Activity report on the project "*Microplastic concentration in sediments and waters of Matagorda and San Antonio Bays: Initial assessment and mitigation plans*"

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Period: January 1st 2023 to March 31th 2023 – Continuation of laboratory microplastics separation, open new cores, conduct FTIR analyses at Marine Science Institute and collect new field samples.

During the quarter of January to March 2023, we continued the work on separation of microplastics from sediments by opening more sediment cores collected. We started to analyze microplastics in plankton tow samples collected in 2022. We also have been in the field and collected additional samples along the shoreline areas in the Lavaca Bay, Palacios Bay, and Colorado Delta.

During January 2023 we conducted a fieldtrip to collect new samples in the coastal area of Matagorda. The scope was to sample sediments and observe sedimentation processes (erosional/depositional, specific bedforms) along the shorelines of the Lavaca and Palacios bays as well as in the area adjacent to the Colorado River outlet (Figure 1).

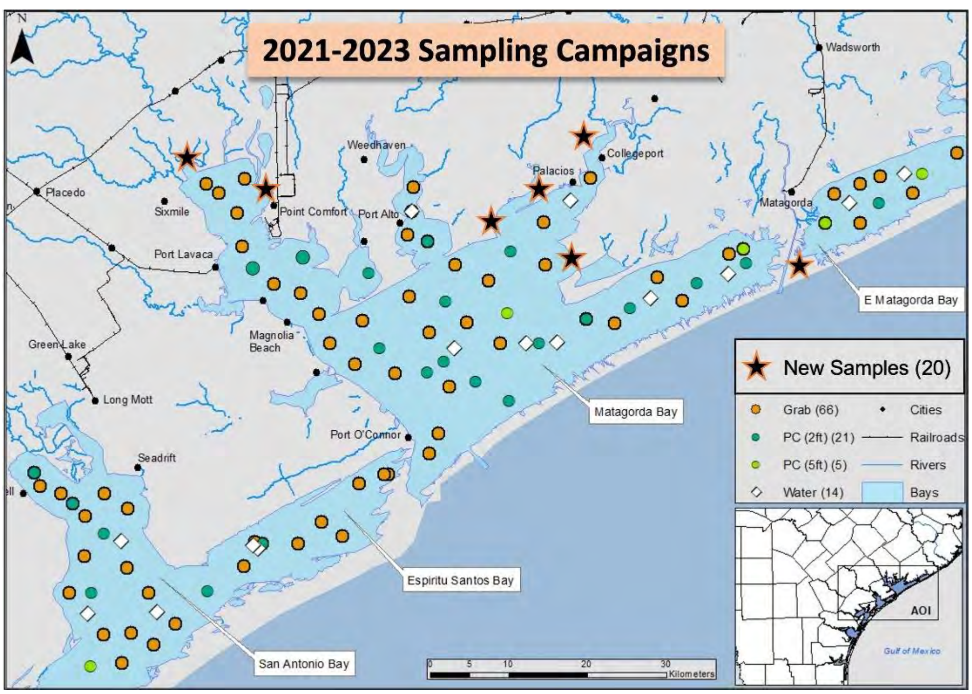

Figure 1. Map of 2021 sampling campaign with additional January 2023 samples. Locations of sediment grab, push core (PC) and water (Secchi disk, plankton tow, pH, salinity) samples have different symbol. The stars are just sediment grab samples in the proximity of the shoreline.

January 2023 trip focused on sampling sedimentary deposits below and above shoreline, where we observed the plastic (macro and micro-plastics) concentrated along storm lines (high water mark) (Figure 2). Visually microplastics concentrate and mix with organic material and wood debris and form cm thick accumulation locally.

