Spatial Patterns of Belowground Biomass and Productivity along two Mangrove Vegetation Landscapes in the Florida Coastal Everglades

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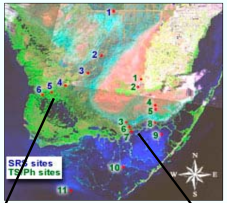
Research Problem

Belowground production represents a significant proportion of total annual net primary productivity in most ecosystems. Increased root production plays an important role in ecosystem processes such as nutrient cycling, nutrient storage, soil organic matter composition, and vertical accretion. Mangrove forests in particular, may allocate a large proportion of their biomass to the belowground component, up to 40-60% of the total production. Fine roots increase nutrient cycling and availability within the soil, facilitating acquisition, rapid root turnover, and recycling. Mangrove forests in the Florida Coastal Everglades (FCE) are one of the most conspicuous vegetation communities, representing a combination of different mangrove types distributed across a carbonate environmental setting with gradients in resources, regulators, and hydroperiod. Despite their relevance, there are large information gaps on ecosystem properties such as primary productivity and nutrient cycling and on the factors regulating these processes. We pay particular attention to the belowground compartment to estimate its contribution to total net primary productivity, due to the lack of information regarding this theme in the area. Thus, the objective of this study is to evaluate the spatial and temporal patterns of belowground biomass and productivity along two FCE mangrove transects (Shark River and Taylor River Sloughs) with distinct hydroperiods and nutrient resource gradients. We tested the hypothesis that gradients in nutrient resources and hydroperiod play a role in the structure, turnover, and productivity of belowground mangrove systems.

Study Area

Six of the indicated sites were sampled; SRS-4, SRS-5, SRS-6, and TsPh-6, TsPh-7 and TsPh-8.



SRS6

TsPh7

Research Questions

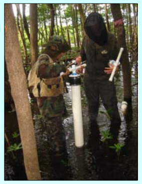
1) What are the spatial patterns of belowground biomass and productivity across the FCE mangrove sites?

2) How do biomass and productivity vary with location (inland vs. edge) within the forest and with depth?

3) how do nutrient resource gradients and hydroperiod constrain biomass allocation and productivity between the two contrasting mangrove regions?

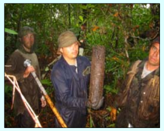
Approach





We performed two separate field experiments (from December 2000 to December 2002 and from December 2002 to February 2006) to estimate standing crop root biomass, belowground productivity, and root distribution with depth (top: 0-45 cm and bottom: 45-90 cm) in six mangrove sites (SRS4, SRS5, SRS6, TsPh6, TsPh7 and TsPh8).

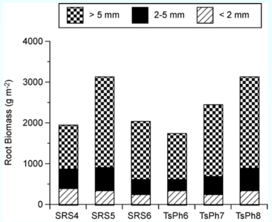
Root cores were collected once at the beginning of the experiment to estimate standing crop biomass by using the sequential coring technique.

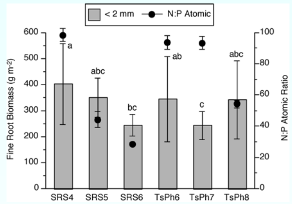

After cores for biomass estimation were removed, ingrowth bags of equal dimension (10.2 x 45 cm) filled with Sphagnum peat moss replaced each soil core. Ingrowth cores were allowed to incubate in situ from 5 to 24 months (experiment 1) and from 12 to 38 months (experiment 2).

Prior to separation, roots were rinsed with water through 1 mm mesh sieve to remove soil particles. Live root fractions were separated into diameter size classes of <2 mm, 2-5 mm, and >5 mm. Live roots were oven-dried at 60 ºC until constant weight.

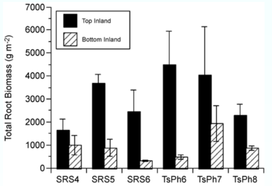
Results and Discussion



Root biomass of small roots (<10 mm, to a depth of 45 cm) along the Shark and Taylor River Sloughs. Mean values were consistent between both experiments and varied significantly among sites. Total root biomass ranged from 1730 ± 594 g m^{-2} (TsPh6) to 3121 ± 1213 g m^{-2} (SRS5). Fine root biomass was 20% of total production, while coarse root biomass (>5 mm) contributed between 50-70% of total production.

