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Impacts of Runaway Transgression on Back Barrier Marsh Ecosystems

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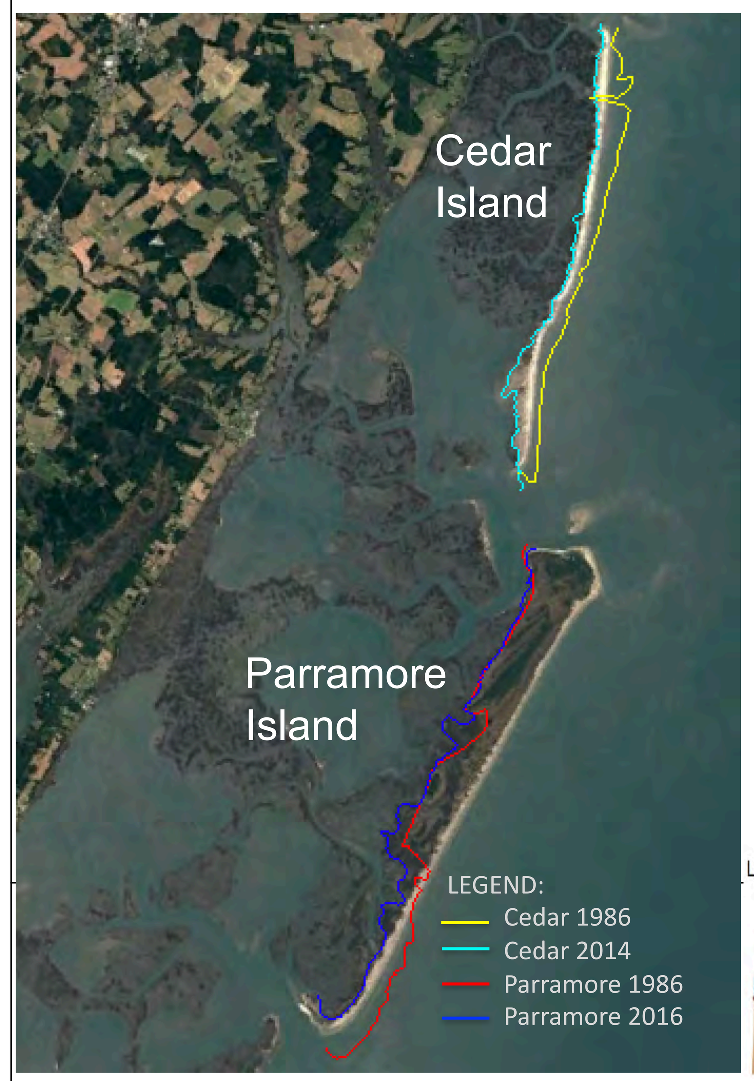
INTRODUCTION:

Storms and sea level rise can radically change the geography of barrier island and back barrier island ecosystems. Changes include overwash events and the formation of new inlets, which can radically alter the shape of barrier islands through the processes of erosion and deposition. These dynamics also affect the geomorphology of back barrier marsh ecosystems, through changes in tidal fluctuations and sediment inputs.

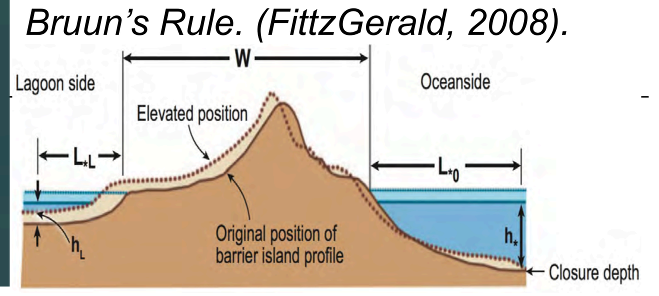
Cedar Island in the Virginia Bays, a part of what has been called the "Arc of Erosion" of the Virginia barrier islands, has been changing rapidly over the last 30 years. In comparison, Parramore Island, directly to the south, has remained largely stable (Figure 1). Cedar Island has narrowed due to erosion and has fallen below the critical barrier width required to maintain it's stability. As a result, overwash events are causing the island to rollover on itself, redistributing sediments to the back barrier and ocean slope (FitzGerald, 2008, Lorenzo-Trueba 2014).

Figure 1: Outline of the back barrier island wetland coastline. Background image is 2016 Google Earth Imagery.



