



Ten-Year Performance of Eight Longleaf Pine Provenances in Virginia

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Abstract

Today in Virginia fewer than 200 mature native longleaf pines remain from a population that once numbered in the hundreds of millions. Recent restoration efforts have relied on collecting seeds from those scattered individuals. To help assess the value of this "native" genotype, a study was installed at three locations in Virginia in early 2006 to compare the survival and growth of longleaf pine seedlings originating from sources in Alabama, Florida, Georgia, Mississippi, North Carolina (two sources) and South Carolina to the Virginia natives. Periodic measurements of survival, total height and diameter at breast height (dbh) have been completed through age 10, and volume and overall fitness indices have been calculated based on those data. At age three, 81 percent of VA seedlings had emerged from the grass stage compared to 66 percent for the best of the other sources. By age 10, 80 percent of VA seedlings were still alive while the best of the other sources (NC Orchard) had 68 percent survival. The VA source trailed only the NC orchard in terms of individual tree height and diameter, but those differences in size were not statistically significant. Primarily due to the impacts of early growth initiation and survival, the VA source has produced significantly more volume per acre and ranks higher in fitness score than the other provenances.

Background

Historical estimates indicate the pre-settlement population of longleaf pine in Virginia included hundreds of millions of trees occupying almost 1.5 million acres in the southeastern Coastal Plain and Piedmont provinces of Virginia (Frost 1993). By 1998, a census found that approximately 4,400 longleaf pines remained on less than 800 acres (Sheridan, et al. 1999). After trees from Louisiana that were planted by Union Camp Corporation in the 1950s as part of a reforestation project are excluded, we now believe the number of surviving mature longleaf pine trees truly native to Virginia is less than 200. Most of these are located in and around the Blackwater River basin.

Recent restoration efforts on public lands in Virginia have relied heavily on seed collected from these few scattered individuals and small stands of native Virginia longleaf in southeastern Virginia and northeastern North Carolina. Most of this seed has come from trees located on the Virginia Department of Conservation and Recreation's South Quay Sandhills Natural Area Preserve.

Because the known native Virginia longleaf pine genotype is so diminished, we decided it would be useful to document its relative performance compared to other geographic locations

(provenances). This would help to determine how much effort and expense is warranted to protect the native source. This study was designed with that objective and has helped to quantify the value of continued efforts to preserve this genotype. Results from this study through age five were summarized in the May 2011 issue of the Forest Research Review, and a thorough review of the history and status of longleaf pine in Virginia was published in 2014 (Asaro 2014).

Methods

The eight provenances being compared are (Figure 1): Talladega Co., Alabama (AL); Santa Rosa Co., Florida (FL); Colquitt Co., Georgia (GA); Forest Co., Mississippi (MS); NC Forest Service Improved Longleaf Seed Orchard, Wayne Co., NC (NC orchard); Richmond Co., North Carolina (NC); Dorchester Co., South Carolina (SC), and City of Suffolk, Virginia (VA). All but the VA and NC orchard seed was provided thanks to support from Wayne Bell at International Forest Company. The VA seed was a mix collected at the South Quay Sandhills Natural Area Preserve from the remaining native Virginia longleaf pines.

Seedlings were propagated in a greenhouse facility at the Virginia Department of Forestry's New Kent Forestry Center in 2005 and planted in early 2006 in 49-tree plots replicated twice at each of three locations: the Garland Gray Forestry Center ("G" - in Sussex County); the New Kent Forestry Center ("N" - in New Kent County), and Sandy Point State Forest ("S" - in King William County) – a total of six replications in a randomized complete block design (Figure 1). Periodic measurements of survival, total height and diameter at breast height (dbh) have been completed through age 10. A volume index in cubic feet per acre was also calculated for each plot by multiplying $dbh * dbh * height * survival * 500$ stems per acre (assumed).

In addition, with help from Dr. Phil Sheridan of the Meadowview Biological Research Station, we calculated combined relative fitness rankings for average age three grass stage emergence and age 10 height, diameter and survival. The fitness scores are calculated dividing the average for any attribute (height, dbh, etc.) for each source by the average for the top ranked source. For example, from Table 1, the age 10 *height* fitness score for the Virginia provenance would be 22.5 divided by 23.2 (the average for the top-ranked NC orchard provenance) or 0.97. In essence, this says that the measured height performance of the VA source is 97 percent that of the top-ranked source. The fitness scores for height, dbh, survival and grass stage emergence can then be combined into an overall metric by multiplying them together.

The statistical significance of the provenance effect on these measured and calculated attributes was tested using analysis of variance.

Results

Age three grass stage emergence and age 10 survival, individual tree height and dbh, per-acre volume index (calculated as $dbh^2 * height * survival * 500$ trees per acre) and fitness ranking are summarized in Table 1.

