Activity report on the project “MIRROR: a Microplastic Raman Optical Rover to Understand Microplastics Variability Along Beaches of Matagorda Peninsula”

MBMT contract # 072

Period: July 1st, 2025 to September 30th, 2025

PIs: Cornel Olariu, Christian Claudel and Carlos Baiz, The University of Texas at Austin
PhD students: - Gus Santaella, Joseph Shirley, Kobini Antony Rex
MS student: Danielle Zaleski
Undergraduate students - – Aditya Matam, Shreya Arvind, Campbell Jordan, Jack Fenton

During the period from July to September 2025, the project focused on: (1) processing the UAV images collected from the beach area and building 3-D models; (2) identifying and mapping plastic in the 3-D models; and (3) analyzing sediment samples collected from the Matagorda Peninsula beach for microplastic content.

The MIRROR project used the beach 3-D models built with drone (UAV) imagery to map plastics larger than a few centimeters. The UAV was flown at 4 m above the ground over a 50 m stretch of beach, at 15 m above the ground for about 1.28 km, and at 30 m above the ground for about 13.7 km (Figure 1). Analysis of the imagery collected at different UAV flight altitudes (4 m, 15 m, and 30 m) showed the ability to detect plastic materials of various sizes. On images collected at 4 m altitude, plastics larger than 2–4 cm can be recognized; on images collected at 15 m altitude, plastics larger than 5–10 cm can be recognized; and on images collected at 30 m altitude, plastics larger than 10 cm can be recognized.

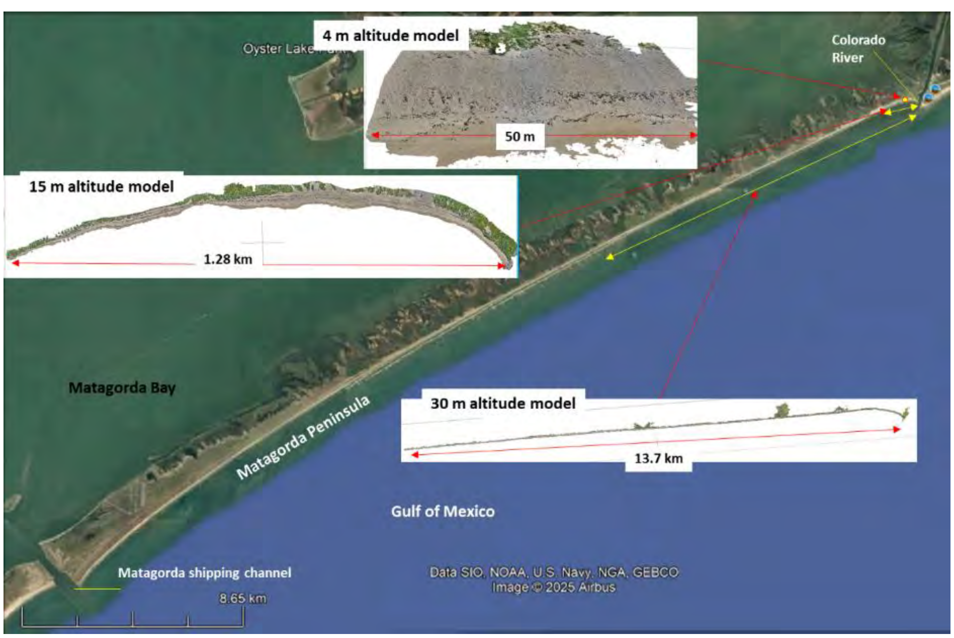

Figure 1. Map of the Matagorda Peninsula showing the area of UAV imagery collected at different altitudes for comparison.

Preliminary field observations suggest that UAV imagery from 30 m altitude is suitable for recognizing large plastic objects (macroplastics) around 10 cm (4 inches) or even slightly smaller if the object is brightly colored. The UAV imagery from the 30 m altitude model (30m-A-M), covering 13.7 km, represents more than one-third of the entire Matagorda Peninsula (~40 km) length (Figure 1), which we plan to study. Insofar models built from 4m and 15m altitude have been used for mapping plastics.

