

Effects of prescribing burning on tree scarring, crown vigor and plant species composition



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Introduction

Prescribed fire is a forest management tool used extensively in the Missouri Ozarks to achieve specified forest ecosystem goals. The purpose of our research was to determine the effects of prescribed fire on forest health. Our project explored three primary research questions: 1) how does prescribed fire affect crown vigor in overstory red and black oaks? 2) how do landscape factors and char height influence fire scars on overstory trees? and 3) how does prescribed fire influence ground flora cover?



Photo by Erin McMurry

Methods and Materials

The study area lies within the Ozark Highlands Section of Missouri. The area is characterized by the slight rolling terrain of the oak-pine woodland dissected plains, the moderate topography of the oak-pine forest hills, and the deeply dissected oak forest breaks. The area also contains clusters of Precambrian igneous glade-oak forest knolls. Study sites include the NPS Ozark National Scenic Riverways, the Chilton Creek TNC Preserve, and five Missouri Department of Conservation Areas. Twenty five burn units with known prescribed fire history were sampled from the study sites.



Transects perpendicular to the slope were established in burn units within each study site. One hundred 20-m radius plots were sampled at different slope positions along the transects. Crown data were collected from up to four overstory black and red oaks in each plot. Data for fire scar size and frequency were collected for selected tree species with dbh > 10 cm. Collection of fire scar data was restricted to red oaks (*Quercus coccinea* and *Q. shumardii*), black oak (*Q. velutina*), white oak (*Q. alba*), post oak (*Q. stellata*), hickories (*Carya* spp.) and shortleaf pine (*Pinus echinata*). Slope position, slope steepness, aspect, and average maximum char height on hardwoods were recorded for each plot.



Crown variables were converted to three crown vigor variables that were averaged by plot. Crown efficiency (CEFF) was calculated as the exposed crown surface area divided by the crown volume (Zamoch 2004). Crown surface index (CSI) was calculated as the exposed crown surface area adjusted for the crown ratio, and tree vigor index (TVI) was calculated as the crown surface index standardized by the stem surface (Voelker 2004). ANOVA was used to compare TVIs between burned and unburned plots.

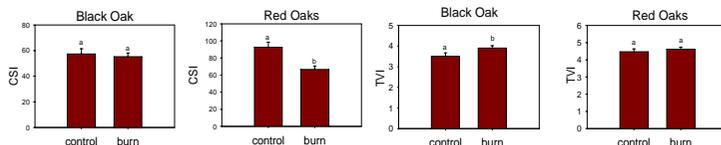
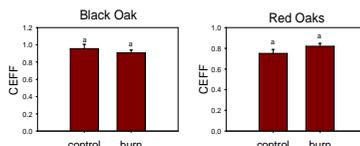
Scar height data was analyzed using stepwise linear regression. The probability of scarring was determined using logistic regression.

Ground flora was sampled from 74 plots within burned areas and 34 plots within unburned areas. Ground flora data were collected from 16 1-m² quadrats nested within each 20-m radius plot. During data collection ground flora was grouped physiognomically: grasses, sedges, legumes, forbs, woody vines, woody shrubs, and tree seedlings < 2 m in height.

Results and Discussion

Crown Vigor

There was no significant difference in CEFF between burned and unburned plots for black and red oaks. The CSI for red oaks was significantly higher in control plots, but there was no significant difference in black oak CSI between burned and unburned plots. The TVI for black oaks was significantly higher in burned plots, but there was no significant difference in red oak TVI between burned and unburned plots.



Average Scar Height

The stepwise linear regression revealed that char height was an important predictor of scar height for all tree species. Aspect was a significant predictor for white oaks, and slope position and slope steepness were significant predictors for hickories. Substantial variability in scar height predictions existed for all species.

Table 1. Significant predictors of scar height as determined by stepwise linear regression

	Char ht	Aspect	Slope pos.	Slope
Red oaks	<.001	NS	NS	NS
Black oak	<.001	NS	NS	NS
White oak	<.001	<.001	NS	NS
Post oak	<.001	NS	NS	NS
Hickories	<.001	NS	<.05	<.05
Shortleaf Pine	NS	NS	NS	NS

Table 2. Summary of stepwise regression for scar heights

	Equation	p-value	R ²
Red oaks	16.7 + 77.8(char)	<.001	.38
Black oak	16.7 + 57.7(char)	<.001	.46
White oak	47.1 + 41.7(char) - 16.8(aspect)	<.001	.36
Post oak	-7.2 + 60.8(char)	<.001	.53
Hickories	19.6 + 23.1(char) - 2.3(pos) + 2.4(slope)	<.001	.23

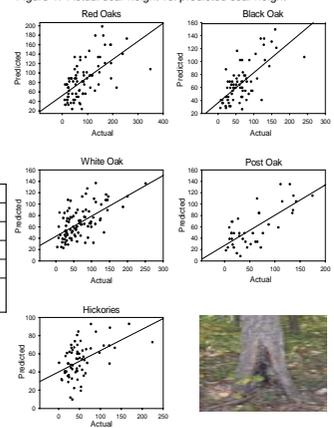
Probability of Scarring

The logistic regression analysis showed that char height was the best predictor of scarring probability for all tree species. Aspect was significant for five tree species and all trees combined, and slope steepness was significant for post oaks.

Table 3. Significant predictors of scarring probability as determined by logistic regression.

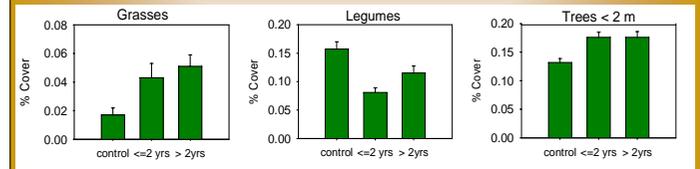
	Char height	Aspect	Slope
Red Oaks	<.001	NS	NS
Black Oak	<.001	.001	NS
White oak	<.001	<.001	NS
Post oak	<.001	<.001	<.001
Hickories	<.001	<.05	NS
Shortleaf pine	<.01	<.05	NS
All trees	<.001	<.001	NS

Figure 1. Actual scar height vs. predicted scar height



Ground Flora Cover

Treatments for ground flora analysis were unburned (control), two years or less since last burn, or greater than two years since burn. Initial ground flora data indicates that grasses and tree seedlings had higher cover in burned plots, while legumes had higher cover in unburned plots. No other plant group showed differences between burned and unburned plots.



Conclusions

- Crown surface index (CSI) of red oaks was negatively affected by prescribed burning.
- Tree vigor index (TVI) of black oaks was positively affected by prescribed burning.
- Char height on hardwoods is the most important predictor of scar height and probability of scarring.
- Prescribed burning increases grass and tree seedling cover but decreases legume cover.



References

- Voelker, S. L. 2004. Causes of forest decline and consequences for oak-pine stand dynamics in southeastern Missouri. Columbia, MO: University of Missouri. MS thesis.
- Zamoch, S.J., W.A. Bechtold, and K.W. Stolte. 2004. Using crown condition variables as indicators of forest health. CJFR 34: 1057-1070.

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