Pine Plantations on Reclaimed Minelands: Growth Rates Versus Unmined Lands

Jeremy S. Priest, Jeremy P. Stovall, and Dean W. Coble

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

INTRODUCTION

Strip-mining is a common practice in the Gulf Coastal Plain, with some individual mines spanning over 10,000 acres. Loblolly pine (*Pinus taeda L.*) plantations are a widespread reclamation landuse in east Texas, although the productivity of these plantations compared to those on unmined lands is not well-documented. The objective of our study is to quantify current site quality of loblolly pine plantations on two mines as compared to stands on unmined soils. The two mines differ in the method of overburden replacement (**Fig. 1**). Substituting mixed overburden for topsoil generally results in no distinction of original soil layers following reclamation (Beckville Mine, BM), while removing and mixing the pre-mining upper, oxidized soil layers for topsoil in the post-mining reclamation areas creates some stratification (Oak Hill Mine, OHM).

METHODS

We quantified 72 stands on two east Texas Luminant mines: 48 stands at BM and 24 stands at OHM (**Fig. 2**). Stands were selected to sample at least one for every year of planting from 1984-2011 for BM and 1988-2011 for OHM. Some years were not available and plots were selected from the prior or the following year in those cases. **Table 1** shows stand data. In each stand all trees within a single quarter-acre sample plot were measured. Plots were located randomly and had rectangular dimensions of 66 ft along the direction of the rows and 164 ft across the rows. Analyses involved height by age regression using the formula from Coble and Lee (2006):

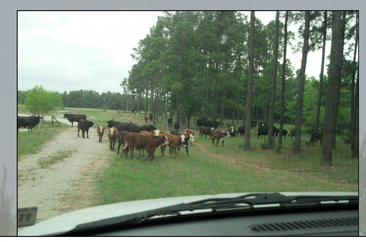
$$\text{Height} = b_0(1-e^{-b1(\text{age})})^{b2}$$

Mean site index prior to mining was estimated from the USGS Web Soil Survey and extrapolated to current productivity levels from base age 50 years natural stands by adding 10 feet to the height at age 25 to account for improved genetics and silviculture.

Figure 3. Calculated site index curves for Luminant Oak Hill and Beckville Mines. Points represent average height of the dominant and co-dominant trees at each sample plot. Also shown are approximate original site indices for each mine and the range of site indices present across both mines.

RESULTS

Preliminary results show site index was 51.6 ft at 25 years and 59.4 ft at 25 years for BM and OHM, respectively (**Fig. 3**). This is less than the mean site index across east Texas of 69 ft (Coble and Lee 2006). The current site index at BM is 18.4 ft lower than prior site index at BM of 70 ft. The current site index at OHM is 6.6 ft lower than prior site index at OHM of 66 ft. All regression coefficients were significantly different between mines at the 0.05 confidence level. Additionally the pre-mining site index estimates fell outside the 95% confidence intervals for both mines.



Above: An example of agroforestry management on an older stand at the Luminant Beckville Mine. Right: A 19 year old stand at the Luminant Oak Hill Mine.

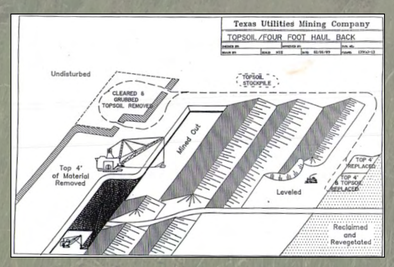


Figure 1. Illustration of Oak Hill Mine Haulback Method (Railroad Commission 1990)

A dragline in operation at the Luminant Beckville Mine

Height data was obtained using a Tru-Pulse 360 R laser rangefinder (Laser Technology Inc. 6912 Quentin Street Centennial, Colorado 80112 USA).

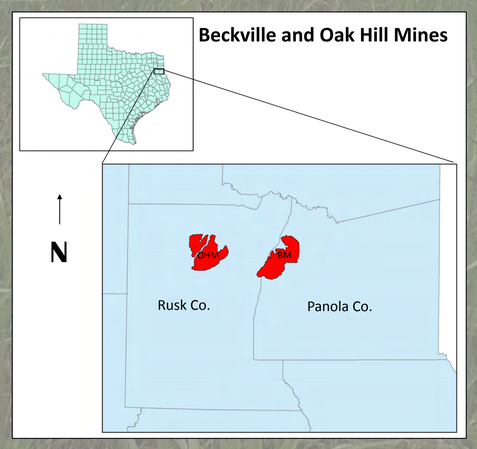


Figure 2. The Beckville and Oak Hill Mines are located near Martin Lake in Panola and Rusk Counties, Texas.

Table 1. Stand data for 72 plots on Beckville and Oak Hill Mines. "Thinned" indicates the percentage of stands within the age class which have been operationally thinned. Statistically significant ($\alpha = 0.05$) differences between mines by age class are indicated by an asterisk. Data collected from May to July 2013.

Mine	Age Class (years)	n	Thinned	Density (trees ac^{-1})	Basal Area (ft^2 ac^{-1})	QMD (in)	Height (ft)
BM	3-5	8	0%	329	2.6	1.0 *	4.5 *
	6-10	8	0%	342	16.1	2.5 *	15.7 *
	11-15	8	0%	465	86.6	5.8	31.5 *
	16-20	8	50%	349	93.2	7.3 *	43.1
	21-25	9	56%	313	110.6	7.8 *	46.3 *
	26-30	7	86%	225	102.9	10.4 *	56.1
OHM	3-5	3	0%	298	3.0	1.3 *	7.5 *
	6-10	5	0%	421	27.6	3.4 *	17.8 *
	11-15	5	0%	501	88.7	5.7	29.7 *
	16-20	5	20%	494	149.1	7.6 *	43.5
	21-25	5	80%	257	108.1	9.0 *	52.9 *
	26	1	100%	150	114.2	11.8 *	60.8

DISCUSSION

While OHM is growing at a faster rate than BM, both reclaimed mine sites yield much slower height growth rates than are typical for east Texas. The difference between current site index and estimated prior site index does show a clear reduction in site index for both mines. There are also apparent differences in the site index curve shape, which could indicate a need to reparameterize the site index curves. Correlating height and age to estimate site index using existing SI curves will result in different estimated site indices depending on the age of the trees being sampled.

ACKNOWLEDGMENTS

Special thanks to the Luminant Environmental Research Program and Steering Committee which provided funding, logistics, and advice. We also thank Bryent Daugherty, Phil Grimes, Dan Darr, and Jeff Lamb for their contributions to data collection

LITERATURE CITED

Coble, D.W., and Y.J. Lee. 2006. Use of a generalized sigmoid growth function to predict site index for unmanaged loblolly and slash pine plantations in east Texas. In: Proceedings of the 13th Biennial Southern Silvicultural Research Conference, 2006; Connor, K.F., editor. USDA For. Serv. Gen. Tech. Rep. SRS – 92, p. 291 – 295.

Railroad Commission of Texas. 1990. Oak Hill Mine Permit 46B Renewal/Revision. 145:1-12.