Use of Incubation Chambers to Determine Contributions of Benthic Communities to Total System Metabolism

Stephanie Bonner, Adam Essene, Casey S. Lee
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Background

Total system metabolism (TSM), or the net photosynthesis and respiration occurring within a system, is a critical index of an ecosystem's structure and function (Petersen 1998). TSM can be measured in aquatic systems by monitoring dissolved oxygen (DO), which is consumed and produced by respiration and photosynthesis (Clesceri 1998). Assuming a water column is well-mixed, aquatic TSM may be determined by measurements of metabolic processes from phytoplankton, sediment communities, and submerged aquatic vegetation (SAV). Summed, metabolic contributions of all three communities should approximate TSM (Petersen 1998).

Uchrin et al. (2005) developed a technique to isolate the metabolism of SAV. This technique, in combination with the standard light-dark bottle incubation could be applied to elucidate the relative contributions of planktonic, sedimentary, and SAV communities to TSM.

Objectives

Determine the relative contribution of several ecosystem components to metabolism by

•Using the incubation chamber technique by Uchrin et al (2005) to isolate the metabolic contribution of benthic communities.

• Using a free-floating in situ probe to determine TSM.

• Using the light-dark bottle technique to isolate the metabolic contribution of planktonic communities.

Methods

The experiment took place at a constructed wetland plot on the George Jones' Memorial Farm, a site located about two miles SE of Oberlin, OH. We built three incubation chambers to isolate our *in situ* DO probes from the water column. The two experimental benthic incubation chambers consisted of inverted buckets inserted into the sediment, containing SAV. The control chamber was identical to the two benthic incubation chambers, but a lid was placed on the bucket; it rested upon, and was not inserted into, the sediment. A continuous dissolved oxygen probe was suspended in each chamber, with cabling exiting the bucket and running to a datalogger. All DO probes were equipped with a magnetic stir-bar that ensured the water in the apparatus is well mixed.

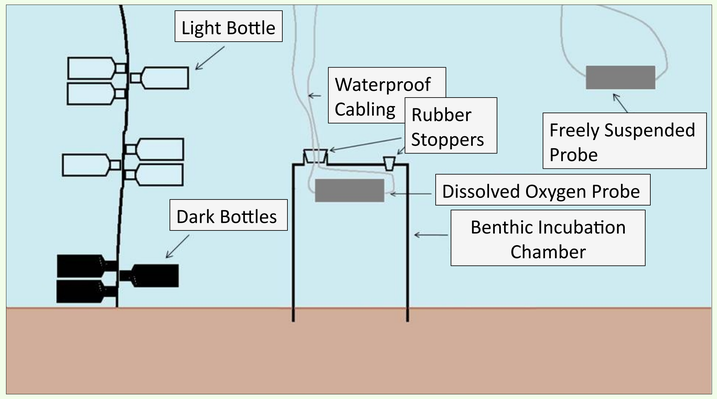

Figure 1. The light-dark incubated bottles, a benthic incubation chamber (cutaway view), and the freely suspended DO probe.

We measured metabolism of the water column in isolation from the sedimentary processes using a standard light-dark bottle technique (Gaardner and Grann 1927). We also tracked DO of the entire system using a probe suspended freely in the water column. We did not directly measure the contribution of SAV to TSM.

Results

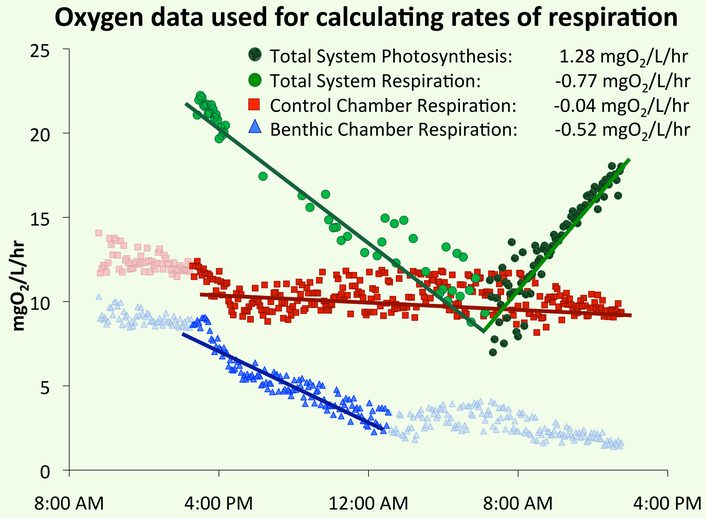

Figure 2. DO data from probes in the benthic chamber, the control chamber, and the whole system. Regression lines depict the rate of respiration as the slope of oxygen loss over time.

The slope of the linear regression lines in Figure 2 are the respiration rates of the total system and the control and benthic chambers. They were calculated only with the highlighted data for which respiration was the dominant process. We subtracted the rate of respiration in the control chamber from the benthic rate of respiration to account for any experimental artifact. We added that rate of benthic respiration to the rate of respiration in the bottle incubation chambers and compared it to the average rate of respiration in the system as a whole. The two rates were comparable (Figure 3).

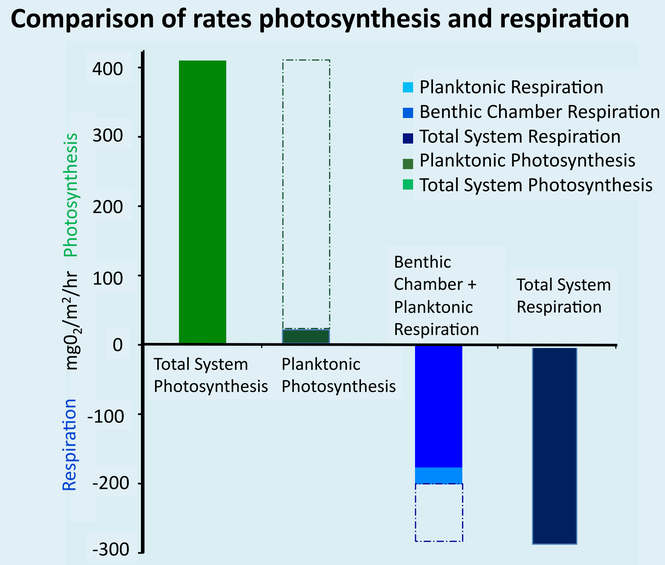

Figure 3. We changed the units from mg O_2/L to mg O_2/m^2 because benthic processes occur on a two-dimensional plane.

Conclusions

There is a gap between the sum of the respiration in the benthic incubation chamber and the light-dark bottles, and respiration of the system as a whole. Based on this gap, we conclude that benthic plant communities contribute more to photosynthesis than was included in the benthic chamber. Additionally, plant communities are heterogeneously distributed on the floor of the wetland. In order to account for this heterogeneity, we recommend that future studies use replicate benthic chambers distributed over the wetland floor. Our study shows that benthic processes are the largest factor contributing to total system respiration.

Our results also show a gap between total system photosynthesis and the photosynthesis from the water column. This can probably be explained by the additional photosynthesis of SAV. SAV was excluded from our light-dark bottle apparatus, which only captured the photosynthesis of phytoplankton. The gap in photosynthesis is significantly larger than the gap in respiration, because SAV probably contributes less to total system respiration than total system photosynthesis.

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Works Cited:

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