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

Prior to a century of fire suppression, oak forests in the Central Appalachians were once sustained with fire by Native Americans and later Euro-American Settlers. Prescribed fire is used to reduce mesophytes and improve oak regeneration, yet it has been challenging to shift to a greater dominance of pyrophytic (fire-adapted) species because of the high abundance of mesophytes, which sprout readily after topkill. Oak recruitment to the midstory, and eventually the overstory, likely requires an extended fire free period. A paper authored by Beth Blankenship, Zachary Poynter, and Mary Arthur, published in the journal *Forest Ecology and Management* titled, "*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.

Study Hypotheses: After 20-years (study began in 1995) 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 including in the midstory sapling layer.
- *Controls*: Continued fire-excluded sites would show:
  - Red maple, the primary mesophyte, to become more dominant in the midstory and more abundant in the subcanopy and canopy layers.

Study Site and Field Methods:

- Study sites were in the Cliff Section of the Cumberland Plateau, on the Cumberland Ranger District of the Daniel Boone National Forest.
- In 1995, mature closed-canopy forests were dominated by chestnut oak and scarlet oak; other common overstory species were black oak, white oak, hickory, pitch and Virginia pine, and shortleaf pine. The subcanopy and midstory were dominated by shade-tolerate mesophytes of red maple, white pine, blackgum, and sourwood.
- Prescribed fire units were 3X or 4X burned in the spring dormant season between 1995 - 2005. Fire intensity was 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:

- 3X and 4X burn units had reductions in the density of overstory and subcanopy trees. 4X burned had significant basal area reduction from 153 to 103 ft^2/acre.
- 4X burned had midstory stem density decline sharply after fire, then re-developed after 10 fire-free years to a much greater degree.
- Oak 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) increased by year 20 on the 4X burn units.
- Red maple and sourwood sapling densities increased on the 4X burn units during the fire- free period and remained dominant (60% of stems) in the midstory. 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.

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.

Links 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, 54 https://doi.org/10.1016/j.foreco.2023.121367

https://www.appalachianfire.org/_files/ugd/696505_2d30d66f2c78412f8e3f8d8ac2aebc2d.pdf

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. https://doi.org/10.5849/jof.11-080

Arthur, Mary A.; Varner, J. Morgan.; Lafon, Charles W.; Alexander, Heather D.; Dey, Daniel C.; Harper, Craig A.; Horn, Sally P.; Hutchinson, Todd F.; Keyser, Tara L.; Lashley, Marcus A.; Moorman, Christopher E.; Schweitzer, Callie J. 2021. Fire Ecology and Management in Eastern Broadleaf and Appalachian Forests. In: Fire Ecology and Management: Past, Present, and Future of US Forested Ecosystems. Volume 39, Part of the Managing Forest Ecosystems series. Springer. Chapter 4.
https://doi.org/10.1007/978-3-030-73267-7_4

https://www.appalachianfire.org/oak

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.