Stable and diverse seagrass meadows store more blue carbon, in part because they often contain turtle grass

INTRODUCTION

Seagrass meadows as blue carbon

Anthropogenic greenhouse gas emissions are driving climate change but may be offset by organic carbon captured and stored in seagrass sediments (blue carbon)[1]. Seagrass blue carbon pools are globally significant, storing up to 8.4 Pg carbon[2].

Seagrass ecosystems are effective carbon sinks, but carbon storage is highly variable across meadows

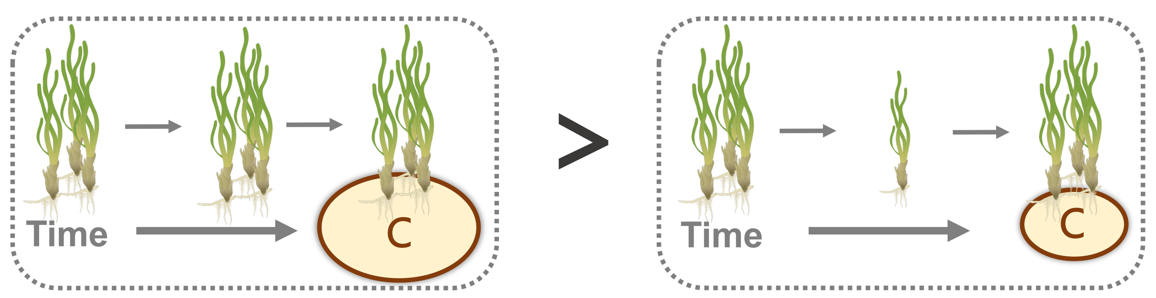
Seagrasses are submerged marine plants that grow along most coastlines and promote long-term carbon storage through burial of organic carbon in anoxic sediments[3]. Coastal managers and policymakers are interested in monetizing this storage through offset credits, but seagrass carbon storage is difficult to predict because it varies globally, regionally, throughout estuaries and within meadows[4-6].

Can biodiversity theory predict differences in storage?

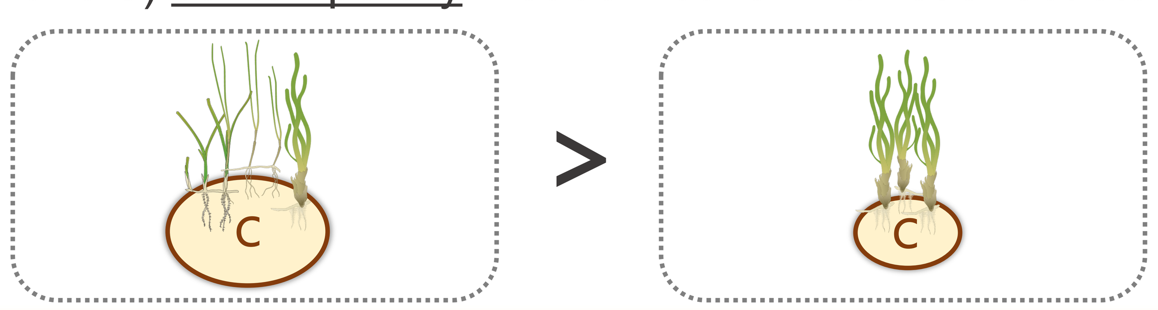
Seagrass species vary in size, shape, and other traits that can affect how well they trap and bury organic carbon in underlying sediments. Theory predicts that a diverse set of traits will result in a more stable meadow over time[7]. Since carbon accumulation occurs over long periods of time, historical meadow composition (related to species richness) may be a better predictor of carbon storage than contemporary cover.

We hypothesized:

1) carbon storage increases with historical seagrass cover and stability in cover (low variation in cover)



2) carbon storage increases with historical species richness and 3) contemporary meadow cover will not affect storage



Approach: we collected data in 2020 (referred to as "contemporary" or "current") and analyzed existing data from the Florida DEP (2006-2019) to test the effects of historical vs. contemporary cover and diversity on sediment organic carbon.

