

ESTIMATING THE PROBABILITY OF ACHIEVING SHORTLEAF PINE REGENERATION AT VARIABLE SPECIFIED LEVELS

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POSTER SUMMARY

A model was developed that can be used to estimate the probability of achieving regeneration at a variety of specified stem density levels. The model was fitted to shortleaf pine (*Pinus echinata* Mill.) regeneration data, and can be used to estimate the probability of achieving desired levels of regeneration between 300 and 700 stems per acre 9-10 years after thinning to a specified level of overstory basal area per acre. The level of regeneration to be achieved was used to modify a logistic model to estimate probability of obtaining regeneration at the desired level. Variables used in the model to predict probability of achieving the desired regeneration level were site index for shortleaf pine (base age 50), overstory basal area, age at time of thinning and a dummy (0 or 1) variable representing year of plot establishment.

The data consisted of measurements made on 5-milacre plots located within 182 circular permanent plots, 0.2-acre in size. These plots were established in natural even-aged pure shortleaf pine stands thinned to predetermined residual overstory basal area levels in one of four density categories: 30, 60, 90 or 120 square feet per acre. Plots were established in four age categories (20, 40, 60 and 80 years) and in four site index classes (50, 60, 70, 80 feet at 50 years). At the time of plot establishment hardwoods were treated with herbicide by tree injection or girdling. Each 0.2-acre plot was surrounded by a 33-foot buffer strip, which received the same thinning and herbicide treatment. Shortleaf pine regeneration stems were tallied on two 5-milacre plots located due north and south midway between the plot center and the boundary of each 0.2-acre shortleaf pine overstory plot. The regeneration sample occurred 9-10 years after plot establishment.

Larson and others (1997) used a logistic model to predict the probability of achieving specified levels of oak regeneration. Target density levels could not be varied within a particular equation for the models developed by Larson and others (1997). However, they fitted several equations independently to different target density

levels. For the current study, varying levels of shortleaf pine regeneration density levels were obtained by using the natural logarithm of the specified density level as an independent variable in a logistic model. To obtain a satisfactory fit for the model it was necessary to form an independent variable by multiplying the natural logarithm of density level by the square of site index.

Parameter estimation for this model with common logistic regression software is problematic because the level of regeneration success is variable. Therefore, a maximum likelihood procedure was developed and used to estimate parameters in this model. Three levels of regeneration success were specified for the purpose of parameter estimation: 300, 500 and 700 stems per acre. These levels were used to define regeneration categories such that each plot could be assigned to one of these categories, for example, more than 300 but less than 500 stems per acre. A multinomial distribution based on these categories was used to develop a likelihood function. The modified logistic function was used to represent probabilities in the likelihood function. The LOGDEN function in SHAZAM (White 1993) econometric software was used to maximize the likelihood function with respect to equation parameters so that maximum likelihood estimates were obtained.

Parameter estimates from the model indicate that adequate shortleaf pine regeneration is less likely on good sites than on poor sites as measured by shortleaf pine site index. Adequate shortleaf pine regeneration becomes less likely as overstory basal area per acre increases, and is less likely at young overstory stand ages. The parameter estimate associated with year of thinning and herbicide treatment indicates that the probability of obtaining adequate regeneration can vary substantially due to the year in which thinning and herbicide treatment occurred. This could be due to variability in shortleaf pine seed crops and/or conditions for seedling establishment and survival. The resulting model for prediction of probability for regeneration success should be applicable for levels of shortleaf pine regeneration between 300 and 700 stems per acre.

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