

# SOME RESPONSES OF MANGROVE SAPPLINGS TO THE SALINITY AND HYDROPERIOD INTERACTION

Pablo Cardona-Olarte and Robert R. Twilley

Center for Ecology and Environmental Technology, Lafayette, LA 70507 and Department of Biology, University of Louisiana at Lafayette, Lafayette, LA 70504



Fig 1. Experimental layout showing the tidal tables in which each white bucket represents an experimental unit. They host saplings of either *Rhizophora* or *Laguncularia*.

## METHODS

To test our hypothesis we ran a mesocosm experiment composed of tidal platforms that can simulate different hydroperiods. These platforms consist of buckets (23 L, 48 cm deep) situated on top of a 190-L reservoir (Figs 1 and 2). Salt water is distributed to each individual bucket. Tidal amplitude is controlled independently in each bucket. Permanent flooding is controlled by preventing drainage. Timers control inundation, frequency and duration on a semidiurnal pattern.

The tidal system is set up in a 1.8 ha greenhouse located at the Center for Ecology and Environmental Technology, University of Louisiana at Lafayette. Air temperatures in the greenhouse are maintained above 8 C and within 2 C of the high summer temperatures. Light within the greenhouse is 53% of the ambient solar energy. Salinity in the water circulating between the buckets and the reservoirs was  $10 \pm 2.5$  g/kg for the low salinity treatment, and  $40 \pm 2.5$  g/kg for the high salinity treatment.



Fig 2. Experimental tidal table showing saplings of *R. mangle* (the smaller ones) and *L. racemosa* (tall ones) planted inside buckets (shaded to avoid algae growth).

## ABSTRACT

Patterns of net primary productivity, biomass allocation, and leaf turnover were determined on *Laguncularia racemosa* and *Rhizophora mangle* saplings growing on a fertile soil under greenhouse conditions. The experiment was run from October 2000 through August 2001 with the purpose of quantifying the responses of species-specific plant traits to the combined effects of hydroperiod and salinity. Data demonstrate that under salinity as low as  $10 \pm 2.5$  g/kg and as high as  $40 \pm 2.5$  g/kg *L. racemosa* significantly reaches higher biomass production than *R. mangle* in both permanently flooded and tidal conditions. However, at salinity equal to  $40 \pm 2.5$  g/kg the difference in productivity decreases under permanently flooded conditions. Similar patterns prevailed for leaf area ratio. Values of root/shoot ratio indicate that in all four treatment combinations *L. racemosa* allocates significantly less biomass to roots compared to shoots, with the opposite pattern for *R. mangle*. These results suggest that the stress resulting from environmental regulators such as salinity and hydroperiod can be ameliorated in fertile soils, which favors traits such as net primary productivity, higher biomass allocation to shoots, and higher leaf area ratio. These traits favor competitive dominance of *L. racemosa* over *R. mangle* under fertile soils. This type of information is fundamental to predictive exercises aimed to guide management decisions regarding hydrologic restoration.

## INTRODUCTION

Regulators are central factors in the organization of ecological communities. Stress caused by regulators modifies survival and fitness of plants. In habitats such as coastal wetlands several regulators such as salinity, sulfides, and flooding can affect both plant performance and species interactions (Chesson and Huntly 1997). Species-specific responses to regulators depend on plant traits and determine the outcome of ecological interactions (Huston 1994). Thus, responses of mangrove species to environmental regulators are key mechanisms to uncover if we are to predict spatial and temporal patterns of mangrove forests.

Because of the relative simplicity of neotropical mangroves forests, these communities offer an excellent opportunity to test hypotheses on the effects of environmental factors on community organization and development. Dynamics of coastal mangroves are strongly affected by gradients of fertility, salinity, sulfides and hydroperiod (Twilley 1998). We hypothesized that because of tradeoffs resulting from morphological and physiological-specific traits, which affect plant performance (Huston and Smith 1987), *L. racemosa* would have a competitive advantage over *R. mangle* when growing under moderate stress by salinity (lower than 40 g/kg) and hydroperiod in fertile soils.

