Flux of nutrients in a fringe mangrove forest in the Shark River Estuary, Florida, USA

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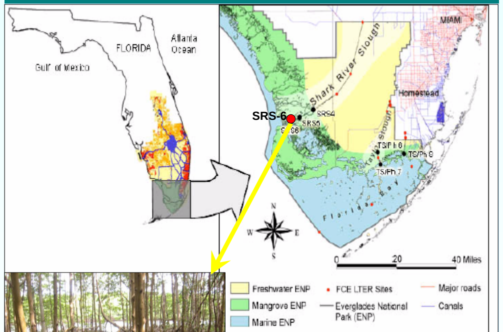
Abstract

We evaluated fluxes of NH_4^+, NO_2+NO_3 , PO_4, Si, total nitrogen and total phosphorus in a fringe mangrove forest using the flume technique during the dry (May, December 2003) and rainy (October 2003) seasons in the Shark River Estuary. Concentrations were similar at both ends of the flume, indicating that the flume spatial scale (24 m^2) was inadequate to evaluate net inorganic nutrient fluxes in this site. Measuring fluxes at the tidal creek scale (125 m^2) might be more critical to correctly evaluate the role of mangrove forests as sink, source or transformers of nutrients in this estuarine system.

Research Problem

Nutrient exchange between mangroves and near-shore waters is poorly understood given the difficulty of measuring nutrient fluxes in coastal wetlands. Although some studies in mangrove forests have shown a net export of detritus and negligible net exchange of nitrogen, much work is necessary before we can determine the role of mangroves in nutrient cycling in tropical estuaries. Most of the available information on nutrient fluxes in mangrove ecosystems has been determined using the"Eulerian" analysis of fluxes in tidal creeks. In this study we used the flume technique to estimate fluxes of organic and inorganic nitrogen and phosphorus, and silicate in a fringe mangrove forest in South Florida.

Study Site



The study site (SRS 6) is part of the Long Term Ecological Research network located in the Everglades National Park, Florida.

Objectives

We evaluated:

1) the role of the mangrove forest as sink or source of inorganic and total nitrogen (TN), SRP, total phosphorus (TP) and silicate.
2) the seasonality of nutrient fluxes.
3) the applicability of the flume technique in this environmental setting.

Approach

A flume (2 m wide, 12 m long) was installed at the boundary between a tidal creek and a fringe mangrove forest. The flume was open at each end to allow exchange from creek to interior forest.

Nutrient exchange was measured at each end of the flume; while nutrient concentrations were also monitored at the entrance of the creek.

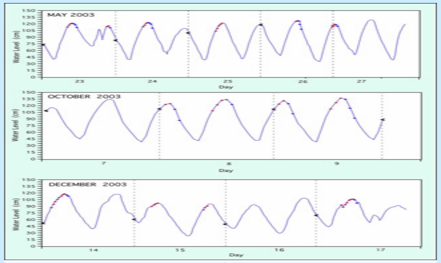
Microtopography within the flume was used to calculate changes in water volume during a tide. Fluxes were calculated from estimates of changes in water volume together with measures of nutrient concentration at each end of the flume (Childers and Day 1988, Rivera-Monroy et al. 1995). Analysis was performed for inorganic nitrogen (NH_4^+, NO_2+NO_3) soluble reactive phosphorus (SRP), silicate, total nitrogen and total phosphorus using standard techniques.

Net areal flux (mg m^{-2} h^{-1}) was calculated as:

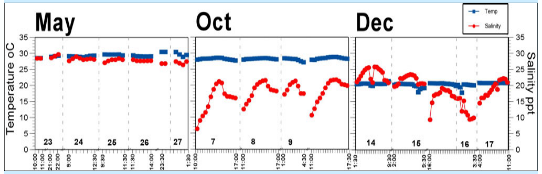
$$\frac{\text{total flux}_{\text{upstream}} - \text{total flux}_{\text{downstream}}}{\text{flume area x total time}}$$

• Water samples were taken with autosamplers at the mouth of the creek and at each end of the flume

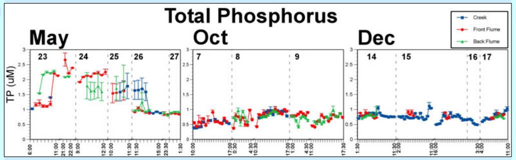
Results

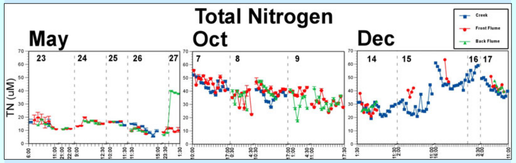


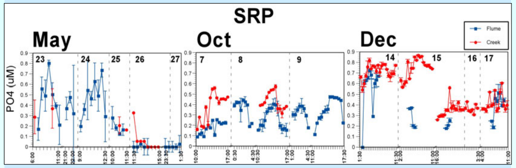
• Water levels, temperature and salinity were measured at the mouth of the tidal creek. The study area has a semi-diurnal tidal regime. The dots at the highest water levels indicate when the forest floor was inundated.

