by Myron D. Ostrander
and Robert L. Brisbin

SAWLOG GRADES for EASTERN WHITE PINE

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NORTHEASTERN FOREST EXPERIMENT STATION, UPPER DARBY, PA.
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
WARREN T. DOOLITTLE, DIRECTOR

THE AUTHORS

MYRON D. OSTRANDER received his bachelor's degree in forestry at the University of Minnesota in 1936 and has served with the USDA Forest Service since 1937, except for 1 year with a large lumber company. He has been with the Northeastern Forest Experiment Station since 1948, and most of his research effort has been in marketing and utilization. He has served on several short-term details in Central America as a utilization and sawmilling specialist. At present he is a project leader in the Northeastern Station's eastern softwood timber-quality research project at Upper Darby, Pa.

ROBERT L. BRISBIN, a research forest products technologist, received his bachelor's degree in forestry from Iowa State University in 1961 and his master's degree in wood technology from The Pennsylvania State University in 1969. He has served with the Northeastern Forest Experiment Station since 1961, except for 2 years of military service. He is at present on the staff of the Station's eastern softwood timber-quality project at Upper Darby, Pa.

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FOREWORD

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

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

The project staff thank the many individuals and organizations who contributed time and services to this research effort, including Regions 8 and 9 of the National Forest System; the Minnesota Agency, Bureau of Indian Affairs; the New York State University College of Forestry at Syracuse, N. Y.; the Maine Forest Service; the Northeastern Lumber Manufacturer's Association and the Northern Hardwood and Pine Manufacturer's Association and their member sawmill operators.

INTRODUCTION

ALTHOUGH EASTERN WHITE PINE now accounts for only a small percentage of the total national softwood lumber production, it does hold a prominent position in the timber economies of New England, portions of the Lake States, and the Southern Appalachian area. Because of the extreme variability in quality of white pine timber, a grading system that will accurately and consistently stratify sawlogs into distinct value classes is necessary for timber appraisal and management purposes.

After the New England hurricane of 1938, the USDA Forest Service developed an arbitrary set of eastern white pine log-grade specifications for use in its timber-salvage program. These specifications proved reasonably adequate for this program, but questions arose about identification and evaluation of certain grading factors in the system. The lack of consideration for other important quality criteria also suggested need for improvement. In addition, performance tables for the system were limited to the rough green lumber condition without consideration of log diameter, thus reducing the accuracy of the system.

Sporadic use of these rules by the Forest Service and other Government agencies continued through the mid-1940's, and these rules were also adopted for use in the Forest Survey. Within this same period, a number of companies and associations also developed grading systems for the species. All of these fell short of satisfying basic objectives and desirable performance standards.

DEVELOPMENT OF THE IMPROVED SYSTEM

In 1955 the Northeastern Forest Experiment Station, in cooperation with the State University of New York College of Forestry at Syracuse, N. Y. began a study to develop an improved sawlog-grading system for eastern white pine. The study resulted in an improved grading system that was designated as the "trial" sawlog-grade specifications for eastern white pine.

Additional white pine lumber-grade yield studies were conducted in Maine and New Hampshire in 1957, 1958, and 1960 (fig. 1). Analysis of data from these studies indicated that the "trial" system was superior to the old "timber-salvage" grading system and also suggested several minor modifications. Data for all Northeastern studies were then combined and the improved "trial" grade specifications, with accompanying lumber-grade yield tables, were made available for use in the Northeast.

In 1960, timber-quality research in eastern softwoods was given project status as part of the overall Forest Service log- and tree-grade program. Testing of the "trial" white pine log-grading system over the species' range was begun. Tests were made in the Lake States and the Southern Appalachians (fig. 1). Results of these tests also indicated that the "trial" system satisfactorily met the standards desired of a good log-grading system. In 1969 the Forest Service Log Grade Committee recommended that the system be accepted as the Forest Service standard, and this was approved in 1970.

GRADING PROCEDURE

GENERAL CONSIDERATIONS

The specifications for the approved system (fig. 2) apply to *cut* eastern white pine sawlogs. They are not recommended for use in grading logs in standing trees—separate specifications have been developed for grading standing trees. Also, they do not apply to logs from artificially pruned trees. The grades are

