Basket Flats Final Grant Report

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I. Introduction

The peninsula known as "Basket Flats" is located at the mouth of the Maurice River in Cumberland County, New Jersey (Figure 1). The peninsula is a remnant of a former meander of the Maurice River. Its current state is the result of shoreline erosion that has been widespread across the Delaware Bay. The nearby town of Bivalve is situated just a half mile north of the peninsula. A historically significant center for the oyster industry in the Delaware Bay, Bivalve is the current home to the Surfside clam processing facility, the Rutgers Haskins field station, and the Bayshore Center at Bivalve, the home port of New Jersey's official tallship the AJ Meerwald.

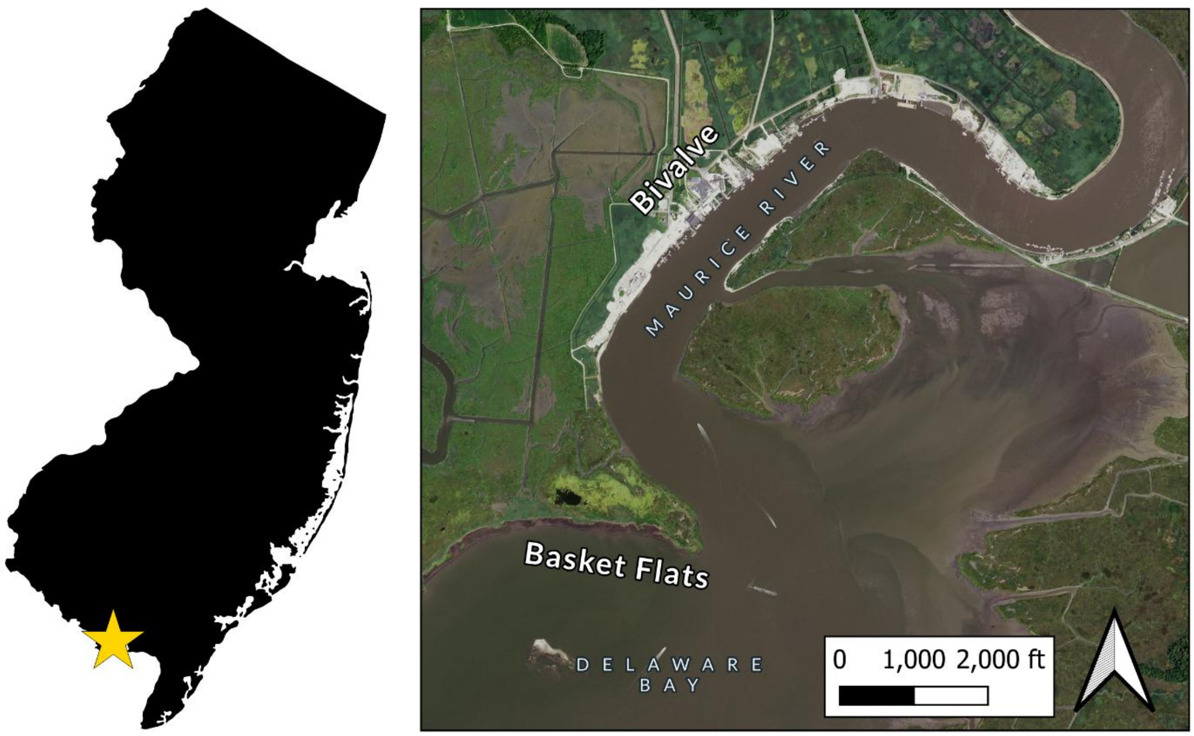

Figure 1: Overview of Basket Flat's location in New Jersey and relative to the nearby town of Bivalve, Commercial Township.

Basket Flats has long protected Bivalve by acting as a physical barrier from the full wave energy of the Delaware Bay. As demonstrated by historical imagery in Figure 2, the peninsula has been steadily decreasing in size over the last century. The trajectory of decline facing the peninsula threatens to weaken or eliminate its ability to shelter Bivalve from severe coastal erosion. Over the years, several projects were proposed to help stabilize the peninsula but did not materialize. In 1998, the New Jersey Department of Environmental Protection placed sunken barges to act as breakwaters along the tip of the peninsula, but this ultimately failed in stemming the peninsula's decline.

Figure 2: As seen here, Basket Flats has been on a continual trajectory towards erosion over the last century. Imagery obtained via the NJ Office of Information Technology, Office of GIS (NJOGIS) and USDA-FPAC-BC Aerial Photography Field office.