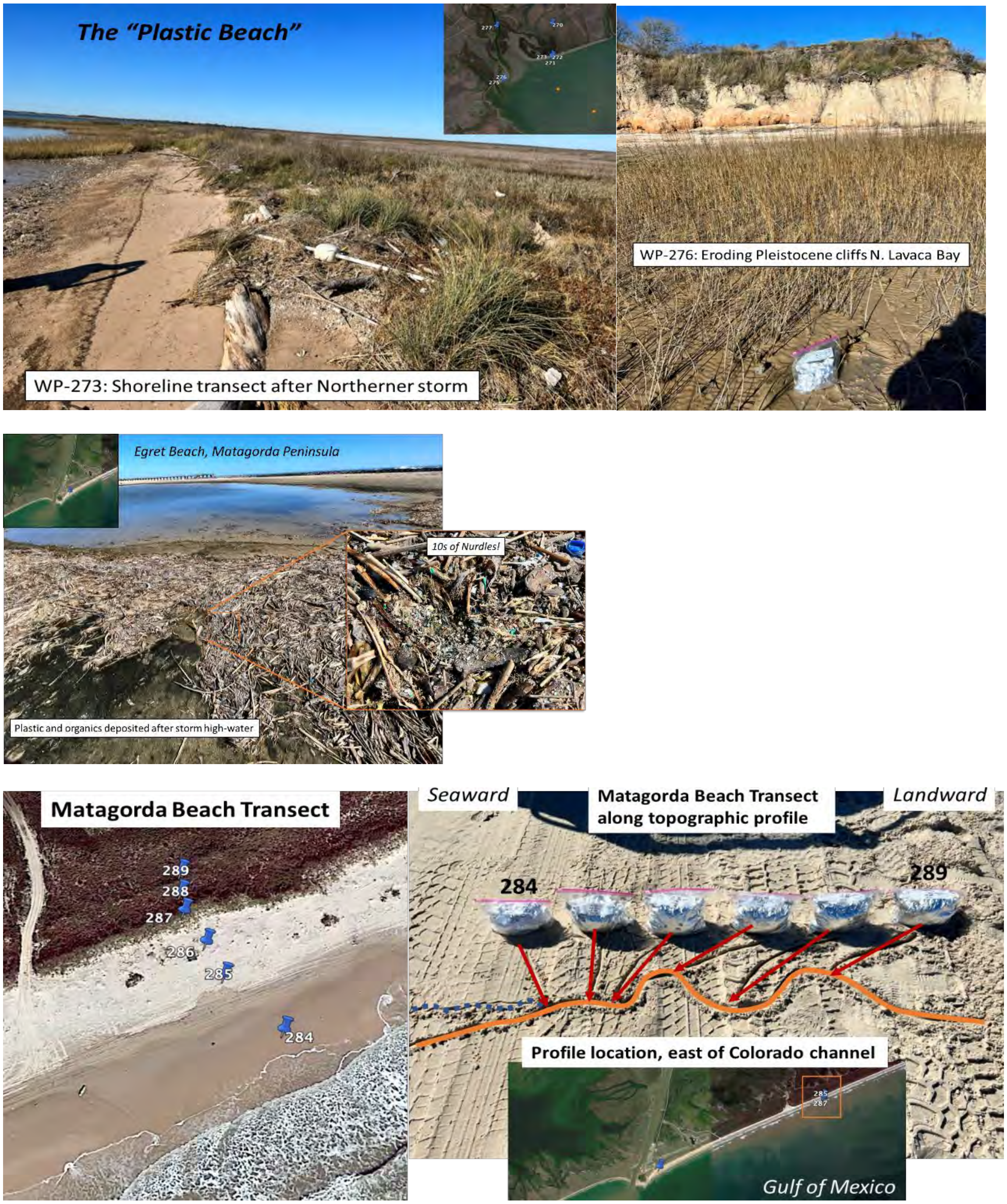

Figure 2. Photos of some sampling locations during January 2023 trip. Top 2 figures along northern shore of Lavaca Bay. Middle, near the mouth of the Colorado channel outlet. Bottom, the location of the samples along the Matagorda beach transect from foreshore to dunes area.

In the laboratory, more sediment cores have been opened and sampled (Figure 3). The results show homogenous sedimentation in some cores/areas while in some cores cm thick shell debris layers, or organic rich layers have been observed (Figures 4 and 5). The homogenous layers suggest relative constant sedimentation conditions or complete sediment mixing after deposition, while the shells and organic rich layers suggest changing conditions such as an event bed, or seasonal accumulation of organic material (Figures 4 and 5). In some sediment cores analyzed, low amounts of microplastics have been identified at the core bottom (with depth up to 1m, see figure 4).

