TREE GRADES for EASTERN WHITE PINE

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FOREWORD

IN 1957 the Forest Service Log Grade Committee recommended a service-wide action program in log and tree grade research. Approval of the program late in 1958 resulted in the establishment of five species-oriented timber-quality research projects covering the several groups of commercially important timber species.

The eastern softwood timber-quality project was activated in 1960. The initial objective of the project was to develop better log and tree grades for eastern white pine. This report presents the results of the initial research on tree grades.

The authors thank the many individuals and organizations who contributed time and services in this research effort. Worthy of mention are: Regions 8 and 9 of the National Forest System; the Minnesota Agency, Bureau of Indian Affairs; the New York State University College of Forestry, Syracuse, N. Y.; the Maine Forest Service; the Northeastern Lumber Manufacturer's Association and its member mills; and the Northern Hardwood and Pine Manufacturer's Association and its member mills.

INTRODUCTION

EASTERN WHITE PINE accounts for only a small percentage of the Nation's total softwood lumber production, but it plays an important role in the overall timber economy of the Northeast, the southern Appalachians, and the Lake States. Because the quality of eastern white pine is extremely variable throughout its commercial range, an adequate tree-grading system is necessary for consistent stratification of trees into distinct value classes for appraisal and inventory purposes.

The tree-grading system presented in this report is not intended to replace the standard white pine log-grading system. To correctly apply the log grades, the ends of the log, as well as the bark surface, must be evaluated. Therefore it is impossible to apply the standard white pine log grades to portions of standing trees.

However, certain situations require that trees be evaluated instead of logs. For example, when a tract of timber is sold, some method must be used to determine an objective value of the trees in the sale. An adequate tree-grading system provides a way of estimating this value. Forest inventory is another example where a standard tree-grading system is useful for evaluating changes in timber quality over a period of time.

The only apparent record of any previous attempt to grade eastern white pine trees was a system developed in 1950 at the Pack Demonstration Forest in New York. However, it

was more of a growing-stock grading system that could be applied to trees as small as 6 inches in diameter at breast height (d.b.h.). Although it segregated trees into relative value classes, the system proved to be more of a management tool for improving growing stock. No record of performance data were available for this early system.

DEVELOPMENT OF THE SYSTEM

The development of the tree grades for eastern white pine paralleled the development of the log grades (*Ostrander and Brisbin 1971*). Most of the studies were designed and carried out so that the lumber-yield data could be related back to the tree from which it orginated. Also, tree diagrams, describing the surface characteristics of the entire tree, were made by combining all of the log diagrams for each tree. These two sets of data—the lumber-grade yields and the tree diagrams—formed the basis for the development and analysis of the tree-grading system.

A trial tree-grading system was developed from the initial lumber-grade yield study in the Northeastern area (New York and Maine) by applying a modified set of the log-grade specifications to the butt 16-foot section of the tree. Four possible tree-grading systems were developed from detailed analyses of the graded tree diagrams (See Appendix for development details). The four grading systems were all based on the application of the modified log-grade specifications to the surface of the butt section of the tree.

Tree diagrams from two additional areas—southern Appalachian and Lake States—were then graded by these four systems. Analyses of the data from each of the three areas indicated that the tree-grading system described here stratified the trees into distinct value classes and resulted in substantial and uniform differences of value among the various grades. The system also proved to be relatively easy to apply after a limited amount of training.

GRADING PROCEDURES

General Considerations

The specifications for the approved tree-grading system apply to merchantable unpruned eastern white pine trees (fig. 1). The grades are based on external characteristics of the butt 16-foot section of the tree and visual indications of

EASTERN WHITE PINE TREE GRADE SPECIFICATIONS

GRADING FACTOR	TREE GRADE 1	TREE GRADE 2	TREE GRADE 3	TREE GRADE 4
(1) MINIMUM D.B.H. (inches)	10	10	10	10
(2) MAXIMUM WEEVIL INJURY IN BUTT 16-FT. SECTION (number)	None	None	2 injuries	No limit
(3) MINIMUM FACE REQUIREMENTS ON BUTT 16-FT. SECTION	Two full length or four 50% length good faces.[1] (In addition, knots on balance of faces shall not exceed size limitations of Grade 2 sections.)	NO GOOD FACES REQUIRED. Maximum diameter of knots on three best faces:		Includes all trees not qualifying for Grade 3 or better and judged to have at least one-third of their gross volume in sound wood suitable for manufacture into standard lumber.
		SOUND RED KNOTS not to exceed 1/6 scaling diameter and 3 inch maximum.[2]	SOUND RED KNOTS not to exceed 1/3 scaling diameter and 5 inch maximum.[2]	
		DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/12 scaling diameter and 1½ inch maximum.[2]	DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/6 scaling diameter and 2½ inch maximum.[2]	
(4) MAXIMUM SWEEP OR CROOK IN BUTT 16-FT. SECTION (percent)	20	30	40	No limit
(5) MAXIMUM TOTAL SCALING DEDUCTION IN BUTT 16-FT. SECTION (percent)	50	50	50	No limit
After the tentative grade of the section is established from face examination, the section will be reduced in grade whenever the following defects are evident: (6) CONKS, PUNK KNOTS, AND PINE BORER DAMAGE ON SURFACE OF SECTION[3] Degrade one grade if present on one face. Degrade two grades if present on two faces. Degrade three grades if present on three or four faces.				
(7) If the final grade of the grading section is 1, 2, or 3, examine the tree for weevil injuries in the merchantable stem *above* 16 ft. If the total apparent weevil injuries exceed three, degrade the tree one grade below the section grade.[3] Otherwise the tree grade is the same as the final section grade.				

