

Diurnal and Monthly Water Quality Trends: Comparisons Between Two Stations on the York River, Chesapeake Bay

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Introduction

Estuaries play an important, if not well understood, role in the global carbon cycle. Research is ongoing to understand how riverine carbon is processed in estuaries and is then exchanged with the atmosphere or the coastal ocean. Previous work examined historical trends from one water quality station for the year 2008, but here we compared historical water quality data from two National Estuarine Research Reserve System (NERRS) research stations along the York River in Virginia, a tributary of the Chesapeake Bay. The goal is to examine differences in diurnal and monthly trends for one year between upstream (dominated by riverine inputs) and downstream waters (influenced more by bay and ocean waters).

Research Questions

1. How do the monthly means of Partial Pressure of CO₂ (*p*CO₂) and Dissolved Oxygen (DO) compare between Taskinas Creek and the Sweethall NERRS stations?
2. How do the mean diurnal ranges of *p*CO₂ and DO compare between the two sites?

Methods

Data from the Taskinas Creek and Sweethall sites, for 2008, were requested and downloaded from the NERRS's Centralized Data Management Office (CDMO) website. The data included temperature, pH, DO, water depth and salinity. Alkalinity values were calculated from the salinity. The *p*CO₂ values were calculated from the pH and the alkalinity. All DO values in this study represent the oxygen concentration minus the oxygen saturation, called the saturation differential. This unit is preferred because it removes the effects of temperature on oxygen concentration.

The open-source coding language R was used to process the data. Taskinas Creek and Sweethall were chosen because they represent two different environments along the York River, a major tributary of the Chesapeake Bay. The year 2008 was chosen because it contained nearly a complete data set that was typical for the tributary (close to average).

