Leaf productivity in Florida coastal Everglades mangrove forests

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ABSTRACT: We measured leaf productivity in six mangrove forests as part of ongoing studies to estimate productivity in the mangrove forests within the FCE-LTER sites. Leaf productivity was higher in the Shark River sites relative to the Florida Bay sites. Productivity was a function of basal area and soil phosphorus levels. Productivity was however, not related to soil salinity.

INTRODUCTION

The Everglades is a unique subtropical oligotrophic wetland ecosystem that is currently undergoing hydrologic restoration. The effects of restoration on processes such as nutrient cycling and forest productivity in the mangrove forests of the Florida coastal Everglades however, have not been completely understood.

We are currently investigating how increasing freshwater and nutrient input, at the fresh-saline transition zone, will affect forest structure and productivity. In this study, we evaluated leaf productivity along salinity and soil total phosphorus (P) concentration gradients.

METHODS

Six sites (Fig. 1) were established, 3 along Shark River (SRS4,5 and 6) and 3 in Florida Bay (TS/Ph 6,7 and 8). At each site, two 20 x 20 m plots were set up to measure forest composition, structure, and productivity. To measure productivity, litterfall traps (n=10) were placed at the Shark River sites (Fig. 1a) and TS/Ph8. Litter was collected each month (Fig. 1b), dried at 60^{o}C and separated into leaves, branches and reproductive components.

Due to the low canopy at TS/Ph 6 and 7, leaves and branches were tagged (Fig. 1d) to measure turnover rates. The number of leaves were counted on tagged branches at approximately 6-month intervals. To estimate forest cover at these sites, aerial photographs (courtesy SFWMD) (Fig. 1c) were digitized and percentage vegetation measured using ImageJ (v1.31, NIH, USA).

In 2003, phosphorus (P) levels in the soil were determined by collecting soil cores (to 40 cm) at each site. Soil salinity was measured 30 cm belowground at each site during field sampling.

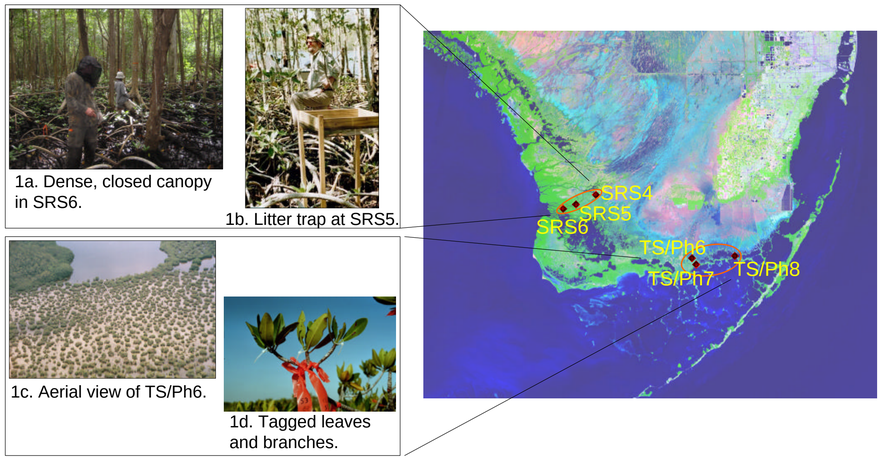

Figure 1. Study locations at Shark River (SRS) and Florida Bay (TS/Ph).

Table 1. Species composition, canopy height and leaf productivity at study sites.

Site	Forest composition*	Basal area (m^2 ha^{-1})	Productivity (g m^{-2} yr^{-1})
SRS-4	*C. erectus, R. mangle, L. racemosa*	18.7 ± 8.0	551 ± 17
SRS-5	*R. mangle, A. germinans, L. racemosa*	21.2 ± 5.2	586 ± 10
SRS-6	*R. mangle, L. racemosa, A. germinans*	35.9 ± 3.7	783 ± 16
TS/Ph6	*R. mangle, C. erectus*	-	526 - 791
TS/Ph7	*R. mangle, C. erectus*	-	279 - 310
TS/Ph8	*C. erectus, L. racemosa, R. mangle*	-	295

* Species listed in order from most dominant to least.

