Issued November 22, 1910.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—BULLETIN 36.
HENRY S. GRAVES, FORESTER.

THE WOODSMAN'S HANDBOOK

(REVISED AND ENLARGED)

BY
HENRY S. GRAVES,
FORESTER,
AND
E. A. ZIEGLER,
DIRECTOR, PENNSYLVANIA STATE
FOREST ACADEMY.

Reprint, March, 1912.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., February 11, 1910.

SIR: I have the honor to transmit herewith the manuscript of a revised and enlarged edition of Bulletin 36 of the Forest Service, "The Woodsman's Handbook," and to recommend its publication to take the place of the proposed second part of this bulletin, so as to include both parts in one publication. The sixteen text figures are necessary for its proper illustration.

Very respectfully,

HENRY SOLON GRAVES,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE WOODSMAN'S HANDBOOK.

INTRODUCTION.

The purpose of the Woodsman's Handbook is to give a collection of tables and rules of practical use to lumbermen, foresters, and others interested in the measurement of wood and timber. The Handbook is not intended as a treatise on forest mensuration, and only such information is included as is deemed of immediate practical value to American woodsmen. More complete discussions of the principles of forest measurements can be found in technical treatises.

The first edition of the Handbook[a] discussed all of the log rules in use in this country and in Canada, or as many of them as were available. Its purpose was to bring the discrepancy in log rules before the public and to urge uniformity in the methods of measuring logs. In the present edition, which takes the place of the proposed Part II, only those log rules are described which have value or usage enough to justify special attention. The other rules are mentioned merely for comparison. Only three are given in full: The Scribner Decimal Rule, which has been adopted for timber sales on the National Forests; the Doyle Rule, and the Inscribed Square Rule.

Certain changes have been made in the text of Part I, and some tables, which were desirable at the time of the first issue, have been omitted, because they are now of little or no value. Most of the volume tables are new and are the result of investigations made since Part I was published.

The first edition announced that the second volume would include a description of how to measure growth, together with growth and yield tables of American trees. A summary of growth investigations has been included in this volume under the chapter on tree growth.[b]

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[a] Forest Service Bulletin 36, Part I.

[b] These growth investigations are given in greater detail in Senate Document 676—Report of the National Conservation Commission.

UNITS OF LOG MEASURE.

In the United States and Canada logs are most commonly measured in board feet. In small transactions standing timber is often sold by the lot or for a specified amount per acre. Standing trees which are to be used for lumber are occasionally sold by the piece. Hoop poles and other small wood are sold by the hundred or thousand. Ties and poles are sold by the piece; piles and mine props by the piece or by linear feet, the price varying in piece sales according to specifications as to diameter, length, and grade.

Firewood and wood cut into short bolts, as for small pulp wood, excelsior wood, spool wood, novelty wood, and heading, is ordinarily measured in cords.

In certain sections of the East it has been the custom to use a standard log as a unit of measure. In the Adirondacks a common unit of measure is the 19-inch standard or, as it is often called, the "market." In this case the standard log is 19 inches in diameter at the small end inside the bark and 13 feet long. In New Hampshire the Blodgett standard is in common use. This unit is a cylinder 16 inches in diameter and 1 foot long. There were formerly other standards in use, such as the 24-inch standard once used in New England, and the 22-inch standard in use in certain parts of Canada and northern New York. The standard measure is decreasing in use and will undoubtedly soon become obsolete.

The cubic foot is the best unit for measuring the volume of logs. It has gained a foothold in this country and will unquestionably be the unit of the future. Even now, red-cedar pencil wood, wagon stock, and other valuable hardwood material is occasionally sold by the cubic foot in certain sections of the East. The unit is used by a few companies in Maine for measuring pulp wood. A special commission on the measurement of logs has recently recommended to the legislature of Maine that the cubic foot be adopted as a statute unit of measurement.

The cubic foot has for a long time been used for the measurement of square timber. Round logs are often measured in terms of cubic feet, but the plan is to determine the contents of the square which can be cut from the log, rather than the full contents, including slabs. The cubic foot is in common use in the measurement of precious woods which are imported from the tropics.

In continental Europe and the Philippine Islands the cubic meter has been established as the standard unit for measuring logs and timber.

BOARD MEASURE.

Board measure is designed primarily for the measurement of sawed lumber. The unit is the board foot, which is a board 1 inch thick and 1 foot square, so that with inch boards the content in board measure is the same as the number of square feet of surface; with lumber of other thicknesses the content is expressed in terms of inch boards.

In recent years board measure has been used as a unit of volume for logs. When so applied the measure does not show the entire content of the log, but the quantity of lumber which, it is estimated, may be manufactured from it. The number of board feet in any given log is determined from a table that shows the estimated number which can be taken out from logs of different diameters and lengths. Such a table is called a log scale or log rule, and is compiled by reducing the dimensions of perfect logs of different sizes, to allow for waste in manufacture, and then calculating the number of inch boards which remain.

The amount of lumber which can be cut from logs of a given size is not uniform, because the factors which determine the amount of waste vary under different circumstances, such as the thickness of the saw, the thickness of the boards, the width of the smallest board which may be utilized, the skill of the sawyer, the efficiency of the machinery, the defects in the log, the amount of taper, and the shrinkage. This lack of uniformity has led to wide differences of opinion as to how log rules should be constructed. There have been many attempts to devise a log rule which can be used as a standard, but none of them will meet all conditions. The rules in existence have been so unsatisfactory that constant attempts have been made to improve upon them. As a result there are now actually in use in the United States 40 or 50 different log rules, whose results differ in some cases as much as 120 per cent for 20-inch to 30-inch logs and 600 per cent for 6-inch logs.[a] Some of these are constructed from mathematical

[a] See Constantine and Cumberland River log rules in comparison table, pp. 16–19.

formulæ; some by preparing diagrams that represent the top of a log and then determining the amount of waste in sawdust and slabs; some are based on actual averages of logs cut at the mill; while still others are the result of making corrections in an existing rule to meet special local conditions.

The large number of log rules, the differences in their values, and the variation in the methods of their application have led to much confusion and inconvenience. Efforts to reach an agreement among lumbermen on a single standard log rule have failed so far. A number of States have given official sanction to specific rules, but this has only added to the confusion, because the States have not chosen the same rule, so there are six different state log rules, and, in addition, three different official log rules in Canada. It is probable that a standard method of measuring logs will not be worked out satisfactorily until a single unit of volume, like the cubic foot, is adopted for the measurement of logs.

THE VARIOUS LOG RULES.

The most important log rules in common use are the Scribner Rule, the Doyle Rule, the Maine Rule, and the Spaulding Rule. These are rated important because of their wide use; though the best rules, from a theoretical standpoint, are the Champlain Rule and the International Rule; in practice, however, these are not used to any extent.

