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Lumber grade yields for graded aspen [Populus tremuloides] logs and trees

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Abstract

Green lumber grade yields for aspen were determined for use with the U.S. Forest Service hardwood log and tree grades. The yields for logs are expressed in percent of total lumber tally volume, and those for trees are expressed in board feet. Overruns for the International 1/4-inch and Scribner log rules along with lumber recovery factors are shown by log grade.

INTRODUCTION

U.S. FOREST SERVICE standard log and tree grades for all Eastern hardwoods are available (Hanks 1976, Rast and others 1973). Lumber grade yields to accompany the log and tree grades have been published for many species (Hanks 1965, Hanks 1976, Schroeder and Hanks 1967, Vaughan and others 1966). Aspen has been one exception.

Aspen, while not commonly thought of as a major hardwood lumber species, has received increased interest in the lumber market. To consider all aspen logs as pulpwood is unwise, for a significant volume of graded aspen lumber is being produced and sold.

For this study, we determined green lumber grade yields for graded aspen logs and trees. Part I presents yield and overrun information for the logs, and Part II, yields for the trees. By applying current lumber prices to these yields, you can estimate the value of lumber in a log or tree. Then, after the appropriate costs are subtracted, you can predict value at either the stump or at the mill.

PART I — ASPEN LOGS

Data collection

More than 600 aspen logs were available for Part I of this study. About two-thirds of these logs were bucked from the sample trees used for Part II of this paper. The remaining one-third were from mill analyses conducted by the State and Private branch of the U.S. Forest Service in cooperation with the state of Minnesota. The logs which were sawn at three band sawmills, were representative of a variety of geographic locations.

Each log was graded according to the U.S. Forest Service Standard Grades for Hardwood Factory Lumber Logs. Specifications for the log grades may be found in the Appendix. The gross board-foot scale, by both the International 1/4-inch and Scribner log rules, and the defect percentage were obtained for each log; the defect percentage was converted into board feet, and the net scale by both log rules was calculated for each log. The green lumber from each log was graded by a National Hardwood Lumber Association certified inspector. Thickness, surface measure, and grade were recorded for each board. Gross cubic-foot log volumes were computed by Smalian's equation:

$$\text{cubic-foot volume} = \left(\frac{B_1 + B_2}{2} \right) L$$

where

B_1 = area of large end, inside bark
B_2 = area of small end, inside bark
L = log length

Results

Board-foot volume by lumber grade was summed for each log-grade diameter class. These volumes formed the base for the percentage distributions in Table 1 which represent the actual green lumber grade yields. We have also provided curved lumber grade yields (Table 2). Yields for each combination of log grade and lumber grade were developed by solving regression equations in which dib (scaling diameter) and $(dib)^2$ were the independent variables (Table 3). For the 13-inch class, we have demonstrated the effect of log grade on lumber grade yield (Fig. 1). The predicted yield of No. 1C and Better lumber for grades 1, 2, and 3 was 60, 40, and 25 percent, respectively.

The lumber thickness distribution that resulted from sawing the study logs is presented in Table 4. Note that over 95 percent of the volume was sawed into 4/4-inch lumber.

Overrun percentages[1] for both the International 1/4-inch and Scribner log rules are shown in Table 5 along with cubic-foot volumes and lumber recovery factors.

Overrun averaged 4.5 percent for the International 1/4-inch rule and 24.0 percent for the Scribner log rule. For these logs, overrun was related to log grade; and within each log grade, overrun decreased as log size increased. Lumber recovery factor (LRF) represents board feet of lumber sawn per gross cubic foot of log volume. The overall average LRF was 6.12. As expected, both log grade and log size affected the LRF.