RESULTS

Species composition varied between the two riverine systems. Although *R. mangle* was the most widely distributed and dominant at most sites, *C. erectus* was prevalent in 4 of the 6 sites studied. Spatially, productivity was higher in the Shark River mangroves (551-782 g m^{-2} yr^{-1}) relative to the Taylor River (250 g m^{-2} yr^{-1}) sites (Table 1). Similarly, our data suggest that there is a gradient of productivity at the Shark sites—leaf productivity increased with greater inputs from the Gulf of Mexico. In Taylor River, there was an inverse gradient of productivity—leaf production was higher at the most inland site (TS/Ph6) relative to the TS/Ph7 and 8. Temporally, there was a strong seasonal trend to litterfall with high rates of litterfall observed during the summer months (Fig. 3).

Although the forest structure was very different between the SRS and TS/Ph sites, leaf productivity was significantly correlated to basal area across all sites (Fig. 2a). Similarly, leaf production was significantly correlated to total P in the soil (Fig. 2b). In contrast, soil salinity was not correlated to litterfall production since soil salinity values were relatively similar at all sites (average 40 ppt).

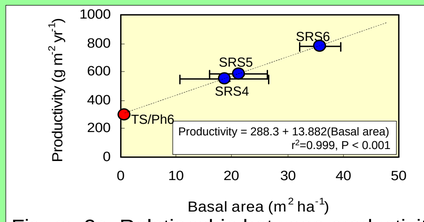

Figure 2a. Relationship between productivity and basal area at the SRS sites and TS/Ph 8.

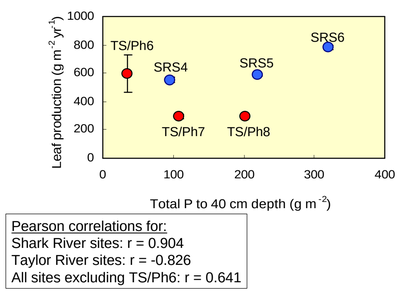

Figure 2b. Leaf productivity as a function of soil P content.

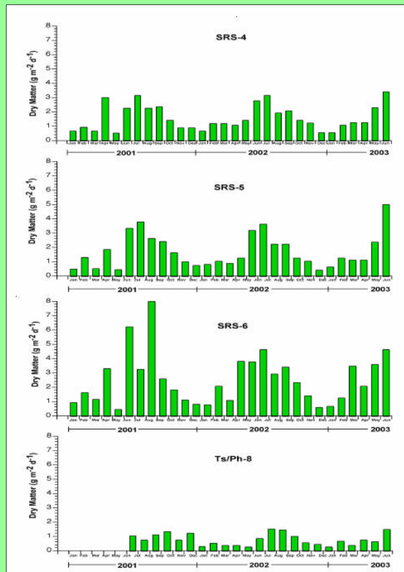

Figure 3. Monthly litterfall at the Shark River sites and TS/Ph8.

DISCUSSION

Leaf productivity patterns can be explained both by differences in forest basal area and soil P levels. The Shark and Taylor sites have very different forest structures. At Shark River, the forest in general, is much taller and has a closed canopy (Fig. 1a). The Florida Bay mangroves are shorter and occur in clumps (Fig. 1c). The annual pulse in litterfall during the early summer months (Fig. 3) indicates that litter production is strongly correlated to growth at these forests.

The patterns in forest structure are most likely dependent on soil P availability at the Shark River sites (Table 2, Fig. 2b). The Shark River mangrove ecosystem receives most of its inputs from the Gulf of Mexico but these inputs are not available to the Florida Bay mangroves. Productivity values from TS/Ph7 and 8 show that these sites had lower productivity than Shark River sites with similar P contents (Fig. 2b). These lower Taylor River values are potentially a function of different substrate types and flooding duration.

The productivity estimate from TS/Ph 6 was contrary to expectations as this site had the lowest P soil content and productivity levels comparable to that of the Shark River sites. This might be due to the use of different techniques when estimating leaf production (i.e. leaf fall vs. leaf tagging). More work is need to explain the patterns observed from the Florida Bay mangroves. Leaf productivity values at TS/Ph6 and 7 were based on aerial photography estimates of vegetation cover for the whole site. Further work is still needed to refine these values.