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

MBMT contract # 072

Period: October 1st, 2025 to December 31st, 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 October to December 2025, the project focused on: (1) identifying and mapping plastic in the 3-D models for the Matagorda Peninsula; (2) analyzing the size and location of the plastics on the beach; and (3) analyzing sediment samples collected in 2025 from the Matagorda Peninsula beach for microplastic content.

The MIRROR project continues to make use of the 3-D models built with drone (UAV) imagery to map plastics larger than a few centimeters. The UAV models built from 4 m above the ground and at 15 m above the ground for about 1.28 km (Figure 1) have been used for plastic mapping (see previous reports). For this period, the south-western part of the 13.7 km long 3D model (Figure 1) was used for plastic identification and analysis for a length of about 1.7 km.

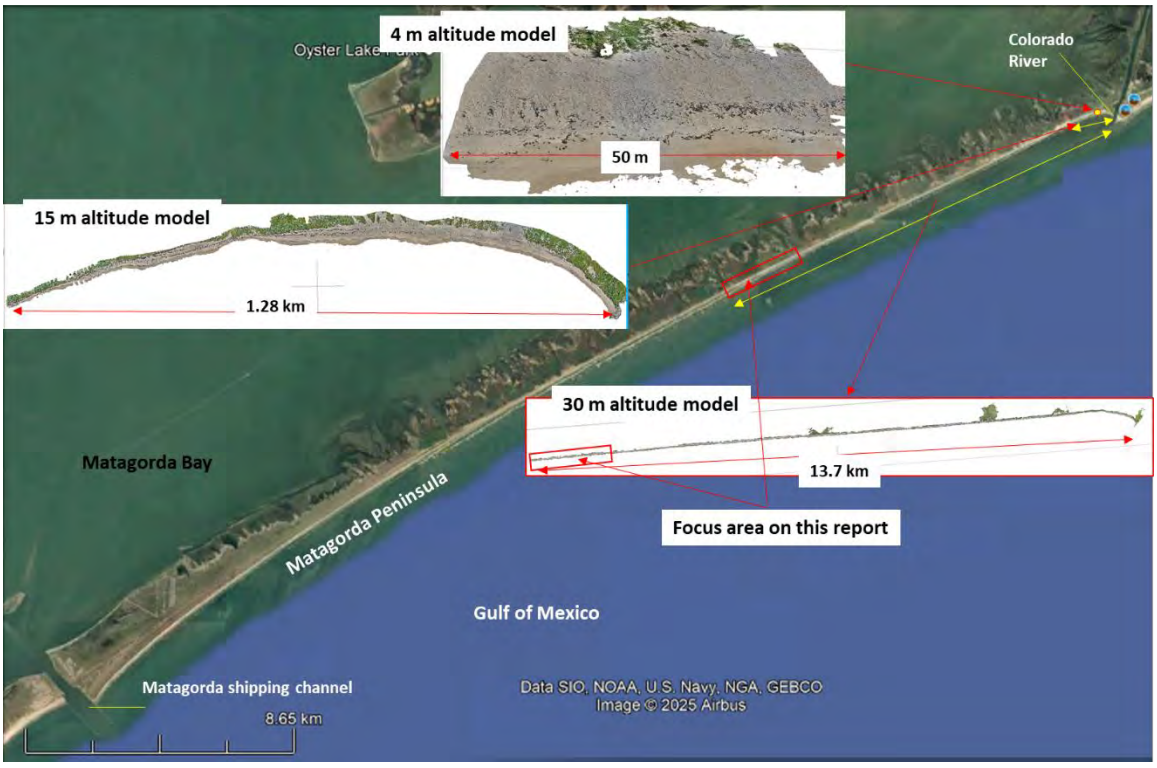

Figure 1. Map of the Matagorda Peninsula showing the area of UAV imagery collected at different altitudes for comparison.

About 3474 Plastic objects have been mapped on the western part of the 30m-A-M model over a length of 1.4 km, in the central part of the Matagorda Peninsula (Figure 2, Bottom). The mapping show an average of about 250 plastic objects per 100m. That is less than 300 plastics/ 100m mapped on the 15-A-M model (Figure 2, top).

