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Soil Seed Banks and the Restoration Potential of Fire-adapted Species in the Allegheny Plateau, West Virginia

The soil seed bank is a potential reservoir of plant diversity in fire-adapted communities in the Appalachian Region. Dense closed-canopy sites that have been fire suppressed for many decades, especially drier sites, typically have species poor groundlayers. These sites are stressful for plants in having both limited soil moisture and limited light. Prescribed fire, by consuming a portion of litter and duff layers and reducing midstory density, can stimulate germination from the seed bank by increasing light penetration to the mineral soil, where dormant seeds reside. However, this response may be limited in long-unburned sites due to a lack of seeds of fire-adapted species persisting in the soil.

Throughout the Appalachians, forest types vary from pyrophilic (fire-adapted oaks and pines) on drier sites to pyrophobic (fire-sensitive maples and yellow-poplar) on moist, sheltered sites. Research comparing soil seed banks across site types related is largely lacking for the region. A new paper **“Comparison of seed bank composition over a gradient of pyrophilic vegetation”**, authored by Cynthia Huebner, Melissa Thomas-Van Gundy, and Chris Underwood, examines the composition of seed banks and present groundlayer vegetation on sites ranging from pyrophilic to pyrophobic, based on historic vegetation (witness tree records).

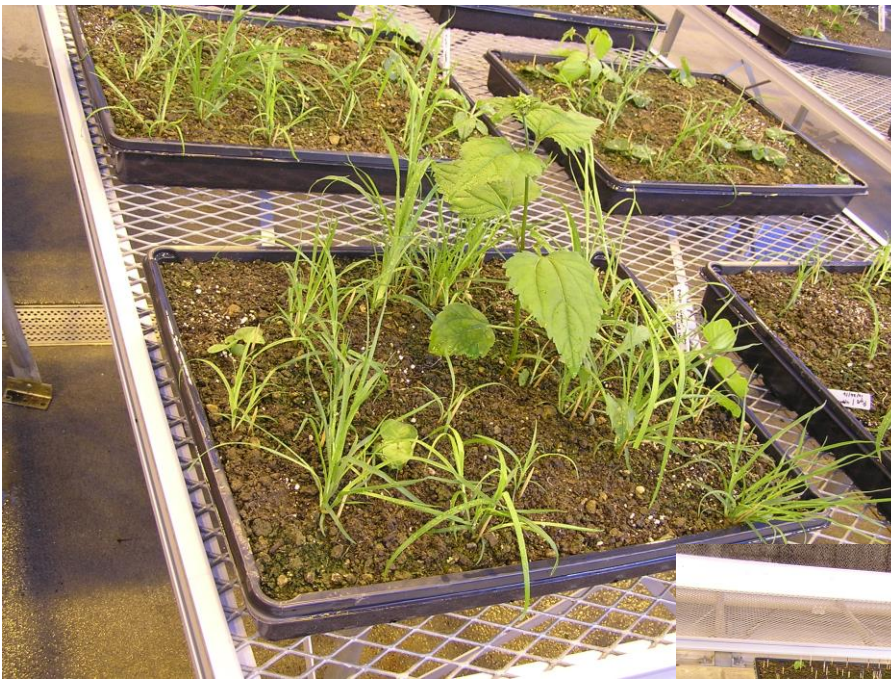


Main Hypotheses:

1. Pyrophilic sites will have the greatest number of pyrophilic (fire-adapted) species in the seedbank – conversely, pyrophobic sites will have least.
2. Due to a history of fire followed by decades of fire suppression on dry pyrophilic sites, the seed bank composition, containing fire-adapted species, will be most dissimilar from the current groundlayer vegetation, which will lack fire-adapted species.