The tables which follow show a comparison of the different rules for 16-foot logs of representative diameters.

TABLE 1.—**Comparison of Log Rules for Board Measure.**

SIXTEEN-FOOT LOGS.

	NAME OF RULE.	DIAMETER IN INCHES.						
		6	8	10	12	14	16	18
		BOARD FEET.						
1	Scribner[a]	18	32	54	79	114	159	213
2	Doyle	4	16	36	64	100	144	196
3	Doyle and Scribner	4	16	36	64	100	144	196
4	Holland or Maine	20	44	68	105	142	179	232
5	Humphrey or Vermont	24	43	66	96	130	170	217
6	Bangor	23	41	69	100	137	182	238
7	Cumberland River	.....	.....	47	68	93	121	153
8	Hanna	.....	32	51	80	117	160	213
9	Spaulding	.....	.....	50	77	114	161	216
10	Favorite	.....	.....	.....	64	98	142	197
11	Baxter	.....	34	56	84	117	156	200
12	Doyle and Baxter	.....	.....	36	64	100	144	196
13	Square of three-fourths	27	48	75	108	147	192	243
14	Square of two-thirds	.....	.....	58	85	114	150	192
15	Herring	.....	25	49	77	107	142	183
16	Dusenberry	.....	.....	42	68	100	136	170
17	Orange River	.....	.....	.....	76	104	136	173
18	Chapin	.....	.....	64	84	112	144	186
19	Northwestern	.....	33	61	77	117	170	206
20	Derby	28	49	75	110	148	195	248
21	Partridge	26	46	68	102	140	180	236
22	Parsons[b]	21	41	64	100	140	179	231
23	Ropp	.....	.....	.....	69	109	157	211
24	Stillwell	.....	.....	65	96	133	176	225
25	Baughman's rotary saw	17	41	70	105	145	193	244
26	Baughman's band saw	20	41	73	112	156	209	270
27	Saco River[b]	26	49	75	108	147	192	246
28	Ballon	22	40	61	79	117	170	206
29	Wilson	23	46	67	101	144	184	244
30	Wilcox	.....	.....	.....	66	101	144	180
31	Warner	.....	30	40	62	98	128	162
32	Boynton	.....	32	60	90	124	170	216
33	Forty-five	.....	38	61	90	125	168	218
34	White	.....	30	51	79	114	161	214
35	Finch and Apgar	.....	.....	.....	74	112	157	203
36	Constantine	.....	67	105	151	213	268	339
37	Ake	.....	41	65	95	128	167	212
38	Quebec	16	32	59	80	120	160	213
39	British Columbia	.....	.....	55	84	119	160	207
40	New Brunswick	.....	.....	.....	96	130	170	229
41	International	20	45	70	105	150	200	255
42	Champlain	22	43	70	105	146	193	247
43	Clement	18	37	62	94	131	175	226
44	Click	17	35	60	91	129	173	223

[a] Values for 6, 8, and 10 inches are those used by the Santa Clara Lumber Company, New York.

TABLE 1.—**Comparison of Log Rules for Board Measure**—Continued.

SIXTEEN-FOOT LOGS—Continued.

DIAMETER IN INCHES.										
20	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	
BOARD FEET.										
280	334	404	500	582	657	736	800	923	1,068	1
256	324	400	484	576	676	784	900	1,024	1,156	2
256	324	400	484	582	657	736	800	923	1,068	3
302	363	439	507	614	706	795	900	1,026	1,135	4
267	320	384	.....	.....	.....	.....	.....	.....	.....	5
300	369	444	526	609	697	792	892	.....	.....	6
190	229	268	320	372	427	485	548	614	685	7
272	336	416	501	576	656	741	832	933	1,066	8
276	341	412	488	569	656	748	845	950	1,064	9
248	324	392	476	562	632	726	845	920	1,037	10
250	305	366	432	504	582	665	754	848	.....	11
256	305	366	432	504	582	665	754	848	.....	12
300	365	432	507	588	675	768	867	972	.....	13
236	285	341	400	464	533	605	684	768	854	14
230	284	344	411	485	567	655	752	857	963	15
229	285	346	414	487	567	652	744	841	945	16
213	258	308	360	418	480	546	616	692	769	17
233	294	374	465	563	666	777	896	1,027	1,161	18
248	324	392	450	536	632	725	845	920	1,037	19
307	368	438	512	593	680	773	872	977	.....	20
288	350	416	486	564	650	738	834	998	.....	21
300	366	433	506	600	705	.....	.....	.....	.....	22
272	339	413	493	579	672	771	877	989	1,107	23
261	320	385	456	533	588	675	768	.....	.....	24
310	382	457	540	633	722	822	934	1,054	1,142	25
340	417	500	590	686	790	900	1,022	1,182	1,286	26
302	366	436	513	590	674	771	.....	.....	.....	27
280	.....	.....	.....	.....	.....	.....	.....	.....	.....	28
306	374	448	529	616	713	814	922	.....	.....	29
240	313	373	446	513	592	673	754	853	973	30
203	258	316	372	431	490	560	630	.....	.....	31
266	322	384	450	522	.....	.....	.....	.....	.....	32
275	341	415	498	590	691	803	925	1,058	.....	33
290	338	402	492	575	649	728	797	.....	.....	34
258	318	400	474	552	624	733	840	928	1,054	35
416	507	603	708	821	942	1,072	1,210	1,356	1,511	36
261	316	377	441	512	588	669	.....	.....	.....	37
280	347	420	507	580	673	760	867	947	1,040	38
261	320	386	457	535	619	708	804	906	1,015	39
300	362	432	.....	.....	.....	.....	.....	.....	.....	40
320	390	470	555	645	745	850	965	1,085	1,210	41
308	376	450	532	620	714	814	923	1,038	1,159	42
282	345	414	490	571	659	753	854	961	1,074	43
280	343	413	489	571	660	755	857	965	1,079	44

[b] Values read off from a scaler's stick.

TABLE 1.—**Comparison of Log Rules for Board Measure**—Continued.

SIXTEEN-FOOT LOGS—Continued.