II. Restoration Actions

To slow the process of erosion on the peninsula, American Littoral Society, Wildlife Restoration Partnerships (WRP), and partner Stockton University conducted restoration actions including the construction of nine 200-ft long stone breakwaters along the peninsula's southern shoreline and one 450-ft long stone revetment along the peninsula's eastern point. The revetment was constructed in September 2022 and the breakwaters were constructed in October 2022.

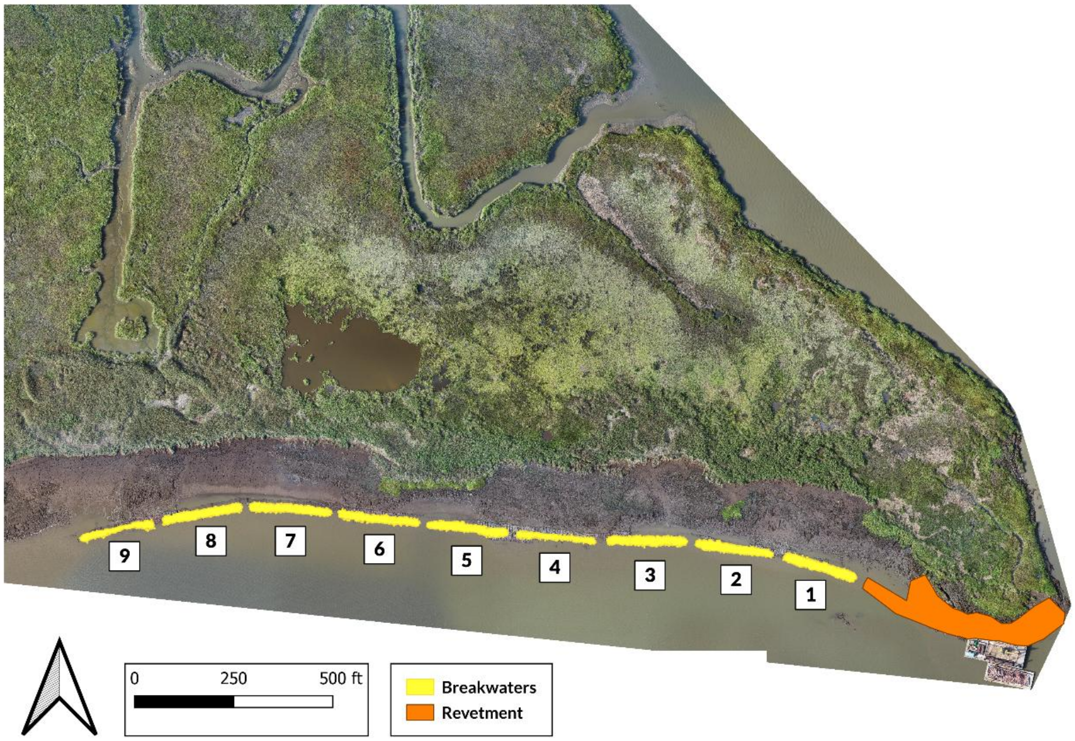

Figure 3: Graph representing a drone-based elevation cross section of the breakwater structures, from west to east. The lines are color-coded according to the time of data capture.

III. Monitoring

Wildlife Restoration Partnerships conducted drone monitoring of the project from December 2020 to September 2024, allowing for comparisons of the site before, during, and after restoration actions were taken. Ten drone mapping flights were conducted over this period, with three occurring before the breakwater and revetment construction, and seven after construction.

Drone imagery and photogrammetric elevation models provided insights into several elements of the restoration, including:

- Changes in breakwater elevation after construction
- Accumulation and movement of sediment behind the breakwaters
- Changes in the peninsula's shoreline
- Changes in the composition of salt marsh vegetation in the interior of the peninsula

Breakwater Elevation Tracking

Drone imagery-based photogrammetry was used to create digital elevation models of the breakwater structures after each successive mapping mission. This allowed for real-time observation of changes in the breakwaters' elevation and the ability to individually gauge each breakwater's performance in holding their vertical positions.

