ECOHYDROLOGICAL RESPONSES OF *QUERCUS RUBRA* AND *Q. VELUTINA* TO 7 YEARS OF EXPERIMENTAL DROUGHT

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PURPOSE AND SCOPE

Red oaks (northern red oak, *Quercus rubra* and black oak, *Q. velutina*) are an abundant and valuable timber resource in much of New England, and are physiologically and ecologically distinct from other tree species with which they co-occur. Oaks are generally thought to be deeply rooted and well suited to dry sites, so it is often assumed that they will outperform conifers and more mesic hardwoods as the climate warms and the interannual variability of precipitation leads to more intense drought despite increases in mean precipitation. However, despite their ability to avoid moderate drought stress via their rooting structure, it has been suggested that their risky hydraulic architecture may make them as vulnerable as other species (Novick et al. 2022) to severe droughts.

METHODS AND APPROACH

We experimentally simulated growing-season drought in two oak-pine forest stands at Thompson Farm in Durham, NH for seven growing seasons (2016 to 2022). Approximately 50 percent of throughfall was diverted from two 30-m by 30-m plots between mid-May and late September each year, with intensified diversion (estimated at 90 percent) during the final treatment year in 2022 (fig. 1). Each treated plot was paired with a nearby control plot of similar species composition, and pretreatment data collection began in 2015. Soils were Inceptisols, developed on thin glacial till, and Entisols, on deeper glacial outwash. Water use was monitored using sapflow sensors employing the heat ratio method, and diameter growth was monitored using band dendrometers and increment cores. Root depth distributions were analyzed in quantitative soil pits and power cores in 2019. Leaf water potential, stomatal conductance, and photosynthesis were monitored in a subset of years.

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Figure 1— Part of a throughfall diversion structure covering one of two 30-m by 30-m plots at Thompson Farm in Durham, NH. Half of growing season throughfall was diverted for 6 years, and in the final year, as shown here, coverage was increased to the maximum degree feasible. (Photo courtesy of Matt Vadeboncoeur)

FINDINGS AND IMPLICATIONS

All monitored codominant oaks and pines in treatment and control plots survived the experiment. Oaks downregulated water use more slowly than pines as soils dried, and their intrinsic water-use efficiency was less responsive than pines to both the throughfall reduction treatment and naturally dry summers (Asbjornsen et al. 2021). Preliminary interpretation of xylem water stable oxygen isotope ratios suggests that oaks access water from deeper soil horizons than do pines or maples, which is consistent with observed root depth distributions (Vadeboncoeur et al. 2023) and observations of predawn leaf water potential. However, cumulative reductions in oak basal area increment (27 percent) were surprisingly greater than reductions in co-occurring pine basal area increment (19 percent). Because oaks generally completed each year's radial growth by early August, and soils were usually driest in both the drought and control plots during August and September, the growth effect of a particularly dry summer was typically seen in the following year's growth. No significant differences between northern red and black oak were observed in any of measured treatment effects.

Monitoring of recovery of growth and water-use efficiency after the completion of experimental drought treatments is ongoing. Together, these data will improve our understanding of how these species may respond to a warmer climate with a more variable precipitation regime.

LITERATURE CITED

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