Continuing Project

The effects of dominant tree height definition on loblolly pine growth and yield model outputs in the southeast U.S.

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Justification

- Site index is the average total height of dominant and codominant trees at a reference age

- There is no commonly accepted definition for dominant tree height in the southeast US

- Dominant height and site index are used as variables in Growth & Yield Models, thus having the potential to impact model outputs

Examples

Schumacher (1939): $$\ln V_2 = \beta_0 + \beta_1 \ln H_2 + \beta_2 \frac{1}{A_2} + \beta_3 \ln B_2 + \varepsilon$$

Zhao et al. (2007): $$N_2 = N_1 e^{\beta_1 S (A_2^{\beta_2} - A_1^{\beta_2})} + \varepsilon$$

- Growth and yield model outputs guide silvicultural management and timberland investment decisions

Objectives

1. Examine the differences in average dominant tree height estimations based on how dominant trees are defined

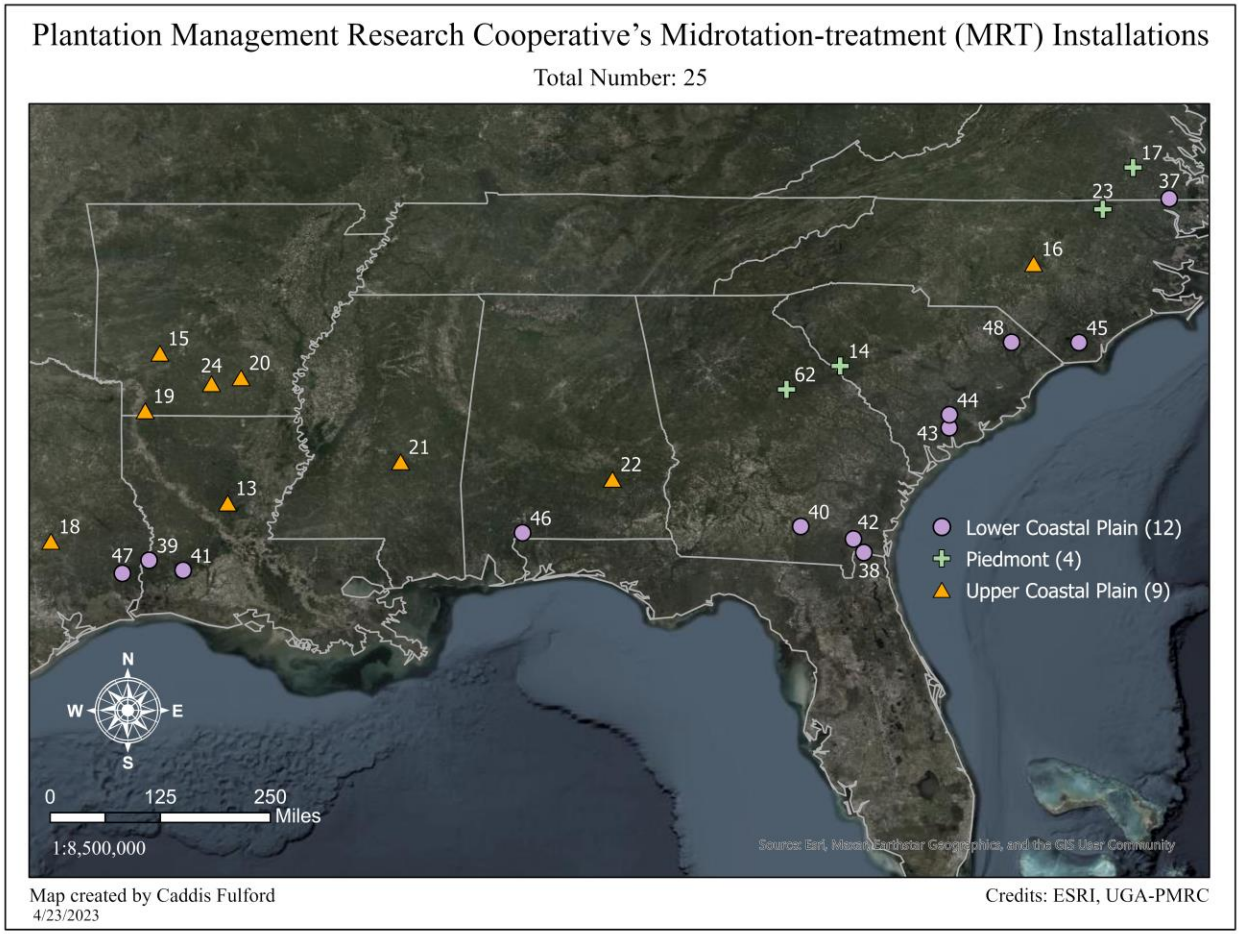
2. Investigate the relationship between silvicultural treatments, as well as stand characteristics, and the evaluated dominant tree height definitions