Figure 4 shows a series of elevation cross-sections of all nine breakwaters that was generated using a drone-based elevation map. Each cross-section is color-coded according to the time of flight. As seen here, the breakwaters experienced settling to varying degrees. Breakwater 9 experienced significant settling shortly after construction, though before the first drone monitoring flight, as reflected in its 'bow' shaped cross section starting from the initial drone mapping effort. Breakwaters 8, 7, 6, 5, 3, and 1 had an initial settling of about 0.8 – 1 ft between November 2022 and January 2023, slight settling between January 2023 and October 2023, and no significant change between October 2023 and September 2024. Breakwaters 4 and 2 experienced about 2 ft of settling between November 2022 and October 2023 but stabilized thereafter. Overall, the breakwaters were successful and behaved as expected, with an initial period of settling followed by stabilization.

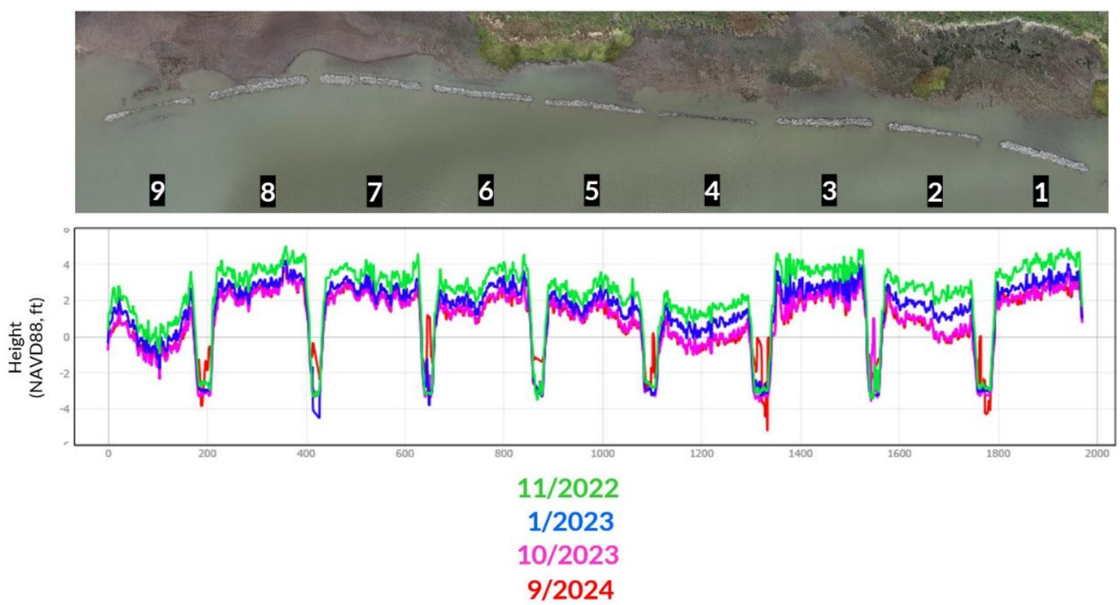

Figure 4: Graph representing a series of drone-based elevation cross sections of the breakwater structures, from west to east. The lines are color-coded according to the time of data capture.

Early in the monitoring process, it became clear that breakwaters 9, 3, and 2 were experiencing more rapid settling than the other structures. Comparison with historical aerial imagery indicates that this could be influenced by drainages that ran through the former marsh at these locations. Figures 5 and 6 show an overlay of 1970 Wetlands (NJOGIN) aerial imagery onto 2023 drone imagery of the breakwater structures. There is an apparent correlation between the breakwaters that experienced more significant settling and the presence of former drainages. Drainages in salt marshes tend to be muddy, soft, and unstable, which could explain why a breakwater constructed over a former drainage would not hold its vertical position as well. Breakwater 9's dramatic settling shortly after construction seems to correlate with the wider extent of the former drainage underlaying it. Sediments within this area would likely be even less stable than the areas with smaller drainages.

Figure 5: 1977 NJ Wetlands imagery overlaid onto 2023 drone imagery, demonstrating that breakwater 9's significant initial sinking behavior may be related to its position over a former drainage.

