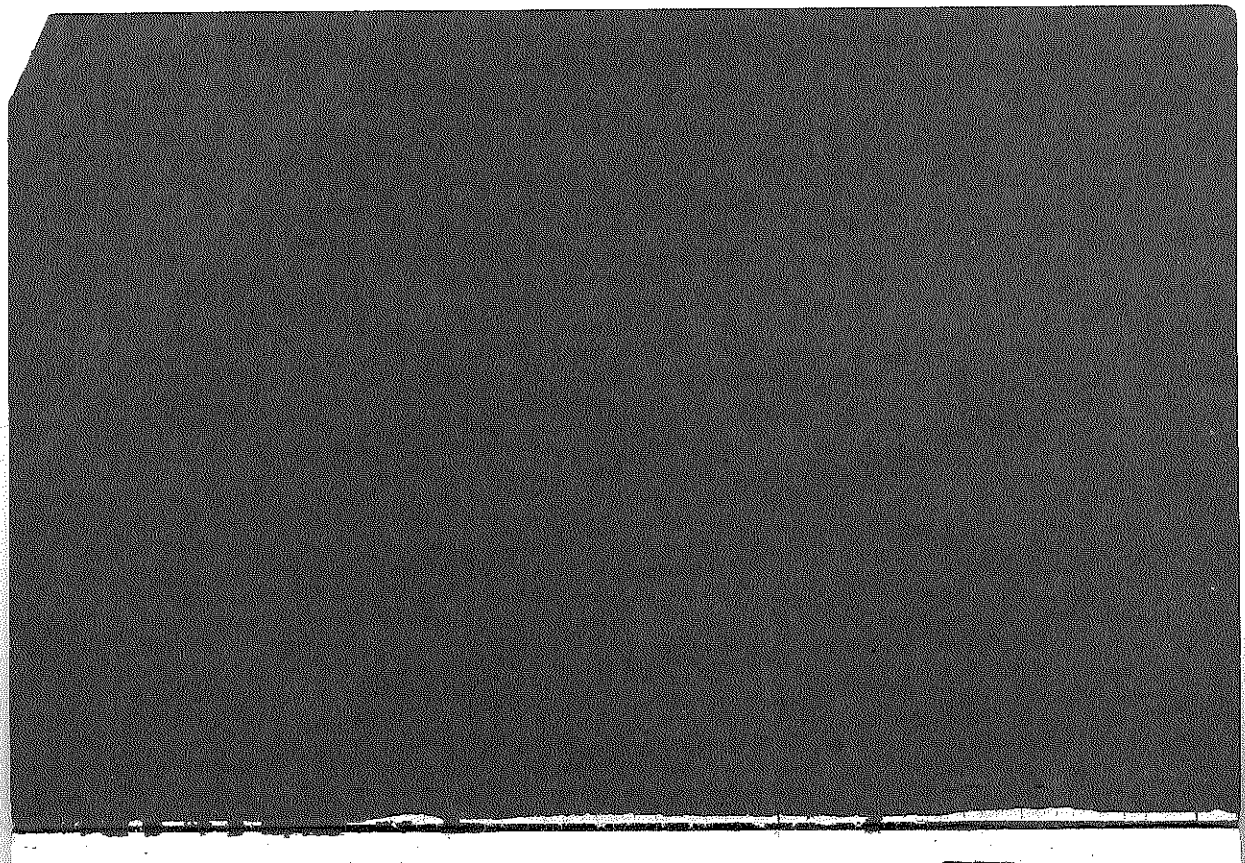
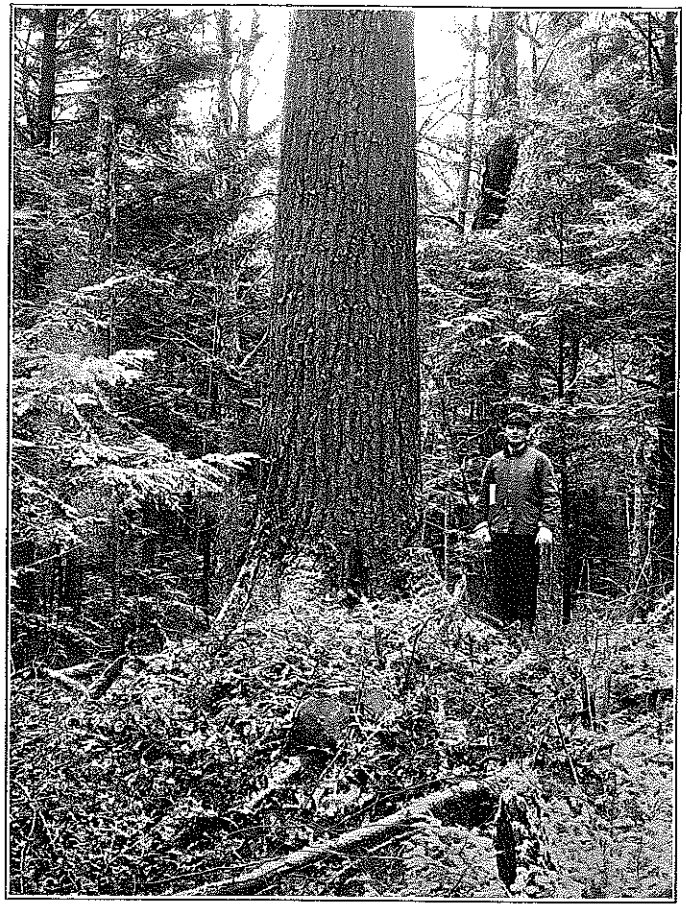
FOREST MENSURATION

TABLES FOR THE MEASURING OF LOGS, TREES AND GROWTH OF STANDS

PUBLISHED BY
COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF CONSERVATION
DIVISION OF FORESTRY

BOSTON
WRIGHT & POTTER PRINTING CO., STATE PRINTERS
32 DERNE STREET
1921





A primeval white pine. Height, 150 feet; diameter, breast high, 48 inches; contents, 5,000 board feet. (Photograph by R. T. Fisher.)

FOREST MENSURATION

TABLES FOR MEASURING LOGS, TREES AND THE GROWTH OF STANDS

BY

THE MASSACHUSETTS STATE FORESTER

H. O. COOK, Chief Forester

THE HARVARD FOREST

R. T. FISHER, Director

PUBLISHED BY

THE COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF CONSERVATION

W. A. L. BAZELEY, Commissioner

BOSTON

WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS

32 DERNE STREET

1921

Publication of this Document
approved by the
Supervisor of Administration.

CONTENTS.

INTRODUCTION.

In 1908 the State Forester published, under the title "Forest Mensuration of the White Pine," a booklet containing most of the data on the white pine included in this bulletin. A second edition was published in 1911, and as that is now exhausted a third edition seems necessary. Since the original investigation of the white pine was made the Department has also collected similar data on other species, and the Department of Forestry at Harvard University has in its research work published a large amount of information along similar lines. It seemed to the Commissioner of Conservation that these tables, many of which are very valuable and interesting to the forest owner, should be made available for use of the general public by including them with the original material. Director R. T. Fisher of the Harvard Forest has very graciously accepted this suggestion, and has turned his material over to us for use in this bulletin. To Mr. H. O. Cook, M.F., the author of the original bulletin on white pine mensuration, has been assigned the task of compiling and editing the present publication.

WM. A. L. BAZELEY,
Commissioner of Conservation.

FOREST MENSURATION.

THE BOARD FOOT.

The unit of measure on which sawed lumber is almost universally sold in the United States is the board foot, which is a board 12 inches square and 1 inch thick. In southeastern Massachusetts, however, they have a practice of sawing lumber five-eighths inch thick, and they call a board foot a board which is 12 inches square and only five-eighths inch in thickness. The variation is often the cause of some misunderstanding by those who are ignorant of the local system. The number of board feet in any given piece of lumber is obtained by multiplying the product of the width and thickness in inches by the length in feet, and dividing by 12. For instance, a plank 8 inches wide, 2 inches thick, and 12 feet long will figure as follows: $\frac{2' \times 8'' \times 12'}{12} = 16$ board feet.

Professional scalers have a board rule which is laid across the width of a board, and on the rule are given the board-feet contents of that particular width and length, provided it is 1 inch thick. If, however, it happens to be thicker, say $1\frac{1}{2}$ inches instead of 1, the scale as indicated on the rule must be increased 50 per cent to allow for the additional thickness. The scaling of square-edge lumber with straight and parallel sides is a mere mechanical process, but it happens that most of our native lumber cut in Massachusetts is sawed through and through, with the bark left on the edges. Such lumber is narrower on one face than on the other, and the board is

narrower at one end than at the other. (See diagrams on page 63.) The rule for scaling this form of lumber provides that it must be scaled on the narrow face inside the bark at the place of average width. The determination of the place of average width is left to the scaler, so that it means that a man measuring this kind of lumber must have good judgment and be without bias.

LOG RULES.

The contents of round logs are usually expressed in terms of board feet, and a log rule purports to show the number of board feet that can be sawed from a log of given length and diameter. Log rules are of two classes. The first class may be called the theoretical rules, which are based on geometrical or mathematical formulæ, where given values are allowed for lumber that must be wasted in slabs and saw kerf, and the remainder figured as usable boards. There are more than forty such rules in use in America, no two of which give the same value to the same log. As they are nearly all meant to apply to square-edge lumber they have no value for use under our local conditions. The second class is made from mill tallies; that is, logs are followed through the mill and the number of board feet each log actually sawed out noted. The results of many logs are then averaged. The log rules printed in this book were constructed in this fashion, and they are commended for use in all transactions for buying or selling logs where the ultimate product is to be in the form for which the log rule is constructed. They are based on conditions of lumbering and sawing found in this State, and are the results of averaging the saw bill of many mills, most of them of the portable kind, having circular saws cutting a $\frac{1}{4}$ inch kerf, unless otherwise noted.

In addition to log rules based on board feet we have in use in northern Massachusetts, and also to some extent in southern Massachusetts, the so-called caliper cord. The basis of this rule is the cylindrical foot, — a cylinder a foot in diameter and a foot in length. It will be seen that by placing four of these end to end one has a stick 4 feet long and 1 foot in diameter. Eight such sticks placed side by side and four ranks deep will occupy a space 8 feet by 4 feet by 4 feet, or a cord, hence 128 cylindrical feet equal a cord. By means of a special caliper measure used on the middle of the log the number of cylindrical feet in that log are determined, and 128 such feet are called a cord.

There is a variation of this caliper cord rule very considerably used, called the Humphrey rule, in which the cylindrical foot unit is somewhat larger than 1 foot, and so proportioned that 100 instead of 128 cylindrical feet will occupy 128 cubic feet of space. This makes it possible to express the volumes of the logs in decimal parts of a cord, and it is therefore very convenient to use. The resulting sum is exactly the same as the ordinary caliper cord rule.