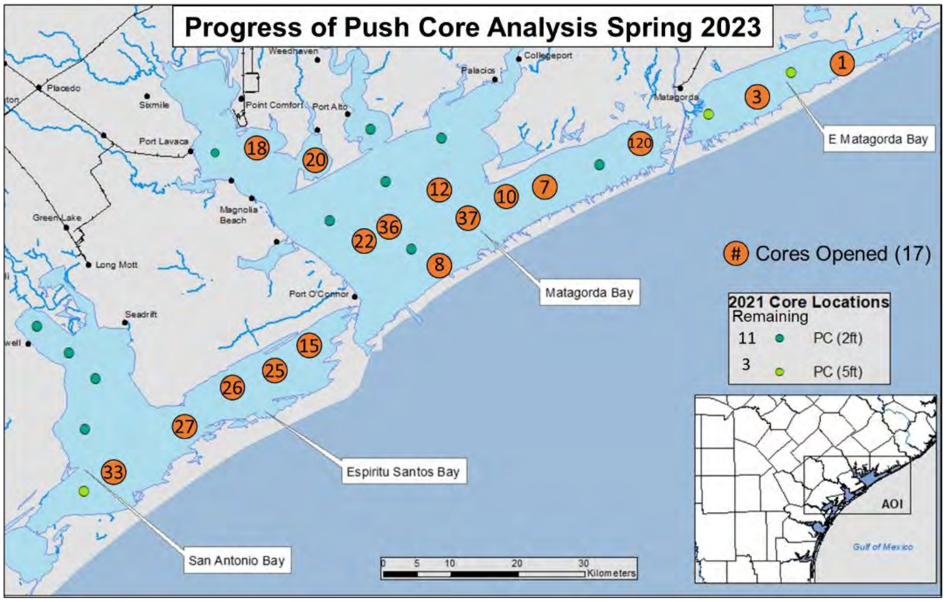

Figure 3. Location of the new opened cores during January-March 2023.

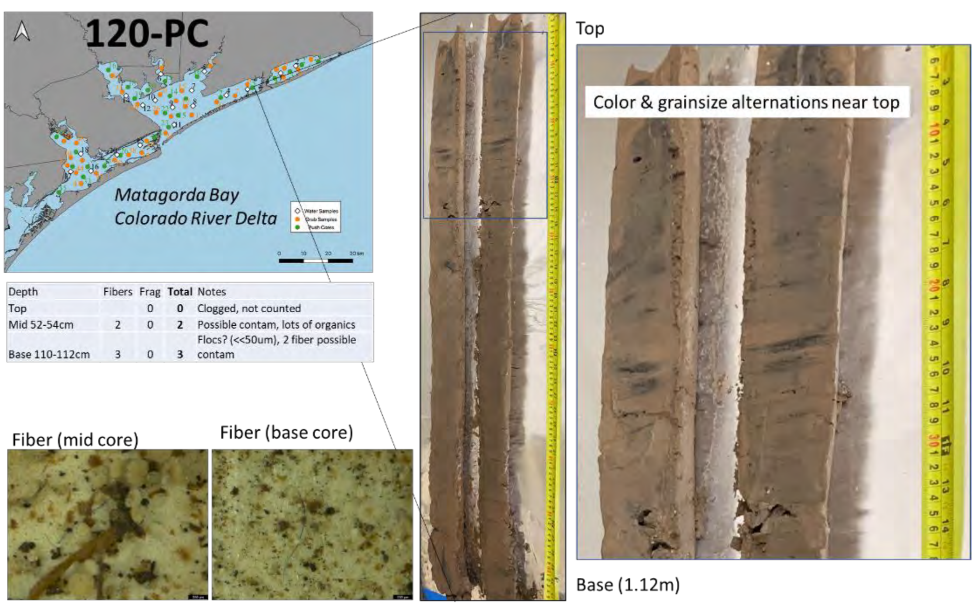

Figure 4. Pushcore site 120. Location, core sediment photos and microscope photos. Microplastics fibers observed at the 1m depth but repeated future analysis are needed to verify possible sample contamination.