	NAME OF RULE.	DIAMETER IN INCHES.			
		40	42	44	46
		BOARD FEET.			
1	Scribner	1,204	1,343	1,480	
2	Doyle	1,296	1,444	1,600	1,764
3	Doyle and Scribner	1,204	1,343	1,480	
4	Holland or Maine	1,261	1,401	1,523	1,701
5	Humphrey or Vermont				
6	Bangor				
7	Cumberland River	759	835	918	1,003
8	Hanna	1,200	1,333	1,477	1,616
9	Spaulding	1,185	1,312	1,448	1,581
10	Favorite	1,160	1,266	1,402	1,546
11	Baxter				
12	Doyle and Baxter				
13	Square of three-fourths				
14	Square of two-thirds	946	1,045	1,146	1,253
15	Herring	1,067	1,176		
16	Dusenberry	1,054	1,170		
17	Orange River	853			
18	Chapin	1,296	1,437	1,577	1,721
19	Northwestern	1,160	1,266	1,402	1,546
20	Derby				
21	Partridge				
22	Parsons				
23	Ropp	1,232	1,363	1,501	1,645
24	Stillwell				
25	Baughman's rotary saw	1,294	1,430	1,577	1,732
26	Baughman's band saw	1,425	1,582	1,745	1,900
27	Saco River				
28	Ballon				
29	Wilson				
30	Wilcox	1,120			
31	Warner				
32	Boynton				
33	Forty-five				
34	White				
35	Finch and Apgar	1,181	1,280	1,410	1,584
36	Constantine	1,671	1,846	2,026	2,215
37	Ake				
38	Quebec	1,173	1,267		
39	British Columbia	1,129	1,249	1,376	1,508
40	New Brunswick				
41	International	1,345	1,490	1,635	1,790
42	Champlain	1,287	1,422	1,564	1,711
43	Clement	1,193	1,319	1,451	1,589
44	Click	1,200	1,327	1,461	1,601

TABLE 1.—**Comparison of Log Rules for Board Measure**—Continued.

SIXTEEN-FOOT LOGS—Continued.

DIAMETER IN INCHES.							
48	**50**	**52**	**54**	**56**	**58**	**60**	
BOARD FEET.							
							1
1,936	2,116	2,304	2,500	2,704	2,916	3,136	2
							3
1,848							4
							5
							6
1,092	1,172	1,281	1,382	1,486	1,594	1,707	7
1,765	1,930						8
1,724	1,872	2,025	2,184	2,350	2,524	2,704	9
1,696							10
							11
							12
							13
1,365	1,481						14
							15
							16
							17
1,865	2,016	2,160	2,313	2,467	2,627	2,791	18
1,696							19
							20
							21
							22
1,795	1,952	2,115	2,285	2,461	2,643	2,832	23
							24
1,884	2,041	2,206	2,396	2,590	2,764	2,898	25
2,089	2,270	2,449	2,636	2,841	3,073	3,265	26
							27
							28
							29
							30
							31
							32
							33
							34
							35
2,425	2,617						36
							37
							38
1,647	1,791	1,942	2,099	2,262	2,431	2,606	39
							40
1,955	2,125	2,300	2,485	2,675	2,870	3,075	41
1,866	2,028	2,196	2,371	2,553	2,741	2,936	42
1,734	1,884	2,042	2,205	2,375	2,550	2,733	43
1,747	1,900	2,059					44

DESCRIPTION OF THE MORE IMPORTANT LOG RULES.

The Scribner Rule.

This is the oldest log scale now in general use. It was originally published in Scribner's Lumber and Log Book, in later editions of which it was replaced by the Doyle Rule. It is now usually called the "Old Scribner Rule," and is used to some extent in nearly every State. The rule was based on computations derived from diagrams drawn to show the number of inch boards that can be sawed from logs of different sizes after allowing for waste. The contents of these boards was then calculated and the table built up in this way. Sometimes the Scribner Rule is converted into what is known as the Scribner Decimal Rule by dropping the units and rounding the values to the nearest tens. Thus 107 board feet would be written 11 in the Decimal Rule; 104 would be written 10. The Hyslop Rule is practically the same as the Scribner Decimal Rule. The Scribner Rule is known in Minnesota as the Minnesota Standard Rule. In the original table no values were given below a diameter of 12 inches.

In the judgment of most sawyers, the Scribner Rule gives very fair results for small logs cut by circular saws (about 8 gage), but that for large logs, about 28 inches, for example, the results are too small. It often happens that defects are greater in large logs than in small ones, because the larger are from older trees, which are more likely to be overmature. Even with these, however, the Scribner Rule is fairly satisfactory if the scaler does not make a further deduction for defects. As a matter of fact, a log rule should make no allowance for defect, because that is unfair to high-grade sound logs; only the scaler should make such allowance. In sound logs the saw cut has been known to overrun the Scribner scale from 10 to 20 per cent.

The Forest Service of the United States Department of Agriculture has adopted the Scribner Decimal Rule for timber sales on the National Forests. It has been in use for about four years and, in the main, has proved satisfactory, since competitive bids enable the buyer to bid higher if the character of the logs indicates a mill overrun.

TABLE 2.—Scribner Log Rule.

[Decimal "C."][a]

Diameter.	LENGTH (FEET).						Diameter.
	6	8	10	12	14	16	
Inches.	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Inches.*
6	0.5	0.5	1	1	1	2	6
7	0.5	1	1	2	2	3	7
8	1	1	2	2	2	3	8
9	1	2	3	3	3	4	9
10	2	3	3	3	4	6	10
11	2	3	4	4	5	7	11
12	3	4	5	6	7	8	12
13	4	5	6	7	8	10	13
14	4	6	7	9	10	11	14
15	5	7	9	11	12	14	15
16	6	8	10	12	14	16	16
17	7	9	12	14	16	18	17
18	8	11	13	16	19	21	18
19	9	12	15	18	21	24	19
20	11	14	17	21	24	28	20
21	12	15	19	23	27	30	21
22	13	17	21	25	29	33	22
23	14	19	23	28	33	38	23
24	15	21	25	30	35	40	24
25	17	23	29	34	40	46	25
26	19	25	31	37	44	50	26
27	21	27	34	41	48	55	27
28	22	29	36	44	51	58	28
29	23	31	38	46	53	61	29
30	25	33	41	49	57	66	30
31	27	36	44	53	62	71	31
32	28	37	46	55	64	74	32
33	29	39	49	59	69	78	33
34	30	40	50	60	70	80	34
35	33	44	55	66	77	88	35

[a] The total scale is obtained by multiplying the figures in this table by 10. Thus the contents of a 6-inch 8-foot log are given as 0.5, so the total scale is 5 board feet. A 30-inch 16-foot log is given as 66, or a total scale of 660 board feet.

TABLE 2.—**Scribner Log Rule**—Continued.

[Decimal "C."]

