Understanding the relationship between sediment grain size and organic matter in a temperate seagrass meadow.

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Introduction

Seagrass meadows are critical coastal ecosystems that act as natural carbon sinks, storing organic carbon in their sediments.

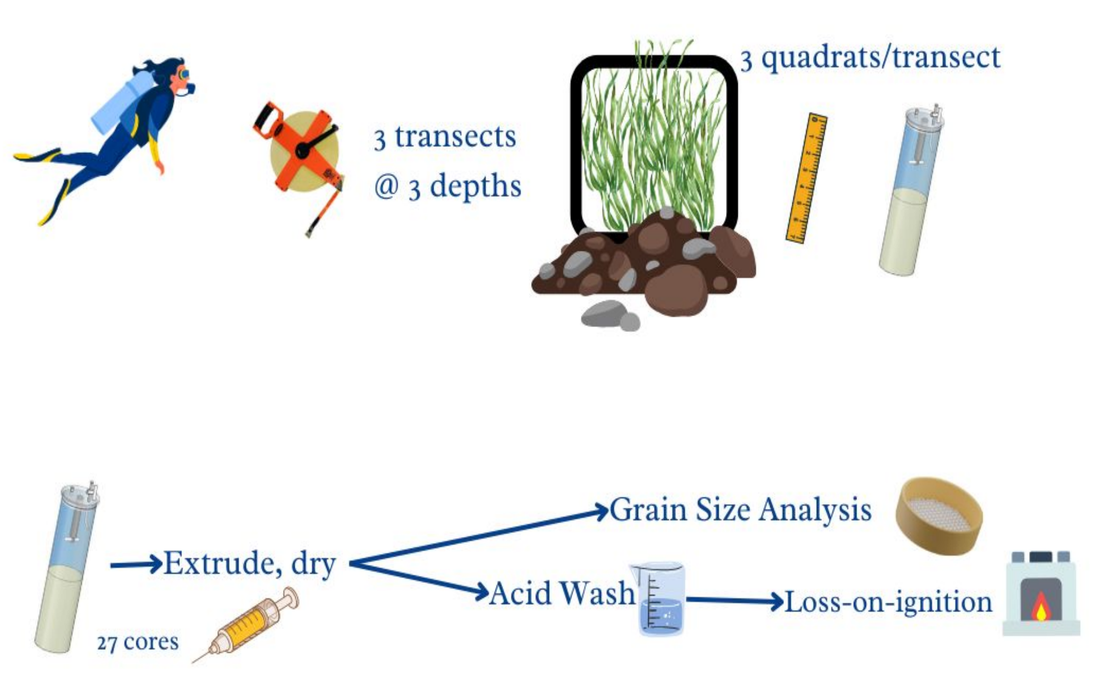
Protecting and restoring these habitats is essential for mitigating rising atmospheric carbon levels (Ricart et al., 2017). However, the specific environmental factors that influence the carbon storage potential of seagrass meadows remain insufficiently understood (McHenry et al., 2023).

In particular, sediment grain size may play an important role, as finer sediments are thought to retain more organic material due to their greater surface area (Dahl et al., 2016). This study investigates the relationship between sediment grain size and organic carbon content in a temperate seagrass meadow. We hypothesize that finer-grained sediments will store greater amounts of organic matter. To test this, we collected sediment samples from the San Dieguito Lagoon, a wetland located near San Diego, CA

Rationale:
Understanding how sediment characteristics influence carbon storage can inform seagrass restoration efforts and direct blue carbon management strategies.

Study Site

Methodology



Sample collection:

- Seagrass shoots and sediment cores were collected on SCUBA in October of 2024 from the W1 area of the San Dieguito Lagoon.
- Sampling occurred at shallow, middle, and deep transects
- Within each of the three transects, we collected data for three quadrats

Statistical Analysis:

- To understand the relationship between organic matter and depth (RTE), we ran a linear regression for all core samples using vertical datum and % organic matter data.
- We also plotted % total organic matter (TOM) against % mud (grain size <0.63 microns), as well as dry bulk density.

Next Steps:

- Elemental Analysis for relationship between total organic matter (TOM) and total organic carbon (TOC).
- Compare San Dieguito Sediment with Samples from other sites along the coast of California.

Results

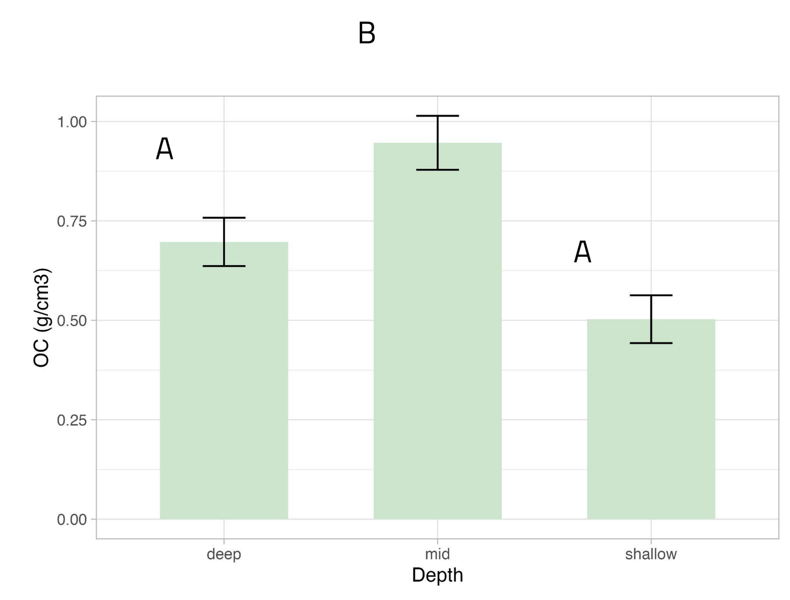


Figure 1.
Average organic carbon density (g/cm³) ± SE for each depth category. The "mid" depth category showed a significantly higher amount of carbon than deep and shallow depths. ($p<0.001$)

