

# Quantitative Analysis of Microplastics on Texas Beaches

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**Abstract**—Marine debris and microplastics have been found in all marine environments from the open ocean, to pelagic waters and beach sediments. A recently published two-year survey of marine debris spanning the Gulf of Mexico (GofM) from North Padre Island, Texas to Santa Rosa, Florida found that marine debris accumulation rates were ten times greater in Texas than similar coastlines of the north central GofM. The goal of this study was to determine if there were discernible differences in the abundance or quality of plastic pollution on Texas state beaches and investigate potential causes. Collections took place at three beach sites (Galveston Island, Mustang Island and Sea Rim) and during the months of summer (June–August), fall, (September to November) of 2019, and winter (January to March) 2020. (TPWD Pe No: 2019-R4-01). At each beach, a 50 X 1-meter transect was laid out on the high tide line, which was established visually by the wrack line and water marks. A total of 4179 microplastics, categorized as 4214 plastics, 155 nurdles, and 27 fibers were collected at all three sample sites from June 2019 to March 2020. The most common colors observed were blue, green, and white. During summer and fall 2019 the beach with the greatest microplastic pollution was Galveston Island State Park and during winter 2020 the site with the greatest microplastic pollution was Mustang Island State Park. The presence of microplastics on state park beaches may indicate that microplastic pollution occurs with sandy beach meiofauna and macrofauna. This study will result in the identification of trends in dispersal and seasonality of microplastics on the Texas coast.

**Keywords**—Microplastics, Beaches, Texas, Occurrence

## I. INTRODUCTION

The beach serves as a transition zone between land and sea for plastic debris as a result of high turnover rates of sediment due to changes in ocean currents, wave action, and wind patterns. Microplastics are defined as plastic particles that are 5 mm or smaller in size [1]. A recently published two-year survey of marine debris spanning the Gulf of Mexico (GofM) from Padre Island National Seashore, Texas to Santa Rosa, Florida found that marine debris accumulation rates were ten times greater in Texas than similar coastlines of the north central GofM, with 69-95% of the marine debris consisting of plastics [2]. Furthermore, the survey found that marine debris accumulation was highest in the late spring to early summer, with greater debris accumulation in the northwestern GofM than

the northcentral GofM. Plastics dominated the marine debris collected, with a gulf-wide average of 93% ( $\pm 19$ ) plastic, and all of the 270 samples collected from the 12 sites contained plastic. Additionally, the presence of nurdles, or small plastic pellets which serve as the raw material for the production of plastic products, have been found to span the GofM from Texas to Florida [3]. The Texas coastline may be under particular pressure due to the high debris input and accumulation rates, making it important to continue to study and document the effects of plastic pollution.

Wessel et al. (2019) surveyed beaches on barrier islands using the NOAA Marine Debris Program protocol during a two-year study. This study found that plastic was among the most prevalent debris category, but did not differentiate between microplastics and macroplastics. Of the six sample sites on the Texas Coast, these sites were located on the southern expanse of the shoreline from Padre Island National Seashore to San Jose Island beach access point 16 (Fig. 1). This study plans to sample Texas beaches that are further north and that give a more widespread overview of the 367-mile Texas coastline (Congressional Research Services) from Galveston Island State Park to Sea Rim State Park.

Although there are a few preliminary studies on the spread of microplastic pollution in the Gulf of Mexico (Wessel et al, 2019), there is little information on the distribution and seasonal variation of microplastics on Texas beaches. Texas has a range of beaches from heavily used recreational areas to isolated beaches. Studies in other locations have shown variability of deposition of microplastics on beaches, therefore I suspect a range of microplastic distribution on Texas beaches [4]–[6].

The goal of this study was to determine if there were discernible differences in the abundance or quality of plastic pollution on Texas state beaches and investigate potential causes. This was done by conducting quarterly surveying of beaches using transects, to characterize of microplastic contamination.



Figure 1: Map of six sample sites on the Texas coast from Wessel et al 2019 (blue) and state park sample sites for this study (red).

