Changes in Nitrogen Uptake Rates as a Result of P-Loading

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Abstract

An *in situ* mesocosm experiment was conducted in the freshwater marshes of the Southern Everglades. The objective of this experiment was to compare ^{15}N natural abundances to N-cycling in mesocosms amended with ^{15}N tracer. The ^{15}N tracer technique allowed us to isolate the flows of N among various ecosystem components. The experiment ran for a period of 21 days with six mesocosms ($2m^2$) being deployed at the oligotrophic, P-limited, and near-canal site TS/Ph 4. Numerous research efforts have been carried out to better understand the fate and availability of phosphorus, since it is the limiting nutrient in the Everglades wetlands. In this experiment as a complement to the ^{15}N tracer addition, three varying loads of phosphorous (0.00gP, 6.66gP, 66.6gP) were added to mesocosms to determine what, if any, effects P-load has on the rate of N cycling. The control P-load of 0.00gP in mesocosm #7 lead to a peak ^{15}N value of 307.45‰ occurring on day 3; meanwhile, the 6.66gP load in mesocosm #8 lead to a peak 15N value of 265.65‰ occurring one day earlier on day 2. In addition, it appears that in both treatments^{15}N values for periphyton reached equilibrium of 176.23‰ and 168.06‰ respectively, following the peak values on days 3 and 2. These values could represent an N uptake threshold for periphyton. These preliminary finding illustrate that P availability may be interconnected to nitrogen cycling rates and that we are beginning to address the objective of how P availability regulates N cycling rates in freshwater marshes of the southern Everglades. Further analysis of these data on N-cycling rates and P supply will lead to a better understanding not only of the nitrogen cycle itself, but of the relationship between nitrogen and phosphorus in the marsh ecosystem.

Study System

In 1996, the removal of the C-111 levee completely altered the regions hydrology.

Water from canal currently flows across the marsh, through the basin, and finally into Florida Bay.

The C-111 basin is a sawgrass (*C. jamaicense)* dominated marl marsh.

Hydrology of region controlled by SFWMD (via S-18C gate structure) and through precipitation inputs to the basin.

Phosphorus is the limiting nutrient in the marshes studied. The marsh system is a sink for TP.

The marsh is also a source of TN, DOM, and a sink for inorganic nitrogen

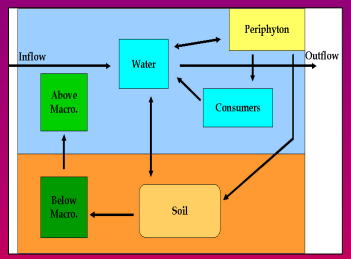


Figure 1: Conceptual diagram of primary ecosystem components and processes that were studied in the mesocosm experiment.

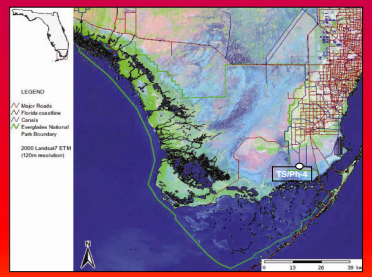


Figure 2: Landsat map of South Florida with FCE LTER sites overlaid. Red box show C-111 basin and the study sites (TS/PH 4).

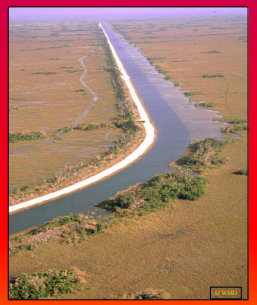


Figure 3: C-111 canal site TS/PH-4 after levee removal.

Methodology

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

Figure 5: Picture of *in situ* mesocosm at TS/PH4.

***In situ* Mesocosm P-Loading Experiment**

Six $2m^2$ mesocosms (1.6m diameter) were installed at the near-canal site, TS/PH-4.

^{15}N labeled $Ca(NO_3)^2$ was added to the mesocosms the day following mesocosm installation

The tracer addition lead to the mesocosm water possessing a $\delta^{15}N$ value of 300‰ and a 1.5µM nitrogen concentration.

Three varying loads of phosphorous: 0.00gP, 6.66gP, 66.6gP were added to mesocosms in a one-time only phosphorus load.

Periphyton and water sampled: t=0, 5, 10, 20, and 30min, 1, 3, and 6hr, 2, 3, 5, 9, 15, and 21days.

Soil sampled: t=0, 9, and 21day. Soil cores were sectioned into 0-1cm, 1-5cm samples.

Macrophytes samples: t=0, 5, 9, 15, and 21days. Both above- and below-ground samples of the macrophyte *C. jamaicense* were collected

Consumers sampled (*G. holbrooki)*: t=0, 3hr, 2, 5, 9, 15, and 21days.