METHODS

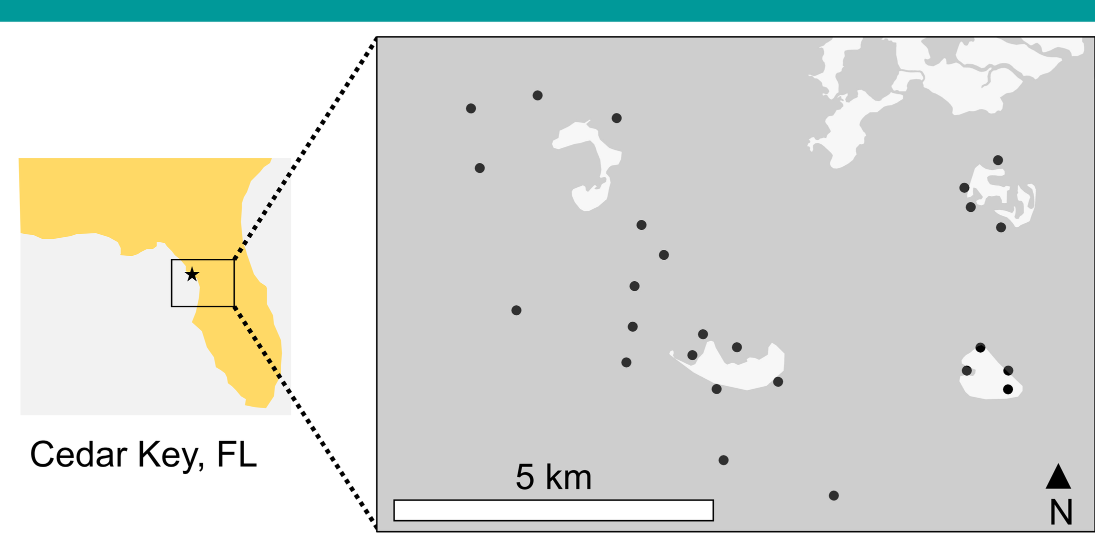
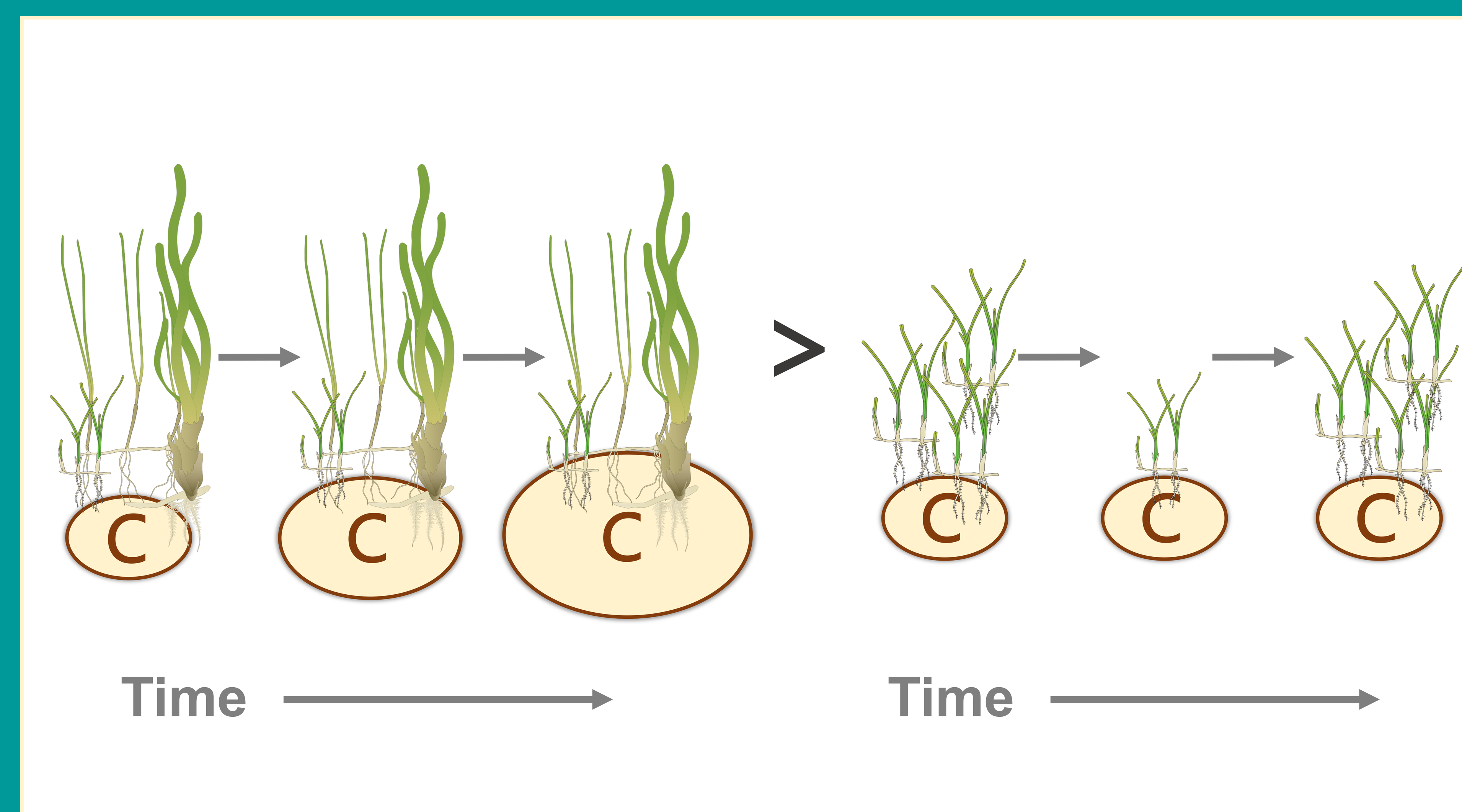
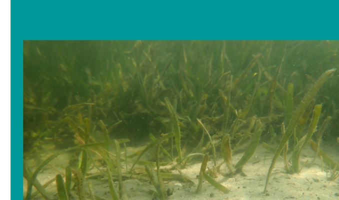


