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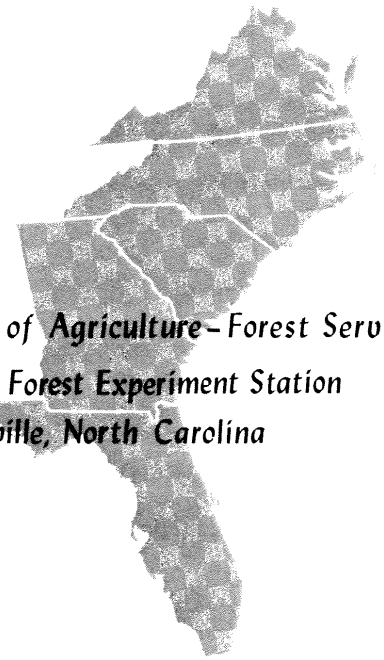

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PREDICTED GREEN LUMBER AND RESIDUE YIELDS FROM THE MERCHANTABLE STEM OF YELLOW-POPLAR

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Because of increasing demands for timber and changing utilization practices, chippable residues are now marketable products. Timber appraisals, therefore, should consider not only volumes of lumber anticipated but also amounts (weights) of chippable residue produced when processing sale trees. Some information is available on saw-log weight and amount of chippable residue produced from trees and logs of certain hardwood species (King 1952; Callahan and Nacker 1970; Timson 1972; Phillips 1974; Phillips et al. 1974), but no information is available on amount of chippable residue produced from the merchantable stem of yellow-poplar (Liriodendron tulipifera L.).

This paper reports prediction equations and yield tables for estimating chippable residue, bark residue, lumber, and sawdust weight produced from yellow-poplar sawtimber trees. It also reports cubic-foot volumes, board-foot volumes, and weights of the main stems.

PROCEDURE

A stratified random sample of 47 yellow-poplar sawtimber trees was selected from a mountain cove stand of mature, uneven-aged, natural yellow-poplar on the Pisgah National Forest in western North Carolina. Site index (age 50) ranged from 100 to 110. Five or six trees from each even-inch class from 12 to 26 inches and two trees from the 28-inch class were selected. Sample trees averaged 19.3 inches d.b.h. and 69 feet to an 8-inch or merchantable top. Means and ranges in tree characteristics were:

Item and unit of measure	Mean	Range
D.b.h. (inches)	19.3	11.7 - 28.4
Total height (feet)	116	85 - 147
Height to 8-inch or merchantable top (feet)	69	34 - 102
Form class	83	78 - 91
Age (years)	70	56 - 99

This study was conducted by the Southeastern Forest Experiment Station in cooperation with and through the financial assistance of the Range, Timber, and Wildlife Program Area of Region 8 of the National Forest System. Field personnel were provided by the Pisgah District of the Pisgah National Forest. Cooperation and assistance were also received from the Canton Hardwood Lumber Company and the Timberlands Division of Champion International Corporation.

After felling and limbing, the main stem of each sample tree was bucked into merchantable saw logs 8 to 16 feet long. Saw-log merchantability was limited by an 8-inch d.i.b. top or degrading quality indicators such as large knots. Saw-log stem top d.i.b. averaged 9.5 inches. Stem material above saw-log merchantability to a 4-inch d.i.b. top was classed as pulpwood and all stem material from a 4 to 2 inch d.i.b. top was considered topwood. Maximum and minimum diameters were measured on both ends of each log, and log length was recorded. Pulpwood and topwood were weighed in the field, and saw logs were weighed individually before and after debarking at the sawmill.

The debarked logs were sawn into 4/4 lumber on a bandsaw. During sawing, chippable residue (slabs, edgings, and end trim) from each log was collected and weighed. Lumber was weighed and tallied by size, grade,[1] and surface measure. Sawdust weight was determined by subtracting the weight of chippable residue and lumber from debarked log weight.

Moisture content and specific gravity of stemwood and bark were determined from disks taken at each saw-log bucking point and at 4 and 2 inches d.i.b. Cross sections removed at 8, 4, and 2 inches d.i.b. were used to determine bark percent for pulpwood and topwood. Moisture content samples were dried to a constant weight at 103° C, and the results expressed as a percent of ovendry weight. Specific gravity is based on green volume and ovendry weight. Weighted values for moisture content and specific gravity of bark and wood were calculated by weighting cross-section values in proportion to the volume of the component they represent.