TABLE NO. 1. — *Mill Tally Log Rule for Mixed Oak.*

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	LENGTH OF LOG (FEET).					
	6	8	9	10	12	16
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
6, ...	6	10	12	14	17	23
7, ...	10	15	18	20	25	33
8, ...	15	21	24	27	34	46
9, ...	20	27	33	37	45	61
10, ...	26	38	43	49	58	77
11, ...	33	47	54	60	72	94
12, ...	39	56	64	73	87	113
13, ...	46	66	76	88	104	134
14, ...	54	77	89	104	122	154
15, ...	62	89	103	121	140	175
16, ...	69	101	118	139	158	195
17, ...	77	114	132	156	176	215
18, ...	86	127	147	174	195	234
19, ...	94	140	164	192	214	254
20, ...	–	–	–	–	–	–

Based on 1,100 logs sawed into 1⅛-inch, 2-inch, 2½-inch, and 3-inch round-edge plank. Constructed by Massachusetts State Forester.

TABLE NO. 2. — *Mill Tally Log Rule for White Pine.*

DIAMETER, OUTSIDE BARK AT MIDDLE OF LOG (INCHES).	LENGTH OF LOG (FEET).			
	10	12	14	16
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
5, ...	8	12	16	20
6, ...	12	16	20	24
7, ...	15	20	25	30
8, ...	20	26	31	36
9, ...	26	33	39	45
10, ...	34	41	49	57
11, ...	42	51	60	70
12, ...	51	62	75	86
13, ...	61	73	88	105
14, ...	71	85	103	120
15, ...	82	99	120	140
16, ...	93	116	137	162
17, ...	104	132	156	184
18, ...	116	148	175	206
19, ...	130	166	195	230
20, ...	–	185	218	257
21, ...	–	204	240	285
22, ...	–	226	266	312
23, ...	–	250	292	–
24, ...	–	275	322	–
25, ...	–	296	350	–

Based on 1,200 logs sawed principally into 1-inch and 1¼-inch round-edge lumber. Constructed by State Forester.

TABLE NO. 3. — *Mill Tally Log Rule for White Pine.*

Diameter, Inside Bark at Small End (Inches).	Length of Log (Feet).			
	10	12	14	16
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
4,	9	13	17	21
5,	13	17	21	26
6,	17	22	27	32
7,	23	29	35	40
8,	30	37	44	51
9,	39	47	55	64
10,	48	58	68	79
11,	58	70	82	98
12,	69	83	97	115
13,	80	96	113	136
14,	92	111	131	158
15,	104	129	150	180
16,	117	146	170	205
17,	131	165	192	230
18,	–	184	220	256
19,	–	206	243	288
20,	–	230	272	–
21,	–	255	300	–
22,	–	280	330	–
23,	–	310	–	–
24,	–	340	–	–

Based on 1,200 logs sawed principally into 1-inch and 1¼-inch round-edge lumber. Constructed by State Forester.

TABLE NO. 4. — *Mill Tally Log Rule for White Pine.*

Diameter, Inside Bark at Small End (Inches).	Length of Log (Feet).		
	8	10	12
	Ft. B. M.	Ft. B. M.	Ft. B. M.
3,	4	5	6
4,	6	8	10
5,	10	12	15
6,	14	17	21
7,	18	22	28
8,	24	29	37
9,	30	37	47
10,	38	47	58
11,	45	57	70
12,	54	69	85
13,	63	82	100
14,	73	95	115
15,	85	109	133
16,	99	125	152
17,	113	141	173
18,	129	158	193
19,	145	178	215
20,	164	198	236
21,	–	217	257

The mean or average of seven individual tables constructed on the Harvard Forest in different years and based on the actual volume in board feet sawed from 3,500 logs, as follows: 8-foot logs, 714; 10-foot logs, 564; 12-foot logs, 2,222. Sawing: 60 per cent, 2¼-inch round-edge; remainder, 1-inch square-edge and 1-inch sidings.

TABLE NO. 5. — *Mill Tally Log Rule for Chestnut.*

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	LENGTH OF LOG (FEET).		
	8	10	12
	Ft. B. M.	Ft. B. M.	Ft. B. M.
3,	3	4	6
4,	7	8	10
5,	11	12	15
6,	15	17	22
7,	20	23	30
8,	26	30	39
9,	33	39	50
10,	41	49	62
11,	50	60	77
12,	61	74	91
13,	72	88	106
14,	84	102	124
15,	96	118	142
16,	109	134	159
17,	123	152	178
18,	–	168	197
19,	–	186	219
20,	–	205	241
21,	–	–	267
22,	–	–	294

The mean or average of three individual tables constructed on the Harvard Forest in different years and based on the actual volume in board feet sawed from 934 logs, as follows: 8-foot logs, 169; 10-foot logs, 143; 12-foot logs, 622. Sawing: 50 per cent, 1½-inch round-edge; remainder, 1-inch round-edge and 1-inch sidings.

TABLE NO. 6. — *Graded Mill Tally Log Rule for Yellow Birch.*

10-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7,	–	–	–	–	10	10	20
8,	–	–	–	–	10	10	20
9,	–	–	–	–	15	15	30
10,	–	–	–	10	15	15	40
11,	–	–	5	10	20	15	50
12,	–	–	5	15	20	20	60
13,	–	–	10	20	20	20	70
14,	–	5	10	20	20	25	80
15,	5	5	15	20	20	25	90
16,	10	10	20	25	20	25	110
17,	10	15	20	30	20	25	120
18,	15	15	25	30	20	25	130
19,	25	20	30	30	20	25	150
20,	30	20	30	30	20	30	160
21,	35	25	35	30	25	30	180
22,	45	30	40	30	25	30	200
23,	60	30	45	30	25	30	220
24,	70	30	55	35	25	35	250

Constructed by students of the Harvard Forest School under the direction of Irving W. Bailey. First published in the Forestry Quarterly, Vol. XII, No. 1, pages 5-23, "Graded Volume Tables for Vermont Hardwoods," by Irving W. Bailey and Philip C. Heald. Tables 6, 7, and 8 give the contents in graded lumber of a large number of logs (yellow birch, 1,530; beech, 631; sugar maple, 943) from hardwood stands on lower slopes and foothills of the Green Mountains in southern Vermont. The logs were run through a single-action band saw cutting a ⅛-inch kerf, and the lumber from each was graded according to the grading rules of the Northern Hardwood Lumber Association, the results being averaged by a curve. The lumber was mostly 1-inch stock, sawed 1¼ inches thick to allow for shrinkage. The mill crew were men of average skill, experienced in hardwood mills in other regions.

TABLE No. 6. — *Graded Mill Tally Log Rule for Yellow Birch* — Continued.

12-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7,	–	–	–	–	10	10	20
8,	–	–	–	5	10	15	30
9,	–	–	–	10	15	15	40
10,	–	–	5	15	15	15	50
11,	–	–	5	20	15	20	60
12,	–	5	10	20	15	20	70
13,	5	5	15	20	15	20	80
14,	5	5	20	25	15	30	100
15,	10	5	25	25	15	30	110
16,	15	10	30	30	15	30	130
17,	25	10	40	30	15	30	150
18,	30	15	45	30	20	30	170
19,	40	15	50	30	15	30	180
20,	50	15	55	30	20	30	200
21,	60	20	60	30	20	30	220
22,	70	25	65	35	20	35	250
23,	85	30	70	30	20	35	270
24,	90	30	70	35	25	40	290

The merchantable length of the trees was seldom over 32 feet; practically no logs were taken above the first branches. The percentage of 1, 2 and 3 log trees was as follows: —

	Birch.	Maple.	Beech.
1-log trees,	23	22	37
2-log trees,	62	60	58
3-log trees,	15	18	5

TABLE No. 6. — *Graded Mill Tally Log Rule for Yellow Birch* — Continued.

14-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7,	–	–	–	5	15	10	30
8,	–	–	–	10	15	15	40
9,	–	–	–	10	15	15	40
10,	–	–	5	15	15	15	50
11,	–	–	10	20	20	20	70
12,	–	5	10	25	20	20	80
13,	5	5	20	25	20	25	100
14,	10	5	25	25	20	25	110
15,	15	5	35	30	20	25	130
16,	15	10	40	35	20	30	150
17,	20	15	50	35	20	30	170
18,	35	15	55	35	20	30	190
19,	45	20	70	35	20	30	220
20,	60	20	75	35	20	30	240
21,	75	25	80	35	25	30	270
22,	90	25	90	30	25	30	290
23,	105	25	95	40	25	30	320
24,	120	25	95	40	25	35	340

Nearly one-half of the logs cut were defective or abnormal in some particular, as shown in the following table: —

	BIRCH.				
	Volume reduced 10 Per Cent and Less.	Volume reduced 10–20 Per Cent.	Volume reduced 20–30 Per Cent.	Volume reduced 30 Per Cent and Over.	Total Defective Logs.
Butt defects,	54	27	30	39	150
Top defects,	26	21	10	15	72
Crook,	102	45	32	28	207
Sweep,	24	45	21	10	100
Knotty,	47	14	6	5	72
Seam,	0	6	3	4	13
Shake,	7	8	6	3	24
Miscellaneous,	11	5	1	3	20
Total,	271	171	109	107	658

Defective, 43 per cent.

TABLE NO. 6. — *Graded Mill Tally Log Rule for Yellow Birch* — Concluded.

16-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7, . . .	–	–	–	5	15	10	30
8, . . .	–	–	–	10	15	15	40
9, . . .	–	–	–	15	20	15	50
10, . . .	–	–	5	15	20	20	60
11, . . .	–	–	10	20	20	20	70
12, . . .	5	5	15	25	20	20	90
13, . . .	5	5	20	30	25	25	110
14, . . .	10	5	35	30	25	25	130
15, . . .	15	10	45	30	25	25	150
16, . . .	25	10	55	35	25	30	180
17, . . .	30	15	60	40	25	30	200
18, . . .	40	15	70	40	25	30	220
19, . . .	55	20	80	40	25	30	250
20, . . .	70	25	90	40	25	30	280
21, . . .	90	25	100	40	25	30	310
22, . . .	110	25	110	40	25	30	340
23, . . .	130	25	115	40	25	35	370
24, . . .	145	25	120	40	25	35	390

TABLE NO. 7. — *Graded Mill Tally Log Rule for Beech.*

10-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
8, . . .	–	–	5	25	30
9, . . .	–	–	10	20	30
10, . . .	–	10	10	20	40
11, . . .	–	10	15	25	50
12, . . .	–	15	15	30	60
13, . . .	5	20	15	30	70
14, . . .	10	25	15	30	80
15, . . .	15	25	15	35	90
16, . . .	20	30	20	40	110
17, . . .	30	35	20	45	130

Nearly one-half of the logs cut were defective or abnormal in some particular, as shown in the following table: —

	BEECH.				
	Volume reduced 10 Per Cent and Less.	Volume reduced 10-20 Per Cent.	Volume reduced 20-30 Per Cent.	Volume reduced 30 Per Cent and Over.	Total Defective Logs.
Butt defects, . . .	16	8	1	4	29
Top defects, . . .	8	4	6	2	20
Crook, ...	69	29	17	6	121
Sweep, ...	33	19	8	9	69
Knotty, ...	29	7	3	3	42
Seam, ...	8	5	2	6	21
Shake, ...	–	–	–	–	–
Miscellaneous, . . .	7	4	5	2	18
Total, ...	170	76	42	32	320

Defective, 51 per cent.

