Introduction

Seagrasses can store vast amounts of carbon in their leafy canopies, root systems, and sediments, preventing CO₂ from entering the atmosphere. As such, seagrass restoration has gained traction as a viable CO₂ removal strategy that could be harnessed to mitigate climate change. However, natural variation in carbon storage by seagrasses is poorly resolved, particularly at scales relevant to restoration decisions. Additionally, the relative influence of ecological, physical, and oceanographic factors on carbon storage potential is still unknown, creating uncertainty about the likely outcomes of proposed restoration projects and how these benefits might vary over geographic scales.

We aim to quantify geographic variation in carbon storage associated with seagrass beds along the Florida Gulf Coast (FGC).

Methods

- In 2019, we visited seagrass beds (n=28) and nearby control sites without seagrasses (n=6) in panhandle of the FGC (Fig. 1), and conducted replicate seagrass surveys, biomass collections, and sediment coring (Fig. 2).
- In the lab, seagrass and rhizome biomass was dried, weighed, and identified. Sediment cores slices were dried, combusted to measure the fraction of organic content, and sieved for grain size composition (Fig. 2). We subsampled each slice for elemental analysis to estimate organic carbon.
- We used generalized additive models (GAMs) to assess how different seagrass carbon stocks—i.e., seagrass canopy biomass, rhizome biomass, and sedimentary organic carbon—vary in relation to seagrass community structure, physical properties, and oceanographic conditions.

Results

- GAMs for seagrass canopy biomass, rhizome biomass, and sedimentary organic carbon performed well (Table 1), with a small number of predictors explaining 70-85% of the variation.
- Seagrass canopy biomass generally increased with the water-column chlorophyll concentration, light availability at the seabed, proximity to shore, and the percent of sand sediment (Fig. 3A).
- Rhizome biomass increased with the seagrass cover and salinity but declined further from rivers and with manatee grass present (Fig. 3B).
- Sedimentary organic carbon was significantly higher in seagrass beds than unvegetated areas and increased further from rivers, in areas with lower current velocity, and where there was a higher silt (Fig. 3C).

Conclusions

- Our results indicate that carbon stored by seagrass canopy and rhizome biomass likely varies considerably across the study area with the oceanographic conditions. We also confirm that seagrasses significantly enhance sedimentary organic carbon stocks in this region. However, we found geographic variability that was unrelated to seagrass communities.
- These results suggest that blue carbon benefits from seagrass restoration are likely sensitive to variability in environmental drivers such as nutrient levels and sediment deposition rates, which may themselves be influenced by human disturbance.

Next Steps

- We will combine model outputs with existing seagrass distribution models, sedimentation maps, and oceanographic conditions to estimate the current distribution and variability of seagrass carbon stocks in the FGC.
- We also plan to explore likely carbon benefits from seagrass restoration within areas that have been identified for potential seagrass recovery.


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Figure 1. Sampling locations (orange) and the extent of confirmed seagrass beds (green) in the FGC.

Figure 2. Images from field sampling (top row) and laboratory analyses (bottom row).

Figure 3. Partial response curves for seagrass canopy biomass (A), rhizome biomass (B), and sedimentary organic carbon (C). Each plot shows the individual effects of each variable, holding all other variables in the model constant. The response is represented in terms of the mean center effect of predictor variables on the response value.