



RESEARCH NOTES

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BUTT LOG TREE GRADES ANALYZED

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INTRODUCTION

The assignment of tree grade on the basis of the grade of the butt log of the standing tree is a technique used in the inventory and appraisal of hardwood timber. For example, several industrial Continuous Forest Inventory (CFI) cases in the North Central States use a procedure wherein the Forest Products Lab (FPL) hardwood log grade rules (6) are applied to the butt log of each hardwood sawtimber tree in the sample. No specific log length is graded; rather the log which would most logically be cut in commercial practice is graded in the longest length which would yield the highest grade.

The technique of applying log grading rules to standing trees has been studied and, in general, validated for nearly 30 years (1) (2) (3) (4) (5) (7) (8). This practice must naturally rely largely on surface indications, and therefore, is not foolproof. However, all grading faces of the log are clearly visible, there is no dirt to obscure degrading defects, and length of clear cuttings can be measured directly. Experience and skill can be valuable aids in judging hidden defect; careful sounding with a light axe will detect unsound areas; and the use of taper tables will enable fairly accurate determination of log top diameters. These procedures can produce a satisfactory and workable system for assessing individual tree quality.

The butt-log tree grade is an excellent measure of timber quality and value in itself. However, there is need for supporting data to enable the conversion of tree grade data into the "log grade mix" which the whole tree should

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yield. With such data, for example, it would be possible to translate a timber marking tally by tree grade into a reliable prediction of the volume by log grades which would result from a given cut.

The quality make-up of the entire sawlog hardwood tree has been the subject of study at the Ford Forestry Center. The data resulting has been used to relate butt log grade to total-tree quality.

PROCEDURES

The data derive from one phase of a comprehensive tree value study being conducted by the Center, wherein each log in 677 standing hardwood trees was graded. This phase of the study involved 125 permanent 1/5 acre CFI plots representing sawtimber stands of the Northern Hardwood-Hemlock cover type. The plots were widely distributed throughout the former Ford Timberlands in Baraga County, Michigan.

The FPL hardwood log grade was determined for each log in each hardwood sawtimber tree. These trees were also measured for Girard form class at the same time. The need to take the ladder to each tree made it possible to obtain a close view of upper log defects and to measure the length of clear cuttings in second logs. The form class measurements also provided the basis for the application of taper tables to obtain log scaling diameters.

The 677-tree sample provided data on 83,400 bd. ft. of sawtimber in 1375 logs.

TREE GRADES

The plots sampled uneven-aged stands resulting from a first "selective" cut of old growth timber in 1936 to 1938. This cut was heavy by today's standards; and there is evidence of high-grading. The stand in 1965 averages 5100 net bd. ft. per acre (Scribner). However 35% of the volume is in ungraded softwood species primarily hemlock.

The hardwood component of the stand consists of 65% hard maple (net bd. ft. Scribner scale), 20% yellow birch, and 15% mixed red maple, basswood, elm, and ash.

Table 1 presents the tree grade picture of the hardwood component. The net bd. ft. volumes represent total-inventory in sawtimber growing stock to a variable minimum 10" top diameter.

Characteristics of the graded trees are as follows:

Grade 1 trees average 217 bd.ft. per tree and the 6.0 trees per acre contain 39% of the hardwood sawtimber volume.

Grade 2 trees average 126 bd.ft. per tree and the 10.7 trees per acre contain 40% of the hardwood sawtimber volume.

Grade 3 trees average 66 bd.ft. per tree and the 10.4 trees per acre contain 21% of the hardwood sawtimber volume.

