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Fire Season and Heat Effects on Shortleaf Pine Germination: New Study Indicates the Benefits of Fall Burning

It's estimated that the abundance of shortleaf pine (SLP) today is only 8% of what it was historically, due to overharvesting followed by a century of fire suppression (Oswalt 2012). The decline has been greater in the eastern part of its range, including the southern and central Appalachians. Forest Inventory and Analysis (FIA) data also show that most SLP trees are mature, and regeneration is sparse. Concern for this decline led to the establishment of the [Shortleaf Pine Initiative](#) in 2013. SLP is highly fire-adapted, and fire history research indicates it was promoted and sustained by frequent fires historically. When established regeneration is sparse or absent, management to promote regeneration from seed or planting is needed to sustain SLP on the landscape. However, relatively little is known about the direct effects of fire (heat and smoke) on seed germination and the effect of fire season on seedling establishment. To address this knowledge gap, a team of researchers from the University of Missouri and the Northern Research Station (USDA Forest Service) designed and carried out a study that included a greenhouse germination experiment and a field experiment of burn seasonality. The paper, authored by Hope Fillingim, Benjamin Knapp, John Kabrick, Michael Stambaugh, Grant Elliott, and Dan Dey, was recently published in the journal *Fire Ecology* and is titled "[Direct and indirect effects of fire on germination of shortleaf pine seeds](#)"

Lab/greenhouse experiment – How does exposure to heat or smoke affect the germination rate of shortleaf pine seeds?

Because SLP was historically sustained by frequent fire, the authors hypothesized that exposure to heat or smoke may increase germination rates. However, they also hypothesized that too much heat would result in seed mortality and reduce germination.

Methods

- In an oven, seeds of SLP were exposed to a range of temperatures from 140°F to 518°F for 1, 5, or 10 minutes.
- Another set of seeds were exposed to smoke, with an electric infuser used for cooking, for 5, 10, or 90 minutes.
- Seeds treated with heat or smoke, as well untreated seeds, were then placed in growing trays in the greenhouse and monitored for germination for 40 days.

Key findings

- 81% of untreated seeds germinated. Seeds exposed to 140°F for any length of time germinated at the same rate as untreated seeds. However, seeds exposed to 176°F for more than 1 minute (5 or 10) had lower germination rates and seeds exposed to temperatures $\geq 248^\circ\text{F}$ for any length of time failed to germinate due to mortality.
- Exposure to smoke did not increase or decrease germination.



Greenhouse germination of treated SLP seeds

Take Home

Unlike some species in fire-adapted communities, exposure to heat or smoke did not increase germination of SLP, and seeds were killed at temperatures of 250°F and greater. This highlights the potential for seeds in the litter layer (where they reside after seed fall in late-November to December through the winter and spring) to be killed in moderate/high intensity and/or longer-residence time prescribed fires in the winter or spring.

Results suggest that burning in the fall (October to mid-November) before seed fall will limit seed mortality from heat.

Field experiment – How does fire season affect the germination rate of shortleaf pine seeds in a natural setting?

The great majority of prescribed fires in the shortleaf pine range are conducted in the late winter and early spring. Because recently dispersed seeds reside in the litter during this period, the authors hypothesized that germination rates would be lower after early spring dormant season fires and especially after a late spring growing season fire (during the seedling emergence period), compared to a fall burn conducted prior to seed dispersal.

Study Site and Field Methods

- The field study was conducted in fully stocked 90-year-old shortleaf pine plantations in Missouri.
- Four plots (27' by 57') were established in several different locations, and at each location the plots received one of four treatments: control (no burn), fall burn (early November), early spring burn (early March), and late spring burn (early May).
- Due to the variable annual seed production of SLP, additional seeds (~750/plot) were scattered on the surface of the plots on November 11 (soon after the fall fire).
- The plot-scale prescribed fires were low-intensity but burned the plots completely and consumed about 75% of the litter.
- Newly germinated seedlings were tallied in the plots in mid-May (after the late spring burn) and then again at the end of the growing season in October.

