Regional Controls of Population and Ecosystem Dynamics in an Oligotrophic Wetland-dominated Coastal Landscape - Introducing a New Long Term Ecological Research (LTER) Project in the Coastal Everglades

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Estuaries and coastal landscapes experience a range of stresses, both natural and anthropogenic. Among these, cultural eutrophication affects most U.S. coastal ecosystems. As a result, most coastal ecological research has been conducted in systems that are experiencing eutrophication. In our new Florida Coastal Everglades LTER project (FCE LTER), we are investigating how variability in regional climate, freshwater inputs, disturbance, and perturbations affect land-margin ecosystems. This coastal LTER project is particularly appropriate for studying these questions because the entire system is oligotrophic, it is the focus of the largest watershed restoration effort ever implemented, and freshwater flow is controlled in different ways by the highly variable precipitation regime and water management. Our long term research program focuses on the following central idea and hypotheses:

Regional processes mediated by water flow control population and ecosystem level dynamics at any location within the coastal Everglades landscape. This phenomenon is best exemplified in the dynamics of an estuarine oligohaline zone where fresh water draining phosphorus-limited Everglades marshes mixes with water from the more nitrogen-limited coastal ocean.

Hypothesis 1: In nutrient-poor coastal systems, long-term changes in the quantity or quality of organic matter inputs will exert strong and direct controls on estuarine productivity, because inorganic nutrients are at such low levels.

Hypothesis 2: Interannual and long-term changes in freshwater flow controls the magnitude of nutrients and organic matter inputs to the estuarine zone, while ecological processes in the freshwater marsh and coastal ocean control the quality and characteristics of those inputs.

Hypothesis 3: Long-term changes in freshwater flow (primarily manifest through management and Everglades restoration) will interact with long-term changes in the climatic and disturbance (sea level rise, hurricanes, fires) regimes to modify ecological pattern and process across coastal landscapes.

We are testing these hypotheses along freshwater to marine gradients in two Everglades drainage basins. We have observed a clear productivity peak in the low salinity zone of one but not the other. This peak appears to be the result of low P, high N freshwater meeting higher P, lower N marine water. We are quantifying nutrient regeneration from dissolved organic matter (DOM), and expect this to be a major contribution to this oligohaline productivity peak. We are also examining how this stimulus of the microbial loop affects secondary production. This LTER will thus focus on how changes in freshwater flow and climatic variability control the relative roles that nutrients and organic matter play in regulating estuarine and coastal productivity.

Our transect design is conceptually analogous to a Lagrangian approach in which we follow parcels of water as they flow through freshwater marshes and mangrove estuaries to offshore. Along the way, we quantify patterns and processes in the water and in the wetlands through which it is flowing using long-term sampling and short-term mechanistic studies. We are quantifying: 1) primary productivity; 2) concentrations and turnover dynamics of inorganic nutrients and organic matter (particularly DOM); 3) organic matter accretion and turnover in soils and sediments, and; 4) consumer dynamics and productivity. We use process-based simulation models to link key components, such as the relationships between DOM quantity and quality, microbial loop dynamics, and higher trophic levels. Data synthesis also includes hydrologic models to simulate water residence times along the transects, and a GIS-based project database that integrates data from this LTER research with information from other related projects. The GIS database will be linked to our FCE LTER web site to maximize the exchange and dissemination of information within the south Florida scientific, management, and regulatory community as well as within the NSF LTER Network.

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