# Ecosystem Characterization and Hydrologic Dynamics of Seasonally Flooded Tree Islands in the Southern Everglades


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## Abstract


Freshwater flow is the subject of great interest concerning Everglades restoration. Restoring freshwater flow to the system will not only increase flow, but may also increase nutrient inputs to downstream communities. Tree islands are ecologically important communities in the southern Everglades, and this area is currently receiving canal water delivery as part of hydrologic restoration. Local nutrient cycling and forest dynamics of the islands are key to understanding how wetland management will affect tree island structure and function. To investigate this relationship, I quantified the structure, growth, nutrient utilization and soil dynamics of the seasonally flooded tree islands of the southern Everglades. In an ongoing project, an experimental design was established with "flow" (islands experience both flow and nutrient effects of canal water delivery), "walled" (islands experience only nutrient effects), and "no flow" (islands have greatly reduced flow and nutrient effects) treatment groups. Edaphic variables showed significantly higher soil redox potential and standing litter, but lower marsh water flow, island water levels, and nutrient use efficiency in the "no flow" treatment group than the "flow" treatment group. Further study must be conducted to determine whether these differences are an effect of less water flow over time, or a temporary effect of levee removal, to determine if water flow is a stress or subsidy in the hydrologically altered southern Everglades.


## Introduction

Tree island communities are a unique component of the Everglades landscape. The existence of these islands increases habitat complexity, and consequently, increases the diversity of the Everglades flora and fauna. Hydrologic restoration of the Everglades landscape is currently underway, and the effects of increased freshwater flow on Everglades biotic communities, including tree islands, are unknown. Wetland ecosystem studies are complex, but necessary to understand how ecosystems will respond to landscape-scale perturbations. With this project, we have established an ecosystem experiment to characterize the ecological structure and function of wetland tree islands and their ecosystem response to increased freshwater flow in the southern Everglades.

## Study Site

The southern Everglades is a short hydroperiod marl marsh. The hydroperiod averages 8 – 10 months in the eastern half of the study area, and 6 – 8 months in the western half. Pre-drainage models show similar hydroperiods for both sections of the study area (6 – 8 months; Davis and Ogden, 1994). The islands are seasonally flooded, with a soil elevation relatively low in relation to the marsh. The vegetation is a mixed assemblage of mesophytic and hydrophytic plant species, dominated by *Chrysobablanus icaco*, or cocoplum.

**Hydrologic Restoration in the Southern Everglades –**
Effects of levee removal??

Ongoing studies in the Southern Everglades show that:

- ⬆ N that ⬇ as water flow ⬆;
- periodic ⬆ P with ⬆ water flow;
- ⬆ canal distance
- ⬇ sawgrass productivity
- ⬆ periphyton productivity

(Childers et al., 2001)

## Hypotheses

Increased freshwater flow was hypothesized to be a subsidy to forested wetland communities by oxidizing soils and increasing nutrient supply (Odum et al., 1979), and therefore would:

1) Decrease soil C:N ratio; 2) Increase litterfall production; 3) Increase litter turnover rates; 4) Decrease nutrient use efficiency; and 5) Increase growth rates of cocoplum plant species

## Objectives

I. To describe the general structural and ecosystem properties of the seasonally flooded forests of the Southern Everglades

II. To describe these ecological properties in terms of water management and experimental manipulation in the C-111 Basin

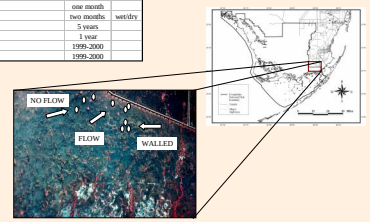
## Experimental Design

Here, we present the first year of data of a long-term experiment…..

**Three treatments groups**

1) **"Flow"**- islands encounter both flow and nutrient effects of canal water delivery
2) **"Walled"** - sheetflow is reduced by experimental manipulation
3) **"No Flow"**- islands are located in an area of the marsh where levee removal has not been implemented and therefore have greatly reduced flow and nutrient effects

| Variable | Interval | Season |
|---|---|---|
| Island Vegetation Structure | 5 years | |
| Soil % OM, bulk density, TN, TP, and TC | 1 year | |
| Island and Marsh water level | one month | |
| pH, Eh | two months | |
| Porewater nutrients and DOC, marsh flow rates, and nutrient loading | two months | wet |
| Marsh flow rates and TP, TN, and TOC loading | two months | wet |
| Litterfall Production | one month | |
| Live leaf TN, TP, and TC | two months | wet/dry |
| Litter Turnover | 5 years | |
| Litterfall Nutrient Use Efficiency | 1 year | |
| Cocoplum Productivity | 1999-2000 | |
| Annual Cocoplum Biomass Production | 1999-2000 | |



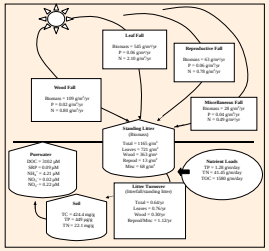



## Preliminary Results

Average annual values for biomass and nutrient fluxes through a seasonally flooded tree island of the Southern Everglades were estimated. This data will provide the baseline information with which we will continue to quantify tree island ecosystem processes with hydrological restoration of the Everglades.

