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Research Project No. 11, Stand Structure and Yield of Loblolly Pine Plantations on Non-old-fields in East Texas

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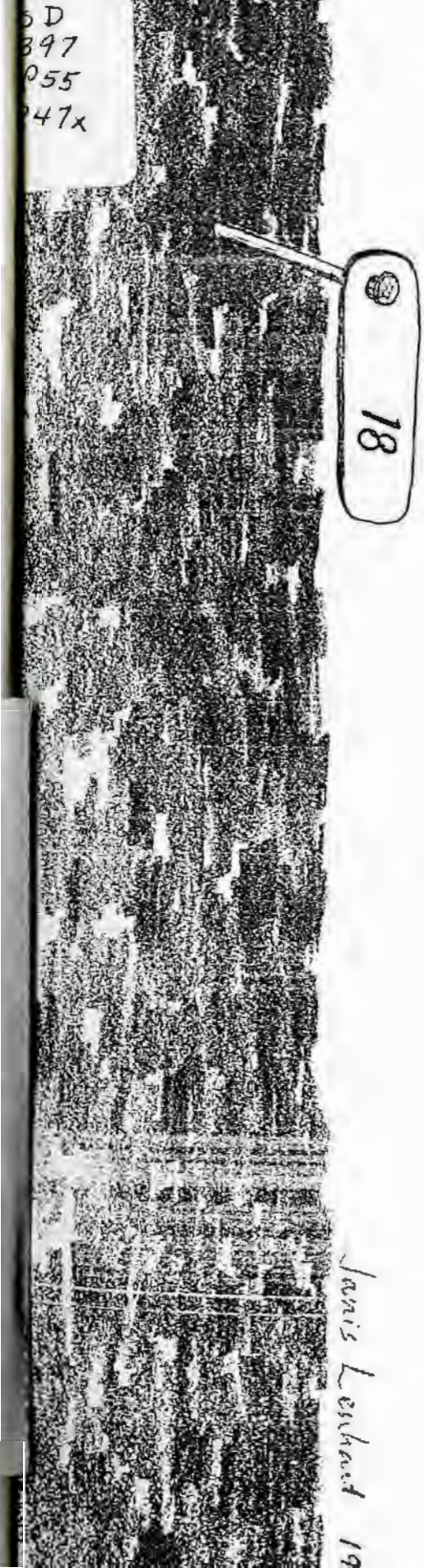

STAND STRUCTURE AND YIELD OF LOBLOLLY PINE PLANTATIONS ON NON-OLD-FIELDS IN EAST TEXAS

by

J. David Lenhart

REPORT NUMBER 11

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

November, 1986

This is the eleventh 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.

* * * * * * * * *

Support from the participating companies...
Champion International Corporation,
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This report is based on work by J. David Lenhart.

J. David Lenhart
Project Director
November 21, 1986

STAND STRUCTURE AND YIELD OF LOBLOLLY PINE PLANTATIONS ON NON-OLD-FIELDS IN EAST TEXAS

by

J. David Lenhart
Professor, School of Forestry, SFASU

ABSTRACT. A diameter distribution yield prediction system is presented for loblolly pine (*Pinus taeda* L.) plantations on non-old-fields in East Texas. The system was developed using data from the initial measurement of the ETPPRP permanent plots in loblolly pine plantations.

INTRODUCTION

Many of the loblolly pine plantations in East Texas that were established on sites converted from mixed pine-hardwood stands are approaching possible timber harvest. In order to optimize the timing of the harvests, information is needed on the amount of wood per acre expected at various plantation ages with differing trees per acre and site index values. If, in addition, the wood per acre can be predicted on a dbh class basis, it would assist the forest manager in assigning different stumpage prices to various tree size classes.

With the completion of the initial cycle of measuring the permanent plots of the East Texas Pine Plantation Research Project, a complete data set was available for diameter distribution yield prediction analysis.

In this report, a method is presented to predict the stand structure-number of trees per acre by dbh classes and individual total tree heights by dbh classes-and subsequently, the amount of wood per acre by dbh classes for loblolly pine plantations on non-old-fields in East Texas.

The material in this report was described in a paper presented at the Fourth Biennial Southern Silvicultural Research Conference in Atlanta, Georgia on November 6, 1986.

PERMANENT PLOT MEASUREMENTS

The ETPPRP permanent plots were installed and measured during the summers of 1982, 1983 and 1984 by a field crew from the School of Forestry at Stephen F. Austin State University.

Each plot consists of two subplots - one to remain unthinned and the other may eventually receive thinning treatments (Lenhart et al. 1985). For our stand structure and yield analysis, the to-remain-unthinned subplot was classified as the regression subplot, and the other subplot was classified as the evaluation subplot. The diameter distribution yield prediction system was developed using the regression subplots and tested using the evaluation subplots.

Within a subplot in a plot, each planted pine was measured as to dbh - nearest tenth of inch and total tree height - nearest foot, among other values.

The observed values available for stand structure analysis were:

1. Age - number of growing seasons completed (A).
2. Stand height - average height of the ten tallest trees (H).
3. Total number of trees per acre (T).
4. Number of trees per acre by dbh class.
5. Minimum dbh - (DMIN).
6. Arithmetic mean dbh - (DMEAN).
7. Quadratic mean dbh - (DQMEAN).

A site index (base age = 25 years) value (S) was predicted for each plot using an equation developed by Blackard (1985a, 1986) and Lenhart et al. (1986).

An exploratory investigation of fitting the Weibull distribution to the observed number of trees per acre by diameter class indicated that a regression subplot had to have trees in three dbh classes or more. If two dbh classes or less were occupied, the fitting routines would usually fail to find a solution.

Thus, the number of loblolly plots available for analysis was reduced from 174 to 77. Number of plots by county is shown in Figure 1. Distributions of the 77 plots by age, site index and number of trees per acre are illustrated in Figures 2-4.

For the 77 plots, average stand parameters are:

1. Age = 9 years.
2. Height = 31 feet.
3. Site index = 72 feet.
4. Number of trees per acre = 457.
5. Average minimum diameter = 1.2 inches.
6. Average arithmetic mean diameter = 4.2 inches.
7. Average quadratic mean diameter = 4.4 inches.

This is a set of young plots on productive sites with wide tree spacing.

n = 77 plots

FIG. 1. DISTRIBUTION OF LOBLOLLY PINE ETPPRP PLOTS UTILIZED IN REGRESSION ANALYSES BY COUNTY.