[1] Trees under 16 inches d.b.h. require four full length good faces.
[2] Scaling diameter is estimated at the top of the 16-foot grading section.
[3] No tree will be degraded below Grade 4 unless net tree scale is less than one-third of gross tree scale.

Figure 1.—Eastern white pine tree-grade specifications.

weevil damage in the upper merchantable stem. Trees must have a d.b.h. of at least 10 inches and have at least one-third of the gross volume in sound wood suitable for manufacture into standard yard lumber.

The grading system is designed to stratify trees into distinct value classes and to predict differences in lumber-grade yield of trees sawed into standard yard lumber. The lumber-grading rules of the Northeastern Lumber Manufacturer's Association and the Northern Hardwood and Pine Manufacturer's Association define the grades of standard yard lumber.

Grading Factors and Definition of Terms

The following description of grading factors and definitions of terms are presented in the same descending order as listed in the specifications. For detailed descriptions of defects and other log and tree characteristics, see Ostrander (*1971*).

(1) Tree diameter. —A tree must have at least a 10-inch d.b.h. to be graded by these specifications.

(2) Weevil injury in the grading section. — Evidence of weevil injury can be recognized by moderate to severe crook at the point of injury. At the point of injury, limbs are usually large and acute-angled. Grading sections showing none of these characteristics are considered free of weevil injury.

(3) Minimum Face Requirements on the grading section. —A face is one-fourth the circumference of the surface for the full length of the grading section. A good face is one that is free of knots of any type larger than ½ inch in diameter, overgrowths indicating larger knots, and conks or punk knots. A half face is one-half the length of the section. Good half faces must be in either the butt or top half of the grading section.

Sound red knots are any visible branches, stubs, or sock-

ets that resulted from living branches or branches that have been dead for a short time. They are intergrown with the surrounding wood and contain no rot. The average diameter of sound red knots is measured at the point where the limb would normally be trimmed from the main stem. Knot size is determined by measuring only the diameter of the red heartwood portion of the knot.

Dead or black knots are visible branches, stubs, or sockets that do not conform to the definition of sound red knots. The average diameter of dead knots is measured at the same point as the sound red knots; however, the total limb diameter is considered rather than just the red heartwood portion.

Overgrown knots are identified by a distinctive circular or elliptical pattern in the bark and are treated the same as dead knots. The size of the branch stub underlying the overgrowth can be estimated by observing the adjacent visible knots.

(4) Maximum sweep or crook allowance in the grading section.—Sweep is the gradual deviation in inches of the longitudinal axis from a straight line connecting the centers of each end of the grading section. Crook is an abrupt curve or bend deviating from the straight longitudinal axis of the section. Although sweep and crook are normally considered as scaling deductions, they also may cause lumber degrade and therefore must be treated as grading factors. For grading purposes, the amount of sweep or crook present in the grading section is calculated by the following two formulas described by Grosenbaugh (1952):

$$\text{Percent sweep} = \frac{\text{Sweep (inches) minus 2}}{\text{Section scaling diameter (inches)}} \times 100$$

$$\text{Percent crook} = \frac{\text{Deviation (inches)}}{\text{Section scaling diameter}} \times \frac{\text{Section affected length (feet)}}{16} \times 100$$

(5) Maximum total scaling deduction in the grading section.—The total scaling deduction includes sweep and crook deductions as well as deductions for other scalable defects

in the grading section. For grading purposes, the amount of scalable defect must be expressed as a percent of gross volume.

(6) Conks, punk knots, and borer damage on the grading section.—A conk is a fruiting body of a wood rotting fungus (generally *Fomes pini* in eastern white pine). A punk knot is completely rotten, and the brown mycelial mass of the rot fungus is visible within the knot. Pine borer damage can be recognized by entrance channels (holes 3/16 to 1/2 inch in diameter) on the bark surface.

(7) Weevil damage in the upper merchantable stem.—Weevil injuries in the upper stem can be recognized by severe crook and by large acute-angled branches at the point of injury.

