Structural Allometry of Three Locally-dominant Deciduous Tree Species in West Michigan

Joshua L. Stayman, Gary K. Greer (mentor), in association with Brendan May, Collin Fox, Nicole Foy, Noah Holkeboer, and Annie Eckman

Introduction.

Trees encounter a myriad of stressors that require them to change their body structure throughout their lives.[1]. In this study two models have emerged to investigate purpose.

- The Unified Stress Model (USM) which predicts branch stress to be optimum at 1:1 proportional to the mass is carries.
- The West-Brown-Enquist Model (WBEM) which predicts an optimum 1:1 ratio of mother radius to the sum of the daughter radii.

The goals of this study are to demonstrate that nondestructive methods can generate significant data and that such tools can be used to make species level inferences about structural geometry.

Methods.

- Photo imaging of 30+ individuals of each *Acer saccharum, Fagus grandifolia, and Quercus rubra* were analyzed using Image J. (figs. 1 and 2).
- Both USM and WEBM optimization occurs when Σ daughter radii = mother radii.
- A regression was done to generate a predicted and observed equation to compare mother and daughter attributes. ANCOVA was used to compare predicted and observed slopes and y – intercepts.

Figure 1. A whole tree photo of *Quercus rubra* (red oak).

Figure 2. A close-up image used with image J measurements highlighted.

Key Results & Conclusions.

1. all 3 species had observed slopes significantly different than predicted (1); (p=0.002, 0.001, 0.001), (slopes=0.95, 0.84, 0.90) for USM. WBEM observed slopes were statistically different than 1 for *Acer saccharum* and *Quercus rubra* (p<0.001). (Slopes=0.96, 1.02) (figure 3.).
2. *Quercus rubra's* observed USM slope of less than 1 (fig. 4) Is negatively allometric. This means that as the Red oak height increases the resources allocated to branching support is less optimized. Conversely Red oaks WBEM slope of 1.02 (figure 5.) is positively allometric. Meaning that it over optimizes for total mass support.

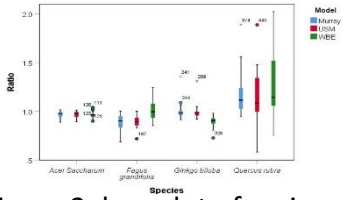


Figure 3. box plot of various USM and WBEM slopes for different species.

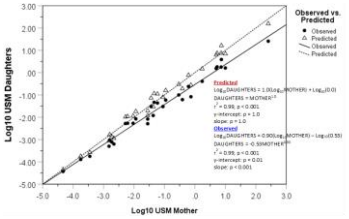
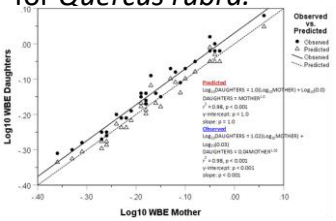


Figure 4. observed and predicted output for USM for *Quercus rubra.*



Red oak is more optimized for height and mass support than branching support. Novel imaging techniques proved to be able find statistical significance even after observed regressions were added to predicted isometric variables to reduce the likelihood of type 2 error. By investigating more allometric relationships of forests at larger scales, implications for using non-invasive data collection techniques could be used to better inform management decisions.

Literature cited available upon request