DOC and fDOM Cycling in Tidal Marshes and Oyster Aquaculture Facilities

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Introduction

- Tidal marshes play a crucial role in the production and transport of various forms of carbon in riverine and estuarine ecosystems
- As tidal marshes are at risk of drowning and disappearing due to sea level rise, oyster aquaculture facilities are increasing as demands rise for seafood produced with less environmental impact
- Comparison of carbon concentrations, tidal trends, and seasonal trends in tidal marshes (TM) and oyster aquaculture facilities (OA) could reveal similarities that allow OA to supplement the coastal carbon cycling provided by TM[1]
- Dissolved organic carbon (DOC) compounds are smaller than 0.7 µm and are produced from erosion, decomposition, plate leachates, plankton, and a variety of other terrestrial and aquatic sources[2]
- Fluorescent dissolved organic matter (fDOM) is made up of marine and terrestrial components that can be characterized by their fluorescent properties

Study Area

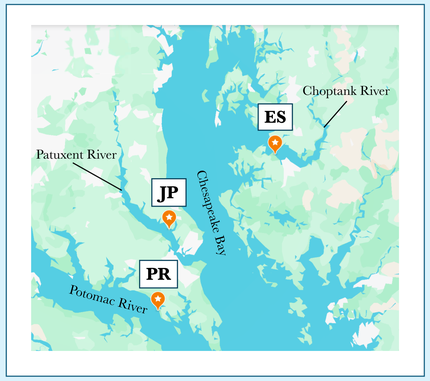

Figure 1. Study area map of three water sampling sites in Maryland: Horn Point Laboratory on the Eastern Shore (ES), Jefferson Patterson Park and Museum (JP), and Potomac River in Tall Timbers (PR).

Methodology

- At paired OA and TM sites in each sampling location (ES, JP, PR), 950 mL of water were sampled by Teledyne ISCO 6712 Automatic Water Sampler every 2.5 hours for 25 hours (11 samples) every other month[1]
- All samples were vacuum filtered; DOC samples were additionally filtered through 0.2 µm Supor membrane syringe filters and acidified with 2 µL 4M HCl per 1 mL water[3]
- Concentration of DOC in water samples was measured using Shimadzu TOC-L with TNM-L
- fDOM samples were analyzed using Shimadzu RF-6000 Spectro Fluorophotometer to produce excitation-emission matrices (EEMs)[4]
- EEMs were analyzed for fDOM components and maximum fluorescence (fMax) intensity values using parallel factor analysis (PARAFAC)[5]

Results

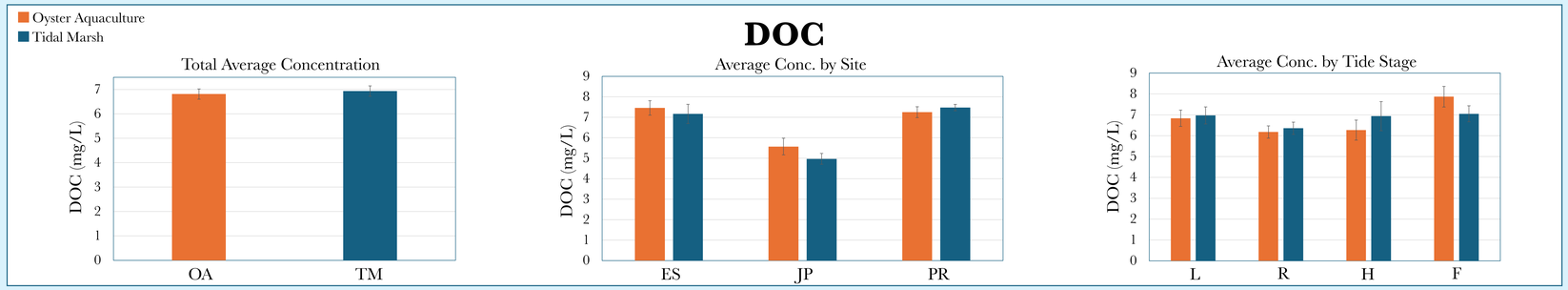

Figure 2. Average concentrations of DOC (mg/L) measured in oyster aquaculture and tidal marsh water samples collected in June 2025 at ES, JP, and PR sites. No statistically significant differences were observed between the OA and TM total averages across all sites (left), averages at each individual sampling site (middle), or averages at each tide stage: low, rising, high, and falling (right).

