Consortium of Appalachian Fire Managers and Scientists
A JFSP KNOWLEDGE EXCHANGE CONSORTIUM

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Burning for Oak Regeneration: A Fire-free Period after Repeated Burns Promotes the Development of Oak Saplings, but Red Maple Competition Persists

Although historic fires ignited by Native Americans and then Euro-American settlers sustained oak forests in the Central Appalachians, nearly a century of fire suppression has allowed red maple and other mesophytes to become abundant in forest midstories and understories. The use of prescribed fire to reduce mesophytes and improve oak regeneration has become an increasingly common practice on public lands. However, due to the abundance of mesophytes, some of which sprout readily after topkill by fire, it has proved challenging to shift midstories and understories to greater dominance by oaks and other fire-adapted (pyrophytic) species, even after multiple fires. Oak recruitment to the midstory and eventually the overstory likely requires an extended fire free period, which few studies have investigated. A new paper authored by Beth Blankenship, Zachary Poynter, and Mary Arthur, "*Fire Exclusion vs. a fire-free interval following repeated prescribed fire: consequences for forest stand structure and species composition in an upland oak forest*" examines forest responses over 20 years, including a 10-year fire-free period after several fires.

One of several prescribed fires conducted in the study

Study Hypotheses: After 20-years, the authors predicted:
Burn Units: multiple burns followed by a fire-free period would show:

- Reduced basal area and stand density
- Increased oak regeneration abundance compared to mesophytes, including in the midstory sapling layer.

Controls: Continued fire-excluded sites would exhibit:

- Red maple, the primary mesophyte, will have become more dominant in the midstory and more abundant in the subcanopy and canopy layers.

Study Site and Field Methods

- Study sites were located in the Cliff Section of the Cumberland Plateau, on the Cumberland Ranger District of the Daniel Boone National Forest.
- When the study began in 1995, mature closed-canopy forests were dominated by chestnut oak and scarlet oak; other common overstory species were black oak, white oak, hickories, pitch pine, shortleaf pine, and Virginia pine. The subcanopy and midstory were dominated by shade-tolerant species: red maple, white pine, blackgum, and sourwood.
- Prescribed fire units were burned 3X or 4X in the spring dormant season between 1995 and 2005. Fire intensity was generally low, but flame lengths 3 to 6 ft were occasionally observed.
- Plots were measured for overstory trees (>7.9" DBH), subcanopy poles (3.9 – 7.9" DBH), midstory saplings (0.8 – 3.9" DBH), and regeneration (<0.8" DBH) before treatments (1995), after fires (2007), and then again after a 10-year fire-free period (2015).

Key findings:

- Both 3X and 4X burn units had reductions in the density of overstory and subcanopy trees. However, significant basal area reduction occurred only on the 4X burn units – from 153 to 103 ft^2/acre.
- Midstory stem density declined sharply after fire but then had re-developed after 10 fire-free years, to a much greater degree on the 4X burn units.
- Oaks: Sapling densities increased significantly only on the 4X burn units, where basal area had been reduced. Oak and hard pine regeneration (stems <0.8" DBH) also increased by year 20 on the 4X burn units.
- Mesophytes: Sapling densities of red maple and sourwood also increased on the 4X burn units during the fire-free period and remained dominant (60% of stems) in the midstory. However, in the subcanopy, red maple density decreased significantly on both burn treatments.
- For the burn units, the hypotheses were partially supported on the 4X units.
- As predicted on the fire-excluded sites, red maple became more abundant in the overstory, subcanopy, and midstory.

View of the Red River Gorge Geological Area, on the Cumberland Ranger District, Daniel Boone National Forest

Conclusions:

The greater basal area reduction on the units burned 4X compared to 3X was unexpected and led to greater midstory ingrowth during the 10-year fire free period. The authors suggest that one additional fire may have predisposed overstory trees to be more susceptible to mortality in wind events or ice storms, which occurred during the study. Although midstory sapling oaks gained some ground relative to red maple saplings, the authors note the strong legacy effects of long-term fire suppression, as red maple and sourwood were abundant in year 20 – persisting after repeated topkilling and then growing into the midstory. Importantly, this long-term study also shows that mesophication progressed steadily without fire, as red maple became more prominent throughout the midstory, subcanopy, and canopy layers.