Plastic objects have been mapped on the 4m-A-M across an approximately 50-meter length of the beach, located southwest of the Colorado Canal (Figure 1), and their dimensions were measured. About 147 plastic objects with dimensions ranging from 2 cm to 75 cm have been identified (Figure 2). There are also many plastics smaller than 5 cm in the size-distribution map. Plastics are recognized if they are colored or have geometric/angular shapes or other unnatural shapes, such as square edges or surface wrinkles. The type of plastic (e.g., bottle, rope, container, bottle cap, fragment, foil, shoe, spoon) was also recorded.

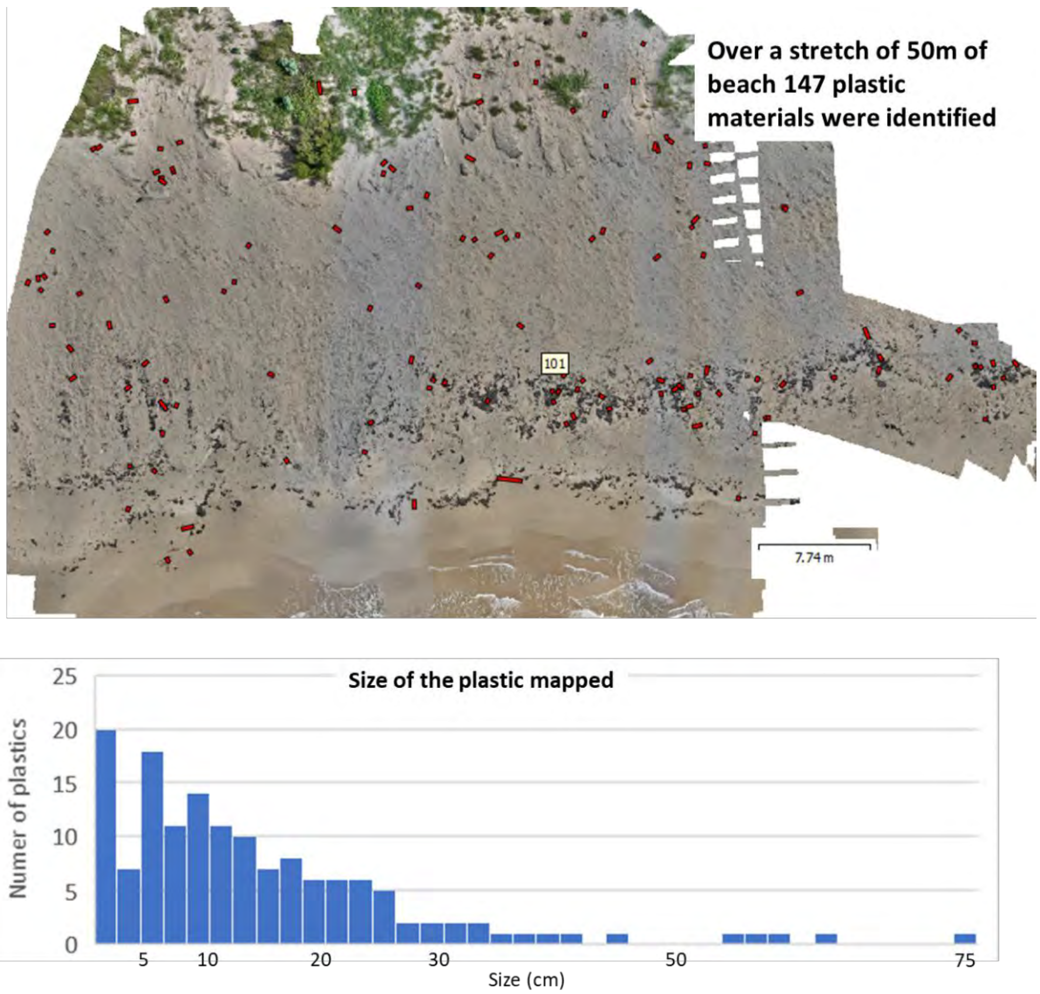

Figure 2. Microplastics mapped on the 4m-A-M model. Top: red dots show plastic location. Bottom: Histogram plot showing the distribution of plastic-object sizes.