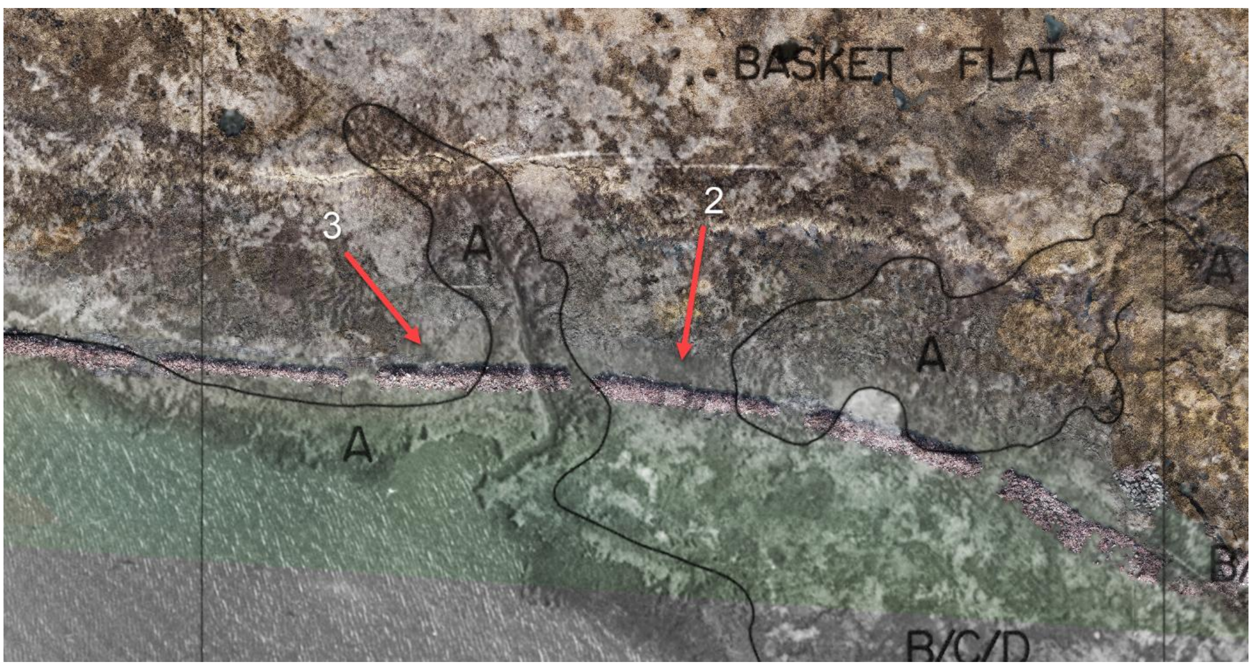

Figure 6: 1977 NJ Wetlands imagery overlaid onto 2023 drone imagery showing that both breakwaters 2 and 3 are positioned over a former drainage.

This information was helpful, not only to elucidate the causes of changes in elevation as they occurred during the monitoring period, but to help inform future restoration projects. With the gained experience that breakwaters placed on former drainages may suffer greater elevation loss, breakwater placement can now be better planned to avoid such areas.

Sediment Accumulation Behind the Breakwaters

Drone-based elevation maps and imagery show that the breakwaters have allowed sediment to continuously build in elevation in the landward low-lying areas behind them. This indicates that the breakwaters have been successful in reducing wave energy and erosional forces in the intertidal area, as well as retaining sediment from being lost from the system during ebb tides.

