STAND DYNAMICS OF A LONGLEAF PINE RESTORATION PROJECT

John S. Kush and Ralph S. Meldahl[1]

Abstract—Ecological restoration in a longleaf pine (*Pinus palustris* Mill.) stand is being studied in the Flomaton Natural Area (FNA) in Escambia County, AL. The FNA had been protected from fire for over 45 years. The absence of fire permitted a hardwood midstory and litter layer to develop at the expense of longleaf pine regeneration and an herbaceous understory. Reintroducing fire posed a problem because of the existing fuel conditions. The stand was burned in 1995, 1996, 1997, 2001, and 2003. Longleaf pine density has decreased while basal area has remained relatively stable during the restoration efforts. The fuel loads are decreasing slowly and despite the heavy litter layer, longleaf pine regeneration has been established.

INTRODUCTION

Prior to European settlement, forested savannas dominated by longleaf pine and the most diverse herbaceous layer in temperate North America blanketed an estimated 90 million acres in the Southeastern United States. These forests were swept by fire every 1 to 10 years, resulting in an open, park-like nature (Chapman 1932). Due to fire suppression, agriculture, and site conversion, longleaf forests now exist on < 3 percent of their former range. A 1995 U.S. Biological Survey Report listed the longleaf pine forest as the third most endangered ecosystem in the United States (Noss and others 1995). Old-growth longleaf pine forests exist in an even more imperiled state, covering less than 9,900 acres, or 0.01 percent of their former extent (Varner and Kush 2004).

Private, state, and federal land managers have recently undertaken ecological restoration of the longleaf pine forests in the Southeastern United States. Restoration to this point has lacked information on reducing litter accumulations, herbaceous species establishment, changes in overstory structure, and the fate of longleaf pine regeneration during the restoration process.

The Flomaton Natural Area (FNA) is a 60-acre virgin stand of old-growth longleaf pine, currently owned by International Paper, which underwent more than 45 years of fire suppression. The Society of American Foresters (SAF) recognized the importance of this stand in 1963 when they designated the area as the E.A. Hauss Old-Growth Longleaf Natural Area (Walker 1963). The SAF's definition of a natural area is a tract of land set aside to preserve permanently in unmodified condition a representative unit of virgin growth of a major forest type with the preservation primarily for scientific and educational purposes. In 1995, we began a major restoration project with the re-introduction of fire into this fire-suppressed ecosystem (Varner and others 2000). Since then, we have been monitoring and managing the FNA as an old-growth longleaf pine habitat.

METHODS

Study Area

The FNA is located within the city limits of the southern Alabama city of Flomaton, in Escambia County. The climate is humid and mild with a mean annual precipitation of 61 inches well distributed throughout the year. The predominant soil series is the Orangeburg. Formed in marine sediments of sandy loams and sandy clay loams, these soils are low in natural fertility and organic matter.

Prior to the onset of reintroducing fire, 30 permanent 1/5-acre plots were established on a 3 by 4 chain grid to monitor restoration efforts. Within these, four 1-m square quadrats per plot have been surveyed annually for longleaf pine seedlings and herbaceous vegetation.

Fire was reintroduced in 1995. One-half of the FNA was burned in the winter and the other half in the spring. The stand was prescribed burned in 1996, 1997, 2001, and 2003. Due to relatively dry winters and springs and/or lack of help, the stand was not burned between 1997 and 2001. In 2000, the stand was bush-hogged because of the vines and blackberries that were taking over the understory. The bush-hog operation was carried out in such a way to minimize the impact to the longleaf pine regeneration, and there was no noticeable loss in seedling density.

We realized that fire alone would never remove all of the hardwoods. Once hardwoods reach 3 to 4 inches d.b.h. they are little affected by the cooler burns that should be used for the first few fires in old-growth stands. In 1997, a fuelwood operation was conducted in the stand to remove all hardwoods. The operation was conducted carefully, and there was very little damage to the longleaf pine.

RESULTS AND DISCUSSION

Longleaf Pine Overstory

Prior to restoration efforts, longleaf pine accounted for 40 percent of the density, 70 percent of the basal area, and there were no longleaf pine saplings < 1-inch d.b.h. (Kush and Meldahl 2000). The plots have been re-measured three times since 1993. The initial longleaf pine density and basal area were 256 trees acre^{-1} and 78.8 feet^2 acre^{-1}. By 1996, the density dropped to 124 trees acre^{-1}, but the basal area only dropped to 77.6 feet^2 acre^{-1}. The loss in density occurred in the smaller d.b.h. classes as no longleaf < 3 inches d.b.h. remained. In 2000, the density fell to 100 trees acre^{-1} and

[1] Research Associate and Associate Professor, respectively, Auburn University, School of Forestry and Wildlife Sciences, 108 M. White Smith Hall, Auburn, AL 36849.

Citation for proceedings: Connor, Kristina F., ed. 2006. 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. 640 p.

basal area to 76.0 feet^2 acre^{-1}. By 2004, there were 91 trees acre^{-1} and a basal area of 74.9 feet^2 acre^{-1}.

