LIGHTING GAP CHARACTERISTICS IN THE MANGROVES OF SOUTH FLORIDA.

Kevin R. T. Whelan[1], Thomas J. Smith III[2], and Ives van Leth[3]

[1] Student Career Experience Program
USGS-BRD,
Florida Caribbean Science Center.
C/o Biological Sciences, OE 167,
University Park
Florida International University
Miami, Florida, 33199. 305-348-6047,
whelank@fiu.edu

[2] USGS-BRD
USGS Center for Coastal Geology
tom_j_smith@usgs.gov

[3]International Agricultural College
Larenstein, Velp, The Netherlands

Photo 1: Aerial view of a recently created lightning gap, Shark River area.

ABSTRACT

Lightning gaps have been identified as a common disturbance in mangroves throughout the world. Florida has the highest level of cloud to ground lightning strikes in the United States. Consequently, gap formation in the mangroves as a result of these lightning strikes is a common disturbance phenomenon. We investigated characteristics of lightning gaps in the mangroves of Southwest Florida. The 39 lightning gaps censused were comprised of mixed species and age classes of mangroves. The mean canopy gap area was 212 m^2 and the expanded gap was 299 m^2. Gaps were slightly elliptical in shape with an average eccentricity of 1.28. There was a preferential directional bias to the longest axis of the gaps. However, there was no evidence of wind extensions to the gaps. Gap size was partially explained (33%) by surrounding tree height. There was no difference in gap characteristics between new and older gaps (greater than 3 years old). It appears that lightning created gaps in the mangroves recover by saplings filling the gap area instead of lateral branch extensions from surrounding canopy trees. To further understand the role of lightning strikes gaps we plan to investigate successional patterns of closing gaps in the mangroves of Southwest Florida.

Keywords: Lightning strike, gaps, expanded gap area, mangroves

INTRODUCTION

Lightning gaps have been identified as a common disturbance in mangroves throughout the world; including Papua New Guinea (Paijmans and Rollet 1977), Malaysia (Anderson 1964), Panama (Smith 1992), Florida (Odum et al. 1982, Smith et al. 1994), and the Dominican Republic (Sherman et al. 2000). In the mangrove forest, lightning gaps alter several physical factors: humidity is lowered, soil salinity and evapotransporation are decreased, soil temperatures are higher, light levels are dramatically higher, and the soil nutrient status may change (Smith 1987).

In mangrove forests of Florida's West Coast, seedlings and some saplings present under the canopy survive the lightning strike; this completely different phenomenon is not common or very well understood (Personnel observation, Pers. comm. W. Sousa). Brunig (1964) observed a similar phenomenon in *Shorea albida* forest in Sarawak. The successional implications made be substantial.

If lightning strike gaps are an important aspect in mangrove communities in South Florida, it is imperative to understand the basic characteristics of these types of gaps. (Photo 1, 2, 3). This work represents only second time characteristics for lightning created gaps in the mangrove ecosystem have been reported.

OBJECTIVES

- Assess 3 different techniques for measuring expanded gap area.
  - Elliptical approximation, summation of triangles, and GIS-polygon
- Determine basic gap characteristics.
  - Compare canopy gap area and expanded gap area.
  - Size distribution, gap orientation.
  - Relationship of gap area to surrounding forest height.
- Investigate differences due to gap age.

METHODS

Measurements Techniques:

Use 3 techniques for determining expanded gap area (Diagram 1).

- Elliptical approximation - area = π LW/4
  Three estimations (visual longest axis, cardinal and primary intercardinal compass directions)
- Summation of triangles - 2 estimates
  area = (X * Y sin (θ))/2 and area = SQRT (P (P-a)(P-b)(P-c) (note P = perimeter)
- GIS-polygon area
  (ERIS ARCVIEW 3.2 – XY Cartesian planer system) -
  Generated from compass bearing and distant measurement from the center of the gap.

Compare Expanded gap area and canopy area.

Expanded gap area (same as the extended gap area - area between the trunks of the living edge trees) (Runkle 1981).

- Height measurements of 8 outside - gap trees (average tree height), using a clinometer.

Gap Age

- Gap age - new gaps : ≤ three years old, old gaps : > three years old

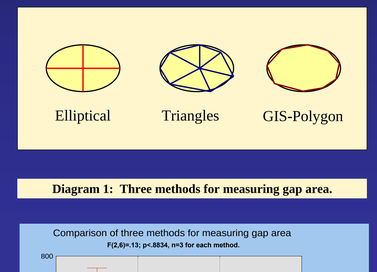

Diagram 1: Three methods for measuring gap area.

