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

Terry L. Hackett

ESTIMATING SURVIVAL FOR EAST TEXAS PINE PLANTATIONS

by

J. David Lenhart

Terry L. Hackett

REPORT NUMBER 19

TO

PARTICIPATING COMPANIES

IN THE

EAST TEXAS PINE PLANTATION RESEARCH PROJECT

A STUDY OF

LOBLOLLY AND SLASH PINE PLANTATIONS

IN

EAST TEXAS

CENTER FOR APPLIED STUDIES
SCHOOL OF FORESTRY
STEPHEN F. AUSTIN STATE UNIVERSITY
NACOGDOCHES, TEXAS 75962

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This is the nineteenth in a continuing series of reports describing results from the East Texas Pine Plantation Research Project.

Subject and content of each ETPPRP report is regional in scope and of particular interest to loblolly and slash pine plantation owners in East Texas.

Any suggestions, ideas or comments will always be welcomed.

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This report is based on work by J. David Lenhart, Professor, SFASU and Mr. Terry L. Hackett, Statistician, Indian River International, Nacogdoches, TX. Mr. Hackett received an MSF degree from SFASU in 1987.

J. David Lenhart
Project Director
February 12, 1988

ESTIMATING SURVIVAL FOR EAST TEXAS PINE PLANTATIONS

By

J. David Lenhart
School of Forestry, SFASU, Nacogdoches, TX 75962

Terry L. Hackett
304 King Street, Nacogdoches, TX 75961

ABSTRACT. Equations to estimate the expected number of trees per acre at future points within a rotation are presented for planted loblolly pine (*Pinus taeda* L.) and slash pine (*Pinus elliottii* Engelm) trees on non-old-fields in East Texas. Separate functions are presented for fusiform rust infected trees and uninfected trees.

INTRODUCTION

Accurate and precise estimates of wood production by East Texas pine plantations at various future points during a rotation requires reliable survival functions. These forecasts of number of trees per acre can be combined with plantation age and site index to predict wood yields at those points in time.

Survival prediction for loblolly and slash pine plantations in the southern United States is complicated by the occurrence of fusiform rust (*Cronartium quercuum* (Berk.) Miyabe ex Shirai f. sp. *fusiforme*). Growth and survival of all the planted pines are affected by factors, such as climate, insects and competition from non-planted vegetation, as well as neighboring planted stems. However, a rust-infected tree is less likely to survive these factors due to a weakened condition from stem galls.

Since stem rust infection rates are averaging about 11% in loblolly and 57% in slash pine plantations in East Texas(Hunt and Lenhart 1986), it is necessary to model survival functions that incorporate the additional effect of rust galls on tree stems. This report presents a set of survival estimation equations for East Texas pine plantations.

Some of the material in this report has been submitted to the Southern Journal of Applied Forestry for consideration for possible publication.

PLANTATION MEASUREMENTS

East Texas Pine Plantation Research Project (ETPPRP) plots in plantations five years or older at initial measurement were selected for survival analysis. A five year age limit was required, because field crews were not able to reliably detect fusiform rust galls on trees less than 5 years old. Seventy loblolly and 38 slash pine ETPPRP plots met this requirement.

Within each subplot of a plot, at both initial measurement (1982-84) and second measurement (1985-87), the occurrence of fusiform rust was recorded for each planted pine as:

1. Infected Stem - Gall on stem or on a live branch within 12 in. of stem.
2. Infected Branch - Gall on a live or dead branch more than 12 in. from stem.

For each subplot, the variables available for analysis are:

A_i = Number of growing seasons completed at initial measurement.

N_{ui} = Number of uninfected stems per acre at initial measurement.

N_{ii} = Number of infected stems per acre at initial measurement.

A_s = Number of growing seasons completed at second measurement.

N_{us} = Number of uninfected stems per acre at second measurement, that were also uninfected at initial measurement.

N_{is} = Number of infected stems per acre at second measurement, that were also infected at initial measurement.

Means and ranges of the plantation variables are tabulated by subplot type and species in Table 1.

Table 1. Descriptive statistics of pine plantation survival observations by species and subplot type.