## II. METHODS

### Sample Sites

I sampled three state park beaches in Texas: Sea Rim State Park in Jefferson County (29.673915°N, 94.043423°W), Galveston Island State Park in Galveston (29.183497°N, -94.968376°W), TX, and Mustang Island State Park, in Corpus Christi, TX (27.669056°N, 97.171578°W), (Texas Parks and Wildlife Permit # 2019-R4-03; Figure 1). Collections at each field site took place once per season throughout the year: summer (June-August), fall (September-November), and winter (December-February) from June 2019 to February 2020. At each beach, a 50 X 1 meter transect was laid out on the high tide line, which was established visually by the wrack line and water marks. The samples were collected from the sediment surface via visual inspection/sight.

### Microplastic Visualization

Microplastics from visual surface transects and sediment cores were observed under a dissection microscope and a photo was taken using a document camera mounted on the ocular lens with a ruler in the field of view [7]–[9]. If fibers and particles collected in the 50mL tube cannot be fully viewed under the dissecting microscope, a photo was taken by mounting a camera over a white surface with a ruler in the field of view. Plastics were assessed for type, size and color and were sorted into three categories; plastic, nurdle, and fiber. Plastics, nurdles, and fibers (Fig. 2) were distinguished from sand, shells, and other organic matter based on three criteria (1) no organic structures are visible, (2) microfibers should be equally thick throughout their length, and (3) particles have clear and homogeneous colors [10]. The width of the microplastics were measured using the program FIJI. For irregularly shaped microplastics, the widths were taken from the longest axis. Furthermore, plastics were sorted into three size ranges, macroplastic (>0.5cm) and microplastic (0.1<0.5cm), and nanoplastic (<0.1cm).

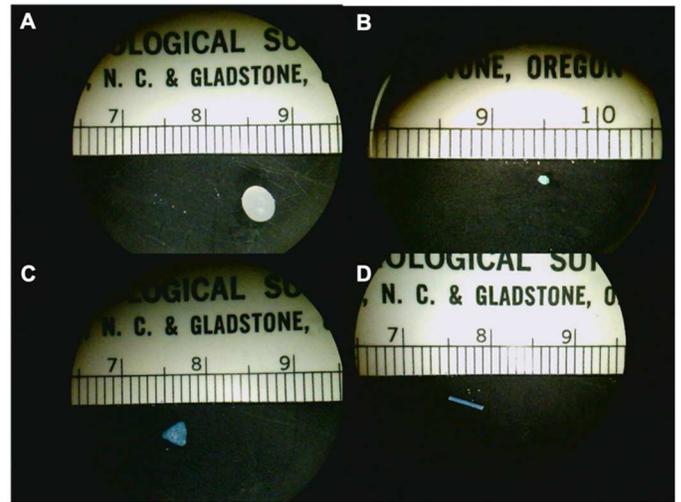


Figure 2: Types of marine debris : (A) Nurdle, (B) Nanoplastic, (C) Microplastic, (D) Microfiber.

## III. RESULTS

Marine debris were found at all three sample sites during the summer, fall, and winter collections from June 2019-March 2020. A total of 6227 pieces of marine debris were collected, with 3465, the greatest amount of marine debris being collected from Mustang Island State Park in Winter 2020 (Table 1). During summer and fall 2019 the beach with the greatest microplastic pollution was Galveston Island State (Figure 3). Marine debris were separated into three size categories, with microplastics having the highest number of collected samples and nanoplastics having the least amount of marine debris (Table 1). Microplastics were split into three groups; plastic particle, nurdles, and fibers (Fig. 4). A total of 4179 microplastics, categorized as 4214 plastics, 155 nurdles, and 27 fibers were collected from all three sample sites throughout the sampling period (Fig. 3) Microplastics were split into 13 color categories, with the most common colors observed were blue, green, and white (Fig. 4).

Table 1: Number of macroplastics, microplastics, and nanoplastics collected at each beach site: Galveston Island State Park (GISP), Mustang Island State Park (MISP), and Sea Rim State Park (SRSP). MISP Winter 2020 only includes the number of colored particles. \*MISP 2020 includes colored microplastics (545) and white microplastics (1644)

		Macroplastic	Microplastic	Nanoplastic	Total
Summer	GISP	300	217	2	519
	MISP	99	72	0	171
	SRSP	175	134	2	311
Fall	GISP	396	181	0	577
	MISP	82	44	0	126
	SRSP	229	105	0	334
Winter	GISP	88	89	2	179
	MISP	345	*525/1644	1296	3830
	SRSP	123	57	0	180

