SUSCEPTIBILITY OF CENTRAL HARDWOOD TREES TO STEM BREAKAGE DUE TO ICE GLAZING

KaDonna C. Randolph[1]

ABSTRACT

Introduction

During January 26-28, 2009, a winter storm dropped a mix of rain, ice, and snow from Texas across the Ohio River Valley and into New England. The storm caused multiple fatalities and millions of dollars of property damage and was called "the biggest natural disaster in modern Kentucky history" (Brammer and Funk 2009: 13). The storm disturbed an estimated 2.4 million acres of forest land across the central United States, including 2.1 million acres in Arkansas and Kentucky (Miles 2013). Ice accumulations up to 2.0 inches thick caused extensive damage to trees throughout the region.

Methods

Susceptibility to damage from ice storms, also known as glaze events, varies among tree species; however, there are some generally consistent trends (Hauer et al. 2006, Kraemer and Nyland 2010). For example, elm (*Ulmus* spp.) and black cherry (*Prunus serotina*) tend to be susceptible to damage, whereas hickory (*Carya* spp.) and black walnut (*Juglans nigra*) tend to be resistant. Maple (*Acer* spp.) and oak (*Quercus* spp.) are generally moderately susceptible to ice damage. The consistency of these trends in Arkansas and Kentucky following the January 2009 ice storm were examined with data collected between February 1, 2009, and January 31, 2012, by the U.S. Forest Service Forest Inventory and Analysis (FIA) program.

Each live tree with a diameter at breast height (d.b.h.) of at least 1.0 inch measured by the FIA program prior to the storm was matched with its post-storm assessment and designated as broken if after the storm the crown was broken and completely detached from the main stem. Broken and unbroken trees were grouped by the FIA disturbance variable[2] into two categories, disturbed only by ice in 2009 or undisturbed. Trees on undisturbed plots in counties with an ice-disturbed FIA plot were excluded. Hardwood species with at least 50 observations across all of the disturbed plots were included in the analysis. Species susceptibility to glazing was ranked according to the percentage of broken trees on the disturbed plots and by the odds ratio comparing the odds of a tree sustaining a broken top on a disturbed plot to the odds of a tree sustaining a broken top on an undisturbed plot. Trees were placed into categories of high, moderate, and low susceptibility based on the percentage of broken trees (greater than 20 percent, 10 to 20 percent, and less than 10 percent, respectively) and on the odds ratio (greater than 6.0, 3.0 to 6.0, and less than 3.0, respectively).

[1] Mathematical Statistician, U.S. Forest Service, Southern Research Station, 4700 Old Kingston Pike, Knoxville, TN 37919. To contact, call 865-862-2024 or email at krandolph@fs.fed.us.

[2] U.S. Department of Agriculture Forest Service. 2010. Forest inventory and analysis national core field guide: field data collection procedures for phase 2 plots. Version 5.0. Unpublished report. Available at http://www.fia.fs.fed.us/fia/data-collection/. (Accessed January 31, 2014).

Results and Discussion

Susceptibility rankings based on the percent broken criterion agreed with the susceptibility rankings based on the odds ratio criterion for 20 of 31 species. Susceptibility ranked high for black locust (*Robinia pseudoacacia*) and sassafras (*Sassafras albidum*) according to the percent broken criterion but low according to the odds ratio criterion. This was because both species sustained a high percentage of broken stems in the undisturbed conditions, suggesting that glazing only exacerbated the tendency of these species to sustain broken stems. Species such as bitternut hickory (*Carya cordiformis*), chinkapin oak (*Quercus muehlenbergii*), black walnut, and flowering dogwood (*Cornus florida*), that ranked relatively low in terms of percent broken on the undisturbed plots but relatively high on the disturbed plots, had high odds ratios suggesting that these species may be particularly susceptible to glazing.

Based on the odds ratio criterion, the susceptibility rankings for black cherry (high) and maple (moderate) agreed with general trends reported for previous storms; however the rankings for other species varied from previously reported rankings. Oak species ranked in all three susceptibility categories. Blackjack oak (*Quercus marilandica*), southern red oak (*Q. falcata*), and chinkapin oak ranked high. White oak (*Q. alba*), black oak (*Q. velutina*), and northern red oak (*Q. rubra*) ranked moderate, and post oak (*Q. stellata*) and chestnut oak (*Q. prinus*) ranked low. Bitternut hickory ranked high, whereas the other hickory species (*C. alba*, *C. glabra*, *C. ovata*, and *C. texana*) ranked moderate. Among the elms, American elm (*Ulmus americana*) ranked moderate and slippery (*U. rubra*) and winged (*U. alata*) elm ranked low.

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