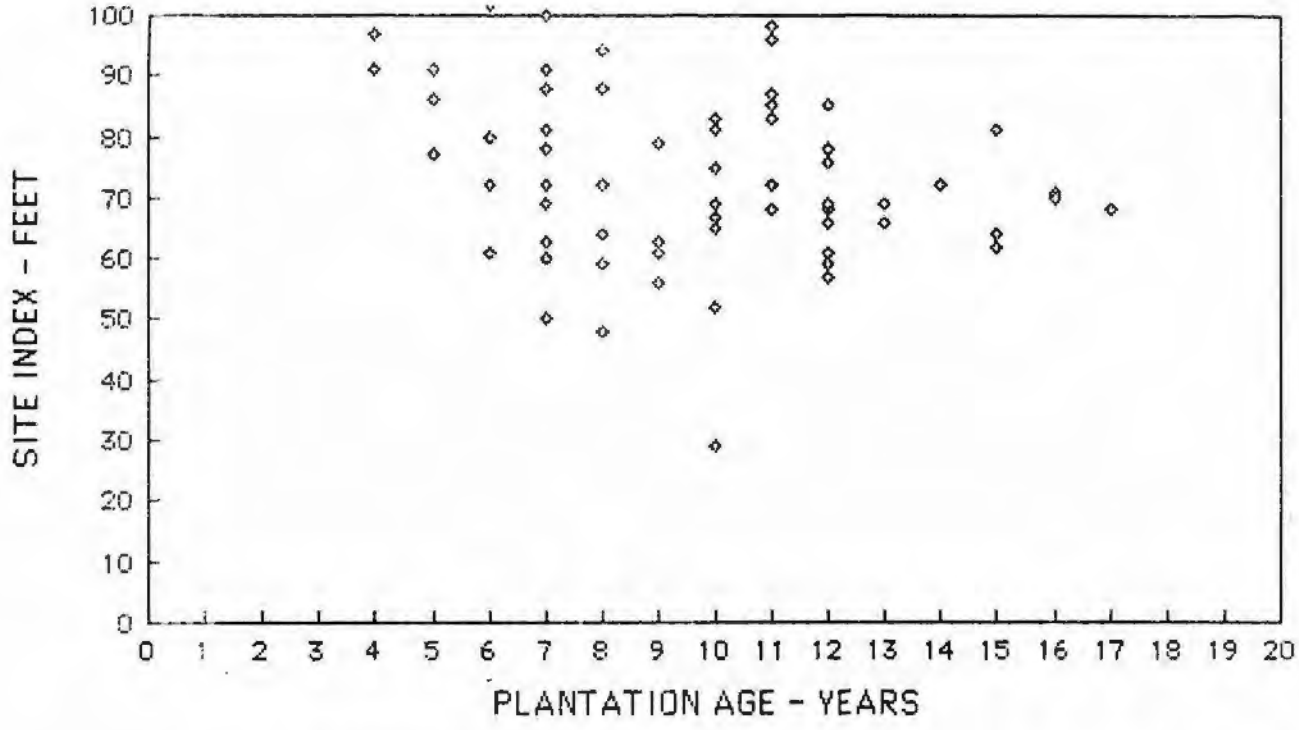


FIG 3. NUMBER OF LOBLOLLY REGRESSION SUBPLOTS BY SITE INDEX AND AGE. n = 77 obs.

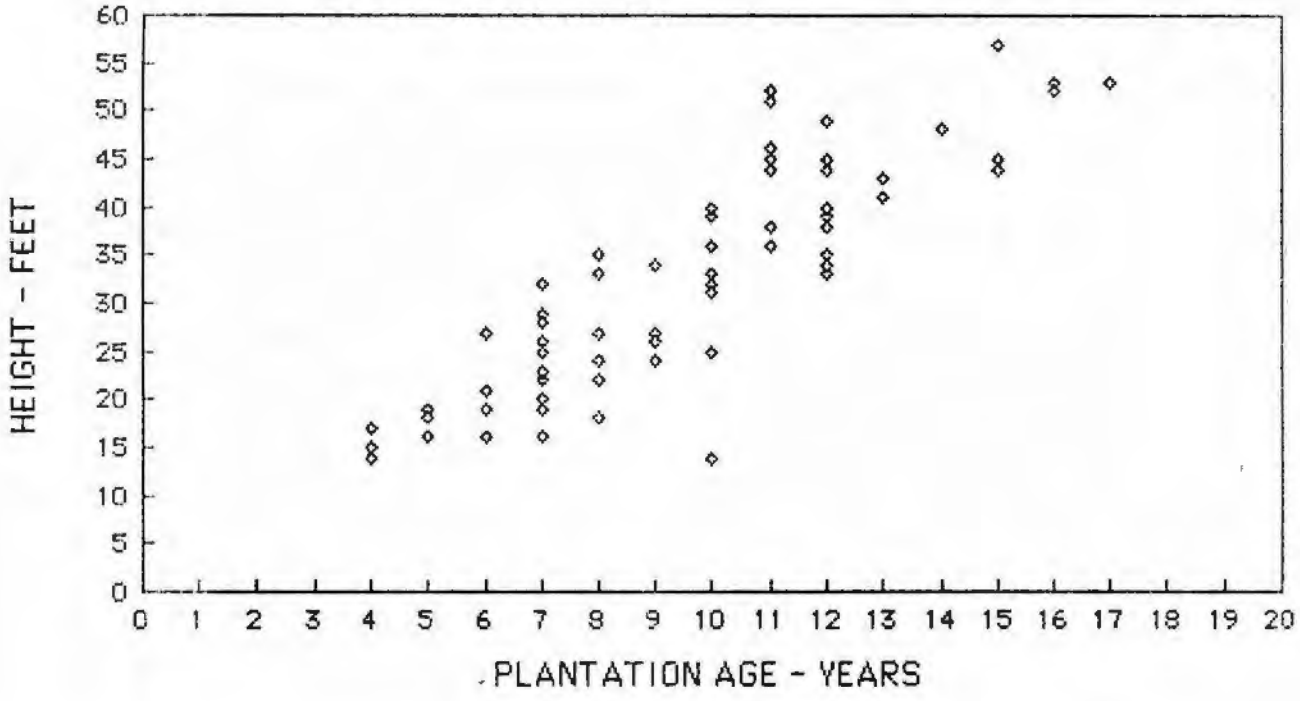


FIG. 2. NUMBER OF LOBLOLLY REGRESSION SUBPLOTS BY HEIGHT AND AGE. n = 77 obs.