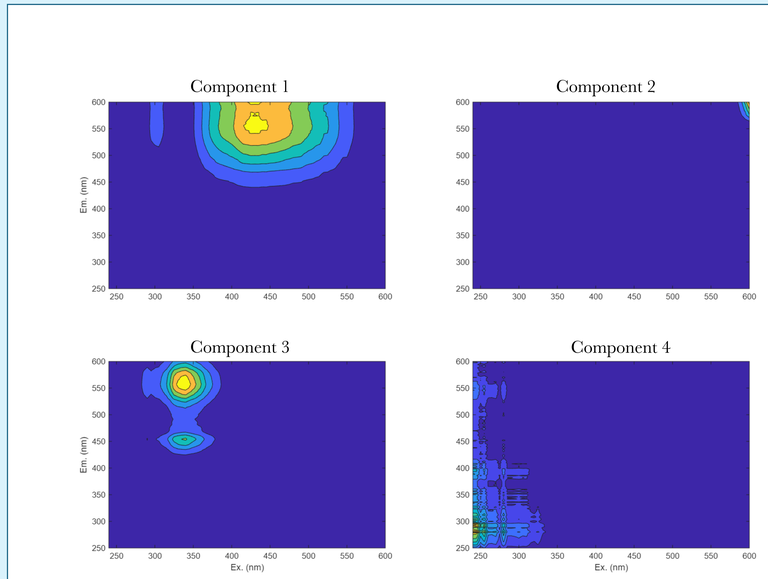

Figure 3. Four components of fDOM derived from PARAFAC of EEMs. Components 1 and 2 are likely terrestrial due to their high fluorescence. Component 3 is similar to traditional peak "M" which is characterized as marine humic-like.[4] Component 4 is likely marine humic-like.[6]

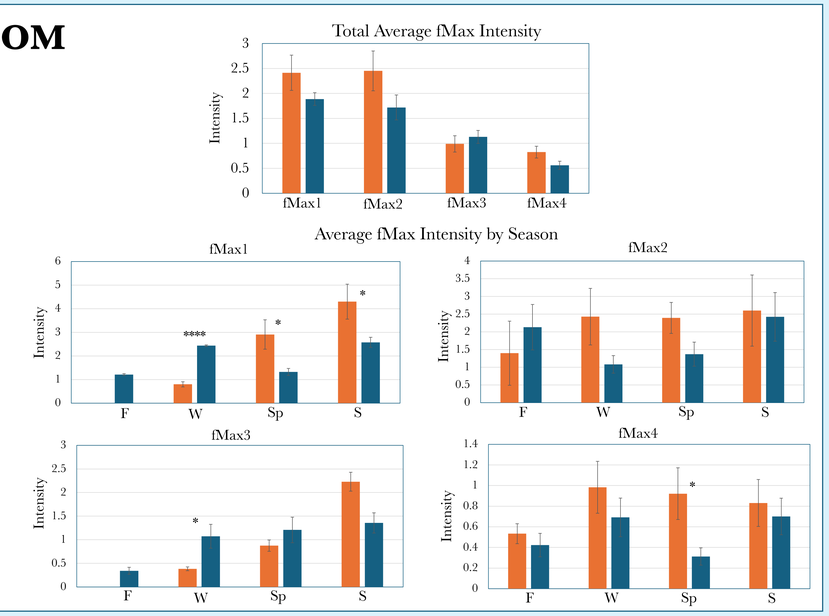

Figure 4. Average intensity of the fMax of each fDOM component measured in OA and TM water samples collected from Oct 2024 – June 2025 at ES, JP, and PR sites. No statistically significant difference was observed between the OA and TM averages across all sites (top). Asterisks denote statistically significant differences between OA and TM average intensities of individual components (fMax1-4) in certain seasons (**** $p<0.0001$, * $p<0.05$).

Conclusions

OA and TM do not differ significantly in average DOC concentration in total, by site, or at different tide stages. This supports the potential for oyster aquaculture and tidal marshes to contain similar concentrations and tidal fluctuations of DOC, which will become increasingly important as tidal marshes are lost and oyster aquaculture expands.

OA and TM do not differ significantly in average total fMax intensity for any of the four components, however, seasonal differences between OA and TM were significant. Specifically, there was significant seasonal variation in terrestrial components (1) across all seasons, while marine components (3 and 4) varied significantly only in winter and spring. These differences in fDOM composition indicate that although carbon concentrations are similar between OA and TM, the composition of this organic matter varies between them.

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