Stand Parameter	Species			
	Loblolly Subplots		Slash Subplots	
	Development	Evaluation	Development	Evaluation
Initial Age (A_i)				
Mean	9.1	9.1	8.8.	8.8
Range	5-17	5-17	5-16	5-16
Remeasured Age (A_s)				
Mean	11.6	11.6	11.4	11.4
Range	7-19	7-19	7-18	7-18
Uninfected Initial Trees/Acre (N_{ui})				
Mean	413	420	201	223
Range	113-714	139-732	43-845	44-758
Uninfected Surviving Trees per Acre (N_{us})				
Mean	407	414	197	219
Range	113-688	135-697	43-845	40-754
Survival Rates for Uninfected Trees	99%	99%	98%	98%
Infected Initial Trees per Acre (N_{ii})				
Mean	32	30	145	143
Range	0-200	0-144	26-322	26-331
Infected Surviving Trees per Acre (N_{is})				
Mean	30	27	126	120
Range	0-191	0-109	26-261	26-249
Survival Rates for Infected Trees	94%	90%	87%	84%

ESTIMATING SURVIVAL

A survival estimation model developed by Devine and Clutter (1986) expresses the additive effects of mortality associated with fusiform rust infected trees in addition to mortality associated with uninfected trees as:

$$N_s = N_i \exp(b_1 K(A_s - A_i) + b_2 K(\ln(A_s/A_i)) + b_3(A_s - A_i)) \quad (1)$$

where

N_i = Initial number of trees present at start of projection period--age A_i,

N_s = Surviving number of trees present at end of projection period--age A_s,

K = 1, when the model is applied to trees with infected stems,

K = 0, when the model is applied to uninfected trees,

b_1, b_2, b_3 = Regression coefficients and

ln = Natural logarithm.

Equation (1) was fit to the loblolly pine model development subplot data using nonlinear regression procedures as:

$$N_s = N_i \exp(-0.038119(K)(A_s - A_i) + 0.236920(K)(\ln(A_s/A_i)) - 0.005747(A_s - A_i)) \quad (2)$$

with associated asymptotic standard deviations:

S(-0.38119) = 0.029311,

s(0.236920) = 0.328420 and

S(-0.005747) = 0.000792.

If equation (2) is applied to loblolly pines that do not have stem galls, set K = 0, delete terms and the equation is modified to:

$$N_{us} = N_{ui} \exp(-0.005747(A_s - A_i)) \quad (3)$$

If equation (2) is applied to planted loblolly pine trees that do have stem galls, set K = 1, combine terms and obtain:

$$N_{is} = N_{ii} \exp(-0.043866(A_s - A_i))(A_s/A_i)^{0.236920} \quad (4)$$

Table 2. Instantaneous mortality rates for rust-infected planted loblolly and slash pine trees in East Texas.

Plantation Age (yrs)	Instantaneous Mortality Rates	
	Loblolly	Slash
6	-0.0044	-0.1264
8	-0.0143	-0.1059
10	-0.0202	-0.0935
12	-0.0241	-0.0853
14	-0.0270	-0.0794
16	-0.0291	-0.0750
18	-0.0307	-0.0716
20	-0.0320	-0.0688

EVALUATION

On the average, for a relatively short projection period of two to four years, the evaluation subplots in loblolly pine plantations, predicted survival of trees without cankers on the stem exceeded actual survival by 0.42 trees per acre, and predicted survival of trees with stem galls was greater than actual survival by 1.47 trees per acre or about 5%. More variability was seen for evaluation subplots in slash pine plantations, where expected survival of trees clear of stem galls exceeded observed survival by 1.48 trees per acre, and predicted survival of trees with rust-infected stems was underestimated by 11.35 trees per acre or about 9.5%. For each species, plottings of survival differences over stand parameters indicated no adverse trends.

APPLICATION

Initial fusiform rust stem infection rates of 10% and 50% were applied to example 5-year old East Texas loblolly and slash pine plantations, respectively. For each species, initial number of stems per acre at age 5 was 400. Equations (3) and (4) were utilized to predict future number of trees per acre for loblolly, and Equations (6) and (7) estimated future trees per acre for slash, Table 3.

For loblolly pine during each of the three successive 5-year periods, the number of trees with stem galls that died was 2, 4 and 5. In contrast, for slash pine, during the 3 periods, the number of infected trees that died was 86, 39 and 23. During the 15-year projection period, 30 uninfected loblolly pines, and 9 uninfected slash pines died.

LITERATURE CITED

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