



Stand Level Nutrient and Carbon Content Across One Rotation of Loblolly Pine Plantations on a Reclaimed Surface Mine



H.Z. Angel, J.S. Priest, J.P. Stovall, B.P. Oswald, Y. Weng, and H.M. Williams
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, Texas

Introduction

Loblolly pine (*Pinus taeda L.*) trees growing on reclaimed mined lands in east Texas exhibit similar productivity compared to unmined lands (Priest et al., 2015). Numerous studies have previously assessed loblolly pine aboveground biomass (Baldwin, 1987), carbon (Zhao et al., 2014), and nutrient contents (Albaugh et al., 2004); however, similar data have not been collected on mined lands for loblolly pine in the Gulf States Region, and most studies do not assess trees with ages spanning a full rotation. This study investigated temporal changes in aboveground carbon and nutrient contents for first rotation reclaimed loblolly pine stands growing at Luminant's Beckville Mine (Fig. 1).

Methods

Objectives: To assess C, N, Ca, Mg, K, and P in loblolly pine aboveground biomass components over a 32 year rotation. Simple linear regression was used to evaluate the relationship between elemental content (concentration scaled by biomass) and stand age. Methods include:

- 1) Aboveground destructive harvesting of 47 trees in 1/10th hectare plots (summer 2013).
- 2) Branches were removed at the bole in three crown portions (top, middle, and lower).
- 3) Stem-disks were removed by chainsaw including one sample at DBH and one at tallest tree section.
- 4) Tissue components (needles, branches, stem wood) were oven-dried at 65°C to a constant weight.
- 5) Sub-samples of each component were ground and analyzed using a C/N analyzer and ICP at the SFASU Soil, Plant, and Water Analysis Lab.
- 6) Carbon and nutrients were scaled to stand-level and expressed as the product of dry aboveground mass and elemental content by tissue component.