[1] $\text{Overrun (percent)} = \dfrac{\text{lumber tally} - \text{net scale} \times 100}{\text{net scale}}$

Table 1.—Actual green lumber grade yields for aspen sawlogs,[a] in percent

Scaling diameter (inches)	Number of logs	Total green lumber tally (fbm)	Lumber grade				
			FAS	SEL	No. 1C	No. 2C	No. 3C
			LOG GRADE 1				
13	42	4,715	9.3	16.8	31.1	37.1	5.7
14	23	3,266	15.8	23.5	28.9	24.6	7.2
15	13	2,058	23.6	20.5	27.9	23.7	4.3
16	10	1,573	15.9	19.8	33.3	25.3	5.7
17	1	221	5.0	43.9	22.6	28.5	.0
18	1	240	33.3	26.7	14.2	25.8	.0
			Total Lumber Tally, Board Feet				
	90	12,073	1,783	2,451	3,594	3,564	681
			LOG GRADE 2				
10	18	1,086	3.6	16.5	22.5	45.4	12.0
11	53	3,628	2.3	10.4	23.1	43.4	20.8
12	74	6,130	3.3	10.3	24.4	48.5	13.5
13	41	3,877	3.8	10.0	24.1	38.2	23.9
14	22	2,182	6.2	14.5	29.8	36.4	13.1
15	14	1,700	4.3	15.7	28.8	37.0	14.2
16	5	686	8.7	10.1	24.9	36.3	20.0
17	1	125	.0	7.2	31.2	34.4	27.2
			Total Lumber Tally, Board Feet				
	228	19,414	739	2,234	4,863	8,241	3,337
			LOG GRADE 3				
8	40	821	0.0	0.0	2.3	46.8	50.9
9	48	1,352	.0	.7	2.0	57.7	39.6
10	89	3,961	.6	4.0	11.4	48.5	35.5
11	44	2,353	.2	3.1	11.4	40.0	45.3
12	36	2,601	.3	2.2	23.9	33.7	39.9
13	23	1,973	1.4	3.5	16.4	50.2	28.5
14	5	423	.0	.0	26.0	42.8	31.2
15	3	296	2.0	2.7	20.3	55.1	19.9
16	3	399	3.5	6.0	27.8	41.1	21.6
			Total Lumber Tally, Board Feet				
	291	14,179	86	399	1,990	6,402	5,302

[a] National Hardwood Lumber Association rules for the measurement and inspection of hardwood and cypress lumber. (Published biennially by National Hardwood Lumber Association, Chicago, Illinois.)

Table 2.—Curved green lumber grade yields for aspen sawlogs, in percent

Scaling diameter (inches)	Lumber grade				
	FAS	SEL	No. 1C	No. 2C	No. 3C
			LOG GRADE 1		
13	11	18	31	34	6
14	14	20	30	30	6
15	17	22	30	26	5
16	21	24	28	22	5
17	24	26	28	18	4
18	28	28	27	14	3
			LOG GRADE 2		
10	3	13	22	46	16
11	3	12	23	45	17
12	3	11	24	44	18
13	4	11	25	42	18
14	5	11	27	39	18
15	6	13	28	36	17
16	7	16	29	32	16
17	8	19	30	28	15
			LOG GRADE 3		
8	0	0	0	54	46
9	0	2	5	50	43
10	0	3	10	47	40
11	1	3	14	44	38
12	1	3	18	43	35
13	1	3	21	42	33
14	2	3	23	42	30
15	2	2	25	43	28
16	2	2	26	45	25

Table 3.—Regression equations, mean lumber volumes, standard error of the estimates, and correlation coefficients for aspen log grades