Application Procedure

Trees are graded in one or two steps. First, a tentative grade is established for the butt 16-foot section, using factors 1 through 6 of the tree grade specifications (fig. 1). If the tentative grade of the grading section is grade 4, no further examination is necessary; the tree is a grade 4. However, if the tentative grade of the butt 16-foot section is 1, 2, or 3, examine the upper merchantable stem for weevil injuries. If the total apparent weevil injuries exceed three, degrade the tree one grade below that of the tentative grade.

PERFORMANCE OF THE GRADING SYSTEM

Lumber-grade recovery yields for each tree grade are necessary for estimating the value of trees that have been graded by this system. Percent lumber-grade yields for each sample area and tree grade were developed from regression analysis, using combinations of d.b.h. and merchantable height as independent variables. The tabulated lumber-grade

recoveries for each tree grade show the expected percent volume of each standard lumber grade by various d.b.h. and merchantable height combinations (tables 1 through 12).

Separate performance tables for each geographic area are presented because of the different lumber-grading systems in use and because of the much higher incidence of weevil injury in the Northeast area as compared to the southern Appalachian area. The difference in lumber yields between the Northeast area and southern Appalachian area are particularly evident in tree grades 3 and 4. A higher incidence of weevil injury accounts for the significantly higher proportion of No. 4 Common lumber in grade 3 trees of the Northeast sample. The Lake States sample has a significantly greater proportion of No. 1 and 2 Common lumber in all four tree grades as compared to either the Northeast or southern Appalachian samples. This is because the Lake States use a different lumber-grading rule.

The curved lumber-grade yields are an average estimate for each geographic area. Therefore it is not likely that they will precisely predict the output of any particular mill. Because sawing patterns and lumber thicknesses may vary from mill to mill, users of these grades should develop performance data that are specifically tailored to their particular set of conditions.

The recovery tables for the Northeast area reflect the performance of trees from ten different timber stands in New York and Maine. The logs from these trees were sawed into 4/4 standard yard lumber at three circular sawmills. The recovery tables for the southern Appalachian area are based on trees from seven different timber stands in southern North Carolina and northern Georgia. They were sawed at one circular mill. Both 4/4 and 8/4 standard yard lumber were produced. In both the Northeast and southern Appalachian areas, the lumber was graded according to the rules of the Northeastern Lumber Manufacturer's Association.

In the Lake States area, trees from six medium-to-old-growth stands in Minnesota and Michigan were converted

into 4/4 and 8/4 standard yard lumber at two band sawmills. The lumber was graded by the rules of the Northern Hardwood and Pine Manufacturer's Association.

The distribution of the sample trees by d.b.h. and tree grade in each area (table 13) is an indication of the relative precision of the lumber-grade recovery tables. In the Northeast and Lake States areas, very few sample trees were larger than 28 inches d.b.h. Most of the trees in the southern Appalachian sample were smaller than 34 inches d.b.h., although a few trees were in the 36- and 38-inch d.b.h. class.

In the Northeast and Lake States areas, a substantial price differential by board width exists within several lumber grades. Because of this, the distribution of lumber widths in each lumber grade and tree d.b.h. class is important. We found a substantial difference in lumber width-class distribution between the select and combined common grades of lumber (table 14). Tree grade or merchantable height did not significantly affect width-class distribution after tree d.b.h. and lumber grade were considered. The distribution percentages can be applied to the curved yields to provide an estimate of the lumber-grade yields by width class.

To effectively use the lumber-grade yield tables for estimating lumber recovery, tree overruns must be developed to convert tree-scale volume to lumber-tally volume. Tree overruns depend on several factors such as the volume table used to estimate gross tree volume, the type of scaling procedures used to estimate net tree volume, the type of sawmill used to convert the trees to lumber, and the size and mix of products produced from the trees.

We have computed the overruns by the International ¼-inch log rule for each of the three sample areas (table 15). Overruns by the Scribner Decimal C log rule were computed for only the southern Appalachian and Lake States samples (table 15). These overruns are based on the sum of the net *log* scales and lumber-tally volumes for each tree, not on a net tree scale estimated from a tree-volume table. Many different types of tree-volume tables and methods of arriv-

ing at net tree scale are in use; therefore, we felt that summing the net log-scale volumes within a tree would provide a more common base.

In the Northeast area, the overruns represent an average of three circular sawmills. The overruns for the southern Appalachian and Lake States samples are based on one and two mills, respectively. Because of the numerous factors affecting overrun, users of the system should develop their own overrun values.

SUMMARY

The standard Forest Service grades for eastern white pine trees presented in this report resulted from many years of research and cooperative effort from the lumber industry. This grading system is recommended for use by timber buyers, sellers, and processors throughout the commercial range of eastern white pine.

The lumber-grade yield tables in this report represent the performance of better-than-average sawmills in the respective geographic areas, but may not predict precisely any particular mill's output because of differences in lumber thicknesses and sawing patterns. Therefore, it is recommended that users of this grading system conduct mill-scale studies at their own mills, thus assuring more precise estimates of lumber-grade yields by tree grade. Both lumber-grade yields and overrun factors can be developed from the same mill-scale study.