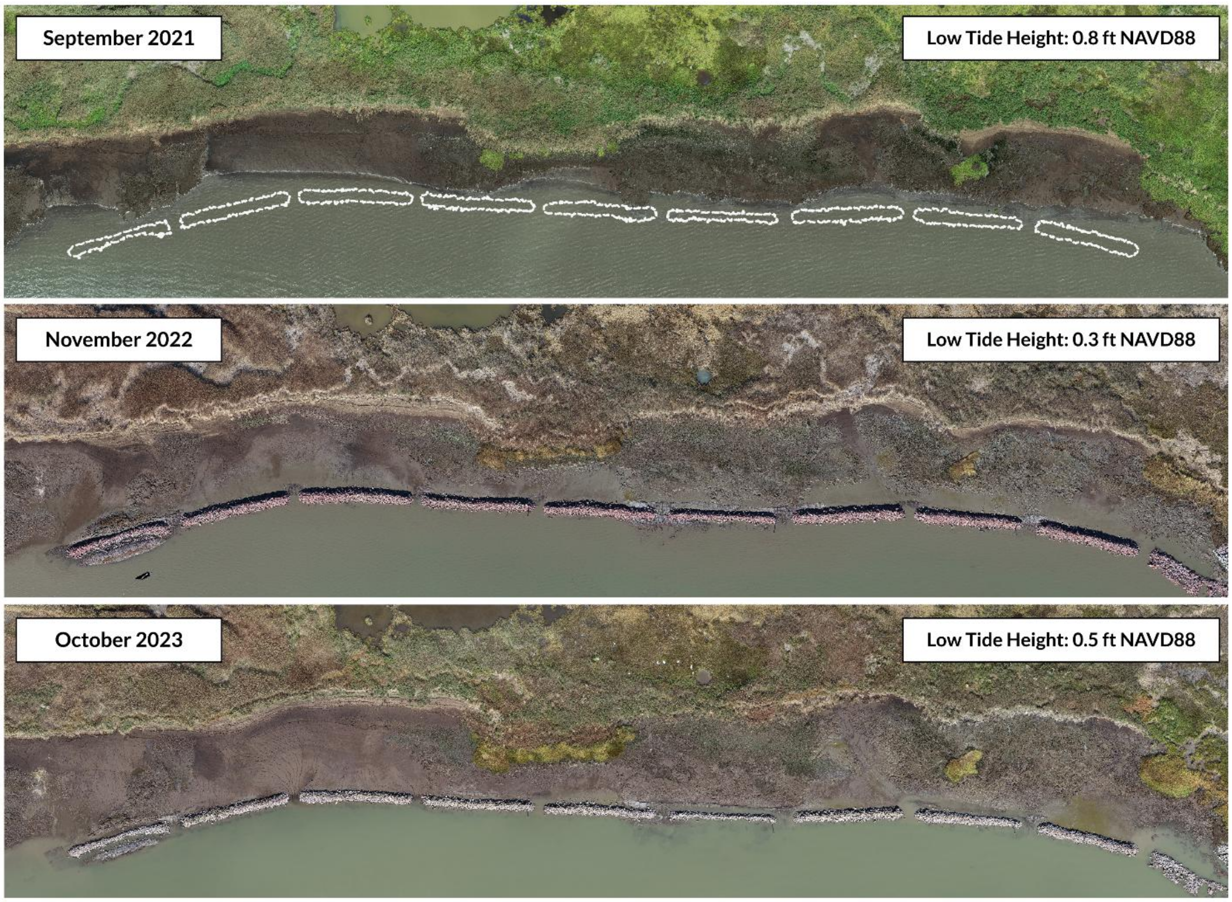

Figure 7: Comparison of the extent of the intertidal zone at low tide from 2021 to 2023. Note that the breakwaters were initially disconnected from the shoreline at first, but sediment accretion has resulted in a low tide shoreline that now reaches the breakwaters.

The above figure shows the progression of sediment buildup behind the breakwaters from one year before, one month after, and one year after the breakwaters were constructed. Notice the change from 2021's shoreline that was entirely disconnected from the future locations of the breakwaters (outlined in white) to 2022 and 2023's shorelines that hug the line of breakwaters across the peninsula. This indicates that even a month after construction in October 2022, sediment was beginning to build behind the breakwaters. This combination of lower wave action and buildup in elevation capital is promising. If the trend continues, it could create more suitable seeding conditions for *Spartina alterniflora* to grow on the intertidal area.

Drone elevation maps have allowed us to gauge sediment buildup behind individual breakwaters. Figure 8 shows elevation cross-sections taken from each breakwater, with each graph starting at the breakwater on the left side and ending at the marsh edge on the right side. Breakwaters with an observable amount of sediment buildup are marked with a red asterisk. Based on these observations, breakwaters with settled elevations above 2 ft NAVD88 were more successful in building a landward bed of sediment compared to those below 2 ft NAVD88.

