Pine Plantations on Reclaimed Minelands:

Growth Rates Versus Unmined Lands

Luminant

Jeremy Priest,
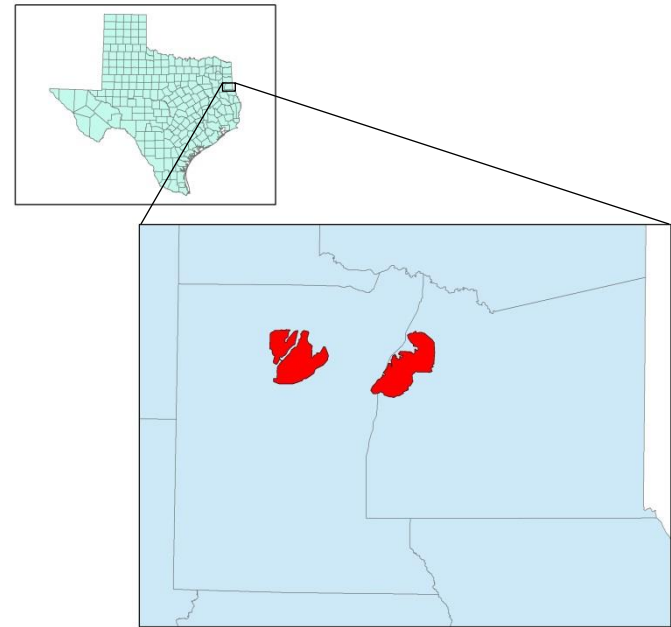**J. Stovall, D. Coble, B. Oswald, and H. Williams**
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Study Sites

- Research conducted on Luminant's Beckville and Oak Hill Mines located near Martin Lake in East Texas

- 48 study plots established at Beckville

- 24 study plots established at Oak Hill

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Reclamation Methods

- Both are surface mines producing lignite

- Strip-mining removes the overburden to allow access to the coal

- Replacement of the overburden results in a mixed spoil that will serve as soil substitute

- Beckville uses mixed overburden method

- Oak Hill is required to place 4 feet of previously removed oxidized material on the mixed overburden

- This is the oxidized material haul back method

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Beckville and Oak Hill Mines
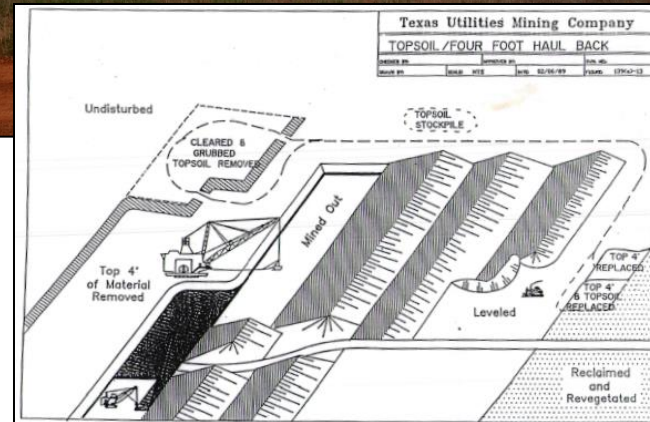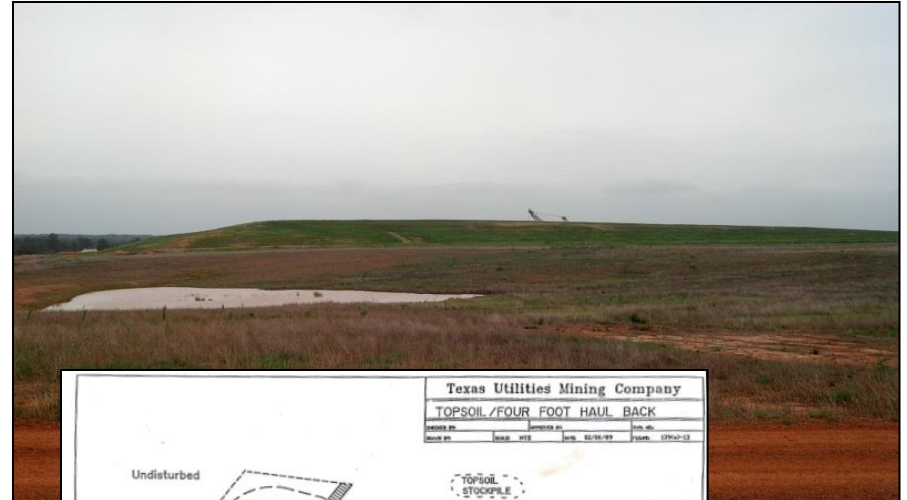
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Forestry Reclamation

- Vegetative reclamation through loblolly pine plantations follows topographic reclamation

- Reclamation is regulated by the Railroad Commission of Texas

- Requirements for returning land to a productive state include a fixed number of live trees per acre

- The minimum stocking is set by the Texas Forest Service

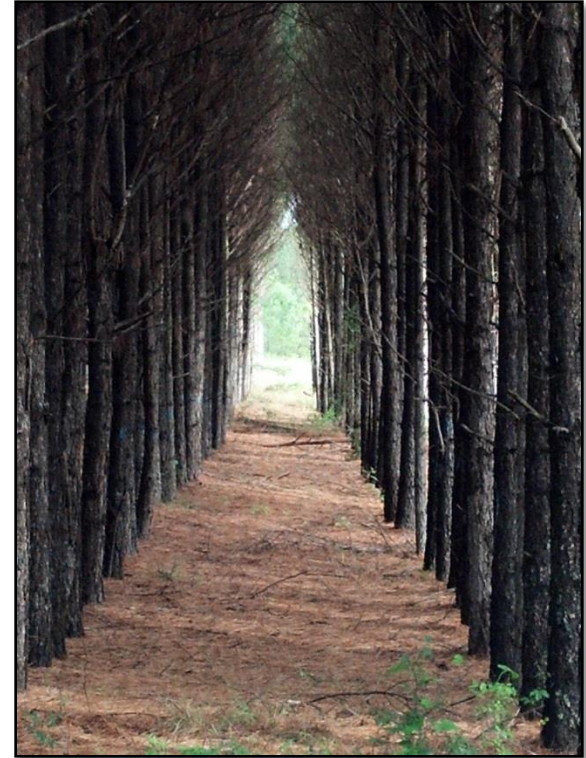- Productivity based on coverage not a growth metric

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Site Index

- Site index (SI) is a commonly applied technique to approximate the quality of a site to grow a specific species

- Loblolly pine (*Pinus taeda*) is one of the most commonly planted tree species in east Texas

- Site index curves have been well developed to estimate site index at any age, but not on reclaimed mines

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Methods: Tree Selection

- 1/4th acre study plots were established in stands of various ages during summer 2013

- Stand data collected at that time allowed selection of proper site index trees

- 1 of the 10 tallest trees in each study plot was selected randomly for destructive sampling

- Destructive sampling occurred from December 2013-January 2014

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Study Plots

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Methods: Destructive Sampling

- After felling, cross-section cookie samples were taken at specified heights

- The first cookie was at 1.5 feet above the ground line

- Then 4.5 feet and 4 foot increments

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Methods: Stem Analysis

- Annual rings were analyzed using the Carmean (1972) method

- Height-Age models were fit following the procedures of Coble and Lee (2006)