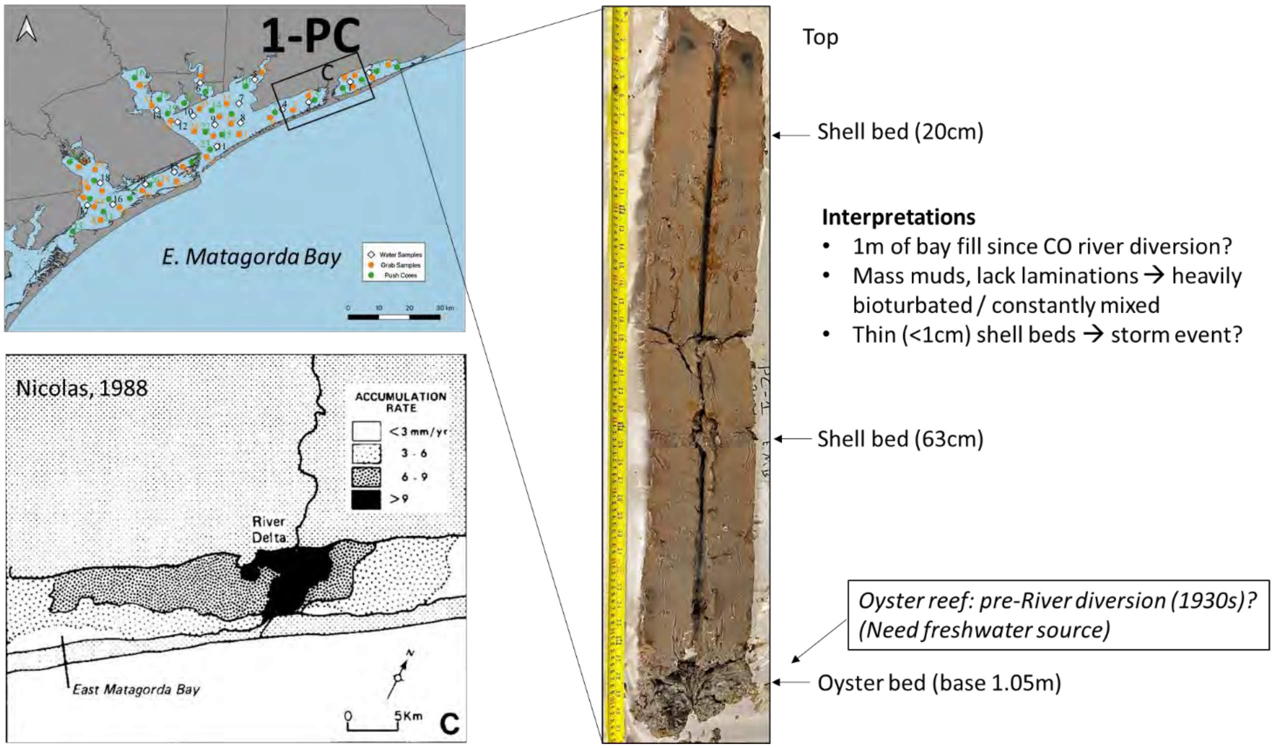

Figure 5. Pushcore site 1. Location and core sediment photo. The core is about 1 m thick. At the base it has an oyster shell bed. Multiple shell beds suggest the recording of possible storm events.

FTIR analyses on filtered material

Six filters were analyzed at Marine Science Institute using FTIR method. The samples were located in inner bay, central bay or closer to the coast in the tidal delta. The microplastics have been confirmed in samples from the inner bays (31G), center of the bay (21G) and in tidal delta (24G) (Figure 6).

The first important observation is that some of the microplastics have whitish to dark grey colors and not easily recognized colors (blue, green, red). That suggest some of the microplastics particles count have been underestimated if the color was grey and the shape was not angular or fibrous.

Another key observation is that measured signal is noisy but the microplastic was confirmed when the match score got higher than 600 (Figure 6).