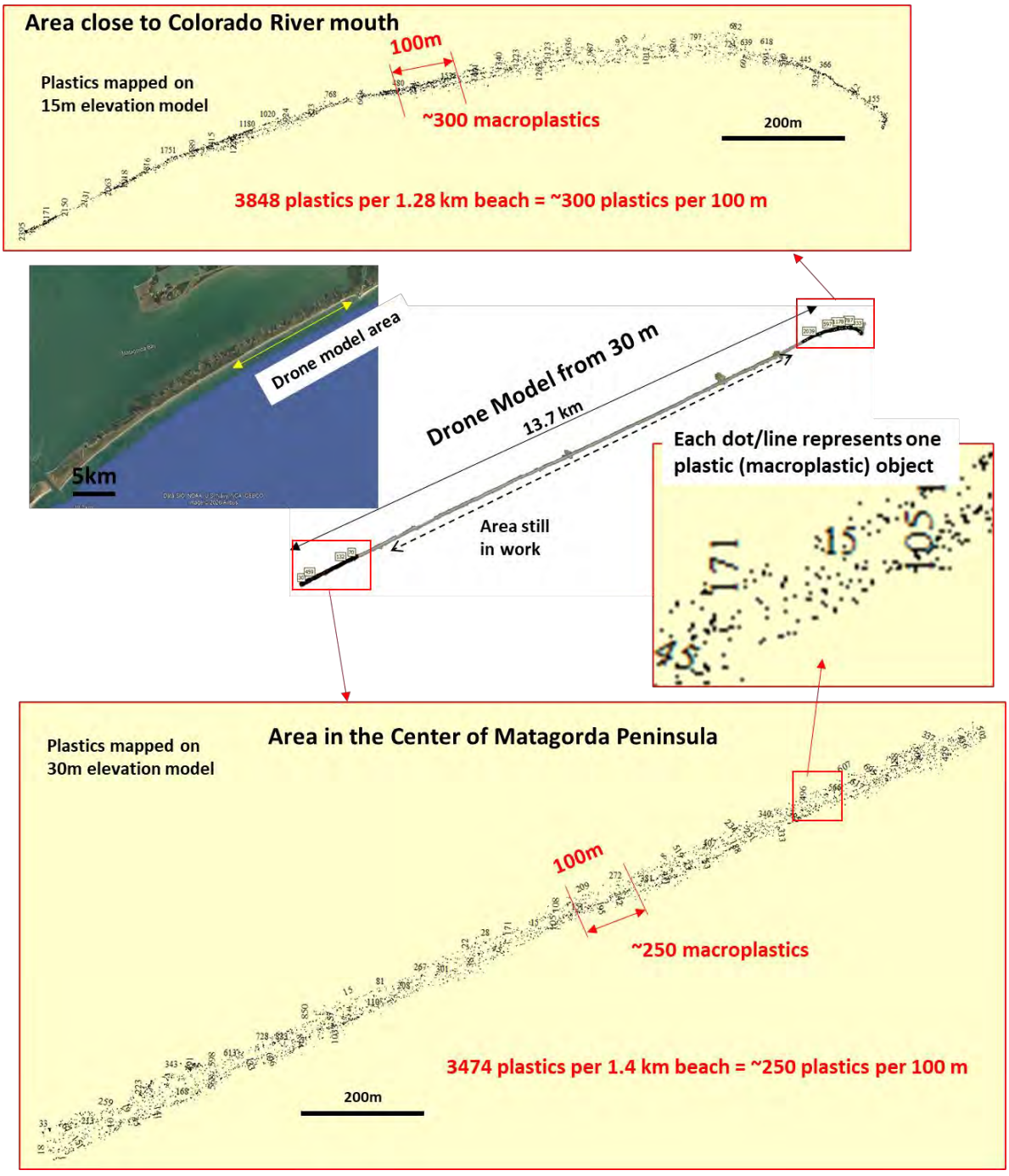

Figure 2. Macroplastics mapped on the 3D models. Top: Plastics mapped on 15-A-M model about 300 objects per 100 m. Bottom: Plastics mapped on 30-A-M model about 250 objects per 100 m.

The amount difference between plastics mapped on 15-A-M versus on 30-A-M, that is 300 vs 250 object per 100m, might be caused by the resolution of the photos or by the location of the 15-A-M model closer to the Colorado River mouth (Figure 2), where there is a higher density of plastics. In terms of the sizes of the objects mapped, in the area close to Colorado mouth, most plastics are around 5cm with another peak at 20cm in size (Figure 3, middle plot). In the central part of the Matagorda Peninsula, most plastics seem to be around 10 cm in size. The difference might be caused by the resolution of the images or by the water dynamics along the coast. More analysis is needed to determine if the size of the plastics is linked to the littoral transport of the sediments. Some of the largest/ longest plastic objects mapped (tens of cm to 1m) are ropes.