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Original Site Index

- Average site index prior to mining was estimated from the USGS Web Soil Survey

- Prior site index used base age 50 for natural stands

- We extrapolated to current site index methods by adding an estimated 10 feet to the height at age 25 to account for improved genetics and silviculture
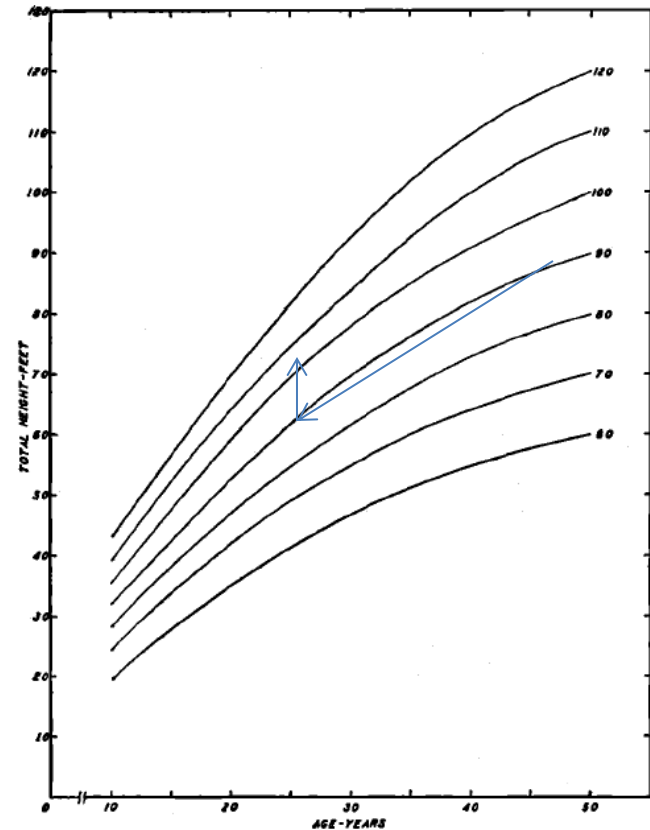

Fig. 4.—Adjusted site index curves for young loblolly pine stands.

Figure from Coyle and Schumacher 1953

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Original Site Index

- Using the +10 ft. method:
  - The average site index at BM was 70' at 25 yrs.
  - The average site index at OHM was 66' at 25 yrs.
- This seems to be an appropriate estimation as Coble and Lee found an average site index in east Texas of 71' at 25 yrs.

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Methods: Statistical Analysis

- Non-linear age-height models were tested for statistical significance using parameter estimates

- This was only possible using Coble and Lee's parameter estimates

- Parameters represent shape and asymptote

- 95% confidence intervals allow heights to be compared at a given age, but p-value cannot be calculated

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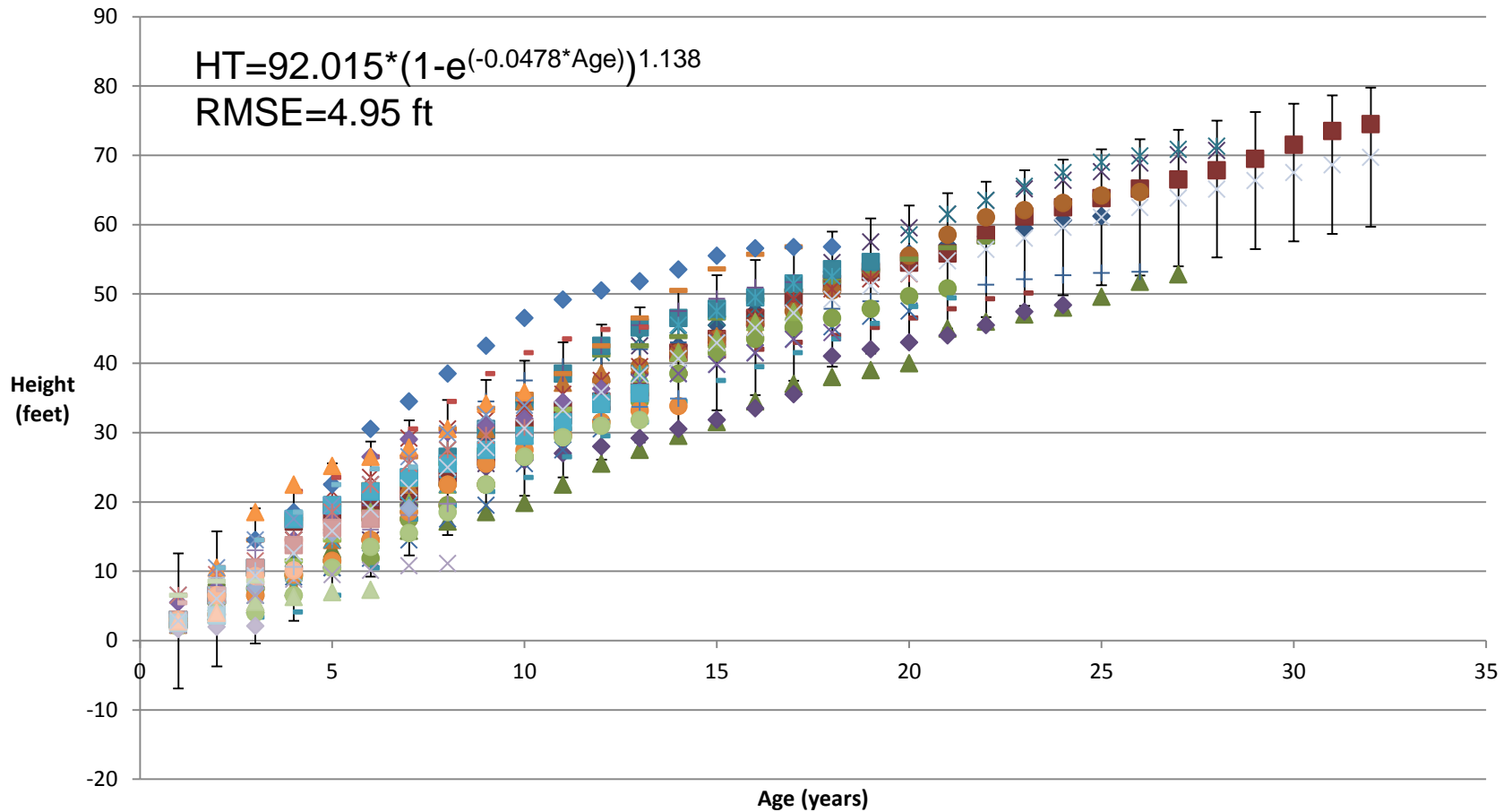*Stephen F. Austin State University*