TABLE No. 7. — *Graded Mill Tally Log Rule for Beech* — Continued.

12-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
8,	–	–	5	25	30
9,	–	5	10	25	40
10,	–	10	10	30	50
11,	–	15	15	30	60
12,	5	15	15	35	70
13,	10	20	15	35	80
14,	15	25	15	35	90
15,	20	30	20	40	110
16,	30	35	20	45	130
17,	40	40	20	50	150

14-Foot Logs.

8,	–	–	5	25	30
9,	–	5	10	25	40
10,	–	10	10	30	50
11,	–	20	15	35	70
12,	5	20	15	40	80
13,	15	25	20	40	100
14,	20	30	20	40	110
15,	25	35	20	50	130
16,	35	40	25	50	150
17,	45	45	25	55	170

For yellow birch a comparison was made of the contents of nondefective butt logs, nondefective top logs, and the average of all logs. This showed that the difference in volume due both to defect and position in the tree was negligible for logs under 12 inches in diameter at the small end, while for logs 12 inches and over in diameter it amounted to about 9 per cent of the volume of the sound butt logs. It was less than 6 per cent for logs from 12 to 16 inches in diameter, and a little less than 11 per cent for 21 to 24 inch logs. The difference due to position in the tree between sound normal top and butt logs varied from about 3 per cent of the volume of the 12 to 16 inch butt logs to about 10 per cent of the 21 to 24 inch butt logs.

In the table for yellow birch it will be noted that the 10-foot logs show a greater proportion of the poorer grades than do the longer logs. This is particularly noticeable in the No. 1 common red and the No. 2 common grades, and is due especially to the fact that the majority of the 10-foot logs were top logs and hence knotty and of inferior quality.

TABLE No. 7. — *Graded Mill Tally Log Rule for Beech* — Concluded.

16-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
8,	–	–	10	30	40
9,	–	10	10	30	50
10,	–	10	15	35	60
11,	–	20	20	40	80
12,	5	25	20	40	90
13,	15	30	20	45	110
14,	20	35	25	50	130
15,	30	40	25	55	150
16,	40	45	25	60	170
17,	55	55	25	65	200

While they can be applied with substantial accuracy only to conditions similar to those under which they were made, these tables may perhaps be used in other regions by carefully studying and comparing defects, methods of utilization, etc., and applying suitable converting factors. With these precautions graded volume tables can be constructed by combining the graded log rules here given with tables which show the average taper of trees. Graded volume tables actually constructed from these tables will be found on pages 37 to 47. They are not based upon tapor tables but on felled trees (yellow birch, 505; sugar maple, 301; beech, 220).

TABLE No. 8. — *Graded Mill Tally Log Rule for Sugar Maple.*

10-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7,	–	–	5	15	20
8,	–	–	10	20	30
9,	–	–	10	20	30
10,	–	10	10	20	40
11,	5	15	10	20	50
12,	5	20	15	20	60
13,	10	25	10	25	70
14,	15	25	15	25	80
15,	25	30	15	30	100
16,	35	30	15	30	110
17,	50	30	15	35	130
18,	60	30	15	35	140
19,	75	35	15	35	160
20,	90	40	15	35	180

Nearly one-half of the logs cut were defective or abnormal in some particular, as shown in the following table: —

	MAPLE.				
	Volume reduced 10 Per Cent and Less.	Volume reduced 10–20 Per Cent.	Volume reduced 20–30 Per Cent.	Volume reduced 30 Per Cent and Over.	Total Defective Logs.
Butt defects,	39	9	12	14	74
Top defects,	29	15	15	8	67
Crook,	46	22	24	7	99
Sweep,	37	17	12	3	69
Knotty,	62	15	10	4	91
Seam,	4	2	4	5	15
Shake,	–	–	–	–	–
Miscellaneous,	3	1	2	6	12
Total,	220	81	79	47	427

Defective, 45 per cent.

TABLE No. 8. — *Graded Mill Tally Log Rule for Sugar Maple* — Continued.

12-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7,	–	–	5	15	20
8,	–	5	5	20	30
9,	–	10	10	20	40
10,	–	10	10	20	40
11,	5	15	10	20	50
12,	10	20	15	25	70
13,	15	25	15	25	80
14,	20	30	15	25	90
15,	30	35	15	30	110
16,	45	35	15	35	130
17,	60	35	15	40	150
18,	70	35	15	40	160
19,	85	40	15	40	180
20,	100	40	20	40	200

14-Foot Logs.

7,	–	–	10	20	30
8,	–	5	10	25	40
9,	–	10	10	20	40
10,	–	15	10	25	50
11,	5	20	10	25	60
12,	10	25	15	30	80
13,	15	30	15	30	90
14,	25	35	20	30	110
15,	35	40	20	35	130
16,	50	40	20	40	150
17,	60	40	20	40	160
18,	80	40	20	40	180
19,	100	45	20	45	210
20,	120	45	20	45	230

See footnote under Graded Mill Tally Log Rule for Yellow Birch.

TABLE No. 8. — *Graded Mill Tally Log Rule for Sugar Maple* — Concluded.

16-Foot Logs.

DIAMETER, INSIDE BARK AT SMALL END (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
7,	–	–	10	20	30
8,	–	5	10	25	40
9,	–	10	15	25	50
10,	–	15	15	30	60
11,	5	20	15	30	70
12,	10	30	20	30	90
13,	20	35	20	35	110
14,	30	40	20	40	130
15,	45	45	20	40	150
16,	60	45	20	45	170
17,	75	50	20	45	190
18,	90	50	25	45	210
19,	100	50	25	45	230
20,	140	55	25	50	270

VOLUME TABLES.

A volume table gives the number of board feet or other units that one may expect to obtain from a tree of given dimensions, the given dimensions being the diameter breast high and the total height, or the used length of the trunk of the tree. Many lumbermen use the diameter at the top of the stump as the diameter of the tree, but this is unsatisfactory, because stump heights vary, and also there is usually a considerable swell at the base which varies greatly in trees of the same general size. Breast-high diameter (about $4\frac{1}{2}$ feet above the ground) is at a convenient elevation for actual use, and it avoids the two objections to stump diameters just enumerated. In the pine and chestnut volume tables it is presumed that all the bole above a 6-inch stump and below a top diameter of 4 inches is used.

The utility of volume tables lies in estimating the quantity of standing timber. A dozen different methods of estimating can be suggested in which volume tables play a part, and which vary in accuracy. The most accurate and best method for small lots is to caliper every tree, obtaining thus their diameter and number. Then obtain the average height of the stand, if it is more or less uniform, or otherwise divide the trees into two or more diameter classes, and get the average height of each class. From the volume tables obtain the volume of each diameter class, multiply by the number of trees, and add all together to make the volume of the stand.

A second method is to select a "sample plot" of known area, preferably one-quarter acre. A circle with a 59-foot radius, or a square 104 feet on a side, encloses one-quarter acre. Caliper all trees on this plot, and obtain the volume as above. The total volume will be to this volume as the total area is to the area of the sample plot.

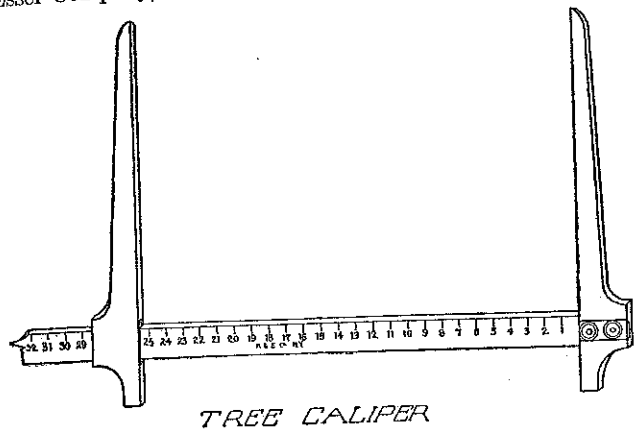
A simple, but yet more uncertain, method is to count the trees on the lot, pick five or six which appear to be average, scale these by the volume table to obtain the volume of the average tree, and multiply this amount by the total number of trees. If one is not careful in selecting his average trees the error is multiplied many times, so that this method is not highly recommended.

The simplest although not the least laborious way of getting at the height of a stand is to cut down an average tree and measure it with tape. Fallen trees can often be found on the ground. Any instrument that reads angles, a measuring tape, and the application of a little trigonometry will give the desired results. There are several instruments constructed to give by direct reading the heights of trees.

There is a method of obtaining the height of a tree that is fairly simple and requires no instrument but a stick which, when stuck in the ground, will come to the level of your eye. Set this stick in the ground at such a distance from the base of the tree to be measured so that when you lie on the ground with your feet at the stick the top of the tree and the top of the stick are in line. The distance between your head and the base of the tree is equal to its height.

A caliper of great convenience for use in connection with volume tables and log scales mentioned in this book consists of a beam 36 inches long and graduated into inches and tenths. At the left end is a rigid arm set at right angles to the beam,

while another arm is so fixed that it will slide back and forth at will. These calipers can be purchased from Keuffel & Esser Company, of Jersey City, N. J.



TREE CALIPER

The volume tables for pine are of three kinds, — first, a table showing quantities in board feet; second, one showing volumes in caliper cords; and third, one showing volumes in solid cubic feet. The volume table for oak is classed, not on diameter and total height, but on diameter breast high and merchantable length. By merchantable length we mean that portion of the bole that can be cut into saw logs. In the table on chestnut only the volumes in board feet are given.