Dependent variable: lumber grade	Independent variables			Mean lumber volume (percent)	Standard error of the estimate	Multiple correlation coefficient
	Constant	Dib	Dib^2			
			LOG GRADE 1			
FAS	−33.84	3.4209	—	14.0	3.8	0.72
SEL	−7.58	1.9582	—	19.8	3.1	.59
No. 1C	40.85	−.7735	—	30.0	2.3	.36
No. 2C	88.06	−4.1226	—	30.4	4.1	.76
No. 3C	12.51	−.4834	—	5.8	1.1	.44
			LOG GRADE 2			
FAS	5.46	−0.9095	0.06106	3.6	0.9	0.72
SEL	77.63	−10.6741	.42479	11.5	2.0	.51
No. 1C	9.54	1.2520	−.00122	24.7	1.3	.80
No. 2C	17.53	6.1373	.32641	43.0	3.4	.69
No. 3C	−10.17	4.1944	−.15822	17.2	4.5	.11
			LOG GRADE 3			
FAS	2.62	−0.6116	0.03749	0.4	0.4	0.73
SEL	−23.02	4.3315	−.17628	2.4	1.2	.67
No. 1C	−63.80	10.3739	−.29682	11.1	3.3	.90
No. 2C	115.23	−11.0289	.41543	46.7	6.2	.51
No. 3C	68.96	−3.0649	.02018	39.4	5.2	.65

Table 4.—Thickness distribution by lumber grade for aspen, in percent

Lumber thickness (inches)	Lumber grade				
	FAS	Selects	No. 1C	No. 2C	No. 3C
3/4	0.3	0.7	0.4	2.2	4.5
4/4	99.7	98.4	98.4	94.3	90.5
5/4	—	.9	1.1	3.1	4.4
6/4	—	—	.1	.4	.6
	Total Lumber Tally, Board Feet				
	2,608	5,084	10,447	18,207	9,320

Table 5.—Log scale, overrun, cubic volume, and lumber recovery factors of aspen sawlogs

Scaling diameter (inches)	Number of logs	Total green lumber tally	Int. 1/4″ log rule			Scribner log rule			Gross cubic log volume	Lumber recovery factor
			Gross	Net	Overrun	Gross	Net	Overrun		
		------fbm---			Percent	----fbm----		Percent	ft^3	
					LOG GRADE 1					
13	42	4,715	4,275	4,223	11.6	3,630	3,579	31.7	735.32	6.41
14	23	3,266	2,835	2,795	16.9	2,370	2,330	40.2	479.46	6.81
15	13	2,058	2,010	1,964	4.8	1,770	1,718	19.8	320.64	6.42
16	10	1,573	1,530	1,481	6.2	1,390	1,325	18.7	241.95	6.50
17	1	221	205	205	7.8	180	180	22.7	33.72	6.55
18	1	240	230	230	4.3	210	210	14.2	33.99	7.06
Average					10.8			29.2		6.54
					LOG GRADE 2					
10	18	1,086	995	982	10.6	830	819	32.6	177.03	6.13
11	53	3,628	3,535	3,400	6.7	2,910	2,762	31.4	597.92	6.07
12	74	6,130	5,740	5,655	8.4	4,870	4,784	28.1	937.97	6.54
13	41	3,877	3,790	3,705	4.6	3,240	3,145	23.3	603.57	6.42
14	22	2,182	2,420	2,325	−6.2	2,060	1,962	11.2	364.20	5.99
15	14	1,700	1,850	1,714	−0.8	1,650	1,515	12.2	270.51	6.28
16	5	686	730	635	8.0	660	568	20.8	114.22	6.01
17	1	125	150	122	2.5	140	101	23.8	21.19	5.90
Average					4.7			24.0		6.29
					LOG GRADE 3					
8	40	821	790	715	14.8	610	549	49.5	157.74	5.20
9	48	1,352	1,450	1,290	4.8	1,290	1,126	20.1	257.26	5.26
10	89	3,961	4,200	3,967	−0.2	3,470	3,238	22.3	724.51	5.47
11	44	2,353	2,550	2,405	−2.2	2,100	1,947	20.9	411.36	5.72
12	36	2,601	2,625	2,547	2.1	2,240	2,158	20.5	426.85	6.09
13	23	1,973	2,195	2,080	−5.1	1,900	1,757	12.3	336.49	5.86
14	5	423	620	515	−17.9	520	393	7.6	90.98	4.65
15	3	296	350	294	.7	320	251	17.9	60.86	4.86
16	3	399	445	445	−10.3	400	400	−0.2	69.63	5.73
Average					−0.6			20.0		5.59