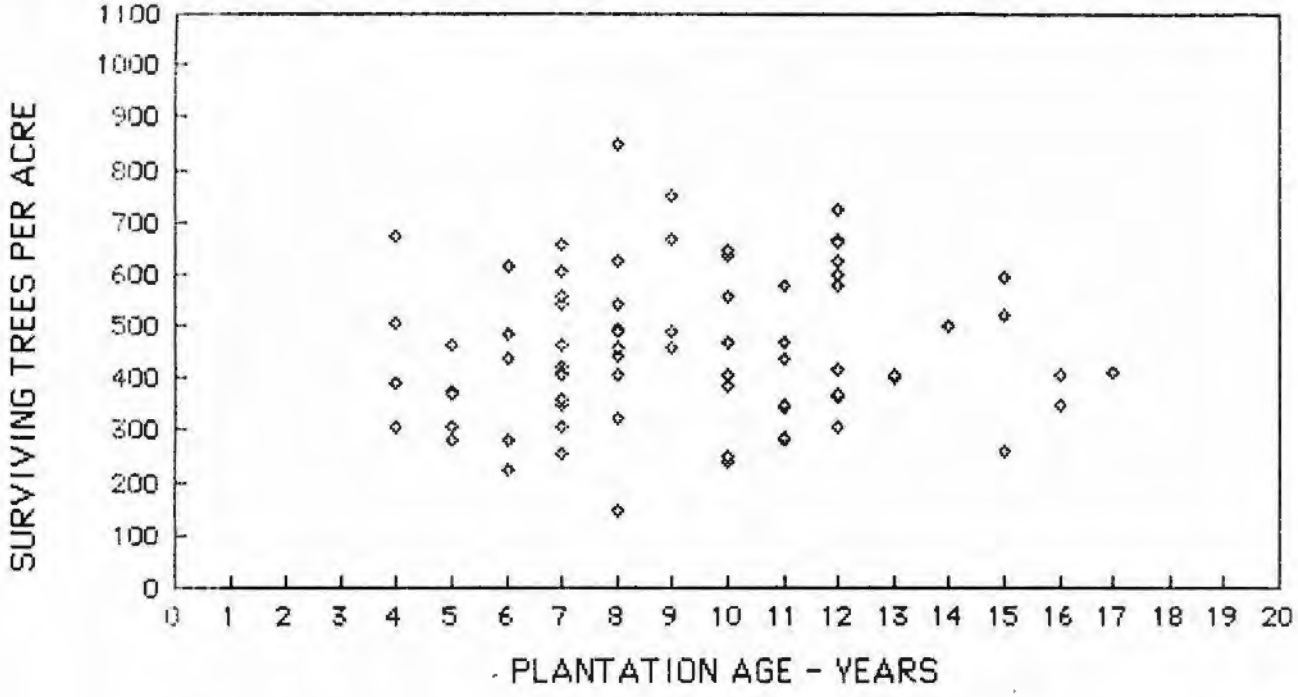


FIG. 4. NUMBER OF LOBLOLLY REGRESSION SUBPLOTS BY TREES PER ACRE AND AGE. n = 77 obs.

PREDICTING STAND STRUCTURE AND YIELD

After considering several possible methods of fitting the Weibull distribution to the data set, I decided to use the Weibull parameter recovery procedure developed by Burk and Burkhart (1984). The Burk and Burkhart method consists of:

1. Using stand values to estimate the minimum diameter, which is the location parameter of the Weibull distribution.
2. Using stand values to estimate the arithmetic mean diameter.
3. Using stand values to estimate the quadratic mean diameter.
4. Obtaining values for the scale and the shape parameters of the Weibull distribution through iterative procedures.

The complete system for predicting the stand structure and amount of wood per acre for loblolly pine plantations in East Texas is described in Figure 5.

Computer software written in FORTRAN or BASIC is available from the ETPPRP to generate diameter distributions for loblolly pine plantations in East Texas showing:

1. Number of trees per acre by diameter class.
2. Individual tree heights by diameter class.
3. Volume and weight per acre by diameter class.

Figure 5. A diameter distribution yield prediction system for loblolly pine plantations in East Texas.

---

1. Determine:

   a. Number of growing seasons completed since plantation establishment (A).

   b. Number of surviving trees per acre (T) at that age.

   c. Average total height of ten tallest trees (H) in plantation. If unknown, but site index (S) (base age = 25 years) is known, then predict H using:

$$H = S((1-\exp(-0.08005275A))/0.8648429)^{1.628569} \quad (1)$$

   (This equation was developed by Blackard 1985a, 1986 and Lenhart et al. 1986)

2. Predict:

   a. Dbh of smallest tree (DMIN) in plantation, using:

$$DMIN = -0.08975 + 0.05913H - 0.00126498T \quad (2)$$
$$(R^2 = 67\%)$$

   If DMIN is less than 0, DMIN = 0.

   b. Quadratic mean dbh (DQMEAN) for plantation, using:

$$DQMEAN = 10^{(1.17470 - 12.93480(1/H) - 0.000196042T)} \quad (3)$$
$$(R^2 = 96\%)$$

   c. Arithmetic mean dbh (DMEAN) for plantation, using:

$$DMEAN = -0.13343 + 0.99393DQMEAN \quad (4)$$
$$(r^2 = 99\%)$$

3. Compute the expected number of trees per acre for the plantation using the Weibull distribution. Weibull parameters are "recovered" with techniques developed by Burk and Burkhart (1984). The recovery process is:

   a. Location parameter (a) is equal to DMIN (Eq. 2).

   b. Shape parameter (c) is calculated by solving the following equation:

$$(DQMEAN)^2 - a^2 - 2a(DMEAN - a) - (DMEAN - a)^2 \Gamma(1 + 2/c)/\Gamma(1 + 1/c) = 0 \quad (5)$$

   where: Γ = The complete gamma function.

   c. Scale parameter (b) is obtained using:

$$b = (DMEAN - a)/\Gamma(1 + 1/c) \quad (6)$$

Computer software is available to solve Eq. 5 in an interative manner.

Solve the Weibull distribution to determine the proportion (P) of T in each dbh class as:

$$d_l < P < d_u = \exp(-((d_l - a)/b)^c) - \exp(-((d_u - a)/b)^c) \quad (7)$$

Where: d_l & d_u = lower & upper bound of diameter class.

Computer software can be easily developed to solve Eq. 7.

Multiply each P by T to obtain the expected number of trees per acre (n) in each dbh class.

4. Predict the total height (h) of each tree with dbh class mid-point dbh (d) (5.0, 6.0, etc.) using:

$$h = \exp(\ln(H) + 0.0071609 - 0.12505\ln(A)(\ln(DMAX) - \ln(d) - 0.13367\ln(H/A)(\ln(DMAX) - \ln(d) + 0.004739\ln(T)(\ln(DMAX) - \ln(d)) \quad (8)$$

($R^2 = 68\%$)

Where: DMAX = Dbh of largest tree in plantation.

(This equation developed by Blackard 1985b, 1986.)

5. Estimate the content (cubic feet, green weight, etc.) of the tree representing each dbh class mid-point.

An equation to estimate the cubic feet of wood (CFW) in a loblolly pine plantation in East Texas is:

$$CFW = 0.000928d^{1.973735}h^{1.213909} \quad (9)$$

($R^2 = 99\%$)

(This equation developed by Wiswell et al. 1986.)

6. For the loblolly pine plantation, we now know:

   a. The number of trees per acre (n) for each dbh class.

   b. The cubic feet of wood per tree (CFW) for each dbh class.

Multiply CFW by n to obtain the cubic feet of wood per acre by dbh class.

Sum the CFW values across all dbh classes to determine the total cubic feet of wood per acre.

By selective summing across specified dbh classes, the CFW per acre by various tree size groups or different products (pulp, chip-n-saw, lumber, plywood, etc.) can be calculated.

EVALUATION

The diameter distribution yield prediction system was evaluated using both the regression and evaluation subplots.

Regression Subplots. Plottings of the 77 residuals (predicted - observed volume) over stand parameters indicated no bias or adverse trends. Plot of predicted volume over observed volume is shown in Figure 6. On the average, an under-prediction of 25 cubic feet occurred.