3. Compare average dominant tree height estimations derived from a UAV, with LiDAR capability, and traditional forest inventory height measurements (*Tentatively*)

4. Examine the influences and impacts from tree height definition usage on growth and yield model outputs of stand-level characteristics and economic returns

Methods

Study Sites & Data



- Species: ***Pinus taeda L.***
- 5 Treatments
  - Control
  - Thin-Only
  - T+Fertilization
  - T+Release
  - T+F+R
- Treatments completed
  - ages 12-20 years
- Treatment Plots
  - 125 in total
  - 0.75 ac in size
  - Remeasured every 2 years
- Current age of plots
  - ~25 years

Methods

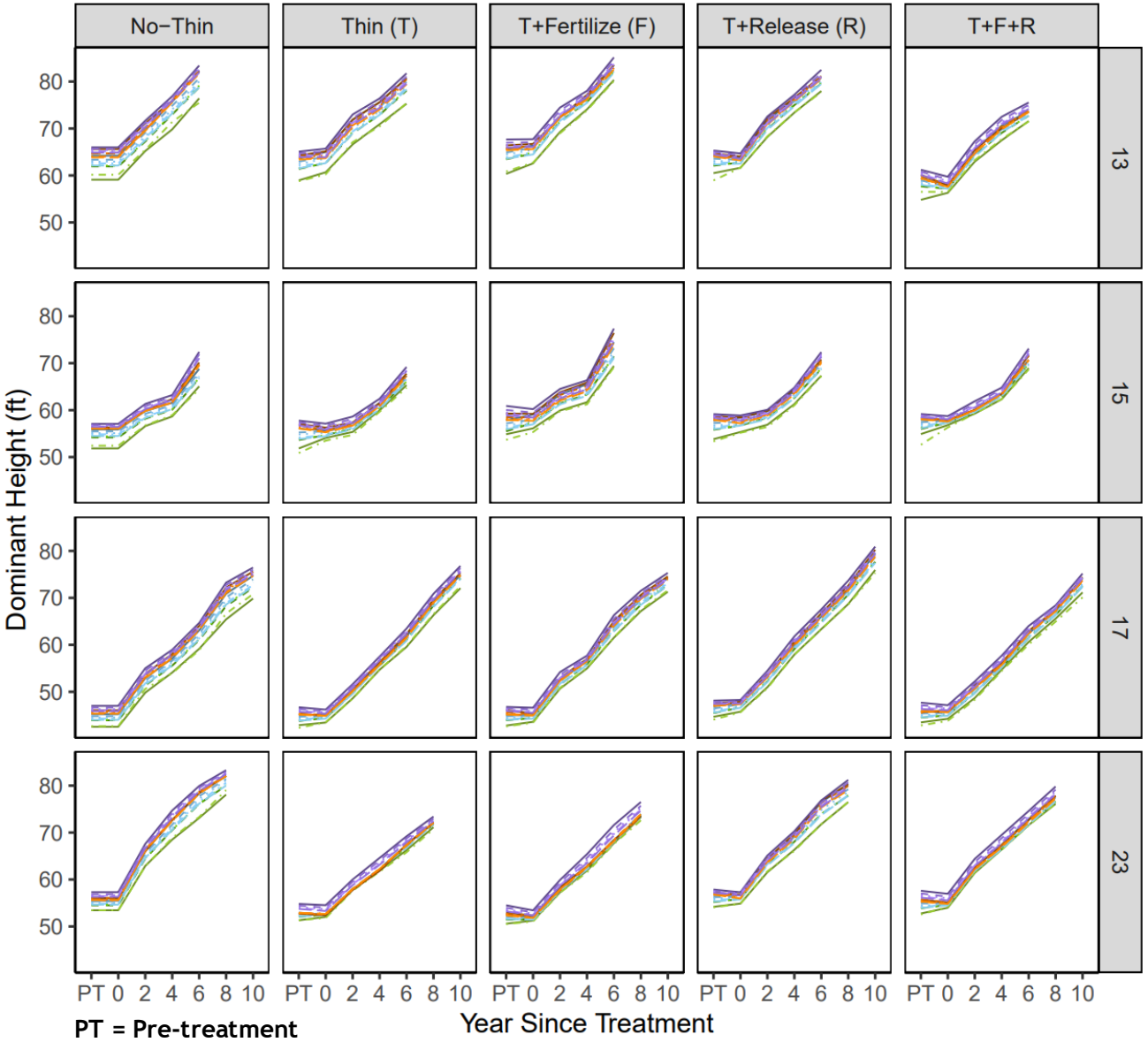
Dominant Tree Height Definitions Evaluated (19 in total)

