A Proposed Food Web Analysis Using Stable Isotopes to Estimate Origins of Production and Trophic Position of Everglades Fish Communities

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ABSTRACT

Stable isotope analyses of carbon (d^{13}C) and nitrogen (d^{15}N) are powerful methods used to interpret pathways of energy flow in food webs and trophic position of higher consumers. Isotopic baseline species are used when comparing across ecosystems due to variation in d^{13}C and d^{15}N at the base of the food web. Stable isotope analyses and gut studies permit assessment of the importance of primary production from algae or vascular plant detritus as the energetic base for higher trophic levels. Taylor Slough, Shark River Slough, and Lostman's River provide an ideal location for interpreting the patterns of fish and invertebrate communities along salinity and primary-productivity gradients. A productivity peak is evident in the Shark River Slough oligohaline region, while Taylor Slough displays a much lower peak in productivity. The Everglades is currently the focus of major restoration efforts, and food-web analyses will aid in the overall understanding of processes and functioning.

INTRODUCTION

Estuaries typically provide nursery habitats for juvenile gamefish and commercially important species, which spend at least part of their life cycles within the brackish habitat. In south Florida, threatened species of wading birds also use them as feeding grounds. Estuarine productivity has been hypothesized to be fueled by a variety of factors, including marine and freshwater derived nutrients, water circulation, and microbial activity that makes energy available to higher trophic levels.

Historically, the Everglades received its freshwater inputs from Lake Okeechobee and from its seasonal deluge of wet season rains, and created a continuous wetland system flowing southerly toward Florida Bay. A gradual dry down of the marsh surfaces occurred starting in November when rainfall decreased. Shark River Slough and Taylor Slough are the major drainage basins for the Everglades, but their water delivery patterns have been altered by canal construction and development. The headwaters of these sloughs are located in the freshwater Everglades, and are dominated by sawgrass (*Cladium jamaicense*) stands and shallower wet prairies featuring spikerush (*Eleocharis cellulose*). The sloughs flow through a mangrove (*Rhizophora mangle, Laguncularia racemosa, Avicennia germinans*) transitional zone, before emptying into the saline environments of the Ten Thousand Islands area and of Florida Bay. The composition of the aquatic vegetation communities reflects these different salinity regimes. The estuarine areas associated with the Everglades have been impacted by anthropogenic influences, such as dredging of canals, which have altered the historic water delivery patterns. Such pervasive environmental changes are likely to influence food webs and energy flow as well.

OBJECTIVES

- Quantitatively sample fish and invertebrate communities of the Everglades oligohaline region
- Determine primary energy inputs for higher trophic levels
- Use stable isotope analyses to illustrate the among-slough variation in food chain length

The estuarine portion of Taylor and Shark River Slough show significant differences in primary production as a function of distance from freshwater inputs (Figure 1). Additionally, an ongoing debate exists as to whether the food web of the Everglades is primarily a detritus or algae supported system. Food web complexity is thought to be linked to patterns of secondary productivity. There are many pathways, which form the complete trophic structure, and the length of each link is determined by the energy flow from one level to the next. The *productivity hypothesis* states that food chain length should increase with increased resource availability or primary productivity. Recent studies indicate that this hypothesis, in addition to ecosystem size, are influential in determining food chain length. However, in the freshwater Everglades, time since the last drying event is also correlated with food chain length. The fish and invertebrate communities of the Everglades provide an excellent opportunity to further explore these issues related to food chain length.