Diameter.	LENGTH (FEET).						Diameter.
	6	8	10	12	14	16	
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Inches.*
36	35	46	58	69	81	92	36
37	39	51	64	77	90	103	37
38	40	54	67	80	93	107	38
39	42	56	70	84	98	112	39
40	45	60	75	90	105	120	40
41	48	64	79	95	111	127	41
42	50	67	84	101	117	134	42
43	52	70	87	105	122	140	43
44	56	74	93	111	129	148	44
45	57	76	95	114	133	152	45
46	59	79	99	119	139	159	46
47	62	83	104	124	145	166	47
48	65	86	108	130	151	173	48
49	67	90	112	135	157	180	49
50	70	94	117	140	164	187	50
51	73	97	122	146	170	195	51
52	76	101	127	152	177	202	52
53	79	105	132	158	184	210	53
54	82	109	137	164	191	218	54
55	85	113	142	170	198	227	55
56	88	118	147	176	206	235	56
57	91	122	152	183	213	244	57
58	95	126	158	189	221	252	58
59	98	131	163	196	229	261	59
60	101	135	169	203	237	270	60
61	105	140	175	210	245	280	61
62	108	145	181	217	253	289	62
63	112	149	187	224	261	299	63
64	116	154	193	232	270	309	64
65	119	159	199	239	279	319	65
66	123	164	206	247	288	329	66
67	127	170	212	254	297	339	67
68	131	175	219	262	306	350	68

TABLE 2.—Scribner Log Rule—Continued.

[Decimal "C."]

Diameter.	LENGTH (FEET).						Diameter.
	6	8	10	12	14	16	
Inches.	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Inches.*
69	135	180	226	271	316	361	69
70	139	186	232	279	325	372	70
71	144	192	240	287	335	383	71
72	148	197	247	296	345	395	72
73	152	203	254	305	356	406	73
74	157	209	261	314	366	418	74
75	161	215	269	323	377	430	75
76	166	221	277	332	387	443	76
77	171	228	285	341	398	455	77
78	176	234	293	351	410	468	78
79	180	240	301	361	421	481	79
80	185	247	309	371	432	494	80
81	190	254	317	381	444	508	81
82	196	261	326	391	456	521	82
83	201	268	335	401	468	535	83
84	206	275	343	412	481	549	84
85	210	281	351	421	491	561	85
86	215	287	359	431	503	575	86
87	221	295	368	442	516	589	87
88	226	301	377	452	527	603	88
89	231	308	385	462	539	616	89
90	236	315	393	472	551	629	90
91	241	322	402	483	563	644	91
92	246	329	411	493	575	657	92
93	251	335	419	503	587	671	93
94	257	343	428	514	600	685	94
95	262	350	437	525	612	700	95
96	268	357	446	536	625	715	96
97	273	364	455	546	637	728	97
98	278	371	464	557	650	743	98
99	284	379	473	568	663	757	99
100	289	386	482	579	675	772	100
101	295	393	492	590	688	787	101

TABLE 2.—**Scribner Log Rule**—Continued.

[Decimal "C."]

Diameter.	LENGTH (FEET).						Diameter.
	6	8	10	12	14	16	
Inches.	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Bd.ft.*	*Inches.*
102	301	401	502	602	702	803	102
103	307	409	512	614	716	819	103
104	313	417	522	626	730	835	104
105	319	425	532	638	744	851	105
106	325	433	542	650	758	867	106
107	331	442	553	663	773	884	107
108	337	450	563	675	788	900	108
109	344	459	573	688	803	917	109
110	350	467	583	700	817	933	110
111	356	475	594	713	832	951	111
112	362	483	604	725	846	967	112
113	369	492	615	738	861	984	113
114	375	501	626	751	876	1,001	114
115	382	509	637	764	891	1,019	115
116	389	519	648	778	908	1,037	116
117	396	528	660	792	924	1,056	117
118	403	537	672	806	940	1,075	118
119	410	547	683	820	957	1,093	119
120	417	556	695	834	973	1,112	120

NOTE.—The original rule did not extend beyond a diameter of 60 inches. The extension to 120 inches was made by the Forest Service.

The Doyle Rule.

The Doyle Rule is variously known as the Connecticut River Rule, the St. Croix Rule, the Thurber Rule, the Moore and Beeman Rule, and the Scribner Rule—the last name due to the fact that it is now printed in Scribner's Lumber and Log Book. It is used throughout the entire country, and is more widely employed than any other rule. It is constructed by deducting 4 inches from the small diameter of the log as an allowance for slab, squaring one-quarter of the remainder, and multiplying the result by the length of the log in feet.

The important feature of the formula is that the width of slab is always uniform, regardless of the size of the log. This waste allowance is altogether too small for large logs and is excessive for small ones. The principle is mathematically incorrect, for the product of perfect logs of different sizes follows an entirely different mathematical law, and it is, therefore, astonishing that this incorrect rule, which gives wrong results for both large and small logs, should have so general a use.

Where the loss by defects in the timber and waste in milling have accidentally about balanced the inaccuracies of the rule, fairly accurate results have been obtained. Frequently, however, mill men recognize the shortcomings of the rule and make corrections to meet their special requirements. In general, the mill cut overruns the Doyle Rule log scale by about 25 per cent for short logs 12 to 20 inches in diameter; and for long logs with a small top diameter the overrun is very much higher.

TABLE 3.—**Doyle Rule.**

Length in feet.	DIAMETER IN INCHES.								
	6	7	8	9	10	11	12	13	14
	BOARD FEET.								
8.....	2.0	4.5	8	12	18	24	32	40	50
9.....	2.3	5.1	9	14	20	28	36	46	56
10.....	2.5	5.6	10	16	23	31	40	50	62
11.....	2.8	6.2	11	17	25	34	44	55	69
12.....	3.0	6.8	12	19	27	37	48	61	75
13.....	3.3	7.3	13	20	29	40	52	66	81
14.....	3.5	7.9	14	22	32	43	56	71	88
15.....	3.8	8.4	15	23	34	46	60	76	94
16.....	4.0	9.0	16	25	36	49	64	81	100
17.....	4.3	9.6	17	27	38	52	68	86	106
18.....	4.5	10.1	18	28	41	55	72	91	112
19.....	4.8	10.7	19	30	43	58	76	96	119
20.....	5.0	11.3	20	31	46	61	80	101	125
21.....	5.3	11.8	21	33	48	64	84	106	131
22.....	5.5	12.4	22	34	50	67	88	111	137
23.....	5.8	12.9	23	36	52	70	92	116	144
24.....	6.0	13.5	24	37	54	74	96	122	150
25.....	6.3	14.0	25	39	56	77	100	127	156
26.....	6.5	14.6	26	41	59	80	104	132	163
27.....	6.8	15.2	27	42	61	83	108	137	169
28.....	7.0	15.8	28	44	63	86	112	142	175
29.....	7.3	16.3	29	45	65	89	116	147	182
30.....	7.5	16.8	30	47	68	92	120	152	188
31.....	7.8	17.4	31	48	70	95	124	157	193
32.....	8.0	18.0	32	50	72	98	128	162	200
33.....	8.3	18.5	33	52	74	101	132	167	206
34.....	8.5	19.1	34	53	77	104	136	172	212
35.....	8.8	19.7	35	55	79	107	140	177	219
36.....	9.0	20.3	36	56	81	110	144	182	225
37.....	9.3	20.8	37	58	83	113	148	187	231
38.....	9.5	21.4	38	59	85	116	152	192	237
39.....	9.8	21.9	39	61	88	119	156	197	243
40.....	10.0	22.5	40	62	90	122	160	202	250

TABLE 3.—**Doyle Rule**—Continued.