On the model built from 15 m altitude (15m-A-M), plastic has also been mapped over a distance of 1.28 km of beach, and approximately 3858 plastic objects have been recognized (Figure 3). The size of the plastics ranges from very large—meter-scale ropes—to 0.5–1 m containers, and centimeter-size fragments and bottle caps (Figures 3 and 4). The plastic size distribution (Figure 3) shows a peak at around 20 cm and a significant increase at 5 cm or smaller. Based on mapping observations, the peak around 20 cm corresponds to the large number of bottles observed (see Figure 4), most of which are around 20 cm in length. The increase at 5 cm or smaller is due to the bottle caps, which are about 3–4 cm in diameter, or to plastic fragments of larger objects. This trend is expected as plastics weather and gradually fragment in the environment. The most frequent plastic objects observed are bottle caps or bottles, but tires, chairs, shoes, and hard hats were also identified among the objects (Figure 4).

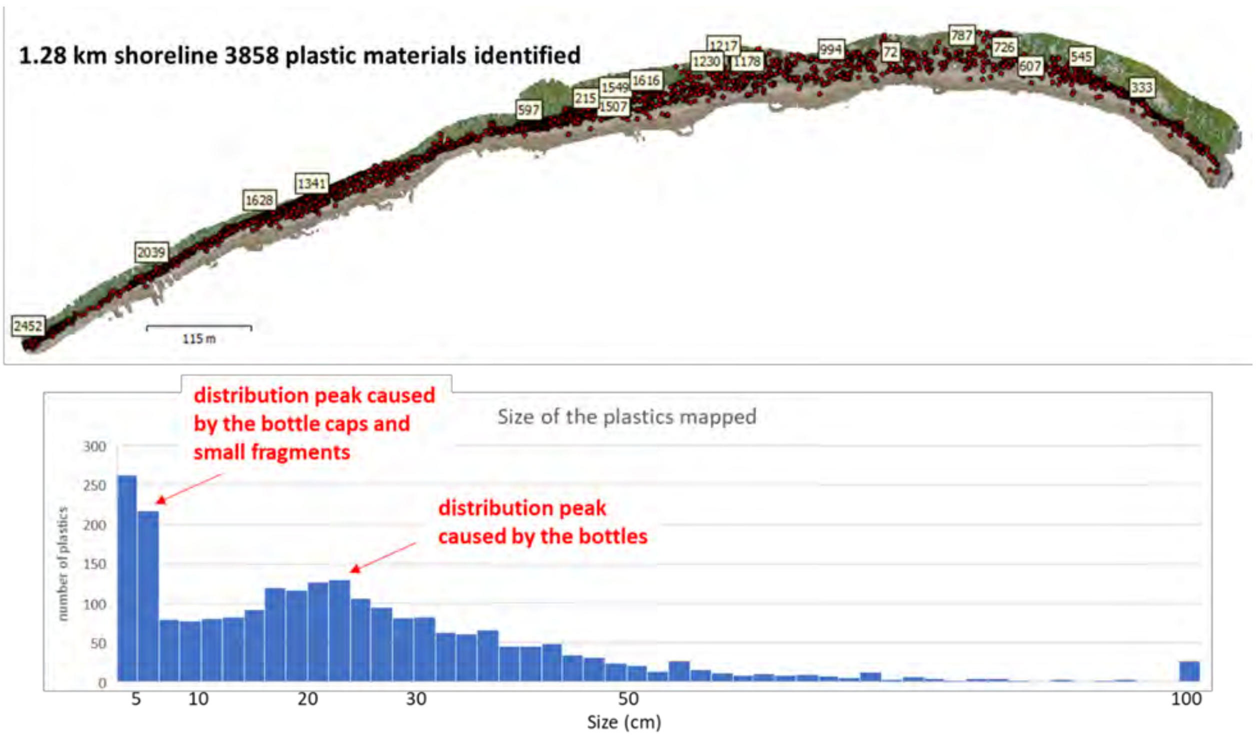

Figure 3. Microplastics mapped on the 15m-A-M model across a length of about 1.25 km. Top: red dots show plastic location. The numbers are “point numbers” of the objects mapped. Bottom: Histogram plot showing the distribution of plastic-object sizes. Note the two peaks in the distribution.