Study Site and Methods

- The study was conducted in the Greenbrier Ranger District on the Monongahela National Forest. Three 80-year-old forest sites were selected on a 4 mile transect.
 - High – witness trees were 80-90% pyrophilic oak-dominated (chestnut, white, northern red); elevation 2,600 ft.
 - Medium – witness trees were 40-50% pyrophilic mixed-mesophytic (oak, sugar maple, basswood); elevation 3,200 ft.
 - Low – witness trees were 0-10% pyrophilic (red spruce); elevation 3,700 ft.
- Plots were established at each site, where soil cores were collected to determine the seed bank composition and current groundlayer vegetation was recorded. Soils were also collected to identify and age charcoal fragments that would indicate historic fires.
- Soil cores were cold-stratified and transferred to a greenhouse and spread on trays and then watered regularly and to stimulate germination. Trays were monitored for 5 months, and germinated seedlings were counted and identified to species.
- Charcoal fragments in soil samples were quantified and a subset of these were dated using radiocarbon methods.



Key findings:

- Soil charcoal: Unexpectedly, the Medium site had the greatest amount of charcoal in the soil. Charcoal at the Medium and High site dated to the 1600s and 1700s. Also unexpectedly, the higher elevation pyrophobic site had the oldest charcoal – dating to the late Woodland Period (900-1650 AD).
- Across all sites, 61 species were recorded in the present vegetation plots, and few are considered fire-adapted (61 additional species were identified between sample plots). There were 56 species that germinated from the seed bank samples – more of these were fire-adapted - and these species were very different from the present vegetation.
- The drier pyrophilic site did contain the greatest number of pyrophilic species in the seed bank and was the most diverse overall (44 species); however, this site also had the lowest abundance of seeds. Fire-adapted species in the seed bank were primarily grasses (e.g., panic grasses).
- As predicted, the drier pyrophilic site showed the greatest difference in composition between the current vegetation and the seed bank – the current ground-layer has undergone mesophication and lacks fire-adapted species.
- Due to the low abundance of seeds in the soil at the dry pyrophilic site, the authors conclude that restoration to a more diverse and fire-adapted groundlayer flora may be an uphill battle, after a century of fire exclusion. In similar sites where fire is being re-introduced, supplemental seeding of fire-adapted species may be required due to a lack of seed bank abundance and diversity.

Link to the paper:

[Huebner, C.D., Thomas-Van Gundy, M. and Underwood, C.A., 2023. Comparison of seed bank composition over a gradient of pyrophilic vegetation. *Journal of the Torrey Botanical Society*.](#)

Other related papers:

[Thomas-Van Gundy, M.A. and Nowacki, G.J., 2013. The use of witness trees as pyro-indicators for mapping past fire conditions. *Forest Ecology and Management*, 304, pp.333-344.](#)

The lead author, [Dr. Cynthia Huebner](#), is a Research Botanist with the USDA Forest Service, Northern Research Station, located in Morgantown, WV. Dr. Huebner's research focuses on the biology and ecology of invasive plant species in forest systems, especially in association with anthropogenic and natural disturbances. Dr. Melissa Thomas-Van Gundy, a co-author (and CAFMS Board member), noted "***I had a vague idea of how seed bank composition might vary along the pyrophilic percentage gradient and hoped that we could find a signal of past fire in the seed bank. Obviously, it's more complicated than that and I am grateful to Cindy for taking my vague ideas and conducting this study. I think, the indicator species analysis and species frequency table could be used as indicators of woodland conditions and to monitor success of prescribed fire.***"



Thanks for Everything, Jen!

CAFMS Public Info Coordinator, Jen Bunty has accepted a new position with the USFS. Her impact on CAFMS over the past 7.5 years has been BIG. There just aren't words to express our gratitude! Jen wrote a blog post that reflects on her time with CAFMS.

[The story - behind the story - behind the science \(appalachianfire.org\)](https://appalachianfire.org)



FIEO field trip to the Gus Engeling WMA in Anderson County, Texas

Did you miss the 7th Fire in Eastern Oak Forests conference this past May?
You can find many of the recorded presentations here:

[Fire in Eastern Oaks Conference Videos](#)



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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.

www.apalachianfire.org

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