(Continued)

Table 5.—Continued

Scaling diameter (inches)	Number of logs	Total green lumber tally	Int. 1/4″ log rule			Scribner log rule			Gross cubic log volume	Lumber recovery factor
			Gross	Net	Overrun	Gross	Net	Overrun		
			----fbm----		Percent	----fbm----		Percent	ft³	
					ALL LOGS					
8	40	821	790	715	14.8	610	549	49.5	157.75	5.20
9	48	1,352	1,450	1,290	4.8	1,290	1,126	20.1	257.26	5.26
10	107	5,047	5,195	4,949	2.0	4,300	4,057	24.4	901.54	5.60
11	97	5,981	6,085	5,805	3.0	5,010	4,709	27.0	1,009.28	5.93
12	110	8,731	8,365	8,202	6.4	7,110	6,942	25.8	1,364.82	6.40
13	106	10,565	10,260	10,008	5.6	8,770	8,481	24.6	1,675.38	6.31
14	50	5,871	5,875	5,635	4.2	4,950	4,685	25.3	934.64	6.28
15	30	4,054	4,210	3,972	2.1	3,740	3,484	16.4	652.01	6.22
16	18	2,658	2,705	2,561	3.8	2,450	2,293	15.9	425.80	6.24
17	2	346	355	327	5.8	320	281	23.1	54.91	6.30
18	1	240	230	230	4.3	210	210	14.2	33.99	7.06
Average					4.5			24.0		6.12

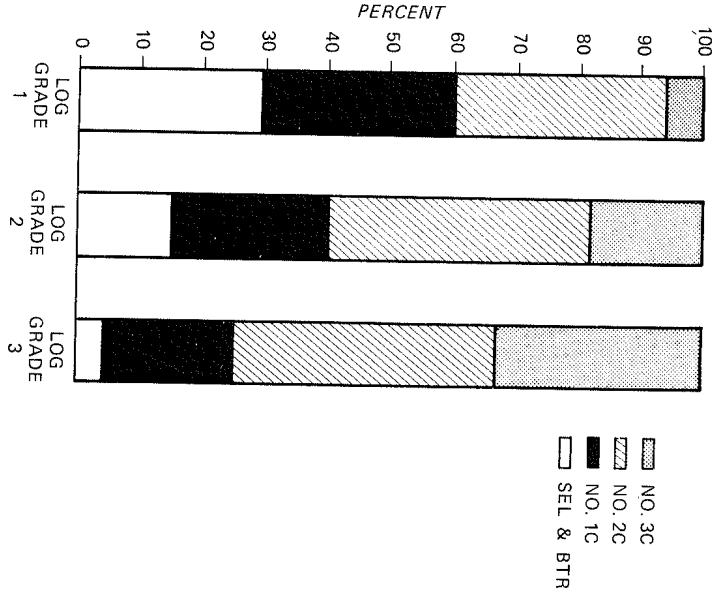

Figure 1.—Cumulative distribution of lumber grades for 13-inch aspen logs.

PART II — ASPEN TREES

Data collection

Our data base for Part II (Table 6) was 182 aspen trees selected in northern Minnesota. We have learned from past studies that 60 trees per grade, spread across the available range of dbh (diameter at breast height) and merchantable heights, is adequate for the development of lumber grade yields. We measured dbh and graded the trees before felling them. Specifications for the tree grades may be found in the Appendix. Merchantable height was measured before the logs were bucked, and was defined as the distance from the stump to the point where local-use class material stopped. A local-use log must scale at least 8 inches dib by 8 feet long, and must be one-third sound. For a detailed discussion of local-use logs, see Rast and others (1973), p. 22-23.