Cubic volumes of the saw-log and pulpwood sections were computed by Smalian's formula:

$$\text{stem cubic foot volume } (V) = \left(\frac{B + b}{2}\right) L$$

where: V = volume in cubic feet

B = area of disk from base of log in square feet

b = area of disk from top of log in square feet

L = length of log in feet

To adjust for taper in the butt log, its volume was computed by applying Smalian's formula to two sections within the log--the butt 4 feet and the remainder. The volumes of the saw-log and pulpwood sections were summarized to determine tree cubic volume.

Regression equations were developed to predict green weight of chippable residue, bark residue, lumber, and sawdust, and the green board-foot volume of lumber produced from the saw-log portion of the stem. Equations were also developed to predict weight and cubic-foot volume of the main stem to 8-, 4-, and 2-inch d.i.b. merchantable tops. Independent variables examined in various combinations were d.b.h., merchantable height, total height, and form class. The variable D^2Mh (d.b.h.^{2} x merchantable height) accounted for most of the variation associated with regression. Component weights were estimated with the equation

[1] Lumber graded by National Hardwood Lumber Association certified grader.

$$Y = b_o + b_1 D^2Mh + e \quad (1)$$

where: Y = green weight or volume of component

b_o, b_1 = regression coefficients

D = diameter at breast height in inches

Mh = merchantable height in feet

e = experimental error

Since plottings of the data indicated a heterogeneous variance, a weighted model was developed to make the variance more nearly homogeneous and meet the basic assumptions of regression analysis. A weighting factor inversely proportional to the variance of the residuals was developed for each component by Schreuder and Swank's (1971) procedure. An average of the weighting factors was computed and applied to all prediction equations so that component equations would be additive. Green weight or volume of each component was computed with equation (2):

$$\frac{Y}{(D^2Mh)^{0.4}} = \frac{b_o}{(D^2Mh)^{0.4}} + b_1 (D^2Mh)^{0.6} \quad (2)$$

Appropriate coefficients for each true component were estimated by least squares regression analysis, and each equation was algebraically transformed back to its original form.

RESULTS AND DISCUSSION

Lumber and Residue Yields

The 47 yellow-poplar stems weighed 269,354 pounds. Of this amount, 89 percent was saw-log material, 10 percent pulpwood, and 1 percent topwood which was left with the crown as logging residue. The saw-log portion of the trees yielded 54 percent lumber, 18 percent chippable residue (slabs, edgings, end trim), 15 percent bark residue, and 13 percent sawdust (table 1). The trees produced 28,135 board feet of 4/4 lumber.

Table 1.--Lumber tally, saw-log-merchantable stem weight, and proportions of lumber, chippable residue, bark residue, and sawdust recovered for yellow-poplar sawtimber trees, by d.b.h. class

D.b.h. class (inches)	Average merchantable height[1]	Sample trees	Average lumber tally	Average stem weight[2]	Average component recovery			
					Lumber	Chippable residue	Bark residue	Sawdust
	Feet	Number	Board feet	Pounds	Percent			
12	43	6	117	1,241	42	29	17	12
14	60	6	224	2,202	48	23	16	13
16	68	6	353	3,063	52	20	15	13
18	66	5	409	3,661	51	19	17	13
20	70	5	595	5,044	55	18	15	12
22	76	6	736	6,103	55	18	14	13
24	88	5	1,008	8,232	55	17	15	13
26	77	6	1,130	9,342	56	18	14	12
28	82	2	1,352	11,623	59	16	12	13
Study average			599	5,099	54	18	15	13

[1] Merchantable height to an 8-inch or merchantable top (includes a 1-foot stump allowance).
[2] Saw-log stem weight with bark.

The proportion of the tree in lumber and mill residue varies with tree size (table 1). Lumber yield increased as tree size increased, ranging from 42 percent in 12-inch trees to 59 percent in 28-inch trees. Chippable residue decreased as tree size increased and ranged from 29 percent in small trees to 16 percent in large trees. The portion of the saw-log-merchantable stem removed as bark residue during processing ranged from 17 percent in small trees to 12 percent in large trees. Bark residue includes an estimated 2 to 3 percent wood removed during debarking on the rosser-head debarker. Sawdust produced averaged 12 to 13 percent regardless of tree size.

Prediction Equations

Regression equations developed to predict weight of green lumber, chippable residue, bark residue, sawdust, and green lumber volume produced when processing the saw-log portion of the stem are presented in table 2. Also shown in table 2 are equations to predict stem weight with and without bark, and bark weight alone as well as stemwood cubic volume to an 8-inch, 4-inch, and 2-inch top. The coefficient of determination and the standard error of the estimate are shown for each equation. Diameter at breast height and saw-log-merchantable height are tree measurements normally made during timber cruises, and the weighted combination of these variables accounted for 97 to 99 percent of the variation associated with regression, as indicated by the coefficients of determination.

