EXPLORING GENETIC DIVERSITY, PHYSIOLOGIC EXPRESSION AND CARBON DYNAMICS IN LONGLEAF PINE: A NEW STUDY INSTALLATION AT THE HARRISON EXPERIMENTAL FOREST

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In 1960, an experiment was established on the Harrison Experimental Forest in southeast Mississippi to compare productivity and wood properties of planted longleaf (*Pinus palustris*), loblolly (*Pinus taeda*), and slash (*Pinus elliotii*) pines under different management intensities: cultivation, cultivation plus three levels of NPK fertilizer and a control (Smith and Schmidtling 1970). Key findings over the years demonstrate that longleaf pine lagged in productivity the early years, but eventually surpassed loblolly and slash pine:

- Age 9, intensive culture increased productivity of all species; loblolly pine had greater height and volume than longleaf or slash pine (Schmidtling, 1973). Yield differences between species in the highest fertilizer treatment were considerable: loblolly 41 Mg ha^{-1}, slash 29 Mg ha^{-1}, longleaf 12 Mg ha^{-1}.

- Age 25, longleaf had surpassed both slash and loblolly pine in height in the control plots, characterized by low nutrient availability. At the highest level of management intensity loblolly was still >2 m taller than the other species (Schmidtling, 1986).

- Age 39, longleaf pine attained similar height as loblolly pine, though it lagged behind slash pine in height and diameter growth

- Age 45, Hurricane Katrina impacted the site; longleaf pine suffered the least mortality, followed by slash and loblolly pine respectively (7 percent, 15 percent, 26 percent) (Johnsen and others, 2009). In 2006, after hurricane Katrina, mean basal area across all treatments was 23 m^2 ha^{-1} for longleaf pine and 19.3 m^2 ha^{-1} for slash pine and 12.4 m^2 ha^{-1} for loblolly pine.

Hurricane Katrina (August 2005) left the experiment heavily damaged, especially the loblolly plots, limiting the experiment's usefulness for future comparisons between pine species. We saw this as an opportunity for continuing longleaf pine research on the site with a new experimental design and study installation. While there is strong region-wide interest in restoring longleaf pine to enhance forest resilience to climate change and extreme climate events, little is known about the level of variability among and within regional seed sources and how this might affect adaptive traits. The goal of the new design is to better understand genetic control of physiologic traits that enhance survivorship and productivity at a hurricane prone site with relatively low native soil fertility.

The new installation will compare four longleaf pine sources originating from similar latitudes from Texas to South Carolina under three planting densities (750, 1330, 2200 trees per hectare) using a completely randomized design replicated four times for a total of 12 plots. Within each plot, there will be four genetic source split-plots: Region 8 improved TX source, Region 8 improved south MS/south AL source, Region 8 improved SC source, and unimproved local source (i.e., control, representing genetic quality of original planting). The tested genetic sources define a west-to-east transect covering the full range of south coastal longleaf pine. Each genetic source, excluding the control, represents one generation of genetic improvement as completed by the Region 8 tree improvement program. Physiologic differences among and within sources will be analyzed along with differences in height, diameter, stem taper and carbon allocation to specific components (foliage, branches, stems, roots) across the planting density gradient. Allelic states of several genes will be related to survival and performance traits to determine which genes affect which traits and to measure and monitor the resident genetic diversity in these sources as the stand matures. Experiments such as this will inform development of genetic guidelines for restoring resilient longleaf pine ecosystems.

The original experiment has been invaluable for comparing long-term productivity and carbon dynamics among three species of planted pines, and the study continues to have

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demonstration and research value. Instead of simply harvesting the entire site and starting over, a novel plan which includes retaining some of the original plots and moving them to uneven age management with thinning was devised. Natural regeneration of longleaf pine is most successful in large gaps in the canopy. We propose to install each of the new measurement plots in 55 m by 55 m gaps created by clear cutting (Figure 1). Some of the original longleaf pine plots have accrued exceptional basal area over the past 50 years, with a few plots approaching 45 m^2 ha^{-1}. Eleven of these plots will be thinned to 23 m^2 ha^{-1} to continue studying them under relatively high density (Figure 1). The rest of the original planting will be thinned to 14 m^2 ha^{-1}. Prescribed fire will be continued on a 2 year cycle.