Length in feet.	DIAMETER IN INCHES.							
	15	16	17	18	19	20	21	22
	BOARD FEET.							
8	60	72	84	98	112	128	144	162
9	68	81	95	110	127	144	163	182
10	75	90	106	122	141	160	181	202
11	83	99	116	135	155	176	199	223
12	91	108	127	147	169	192	217	243
13	98	117	137	159	183	208	235	263
14	106	126	148	171	197	224	253	283
15	113	135	158	184	211	240	271	303
16	121	144	169	196	225	256	289	324
17	128	153	180	208	239	272	307	344
18	136	162	190	220	253	288	325	364
19	143	171	201	233	267	304	343	384
20	151	180	211	245	280	320	361	404
21	158	189	222	257	295	336	379	425
22	166	198	232	269	309	352	397	445
23	174	207	243	282	323	368	415	465
24	181	216	253	294	338	384	433	486
25	189	225	264	306	351	400	451	506
26	196	234	275	318	366	416	470	526
27	204	243	285	331	380	432	488	546
28	212	252	296	343	394	448	506	566
29	219	261	306	355	408	464	524	586
30	226	270	317	367	421	480	542	606
31	234	279	327	380	436	496	560	627
32	242	288	338	392	450	512	578	648
33	249	297	349	404	464	528	596	668
34	256	306	359	416	478	544	614	688
35	265	315	370	429	492	560	632	708
36	272	324	380	441	506	576	650	729
37	280	333	391	453	520	592	668	749
38	287	342	401	465	534	608	686	769
39	295	351	412	478	548	624	704	790
40	302	360	422	490	562	640	722	810

TABLE 3.—**Doyle Rule**—Continued.

Length in feet.	DIAMETER IN INCHES.						
	23	24	25	26	27	28	29
	BOARD FEET.						
8	180	200	220	242	264	288	312
9	203	225	248	272	297	324	352
10	226	250	276	302	330	360	391
11	248	275	303	334	363	396	430
12	271	300	331	363	397	432	469
13	293	325	358	393	430	468	508
14	313	350	386	423	463	504	547
15	336	375	413	458	496	540	586
16	359	400	441	484	530	576	625
17	383	425	469	514	563	612	664
18	406	450	496	544	596	648	703
19	429	475	524	575	630	684	742
20	452	500	551	605	661	720	782
21	473	525	579	635	693	756	820
22	496	550	606	665	726	792	860
23	519	575	634	696	760	828	898
24	541	600	661	726	794	864	938
25	562	625	689	756	827	900	977
26	586	650	717	786	860	936	1,016
27	606	675	744	817	893	972	1,055
28	626	700	772	847	926	1,008	1,094
29	649	725	799	877	959	1,044	1,133
30	672	750	827	907	992	1,080	1,172
31	695	775	854	938	1,026	1,116	1,211
32	718	800	882	968	1,060	1,152	1,250
33	742	825	910	998	1,093	1,188	1,289
34	766	850	937	1,028	1,126	1,224	1,328
35	789	875	965	1,059	1,159	1,260	1,367
36	812	900	992	1,089	1,192	1,296	1,406
37	835	925	1,020	1,119	1,223	1,332	1,445
38	857	950	1,047	1,149	1,256	1,368	1,484
39	880	975	1,075	1,180	1,289	1,404	1,523
40	903	1,000	1,102	1,210	1,322	1,440	1,562

TABLE 3.—**Doyle Rule**—Continued.

Length in feet.	DIAMETER IN INCHES.							
	30	31	32	33	34	35	36	37
	BOARD FEET.							
8	338	364	392	420	450	480	512	544
9	380	410	441	473	506	540	576	613
10	422	456	490	526	562	601	640	681
11	465	502	539	578	619	661	704	749
12	507	547	588	631	675	721	768	817
13	549	592	637	683	731	781	832	884
14	591	638	686	736	787	841	896	953
15	633	683	735	789	844	901	960	1,021
16	676	729	784	841	900	961	1,024	1,089
17	718	774	833	894	956	1,021	1,088	1,157
18	761	820	882	946	1,012	1,081	1,152	1,225
19	803	865	931	999	1,069	1,141	1,216	1,293
20	845	912	980	1,051	1,125	1,202	1,280	1,361
21	887	957	1,029	1,104	1,181	1,261	1,344	1,430
22	930	1,004	1,078	1,156	1,237	1,322	1,408	1,497
23	972	1,049	1,127	1,209	1,293	1,381	1,472	1,566
24	1,014	1,094	1,176	1,262	1,350	1,442	1,536	1,634
25	1,056	1,139	1,225	1,314	1,406	1,501	1,600	1,702
26	1,098	1,184	1,274	1,367	1,462	1,562	1,664	1,768
27	1,140	1,230	1,323	1,420	1,518	1,622	1,728	1,838
28	1,182	1,276	1,372	1,472	1,575	1,682	1,792	1,906
29	1,224	1,321	1,421	1,524	1,631	1,742	1,856	1,974
30	1,266	1,366	1,470	1,577	1,687	1,802	1,920	2,042
31	1,309	1,412	1,519	1,629	1,743	1,862	1,984	2,110
32	1,352	1,458	1,568	1,682	1,800	1,922	2,048	2,178
33	1,394	1,503	1,617	1,735	1,856	1,982	2,112	2,246
34	1,436	1,548	1,666	1,787	1,912	2,042	2,176	2,314
35	1,479	1,594	1,715	1,840	1,968	2,102	2,240	2,383
36	1,522	1,640	1,764	1,892	2,025	2,162	2,304	2,450
37	1,563	1,686	1,813	1,945	2,081	2,222	2,368	2,518
38	1,606	1,731	1,862	1,998	2,138	2,282	2,432	2,586
39	1,648	1,778	1,911	2,050	2,194	2,342	2,496	2,654
40	1,690	1,822	1,960	2,102	2,250	2,402	2,560	2,722

TABLE 3.—**Doyle Rule**—Continued.