Table 2.--Regression equations for predicting green weight of lumber, chippable residue, sawdust, and bark residue; merchantable stem weight with and without bark; and volume of stem and lumber of yellow-poplar trees in western North Carolina

Component	Equation	Coefficient of determination (R^2)	Standard error of estimate ($S_{y.x}$)
Primary product weight (pounds)			
Chippable residue	$Y = 185.56929 + 0.02570\ D^2Mh$	0.99	1.89
Bark residue	$Y = 85.79319 + 0.02255\ D^2Mh$	0.98	1.60
Lumber	$Y = -81.67664 + 0.09688\ D^2Mh$	0.98	6.48
Sawdust	$Y = 32.15269 + 0.02071\ D^2Mh$	0.98	1.35
Lumber volume (board feet)	$Y = -14.61814 + 0.02085\ D^2Mh$	0.99	0.98
Stem weight with bark (pounds) to			
8-inch top d.i.b.	$Y = 221.83854 + 0.16583\ D^2Mh$	0.99	9.50
4-inch top d.i.b.	$Y = 529.21459 + 0.17735\ D^2Mh$	0.97	16.76
2-inch top d.i.b.	$Y = 567.34904 + 0.17721\ D^2Mh$	0.97	16.77
Stem weight without bark (pounds) to			
8-inch top d.i.b.	$Y = 136.04534 + 0.14328\ D^2Mh$	0.98	8.96
4-inch top d.i.b.	$Y = 380.65921 + 0.15315\ D^2Mh$	0.97	14.93
2-inch top d.i.b.	$Y = 412.20504 + 0.15303\ D^2Mh$	0.97	14.95
Stem bark weight (pounds) to			
4-inch top d.i.b.	$Y = 148.55538 + 0.02419\ D^2Mh$	0.97	2.59
2-inch top d.i.b.	$Y = 155.14400 + 0.02418\ D^2Mh$	0.97	2.59
Stem volume without bark (cubic feet) to			
8-inch top d.i.b.	$Y = 3.51846 + 0.00293\ D^2Mh$	0.99	0.12
4-inch top d.i.b.	$Y = 8.22224 + 0.00309\ D^2Mh$	0.98	0.22
2-inch top d.i.b.	$Y = 8.78961 + 0.00309\ D^2Mh$	0.98	0.22

Equations were developed for predicting weights of pulpwood and topwood above the merchantable saw-log top, but these equations are not included in this paper. Pulpwood equations were poor predictors because amount of pulpwood above the saw-log top varies considerably due to defects which stop saw-log merchantability short of 8 inches. On the average, there were 672 pounds of pulpwood from an 8- to 4-inch top, of which 17 percent was bark. Since weight and cubic volume of topwood remain nearly constant as tree size increases, as indicated by the slopes and intercepts in the 4- and 2-inch stem equations (table 2), topwood regression equations were also poor predictors. Topwood had an average volume of about 0.6 cubic foot and weighed approximately 34 pounds, of which 23 percent was bark.

Wood Properties

Wood specific gravity averaged 0.412 in the saw-log portion of the stem, 0.428 in the pulpwood portion, and 0.436 in the topwood. Weighted stemwood specific gravity did not vary significantly with tree size except in 28-inch trees, in which specific gravity was 10 percent higher than the study average.

Moisture content of the saw-log portion of the main stem averaged 98 percent, pulpwood moisture content 94 percent, and topwood 112 percent. Moisture content, like specific gravity, did not vary significantly with tree size except for the 28-inch trees, in which moisture content of the main stem was 5 percent lower than the study average.

Bark specific gravity averaged 0.308, 0.347, and 0.343, respectively, for the saw-log, pulpwood, and topwood portions of the stem. Bark moisture content averaged 114 percent in the saw-log portion of the stem, 102 percent in the pulpwood, and 139 percent in the topwood. Bark specific gravity and moisture content varied considerably, but showed no trends with increasing tree size.

Weight Factors

Weight conversion factors based on original data were developed for each d.b.h. class sampled to show how they vary with tree size (table 3). Green weight of chips per board foot of lumber produced and green weight of chips per cubic foot of log input both decreased as tree size increased. Weight of chips per board foot of lumber ranged from 3.0 pounds in the 12-inch trees to 1.4 pounds in the 28-inch trees and averaged 1.6 pounds (table 3). Green weight of chips per cubic foot of wood input decreased from 15.9 pounds in small trees to 10.0 pounds in large trees and averaged 10.5 pounds.

