Community growth physiology and nutrient chemistry in an estuarine coastal environment in the Northern Gulf of Mexico

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ABSTRACT

The measurement of Net Primary Production (NetPP) is the difference between gross production and respiration (RESP) and is a direct indicator of trophic status and health of an ecosystem. The Mississippi coastal estuarine system is characterized by extensive fluvial input, terrestrial runoff, and high benthic sediment fluxes, resulting in an abundance of inorganic and organic substrates fueling biological activity. Seasonal changes in light availability and nutrient chemistry have a significant effect on NetPP and community RESP. On a community level, the NetPP:RESP ratio can affect biogeochemical regeneration and alter nutrient availability, thus affecting plankton growth physiology. In this study, surface in-situ measurements of NetPP and RESP were determined in the Mississippi Sound and the Mississippi Bight by time-course detection of dissolved oxygen using novel optode technology. Rate measurements from two different stations are compared to a time-series record of several biogeochemical and optical parameters over the course of one year. In this study we demonstrate how nutrient chemistry and incident solar radiation may affect growth physiology and determine ecosystem metabolism in the estuary.

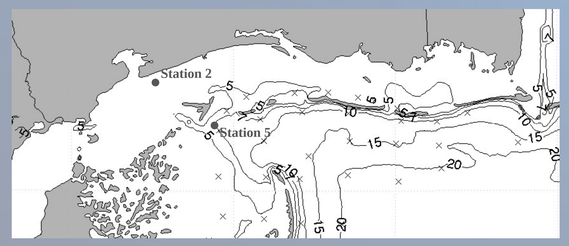


Figure 1. Map of study area in the Mississippi Coastal Estuarine Region

MATERIALS & METHODS

In situ incubations were performed at two different stations (Figure 1) using an optode DO sensor (Aanderaa), polycarbonate bottle, magnet stirrer and a data acquisition unit (Figure 2). Water was sampled and screened through a 200 µm mesh. The incubation array was fastened to a stationary anchor and deployed from morning until midday. In addition, subsurface light intensity was monitored through the duration of each incubation. Inorganic nutrients were measured using fluorometric (NH_4) and spectrophotometric ($NO_3/NO_2/PO_4$) methods on an Astoria-Pacific A2+2 nutrient analyzer. PTP was performed in accordance with Solorzano and Sharp 1980, CHN analysis complied with methods outlined in JGOFS 1996.

RESULTS

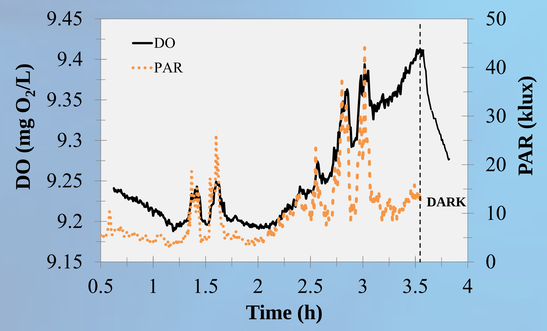


Figure 3. *In situ* monitoring of Net PP and RESP on cloudy day (21July 2011) with variable sunlight. Note the physiological response of the community to flashes of natural sunlight throughout the day.

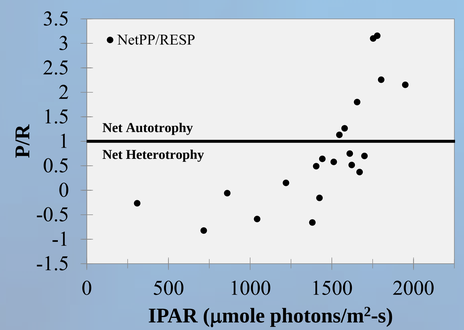


Figure 4. Monthly NetPP normalized to community RESP plotted as a function of instantaneous PAR (taken at time of incubation). IPAR readings were taken from a LI-190 quantum sensor.

