RESEARCH BRIEF

What fire frequency is appropriate for shortleaf pine regeneration and survival?

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Shortleaf Pine Restoration and Ecology in the Ozarks: Proceedings of a Symposium, November 2006, p.121-128

In this study, researchers sought to determine what fire frequency is most likely to lead to successful shortleaf pine regeneration, and what length of fire-free interval is required to allow saplings to become fire-tolerant.

To evaluate the relationship between fire interval (years between fires) and shortleaf pine regeneration and survival, study authors: 1) considered past conditions using a historical fire-scar database; 2) assessed current conditions with recent prescribed fire data; and 3) used a model to simulate future forest conditions under different fire frequencies.

Historical fires. The historical fire-scar database catalogues evidence collected from about 600 living and dead fire-scarred Ozark shortleaf pine trees. Within this database, authors identified nearly 100 trees that contained both fire scars and stem initiation age (pith date); the latter ranged between 1585 and 1896.

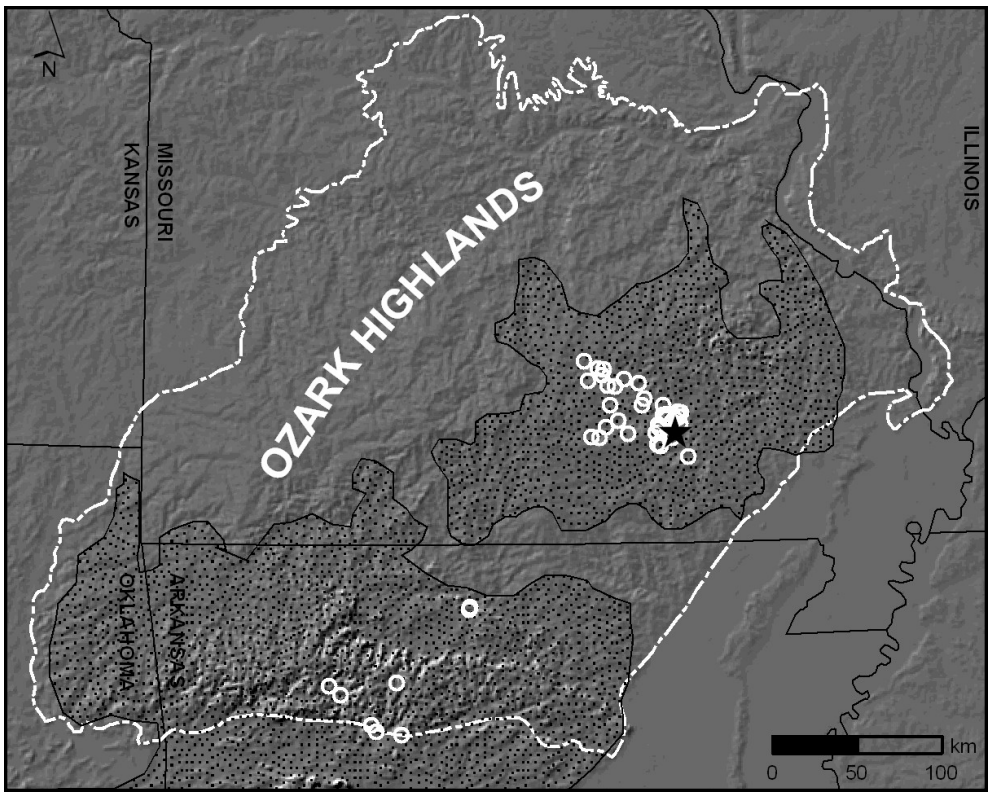
Fire scars showed that fires historically occurred almost exclusively when trees were dormant (approximately October to March). Previous research suggests that mixed-severity fires that killed small stands historically occurred in Ozark shortleaf pine forests about every 20 years (see Guyette et al. 2006 for more information on this).

Among the selected trees, the mean number of years between pith date and fire event was 6.8. The majority of trees had pith dates within 8 years after a known fire event, and the evidence indicates that regeneration success fell sharply as the number of years increased after a fire. Most survived at least one fire during their first 20 years.

Present-day burning. Data for present-day fire effects originated at the 5700-acre Chilton Creek Preserve, located along

MANAGEMENT IMPLICATIONS

- To maximize shortleaf pine seedling survival, prescribed burns should precede seed dissemination, typically late October or November, or should occur in early spring, prior to seedling development.
- Varying the number of years between fires mimics historical conditions. Fire frequency of 1 to 4 years promotes shortleaf pine regeneration; however those trees may not survive subsequent fires.
- An 8- to 15-year fire-frequency range offers young shortleaf pine good probability of recruiting into the forest overstory.



Locations of shortleaf pine fire history sites (white circles), the Chilton Creek Preserve (black star), the boundary Ozark Highlands ecoregion (white line), and the approximate range of shortleaf pine (stippled area). Fire history sites are where shortleaf pine specimens used in the growth and fire scar analysis were collected. The Chilton Creek Preserve is the location from which fire effects data were summarized.

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Fire frequency appropriate for shortleaf pine

Missouri's Current River in Carter and Shannon counties. There, since 1998, five management units of about 500 acres each have burned under prescription during the dormant season on 1- to 4-year intervals, randomly determined.