Bark weight per board foot of lumber decreased from 1.8 pounds per board foot in 12-inch trees to 1.0 pound per board foot in 28-inch trees and averaged 1.2 pounds per board foot (table 3). Weight of sawdust produced per board foot of lumber sawn did not differ with tree size except for 12- and 14-inch trees which produced 1.3 pounds of sawdust per board foot compared to the study average of 1.1 pounds of sawdust per board foot. Since residue weight factors vary with tree size, estimates of sawmill residue yields based on weight factors must consider the size and distribution of the trees being processed.

Table 3.--Average yellow-poplar green weight conversion factors by tree d.b.h. classes

D.b.h. class (inches)	Merchantable height	Lumber weight	Chippable residue weight	Bark residue weight	Sawdust weight	Saw-log stemwood weight	Chippable residue weight	Lumber recovery factor
	Feet	- - - - Pounds/board foot - - -				Pounds/cubic foot		Board feet/ cubic foot
12	43	4.4	3.0	1.8	1.3	46.0	15.9	5.2
14	60	4.7	2.2	1.6	1.3	49.9	13.6	6.1
16	68	4.5	1.8	1.3	1.1	47.4	11.4	6.4
18	66	4.6	1.7	1.5	1.1	47.1	11.0	6.3
20	70	4.7	1.5	1.3	1.0	49.1	10.0	6.8
22	76	4.6	1.5	1.2	1.1	48.5	10.0	6.8
24	88	4.5	1.4	1.2	1.0	47.7	9.9	6.9
26	77	4.6	1.4	1.2	1.0	48.0	9.8	6.9
28	82	5.0	1.4	1.0	1.1	53.0	10.0	7.0
Study average		4.6	1.6	1.2	1.1	48.5	10.5	6.7

Lumber weight per board foot averaged 4.6 pounds and did not differ significantly with tree size except in 28-inch trees, which yielded 9 percent heavier lumber due to higher wood specific gravity. Wood green weight averaged 48.5 pounds per cubic foot and did not increase consistently with increasing tree size. However, average wood green weight per cubic foot was slightly lower in 12-inch trees and slightly higher than the study average in 28-inch trees (table 3).

Lumber recovery factor (L.R.F.)[2] increased with tree size up to 20 inches d.b.h. and then remained relatively constant. The L.R.F. ranged from 5.2 board feet per cubic foot in 12-inch trees to 7.0 board feet per cubic foot in 28-inch trees. Average L.R.F. for the study was 6.7 board feet per cubic foot (table 3).

Yield Tables

Predicted green weights of chippable residue, bark residue, sawdust, and lumber for trees 12 to 30 inches are presented in tables 4-7 of the Appendix. Predicted green lumber volume yields in board feet are presented in Appendix table 8. Green weight of the merchantable stem with and without bark, weight of bark alone, as well as cubic-foot volume of wood in the stem to an 8- and 4-inch top are presented in Appendix tables 9-15. Estimates of pulpwood can be computed by subtracting predicted merchantable stem weight to an 8-inch top from predicted weight to a 4-inch top for comparable sized trees.

Weight factors and yield tables presented in this paper should not be used indiscriminately over the range of yellow-poplar. Differences in green weight per cubic foot and tree form could affect the precision of these data. For optimum predicting performance, these equations and weight factors should be applied to timber of the same form and wood properties which will be cut at a band sawmill.

[2]Lumber recovery factor is the ratio of actual lumber volume recovered to the cubic volume of the piece processed; expressed as board feet/cubic foot.

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APPENDIX

Table 4.--Weight of chippable residue from yellow-poplar saw-log-merchantable stem to 8-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	278	308	337	367	397	426	456				
13	294	329	364	398	433	468	503	537			
14	311	352	392	432	473	513	553	594	634		
15	330	376	423	469	515	561	608	654	700	746	
16		403	455	508	561	613	666	718	771	824	876
17		431	490	550	609	668	728	787	847	906	965
18		460	527	594	660	727	793	860	927	993	1,060
19			566	640	714	789	863	937	1,011	1,086	1,160
20			607	689	772	854	936	1,018	1,100	1,183	1,265
21			650	741	832	922	1,013	1,104	1,194	1,285	1,376
22			696	795	895	994	1,094	1,193	1,293	1,392	1,492
23				852	961	1,069	1,178	1,287	1,396	1,504	1,613
24				911	1,029	1,148	1,266	1,385	1,503	1,621	1,740
25				973	1,101	1,230	1,358	1,487	1,615	1,744	1,872
26					1,176	1,315	1,454	1,593	1,732	1,871	2,010
27					1,253	1,403	1,553	1,703	1,853	2,003	2,153
28					1,334	1,495	1,656	1,818	1,979	2,140	2,301
29						1,590	1,763	1,936	2,109	2,282	2,455
30						1,689	1,874	2,059	2,244	2,429	2,614

