Contribution of Sandy Benthos to Photosynthesis and Respiration in the Northeast Gulf of Mexico

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Dissolved oxygen in marine environments is critical for sustaining aerobic respiring life and maintaining higher trophic levels in food webs. Photosynthesizing organisms release oxygen to the water, and in the shallow shelf, where light can penetrate to the bottom, sediment-dwelling algae contribute to this oxygen production. About one third of the global shelf receives enough light for benthic photosynthesis. Although this process therefore could be a significant contributor for oxygen production and carbon fixation, the role of the phytoplankton to fix oxygen dynamics and carbon cycling is poorly understood. In the West Florida Shelf, benthic photosynthesis plays a major role, and carbon uptake is very high, reaching 9-10 mmol CO2 m^-2 h^-1. Although the contribution of pelagic primary production has been studied, the role of benthic primary production in the coastal zone has not been well defined. Many studies have suggested that benthic primary production is important, but the contribution has not been well quantified. This study used oxygen production and consumption measurements for the assessment of primary production and consumption by sediments and water of the West Florida Shelf. In situ and laboratory experiments were used to quantify the contributions of sediment and water to photosynthesis and respiration. The results demonstrate that the relative importance of benthic photosynthesis and its effect on oxygen dynamics, decrease of the benthic contribution with depth.

Introduction
The continental shelf of the northern Gulf of Mexico is covered in large part by sandy permeable sand. This sand is biogeochemically and microbiologically highly active as revealed by relatively large oxygen fluxes caused by benthic organisms. Previous work in oceanic photosynthesis rates has focused largely on pelagic algae. We propose that the microphototrophic of sandy shallow continental shelf, which is being conducted, can contribute to a significant portion of primary production down to water depth of 200 m (Gattuso, 2006). In the West Florida Shelf, where the water is relatively clear, benthic algal growth on the sandy sediments can be observed at mid shelf depth (60m) (Darrow, 2003). In clear, relatively oligotrophic waters, anthropogenic activities may lead to higher water column primary production which may reduce light penetration to the sea floor and thereby a shift from benthic to pelagic primary production. This shift would entail major shifts in the food chain and thereby affect benthic communities, fisheries and the cycling of matter (Okey, 2004). This study used oxygen production and consumption measurements for the assessment of primary production and consumption by sediments and water of the West Florida Shelf. The results demonstrate that the relative importance of benthic photosynthesis and its effect on oxygen dynamics, decrease of the benthic contribution with depth.

Methods
Study sites
A transect from the FSU marine lab to an Air Force-built tower known as K-tower 18 miles offshore was used for sediment and water sampling at Sites A, B, and K-tower. Site A is at 5 m depth, near the coast, and in an embayment protected by barrier islands. Site B is located at 10 m depth and just outside the protection of the barrier islands. K-tower is at 18 m in depth and the water here was the least turbid compared to the other two sites (Fig. 1). Despite the different depths of sites A, B, and K-tower, the sites are relatively similar, because the water at the shallower sites is more turbid. The sediment at all sites on the transect consists of permeable sand. The relative contribution of the benthic photosynthesis and its effect on oxygen dynamics, decrease of the benthic contribution with depth.

Laboratory oxygen production and consumption rate measurements:
Sediment cores and water samples were collected over a 1.5 year period at the sites on the K-tower transect to measure oxygen production and consumption and rates of the sediment and water column separate. The oxygen measurements were conducted on sediment and water samples retrieved from the three sites. For the sediment, filtered seawater was pumped over a sealed core under oscillating periods of light and darkness (every 15 minutes. A month is about the length of time that the sediment could change before it would begin to show a response). For the water, oxygen concentrations in the water above the core were measured by a sensor located in the water sample productivity and consumption experiments (Figs. 3 a, b, and c).

Conclusion:
The data collected in this study demonstrate that the contribution of the microphototrophic oxygen dynamics in West Florida Shelf waters is very evident as clearly visible at our 5 m station, but also measurable at the 10 and 15 m stations. Within 1-1.5% contribution to the total primary production, the microphototrophic is an important component of the food chain and carbon cycle. In general, sediment and water were very high in terms of production, i.e. produced more oxygen than they consumed (include here average ratio of production/consumption). Because the sites are relatively clear, microphototrophic production is active over the entire width of the shelf and can provide food for bottom dwellers. Changes in water column oxygen production can change light penetration to the bottom and thereby reduce benthic primary production which may cause large changes in the benthic ecosystem. Photosynthesis rates of the sediment showed the microphototrophic was highly active. Where we found flux rates ranging from 7 to 10.7 mmol O2 m^-2 h^-1. A similar study (Murphy, 2005) in the Passaic River, FL, averaging 13.6 mmol O2 m^-2 h^-1 in the shallower areas and 11.6 mmol O2 m^-2 h^-1 in the shallow areas. Another study on microphototrophic (An, 2001) at the coast of Galveston, TX didn't see sediment production exceed 17.7 mmol O2 m^-2 h^-1.

Table 1: Average of oxygen production and consumption rates for sediment, bottom water, mid water, and surface water for each site are displayed. Average percent contribution of the sediment to total photosynthesis calculated.