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Regenerating Oak on Dry Sites in Central Hardwood Forests with Shelterwood Harvest and One Prescribed Burn

Valued for timber and wildlife, oaks (*Quercus* spp.) face many regeneration challenges in the eastern United States. Decades of fire suppression have produced favorable conditions for tree species that grow well in humid climates, such as maples, and less favorable conditions for species that thrive under drier conditions, such as oaks. The Hoosier National Forest in southern Indiana noticed a lack of oak advance regeneration in the 2010s, when long-term research showed that clearcut harvests performed in the 1980s, which were intended to regenerate oak, were now more dominated by red maple, tulip tree, poplar, and black cherry.

Looking for a way to regenerate oak, United States Department of Agriculture, Forest Service staff worked together. Chris Thornton, then the Hoosier National Forest silviculturist, consulted Northern Research Station scientists Daniel Dey and John Kabrick to explore potential solutions. They brought in partners from Purdue University to investigate why oak were not regenerating on the Hoosier. In a recent article, the researchers describe how they tested a method developed in more productive sites in the eastern United States that typically involves multiple prescribed burns and evaluated whether oak preferentially regenerated on drier sites with fewer prescribed burns. Successful oak regeneration after one or even a few prescribed burns could make this method more cost-effective to implement.

Shelterwood and Prescribed Burn

The main treatment applied in this study—a shelterwood harvest accompanied by at least one prescribed burn—originated from earlier Forest Service research studies conducted in humid forests in the eastern United States. This method involved prescribing a shelterwood harvest, which can include a series of partial harvests to increase light and resource availability, followed by one or more prescribed burns to favor oak regeneration over competitors.

The shelterwood at the Hoosier National Forest was established between 2012 and 2015 and included the removal of tree species that competed with oak, such as sugar maple, tulip tree, and American beech, and of poor-quality trees. Dominant and co-dominant oak and hickory trees were left standing. This shelterwood was performed across eight experimental units totaling 71 acres. One prescribed fire was applied in April 2019.

White oak seedling regenerating after the prescribed burn at the Hoosier National Forest. USDA Forest Service photo by J. Travis Swaim.

PUBLIC BENEFITS

Shelterwood harvesting and prescribed burning restores oak in forests where current conditions and past management have hindered oak regeneration. Oak wood is used in construction, flooring, and to make furniture, bourbon barrels, and many other products. Oak trees also provide critical habitat and food resources for wildlife.

Oak Outperforms Other Species

Overall, oak seedling density increased after the shelterwood cut and prescribed burn. Oaks and hickories survived at a higher rate following the prescribed fire than other competing species; oaks and hickories averaged over 90 percent survival, while maple species averaged less than 67 percent survival. Oak seedlings also sprouted at a higher rate than maple seedlings, resprouting at a rate of nearly 93 percent for oaks compared to 67 percent for red maple. Altogether, this evidence shows that a shelterwood establishment cut and one prescribed burn could be enough to shift the regenerating species composition from maple to oak.

When considering site conditions, the researchers found that the shift in species composition from maples to oaks was strongest in sites that were less productive, which was indicated by higher soil aluminum concentrations, lower soil nitrogen and organic matter concentrations, and lower soil pH. This result could mean that oak regeneration may be more successful, and therefore cost-effective, when promoted in less productive, dry forests on the landscape.

Restoring Oak

Oak species hold high timber value and are critical to wildlife species, but regenerating oaks can be time and labor intensive. This collaborative research with the Hoosier National Forest demonstrates a way to successfully regenerate oak in central hardwood forests and shows that this method may be more cost-effective when applied in drier and less productive areas, where only one prescribed burn may be needed. Management activities on dry and less productive sites could help maintain oak species across forest landscapes with less effort than where repeated burning and other follow-up treatments may be required.

PROJECT LEADS

Daniel Dey is an assistant director and research forester with the Sustainable Management of Central Hardwood Ecosystems and Landscapes research work unit of the Northern Research Station. Dey's research evaluates silvicultural practices and focuses on forest regeneration and restoration in primarily oak/pine forests, woodlands, and savannas.

John Kabrick is a research forester and project leader for the Sustainable Management of Central Hardwood Ecosystems and Landscapes research work unit of the Northern Research Station. Kabrick studies the ecology and silviculture of hardwood-softwood mixtures, the composition and silviculture of woodlands and open forests, and dynamic soil properties for sustainable forest management.

Jenna Zukswert is the author of this Rooted in Research science brief.

KEY FINDINGS

- Oak seedlings doubled in density and survived at a higher rate than other competing tree species after one prescribed burn in a shelterwood harvest in central Indiana.
- Regenerating oak using shelterwood and one prescribed burn on drier, less productive sites could help return oaks to the landscape in a cost-effective way.
- Collaboration between foresters and researchers can yield insights into the effects of site conditions on management strategies.

Prescribed burn in the Hoosier National Forest research plots in 2019. USDA Forest Service photo by J. Travis Swaim.

FURTHER READING

Rademacher, Sarah J.; Dey, Daniel C.; Kabrick, John M.; Quackenbush, Robert W. E.; Saunders, Michael R.; Swaim, J. Travis; Thornton, Christopher D.; Jenkins, Michael A. 2025. Regeneration response to shelterwood-burn treatments in a dry oak-dominated forest. Forest Science. https://doi.org/10.1007/s44391-025-00022-y.

Swaim, J. Travis; Dey, Daniel C.; Saunders, Michael R.; Weigel, Dale R.; Thornton, Christopher D.; Kabrick, John M.; Jenkins, Michael A. 2018. Overstory species response to clearcut harvest across environmental gradients in hardwood forests. Forest Ecology and Management. 428: 66–80. https://doi.org/10.1016/j.foreco.2018.06.028.

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For questions on Rooted in Research, please contact Andrea Brandon-Hennig. Technical editing by Carol Hollar-Zwick. Design and layout by Jeremy Siegrist.

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