ESTIMATING THE PROBABILITY OF SURVIVAL OF INDIVIDUAL SHORTLEAF PINE (PINUS ECHINATA MILL.) TREES

Sudip Shrestha, Thomas B. Lynch, Difei Zhang, and James M. Guldin

A survival model is needed in a forest growth system which predicts the survival of trees on individual basis or on a stand basis (Gertner, 1989). An individual-tree modeling approach is one of the better methods available for predicting growth and yield as it provides essential information about particular tree species; tree size, tree quality and tree present status. Individual tree survival models simulate survival and growth of individual trees in a forest stand. They are important in determining the development pattern of stand. A survival model is a major component of the Shortleaf Pine Stand Simulator (SLPSS) (Huebschmann, 1998) which has been developed for even-aged natural shortleaf pine forests. SLPSS includes a prediction equation for probability of tree survival which is based on repeatedly measured plots permanently located in the Ozark and Ouachita National forests which have diverse ages, site qualities and densities.

We developed an individual tree survival model for shortleaf pine (*Pinus echinata* Mill.) trees. Data for this study were from more than 200 permanently established plots on even-aged natural shortleaf pine stands that were located in the Ozark and Ouachita National Forests. Plots were established during the period of 1985-1987. Plots have been remeasured in every 4 to 6 years and individual tree survival or mortality was recorded at each measurement. Logistic regression was used to find the best sets of significant predictor variables to predict periodic survival.

Significant variables found in predicting the survival were mid-period basal area per acre (Mid-BA), inverse of ratio of quadratic mean diameter to DBH (diameter at breast height) (DRINV), their interaction and square of DBH (DBHSQ). These independent variables were found to be very significant in predicting annual probability of survival of a tree (Shrestha 2010). Parameters of the logistic equation were estimated using iteratively re-weighted nonlinear regression. Various independent variables such as square root of DBH, square of DBH / mid-basal area, tree dominant height, site index, and mid-plot age etc. were tested in addition to the variables finally selected for use in the model but they were found nonessential in estimating annual survival of individual shortleaf pine trees.

The final model selected for this study contained the following independent variables: Mid-BA, DRINV, DBHSQ, and Mid-BA × DRINV. Predicted values from the model can be interpreted as probabilities of survival for shortleaf pine trees having the characteristics indicated by the independent variables. Based on the results from the final model, the observed frequencies of individual tree survival have no severe deviation from the expected frequencies indicating that the model for survival fits well. The final model above was evaluated using the Chi-square goodness of fit test and it was found that the model was not rejected at the alpha level of 0.01 significance. The model was rejected by the goodness-of-fit test at the significant level of 0.05 because of these high mortality results in some of the diameter classes. We found that the contribution to chi-square value from mortality is much higher than for survival and there was much more fluctuation in observed and expected number of mortality trees as compared to survival trees suggesting the model did not always behave as well for mortality trees.

The final model is considered as a better alternative than a constant survival rate and could be selected for use in the SLPSS, which is a distance-independent individual tree growth simulator for naturally-regenerated shortleaf pine. This individual tree survival model can be used to predict the annual survival rate of individual trees of even aged shortleaf pine forests located in Ozark and Ouachita National Forests.

Sudip Shrestha, Former Graduate Research Assistant, Dept. Natural Resource Ecology and Management, Oklahoma State University, 008C Ag Hall, Stillwater, OK 74078
Thomas B. Lynch, Professor, Dept. Natural Resource Ecology and Management
Difei Zhang, Assistant Professor, Dept. Natural Resource Ecology and Management
James M. Guldin, Forest Ecologist/Supervisory Project Leader, USDA Forest Service Southern Research Station, USDA Forest Service, Hot Springs, AR 7192

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