Several goals are achieved with this new experimental design: 1) creation of a new longleaf pine planting density x genetic source study, 2) restoration of a longleaf pine ecosystem with fire and planting, 3) enhanced aesthetics and habitat with gap layout, 4) unique opportunity to study longleaf genetics and physiology at the Harrison Experimental Forest in a multi-age stand, and 5) initiation of a powerful experimental design for genetically mapping quantitative traits in longleaf pine. Thinning and harvesting are planned for summer 2011, site preparation in fall 2011, followed by planting during the 2011-2012 winter season.

This new study is made possible by a close partnership with the DeSoto Ranger District of the DeSoto National Forest. Without their assistance with prescribed burning, timber sale administration, site preparation, and advice on land use policy and regulations this project would not be possible. Special thanks to Ronald Smith, District Ranger, James Mordica, Ecosystem Restoration Coordinator, and Larry Lott for serving as an onsite liaison between the SRS and the district personnel.

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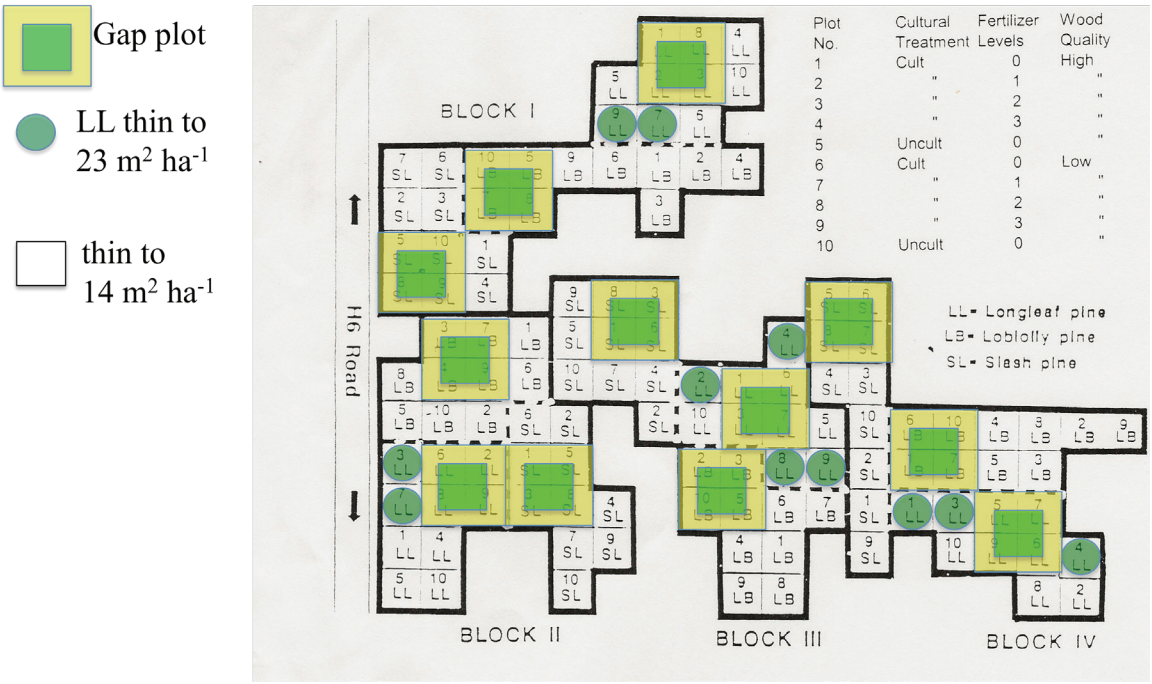

Figure 1—Map showing the location of 12 new gap plots created by combining 4 adjacent plots from the original experiment. A 5 tree buffer (yellow) will surround the new measurement area (green). The buffer area will be thinned to 14 m^2 ha^{-1}, while a 55 m by 55 m area will be clear cut to create the new measurement plot. The location of 11 longleaf plots which will be thinned to 23 m^2 ha^{-1} are marked with a green circle, all other plots will be thinned to 14 m^2 ha^{-1}.