Figure 1: Map of 25 monitoring/sampling stations.

1. historical predictor variables
   - historical mean annual seagrass cover
   - historical mean annual seagrass species richness
   - variability in seagrass cover (coefficient of variation)
2. contemporary predictor variables
   - contemporary seagrass biomass
   - contemporary seagrass species richness
3. response variables
   - total organic carbon (TOC) and dry bulk density of surface sediments at 10 cm depth
     - TOC = TC – TIC
     - measured total carbon (TC) via spectrometry
     - measured total inorganic carbon (TIC) coulometrically
   - scaled TOC to sediment organic carbon per unit volume as mg organic carbon (OC) cm^{-3}



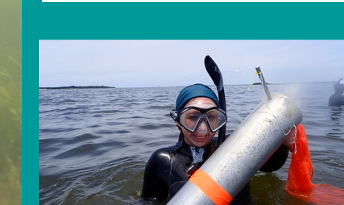
shoal grass



turtle grass

measuring seagrass cover

sediment sample



biomass core

sorting seagrass biomass

Seagrass species identity and historical cover influence sediment organic carbon stocks

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RESULTS & DISCUSSION

1) Carbon storage is highest in stable, high-cover seagrass meadows.

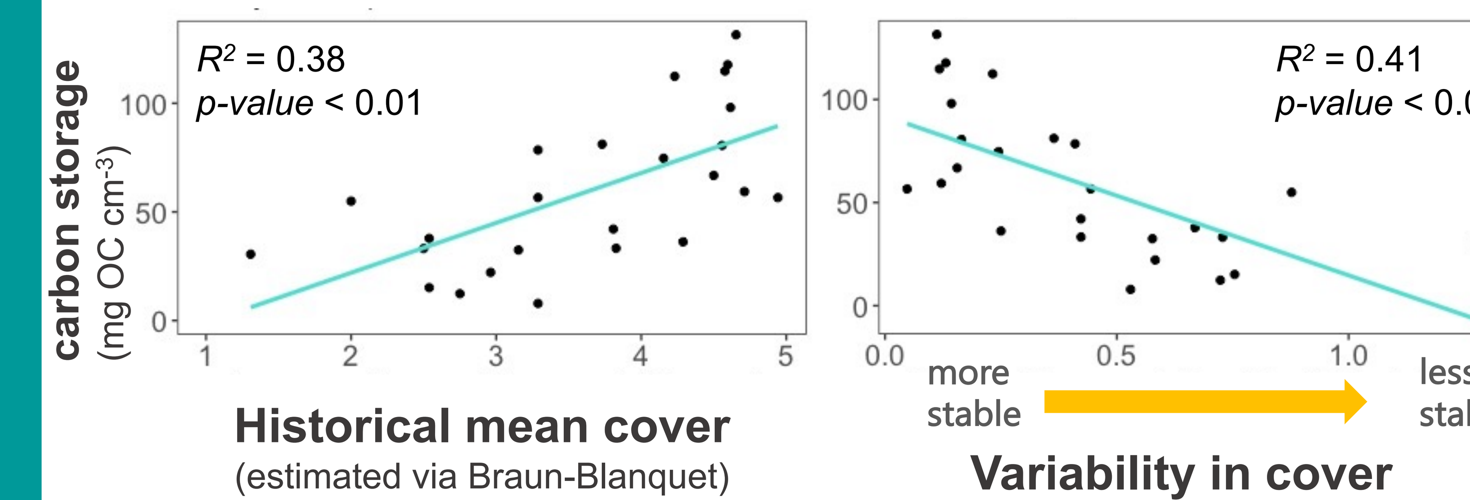

Figure 2: Relationships between historical mean cover (left) or variability in cover (right) and sediment organic carbon stocks.

2) Carbon storage is highest in diverse meadows.