At age three, 81 percent of VA seedlings had emerged from the grass stage (defined as terminal bud height of four inches or greater) compared to 66 percent for the best of the other sources. The provenance effect was statistically significant; the chances of the differences being due to random chance are less than 0.0006.

After 10 years, 80 percent of VA seedlings were still alive, while the best of the other sources (NC orchard) had 68 percent survival. Again, the provenances differed significantly; the chances of the differences being due to random chance are less than 0.04.

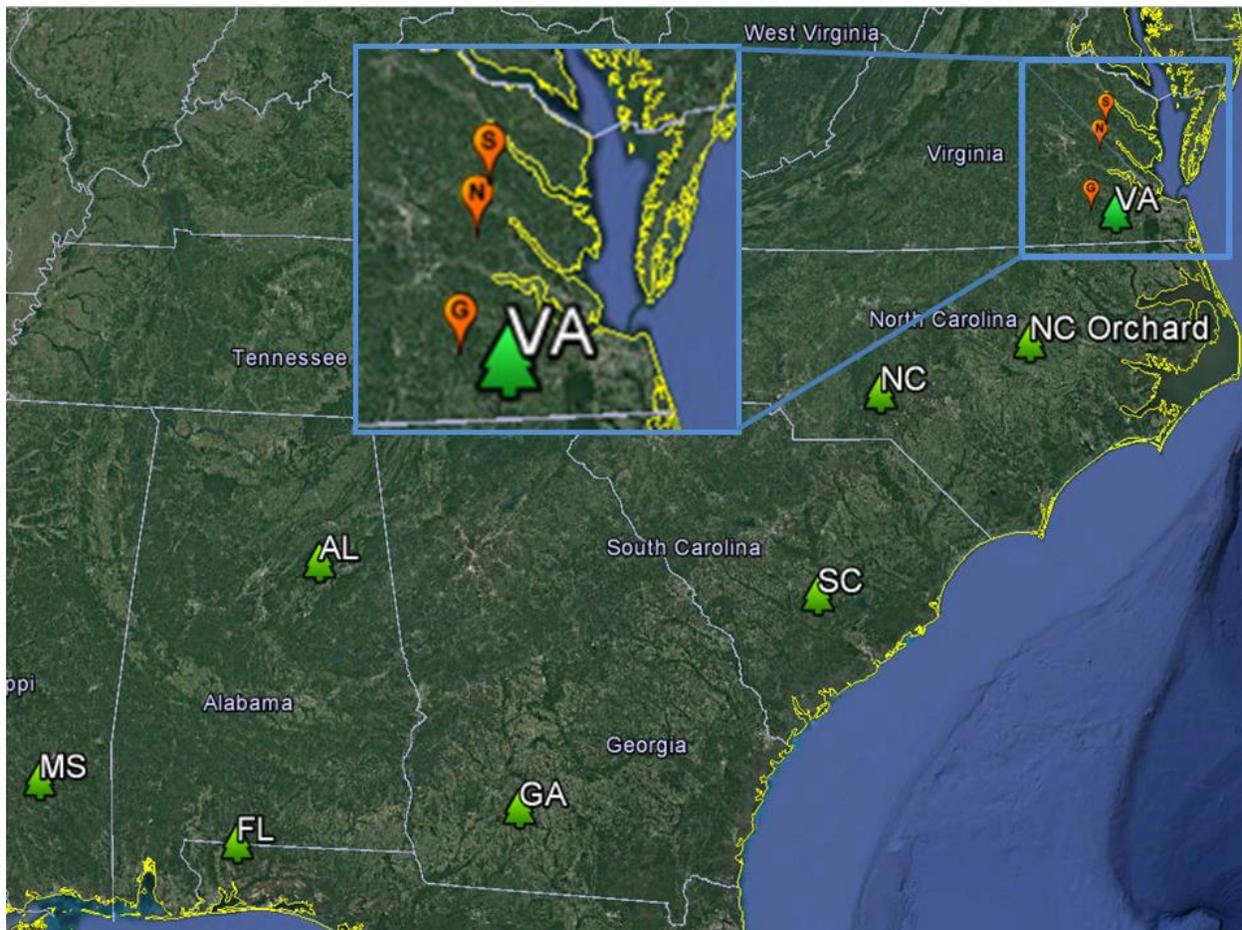


Figure 1. Location map of provenances included in the study (green tree symbols) and study sites (red balloon symbols: G=Garland Gray Forestry Center, N=New Kent Forestry Center, S=Sandy Point State Forest).

The VA source trailed only the NC orchard in terms of individual tree size, but these differences in height and diameter were not statistically meaningful; they could just as well have been caused by random chance as by geographic source. Across all provenances, the age 10 average tree height and diameter at breast height (dbh) were 22.4 feet and 4.8 inches, respectively. It is possible that this result is confounded by survival; individual tree growth may have increased on the non-Virginia plots in response to their lower stand densities.