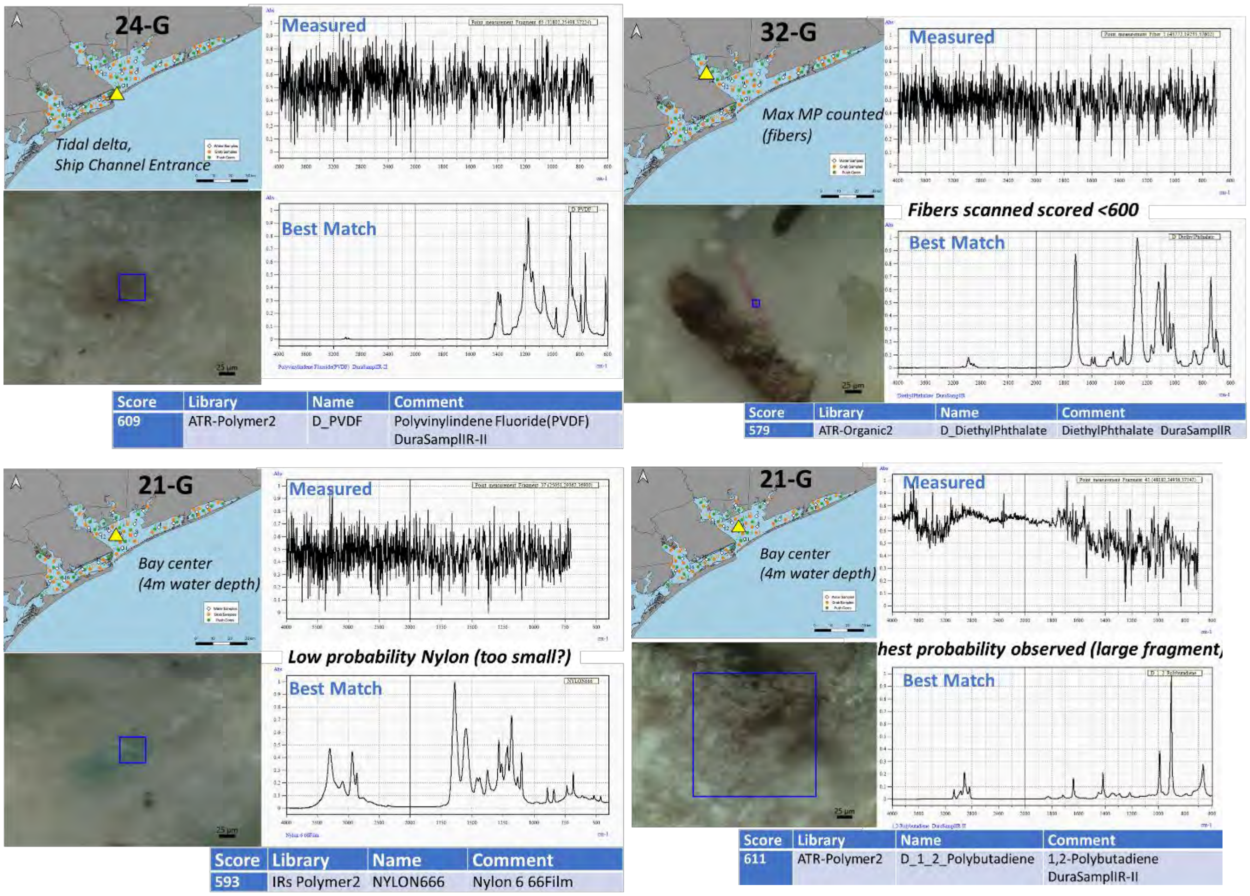

Figure 6. Examples of FTIR results on sediment grab samples 21, 24 and 32. Sample location, microscope photo, FTIR response and catalog spectra is shown for each sample.

Microplastics in FTIR analyses on suspended particles in the water column

Suspended particles were collected using a plankton tow (150 µm) at 11 sites in Fall 2021. Surface water samples (<1m) were collected at all sites, but at sites 3, 4, 6, 9, 18, and 20, deep water samples (2-3 m) were also collected. The particulate samples were filtered using an ASTM metal sieve with a pore size of 150 µm and dried in an oven for 2 days at 60°C. About 20-25 mL of 30% hydrogen peroxide were added to the dried residues and incubated in the oven for 2 days at 60°C. The samples were then filtered with MCE Green Grid membrane filters with a pore size of 5 µm. About 1 mL of 6 mol/L of HCl was added to the membrane filters to remove the possible carbonate on the filter. The membrane filters were left to dry for a day and then were analyzed using an AIM-9000 FTIR microscope.

Out of the 195 suspected microplastics observed at all sites, there were 169 fragments, 23 films, 2 spheres, and 1 fiber (Figure 7). Fragments were the most abundant, while fibers were the least. Sites 1, 2, 9, 17, 18, and 20 had replicates, so the average was calculated along with the standard deviation (Figure 8). Site 18 had the highest abundance of microplastics, while Sites 4,5,6, 9, and 10 had the lowest abundances.

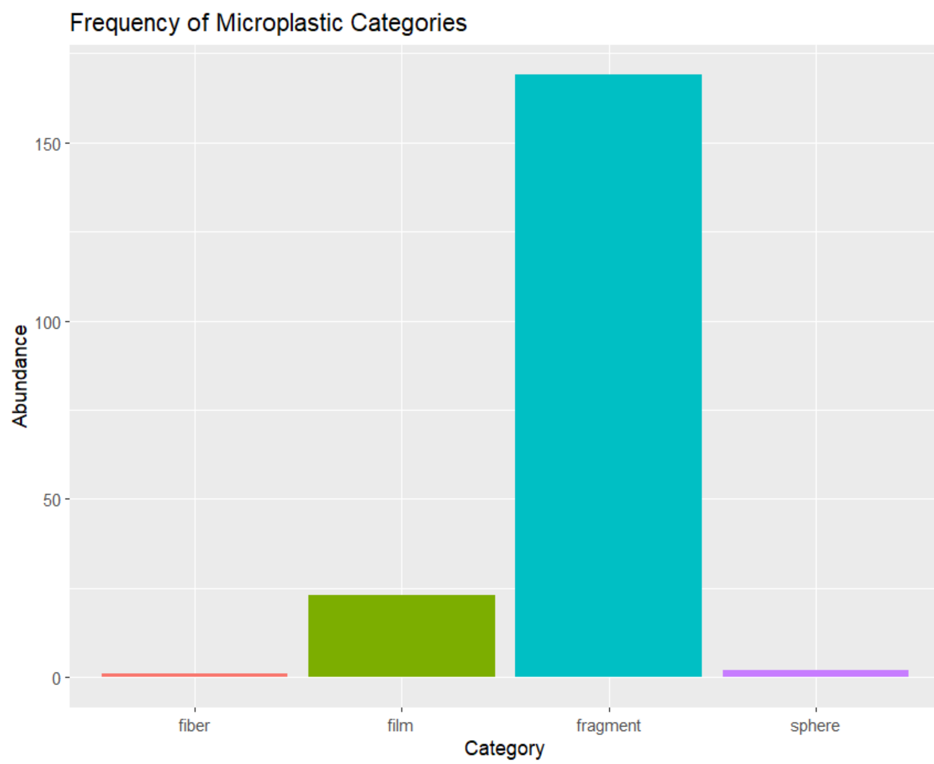

Figure 7: A bar graph that shows the abundance of each category of microplastic shape for the microplastics that were found in all samples. The categories shown are fragments, films, fibers, and spheres.

