TSS and POC in Coastal Carbon Cycling Comparing Tidal Marshes and Oyster Aquaculture

Lauren VanMeter, Amanda L. J. Knobloch

Patuxent Environmental and Aquatic Research Laboratory, Morgan State University, St. Leonard, MD

Introduction

Tidal marshes are important coastal habitats that influence water quality, support ecosystem health, and play key roles in the coastal carbon cycle (Bianchi and Bauer, 2011). As these habitats decline due to climate change and human activity, finding alternative solutions that can provide similar ecosystem functions is crucial. This project explores whether oyster aquaculture can replicate the carbon cycling functions of tidal marshes

Particulate organic carbon (POC) comes from stirred up sediments and estuary production, usually settling on marsh surfaces or creek sediments. Total suspended solids (TSS) are sediment and organic matter particles floating in water, affecting clarity and carbon transport (Knobloch, 2021). By looking at these parameters and their fluxes throughout tidal marshes and oyster aquaculture sites, we can assess the potential of oyster aquaculture as a viable solution.

Objectives of this study:

1. Compare the influence of saltwater tidal marshes and oyster aquaculture farms on coastal carbon cycling.
2. Advance knowledge of the coastal carbon cycle through continuous, long-term sampling methods.
3. Explore how tidal marshes and oyster farms affect coastal biogeochemical cycles.

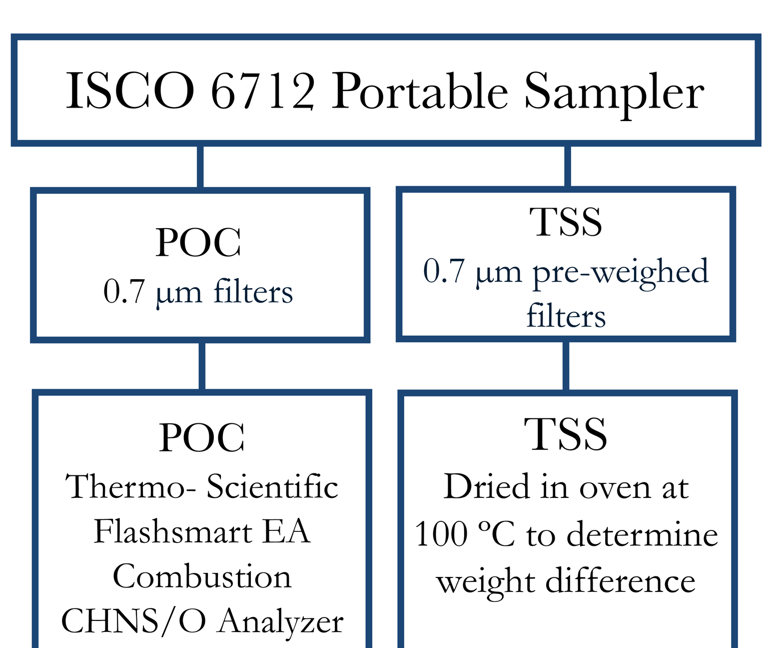
Study Site

Figure 1. Water sampling occurred at three sites shown on the map, at tidal marshes and oyster aquaculture farms — Cambridge, MD (Maryland Eastern Shore), Patuxent River (Jefferson Patterson Park), and Tall Timbers (Potomac River), which were chosen for similar salinity, tides, and geography.

Site	Site ID
Eastern Shore	ES
Patuxent River	PR
Jefferson Patterson	JP

Methods

Figure 2. Paired tidal marsh and oyster aquaculture sites were sampled by the Teledyne ISCO 6712 Full-Size Portable Sampler — sampling every 2.5 hours for 25 hours. Samples are then refrigerated to prevent degradation. Water is filtered onto glass fiber filters (GF/F, 0.7 µm pore size) for POC and TSS. After POC is acidified and pelletized, samples analyzed on a Thermo- Scientific Flashsmart EA Combustion CHNS/O Analyzer. TSS samples were dried at 100 °C to compare the weight of the unused filter to the weight after filtration.