TABLE No. 9. — *Volume Table for Mixed Oak.*

DIAMETER, BREAST HIGH (INCHES).	MERCHANTABLE HEIGHT (FEET).					
	20	25	30	35	40	45
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
8,	26	33	40	47	54	61
9,	39	47	55	62	70	78
10,	54	63	73	81	90	99
11,	71	81	92	101	111	122
12,	88	100	112	123	133	145
13,	108	121	134	147	160	175
14,	130	145	160	175	190	206
15,	155	172	188	205	224	244
16,	183	202	220	240	260	281
17,	213	233	253	274	297	323
18,	244	265	287	310	337	366
19,	275	297	322	347	377	410
20,	306	331	357	385	420	454
21,	337	364	394	425	461	499
22,	370	397	430	465	503	543
23,	401	430	465	505	545	586

Data from North Andover and Middleborough based on 570 trees sawed into 1¼-inch, 1⅝-inch, 2⅛-inch, 2½-inch and 3-inch round-edge plank (portable mill operation). Constructed by State Forester.

TABLE No. 10. — *Volume Table for White Pine.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT (FEET).							
	30	40	50	60	70	80	90	100
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
5,	10	–	–	–	–	–	–	–
6,	15	20	30	–	–	–	–	–
7,	20	30	40	50	65	–	–	–
8,	25	35	50	65	85	–	–	–
9,	30	45	60	80	105	115	–	–
10,	40	55	75	95	125	145	–	–
11,	–	65	90	115	145	170	200	230
12,	–	75	105	135	165	200	230	260
13,	–	85	120	155	190	235	260	295
14,	–	100	140	175	215	265	300	335
15,	–	115	160	200	245	300	340	375
16,	–	–	180	230	275	335	380	420
17,	–	–	–	260	310	370	425	470
18,	–	–	–	295	350	410	475	530
19,	–	–	–	335	390	455	530	600
20,	–	–	–	380	435	505	580	660
21,	–	–	–	–	480	550	635	720
22,	–	–	–	–	520	595	680	780
23,	–	–	–	–	565	640	730	835
24,	–	–	–	–	600	690	780	890
25,	–	–	–	–	645	740	830	940
26,	–	–	–	–	–	–	885	995
27,	–	–	–	–	–	–	940	–

Based on 1,300 trees scaled from rules made by mill tallies. Constructed by State Forester.

TABLE NO. 11. — *Volume Table, in Caliper Cords, for White Pine.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT (FEET).						
	30	40	50	60	70	80	90
	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
5,	.03	–	–	–	–	–	–
6,	.03	.04	.05	–	–	–	–
7,	.04	.05	.07	.09	–	–	–
8,	.05	.07	.09	.11	.13	–	–
9,	.07	.09	.11	.13	.16	–	–
10,	–	.11	.13	.16	.19	.22	–
11,	–	.13	.16	.19	.23	.26	.30
12,	–	.15	.19	.22	.27	.31	.35
13,	–	.17	.22	.26	.31	.36	.40
14,	–	–	.25	.30	.34	.41	.45
15,	–	–	.28	.34	.40	.46	.51
16,	–	–	.32	.38	.44	.52	.58
17,	–	–	–	.42	.49	.58	.64
18,	–	–	–	.47	.55	.64	.71
19,	–	–	–	.51	.60	.70	.79
20,	–	–	–	.55	.66	.77	.87
21,	–	–	–	–	.72	.85	.95
22,	–	–	–	–	.78	.92	1.04
23,	–	–	–	–	.84	1.01	1.13
24,	–	–	–	–	.90	1.08	1.22
25,	–	–	–	–	.97	1.16	1.32
26,	–	–	–	–	–	–	1.42
27,	–	–	–	–	–	–	1.51

Constructed by State Forester.

TABLE NO. 12. — *Volume Table for White Pine.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT (FEET).						
	30	40	50	60	70	80	90
	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.
5,	1.8	–	–	–	–	–	–
6,	2.6	3.3	4.3	–	–	–	–
7,	3.4	4.4	6.1	7.7	–	–	–
8,	4.5	6.0	7.8	9.8	12.0	–	–
9,	5.9	7.7	10.0	12.0	15.0	–	–
10,	–	9.6	12.0	15.0	17.9	20.9	–
11,	–	11.6	14.6	17.9	21.4	24.9	28.7
12,	–	13.9	17.6	21.1	25.3	29.8	33.7
13,	–	16.2	20.4	24.8	29.2	34.7	38.7
14,	–	–	23.7	28.7	32.5	39.6	43.6
15,	–	–	26.8	32.6	37.9	44.5	49.5
16,	–	–	30.5	36.5	42.3	49.8	55.9
17,	–	–	–	40.3	47.2	56.7	62.3
18,	–	–	–	44.6	52.6	61.5	69.1
19,	–	–	–	49.0	57.9	67.8	76.9
20,	–	–	–	52.9	63.2	74.7	84.8
21,	–	–	–	–	69.1	82.0	92.6
22,	–	–	–	–	74.9	89.3	101.4
23,	–	–	–	–	81.3	98.1	110.8
24,	–	–	–	–	87.1	104.9	119.0
25,	–	–	–	–	94.0	112.6	128.8

Constructed by State Forester. Volume outside bark up to a 4-inch top.

TABLE NO. 13. — *Volume of Chestnut in 6 by 8 Inch Ties and Additional Cordwood.*

DIAMETER, BREAST HIGH (INCHES).	HEIGHT (FEET).									
	50		60		70		80		90	
	Ties.	Cords.	Ties.	Cords.	Ties.	Cords.	Ties.	Cords.	Ties.	Cords.
10, . .	1	.11	1	.13	1	.14	1	.13	3	.12
11, . .	1	.10	1	.12	2	.13	2	.13	4	.12
12, . .	2	.09	2	.11	3	.13	3	.13	4	.13
13, . .	3	.09	3	.10	3	.12	4	.12	5	.13
14, . .	3	.08	3	.10	5	.12	5	.12	8	.13
15, . .	5	.08	5	.09	5	.12	6	.12	9	.13
16, . .	6	.07	6	.09	7	.11	7	.13	9	.14
17, . .	–	–	6	.08	8	.11	8	.13	10	.16
18, . .	–	–	7	.07	8	.12	9	.14	11	.17
19, . .	–	–	7	.07	8	.12	10	.15	12	.19
20, . .	–	–	8	.06	10	.12	11	.17	13	.22
21, . .	–	–	9	.06	10	.13	11	.18	14	.24
22, . .	–	–	11	.06	10	.14	14	.21	17	.27
23, . .	–	–	12	.06	12	.15	14	.23	17	.31
24, . .	–	–	12	.06	13	.16	15	.27	19	.36
25, . .	–	–	15	.06	15	.18	18	.30	21	.42

Computed from tables in Forest Service Bulletin No. 96.

TABLE NO. 14. — *Volume Table for Chestnut.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT OF TREE (FEET).						
	40	45	50	55	60	65	70
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
5, . . .	15	–	–	–	–	–	–
6, . . .	–	22	27	32	–	–	–
7, . . .	–	30	34	39	50	–	–
8, . . .	–	–	42	50	58	72	–
9, . . .	–	–	56	61	70	81	–
10, . . .	–	–	73	78	85	94	103
11, . . .	–	–	89	93	100	110	122
12, . . .	–	–	–	111	120	132	148
13, . . .	–	–	–	125	138	155	177
14, . . .	–	–	–	–	166	183	208
15, . . .	–	–	–	–	191	211	242
16, . . .	–	–	–	–	220	243	278
17, . . .	–	–	–	–	249	277	318
18, . . .	–	–	–	–	279	315	360

Constructed on the Harvard Forest by Richard T. Fisher and H. B. Shepard in 1915–16. Based on 210 trees cut in an even-aged sprout chestnut stand with 30 to 40 per cent of red oak, black oak, paper birch and other hardwoods; Quality II, age 50 to 60 years, well stocked, trees of normal forest form. Sawing: round-edge lumber, the better quality, amounting to about 80 per cent, 1½ inches, the balance, including sidings, wormy and knotty or top logs, 1 inch. Minimum size of log: 8 feet long and large enough to yield a board with a 3-inch face.

TABLE NO. 15. — *Volume Table for Red Maple.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT OF TREE (FEET).						
	20	30	40	50	60	70	80
	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.	Cords.
3, . . .	0.009	0.011	0.015	0.018	–	–	–
4, . . .	.015	.019	.024	.029	–	–	–
5, . . .	–	.031	.034	.043	0.051	–	–
6, . . .	–	–	.048	.060	.072	0.081	–
7, . . .	–	–	.063	.079	.095	.113	–
8, . . .	–	–	.078	.101	.122	.140	0.153
9, . . .	–	–	.095	.125	.149	.168	.184
10, . . .	–	–	–	.151	.179	.199	.217
11, . . .	–	–	–	.179	.212	.235	.252
12, . . .	–	–	–	.210	.251	.276	.294
13, . . .	–	–	–	.246	.292	.324	.343
14, . . .	–	–	–	.286	.338	.374	.392
15, . . .	–	–	–	.332	.390	.430	.450
16, . . .	–	–	–	.383	.451	.491	.565
17, . . .	–	–	–	–	–	–	.607

Constructed by E. E. Carter and first published in Bulletin of the Harvar Forestry Club, Vol. II, 1913, pages 1–8, "A Volume Table for Red Maple on th Harvard Forest." Revised and enlarged by the author in 1915 and published i United States Department of Agriculture Bulletin No. 285, "The Norther Hardwood Forest," pages 61–63. The present tables are taken from the latt source. Cubic foot volumes are for stem and branch wood to a minimu diameter, outside the bark, of about 2 inches at the middle of a 4-foot lengt The measurements were taken in a wide variety of types, including bottom swale, pine slopes, swamp, and birch and maple coppice. Most of the tre over 6 inches, breast high, were of seedling origin.

In 1920 the cord volume table was given the following test. A square quarte acre was laid off in an even-aged mixed hardwood stand. By calipering eac tree and measuring a number of heights the volume in cords was computed b the use of the table. The area was then clear cut and the wood piled. Th actual volume cut was 5.772 cords; the volume as derived from the table amounte to 5.725 cords. The test indicated that the volume table for red maple is appl cable to second growth mixed hardwood, regardless of species.