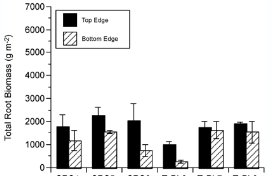


Fine root biomass and N:P atomic ratios along the Shark and Taylor River sites. There was a direct relationship between fine root biomass and N:P ratios along the freshwater-estuarine transect of Shark River. Along the Taylor River sites, fine root biomass was greater in all sites and N:P ratios were >50, indicating strong nutrient limiting conditions, when compared to SRS6.



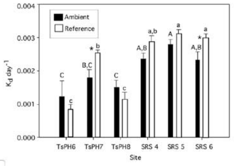
Location of ingrowth bags in the inland section of mangrove islands.

Along the Shark River sites, the location of ingrowth bags in the inland (60 m) or edge (40 m) sections of mangroves is relative to the water edge.



Location of ingrowth bags in the edge section of mangrove islands.

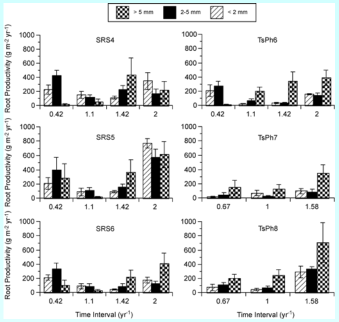
Variation (Mean ± SE) in root biomass and distribution with depth (0-45 cm top and 45-90 cm bottom) and location (inland vs. edge) within the forest. Mean total root biomass was significantly greater in the top vs. the bottom section and in the inland vs. the edge section of the forests.



Reference: Poret, N., R.R. Twilley, V.H. Rivera-Monroy, and Coronado, C. **In press**. Belowground Decomposition of Mangrove Roots in Florida Coastal Everglades. **Estuaries**

Root decomposition rates were significantly higher in TsPh7 as compared to TsPh6 and TsPh8, and similar to SRS4 and SRS6 rates. These results coupled to high fine root biomass and faster turnover rates in this site, might explain the high rate of decomposition in TsPh7 relative to other Taylor sites.

Results and Discussion (cont'd)

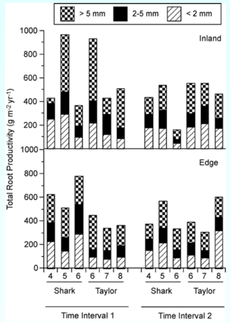


Time series of belowground productivity (to a depth of 45 cm) from December 2000 to December 2002 for each of the FCE mangrove sites.

Root production rates increased over time. Rates ranged from 17.2 ± 6.5 g m^{-2} yr^{-1} (TsPh6; t=13 mo; <2 mm) to 769 ± 65 g m^{-2} yr^{-1} (SRS5; t=24 mo; <2 mm). Overall, higher mean total productivity rates were observed in Shark River (224.6 ± 11.1 g m^{-2} yr^{-1}) compared to Taylor River 162.5 ± 11.3 g m^{-2} yr^{-1}).

Fine root productivity follows the pattern SRS5> SRS4>TsPh8>SRS6>TsPh 6>TsPh7.

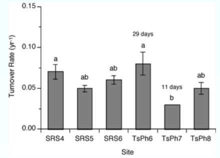
Time intervals: 0.42 = 5 mo; 0.67 = 8 mo; 1.0 = 12 mo; 1.1 = 13 mo; 1.42 = 17 mo; 1.58 = 19 mo; 2.0 = 24 mo



Belowground productivity integrated to a depth of 90 cm in the inland and edge locations within the mangrove forest. Total mean root production was higher in the inland section (175.7 ± 17 g m^{-2} yr^{1}) of the forest compared to the edge section (156.2 ± 12.1 g m^{-2} yr^{1}). Total root production was significantly ($P < 0.05$) different among sites.

Time interval 1: 1.0 yr (24 mo) for all sites

Time interval 2: 2.75 yr (33 mo) for SRS sites and TsPh6; 3.17 yr (38 mo) for TsPh6-7.



Root turnover rates along the Shark and Taylor River sites. Data were based on the ratio of productivity to biomass for each site. Turnover rates were significantly ($P < 0.05$) different among sites ranging from 0.03 yr^{-1} (TsPh7) to 0.08 yr^{-1} (TsPh6).

Conclusions

Our results confirm our hypothesis that mangroves under P-limited conditions such in the Taylor River sites and one upstream site in Shark River (SRS4), allocate more resources to roots when compared to the landscape site (SRS6) with the highest soil P concentrations (93 g m^{-2}) in the region.

Root biomass and productivity are variable across the two freshwater-estuarine transects of the FCE mangroves and are influenced by gradients in resources, regulators, and hydroperiod.

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