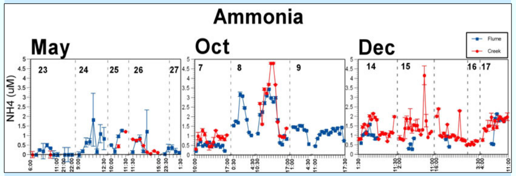


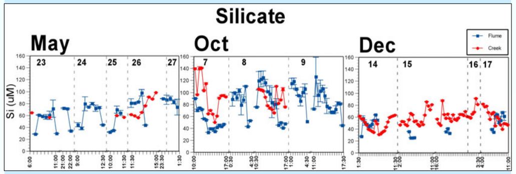
Results

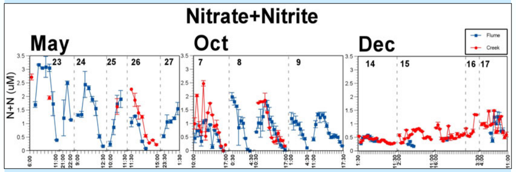












• Concentrations in the flume ranged from 0.0-0.8 µM (PO_4), 0-5.2 µM (NH_4), 41-103 2 µM (Si), 0.0-3.5 µM (NO_2+NO_3), 0.4-2.7 µM (TP) and 6.2-64.0 µM (TN); and in the tidal creek from 0-0.9 µM (PO_4), 0-4.0 µM (NH_4), 53-141 µM (Si), 0.2-2.7 µM (NO_2+NO_3), 0.4-3.5 µM (TP) and 5.4-61.6 µM (TN). Error bars indicate the standard error.

Results (cont'd)

Net fluxes were calculated only when both sides of the flume were flooded either during the flood or ebb tide. Nutrient concentrations at both end of the flumes were not significantly different (p>0.5) in all sampling dates. This result indicates that water residence time in the flume was too short for any nutrient exchange to occur between the water column and the forest floor.

Date	Tide No.	PO4	NH4	Si	N+N	TN	TP
23 May, 2003	1	-0.011	-0.008	-0.548	-0.005	0.008	-0.075
24 May, 2003	1	0.003	-0.032	0.415	0.190	0.106	0.009
26 May, 2003	1	0.000	0.625	-2.204	-0.011	0.022	0.006
27 May, 2003	1	0.001	-0.013	-1.007	0.023	-0.149	0.001
8 October, 2003	1	-0.009	-0.092	-1.013	-0.046	-0.026	0.020
	2	0.016	-0.010	-1.376	0.075	-0.057	0.004
9 October, 2003	1	0.003	-0.037	1.309	0.012	-0.572	-0.010
	2	-0.002	0.002	2.617	-0.024	0.161	0.010
14 December, 2003	1	-0.004	-0.021	-0.254	0.000	-0.141	-0.002

• Flume nutrient net areal fluxes (mg m^{-2} h^{-1}). A negative flux indicates a release of nutrients from the forest to the water column while a positive flux indicates an uptake of nutrients by the forest.

Conclusions

•Nutrient concentrations were different among seasons. The high TP and lower TN concentrations at the end of the dry season (May) indicate that the nitrogen and phosphorus sources were upland freshwater run- off and tidal exchange with the Gulf of Mexico, respectively.

•Nutrient areal fluxes measured in the flume were not significant in all sampling dates. This result suggests that the flume dimensions (2 m x 12 m) used in this study are not adequate to measure nutrient exchange in this forest. Thus, at this sampling scale it is not possible to evaluate if this fringe mangrove forest is a sink or source of nutrients.

• Similar temporal changes in nutrient concentrations in both the flume and the mouth of tidal creek indicate that nutrient exchange between the mangrove forest and the adjacent estuarine waters needs to be evaluated on a weekly basis at spatial scales >100 m^2. Particularly since nutrient concentrations in the creek are strongly influenced by the previous tidal stage causing significant differences in concentrations among tides.

Acknowledgments

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