Stem Analysis Data: Both Mines
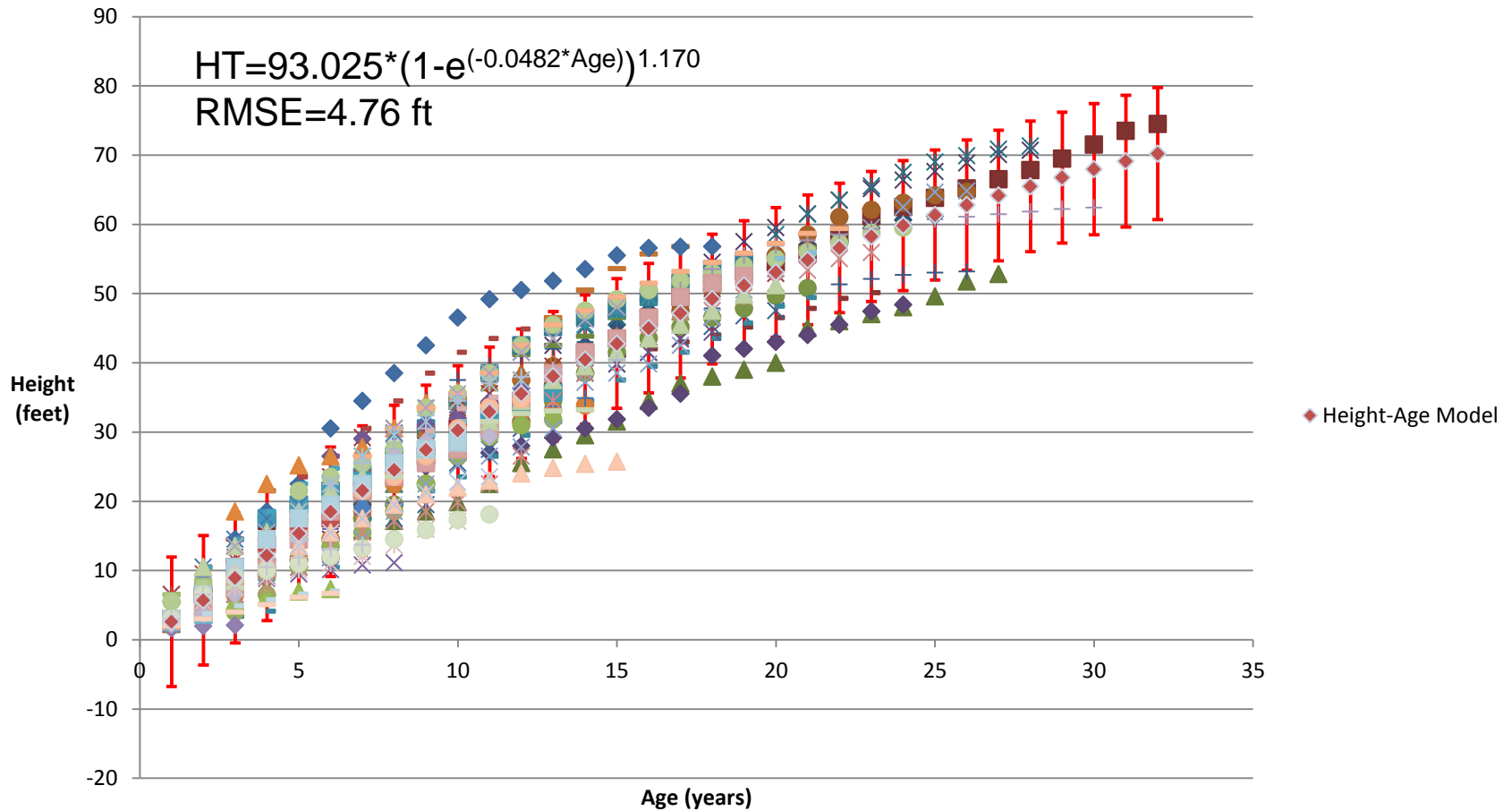
$HT = 93.025*(1-e^{(-0.0482*Age)})^{1.170}$
$RMSE = 4.76$ ft

Height (feet)

Age (years)

◆ Height-Age Model
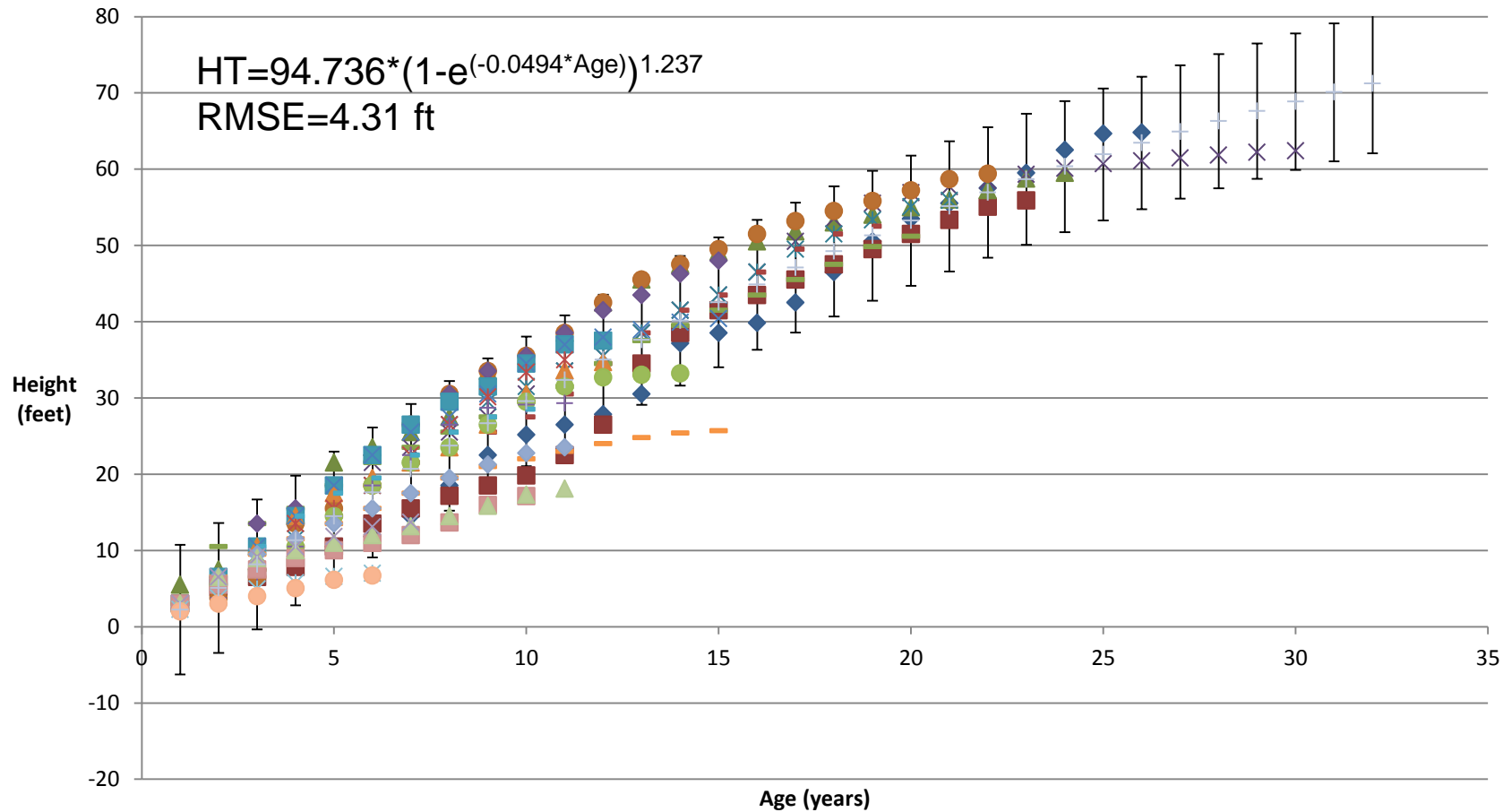
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Stem Analysis Data: Beckville

$$HT = 92.015 * (1-e^{(-0.0478*Age)})^{1.138}$$
$$RMSE = 4.95 \text{ ft}$$

Height (feet)

Age (years)

