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VOLUME TABLE for NATURAL SWEETGUM in ALABAMA

AGRICULTURAL EXPERIMENT STATION
AUBURN UNIVERSITY

R. DENNIS ROUSE, *Director*

Auburn, Alabama

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Volume Table for Natural Sweetgum in Alabama

E. S. LYLE, JR.[1]

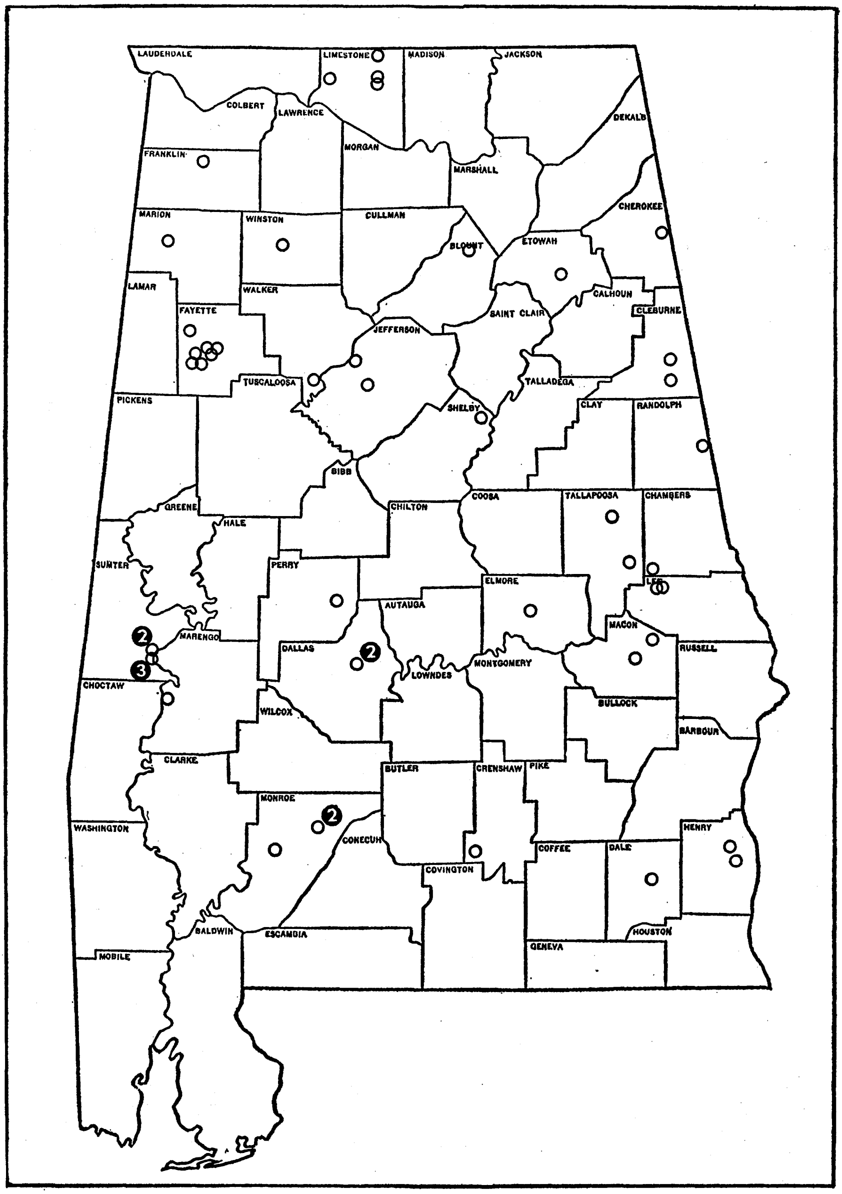
THERE HAS BEEN an increased interest in the growth and management of all Southern hardwoods in the past few years. Sweetgum (*Liquidambar styraciflua* L.), which is one of the more important of these hardwoods, forms pure stands that are amenable to growth studies. According to the U.S. Forest Service there are approximately 900 million cubic feet of sweetgum in Alabama, which exceeds the volume of any other hardwood species. Consequently, it seems worthwhile to have a volume table for sweetgum based solely on data from natural stands in Alabama.