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APPENDIX I

PERFORMANCE TABLES

Tables 1-12.—Curved white pine lumber grade yields

Table 13.—Distribution of trees in each sample area by tree grade and d.b.h. class

Table 14.—Lumber width-class distribution by lumber grade and d.b.h. class

Table 15.—Percent overruns of the International ¼-inch and Scribner Decimal C rules by d.b.h. for each sample area

NORTHEAST—TREE GRADE 1

Table 1.—Curved white pine lumber grade yields, in percent

[Basis: 71 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		1-LOG TREES			
10	18	44	32	6	0
12	23	35	32	10	0
14	26	28	33	13	0
16	28	24	32	16	0
18	30	20	33	17	0
		2-LOG TREES			
10	15	38	34	13	0
12	19	30	34	17	0
14	23	24	33	20	0
16	25	20	32	22	1
18	27	17	32	23	1
20	28	14	33	24	1
22	30	13	31	25	1
24	31	11	31	26	1
		3-LOG TREES			
12	16	25	36	23	0
14	19	20	34	26	1
16	21	16	34	28	1
18	23	13	34	29	1
20	25	11	33	30	1
22	26	10	31	31	2
24	27	9	31	31	2
26	28	8	30	32	2
		4-LOG TREES			
14	16	15	36	32	1
16	18	12	35	34	1
18	20	10	34	34	2
20	21	8	33	36	2
22	23	7	32	36	2
24	24	7	31	36	2
26	24	6	30	38	2
28	25	6	29	37	3

NORTHEAST—TREE GRADE 2

Table 2.—Curved white pine lumber grade yields, in percent

[Basis: 41 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		1-LOG TREES			
10	7	20	53	19	1
12	8	22	47	22	1
14	9	23	43	25	0
16	9	23	42	26	0
18	10	23	39	28	0
		2-LOG TREES			
10	7	16	52	24	1
12	8	17	47	27	1
14	9	18	42	30	1
16	10	18	39	32	1
18	10	18	37	34	1
20	11	17	36	35	1
22	11	17	34	36	2
24	12	17	32	37	2
		3-LOG TREES			
12	8	13	46	33	0
14	9	13	41	36	1
16	10	13	38	38	1
18	11	12	36	39	2
20	11	11	34	42	2
22	12	10	32	43	3
24	12	9	31	45	3
26	13	8	30	45	4
		4-LOG TREES			
14	9	8	41	41	1
16	10	7	37	44	2
18	11	6	35	46	2
20	12	5	33	47	3
22	12	4	31	49	4
24	13	2	30	50	5
26	13	1	28	52	6
28	14	0	27	53	6

NORTHEAST—TREE GRADE 3

Table 3.—Curved white pine lumber grade yields, in percent

[Basis: 59 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		1-LOG TREES			
10	3	7	43	43	4
12	3	5	40	48	4
14	3	4	38	51	4
16	3	3	37	53	4
18	4	3	36	53	4
		2-LOG TREES			
10	3	5	41	46	5
12	3	4	38	50	5
14	3	3	36	53	5
16	4	3	34	54	5
18	4	2	33	56	5
20	4	2	32	57	5
22	5	2	31	57	5
24	5	3	30	58	4
		3-LOG TREES			
12	3	2	35	53	7
14	3	2	33	55	7
16	4	2	31	57	6
18	4	2	30	58	6
20	5	2	29	58	6
22	5	2	28	60	5
24	6	3	27	59	5
26	6	3	26	60	5
		4-LOG TREES			
14	3	1	30	58	8
16	4	1	28	60	7
18	5	1	27	60	7
20	5	2	26	61	6
22	6	2	25	61	6
24	6	3	24	62	5
26	7	4	23	61	5
28	8	4	22	62	4

NORTHEAST—TREE GRADE 4

Table 4.—Curved white pine lumber grade yields, in percent

[Basis: 49 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		1-LOG TREES			
10	2	2	19	52	25
12	1	1	17	61	20
14	1	1	16	66	16
16	1	0	15	70	14
18	1	0	14	73	12
		2-LOG TREES			
10	1	3	23	55	18
12	1	2	21	62	14
14	1	1	20	66	12
16	2	1	19	67	11
18	2	1	18	69	10
20	2	1	18	68	11
22	2	0	17	70	11
24	2	0	17	68	13
		3-LOG TREES			
12	1	3	25	63	8
14	2	2	24	65	7
16	2	2	23	65	8
18	2	1	22	66	9
20	2	1	21	66	10
22	2	1	21	64	12
24	3	1	20	61	15
26	3	0	20	60	17
		4-LOG TREES			
14	2	3	28	64	3
16	2	2	27	64	5
18	2	2	26	63	7
20	3	2	25	60	10
22	3	1	25	58	13
24	3	1	24	55	17
26	4	1	24	50	21
28	4	1	23	47	25

