# Spatial Patterns in Aquatic Metabolism in Pensacola Bay, Florida

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## Introduction

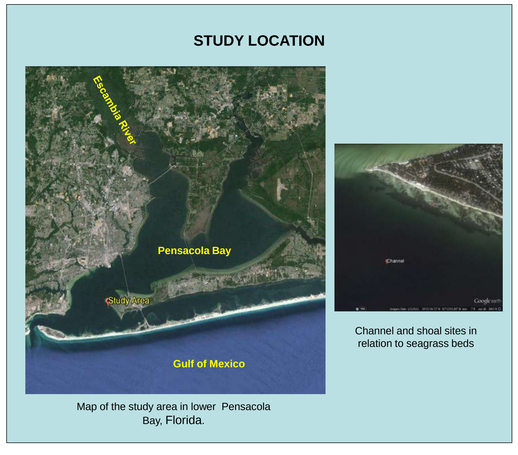
•Measures of primary production and respiration provide fundamental information about the trophic status of ecosystems.

•Water quality simulation models can be improved when constrained by estimates of primary production and respiration. Rarely are there sufficient numbers of process measurements to evaluate models.

•We investigated patterns in ecosystem and plankton metabolism (gross production, respiration, and net ecosystem metabolism) in the Pensacola Bay estuary along a nearshore-offshore gradient.

•We compared metabolism in a shallow seagrass bed environment (2 m depth) to an adjacent channel site ~0.5 km offshore (6 m depth).

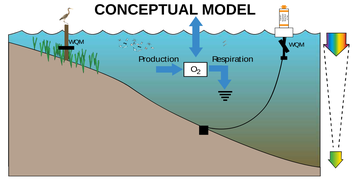
•The study was conducted over the spring-summer 'growing season' from Apr-Sept 2013.




Map of the study area in lower Pensacola Bay, Florida.

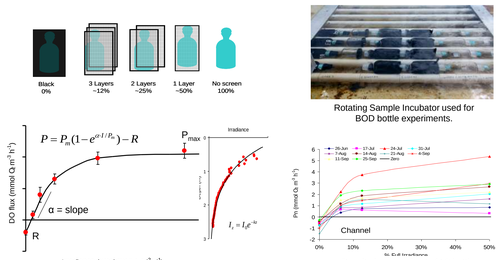


Channel and shoal sites in relation to seagrass beds




Schematic showing location of WQM deployments in a seagrass bed and in the adjacent channel. Light attenuation through the water column is depicted at right.

## Methods – Plankton Metabolism




Classical Photosynthesis-Irradiance and light attenuation models used to scale plankton metabolism measurements



Rotating Sample Incubator used for BOD bottle experiments.



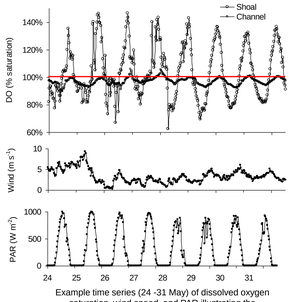

Results from a subset of 10 bottle experiments from the channel site showing the plankton response to light treatments

**•Conducted ~weekly (n=20) plankton production-respiration experiments**
**•Included 4 replicated treatments (3 light levels + 1 dark )**
**•DO measured via precision Winkler titration on a Metrohm system.**

## Methods - Ecosystem Metabolism

Weather station at the laboratory dock ~ 5 km from study site.

WQM and buoy at channel site showing extensive biofouling after 81 days. Note that sensors remained clean.




Example time series (24 -31 May) of dissolved oxygen saturation, wind speed, and PAR illustrating the synchronous diel patterns.

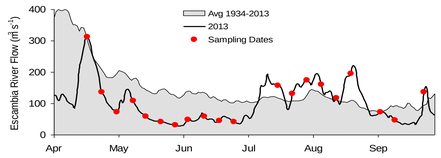
$$\frac{dC}{dt} = P - R + D$$

$$D = k_a(C_s - C)$$

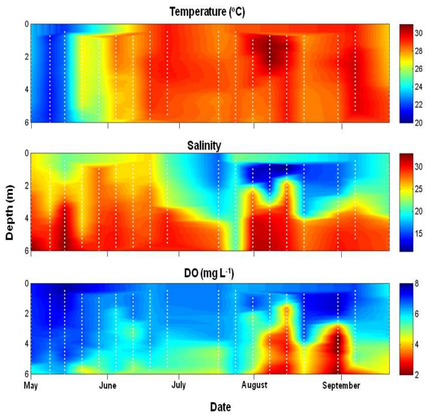
Equations used to model DO and wind time series to calculate ecosystem production (P) and respiration (R).