Periphyton

Figure 6: Mesocosm #7 Periphyton - 15N Enriched & 0.00gP

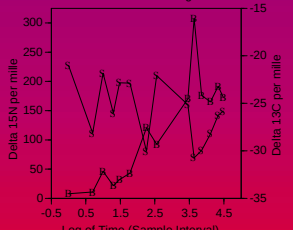
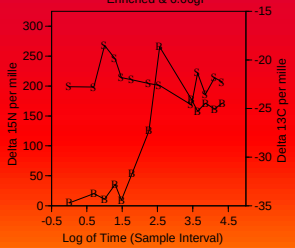


Figure 7: Mesocosm #8 Periphyton - 15N Enriched & 6.66gP



The control P-load of 0.00gP in mesocosm #7 lead to a peak ^{15}N value of 307.45‰. This peak ^{15}N value occurred on day 3 (Figure 6).

The 6.66gP load in mesocosm #8 lead to a peak ^{15}N value of 265.65‰. This peak ^{15}N value occurred one day earlier on day 2 (Figure 7).

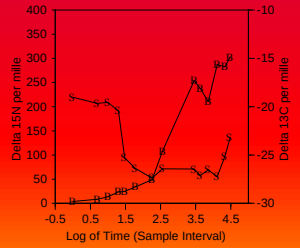
In both phosphorus treatments (0.00gP and 6.66gP) ^{15}N values for periphyton reached equilibrium of 176.23‰ and 168.06‰ respectively, following the peak values on days 3 and 2.

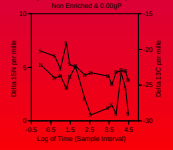
These values could represent an N uptake threshold for periphyton and could illustrate that P availability may be interconnected to nitrogen cycling rates.

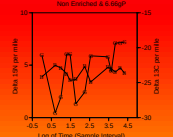
Figure 8 represents nitrogen uptake from a previous experiment conducted at TS/Ph4 earlier in the wet-season. A maximum ^{15}N value of 302.63‰ was reached on d=21

How does this later peak of tracer uptake compare to the other uptake values from the second experiment conducted later in the wet season?

Figure 8: Mesocosms #1, 2, 3 Average Periphyton Values - Enriched







Consumer

Figure 11: Mesocosm #7 Consumer - 15N Enriched & 0.00gP

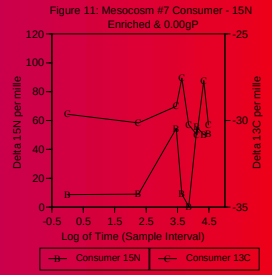


Figure 12: Mesocosm #8 Consumer - 15N Enriched & 6.66gP

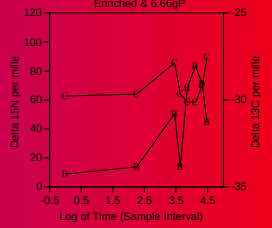
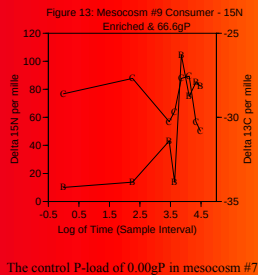


Figure 13: Mesocosm #9 Consumer - 15N Enriched & 66.6gP



The control P-load of 0.00gP in mesocosm #7 lead to a peak ^{15}N value of 55.30‰. This peak ^{15}N value occurred on day 21 (Figure 11).

The 6.66gP load in mesocosm #8 lead to a peak ^{15}N value of 83.63‰. This peak ^{15}N value occurred several days earlier on day 9 (Figure 12).

The 66.66gP load in mesocosm #9 lead to a peak ^{15}N value of 104.53‰. This peak ^{15}N value occurred 4 days earlier on day 5 (Figure 13).

These preliminary finding illustrate that P availability may be interconnected to nitrogen cycling rates and that we are beginning to address the objective of how P availability regulates N cycling rates in freshwater marshes of the southern Everglades.

Integration / Nutrient Budget

The next step in the analysis of these data will be the creation of a nutrient budget for the TS/Ph-4 study site. On the final day of the experiment (day 21) a harvest of the ecosystem components (above- belowground macrophytes, periphyton, soil and consumers) was taken. These harvested samples will be dried, weighed, and nutrient samples will be taken. From these data nitrogen pool size will be determined and combined with 15N isotope data to calculated N fluxes in and out of ecosystem components

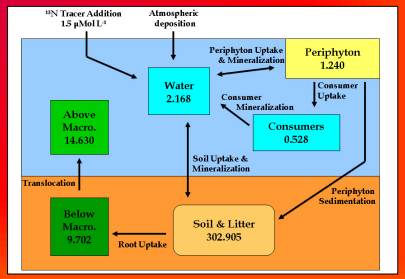


Figure 14: Hypothetical example of the fluxes that will be addressed by nutrient budgets