Field Data Collection

Fifty stands of natural sweetgum were located within the State by extensive exploration during 1971 and 1972. The figure shows the approximate location of each stand. All of these stands had closed canopies, were even-aged, and ranged in age from 6 to 50 years. Stand basal area ranged from 25 sq. ft. to 200 sq. ft. At least 80 per cent of the trees in each stand were sweetgum. Topographic positions ranged from bottoms to hillsides. Approximately 45 of the stands could be identified as having originated on old fields, and the others may have been of similar origin. Stands in which more than 20 per cent of the trees had multiple stems or top die-back were excluded from this study.

At each stand, the first two dominants encountered within the stand were selected as sample trees and felled. Diameter measurements both inside and outside bark were made at 4-foot intervals beginning at the top of a 6-inch stump. Other measure-

[1] Assistant Professor, Department of Forestry.



LOCATION OF SWEETGUM STANDS IN ALABAMA.

ments taken were diameter at breast height and total tree height. Diameters at breast height ranged from 1.4 to 13.9 inches and total tree heights from 13.9 to 99.9 feet.

Volume Equation Development

Smalian's formula was used to calculate the volume of each 4-foot bolt, and the volume of the tip of the tree was obtained by treating it as a cone.[2] Total volumes for both inside and outside bark were calculated from this data for each tree.

Regression equations were developed that described the relationship between tree volume and a function of d.b.h. or of d.b.h. and total tree height. These equations were fitted to the data by least squares.[3] Table 1 shows the equations that were examined and some statistics of fit.

All equations examined accounted for at least 84 per cent of the variation in cubic foot volume. The addition of a height variable to equations containing either d.b.h. or $(\text{d.b.h.})^2$ was not significant. The interaction variable, $(\text{d.b.h.})^2$ x height, was the single most potent variable. However, the addition of $(\text{d.b.h.})^2$ was significant even after fitting the interaction variable. Plots of the independent variable $(\text{d.b.h.})^2$ x height on volume indicated that volume variances were homogeneous about the regression line. Therefore, weighting to account for non-homogeneous variances, common in most volume equations, was not necessary.

TABLE 1. VOLUME EQUATIONS EXAMINED AND STATISTICS OF FIT

Equation No.	Equation[1]						R^2	$\hat{S}y \cdot x$
	Y	b_0	b_1	X_1	b_2	X_2		
1	Vob	−12.823975	+3.098044	D	----	----	0.860	3.2181
2	Vib	−11.190348	+2.642770	D	----	----	0.846	2.8984
3	Vob	− 2.95676049	+0.21221190	D^2	----	----	0.949	1.9433
4	Vib	− 2.81563178	+0.18165156	D_2	----	----	0.940	1.8053
5	Vob	− 0.02372664[2]	+0.00227509	D^2H	----	----	0.991	0.8280
6	Vib	− 0.33246026	+0.00195291	D^2H	----	----	0.987	0.8329
7	Vob	0.55610109	+0.00265356	D^2H	−0.03665529	D^2	0.992	0.7909
8	Vib	0.41912093[2]	+0.00244348	D^2H	−0.04751313	D^2	0.989	0.7670
9	Vob		+0.00227205	D^2H	----	----	0.997	0.8239
10	Vib		+0.00228576	D^2H	−0.03039457	D^2	0.996	0.7776

[1] Where: Vob = volume outside bark in cu. ft.
Vib = volume inside bark in cu. ft.
D = d.b.h. outside bark in inches.
H = total tree height (excluding 0.5 ft. stump) in ft.
[2] Coefficient not significantly different from 0.0 at $\alpha = 0.05$.

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[2] The computer program for this procedure was developed by J. W. Gooding, Dept. of Forestry, Auburn University.

[3] Statistical Analysis System by A. J. Barr and J. H. Goodnight, Dept. of Statistics, North Carolina State University, Raleigh, N.C., May 1971.