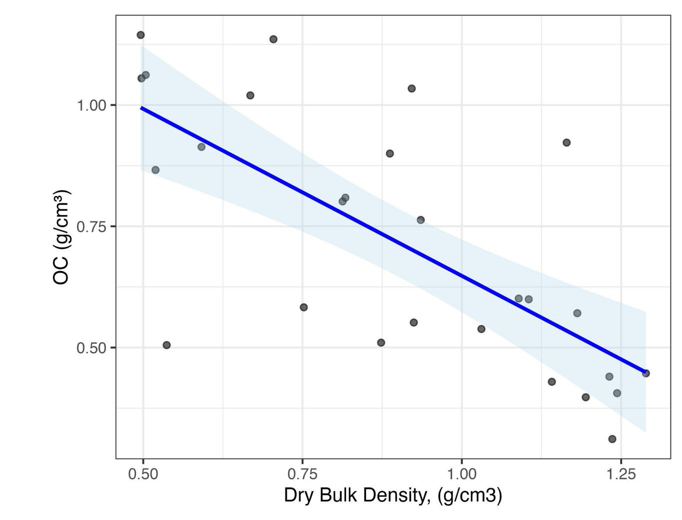


Figure 2.
Linear regression for the relationship between dry bulk density (DBD, g/cm3) and sediment organic carbon. Relationship was significant, $p<0.0001$, $R^2=0.4868$.

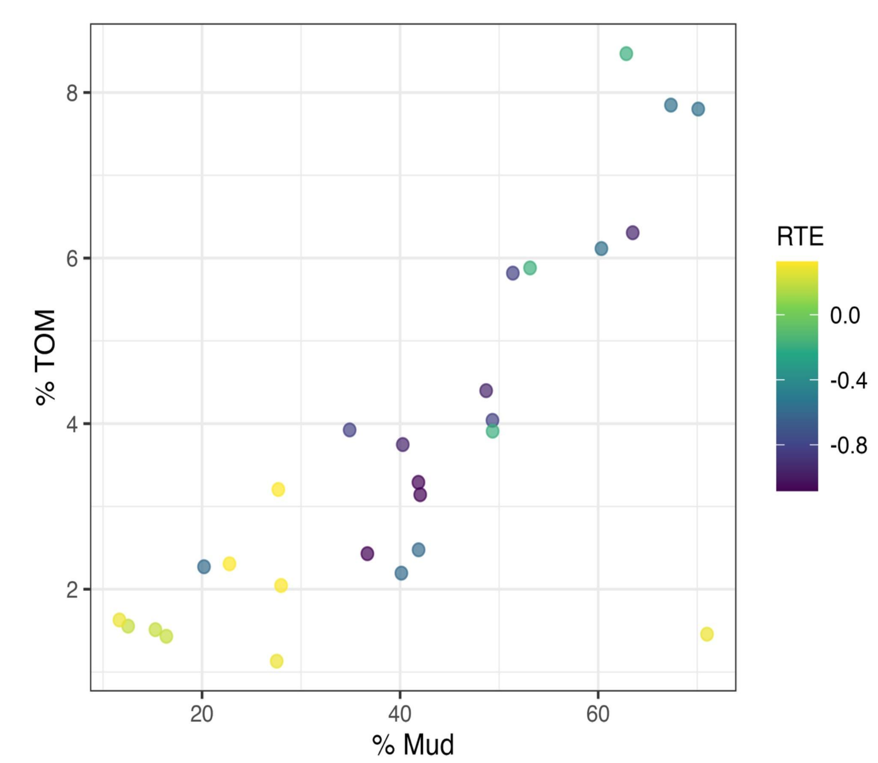


Figure 3.
Relationship between total organic matter (TOM, %) and sediment mud content (%). Points are colored by Relative Tidal Elevation (RTE), with lower elevation sites (deeper) (more negative RTE) associated with muddier sediments and higher organic matter content.

Organic carbon density was highest at mid-depth points compared to shallow depth sites (Figure 1). There was a statistically significant difference between groups ($p<0.001$). Suggesting that mid-depth sediments are more favorable for carbon accumulation. A negative linear relationship between was found between dry bulk density and organic carbon content (Figure 2). This result indicates that less dense sediments have higher carbon storage capacities ($p<0.0001$, R2=0.4868). Higher mud content was associated with an increase in total organic matter (TOM) and lower elevation sites (more negative RTE) tend to have more mud and organic carbon content (Figure 3). This suggests that elevation and mud content play a role in controlling carbon storage, with deeper, less dense, muddier areas acting as ideal conditions for carbon sequestration.

Conclusion

Our results support the hypothesis that finer grain sediments in seagrass meadows retain more organic carbon, likely due to their higher surface area and binding capacity (Dahl et al., 2016). This relationship highlights the importance of sediment composition in blue carbon storage. We also show a significant inverse relationship between dry bulk density and organic carbon. Understanding these dynamics can inform site selection and sediment management strategies in future seagrass restoration projects aimed at maximizing carbon sequestration.

References

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