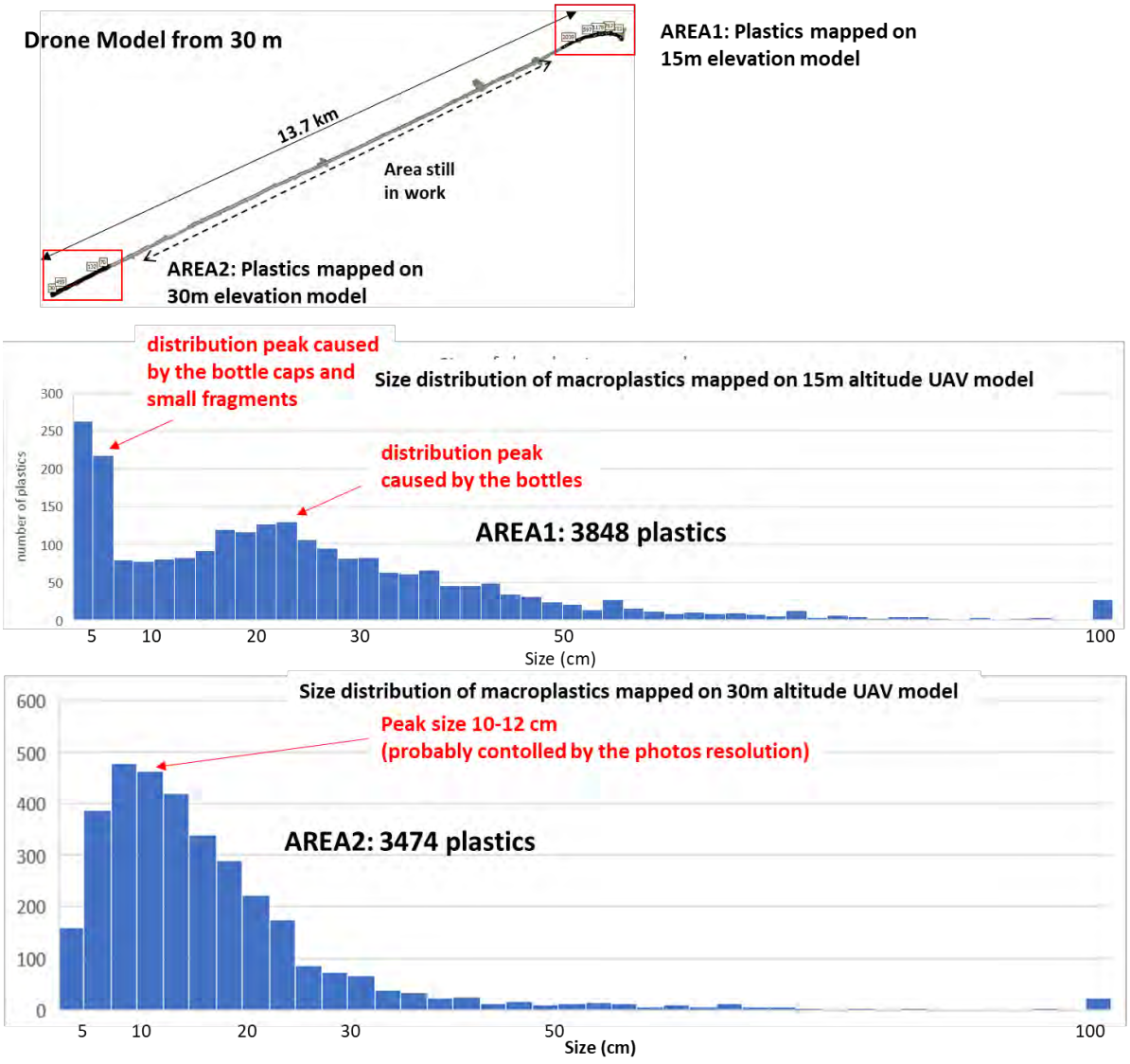

Figure 3. Size distribution comparison between plastics mapped previously on the 15m-A-M model and 30m-A-M model. TOP: location of the two areas mapped. MIDDLE: Histogram distribution of plastic size for the area close to Colorado mouth, mapped on 15m-A-M model. BOTTOM: Histogram distribution of plastic size for the area in the central part of Matagorda Peninsula mapped on 30m-A-M model.

