

Quantifying N cycling rates in freshwater marshes of the Southern Everglades using ^{15}N tracer techniques: A pilot study



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Abstract

This research project will address the question of how hydrologic restoration of the Southern Everglades is impacting the overall dynamics of the ecosystem. Specifically, this project will analyze these effects by quantifying the nitrogen cycle in the region. This will be achieved via stable isotope tracer techniques. Before this project can be fully implemented, a pilot study is necessary to consider logistics, sample schedule, and sample methodology; this poster will address this pilot study. The pilot study utilized ^{15}N tracer techniques that enable the quantification of several ecosystem processes, including N fluxes between periphyton-water column, soil-water column, and soil-macrophyte interactions. The pilot study data has shown that all major sampled components of the ecosystem incorporated the ^{15}N tracer in quantifiable amounts, except for the soil. Periphyton appears to utilize the tracer most readily, and in the greatest quantity. Both above/below ground macrophytes and consumers displayed varied uptake throughout the pilot study, however this uptake occurred on varied time scales. Using these results, a more comprehensive field study will be carried out that will address the following research questions: 1) What is the immediate fate of canal-borne N in marshes adjacent to the canal? 2) What ecosystem component is most active in "new" N uptake? 3) How quickly does N cycle through the periphyton mats? 4) Do periphyton mats act as sources, sinks, or transformers of N? and 5) How long does it take water-borne N to be incorporated into macrophyte tissues? Thus, canal N will be tracked by following the ^{15}N as it is taken up and cycled through the different components of the ecosystem. Phosphorus is the limiting nutrient in Everglades wetlands; therefore, numerous research efforts have been carried out to understand its concentrations, fate, and availability. Further research on N-cycling rates and N supply will lead to a better understanding of the relationship between nitrogen, phosphorus, and other nutrients in the marsh ecosystem.

Study Area

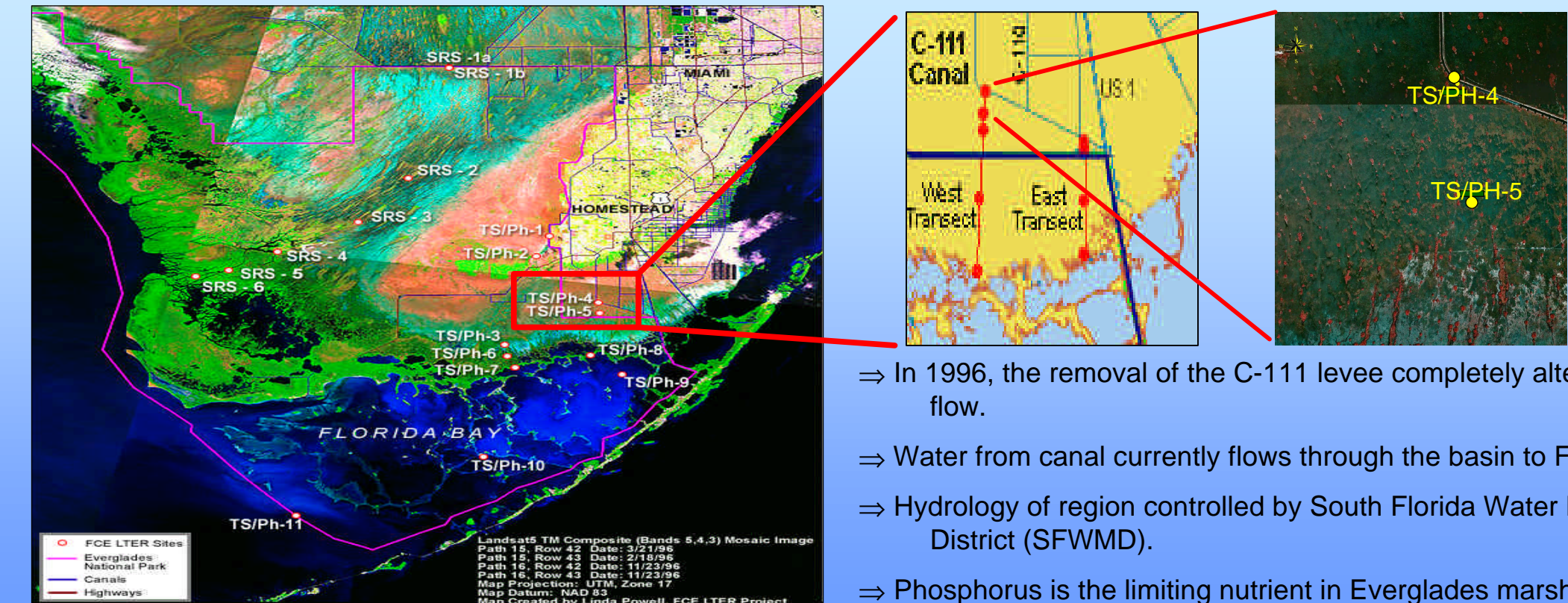


Figure 5 Landsat map with FCE sites (TS/PH 4). Enlarged area shows C-111 basin, and further enlarged satellite image shows C-111 canal and LTER sites.

