LONGLEAF PINE: A LONG-ROTATION TREE IN A VERY SHORT-SIGHTED WORLD

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Abstract—Longleaf pine is a long-rotation tree, with potential intermediate products from pine straw, frequent thinnings, hunting leases, and wildlife habitat. Despite a focus on plantations and short-rotation management, many landowners and managers are still interested in long-term management because of high-valued products derived from longer rotations. Do we have the most basic and reliable information to write management plans for long-term rotations like a 45-, 65-, or 120-year rotations? Can we improve planning for longleaf silvicultural activities of regeneration, thinning, and burning? We would argue the data exists to help answer these questions in the U.S. Forest Service's Regional Longleaf Growth Study (RLGS) established in 1964. The study's original objective was to obtain a database to develop growth and yield predictions for naturally regenerated, even-aged longleaf pine stands. We have expanded the RLGS to examine pine straw, utility pole, forage production, and more. Recent results include a site index equation and stand level growth models. The RLGS has 40+ years implementation of basal area management regimes and replication in time component that can address adaptive management and climate change issues. The future of the RLGS is doubtful and "how can this be?" is a good question. This irreplaceable investment of decades in documented management cannot be ignored and should be more relevant with longleaf pine restoration efforts. This presentation will show how the nearly 50-year old RLGS has addressed numerous questions related to longleaf pine management and the importance for its continuance.

INTRODUCTION

Robert M. Farrar, Jr. (honored posthumously)

Before I begin the discussion of my topic, the Regional Longleaf Pine Growth Study (RLGS) and what it has added to the longleaf pine knowledge base, I need to honor the memory of Dr. Robert (Bob) M. Farrar, Jr. Bob passed away in early 2014 in Starkville, Mississippi. Bob worked for the U.S. Forest Service (USFS) for 30 years, much of his time researching longleaf pine. Bob always presented at the Biennial Southern Silvicultural Research Conference (BSSRC), while with the USFS. He would show up with Mylar sheets in hand and put them on an overhead projector. These sheets were filled with numbers and equations that few of us could keep up with. Long before there was the effort to restore longleaf, Bob said this about the longleaf situation: "Everyone is "looking" but few are "seeing" what is happening to longleaf". Bob was right about that and much more.

REGIONAL LONGLEAF GROWTH STUDY

In 1964, the USFS (Bob's PhD) established the RLGS in the Gulf States (Farrar 1978). The RLGS had a rare longitudinal approach in that there were research plots from the Panhandle of Florida to western Mississippi, and north into the mountains of Alabama. The original objective of the study was to obtain a database for the development of growth and yield predictions for naturally regenerated, even-aged longleaf pine stands.

Plots were installed to cover a range of ages, densities, and site qualities. The study was UNIQUE in that it accounted for change in growth with the addition of new plots in the youngest age class every 10 years on the Escambia Experimental Forest (EEF) located just south of Brewton, Alabama. These series of plots were referred to as "Time-rep plots". The 6th set off of these were scheduled for installation in 2014.

Plot selection within the RLGS was based upon a rectangular distribution of cells formed by: 6 age classes from 20 to 120 years; 4 site quality classes from 50 to 80 feet (base age 50); 6 density classes ranging from 30 to 150 square feet/acre; and plots left un-thinned to grow. If the plot basal area had grown 7.5 square feet/acre beyond the target basal area, plots were thinned back to the previously assigned target. Thinning generally low intensity and done from below. Plots should have been prescribed burned at least every 3 years with cool, dormant season fires. The initial installation in the mid-1960's resulted in 185 sample plots. By 1981, the number of plots was down to 166

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due to hurricanes, tornadoes and trespass cutting. In 1984, Auburn University (SOFWS), in a cooperative agreement with the USFS, re-measured the plots for its 4th measurement period (20-year). Auburn has been re-measuring the RLGS since on a 5-year cycle. Today, there are 305 plots in the RLGS, with nearly 40 percent of them on the EEF.

