Mangroves and seagrass positively affect water quality and grazer populations on Eastern Caribbean reefs

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Introduction

Mangroves, seagrasses, and coral reefs are intricately linked through many biological, chemical, and physical processes, which include sediment trapping, nutrient export, nutrient trapping, and nursery provision[1]. These processes contribute to the reef ecosystem by maintaining water quality[2], introducing alternative sources of carbon[3], limiting the introduction of excess nitrogen and phosphorous, and controlling algal growth via herbivory, respectively.

Because the health and resilience of coral reefs depend on these processes influenced by mangroves and seagrasses, we must understand and preserve these linkages for effective coastal management.

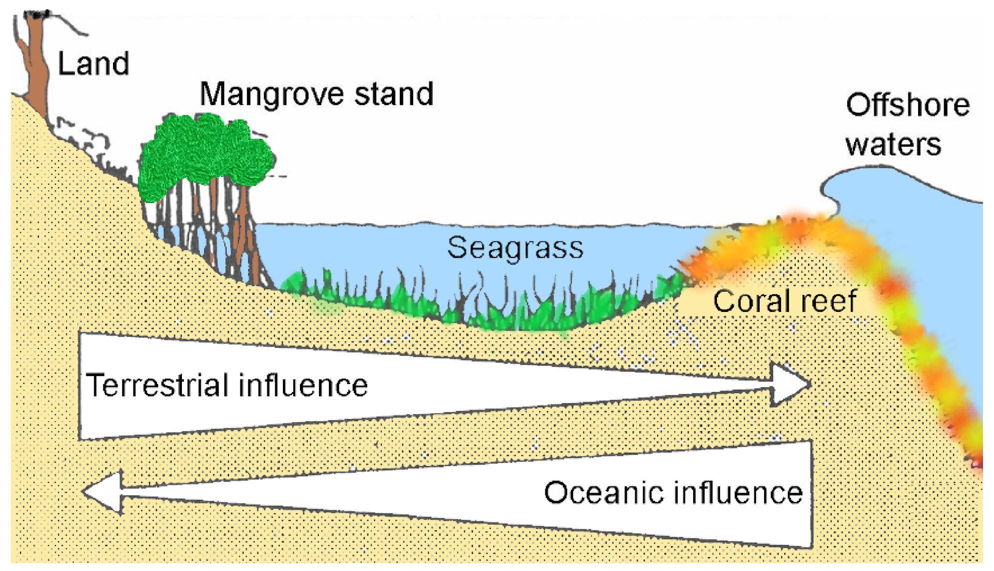

Figure 1: Two-way influences among mangrove, seagrass, and coral reef ecosystems (Modified from Vanderstraete, 2007)

Objectives

- Compare water quality at nearshore sites with mangroves and/or seagrasses to sites with neither
- Assess whether juvenile grazer density differs between sites with mangroves and/or seagrasses and sites with neither
- Determine how water quality changes with distance from shore, along the mangrove-seagrass-coral reef continuum

Figure 2: Map of Eastern Caribbean showing study sites (n=10)

Methods

This study examined 10 sites in 4 countries across the Eastern Caribbean in late 2017. I conducted visual fish surveys for juvenile grazers, namely Scaridae (parrotfish) and Acanthuridae (surgeonfish), and collected water samples at varying distances from shore to quantify the following:

- Suspended particulate matter (SPM)
- Dissolved organic carbon (DOC)
- Chlorophyll *a*
- Nitrates and Phosphates

All data were collected and processed onboard the SSV Corwith Cramer, operated by Sea Education Association, with support from SEA faculty, staff, and fellow SEA Semester students.