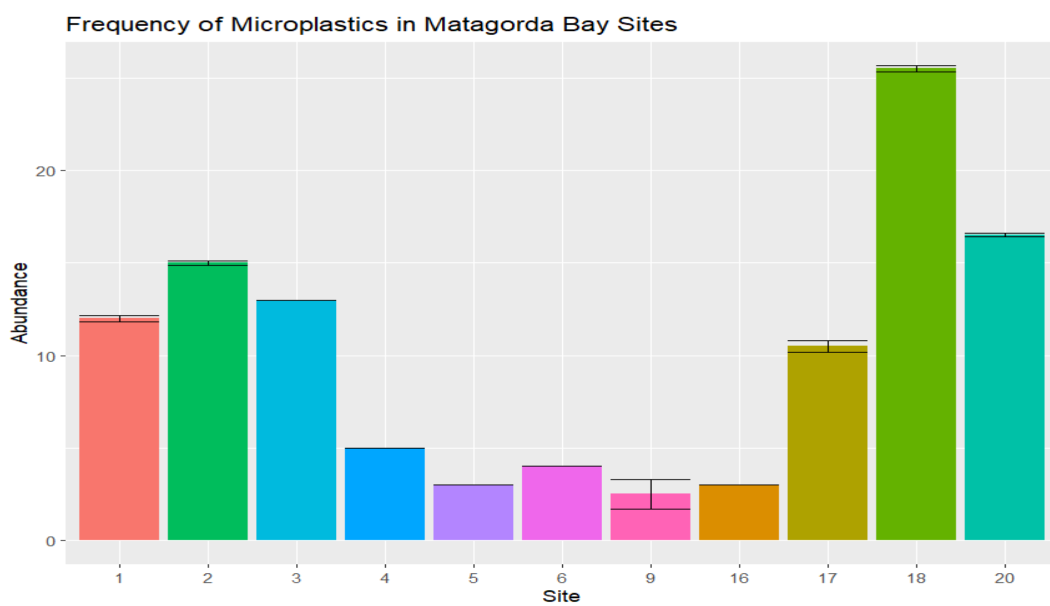

Figure 8: A bar graph that shows the abundance of microplastics for each of the eleven Matagorda Bay sites. The figure includes microplastics found in both surface and deep water samples. Standard error bars are included for sites that had replicates.

Microplastics were identified in all surface water samples (Figure 9). Microplastics were more abundant at Sites 2, 1, 3, 17, 19, and 20 than Sites 4, 5, 6, 9, and 16. Microplastics were also found in all the deep-water samples (Figure 10), but Site 3 was not included since the analysis of samples from this site is still on going. Site 9 had the highest concentration of microplastics for deep water samples. Sites 1, 3, 17, and 20 have intermediate concentrations of microplastics. Sites 4 and 6 had the lowest concentrations of microplastics for deep water samples.