Evaluation Suplots. Plottings of the 77 residuals from these subplots over stand parameters also indicated no bias or adverse trends. Figure 7 shows a plot of predicted volume over observed volume. On the average, an under-prediction of 44 cubic feet occurred.

A detailed look at the ability of the yield prediction system to predict the number of trees per acre by dbh class and cubic feet of wood per acre by dbh class is presented for loblolly evaluation subplot 155 in Figures 8 and 9. The predicted trees per acre by dbh class match the observed trees per acre by dbh class very well, while the prediction of cubic feet of wood does not match the observed cubic feet of wood as well.

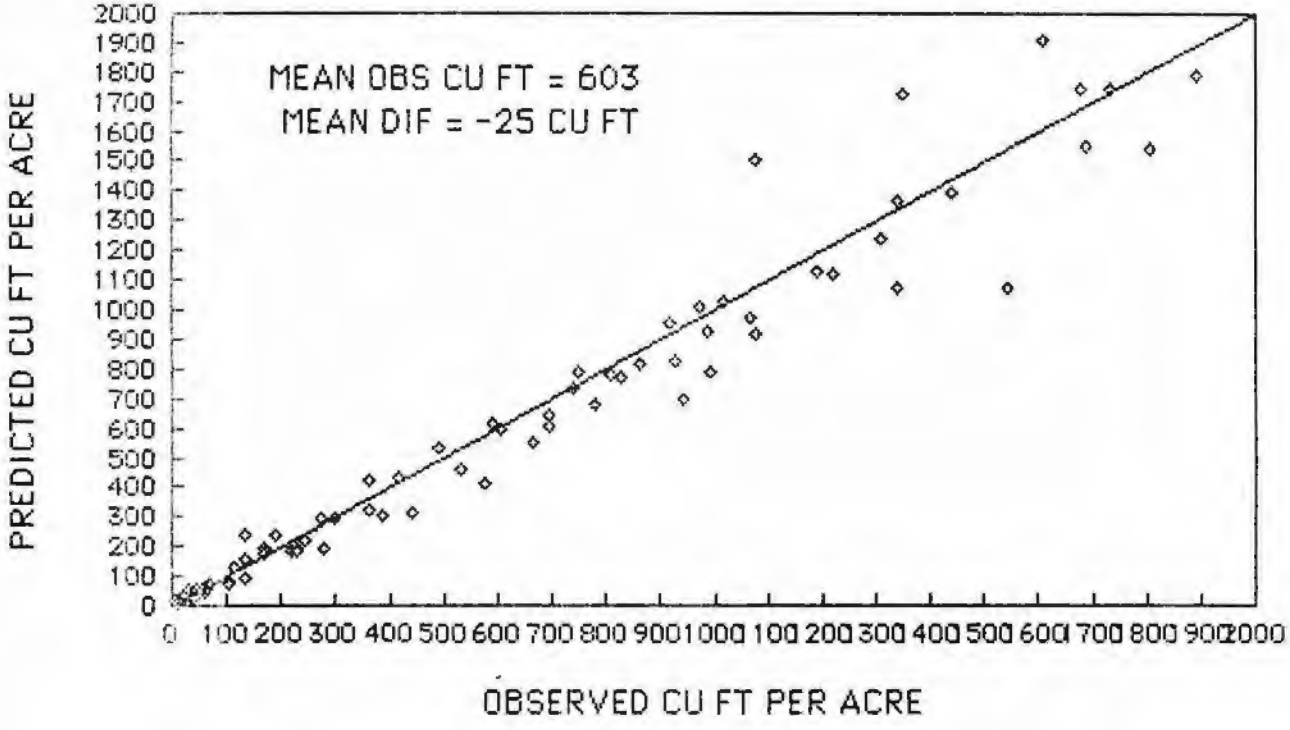


FIG. 6. PREDICTION PERFORMANCE
FOR LOBLOLLY REGRESSION SUBPLOTS.

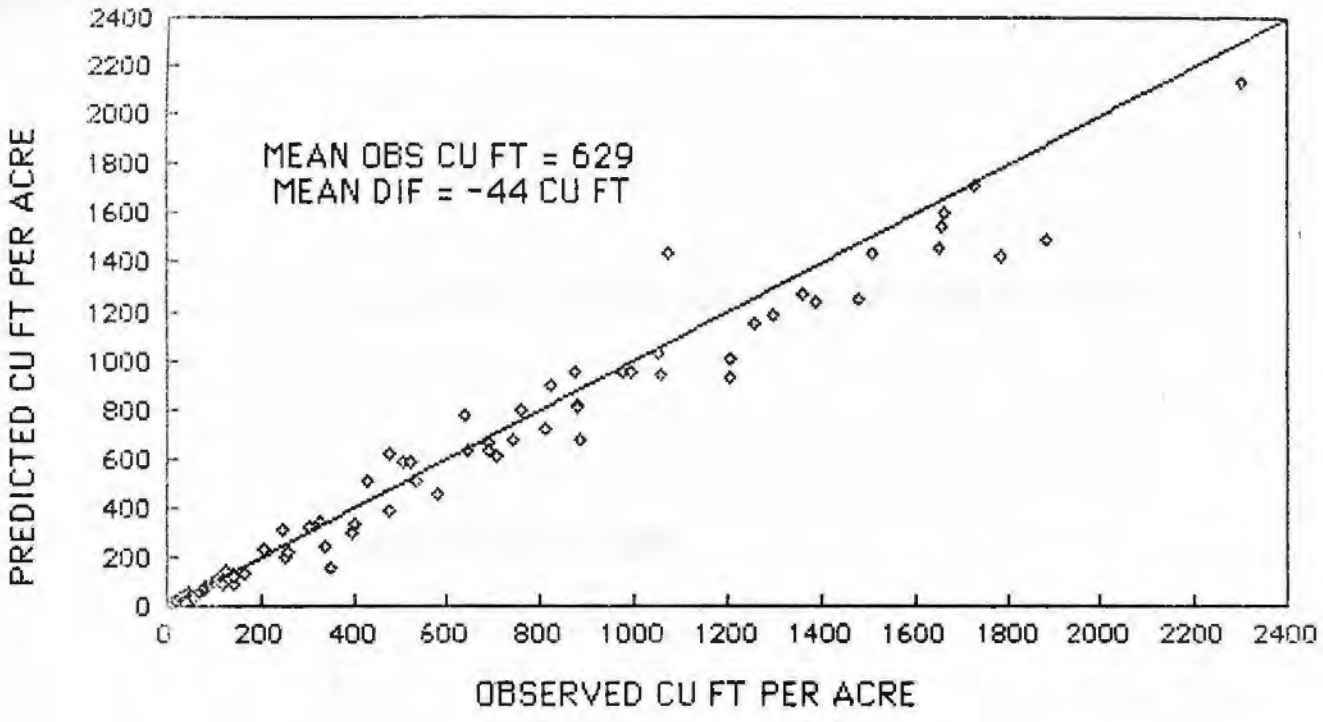


FIG. 7. PREDICTION PERFORMANCE
FOR LOBLOLLY EVALUATION SUBPLOTS.