[1/] $Y = 185.56929 + 0.02570\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 5.--Weight of bark residue from yellow-poplar saw-log-merchantable stem to 8-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	167	193	219	245	271	297	323				
13	181	212	242	273	303	334	364	394			
14	196	232	267	302	338	373	408	444	479		
15	213	253	294	334	375	416	456	497	537	578	
16		276	322	369	415	461	507	553	600	646	692
17		301	353	405	457	509	562	614	666	718	770
18		327	385	444	502	561	619	678	736	794	853
19			420	485	550	615	680	745	810	875	941
20			456	528	600	672	744	816	889	961	1,033
21			494	573	653	732	812	891	971	1,050	1,130
22			533	621	708	795	883	970	1,057	1,144	1,232
23				670	766	861	957	1,052	1,147	1,243	1,338
24				722	826	930	1,034	1,138	1,242	1,346	1,450
25				776	889	1,002	1,115	1,227	1,340	1,453	1,566
26					955	1,077	1,199	1,321	1,442	1,564	1,686
27					1,023	1,154	1,286	1,417	1,549	1,680	1,812
28					1,094	1,235	1,376	1,518	1,659	1,801	1,942
29						1,318	1,470	1,622	1,774	1,925	2,077
30						1,405	1,567	1,730	1,892	2,054	2,217

[1/] $Y = 85.79319 + 0.02255\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 6.--Weight of sawdust from yellow-poplar saw-log-merchantable stem to 8-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	107	131	154	178	202	226	250				
13	120	148	176	204	232	260	288	316			
14	134	166	199	231	264	296	328	361	393		
15	149	186	223	260	298	335	372	410	447	484	
16		207	250	292	334	377	419	462	504	546	589
17		230	278	325	373	421	469	517	565	613	661
18		254	307	361	415	468	522	576	629	683	737
19			339	398	458	518	578	638	698	757	817
20			372	438	504	571	637	703	769	836	902
21			407	480	553	626	699	772	845	918	991
22			443	523	604	684	764	844	924	1,004	1,085
23				569	657	744	832	920	1,007	1,095	1,182
24				617	712	808	903	998	1,094	1,189	1,285
25				666	770	873	977	1,081	1,184	1,288	1,391
26					830	942	1,054	1,166	1,278	1,390	1,502
27					893	1,013	1,134	1,255	1,376	1,497	1,617
28					958	1,088	1,217	1,347	1,477	1,607	1,737
29						1,164	1,304	1,443	1,582	1,722	1,861
30						1,244	1,393	1,542	1,691	1,840	1,989

[1/] $Y = 32.15269 + 0.02071\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 7.--Weight of 4/4 lumber produced from yellow-poplar saw-log-merchantable stem to 8-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	267	379	490	602	714	825	937				
13	328	459	590	721	852	983	1,114	1,245			
14	393	545	697	849	1,001	1,153	1,304	1,456	1,608		
15	463	638	812	986	1,161	1,335	1,510	1,684	1,858	2,033	
16		737	935	1,134	1,332	1,530	1,729	1,927	2,126	2,324	2,522
17		842	1,066	1,290	1,514	1,738	1,962	2,186	2,410	2,634	2,858
18		954	1,205	1,456	1,708	1,959	2,210	2,461	2,712	2,963	3,214
19			1,352	1,632	1,912	2,192	2,471	2,751	3,031	3,311	3,591
20			1,507	1,817	2,127	2,437	2,747	3,057	3,367	3,677	3,987
21			1,670	2,012	2,354	2,695	3,037	3,379	3,721	4,063	4,404
22			1,841	2,216	2,591	2,966	3,341	3,716	4,092	4,467	4,842
23				2,430	2,840	3,250	3,660	4,070	4,480	4,890	5,300
24				2,653	3,099	3,546	3,992	4,438	4,885	5,331	5,778
25				2,885	3,370	3,854	4,338	4,823	5,307	5,792	6,276
26					3,651	4,175	4,699	5,223	5,747	6,271	6,795
27					3,944	4,509	5,074	5,639	6,204	6,769	7,334
28					4,248	4,855	5,463	6,071	6,678	7,286	7,893
29						5,214	5,866	6,518	7,170	7,821	8,473
30						5,586	6,283	6,981	7,678	8,376	9,073