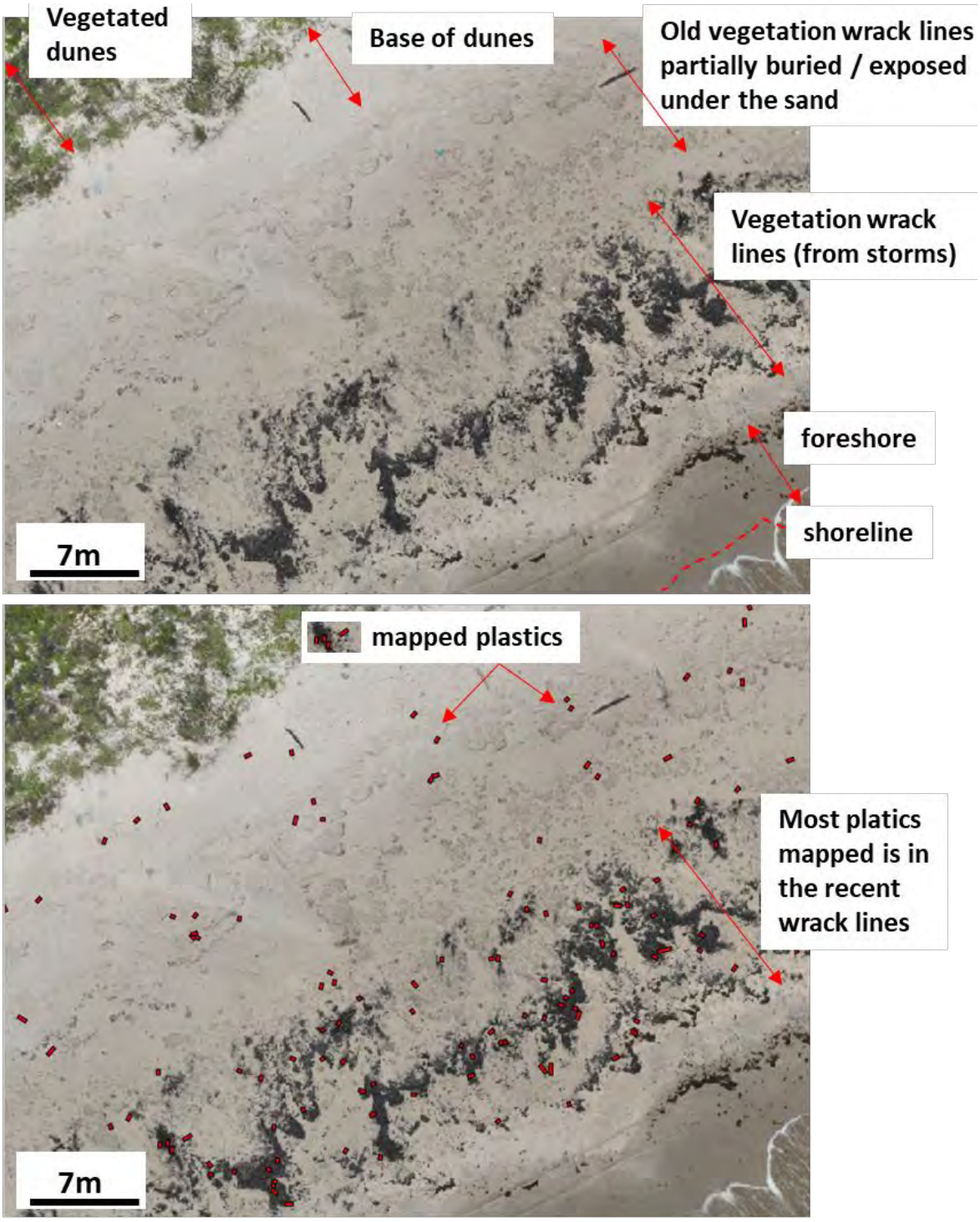

Figure 4. Detailed drone-model images of the Matagorda Peninsula Beach with mapped plastics. TOP: beach image with the separation of the main morphological areas (foreshore, recent storm wrack lines/ berm, older buried wrack lines, dune area). BOTTOM: Mapped plastics (red lines and dots) on the drone images. Note, most of the plastics are associated with recent wrack lines.