Results – TSS & POC

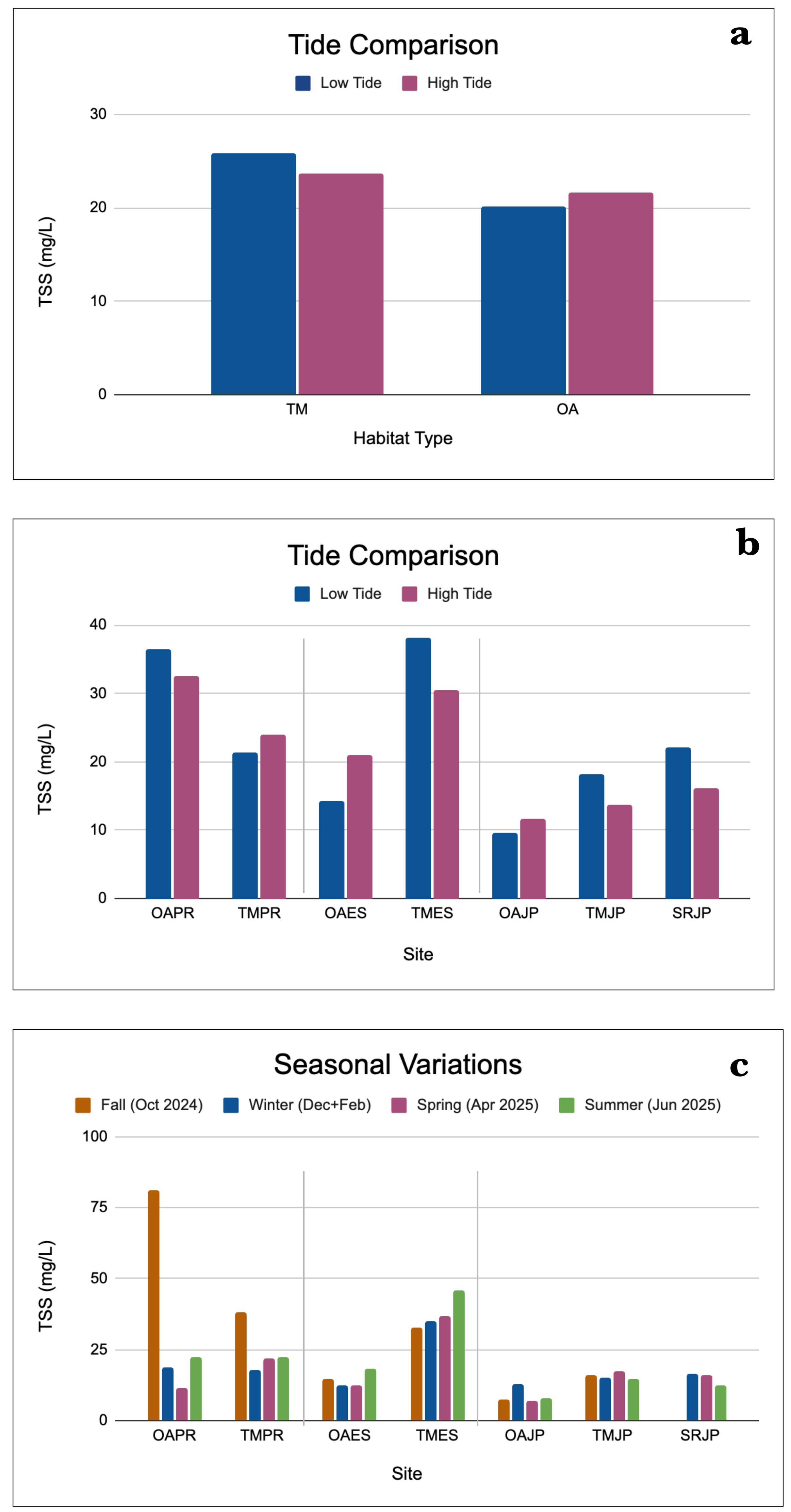


Figure 3. Comparisons of TSS concentrations between site types at low and high tides (a), between all sites at low and high tides (b), and across seasons at low and high tides at each site (c).