- ⇒ In 1996, the removal of the C-111 levee completely altered hydrological flow.
- ⇒ Water from canal currently flows through the basin to Florida Bay.
- ⇒ Hydrology of region controlled by South Florida Water Management District (SFWMD).
- ⇒ Phosphorus is the limiting nutrient in Everglades marshes.
- ⇒ The marsh is a sink for TP.
- ⇒ Source of TN, DOM, and a sink for inorganic nitrogen

Research Goals

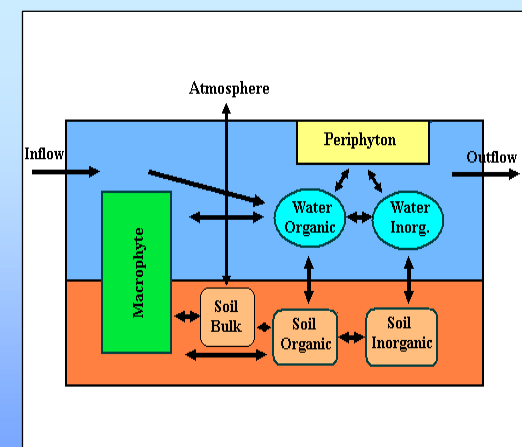


Figure 1: Conceptual diagram of primary ecosystem components and processes that were studied.

- ⇒ How is the hydrological restoration of the Everglades impacting the overall dynamics of the ecosystem?
- ⇒ More specifically, what will be the impacts on nutrient dynamics and nutrient cycling?
- ⇒ How does the marsh ecosystem processes nutrients (the nitrogen cycle)?
- ⇒ What is the fate of nitrogen from canal water as it enters the marsh and how it is processed in the marsh prior to its export into Florida Bay?

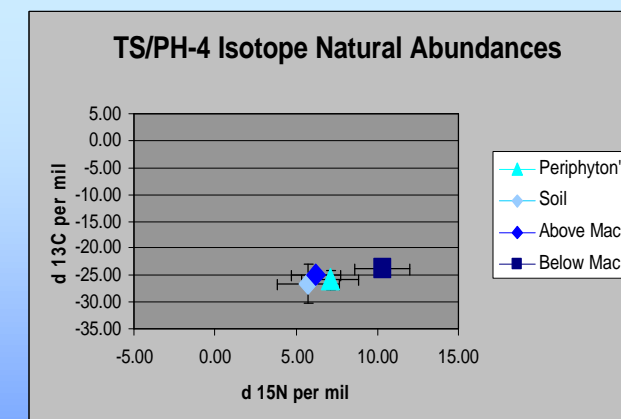


Figure 2: Natural abundance of $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$ of primary ecosystem components at TS/PH-4.

Results and Conclusions

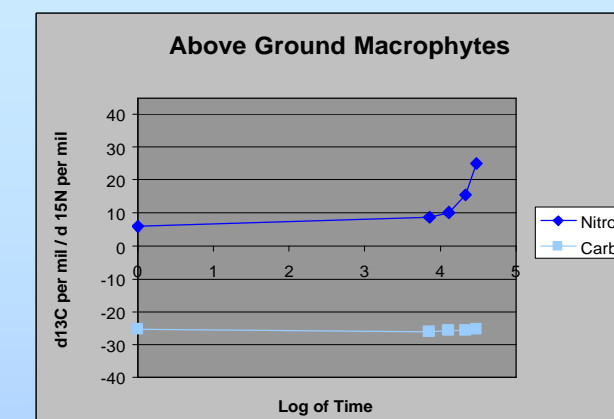


Figure 6: $d^{15}\text{N}$ and $d^{13}\text{C}$ values for above ground macrophytes (*Cladium jamaicense*).

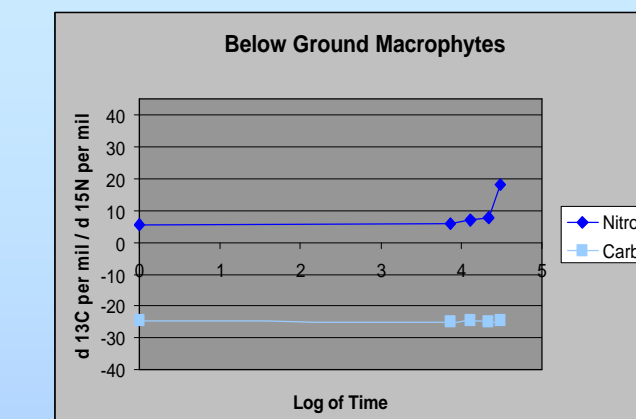


Figure 7: $d^{15}\text{N}$ and $d^{13}\text{C}$ values for below ground macrophytes (*Cladium jamaicense*).