Equations 5 and 8 had y-intercepts which were not significantly different from zero at $\alpha = 0.05$. Consequently, these regressions were recomputed so that the line passed through the origin. These two final equations (Eq. 9 and 10) were used for calculation of the cubic foot volumes in Tables 2 and 3. The predicted values from equations 9 and 10 yield cubic foot volume estimates that are plus or minus approximately 1.5 cu. ft. per tree with 95 per cent confidence.

TABLE 2. TOTAL CUBIC-FOOT VOLUMES (OUTSIDE BARK) FOR NATURAL SWEETGUM IN ALABAMA

D.b.h. (inches)	Total tree height[1] (feet)																				Diameter dist.
	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	
	(cubic feet)																				
2	0.14	0.18	0.23	0.27	0.32																1
3	0.31	0.41	0.51	0.61	0.71	0.82	0.92														5
4		0.73	0.91	1.09	1.27	1.45	1.63	1.82	2.00												5
5			1.42	1.70	1.99	2.27	2.55	2.84	3.12	3.40	3.69										8
6				2.45	2.86	3.27	3.68	4.09	4.49	4.90	5.31	5.72	6.13								10
7						4.45	5.01	5.56	6.12	6.67	7.23	7.79	8.34	8.90	9.45						12
8								7.26	7.99	8.72	9.44	10.17	10.90	11.62	12.35	13.08					12
9								9.19	10.11	11.03	11.95	12.87	13.79	14.71	15.63	16.55	17.47				22
10									12.48	13.62	14.75	15.89	17.02	18.16	19.29	20.43	21.56	22.70			12
11										16.48	17.85	19.23	20.60	21.97	23.35	24.72	26.09	27.47			7
12										19.61	21.25	22.88	24.52	26.15	27.78	29.42	31.05	32.69	34.32		3
13										23.02	24.94	26.85	28.77	30.69	32.61	34.53	36.44	38.36	40.28	42.20	0
14												31.14	33.37	35.59	37.82	40.04	42.27	44.49	46.72	48.94	2
15														40.86	43.41	45.97	48.52	51.07	53.63	56.18	0
Height dist.	2	0	1	4	3	3	6	4	8	8	9	12	10	15	7	6	0	2	0	0	

[1] Does not include a six inch stump.
Block shows extent of observed data.
Confidence limits per tree are ± 1.5 cu. ft. with 95% confidence.

TABLE 3. TOTAL CUBIC-FOOT VOLUMES (INSIDE BARK) FOR NATURAL SWEETGUM IN ALABAMA

D.b.h. (inches)	Total tree height[1] (feet)																				Diameter dist.
	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	
	(cubic feet)																				
2	0.02	0.06	0.11	0.15	0.20																1
3	0.03	0.14	0.24	0.34	0.45	0.55	0.65														5
4		0.25	0.43	0.61	0.79	0.98	1.16	1.34	1.53												5
5			0.67	0.95	1.24	1.53	1.81	2.10	2.38	2.67	2.95										8
6				1.37	1.79	2.20	2.61	3.02	3.43	3.84	4.25	4.67	5.08								10
7						2.99	3.55	4.11	4.67	5.23	5.79	6.35	6.91	7.47	8.03						12
8								5.37	5.10	6.83	7.56	8.29	9.03	9.76	10.49	11.22					12
9								6.80	7.72	8.65	9.57	10.50	11.42	12.35	13.28	14.20	15.13				22
10									9.53	10.68	11.82	12.96	14.10	15.25	16.39	17.53	18.68	19.82			12
11										12.92	14.30	15.68	17.07	18.45	19.83	21.21	22.60	23.98			7
12										15.37	17.02	18.66	20.31	21.96	23.60	25.25	26.89	28.54	30.18		3
13										18.04	19.97	21.90	23.84	25.77	27.70	29.63	31.56	33.49	35.42	37.36	0
14												25.40	27.64	29.88	32.12	34.36	36.60	38.84	41.08	43.32	2
15														34.30	36.88	39.45	42.02	44.59	47.16	49.73	
Height dist.	2	0	1	4	3	3	6	4	8	8	9	12	10	15	7	6	0	2	0	0	

[1] Does not include a six inch stump.
Block shows extent of observed data.
Confidence limits per tree are ± 1.5 cu. ft. with 95% confidence.