The mortality of longleaf pine between 1993 and 2001 was primarily due to suppression. Between 2000 and 2004, much of the mortality was due to lightning, 48.1 percent, and associated insect attack, 23.6 percent. It appeared that the restoration efforts with the use of fire were responsible for 10.2 percent of the mortality.

Litter Layer

The major problem with the re-introduction and use of fire in the restoration process has been the accumulated fuel loads. The lethal nature of fire occurs when it kills a large portion of the feeder roots which developed over the decades or when the litter around the base of the tree burns, girdling the tree. One of the major concerns with any restoration effort is avoiding a rapid reduction of the accumulated litter layer. Prior to the reintroduction of fire, there were an average of 2.92, 4.79, and 8.03 tons acre^{-1} of litter, partially decomposed litter, and humus in the stand, respectively. By 1997, there were 2.04, 5.02, and 6.54 tons acre^{-1} of litter, partially decomposed litter, and humus, and by 2003, measurements were 1.37, 5.15, and 5.67 tons acre^{-1}, respectively. While progress has been made in reducing the fuel load, a tremendous amount remains. It will take several more years of careful burning to eliminate the partially decomposed litter and humus layer.

Herbaceous Layer

Prior to restoration efforts, there were a number of shrubs and woody vines and only one herbaceous species (Varner and others 2000). After the 1997 fire, there were 23 herbaceous species. There are now 25 genera and more than 40 herbaceous plants and grasses that have appeared within the stand. Most of these species are native plants whose seeds have been stored in the seed bank.

Longleaf Pine Regeneration

H.H. Chapman (1909) wrote "Longleaf pine is found in pure stands but seldom even-aged. Although an extremely intolerant tree, which will thrive best in even-aged stands, the natural form of this forest constantly trends toward small, even-aged groups of a few hundred square feet. Being naturally resistant to fire, large clearings never occur from this cause. In regions of severe winds, or tornadoes, larger even-aged patches and strips are found, sometimes one-quarter to one-half mile in width, which have come in after blowdown. These are pretty well interspersed with patches or single survivors of the old forest, which have acted as seed trees."

Several decades later Wahlenberg (1946) wrote: "The original longleaf pine forests were made up mainly of pure, even-aged irregularly open stands. The even-aged character was the result of relatively infrequent but heavy seed falls and the ability to reproduction to survive only in openings free of an overstory."

During the early hours of September 16, 2004, the eye of Hurricane Ivan passed somewhere to the west of the Flomaton, AL. Winds in the Flomaton, AL area were estimated to be 120 miles per hour. Within a matter of moments, nearly one-third of the eastern side of the stand was on the ground; trees were uprooted or snapped off at various heights along the bole. Those words of Chapman and Wahlenberg describe what is happening in the FNA today. Work by Kush and others (2004) discussed the status of longleaf pine regeneration within the FNA. In 2002, they found 3,100 seedlings acre^{-1} across the entire stand and an average of 8,800 seedlings acre^{-1} across 5 randomly measured gaps. Despite the litter depth, seedlings are becoming established at the FNA. The reason for this apparent success may be due to the low intensity fires and extensive mop-up efforts after burning that have been used to avoid the entire consumption of the litter layer.

ACKNOWLEDGMENTS

Funding for the demonstration component of this project was provided by the Joint Fire Science Program (JFSP). Funding for an Interpretative Trail was provided by a grant from the Forest Stewardship Education Program of the Alabama Forestry Commission. Other partners include: the U.S. Department of Agriculture Forest Service Southern Research Station and International Paper Corporation.

The authors want to express their gratitude to Charlie McMahon, Richard Sampson, Ron Tucker, George Ward, Morgan Varner, and numerous students and other individuals that have been involved in the restoration efforts at the Flomaton Natural Area.

LITERATURE CITED

Chapman, H.H. 1909. An experiment in logging longleaf pine. Forest Quarterly. 7: 385-395.

Chapman, H.H. 1932. Is the longleaf type a climax? Ecology. 13: 328-334.

Kush, J.S.; Meldahl, R.S. 2000. Composition of a virgin stand of longleaf pine in south Alabama. Castanea. 65(1): 56-63.

Kush, J.S.; Meldahl, R.S.; Avery, C. 2004. A restoration success: longleaf pine seedlings established in a fire-suppressed, old-growth stand. Ecological Restoration. 22(1): 6-10.

Noss, R.F.; LaRoe, E.T.; Scott, J.M. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. Biological Report 28. Washington, DC: U.S. Department of Interior, National Biological Service. 58 p.

Varner, J.M., III; Kush, J.S. 2004. Remnant old-growth longleaf pine (*Pinus palustris* Mill.) savannas and forests of the Southeastern USA: importance, status, and threats. Natural Areas Journal. 24(2): 141-149.

Varner, J.M., III; Kush, J.S.; Meldahl, R.S. 2000. Ecological restoration of an old-growth longleaf pine stand utilizing prescribed fire. Tall Timbers Fire Ecology Conference Proceedings. 21: 216-219.

Wahlenberg, W.G. 1946. Longleaf pine: its use, ecology, regeneration, protection, and management. Washington, DC: Charles Lathrop Pack Forestry Foundation. 429 p.

Walker, L.C. 1963. Natural areas of the Southeast. Journal of Forestry. 61(9): 670-673.