Table 1. Hardwood Tree Quality Distribution.
Hardwood-Hemlock Sawtimber Stands, Baraga County, Michigan
Basis - 125 1/5 Acre Plots

A. Stand by Tree Grade -- All Hardwood Species

Tree Dia.	Net Scribner Bd.Ft. Volume by Tree Grade			Total Net Bd.Ft. Volume/Acre : %	
	Grade 1	Grade 2	Grade 3		
12	-	7.8	139.5	147.3	4.4
14	-	300.7	171.6	472.3	14.2
16	198.3	437.8	164.4	800.5	24.0
18	443.0	312.5	107.6	863.2	25.9
20	482.5	199.6	68.5	750.5	22.5
22	123.0	57.4	23.9	204.3	6.1
24+	68.1	29.0	-	97.1	2.9
Total	1314.9	1344.8	675.5	3335.2	100%

B. Percent Tree Grade by Diameter

Tree Dia.	Percent Net Scribner Volume by Tree Grade			Total Net Bd. Ft. Volume/Acre
	Grade 1	Grade 2	Grade 3	
12	-	5.3	94.7	147
14	-	63.7	36.3	472
16	24.8	54.7	20.5	800
18	51.3	36.2	12.5	863
20	64.3	26.6	9.1	751
22	60.2	28.1	11.7	204
24+	70.1	29.9	-	97
Avg.%	39.3%	40.2%	20.5%	3335 Bd. Ft.

TOTAL LOG GRADE MIX

Table 2 presents the total log grade mix for each tree grade by tree diameter class for the total hardwood stand. Tables 3, 4, and 5 present the data for the major species components of the stand.

The pattern is similar for the various species. However, Yellow Birch yields a consistently higher percentage of No. 1 and No. 2 logs than sugar maple trees of the same size and tree grades; so there are differences in these relationships between species.

Log grade recovery is quite different among the 3 tree grades, and it is obvious that the tree grades reflect distinct value classes. The importance of tree size in relation to quality is apparent. Few grade 1 logs are produced from trees under 18 inches in diameter.

In analyzing the data it should be remembered that they constitute an inventory of total growing-stock volume. (In this case the limit of top utilization is 10" D.I.B.) Thus, the estimate will differ from that of a local cruiser who drops grade 3 logs from his appraisal. It will also differ from that of a local jobber who claims to produce "40% No. 1 logs," but actually leaves 30% of total stand volume in the woods or diverts it to another product use.

SUMMARY AND CONCLUSIONS

Correct assessment of hardwood sawtimber quality and value cannot really be made without a reasonably precise tree grading system. Data developed in this paper provide a better understanding of the butt log tree grade; and its use in tree quality appraisal.

Because of the basic relationships that exist between the various logs in a tree it should be possible to use information such as developed here as standard data which can be applied to butt log tree grades for other stands; especially if applied on a weighted basis by species and tree size. This should be particularly true of stands similar in history and stand structure. A few obvious conclusions should serve to strengthen this statement:

- 1) From other studies conducted by the Center it is known that the graded butt logs constitute 45% of actual tree volume in local Northern Hardwood stems. No "conversion" to log grades is needed for this portion of the volume which is graded directly.
- 2) The top log in multi-log trees is almost always grade 3.
- 3) Log quality ordinarily declines markedly with each successive log in the tree; so the relationships in log grade upward from grade 1 or 2 butts should be similar for trees of a given size.

- 4) Grade 3 (butt) trees will yield very few logs other than grade 3 or poorer.
- 5) Grade 2 (butt) trees will yield very few logs other than grades 2 or 3.

There are other factors which could limit the use of these tables as standard data:

- 1) In extremely short trees the butt log represents a high proportion of tree volume and average log grade conversions will not apply.
- 2) Extremely tall timber may require a different set of factors to convert tree grade to a log grade mix.
- 3) Certain species representing different "quality types" may vary markedly from others. For example, upper logs in beech may be largely No. 3; whereas in basswood and white ash, uppers may run largely to grades 1 and 2.
- 4) Black heart in sugar maple will reduce grade yield. In areas where this hidden defect occurs, local correction factors will have to be applied to estimates of grade in standing timber.

Further work is planned in order to determine the extent to which similar relationships hold for other stands. It should be possible to develop a body of standard data which would be suitable for wide scale application. If this can be done the butt-log tree grade would have more meaning, inasmuch as it could be readily converted into log grade volume yield figures; and could be used directly as a means of determining total tree value.

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Table 2. Log Grade Yield From Trees of Given Butt-Log Grades.
Hardwood-Hemlock Sawtimber Stands, Baraga County, Michigan.

Basis - 125 Permanent Plots - All Hardwood Stems.