Length in feet.	DIAMETER IN INCHES.						
	38	39	40	41	42	43	44
	BOARD FEET.						
8	578	612	648	684	722	761	800
9	650	689	729	770	812	856	900
10	723	765	810	856	902	951	1,000
11	795	842	891	941	993	1,046	1,100
12	867	910	972	1,027	1,083	1,141	1,200
13	939	996	1,053	1,112	1,173	1,237	1,300
14	1,011	1,070	1,134	1,198	1,264	1,331	1,400
15	1,083	1,149	1,215	1,284	1,354	1,426	1,500
16	1,156	1,225	1,296	1,369	1,444	1,521	1,600
17	1,228	1,302	1,377	1,455	1,534	1,616	1,700
18	1,300	1,379	1,458	1,540	1,625	1,711	1,800
19	1,372	1,455	1,539	1,626	1,715	1,806	1,900
20	1,446	1,530	1,620	1,711	1,805	1,902	2,000
21	1,518	1,607	1,701	1,797	1,895	1,997	2,100
22	1,590	1,684	1,782	1,882	1,986	2,091	2,200
23	1,662	1,761	1,863	1,968	2,076	2,187	2,300
24	1,734	1,838	1,944	2,053	2,166	2,282	2,400
25	1,806	1,915	2,025	2,139	2,256	2,376	2,500
26	1,878	1,992	2,106	2,225	2,346	2,472	2,600
27	1,950	2,067	2,187	2,310	2,437	2,567	2,700
28	2,022	2,144	2,268	2,396	2,527	2,662	2,800
29	2,095	2,221	2,349	2,481	2,617	2,756	2,900
30	2,166	2,298	2,430	2,567	2,708	2,852	3,000
31	2,239	2,373	2,511	2,652	2,798	2,946	3,100
32	2,312	2,450	2,592	2,738	2,888	3,042	3,200
33	2,386	2,526	2,673	2,824	2,978	3,137	3,300
34	2,456	2,604	2,754	2,909	3,068	3,232	3,400
35	2,529	2,681	2,835	2,995	3,159	3,327	3,500
36	2,601	2,756	2,916	3,080	3,249	3,423	3,600
37	2,673	2,833	2,997	3,166	3,339	3,517	3,700
38	2,745	2,909	3,078	3,251	3,429	3,612	3,800
39	2,818	2,986	3,159	3,337	3,520	3,707	3,900
40	2,890	3,062	3,240	3,423	3,610	3,802	4,000

The Spaulding Rule.

The Spaulding is the statute rule of California, adopted by an act of the legislature in 1878. It is used also in Oregon, Washington, Utah, and Nevada. It was computed from carefully drawn diagrams of logs from 10 to 96 inches in diameter at the small end. Mill men seem to be well satisfied with its results. It is very similar to the Scribner Rule.

The Maine Rule.

The Maine Rule, which is also known as the Holland Rule, the Bangor Rule, and Fabian's Rule, is used only in northern New England, chiefly in Maine, where it has long been the principal log scale. It was prepared from diagrams representing the small ends of logs of all diameters from 6 to 48 inches. The inscribed square of the logs was first determined, and the contents of the logs were then computed by allowing 1 inch for each board and one-fourth of an inch between the boards for saw kerf. The boards outside the square were reckoned, if not less than 6 inches in width; otherwise the whole slab was disregarded. In practice, logs over 32 feet long are reckoned as two logs, the scaler measuring the diameter of the top log at the small end and estimating the top diameter of the lower log.

This rule, like all the rules commonly used, was devised for short logs and not for long ones, to which it is now frequently applied. Mill men very generally agree that the Maine Rule is fairly satisfactory for short logs, and in fact it probably comes nearer to satisfying the present milling requirements, where long logs are exceptional, than any of the other rules in common use.

STANDARD MEASURE.

The unit of standard measure is the merchantable contents of a log of a fixed diameter and length agreed upon as the standard log. The contents of logs of other diameters and lengths are determined by reference to, and in terms of, the standard log. A table of standards is based on the principle that the contents of logs vary directly as their lengths and as the squares of their respective diameters. To obtain the volume of any given log in terms of a specified standard, square the diameter of the log at the small end

and divide by the square of the diameter of the standard; then divide by the length of the standard and multiply by the length of the log.

THE NINETEEN-INCH STANDAND RULE.

One of the standards in most common use is the so-called Nineteen-inch Standard, or "market," of which the unit is a log 13 feet long and 19 inches in diameter at the small end inside the bark. Expressed algebraically, the formula for determining the contents of a given log by the nineteen-inch Standard Rule is:

$$V=\frac{D^2}{19^2}\times\frac{L}{13}$$

in which V represents the volume in standards, D the diameter inside the bark at the small end, and L the length of the log.

This log rule is most commonly used in the Adirondack Mountains of New York. It is particularly popular in measuring pulp wood, because the rule is based on volume and not on board measure.

Standard measure is commonly, though incorrectly, translated into board measure by multiplying the volume of a given log in standards by a constant. In the case of the Nineteen-inch Standard Rule it is assumed that one standard is equivalent to 200 board feet, and the number of standards in a lot of logs, multiplied by 200, gives the approximate board contents.

THE NEW HAMPSHIRE (BLODGETT) RULE.

Although usually not recognized as a standard log rule, the Blodgett Rule, which has been adopted as the statute rule of New Hampshire, is nothing more nor less than a standard rule based on the same principles as that of the Adirondack "market." The Blodgett standard assumes as a unit a log 1 foot long and 16 inches in diameter. The contents in so-called cubic feet (more correctly, standards) of a log of any dimensions is found by the following formula:

$$V=\frac{D^2}{16^2}\times L$$

in which V is the volume in standards or "Blodgett cubic feet," D the diameter in inches, and L the length of the log in feet.

Just as in the case of the Adirondack standard, lumber men are accustomed to convert the Blodgett Rule into board measure. The statute requires that the ratio of the Blodgett standard to the thousand feet shall be as 100 is to 1,000, or 10 board feet in every cubic foot. In practice, however, the lumber men consider that there are 115 Blodgett feet in 1,000 board feet when the diameter measurement is taken at the middle of the log and 106 Blodgett feet per 1,000 board feet when the measurement is taken at the small end of the log. These figures are fair averages for small logs only, and in practice are suitable for converting the scale of a large lot of small logs lumped together from one measure to the other. It is not, however, fair to construct a log table for board measure by dividing the values in the Blodgett Rule by the constants 106 or 115. Factors that are good for small logs give too low results for large ones; and this is the case with the New Hampshire Rule.

OTHER STANDARD RULES.