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Stem Analysis Data: Oak Hill

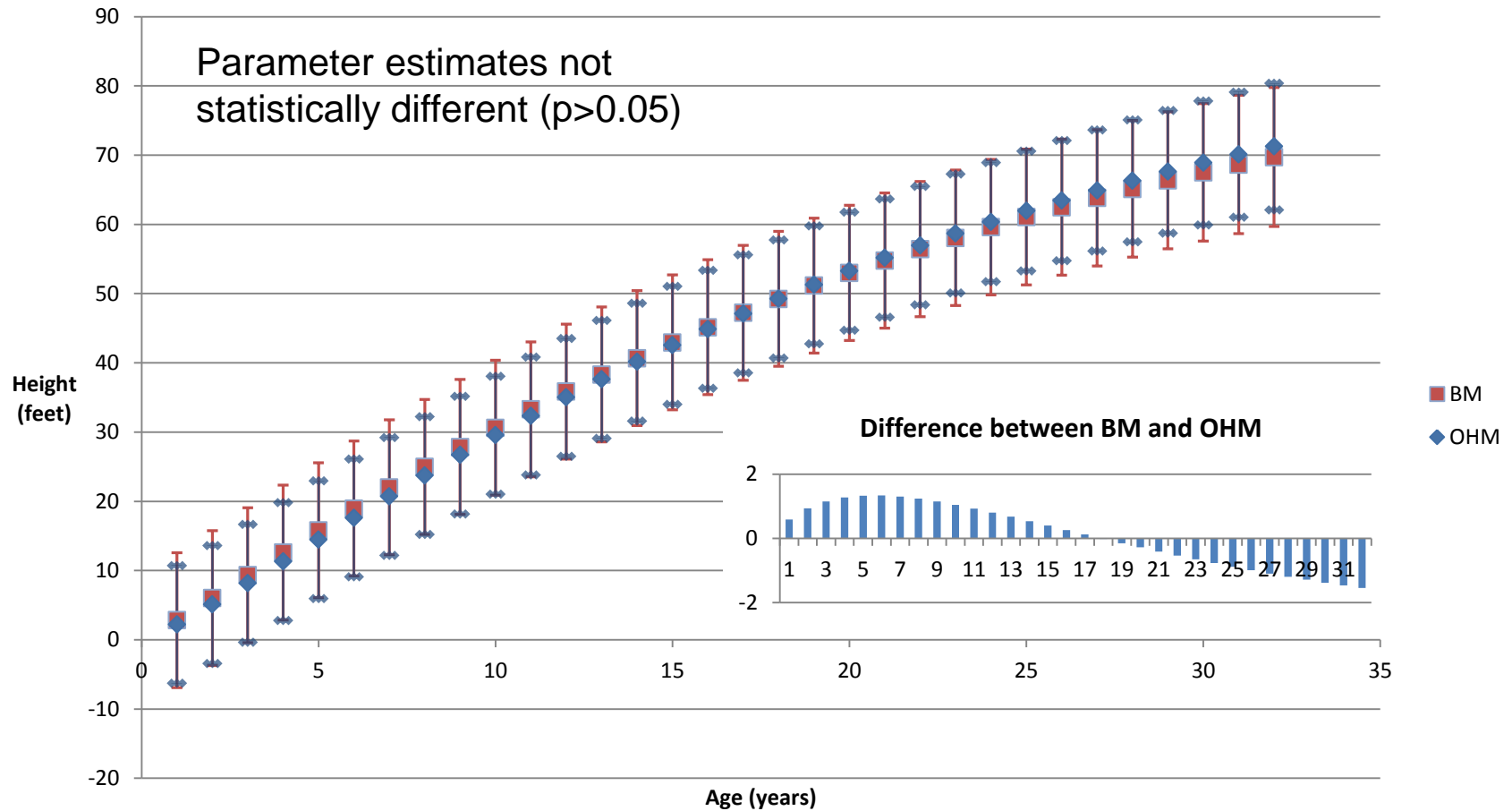$HT = 94.736*(1-e^{(-0.0494*Age)})^{1.237}$

$RMSE = 4.31$ ft

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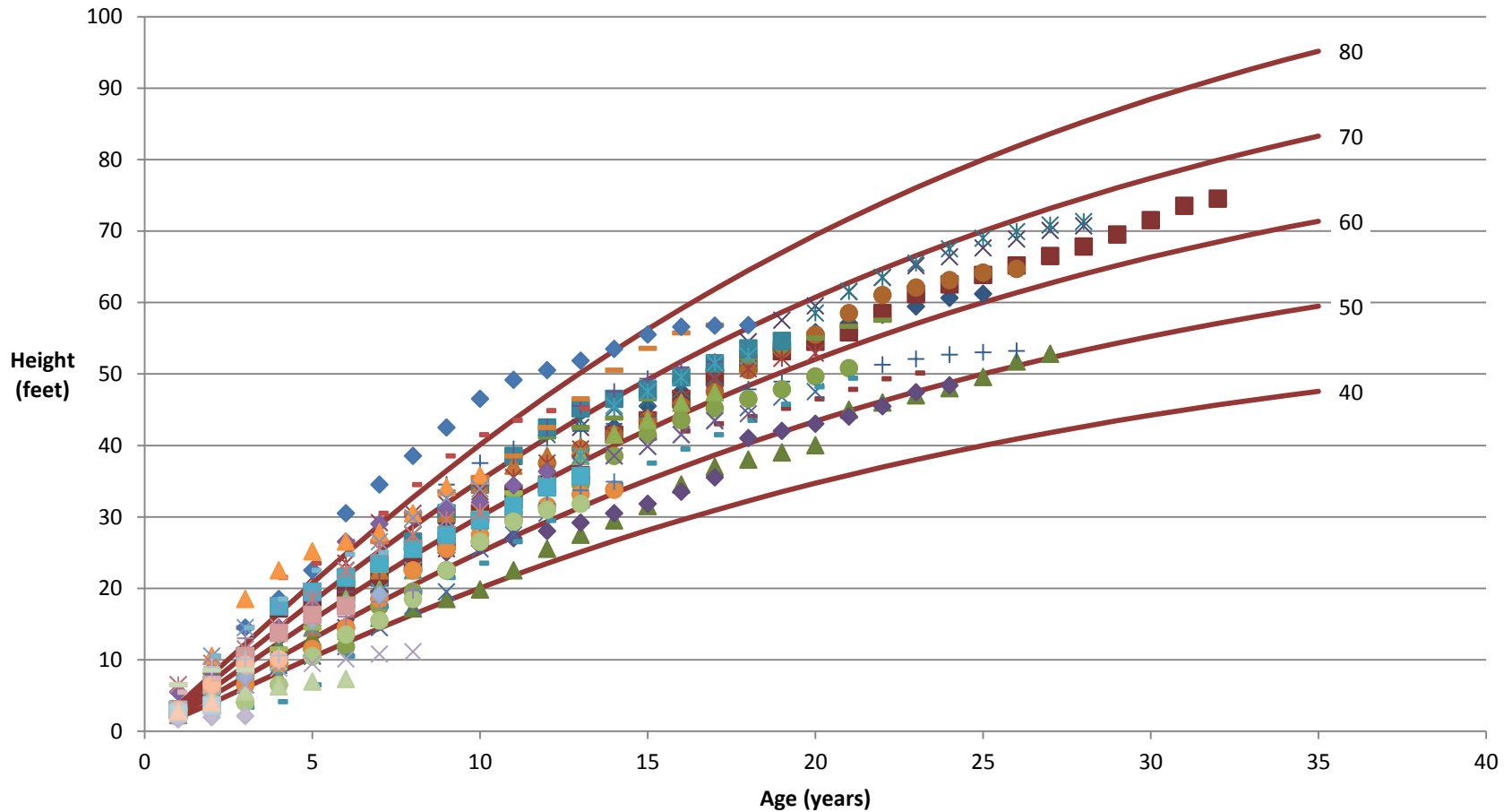*Stephen F. Austin State University*