The trees were bucked to log lengths of 8 to 16 feet to yield the best grade possible. Of the 527 logs, 416 were Grade 3 or better and 111 were classed as construction or local-use logs. The logs were sawed and the lumber was graded as described earlier. A tally of the lumber from each tree was maintained.

Results

For each lumber grade within the three tree grades, we developed a multiple regression equation that can be used to predict green lumber grade volumes in board feet (Table 7).

The equations were of the form:

$$\text{Lumber volume} = a + b\,(\text{dbh})^2 + c\,(\text{merchantable height}) + d\,(\text{dbh}^2 \times \text{merchantable height})$$

In a few situations, selected nonsignificant variables were omitted from the equation. For example, merchantable height had no significant effect on volume of FAS lumber in Grade 2 trees because there was very little lumber of that grade above the first log.

The lumber grade volume table was developed by solving the equations for desired combinations of dbh and merchantable height (Table 8). Mean lumber volumes, standard error of the estimates, and multiple correlation coefficients are shown in Table 7. This information will prove useful to those interested in developing a scheme for sampling trees to be graded.

Use of the lumber grade volume table or equations requires the following field data for each tree:

- Tree grade
- Dbh to the nearest inch
- Merchantable height to the nearest foot as measured from the top of a 1-foot stump to the point where local-use material ends.

If the user is certain that prediction will be based on the tabular volumes, merchantable height should be estimated to the nearest half-log. However, if the equations are used to estimate lumber grade volumes, accuracy can be improved if height to the nearest foot is recorded.

The predicted green lumber grade volumes are net volumes derived from actual mill yields and should not be adjusted for cull or overrun.

If the reader is interested in a detailed discussion of the application of the tree grades for timber appraisal, refer to Hanks (1976), p. 2-6.

Table 6.—Number of aspen trees, by grade and dbh

Dbh (inches)	Tree grade		
	1	2	3
10	—	—	5
11	—	—	16
12	—	—	16
13	—	8	10
14	—	17	5
15	—	15	3
16	12	10	2
17	17	6	1
18	11	5	0
19	11	1	0
20	4	2	0
21	2	1	0
22	2	0	0

Table 7.—Regression equations, mean lumber volumes, standard error of the estimates, and correlation coefficients for aspen tree grades

Dependent variable: lumber grade	Independent variables				Mean lumber volume (board feet)	Standard error of the estimate	Multiple correlation coefficient
	Constant	Dbh^2	Merchantable height	$Dbh^2 \times$ merchantable height			
			TREE GRADE 1 (Basis: 59 Trees)				
FAS	−1.4	0.04277	−0.5865	0.003084	27.2	24.9	0.41
SEL	−16.1	.18446	—	—	43.0	19.7	.56
No. 1C	−9.4	.13571	−0.2518	.003311	63.9	23.7	.66
No. 2C	3.5	.03034	2.0224	.002009	110.9	32.7	.72
No. 3C	−13.7	—	.9432	—	20.5	17.2	.55
			TREE GRADE 2 (Basis: 65 Trees)				
FAS	−1.4	0.02737	—	—	5.1	7.4	0.24
SEL	11.6	.00719	−0.4004	0.002093	16.8	14.2	.33
No. 1C	1.9	.05961	−0.8487	.006752	42.6	25.0	.62
No. 2C	9.4	−.04741	.3155	.011053	101.4	29.0	.81
No. 3C	−3.5	—	.6157	—	18.2	15.6	.46
			TREE GRADE 3 (Basis: 58 Trees)				
FAS	0.7	—	—	—	0.7	2.1	—[a]
SEL	−3.2	0.04755	0.0671	−0.000305	4.6	6.7	0.28
No. 1C	−0.8	.08580	−0.3069	.001968	12.3	10.4	.53
No. 2C	1.7	.07881	.9367	.004738	63.8	20.2	.76
No. 3C	−6.8	−.03061	.3272	.004469	18.9	14.0	.69

[a] For this lumber grade, the mean lumber volume was used instead of a regression equation. Therefore, multiple correlation coefficient is undefined.