SOUTH—TREE GRADE 1

Table 5.—Curved white pine lumber grade yields, in percent

[Basis: 103 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		2-LOG TREES			
12	20	30	33	17	0
14	22	23	33	22	0
16	23	18	33	26	0
18	24	15	32	29	0
20	26	12	31	31	0
		3-LOG TREES			
12	16	28	37	19	0
14	18	22	36	24	0
16	20	17	35	28	0
18	22	14	34	30	0
20	23	11	33	32	1
22	24	9	32	34	1
24	25	7	31	35	2
26	26	6	29	37	2
		4-LOG TREES			
14	15	20	39	26	0
16	17	16	37	29	1
18	18	12	37	32	1
20	20	10	34	34	2
22	21	8	33	35	3
24	22	7	31	37	3
26	23	5	30	38	4
28	24	5	28	38	5
30	25	4	26	39	6
		5-LOG TREES			
16	14	14	40	31	1
18	15	11	39	33	2
20	17	9	36	35	3
22	18	7	34	37	4
24	20	6	32	37	5
26	21	5	30	38	6
28	22	4	28	39	7
30	23	4	25	39	9
32	24	4	23	39	10
34	25	4	21	39	11

SOUTH—TREE GRADE 2

Table 6.—Curved white pine lumber grade yields, in percent

[Basis: 57 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		2-LOG TREES			
12	8	18	47	27	0
14	8	17	44	31	0
16	9	16	40	35	0
18	9	15	39	37	0
20	10	15	37	38	0
		3-LOG TREES			
12	6	16	47	29	2
14	7	15	42	34	2
16	7	14	40	37	2
18	8	13	38	39	2
20	9	12	36	42	1
22	9	12	35	42	2
24	10	11	34	43	2
26	10	11	33	44	2
		4-LOG TREES			
14	5	13	42	36	4
16	6	12	39	39	4
18	7	11	37	41	4
20	7	10	36	43	4
22	8	9	34	45	4
24	9	9	33	45	4
26	9	8	32	46	5
28	10	7	31	47	5
30	11	7	30	47	5
		5-LOG TREES			
16	4	9	39	42	6
18	5	8	37	44	6
20	6	7	35	45	7
22	7	7	34	45	7
24	8	6	32	47	7
26	9	5	31	47	8
28	9	4	31	48	8
30	10	4	30	48	8
32	11	3	29	48	9
34	11	2	29	49	9

SOUTH—TREE GRADE 3

Table 7.—Curved white pine lumber grade yields, in percent

[Basis: 57 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		2-LOG TREES			
12	3	7	43	43	4
14	3	6	44	44	3
16	3	5	44	45	3
18	3	4	44	47	2
20	4	3	43	48	2
		3-LOG TREES			
12	3	9	42	42	4
14	3	8	42	44	3
16	3	7	41	46	3
18	4	6	41	46	3
20	4	5	40	48	3
22	4	4	39	50	3
24	4	3	38	51	4
26	5	2	36	53	4
		4-LOG TREES			
14	3	10	40	44	3
16	3	9	39	46	3
18	4	8	38	47	3
20	4	6	37	49	4
22	4	5	35	51	5
24	5	4	33	53	5
26	5	3	31	55	6
28	6	2	30	55	7
30	6	1	28	57	8
		5-LOG TREES			
16	3	11	37	46	3
18	4	9	35	48	4
20	4	8	33	50	5
22	5	7	31	51	6
24	5	5	29	54	7
26	6	4	26	56	8
28	6	3	24	58	9
30	7	2	22	58	11
32	7	0	19	62	12
34	8	0	16	63	13

SOUTH—TREE GRADE 4

Table 8.—Curved white pine lumber grade yields, in percent

[Basis: 15 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		2-LOG TREES			
12	1	2	19	53	25
14	2	1	18	56	23
16	2	1	18	57	22
18	2	0	17	60	21
20	2	0	17	60	21
		3-LOG TREES			
12	2	3	21	56	18
14	2	2	20	59	17
16	2	2	20	59	17
18	2	1	20	60	17
20	2	1	19	60	18
22	2	0	19	61	18
24	2	0	19	60	19
26	3	0	19	57	21
		4-LOG TREES			
14	2	3	22	61	12
16	2	3	22	61	12
18	3	2	22	60	13
20	3	2	22	59	14
22	3	1	22	58	16
24	3	1	22	57	17
26	3	1	22	55	19
28	3	0	23	53	21
30	3	0	23	51	23
		5-LOG TREES			
16	3	4	24	62	7
18	3	3	24	61	9
20	3	3	24	59	11
22	3	2	24	58	13
24	3	2	25	55	15
26	4	2	25	51	18
28	4	1	26	49	20
30	4	1	26	46	23
32	4	1	27	42	26
34	4	1	27	39	29