From the first 10 years of the study, Farrar published growth predictions and produced a site-index function for naturally regenerated longleaf pine in the East Gulf area (Farrar 1979, 1981, 1985). After the addition of the next 25 years' worth of data, Lauer and Kush (2010, 2011) updated Farrar's work. Unique in the Lauer and Kush site index equation is the ability to allow the user to specify the number of years of required for tress to reach 4.5-feet or diameter at breast height (DBH). Farrar's site index added 7 years to the ring count at DBH. The stand level growth and yield model by Lauer and Kush was developed with survival curves to provide improved information for timing of thinning to capture potential mortality. In addition, the models indicate longleaf is very well-suited to frequent thinning; there is a growth response following thinning regardless of age; and the species can be managed well beyond 100 years old and the trees will still grow (the oldest trees in the RLGS are 130 years old). This information should be very helpful to the USFS if they are planning 120-year rotations for their longleaf pine stands.

Over the past 30 years, SOFWS put additional efforts beyond plot re-measurement to utilize the RLGS plots; it was more than just a growth and yield study. The RLGS was ideal for providing information on a number of critical issues: mortality; climate change – time-rep plots; utility poles; pine straw; mapping and GIS layers; impacts from hurricanes; and forage for silvopasture, wildlife, or threatened and endangered species.

Mortality

There is not much that kills longleaf pine (Kush and others 2015). Many landowners fear if they manage longleaf pine for high-value products that lightning will kill those trees. Mortality due to lightning kills less than 0.5 trees/acre/year. The largest cause of death is due to suppression. This is the result of the nature of the study to determine just how dense of a stand longleaf pine can grow in before mortality happens in the smaller diameter classes. The RLGS does show you can kill longleaf pine with fire, especially in young, dense stands and a 3-year fire return interval. The RLGS has been severely impacted by hurricanes over the decades. Hurricane's Frederick, Opal, and Ivan destroyed a total 29 plots.

Climate

Rayamajhi (1996) found parameters in Farrar's (1979, 1985) model did not remain stable when used for longer projections periods. Meldahl and others (1997) using the work from Rayamajhi found climatic factors reduced error the growth and yield models. Precipitation and minimum temperature were the most important climate variables for modeling growth changes in longleaf pine. In addition, ignoring climate resulted in bias estimates for long-term growth projections.

When the time-rep series plots were examined, basal area increment/year was significantly different between the time series (Rayamajhi and others 1998, Rayamajhi and Kush 2006). Again, these series of plots are located on the EEF where soils and management are uniform. Those plots established in the mid-1960's grew significantly less than the series of plots established in the 1980's and 1990's. Something has changed to increase growth and this is not the only growth increase documented in the past few decades (Boyer 2001, West and others 1993).

Utility pole

For every tree > 5.6" DBH the RLGS documented whether or not the tree was a pole and if so, what was the length? Nearly 75 percent of the longleaf in a "typical natural stand" made poles. The percentage of poles in a stand increased rapidly with age to 60-80 years and then decreased as trees grew out of pole size. In addition, there were a higher percentage of poles on lower to medium site quality sites when compared to better sites (site index > 80 feet at base age 50) (Shaw and others 1991). Poles have been of interest for several decades because of the price they bring when compared to sawtimber.

Pine straw

As part of the Southern Global Change Program (SGCP), needlefall was monitored on a subset of RLGS plots for three years to determine productivity (Meldahl and others 1997). Needle production decreased linearly with age and increased with site index. Dyer and others (2012) used these data to develop an equation for the number of potential bales of pine straw a landowner could anticipate from a stand.

Hurricane impacts

Kush and Gilbert (2010), and Gilbert and Kush (2013) reported on the impacts of Hurricane Ivan on the RLGS plots. Well-stocked stands suffered little damage compared to plots in, or adjacent to, openings.

