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Old-growth montane longleaf pine forest age structure: *A preliminary assessment*

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ABSTRACT: Presettlement longleaf pine forests of the Southeast have been described as uneven-aged forests comprised of even-aged patches. Less than 4000 ha of old-growth longleaf forest remains. From these few sites remaining, a limited volume of age related literature has evolved, and these studies have been limited to the Lower Coastal Plain physiographic province. This study attempts to quantify the age structure of several old-growth stands in the Choccolocco Mountains of Fort McClellan, Alabama. While several examples of old-growth longleaf forest exist in the Coastal Plain, Fort McClellan's remnant populations represent the best examples of the disappearing montane longleaf pine forest, including several old-growth stands. Our presentation will focus on quantifying the temporal and spatial patterns of the montane longleaf forests of Fort McClellan. Preliminary analyses of stands studied depict a forest of several distinct age classes, individual tree ages exceeding 225 years, with many above 100 years. Additionally, preliminary results of coring indicate a much greater incidence of redheart infection in the montane longleaf pine sampled than in two old-growth populations in the Lower Coastal Plain. Redheart disease causes the heartwood to decay, thereby making age determination impossible, but creates the conditions favorable for cavity excavation by the endangered red-cockaded woodpecker. Finally, a comparison of the age structure of this montane population to Coastal Plain descriptions will be included. It is hoped that by gaining a better understanding of montane longleaf pine forests, we will be better able to restore and manage this ecosystem.

INTRODUCTION

Longleaf pine (*Pinus palustris* Mill.) forests once covered an estimated 37 million ha prior to European settlement (Frost 1993). Over the past 300 years, these forests have dwindled to less than 1.2 million ha, of these only 3900 ha scattered over 14 tracts remains in an old-growth condition (Means 1996). With these declines continuing, understanding the remaining longleaf pine forests is critical to any ecosystem-based restoration or management effort.

The pristine longleaf pine forest has been described as uneven-aged forests comprised of a mosaic of even-aged patches. These patches arise from large canopy gaps (1000--2000 m^2) caused by large storm events, lightning strikes, and high temperature fires. These canopy gaps then provide a suitable environment for seedling germination and establishment (Palik and Pederson 1996).

The few sites where age structure and dynamics have been investigated lie within the Coastal Plain physiographic province. However, longleaf pine forests, while commonly associated with the Coastal Plain, exist over a wide geographic range. No published reports exist on the dynamics of montane longleaf pine forests. Restoration and management of montane longleaf forests will require an understanding of tree longevity, seedling replacement patterns, and influences of disturbance on stand and age structure.

METHODS

This study of montane longleaf pine forests took place in the Choccolocco Mountains of Fort McClellan, a US Department of Defense Army post in northeastern Alabama. Fort McClellan contains a large portion of the Choccolocco Mountain Range lying within the Blue Ridge physiographic province (Harper 1943). Fort McClellan contains the best example of the critically endangered montane longleaf pine forest (Garland 1997). Fort McClellan was surveyed for the presence of old-growth longleaf pine stands from January to August 1998. To date, seven areas have been found containing stands with trees with >150 rings. Trees were cored from each of the seven areas. The stand with the best evidence of frequent fire and largest spatial extent was chosen to be cored for age structure and dynamics analysis. The remaining stands are being measured, and await complete analysis. The Caffey Hill Old-growth Area, located from 400 to 460 m above mean sea level (MSL) on Caffey Hill, represents the classic biotic and abiotic environment of the montane longleaf pine forest. Slopes range from 40 to 60%. Soils are mapped as *Rough Stony Land*,

extremely rocky, highly erodible, with high runoff, and low infiltration (Harlin et al. 1961). All trees >10 cm DBH within the Caffey Hill stand were cored completely through at 1 m. Cores were mounted and sanded for microscope examination to determine tree age. Since longleaf pine does not produce annual growth rings during its juvenile grass stage (which can last from 1 to > 24 years (W. D. Boyer, Auburn , AL, unpublished data)), true age can not be determined. Ring count at 1 meter will be used as a surrogate for age, as has been done in previous studies (Platt et al. 1988, Meldahl et al. *In Press*).

RESULTS & DISCUSSION

Age Structure

Within the Caffey Hill Old-growth Area, 175 trees were cored and aged. Ring counts of trees ranged from 12 to 228+ years. The two oldest individuals both contained rotten centers indicating redheart disease. The relation of diameter to age is depicted in Figure 1. The wide scattering of data points (R^2=.656), indicating a weak linear relationship between age and diameter of the Caffey Hill Old-growth Area.