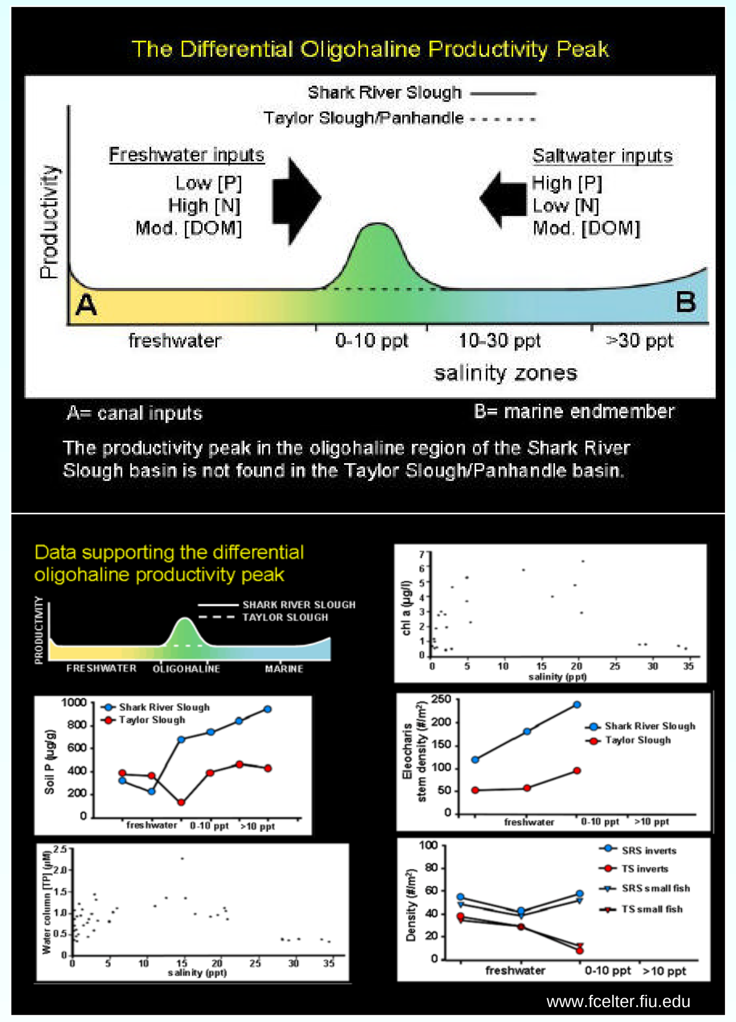
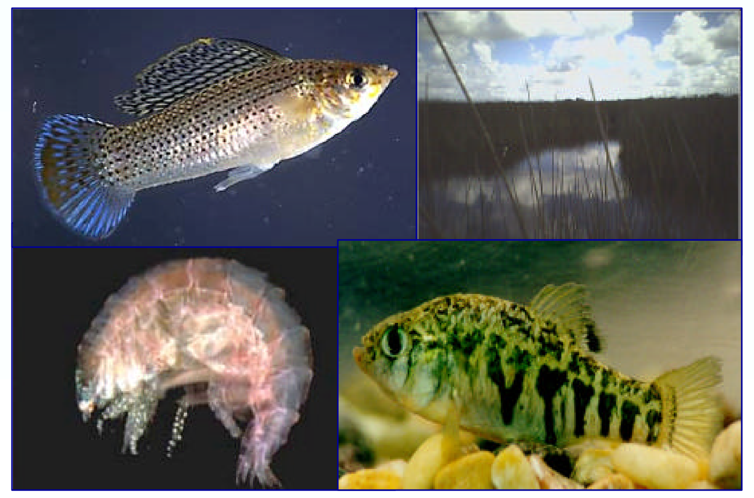


Figure 1. The productivity peak in the oligohaline region and supporting data.



METHODS

We will estimate food chain level and relative detritivory along transects that stretch from the headwaters of three sloughs (freshwater), continue through the mangrove transitional zones, and terminate in the saline environment. The majority of our study sites will be located along transects currently used for long term studies of Everglades ecology (Figure 2). Due to the wet and dry season changes in hydrology at these sites, we will collect representative samples during each period of the year.

We will quantitatively sample fish and invertebrate communities along these gradients to provide a description of community structure along the salinity gradients. Throw traps have been shown to be effective sampling techniques in vegetated areas (Figure 3), and a new 1m^2 drop down net will also be used. Drop down nets have been used effectively for fish sampling in the dwarf mangrove ecotone of northeastern Florida Bay. In a preliminary study, we will compare these two methods to assure efficiency and accuracy is comparable among samples. Community structure, species composition, and standing crop estimates will be determined from these samples. Macrophyte composition, distribution, and abundance will be determined by visual surveys of quadrats. In addition, water quality data will be collected through the use of nearby hydrological stations, which are currently used for long term studies that monitor changes in salinity and water level.

Analysis of isotope ratios of carbon and nitrogen through the estuarine food web is a powerful approach to document patterns of relationships among trophic levels. Carbon isotope ratios can be used to indicate the source of energy, while nitrogen isotope ratios provide an indicator of food chain length and trophic position. Following organic matter cycling with isotopes, in addition to our quantitative sampling, will permit us to document food web dynamics along salinity gradients in the Everglades oligohaline zone and test food web production related hypotheses.

We will use stable isotope analyses to interpret the pathways of energy from primary consumers to the higher trophic levels. We will identify two primary consumers, a detritivore and an algae feeder, so that isotopic signatures can be found for the two main trophic pathways. Higher trophic level organisms will then be analyzed to demonstrate the flow of energy from each pathway. Stable isotope analyses will supplement our quantitative samples to describe changes of fish and invertebrate communities along primary productivity gradients.

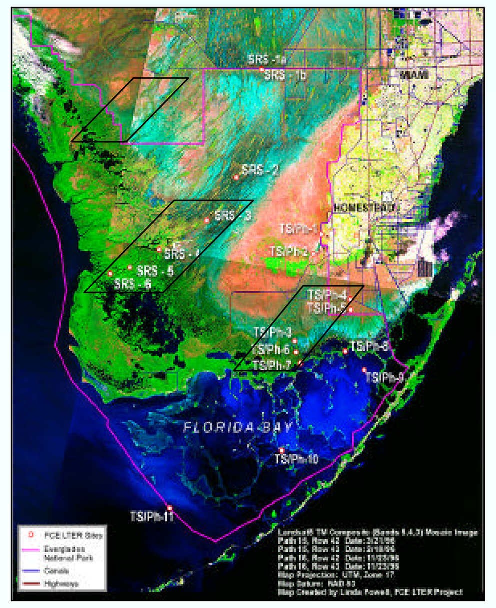


Figure 2. Map showing permanent LTER study sites, and general areas where fish and invertebrate sampling transects will be located.

Figure 3. Throwtraps will be used to quantitatively sample fish and invertebrate communities.

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