[1/] $Y = -81.67664 + 0.09688\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 8.--Volume of 4/4 lumber produced from yellow-poplar saw-log-merchantable stem to 8-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Board feet										
12	60	84	108	132	157	181	205				
13	73	102	130	158	186	214	243	271			
14	88	120	153	186	218	251	284	316	349		
15	103	140	178	215	253	290	328	365	403	440	
16		162	204	247	290	332	375	418	460	503	546
17		184	232	281	329	377	425	473	522	570	618
18		208	262	316	370	424	479	533	587	641	695
19			294	354	414	475	535	595	655	715	776
20			327	394	461	527	594	661	728	794	861
21			362	436	509	583	657	730	804	877	951
22			399	480	561	641	722	803	884	964	1,045
23				526	614	702	791	879	967	1,055	1,143
24				574	670	766	862	958	1,054	1,150	1,246
25				624	728	832	937	1,041	1,145	1,249	1,354
26					789	902	1,014	1,127	1,240	1,353	1,465
27					852	973	1,095	1,217	1,338	1,460	1,581
28					917	1,048	1,179	1,309	1,440	1,571	1,702
29						1,125	1,265	1,406	1,546	1,686	1,827
30						1,205	1,355	1,505	1,655	1,806	1,956

[1/] $Y = -14.61814 + 0.02085\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 9.--Yellow-poplar saw-log stem weight with bark to 8-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	819	1,010	1,201	1,392	1,583	1,774	1,965				
13	922	1,147	1,371	1,595	1,819	2,043	2,268	2,492			
14	1,034	1,294	1,554	1,814	2,074	2,335	2,595	2,855	3,115		
15	1,155	1,453	1,752	2,050	2,349	2,647	2,946	3,244	3,543	3,841	
16		1,623	1,962	2,302	2,642	2,981	3,321	3,660	4,000	4,340	4,679
17		1,803	2,187	2,570	2,954	3,337	3,720	4,104	4,487	4,871	5,254
18		1,995	2,425	2,855	3,284	3,714	4,144	4,574	5,004	5,434	5,863
19			2,676	3,155	3,634	4,113	4,592	5,071	5,550	6,029	6,508
20			2,941	3,472	4,003	4,533	5,064	5,595	6,125	6,656	7,187
21			3,220	3,805	4,390	4,975	5,560	6,145	6,730	7,316	7,901
22			3,513	4,155	4,797	5,439	6,081	6,723	7,365	8,007	8,649
23				4,520	5,222	5,924	6,626	7,327	8,029	8,731	9,433
24				4,902	5,666	6,431	7,195	7,959	8,723	9,487	10,251
25				5,300	6,130	6,959	7,788	8,617	9,446	10,275	11,104
26					6,612	7,508	8,405	9,302	10,199	11,096	11,992
27					7,113	8,080	9,047	10,014	10,981	11,948	12,915
28					7,632	8,673	9,713	10,753	11,793	12,833	13,873
29						9,287	10,403	11,518	12,634	13,750	14,865
30						9,923	11,117	12,311	13,505	14,699	15,893

[1/] $Y = 221.83854 + 0.16583\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 10.--Yellow-poplar saw-log stem weight without bark to 8-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	652	817	982	1,147	1,312	1,477	1,642				
13	741	935	1,129	1,323	1,516	1,710	1,904	2,097			
14	838	1,063	1,287	1,512	1,737	1,961	2,186	2,411	2,635		
15	942	1,200	1,458	1,716	1,974	2,232	2,489	2,747	3,005	3,263	
16		1,346	1,640	1,933	2,227	2,520	2,814	3,107	3,401	3,694	3,987
17		1,503	1,834	2,165	2,496	2,828	3,159	3,490	3,821	4,153	4,484
18		1,668	2,039	2,411	2,782	3,154	3,525	3,896	4,268	4,639	5,010
19			2,257	2,671	3,084	3,498	3,912	4,326	4,739	5,153	5,567
20			2,486	2,944	3,403	3,861	4,320	4,778	5,237	5,695	6,154
21			2,727	3,232	3,738	4,243	4,749	5,254	5,760	6,265	6,771
22			2,979	3,534	4,089	4,644	5,198	5,753	6,308	6,863	7,418
23				3,850	4,456	5,063	5,669	6,275	6,882	7,488	8,095
24				4,180	4,840	5,500	6,161	6,821	7,481	8,141	8,802
25				4,524	5,240	5,957	6,673	7,390	8,106	8,822	9,539
26					5,657	6,432	7,207	7,981	8,756	9,531	10,306
27					6,090	6,925	7,761	8,597	9,432	10,268	11,103
28					6,539	7,438	8,336	9,235	10,134	11,032	11,931
29						7,968	8,932	9,896	10,860	11,824	12,788
30						8,518	9,550	10,581	11,613	12,644	13,676