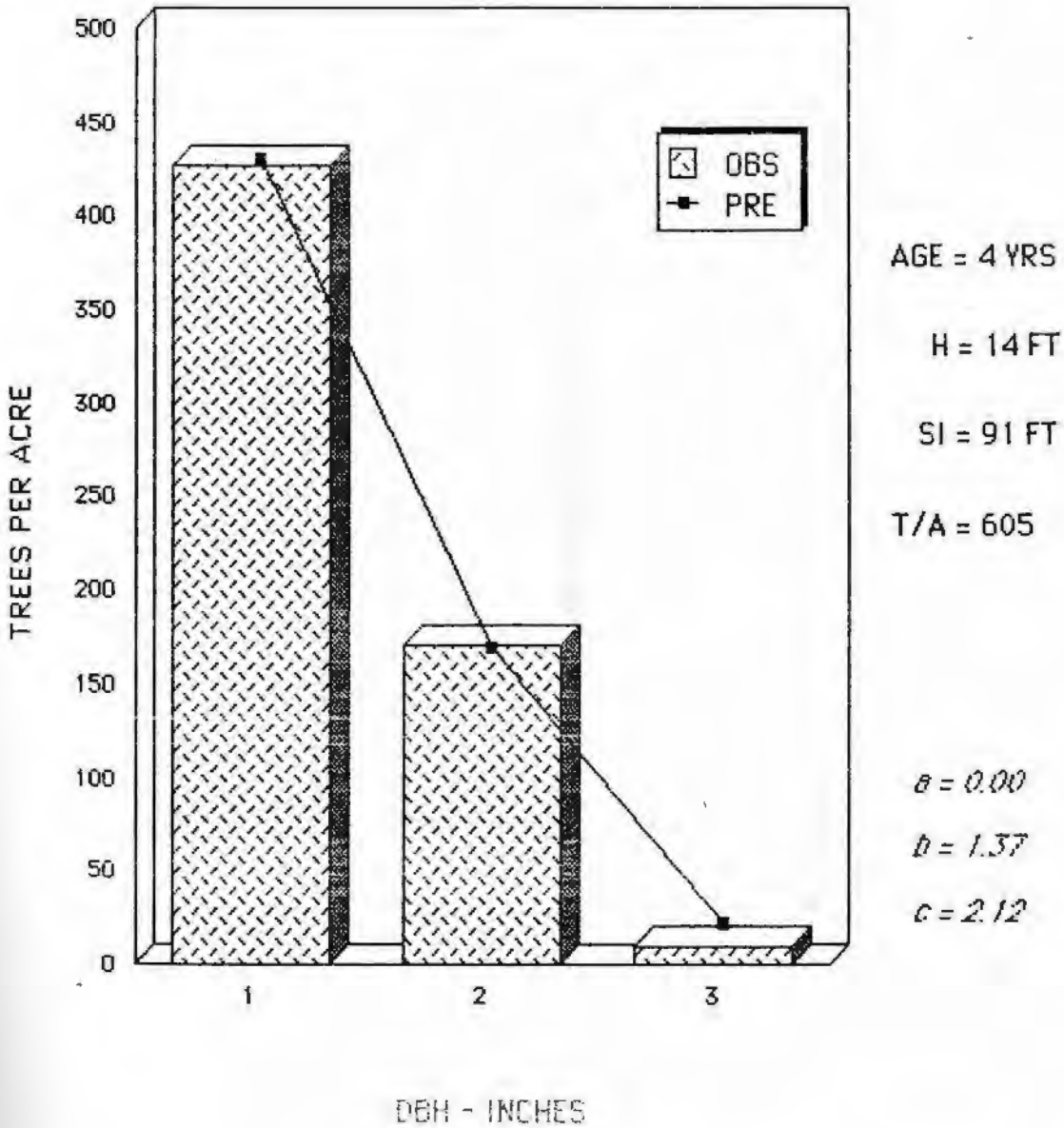


FIG. 8. OBSERVED T/A COMPARED TO PREDICTED T/A FOR LOBLOLLY EVALUATION SUBPLOT 155.