Using five-year age classes, we created an age structure relationship in Figure 2. Five-year age classes were used due to the more frequent seed crops observed in montane longleaf pine stands (W. D. Boyer, pers. comm. of unpublished data, Auburn, AL). From the depiction in Figure 2, several points are worthy of mention. First, several distinct age classes are shown. Sharp peaks are found in the 35 -- 40, 55, 65, 90, and 130 year age classes depicting multiple regeneration-establishment events. Secondly, as has been observed in prior studies (Platt et al. 1988, Meldahl et al. *In Press*), gaps exist between age classes. These gaps may be caused by a number of factors, including lack of disturbance, absence of adequate seed crop, or dense overstory. Lastly, the distribution follows other old-growth longleaf pine and other long-lived conifer age class distributions (*sensu* Platt et al. 1988).

Comparisons

To investigate the differences in old-growth longleaf pine age structure and dynamics between montane and Coastal Plain stands, we plotted data from the only two well documented old-growth longleaf pine stands, the Wade Tract in southwestern Georgia (Platt et al. 1988) and the Flomaton Natural Area in lower Alabama (Meldahl et al. *In Press*). Using 25-year age class data from both studies, we created a comparison of old-growth longleaf pine age structure (Figure 3).

The relationships within Figure 3 illuminate patterns and introduce several questions relating to stand-level up to regional replacement and maintenance patterns. The irregularly skewed distribution of each stand results from the dynamics associated with successful or failed regeneration attempts, small and large-scale mortality events, and variability in disturbance in the longleaf pine forest. For example, the variable peaks in each stand's distribution probably occur in response to a seed crop year when a large-scale environment was favorable to seedling germination (exposed soil), seedling survival (decreased competition), and potentially, reduced canopy closure. Troughs, on the other hand, may or may not occur during a seed crop year, during variable seedling environments and disturbance regimes. For example, the disparate peak in the 50-year age class at Flomaton Natural Area coincides with cessation of burning. An environment that had maintained a competition-free seedling site was changed to a mortality-free environment with the 50-year absence of fire. In the Caffey Hill population, these patterns are not well documented, but further analysis should help explain these peaks and troughs.

Redheart Incidence

Redheart decay, causing heartwood of southern pines to soften, is of interest to forest managers region-wide. The reason for this interest is that the weakened heartwood improves the nest-creation environment for the federally endangered red-cockaded woodpecker. A factor in the suitability of habitat for red-cockaded woodpeckers is the presence of potential cavity trees.

Our analysis of the three old-growth longleaf pine stands showed drastic differences between stands in levels of redheart decay. Caffey Hill's population had 5.9% decay rate, more than 2 ½ and 3 times greater than Wade Tract and Flomaton Natural Area, respectively. The reason for this disparity is unknown, but may be related to the characteristics of high incidence of basal fire scars, ice breakage, or potentially genetics of the montane longleaf pine forest. Each of these possibilities awaits further investigation.

CONCLUSIONS

This study of a montane old-growth longleaf pine stand gives evidence for age structure similarities across regional scales, differences in incidence of redheart decay, and distinct peaks and troughs in age classes. These data and inferences arrived from them can give managers and scientists a better understanding of long-term replacement and maintenance patterns in old-growth longleaf pine stands. From this understanding, we can then begin to restore and manage the glory of the montane longleaf pine ecosystem.

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LITERATURE CITED

Frost, C. C. 1993. Four centuries of changing landscape patterns in the longleaf pine ecosystem. Pages 17-43 in: Hermann, S. H. (ed.) Proc. 18th Tall Timbers Fire Ecology Conf. The longleaf pine ecosystem: ecology, restoration, and management. Tall Timbers, Tallahassee, FL.

Garland, B. W. 1997. Montane longleaf pine forests of Fort McClellan, Alabama. Pages 73-74 in: Kush, J. S. (ed.) Proc. First Longleaf Alliance Conference. Longleaf pine: A regional perspective of challenges and opportunities. Longleaf Alliance Report No. 1. Auburn, AL. 178 p.

Harlin, W. V. , H. T. Wingate, W. S. Hall, H. O. White, J. A. Cotton, W. B. Parker, and R. B. McNutt. 1961. Soil Survey of Calhoun County. USDA Soil Conservation Service, Washington, DC. 97 p.

Harper, R. M. 1943. Forests of Alabama. Monograph 10. Geological Survey of Alabama, Tuscaloosa, AL. 230 p.

Means, D. B. 1996. The longleaf ecosystem, going, going... Pages 210-219 in: Davis, M. B. (ed.) Eastern old-growth forests: Prospects for rediscovery and recovery. Island Press. Washington, DC.