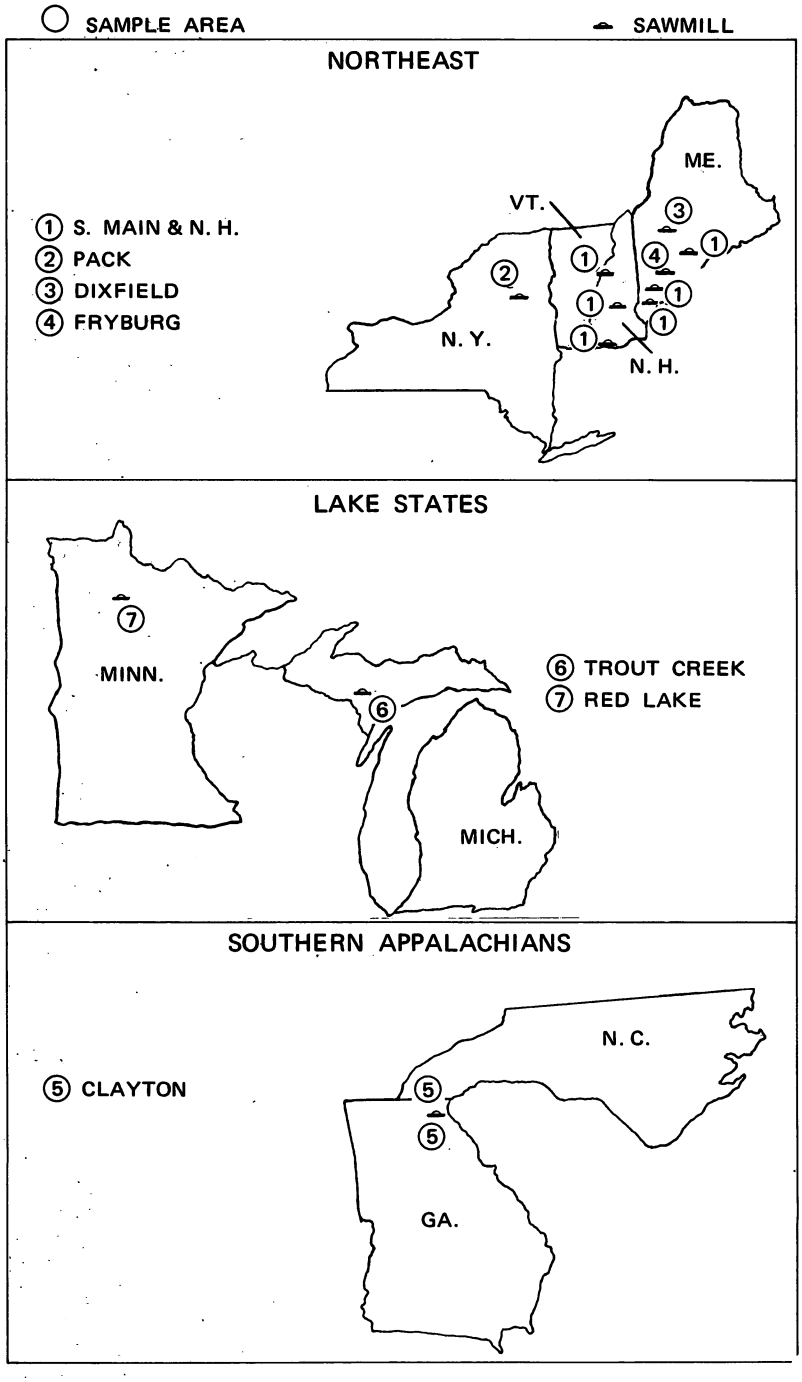


Figure 1.—Location of sample areas and study sawmills.

EASTERN WHITE PINE SAWLOG GRADE SPECIFICATIONS

GRADING FACTOR	LOG GRADE 1	LOG GRADE 2	LOG GRADE 3	LOG GRADE 4
(1) MINIMUM SCALING DIAMETER (inches)	14[1]	6	6	6
(2) MINIMUM LOG LENGTH (feet)	10[2]	8	8	8
(3) MAXIMUM WEEVIL INJURY (number)	None	None	2 injuries[3]	No limit
(4) MINIMUM FACE REQUIREMENTS	Two full length or four 50% length good faces.[4] (In addition, log knots on balance of faces shall not exceed size limitations of grade 2 logs.)	No GOOD FACES REQUIRED. Maximum diameter of log knots on three best faces: SOUND RED KNOTS not to exceed 1/6 scaling diameter and 3 inch maximum. DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/12 scaling diameter and 1½ inch maximum.	SOUND RED KNOTS not to exceed 1/3 scaling diameter and 5 inch maximum. DEAD OR BLACK KNOTS including overgrown knots not to exceed 1/6 scaling diameter and 2½ inch maximum.	Includes all logs not qualifying for No. 3 or better and judged to have at least one-third of their gross volume in sound wood suitable for manufacture into standard lumber.
(5) MAXIMUM SWEEP OR CROOK ALLOWANCE (percent)	20	30	40	66⅔
(6) MAXIMUM TOTAL SCALING DEDUCTION (percent)	50	50	50	66⅔

After the tentative log grade is established from face examination, the log will be reduced in grade whenever the following defects are evident:

(7) CONKS, PUNK KNOTS, AND PINE BORER DAMAGE ON BARK SURFACE[5]

Degrade one grade if present on one face.
Degrade two grades if present on two faces.
Degrade three grades if present on three or more faces.

(8) LOG END DEFECTS: RED ROT, RING SHAKE, HEAVY STAIN AND PINE BORER DAMAGE OUTSIDE HEART CENTER OF LOG[5]

Consider log as having a total of 8 quarters (4 on each end) and degrade as indicated below:
Degrade one grade if present in 2 quarters of log ends.
Degrade two grades if present in 3 or 4 quarters of log ends.
Degrade three grades if present in 5 or more quarters of log ends.