Average height of trees…

- (**DC**) in the **dominant** and **codominant crown classes**
- (**MD**) with a diameter greater than the **mean diameter**
- (**QMD**) with a diameter greater than the **quadratic mean diameter**
- (**ST**) in the **sawtimber potential** class 0 (i.e., no defects)
- (**LD**P**) of the **10**, **20**, **30**, **40**, & **50% largest dbh** trees per ac
- (**LD****) of the **20**, **30**, **40**, **50**, & **60 largest dbh** trees per ac
- (**TT****) of the **20**, **30**, **40**, **50**, and **60 tallest trees** per ac

Major Findings

Average Dominant Tree Height Curve Example



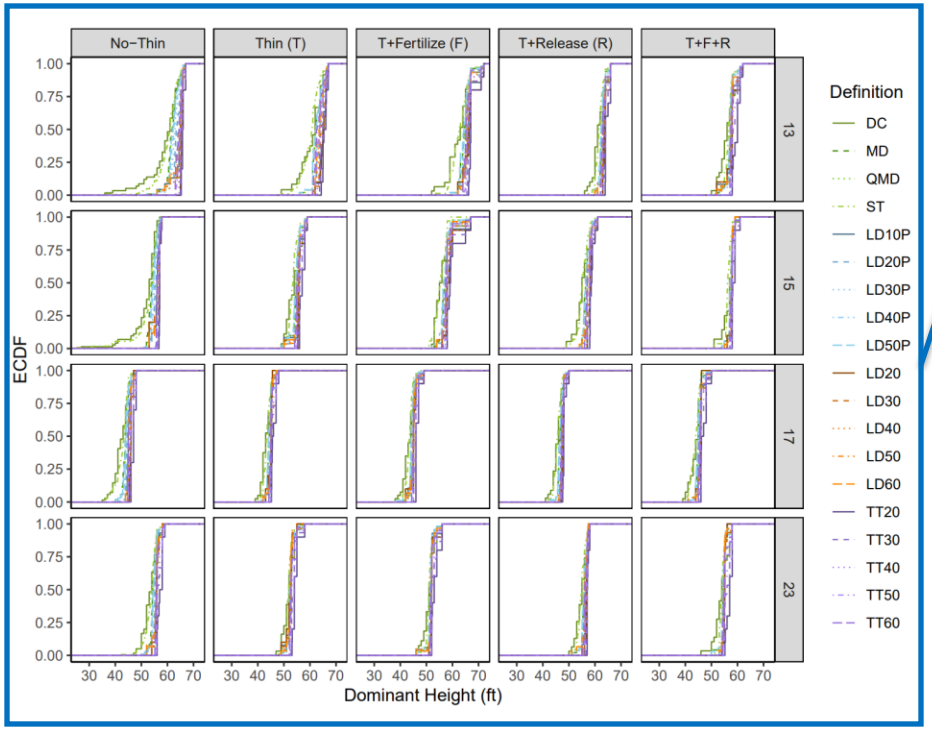
Installations 13, 15, 17, & 23 located in the Piedmont & Upper Coastal Plain regions

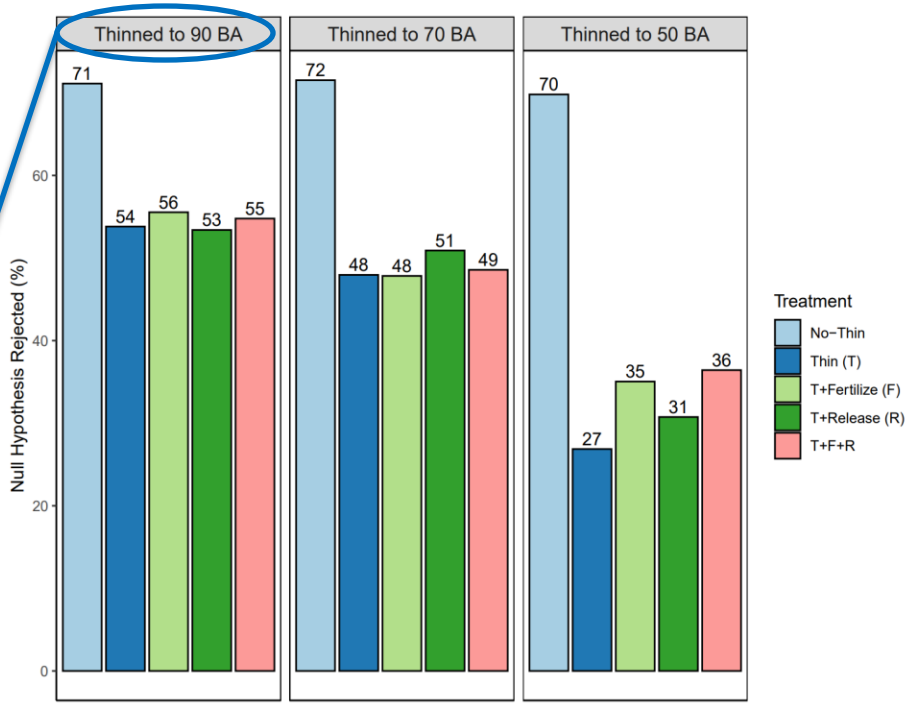
Thinning treatment = residual basal area of 90 ft^2 ac^{-1}

Center for Advanced Forestry Systems

Major Findings

Results for Anderson-Darling Distribution Test at Post Treatment





- Empirical cumulative distribution functions for installations located in the Piedmont & Upper Coastal Plain regions

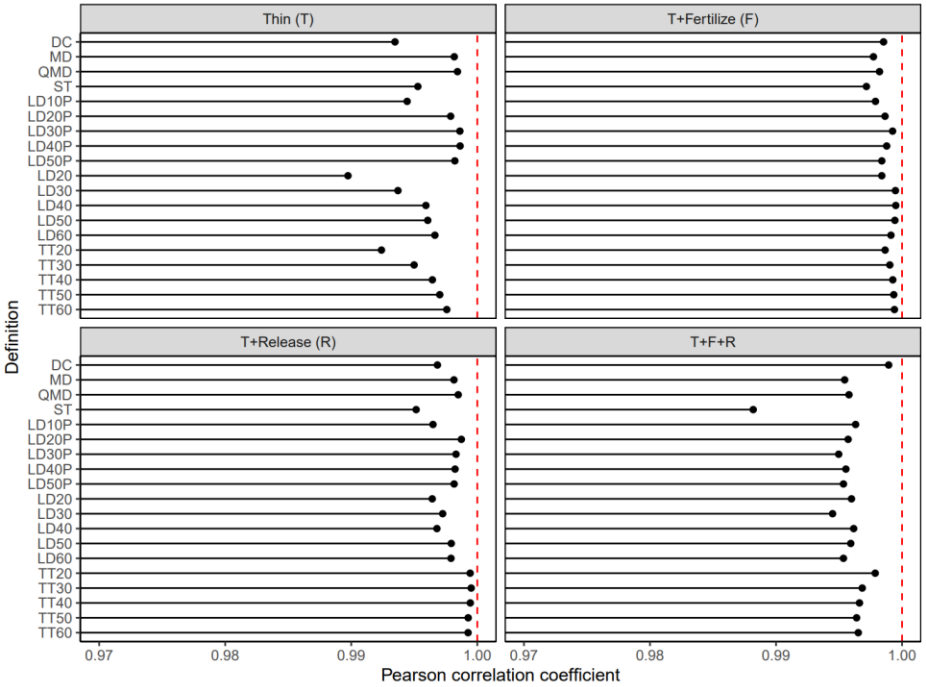
- **Null hypothesis (α = 0.05)**

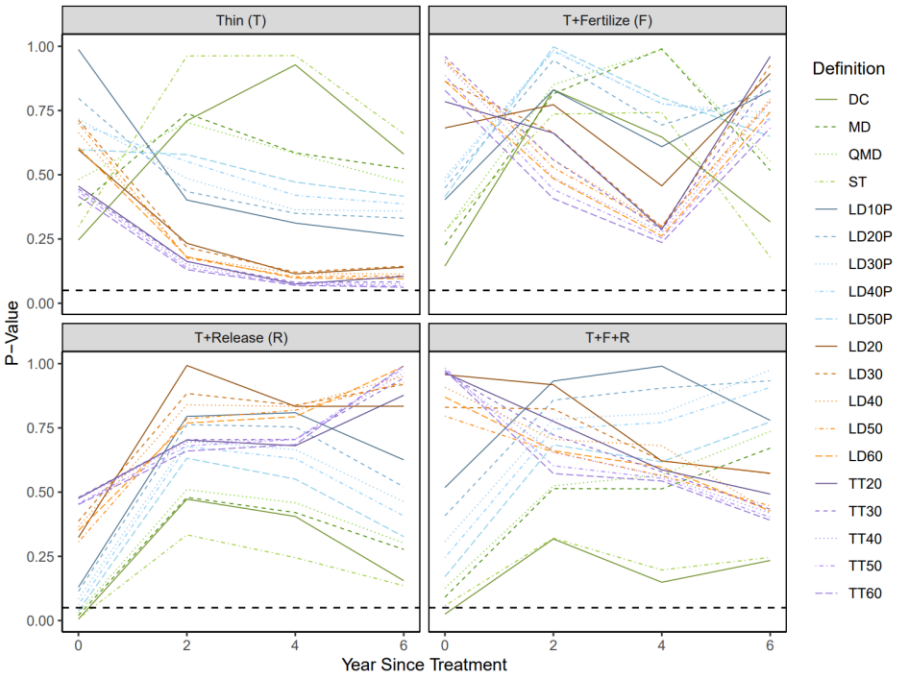
Two dominant tree height samples come from the same continuous distribution

Major Findings

Dominant Tree Height Definition's Sensitivity to Treatments

Thinnings = residual basal area of 90 ft^2 ac^{-1}

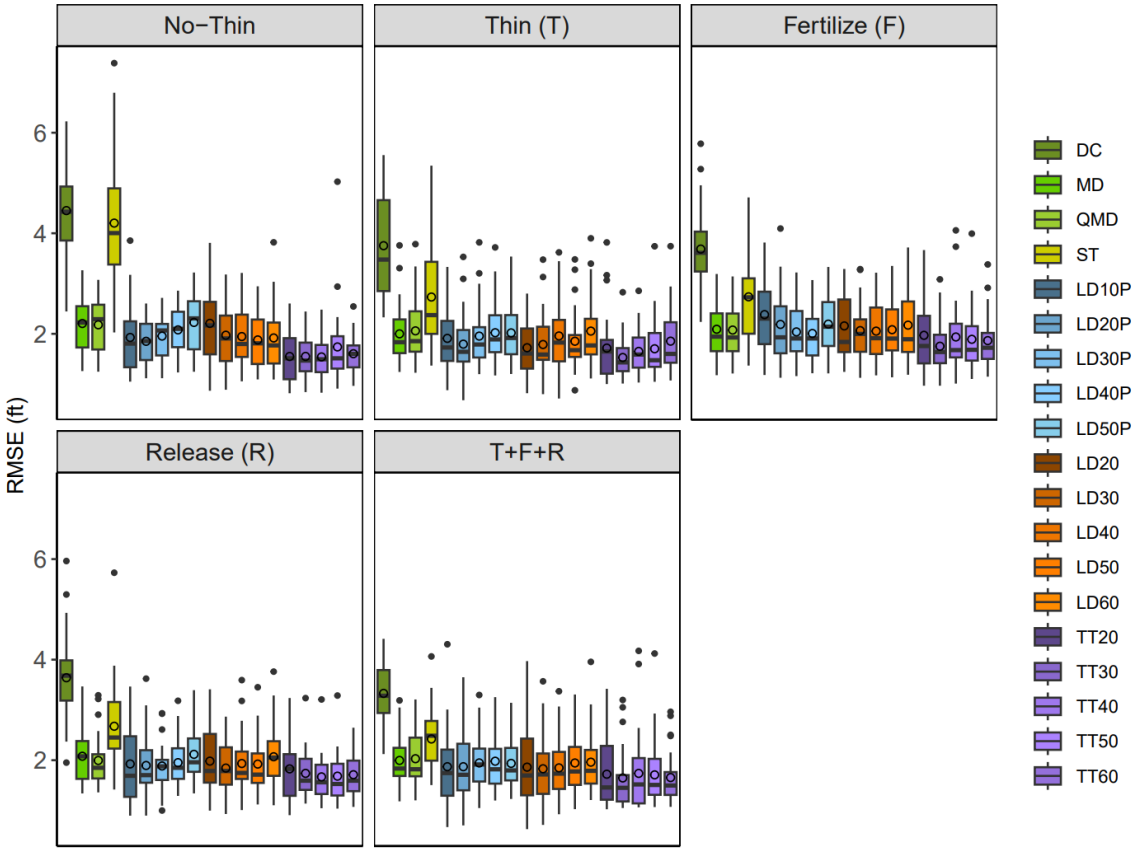




- Pearson correlation coefficient between post- & pre-treatment average dominant tree height estimation
- The p-values = how significantly different each treatment levels are from the control treatment with respect to their effect on the average dominant tree height

Major Findings

Chapman-Richards Site Index Model Performance



$$Ht = \beta_1(1 - e^{\beta_2 Age})^{\beta^3}$$

$$SI_{25} = Ht_n \frac{\left(1 - e^{\beta_2 Age_{25}}\right)^{\beta^3}}{(1 - e^{\beta_2 Age_n})}$$

- Maximum log-likelihood parameterization was used to fit the model
- Models were fit at the plot level
- New 2022/2023 data was collected, so models will be re-fit

Deliverables

- Poster and oral presentation on the project's progress at several regional professional meetings
- Graduate student thesis on the topic
- Publication(s) in peer-reviewed literature
- Summary reports for member companies

Company Benefits

- Greater understanding of the impacts of dominant height definitions on growth and yield model outputs in loblolly pine
- Identify the most appropriate dominant tree height definition from those considered over a range of stand conditions and silvicultural treatments
- Highlight any potential influence on forest management decisions and/or financial investment decisions as a result of the variability between different dominant tree height definitions

Summary

- Largest differences in avg. dominant tree height: 4.8 ± 0.1 feet
- Some results from the Anderson-Darling test:
  - Null hypothesis rejected 71% of the time in unthinned plots
  - Null hypothesis rejected 23% of the time in plots thinned to a BA of 50 $ft^2\ ac^{-1}$
- Average Pearson correlation coefficient between post- and pre-treatment for average dominant tree height: 0.995 ± 0.0003
- Through 6 years post treatment, the significance pattern between the control and the other treatment levels varied based on definition usage
- Chapman-Richards site index model's performance:
  - RMSE on average for DC was 3.7 feet
  - RMSE on average for LD40 was 1.9 feet
- Future investigation: the influences on Growth & Yield models