Meldahl, R. S., N. Pederson, J. S. Kush, and J. M. Varner. Dendrochronological investigations of climate and competitive effects on longleaf pine growth. In: Wimmer, R. and Vetter, R. E. (eds.) Tree Ring Analysis: Biological, Methodological, and Environmental Aspects. CAB International. Wallingford, UK. *In Press.*

Palik, B. J. and N. Pederson. 1996. Overstory mortality and canopy disturbances in longleaf pine ecosystems. Can. J. For. Res. 26:2035-2047.

Platt, W. J., G. W. Evans, and S. L. Rathbun. 1988. The population dynamics of a long-lived conifer (*Pinus Palustris*). The American Naturalist 131(4): 491-525.

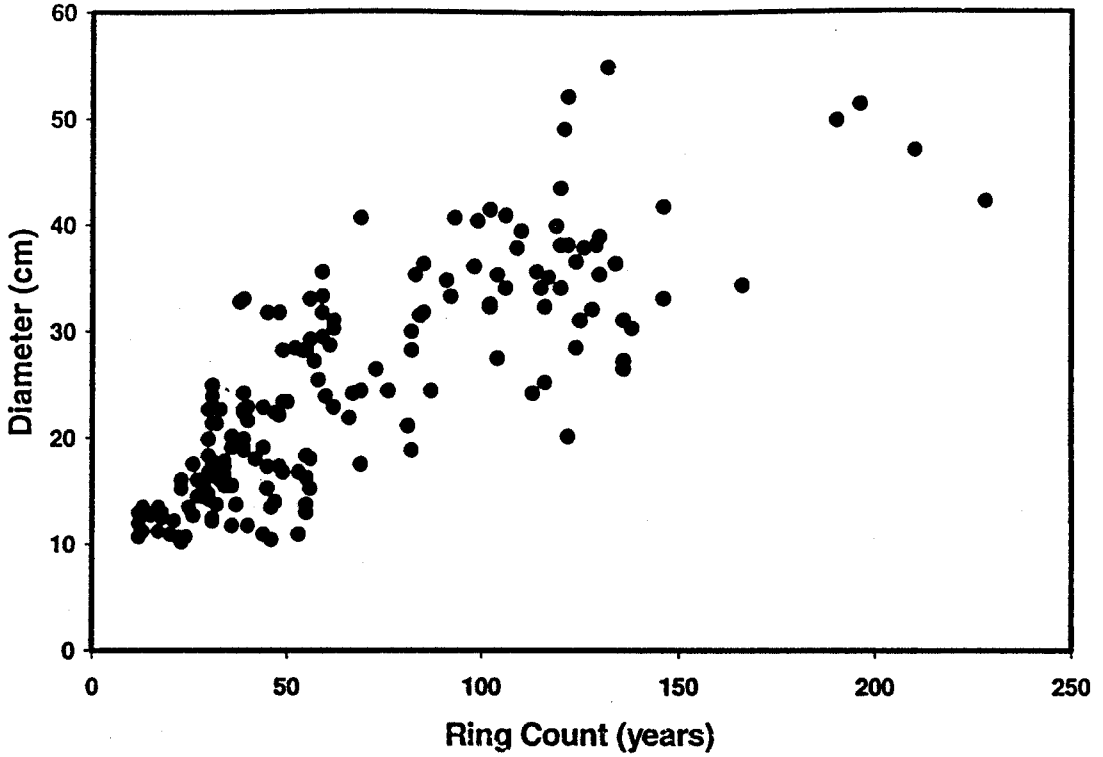

Figure 1. Age-diameter relationship of all trees within Caffey Hill Old-growth Area, Fort McClellan, AL.

