state 2, light breeze

3.2 MARINE DEBRIS SURVEY

A total of 30 surveys were completed opportunistically throughout the duration of the study period from a variety of occupational backgrounds who went out to sea. Just two people who got asked didn't want to cooperate and rejected the questions. All the participants were living on Isla Mujeres, yet, many of the participants were not originally from Isla Mujeres. The participants were one of four

occupations: administration, professional diver, crew member (including captain, tour guide and mechanic), or operator. The time the participants have worked in this study area ranged from three weeks to 43 years.

Most of the participants (93.3%) went out to the ocean more than three times a week. The survey showed that every participant saw marine debris either every boat trip, often or sometimes (Figure 7). The general opinion from the participants was that the amount marine debris was either the same or more from when the participant first started working (Figure 8). Note that, the participant who had only been on Isla Mujeres for three weeks was disregarded from this question. Thirteen of the participants expressed their reasons for their answer on whether there is more, or less marine debris since they started working (Table 1).



Figure 7. Answers to the question: 'How often trash is observed per boat trip from the participants?'

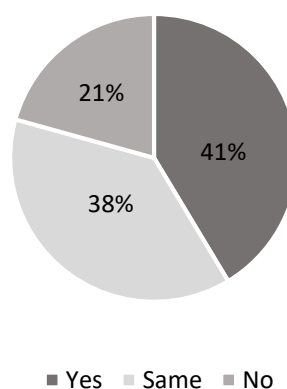


Figure 8. Proportion of answers to the question: 'Has the amount of marine debris observed on boat trips increased since first working in this study area?'

Table 1. Answers, reasons and number of mentions to the question: 'Is there more trash in the sea from when first started working on the local area and why?'

Answers	Numbers of mentions
Yes: Not enough information given to tourists	1
Yes: Less stewardship of the ocean	1
Yes: Increase in tourists visiting	7
Same: Expects there to be more trash	1
No: More awareness to public	1
No: More stewardship of the ocean	2

The areas where the most marine trash has been observed was Blue Water and near Isla Mujeres (Table 2), although two participants specifically expressed all areas were the same, one of which believed the current removed the trash from the Yucatán Peninsula. Many types of marine litter were observed in the ocean with eight different types mentioned in the surveys conducted (Table 3). The most common types of marine trash found on boat trips was plastic bottles (Table 4). Of the participants who completed the survey 83.3% said they would pick up any marine litter they see in the ocean. Only five participants believed that the marine litter did not affect them, the rest expressed negative views about how the litter affects them with the danger to marine life being mentioned the most (Table 5).

Table 2. Answers and number of mentions to the question: 'What area had the most trash seen from boat trips, from the participants who completed the marine debris survey?'

Answers	Number of mentions
Blue Water	9
Green Water	3
Near Isla Mujeres	14
Near Isla Contoy	2
All the same	2

Table 3. Answers and the number of mentions to the question: ‘What kinds of trash are observed on boat trips, from the participants who complete the marine debris survey?’

Answers	Number of mentions
Aluminium cans	6
Fishing equipment	6
Kitchenware and food/drink packaging	10
Lost diving equipment and clothes	5
Miscellaneous plastics	2
Other non-plastic debris	11
Plastic bags	26
Plastic bottles	28

Table 4. Answers and number of mentions to the question: ‘What was the most common kind of trash observed on boat trips, from the participants who completed the marine debris survey?’

Answers	Number of mentions
Can	3
Plastic cup	1
Glass bottle	1
Plastic bag	9
Plastic bottle	21
Styrofoam	1
Snorkelling gear	1

Table 5. Answers and numbers of mentions to the question: ‘How does the trash affect you, from the participants who completed the marine debris survey?’

Answers	Number of mentions
Aesthetically displeasing	3
Negative views from tourists	9
Bad image for the island	5
Danger to marine life	13
Annoyance/Mechanical Issues	5

Of the 30 participants who completed the survey 22 had seen marine organisms affected by marine litter, with a wide range of organisms being affected (Table 6). Participants who answered that they had seen marine organisms affected, 20 of the 22 gave a statement regarding how the species were affected by marine debris. Of the 40% that expressed concern that marine organisms were negatively affected by fishing gear and 40% mentioned species were entangled in marine debris. In addition 30% had observed that marine organisms were feeding on plastic (Table 7). Only three participants stated

that they had previously removed debris from animals and seven participants pledged to help marine organisms affected by marine debris, in the future.

Table 6. Answers and number of mentions to the question: ‘What species were affected to marine litter?’, to the participants who answered yes to the question: ‘Have you seen any animals affected negatively by trash?’