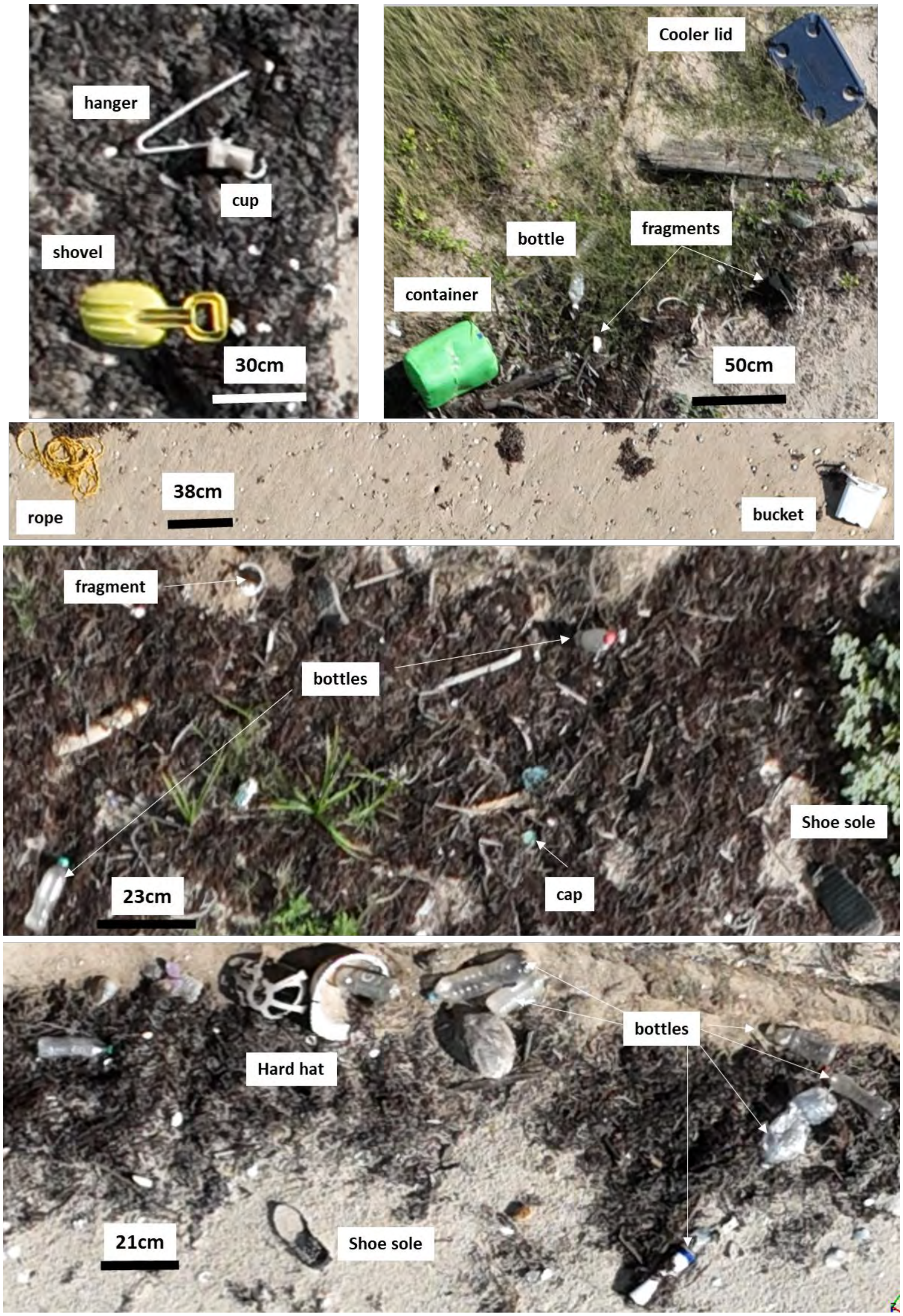

Figure 4. Examples of plastic objects mapped on the 15m-A-M model across a length of about 1.25 km. Most of the objects are bottles, but shoe soles, hard hats, containers, shovels, hangers, and fragments also appear. Plastic bottles that are typically 4–5 cm or smaller are not shown. Note that the scale bars are different in each photo.

The 3858 plastic objects are not evenly distributed along the beach, and their density varies substantially alongshore. Also, along the profile from the beach to the dune areas, the distribution differs; in some areas, objects are more evenly scattered, while in others they concentrate along a narrow band (Figure 6). Plastics are more abundant within the organic flotsam (beach wrack), and the distribution of flotsam and beach elevation (morphology) likely controls the location of plastics.