The identified plastics on the drone images are measured along the long axis (Figure 5). The line records the location of the plastic on the beach, the size (length of the largest dimension), and also the orientation of the long axis (in case the object is elongated). The recording of these parameters will allow an analysis to answer the following questions: where do plastics concentrate along the beach morphological profile? Is there a plastic size distribution from shoreline to dunes? Is it a preferred orientation (of the long axis) of the plastics that might reflect their transport?

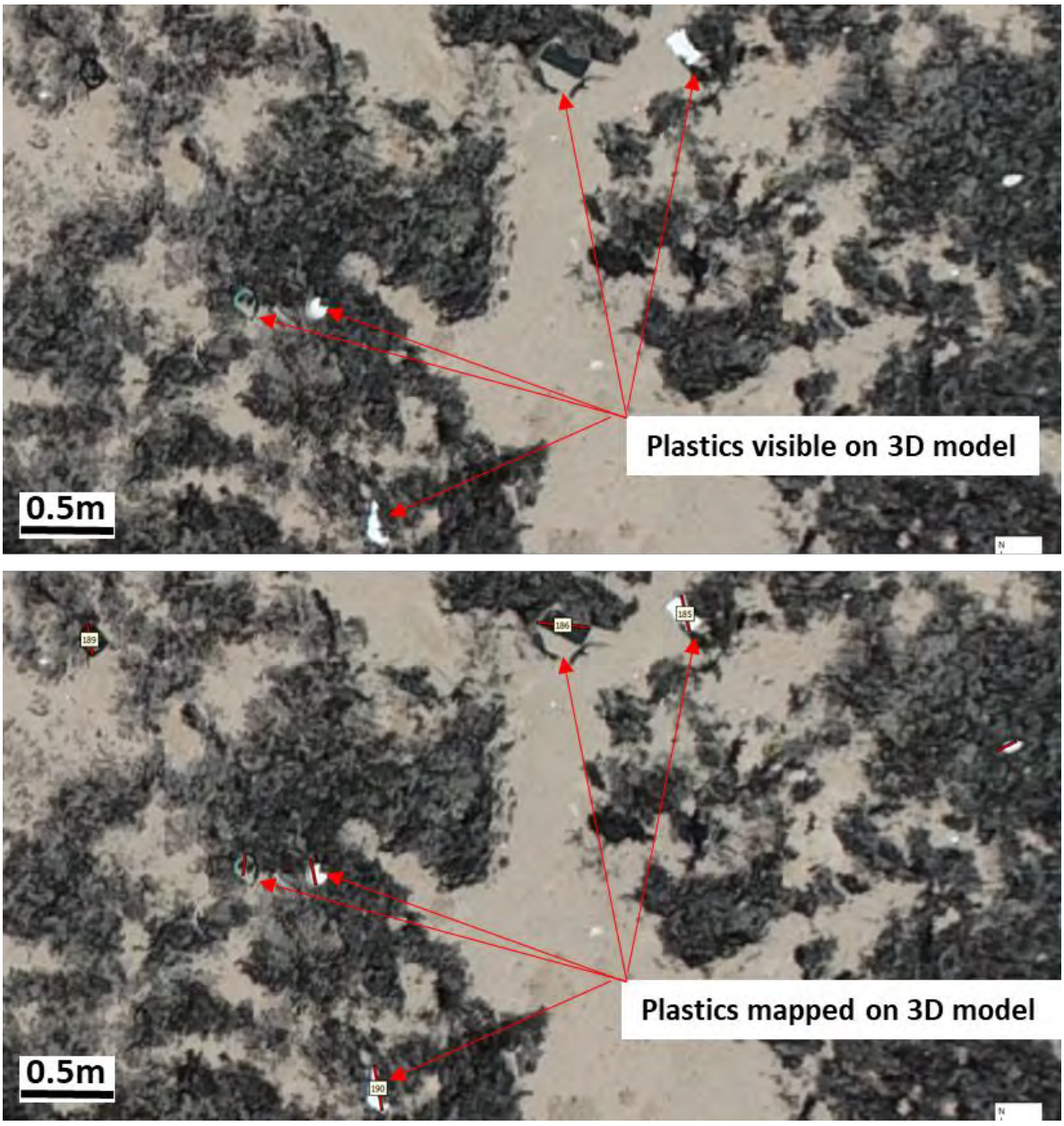

Figure 5. Detailed view of the drone-model images. TOP: plastic visible in images. BOTTOM: mapped (line drawing) of the plastics observed. The lines are recording the location, size, and orientation of the plastics. Note that the image is from the recent wrack area where more plastics are visible.