Understory biomass production

The RLGS is uniquely qualified to answer a number of questions regarding foraging habitat for wildlife species and for threatened and endangered species (T & E) such as the red-cockaded woodpecker and gopher tortoise. In addition, with the renewed interest in silvopasture (bringing grazing back to the South), the RLGS could answer how much forage a landowner could expect from a stand. A subset of plots by basal area class on the EEF was subsampled for forage production. In areas with less than 30 square feet/acre there was nearly 400 pounds/acre of forage and good longleaf pine regeneration. For plots with a basal area between 30 and 70 square feet/acre, forage production dropped to 350 pounds/acre and longleaf regeneration was found in openings in the plots. On plots with greater than 70 square feet/acre, forage production rose to 450 pounds/acre with no regeneration. Despite the higher basal area, the frequent burning on the EEF has many areas with good forage production.

THE END OF THE RLGS?

What has the RLGS provided for longleaf pine management? Initial conclusion: Not as much as it could (should) have. There have many obstacles out there. Long-term research is not well-suited to today's lifestyle and our need for instantaneous information. Many look at longleaf but do not understand its silvics. Wahlenberg (1946, page 102) in his "Problems of Natural Reproduction" chapter wrote "...mismanagement of longleaf pine has been the rule rather than the exception, due to the ignorance of the unique life history and incomplete knowledge of factors determining the life and death of seedlings and hence the succession of forest types." Not much has changed in the 70 years since he penned this sentiment.

There has been an increase in longleaf acreage on public lands. However, we have not stopped the loss of longleaf on private lands; we are losing some of our most ecologically significant forests. We are not giving private land owners and land managers the needed reasons/information to keep longleaf pine. Landowners want and need information on a number of topics: timber type/species; stocking levels; markets; potential management interactions; natural resource enterprises and small business opportunities. There is a need for growth and yield information. They provide more than amount of timber or economic value. How do you manage for individual T & E species, entire ecosystems, aesthetics, and other multiple uses, or possibly meet military mission objectives and still produce some timber products? The answer resides in growth and yield (mortality) models. And the research from the RLGS has shown that model parameters are changing.

The RLGS has been incredible resource – an underutilized wealth of information and knowledge about longleaf ecology and management. It appears that the RLGS has come to an end just as it reached its 50th-year. While not perfect, the RLGS has data difficult to find anywhere about any species – a known history of: stem mapped trees; age classes; stand density and basal area classes; soils and site classes; pine straw and pole production; thinning history; and burning history.

Definitions: Looking - have the appearance or give the impression of being; seeing - discern or deduce mentally after reflection or from information; understand. Bob was right: we are not seeing what is happening to longleaf pine and what landowners want. We are not using our knowledge of the species and its silvics. It is a long-rotation species trying to make it in a very short-sighted world.

FINAL THOUGHTS

Bob would be the first to say longleaf pine was not for everybody but it offered opportunities other species did not. He believed longleaf should be grown with landowners and land managers in mind. Bob battled decades for longleaf pine and for the RLGS. And now it appears as if the RLGS is about to pass away. At a time when there is this discussion about climate change, data from the RLGS has shown an increase in growth over the past four decades. How can we not see where the next decades go? At a time when federal and state agencies talk about longer rotations for longleaf, the RLGS has data for plots beyond 120 years old. How can we not see where these plots will go?

The dedication to Wahlenberg's (1946) book reads "Dedicated to a future in American forestry for one of the finest timber trees the world has ever known". We are a short-sighted species living in our short-sighted world. Longleaf pine has never been a short-rotation species and will never be. If it becomes that it will no longer be longleaf pine.

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LITERATURE CITED

Boyer, W.D. 2001. A generational change in site index for naturally established longleaf pine on a southern Alabama Coastal Plain site. Southern Journal of Applied Forestry. 25(2): 88–92.

Dyer, J.F.; Barlow, R.J.; Kush, J.S.; Gilbert, J.C. 2012. Pine straw production: From forest to front yard. In: Butnor, J.R., ed. Proceedings of the 16th biennial southern silvicultural research conference. e-Gen. Tech. Rep. SRS-156. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 100-108.

Farrar, R.M., Jr. 1978. Silvicultural implications of the growth response of naturally regenerated even-aged stands of longleaf pine (*Pinus palustris* Mill.) to varying stand age, site quality, and density and certain stand measures. Athens, GA: University of Georgia. 132 p. Ph.D. dissertation.

