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Understanding Critical Biogeochemical Processes Controlling Biological Health in Apalachicola Bay, Florida

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Apalachicola Bay, a shallow, bar-built estuary located in the northern Gulf of Mexico, is one of the most productive estuaries in the Northern Hemisphere. The bay is principally fed by the Apalachicola River, an alluvial river which drains a large watershed of 12,544,000 square acres. The river is characterized by spring floods, high interannual variability, and a trend of decreasing mean annual riverine discharge over the past half century. This decreasing trend has coincided with the collapse of the bay's oyster population in 2012, a key fishery which once supplied 90 percent of all oysters from Florida. Declines in freshwater inflow are likely to continue given the United States Supreme Court ruling against limitations on upstream water consumption [1]. This study is designed to understand how riverine flow conditions impact productivity, respiration, acidification, and calcification rates in the bay. Diurnal measurements of estuarine metabolism across two different benthic environments are performed monthly in mudflats and seagrass meadows. In order to quantify and model water column metabolic processes, key environmental parameters across both interfaces and in the water column itself are continuously monitored. At the air-water interface, eddy covariance measurements of CO_2 flux are made in addition to waterside and airside pCO_2 and dissolved oxygen. This has allowed estimates of CO_2 flux in addition to model-based O_2 using the calculated CO_2 transfer velocity (k). At the benthic-water column interface, the gradient flux method [2] is used to quantify the O_2 flux and calcification/dissolution. Within the water column, automated light-dark incubations are made over the diurnal period that allow for the calculation of GPP, NEP and R. Water column PAR measurements are also taken to map photosynthesis-irradiance (PI) curves. The synthesis of these measurements allows for better constraints on estuarine metabolism, both spatially and seasonally, across differing benthic environments. In addition, correlations to riverine flow provide a greater understanding of the role that riverine inputs play on estuarine production and respiration.

[1] Florida v. Georgia (2021), 592 U. S. 433.

[2] McGillis et al. (2011), *Geophysical Research Letters*, 38(3).