Microplastics analyses continued. Part of the sediment samples collected along six profiles (Figure 6) have been analyzed. The samples were collected from the foreshore to the limit of the vegetation (see the inset in Figure 6). The samples have been analyzed in the laboratory using the method described by Bailey et al. (2025). The filtered and identified microplastics were counted, identified as fiber or fragment, and measured. In addition, the color of the particle was recorded.

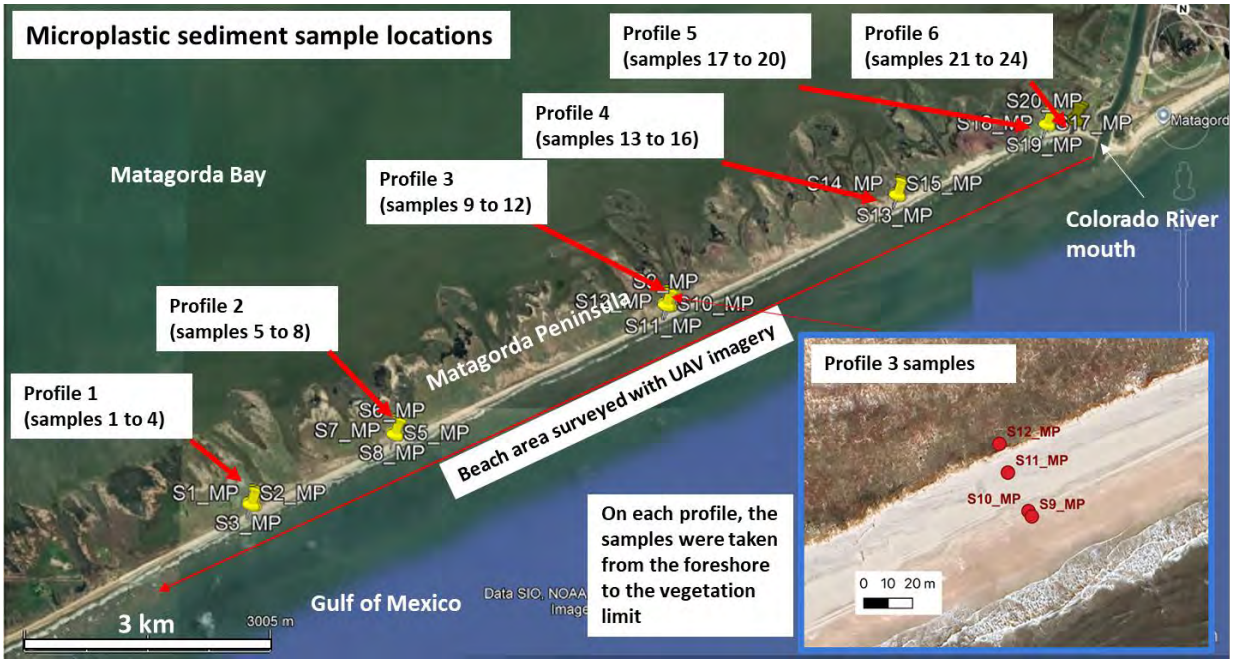

Figure 6. Location of the sediment samples collected for microplastics analysis along six profiles on Matagorda Peninsula beach. The inset shows examples of sample locations on profile 3.

Microscope identification of the microplastics on multiple samples collected on Matagorda Beach identified up to 35 particles per 100g of sediment sampled (Figure 7) with some samples having less than 10 particles per 100g. Samples analyzed are from 4 profiles and represent different locations, on foreshore, berm(s) or in front of dunes area.

An interesting finding is there are significant more fibers than fragments (see red color areas of the circles in figure 7) in almost all samples. A preliminary interpretation is that fibers are easier to be kept in suspension (in coastal waters) or are easier to be blown by the wind and concentrating the sediment, especially in front of the dunes or vegetated area.

The colors of the microplastics (Figure 8) are quite variable, some samples show poly-color particles while others are dominated by one color (i.e. black fibers of on the profile 2). If the color variability reflects the source of microplastics with more varied colors and morphology suggesting a wider range of sources. A narrow range of colors (such as black fibers) might suggest a similar source from a decayed close by microplastics.

