HARDWOOD REGENERATION RELATED TO OVERSTORY SHORTLEAF PINE (*PINUS ECHINATA* MILL.) BASAL AREA, SITE INDEX, AND TIME SINCE CUTTING IN ARKANSAS AND EASTERN OKLAHOMA

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INTRODUCTION

Shortleaf pine grows in association with many other species, particularly understory hardwoods, which compete with it, limiting its productivity (Bower and Ferguson 1968, Cain 1988). Which species are the most competitive varies with site quality, density of the pine overstory and years since thinning. Basal area and site index closely approximate the principle ordination axes, indicating their importance as proxies of competition and site quality. The objective was to measure temporal changes in species composition of the understory over a range of overstory site indices, stand ages and stocking levels.

METHODS

Over 200 fixed-radius 0.081-ha plots were permanently established in naturally-occurring shortleaf pine stands located in the Ozark and Ouachita National Forests during the period 1985-1987 as part of a forest growth study. The study used a 3 by 4 by 5 factorial design with three 50-year-basis site index classes (<55, 55-75 and >75), four initial age classes (11-30, 31-50, 51-70 and 71-90) and five overstory basal area classes (16-45, 45-75, 75-90, 90-135 and >135 square feet). Initially, plots were thinned to assigned basal area levels and hardwoods were treated with chemical herbicide. During the 1995-1997 re-measurement of these plots, two 0.02-ha subplots were established within each of the shortleaf growth plots to assess shortleaf regeneration and abundance of understory hardwoods. During the 2000-2001 re-measurement, an additional two 0.02-ha subplots were added. Seedling counts from each of the four subplots were added together for analysis. Fifty-two hardwood species were included.

Site index was calculated using Graney's (1976) model for each of four shortleaf pines in each plot. The results were then averaged to obtain a plot site index. For analysis, overstory basal area, site index and overstory age were treated as continuous variables.

RESULTS

Canonical correspondence analysis using CANOCO (ter Braak and Smilauer 1998) showed the overstory pine basal area, site index and time axes meeting almost at right angles, indicating low covariance among the variables and their usefulness as predictors of seedling stocking. Sweetgum (*Liquidamber styraciflua* L.) predominated on sites with pine site indices greater than 85; dogwood (*Cornus* spp. L.) on sites between 70 and 85 and red maple (*Acer rubrum* L.) on sites with pine site indices less than 70.

Sweetgum stem counts decreased exponentially as pine basal area increased. On sites with pine site indices greater than 65, seedling stem counts for sweetgum increased exponentially as site index increased, but remained constant with time (10 to 16 years after thinning).

As pine site indices increased, dogwood stem counts increased to a high at 85 square feet, and then decreased. Dogwood stem counts at first decreased with overstory pine basal area to a low at 30 square feet, and then increased exponentially with increasing basal area. Dogwood stem counts decreased for the first 12 years after thinning, then increased. After the twelfth year, there were no dogwood seedlings at all on sites with pine basal areas between 20 and 45.

Red maple stem counts decreased to a minimum at 45 square feet of overstory basal area, and then increased exponentially as overstory basal area increased. Red maple stem counts increased in a straight line as pine site index increased. Red maple reached a maximum stem count in the 11th year following thinning.

Mockernut hickory (*Carya tomentosa* Nutt.) was present on every plot. Stem counts reached a maximum at a pine site index of 60, decreasing in both directions. Stem counts reached a minimum in the 11th year following thinning, and then started to rise.

CONCLUSIONS

Sweetgum's sensitivity to pine site quality and relative insensitivity to time suggests it could be used as an indicator species for shortleaf pine site index. Sweetgum appears to suppress pine regeneration on sites with indices above 85. Red maple stem counts exceeding those of dogwood and sweetgum are indicative of pine site index below 70. Basal area of the pine overstory and pine site index are important indicators of species composition. Complex requirements of most understory species will require many different models to make prediction of species composition possible. It is theoretically possible to use species composition as a variable in predicting shortleaf pine growth and yield.

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