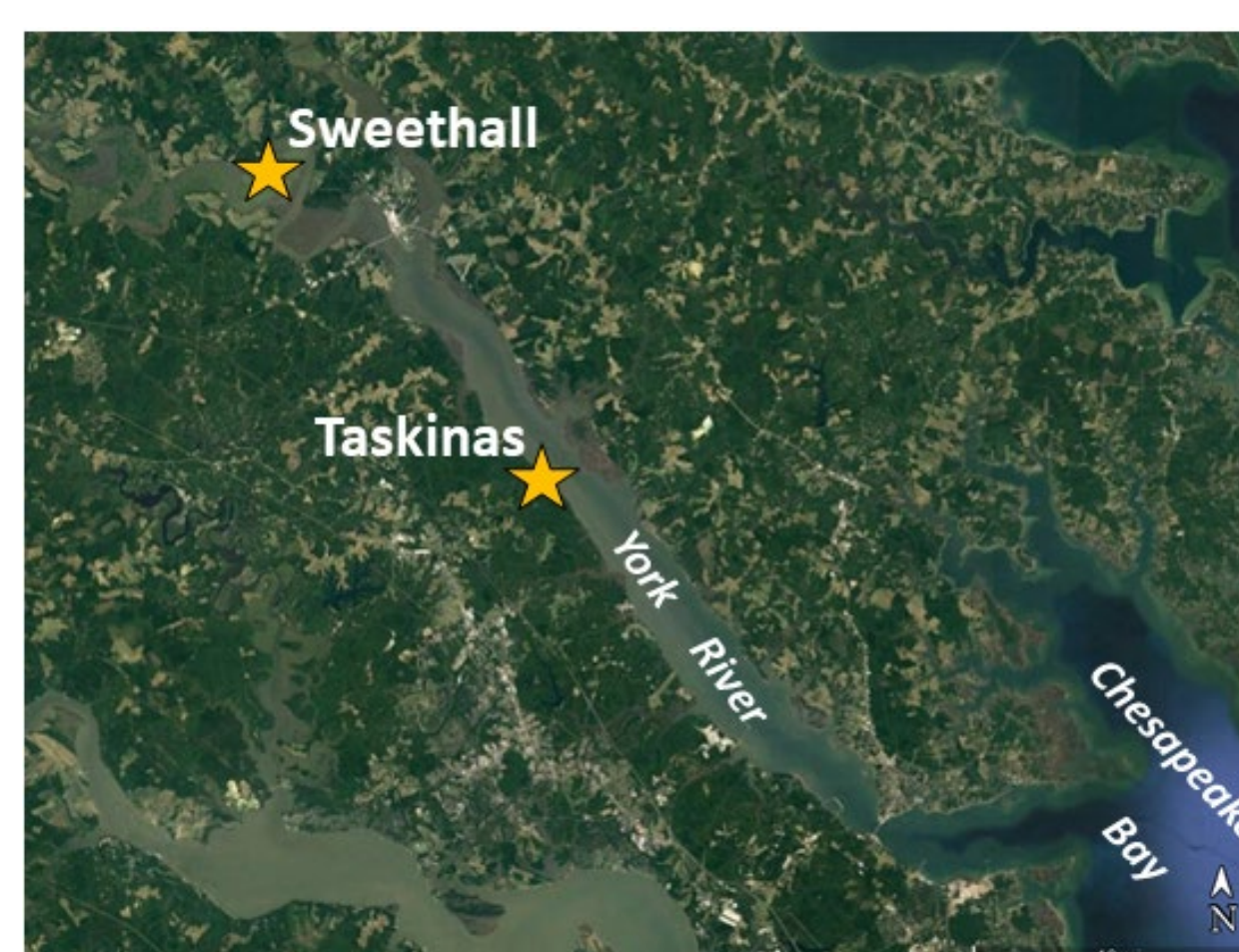
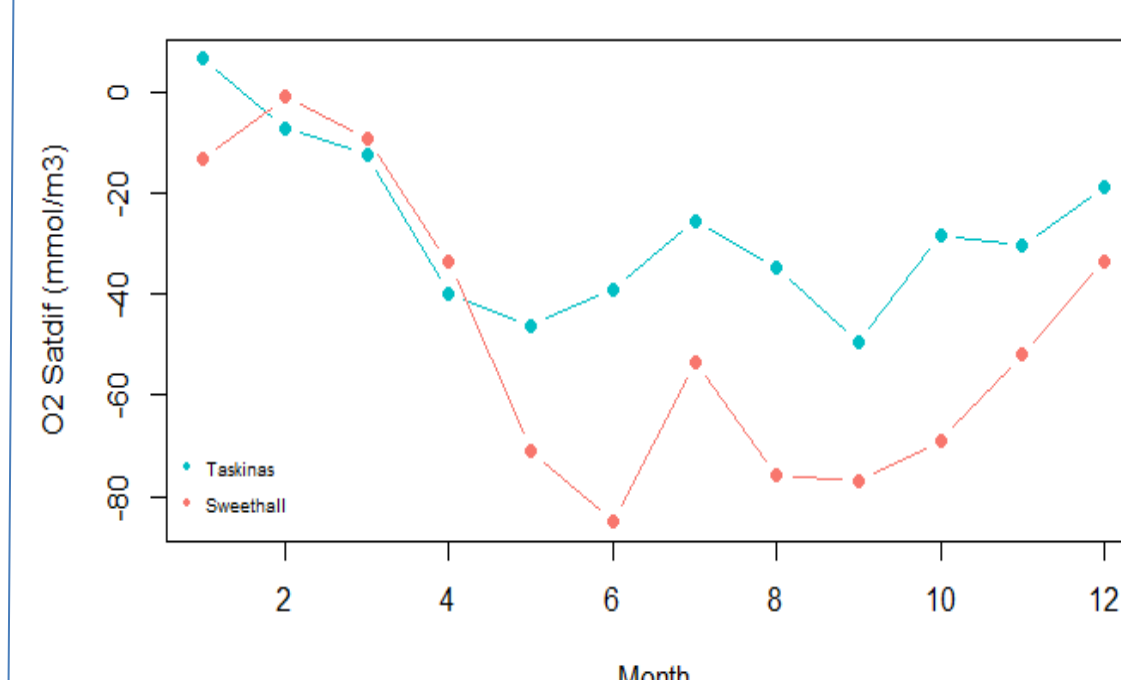


Figure 1 Map showing the York River tributary of the Chesapeake Bay with the location of the two NERRS stations investigated during this project.