Integrating the individual tree growth and survival data to arrive at a volume per acre demonstrates an overall performance advantage of the VA source to date (Figure 2), and the provenance effect is significant (odds of the differences being due to random chance are less than one in a thousand). In a stand planted at 500 seedlings per acre, the VA source has out-produced the other provenances by between 82 cubic feet per acre and 607 cubic feet per acre. Primarily due to the impacts of early growth initiation and survival, the VA source has a substantially higher fitness score in these test locations than the other provenances (Figure 3).

Table 1. Age three grass stage emergence and age 10 survival, growth and fitness score of eight longleaf pine provenances in Virginia.

Provenance	Age Three	Age 10				
	Percent Emerged from Grass Stage	Height (ft)	DBH (in)	Survival (%)	Volume Index* (ft ³ /ac)	Fitness Score*
VA	81	22.5	4.9	80	1,572	0.93
NC orchard	66	23.2	5.0	68	1,490	0.70
SC	61	22.3	4.8	63	1,222	0.54
MS	55	21.5	4.7	51	965	0.37
FL	55	22.7	4.9	51	1,010	0.40
NC	56	22.4	4.8	67	1,321	0.53
AL	61	22.2	4.8	62	1,195	0.53
GA	65	22.3	4.7	62	1,148	0.56

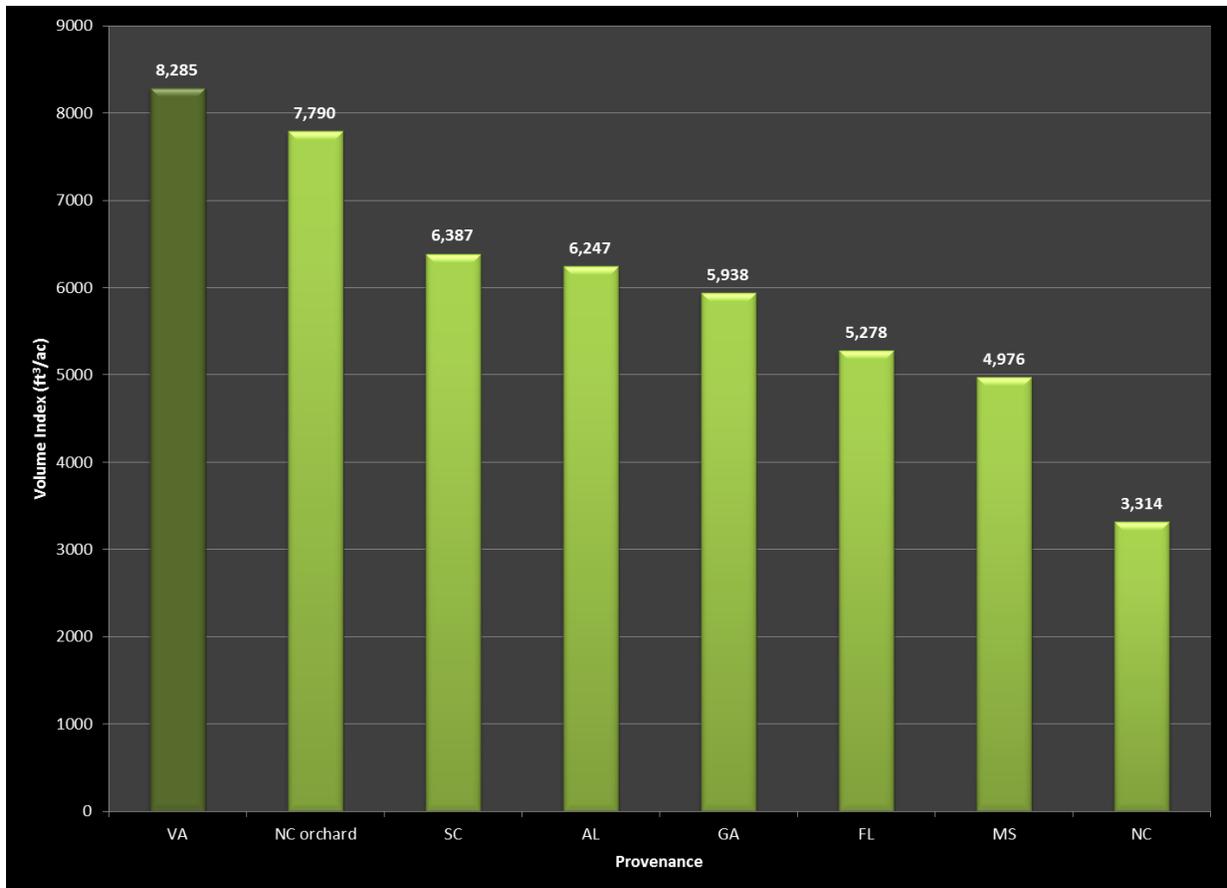


Figure 2. Age 10 volume index (calculated as $dbh^2 \times height \times survival \times 500$ trees per acre).