Answers	Number of mentions
Birds	3
Corals	3
Dolphins	1
Fish	4
Seagrasses	1
Turtles	13
Whale sharks	2

Table 7. Answers and number of mentions to the question: ‘How the marine species were affected by the marine debris?’

Answers	Number of mentions
Feeding on plastic	6
Organisms entangled in fishing gear	8
Organisms entangled in plastic	8
Habitat use	1

4. DISCUSSION

4.1 OVERVIEW

From our study on marine debris and microplastics in the marine area around Isla Mujeres it has been found that marine litter is very much prominent in the marine environment. Plastic material is the most common debris found in the marine environment. From the trawls, there was a larger total count microplastics than of mesoplastics, although the total counts were still smaller than expected. With the general view from the surveys that the presence of marine debris is increasing, it is understandable why many of the participants are interested and are aware of the implications of increased marine litter for many reasons. For example, danger to marine life and more litter may cause Isla Mujeres to have a bad image, therefore possibilities of less tourism. The marine species that were observed to be most affected by marine debris were turtles.

One of the main origins for marine debris is tourism (Thiel et al. 2013), which is a big economic value for Isla Mujeres, as the island was developed for tourism 45 years ago (Weinbaum 1997). However, as

the trawl and surveys were conducted only during the tourist season there was no comparison to see if there is a significant relationship with increased tourism and the extent of marine debris. From the marine debris survey, the most trash was found near Isla Mujeres and then Blue Water, this could be due to more tourism operations being conducted in the “Blue water” area, than the other areas. The low count of microplastics could be due to a number of reasons. Firstly, there are seasonal variations in current and wind patterns in the Yucatán Peninsula (Thiel et al. 2013). Secondly, plastic/marine debris can sink and accumulates in the areas first entered by the sea (Thiel et al. 2013), so could be below sea level. Thirdly, some microplastic may have been missed from the sample due to no access to the laboratory. Green turtles (*Chelonia mydas*) are affected by marine debris as they mistake many types of litter as food, or become entangled in the debris (Schuyler et al. 2014). This can be of greater concern during egg laying season which coincides with the tourism season (Mackay & Spencer, 2017).

The study brought about some limitations, which should be considered and improved for future studies. The manta trawls were conducted at random locations on every boat trip, and no direction of current was noted. This detail may have enabled an indication of where the plastic was, or areas to conduct the trawl. In addition it is important to make sure that the boat speed is under 3 Knots to get all the microplastic and macroplastic collected. If the boat speed is over 3 Knots the samples collected could be deemed as unreliable. In the case of this study this may not have been adhered to. The collected samples, from the manta trawl, have not yet been further analysed under a microscope and there is a possibility the total count of microplastics could be much larger. Categorizing the plastics into pellet, line, fragment, film, and foam was subjected by the analyser. The participants of the marine debris survey were only working in the tourism industry and the future sample size should include more participants and also more fishermen. There was a vast range of answers given for many of the questions, and some answers were unclear. For example, five times could represent, five days a week or five times in the week (ranging over less than five days). Some of the questions could have been designed to enable more structured answers, in turn, aiding analysis. It is suggested that amendments need to be made in future.

In the future, surveys could reach a larger audience and further expand upon the participants actual opinions and motivations towards marine debris and the use of plastic in general. This study can be used for more education and awareness on sustainable living for the locals, children and tourists.

4.2 PARTICIPATION WITH 5GYRES MANTA TRAWL

Participation in this study was really interesting, particularly due to how much the media is now highlighting the problem with plastics. Finding out about the amount of microplastic, mesoplastic, and macroplastic in our case study area the Mexico Caribbean. Participation in this process has allowed all of the Mexico Caribbean Manta Project team to gain new skills and experiences from following the protocol, collecting samples, analysing the samples and recording our findings in a report. However, the total count of microplastic and mesoplastic in our samples was small, but on a global scale we are contributing to a global estimation of marine plastic pollution. It is encouraging that groups of individuals globally want to be part of the change in marine plastics around the world's oceans. More awareness is indicated and others should begin to think about how to live more sustainably, and not use disposable one-use plastics.