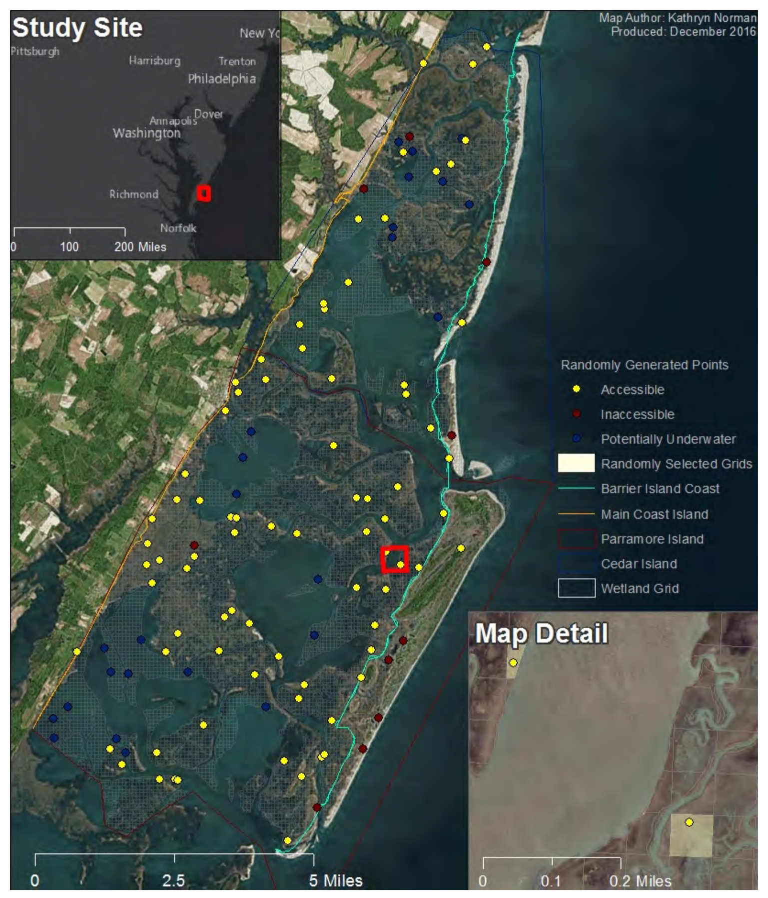
Cedar Island migration and disintegration is a source of sediment to the backbarrier, a source absent from Parramore. In addition, barrier island migration has reduced the backbarrier area behind Cedar, whereas backbarrier area has remained relatively constant behind Parramore. Therefore, we predict changes in marsh elevation in the backbarrier of Parramore Island relative to Cedar. Changes in the amount and content of sediment inputs are also likely to affect soil carbon and vegetation.

Figure 2: Overwash events cause barrier island width shrinkage and elevation increases, known as Bruun's Rule. (FittzGerald, 2008).



Sampling techniques for this project incorporate traditional vegetation sampling with GIS (Johnston et al, 2009. Barbour et al, 1999). Tidal wetlands (identified in the National Wetlands Index shapefile) were trimmed to the areas of Parramore and Cedar Island. One percent of grid cells within a 100 x 100m grid were randomly selected, and visited during June and July 2016. At each site, we sampled five randomly tossed 1m^2 quadrats for salinity, elevation, soil carbon, and vegetation composition. Elevation was measured with a Topcon RTK-GPS unit to within 1cm.

Figure 3: Map generated to identify sampling locations using data from NOAA's National Wetland Mapper.



FIGURES:

Figure 4 (above): *Distribution of elevation data across both marsh ecosystem behind both islands.*