After the first burn, shortleaf pine had the highest mortality - both seedlings and saplings - of any species recorded. However, in subsequent fires shortleaf pine had only one percent additional mortality, while all other species sustained higher mortality rates. Following three-plus annual burns, shortleaf pine had the lowest percent total damage, calculated considering both mortality and shoot dieback.

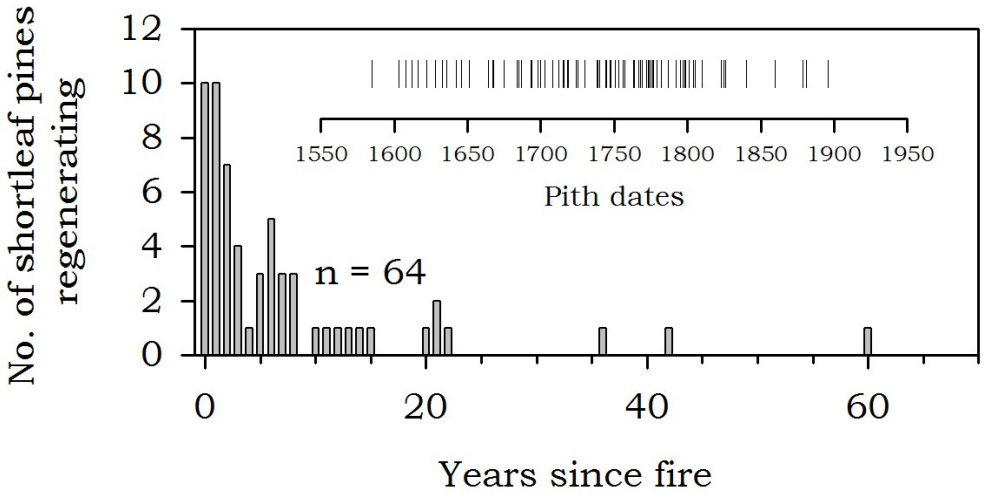
The ability of shortleaf pine trees to survive a fire appeared to be strongly related to stem size. Small diameter trees, those less than 2 cm basal diameter, had less than a 40 percent probability of surviving a single spring surface fire, which was lower than similarly sized hardwood seedlings. Conversely, shortleaf pines at least 10 cm basal diameter had at least a 90 percent probability of surviving the same fire. Trees larger than 5 cm basal diameter that had already survived one fire had a high probability of surviving subsequent dormant-season surface fires.

VDDT model. To simulate effects of burn frequency, authors modeled shortleaf pine regeneration and survival using the Vegetation Dynamics Development Tool (VDDT). Forest composition (initially oak-pine) was projected over a 500 year period, for five forest seral states, with fire intervals of 2, 4, 8, 15, and 40 years, and a simulation of no fire.

The VDDT model showed that states of forest development were highly sensitive to small changes in fire frequency. Simulation suggested that shortleaf pine does not survive if fires occur frequently over long periods of time. The model predicted that nearly 60 percent of the landscape would be continuously in an early seral state if it burned annually. With fire intervals of 1 to 4 years, pine seedlings would regenerate but would not survive subsequent repeated fires.

On the other extreme, if intervals were long (40 years or more), the model predicted that hardwoods would dominate. In oak-pine forests where fire has been excluded for decades, substantial litter accumulates, which forms a barrier inhibiting shortleaf pine seedlings from becoming established (for more on this point see Stambaugh et al. 2006). In the no-fire simulation, the model predicted virtually no shortleaf pine present by year 500.

After synthesizing findings from the three methods, study authors concluded that shortleaf pine regenerates in response to fire and needs recurring fire to persist, though tree recruitment requires a period of lower fire frequency. Data from this study indicate that most shortleaf pine regeneration occurred within 10 to 15 years following a fire, probably because of favorable conditions such as available light, nutrients released by fire, lack of litter cover, and the species' ability to resprout after being top-killed. Findings also indicate that trees 8 to 15 years old (typically 4-20 cm basal diameter and 4-5 meters tall) appear to be sufficiently fire-tolerant to survive low intensity fires.



Bar graph of the number of shortleaf pines regenerating during the years following fire events. Data were generated from a historic shortleaf pine specimen database. Years of regeneration of these trees are shown as pith dates (upper right of graph).

FOR FURTHER READING

Dey, D.C.; Hartman, G. 2005. Returning fire to Ozark Highland forest ecosystems: effects on advanced regeneration. Forest Ecology and Management. 217: 37-53.

Guyette, R.P.; Spetich, M.A; Stambaugh, M.C. 2006. Historic fire regime dynamics and forcing factors in the Boston Mountains, Arkansas, USA. Forest Ecology and Management. 234: 293-304.

Stambaugh, M.C.; Guyette, R.P.; Grabner, K.; Kolaks, J. 2006. Understanding Ozark forest litter variability through a synthesis of accumulation rates and fire events. In: Butler, B.W.; Andrews, P.L., comps. Fuels management - how to measure success: Conference Proceedings; 2006 March 28-30; Portland, OR. Proceedings RMRS-P-41. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

This research brief was funded by The Joint Fire Science Program. www.firescience.gov