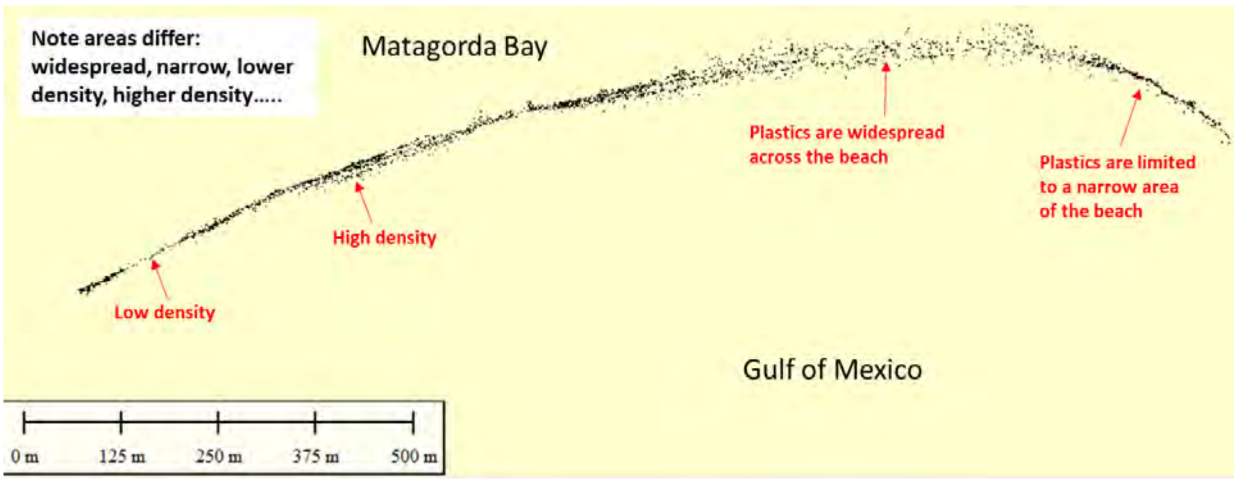

Figure 5. Distribution of plastic objects on the 15m-A-M model across a length of about 1.28 km. Each plastic object is represented by a black line indicating its size. Areas with higher plastic density have more lines on the map (appear blacker). Note that the plastic distribution varies along the beach.

Microplastics have been observed in the swash zone, concentrating along the uppermost line of the water (Figure 6). Microplastics appear to be transported landward across the beach face in the swash zone by the uprush and left behind when water retreats during backwash. Along and just below the uprush waterline, microplastics concentrate (see right image in Figure 6). We need to document this process in more detail because it might be important to understand microplastic transport along beaches. The swash zone might be the area where sediment transport processes sort and form larger microplastic concentrations.

Sediment samples collected along five profiles (Figure 7) have begun to be analyzed in the laboratory using the method described by Bailey et al. (2025). Microscope counting of the microplastics on the filter of sample 3 (Figure 8) identified six fragment particles with sizes between 80 and 160 microns, equivalent to very-fine to fine sand; eleven fibers with sizes between 118 microns and 2.5 mm, equivalent to fine to very-coarse sand; and seventy-three black (possibly tire/road) particles with sizes between 50 and 400 microns, equivalent to very-fine to medium sand.

The number of microplastics identified so far in 100 g of beach sediment is about the same as previously found in sediments collected in Matagorda Bay (Bailey et al., 2025). Analyses of more collected samples will continue to understand if there are significant variabilities along the coastal profiles or between profile locations.