TABLE NO. 16. — *Volume Table for Red Maple.*

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT OF TREE (FEET).							Basis (Trees).
	20	30	40	50	60	70	80	
	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.	
2, . .	0.25	0.35	0.55	–	–	–	–	59
3, . .	.60	.71	1.00	1.2	–	–	–	51
4, . .	1.00	1.30	1.65	2.0	–	–	–	36
5, . .	–	2.15	2.40	3.0	3.6	–	–	38
6, . .	–	–	3.45	4.3	5.2	6.2	–	42
7, . .	–	–	4.70	5.9	7.1	8.4	–	25
8, . .	–	–	6.05	7.8	9.4	10.8	11.8	39
9, . .	–	–	7.65	10.1	12.0	13.5	14.8	28
10, . .	–	–	–	12.7	15.0	16.7	18.2	20
11, . .	–	–	–	15.6	18.5	20.5	22.0	23
12, . .	–	–	–	18.9	22.5	24.8	26.4	10
13, . .	–	–	–	22.6	26.8	29.7	31.4	9
14, . .	–	–	–	26.8	31.6	35.0	36.7	8
15, . .	–	–	–	31.5	37.0	40.7	42.7	3
16, . .	–	–	–	36.6	43.2	47.0	49.7	4
17, . .	–	–	–	–	–	–	58.4	2
								397

TABLE NO. 17. — *Per Cent of Solid Wood in Red Maple Cordwood.*

Diameter, Breast High, of Trees Cut and piled (Inches).	Per Cent of Wood in Piles.	Diameter, Breast High, of Trees Cut and piled (Inches).	Per Cent of Wood in Piles.	Diameter, Breast High, of Trees Cut and piled (Inches).	Per Cent of Wood in Piles.	Diameter, Breast High, of Trees Cut and piled (Inches).	Per Cent of Wood in Piles.
3	52.5	7	58.0	11	68.0	15	74.0
4	53.6	8	60.2	12	70.0	16	74.6
5	54.9	9	62.8	13	71.5	17	75.0
6	56.2	10	65.5	14	73.0	–	–

See footnote under Volume Table for Red Maple in Cords.

TABLE No. 18. — *Number of Red Maple Trees required t*
yield One Cord of Wood.

DIAMETER, BREAST HIGH (INCHES).	TOTAL HEIGHT OF TREE (FEET).						
	20	30	40	50	60	70	80
3, . . .	111	91	67	56	–	–	–
4, . . .	67	53	42	34	–	–	–
5, . . .	–	32	29	23	20	–	–
6, . . .	–	–	21	17	14	12	–
7, . . .	–	–	16	13	11	9	–
8, . . .	–	–	13	10	8.2	7.1	6.5
9, . . .	–	–	11	8.0	6.6	6.0	5.4
10, . . .	–	–	–	6.6	5.6	5.0	4.6
11, . . .	–	–	–	5.6	4.7	4.3	4.0
12, . . .	–	–	–	4.8	4.0	3.6	3.4
13, . . .	–	–	–	4.1	3.4	3.1	2.9
14, . . .	–	–	–	3.5	3.0	2.7	2.5
15, . . .	–	–	–	3.0	2.6	2.3	2.2
16, . . .	–	–	–	2.6	2.2	2.0	1.9
17, . . .	–	–	–	–	–	–	1.6

Derived from Volume Table for Red Maple in Cords.

TABLE No. 19. — *Graded Volume Table for Yellow Birch.*

Used Length, 12 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10, . . .	–	–	–	5	15	10	30
11, . . .	–	–	–	10	15	15	40
12, . . .	–	–	5	15	15	15	50
13, . . .	–	–	5	15	20	20	60
14, . . .	–	–	10	20	20	20	70
15, . . .	–	5	10	25	20	20	80
16, . . .	5	5	15	25	20	20	90
17, . . .	5	5	20	30	20	20	100
18, . . .	10	5	20	30	20	25	110
19, . . .	–	–	–	–	–	–	–
20, . . .	–	–	–	–	–	–	–
21, . . .	–	–	–	–	–	–	–
22, . . .	–	–	–	–	–	–	–
23, . . .	–	–	–	–	–	–	–
24, . . .	–	–	–	–	–	–	–

Used Length, 14 Feet.

10, . . .	–	–	–	5	15	10	30
11, . . .	–	–	–	10	15	15	40
12, . . .	–	–	5	10	15	15	50
13, . . .	–	–	5	15	20	20	60
14, . . .	–	–	10	20	20	20	70
15, . . .	–	5	10	25	20	20	80
16, . . .	5	5	20	30	20	20	100
17, . . .	10	5	20	30	20	25	110
18, . . .	10	5	30	35	25	25	130
19, . . .	15	10	35	35	20	25	140
20, . . .	20	10	45	35	25	25	160
21, . . .	25	15	50	35	20	25	170
22, . . .	35	15	55	35	25	25	190
23, . . .	40	20	65	35	25	25	210
24, . . .	50	20	70	35	25	30	230

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19. — *Graded Volume Table for Yellow Birch* — Continued.

Used Length, 16 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10,	–	–	–	10	15	15	40
11,	–	–	–	15	20	15	50
12,	–	–	5	15	20	20	60
13,	–	–	10	20	20	20	70
14,	–	5	10	25	20	20	80
15,	–	5	15	25	20	25	90
16,	5	5	20	30	20	20	100
17,	10	5	25	30	25	25	120
18,	15	10	30	35	25	25	140
19,	20	10	40	35	20	25	150
20,	25	15	45	35	25	25	170
21,	30	15	55	35	25	30	190
22,	35	15	60	35	25	30	200
23,	40	20	65	40	25	30	220
24,	55	20	80	40	25	30	250

Used Length, 20 Feet.

10,	–	–	–	5	20	25	50
11,	–	–	–	10	25	25	60
12,	–	–	5	15	25	25	70
13,	–	–	5	25	30	30	90
14,	–	–	10	30	30	30	100
15,	–	5	10	30	30	35	110
16,	5	5	20	40	30	40	140
17,	10	5	30	40	30	45	160
18,	15	10	35	45	30	45	180
19,	20	10	45	50	30	45	200
20,	30	15	50	50	30	45	220
21,	35	15	60	55	35	50	250
22,	40	20	70	55	35	50	270
23,	50	25	75	60	35	55	300
24,	65	30	85	60	35	55	330

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19. — *Graded Volume Table for Yellow Birch* — Continued.

Used Length, 22 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10,	–	–	–	5	20	25	50
11,	–	–	5	15	25	25	70
12,	–	–	5	20	25	30	80
13,	–	–	5	25	30	30	90
14,	–	–	10	30	30	30	100
15,	–	5	15	35	30	35	120
16,	5	10	25	40	30	40	150
17,	10	10	30	45	30	45	170
18,	15	10	40	50	30	45	190
19,	22	10	45	50	35	50	210
20,	30	15	55	55	35	50	240
21,	35	15	65	60	35	50	260
22,	45	20	70	60	35	50	280
23,	50	25	80	60	40	55	310
24,	65	30	90	60	40	55	340

Used Length, 24 Feet.

10,	–	–	–	10	25	25	60
11,	–	–	–	15	25	30	70
12,	–	–	–	20	30	30	80
13,	–	–	10	30	30	30	100
14,	–	–	10	35	30	35	110
15,	5	5	15	35	30	40	130
16,	10	10	25	40	35	40	160
17,	10	10	30	50	35	45	180
18,	15	10	40	50	35	50	200
19,	20	10	50	55	35	50	220
20,	30	15	60	60	35	50	250
21,	35	20	65	60	40	50	270
22,	40	20	75	65	40	50	290
23,	50	25	85	65	40	55	320
24,	70	30	95	65	40	60	360

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19.—*Graded Volume Table for Yellow Birch*—Continued.

Used Length, 26 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
12, . . .	–	–	10	20	30	30	90
13, . . .	–	–	10	30	30	30	100
14, . . .	–	–	10	35	30	35	110
15, . . .	–	–	15	40	35	40	130
16, . . .	5	5	25	45	35	45	160
17, . . .	10	10	35	50	35	50	190
18, . . .	15	10	45	55	35	50	210
19, . . .	25	10	55	60	40	50	240
20, . . .	30	15	60	60	40	55	260
21, . . .	35	15	70	65	40	55	280
22, . . .	45	20	75	70	40	60	310
23, . . .	50	25	85	70	40	60	330
24, . . .	65	30	100	70	45	60	370

Used Length, 28 Feet.

12, . . .	–	–	5	20	35	30	90
13, . . .	–	–	10	30	35	35	110
14, . . .	–	5	10	35	35	35	120
15, . . .	–	5	20	40	35	40	140
16, . . .	10	5	30	45	35	45	170
17, . . .	10	10	40	50	40	50	200
18, . . .	15	10	50	55	40	50	220
19, . . .	25	15	55	60	40	55	250
20, . . .	30	15	65	65	40	55	270
21, . . .	35	20	70	65	40	60	290
22, . . .	45	20	80	70	45	60	320
23, . . .	55	30	90	70	45	60	350
24, . . .	70	35	105	70	45	65	380

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19.—*Graded Volume Table for Yellow Birch*—Continued.

Used Length, 30 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
12, . . .	–	–	–	–	–	–	–
13, . . .	–	–	–	–	–	–	–
14, . . .	–	5	20	40	40	45	150
15, . . .	10	5	30	45	40	50	180
16, . . .	10	10	40	55	40	55	210
17, . . .	15	10	50	60	40	55	230
18, . . .	25	15	55	65	40	60	260
19, . . .	30	15	65	65	45	60	280
20, . . .	40	20	75	70	45	60	310
21, . . .	45	25	80	70	45	65	330
22, . . .	55	30	90	75	45	65	360
23, . . .	70	35	110	75	45	65	400

Used Length, 32 Feet.

15, . . .	5	5	20	45	40	45	160
16, . . .	10	10	30	50	40	50	190
17, . . .	15	10	40	60	40	55	220
18, . . .	15	10	50	60	45	60	240
19, . . .	25	15	60	65	45	60	270
20, . . .	30	15	70	70	45	60	290
21, . . .	40	20	75	75	45	65	320
22, . . .	45	20	85	75	50	65	340
23, . . .	55	25	95	75	50	70	370
24, . . .	75	35	115	75	50	70	420

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 19. — *Graded Volume Table for Yellow Birch* — Concluded.

Used Length, 34 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.						
	1sts and 2ds Red.	1 C. Red.	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
15, . . .	–	–	–	–	–	–	–
16, . . .	10	10	35	50	45	50	200
17, . . .	15	10	40	60	45	60	230
18, . . .	15	10	55	60	45	65	250
19, . . .	25	15	60	70	45	65	280
20, . . .	30	15	70	70	50	65	300
21, . . .	40	20	80	75	50	65	330
22, . . .	45	25	90	80	50	70	360
23, . . .	55	30	95	80	50	70	380
24, . . .	75	35	115	80	50	75	430

Used Length, 36 Feet.

