OAK DEMOGRAPHICS AND DISTRIBUTIONS ON THE PAINT ROCK FOREST DYNAMICS PLOT IN NORTHERN ALABAMA, USA

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PURPOSE AND SCOPE

Understanding the factors that influence growth, distribution, and regeneration of oaks (*Quercus*) in uneven-aged forests is important for addressing ongoing concerns about viable oak regeneration and for explaining oak demographics seen in mixed mesophotic forests in North America (Cavender-Bares 2016, McEwan et al. 2011). To explore oak demographics, we used census data from nine species of oak identified in the 20-ha Paint Rock Forest Dynamics Plot. The plot is in northern Alabama and within the Cumberland Plateau physiographic region. Forests within the region are mature, and prior disturbances to the site, circa 1900 included repeated high-grade logging, forest roads creation, and small-scale clearings for agriculture. We present results from the first census, including size-class and species distribution analyses for all *Quercus* species in the plot. These data should help clarify the demographic status and distribution patterns for oaks under natural regeneration, and guide future research directions.

METHODS AND APPROACH

Between 2019 and 2022, all woody stems (excluding lianas) at least 1 cm in diameter at breast height (d.b.h., at 1.37 m height) were tagged with a unique number, mapped, and identified to species within the 20-ha plot. Aboveground biomass was estimated using updated biomass equations for North American tree species. Biomass was calculated as Mg/ha using R Studio Statistical Software (R Core Team 2023). Percentage of biomass by species and percentage of stems by species were calculated, along with the total biomass of each species at a resolution of 20 m by 20 m (fig. 1). Diameter distributions were graphed. To examine biomass relative to topography and moisture, landform position index and a topographic wetness index were used to assess relationships.

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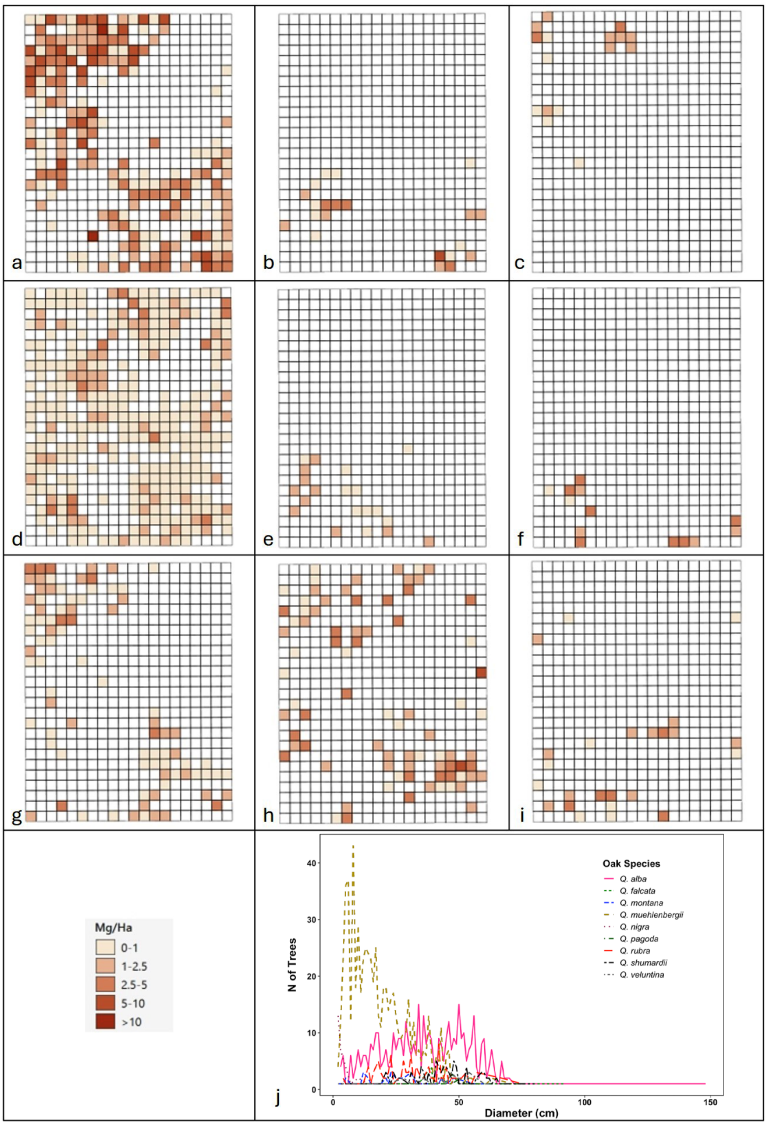