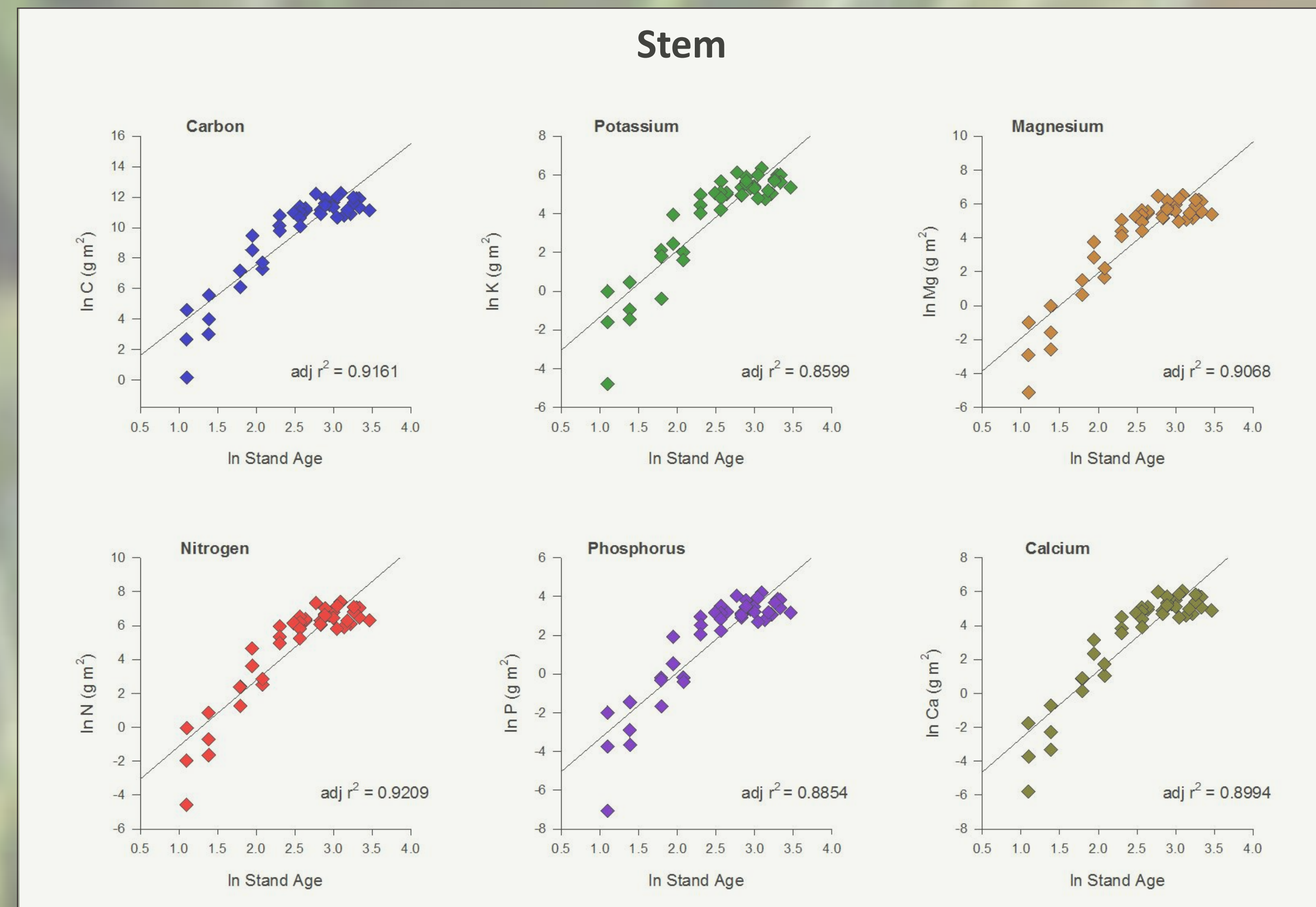
