1972

Predicting Survival Of Unthinned, Old-Field Loblolly Pine Plantations

J. David Lenhart
Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University

Predicting Survival Of Unthinned, Old-Field Loblolly Pine Plantations

ABSTRACT—A prediction equation, graph, and tables can assist forest landowners in estimating tree survival in unthinned loblolly pine (Pinus Taeda *L.*) *plantations in the Interior West Gulf coastal plain.*

Development of equations to predict survival of planted trees requires measurements in many locations repeated over long time intervals. Unfortunately, very few such long-term records are available owing to the extreme cost and short life of many "permanent" plots. But a yield study (*1*) involving one-point-in-time measurements in 219 loblolly pine plantations has permitted the construction of a survival prediction equation which may be useful to forest management.

Values collected from temporary sample plots located randomly within each of the plantations included present plantation age, initial number of trees planted per acre (calculated by expanding initial planting spacing), and surviving number of trees per acre at the present age. To be considered for sampling, each plantation had to be at least nine years old, unthinned, unburned, and relatively free of insect damage and disease occurrence (such as fusiform rust). The plantations were located through the Interior West Gulf coastal plain region of Texas, Oklahoma, Arkansas, and Louisiana.

Tree survival was expressed as the ratio of the surviving number of trees to the initial number of trees. To better satisfy linearity assumptions and restrict the range of predicted survival rates to the interval 0.0 to 1.0, the survival rates were transformed to probits.[1]

J. David Lenhart

THE AUTHOR is assistant professor of forest biometrics, School of Forestry, Stephen F. Austin State Univ., Nacogdoches, Tex. Study supported in part by funds under the McIntire-Stennis Act.

Prediction Equation

Using techniques developed by Lenhart and Clutter (*2*), the prediction equation developed from multiple linear regression analysis is

$$\text{Probit}(SP) = 10.48246 - 1.290061\text{og}(A) - 1.136441\ \text{og}(IT),$$

where: Probit(SP) = the probit of survival percentage,

[1] The probit of a value, x, is the standard normal deviate of x plus 5.

Table 1. Planting Densities Required to Obtain a Specified Stand Density at a Given Age.

Desired density	Plantation age 10	15	20	25
Trees per acre	*Initial number of trees per acre*			
500	585	640	701	766
600	728	800	889	985
700	870	981	1,100	1,242
800	1,025	1,169	1,332	1,525
900	1,193	1,376	1,585	
1,000	1,357	1,592		
1,100	1,540			
1,200	1,722			

A = present plantation age, and
IT = initial number of trees planted per acre.[2]

For this equation, 12.2 percent of the total variation in the dependent variable was accounted for by the independent variables. The standard deviation of the estimate was 0.484. Though the relationship shown in this equation is weak, the equation should be useful in presenting logical trends of mortality within a loblolly pine plantation over time. The coefficient of determination for this study is almost identical to 12.0 percent found by Lenhart and Clutter for loblolly pine plantations in the Georgia Piedmont using the same variables.

To calculate the number of trees expected to survive at a future age, the probit must first be determined by inserting the intial number of trees planted per acre and the future plantation age into the prediction equation. Five should then be subtracted from the predicted probit, which will result in a Z value. The probability or survival rate associated with the Z value can be determined from a table of the standard normal deviate. Tree survival is the product of the predicted survival rate times the initial number of trees planted.

Application

An indication of the expected long-term success of regeneration efforts is possible by using the survival-prediction equation. For example, if 1,000 trees were planted initially, how many trees might be alive in 10 years? 20 years? Letting $A = 10$ and $IT = 1{,}000$, then Probit $(SP) = 5.78$. Subtracting 5 gives a Z of 0.78. The probability or survival rate associated with this Z value is $0.5 + 0.2823$ or 0.7823. Multiplying this value times the initial number of trees, 1,000, results in 782 trees expected to survive to age 10. Following this same procedure, but letting $A = 20$, about 652 trees will be living, which implies that 130 trees will die between the ages of 10 and 20. Figure 1 illustrates these trends for selected values of initial planting densities.