15, . . .	–	–	–	–	–	–	–
16, . . .	10	10	35	50	45	50	200
17, . . .	15	10	45	60	45	65	240
18, . . .	20	10	55	65	45	65	260
19, . . .	25	15	60	70	50	70	290
20, . . .	30	15	70	75	50	70	310
21, . . .	40	20	80	80	50	70	340
22, . . .	45	25	90	80	55	75	370
23, . . .	50	30	100	80	55	75	390
24, . . .	75	35	120	85	55	80	450

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 20. — *Graded Volume Table for Sugar Maple.*

Used Length, 12 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10, ...	–	–	10	20	30
11, ...	–	–	10	20	30
12, ...	–	10	10	20	40
13, ...	5	10	10	25	50
14, ...	10	15	10	25	60
15, ...	10	20	15	25	70
16, ...	15	30	15	30	90
17, ...	20	35	15	30	100
18, ...	30	35	15	30	110

Used Length, 16 Feet.

10, ...	–	5	10	25	40
11, ...	–	10	10	20	40
12, ...	5	10	10	25	50
13, ...	5	15	15	25	60
14, ...	10	20	15	25	70
15, ...	10	30	20	30	90
16, ...	15	35	20	30	100
17, ...	20	40	20	30	110
18, ...	30	40	20	40	130

Used Length, 20 Feet.

10, ...	–	5	15	30	50
11, ...	–	10	15	35	60
12, ...	5	15	15	35	70
13, ...	5	15	20	40	80
14, ...	10	25	20	45	100
15, ...	15	35	20	50	120
16, ...	20	45	25	50	140
17, ...	30	50	25	55	160
18, ...	40	55	25	60	180

For notes on construction and use see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 20. — *Graded Volume Table for Sugar Maple* — Continued.

Used Length, 24 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10,	–	5	15	40	60
11,	–	10	20	40	70
12,	5	15	20	40	80
13,	5	20	20	45	90
14,	10	30	20	50	110
15,	15	40	25	50	130
16,	20	45	30	55	150
17,	30	50	30	60	170
18,	40	60	30	60	190

Used Length, 28 Feet.

11,	–	15	20	45	80
12,	5	20	20	45	90
13,	5	25	20	50	100
14,	10	35	25	50	120
15,	15	40	30	55	140
16,	25	50	30	55	160
17,	35	55	30	60	180
18,	45	65	30	60	200

Used Length, 32 Feet.

11,	–	15	25	50	90
12,	5	20	25	50	100
13,	5	25	25	55	110
14,	10	35	30	55	130
15,	15	45	30	60	150
16,	25	50	30	65	170
17,	35	60	30	65	190
18,	45	70	35	70	220

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 20. — *Graded Volume Table for Sugar Maple* — Concluded.

Used Length, 36 Feet.

DIAMETER, BREAST HIGH (INCHES).	GRADE OF LUMBER.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
12,	5	20	25	60	110
13,	5	30	30	65	130
14,	10	40	30	70	150
15,	15	50	35	70	170
16,	25	55	35	75	190
17,	35	65	35	75	210
18,	50	70	40	80	240

Used Length, 40 Feet.

13,	5	30	35	70	140
14,	10	40	35	75	160
15,	15	50	35	80	180
16,	25	55	40	80	200
17,	35	65	45	85	230
18,	45	75	45	95	260

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 21.—*Graded Volume Table for Beech.*

Used Length, 12 Feet.

Diameter, Breast High (Inches).	Grade of Lumber.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
10,	–	5	10	25	40
11,	–	5	10	25	40
12,	–	10	10	30	50
13,	–	15	15	30	60
14,	5	20	15	30	70
15,	10	20	15	35	80
16,	15	25	15	35	90
17,	20	25	15	40	100
18,	20	30	20	40	110

Used Length, 16 Feet.

10,	–	10	10	30	50
11,	–	10	15	35	60
12,	5	15	15	35	70
13,	5	20	15	40	80
14,	10	20	20	40	90
15,	10	25	20	45	100
16,	15	30	20	45	110
17,	20	35	25	50	130
18,	25	40	25	50	140

Used Length, 20 Feet.

11,	–	10	15	45	70
12,	–	15	20	45	80
13,	–	20	20	50	90
14,	10	25	25	50	110
15,	10	30	25	55	120
16,	15	40	25	60	140
17,	20	45	25	60	150
18,	25	50	30	65	170

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

TABLE No. 21.—*Graded Volume Table for Beech*—Concluded.

Used Length, 24 Feet.

Diameter, Breast High (Inches).	Grade of Lumber.				
	1sts and 2ds.	1 C.	2 C.	3 C.	Total.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
11,	–	10	20	50	80
12,	–	20	20	50	90
13,	5	25	25	55	110
14,	10	30	30	60	130
15,	10	35	30	65	140
16,	20	40	30	70	160
17,	25	45	35	75	180
18,	30	55	35	80	200

Used Length, 28 Feet.

11,	–	15	25	60	100
12,	–	20	25	65	110
13,	5	25	25	65	120
14,	10	30	30	70	140
15,	15	35	35	75	160
16,	20	45	35	80	180
17,	30	50	40	80	200
18,	40	60	40	90	230

Used Length, 32 Feet.

12,	5	25	25	65	120
13,	5	25	30	70	130
14,	10	35	30	75	150
15,	20	40	35	85	180
16,	25	45	40	90	200
17,	30	50	45	95	220
18,	45	60	45	100	250

For notes on construction and use, see footnote under Graded Mill Tally Log Rule, page 15.

YIELD TABLES.

Yield tables show the volume in board feet or other units for an acre of fully-stocked woodland at any given age. By the term "fully-stocked" we mean that the crowns of the trees occupy all the available space on the acre and that there are no blanks nor openings.

A yield table can be used to predict the future yield of young or middle-age stands. The owner finds the age and volume of his present stand in order to determine in which quality site it belongs, and from the table he can predict its yield at any period in the future. In making his calculations allowance must be made for the fact that his immature stand may not be fully stocked. In the same way the yield table is necessary in predicting the returns from an investment in planting. They are of particular value in suits where damage to immature timber is involved, for in such case the loss is the destruction of possible future growth. They are of some use in estimating the present contents of stands if the estimator can determine the present age, and, from the height, the quality of the site on which his stand is growing.

For the data on the pine yield tables 177 sample plots were measured in stands ranging from twenty to seventy years. All the trees on each quarter or eighth acre plot were calipered, and the volumes computed from the volume tables. These sample plots were divided into three site or soil classes (called Quality I, II, III) according to their rate of growth in volume. It has since been generally agreed by foresters that height growth is a better index of quality of site than volume, and the yield tables on hardwoods are divided on this basis. For the latter, two sets of tables are given, one of which includes all trees of 2 inches diameter and over, in which the merchantable volume is expressed entirely as cordwood; and second, a table containing only the trees of over 7 inches diameter, where the merchantable volume is expressed in board feet and additional cordwood. There is a third yield table for inferior hardwoods. By the term "inferior hardwoods" is meant stands composed principally of gray birch, red maple and poplar. Naturally the amount of saw timber to be obtained from such weed species is small.

TABLE No. 22. — *Normal Yield per Acre, in Cubic Feet and Cords, of Better Second Growth Hardwood Stands in Central New England.*

SITE CLASS I.

All trees 2 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Basal Area (Square Feet).	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acre (Cords).	Forest Form Factor.
20, . . .	1,250	66.0	27.1	3.11	1,041	15.80	.582
25, . . .	1,120	90.8	33.0	3.86	1,625	23.71	.542
30, . . .	1,010	107.2	37.5	4.41	2,150	29.75	.501
35, . . .	900	119.9	41.5	4.94	2,628	34.96	.503
40, . . .	800	130.2	45.0	5.46	3,058	39.63	.520
45, . . .	700	139.7	48.2	6.05	3,495	44.03	.520
50, . . .	610	148.0	50.7	6.69	3,898	48.00	.520
55, . . .	525	155.7	53.1	7.37	4,298	51.84	.520
60, . . .	450	162.5	55.4	8.14	4,677	55.50	.520
65, . . .	390	169.0	57.8	8.91	5,068	59.25	.520
70, . . .	340	175.1	59.8	9.72	5,462	62.75	.522
75, . . .	300	180.9	61.9	10.51	5,833	66.18	.521
80, . . .	270	186.3	64.0	11.25	6,200	69.50	.520

First published in Harvest Forest Bulletin No. 2, "Growth Study and Normal Yield Tables for Second Growth Hardwood Stands in Central New England," by J. Nelson Spaeth. Data gathered in northern Worcester County, Mass., in 1919. Based on forty fully stocked, natural, even-aged sample plots containing over 15,000 trees. The principal species were red oak, white ash, red maple and basswood. Cubic foot and cord volumes were obtained by the use of Harvard Forest Revised Red Maple Volume Tables (tables 15 and 16 in this Handbook); board foot volumes were computed by the use of Clark's International Log Rule (as published in Graves's "Mensuration"), which agrees closely with average yields from the customary round-edge sawing. Conclusions drawn from this study were that, for even-aged second growth hardwood stands, in spite of wide variation in percentage of species in mixture, for a given site, age and density the volume in board feet, cubic feet and cords is constant; also that the volume of a tree of given height and diameter in cords and cubic feet is the same, regardless of species. (For full discussion see original publication.)

TABLE No. 23. — *Normal Yield per Acre, in Cubic Feet and Cords, of Better Second Growth Hardwood Stands in Central New England.*

SITE CLASS II.

All trees 2 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Basal Area (Square Feet).	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acre (Cords).	Forest Form Factor.
25, . . .	1,360	59.8	27.8	2.84	982	14.65	.593
30, . . .	1,235	77.9	31.8	3.40	1,380	20.40	.557
35, . . .	1,125	91.1	34.8	3.86	1,798	25.48	.567
40, . . .	1,030	101.6	37.4	4.25	2,180	29.53	.574
45, . . .	940	110.3	39.8	4.66	2,534	33.04	.577
50, . . .	855	117.9	41.5	4.94	2,828	35.98	.580
55, . . .	775	124.6	42.8	5.43	3,118	38.55	.584
60, . . .	700	130.7	44.2	5.85	3,375	41.08	.584
65, . . .	630	136.6	45.3	6.31	3,638	43.42	.587
70, . . .	565	142.2	46.3	6.79	3,895	45.61	.592
75, . . .	500	147.7	47.0	7.36	4,146	47.75	.598
80, . . .	440	153.0	47.6	7.98	4,390	49.80	.601

See footnote to Table No. 22, page 50.

TABLE No. 24. — *Normal Yield per Acre in Board Feet and Additional Cords, Cubic Feet and Cords of Better Second Growth Hardwood Stands in Central New England.*

SITE CLASS I.