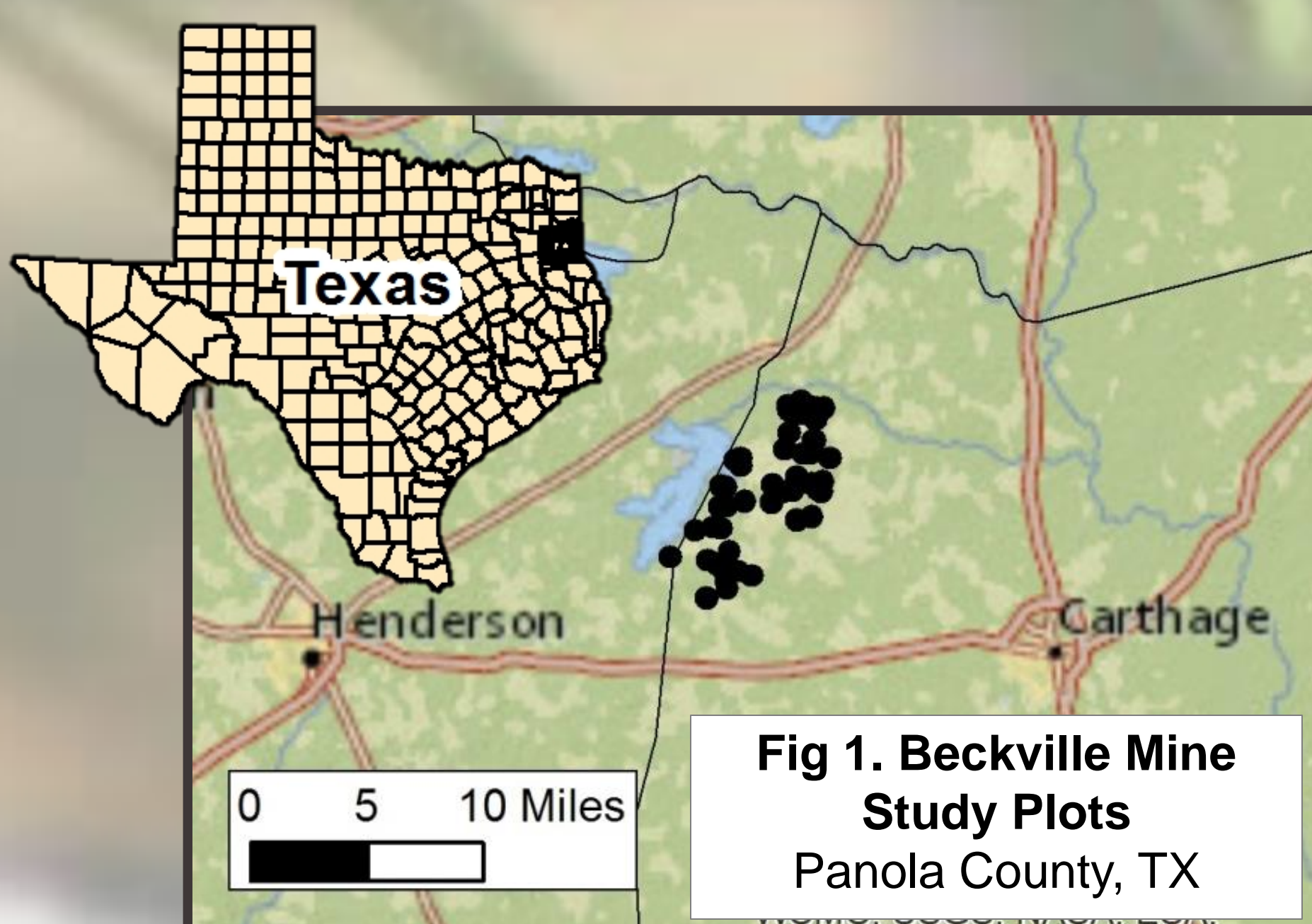