Table 8.—Green lumber grade volumes for graded aspen trees, in board feet

Dbh (inches)	Lumber grade				
	FAS	SEL	No. 1C	No. 2C	No. 3C
		TREE GRADE 1			
		1 LOG			
16	12.7	31.1	34.8	51.8	1.3
17	15.8	37.2	41.0	53.8	1.3
18	19.0	43.7	47.6	56.0	1.3
19	22.4	50.5	54.6	58.3	1.3
20	26.0	57.7	62.0	60.8	1.3
21	29.8	65.2	69.7	63.3	1.3
22	33.7	73.2	77.8	66.0	1.3
		TREE GRADE 1			
		1½ LOGS			
16	14.3	31.1	39.6	72.1	8.9
17	18.2	37.2	46.7	74.7	8.9
18	22.3	43.7	54.2	77.4	8.9
19	26.6	50.5	62.2	80.3	8.9
20	31.1	57.7	70.6	83.4	8.9
21	35.9	65.2	79.4	86.6	8.9
22	40.9	73.2	88.6	90.0	8.9
		TREE GRADE 1			
		2 LOGS			
16	16.0	31.1	44.3	92.4	16.4
17	20.6	37.2	52.3	95.5	16.4
18	25.6	43.7	60.8	98.8	16.4
19	30.8	50.5	69.7	102.3	16.4
20	36.3	57.7	79.1	106.0	16.4
21	42.1	65.2	89.0	109.9	16.4
22	48.2	73.2	99.4	113.9	16.4
		TREE GRADE 1			
		2½ LOGS			
16	17.6	31.1	49.1	112.7	24.0
17	23.1	37.2	58.0	116.3	24.0
18	28.9	43.7	67.3	120.2	24.0
19	35.0	50.5	77.3	124.3	24.0
20	41.5	57.7	87.7	128.6	24.0
21	48.3	65.2	98.7	133.1	24.0
22	55.4	73.2	110.2	137.9	24.0
		TREE GRADE 1			
		3 LOGS			
16	19.2	31.1	53.9	133.0	31.5
17	25.5	37.2	63.6	137.1	31.5
18	32.2	43.7	73.9	141.6	31.5
19	39.2	50.5	84.8	146.3	31.5
20	46.6	57.7	96.3	151.2	31.5
21	54.5	65.2	108.4	156.4	31.5
22	62.6	73.2	121.1	161.9	31.5
		TREE GRADE 1			
		3½ LOGS			
16	20.8	31.1	58.6	153.3	39.0
17	27.9	37.2	69.2	158.0	39.0
18	35.4	43.7	80.5	163.0	39.0
19	43.4	50.5	92.4	168.3	39.0
20	51.8	57.7	104.9	173.8	39.0
21	60.6	65.2	118.0	179.7	39.0
22	69.9	73.2	131.9	185.8	39.0

