AGE DISTRIBUTIONS AND ESTABLISHMENT TRAITS OF WHITE OAK (*QUERCUS ALBA*) ADVANCE REPRODUCTION UNDER UNEVEN-AGED MANAGEMENT IN THE OZARK HIGHLANDS OF MISSOURI, USA

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PURPOSE AND SCOPE

In the Eastern United States, recent reductions in oak regeneration across oak-dominated forests have led to overstory oak mortality rates exceeding the recruitment of new and likely future oak seedlings (Knapp et al. 2021). Although accumulating oak advance regeneration (OAR) and promoting recruitment to the canopy can be achieved using even-aged management strategies, implementing uneven-aged management (UAM) has been of growing interest due to the benefits of promoting old-growth forests, maintaining forest age and structural diversity, maximizing carbon storage, and preventing bottlenecks in forest product supplies. Combining quantitative wood anatomy (QWA) and dendrochronological methods, OAR age distributions and aboveground stem origins (seed versus seedling resprout) were explored across a range of UAM sites within the Ozark Highlands of Missouri.

METHODS AND APPROACH

OAR seedlings (<1.37 m in height) were collected from UAM stands at the Missouri Ozark Forest Ecosystem Project. OAR were excavated from stands similar in species composition and topography, but that varied in their UAM frequency. Sample preparation involved microsectioning, staining, and digitizing thin, xylem tissue cross-sections (von Arx et al. 2016). Due to the resprouting ability of oak species, cross-sections from above and below ground (stem and root) were prepared to obtain separate stem and root ages for each seedling (Dee et al. 2022). Sections were individually ring counted, and their ring widths were crossdated to

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ensure the accuracy of age determinations. Crossdating also provided the year of the most recent resprouting event.

FINDINGS AND IMPLICATIONS

Aboveground stem ages for all seedlings ranged from 1 to 31 years and ages for belowground roots ranged from 2 to 49 years, aside from one outlier that was approximately 91 years old. Age differences between the stem and root of the same seedling ranged from 0 to 46 years. Seedlings with no stem-root age difference indicate no top-killing event since germination. Seedlings with an age differential of ≥2 years (≥1 year for crossdated seedlings) experienced at least one top-killing event. From this, 62 percent of OAR were resprouts.

For the effective UAM of white oak, attention should focus on establishing sufficiently large OAR populations and promoting sustained, competitive growth during the regeneration and recruitment phases. The results from this study could be used to assess the efficacy of forest management practices and harvesting strategies in promoting OAR accumulation and their continued growth towards the canopy.

This study provides new data and perspective on OAR populations and early growth by combining QWA and dendrochronological methods. These novel methods could be further developed and expanded to address oak regeneration questions and assess the management intended to sustain the vast array of ecological and economic benefits that oak species provide.

LITERATURE CITED

Dee, J.R.; Stambaugh, M.C.; Dey, D.C. 2022. Age, growth, longevity, and post-fire/thinning response of chinkapin oak seedlings in a Kansas upland hardwood forest. The Journal of the Torrey Botanical Society. 149(2): 122–134. https://doi.org/10.3159/TORREY-D-21-00027.1.

Knapp, L.S.P.; Snell, R.; Vickers, L.A. [et al.]. 2021. The 'other' hardwood: Growth, physiology, and dynamics of hickories in the Central Hardwood Region, USA. Forest Ecology and Management. 497: 119513. https://doi.org/10.1016/j.foreco.2021.119513.

von Arx, G.; Crivellaro, A.; Prendin, A. L. [et al.]. 2016. Quantitative Wood Anatomy—Practical Guidelines. Frontiers in Plant Science. 7: 197139. https://doi.org/10.3389/fpls.2016.00781.

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