All trees 7 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acre (Cords).	VOLUME PER ACRE.	
						Board Feet.	Additional Cords.
30, . . .	37	51.9	7.28	350	5.2	1,460	1.4
35, . . .	147	57.0	7.86	1,280	13.8	2,900	6.4
40, . . .	186	61.3	8.45	1,950	21.3	4,720	9.2
45, . . .	205	64.8	9.00	2,549	28.3	7,130	10.0
50, . . .	216	68.1	9.48	3,120	34.8	10,310	8.3
55, . . .	223	71.0	9.97	3,680	40.6	13,160	6.3
60, . . .	226	73.6	10.53	4,240	46.1	15,620	5.6
65, . . .	227	75.9	11.08	4,810	51.2	17,850	5.4
70, . . .	226	78.0	11.59	5,360	56.0	19,830	5.3
75, . . .	224	79.8	12.10	5,900	60.8	21,700	5.2
80, . . .	220	81.5	12.62	6,450	65.6	23,400	5.3

See footnote to Table No. 22, page 50.

TABLE No. 25. — *Normal Yield per Acre in Board Feet and Additional Cords, Cubic Feet and Cords of Better Second Growth Hardwood Stands in Central New England.*

SITE CLASS II.

All trees 7 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acre (Cords).	VOLUME PER ACRE.	
						Board Feet.	Additional Cords.
35, . . .	56	49.4	7.25	530	6.7	800	4.7
40, . . .	104	54.5	7.85	1,010	14.0	1,920	9.1
45, . . .	133	56.7	8.41	1,460	19.7	3,250	11.4
50, . . .	157	59.4	8.78	1,870	24.6	4,780	12.3
55, . . .	175	61.6	9.15	2,250	29.1	6,600	12.2
60, . . .	188	63.2	9.51	2,620	32.8	8,660	10.2
65, . . .	197	64.4	9.90	2,970	36.4	10,850	8.6
70, . . .	203	65.4	10.32	3,310	39.7	12,710	7.1
75, . . .	206	66.2	10.75	3,660	42.7	14,220	6.2
80, . . .	207	66.8	11.21	4,020	46.0	15,380	6.1

See footnote to Table No. 22, page 50.

TABLE No. 26. — *Normal Yield in Cubic Feet and Cords o*
Inferior Second Growth Hardwood Stands in Central Ne
England.

All trees 2 inches and over in diameter.

AGE (YEARS).	Trees per Acre.	Height (Feet).	Diameter, Breast High (Inches).	Volume per Acre (Cubic Feet).	Volume per Acr (Cords)
17,	1,050	28.6	2.71	670	10.40
18,	1,535	29.3	2.80	830	14.15
19,	1,640	29.9	2.87	990	16.60
20,	1,708	30.5	2.92	1,130	18.06
21,	1,750	31.1	2.95	1,230	18.95
22,	1,774	31.6	2.98	1,300	19.54
23,	1,778	32.1	3.01	1,360	19.97
24,	1,768	32.5	3.03	1,400	20.30
25,	1,743	32.9	3.05	1,430	20.53
26,	1,710	33.3	3.07	1,440	20.72
27,	1,671	33.6	3.10	1,450	20.86
28,	1,623	33.9	3.13	1,455	20.88
29,	1,575	34.1	3.17	1,460	20.75
30,	1,515	34.4	3.21	1,460	20.63

See footnote to Table No. 22, page 50.

TABLE No. 27. — *Yield Table for White Pine.*

AGE (YEARS).	QUALITY I.			QUALITY II.			QUALITY III.		
	1-Inch Boards.	Caliper Cords.	Cubic Feet.	1-Inch Boards.	Caliper Cords.	Cubic Feet.	1-Inch Boards.	Caliper Cords.	Cubic Feet.
5,	10,825	25.1	2,080	6,750	16.4	1,300	3,975	10.8	750
0,	19,900	44.0	3,750	12,500	31.2	2,740	7,500	18.2	1,400
5,	31,150	60.4	5,420	24,400	49.0	4,375	16,950	35.8	3,035
0,	40,650	70.6	6,590	32,800	58.0	5,300	25,200	46.2	4,080
5,	49,350	78.0	7,420	40,600	64.8	6,075	32,100	51.8	4,785
0,	55,150	84.2	8,035	46,500	70.0	6,725	37,550	56.6	5,475
5,	59,650	89.2	8,575	50,550	74.8	7,200	42,100	60.8	6,015
0,	63,600	93.4	9,075	53,200	79.2	7,655	44,550	64.6	6,340
5,	67,050	97.2	9,550	56,600	83.0	8,050	46,150	68.4	6,550

Constructed by State Forester. Data obtained by measuring 177 sample plots
n all parts of Massachusetts.

TABLE No. 28. — *Yield from Thinnings.*

Trees under 5 inches, from report of the New Hampshire Forestry Commissio
1906.

AGE (YEARS).	TREES OVER 5 INCHES IN DIAMETER.		TREES UNDER 5 INCHES IN DIAMETER	
	Board Feet.	Cubic Feet.	Cords.	Cubic Feet.
25, ...	1,400	280	7½	750
30, ...	3,700	720	6	600
35, ...	4,950	850	4½	450
40, ...	6,000	1,030	3	300
45, ...	6,800	1,140	1½	150
50, ...	7,400	1,240	–	–
55, ...	7,900	1,310	–	–

GROWTH.

The two following tables represent the average growth o
white pine in volume and height as found in different loca
tions or sites. Volume growth is expressed in solid cubi
feet, because it is the best unit for scientific measurement
The material for growth study is obtained from a series o
measurements called a "stem analysis." The trees are felle
and sawed into sections which are subject to the followin
measurements. The diameter on the stump and its heigh
are taken, also the diameters at the large and small end o
each log and its length, and the diameter at the base of th
top and its length. All these diameters are taken inside the
bark. The stump is cubed as a cylinder, each log as the

frustum of a paraboloid, and the top as a cone. By counting
back on the annual rings, and measuring the diameter at
every tenth ring, we can obtain the cubical contents of the
tree as it was ten years, twenty years, ago, and so on back
until it was in the neighborhood of ten years old. The trees
growing in what is described as rich lowland show the most
rapid growth in volume, although those described as coming
from upland pasture are not far behind. It is quite probable
that the latter trees were growing under somewhat more
crowded conditions, and did not have quite as much oppor-
tunity to develop their diameter growth to its fullest capacity.
That they were more crowded is indicated by the fact that
the tables on height growth show a slightly higher rate for
the upland pasture trees. The rate of growth for trees on
sandy soil is very much slower than that for the other two
types, being not much over 50 per cent the rate of the low-
land type. This seems to refute the prevailing idea that soil
and moisture conditions have very little effect on the growth
of pines. In this connection it is interesting to note that
the rate of growth of pines in wet swamp is the lowest of all,
indicating that too much water retards the growth of pines
even more than too little.

The tables of height growth follow the same general lines as
those for volume growth, except that, as stated above, upland
pasture slightly exceeds that of rich lowland. The rate for
the favorable sites (upland pasture and lowland) exceeds
that of the less favorable sites by 20 or 25 per cent, a differ-
ence in rate somewhat less than that of the volume growth.

TABLE No. 29. — *Growth Tables. — Growth in Volume.*

AGE (YEARS).	Rich Lowland. 109 Trees.	Upland Pasture. 73 Trees.	Sandy Soil. 16 Trees.	Wet Swamp. 47 Trees.
	Cu. Ft.	Cu. Ft.	Cu. Ft.	Cu. Ft.
10,	.8	.6	.4	.3
15,	1.8	1.2	.5	.4
20,	3.0	2.0	1.4	1.0
25,	5.5	4.5	2.5	1.6
30,	9.0	7.5	4.0	2.7
35,	13.5	11.5	6.3	4.0
40,	19.5	16.6	9.3	6.9
45,	26.5	22.0	12.5	8.3
50,	35.0	27.7	16.0	10.7
55,	43.5	34.5	19.8	14.5
60,	51.5	41.7	23.6	18.6
65,	60.0	49.0	27.5	23.0
70,	68.0	56.0	31.2	27.2
75,	75.5	–	35.3	31.2
80,	84.0	–	39.0	34.8
85,	93.5	–	42.8	38.0
90,	–	–	–	41.0
95,	–	–	–	43.5

TABLE No. 30. — *Growth Tables. — Growth in Height.*

AGE (YEARS).	Upland Pasture. 73 Trees.	Rich Lowland. 109 Trees.	Sandy Soil. 16 Trees.	Wet Swamp. 47 Trees.
	Feet.	Feet.	Feet.	Feet.
10,	9	8	5	4
15,	16	15	14	10
20,	24	23	23	16
25,	32	31	30	22
30,	40	39	36	28
35,	47	46	40	34
40,	53	52	44	39
45,	59	57	48	43
50,	64	62	51	48
55,	69	66	54	51
60,	73	69	57	54
65,	76	71	59	57
70,	80	73	61	60
75,	82	75	63	62
80,	84	77	65	65
85,	87	79	–	68
90,	89	80	–	70
95,	90	–	–	–
100,	91	–	–	–

TABLE No. 31. — *White Spruce Growth Table for Even-aged Stands.*

AGE.	Diameter, Breast-high (Inches).	Total Height (Feet).	Merchantable Height (Feet).	Total Volume (Cubic Feet).	Merchantable Volume (Cubic Feet).	Mean Annual Growth (Cubic Feet).	Mean Annual Growth (Per Cent).
10, . . .	1.2	7.1	–	0.2	–	0.020	10.0
15, . . .	2.6	12.8	–	0.7	–	0.046	6.6
20, . . .	4.3	20.2	–	1.5	–	0.075	5.0
25, . . .	5.6	27.6	12	2.7	2.0	0.108	4.0
30, . . .	6.6	34.5	17	4.2	3.9	0.130	3.1
35, . . .	7.3	40.2	23	6.2	5.8	0.166	2.7
40, . . .	7.8	45.2	28	8.3	7.7	0.192	2.3
45, . . .	8.4	49.6	34	10.4	9.7	0.215	2.1
50, . . .	8.9	53.4	38	12.5	11.6	0.232	1.9
55, . . .	9.3	56.8	42	14.6	13.5	0.245	1.7
60, . . .	9.8	59.7	45	16.7	15.5	0.258	1.5
65, . . .	10.3	62.2	48	18.8	17.4	0.267	1.4
70, . . .	10.9	64.3	52	20.8	19.3	0.276	1.3

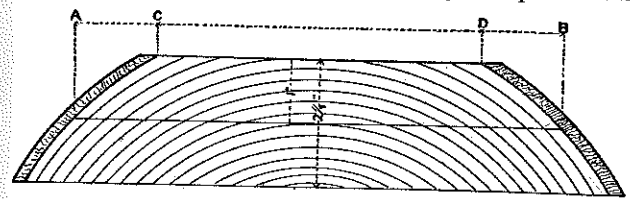
Based on measurement of 199 trees (curved), by H. B. Shepard, Forester Lincoln Pulp Company, 1920. Periodic annual growth (cubic feet and per cent) is for ten-year periods, *i.e.*, 10 to 20, 15 to 25, etc., based on total volumes.