[1/] $Y = 136.04534 + 0.14328\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 11.--Yellow-poplar stem weight with bark to 4-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height to 8-inch d.i.b. top (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	1,168	1,372	1,576	1,781	1,985	2,189	2,394				
13	1,279	1,518	1,758	1,998	2,238	2,477	2,717	2,957			
14	1,398	1,676	1,954	2,232	2,511	2,789	3,067	3,345	3,623		
15	1,527	1,846	2,165	2,484	2,804	3,123	3,442	3,761	4,081	4,400	
16		2,027	2,391	2,754	3,117	3,480	3,844	4,207	4,570	4,933	5,296
17		2,221	2,631	3,041	3,451	3,861	4,271	4,681	5,091	5,501	5,911
18		2,425	2,885	3,345	3,805	4,264	4,724	5,184	5,643	6,103	6,563
19			3,154	3,666	4,179	4,691	5,203	5,715	6,227	6,739	7,252
20			3,438	4,005	4,573	5,140	5,708	6,275	6,843	7,410	7,978
21			3,736	4,362	4,987	5,613	6,239	6,864	7,490	8,116	8,741
22			4,049	4,735	5,422	6,109	6,795	7,482	8,169	8,855	9,542
23				5,126	5,877	6,627	7,378	8,182	8,879	9,630	10,380
24				5,535	6,352	7,169	7,986	8,804	9,621	10,438	11,255
25				5,961	6,847	7,734	8,621	9,508	10,394	11,281	12,168
26					7,363	8,322	9,281	10,240	11,199	12,158	13,118
27					7,899	8,933	9,967	11,002	12,036	13,070	14,104
28					8,455	9,567	10,679	11,792	12,904	14,016	15,129
29						10,224	11,417	12,610	13,804	14,997	16,190
30						10,904	12,181	13,458	14,735	16,012	17,289

[1/] $Y = 529.21459 + 0.17735\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 12.--Weight of bark residue from yellow-poplar stem to 4-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height to 8-inch d.i.b. top (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	236	264	291	319	347	375	403				
13	251	283	316	349	382	414	447	480			
14	267	305	343	381	419	457	495	533	571		
15	285	328	372	415	459	502	546	589	633	677	
16		353	402	452	502	551	601	650	700	749	799
17		379	435	491	547	603	659	715	771	827	883
18		407	470	533	595	658	721	783	846	909	971
19			507	576	646	716	786	856	926	996	1,065
20			545	623	700	777	855	932	1,010	1,087	1,165
21			586	671	757	842	927	1,013	1,098	1,183	1,269
22			629	722	816	910	1,003	1,097	1,191	1,284	1,378
23				776	878	980	1,083	1,185	1,287	1,390	1,492
24				831	943	1,054	1,166	1,277	1,389	1,500	1,612
25				889	1,010	1,131	1,252	1,373	1,494	1,615	1,736
26					1,081	1,211	1,342	1,473	1,604	1,735	1,866
27					1,154	1,295	1,436	1,577	1,718	1,859	2,000
28					1,230	1,381	1,533	1,685	1,836	1,988	2,140
29						1,471	1,634	1,796	1,959	2,122	2,285
30						1,564	1,738	1,912	2,086	2,160	2,435