A. All Hardwood Sp. TREE GRADE I (150 trees)						B. All Hardwood Sp. TREE GRADE II (268 trees)					
Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled	Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled
	Log Gr.1	Log Gr.2	Log Gr.3				Log Gr.1	Log Gr.2	Log Gr.3		
12	-	-	-	-	-	12	-	100.0	-	8	4
14	-	-	-	-	-	14	-	73.9	26.1	301	97
16	49.4	29.6	21.0	198	31	16	-	69.3	30.7	438	89
18	49.8	32.7	17.5	443	56	18	-	74.4	25.6	312	48
20	51.9	31.5	16.6	482	49	20	-	64.1	35.9	200	23
22	57.4	30.2	12.4	123	9	22	-	75.1	24.9	57	5
24+	69.9	15.1	15.0	69	5	24+	-	58.7	48.3	29	2
Stand				1315	150	Stand				1345	268
Avg.%	52.2	30.7	17.1			Avg.%	-	70.9	29.1		

C. All Hardwood Sp. TREE GRADE III (259 trees)						D. All Hardwood Sp. ALL TREE GRADES (677 trees)					
Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled	Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled
	Log Gr.1	Log Gr.2	Log Gr.3				Log Gr.1	Log Gr.2	Log Gr.3		
12	-	-	100.0	139	106	12	-	5.3	94.7	147	111
14	-	0.8	99.2	172	80	14	-	47.3	52.7	472	177
16	-	4.9	95.1	164	41	16	12.2	46.2	41.6	800	161
18	-	11.3	88.7	108	19	18	25.6	45.1	29.3	863	123
20	-	9.8	90.2	68	10	20	33.3	38.2	28.5	751	82
22	-	13.4	86.6	24	3	22	34.6	40.9	24.5	204	17
24+	-	-	-	-	-	24+	49.0	28.2	22.8	98	7
Stand				675	259	Stand				3335	677
Avg.%	-	4.7	95.3			Avg.%	20.6	41.6	37.8		

Table 3. Log Grade Yields From Sugar Maple of Given Butt-Log Grades.
Hardwood-Hemlock Sawtimber Stands, Baraga County, Michigan.

Basis - 125 Permanent Plots

A. Sugar Maple. TREE GRADE I						B. Sugar Maple. TREE GRADE II					
Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled	Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled
	Log Gr.1	Log Gr.2	Log Gr.3				Log Gr.1	Log Gr.2	Log Gr.3		
12	-	-	-	-	-	12	-	100.0	-	6	3
14	-	-	-	-	-	14	-	67.1	32.9	151	44
16	44.5	34.9	20.6	118	17	16	-	66.6	33.4	279	55
18	43.9	33.0	23.1	229	26	18	-	75.6	24.4	240	34
20	47.8	34.2	18.0	281	26	20	-	60.2	39.8	137	15
22	47.1	45.1	7.8	82	6	22	-	71.2	28.8	50	4
24+	65.6	17.3	17.1	59	4	24+	-	58.7	41.3	29	2
Stand				769	79	Stand				892	157
Avg.%	47.4	33.8	18.8			Avg.%	-	68.4	31.6		

C. Sugar Maple. TREE GRADE III						D. Sugar Maple. ALL TREE GRADES.					
Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled	Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled
	Log Gr.1	Log Gr.2	Log Gr.3				Log Gr.1	Log Gr.2	Log Gr.3		
12	-	-	100.0	84	63	12	-	7.0	93.0	91	66
14	-	1.2	98.8	120	55	14	-	37.9	62.1	270	99
16	-	4.2	95.8	135	33	16	9.9	43.7	46.4	532	105
18	-	11.9	88.1	102	17	18	17.6	47.1	35.3	571	77
20	-	-	100.0	49	6	20	28.8	38.3	32.9	467	49
22	-	13.4	86.6	24	3	22	24.9	48.5	26.6	156	13
24+	-	-	-	-	-	24+	44.1	30.8	25.1	88	6
Stand				514	177	Stand				2175	413
Avg.%	-	4.4	95.6			Avg.%	16.8	41.0	42.2		