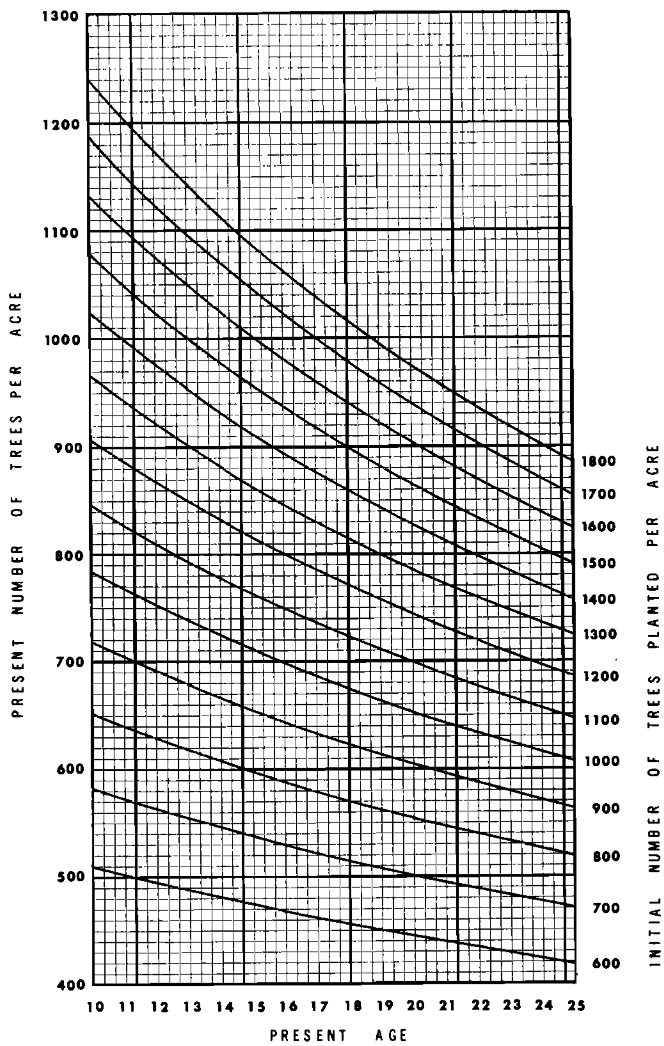
Table 1 may be used to determine the number of trees to plant in order to obtain a desired density at a given plantation age. If 700 trees are required at age 15, then 981 trees should be planted initially. If a forestry operation wishes to increase the number of trees per acre at a harvest age of 25 from 600 to 700, it must increase its planting density by 257 trees from 985 to 1242.

[2] All logarithms are to the base 10.

Table 2. Number of Trees per Acre Expected to Survive Based on Stand Density at Specified Ages.

[illegible]	Number of trees per acre							
[illegible]	[illegible]	600	700	800	900	1,000	1,100	1,200
[illegible]	[illegible]	555	639	725	811	892	976	1,056
[illegible]	[illegible]	516	590	665	741	808	881	947
[illegible]	[illegible]	484	[illegible]	617	682	742	805	863
[illegible]	[illegible]	600	700	800	900	1,000		
[illegible]	[illegible]	554	645	731	817	901		
[illegible]	[illegible]	518	598	673	637	821		
[illegible]	[illegible]	600	700	800	900			
[illegible]	[illegible]	558	647	734	819			

Fig. 1. Predicted survival for unthinned, old-field loblolly pine plantations in the Interior West Gulf coastal plain.



Values in Table 2 can be used to adjust variable density yield tables for expected mortality after a given age and density. If a cruise of a plantation indicates 800 trees at age 15, then 731 and 673 trees are expected to be surviving at age 20 and 25, respectively. Or, if 1,100 trees are present at 10, then 295 or about 27 percent of them will die by age 25.

Information on 30-year survival of 17 small loblolly pine plantations established on cutover sites (not old fields) in central Louisiana was used by Philip C. Wakely to evaluate the survival-prediction model (*personal communication*). The initial number of trees per acre was 800. At age 30, the plantations were highly variable in survival, ranging from 366 to 614 trees per acre, with a midpoint of 490. When the curve in Figure 1 for 800 initial trees is extrapolated to age 30, the value for expected surviving trees is 487. Even though individual plantations varied widely, the prediction model for this one application appears to follow the general trend.

Literature Cited

1. LENHART, J. D. 1972. Cubic-foot yields for unthinned old-field loblolly pine plantations in the Interior West Gulf Coastal Plain. Texas Forestry Paper No. 14. (In press).
2. ———— and J. L. CLUTTER. 1971. Cubic-foot yield tables for old-field loblolly pine plantations in the Georgia Piedmont. Georgia Forest Research Council Report No. 22, Series 3. 12 p.