Dbh (inches)	Lumber grade				
	FAS	SEL	No. 1C	No. 2C	No. 3C
		TREE GRADE 2			
		1 LOG			
13	3.1	12.0	16.6	36.3	6.3
14	3.9	13.1	21.2	39.8	6.3
15	4.7	14.3	26.0	43.5	6.3
16	5.5	15.5	31.2	47.6	63.
17	6.4	16.9	36.7	51.8	6.3
18	7.4	18.3	42.6	56.4	6.3
19	8.4	19.8	48.8	61.2	6.3
20	9.5	21.4	55.3	66.2	6.3
21	10.6	23.1	62.2	71.5	6.3
22	11.8	24.8	69.4	77.1	6.3
		TREE GRADE 2			
		1½ LOGS			
13	3.1	11.6	19.0	53.8	11.3
14	3.9	13.2	24.9	59.6	11.3
15	4.7	14.8	31.4	66.0	11.3
16	5.5	16.6	38.2	72.7	11.3
17	6.4	18.5	45.6	79.9	11.3
18	7.4	20.5	53.3	87.5	11.3
19	8.4	22.7	61.5	95.6	11.3
20	9.5	24.9	70.2	104.1	11.3
21	10.6	27.3	79.3	113.0	11.3
22	11.8	29.7	88.8	122.4	11.3
		TREE GRADE 2			
		2 LOGS			
13	3.1	11.3	21.3	71.2	16.2
14	3.9	13.3	28.7	79.5	16.2
15	4.7	15.4	36.7	88.4	16.2
16	5.5	17.7	45.3	97.9	16.2
17	6.4	20.2	54.4	108.0	16.2
18	7.4	22.8	64.0	118.7	16.2
19	8.4	25.5	74.2	130.0	16.2
20	9.5	28.4	85.0	142.0	16.2
21	10.6	31.4	96.3	154.5	16.2
22	11.8	34.6	108.1	167.7	16.2
		TREE GRADE 2			
		2½ LOGS			
13	3.1	10.9	23.6	88.7	21.1
14	3.9	13.3	32.5	99.4	21.1
15	4.7	16.0	42.1	110.8	21.1
16	5.5	18.8	52.3	123.0	21.1
17	6.4	21.8	63.2	136.1	21.1
18	7.4	25.0	74.7	149.9	21.1
19	8.4	28.3	86.9	164.5	21.1
20	9.5	31.9	99.8	179.9	21.1
21	10.6	35.6	113.3	196.1	21.1
22	11.8	39.5	127.5	213.0	21.1
		TREE GRADE 2			
		3 LOGS			
13	3.1	10.5	26.0	106.2	26.0
14	3.9	13.4	36.3	119.2	26.0
15	4.7	16.5	47.5	133.2	26.0

Table 8.—Continued

Dbh (inches)	Lumber grade				
	FAS	SEL	No. 1C	No. 2C	No. 3C
16	5.5	19.9	59.4	148.2	26.0
17	6.4	23.4	72.0	164.1	26.0
18	7.4	27.2	85.5	181.1	26.0
19	8.4	31.2	99.7	198.9	26.0
20	9.5	35.4	114.6	217.8	26.0
21	10.6	39.8	130.3	237.6	26.0
22	11.8	44.4	146.8	258.4	26.0
		TREE GRADE 3			
		1 LOG			
10	0.7	2.1	6.0	32.1	2.5
11	.7	3.0	8.4	35.4	3.3
12	.7	4.0	11.1	38.9	4.3
13	.7	5.0	14.0	42.8	5.3
14	.7	6.2	17.2	46.9	6.4
15	.7	7.4	20.6	51.4	7.6
16	.7	8.7	24.3	56.2	8.9
17	.7	10.2	28.1	61.3	10.2
		TREE GRADE 3			
		1½ LOGS			
10	0.7	2.4	5.1	43.4	8.7
11	.7	3.2	7.9	47.4	10.3
12	.7	4.2	10.9	51.9	12.0
13	.7	5.2	14.3	56.7	14.0
14	.7	6.2	17.8	61.9	16.0
15	.7	7.4	21.7	67.5	18.2
16	.7	8.7	25.8	73.4	20.6
17	.7	10.0	30.2	79.8	23.2
		TREE GRADE 3			
		2 LOGS			
10	0.7	2.7	4.2	54.7	14.9
11	.7	3.5	7.3	59.5	17.2
12	.7	4.3	10.7	64.8	19.8
13	.7	5.3	14.5	70.6	22.6
14	.7	6.3	18.5	76.8	25.6
15	.7	7.4	22.8	83.5	28.9
16	.7	8.6	27.4	90.6	32.4
17	.7	9.8	32.3	98.2	36.1
		TREE GRADE 3			
		2½ LOGS			
10	0.7	3.0	3.3	66.0	21.1
11	.7	3.7	6.8	71.6	24.2
12	.7	4.5	10.5	77.8	27.6
13	.7	5.4	14.7	84.5	31.3
14	.7	6.4	19.1	91.7	35.3
15	.7	7.4	23.9	99.5	39.6
16	.7	8.5	29.0	107.8	44.2
17	.7	9.7	34.4	116.7	49.1
		TREE GRADE 3			
		3 LOGS			
12	0.7	4.7	10.4	90.7	35.3
13	.7	5.5	14.9	98.4	39.9
14	.7	6.4	19.7	106.6	44.9
15	.7	7.4	25.0	115.5	50.2
16	.7	8.4	30.6	125.0	55.9
17	.7	9.5	36.5	135.1	62.0