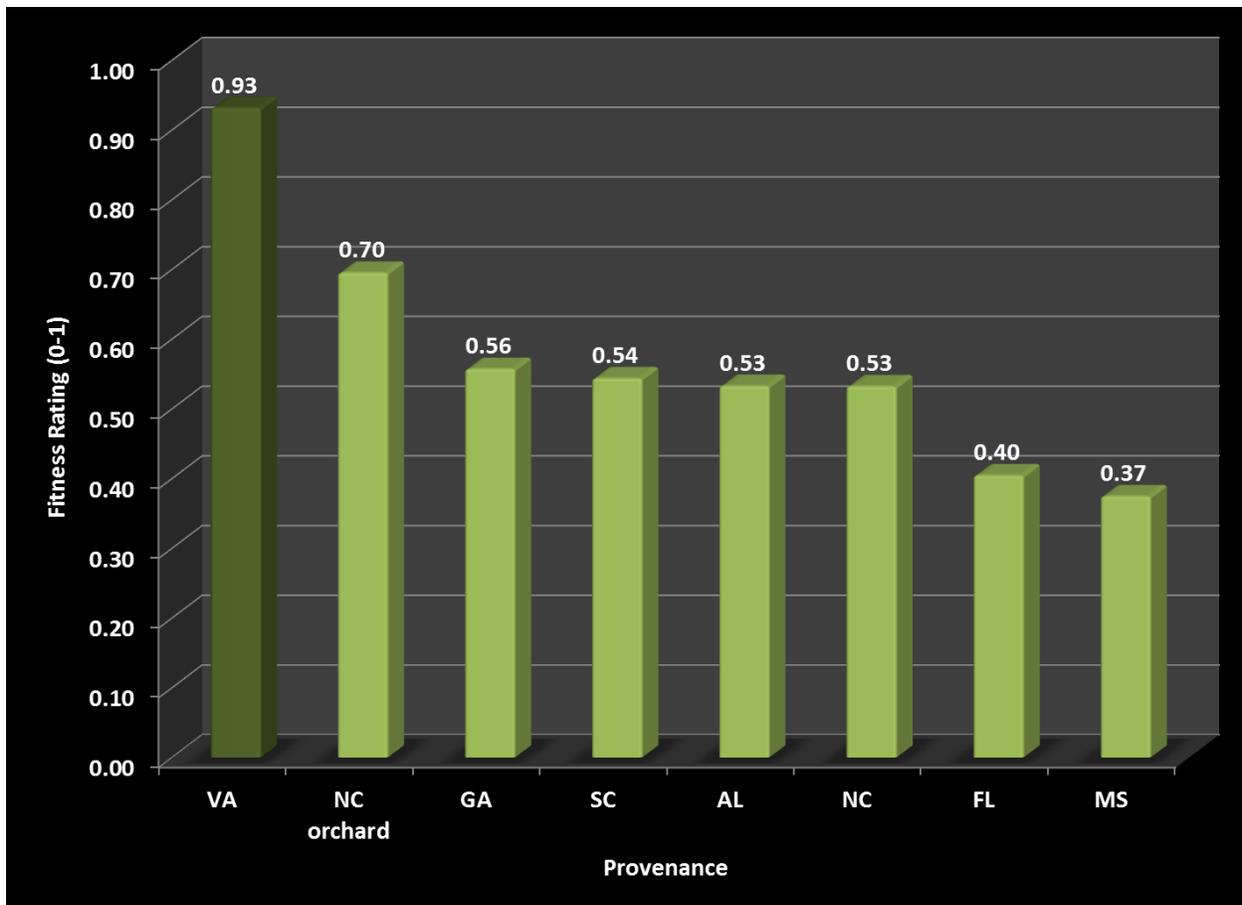


Figure 3. Age 10 combined fitness ratings [grass stage emergence*survival*height*DBH].

Discussion

These data are not meant to suggest that other sources are not suitable or cannot succeed in Virginia. To the contrary, there are other sources – generally those from latitudes closest to Virginia, and in particular the North Carolina orchard source – that have performed well. But they do suggest that there is a difference between native Virginia and other sources that is worth preserving.

Our conclusion is that the few remaining mature trees of the native Virginia source are better adapted to survive and initiate height growth under local conditions than more remote provenances, and therefore merit continued efforts to preserve and propagate the genotype. To that end, the VDOF in collaboration with the Virginia Department of Conservation and Recreation's Natural Heritage Program is continuing to collect as much seed and produce as many seedlings as possible from the remaining native trees for restoration projects in Virginia. We are also grafting scion collected from as many of the remaining native trees as possible in a seed production orchard at the New Kent Forestry Center.

References

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