MISCELLANEOUS NOTES.

While gathering the data for the pine tables in this bulletin it was possible to investigate several related problems which are of especial interest to lumber operators. The available data may not be sufficient in every case to yield conclusive results, but they are offered for what they are worth.

Sawing Boards and Planks.

As has been stated before, nearly all our native pine logs are sawed in round-edge lumber in two general classes, the first being box boards which are usually 1 or $1\frac{1}{4}$ inches in thickness, and the second plank or butt cuts, which are $2\frac{1}{8}$ inches in thickness. The log scale on page 12, compiled by the Massachusetts Forestry Department, was derived from logs sawed into box boards, while the scale compiled at the Harvard Forest was derived from logs sawed largely into plank. If the two scales are compared, one will note that with the smaller logs box boards show a higher yield than plank, while in the larger logs the positions are reversed. The following diagram of a $2\frac{1}{8}$-inch plank taken



Comparison of Scale in Sawing 2⅛" Plank and 1" Boards

from a small log will serve to explain the reason. The plank is scaled on the narrow face C–D and the result multiplied

by 2, whereas if that plank were sawed into two 1-inch boards we would have the combined scales C–D plus A–B, which is larger than twice C–D by A–C and D–B. The larger the logs, however, the smaller the wane, that is, the smaller the difference between the wide and narrow face, so that with the wider planks there is no loss in scale and there is an actual saving in lumber due to the fewer saw kerfs made in sawing 2-inch instead of 1-inch lumber. Therefore on the larger logs the rule for plank exceeds that for box boards.

Band Saw versus Circular.

A portable mill located near Manchaug was equipped with a band saw instead of a circular, so that it was possible by constructing a mill tally rule at this mill to compare the results of using a band saw which makes a kerf only one-eighth of an inch in width with a mill tally rule represented by the general Massachusetts rule, which allow for a circular saw kerf of one-quarter of an inch. The two rules are printed in parallel columns below, and a comparison will show an average gain of 20 per cent in the yield of pine logs by using the band saw. It would seem that this saving would justify a more thorough tryout of the band saw, even in connection with a portable mill.

TABLE No. 32. — *Comparison of Log Scales (Band Saw versus Circular Saw).*

Diameter at Small End (Inches).	10-Foot Logs.		12-Foot Logs.		14-Foot Logs.	
	Band Saw.	Circular Saw.	Band Saw.	Circular Saw.	Band Saw.	Circular Saw.
	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.	Ft. B. M.
4, . . .	12	9	15	13	20	17
5, . . .	17	13	21	17	26	21
6, . . .	23	17	27	22	34	27
7, . . .	30	23	35	29	43	35
8, . . .	38	30	45	37	54	44
9, . . .	49	39	57	47	67	55
10, . . .	61	48	71	58	81	68
11, . . .	75	58	86	70	98	82
12, . . .	90	69	102	83	116	97
13, . . .	107	80	121	96	136	113
14, . . .	124	104	142	111	158	131
15, . . .	–	117	166	129	180	150
16, . . .	–	131	–	146	204	170

Round-edge versus Square-edge Lumber.

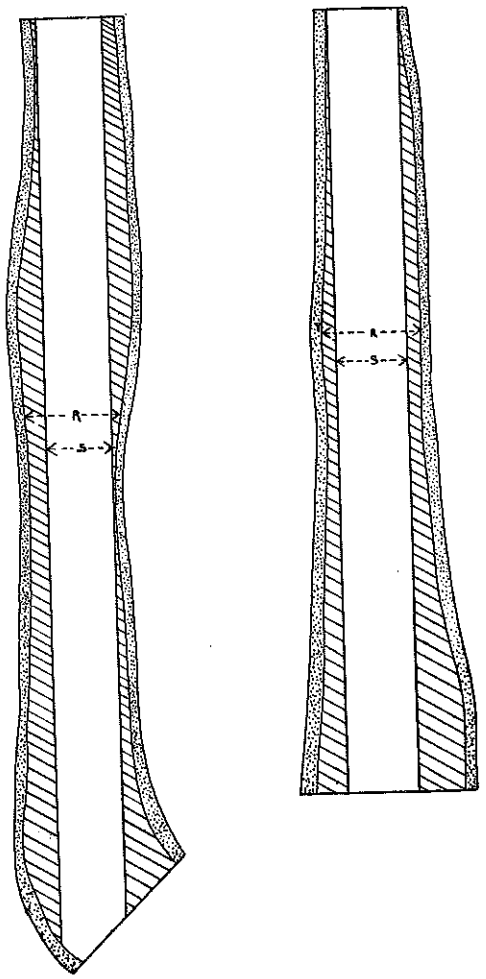
Lumber operators generally recognize the fact that logs sawed into square-edge boards do not yield as much lumber as those sawed into round-edge lumber, but they are not often aware of the precise difference, or why it comes about. We obtained from Mr. Austin Cary a mill tally scale made at a portable mill in Maine which was producing square-edge lumber only, and we have printed that in parallel columns with our Massachusetts rule representing the round-edge yield.

The reader will note that the difference in favor of the round-edge sawing is from 10 to 15 per cent in the smaller logs, and gradually diminishes until it reaches zero in the case of the 16-inch logs. This is as it should be in theory, because the difference between the two methods of sawing is due to the slab which must be removed to produce square-edge lumber, and the proportion of slab to the yield in lumber becomes less and less as the log increases in size. One will also note that the 14-foot log shows a larger difference than the 12-foot log. This is due to the fact that there is a greater taper and consequently greater proportionate waste in slab in squaring the longer logs.

TABLE No. 33. — *Comparison of sawing Round and Square-edge Lumber.*

Diameter at Small End (Inches).	12-Foot Logs.			14-Foot Logs.		
	Cary (Square Edge).	Massachusetts (Round Edge).	Per Cent Difference.	Cary (Square Edge).	Massachusetts (Round Edge).	Per Cent Difference.
6, . . .	Ft. B. M. 20	Ft. B. M. 22	10.00	Ft. B. M. 23	Ft. B. M. 27	17.39
7, . . .	26	29	11.53	30	35	16.66
8, . . .	33	37	12.12	39	44	12.82
9, . . .	43	47	9.34	50	55	10.00
10, . . .	54	58	9.25	61	68	11.47
11, . . .	67	70	4.46	75	82	9.33
12, . . .	81	83	2.46	90	97	7.77
13, . . .	95	96	1.05	105	113	7.61
14, . . .	110	111	.90	124	131	5.64
15, . . .	128	129	.78	135	150	1.11
16, . . .	146	146	–	160	170	.62

The following diagrams explain more clearly the loss of scale and lumber that comes in squaring round-edge lumber. As has been said before, round-edge lumber is scaled on the narrow face at the point of average width; on the other hand, if the board is squared its width is limited by the dimension at the small end or at some other narrow point. The two diagrams show the effect of squaring two round-edge boards, one with an excessive amount of taper and the other with a bad crook. The dotted line R represents the scale of the round-edge board, and the line S the scale of the square-edge board. Although there is a considerable loss in scale, there is even a larger loss in material.



Loss of Scale in Squaring Round-Edged Boards

Equivalent Factors.

The following table contains a series of converting factors which are often useful. The first shows the number of board feet that one can expect to obtain from a log per cubic foot of solid wood. If one has a log which he wishes to scale and is not equipped with a log rule, he can find the solid contents by cubing the log as the frustum of a cone, and then, remembering that the average log will yield 7 board feet per cubic foot, he can convert his cubic contents into board feet. These are the factors for round-edge lumber. In the case of square-edge lumber an average factor is about 6.5 board feet.

One will note that the equivalent factor is only 5 feet for small logs, and 7.5 for the larger. The increase is due to the fact that in the sawing of smaller logs there is a larger percentage of wood which must be wasted in the form of slab and saw kerf.

In the chapter on log rules we called attention to the caliper cord. In commercial practice it is usual to state that it takes a cord and a half to equal a thousand feet, or, to reverse the statement, a cord is equal to 670 board feet of inch lumber. Reference to the table will show that this is a very satisfactory converting factor for a run of logs. The increase in yield from the smaller to the larger logs is due to the same reason as that advanced for the yield per cubic foot, namely, the higher percentage of waste in smaller logs. In southeastern Massachusetts, where the practice is to saw $\frac{5}{8}$-inch lumber, it is common to call 1,000 feet of this sort of lumber equivalent to a cord, although an average run of logs will slightly exceed this yield.

TABLE No. 34. — *Table showing Equivalent Factors for changing Cubic Feet to Board Feet and Cords to Board Feet — White Pine.*

DIAMETER AT MIDDLE OF LOG (INCHES).	Number of Board Feet per Cubic Foot of Solid Wood.	Number of Board Feet per Cord.
5,	5.0	488
6,	5.6	560
7,	6.0	590
8,	6.4	636
9,	6.5	645
10,	6.6	646
11,	6.7	648
12,	6.8	654
13,	6.8	684
14,	6.9	707
15,	7.0	714
16,	7.1	714
17,	7.2	721
18,	7.3	726
19,	7.4	733
20,	7.4	738
21,	7.4	744
22,	7.5	752
23,	7.5	742
24,	7.5	730

MEASUREMENT OF FUEL.

There is considerable confusion attendant upon the buying and selling of fuel wood because it is sold as one thing while the purchaser receives it in another form. It is sold as cord-wood; *i.e.*, wood in sticks 4 feet long piled so as to occupy 128 cubic feet of space, but it is delivered to the consumer as fuel wood cut into lengths 2 feet or less. The State Forester made an investigation to determine the amount of space that an average cord of wood should occupy after it has been cut into the ordinary commercial lengths, — 24-inch, 16-inch, 12-inch, — and then thrown loose into a bin or restacked. At the same time, we experimented to obtain the number of 2 and 4 bushel baskets per cord. We used approximately 150 cords of hardwood of different types, — all cleft, all round, mixed round and cleft, — and the table below gives the average results of those experiments. An attempt was made to make these figures legal standard for a cord, but the proposition was rejected by the Legislature.

TABLE No. 35. — *Fuel Wood Units per Cord.*

Thrown (Cubic Feet per Cord).	Basis (Cords).	Stacked (Cubic Feet per Cord).	Basis (Cords).	2-Bushel Baskets (per Cord).	Basis (Cords).	4-Bushel Baskets (per Cord).	Basis (Cords).
12-Inch Lengths.							
145	45	101	21	54½	11	25½	8
16-Inch Lengths.							
161	25	106	12	59	9	26	7
24-Inch Lengths.							
183	11	110	11	–	–	34	9

Constructed from data collected by State Forester.