The size of the particles identified shows that fibers are a few times larger (500 to 700 microns) than the fragments (100 to 200 microns). Such differences are expected since fibers usually weather and break down in long elongated particles. Similar size differences between fragments

and fibers have been observed in sediments collected in Matagorda Bay (Bailey et al., 2025) and in Lady Bird Lake and Austin Lake close to Austin, TX (Davis et al., in preparation). Analyses of more collected samples will eventually strengthen observations on fiber vs fragments variability.

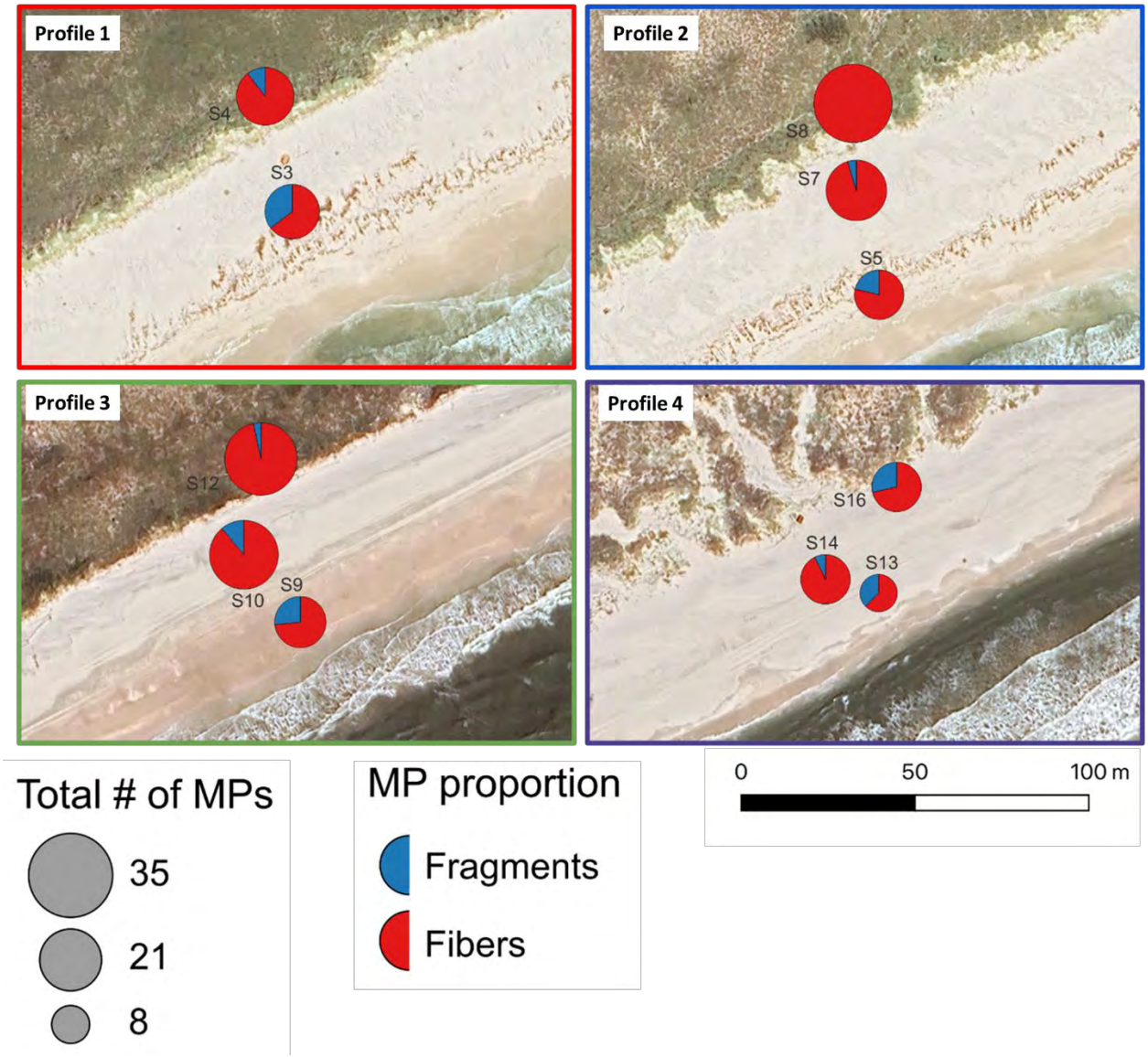

Figure 7. Microplastics were found in samples of 4 profiles across the Matagorda Peninsula beach. (for location of profiles see Figure 6). The size of the circle denotes the number of microplastics while the color shows the number/ratio of fibers vs. fragments in a sample. Note (1) that most of the microplastics identified were fibers, and (2) there are more microplastics closer to the dune area.