<http://cdmo.baruch.sc.edu/>

Results

Monthly Means of DO



Monthly Means of *p*CO₂

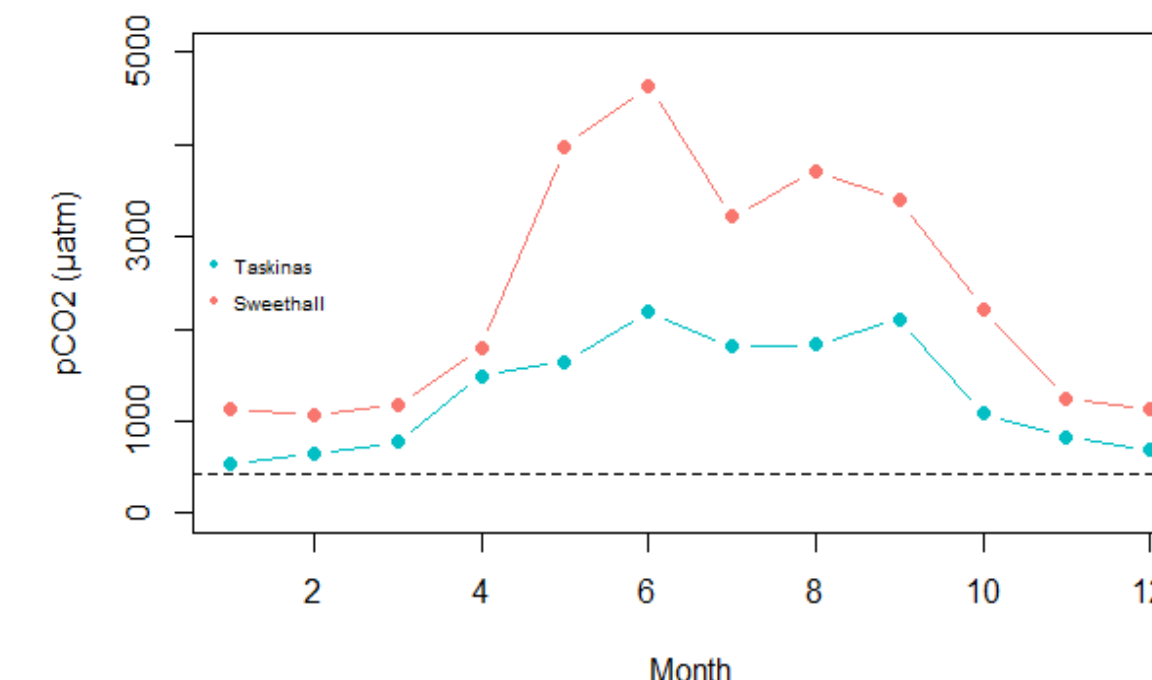
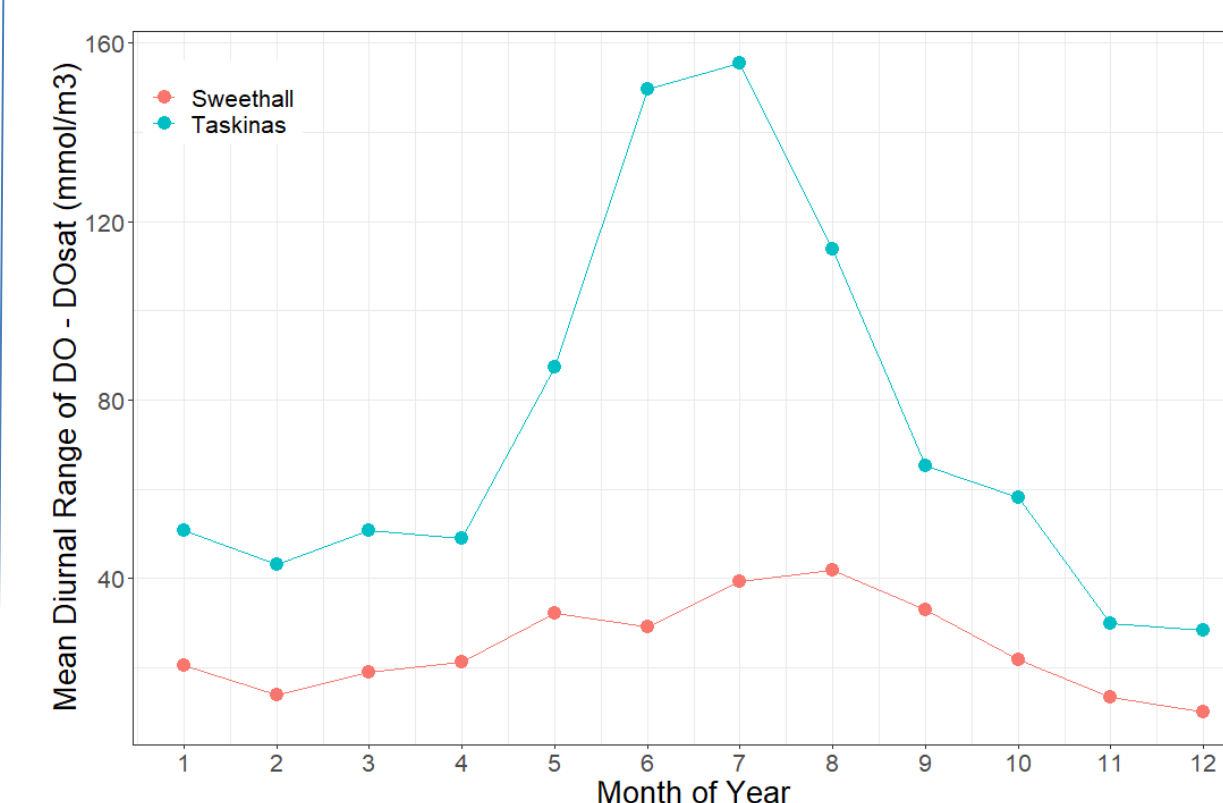


