



Resprouting dynamics suggest different regeneration strategies for shortleaf pine and oak species following surface fires in Missouri Ozarks

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This study compares the postfire resprouting dynamics of shortleaf pine and oaks to determine prescribed fire practices that could promote shortleaf pine regeneration in mixed pine-oak systems found in Missouri's Ozark Highlands. Understanding the postfire recovery strategies of shortleaf pine and co-occurring oaks could improve the effectiveness of prescribed fire management for promoting shortleaf pine regeneration and recruitment.

This study was conducted in the 900-ha (2,200-acre) Midco Shortleaf Pine Restoration Area in the Current River Hills ecoregion of Missouri, where shortleaf pine occurs with post oak, white oak, black oak, and blackjack oak. Established by the Missouri Department of Conservation to reverse shortleaf pine

MANAGEMENT IMPLICATIONS

- Shortleaf pine and many oaks have fire-adapted traits that allow them to survive frequent fire, either by resisting top-kill or by resprouting.
- Oaks require a larger stem size to resist top-kill compared to shortleaf pine.
- Following resprouting, oaks produce fewer but taller sprouts than shortleaf pine.
- Extended fire-free periods give oaks a competitive advantage over shortleaf pine.
- Properly timed fire can release shortleaf pine by top-killing similarly sized oaks.
- Increasing fire intensity amplifies the difference in top-kill resistance between shortleaf pine and oak stems.

declines from early 1900s harvesting, Midco uses prescribed fire, mechanical release, herbicide application, timber harvest, and seedling planting to restore shortleaf pine stands. The range of

shortleaf pine and oak stem sizes at Midco allowed evaluation of postfire resprouting across a wide range of basal diameters.

The study had four objectives:

1. To identify basal diameter thresholds that allow shortleaf pines and oaks to survive fire by resisting top-kill or by resprouting.
2. To evaluate the effects of fire intensity on these basal diameter thresholds.
3. To compare postfire resprouting performance of both species (number of sprouts per stem and sprout height growth).
4. To determine if there is a basal diameter that favors postfire growth of both species.

Research plots were established in three Midco prescribed-fire management units ranging from 68 to 94 ha (170 to 230 acres) that had fire-free intervals of 5, 6, and 7 years prior to prefire data collection. Sampling was conducted based on species groups (shortleaf pine versus oaks) and basal diameter. In each plot, one shortleaf pine and one oak from each of 5 basal



Shortleaf pine can outcompete oaks of similar size in frequent fire settings. (Photo: Hope Fillingim)



Resprouting dynamics for shortleaf pine and oak species

diameter classes (ranging from <1.5 cm [0.6 in.] to 15 cm [5.9 in.]) were tagged, and their locations were recorded. This approach created a “species pair” of a similar size that experienced similar fire behavior in each plot. For all tagged trees, height and basal diameter were measured, and oaks were identified to species. Fire intensity was estimated using aluminum tags painted with temperature sensitive paints that melt at specific temperatures.

Prescribed burns were conducted in the three units in February and March. Postfire sampling took place in June, when each tagged tree was re-visited and classified as alive (resisted top-kill), resprouted (survived with top-kill), or dead. In autumn, trees that resisted top-kill were remeasured for height and basal diameter. For each top-killed tree that resprouted, the number of sprouts and height and basal diameter of the largest sprout were recorded.

Results reflected the high fire tolerance of shortleaf pine and oaks, with 99% of tagged trees surviving through the first growing season. Shortleaf pine had a 50% probability of resisting top-kill at a basal diameter of 2.4 cm (0.9 in.), increasing to 90% at 3.0 cm (1.2 in.). Oaks reached the same probabilities of top-kill resistance at larger basal diameters—3.5 cm (1.4 in.)

and 5.5 cm (2.2 in.).

