

Woody Debris in South Florida Mangrove Wetlands

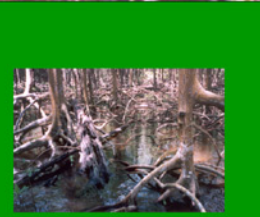
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ABSTRACT

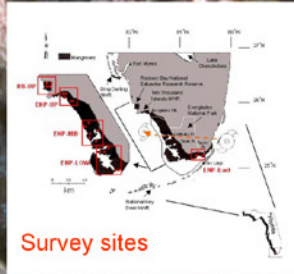
Volume of woody debris in forests provides an often overlooked, yet important ecosystem service. Here, we report on line-intercept woody debris surveys conducted in mangrove wetlands of south Florida between 9 and 10 years after the passage of Hurricane Andrew (1992). The volume of woody debris for all sites combined was estimated at 67 m³ ha⁻¹ and varied from 13-181 m³ ha⁻¹ depending upon differences in forest height, storm circulation quadrant, and maximum estimated sustained wind velocities. Greater volumes of woody debris were found within the storm's eyewall and immediate right quadrants. Likewise, similar percentages of fine woody debris volume relative to coarse woody debris volume were associated with greater storm force, also reflecting differential rates of decomposition. Hurricanes are responsible for large amounts of damage to mangrove ecosystems and components of downed wood may provide a relative index of disturbance among similar mangrove forests.

INTRODUCTION

Woody debris has been associated with several important ecosystem services, including influencing nutrient recycling, controlling erosion, promoting soil pedogenesis, increasing site water retention, serving as a potential nursery bed for germinating seeds, and providing habitat for heterotrophic communities (Harmon *et al.* 1996). Specific to mangroves, woody debris may trap propagules, promote sedimentation, and increase growth of nearby seedlings.

Disturbance to forests greatly influences the amount of woody debris on the forest floor (Sturtevant *et al.* 1997; Allen *et al.* 2000). Determining forest structural changes in response to different environmental impact scenarios (e.g., hurricanes, lightning strikes, hydroperiod fluctuations) continues to be an effective way to predict ecosystem response and persistence (Doyle & Girod 1997; Chen & Twilley 1998). Including downed woody debris in these assessments may be important in accounting for site differences in productivity, community dynamics, and carbon biogeochemistry among ecosystems (Harmon & Hua 1991).

Downed wood as a component of mangrove forest structure has been explored in two other investigations (Robertson & Daniel 1989; Allen *et al.* 2002); both studies were from the old world tropics. The purpose of this study is to provide an estimate of downed wood for the hurricane-prone mangrove wetlands of south Florida. We tested whether the volume of woody debris and relative distribution of fine versus coarse woody debris varies with proximity to the path and windspeed of Hurricane Andrew (1992) as a landscape level gradient of disturbance, and use this gradient to suggest a relative disturbance index for mangrove forests in south Florida.



Survey sites



Line intercept - coarse woody debris



Snorkel gauge - fine woody debris



Taylor River Slough



Study crew near Lastmans RI Everglades National Park

RESULTS

- Differences in combined woody debris (i.e., coarse + fine debris) by sample region were significant ($F_{4,15} = 13.74, P \leq 0.001$) – Table 1
- Peak woody debris was associated with eyewall and immediate right quadrant impact zones of Hurricane Andrew (ENP-UP and ENP-MID) – Table 1, Fig 1
- When analyzed separately, the fine woody debris and coarse woody debris differed by region, with statistical groupings varying only slightly from combined measurements – Fig 1, of Table 1
- Coarse woody debris comprised the largest percentage of downed wood on most surveyed mangrove stands, with a ratio of fine coarse debris ranging from 0.37 to 0.62 on RB-UP, ENP-UP, ENP-MID, and ENP-LOW sites – Fig 1
- Relationships between forest height and woody debris volume were weak – Fig 2

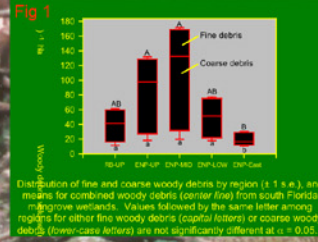
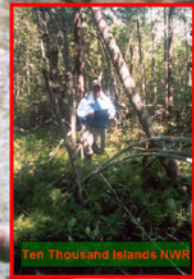


Fig 1. Distribution of fine and coarse woody debris by region (± 1 s.e.), and means for combined woody debris (center line) from south Florida mangrove wetlands. Values followed by the same letter among regions for either fine woody debris (capital letters) or coarse woody debris (lower-case letters) are not significantly different at $\alpha = 0.05$.