Key findings:

As predicted, the plots burned in the fall prior to seed dispersal and additional seeding had significantly greater rates of seed germination/seedling establishment in May compared to all of the other treatments. Also, the late spring burn had the lowest rate of seedling establishment, likely due to direct mortality of new seedlings, while the unburned control plots were similar to the early spring burn plots.

Due to the high stand density and low light levels, survival of the new seedlings was low on all plots by October. The fall burn plots did have a higher number of new seedlings still alive by October (about 2,000 per acre), compared to the other treatments, but the difference was not statistically significant. On the late-spring burn plots, almost no new seedlings were present in October.



Experimental burn plot (March burn)



Shortleaf pine germinant on unburned field plot

Take home

- A fall burn prior to seed dispersal was clearly the best treatment to enhance SLP germination rates. The fall burn prevented seed mortality due to heat exposure and also created an improved seedbed compared to the unburned controls.
- The early spring burn, during the period when most prescribed fires are conducted, had similar germination rates as the unburned controls, likely because there was a balance between mortality of seeds in the litter layer due to heat exposure, but also improved seedbed conditions for surviving seeds.
- The late spring burn had a clear negative impact on SLP germination from seed and is not recommended if new seedling establishment is a key objective.

Conclusions:

Results from both experiments suggest that fall burns, by eliminating heat-caused seed mortality, can be beneficial for SLP regeneration from seed, while late spring burns during the seedling establishment period are likely detrimental. Fire history research indicates that the great majority of historic fires occurred during the dormant season (from Oct-Nov through Mar-Apr) but it's unclear whether fall or spring fires were more common. However, there are a number of historic accounts of Native Americans burning in the fall, and it's very likely that the current practice of burning primarily in the late-winter and early-spring is a departure from the historic regime that sustained shortleaf pine and pine-oak woodlands in the past. The authors note that fire season is likely to be less important when adequate SLP advance regeneration is present, due to its ability to resprout, and they also suggest that fire season may be less important in open stands with higher light levels, which will improve seedling establishment and growth.

Resources

Fillingim, H., Knapp, B.O., Kabrick, J.M., Stambaugh, M.C., Elliott, G.P. and Dey, D.C., 2023. Direct and indirect effects of fire on germination of shortleaf pine seeds. *Fire Ecology*, 19(1), p.53.

Oswalt, C.M., Kush, J., Barlow, R.J. and Gilbert, J.C., 2012. Spatial and temporal trends of the shortleaf pine resource in the eastern United States. In *Proc. of the Shortleaf pine conference: East meets West* (No. 11, pp. 33-37). Spec. Rep.

The lead author, Hope Fillingim, was a doctoral student at the University of Missouri, advised by Dr. Benjamin Knapp ([Silviculture and Restoration Ecology Lab](#)). The focus of Hope's dissertation research was on shortleaf pine regeneration. She now works for the Southern Research Station in Cordesville, SC.



Ben Knapp and Lauren Pile Knapp with daughter Lulu at her first Rx burn!

CAFMS Personnel Updates

Meet Our New Public Information Coordinator

Lindsey grew up in Parker City, IN and attended Ball State University for her undergraduate degree in Recreation and Tourism Management. Prior to joining the Consortium in 2023, she worked for The Nature Conservancy of Virginia performing prescribed burns across the state focusing on the intersection of science and fire dependent and adapted landscapes. She also worked to increase volunteer engagement by orchestrating events that focused on conservation throughout Virginia. Prior to working at TNC, she worked for Utah DNR - Utah Forestry Fire and State Lands as part of the wilderness urban interface program to mitigate the risks of wildfire. Lindsey currently lives in Lexington, VA.



Helen Mohr has accepted a detail with the National Forests in NC as the Pisgah CFLR coordinator. This will begin January 14th, 2024, for 120 days. We are currently looking for someone to detail in behind Helen but Lindsey (lindsey@cafms.org) and Todd Hutchinson our PI (todd.hutchinson@usda.gov) will be available to everyone!

Season 4 is Here!