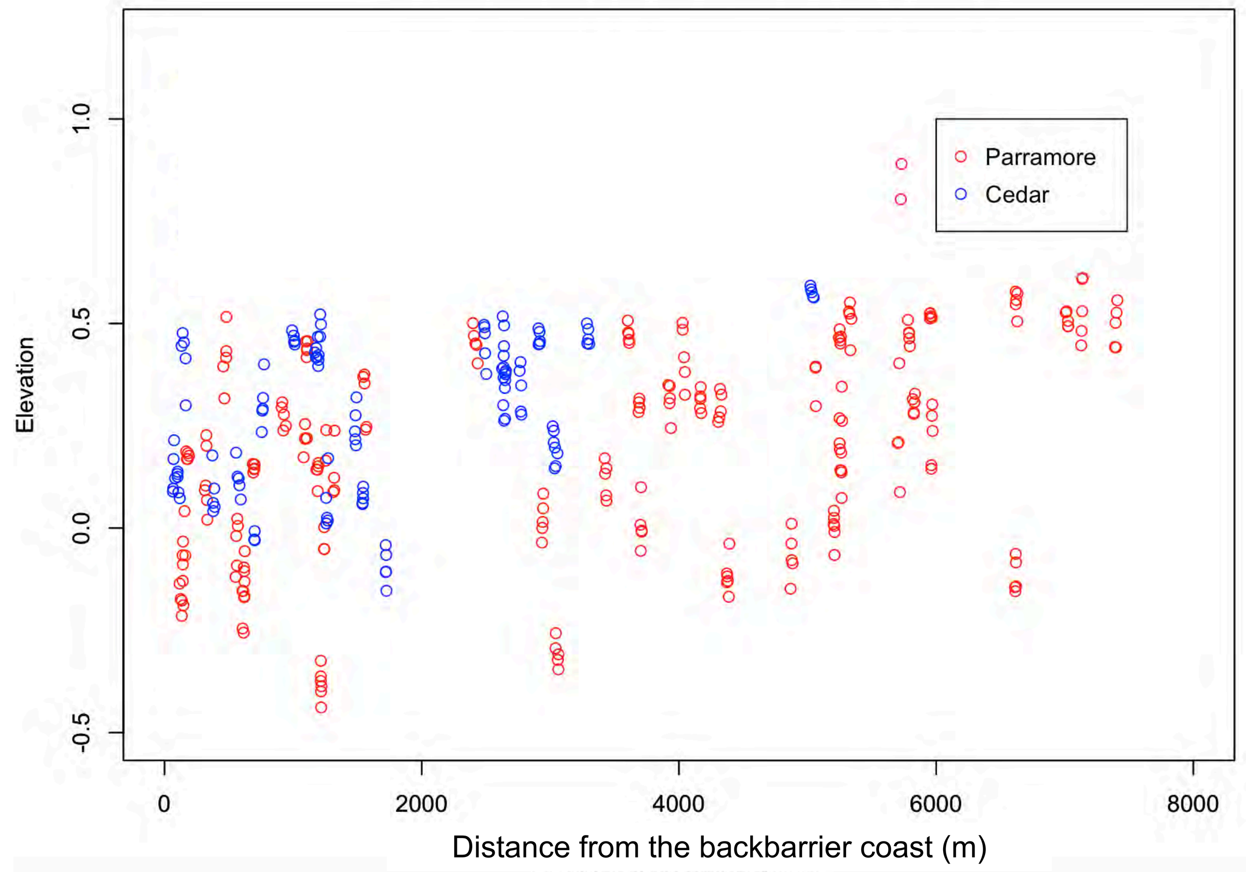


Figure 5 (left): *Plot of marsh elevation data plotted as distance from the back barrier coastline.*

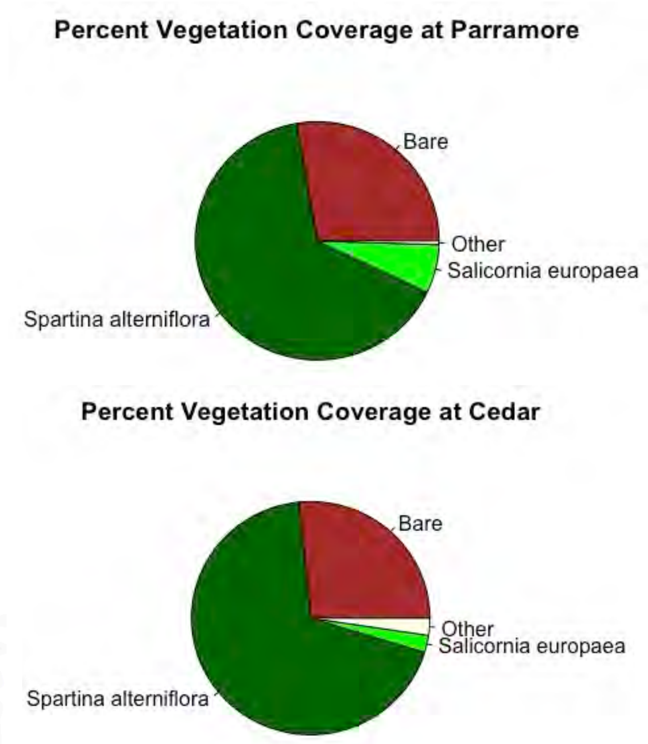


Figure 7: Vegetation composition of an average quadrat behind each island. "Other" species found included Spartina patens, Limonium carolinianum, Distichlis spicata, and Solidago sempervirens.