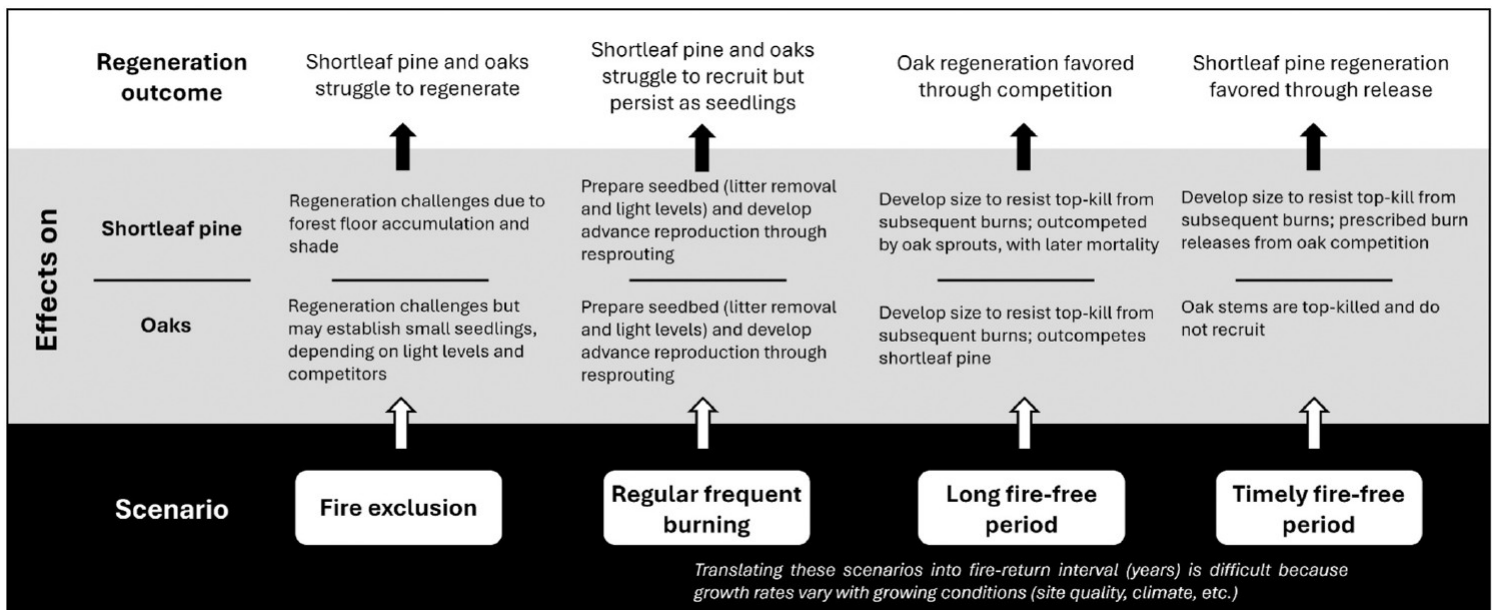
For both species, resistance to top-kill decreased as fire intensity increased; however, the largest size classes (basal diameters > 4.0 cm [1.6 in.]) resisted top-kill regardless of fire intensity. Resistance to top-kill differed between species, with oaks requiring larger basal diameters than shortleaf pine to achieve the same probabilities of top-kill resistance as fire intensity increased.

Postfire resprouting performance differed between species. Shortleaf pine produced numerous, relatively short sprouts, whereas oaks produced fewer, taller sprouts. In shortleaf pine, sprout number increased with prefire basal diameter, with an overall mean of 12.8 sprouts per stem and more than 30 sprouts for stems with diameters > 3.0 cm (1.2 in.). In contrast, oaks had a mean of 3.5 sprouts per stem, with no significant relationship between number of sprouts and basal diameter. All species exhibited increased sprout height with larger prefire basal diameter, with mean measurements of 59.1 cm (23.3 in.) for oaks and 28.6 cm (11.3 in.) for shortleaf pine one year postfire.

For most basal diameter size classes, resprouting outcomes were similar

between species. The smallest stems of both species were typically top-killed, while larger stems generally resisted top-kill. However, the 1.5–4.0 cm (0.6–1.6 in.) basal diameter range presented an important observation: when only one species of a plot’s shortleaf pine-oak pair resisted top-kill, it was usually shortleaf pine. This indicates that shortleaf pine has a significantly higher likelihood of surviving fire than oak in this size class, providing an opportunity to release shortleaf pine of this size from oak competition with prescribed fire.

This study highlights distinct fire-adapted regeneration strategies for shortleaf pine and oaks, suggesting fire frequency scenarios that could inform resource management decisions (see figure below). Long, fire-free intervals would favor oaks, as the relatively rapid growth of their resprouts gives them a competitive advantage over shortleaf pine during periods without fire. Because oaks require a larger basal diameter than shortleaf pine to achieve the same resistance to top-kill, properly timed, shorter fire-free intervals could allow shortleaf pine to reach threshold sizes to out-survive oaks, effectively releasing shortleaf pine from competition.



Conceptualization of the effects of alternative fire return intervals on shortleaf pine and oak regeneration based on resprouting responses observed in our study.