Table 9.—Curved white pine lumber grade yields, in percent

[Basis: 38 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		2-LOG TREES			
10	4	77	17	0	2
12	9	59	22	8	2
14	13	48	24	14	1
16	16	38	26	19	1
18	19	29	28	23	1
20	21	23	30	25	1
		3-LOG TREES			
12	6	67	20	5	2
14	10	54	23	11	2
16	14	43	25	16	2
18	16	37	26	19	2
20	19	30	27	22	2
22	21	25	27	25	2
24	22	20	29	27	2
26	24	16	29	29	2
		4-LOG TREES			
14	7	61	22	8	2
16	11	50	24	13	2
18	14	43	25	16	2
20	16	37	26	19	2
22	18	32	26	22	2
24	20	26	27	24	3
26	22	23	26	26	3
28	24	19	27	27	3
30	25	16	27	29	3
		5-LOG TREES			
14	4	68	21	5	2
16	8	58	22	10	2
18	11	51	23	13	2
20	14	43	24	16	3
22	16	38	24	19	3
24	18	33	25	21	3
26	20	28	25	23	4
28	22	25	25	24	4
30	24	22	24	26	4
32	26	18	24	27	5

Table 10.—Curved white pine lumber grade yields, in percent

[Basis: 65 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		2-LOG TREES			
10	0	40	32	20	8
12	3	34	32	23	8
14	6	30	31	25	8
16	8	27	31	27	7
18	10	24	31	28	7
20	12	22	31	29	6
		3-LOG TREES			
12	1	37	32	21	9
14	4	33	32	23	8
16	7	29	31	25	8
18	8	26	32	27	7
20	10	23	33	28	6
22	11	21	33	30	5
24	12	19	33	31	5
26	13	17	34	32	4
		4-LOG TREES			
14	2	34	33	22	9
16	5	30	33	24	8
18	7	27	33	26	7
20	8	24	35	27	6
22	10	21	35	29	5
24	11	19	36	30	4
26	12	17	36	32	3
28	13	15	37	33	2
30	14	13	37	34	2
		5-LOG TREES			
14	1	36	33	20	10
16	3	32	33	23	9
18	5	28	34	25	8
20	7	25	35	27	6
22	8	22	37	28	5
24	9	19	38	30	4
26	11	17	38	31	3
28	12	15	38	33	2
30	12	12	42	34	0
32	13	10	41	36	0

LAKE STATES—TREE GRADE 3

Table 11.—Curved white pine lumber grade yields, in percent

[Basis: 30 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		2-LOG TREES			
10	0	15	14	56	15
12	3	13	19	52	13
14	6	10	23	49	12
16	8	8	26	47	11
18	9	6	29	47	9
20	10	3	30	49	8
		3-LOG TREES			
12	2	26	20	34	18
14	4	23	24	33	16
16	6	19	27	33	15
18	7	16	29	35	13
20	8	12	30	38	12
22	9	9	31	41	10
24	10	5	32	44	9
26	10	2	33	47	8
		4-LOG TREES			
14	2	34	25	18	21
16	4	30	27	20	19
18	5	26	29	23	17
20	6	21	31	27	15
22	7	17	31	32	13
24	8	12	32	36	12
26	8	8	33	41	10
28	8	3	33	48	8
30	8	0	33	53	6
		5-LOG TREES			
14	0	48	25	2	25
16	2	41	28	6	23
18	3	37	29	11	20
20	4	31	30	17	18
22	5	25	31	23	16
24	5	19	32	30	14
26	6	14	32	36	12
28	6	8	32	44	10
30	6	3	32	51	8
32	6	0	31	58	5

LAKE STATES—TREE GRADE 4

Table 12.—Curved white pine lumber grade yields, in percent

[Basis: 36 trees]

D.b.h. (inches)	Select	No. 1-2 Common	No. 3 Common	No. 4 Common	No. 5 Common
		2-LOG TREES			
10	1	14	27	45	13
12	2	11	25	48	14
14	3	9	23	52	13
16	4	7	22	54	13
18	5	5	22	56	12
20	5	3	22	59	11
		3-LOG TREES			
12	1	22	22	32	23
14	2	19	21	36	22
16	3	16	21	39	21
18	4	14	21	41	20
20	5	12	21	43	19
22	6	9	21	47	17
24	6	7	22	49	16
26	7	5	23	51	14
		4-LOG TREES			
14	1	29	19	20	31
16	2	26	19	24	29
18	3	22	19	27	29
20	4	20	20	30	26
22	5	17	21	33	24
24	6	14	22	36	22
26	7	11	23	40	19
28	8	9	24	42	17
30	8	6	25	46	15
		5-LOG TREES			
14	0	39	16	5	40
16	1	35	17	9	38
18	3	31	18	13	35
20	4	28	19	17	32
22	5	24	20	21	30
24	6	21	21	24	28
26	7	18	23	27	25
28	8	14	25	31	22
30	9	11	26	35	19
32	10	8	28	38	16

Table 13.—Distribution of trees in each sample area by tree grade and d.b.h.

