CORRELATIONS BETWEEN TREE CROWN CONDITION AND SHADE TOLERANCE, CROWN FORM, AND LIGHT AVAILABILITY

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Individual tree crown condition is the result of a combination of many factors including genetic traits, growing site characteristics, and past and present external stresses (e.g., drought, insect outbreaks, fire, etc.). Shade tolerance and the extent to which terminal buds control the length and orientation of lateral branches (epinastic control) are the two primary physiological characteristics affecting crown condition, while light availability is likely the most influential environmental factor. The general literature suggests that shade tolerant species maintain denser, wider, and longer crowns than shade intolerant trees, and that regardless of shade tolerance an increase in light availability allows all species to maintain larger, denser crowns.

Crown condition data collected by the U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis (FIA) Program were analyzed to clarify relationships between stand density variables, crown structure descriptors, and crown condition indicators. FIA measures a suite of crown condition indicators on its Phase 3 (or P3) forest inventory plots to aid the reporting of forest health conditions and trends in the United States. The crown condition indictors utilized were crown density, crown diameter, uncompacted live crown ratio, and crown light exposure. In addition, two stand density variables, number of live stems and total live basal area (trees $\geq$ 5.0 inches dbh), were calculated for each FIA P3 subplot. For the analyses, crown forms and shade tolerances were assigned to 34 hardwood species in 11 states in the Southern United States. Shade tolerances were divided into five groups: very intolerant, intolerant, intermediate, tolerant, and very tolerant. Crown form was partitioned into six classes: conical, columnar, oval, rounded, broad-spreading, and flat-topped. Spearman rank correlations (rho) among the crown condition indicators and stand density variables were calculated for all species combined. Analyses including crown diameter were completed with data collected in 1998 and 1999 (5,351 trees). All other analyses utilized data collected in 2000 and 2001 (4,931 trees).

The correlations among the crown condition indicators and stand density variables supported the suppositions in the general literature. Increased light availability was associated with larger and denser crowns regardless of shade tolerance. Spearman rank correlations between crown light exposure and crown diameter, live crown ratio, and crown density were 0.24, 0.10, and 0.15, respectively. Correlations between the number of live stems per subplot and crown diameter, live crown ratio, and crown density were -0.19, -0.26, and -0.08, respectively. Longer and wider crowns also were associated with increasing shade tolerance; however, denser crowns were not. Spearman rank correlations between shade tolerance and live crown ratio, crown diameter, and crown density were 0.10, 0.11, and -0.04, respectively.

The correlations also indicated that crown diameter and live crown ratio tended to increase as crown form shifted from conical to rounded to flat-topped (rho = 0.24 and 0.14, respectively). Crown density decreased as crown form shifted from conical to flat-topped (rho = -0.07).

Even though the correlations among the different variables were not exceptionally strong, they were generally consistent with expectations based on previous research. The variables considered here probably interact in ways that would provide further insight into the impact of physiological and environmental factors on tree crown condition; however, these simple relationships provide a starting point for understanding and modeling tree crown condition.

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