[1]12 and 13 inch logs with four full length good faces are acceptable.
[2]8 foot logs with four full length good faces are acceptable.
[3]8 foot No. 3 logs limited to one weevil injury.
[4]Minimum 50% length good face must be at least 6 feet.
[5]Factors 7 and 8 are not cumulative (total degrade based on more serious of the two). No log to be degraded below grade 4 if net scale is at least one-third gross log scale.

Figure 2.—Grading specifications for eastern white pine sawlogs.

based on the external surface characteristics of the species—more specifically, on the extent of "good" faces and the size and condition of log knots in relation to log diameter. Evidence of white-pine weevil injury, sweep, crook, red ring rot, ring shake, and pine borer damage may also act as degrading factors.

The log grades are designed for stratifying logs into distinct value classes and predicting differences in the lumber-grade yield of logs sawed into standard yard lumber, as defined by the Northeastern Lumber Manufacturer's Association and the Northern Hardwood and Pine Manufacturer's Association.

GRADING FACTORS AND DEFINITION OF TERMS

The following description of grading factors and definitions of terms used in grading are presented in the same order as in the specifications (fig. 2).

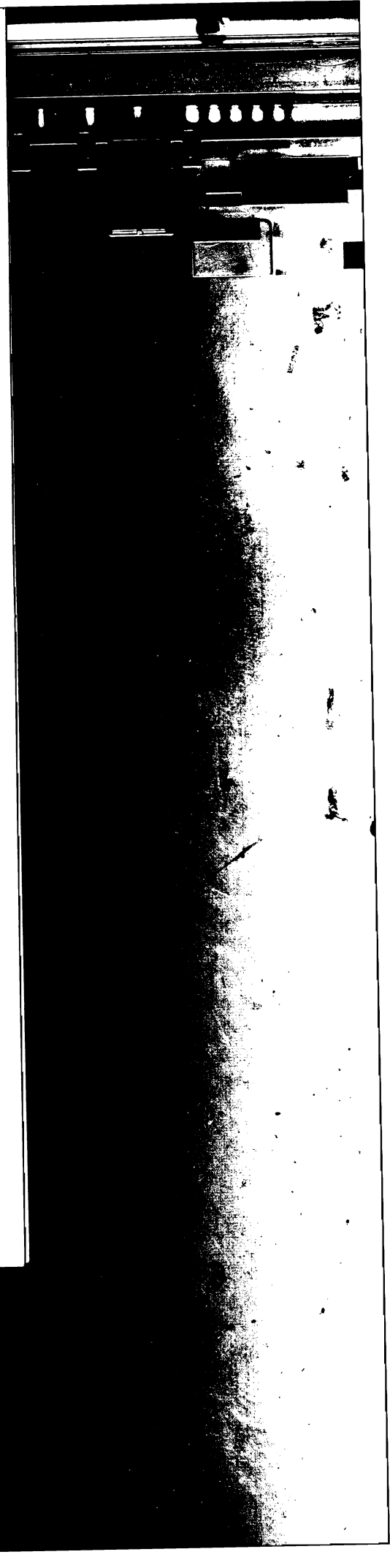
(1) *Log diameter.*—A log must have at least a 6-inch scaling diameter to be graded. Grade 1 logs have further limits on scaling diameter.

(2) *Log length.*—Logs 8 to 16 feet long can be graded with these rules. There are further limits on length for grade 1 logs.

(3) *Weevil injury.*—Evidence of weevil injury can be recognized by moderate to severe crook at the point of injury. Crook is usually more serious in small logs than in large logs. Limbs at point of injury are usually large and acute-angled. Logs showing none of these characteristics are considered free of weevil injury.

(4) *Minimum face requirements.*—A log face is defined as one-fourth the circumference of the log surface for the full length of the log. A *good* face is one that is free of log 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 log. *Good* half faces can be in either half of a full face and must be at least 6 feet long for 10-foot logs.

Log knots.—Sound red log knots are any visible branches, stubs, or sockets 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. Dead or black log knots are visible branches, stubs, or sockets that do not conform to the definition of sound red knots. Overgrown log knots are identified by a distinctive circular or elliptical pattern in the bark, and they are treated the same as dead knots. Size of the branch stub underlying the overgrowth can be estimated by observing the adjacent visible log knots. The average diameter of live or dead knots is measured at the point where the limb would



normally be trimmed from the log. If the knot resulted from a live branch, only the diameter of the red heartwood portion is considered in determining knot size; if the knot resulted from a dead branch or stub, the total limb diameter is considered. All knots ½ inch or less in diameter are disregarded.