[Number of trees]

D.b.h. (inches)	Northeast sample, tree grade—				Southern sample, tree grade—				Lake States sample, tree grade—			
	1	2	3	4	1	2	3	4	1	2	3	4
10	1	5	8	6	1	4	7	4	—	2	1	3
12	2	7	10	3	3	7	6	—	1	4	5	1
14	4	10	7	7	4	13	8	1	4	10	1	4
16	10	5	10	6	13	7	5	—	3	10	3	6
18	18	3	5	9	20	4	5	2	10	12	3	4
20	10	5	8	5	13	4	4	—	6	11	3	5
22	11	2	4	7	13	4	8	3	4	7	2	1
24	10	4	5	4	15	4	4	1	5	4	7	3
26	3	—	2	1	8	3	4	1	2	2	2	1
28	2	—	—	1	5	2	1	1	2	3	1	4
30	—	—	—	—	4	3	1	2	—	—	1	2
32	—	—	—	—	1	1	3	—	—	—	1	—
34+	—	—	—	—	3	1	1	—	1	—	—	2
Total	71	41	59	49	103	57	57	15	38	65	30	36

Table 14.—Lumber width class distribution by lumber grade and d.b.h. class[1]

[In percent]

D.b.h. (inches)	D-Select & Better width class:			No. 1 through 5 Common width class:		
	1	2	3	1	2	3
10	93	7	0	40	60	0
12	66	32	2	28	68	4
14	48	39	13	21	61	18
16	35	44	21	15	56	29
18	26	46	28	11	52	37
20	20	48	32	8	48	44
22	15	48	37	6	44	50
24	12	48	40	5	41	54
26	11	46	43	4	38	58
28	10	45	45	4	35	61
30	9	43	48	3	33	64
32	9	41	50	3	30	67
34	10	39	51	4	27	69

[1] Width class 1—(3 to 5 inches); width class 2—(6 to 9 inches); width class 3—(10 inches and wider).

Table 15.—Percent overruns of the International 1/4-inch and Scribner Decimal C rules by d.b.h. for each sample area[1]

D.b.h. (inches)	Northeast sample		Southern sample			Lake States sample		
	Trees	International overrun	Trees	International overrun	Scribner overrun	Trees	International overrun	Scribner overrun
	No.	Pct.	No.	Pct.	Pct.	No.	Pct.	Pct.
10	20	1.9	—	—	—	6	9.2	29.3
12	22	1.6	1	1.5	11.1	11	5.4	32.8
14	28	1.4	8	1.2	22.5	19	10.4	28.9
16	31	2.0	7	—0.3	17.7	22	11.7	34.5
18	35	0.7	8	—3.8	11.7	29	11.6	32.3
20	28	0.6	4	—1.4	15.3	25	9.8	27.1
22	24	1.9	13	—3.7	8.6	14	9.6	23.9
24	23	—0.5	11	—5.4	4.4	19	11.5	24.9
26	6	0.4	12	—3.1	5.7	7	5.4	13.6
28	3	1.0	7	—2.0	6.2	10	7.1	15.1
30	—	—	10	—0.9	6.0	3	9.0	15.3
32	—	—	5	—4.8	—1.1	1	14.6	18.3
34	—	—	2	—5.8	—0.4	—	—	—

[1] The values in this table were calculated by summing the net log scales and lumber tally for each tree by 2-inch d.b.h. classes and then computing a separate overrun for each 2-inch class. These values have not been curved.

APPENDIX II

DEVELOPMENT AND TESTING OF THE GRADING SYSTEM

Several standards were followed in developing and testing this grading system (*Newport et al. 1958*). These standards include:

1. The grades in a grading system must group the trees so that variability in value or product yields is reduced to a reasonable limit.
2. For a given tree size, one grade should differ from another by not less than 10 percent of the mean value of the higher of the two grades under consideration. The differences in mean value among the several grades should be approximately equal.
3. There should be no more than six grades in any grading system.
4. A grading system should be applicable to a particular species over its commercial range.

The initial study for developing white pine tree grades consisted of a sample of 220 trees from northeastern New York and southwestern Maine (fig. 2). Size measurements were made on each tree before felling, and then the surface characteristics of each log cut from the trees were recorded on diagram sheets before the logs were processed into lumber (*Ostrander et al. 1964*).