Ten Thousand Islands NWR

Table 1 Mean total volume of woody debris in south Florida mangrove forests.

Diameter/Decay Class	Mean volume (m ³ ha ⁻¹)						Mean
	RB-UP	ENP-UP	ENP-MID	ENP-LOW	ENP-LOW	ENP-LOW	
Fine (< 7.5 cm)							
0.0 - 1.0 cm	1.41	2.63	1.16	1.63	6.19	1.93	
1.0 - 2.5 cm	3.79	5.15	4.49	4.31	3.95	4.35	
2.5 - 7.5 cm	12.53	22.36	29.68	17.79	6.36	16.48	
Coarse (> 7.5 cm)							
Small	0.00	0.26	0.00	0.19	0.00	0.09	
Intermediate	0.47	11.22	11.94	11.20	1.38	3.23	
Robin	14.12	36.12	65.34	16.83	2.74	34.00	
TOTAL	47.23	77.54	124.41	37.44	10.31	62.66	

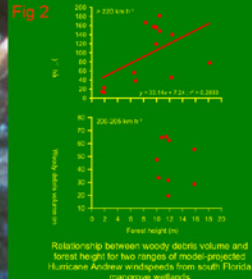


Fig 2. Relationship between woody debris volume and forest height for two ranges of model-predicted Hurricane Andrew windspeeds from south Florida mangrove wetlands.

DISCUSSION

Downed wood represents a large carbon and potential nutrient pool in mangrove wetlands (Robertson & Daniel 1989). Some 9 to 10 years following Hurricane Andrew, woody debris is persistent on south Florida sites. Much of the downed wood, especially in the eyewall and right quadrant areas of the hurricane, were large trees and therefore had much slower decay rates. Mangrove trunk wood can remain in the understory even beyond 15 years of mortality (Robertson & Daniel 1989). Mangrove trees killed by Hurricane Donna (1960) in south Florida had stumps present in 1993, and many *Rhizophora mangle* boles were not completely decomposed even after 30 years. Although not without slight uncertainty, we can assume that the greatest percentage of intersected coarse woody debris in ENP-UP, ENP-MID, and ENP-LOW was from Hurricane Andrew or from natural attrition sometime shortly before or after the storm.

Shifts in the relative percentage of coarse woody debris versus fine woody debris by region and the decomposition state of larger wood further indicates that the majority of the coarse woody debris in ENP-UP, ENP-MID, and ENP-LOW sites may have been from Hurricane Andrew. In fact, a fine coarse woody debris ratio of 0.44 and 0.37 for ENP-UP and ENP-MID, respectively, indicates that lower ratios may indicate relatively higher disturbance regimes when compared to sites of similar forest stature. Fine to coarse woody debris ratios exceeded 0.76 for RB-UP and ENP-LOW, ENP-East sites (3.0) were not comparable on the basis of a much reduced relative forest stature. A low fine to coarse woody debris ratio of 0.11 was found on mangrove sites on Kosrae, Federated States of Micronesia, under an accelerated individual tree harvest regime relative to mangrove forests of Pohpoh (0.56) and Yap (0.61; Allen *et al.* 2000). Such analysis of downed wood components may provide a relative index of disturbance among similar mangrove forests in a geographical region.

It was hypothesized that, perhaps, pre-hurricane surveys of forest structure can indicate potential woody debris fall during a hurricane. But, only as much as 26% of the variation in the volume of woody debris can be explained by the linear relationship of woody debris with forest height. Total stand volume has been shown to be an equally poor indicator of downed woody (Allen *et al.* 2000), yet the relationship with forest basal area can be strong (Santiago 2000). Determining a more appropriate metric to predict the volume of downed wood in Florida mangrove forests may involve intensive studies on plot-level variation within forests, and should be a focus of future woody debris research efforts on long-term ecological research plots.

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