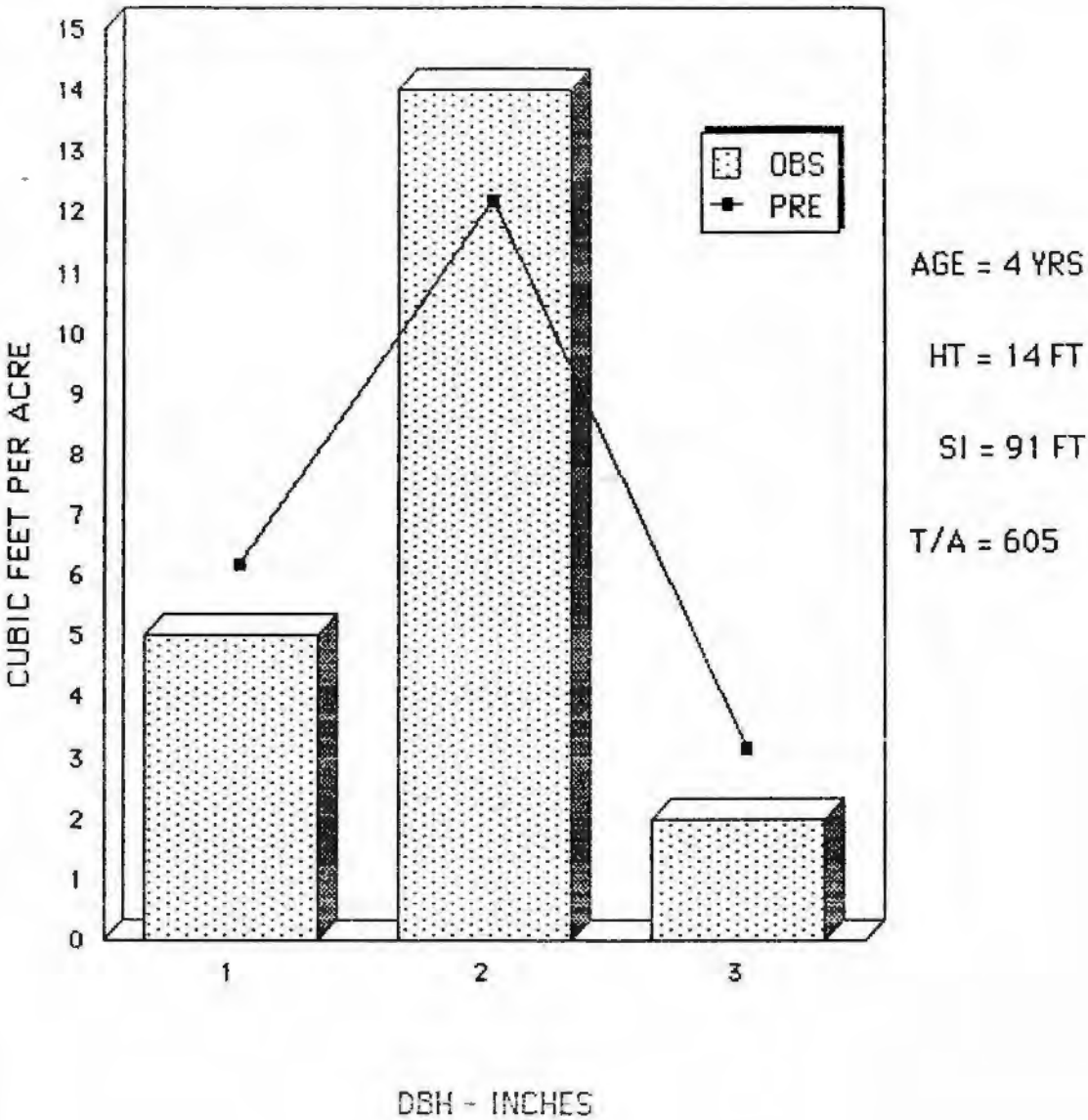


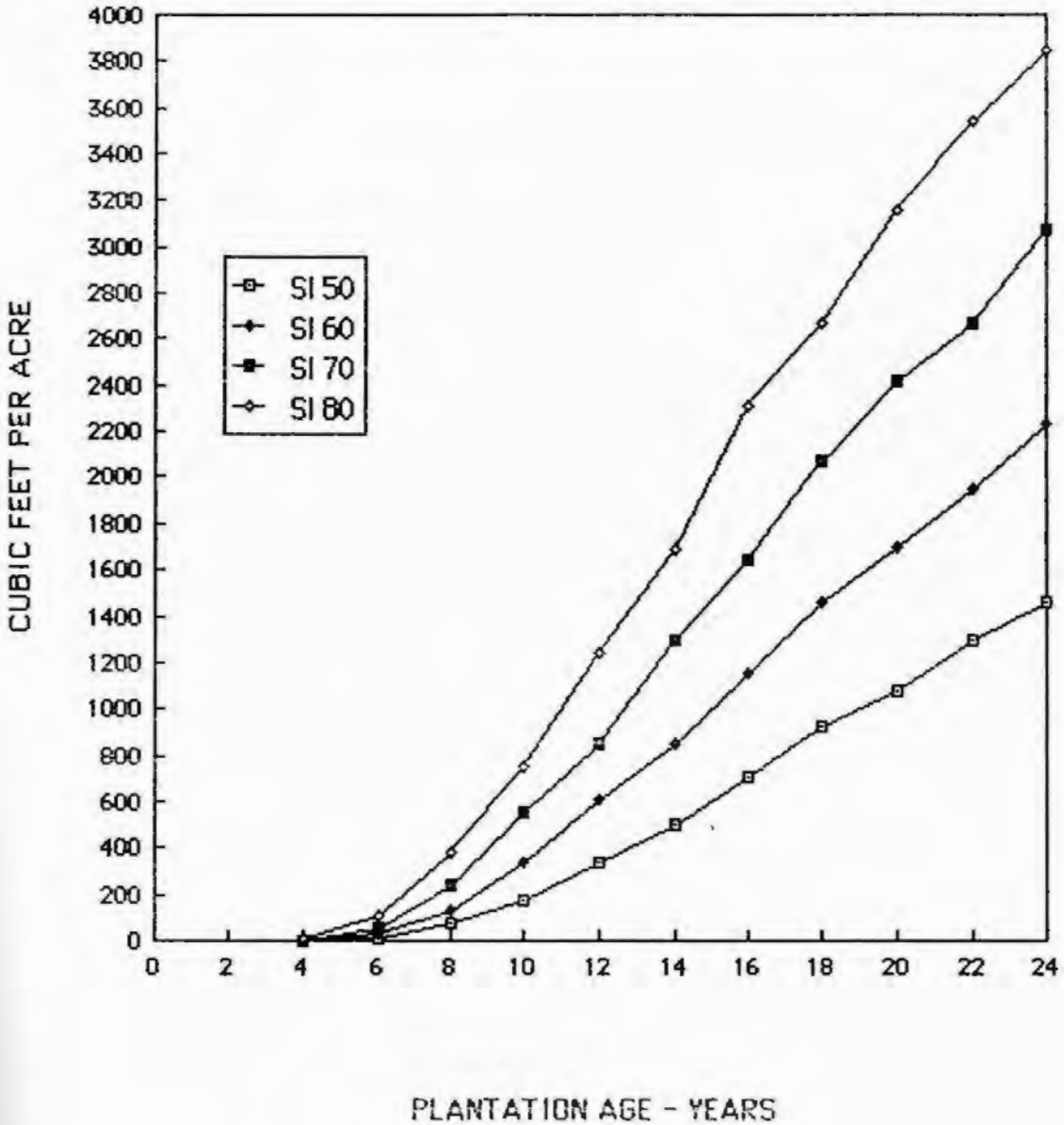
FIG. 9. OBSERVED CFW COMPARED TO PREDICTED CFW FOR LOBLOLLY EVALUATION SUBPLOT 155.

APPLICATION

An example of a set of yield curves is presented in Figure 10. Using the diameter distribution yield prediction system described in this report, the predicted cubic feet of wood per acre were generated using several combinations of site index and age, while holding surviving trees per acre constant. No information on stand structure is provided in Figure 10.

To demonstrate the ability of the system to predict details of the stand structure, as well as yield, the eleven tables following Figure 10 present information describing stands for site index value 70 and surviving trees per acre of 400. Plantation age varies from 4 to 24 years by 2 year increments. For each table, stand structure is described on a diameter class basis. The number of trees per acre, basal area, tree heights and four measures of yield are listed by diameter classes.

Stand structure information provides a forest manager the opportunity to determine the size characteristics of his planted trees and, thus, set different stumpage prices according to the expected tree utilization.



LOBLOLLY - 400 T/A

FIG. 10. PREDICTED CU FT WOOD PER ACRE.

PREDICTED
STAND STRUCTURE
PLUS
VOLUME AND WEIGHT PER ACRE BY DBH CLASS
FOR
LOBLOLLY PINE PLANTATIONS
ON
NON-OLD-FIELDS
IN
EAST TEXAS

****
* AGE = 4 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 4 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN TALLEST TREES = 11 FEET.
2) ARITHMETIC MEAN DBH = .7 INCHES.
3) QUADRATIC MEAN DBH = .8 INCHES.