By Reclamation Method

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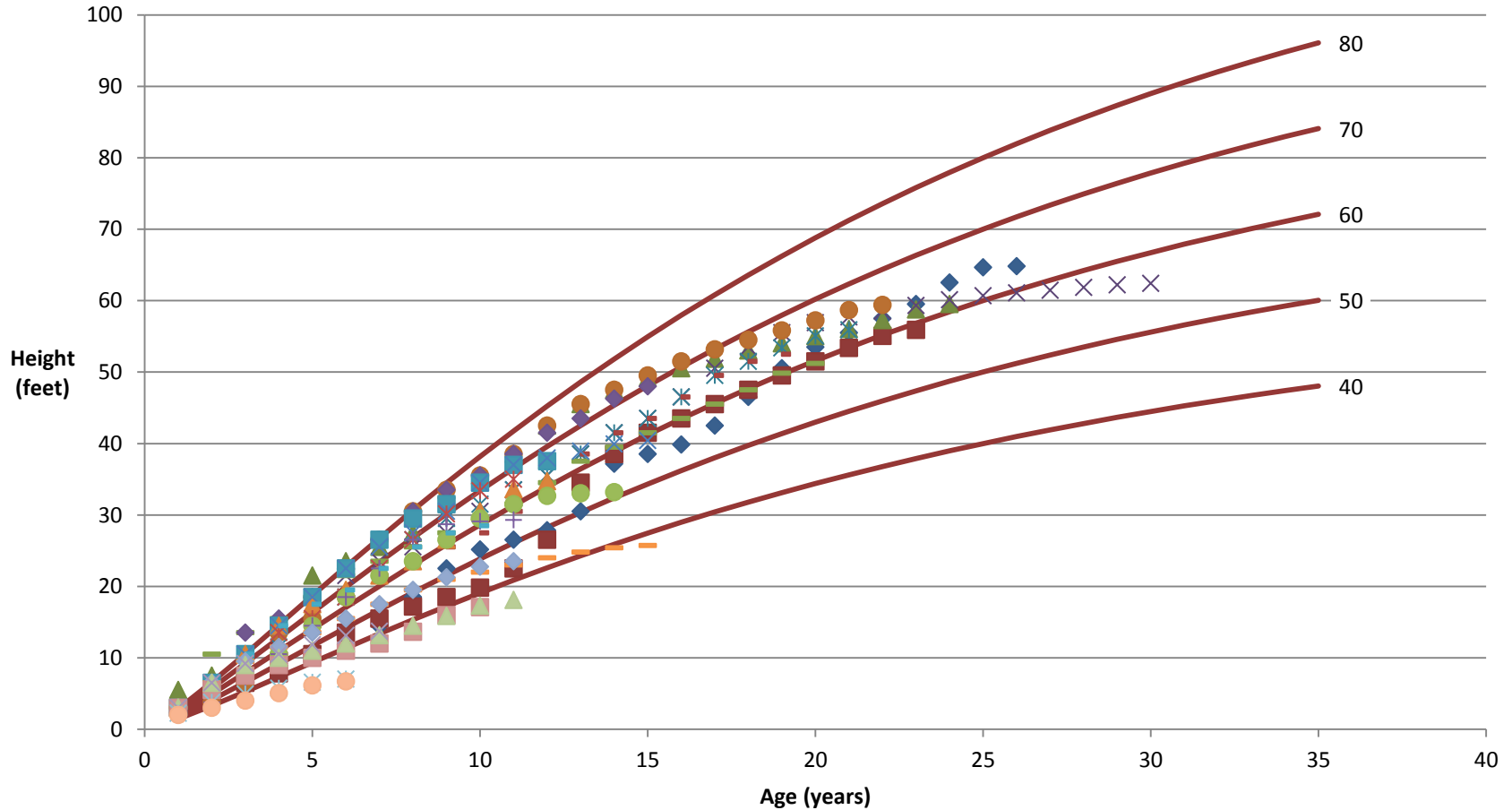*Stephen F. Austin State University*

Guide Curves for Beckville

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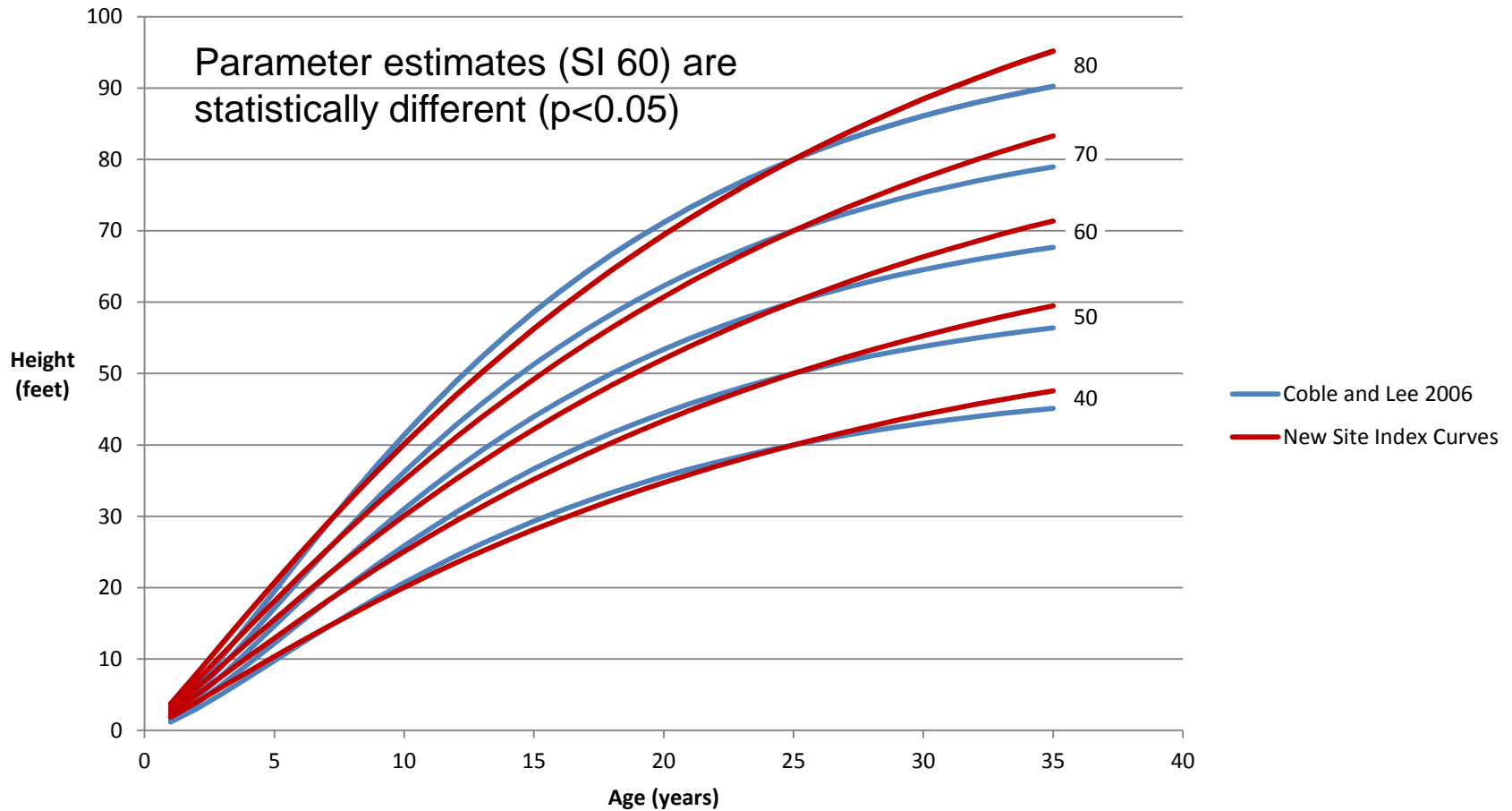*Stephen F. Austin State University*

