SHORTLEAF PINE *(PINUS ECHINATA* MILL.) AND HARDWOOD REGENERATION AFTER THINNING NATURAL SHORTLEAF PINE FORESTS IN SOUTHERN UNITED STATES

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Abstract—Understory pine and hardwood regeneration in the Ozark and Ouachita National Forests were measured in 1995 for the first time following thinning and hardwood control at plot establishment 1985-87. Red maple (*Acer rubrum*), shortleaf pine and flowering dogwood (*Cornus florida*) were the most frequently recorded species. Understory shortleaf pine stems have declined consistently since 1995. The binomial logistic regression model showed that site index and overstory shortleaf pine basal area were negatively related to shortleaf pine regeneration ($P<0.05$). Overstory shortleaf pine thinning may initiate shortleaf pine regeneration at early stage; however, newly regenerated hardwood species will dominate the entire regeneration process long-term, if hardwood control treatments are not applied.

INTRODUCTION

Mixed shortleaf pine hardwood forests are common in southern United States (Kabrick and others 2011, Moser and others 2006). Previous studies have suggested that the overstory shortleaf pine stand area is declining (Moser and others 2006; Lilly and others 2012). At the same time, little is known about the long term regeneration pattern of the understory vegetation in naturally occurring shortleaf pine forests; especially after thinning the overstory shortleaf pine. The purpose of the present study was to evaluate the temporal pattern of regeneration of understory pine and hardwoods after thinning the overstory shortleaf pine. We also predicted the probability of achieving adequate shortleaf pine regeneration after thinning using overstory and understory characteristics.

MATERIALS AND METHODS

Study plot locations were ranged from the Ozark and Ouachita National Forests. There were total of 182 permanent circular study plots 0.2 acres in area. Data were collected approximately every five years. Four circular subplots 0.005 acre area were created inside the 0.2 acre plots, and only two of these were measured in 1996. Understory hardwood trees greater than one inch in diameter at breast height were removed while establishing the plots in 1985-1986. Woody plants greater than breast height were measured beginning in 1995. Species richness, percent density, mean stem density, and relative dominance were calculated. The binomial logistic regression model was used to predict the probability of shortleaf pine regeneration approximately 30 years after thinning.

RESULTS AND DISCUSSION

A total of 68 woody-vegetation species were recorded throughout the measurement periods. The lowest and the highest number of species were recorded in 1996 and 2006 respectively. Red maple was the major species (12.42±3.79 percent in 1996, 15.46±2.93 percent in 2001, 12.47±2.48 percent in 2006 and 22.68±3.79 percent in 2013) in terms of relative density in Ozark National Forest. Flowering dogwood (11.75±1.70 percent in 1996), shortleaf pine (8.56±1.57 percent in 2001) and blackjack oak (9.32±1.63 percent in 2006 and 10.72±1.60 percent in 2013) were the major species in Ouachita National Forest.

Binomial logistic regression model showed probability of getting shortleaf pine stems greater than 500 per acre decreased by 6 percent with each unit increase in site index. Similarly, chances of getting shortleaf pine stems greater than 500 stems per acre decreased by 2 percent with each unit increase in overstory basal area. Results from the present study were consistent with previous findings (Lynch and others 2002).

Results showed red maple and several oak species exceeded shortleaf pine regeneration in recent years. Therefore, control of hardwoods is required to achieve adequate shortleaf pine regeneration. Our results suggested one time thinning of shortleaf pine may not

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be sufficient to obtain the desired amount of shortleaf pine regeneration. Other forest management practices such as controlled burning may be required to achieve the desired shortleaf pine regeneration for long term management.

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