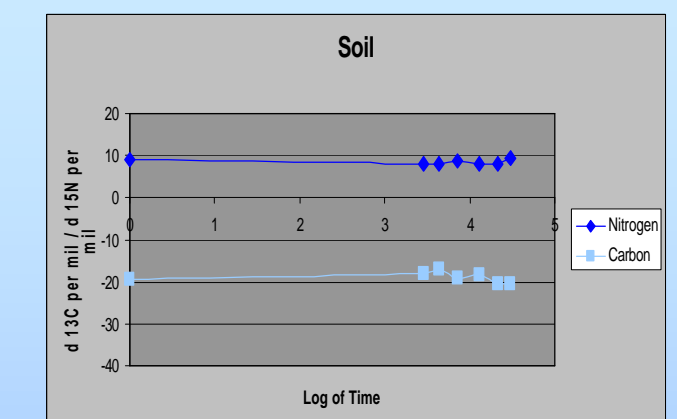


Figure 8: $d^{15}\text{N}$ and $d^{13}\text{C}$ values for soil samples. Sample was collected from the top 10cm of soil.

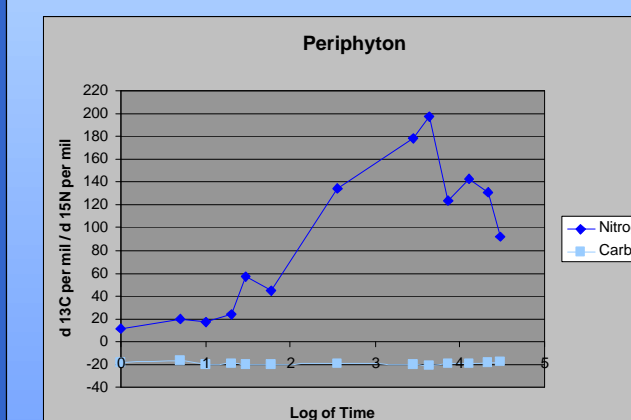


Figure 9: $d^{15}\text{N}$ and $d^{13}\text{C}$ values for periphyton samples. Both epiphytic and epilimnetic periphyton was collected.

- ⇒ This pilot study shows that ^{15}N isotopic tracer addition is a viable tool to track the cycle of N in the Everglades.
- ⇒ All sampled ecosystem components were prepared and analyzed in the Stable Isotope Lab at FIU.
- ⇒ Both above and below ground macrophytes showed tracer uptake at approximately the same time.
- ⇒ Above ground macrophytes were more enriched than below—this could be attributed to and unexpected above ground/water column interaction.
- ⇒ Soil did not take up the tracer—this could be attributed to the benthic periphyton mat isolating the soil.
- ⇒ Periphyton was the main component for ^{15}N uptake.
- ⇒ The decrease in $d^{15}\text{N}$ in the periphyton could be linked to the increase in the $d^{15}\text{N}$ of the consumers. This transfer of nitrogen could of occurred through sloughing or grazing.

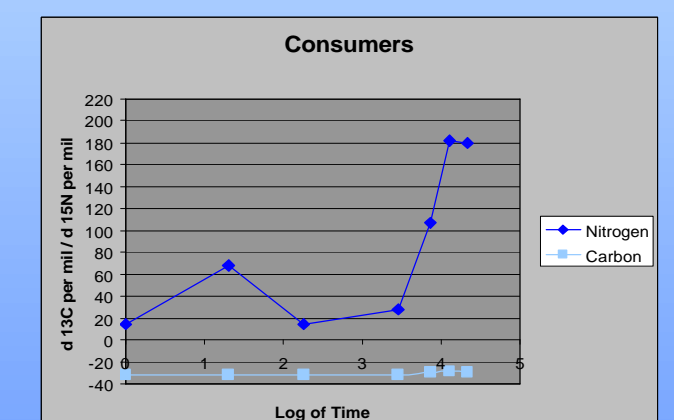


Figure 10: $d^{15}\text{N}$ and $d^{13}\text{C}$ values for consumers. Samples collected at t=0, 20min, & 3hr were composed of *Gambusia holbrooki*, t=5d and on were *Gambusia holbrooki*, and invertebrates.

Methodology

- ⇒ 2m² mesocosm (aprox 1.6m diameter) were installed at TS/PH-4 (Figures 3, 4).
- ⇒ ^{15}N labeled $\text{Ca}(\text{NO}_3)_2$ was added the day following installation.
- ⇒ The tracer add possessed a $\delta^{15}\text{N}$ value of 300‰.
- ⇒ Periphyton and water sampled: T=0, 5min, 10min, 20min, 30min, 1h, 3h, 6h, 2d, 3d, 5d, 9d, 15d, & 21d.
- ⇒ Soil sampled: T=0, 2d, 3d, 5d, 9d, 15d, and 21d.
- ⇒ Macrophytes samples: T=0, 5d, 9d, 15d, and 21d.
- ⇒ Consumers sampled: T=0, 20min, 3h, 2d, 5d, 9d, 15, and 21d.
- ⇒ Water nutrients were sampled at T=0, 5min, and 21d.
- ⇒ The mesocosm was divided into 4 quadrants and subsamples of each component were collected in each quadrants and combined to create one sample.



Figure 3: C-111 canal site TS/PH-4 after levee removal.



Figure 4: Picture of *in situ* mesocosm at TS/PH4.