Another standard rule is the so-called Cube Rule of the Ohio River. This is based on the hypothesis that a log 18 inches in diameter is the smallest one from which a 12-inch square piece can be cut. To use local phraseology, an 18-inch log will cube once, meaning that for each linear foot there will be 1 cube. To estimate the contents of a log, square the diameter in inches, multiply by the length in feet, and then divide by the square of 18. Algebraically:

$$V=\frac{D^2}{18^2}\times L$$

Ordinarily 12 board feet are allowed for 1 cube. This rule is known also as the Big Sandy Cube Rule.

The Twenty-two Inch Standard Rule, sometimes called the Saranac River Standard Rule, is still used to some extent in New York State and probably elsewhere. The unit is a log 12 feet long and 22 inches in diameter at the small end inside the bark. The rule is used in the same way as the Nineteen-inch Standard Rule, and a table may be constructed on the same principle. The 22-inch standard log contains 252 board feet (Scribner Rule). Common usage gives four standards to the thousand board feet.

The Twenty-four Inch Standard Rule is based on a standard 12 feet long. The standard log contains 300 feet, board measure, usually sold by the standard or by the 300 feet, instead of by the thousand feet, as commonly; the logs are scaled by the Doyle Rule and the total number of feet divided by 300, the unit of sale being a certain sum per standard. To obtain the value of the odd number of feet, the latter are divided by 300 and multiplied by the price per standard.

The Canadian standard rules are based on logs 12 feet instead of 13 feet long, and 21 and 22 inches in diameter. These rules are used in the same way as the American standard rules.

LOG SCALING.

The methods of scaling logs differ with the various log rules and with such local conditions as the character of timber, the market, and the habit of the individual scalers.

In regions where the logs are cut into short lengths and piled on skidways for winter hauling, as in the Adirondacks, the scaling is ordinarily done by two men constituting the scaling crew. They are provided with a rule or "scale stick" for measuring the diameters of the logs, a notebook, tally sheets or a "scale paddle" for recording the measurements, a special marking hammer, and crayons for marking the logs. One scaler measures the diameters of the logs inside the bark at the small end; the other records the results. The small diameter is recorded because the log tables are based on this and the length of the log. It is not necessary, however, to measure separately the length of each log, because there are usually only a few standard lengths, as, for example, 10, 12, 13, 14, and 16 feet, and these the scaler can tell at a glance. If a log is slightly longer than the regular lengths, the extra length is disregarded. For example, a log 16.5 feet long is scaled as a 16-foot log, and if 18 feet is the next fixed length, a log 17.5 feet long is scaled as a 16-foot log. Therefore, though a log may be slightly longer than the specified length, it is never shorter; thus, if a log is shorter than the length of the shortest specification (ordinarily 8 or 10 feet) it is discarded entirely. A great deal of this sort of waste is caused by the choppers who are careless in their measurements of log lengths.

In measuring the diameters of logs, they are rounded to whole inches. Thus, if a diameter is nearer 7 than 6 inches, the log is tallied as 7 inches. If the diameter is exactly between whole inches, as, for example, 9.5 inches, the scaler usually tallies it under the lower inch class—in this case, 9. Sometimes scalers endeavor to place about half of such logs into the inch class below and half into the class above. Very conservative scalers record all diameters falling between whole inches in the lower inch class, even if it is within one-tenth of an inch of the next class above—for example, 6.9 inches would be called 6 inches.

When logs are evidently not round, the rule is usually placed at a point on the cross section where the diameter is about an average between the largest and smallest dimensions. Some scalers always take the smallest diameters; this precaution is necessary in measuring veneer logs, for rotary cut.

The field records are commonly taken on special forms prepared by the company owning or buying the logs. Often the scalers use a blank book or wooden scale paddle in the woods, and then transfer the figures to regular forms at the camp.

There are two methods of recording the measurements. The most common way is to tally the logs by diameter and length, and then afterwards compute the volume in the office. The other way is to record, on the ground, the board contents of each log as shown by the scale stick.

When a log has been scaled, the end is chalked to prevent its being measured a second time. Logs which are to be discarded receive a special mark. At this time or later the logs are stamped with the special marking hammer of the purchaser of the logs. It is customary in many places to blaze a tree near each skidway, and mark the number of the skidway and number of logs tallied. Thus $\frac{23}{460}$ would mean that there are 460 logs on skidway number 23.

This description of scaling applies to the northern regions where logs are cut short and where roads are used for hauling. The principles of scaling are practically the same in other regions where short logs are cut.

When the logs are loaded on cars in the woods, the scaling is generally done on the cars after loading. Where logs are to be driven, they may be scaled on the bank before rolling into the river,

or, where slides are used, at the side of the slide before they are started.

Naturally, the accuracy of scalers varies tremendously. Some guess at the dimensions of many of the logs without measuring them, and even estimate the total run of a pile without bothering to measure any of the logs in it.

In Maine and also in some parts of New Hampshire, spruce is cut in long logs; that is, the entire merchantable part of the tree is taken out in one log. The scaling is sometimes done as the logs are hauled to the skidways or yards, and sometimes at the landing if they are to be driven. If the Maine Log Rule is used, the scaler's outfit consists of the ordinary Maine scale stick, a measuring pole or tape, a marking hammer, chalk, and a notebook. The small end and the length of the log are measured, and the results in board feet are read directly from the stick and recorded on special tally blanks or in a notebook.

The Maine Rule gives figures for lengths only up to 30 feet, so that if a log is longer than that, it must be scaled as two logs. In the latter case only the diameter at the small end is ordinarily measured, while the diameter at the middle is merely estimated. Thus, if a log is 36 feet long, the small diameter 7 inches, and the diameter at the center estimated at 9 inches, the contents of two 18-foot logs, respectively 9 and 7 inches in diameter, are read from the stick as the contents of the whole log. The scaler guesses at the middle diameter of the log after measuring the top. The increase in size from top to center (called the "rise") may be estimated very accurately by experienced scalers. Sometimes a scale stick is used which gives the contents of whole logs over 28 feet long, constructed on the principle that logs from 28 to 32 feet long have a rise from tip to center of 1 inch, those from 32 to 36 feet long a rise of 2 inches, those from 36 to 40 feet long a rise of 3 inches. The rise of logs over 40 feet long is left to the scaler's judgment.

Deductions for crooks and other defects are made according to the judgment of the scaler. There are no rules, and the discounting is entirely a matter of experience. In common practice it is the prevailing custom to reduce the total scale of a lot of logs by a certain percentage determined upon as a factor of safety, particu-

larly where the quality of logs is extremely poor. For example, the disease of cypress called "peckiness" is so difficult to discover from external signs that a general reduction for safety is necessary.