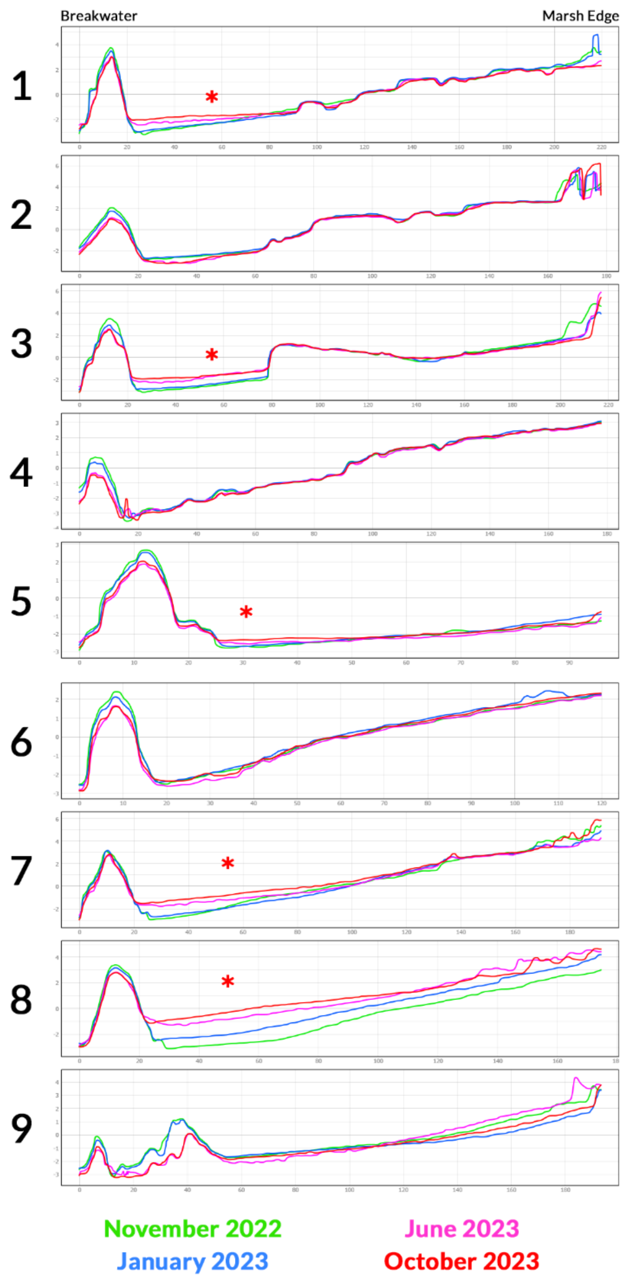

Figure 8: Graphs representing drone-based elevation cross sections from the center of each breakwater to the marsh edge. Breakwaters marked with a red asterisk are those with observable sediment accretion in the landward area behind the breakwaters.

Changes in Vegetation and Marsh Edge

Drone-based surface elevation maps have allowed us to easily visualize changes in the vegetation and marsh edge over the course of the monitoring period. By capturing vegetation heights at different points in time, we were able to produce maps showing the change in a single image. Figures 9 and 10 display maps of changes in vegetation height between November 2022 and September 2024. Areas that gained vegetation height are red, areas that lost vegetation height are blue, and areas that did not change significantly are green-yellow.