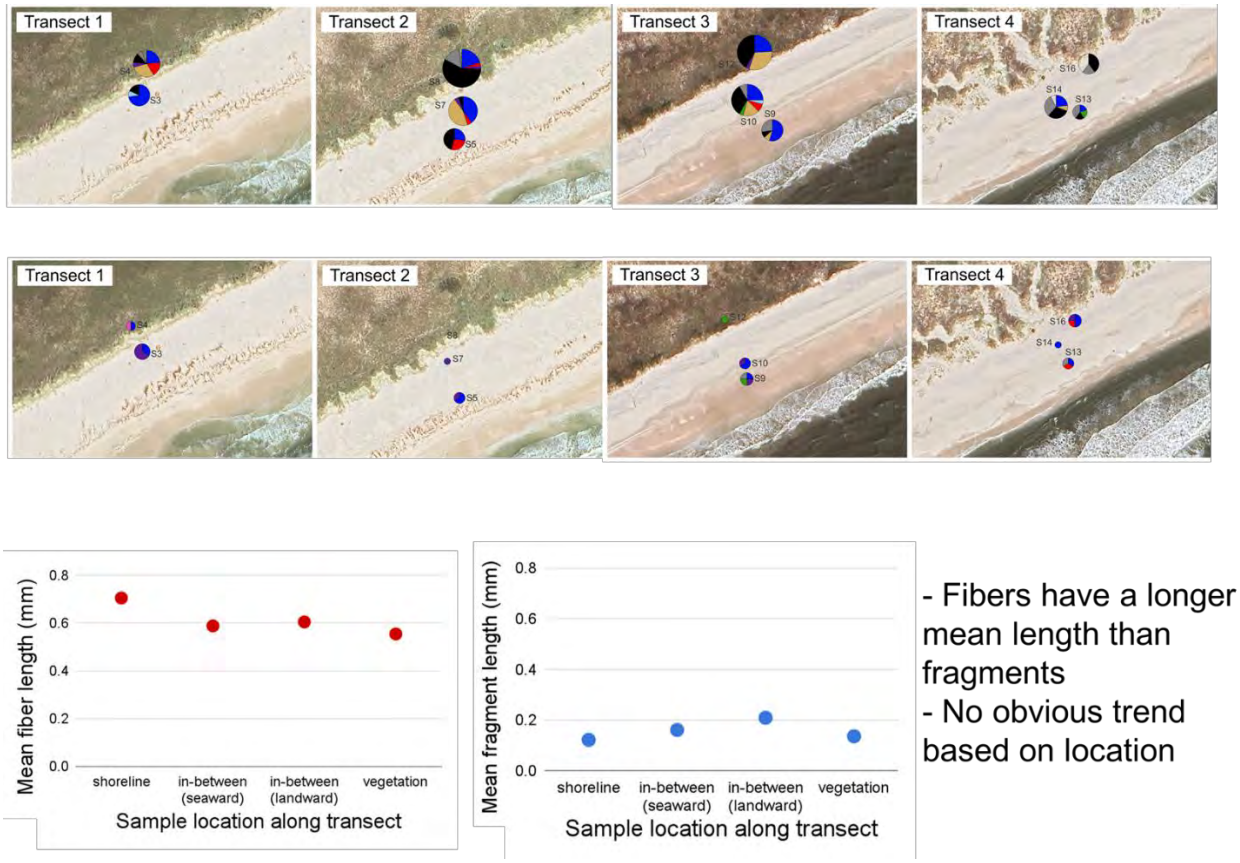

Figure 8. Microplastics analysis results with top row showing fibers and lower row showing fragments. TOP: Images shows the number and the colors of fibers (top row) and fragments (lower row). BOTTOM: Graphs show the size of the fiber and fragment particles from the shoreline (left) to dunes/ vegetation line (right). Note, there is a size difference with fibers being larger but there is no significant trend across beach profile.

REFERENCES

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

Davis, M., Olariu, C., Duncan, D., Bellinger, B., and Cisneros, J., (in preparation), Quantification and Correlation of Sediment Microplastics and Nutrients with Population Density in Lake Austin and Lady Bird Lake. Project report for the City of Austin.