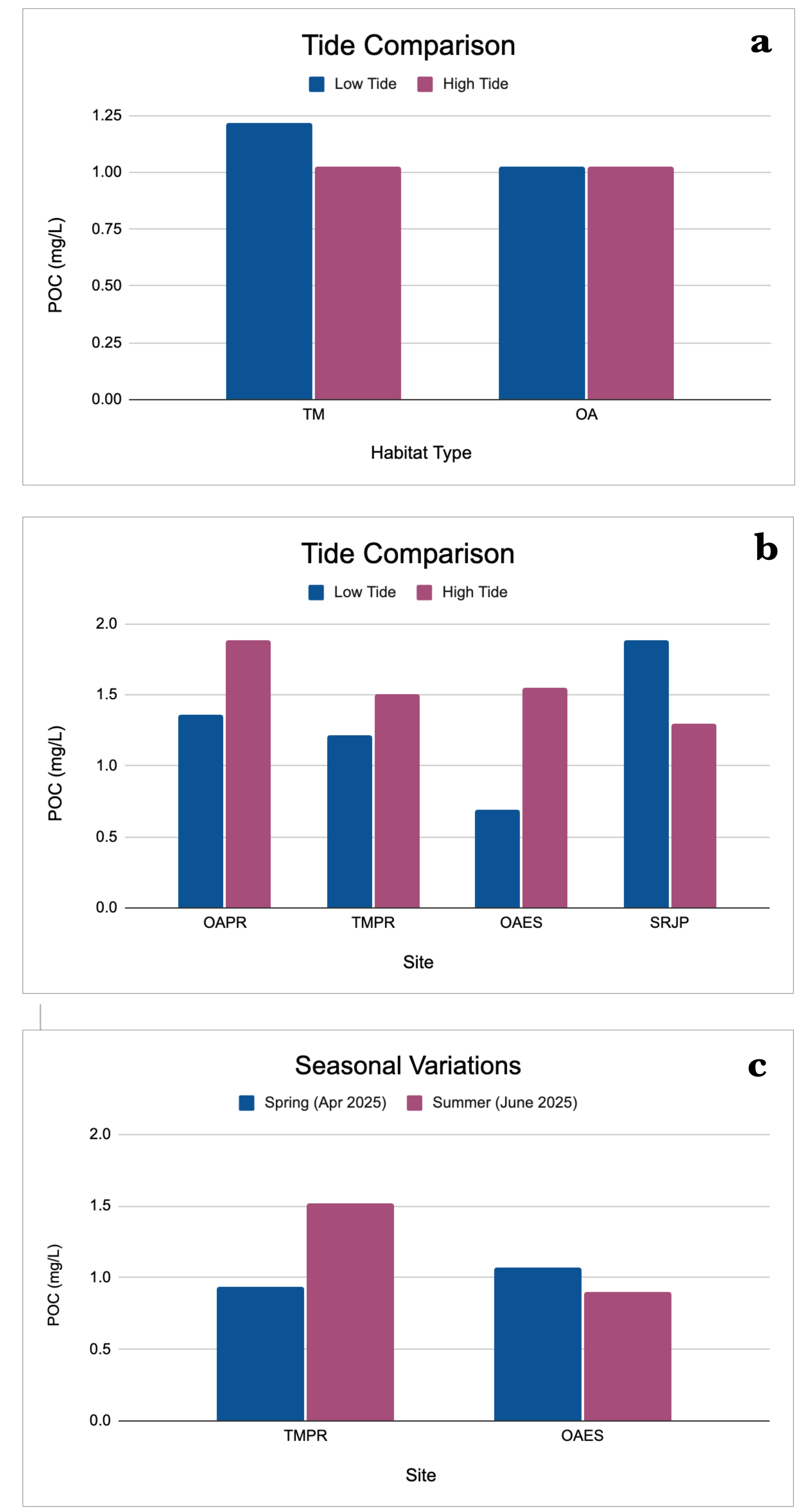


Figure 4. Comparisons of POC concentrations between site types at low and high tides (a) and between all sites at low and high tides (b).

Summary

- TSS concentrations were higher at tidal marshes than at oyster aquaculture facilities, but the difference between tide stages was not significant ($p=0.91$)
- POC concentrations were similar between both habitat types, with slightly higher values at low tide across tidal marshes; no significant differences were detected by site type ($p=0.2$).
- At the site level, OAPR and TMES showed the highest TSS concentrations, especially at low tide; JP sites were significantly different from PR and ES sites ($p<0.005$).
- POC concentrations peaked at OAPR and SRJP sites, particularly at high tide; differences among sites were not significant ($p=0.055$).
- Seasonal patterns show a strong spike in TSS at OAPR during Fall 2024, which drove the significant seasonal difference ($p<0.005$), while other sites showed smaller seasonal variations.
- POC seasonal variations were most pronounced at TMPR, with higher concentrations in Spring 2025 compared to Summer 2025, though seasonal differences were not significant ($p=0.057$).

Conclusion

Understanding how oyster aquaculture systems interact with coastal carbon cycling processes is essential for developing adaptive strategies in the face of climate change. Tidal marshes show how tides and seasons move carbon in and out of the system, revealing how these habitats store, release, and move materials through the estuary (Knobloch, 2021). These habitats naturally filter water, trap sediments, and sequester carbon, which are functions that could possibly be replicated by aquaculture systems (Bianchi and Bauer, 2011). By investigating the parameters of total suspended solids (TSS) and particulate organic carbon (POC) across tidal marshes and oyster aquaculture sites, we gain insights into how these systems compare in terms of carbon processing, sediment retention, and material fluxes. This research will help guide sustainable aquaculture practices and improve our water quality conditions and maintain critical ecosystem functions under changing environmental conditions.

Acknowledgments

Funding for this project was provided by a federal earmark (Congressionally Directed Spending 2023: Morgan State University PEARL Lab Student Research Enhancements) and by NSF Award 2300261 (NSF HBCU – UP: Research Initiation Award: Comparing Carbon Fluxes of Tidal Marshes and Oyster Aquaculture Farms in the Chesapeake Bay).

References

1. Bianchi, T.S., and J.E. Bauer. "Particulate Organic Carbon Cycling and Transformation." *Treatise on Estuarine and Coastal Science*, 2011, pp. 69–117
2. Knobloch, Amanda L., et al. "Carbon pools differ in source and temporal patterns in a tidal Marsh Creek system of the York River, VA Estuary." *Estuaries and Coasts*, vol. 44, no. 7, 18 Feb. 2021, pp. 1848–1865