(5) ***Maximum sweep or crook allowance.***—Sweep is the deviation in inches of the curved central log axis from a straight line connecting the centers of each end of the log. The percent volume loss due to sweep is:

$$\text{Percent sweep} = \frac{\text{Sweep minus one for each 8 feet of log length}}{\text{Log diameter (inches)}} \times 100$$

Crook is an abrupt curve or bend deviating from the straight longitudinal axis of the log. The percent volume loss due to crook is:

$$\text{Percent crook} = \frac{\text{Deviation (inches)}}{\text{Log diameter (inches)}} \times \frac{\text{Log length affected (feet)}}{\text{Total log length (feet)}} \times 100$$

(6) ***Maximum total scaling deduction.***—Total deductions include sweep and crook deductions as well as volume deductions for other scalable defects (rot, shake, insect damage, etc.).

(7) ***Conks, punk knots, and borer damage on bark surface.***—A conk is the 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 is evidenced by entrance channels (holes 3/16 to ½ inch in diameter) on the bark surface.

(8) ***Log-end defects.***—Red ring rot (incipient and advanced stages of decay due to *Fomes pini*) is usually associated with overmature or badly weeviled trees. It can be recognized on log ends by its reddish brown to pink color. It should not be confused with the brown cubical rot usually found in the butts of older trees. Ring shake is a separation of wood fibers along an annual ring; it is usually associated with older trees. Heavy blue

stain is a blue fungal discoloration limited to the sapwood. The color is so pronounced that it nearly obscures the grain of the wood. It usually accompanies an insect attack in logs stored during periods of warm weather. Pine borer damage on log ends is evident from occurrence of entrance channels (holes 3/16 to ½ inch in diameter) on log ends.

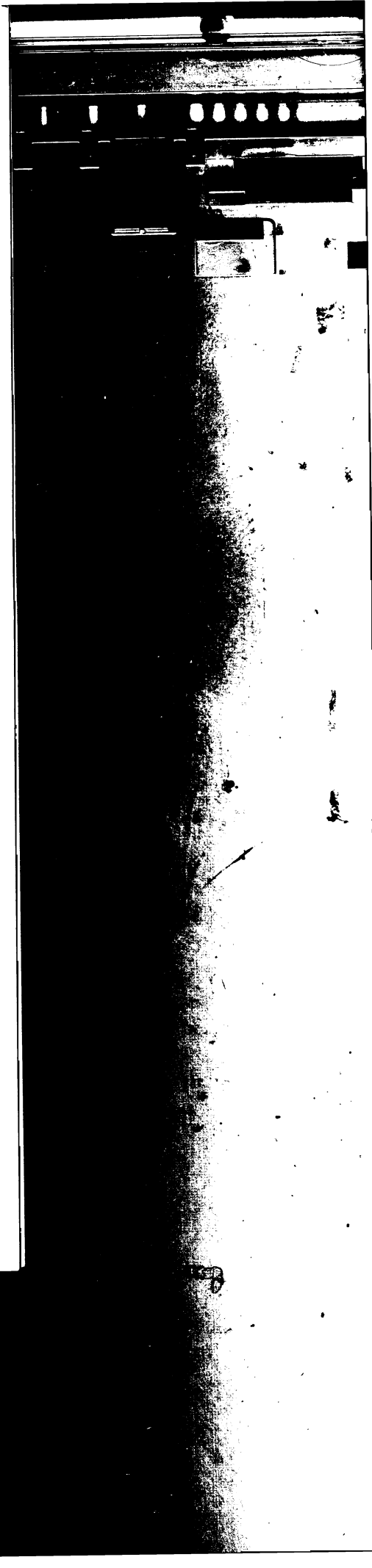
APPLICATION

The following procedure is recommended for grading white pine sawlogs:

1. First, scale the log, following standard Forest Service scaling practice *(USDA Forest Service 1964)*. Proper scaling procedures automatically give the grader measurements of many of the factors involved in grading the log. These include log diameter and length, severity of sweep or crook, and evidence of red rot, ring shake, or borer damage.
2. Then examine the log for possible weevil injuries.
3. Assign a tentative grade to the log, based on log size limitations, allowable scale deduction, weevil injury, and face requirements (factors 1 through 6 in specifications).
4. After the tentative grade is established, determine whether degrade is necessary due to factors 7 and 8.

PERFORMANCE OF THE GRADING SYSTEM

The tabulated dressed-dry lumber-grade recoveries for each geographic area and log grade were calculated from quadratic regression equations of percent lumber-grade yield over log diameter (tables 1 through 12). Separate lumber-grade recoveries are required for each geographic area because of differences in lumber-grading rules between two areas and because of the high incidence of weevil injury in the Northeastern area. 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 tailored specifically to their own particular sets of conditions; i.e., sawing patterns and lumber size mix.

The recovery tables for the Northeastern area reflect the yields of 1,549 logs from 22 different timber stands in New York, New Hampshire, and Maine. The sample logs were sawed into 4/4 standard yard lumber at nine sawmills within this area. The recovery tables for the Southern Appalachian area are based on 498 logs sawed at one circular mill. Both 4/4 and 8/4 standard yard lumber was produced. In both the Northeastern and Southern Appalachian areas the lumber was graded according to the rules of the Northeastern Lumber Manufacturer's Association. In the Lake States area, 753 logs from 6 medium- to old-growth stands were converted into 4/4 and 8/4 standard yard lumber at 2 band mills. The lumber was graded according to the rules of the Northern Hardwood and Pine Manufacturer's Association.

