

FLAMMABILITY OF LITTER FROM 50 SOUTHEASTERN TREE SPECIES ALONG MESOPHICATION GRADIENTS

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EXTENDED ABSTRACT

Fire exclusion and land-use have resulted in dramatic shifts in overstory tree species composition and structure across many southeastern ecosystems. These changes are implicated widely in feedbacks termed “mesophication” (Nowacki and Abrams 2008) where invading species cast litter that diminishes the ignition and spread of surface fires. Past research across the United States illustrates differential flammability among tree species, including research on a number of southeastern tree species (Fonda 2001, Kane and others 2008, Mola and others 2014). There is widespread evidence for mesophication in many southeastern savanna and woodlands (Hanberry and others 2020), but the evidence from a litter flammability standpoint is lacking in many cases (Alexander and others 2021). We performed laboratory experiments and compiled published data from studies using similar methodology to fill holes in the broader understanding of differential flammability and to identify species across mesophication gradients in the Southeastern United States.

We used published data from eight studies that followed the laboratory flammability methods of Fonda (2001) and collected recently fallen litter to supplement this list of species. Surface litter was collected after litterfall from sites across the region. We collected litter beneath individual trees and shipped air-dried samples to the laboratory for experiments. In the laboratory, we followed methods in Fonda (2001) to burn each oven-dried 15-gram sample. Once ignited, we measured the maximum flame height, the duration of flaming, duration of smoldering, and the percentage consumption of the original fuel.

We placed species into their representative ecosystems (Coastal Plain uplands, oak-hickory woodlands, Appalachian forests, and bottomland forests), with some species occurring across more than one ecosystem. We compared species within each ecosystem based on their flammability measures.

Southeastern tree species varied widely in their litter flammability. Several pines were highly flammable, including *Pinus palustris*, *Pinus serotina*, *Pinus echinata*, *Pinus taeda*, and *Pinus rigida*. A few oaks were also highly flammable, including *Quercus laevis*, *Quercus falcata*, and *Quercus alba*. *Castanea dentata* was remarkably flammable. The least flammable species included *Tsuga canadensis*, *Torreya taxifolia*, *Taxus floridana*, *Pinus clausa* var. *clausa*, *Quercus virginiana*, and *Quercus geminata*. The species typically implicated in southeastern mesophication (*Acer rubrum*, *Nyssa sylvatica*, *Liquidambar styraciflua*, and *Tilia americana*) also burned with reduced flammability.

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Citation for proceedings: Willis, John L.; Self, Andrew B.; Siegert, Courtney M., eds. 2022. Proceedings of the 21st Biennial Southern Silvicultural Research Conference. Gen. Tech. Rep. SRS-268. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 262 p. <https://doi.org/10.2737/SRS-GTR-268>.

Within the four forest communities, species followed somewhat predictable gradients that mimicked mesophication gradients. In the Coastal Plain uplands, a majority of the upland pines and oaks burned with high flammability. Exceptions to this pattern included the sand pines, which tend to occur in infrequently burned “scrubs” and a suite of invading evergreen oaks. In oak-hickory woodlands, *Quercus alba*, *Carya tomentosa* and *Carya glabra* burned well, while the mesophytes burned poorly. We found higher than expected flammability for *Oxydendrum arboreum*, *Fagus grandifolia*, and *Liriodendron tulipifera*. The most flammable species in Appalachian forests were *Castanea dentata*, *Pinus echinata*, *Pinus rigida*, *Quercus alba*, and *Carya glabra*, with *Tsuga canadensis* the least flammable. The diverse bottomland forest tree species contained flammable species (*Quercus* and *Pinus* species) and a large number of poorly flammable species that typify this fire-sheltered community.

Our results provide evidence for flammability or mesophication gradients across the four communities we studied and provide flammability data for species previously lacking this information. From a management standpoint, where frequent burning is desirable, our data suggest species that may be targeted for removal to facilitate flammable fuels. These data also illustrate the relative flammability of many southeastern species typically associated with frequently burned ecosystems. Many southeastern pines and oaks, as well as *Castanea dentata* have remarkable flammability that likely sustained open woodlands and deterred invasion by off-site mesophytic species (Kane and others 2008, Kane and others 2019, Kreye and others 2013). Linking these traits to fire protective traits such as bark thickness, reproductive strategies, and fire tolerance will provide a more complete picture of how these species dominated historically and how they may fare in future restoration and management efforts (Kane and others 2019, Varner and others 2016).

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