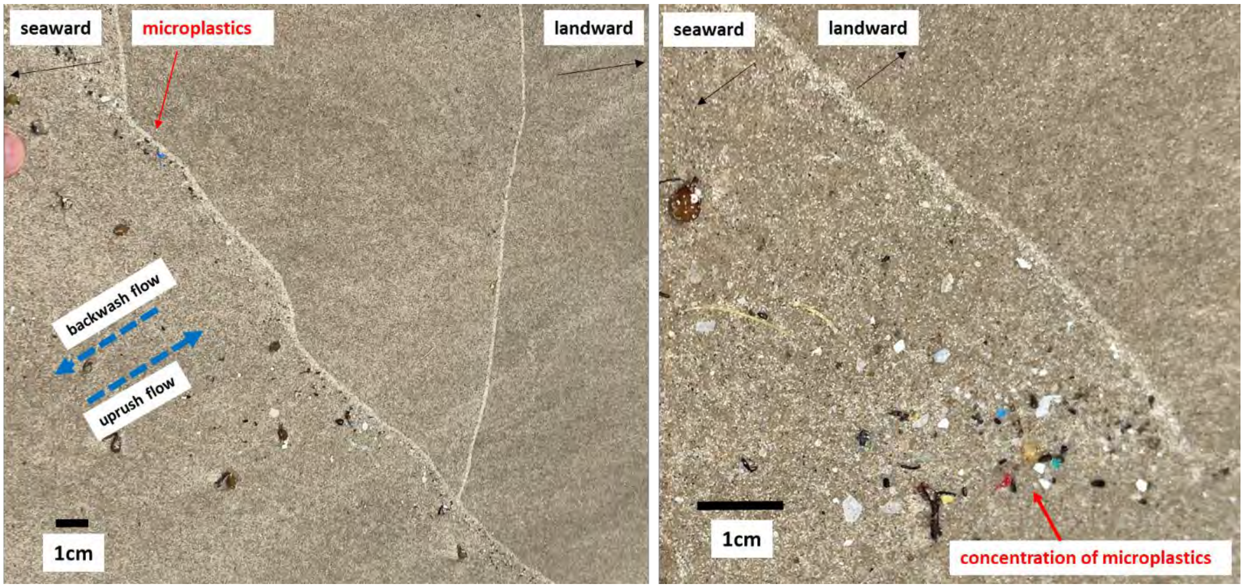

Figure 6. Distribution of microplastics in the swash zone of the beach. Note the concentration of the microplastics (a few hundred microns in size) below, but in the proximity of the maximum wave swash line. Note that the microplastic content varies between successive "wave swash lines" or along the same line.