The distribution of the sample logs by scaling diameter and log grade within each area (table 13) is an indication of the relative precision of the lumber-grade recovery tables. A reasonably good distribution exists in most log grades except for the larger diameters (greater than 20 inches). However, the occurrence of logs larger than 20 inches in diameter is limited throughout most of the range of the species.

The lumber grade yields differ among the three sample areas, particularly in log grades 2, 3, and 4. The higher percentage of No. 3 Common lumber in log grades 3 and 4 of the Southern sample can be attributed to less weevil injury and better natural pruning characteristics. The higher percentage of No. 2 and No. 3 Common lumber in the Lake States sample, as compared to the Northeastern sample, resulted from differences in the lumber-grading systems used. The percentage of No. 5 Common lumber in the grade 4 logs of the Lake States sample is higher because of the greater incidence of red rot.

In the Northeastern and Lake States areas a substantial price differential by board width exists within several of the lumber grades. Because of this, the distribution of lumber widths in each lumber grade and log-diameter class is important. We found

that a substantial difference in lumber-width class distribution existed between the select and common grades of lumber (table 14). Log grade did not have a significant effect on width-class distribution after scaling diameter 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, log overrun data must be developed for converting log-scale volume to lumber-tally volume. Overruns depend on several factors such as the log rule used to estimate the volume, the type of sawmill used to convert the logs into lumber, and the size and mix of products produced from the logs.

We have computed the overruns for each of the three sample areas for the International 1/4-inch and Scribner Decimal C log rules (table 15). In the Northeastern area the computed overruns represent an average of nine circular sawmills. The overruns shown for the Southern and Lake States samples are based on only one and two mills respectively. Because of the numerous factors affecting overrun, users of the system should develop their own overrun values.

DISCUSSION

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

By using the log grades and accompanying lumber-grade yield tables, log buyers and sellers can estimate the value of logs in terms of standard yard lumber grades. Sawmill operators will find the log grades useful for estimating the proportions of the various lumber grades that can be produced from their graded log inventories. The grading specifications are also useful for determining proper bucking practice to provide the optimum yield of standard yard lumber.

The lumber-grade yield tables in this report represent the performance of better-than-average sawmills in the respective geographic areas. These tables will probably not predict precisely any particular mill's output because of differences in lumber thicknesses and sawing patterns. If a user of this grading system wants precise estimates of lumber-grade yields by log grade for his operation, he should conduct a mill-scale study at his own mill. He will also be able to develop overrun factors from the same study.

The application of this grading system will be simplified if it is used in conjunction with USDA Forest Service Research Paper NE-190 *(Ostrander 1971)*, which illustrates and explains the grading factors.

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APPENDIX A

PERFORMANCE TABLES

GRADE 1 LOGS — NORTHEASTERN AREA

Table 1.—*White pine curved lumber-grade yields by log diameter*

[Dressed-dry, basis: 86 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
12	38	24	25	13	(*)
13	38	21	25	15	1
14	39	18	25	17	1
15	39	15	26	19	1
16	40	12	26	20	2
17	41	11	25	21	2
18	42	10	25	21	2
19	43	9	24	22	2
20	44	9	23	22	2
21	46	9	21	22	2
22	48	10	19	22	1
23	50	11	17	21	1

*Less than 0.5 percent.

GRADE 2 LOGS — NORTHEASTERN AREA

Table 2.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 194 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	4	39	44	13	(*)
7	6	35	44	15	(*)
8	8	31	43	18	(*)
9	10	27	43	20	(*)
10	11	23	42	23	1
11	12	20	42	25	1
12	13	17	41	28	1
13	14	14	40	30	2
14	15	12	39	32	2
15	16	10	37	35	2
16	16	8	36	37	3
17	17	7	34	39	3
18	17	6	33	41	3
19	17	6	31	43	3
20	16	6	29	45	4
21	16	6	27	47	4
22	16	6	24	49	5
23	16	6	22	51	5

*Less than 0.5 percent.

GRADE 3 LOGS — NORTHEASTERN AREA

Table 3.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 844 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	1	12	50	36	1
7	1	10	48	40	1
8	2	8	46	43	1
9	2	7	44	46	1
10	2	6	42	48	2
11	2	5	40	51	2
12	3	4	38	53	2
13	3	3	36	55	3
14	4	3	34	56	3
15	4	3	32	58	3
16	4	2	31	59	4
17	5	2	29	60	4
18	5	2	27	61	5
19	6	2	25	61	6
20	7	2	23	61	7
21	7	2	22	61	8
22	8	3	20	60	9
23	8	3	19	60	10

GRADE 4 LOGS — NORTHEASTERN AREA

Table 4.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 425 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	1	2	24	70	3
7	1	2	23	70	4
8	1	1	22	70	6
9	1	1	21	70	7
10	1	1	20	70	8
11	1	1	19	70	9
12	1	1	18	69	11
13	1	1	17	69	12
14	1	1	17	68	13
15	2	(*)	16	67	15
16	2	(*)	15	66	17
17	2	(*)	14	66	18
18	3	(*)	13	64	20
19	3	(*)	13	63	21
20	4	(*)	12	61	23
21	5	(*)	11	60	24
22	6	(*)	10	58	26
23	6	(*)	10	56	28

*Less than 0.5 percent.