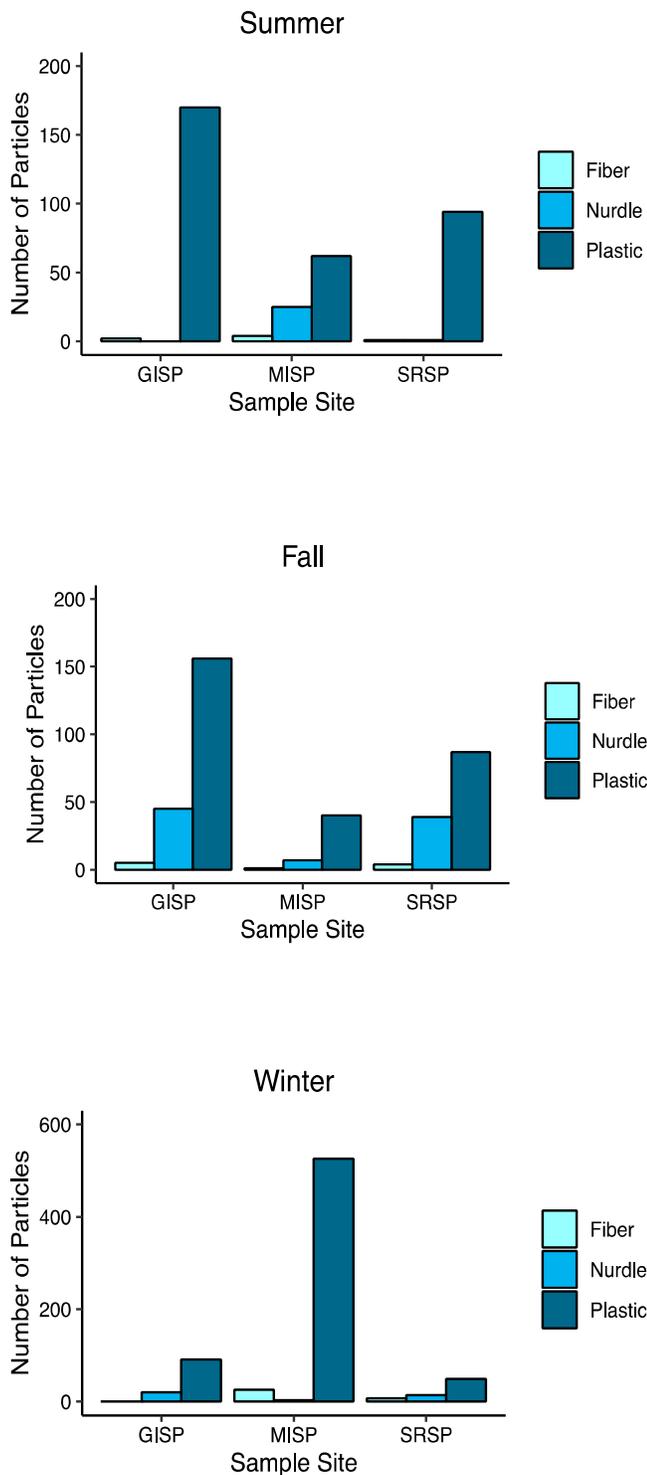


Figure 3: Amount of microplastics found at each beach site: Galveston Island State Park (GISP), Mustang Island State Park (MISP), and Sea Rim State Park (SRSP). MISP Winter 2020 only includes the number of colored particles.  
 \*MISP White Microplastic= 1644. \*MISP White Nanoplastic= 1296