Guide Curves for Oak Hill

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New Beckville Site Curves

Parameter estimates (SI 60) are statistically different (p<0.05)

Height (feet)

Age (years)

Coble and Lee 2006
New Site Index Curves

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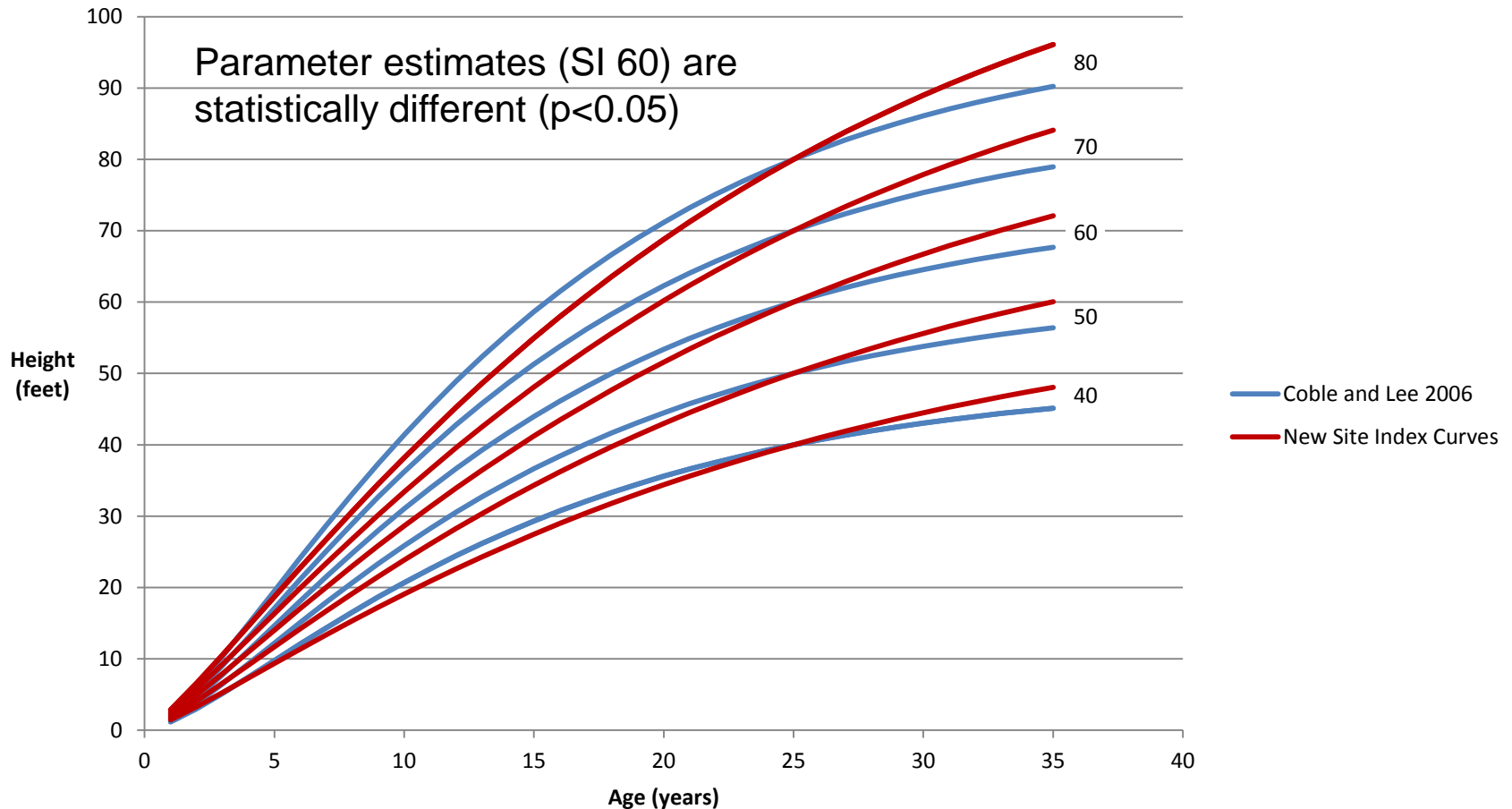*Stephen F. Austin State University*

New Beckville Site Curves

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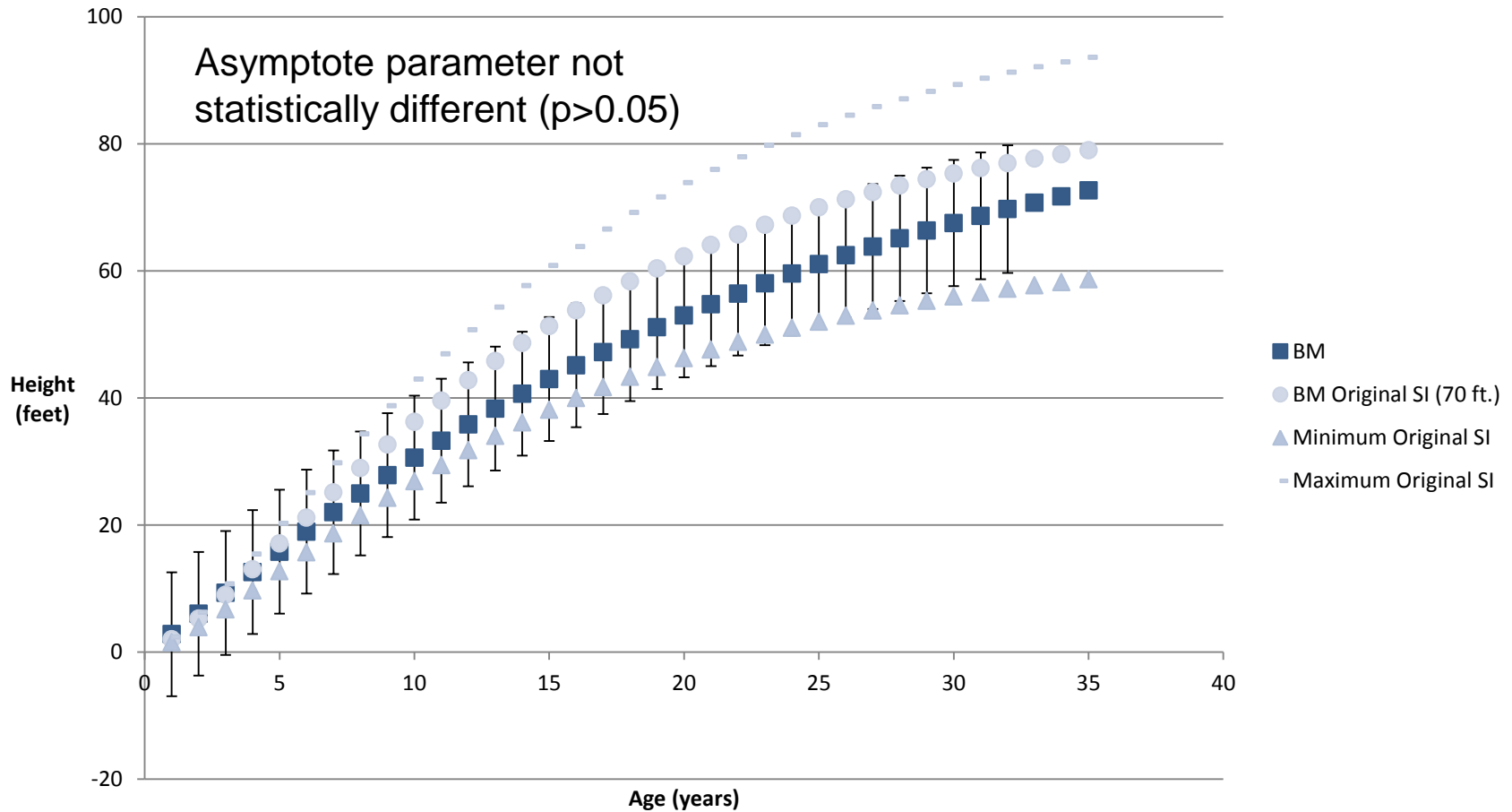*Stephen F. Austin State University*