**•Water quality (T, S, DO) time series collected using Wetlabs WQM instruments**
**•Weather data (wind speed, air temperature, barometric pressure) from laboratory dock**
**•Daily gross primary production and ecosystem respiration calculated (Odum 1956)**
**•Air-sea oxygen exchange was modeled as in Caffrey et al. 2013**

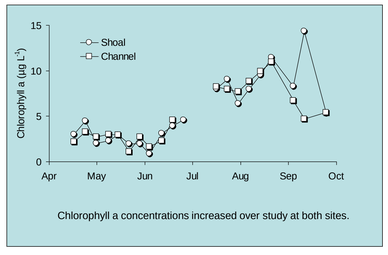
## Results 1 - Hydrography




River flow (black line) during 2013 in relation to long term average (shading). Sampling dates are indicated by red dots. Data from USGS gaging station at Century FL (Site #: 02375500).

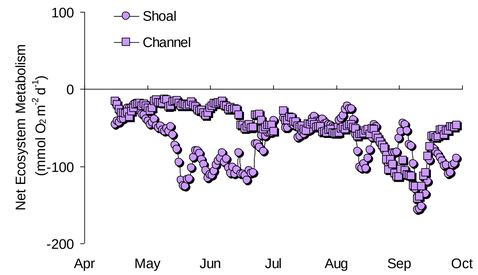



Time-depth contour plots of temperature, salinity, and DO at the channel site. Note the influx of freshwater and stratification beginning in late July that persisted through Sept. DO sag in bottom waters occurred in Aug-Sept.




Chlorophyll a concentrations increased over study at both sites.

## Results 3 - Net Ecosystem Metabolism




Results of modeled integrated ecosystem gross production and respiration calculated from DO time series and weather data.

## Summary

•Coherence between Escambia River flow and salinity at the study area
•Increase in chlorophyll a and plankton metabolism coincided with freshwater influx into study area.

•Channel and shoal sites had similar plankton metabolism rates and chlorophyll concentrations

•Shoal site had higher ecosystem metabolism rates than channel site, indicating the importance of benthic metabolism

•Net Ecosystem Metabolism (NEM) was consistently negative (heterotrophic) and decreased over study at both sites.

•NEM was more negative at shoal site than at channel site

## Future Directions

•Use PAR time series (data not shown) to develop a time varying light model for integrating plankton production through the water column.

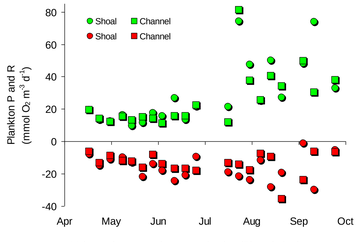
•Examine importance of time-varying vs. fixed pycnocline depths in calculating open water metabolism parameters (currently assumed to be a constant 3.3 m).

•Examine sensitivity of open water model to source and quality of wind data (climatological vs. real time wind data).

•Examine role of sea-breeze induced re-suspension in altering light availability in shoal locations.

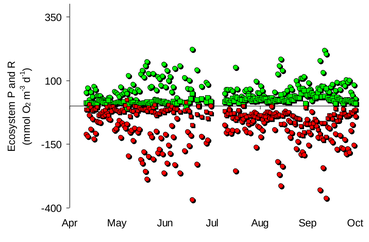
## Results 2 Volumetric Metabolism

### Plankton Metabolism



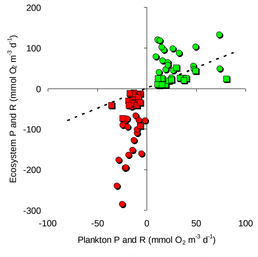

Volumetric gross primary production (P) and plankton community respiration (R) from BOD bottle experiments. Note the seasonal increase in Pg and R. Also note the similar values at both channel and shoal sites.

### Ecosystem Metabolism




Ecosystem gross primary production (P) and ecosystem respiration (R) calculated via the open water method. These are volumetric rates. Note the higher P and R at the shoal site..

### Comparison




Comparison of plankton and ecosystem P and R. Note high ecosystem P and R at shoal site, indicating benthic (seagrass) processes. At channel site, plankton and ecosystem P and R were similar, implying a diminishing benthic role.

### REFERENCES

Caffrey JM, Murrell MC, Amacker KS, Harper JW, Phipps S, Woodrey MS (2013) Seasonal and inter-annual patterns in primary production, respiration, and net ecosystem metabolism in three estuaries in the northeast Gulf of Mexico. Estuaries and Coasts, DOI 10.1007/s12237-013-9701-5.

Odum HT (1956) Primary production in flowing waters. Limnology and Oceanography 1:102–117.

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