RESEARCH BRIEF

Prescribed Fire Causes Wounding and Minor Tree Quality Degradation in Oak Forests

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In this study, authors assessed prescribed fire-caused wounding effects on timber quality of overstory trees in oak-dominated forests. There is need for this information as prescribed fire use has increased in the region, including sites where long unburned, merchantable-sized trees exist. This builds upon previous research of this group of scientists which assessed prescribed fire related changes in sawtimber volume and value at the stand-level in southern Indiana, USA (read this research HERE).

MANAGEMENT IMPLICATIONS

- Likelihood of overstory tree wounding increased with repeated applications of prescribed fire.
- Only one in five (19.7%) fire-wounded trees had associated grade reduction.
- Nearly ten percent (9.2%) of trees in the no-fire (control) treatment exhibited wounding, suggesting a background level of wounding exists in forests even without fire.

This study considers prescribed fire effects on timber quality of individual trees. The research sought to: characterize the distribution of different types of fire-caused wound types (overall and by tree species); estimate how slope, aspect and prescribed fire history influenced wound size; estimate the likelihood of fire-caused injury (overall, and by species, tree size, and number of fires); and, estimate the likelihood of fire-caused wounds to negatively affect tree timber grade.

The likelihood of an overstory tree receiving a fire-caused wound increases with the number of prescribed fires experienced.

Sampling occurred in oak-dominated forest stands located at four eastern U.S. National Forests across the Central Hardwoods Region (Hoosier, Mark Twain, Daniel Boone, and Wayne National Forests). Stands were selected to avoid sites with extensive wildfire history, to have comparable representations of xeric (south, west) and mesic (north, east) aspects, and to have experienced a range of 0 to 6 prescribed fires over the previous 30 years. Stands were restricted to include those which contained an average tree size ≥ 25.4 cm (10.0 in) diameter at breast height, and had upland oak 50-year site indices of > 18.3 m (60.0 ft). This restriction was meant to keep focus on forest conditions for which establishing oak regeneration would be a management objective.

For data collection, variable-radius prism plots were installed across selected stands, with overstory trees (>25.4 cm (10.0 in)) measured for fire-caused wounds. If encountered, fire wounds were classified into five categories based on location and shape characteristics: catface (e.g., triangular), oval, closed-seam, bark slough/multiple seams, and basal flute. Wound dimensions (width, depth, and height) above stump-height (15.2 cm (6.0 in) above ground-level measured on uphill side) were measured for all selected trees, and defect volume was calculated using geometric formulas based on wound shape. For trees with fire-caused wounds, two U.S. Forest Service hardwood tree grades were assigned to the tree, one in

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which all fire-caused wounds were considered in the grading process, and one in which they were ignored. Statistical tests were conducted related to fire-wounding likelihood, sizes, and tree-grade changes among different site aspects, tree species and sizes, and prescribed fire histories.