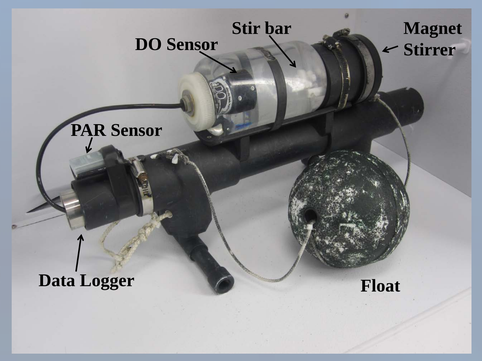
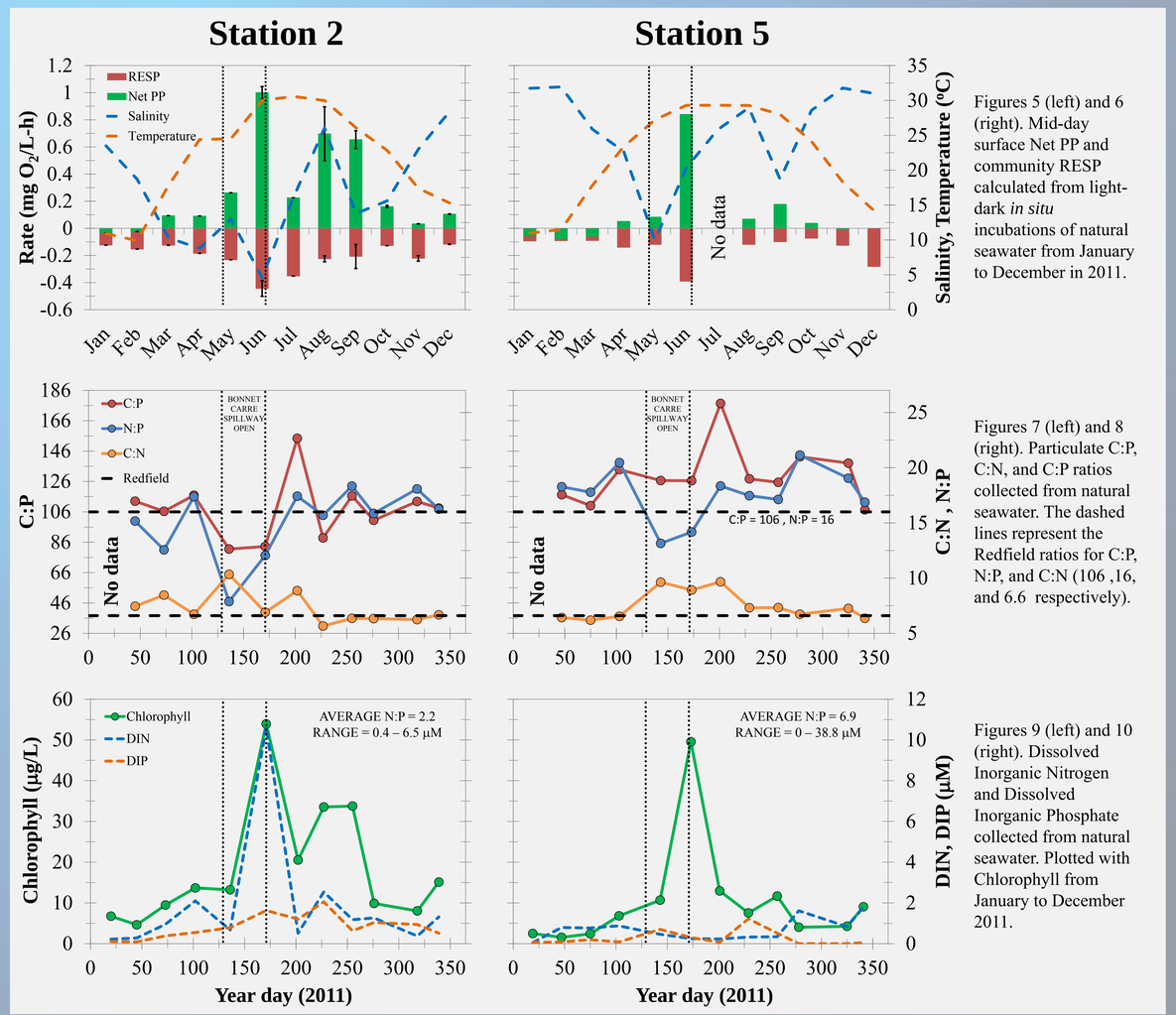


Figure 2. *In situ* incubator equipped with an Aanderra DO optode sensor, Onset HOBO Temperature/Light Sensor, and In Situ TROLL 9500 Data Logger. Incubations were deployed for 2- 6 hours in ambient light at approximately 0.25 m depth.



Figures 5 (left) and 6 (right). Mid-day surface Net PP and community RESP calculated from light-dark *in situ* incubations of natural seawater from January to December in 2011.

Figures 7 (left) and 8 (right). Particulate C:P, C:N, and C:P ratios collected from natural seawater. The dashed lines represent the Redfield ratios for C:P, N:P, and C:N (106 ,16, and 6.6 respectively).

Figures 9 (left) and 10 (right). Dissolved Inorganic Nitrogen and Dissolved Inorganic Phosphate collected from natural seawater. Plotted with Chlorophyll from January to December 2011.

DISCUSSION

Comparisons of *in situ* incubations of seawater in the Mississippi Sound and Bight indicate that:

- NetPP and RESP are impacted by allochthonous nutrient sources, but are not always a direct function of one another.
- Particulate Carbon:Nutrient ratios tend to elevate during levels of nutrient limitation and decline during the onset of high autotrophic growth activity.
- Variations in Carbon:Nutrient ratios also reflect a change in seasonal community composition.
- Dissolved nutrient concentrations show consistent patterns of nitrogen limitation in this estuary.
- The physiological responses of the community to diel and seasonal variations in natural light suggest that there may be a temporal oscillation between nutrient and light limitation.

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