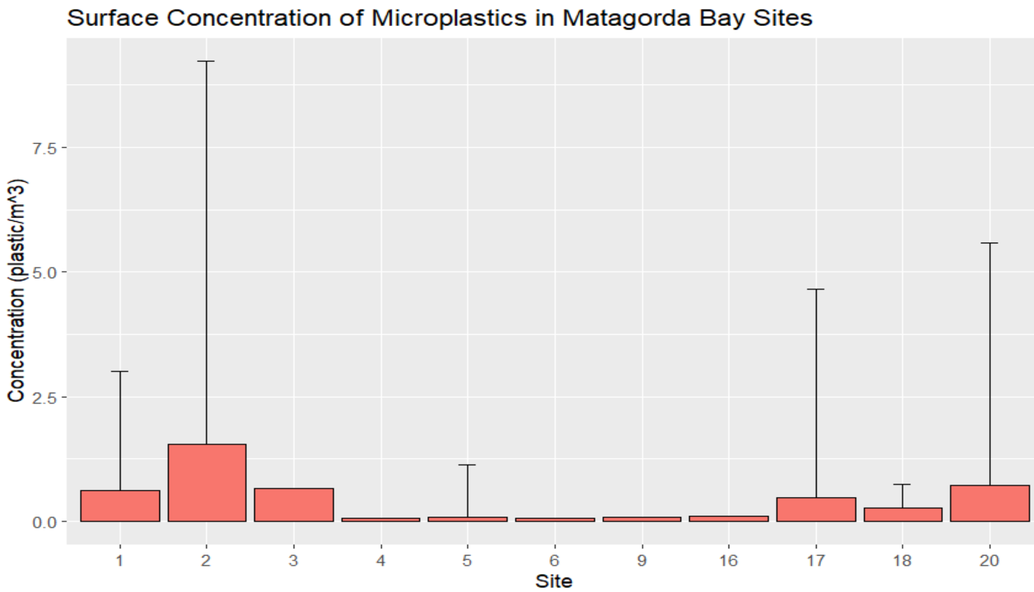

Figure 9: A bar graph that shows the surface water concentrations of microplastics in eleven sites as microplastics per m^3. Standard error bars are included for sites with replicates.

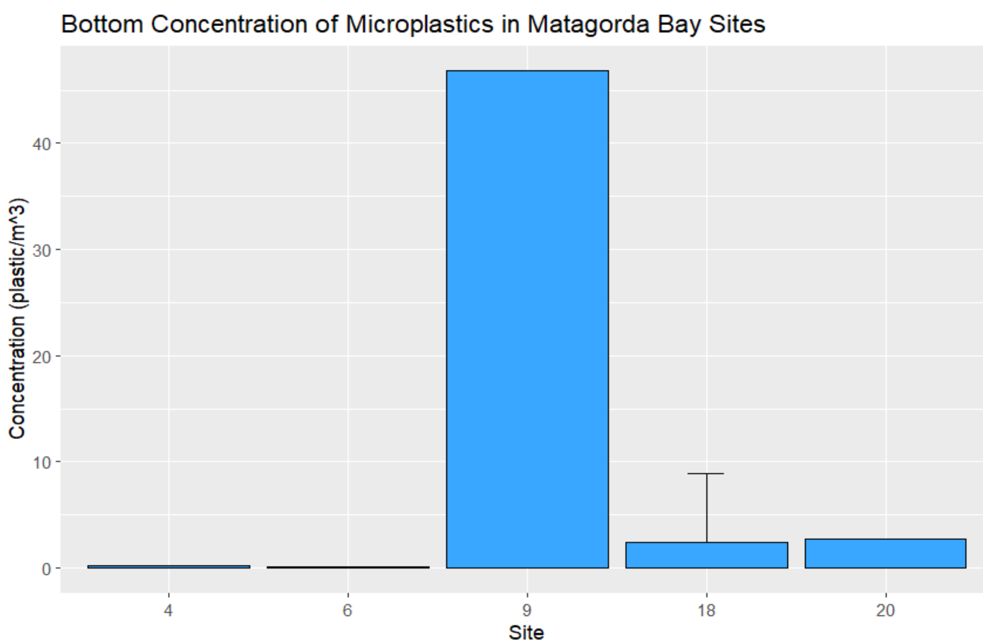

Figure 10: A bar graph that shows the deep water concentrations of microplastics in five sites as microplastics per m^3. Standard error bars are included for sites with replicates.

The type of polymers in microplastics were identified with the FTIR. A high variety of polymers were found (18 types), including polyacrylonitrile-butadiene-styrene (ABS), epoxy, polycarbonate (PC), polyphenylene sulfide (PPS), and rubber etc. (Figure 11). Rubber had the highest abundance out of all polymer types. polyphenylene sulfide and epoxy also had high abundances. There was a similar distribution pattern among the sample sites (Figure 12). Common polymers such as rubber, polyphenylene sulfide, and epoxy appear throughout most of the sites except for some of the sites that had very low abundances of microplastics such as sites 4, 5, 6, 9, and 16.