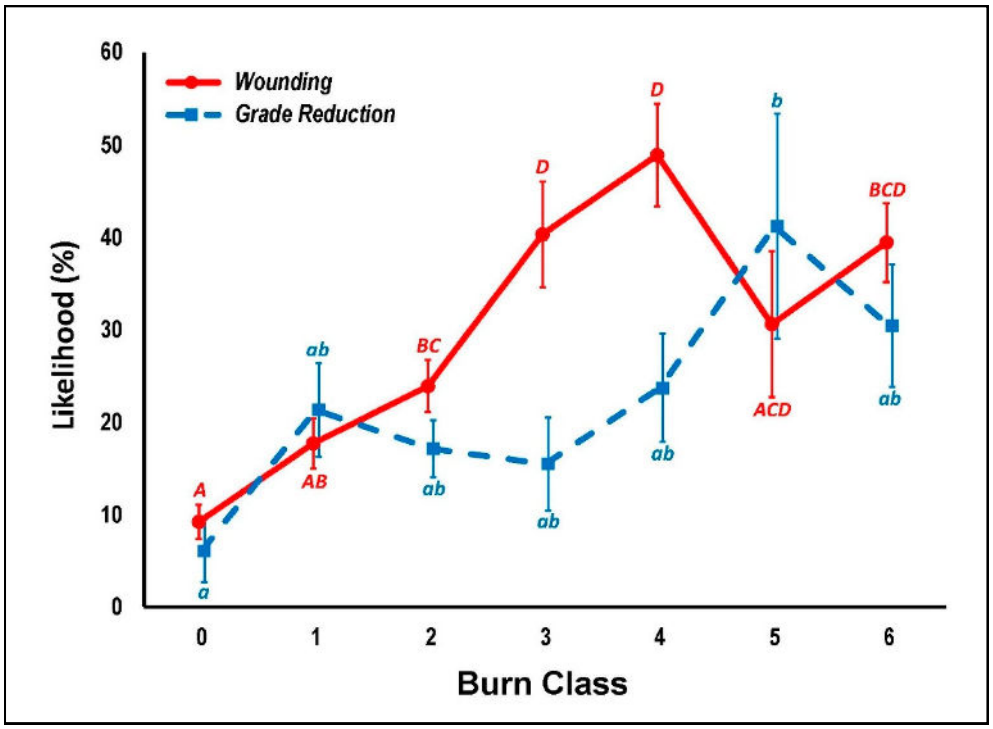
In total, 8093 trees were measured from 139 forest stands, 2160 of which exhibited fire-caused wounds. Catface, bark slough, and closed-seam shaped wounds were the most common wound types (93.1%) and were observed in similar amounts. Catface -shaped wounds accounted for the highest average defect volume (23.4 dm^3 (9.9 board feet)), and ovals and basal/flutes wounds had intermediate levels of defect volume (9.1 and 10.9 dm^3 (3.9 and 4.6 BF)). Approximately one-fifth (19.7%) of fire-wounded trees had associated tree grade reduction.

Likelihood of wounding varied by species, with thick-barked species, including white and chestnut oaks (*Quercus alba*, *Q. montana*), shortleaf pine (*Pinus echinata*), and yellow-poplar (*Liriodendron tulipfera*) having the lowest likelihood of wounding observed, and thinner-barked red oaks (*Q. velutina*, *Q. rubra*, *Q. coccinea*), maples (*Acer saccharum*, *A. rubrum*), and American beech (*Fagus americana*) having the highest. Wound type also varied by tree species, for example, catfaces were most prevalent among thin-barked species (i.e., maples, American beech) and much less common on thicker barked trees such as yellow-poplar and white oak. Closed-seams and bark slough were most common for white oaks (69.0%), while 42.0% of wounds on red oaks were catfaces. Wound size differed among species, with thick-barked species such as shortleaf pine and white oak having the smallest wound sizes (i.e., 2.3 and 7.5 dm^3 (1.0 and 3.2 BF)).

Likelihood of wounding increased with repeated applications of prescribed fire until the third fire, after which little additional effect was observed. Catface wounds (which had the highest defect volumes) likelihood increased with the number of fires experienced. Interestingly, wounds were observed on 9.2% of trees in the control treatment (e.g., no fires in past 30 years), suggesting a background level of wounding in forests even without fire.

Approximately one of five trees (19.7%) with fire-caused wounds experienced a reduction in USFS tree grade. The likelihood of tree grade change increased with the number of fires, and varied among tree species, with white oak, and yellow-poplar, being the least likely, while post and scarlet oaks were the most likely to see a reduction. Neither tree size nor site aspect were observed to affect likelihood of fire wounding or wound sizes; the authors suggest this may be due to high site-to-site variability and low sample size and that further research is needed.

This study documented the likelihood and degree of fire-caused defects to merchantable trees, and importantly shows how this varies among tree species and fire frequency/history. This information, coupled with knowledge of the potential benefits (e.g., increased oak regeneration, wildlife habitat improvement), will facilitate improved, science-informed decision making.



The likelihood of wounding (red) and conditional likelihood of grade reduction assuming wounding (blue) with increasing burn class (i.e., numbers of prescribed fires). Error bars are 1 standard error. Letters indicate significant differences ($p < 0.05$, Tukey's HSD) among mean likelihoods of the burn classes for both wounding (capitalized, red) and grade reduction (lower case, blue).

FOR FURTHER READING

Mann, D,Wiedenbeck, J.K.; Dey, D.C.; Saunders, M.R. Evaluating economic impacts of prescribed fire in the Central Hardwoods Region. Journal of Forestry, 2020, 118, 275–288.

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