Tree islands of the Southern Everglades generate large pools of organic matter which may be contributed to marsh ecosystem processes.

How will this pool be affected by increased freshwater flow?




Conceptual Diagram of Forested Wetland Ecosystem Processes
(Adapted from Franji and Lugo, 1978)

**Summary of year one bimonthly sampling results –**

Increased freshwater flow appeared to:
1) Increase marsh flow rates and TP loading
2) Increase island water levels
3) Decrease soil redox potential
4) Increase litter turnover

But, to date, did not appear to:
1) Decrease soil C:N ratio – Soil N highest in "no flow" group
2) Increase cocoplum growth rates – Highest twig production rates in "no flow" group
3) Increase litterfall production – No differences among groups
4) Decrease nutrient use efficiency – "No flow" group had lower phosphorus and nitrogen nutrient use efficiency than other groups

**Tree island landscape characteristics, soil biogeochemical properties, litterfall production and nutrient use efficiency were then examined with Pearson Correlation Coefficients ($p < 0.05$) to understand how these parameters were correlated in seasonally flooded tree islands ($n = 9$).**

**More oxidized soils** were positively correlated with **soil nitrogen, standing litter, and shallow marsh soils. Soil nitrogen** was positively correlated with **soil carbon**, but negatively correlated with **litter turnover and TP loading**. **Tree island phosphorus nutrient use efficiency** was positively correlated with **TP, TN, and TOC loading.**

These data suggest that increased nutrient loading (calculated from marsh water levels, nutrient concentrations, and flow rates) is related to high phosphorus use efficiency. Transitional wetlands (seasonally flooded) have been shown to have higher NUE (Burke et al., 1999) because potential subsidies of periodic flooding may be negated by anaerobic conditions physiologically stressful for growth (Mitsch and Rust, 1984).

Tree islands with shallow marsh soil depths and more oxidized soils have higher soil nitrogen, carbon and litter accumulating on the forest floor. These are typical characteristics of organic matter accumulation (Mitsch and Gosselink, 2000). With TP loading and litter turnover, there is a negative relationship with soil N, suggesting that increased TP loading and litter turnover may lead to higher organic matter turnover in seasonally flooded tree islands of the Southern Everglades.

| | Correlation Coefficient | p - value |
|---|---|---|
| Water Level, Temperature | -0.820 | ** |
| Eh, Marsh Depth | -0.823 | ** |
| Eh, Soil Nitrogen | 0.839 | ** |
| Eh, Standing Litter | 0.789 | * |
| Marsh Depth, Soil N | -0.719 | * |
| Marsh Depth, Standing Litter | -0.853 | * |
| Soil P, Phosphorus NUE | -0.721 | * |
| Soil N, Soil C | 0.776 | * |
| Soil N, Standing Litter | 0.747 | * |
| Soil N, Litter Turnover | -0.745 | * |
| Soil N, TP Load | -0.713 | * |
| Soil C, Standing Litter | 0.758 | * |
| PNUE, TP Load | 0.696 | * |
| PNUE, TN Load | 0.912 | ** |
| PNUE, TOC Load | 0.835 | ** |
| DOM, Nitrite | 0.850 | ** |
| Ammonium, Nitrate | 0.907 | ** |

*p < 0.05; **p < 0.01

***Does water limit nutrient availability to tree island plants?**
***Is litter turnover increased due to higher phosphorus availability to the microbial community?**
***Does soil oxidation allow for higher carbon and nitrogen accumulation in soils, as well as reduced litter turnover?**
***Is this a short-term response to increased freshwater flow?**

**What trajectory will these islands follow over time??**

## Conclusions

Effects of increased freshwater flow may depend on:
•the current hydrologic setting of tree islands
•the degree of water influx and nutrient supply

A long-term trajectory scenario may better elucidate the effects of increased freshwater flow on southern Everglades tree islands.

## References


Burke, M., B. Lockaby, and W. Conner. 1999. Aboveground production and nutrient circulation along a flooding gradient in a South Carolina Coastal Plain forest. Canadian Journal of Forest Research 29: 1402-1418.

Childers, D. et al. 2001. Effects of modified water delivery in the C-111 Canal Basin on the wetland transition zone: monitoring the effects of modified water delivery on the Southern Everglades. Report submitted to the South Florida Water Management District.

Davis, S. and J. Ogden. 1994. Everglades: the ecosystem and its restoration. St. Lucie Press, Boca Raton, FL.

Franji, J. and A. Lugo. 1985. Ecosystem dynamics of a subtropical floodplain forest. Ecological Monographs 55: 351-369

Mitsch, W. and W. Rust. 1984. Tree growth responses to flooding in a bottomland forest in northeaster Illinois. Forest Science 30: 499-510.

Odum, E., J. Finn, and E. Franz. Perturbation theory and the subsidy-stress gradient. Bioscience 29: 349-352.