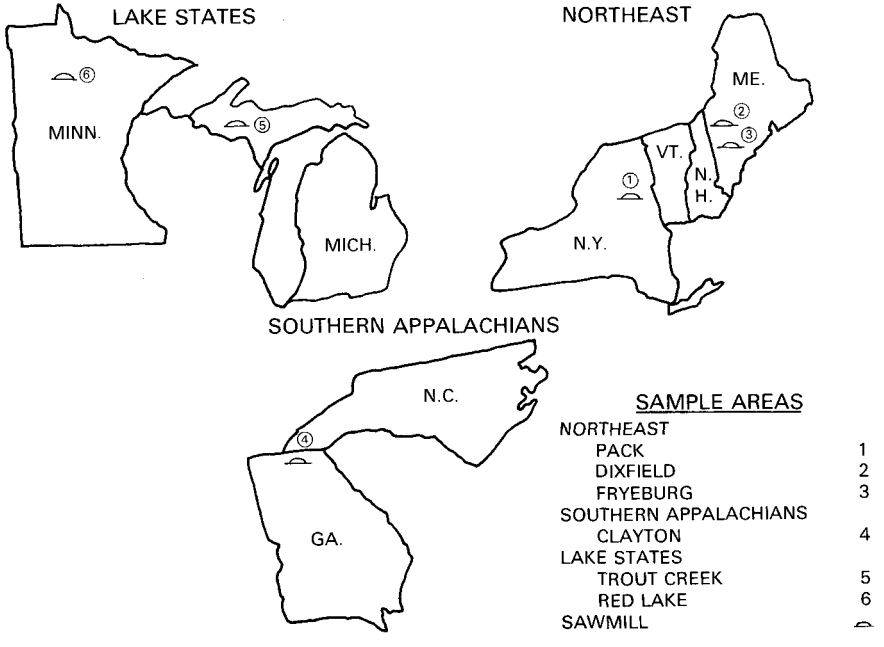

Figure 2.—Location of sample areas and study sawmills.

The total value of each tree and the board-foot volumes by lumber grade were computed by summing all log values and volumes for each tree. Then the tree diagrams were examined, and a grade was assigned to each tree, based on the grade of the best 12-foot section of the butt log. A modified version of the eastern white pine log grades was used to grade the best 12-foot section of the butt log. All of the grading factors in the log-grade specifications were considered except the log end defect factor. Analysis of tree value by the assigned tree grade showed that several grade 1, 2, and 3 trees were considerably below the average value for their respective grade. Further examination of the tree diagrams showed that these trees had several weevil injuries above the graded portion of the tree. A detailed analysis of weevil injuries indicated that grade 1, 2, or 3 trees with four or more weevil injuries in the upper merchantable stem should be degraded one grade.

After the effects of weevil injury in the upper stem were considered, a few grade 1 and 2 trees were still relatively low in value. Diagram analysis showed that if these trees had been graded on a 16-foot section basis rather than on the best 12-foot section basis, they would have been one grade lower. We also found that small grade 2 trees (10 inches to 15 inches d.b.h.) that were degraded only because of diameter limitations actually had higher values than many grade 1 trees.

From the previously described observations and analyses, we developed four possible trial grading systems for further testing:

Trial 1.—The tree grade was based on the grade of the best 12-foot section of the butt log with a minimum d.b.h. of 16 inches for grade 1 trees.

Trial 2.—This was the same as trial 1 except there was no minimum d.b.h. limitation on grade 1 trees.

Trial 3.—The tree grade was based on the grade of the full 16-foot section, with a minimum d.b.h. of 16 inches for grade 1 trees.

Trial 4.—This was the same as trial 3 except there was no minimum d.b.h. limitation on grade 1 trees.

In all four systems, grade 1, 2, and 3 trees were degraded one grade if four or more weevil injuries occurred in the merchantable stem above the grading section.

At this point in the analysis, the tree diagrams from the Northeastern sample, the southern Appalachian sample, and the Lake States sample were graded by the four trial systems. Quadratic regression equations of tree value over tree volume were then computed for each tree grade within each of the four trial systems. Residual variance of value around the regressions was pooled for each of the trial systems. The coefficient of variation at the average volume for each tree grade was also computed.

In the Northeast sample, the variance of grade 1 trees was reduced about 10 percent by eliminating the diameter-limit specification. By grading the full 16-foot section of the butt log, the variances of grades 1 and 2 were further reduced. The pooled variance for the trial 4 system was the lowest. In the southern Appalachian sample, the tree grades based on the full 16-foot section resulted in the lowest pooled within-grade variance. The diameter-limit specification did not have any effect on the trees in the southern Appalachian sample because there were very

few small grade 1 trees. In the Lake States sample, the trial 4 system resulted in the lowest pooled within grade variance and the most uniform coefficients of variation.

Estimated values per 1,000 board feet at selected volumes of lumber recovered were calculated from the regression equations. These values showed that the trial 4 system resulted in the largest and most uniform differences in value among the tree grades.

This grading system has been tested on an independent sample of 75 trees from the Northeast area. The trees were graded by the trial 4 system; then they were sawed into standard yard lumber at a circular sawmill in southern Maine. Lumber-grade volumes and values of the 75 trees were estimated by using the performance tables for the Northeast area shown in this report. The average difference between the actual and estimated value was about 3 percent of the actual value. The detailed results of this test of both the standard tree grades and the standard log grades will be reported in a separate publication.

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