GRADE 1 LOGS — SOUTHERN AREA

Table 5.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 37 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
12	35	16	25	24	(*)
13	35	15	25	25	(*)
14	35	14	25	25	1
15	35	13	25	26	1
16	36	12	24	26	2
17	36	11	24	26	3
18	38	10	23	25	4
19	39	9	21	25	6
20	41	8	19	24	8
21	43	7	17	23	10
22	46	6	15	22	11
23	49	5	12	20	14

*Less than 0.5 percent.

GRADE 2 LOGS — SOUTHERN AREA

Table 6.—*White pine curved lumber-grade yields by log diameter*

[Dressed-dry, basis: 60 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	5	55	34	6	(*)
7	5	51	35	9	(*)
8	5	47	35	13	(*)
9	5	41	36	18	(*)
10	5	36	37	21	1
11	6	30	37	25	2
12	7	26	36	28	3
13	7	22	36	31	4
14	9	18	35	34	4
15	10	15	34	36	5
16	11	12	32	39	6
17	13	10	30	41	6
18	15	8	28	42	7
19	17	6	26	44	7
20	19	5	23	45	8
21	22	5	20	45	8
22	25	4	17	45	9
23	27	5	13	46	9

*Less than 0.5 percent.

GRADE 3 LOGS — SOUTHERN AREA

Table 7.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 326 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	(*)	20	63	15	2
7	(*)	18	62	19	1
8	(*)	16	60	23	1
9	1	14	58	26	1
10	1	12	56	30	1
11	1	10	54	34	1
12	1	9	52	37	1
13	2	7	50	39	2
14	2	6	47	43	2
15	3	5	44	45	3
16	3	4	41	48	4
17	3	4	39	50	4
18	4	3	35	53	5
19	4	3	32	55	6
20	4	2	29	57	8
21	5	2	25	59	9
22	5	2	22	60	11
23	6	2	18	62	12

*Less than 0.5 percent.

GRADE 4 LOGS — SOUTHERN AREA

Table 8.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 75 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	(*)	9	54	30	7
7	(*)	8	49	35	8
8	(*)	6	45	39	10
9	(*)	5	40	43	12
10	(*)	4	36	47	13
11	1	3	32	50	14
12	1	2	28	53	16
13	1	2	25	55	17
14	2	1	22	57	18
15	2	1	19	58	20
16	3	(*)	17	59	21
17	3	(*)	15	60	22
18	4	1	13	59	23
19	4	1	12	58	25
20	5	1	11	57	26
21	6	2	11	55	26
22	6	3	11	53	27
23	7	4	11	50	28

*Less than 0.5 percent.

GRADE 1 LOGS — LAKE STATES AREA

Table 9.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 33 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
12	22	35	17	25	1
13	26	35	17	21	1
14	29	36	17	17	1
15	32	35	18	14	1
16	35	34	18	12	1
17	37	33	18	11	1
18	39	31	18	11	1
19	40	29	18	12	1
20	41	25	18	15	1
21	41	21	17	19	2
22	41	17	17	23	2
23	40	12	16	29	3

GRADE 2 LOGS — LAKE STATES AREA

Table 10.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 168 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	(*)	67	30	3	(*)
7	(*)	66	29	5	(*)
8	1	62	29	8	(*)
9	3	56	29	10	2
10	5	51	28	13	3
11	7	47	28	14	4
12	8	42	28	17	5
13	10	38	28	18	6
14	12	34	28	20	6
15	13	31	29	21	6
16	15	28	29	22	6
17	16	25	30	23	6
18	17	22	31	24	6
19	18	19	32	25	6
20	19	17	33	26	5
21	20	15	35	26	4
22	20	14	37	26	3
23	21	12	39	27	1

*Less than 0.5 percent.

GRADE 3 LOGS — LAKE STATES AREA

Table 11.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 421 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	(*)	54	28	17	1
7	(*)	50	30	18	2
8	1	45	32	20	2
9	1	40	34	22	3
10	1	36	36	24	3
11	2	32	37	26	3
12	2	28	38	28	4
13	2	25	39	30	4
14	3	22	39	32	4
15	3	19	39	34	5
16	4	17	39	35	5
17	4	15	39	37	5
18	5	13	38	39	5
19	5	11	37	42	5
20	5	10	36	44	5
21	6	9	34	46	5
22	6	8	33	48	5
23	7	7	31	50	5

*Less than 0.5 percent.

