INFLUENCES OF OVERSTORY PYROPHYTIC AND MESOPHYTIC TREES AND UNDERSTORY SOLAR IRRADIANCE ON LEAF LITTER AND WOODY DEBRIS FUEL MOISTURE RETENTION

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EXTENDED ABSTRACT

Following decades of fire exclusion, open-canopied, pyrophytic oak (*Quercus* spp.) and pine (*Pinus* spp.) landscapes across the central and Eastern United States are shifting to closed-canopied forests with a dense midstory occupied by shade-tolerant, often fire-sensitive species (i.e., mesophytes) (Alexander and others 2021). Encroaching species may create an understory with increased moisture due to lower solar irradiance beneath the canopy (Alexander and others 2021), and increased small leaf litter, which may compact fuel beds and decrease water evaporation (Cornwell and others 2015, Varner and others 2015), and increase woody debris (MacMillan 1988).

The primary objective of this study was to understand how fine fuel moisture dynamics beneath overstory trees varies by functional groups (pyrophytic pine; pyrophytic oaks; mesophytic oak) and may impact prescribed fire effectiveness in systems with varying levels of mesophytic tree encroachment. We hypothesized that the leaf litter and woody debris of pyrophytic pines (*Pinus palustris*) and pyrophytic oaks (*Quercus margaretta* and *Q. laevis*) will dry faster compared to a mesophytic oak (*Q. laurifolia*) because of their leaf traits (e.g., thickness, specific leaf area, curliness, and volume), which cause lack of fuel compaction, and lower woody density. We also hypothesized that under the canopy of pyrophytic pines and oaks, higher vapor pressure deficit (VPD) would hasten moisture loss of fuels compared to mesophytic oak, and hence influence flammability.

To understand the influence of overstory trees on fuel-drying environments, we conducted a fuel-drying experiment at The Jones Center at Ichauway, GA, which consisted largely of open stands of second-growth

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longleaf pine woodlands and associated communities. We selected 15 focal trees, 5 in each of the studied functional groups. In summer 2022, we implemented five 1-day-long fuel-drying experiments. Each day, we fully hydrated 30 bags of leaf litter (10 per functional group) and 30 bags of 10-hour woody debris (10 per functional group) and placed them under each focal tree (fig. 1). To measure moisture loss, we collected and weighed two bags of each fuel every 2 hours for 10 hours. We also deployed microclimate sensors (Cannon and others 2022) to measure microclimate conditions beneath the focal trees.

Figure 1—Thirty soaked litter bags and 30 soaked 10-hour woody debris bags were placed under 15 trees from the bole to the edge of the crown. (Photo courtesy of Luiza Lazzaro)

Our preliminary results suggest that response time, that is, the time it takes fuels to reach 63 percent of relative moisture loss (Kreye and others 2012, Nelson and Hiers 2008) of the leaf litter, varied by functional group. Pyrophytic pine dried faster than pyrophytic oak and mesophytic oak leaf litter, respectively. We also found that response time also varied with the composition of the overstory. Leaf litter beneath pyrophytic pines dried faster than pyrophytic oak and mesophytic oak overstories, respectively. The response time of woody debris did not vary among functional groups, woody fuels dried faster beneath pyrophytic pine overstories. VPD was lowest beneath mesophytic oak compared to pyrophytic pines and pyrophytic oaks.

As we hypothesized, leaf litter of mesophytic oak had greater response time compared to pyrophytic pines and pyrophytic oaks, which could be explained by leaf litter traits, where their small leaves created a compacted fuel bed and decreased the loss of moisture (Kreye and others 2013, McDaniel and others 2021). We also observed that mesophytic oak had a lower loss of moisture on leaf litter and woody debris, which could be explained by the denser canopy, decreased light incidence and consequently lower VPD (Alexander and Arthur 2010, Babl and others 2020, Canham and others 1994, Siegert and Levia 2011). The lack of differences in woody debris response time among functional groups could be explained by the time of experiment, for the density of the material woody debris should take longer to dry than leaf litter. Thus, we propose a longer experimental measurement period for future studies.

Our findings show that mesophytic species play a significant role in increasing fuelbed moisture levels by not only changing litter traits but through altering the microclimate and drying conditions of fuel beds. Our work also helps to classify the understudied species sand post oak (*Q. margaretta*) and laurel oak (*Q. laurifolia*) into the mesophytic spectrum. By improving our knowledge of fire, climate, and vegetation feedbacks, we can develop more effective conservation management strategies, such as defining more precise windows for prescribed fires in mixed forests.

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