## RESULTS

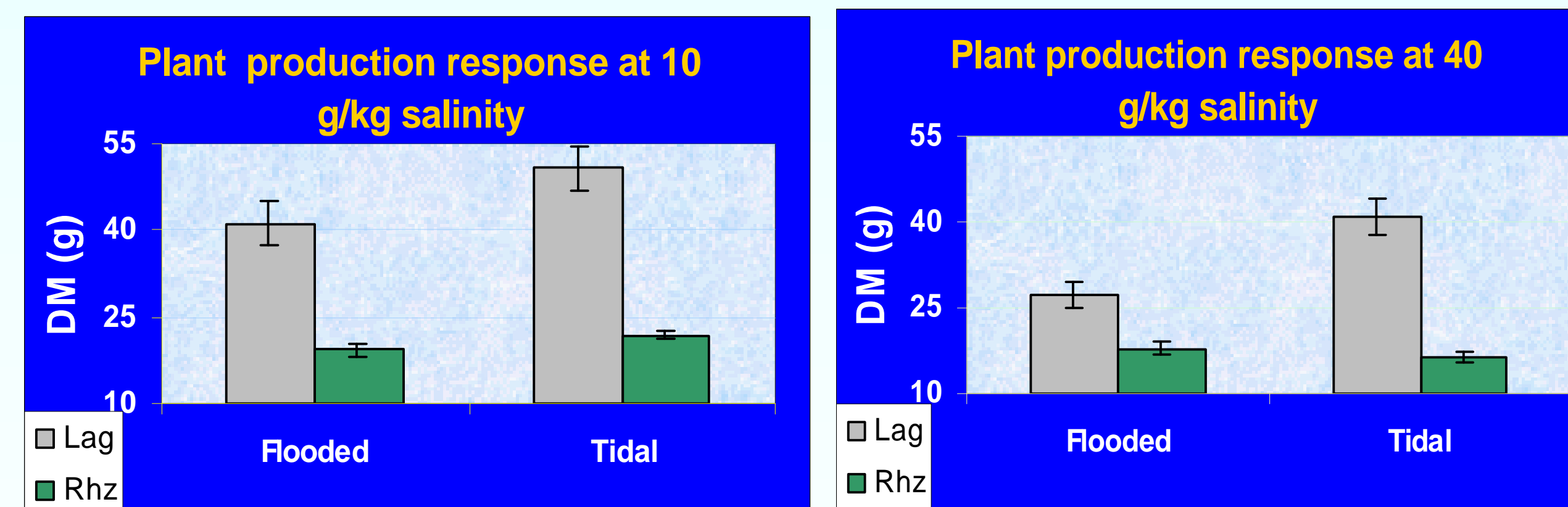


Fig 3. Response of plant dry mass production (DM) in mangrove saplings to the combined effects of hydroperiod and salinity. Lag = *L. racemosa*, Rhz = *R. mangle*. Bars represent  $\pm 1$ SE.

- ❖ *L. racemosa* reaches significantly higher (2- to 3-fold) values of production than *R. mangle* under both levels of salinity and hydroperiod (Fig 3).
- ❖ Plant production was significantly affected by salinity and hydroperiod for both species, with highest values under tidal hydroperiod and 10 g/kg conditions for both species (Fig 3).
- ❖ Biomass allocation to roots was significantly higher in *R. mangle* than in *L. racemosa* in all treatments (Fig 4).
- ❖ Patterns of biomass allocation depended on hydroperiod for both species, and on salinity for *R. mangle*, with higher allocation to roots under tidal conditions for both species (Fig 4). The salinity-hydroperiod interaction was not significant within species.
- ❖ Leaf area ratio (LAR) in both species was significantly affected by both salinity and hydroperiod. Higher LAR occurred at 10 g/kg salinity for both species (Fig 5).