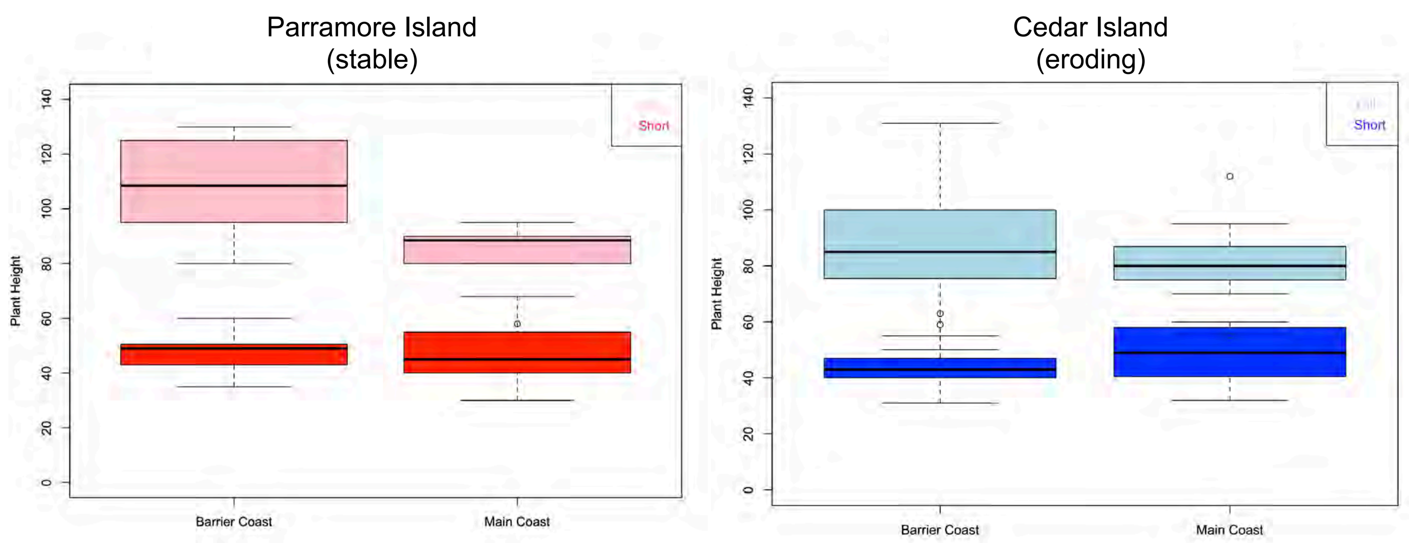


Figure 6: The distribution of tall and short form S. alterniflora *by distance to main land coast or back barrier coast behind Parramore and Cedar. Tall form* S. alterniflora *was tallest closer to the back barrier coast of Parramore.*

RESULTS:

In our data, we observed lower marsh elevations behind stable Parramore Island relative to rapidly migrating and disintegrating Cedar Island (Figure 4, 5). These low elevations were found predominantly within close proximity of either coastline behind Parramore (Figure 4). Marsh elevations reach a maximum of 0.5 m above sea level across all sites. This is consistent with tidal data; NOAA tide data in nearby Wachapreague, VA has the monthly mean highest flood tide reaching 0.564 m above sea level.

Additionally, we observed differences in the mean plant height of tall form *S. alterniflora* behind the two islands (Figure 6). The average height of tall form *S. alterniflora* was approximately 109 cm near the back barrier coast and 90 cm near the main land coast behind Parramore. At Cedar, the average height of tall form *S. alterniflora* was approximately 87cm near the back barrier coast and 82 cm near the main land coast. Outside of these variations in *S.alterniflora* growth patterns, overall patterns in vegetation community composition were similar behind both islands.

CONCLUSIONS:

Plant productivity responds unimodally to sea level rise. At higher elevations, sea level rise can increase aboveground primary productivity. At lower elevations, sea level rise can reduce productivity or drown areas of marsh (Morris et al. 2002). If sea level rise were affecting backbarrier areas of the two islands similarly, we would expect to see similar elevation and plant height distributions across all sites, but we observed differences dependent on barrier island migration status.

We observed higher marsh elevations behind Cedar, and correspondingly lower mean *S. alterniflora* height relative to Parramore Island. Behind Parramore Island, we observed lower elevations and higher mean aboveground *S. alterniflora* height.

We expect that these differences in elevation are due to the additional sediment inputs from Cedar barrier island migration and disintegration. We anticipate that our soil carbon analysis will indicate larger inputs of sand (low carbon concentration) in the areas behind Cedar relative to Parramore.

FUTURE WORK:

Future work for this project includes processing the collected soil data using loss on ignition to determine the percent carbon of soil composition. This data will then be analyzed using GIS and R to determine if there are any correlations between elevation, vegetation composition and blue carbon. Current understanding of blue carbon storage in wetlands and variability across spatial gradients remains limited. For this reason, our data will fill important knowledge gaps in our understanding barrier island dynamics and blue carbon. Wetlands have been shown to be highly efficient at sequestering and storing carbon. In an era of accelerating climate change, the implications of this work are that barrier island migration and evolution is paramount to protecting blue carbon sinks in backbarrier tidal marshes.

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