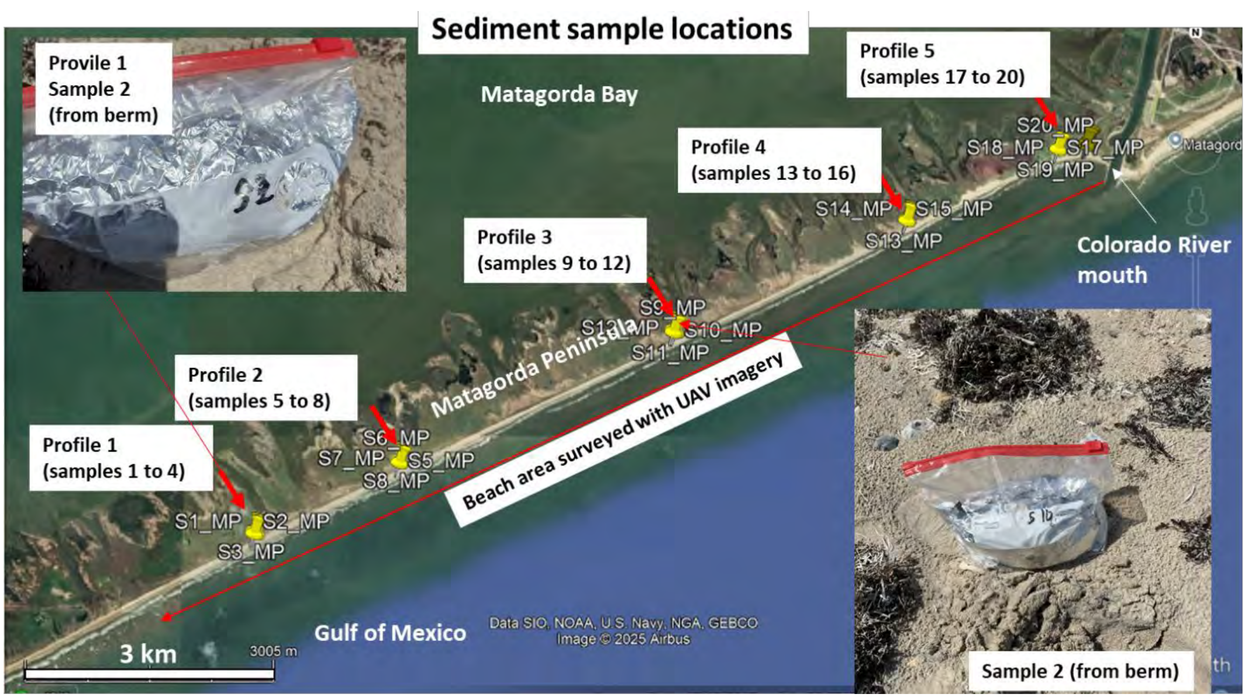

Figure 7. Location of the sediment samples collected for microplastics analysis along five profiles on Matagorda Peninsula beach. The inset shows examples of sample bags collected at the berm location.

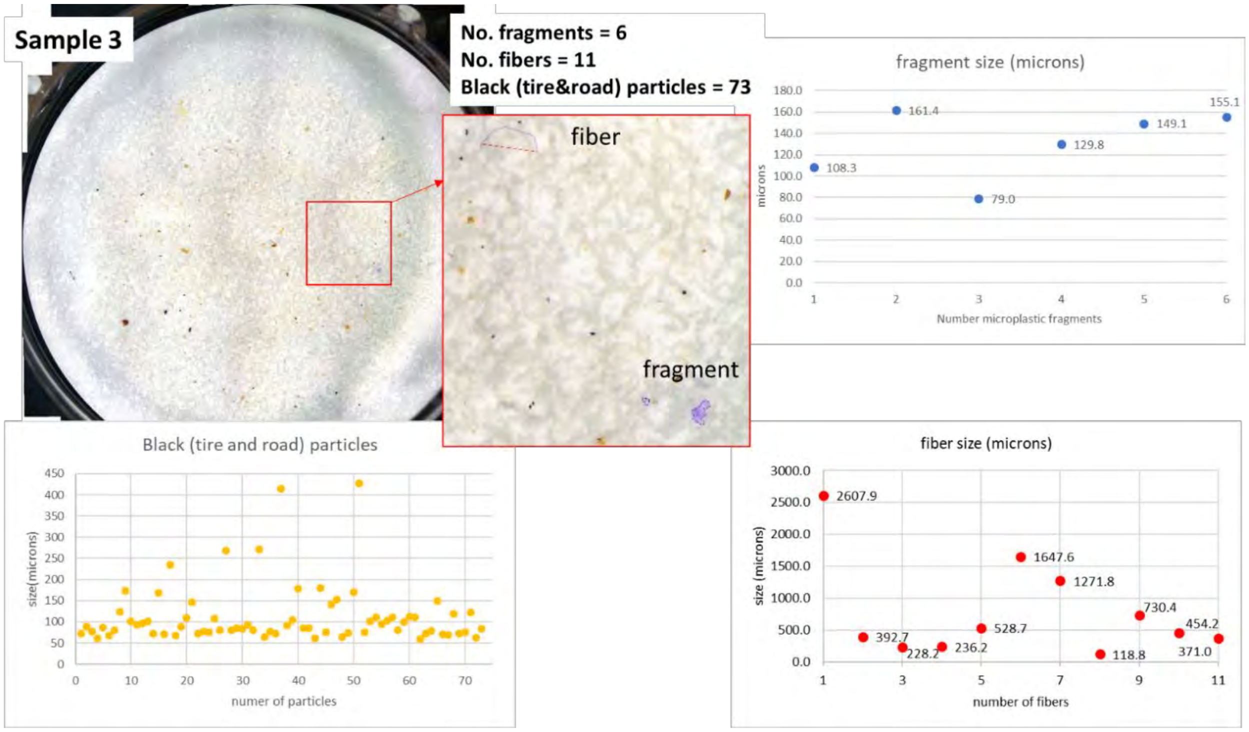

Figure 8. Microplastics identified in 100 g of beach sediment in sample 3 (see Figure 7 for location). Six fragment particles, eleven fibers, and 73 black (possibly tire/road) particles were identified in sample 3.

REFERENCES

Bailey, W., Olariu, C., and Mohrig, D. (2025). Microplastics in Bays along the Central Texas Coast. *Environmental Science & Technology*, 59 (10), 5249–5260.