New Oak Hill Site Curves

Parameter estimates (SI 60) are statistically different (p<0.05)

Legend:
- Coble and Lee 2006
- New Site Index Curves

Y-axis: Height (feet)
X-axis: Age (years)

Curve labels: 80, 70, 60, 50, 40

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Beckville Comparison to Original

Asymptote parameter not statistically different (p>0.05)

Height (feet)

Age (years)

BM

BM Original SI (70 ft.)

Minimum Original SI

Maximum Original SI

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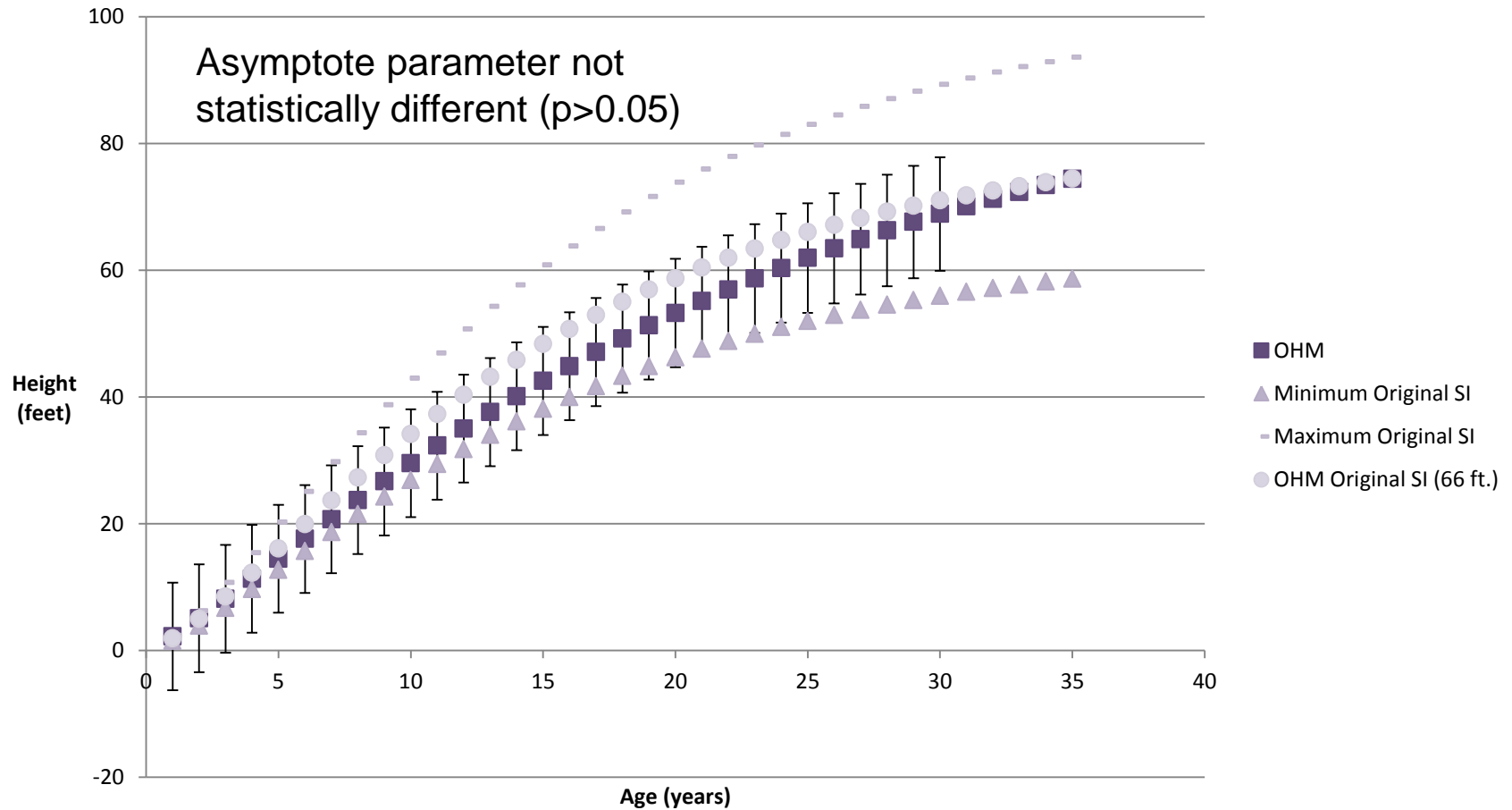*Arthur Temple College of Forestry and Agriculture*
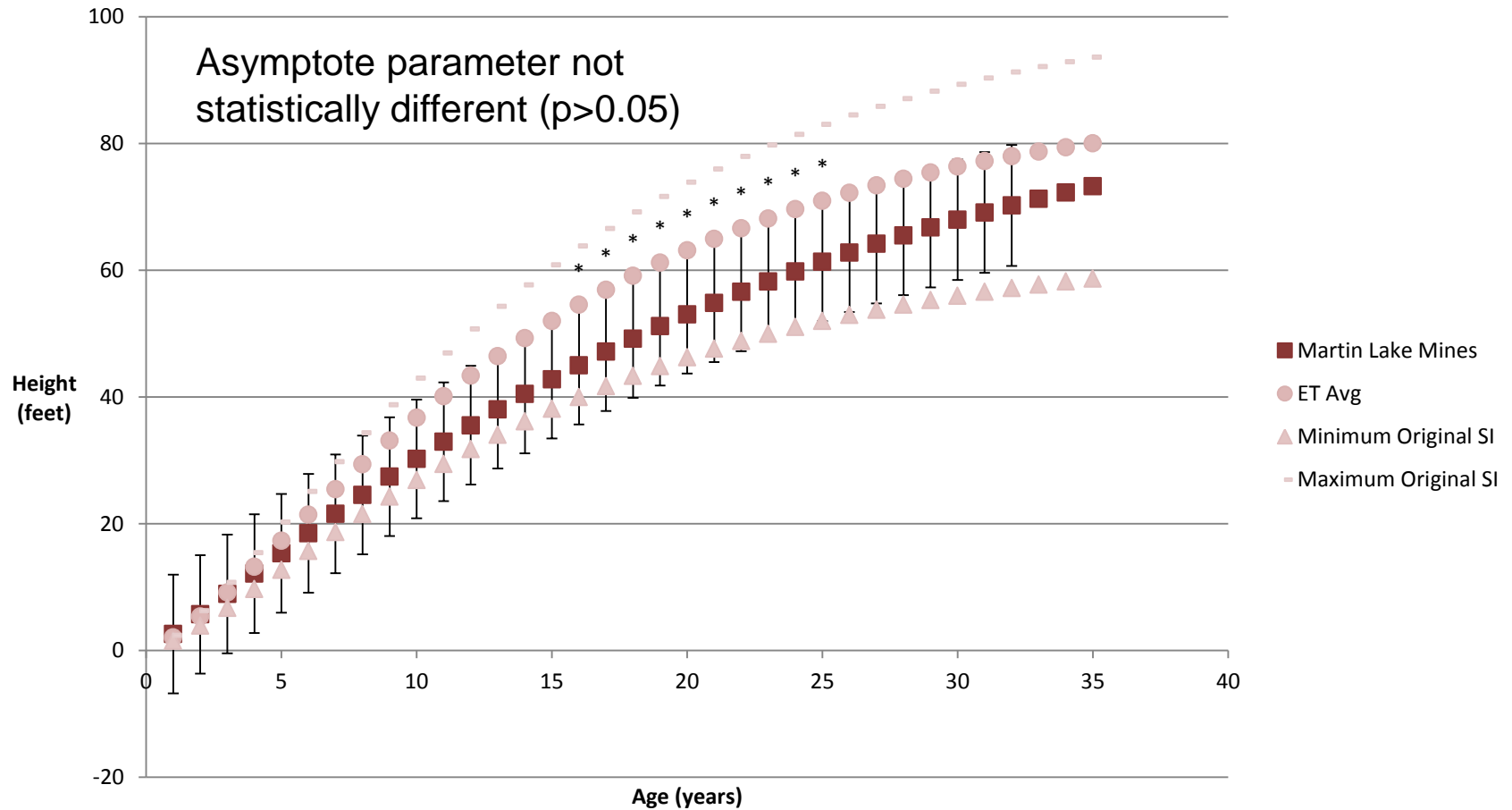*Stephen F. Austin State University*