APPENDIX

Forest Service Standard Grades for Hardwood Factory Lumber Logs[a]

Grading Factors		Log grades							
		F1			F2				F3
Position in tree		Butts only	Butts & uppers		Butts & uppers				Butts & uppers
Scaling diameter, inches		13-15[b]	16-19	20+	11+[c]	12			8+
Length without trim, feet			10+		10+	8-9	10-11	12+	8+
Required clear cuttings[d] on each of 3 best faces[e]	Min. length, feet	7	5	3	3	3	3	3	2
	Max. number	2	2	2	2	2	2	3	No limit
	Min. proportion of log length required in clear cutting	5/6	5/6	5/6	2/3	3/4	2/3	2/3	1/2
Maximum sweep & crook allowance	For logs with less than ¼ of end in sound defects	15%			30%				50%
	For logs with more than ¼ of end in sound defects	10%			20%				35%
Maximum scaling deduction		40%[f]			50%[g]				50%
End defect:		See special instructions (page 18)							

[a] From USDA Forest Service Research Paper FPL-63.
[b] Ash and basswood butts can be 12 inches if they otherwise meet requirements for small #1's.
[c] Ten-inch logs of all species can be #2 if they otherwise meet requirements for small #1's.
[d] A clear cutting is a portion of a face, extending the width of the face, that is free of defects.
[e] A face is ¼ of the surface of the log as divided lengthwise.
[f] Otherwise #1 logs with 41-60% deductions can be #2.
[g] Otherwise #2 logs with 51-60% deductions can be #3.

Reprinted from Rast and others (1973), p. 11.

Hardwood Tree Grades for Factory Lumber

Grade factor	Tree grade 1			Tree grade 2		Tree grade 3
Length of grading zone (feet)	Butt 16			Butt 16		Butt 16
Length of grading section[a] (feet)	Best 12			Best 12		Best 12
Dbh, minimum (inches)	16[b]			13		10
Diameter, minimum inside bark at top of grading section (inches)	13[b]	16	20	11[c]	12	8
Clear cuttings (on the 3 best faces):[d]						
Length, minimum (feet)	7	5	3	3	3	2
Number on face (maximum)		2		2	3	(e)
Yield in face length (minimum)		5/6		4/6		3/6
Cull deduction, including crook and sweep but excluding shake, maximum within grading section (percent)		9		9[f]		50

[a] Whenever a 14- or 16-foot section of the butt 16-foot log is better than the best 12-foot section, the grade of the longer section will become the grade of the tree. This longer section, when used, is the basis for determining the grading factors such as diameter and cull deduction.

[b] In basswood and ash, dib at top of grading section must be 12 inches and dbh must be 15 inches.

[c] Grade 2 trees can be 10 inches ib at top of grading section if otherwise meeting surface requirements for small grade 1s.

[d] A clear cutting is a portion of a face free of defects, extending the width of the face. A face is one-fourth of the surface of the grading section as divided lengthwise.

[e] Unlimited.

[f] Fifteen percent crook and sweep or 40 percent total cull deduction are permitted in grade 2 if size and surface of grading section qualify as grade 1. If rot shortens the required clear cuttings to the extent of dropping the butt log to grade 2, do not drop the tree's grade to 3 unless the cull deduction for rot is greater than 40 percent.

Reprinted from Hanks (1976), p. 2.

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