DO TREES FALL DOWNHILL? RELATIONSHIP BETWEEN TREEFALL DIRECTION AND SLOPE-ASPECT AND WIND IN EIGHT OLD-GROWTH OAK STANDS IN THE CENTRAL HARDWOOD FOREST

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Abstract.—This study examined the relationship between direction of treefall and slope-aspect, and prevailing wind in eight old-growth stands where single-tree canopy gaps characterize the dominant disturbance regime. All live and downed trees were inventoried in 0.45-ha sample plots. To determine crown asymmetry, crown sizes of live trees were measured along two perpendicular axes. Directions of fall and slope-aspect of downed trees also were recorded. Regional prevailing winds and wind gusts were obtained from two nearby airports. I used circular statistics to determine whether directions of treefall for each study stand had a mean direction or whether the directions of fall were uniformly distributed. If directions of treefall had a true mean, they were then compared to mean slope-aspect and mean wind directions. Mean crown asymmetry (ratio of long and short diameters) was 1.26, and there were no significant differences in asymmetry values when current gap border trees and non-border trees were compared. At two stands, treefall directions were uniformly distributed (i.e., no mean direction). However, only one of eight stands showed a significant similarity between mean slope-aspect and mean direction of fall, and only two of the eight stands showed significant similarities between mean treefall and prevailing wind directions. While trees may fall downhill and downwind, the high variation in treefall and wind directions precluded establishing a consistent statistical relationship between these datasets. I suggest that crown asymmetry, resulting from differential crown growth on sloped hillsides as well as within canopy gaps, exerts a larger influence on direction of fall than either slope-aspect or wind direction.

INTRODUCTION

The goal of this study was to investigate the relative influence of wind and topography on directions of treefall in eight oak-dominated, old-growth stands in the central hardwood region. I asked three questions: 1) How asymmetric are the crowns of canopy trees in our old-growth study stands, and does asymmetry vary among gap border trees and non-border trees? 2) Do trees fall downslope, or are slope-aspect and direction of treefall statistically independent of each other? 3) Do trees fall downwind, or are prevailing winds and direction of treefall statistically independent?

METHODS

I inventoried all downed trees in eight 0.45-ha study plots in Ohio, West Virginia, and Pennsylvania. Direction of fall and slope-aspect also were recorded. I measured crowns of live trees along two perpendicular axes, and calculated crown asymmetry as the ratio of long and short axes. I then compared crown asymmetry

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among crown classes, and among current gap-border and non-border trees. Prevailing wind and wind gust data for 1996-2009 were obtained from Pittsburgh, PA, and Clarksburg, WV, airports. I used circular statistics to determine whether treefall directions had a true mean or whether they were uniformly distributed (Rayleigh Test). If treefall directions had a true mean, they were then compared to mean slope-aspect and mean wind directions (Watson's U^2 two-sample test) by study stand.

RESULTS

1. Mean crown asymmetry = 1.26, and there were no significant differences in means among current gap border trees and non-border trees.
2. At two stands, treefall directions were uniformly distributed (i.e., no mean direction).
3. Only one of eight stands showed a significant similarity between mean treefall and mean slope-aspect directions.
4. Only two of eight stands showed significant similarities between treefall and wind directions.

DISCUSSION

The absence of differences in mean asymmetry between current gap border trees and non-border trees suggests that all canopy trees are now, or have been, gap border trees once or several times in these stands. This result is consistent with canopy disturbance rates: between 1700 and 2000, four partial releases were detected from the tree-ring record (Rentch and others 2003). Although trees often fall downhill and downwind, there was no consistent relationship between treefall direction and aspect and wind datasets. I suggest that crown asymmetry, rather than slope-aspect or wind, is responsible for variability in treefall direction. Asymmetry may occur in three forms:

1. Due to differential tree heights and crown shading on sloped sites, trees tend to develop asymmetrical crowns that are larger and heavier on down-slope sides.
2. Trees that form the border of canopy gaps develop asymmetrical crown shapes away from the nearest large neighbor as they laterally close gaps.
3. Trees that lean may exhibit imbalance and asymmetry even if the crown itself is symmetrical around the bole.

CONCLUSION

In this study, asymmetrical crown growth of gap border trees was an important response to the change in resource availability in the gap environment. While directions of treefall often follow slope-aspect and wind direction, the high variability of treefall direction and the absence of consistent relationships between direction of treefall and aspect and wind suggest that crown asymmetry of gap border trees exerts a greater influence than either of these factors. While border trees may not be more likely to fall, when they do, the most common direction of fall is into pre-existing gaps, regardless of slope-aspect or wind direction.

LITERATURE CITED

Rentch, J.S.; Fajvan, M.A.; Hicks, R.R., Jr. 2003. **Spatial and temporal disturbance characteristics of oak-dominated old-growth stands in the central hardwood forest region.** Forest Science. 49: 778-789.