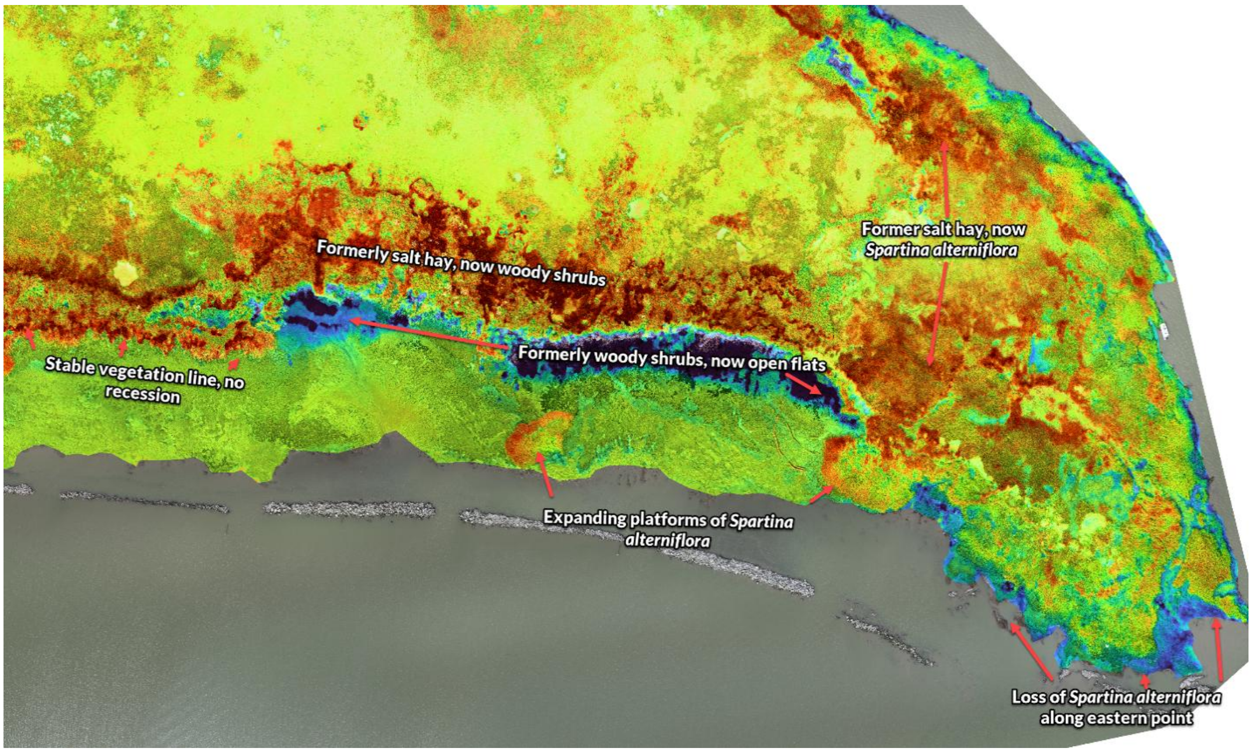

Figure 9: Drone-based digital surface map (DSM) overlaid onto drone imagery of the eastern side of the breakwaters.

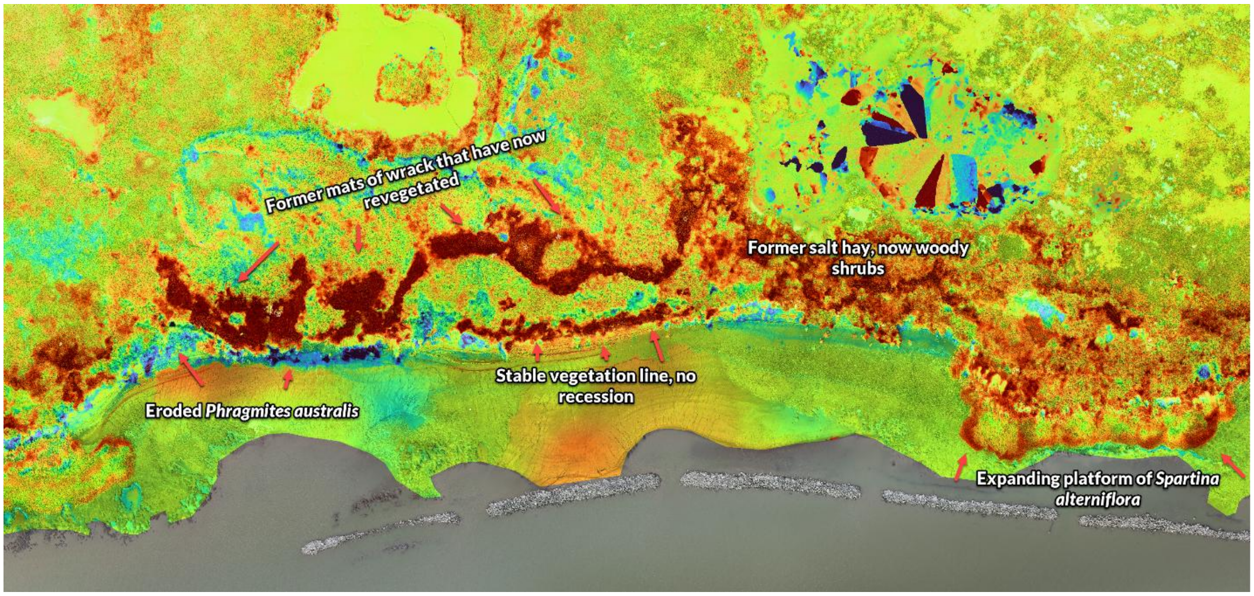

Figure 10: Drone-based digital surface map (DSM) overlaid onto drone imagery of the western side of the breakwaters.

As seen in these figures, the marsh edge behind the breakwaters moved in varying ways along the restoration area. Some woody shrub-dominated areas of the marsh edge receded into exposed mudflat, as seen in the deep blue area behind breakwaters 1, 2, and 3. Drone elevation data suggests that the erosion behind breakwater 3 correlates with lower elevations from a drainage path in that area, as seen in Figure 11. Lower elevations would result in a longer length of time that the area is submerged during the tidal period, which could be why this area experienced more severe erosion in the last year.