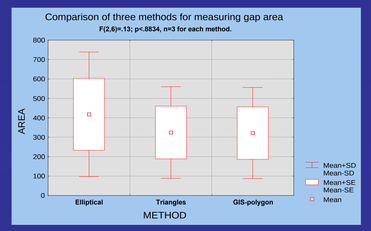

Figure 1 Average area for estimating expanded gap area

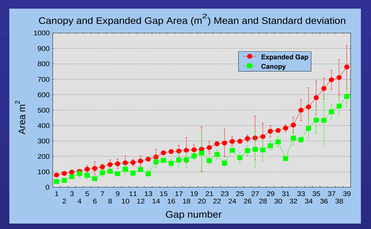

Figure 2 Comparison of canopy and expanded gap area for 39 gaps.

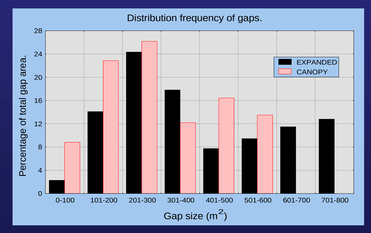

Figure 3 Size distribution of gap area

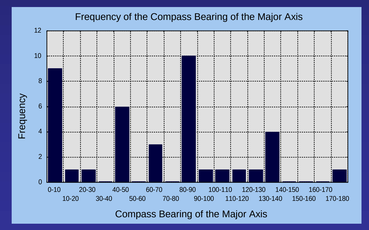

Figure 4 Frequency of major axis compass bearing

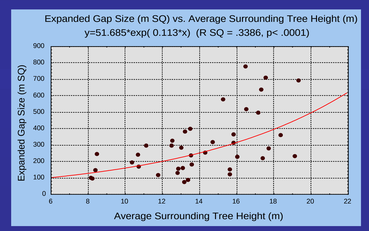

Figure 5 Expanded gap size versus surrounding tree height

Table 1 Summary of gap measurements to determine the average lightning gap size, minimum gap size, Maximum gap size, and gap eccentricity. (No significant difference between new and old gaps Mann-Whitney U test = 157.00, df = 37, p= 0.35). Eccentricity = (length $_{(major\ axis)}$)/ (length $_{(minor\ axis)}$) Eccentricity is an average of three calculations of eccentricity per gap. (No significant difference between new and old gaps Mann-Whitney U test = 159, df = 37, p= 0.38)

Number Of Gaps	Average Size	Minimum Size	Maximum Size	Longest Axis	Eccentricity expanded gap
39	299 m^2	79 m^2	780 m^2	20.6 m	1.28
Number Old Gaps					
20	316 m^2	79 m^2	712 m^2	20.9 m	1.26
Number New Gaps					
19	281 m^2	89 m^2	780 m^2	20.2 m	1.30

Photo 3: Aerial view of newly created lightning gaps and older gaps.

Photo 2: Clearly visible, elliptic patch of dead standing trees, Shark River area.

STUDY AREA

RESULTS

- There is no difference in the three measurement techniques for determining expanded gap size (Figure 1). All other analysis use elliptical approximation for area estimates.
- There is little difference in canopy and expanded gap area. Gap size varies from 37 m^2 to 779 m^2 with the most gaps occurring in the 201 -300 m^2 (25%) with an average canopy gap of 212 m^2 to expanded gap 299 m^2 (Figure 2 + 3).
- There is a preferred directional bias for the longest axis of the ellipse (resultant R = 0.69, n= 39, Critical resultant R = .292, Davis 1986). The first modal direction is 80 to 90 degrees (n=10) and the second modal direction is 0 to 10 degrees (n=9) (Figure 4).
- Gap size was partially explained by surrounding tree height, in that large gaps tend to be in forests of larger trees (Figure 5).
- There are no differences in gap size or eccentricity between new gaps and old gaps. The ratio of canopy area to expanded gap area for new and old gaps is 0.69 indicating little lateral extension (Table 1).

CONCLUSION

We found there was no difference in expanded gap area estimates between elliptical approximation, summation of triangles, and GIS-polygon area method. Lightning created gaps in south Florida are approximately 299 m^2 with a directional bias of the longest axis in the 80-90 degree direction. The surrounding forest height affects the size of the lightning gap created. The lightning gaps are elliptical in shape (1.28 eccentricity). It appears that lightning gaps recover by predominately by filling with saplings and have little branch extensions by surrounding trees. South Florida lightning generated gaps are on average smaller but similar shape to other lightning generated gaps reported (Sherman et al. 2000). Lightning strike created gaps range from small to moderate size disturbance and should have noticeable impact on forest dynamics (Duke 2001). Smith et al. (1994) observed that post hurricane survival of individuals growing in pre-existing canopy gaps was greater than for individuals growing in the surrounding canopy of the mangrove gaps. Before it is possible to understand interaction between large scale hurricanes and lightning gaps a basic understanding of the general successional process needs to be understood. We plan to investigate successional patterns of flora, fauna and sediment processes occurring after a lightning strike.

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