GRADE 4 LOGS — LAKE STATES AREA

Table 12.—*White pine curved lumber-grade yields by log diameter*
[Dressed-dry, basis: 131 logs]

Scaling diameter (inches)	D-Select & Better	No. 1 & 2 Common	No. 3 Common	No. 4 Common	No. 5 Common
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
6	1	17	31	34	17
7	1	16	28	35	20
8	1	14	26	36	23
9	1	13	23	38	25
10	2	11	21	38	28
11	2	10	19	39	30
12	3	9	17	40	31
13	3	8	16	41	32
14	3	8	15	41	33
15	4	7	14	41	34
16	4	6	14	42	34
17	5	6	14	42	33
18	5	6	14	42	33
19	6	6	15	41	32
20	7	6	16	41	30
21	8	6	17	41	28
22	9	6	19	40	26
23	9	7	21	39	24

Table 13.—*Distribution of logs in each sample area by log grade and scaling diameter*

[Number of logs]

Scaling diameter (inches)	Northeast: log grade—				Southern: log grade—				Lake States: log grade—			
	1	2	3	4	1	2	3	4	1	2	3	4
6	—	1	101	42	—	—	—	—	—	1	10	—
7	—	6	92	43	—	1	7	2	—	2	22	5
8	—	18	100	64	—	—	32	5	—	5	56	8
9	—	23	74	49	—	2	24	3	—	6	52	13
10	—	24	89	43	—	6	30	3	—	14	44	11
11	—	24	79	24	—	5	32	2	—	24	38	11
12	4	20	83	30	—	3	36	5	3	13	39	8
13	13	14	61	22	2	4	23	1	1	19	30	9
14	13	19	49	26	4	3	29	1	3	21	30	6
15	11	8	28	22	4	2	20	2	6	17	19	10
16	9	13	30	19	2	3	24	3	3	11	22	10
17	12	10	19	12	2	5	17	5	3	8	13	5
18	9	3	18	11	2	1	13	9	3	6	16	5
19	6	7	6	7	2	6	9	5	3	—	11	8
20	4	2	10	2	2	5	10	5	3	7	6	9
21	2	1	2	2	5	3	7	4	—	3	2	1
22	1	—	1	2	3	3	4	5	3	5	6	2
23[1]	2	1	2	5	9	8	9	15	2	6	5	10
Total	86	194	844	425	37	60	326	75	33	168	421	131

[1]The 23-inch diameter class includes a few logs from 24 inches to 30 inches in several of the grades.

Table 14.—*Lumber width-class distribution by lumber grade and log scaling diameter*[1]

[In percent]

Scaling diameter (inches)	D-Select & Better: width class—			No. 1-5 Common: width class—		
	1	2	3	1	2	3
6	94	6	0	91	9	0
7	85	15	0	56	44	0
8	75	25	0	36	64	0
9	65	35	0	25	75	0
10	56	44	0	18	82	0
11	48	48	4	14	82	4
12	40	50	10	11	74	15
13	33	50	17	8	64	28
14	26	52	22	6	48	46
15	20	52	28	5	37	58
16	16	51	33	4	30	66
17	13	50	37	3	26	71
18	11	48	41	2	23	75
19	10	45	45	2	21	77
20	10	42	48	2	20	78
21	10	40	50	2	21	77
22	10	38	52	2	22	76
23	11	36	53	2	23	75

[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 ¼-inch and Scribner Decimal C rules for each sample area, by log diameter and soundness class*[1]

Scaling diameter (inches)	Northeast		Southern				Lake States			
	International		International		Scribner		International		Scribner	
	Sound	All[2]	Sound	All[2]	Sound	All[2]	Sound	All[2]	Sound	All[2]
6	7	8	—	—	—	—	22	24	48	51
7	7	6	22	24	58	59	19	20	53	54
8	7	6	18	19	47	48	17	19	45	46
9	5	4	10	9	33	33	16	16	44	42
10	3	3	5	5	25	25	12	13	36	38
11	1	1	5	4	24	23	11	13	34	36
12	—1	0	1	1	18	18	10	12	31	33
13	—2	—1	—2	—2	15	15	10	12	29	32
14	—2	—2	—6	—4	9	11	8	10	24	29
15	—2	—1	—5	—4	9	10	6	10	22	26
16	—2	—1	—6	—4	6	9	7	9	20	23
17	—1	—1	—4	—4	6	6	8	9	20	21
18	—1	—1	—6	—5	3	4	9	9	20	20
19	—2	—1	—5	—5	1	1	7	9	13	16
20	—2	—1	—8	—6	—3	—1	6	9	11	15
21	—2	—2	—7	—4	—3	0	4	5	9	11
22	2	—2	—8	—4	—4	1	5	5	11	11
23	6	—4	—7	—3	—2	2	5	5	12	11

[1]The values in this table were computed by summing the net log scales and lumber tallies of all logs within a diameter class and then calculating a rolling 3-group overrun for each scaling diameter.