Figure 2 a) Monthly Means of O₂ - O₂ Sat for both sites and b) Monthly Means of *p*CO₂ for both sites. The Monthly Means show that Sweethall measures less DO than Taskinas, but more *p*CO₂ than Taskinas.

Mean Diurnal Ranges of DO



Mean Diurnal Ranges of *p*CO₂

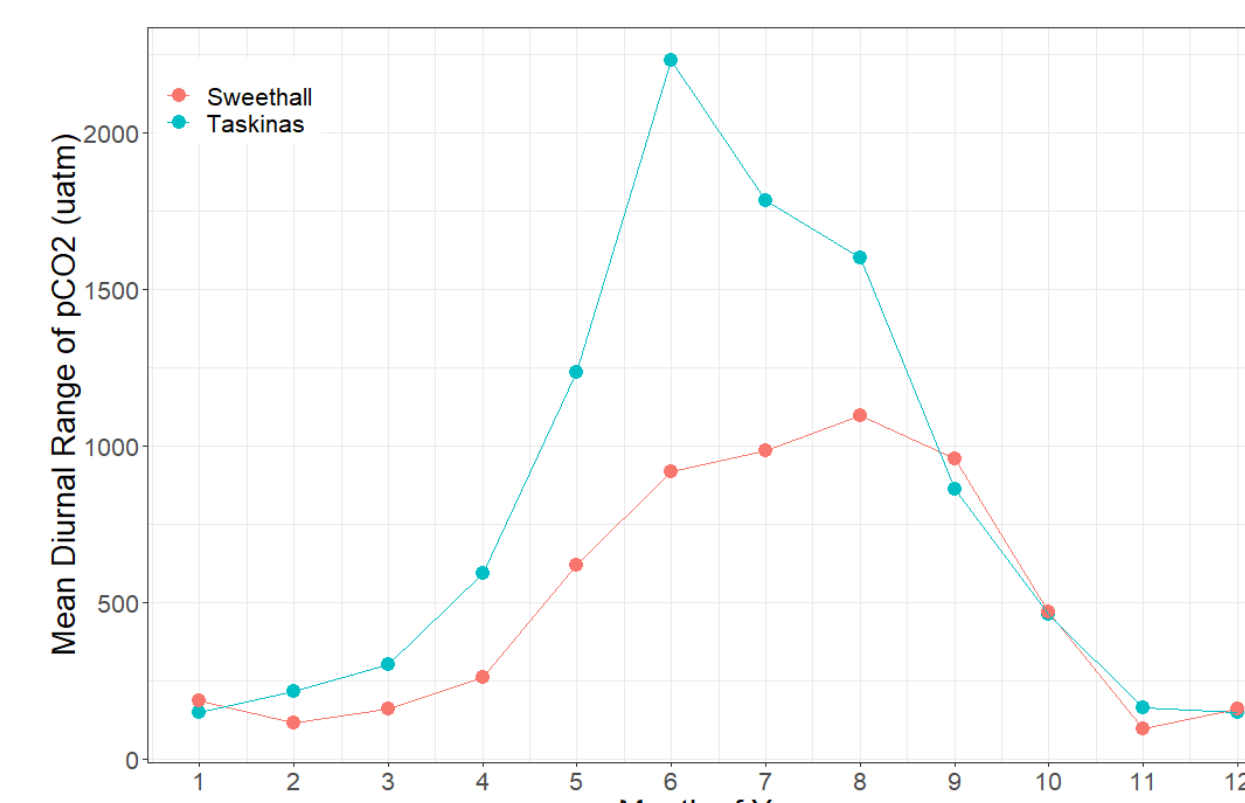


Figure 3 a) Mean Diurnal Ranges of O₂ - O₂ Sat for both sites and b) Mean Diurnal Ranges of *p*CO₂ for both sites. Mean Diurnal Ranges for both sites show that *p*CO₂ and DO values at Taskinas are highly variable particularly in the Spring and Summer. Sweethall measures much less diurnal variation for *p*CO₂ and DO than Taskinas does.

Discussion

- The Sweethall Station is more heterotrophic than the Taskinas Station. This is reflected in lower DO values and higher *p*CO₂ values at Sweethall and the opposite for Taskinas (Fig. 2). This is because the water chemistry of Sweethall is primarily influenced by the process of cellular respiration while the chemistry of Taskinas is mostly influenced by photosynthesis. This is also supported by the large diurnal ranges for DO and *p*CO₂ at Taskinas during the spring and summer.
- Taskinas shows more variability in the diurnal ranges for *p*CO₂ and DO (Fig. 3) because it experiences much more photosynthesis than Sweethall does. This is most likely due to Taskinas being less turbid (less sediment in the water column) than Sweethall which would allow more sunlight to reach more photosynthetic organisms leading to more primary production and more DO in the water.

Future Research

- Future research should examine the turbidity of these two sites to confirm if Taskinas experiences more photosynthesis because of lower turbidity (less sediment in the water column).
- Future research will expand this work to additional NERRS stations throughout the Chesapeake Bay watershed to make more comparisons such as the ones made here. Future work will also look at additional years to ensure that the trends observed here can also be seen in other years as one year is not a significant sample size.

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References

NOAA National Estuarine Research Reserve System (NERRS). System-wide Monitoring Program. Data accessed from the NOAA NERRS Centralized Data Management Office website: <http://www.nerrsdata.org>; accessed 2 July 2021 and 13 June 2022