To register visit: www.fuelingcollab.com

Nov. 16, 2023 – 11:00am-12:30pm EST
Fire History as a Bridge Between Ecological Knowledge Systems

Dec. 14, 2023 – 11:00am-12:30pm EST
The Future is Smoky

Jan. 18, 2024 – 11:00am-12:30pm EST
Phenology of Fire: Listening to the Plants and Animals

Feb. 15, 2024 – 11:00am-12:30pm EST
Successfully Bridging the Gap: Eastern US Models of Fire Science and Management Collaboration





Did you miss our last webinar?

The Dangers of Duff: How Long-Term Fire Exclusion can put “Fire Tolerant” Trees at Risk.

Dr. Mac Callaham, USFS Southern Research Station

You can watch [HERE](#)

**Hosted in Partnership with Oak Woodlands and Forest Fire Consortium*



CAFMS along with TNC South Carolina hosted the 2nd Southern Blue Ridge TREX on October 30 – November 10, 2023. This event was a great success but didn't come without challenges due to the drought and wildfire activity in the Southern Blue Ridge. We prepared 40+ burn units for prescribed burning but after only a couple of days had to transition to assisting our partners with wildfire suppression.

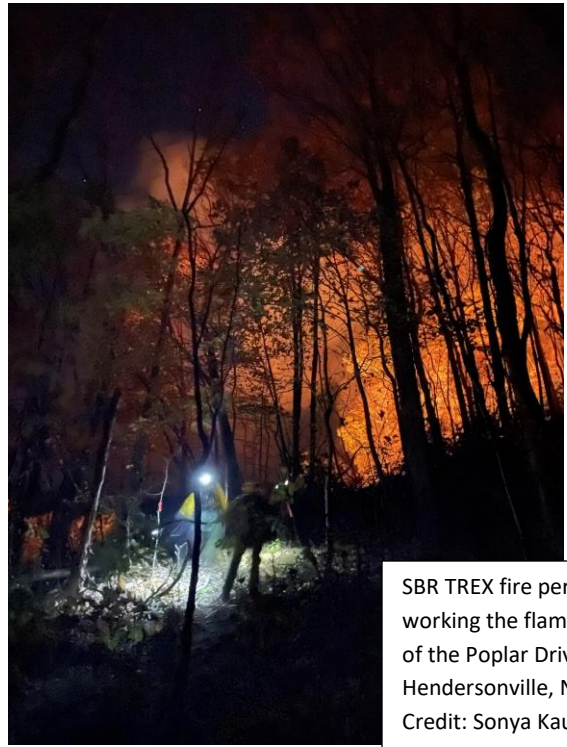
- 28 acres burned with 3 prescribed fires on NC Wildlife Resources Sandy Mush Gamelands
- Provided 6 operational periods of wildfire support on the Mill Mountain Fire (Andrew Pickens Ranger District, Sumter National Forest, SC) and Poplar Drive Fire (Hendersonville, NC)
- 12 taskbook final evaluations
- 29 Training assignments
- Prescribed burn unit line prep: 5.75 miles
- Wildfire firebreak construction: 3.5 miles
- Houses saved: 2

Don't miss the article below that gives a good overview of what was occurring during the SBR TREX. [Wildfires burn across the region as drought continues \(smokymountainnews.com\)](https://www.smokymountainnews.com)

We would like to thank all the partners and participants that came together to make this a successful SBR TREX. Don't miss the next one November 3-14, 2025.



A SBR TREX participant patrols the perimeter of a prescribed fire at NC Wildlife Resources Commission's Sandy Mush Game Lands.
Credit: Sonya Kaufman, TNC



SBR TREX fire personnel working the flaming front of the Poplar Drive Fire, Hendersonville, NC.
Credit: Sonya Kaufman, TNC



Wishing you (our fire family)
wonderful holiday season!

Communicate with Us!



Find us on twitter @APfirescience or find us on Facebook by searching Consortium of Appalachian Fire Managers and Scientists.

Join CAFMS:

The consortium is for all land managers and researchers in the region who deal with any aspect of fire. To join, simply provide us with some contact information at the web site listed below.

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