

# Impacts of Hurricane Isabel on forests in Virginia

Analysis & Reporting Project  
# SO-AR-08-01



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## Introduction

### Hurricane Isabel in Virginia – September 2003 (fig.1)

- Rainfall averaged 4-7 in. (10-18 cm) over much of the State, with the Shenandoah Valley averaging 8-12 in. (20-30 cm) (Beven and Cobb 2004)
- Wind speeds were 37-69 mph (59-111 kph), gusts up to 91 mph (146 kph)
- 77 counties & independent cities were declared disaster zones
- Estimated \$925 million economic loss



Figure 1. Hurricane Isabel as it made landfall on Sept. 18, 2003 (NASA 2003)

## Methods

### Data Collection

- Crown conditions and mortality rates were derived from data collected by the Forest Service's Forest Inventory and Analysis program (FIA)
- FIA uses a fixed-radius plot consisting of 4 subplots 120 ft (37 m) apart (fig. 2) (USDA Forest Service 2005)
- Trees  $\geq 5.0$  in. (12.7 cm) d.b.h. sampled on each subplot
- Plot sample area = 0.166 ac (0.067 ha)

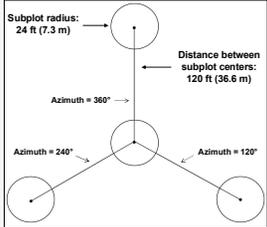


Figure 2. FIA plot design

### Data Analysis

To explore the potential impacts of Hurricane Isabel on Virginia's forests we:

- Identified 1,492 trees measured before and after the hurricane (survivors only).
- Calculated the change in crown condition (by tree) as the difference between the post- and pre-hurricane ratings ( $\delta$  = Post-hurricane condition - Pre-hurricane condition).
- Tested the hypothesis  $H_0: \delta = 0$  with a paired t-test.
- Calculated average change in crown condition per plot.
- Compared the mortality rates of plots measured before the hurricane with those measured after the hurricane.

## Results

Across the State, there was a significant ( $\alpha=0.05$ ) increase in average foliage transparency and a significant decrease in crown density pre- to post-hurricane for hardwoods and softwoods (figs. 3 & 4). The 90<sup>th</sup> percentile for foliage transparency increased from 30% to 50% and 25% to 35% for the softwood and hardwood groups, respectively. Increases in the upper percentiles especially indicate that more trees had poorer conditions after the hurricane than before.

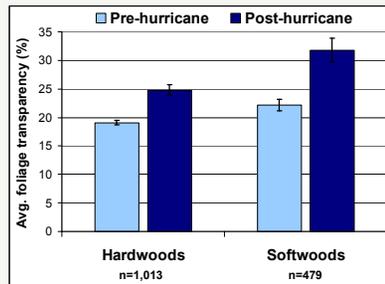


Figure 3. Foliage transparency of hardwoods and softwoods before and after the hurricane. n = number of trees.

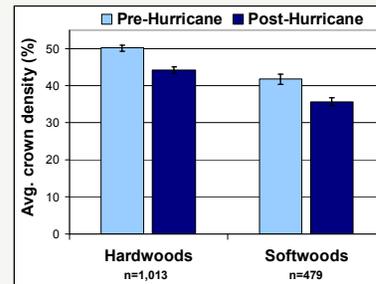


Figure 4. Crown density of hardwoods and softwoods before and after the hurricane. n = number of trees.

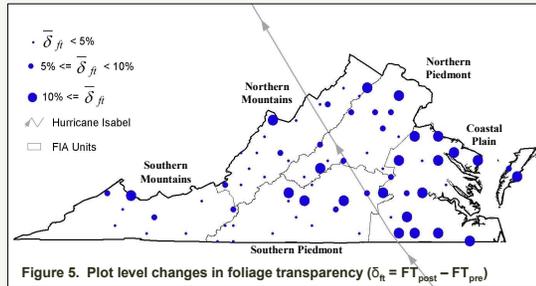


Figure 5. Plot level changes in foliage transparency ( $\delta_{ft} = FT_{post} - FT_{pre}$ )

Plot-level  $\delta_{ft}$  ranged from -6.3 to 31.3, with the highest  $\delta_{ft}$  occurring on plots in the eastern half of the State (fig. 5). On the Coastal Plain,  $\delta_{ft}$  was  $\geq 10$  on 70% of plots. In the Piedmont,  $\delta_{ft}$  was  $\geq 10$  on 18% of plots.

A high percentage of the mortality trees measured after the hurricane (i.e., between 2004 and 2007) were noted as having died in 2003. On the Coastal Plain the percentage of plots with 0% mortality yr<sup>-1</sup> was substantially higher among the plots measured before the hurricane than among the plots measured after (fig. 6).

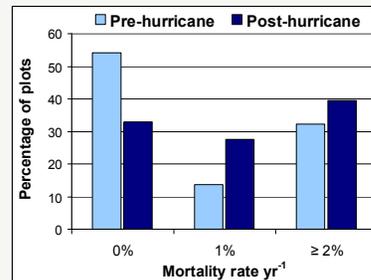


Figure 6. Distribution of plots measured before and after the hurricane, by mortality rate, on the Coastal Plain

## Crown variables measured by FIA:

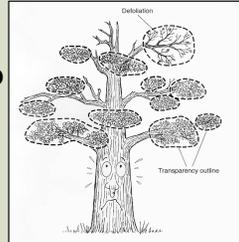
### 1 - Crown Dieback

### 2 - Crown Density (CD)

- amount of sunlight blocked by all live and dead biomass in the crown
- more desirable CD has higher number

### 3 - Foliage Transparency (FT)

- amount of sunlight penetrating the live portion of the crown.
- more desirable FT has lower number.



## Conclusions

The location of our study sites across the entire landscape and the observation that the greatest changes in crown condition occurred in the Coastal Plain, lends support to the hypothesis that these changes were due, at least in part, to the impacts of Hurricane Isabel. In addition to the crown condition indicators, a host of other variables such as tree length, down woody material, and forest floor thickness were assessed on each plot. These data, along with auxiliary weather data (e.g. wind speeds and rainfall) are being explored to further understand and quantify the damage and long-term impacts caused by Hurricane Isabel.

### References

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### CITATION

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