

Evaluating the impact of prescribed surface fire on seedlings in the Central Hardwood Region, USA

Sarah A. Cuprewich and Mike R. Saunders, *Forestry: An International Journal of Forest Research*, January 2024

In this study, the authors examined whether previous applications of prescribed fire met management goals of promoting oak regeneration. Their retrospective study focused on Central Hardwood forest stands in the Hoosier National Forest in southern Indiana and the Wayne National Forest in southern Ohio that had been managed for oak regeneration with varying prescribed fire histories. Burns here are typically low-intensity and patchy, without large areas of complete litter consumption and mineral soil exposure.

In many eastern North American forests, once-dominant oaks (*Quercus* spp.) are being replaced by maples (*Acer* spp.) and other mesic species whose shade tolerance and less flammable litter enables increasingly mesic and shady forest conditions. The mesic species outcompete the more shade-intolerant oak seedlings and recruit into the midstory and canopy, shifting the disturbance regime from fire-mediated (oaks) to self-replacing (maples).

Forest managers have increasingly used prescribed fire in hopes of increasing the competitiveness of oak regeneration and breaking this mesophication cycle. However, the state of the science on using prescribed fire to promote oak regeneration is still evolving. While several studies have demonstrated benefits of prescribed fire in restoring oaks, particularly on drier sites where oaks are

MANAGEMENT IMPLICATIONS

- Oak seedling density increased and seedling density of mesic species such as maple and beech decreased with the number of prescribed burns.
- Greater density increases in taller, competitive oak seedlings occurred after sites had been burned three times, with less than four years between burns.
- Treatment of established mesophytic midstory trees along with repeat applications of prescribed fire may be required in sites that have not burned for a decade or more.

better adapted, factors such as site conditions, competing species, and the presence of an established midstory can influence the success of oak regeneration. The interval length between prescribed fires is also considered crucial, as very short intervals may not allow enough time for oak seedlings to reach a fire-resistant size.

The authors inventoried 63 mature oak-dominated stands; 47 had been managed with prescribed

fire for oak regeneration and 16 were unburned controls. The stands were selected to represent a range of prescribed fire histories, including burn frequency and time since the last burn. In each stand, investigators sampled midstory plots for trees with diameters at breast height (DBH)



Two research sites in the Hoosier National Forest, Indiana. The left photo shows a previously burned stand, with a more developed regeneration layer compared to an unburned control stand with a more developed midstory, shown on the right. (Photos: Sarah A. Cuprewich)



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between 10 and 25 cm (3.9 and 9.8 in) and regeneration plots for all woody stems greater than 15 cm (5.9 in) tall with DBH less than 10 cm (3.9 in). They also estimated percent cover of midstory trees and groundcover. All seedlings were identified to species, and oak seedlings were categorized as belonging to either the white oak group (section *Quercus*) or the red oak group (section *Lobatae*). Site index, trees per acre, and percent slope were categorized as “low,” “medium,” or “high” according to their respective first

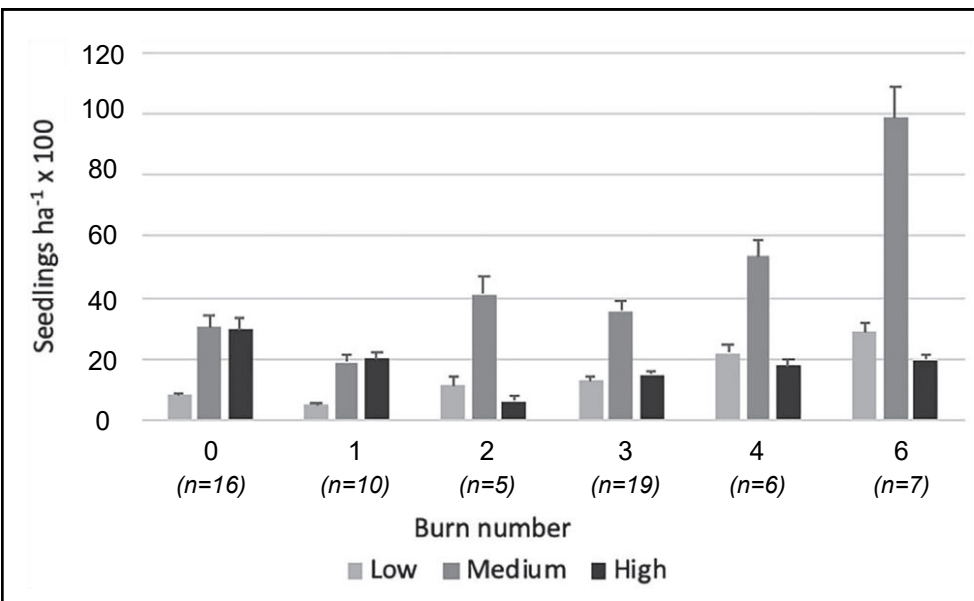
quartile, median, and third quartile distributions. The authors compared seedling densities and species composition based on the number of prescribed burns (burn number), time since the last burn, and other stand variables. They also employed a random forest model to identify the most important variables for predicting oak seedling density.

Total seedling density and the proportion of seedlings over 30 cm (11.8 in) tall generally increased while the

proportion of mesic species seedlings (American beech, red maple, sugar maple) decreased as the number of burns increased (see table). The greatest density of taller, competitive oak seedlings occurred on sites burned three times with less than four years between burns.

The most important and significant predictors of oak seedling density in the random forests model were burn number, slope category, midstory basal area (BA), overstory BA, oak BA and mesic species BA. Slope categories differed from each other in oak seedling density; oak seedling density increased with burn number, especially in moderately sloped sites (see figure).

The authors conclude that in the Central Hardwood forests of Indiana and Ohio, one prescribed fire may condition a site for oak regeneration, but success may require three or more burns with less than four years between them. Additionally, where slopes are steeper or overstory and mid story structure denser, initial mechanical or chemical targeting of mesic midstory species may be required before burning to promote successful oak regeneration.



All oak species seedling density (seedlings ha⁻¹ × 100) for low, medium and high percent slope categories displayed by the total number of burns. Stand sample sizes for each burn class are shown in italics below the x-axis, and error bars are displaying the standard error of the mean.

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Summary statistics categorized by burn number

Burn count	Stands	Seedlings ha ⁻¹	% Tall	% White oak	% Red oak	% Maple/beech
0	16	10500 ± 25	53.8	55.1	9.3	11.3
1	10	9930 ± 40	45.6	38.2	4.0	6.0
2	5	10300 ± 53	63.4	42.8	13.7	4.3
3	19	12100 ± 30	60.4	40.7	11.7	3.1
4	6	1400 ± 50	57.4	55.4	10.6	3.9
6	7	21100 ± 57	72.1	54.9	14.8	1.2

Stands = number of stands sampled for that burn count; seedlings ha⁻¹ = number of seedlings per ha ± SEM; % tall = percentage of all seedlings greater than 30 cm (11.8 in) tall; % white oak = percentage of all seedlings belonging to the white oak species group; % red oak = percentage of all seedlings belonging to other oak species group; % maple / beech = percentage of all seedlings that are either sugar maple, red maple or American beech.