Results

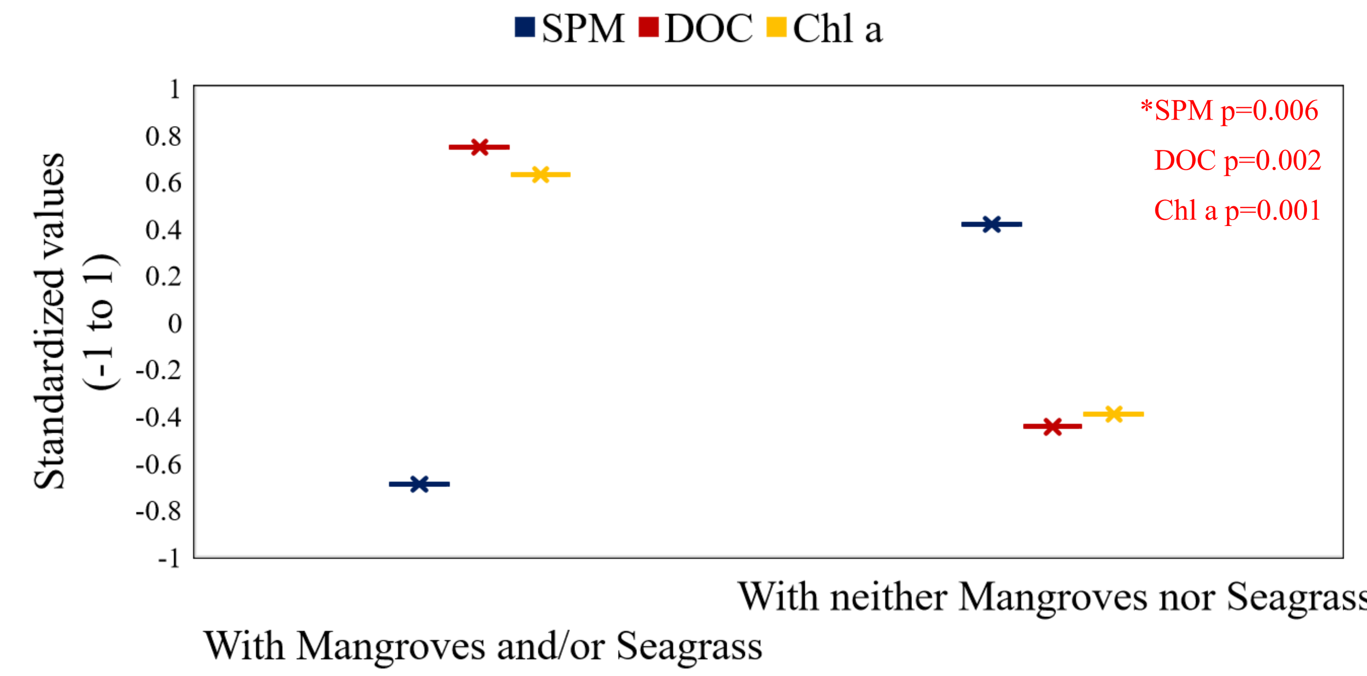

Figure 3: Mean SPM, DOC, and Chlorophyll *a* levels at sites with mangroves and/or seagrass (n=9) and sites with neither (n=15). All values were standardized between ±1.

Mean SPM at sites with mangroves and/or seagrass was less than 40% of that at sites with neither. Thus, these two ecosystems are filtering significant amounts of sediment out of the water and maintaining the water quality within the parameters necessary for photosynthesis[2] on coral reefs.

There was almost twice as much DOC at sites with mangroves and/or seagrass than at sites with neither. This is noteworthy because mangroves and seagrasses are now being recognized as a source of organic carbon for reef ecosystems[3, 4]. This introduction of DOC into the coral reef food web creates more intricate energy paths by diversifying food sources for organisms in the lower trophic levels, which ultimately makes reefs more resilient to disturbances affecting any food source.

Chlorophyll *a* concentration was also much higher at sites with mangroves and/or seagrass than at sites with neither. Nitrates and phosphates did not differ significantly between treatments ($p>0.05$).

Mangrove and/or seagrass presence did not affect the overall density of juvenile grazers (which averaged 0.55 individuals/m^2) but the composition thereof. Parrotfish juveniles were more common at sites with these flora, comprising 98% of total grazers, compared to 85% at sites without mangroves or seagrass. This may be because some species of parrotfish have a functional dependency on mangroves for nursery habitat[1], whereas surgeonfish do not. This disparity can influence the grazer composition on reefs, and thus algal control if the families differ in rates of herbivory.