Link to the paper:

Blankenship, B.A., Poynter, Z.W. and Arthur, M.A., 2023. Fire exclusion vs. a fire-free interval following repeated prescribed fire: Consequences for forest stand structure and species composition in an upland oak forest. *Forest Ecology and Management*, *546*, p.121367.

Related papers:

Arthur, M.A., Alexander, H.D., Dey, D.C., Schweitzer, C.J. and Loftis, D.L., 2012. Refining the oak-fire hypothesis for management of oak-dominated forests of the eastern United States. *Journal of Forestry*, *110*(5), pp.257-266.

Arthur, M.A., Varner, J.M., Lafon, C.W., Alexander, H.D., Dey, D.C., Harper, C.A., Horn, S.P., Hutchinson, T.F., Keyser, T.L., Lashley, M.A. and Moorman, C.E., 2021. Fire ecology and management in eastern broadleaf and Appalachian forests. *Fire Ecology and Management: Past, Present, and Future of US Forested Ecosystems*, pp.105-147.

The corresponding author, Mary Arthur, is Professor Emeritus of Forest Ecology at the University of Kentucky. For a perspective on Mary's career of prescribed fire research in Kentucky, check out her blog post on our CAFMS website. Before retirement, Mary served on the CAFMS User's Board and in 2019 was awarded a lifetime achievement award at the 6th Fire in Eastern Oak Forests Conference.

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

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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

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

Dr. Mac Callaham, USFS Southern Research Station

Webinar – October 24th, 2023

1:00pm Central time

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

Register here: https://umsystem.zoom.us/meeting/register/tJIvdu2urTkrEtZa2jN6kON0SHJo6NXbC_t4

A unique Zoom Meeting link will be emailed to you. Enter the meeting room beginning at 12:45 pm (central time) on the day of the webinar.

The Wildlife Society and **The Society of American Foresters** continuing education credits (1 hour Cat 1)

Webinar abstract: Most forests in the eastern USA are thought to have experienced frequent fires (3–5-year return intervals) in the time period between glacial retreat about 15,000 years ago, up until the time of European colonization. The high frequency of fires likely came about through climate-driven changes in vegetation, with the species composition being influenced by frequent ignitions from both natural (lightning) and human sources. Since the time of broadscale clearing for agricultural purposes, and logging, the frequency of fires has diminished such that most landscapes in the east have been effectively fire-free for many decades. One consequence of this fire exclusion has been the gradual accumulation of organic material in the forest floor (hereafter referred to as duff), which on one hand represents an important storage pool for carbon and nutrients, but which also represents available fuel when ignitions occur under certain environmental conditions. Our recent work suggests that when wildfires occur under very dry conditions, the consumption of duff (and fine roots therein) can result in significant post fire mortality and/or decline of overstory trees – sometimes several years after the fires actually occurred. This pattern of delayed mortality was particularly pronounced for oak-dominated stands, and counterintuitively, was not observed in stands dominated by mesic species such as maple and tulip poplar (where thick duff layers do not form). As such, restoration of oak stands might be improved if restoration treatments specifically targeted duff reduction as an objective. Evidence from one restoration study in the mountains of western North Carolina, where prescribed fire has been applied 4 times over 20 years in combination with mechanical removal of shrubs, suggests that duff reduction can be achieved with repeated management interventions. However, to date, this has failed to effect much change in species composition of the overstory, and that tree species composition in the recruitment age-class was only slightly shifted away from mesophytic species. Taken together, these results suggest that more aggressive treatments (possibly involving selective harvest and/or herbicide applications) may be necessary if managers have the objective of reversing species composition shifts away from oak-dominated stands.

SIXTH NATIONAL COHESIVE WILDLAND FIRE MANAGEMENT STRATEGY WORKSHOP
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