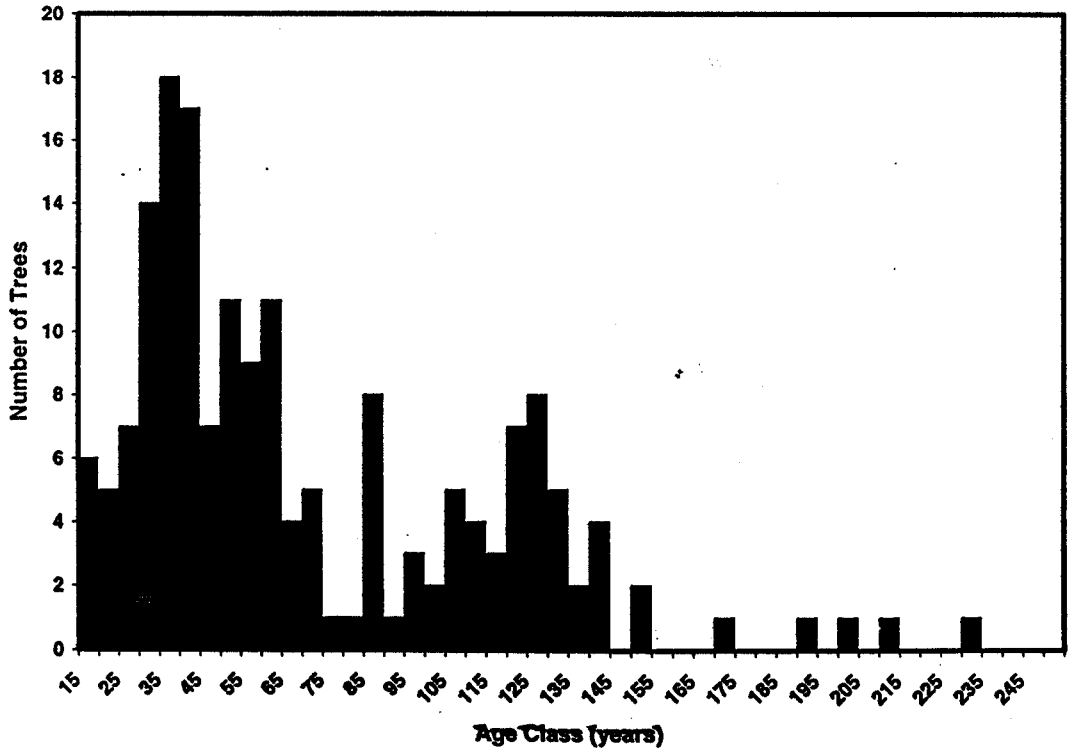

Figure 2. Age class structure of Caffey Hill Old-growth Area, Fort McClellan, AL.

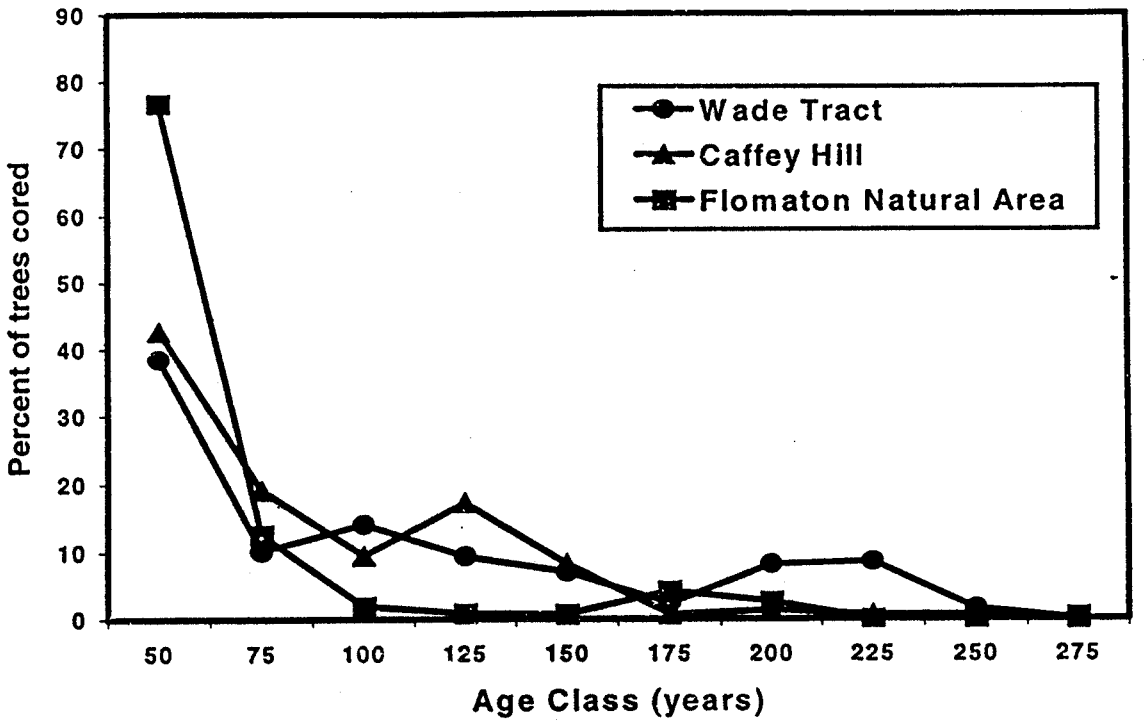

Figure 3. Age class structure comparison of old-growth longleaf pine stands located at Wade Tract, Thomas County, GA, Flomaton Natural Area, Escambia County, AL, and Caffey Hill on Fort McClellan, Calhoun County, AL.