Fig. 2. Stem C/nutrients (Ages 3 - 32). Adjusted R² is derived from the model form (Results).

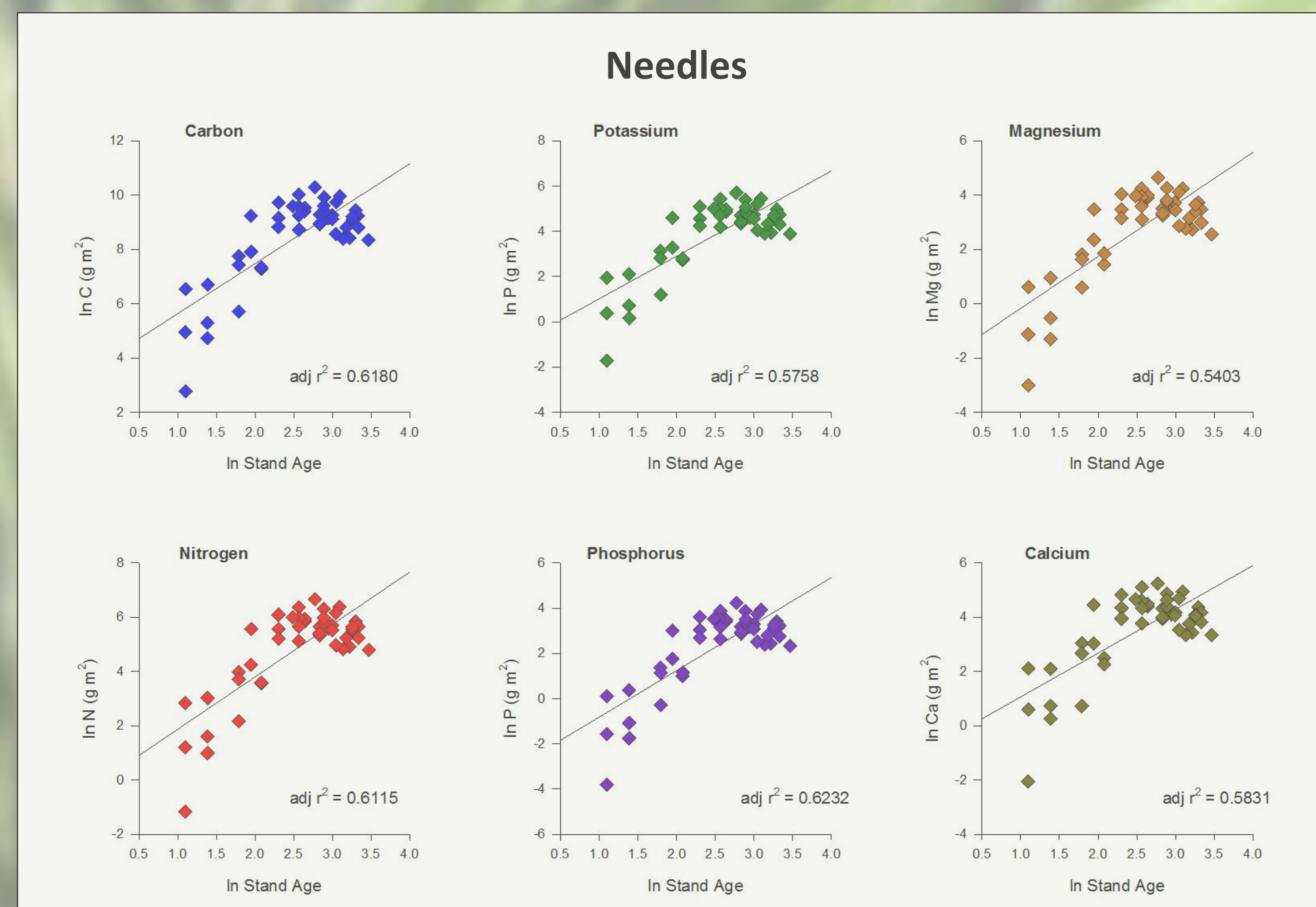


Fig. 3. Needle C/nutrients (Ages 3 - 32). Adjusted R² is derived from the model form (Results).

Table 1. Mean individual elemental concentrations. SE in parenthesis.

Element	Stem (%)	Needles (%)
C	46.18 (0.076)	47.82 (0.081)
N	0.348 (0.006)	1.316 (0.022)
P	0.014 (0.001)	0.118 (0.002)
K	0.104 (0.007)	0.512 (0.016)
Ca	0.095 (0.002)	0.324 (0.014)
Mg	0.152 (0.003)	0.198 (0.007)

Acknowledgements: Luminant Environmental Research Program, Arthur Temple College of Forestry and Agriculture-Stephen F. Austin State University, and McIntire-Stennis Cooperative Forestry Research Program.

Model Fitting

The model form (Baldwin, 1987) in this study was:

$$\ln Y = \beta_0 + \beta_1 \ln(D) + \beta_2 \ln(H) + \beta_3 A^2 + \beta_4 \ln(SI)$$

where,

Y = Elemental content (kg/tree)

D = Tree diameter (cm)

H = Total tree height (m)

A = Stand age since planting (years)

SI = Site index (m)

$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ = Estimated regression parameters



Loblolly pine stem wood disk samples

Results & Discussion

- 1) The model produced good fits for estimating aboveground C and nutrient contents in stem and needle biomass components.
- 2) At the stand level, stem and needle elemental contents aggrade over time (Fig. 2 & 3).
- 3) Concentration does not substantially change in stem and needle components over time for any element analyzed, indicating that observed stand-level patterns are driven by changes in accumulation of tree biomass.

Literature Cited:

- 1) Albaugh, T.J., H.L. Allen, P.M. Dougherty and K.H. Johnsen. 2004. Long term growth responses of loblolly pine to optimal nutrient and water resource availability. *Forest Ecology and Management* 192: 3-19.
- 2) Baldwin, V. 1987. Green and dry-weight equations for above-ground components of planted loblolly pine trees in the West Gulf Region. *Southern Journal of Applied Forestry* 11: 212-218.
- 3) Priest, J., J. Stovall, D. Coble, B. Oswald and H. Williams. 2015. Loblolly pine growth patterns on reclaimed mineland: Allometry, biomass, and volume. *Forests* 6: 3547.
- 4) Zhao D., Kane, M., Teskey, R., Markewitz, D., Greene, D., and B. Borders. 2014. Impact of management on nutrients, carbon, and energy in aboveground biomass components of mid-rotation loblolly pine (*Pinus taeda L.*) plantations. *Annals of Forest Science* 71: 843-851.