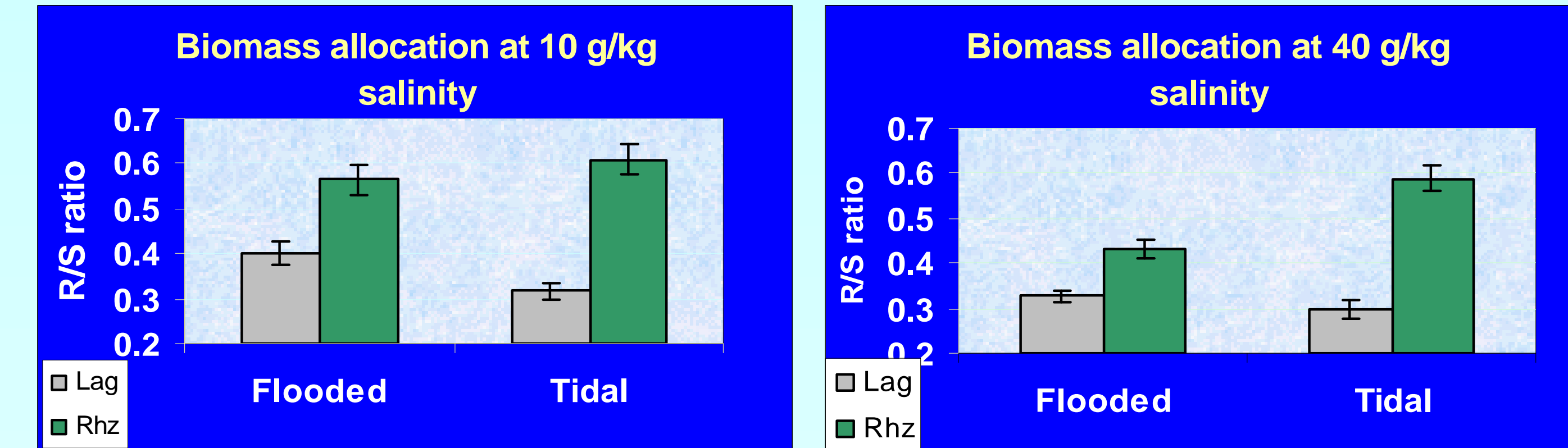


Fig 4. Biomass allocation response in mangrove saplings to the combined effects of hydroperiod and salinity. Lag = *L. racemosa*, Rhz = *R. mangle*. Bars represent  $\pm 1$ SE.

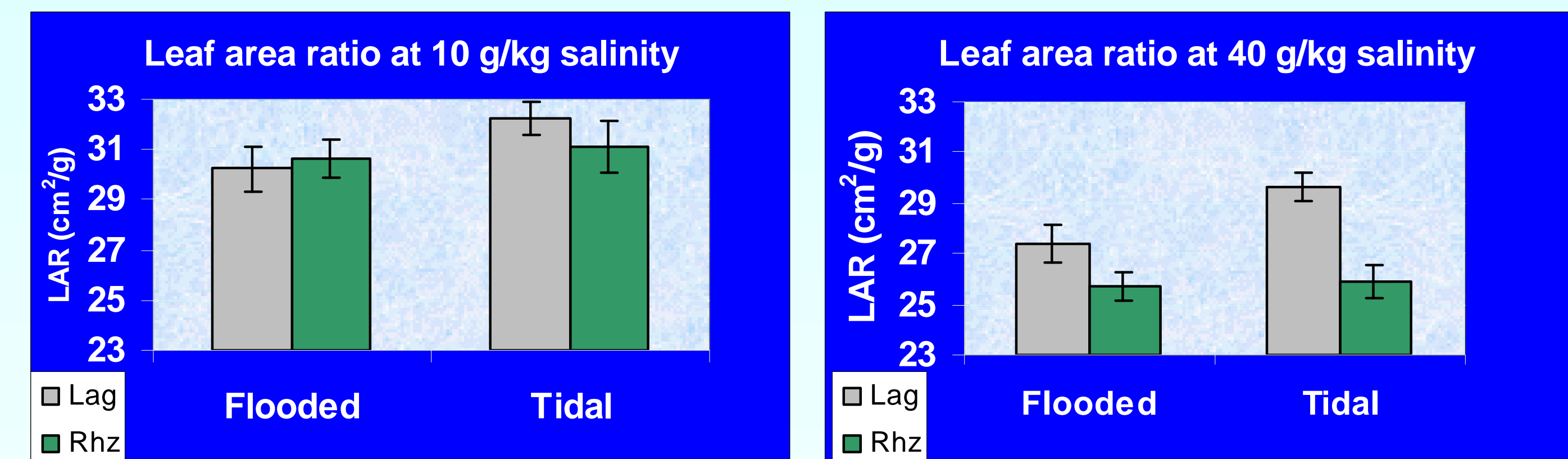


Fig 5. Response of leaf area ratio (LAR) in mangrove saplings to the combined effects of hydroperiod and salinity. Lag = *L. racemosa*, Rhz = *R. mangle*. Bars represent  $\pm 1$ SE.

## CONCLUSIONS

- Under fertile soils with low to moderate stress from hydroperiod and salinity net primary productivity (NPP) is higher in *L. racemosa* than *R. mangle*.
- This higher NPP of *L. racemosa* results from a combination of plant strategies including increased biomass allocation to aboveground parts and increased leaf area ratio. These traits allow *L. racemosa* to compete more successfully for aboveground resources.

## REFERENCES

- Chesson, P. and N. Huntly. 1997. The role of harsh and fluctuating conditions in the dynamics of ecological communities. *American Naturalist* 150: 519-553.
- Huston, M.A. 1994. *Biological diversity*. Cambridge University Press. Cambridge.
- Huston, M.A., and T. Smith. 1987. Plant succession: life history and competition. *American Naturalist* 130:168-198.
- Twilley, R. R. 1998. Mangrove wetlands. Pages 445-473 in M. G. Messina and W. H. Conner, editors. *Southern Forest Wetlands*. Lewis Publishers, New York.

## ACKNOWLEDGEMENTS

We thank National Science Foundation (NSF), LTER-FCE, and Colciencias (COLOMBIA) for providing funding for this study