Farrar, R.M., Jr. 1979. Growth and yield predictions for thinned stands of even-aged natural longleaf pine. Res. Pap. SO-156. New Orleans, LA: U.S. Department of Agriculture Forest Service, Southern Forest Experiment Station. 78 p.

Farrar, R.M., Jr. 1981. A site-index function for naturally regenerated longleaf pine in the East Gulf area. Southern Journal of Applied Forestry. 5: 150-153.

Farrar, R.M., Jr. 1985. Volume and growth predictions for thinned even-aged natural longleaf pine stands in the East Gulf area. Res. Pap. SO-220. New Orleans, LA: U.S. Department of Agriculture Forest Service, Southern Forest Experiment Station. 172 p.

Gilbert, J.C.; Kush, J.S. 2013. Longleaf pine regeneration following Hurricane Ivan utilizing the RLGS plots. In: Guldin, J.M., ed. Proceedings of the 15th biennial southern silvicultural research conference. e-Gen. Tech. Rep. SRS-175. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 137-139.

Kush, J.S.; Gilbert, J.C. 2010. Impact of Hurricane Ivan on the Regional Longleaf Pine Growth Study: Is there a relation to site or stand conditions? In: Stanturf, J.A., ed. Proceedings of the 14th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-121. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 259-261.

Kush, J.S.; Gilbert, J.C.; Barlow, R.J. 2105. What 45 years of RLGS data has to say about longleaf pine mortality – not much. In: Holley, A.G.; Connor, K.F.; Haywood, J.D., eds. Proceedings of the 17th biennial southern silvicultural research conference. e-Gen. Tech. Rep. SRS-203. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 473-477.

Lauer D.K.; Kush, J.S. 2010. Dynamic site index equation for thinned stands of even-aged natural longleaf pine. Southern Journal of Applied Forestry. 34(1): 28-37.

Lauer, D.K.; Kush, J.S. 2011. A variable density stand level growth and yield model for even-aged natural longleaf pine. Special Report No. 10. Auburn, AL: Auburn University, Alabama Agricultural Experiment Station. 16 p.

Meldahl, R.S.; Kush, J.S.; Rayamajhi, J.N.; Farrar, R.M., Jr. 1997. Productivity of natural stands of longleaf pine in relation to competition and climatic factors. In: Mickler, R.A.; Fox, S., eds. The productivity and sustainability of southern forest ecosystems in a changing environment. Ecological Series 128. New York: Springer-Verlag: 231-254.

Rayamajhi, J.N. 1996. Productivity of natural stands of longleaf pine in relation to climatic factors. Auburn, AL: Auburn University. 177 p. Ph.D. dissertation.

Rayamajhi, J.N.; Meldahl, R.S.; Kush, J.S. 1998. Stability of parameters that predict growth and yield of natural stands of longleaf pine (*Pinus palustris* Mill.). In: Waldrop, T.A., ed. Proceedings of the 9th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-20. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 509-514.

Rayamajhi, J.N.; Kush, J.S. 2006. Inclusion of climatic variables in longleaf pine growth models. In: Connor, K.F., ed. Proceedings of the 13th biennial southern silvicultural research conference. Gen. Tech. Rep. SRS-92. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 367-370.

Shaw, D.J.; Meldahl, R.S.; Kush, J.S. [and others]. 1991. Pole availability from naturally regenerated longleaf pine stands: Preliminary data. In: Coleman, S.S.; Neary, D.G., comps., eds. Proceedings of the 6th biennial southern silvicultural research conference. Gen. Tech. Rep. SE-70. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station: 260-264.

Wahlenberg, W.G. 1946. Longleaf pine: Its use, ecology, regeneration protection, growth, and management. Washington, DC: Charles Lathrop Pack Forestry Foundation in cooperation with the Forest Service, U.S. Department of Agriculture. 429 p.

West, D.C.; Doyle, T.W.; Tharp, M.L. [and others]. 1993. Recent growth increases in old-growth longleaf pine. Canadian Journal of Forest Research. 23: 846-853.