PER ACRE VALUES

	STRUCTURE			VOLUME & WEIGHT - TOTAL STEM				
				WOOD & BARK		WOOD ONLY		
DBH (IN)	NUMBER OF TREES	BASAL AREA (SQFT)	AVG IND. TREE HT (FT)	VOLUME (CUFT)	GREEN WEIGHT (LBS)	VOLUME (CUFT)	DRY WEIGHT (LBS)	DBH (IN)
1	375	2	8	7	330	4	141	1
2	24	1	10	2	103	1	44	2
3	1	0	11	0	10	0	4	3
4	0	0	0	0	0	0	0	4
5	0	0	0	0	0	0	0	5
6	0	0	0	0	0	0	0	6
7	0	0	0	0	0	0	0	7
8	0	0	0	0	0	0	0	8
9	0	0	0	0	0	0	0	9
10	0	0	0	0	0	0	0	10
11	0	0	0	0	0	0	0	11
12	0	0	0	0	0	0	0	12
13	0	0	0	0	0	0	0	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	3		9	443	5	189	

NOTE... BASED ON RESEARCH CONDUCTED IN THE
EAST TEXAS PINE PLANTATION RESEARCH PROJECT

SCHOOL OF FORESTRY
STEPHEN F. AUSTIN STATE UNIVERSITY
... BETWEEN 1982 - 1986.

PREDICTED
STAND STRUCTURE
PLUS
VOLUME AND WEIGHT PER ACRE BY DBH CLASS
FOR
LOBLOLLY PINE PLANTATIONS
ON
NON-OLD-FIELDS
IN
EAST TEXAS

****
* AGE = 8 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 8 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN TALLEST TREES = 26 FEET.
2) ARITHMETIC MEAN DBH = 3.8 INCHES.
3) QUADRATIC MEAN DBH = 4.0 INCHES.

PER ACRE VALUES

STRUCTURE			VOLUME & WEIGHT - TOTAL STEM				
			WOOD & BARK		WOOD ONLY		
DBH (IN)	NUMBER OF TREES	BASAL AREA (SQFT)	AVG IND. TREE HT (FT)	VOLUME (CUFT)	GREEN WEIGHT (LBS)	VOLUME (CUFT)	DRY WEIGHT (LBS)	DBH (IN)
1	3	0	12	0	4	0	2	1
2	46	1	16	7	362	5	155	2
3	114	6	19	47	2387	33	1029	3
4	130	11	21	105	5301	75	2291	4
5	78	11	23	107	5427	78	2350	5
6	24	5	25	52	2614	38	1134	6
7	5	1	26	15	764	11	332	7
8	0	0	0	0	0	0	0	8
9	0	0	0	0	0	0	0	9
10	0	0	0	0	0	0	0	10
11	0	0	0	0	0	0	0	11
12	0	0	0	0	0	0	0	12
13	0	0	0	0	0	0	0	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	35		333	16859	240	7293	

NOTE... BASED ON RESEARCH CONDUCTED IN THE
EAST TEXAS PINE PLANTATION RESEARCH PROJECT

SCHOOL OF FORESTRY
STEPHEN F. AUSTIN STATE UNIVERSITY
... BETWEEN 1982 - 1986.

PREDICTED
STAND STRUCTURE
PLUS
VOLUME AND WEIGHT PER ACRE BY DBH CLASS
FOR
LOBLOLLY PINE PLANTATIONS
ON
NON-OLD-FIELDS
IN
EAST TEXAS

****
* AGE = 10 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 10 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN TALLEST TREES = 34 FEET.
2) ARITHMETIC MEAN DBH = 5.0 INCHES.
3) QUADRATIC MEAN DBH = 5.2 INCHES.

PER ACRE VALUES

	STRUCTURE			VOLUME & WEIGHT - TOTAL STEM				
				WOOD & BARK		WOOD ONLY		
DBH (IN)	NUMBER OF TREES	BASAL AREA (SQFT)	AVG IND. TREE HT (FT)	VOLUME (CUFT)	GREEN WEIGHT (LBS)	VOLUME (CUFT)	DRY WEIGHT (LBS)	DBH (IN)
1	0	0	0	0	0	0	0	1
2	7	0	18	1	64	1	27	2
3	43	2	22	21	1088	15	468	3
4	92	8	24	86	4457	62	1925	4
5	115	16	27	188	9841	140	4259	5
6	89	17	29	224	11741	169	5090	6
7	41	11	31	150	7863	114	3413	7
8	11	4	33	56	2935	43	1276	8
9	2	1	34	13	691	10	301	9
10	0	0	0	0	0	0	0	10
11	0	0	0	0	0	0	0	11
12	0	0	0	0	0	0	0	12
13	0	0	0	0	0	0	0	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	59		739	38680	554	16759	

NOTE... BASED ON RESEARCH CONDUCTED IN THE
EAST TEXAS PINE PLANTATION RESEARCH PROJECT

SCHOOL OF FORESTRY
STEPHEN F. AUSTIN STATE UNIVERSITY
... BETWEEN 1982 - 1986.

PREDICTED
STAND STRUCTURE
PLUS
VOLUME AND WEIGHT PER ACRE BY DBH CLASS
FOR
LOBLOLLY PINE PLANTATIONS
ON
NON-OLD-FIELDS
IN
EAST TEXAS

****
* AGE = 14 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 14 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN TALLEST TREES = 47 FEET.
2) ARITHMETIC MEAN DBH = 6.4 INCHES.
3) QUADRATIC MEAN DBH = 6.6 INCHES.

PER ACRE VALUES

DBH (IN)	STRUCTURE: NUMBER OF TREES	STRUCTURE: BASAL AREA (SQFT)	STRUCTURE: AVG IND. TREE HT (FT)	VOLUME & WEIGHT - TOTAL STEM: WOOD & BARK: VOLUME (CUFT)	WOOD & BARK: GREEN WEIGHT (LBS)	WOOD ONLY: VOLUME (CUFT)	WOOD ONLY: DRY WEIGHT (LBS)	DBH (IN)
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	2
3	7	0	26	4	220	3	95	3
4	33	3	30	39	2132	29	920	4
5	70	10	33	141	7761	109	3356	5
6	97	19	36	307	16916	240	7326	6
7	93	25	38	421	23195	332	10061	7
8	62	22	41	396	21889	316	9506	8
9	27	12	43	228	12632	184	5492	9
10	8	4	45	87	4832	71	2103	10
11	1	1	47	14	765	11	333	11
12	0	0	0	0	0	0	0	12
13	0	0	0	0	0	0	0	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	96		1637	90340	1295	39192	

NOTE... BASED ON RESEARCH CONDUCTED IN THE
EAST TEXAS PINE PLANTATION RESEARCH PROJECT

SCHOOL OF FORESTRY
STEPHEN F. AUSTIN STATE UNIVERSITY
BETWEEN 1982 - 1986

PREDICTED
STAND STRUCTURE
PLUS
VOLUME AND WEIGHT PER ACRE BY DBH CLASS
FOR
LOBLOLLY PINE PLANTATIONS
ON
NON-OLD-FIELDS
IN
EAST TEXAS

****
* AGE = 16 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 16 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN TALLEST TREES = 52 FEET.
2) ARITHMETIC MEAN DBH = 6.9 INCHES.
3) QUADRATIC MEAN DBH = 7.0 INCHES.