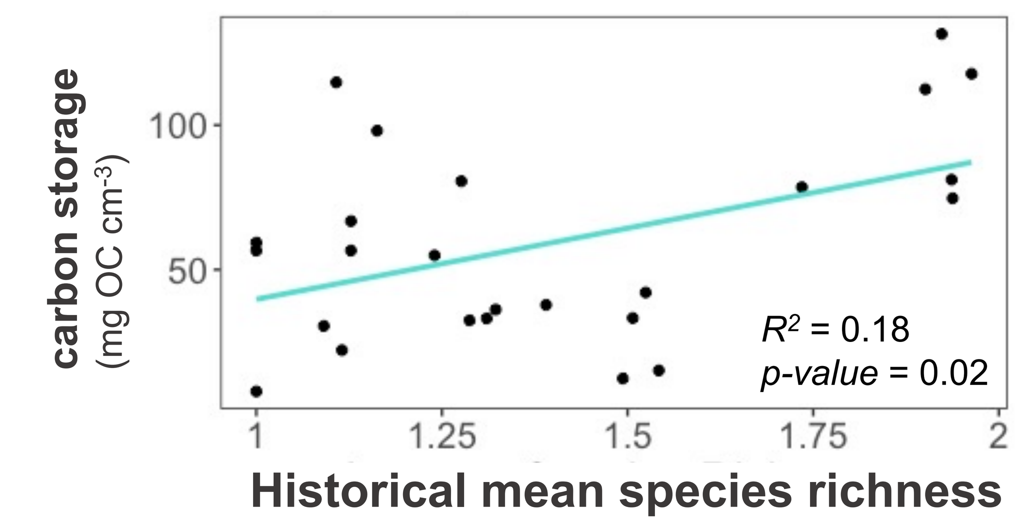

Figure 3: Relationship between historical mean species richness and sediment organic carbon.

3) Meadows with turtle grass store more carbon.

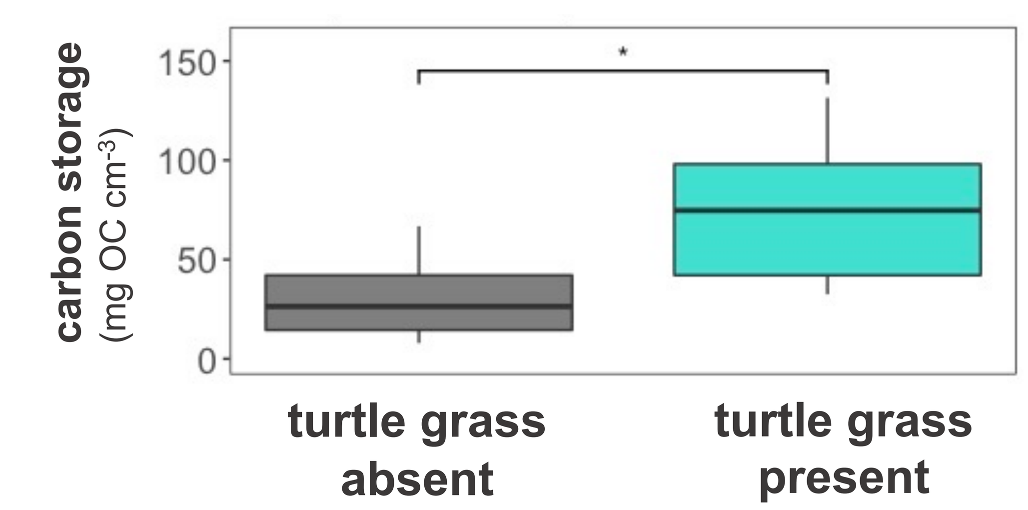

Figure 4: Sediment organic carbon from currently vegetated sites with vs. without turtle grass.

Contemporary species identity, but not biomass or richness, affected carbon storage. Turtle grass is a large, long-lived "climax" species often found in stable meadows.

Next steps: we will determine if turtle grass (*Thalassia testudinum*) is both currently *and* historically dominant in stable, high carbon meadows and use structural equation modeling to examine relationships between predictor variables.

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[1] Duarte, C.M. et al. 2013. *Nat. Clim. Chang.* 3:961-968. [2] Fourqurean, J.W. et al. 2012. *Nat. Geosci.* 5:505-509. [3] Trevathan-Tackett, S.M. et al. 2017 *FEMS Microbiol. Ecol.* 93:1-15. [4] Ewers Lewis, C.J. et al. 2018. Ecosystems 21:263-2379. [5] Ricart, A.M. et al. 2020. *Sci. Rep.* 10:1-12. [6] Oreska, M.P.J. et al. 2017. *PloS One* 1-18. [7] Johnson, K.H. et al. 1996. Trends Ecol. Evol. 11:372-377. Seagrass symbols: Integration and Application Network (ian.umces.edu/media-library)

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