Oak Hill Comparison to Original

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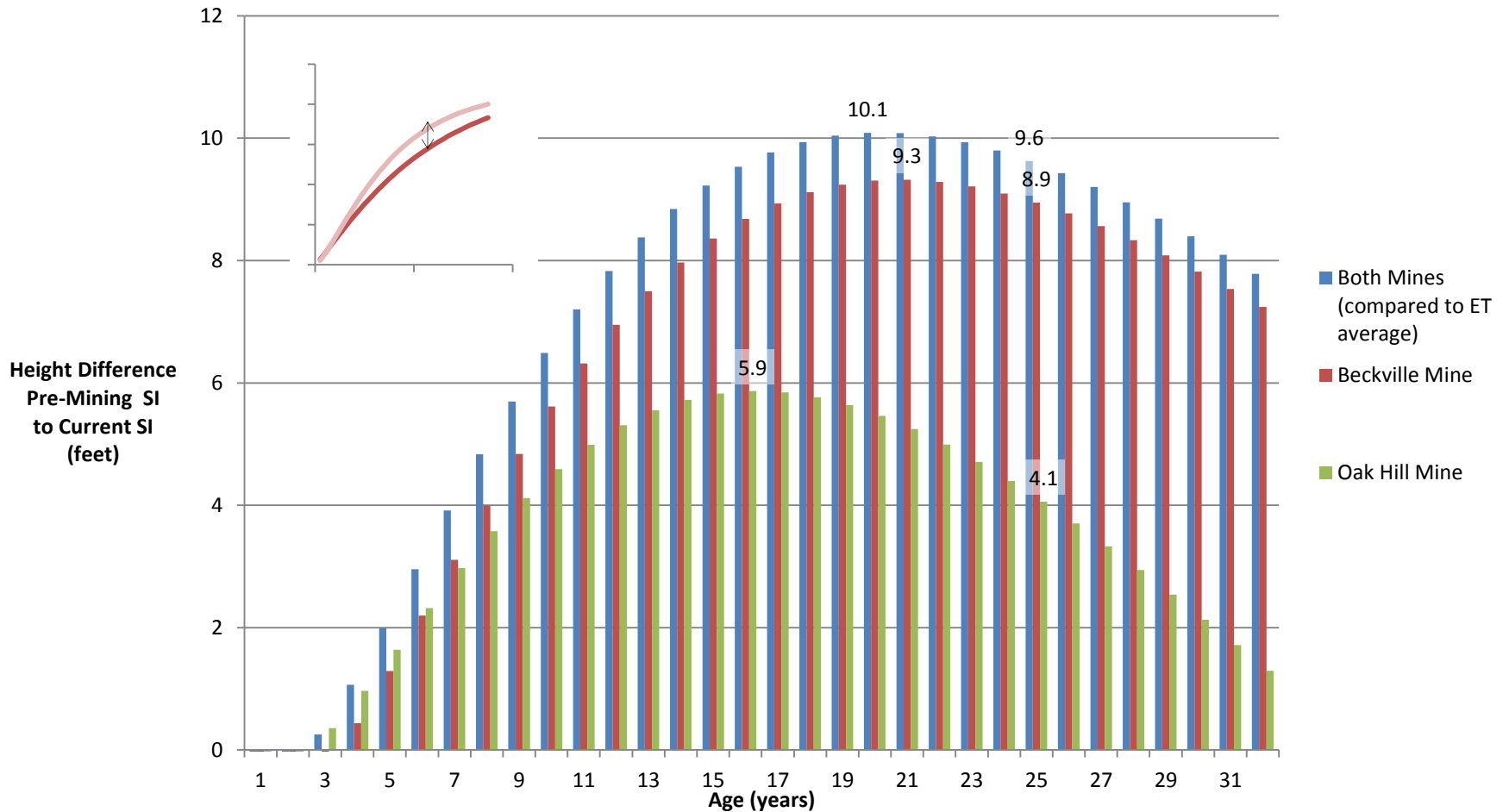Stephen F. Austin State University

Mines Compared to ET Average

Asymptote parameter not statistically different (p>0.05)

Height (feet)

Age (years)

Legend:
- Martin Lake Mines
- ET Avg
- Minimum Original SI
- Maximum Original SI

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Possible Aggrading Site Quality

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Conclusions

- Mid-rotation heights (16-25 years) significantly lower than ET average

- Average site index at each mine is not statistically different from pre-mining site index

- Asymptote parameters of all models are not statistically different from ET average or pre-mining SI

- Oxidized material haul back only improves post-mining SI over mixed overburden SI by 0.88 feet

- The shape and asymptotes of reclaimed mineland guide curves differ from guide curves developed on unmined land ($p < 0.05$)

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Questions?

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