Table 4. Log Grade Yields From Yellow Birch Trees of Given Butt-Log Grades.
Hardwood-Hemlock Sawtimber Stands, Baraga County, Michigan

Basis - 125 Permanent Plots

A. Yellow Birch. TREE GRADE I						B. Yellow Birch. TREE GRADE II					
Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled	Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled
	Log Gr.1	Log Gr.2	Log Gr.3				Log Gr.1	Log Gr.2	Log Gr.3		
12	-	-	-	-	-	12	-	-	-	-	-
14	-	-	-	-	-	14	-	86.4	13.6	102	39
16	55.3	16.8	27.9	25	4	16	-	77.3	22.7	89	21
18	58.4	27.4	14.2	145	21	18	-	71.1	28.9	57	11
20	55.5	27.2	17.3	112	13	20	-	79.6	20.4	36	5
22	78.0	-	22.0	10	1	22	-	100.0	-	8	1
24+	100.0	-	-	9	1	24+	-	-	-	-	-
Stand				301	40	Stand				292	77
Avg.%	58.9	24.7	16.4			Avg.%	-	80.1	19.9		

C. Yellow Birch. TREE GRADE III						D. Yellow Birch. ALL TREE GRADES					
Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled	Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled
	Log Gr.1	Log Gr.2	Log Gr.3				Log Gr.1	Log Gr.2	Log Gr.3		
12	-	-	100.0	19	16	12	-	-	100.0	19	16
14	-	-	100.0	16	11	14	-	74.6	25.4	118	50
16	-	23.7	76.3	10	3	16	11.1	60.9	28.0	124	28
18	-	-	100.0	5	2	18	40.8	38.7	20.5	207	34
20	-	33.7	66.3	20	4	20	37.0	39.3	23.7	168	22
22	-	-	-	-	-	22	44.8	42.5	12.7	19	2
24+	-	-	-	-	-	24+	100.0	-	-	8	1
Stand				70	36	Stand				663	153
Avg.%	-	12.9	87.1			Avg.%	26.7	47.9	25.4		

Table 5. Log Grade Yields From Other-Hardwoods* Trees of Given Butt Log Grades.
Hardwood-Hemlock Sawtimber Stands, Baraga County, Michigan.

Basis - 125 Permanent Plots

A. Other Hardwoods. TREE GRADE I						B. Other Hardwoods - TREE GRADE II					
Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled	Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled
	Log Gr.1	Log Gr.2	Log Gr.3				Log Gr.1	Log Gr.2	Log Gr.3		
12	-	-	-	-	-	12	-	100.0	-	2	1
14	-	-	-	-	-	14	-	67.8	31.2	49	14
16	57.0	24.2	18.8	56	10	16	-	69.5	30.5	69	13
18	51.3	43.1	5.6	69	9	18	-	67.3	32.7	15	3
20	60.0	28.5	11.5	90	10	20	-	63.4	36.6	26	3
22	78.5	-	21.5	30	2	22	-	-	-	-	-
24+	-	-	-	-	-	24+	-	-	-	-	-
Stand				245	31	Stand				161	34
Avg.%	59.1	28.3	12.7			Avg.%	-	68.3	31.7		

C. Other Hardwoods - TREE GRADE III						D. Other Hardwoods - ALL THE GRADES					
Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled	Tree Dia.	% Net Scribner Vol.			Total Net B.F. Per Acre	No. trees Sampled
	Log Gr.1	Log Gr.2	Log Gr.3				Log Gr.1	Log Gr.2	Log Gr.3		
12	-	-	100.0	36	27	12	-	4.0	96.0	38	28
14	-	-	100.0	36	14	14	-	39.5	60.5	84	28
16	-	-	100.0	19	5	16	21.9	42.7	35.4	144	28
18	-	-	-	-	-	18	41.9	47.6	10.5	85	12
20	-	-	-	-	-	20	46.5	36.3	17.2	116	13
22	-	-	-	-	-	22	78.5	-	21.5	30	2
24+	-	-	-	-	-	24+	-	-	-	-	-
Stand				91	46	Stand				497	111
Avg.%	-	-	100.0			Avg.%	29.1	36.0	34.9		

*Basswood Red Maple Elm Paper Birch Black Ash