PER ACRE VALUES

	STRUCTURE			VOLUME & WEIGHT - TOTAL STEM				
				WOOD & BARK		WOOD ONLY		
DBH (IN)	NUMBER OF TREES	BASAL AREA (SQFT)	AVG IND. TREE HT (FT)	VOLUME (CUFT)	GREEN WEIGHT (LBS)	VOLUME (CUFT)	DRY WEIGHT (LBS)	DBH (IN)
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	2
3	3	0	27	2	99	1	43	3
4	22	2	31	27	1483	20	640	4
5	56	8	35	120	6699	93	2896	5
6	87	17	38	291	16269	229	7045	6
7	95	25	41	467	26135	372	11333	7
8	75	26	43	503	28158	405	12225	8
9	42	19	46	381	21436	311	9317	9
10	16	9	48	187	10504	154	4570	10
11	4	3	50	59	3306	49	1440	11
12	1	1	52	18	1023	15	446	12
13	0	0	0	0	0	0	0	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	110		2055	115114	1649	49955	

NOTE... BASED ON RESEARCH CONDUCTED IN THE
EAST TEXAS PINE PLANTATION RESEARCH PROJECT

SCHOOL OF FORESTRY
STEPHEN F. AUSTIN STATE UNIVERSITY
... BETWEEN 1982 - 1986.

PREDICTED
STAND STRUCTURE
PLUS
VOLUME AND WEIGHT PER ACRE BY DBH CLASS
FOR
LOBLOLLY PINE PLANTATIONS
ON
NON-OLD-FIELDS
IN
EAST TEXAS

****
* AGE = 18 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 18 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN TALLEST TREES = 57 FEET.
2) ARITHMETIC MEAN DBH = 7.2 INCHES.
3) QUADRATIC MEAN DBH = 7.4 INCHES.

PER ACRE VALUES

STRUCTURE			VOLUME & WEIGHT - TOTAL STEM				
			WOOD & BARK		WOOD ONLY		
DBH (IN)	NUMBER OF TREES	BASAL AREA (SQFT)	AVG IND. TREE HT (FT)	VOLUME (CUFT)	GREEN WEIGHT (LBS)	VOLUME (CUFT)	DRY WEIGHT (LBS)	DBH (IN)
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	2
3	1	0	29	1	36	0	16	3
4	15	1	34	20	1139	16	491	4
5	44	6	37	100	5655	78	2444	5
6	76	15	41	276	15676	220	6786	6
7	93	25	44	492	28027	397	12149	7
8	83	29	47	612	34952	500	15170	8
9	54	24	50	536	30693	442	13335	9
10	25	14	53	324	18652	271	8111	10
11	8	5	55	130	7461	109	3256	11
12	2	2	57	40	2304	34	1004	12
13	0	0	0	0	0	0	0	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	121		2531	144615	2067	62762	

NOTE... BASED ON RESEARCH CONDUCTED IN THE
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****
* AGE = 20 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 20 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN TALLEST TREES = 61 FEET.
2) ARITHMETIC MEAN DBH = 7.5 INCHES.
3) QUADRATIC MEAN DBH = 7.7 INCHES.

PER ACRE VALUES

DBH (IN)	STRUCTURE: NUMBER OF TREES	STRUCTURE: BASAL AREA (SQFT)	STRUCTURE: AVG IND. TREE HT (FT)	VOLUME & WEIGHT - TOTAL STEM: WOOD & BARK: VOLUME (CUFT)	WOOD & BARK: GREEN WEIGHT (LBS)	WOOD ONLY: VOLUME (CUFT)	WOOD ONLY: DRY WEIGHT (LBS)	DBH (IN)
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	2
3	0	0	0	0	0	0	0	3
4	11	1	36	16	899	12	388	4
5	37	5	40	92	5259	72	2272	5
6	69	14	44	270	15591	217	6747	6
7	90	24	47	511	29533	416	12798	7
8	86	30	50	678	39226	558	17020	8
9	61	27	53	644	37379	536	16236	9
10	32	17	56	440	25633	370	11145	10
11	12	8	59	210	12280	179	5346	11
12	3	2	61	65	3773	55	1643	12
13	0	0	0	0	0	0	0	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	128		2926	169579	2415	73595	

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****
* AGE = 22 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 22 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN-TALLEST TREES = 65 FEET.
2) ARITHMETIC MEAN DBH = 7.7 INCHES.
3) QUADRATIC MEAN DBH = 7.9 INCHES.

PER ACRE VALUES

DBH (IN)	STRUCTURE: NUMBER OF TREES	STRUCTURE: BASAL AREA (SQFT)	STRUCTURE: AVG IND. TREE HT (FT)	VOLUME & WEIGHT - TOTAL STEM: WOOD & BARK: VOLUME (CUFT)	WOOD & BARK: GREEN WEIGHT (LBS)	WOOD ONLY: VOLUME (CUFT)	WOOD ONLY: DRY WEIGHT (LBS)	DBH (IN)
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	2
3	0	0	0	0	0	0	0	3
4	7	1	36	10	572	8	247	4
5	31	4	40	77	4406	61	1903	5
6	62	12	44	243	14009	195	6062	6
7	86	23	48	499	28997	408	12565	7
8	87	30	51	700	40710	579	17663	8
9	67	30	54	721	42059	603	18268	9
10	38	21	57	533	31142	449	13539	10
11	16	11	60	285	16741	243	7284	11
12	5	4	63	111	6555	96	2854	12
13	1	1	65	27	1585	23	691	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	137		3206	186776	2665	81076	

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****
* AGE = 24 YEARS SINCE ESTABLISHMENT *
* SITE INDEX = 70 FEET (INDEX AGE = 25 YRS) *
* T/A = 400 SURVIVING AT AGE 24 *
****

THREE PREDICTED PLANTATION CHARACTERISTICS ARE...
1) AVERAGE HEIGHT OF TEN TALLEST TREES = 69 FEET.
2) ARITHMETIC MEAN DBH = 7.9 INCHES.
3) QUADRATIC MEAN DBH = 8.1 INCHES.

PER ACRE VALUES

DBH (IN)	STRUCTURE: NUMBER OF TREES	STRUCTURE: BASAL AREA (SQFT)	STRUCTURE: AVG IND. TREE HT (FT)	VOLUME & WEIGHT - TOTAL STEM: WOOD & BARK: VOLUME (CUFT)	WOOD & BARK: GREEN WEIGHT (LBS)	WOOD ONLY: VOLUME (CUFT)	WOOD ONLY: DRY WEIGHT (LBS)	DBH (IN)
1	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	2
3	0	0	0	0	0	0	0	3
4	5	0	38	8	438	6	189	4
5	26	4	43	70	4057	56	1752	5
6	56	11	47	235	13778	191	5961	6
7	82	22	51	508	29899	419	12953	7
8	87	30	54	744	43827	620	19010	8
9	71	31	58	825	48876	696	21222	9
10	44	24	61	663	39359	565	17106	10
11	20	13	64	382	22743	329	9893	11
12	7	5	67	166	9936	144	4325	12
13	2	2	69	57	3424	50	1492	13
14	0	0	0	0	0	0	0	14
15	0	0	0	0	0	0	0	15
TOTAL	400	142		3658	216337	3076	93903	

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