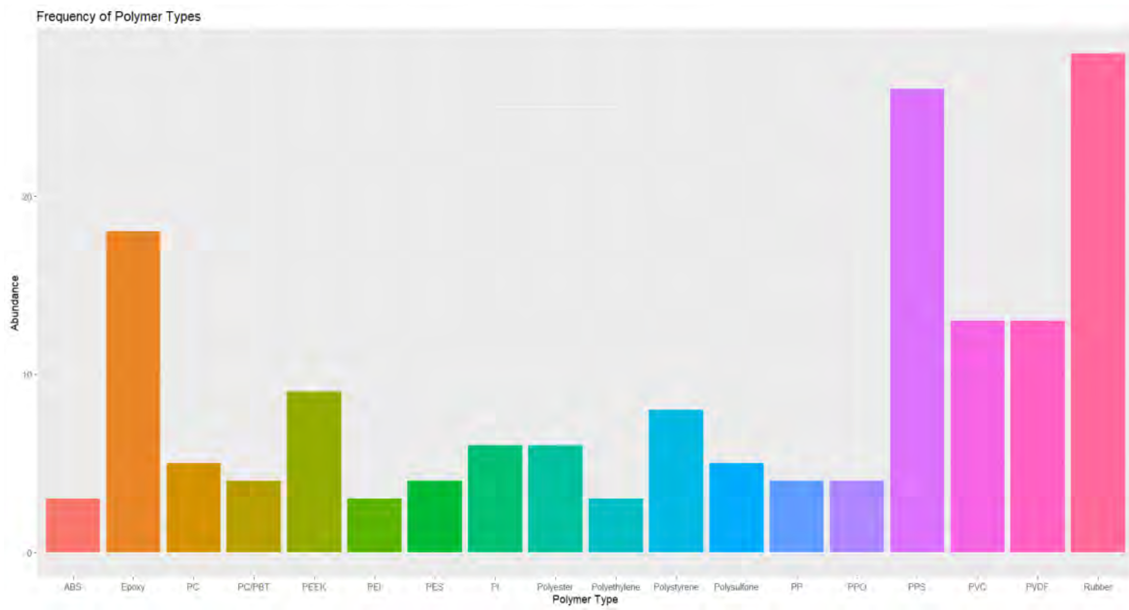

Figure 11: A bar graph showing the abundance of 18 polymer types that were found in all sites and samples. The graph only includes polymers that occurred more than twice in the samples.

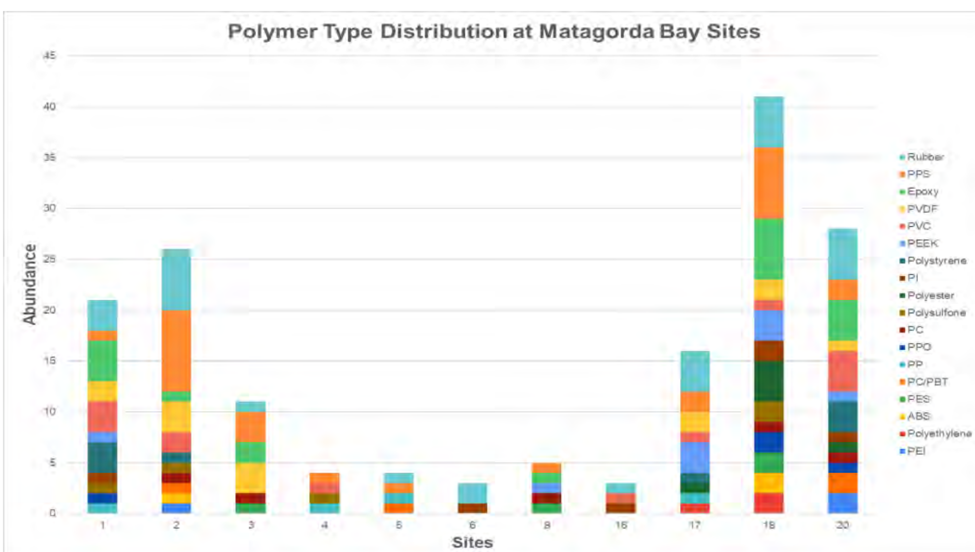

Figure 12: A stacked bar graph showing the distribution and abundance of 18 polymer types across all Matagorda Bay sites. The graph only includes polymers that occurred more than twice in the samples.

Fibers tend to be found in higher abundances in other bays and estuaries in Texas and can even make up to 77% of microplastics (Watford 2021). However, in Matagorda Bay, fibers were found in very low abundance with fragments dominating the samples instead. This may be due to the low human populations in the cities around Matagorda Bay, relative to other bays with high populations such as Chesapeake Bay. Another possibility is that the mesh size of the plankton tow was too large for fibers to be caught in. Other studies used smaller filters like membrane filters that had a pore size of 0.45 μm. In future experiments, smaller mesh sizes could be used in sample collection to see if there is a difference in fiber abundance. It is also interesting that rubber, polyphenylene sulfide, and epoxy are abundant in Matagorda Bay, likely due to their resilience, high molecular weight, and consistent input. Polyphenylene sulfide is used in filter fabric for boilers, electrical insulation, and gaskets. Epoxy is used in metal coatings, electrical components, and adhesives. Rubber is used in products such as tires and hoses. Future work is needed to elucidate the sources of these plastics and their potential toxicity to marine organisms.