[2]Includes both sound and unsound logs. Unsound logs are logs with scalable defect according to standard Forest Service scaling practices.

APPENDIX B

DEVELOPMENT AND TESTING OF THE GRADING SYSTEM

Several standards recommended by the Forest Service Log Grade Committee 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 logs or trees so that variability in value or product yields is reduced to a reasonable limit.
2. For a given log 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 within any grading system.
4. A grading system should be applicable to a particular species over its entire commercial range.

The initial study for developing white pine log grades consisted of a sample of 381 logs from northeastern New York. All surface characteristics of each log were recorded on diagram sheets before the logs were processed into lumber *(Ostrander et al. 1964)*. The logs were sawed into 4/4 standard yard lumber, and all lumber was graded and tallied in the rough-green, rough-dry, and dressed-dry conditions.

Two existing log-grading systems were available for application and testing on eastern white pine logs. These were the Northeastern Timber Salvage Administration (NETSA) white pine log grades and the interim southern pine log grades *(USDA Forest Service 1953)*. All sample logs were graded from the diagrams by these two grading systems. From the rough-green lumber-grade-recovery data and current lumber prices, a quality-index value was assigned to each log. The mean quality-index values for each log grade and the within-grade and pooled variances for the two grading systems were then computed. Results indicated that neither of the two grading systems adequately segregated the logs into distinct and uniform value classes. The within-grade variability of most grades was over three times as high as that recommended by the National Log Grade Commission report.

After a detailed analysis of the log diagrams, we isolated several important quality characteristics not recognized by the two grading systems. By combining these additional characteristics with the good points of the systems, we developed the "trial" eastern white pine log-grading system. The "trial" system resulted in a significant decrease in within-grade and pooled variances as well as more uniform differences in mean quality-index values among log grades.

Subsequently, several more samples of logs were obtained in Maine and New Hampshire. All logs were graded according to the two original systems and the new "trial" system. In each case the "trial" system resulted in a 30- to 35-percent reduction in pooled variance as compared to the NETSA and southern pine systems. After all studies in the Northeast had been analyzed separately, the data were combined and the "trial" log-grade specifications, with accompanying rough-green lumber-grade yield tables for the Northeastern area, were made available.

Since the "trial" system was developed from only Northeastern area data, additional samples of logs were needed to test the system in other areas within the commercial range of eastern white pine. Samples were obtained from both the Southern Appalachian and Lake States areas. All logs were diagrammed and graded by the NETSA and "trial" log-grading systems. The resulting lumber was graded in the dressed-dry condition by the chief inspectors from the respective lumber manufacturers' associations.

The statistical tests of the two grading systems (NETSA and "trial") in each sample area were made, using a general logarithmic regression model described by Newport and O'Regan *(1963)*. Total log value and dressed-dry lumber tally volume of each log were used as the dependent and independent variables respectively in the regression model. Separate sets of regressions were calculated for each sample area.

The analysis showed that the "trial" grading system as compared to the NETSA system reduced the pooled within-grade variance of actual log value by 41 percent in the Northeastern area, 14 percent in the Southern Appalachian area, and 30 percent in the Lake States area. In the Northeastern sample the within-grade variability of the NETSA system ranged from 14 to 19 percent. Within the "trial" system it ranged from 10 to 13 percent. The within-grade variability in the Southern sample ranged from 8 to 24 percent for the NETSA system and 9 to 15 percent for the "trial" system. In the Lake States sample it ranged from 14 to 36 percent for the NETSA system and 12 to 23 percent for the "trial" system. The difference in value between adjacent log grades of the "trial" system at a given log size was at least 10 percent, and it was relatively uniform in all cases. The value differences between log grades of the NETSA system were generally more erratic.

Even though the "trial" system resulted in lower pooled and within-grade variances in all three sample areas, we suspected that certain modifications of the system would result in further reductions, especially in the Lake States sample. In the first modification we reduced the maximum allowable dead knot size in log grades 2 and 3. However, this modification caused no appreciable reduction in pooled or within-grade variance. Further investigation of the lumber-grading rules showed that the Lake States rules permit a greater number of dead knots in the medium to high common grades of lumber than the Northeastern rules. Therefore, even though the dead knots appeared more serious in the Lake States sample logs, they did not affect the log values or lumber-grade yields.

In the second modification, we added two additional grades to the "trial" system. During the processing of the Lake States sample, we observed that several grade 3 and 4 logs were degraded only because of red ring rot in the log ends. We suspected that this type of log would have a different value and yield than the grade 3 or 4 log degraded because of knot size and condition. Therefore, in this modification grade 3 and 4 logs that were degraded only because of red ring rot were placed in two additional grades — grade 5 and grade 6 respectively. This modification caused slightly lower pooled and within-grade variances, although the differences were not significant. The addition of two grades to the system probably accounted for the slight reduction in variance.

Because the two modifications did not reduce variability to any significant degree, we felt that further improvement of the "trial" system was not possible without making the specifications unduly complicated.

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