**PROJECT ID:** CAFS.22.99

**YEAR:**  **2** of 3

**PROJECT TITLE:** The effects of dominant tree height definition on loblolly pine (*Pinus taeda L.*) growth and yield model outputs in the southeast U.S.

**INVESTIGATOR(S): Bronson Bullock (UGA), Cristian Montes (UGA), Rachel Cook (NSCU), Temesgen Hailemariam (OSU), Eric Turnblom (UW), and Aaron Weiskittel (UMaine)**

|  |
| --- |
| **PROJECT DESCRIPTION:** The project will examine the implications derived from different dominant tree height definition usages on growth and yield models. This will also include highlighting any statistical significances between different dominant height definitions and silvicultural treatments (e.g., thinning), stand conditions (e.g., density), and physiographic regions. Additionally, the project will investigate how Net Present Value (NPV) estimations may vary based on dominant tree height definition. |
| **HYPOTHESES or OBJECTIVES:**The overall research objective is to: (1) Highlight the influences of the evaluated dominant tree height definitions on growth and yield model outputs, (2) Based on different stand characteristics and silvicultural treatments, analyze the changes on dominant tree height estimations with each evaluated definition, (3) Compare average dominant tree height estimations derived from a UAV (unmanned aerial vehicle) with LiDAR (Light Detection and Ranging) capability and traditional forest inventory height measurements, and (4) Examine the combined effects from tree height definition usage and stand characteristics on growth and yield model outputs of stand-level volume and economic returns. |
| **METHODS:** The study area will focus on loblolly pine plantations in the southeast region of the United States. The study will use data collected from permanent plots throughout the southeast, provided by the University of Georgia’s Plantation Management Research Cooperative (PMRC). Using descriptive statistics, Anderson-Darling test, two-way ANOVA analysis, model parameterization with maximum log-likelihood, and other various statistical approaches, the project will investigate the relationship between different dominant tree height definitions and growth and yield model outputs. Some examples of growth and yield model outputs at the stand-level that will be examined are basal area projection, site index estimation, stem mortality projection, and volume yield. The project will also statistically examine the significance of dominant height definitions based on silvicultural regimes (e.g., thinnings) and stand characteristics (e.g., density). Previous research by MacFarlane, Green, and Burkhart (2000), found strong evidence between initial planting density and dominant height, indicating that estimated site indices are confounded with trees per acre. In addition, Sharma, Burkhart, and Amateis (2002), showed that stand density influenced stem height, diameter at breast height (dbh), crown growth, and mortality. Different top height definitions were also assessed by Sharma, Amateis, and Burkhart (2001), and they found significant top height differences between the evaluated tree height definitions when different thinning regimes were implemented. Furthermore, this research will include a brief case study to demonstrate the variability between dominant tree height definition usage and NPV estimations using a PMRC growth and yield model. |
| **MAJOR FINDINGS:** * Average dominant tree height estimations varied between the evaluated dominant tree height definitions at the plot, treatment, and year since treatment levels. Across all plots, treatments, and year since treatment, the largest difference observed on average between the evaluated definitions that yielded the highest and lowest estimations for average dominant tree height was approximately 4.8 ± 0.1 feet. Also, the differences generally decreased as the residual basal area decreased with thinning treatments.
* When testing sample distributions at post treatment between all evaluated dominant tree height definitions using the Anderson-Darling test and an alpha level of 0.05, it was found that approximately 71 % of the time the null hypothesis (i.e., two dominant tree height samples come from the same continuous distribution) was rejected in unthinned treatment plots. However, as the basal area was reduced from thinning treatments, the percentage of rejecting the null hypothesis decreased. For example, when plots were thinned down to a residual basal area of 50 ft2 ac-1 in the thin only treatment plots, the null hypothesis was rejected 27 % of the time.
* The Pearson correlation coefficient between post- and pre-treatment for average dominant tree height slightly changed based on which dominant tree height definition was used. Overall, the average Pearson correlation coefficient across all definitions, plots, and treatments were approximately 0.9971, 0.9976, and 0.9910 for post thinning residual basal areas of 90 ft2 ac-1, 70 ft2 ac-1, and 50 ft2 ac-1, respectively.
* A Two-way ANOVA analysis highlighted that some dominant tree height definitions influenced whether treatment levels were significantly (i.e., < 0.05 alpha level) different from the control treatment with respect to their effect on average dominant tree height estimations. In addition, the significance pattern between the control and the other treatment levels varied through 6 years post treatment based on which definition was used.
* When deriving the Chapman-Richards ADA site index model, dominant tree height definition impacted the model’s performance. For example, the highest average RMSE across all plots for one definition was 3.7 feet, while the lowest average observed for another definition was 1.6 feet. Furthermore, when projecting site index to a reference age of 25 years from each measurement period, the average coefficient of variation amongst all dominant tree height definitions was 9.3 ± 0.07 %.
 |
| **DELIVERABLES:**  The deliverables will include a poster and oral presentations on the project’s progress at several regional professional meetings, graduate student thesis on the topic, publications in peer-reviewed literature, and summary reports for member companies. The results will help inform decisions around dominant tree height definition and impacts on growth and yield estimates in loblolly pine.  |
| **MEMBER COMPANY BENEFITS:** Benefits for member companies include a greater understanding of the impacts of dominant tree height definitions on growth and yield model outputs for loblolly pine plantations and, hopefully, designate the most appropriate dominant tree height definition to utilize. Since growth and yield models are used to predict future stand yields and economic returns, the project will also highlight any potential influence on financial investment decisions as a result of the variability between different dominant tree height definitions. |