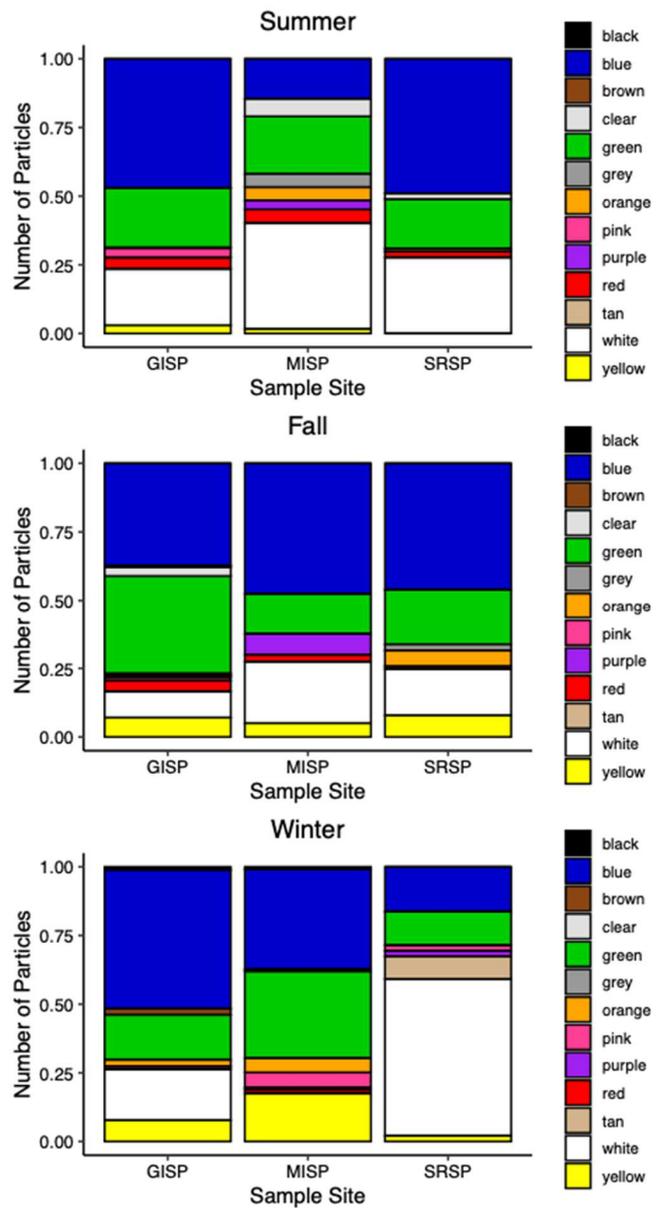


Figure 4: Proportion of colors of microplastics found at each beach site: Galveston Island State Park (GISP), Mustang Island State Park (MISP), and Sea Rim State Park (SRSP). MISP Winter 2020 only includes the number of colored particles.

A linear regression analysis was performed in RStudio using the beeswarm package. Galveston had significantly more microplastics collected for all three sample seasons when compared to Mustang Island (p-value = 0.00344) and Sea Rim (p-value = 0.04233) (Fig. 5). Plastic particles were the most abundant category of materials collected at all three sample sites for all three sample seasons (p-value < 0.001). (Fig. 5). Significantly more plastic particles than fibers were collected at Galveston Island for all three sample seasons (p-value= 0.002). (Fig. 5). There were significantly more microplastics collected at Galveston than Mustang Island for all three collection times. (p-value = 0.019). (Fig. 5).

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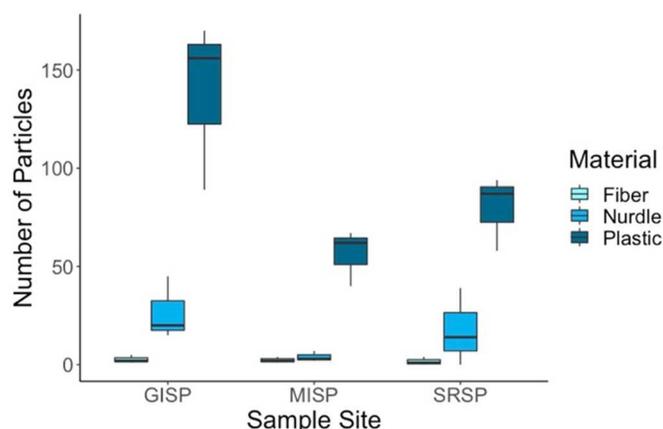


Figure 5: Average amount of microplastics collected per sample site for summer and fall collection times from a sample area of 50 x 1 meter surface transect. Galveston had significantly more microplastics collected for all three sample seasons when compared to Mustang Island (p-value = 0.00344) and Sea Rim (p-value = 0.04233). Plastic particles were the most abundant category of materials collected at all three sample sites for all three sample seasons (p-value = 4.92e-08).

## IV. CONCLUSION

Marine debris and microplastics were found at all three sample sites at all three sampling times from June 2019 through March 2020. Therefore, I strongly suspect that microplastics co-occur in habitats where beach infauna such as amphipods, donax clams and mole crabs are found. This strong likelihood of cooccurrence makes microplastics available as a potential contaminant in the beach environment and may be ingested by local invertebrates and marine fauna.

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