[1/] $Y = 148.55538 + 0.02419\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 13.--Yellow-poplar stem weight without bark to 4-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height to 8-inch d.i.b. top (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Pounds										
12	932	1,108	1,285	1,461	1,638	1,814	1,991				
13	1,028	1,235	1,442	1,649	1,856	2,063	2,270	2,477			
14	1,131	1,371	1,611	1,852	2,092	2,332	2,572	2,812	3,052		
15	1,242	1,518	1,793	2,069	2,344	2,620	2,896	3,172	3,447	3,723	
16		1,674	1,988	2,302	2,615	2,929	3,243	3,556	3,870	4,184	4,497
17		1,841	2,195	2,549	2,903	3,258	3,612	3,966	4,320	4,674	5,028
18		2,018	2,415	2,812	3,209	3,606	4,003	4,400	4,797	5,194	5,591
19			2,647	3,090	3,532	3,974	4,417	4,859	5,301	5,744	6,186
20			2,892	3,382	3,872	4,363	4,853	5,343	5,833	6,323	6,813
21			3,150	3,690	4,230	4,771	5,311	5,851	6,392	6,932	7,472
22			3,420	4,013	4,606	5,199	5,792	6,385	6,978	7,571	8,164
23				4,350	4,999	5,647	6,295	6,943	7,591	8,239	8,887
24				4,703	5,409	6,115	6,820	7,526	8,232	8,937	9,643
25				5,071	5,837	6,602	7,368	8,134	8,900	9,665	10,431
26					6,282	7,110	7,938	8,767	9,595	10,423	11,251
27					6,744	7,638	8,531	9,424	10,317	11,210	12,104
28					7,225	8,185	9,146	10,106	11,067	12,027	12,988
29						8,753	9,783	10,813	11,844	12,874	13,905
30						9,340	10,443	11,545	12,648	13,751	14,853

[1/] $Y = 380.65921 + 0.15315\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 14.--Yellow-poplar stem cubic volume without bark to 8-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Cubic feet										
12	14	17	21	24	28	31	34				
13	16	20	24	28	32	36	40	44			
14	18	22	27	32	36	41	45	50	55		
15	20	25	31	36	41	46	52	57	62	67	
16		28	34	40	46	52	58	64	70	76	82
17		31	38	45	52	59	65	72	79	86	92
18		35	42	50	58	65	73	80	88	96	103
19			47	55	64	72	81	89	98	106	115
20			52	61	70	80	89	98	108	117	127
21			56	67	77	88	98	108	119	129	139
22			62	73	84	96	107	118	130	141	152
23				79	92	104	117	129	141	154	166
24				86	100	113	127	140	154	167	181
25				93	108	123	137	152	166	181	196
26					116	132	148	164	180	196	211
27					125	142	159	177	194	211	228
28					134	153	171	190	208	226	245
29						164	183	203	223	243	262
30						175	196	217	238	259	280

[1/] $Y = 3.51846 + 0.00293\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

Table 15.--Yellow-poplar stem cubic volume without bark to 4-inch d.i.b. top[1/] [2/]

D.b.h. (inches)	Merchantable tree height to 8-inch d.i.b. top (number of 16-foot logs)[3/]										
	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	5-1/2	6	6-1/2
	Cubic feet										
12	19	23	26	30	34	37	41				
13	21	25	30	34	38	42	46	51			
14	23	28	33	38	43	48	52	57	62		
15	26	31	37	42	48	53	59	65	70	76	
16		34	41	47	53	60	66	72	79	85	91
17		38	45	52	59	66	73	81	88	95	102
18		41	49	57	65	73	81	89	97	105	113
19			54	63	72	81	90	99	108	116	125
20			59	69	79	89	98	108	118	128	138
21			64	75	86	97	108	119	130	140	151
22			70	82	93	105	117	129	141	153	165
23				88	101	114	128	141	154	167	180
24				95	110	124	138	152	167	181	195
25				103	118	134	149	165	180	196	211
26					127	144	161	177	194	211	228
27					137	155	173	191	209	227	245
28					146	166	185	204	224	243	263
29						177	198	219	240	260	281
30						189	211	233	256	278	300

[1/] $Y = 8.22224 + 0.00309\ D^2Mh$.

[2/] Blocked-in area indicates the range of our data.

[3/] Includes a 1-foot stump allowance.

☆ G. P. O. 1974— 640-940 / 425, REGION NO. 4

Clark, Alexander III, Taras, Michael A., and Schroeder, James G.
1974. Predicted green lumber and residue yields from the merchantable stem of yellow-poplar. USDA For. Serv. Res. Pap. SE-119, 15 p. Southeast. For. Exp. Stn., Asheville, N.C.

Yellow-poplar sawtimber trees, 12 to 28 inches d.b.h., were selected in western North Carolina to determine weight and volume of the main stem to an 8-, 4-, and 2-inch d.i.b. top. Weights of lumber and sawmill residues were determined after the saw-log portion of the main stem was sawn into 4/4 lumber. Approximately 1 percent of main stem weight was in material 4 to 2 inches d.i.b., 10 percent in pulpwood, and 89 percent in saw logs. On the average, saw logs produced 54 percent lumber, 15 percent bark residue, 18 percent chippable residue, and 13 percent sawdust. Tables developed with regression equations predict weights of main stem, lumber, and sawmill residues by d.b.h. and merchantable height class.

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The Forest Service, U. S. Department of Agriculture, is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.