5. REFERENCES

- Andrady, A.L., 2011. Microplastics in the marine environment. *Marine pollution bulletin*, 62(8), pp.1596-1605.
- Cózar, A., Echevarría, F., González-Gordillo, J.I., Irigoien, X., Úbeda, B., Hernández-León, S., Palma, Á.T., Navarro, S., García-de-Lomas, J., Ruiz, A. and Fernández-de-Puelles, M.L., 2014. Plastic debris in the open ocean. *Proceedings of the National Academy of Sciences*, 111(28), pp.10239-10244.
- Gregory, M.R. and Andrady, A.L., 2003. Plastics in the marine environment. *Plastics and the Environment*, 379, pp.389-90.
- Mackay, E.A. and Spencer, A., 2017. The future of Caribbean tourism: competition and climate change implications. *Worldwide Hospitality and Tourism Themes*, 9(1), pp.44-59.
- Schuyler, Q., Hardesty, B.D., Wilcox, C. and Townsend, K., 2014. Global analysis of anthropogenic debris ingestion by sea turtles. *Conservation biology*, 28(1), pp.129-139.
- Thiel, M., Hinojosa, I.A., Miranda, L., Pantoja, J.F., Rivadeneira, M.M. and Vásquez, N., 2013. Anthropogenic marine debris in the coastal environment: A multi-year comparison between coastal waters and local shores. *Marine pollution bulletin*, 71(1), pp.307-316.
- Weinbaum, B., 1997. Disney-Mediated Images Emerging in Cross-Cultural Expression on Isla Mujeres, Mexico. *The Journal of American Culture*, 20(2), pp.19-29.
- Wright, S.L., Thompson, R.C. and Galloway, T.S., 2013. The physical impacts of microplastics on marine organisms: a review. *Environmental Pollution*, 178, pp.483-492.

6. APPENDIX – SURVEYS (ENGLISH AND SPANISH VERSIONS)

Project for Conservation, Education and Research of Mantarays in the Mexican Caribbean, Marine Debris Survey

- 1) Date: ____/____/2017
- 2) Location: _____
- 3) Survey number: _____
- 4) Interviewer _____
- 5) Interviewee: _____
- 6) Location where the interviewee lives: _____
- 7)
 - a) Sex M F b) Age c) Birth Place d) Occupation e) Education
- 8) How long have you been working on the ocean in this area?
- 9) How many times do you go out on the ocean each week?
- 10) How often do you see trash?
 - a) Every Trip b) Often c) Never
- 11) Do you see more trash these days compared to when you first started working in this area? **Y / N**
- 12) What kinds of trash do you see?
 - a) Plastic Bottles b) Plastic Bags c) Food Wrappers d) Cigarette butts e) Drinking Straws
 - f) Clothing g) Fishing Line h) Fishing Nets i) Styrofoam j) Other
- 13) What types of trash do you see the most?
- 14) In what areas do you see the most trash?
 - a) Near Isla Mujeres b) Near Isla Contoy c) Green Water d) Blue Water
- 15) Do you collect trash from the ocean? **Y / N**
- 16) How does ocean trash affect you?
- 17) Have you seen any animals affected by ocean trash? **Y / N**
- 18) If yes, what species?
 - a) Birds b) Marine Mammals c) Fish d) Shark e) Rays

Comments:

Proyecto de Conservación, Educación y investigación de Mantarrayas en el Caribe Mexico, Estudio de basura en el ecosistema marino

1) Fecha: ____/____/2017

2) Ubicación: _____

3) Número de la encuesta: _____

4) Entrevistador : _____

5) Entrevistado: _____

6) Lugar donde vive el entrevistado: _____

7)

a) Sexo H M

b) años

c) Lugar de nacimiento

d) Ocupación

e) Educación

8) ¿Cuánto tiempo ha estado trabajando en el mar en esta área?

9) ¿Cuántas veces sale al mar cada semana?

10) ¿Con qué frecuencia observa basura?

a) Cada viaje

b) A menudo

c) Nunca

11) ¿Ves más basura en estos días en comparación con la primera vez que comenzó a trabajar en esta área? **S / N**

12) ¿Qué tipo de basura observa?

a) Botellas de plástico

b) Bolsas de plástico

c) Envolturas de Alimentos

d) Colillas de cigarro

e) Popote para beber

f) Ropas

g) Sedal

h) Redes de pesca

i) Espuma de poliestireno

j) Otra

13) ¿Qué tipos de basura observa más?

14) ¿En qué áreas ves más basura?

a) Cerca Isla Mujeres

b) Cerca Isla Contoy

c) Agua verde

d) Agua azul

15) ¿Recoge la basura del mar? **S / N**

16) ¿Cómo le afecta la basura del mar?

17) ¿Has visto algún animal afectado por la basura del mar? **S / N**

18) En caso afirmativo, ¿qué especies?

a) Aves

b) Mamíferos marinos

c) Pescados

d) Tiburones

e) Rayos

Comentarios:
