Benchmarking gains from planting genetically improved loblolly pine

Presenter: Melissa Shockey

Advisor: Dr. Bronson Bullock

PMRC
Plantation Management Research Cooperative
The University of Georgia

UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

CAFS

Objectives

- Evaluate the stand-level properties of enhanced genotypes across a range of genetic families with different levels of genetic homogeneity (HS, FS, Clones)
  - Diameter distributions
  - Height-diameter relationships
  - Variation
  - Volume

- Re-measurement data will be evaluated to see how the stands are developing over time

Introduction

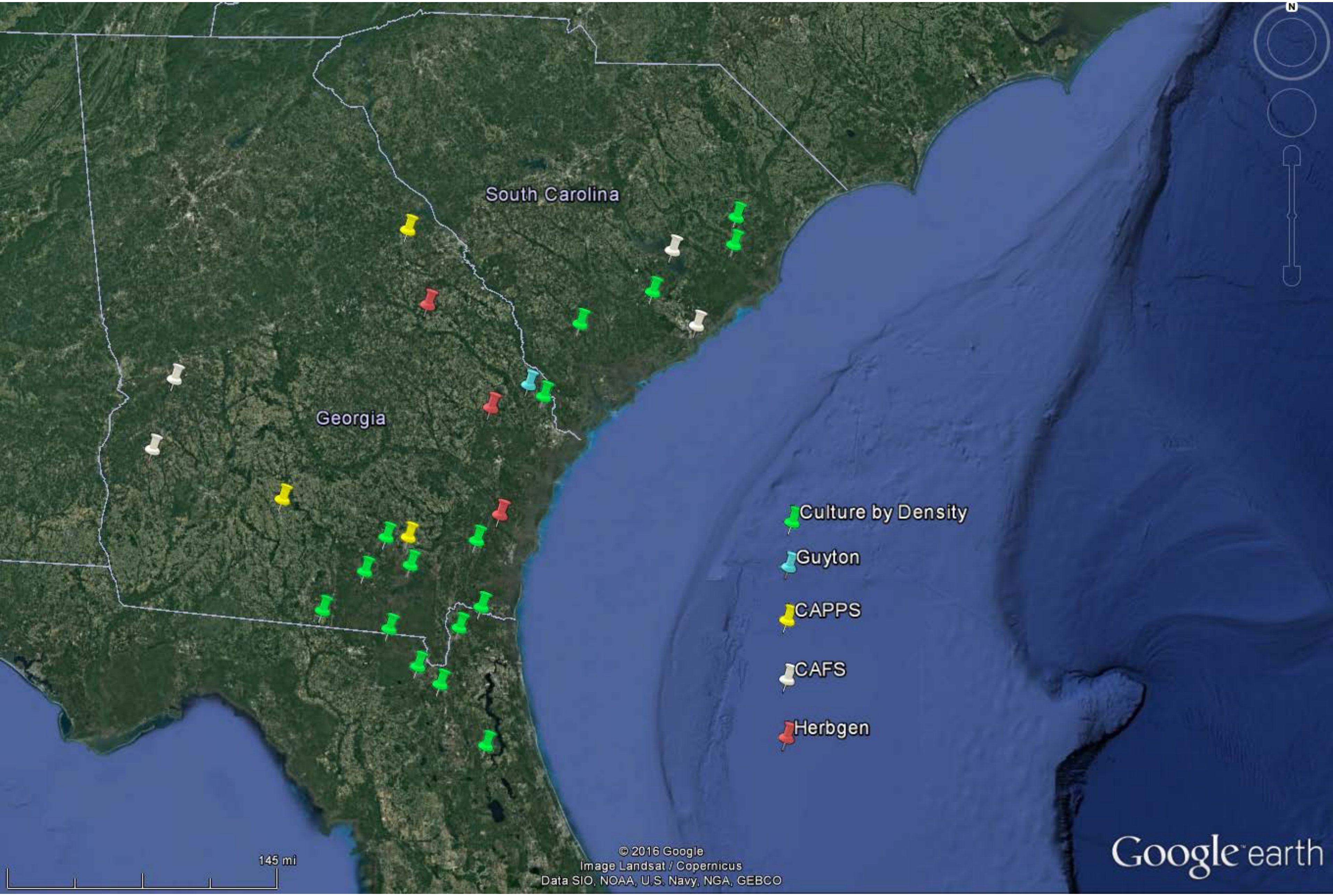
- Around 30 million acres of planted Loblolly pine in the SE
  - Vast majority are genetically improved
- Stands with different genetic backgrounds lead to different stand characteristics over time
- Need to develop benchmark for comparison to see if improvement gains are being met

Methods

- Data from five designed research trials containing single genotype block plot plantings across a range of enhanced genetics with multiple measurements over time will be used to assess changes in stand structure over time. (Pre-thin)
  - Physiographic regions represented from the southeast U.S.:
    - Piedmont
    - Lower Coastal Plain
    - Upper Coastal Plain
  - One commonly planted, well-tested, first-generation open-pollinated (OP) family was planted in all studies and will serve as the baseline for a comparison among genotypes.

Methods

- Datasets—PMRC
  - Elite Variety Block Planting Study
    - Est. 2007
  - Improved Planting Stock & Vegetation Control Study
    - Est. 1986-1987
  - Clonal Block Plot Installations
    - Installations 20 and 21: High-end genetics by density: Est. 2005
    - Installation 23: 2nd gen block plot study: Est. 2001
    - Installation 26: MCP vs. OP block plot study: Est. 2003
  - Coastal Plain Culture-by-Density Study
    - Est. 1995-1996
  - Consortium for Accelerated Pine Production Study (CAPPS)
    - Est. 1987


South Carolina
Georgia
Culture by Density
Guyton
CAPPS
CAFS
Herbgen
145 mi
© 2016 Google
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth

Data Attributes

- **Silviculture**
  - Herbgen
    - Herbicide
    - No Herbicide
  - CAPPS
    - Control
    - Fertilization
    - Herbicide
    - Fertilization / Herbicide
  - Culture/Density
    - Operational
    - Intensive
  - Guyton
    - Fertilization/ Herbicide
  - CAFS
    - Herbicide
    - No Herbicide

Data Attributes

- **Planting density**
  - Herbgen
    - 700-750
  - CAPPS
    - 680
  - Culture/Density
    - 300-1800
  - Guyton
    - 435-726
  - CAFS
    - 388-538

Data Attributes

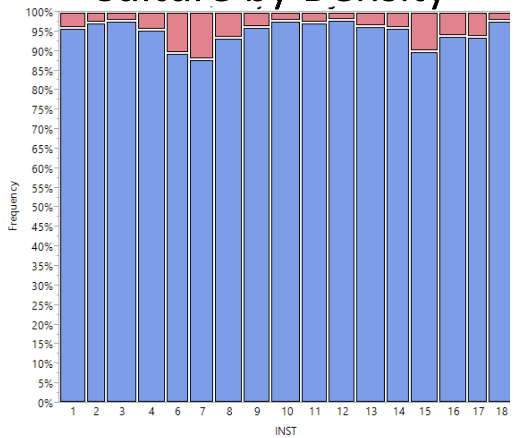
- **Site Index**
  - Herbgen
    - 60’s-70’s
  - CAPPS
    - 60’s-80’s
  - Culture/Density
    - 70’s-90’s
  - Guyton
    - 70’s
  - CAFS
    - 70’s-90’s

Methods

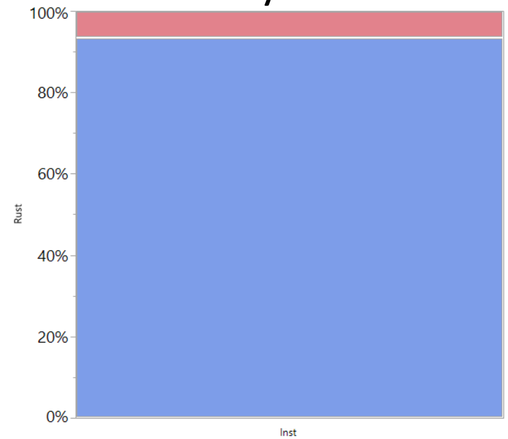
- Summary statistics
  - Average height and diameter per plot
  - Presence or absence of fusiform rust at earliest ages
  - Sawtimber quality scores evaluated at latest ages
  - Variation in measurements of height and diameter

Rust occurrence—earliest age available

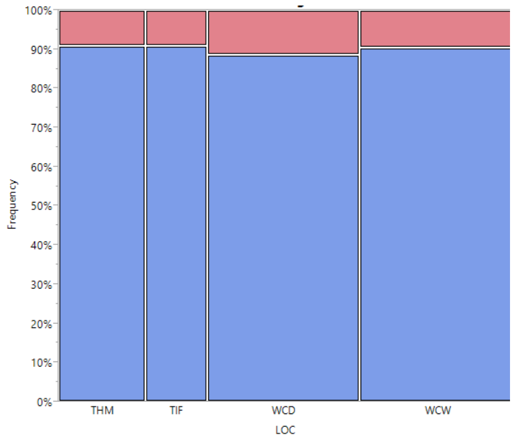
Culture by Density



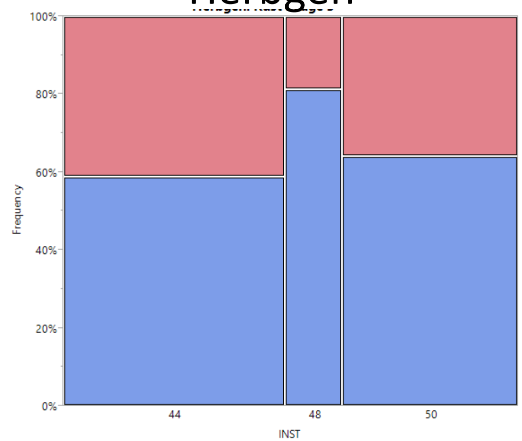
Guyton



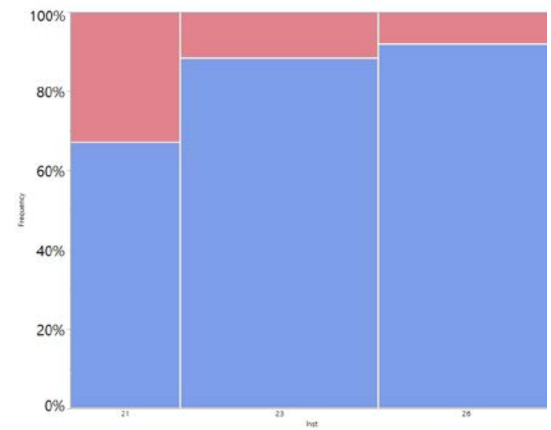
CAPPS



Herbgen

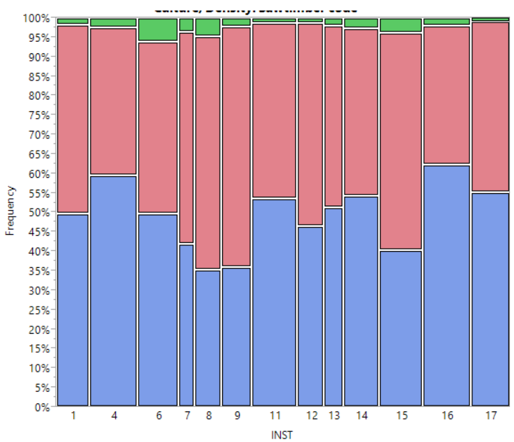


CAFS

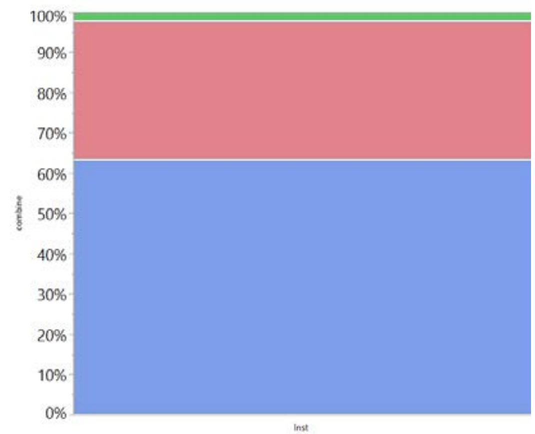


Sawtimber Scores—latest ages available

Culture by Density



Guyton



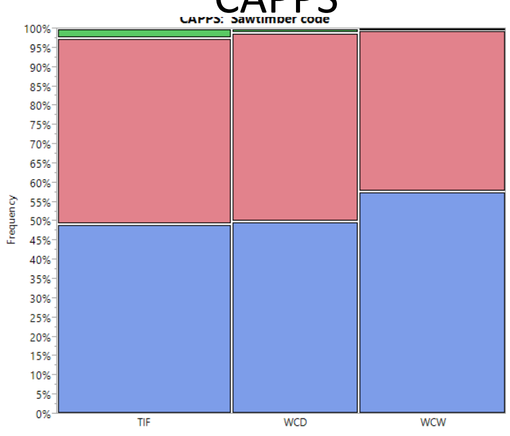
Sawtimber recode

No Defect

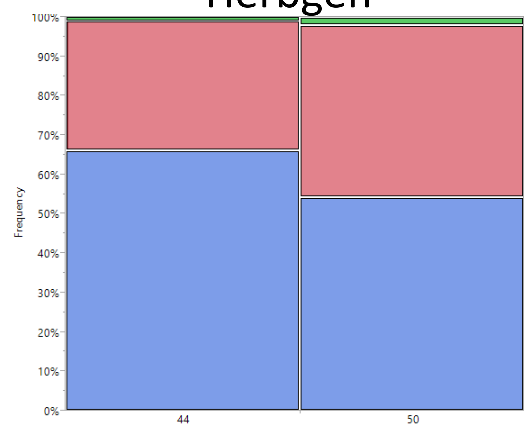
Defect in first log

Rust in first log

CAPPS

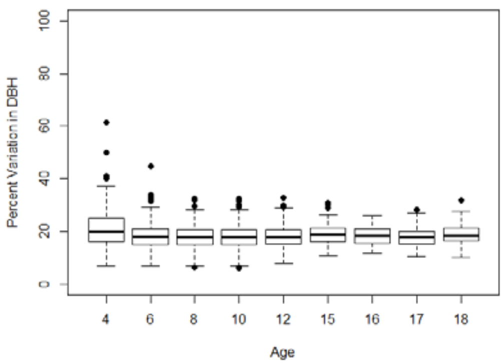


Herbgen

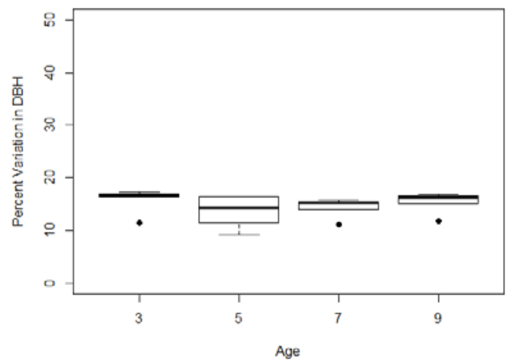


Coefficient of Variation (DBH)

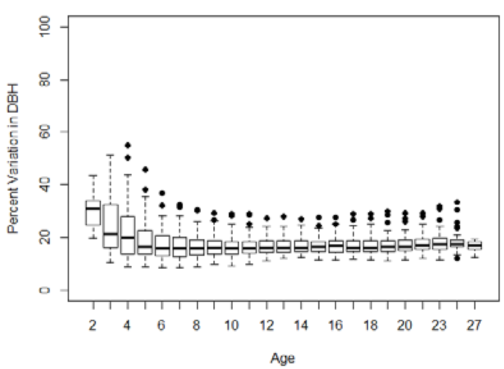
Culture by Density



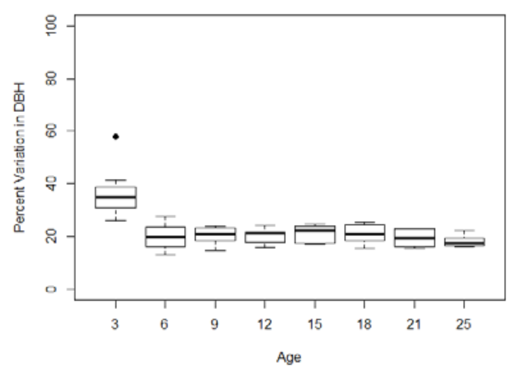
Guyton



CAPPS



Herbgen



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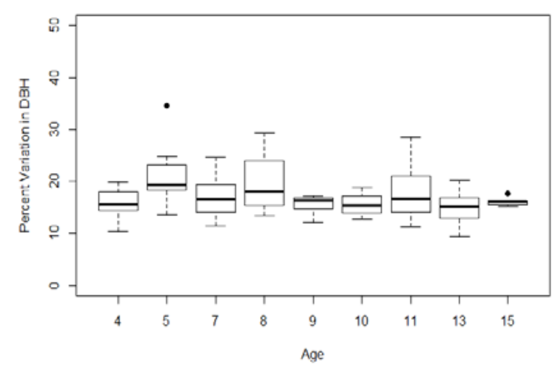
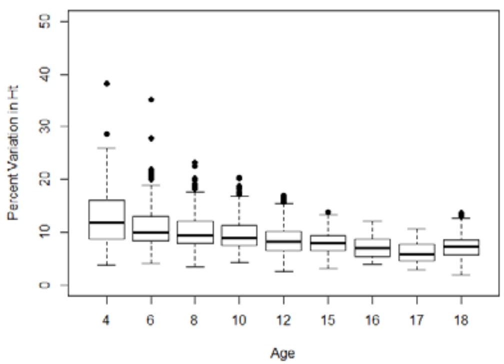
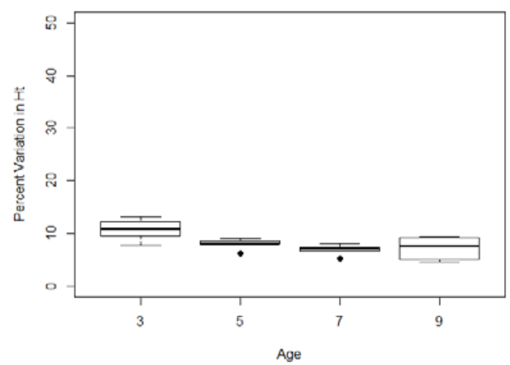


Coefficient of Variation (Height)

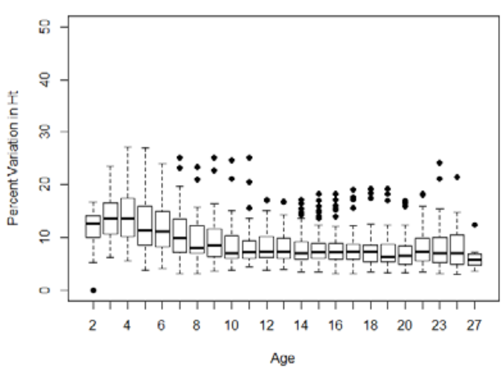
Culture by Density



Guyton



CAPPS



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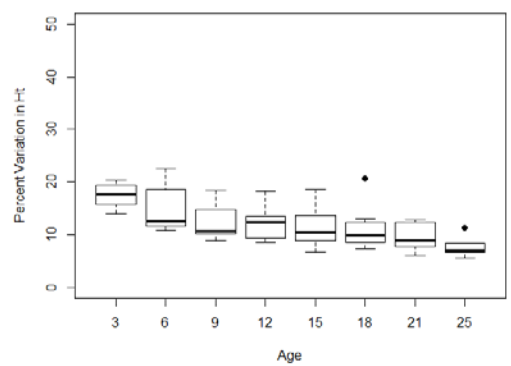

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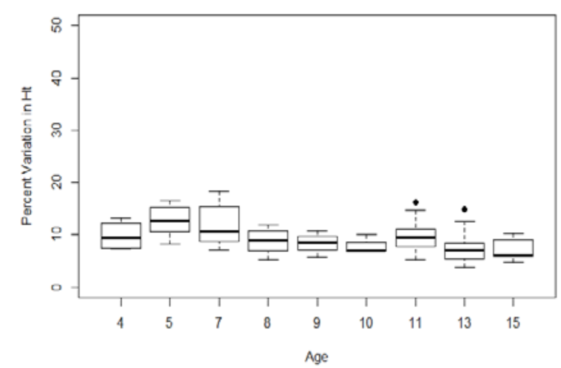
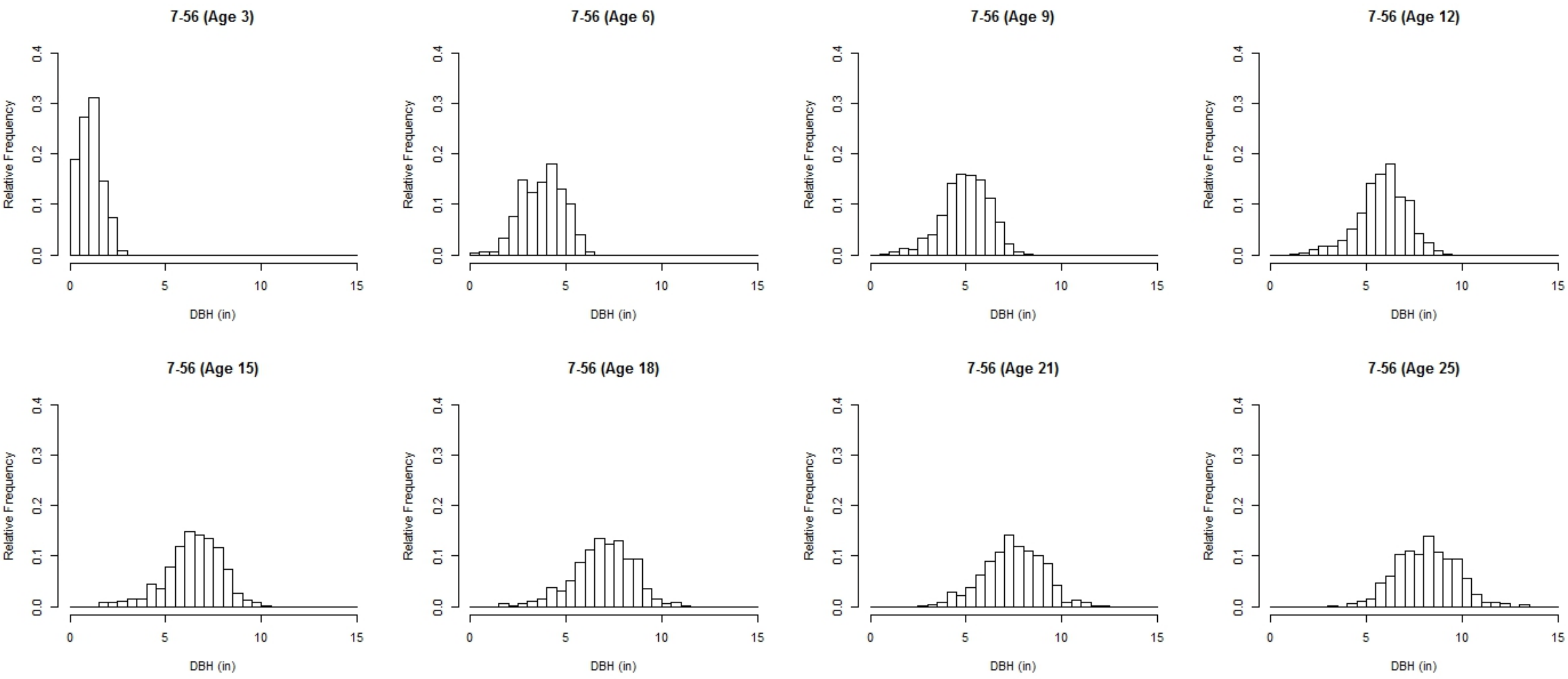
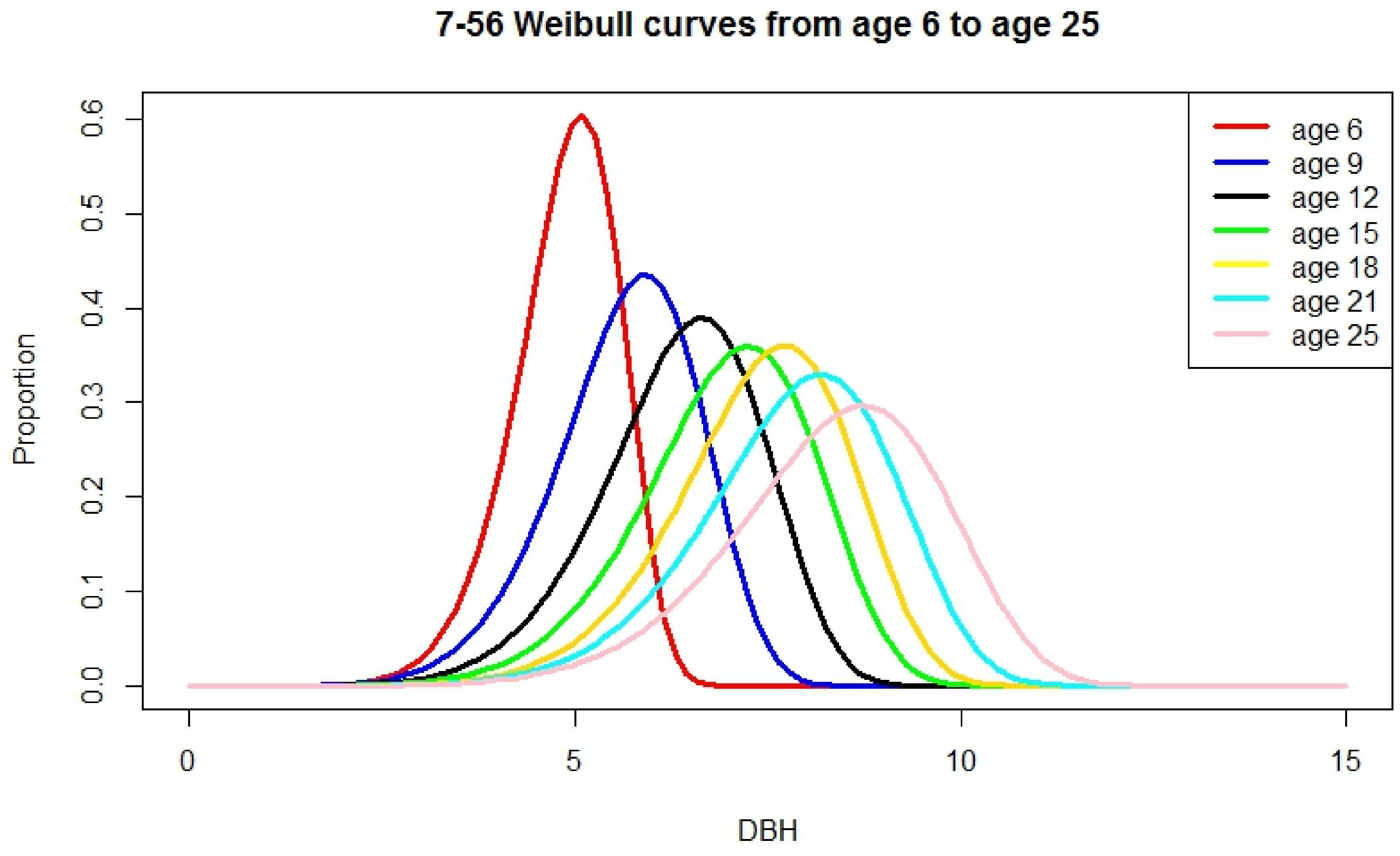


Diameter Distribution—Herbgen

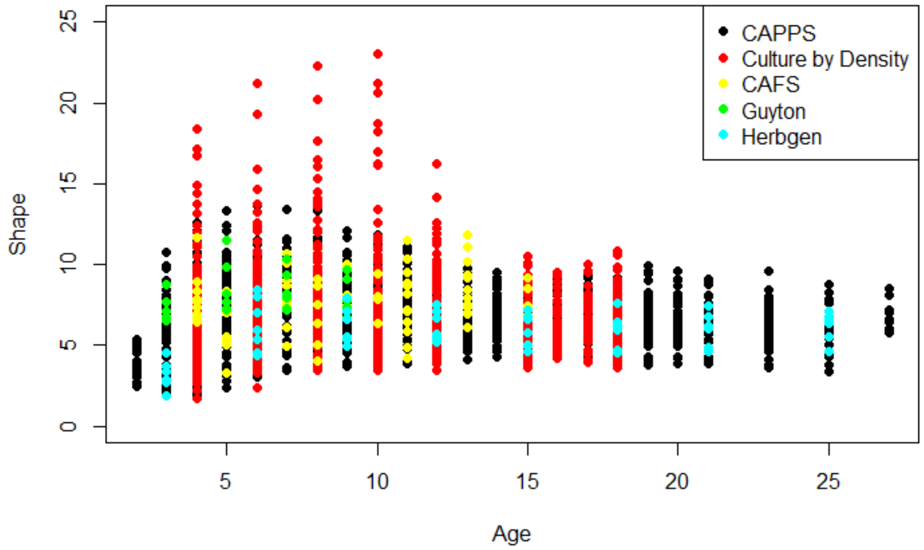


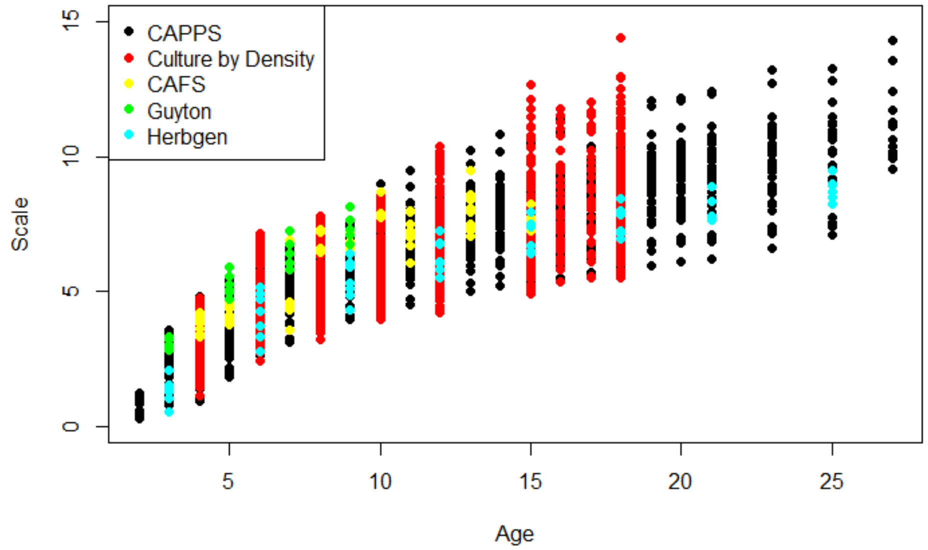
Weibull Distribution

- Flexible and can assume a variety of unimodal shapes making it useful to describe diameter distributions
  - 2 and 3 parameter distributions were fit to data
  - 2 parameter work is shown in the following slides
    - Kolmogorov-Smirnov test (KS test) indicated that the 2 parameter distribution was a good fit to the data


7-56 Weibull curves from age 6 to age 25
Proportion
0.0
0.1
0.2
0.3
0.4
0.5
0.6
DBH
0
5
10
15
age 6
age 9
age 12
age 15
age 18
age 21
age 25

Two Parameter Weibull-Distribution—DBH





Two Parameter Weibull-Distribution

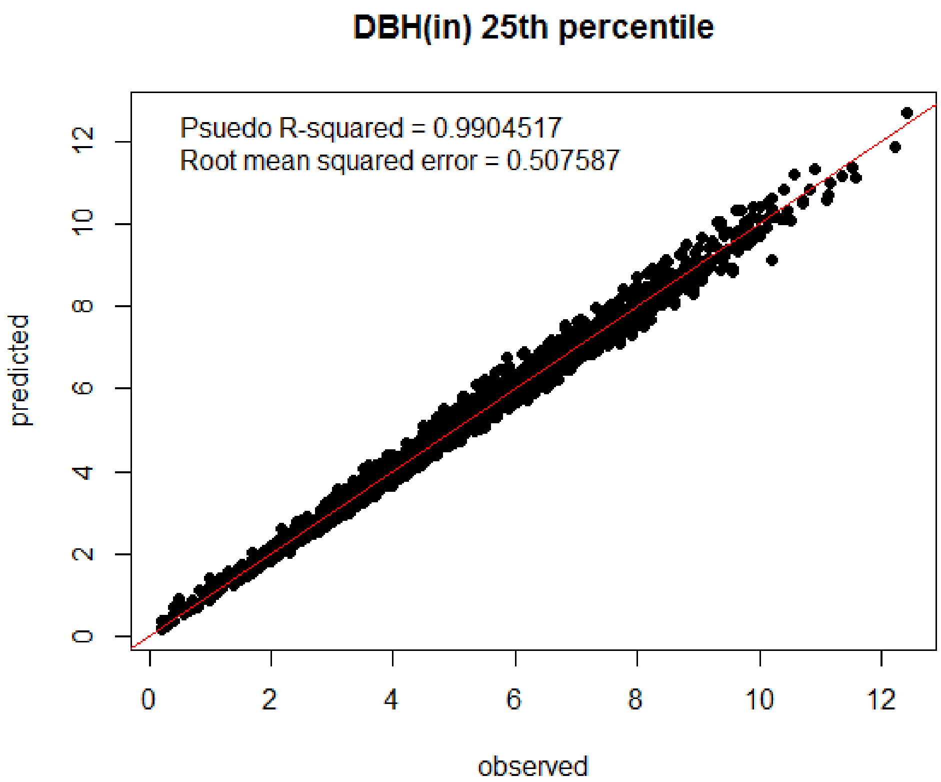
- Follow methods of Bullock and Burkhart, 2002 to model Weibull parameters

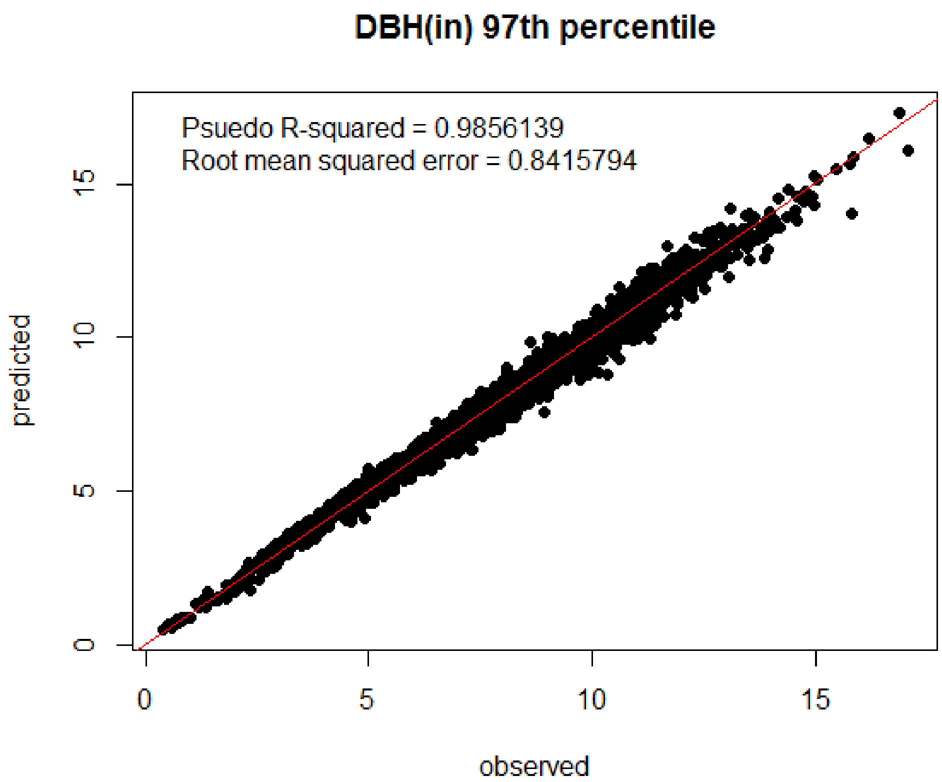
- Parameter recovery techniques were used to derive the shape and scale parameters.