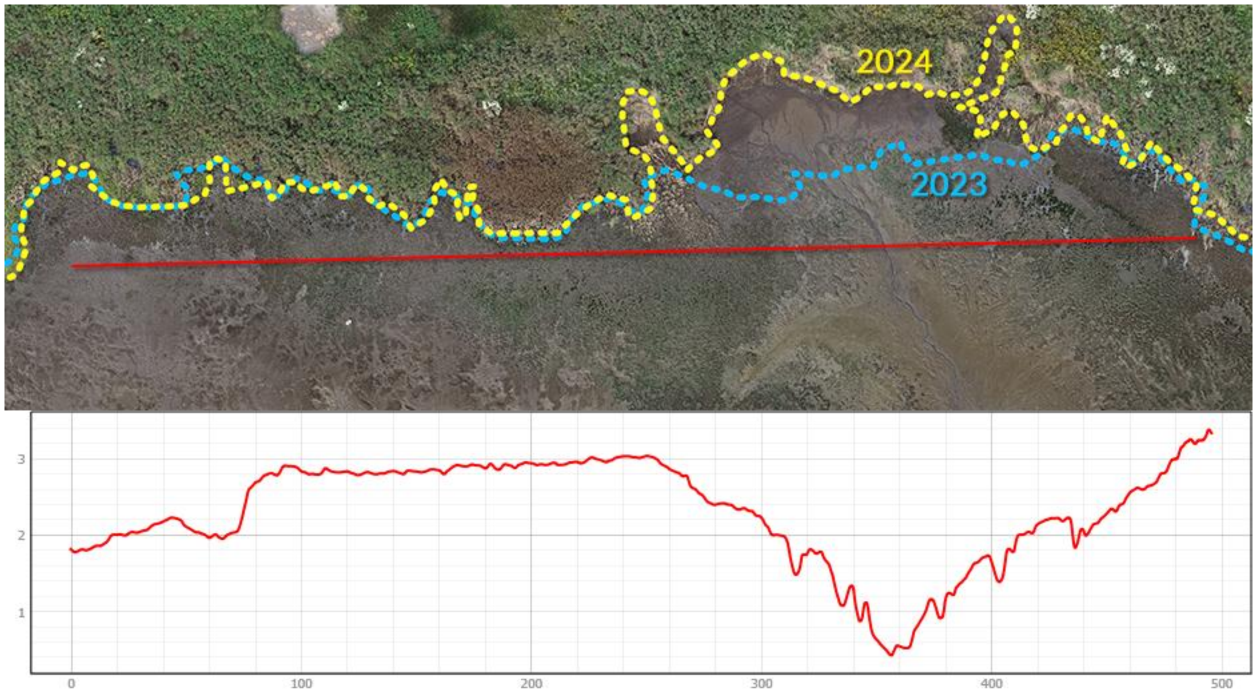

Figure 11: Comparison of the loss of marsh edge with lower elevations in a former drainage cutting through the marsh and intertidal zone.

At the same time, several patches of *Spartina alterniflora* were observed to expand in size along the intertidal flats over the monitoring period. Some areas of the backing marsh that were covered by salt hay (*Spartina patens*) in 2022 are now covered by woody shrubs, particularly just behind the areas that lost woody shrub coverage due to erosion. This could suggest that sediment and organic matter are being lost during erosion, moved into the backing marsh, and increasing the elevation. Woody shrubs, which prefer areas at or above the highest tides, are taking over areas of salt hay, which prefer elevations between mean high tide and the highest high tide. Meanwhile, towards the northeastern point of the peninsula, areas that were formerly covered by high marsh salt hay are transitioning to low marsh *Spartina alterniflora*, suggesting that these areas are becoming more frequently flooded over time.

IV. Next Steps

The restoration and monitoring work conducted at Basket Flats has provided experience and context for what changes can happen before, during, and after restoration. This gained experience includes the understanding of how former drainages can impact breakwater settling behavior, how much sediment can be expected to build behind breakwaters after they're placed, and how the shoreline and marsh edge vegetation will change in varying ways over time.

The monitoring effort will help inform the next steps we intend to pursue to protect Basket Flats. We intend to craft a new proposal to address several issues along the peninsula, including:

- Establishing a sill along the backing river side of the peninsula to control erosion
- Increasing the height breakwater structures that have sunken to bolster their wave-attenuating capability
- Placing coir log barriers along severely eroded marsh vegetation to protect the marsh edge
- Planting *Spartina alterniflora* seedlings in suitable areas of the intertidal zone to stabilize the marsh platform and absorb wave energy
- Continue drone and RTK monitoring of the peninsula to observe changes in the breakwaters, shoreline, intertidal zone, marsh vegetation, and elevation.