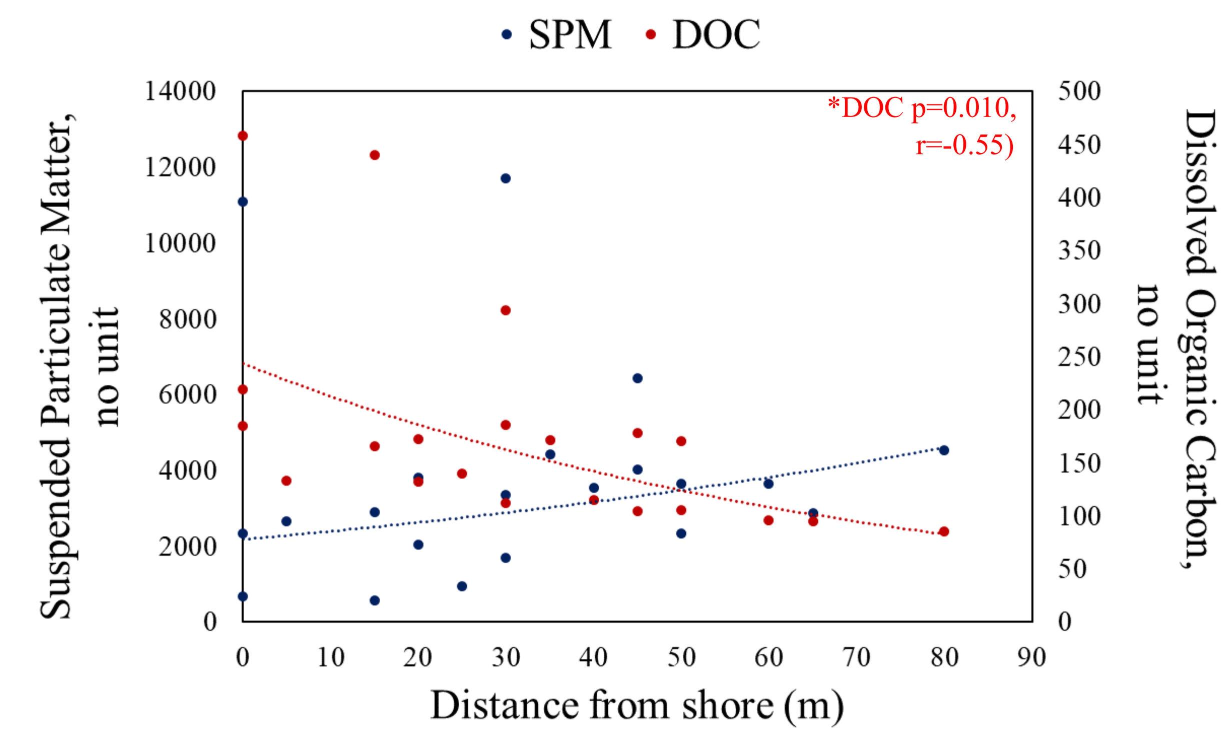

Figure 4: SPM and DOC levels as a function of distance from shore (m), excluding outliers (300–320 m)

Only SPM and DOC showed any trends relative to distance from shore, depending on the inclusion of a outlier site 300–320m from shore. Once the outlier is removed, the positive trend for SPM disappears, but a negative trend for DOC appears. It shows that DOC levels significantly decreased with increasing distance from shore, implying dispersal from the source. Previous studies have traced coastal dissolved organic matter (including DOC) to mangroves more than a kilometre away[4], suggesting that DOC of mangal origin can travel significant distances to be utilized in other coastal systems.

Conclusions

- The presence of mangroves and/or seagrass results in less suspended solids, more dissolved organic matter, and more Chlorophyll *a* in coastal waters, which promotes healthier and more productive coral reefs.
- The presence of mangroves and/or seagrass also influences the grazer population, resulting in a higher proportion of parrotfish on the reef.
- The levels of dissolved organic carbon decrease with distance from shore, as it disperses from its mangal origin.

References

[1]Mumby, P. J., et al. (2004). *Nature*, *427*(6974), 533–536.
[2] Erftemeijer, P. L. A., Riegl, B., Hoeksema, B. W., & Todd, P. A. (2012). *Marine Pollution Bulletin*, *64*(9), 1737–1765.
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[4]Hogarth, P. J. (1999). *The Biology of Mangroves*.
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