    - The 25^{th} and 97^{th} percentiles of the empirical diameters were modeled as a function of: Age, basal area per hectare, and planting density

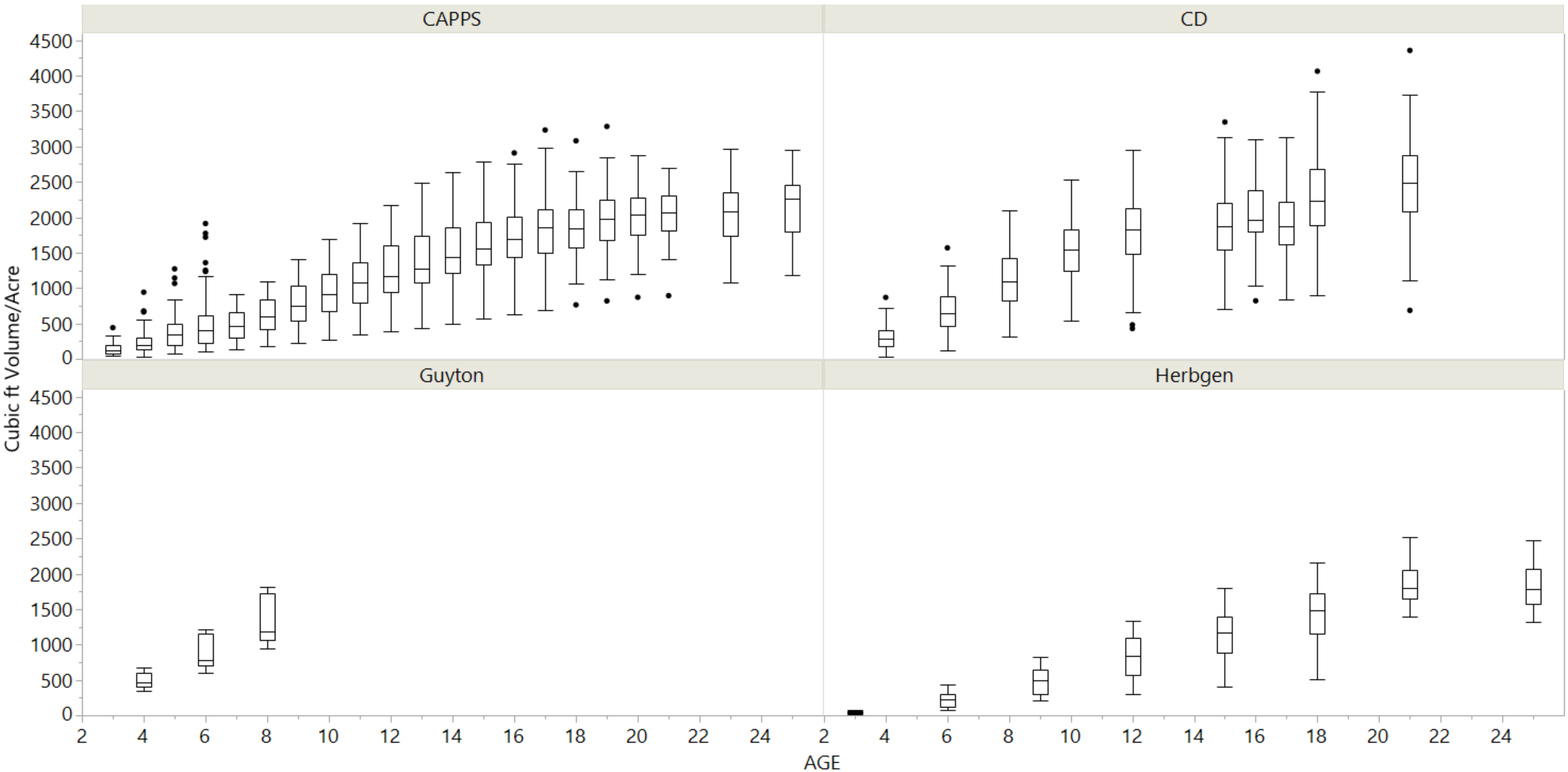
$$ln\left(\widehat{D}_i\right) = b_0 + b_1 ln\left(\frac{BA}{TPH}\right) + b_2 ln(A)$$

Diameter 25th and 97th percentiles





Volume



CAPPS
CD
Guyton
Herbgen
Cubic ft Volume/Acre
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2
4
6
8
10
12
14
16
18
20
22
24
AGE

Future Work

- Continue to evaluate stand characteristics of block plots across a variety of genotypes and genetic improvement over time.
  - Characteristics
    - Diameter distribution
    - Height-Diameter relationships
    - Volume
    - Rust occurrence
    - Sawtimber scores
      - Forking
  - Genetics
    - Half-Sib
    - Full-Sib
    - Clonal

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Questions?