Figure 1—Mapped biomass estimates within the research plot for (a) *Quercus alba*: 446 stems and average 25.8 Mg/ha biomass; (b) *Q. falcata*: 29 stems and average 2.8 Mg/ha biomass; (c) *Q. montana*: 40 stems and average 1.1 Mg/ha biomass; (d) *Q. muehlenbergii*: 674 stems and average 10 Mg/ha biomass; (e) *Q. nigra*: 40 stems and average 0.9 Mg/ha biomass; (f) *Q. pagoda*: 19 stems and average 1.6 Mg/ha biomass; (g) *Q. rubra*: 121 stems and average 4.9 Mg/ha biomass; (h) *Q. shumardii*: 102 stems and average 7.4 Mg/ha biomass; (i) *Q. veluntina*: 30 stems and average 1.8 Mg/ha biomass; and (j) diameter distribution graph for all oak species.

FINDINGS AND IMPLICATIONS

Nine species of *Quercus* (three Section *Quercus*: *Q. alba*, *Q. montana*, *Q. muehlenbergii*, and six Section *Lobatae*: *Q. nigra*, *Q. pagoda*, *Q. rubra*, *Q. shumardii*, and *Q. veluntina*) were identified, making oaks and the family Fagaceae the most represented group in the plot. Though not the most abundant group with only 1,501 (5 percent) of all tagged stems, oaks contributed the most to total biomass at 56.0 Mg/ha or 27 percent of the total plot biomass of 210.9 Mg/ha. *Quercus muehlenbergii* was the most numerous oak species, accounting for 674 (45 percent) of oak stems and 10 percent of total plot biomass. *Quercus alba* was the second most numerous oak species accounting for 446 (30 percent) of oak stems and 25.8 Mg/ha, which was the greatest biomass for any species on the plot. The

least numerous oak species was *Q. pagoda* with only 19 (1 percent) tagged stems. Most *Q. muehlenbergii* had a d.b.h. of <50 cm, though most *Q. alba* had a d.b.h. of >50 cm. The largest d.b.h. on the plot, 148 cm, belonged to a *Q. alba*. In addition to having the greatest number of individuals, *Q. muehlenbergii* was the most widely distributed oak. *Quercus alba* was absent from the lowest elevations and higher biomass was positively correlated with slopes with higher wetness values. When *Q. muehlenbergii* was excluded, most (80 percent) oak stems were >40 cm d.b.h., suggesting that there may be overall low oak recruitment. Future research will look at the effects of soil pH, seed dispersal, and seedling and mortality patterns.

LITERATURE CITED

Cavender-Bares, J. 2016. Diversity, distribution and ecosystem services of the North American oaks. International Oaks. 27: 37–48.

McEwan, R.W.; Dyer, J.M.; Pederson, N. 2011. Multiple interacting ecosystem drivers: toward an encompassing hypothesis of oak forest dynamics across eastern North America. Ecography. 34(2): 244–256. https://doi.org/10.1111/j.1600-0587.2010.06390.x.

R Core Team. 2023. R: A language and environment for statistical computing. R Foundation Statistical Computing. Vienna, Austria. https://www.R-project.org/.

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