The growth of the pulp industry in Maine has introduced a new factor in the scaling of spruce. Inasmuch as the whole log is used in making pulp, a solid measure is more appropriate than board measure. For this reason many operators use the Blodgett Rule. This requires the measurement of the middle diameter of the log instead of the end diameter. The measurement is taken with calipers. The length of the log is measured and the middle point located by a wheel. The diameter is taken outside the bark, the calipers being constructed to allow for an average bark width. The contents of the log are read directly from the beam of the caliper. A deduction for defects is made, as with the Maine Rule.

In scaling long logs by the Doyle Rule the diameter is measured at the middle or the two ends are averaged. Better results are obtained if long logs are measured in short lengths and the diameters taken at the points where the cuts would be made.

The scaling of long logs on the end diameter by the present log rules, making no allowance for the increase in size, or "rise," is one of the greatest evils of these board-foot rules. For example, an average 36-foot spruce log with a top diameter of 12 inches will scale 178 board feet by the Scribner Rule. This same log, if rise were allowed for or if cut into three 12-foot logs with diameters of probably 12, 14, and 16 inches, would scale 59+86+119 board feet, or a total of 264 board feet—an increase over the scale of the single log of 86 board feet, or almost 50 per cent. This same log, if scaled entire by the Doyle-Scribner Rule, would give 144 board feet. Scaled as three 12-foot logs it would scale 48+75+108, or 231 board feet, an increase of 87 board feet, or over 60 per cent. When it is remembered that the saw cut overruns the scale in sound logs, the unjust result of scaling long logs without allowing for "rise" or swell is further accentuated. Long logs with small top diameters of course fare worst in this respect. A mill test on 184 30-foot sound longleaf pine logs, from 6 to $11\frac{3}{4}$ inches in diameter outside the bark at the small end, conducted under strict court supervision in a case in Texas, showed a mill run with a band saw of 65 per cent in the 11-inch logs, and as high as

450 per cent in 6-inch logs over the Doyle Rule, and of 26 per cent in 11-inch logs to 175 per cent in 6-inch logs over the Scribner Rule. These logs were scaled by the smallest diameter outside the bark at the small end. If the inside-bark diameter had been used the discrepancies would have been still greater.

These facts prove that the seller of timber needs to specify in his contract that long logs shall be scaled as two or more short logs, with the proper increase in diameter allowed. On pages 39–43 are given the scaling regulations adopted by the Forest Service.

If all the logs on a skidway were sound and straight the operation of scaling would be largely mechanical and would not require much skill. But many logs are cut and piled which may be partly rotten, or crooked, or seamy. Such logs must be entirely discarded or reductions must be made for imperfections when the contents are calculated. Skill is required in deciding what logs should be thrown out. The obviously rotten logs are not piled on the skidway at all. The contractors include many which are doubtful and which they think may be accepted by the purchaser. The final decision rests with the scalers. There are many logs having center rot or rot only on one side, seamy, shaky, and crooked logs, which contain enough good lumber to pay for the hauling, but can not be given a scale equivalent to straight sound logs of equal dimensions. When such a log is measured a deduction is made to compensate for the loss through the imperfection. If the scaler is recording only the diameters and lengths of the logs, discount for defects in a specified log is usually made by reducing the measured diameter sufficiently to cover the loss. Sometimes, chiefly in the South, the allowance for defect is made by reducing the log's length. If the contents of the logs are reduced in the woods the discount in board feet is made when the log is measured. The experienced scaler who has worked at a sawmill is able to estimate the loss through certain imperfections merely by looking at the log. It requires skill and experience to recognize defects and to know how much they affect the quality of the timber. It also requires good judgment to determine how much the dimensions of a defective log should be reduced to scale what can actually be manufactured from it. The best scalers have this experience and judgment.

FOREST SERVICE SCALING DIRECTIONS.

Unless timber is sold on the basis of an estimate, it must be scaled, counted, or measured before it is removed from the cutting area, or from the place agreed upon for the scaling, counting, or measuring.

All saw timber will be scaled by the Scribner "Decimal C" log rule. This rule drops the units and gives the contents of a log to the nearest ten. When the total scale of a log is desired, all that is necessary is to add one cipher to the sum of the numbers read from the scale stick, excepting the contents of 6 and 8 foot logs, 6 and 7 inches in diameter. These are given as 0.5, which multiplied by 10 gives 5 feet as the actual contents.

In the absence of a scale stick, or where the position of logs in the pile makes its use difficult, the diameters and lengths may be tallied and the contents figured from a scale table later.

Purchasers should be required to skid logs for scaling if the cost of scaling will be materially decreased by these requirements and if the cost of logging will not be greatly increased.

The Forest officer should always insist on having one end of piles or skidways even, so that ends of logs may be easily reached.

When necessary and possible, the purchaser will be required to mark top ends of logs to avoid question when they are scaled in the pile.

Each log scaled must be numbered with crayon. The number will be the same as that opposite which the scale of the log is recorded in the scale book.

The logs in all skidways must be counted and the number in each checked with the entries in the scale book.

Each merchantable log after scaling will be stamped "U. S." on at least one end. Logs so defective as to be unmerchantable will not be stamped, but will be marked "cull."

On all National Forests except those in Alaska and on the west slope of the Cascade Mountains in Washington and Oregon logs over 16 feet long will be scaled as two or more logs, if possible in lengths not less than 12 feet.

The following table shows how the lengths will be divided when scaling logs 18 to 60 feet long. The number of inches to be added

to the diameter at the small end of each log, to cover taper, is placed under each length.

For example, a 42-foot log 16 inches in diameter at the top would be scaled as—

One 12-foot log with a diameter of 16 inches.
One 14-foot log with a diameter of 17 inches.
One 16-foot log with a diameter of 19 inches.

TABLE 4.—**Allowances for Taper, Intended Only as a Guide toward Determining the Actual Taper.**

Total length.	Log lengths.				Total length.	Log lengths.			
Feet.	Butt log.	Second log.	Third log.	Top log.	Feet.	Butt log.	Second log.	Third log.	Top log.
18	10′	.....	.....	8′	40	16′	12′	.....	12′
Increase	1″	.....	.....	0″	Increase	3″	1″	.....	0″
20	10′	.....	.....	10′	42	16′	14′	.....	12′
Increase	1″	.....	.....	0″	Increase	3″	1″	.....	0″
22	12′	.....	.....	10′	44	16′	16′	.....	12′
Increase	1″	.....	.....	0″	Increase	3″	1″	.....	0″
24	14′	.....	.....	10′	46	16′	16′	.....	14′
Increase	1″	.....	.....	0″	Increase	4″	2″	.....	0″
26	14′	.....	.....	12′	48	16′	16′	.....	16′
Increase	1″	.....	.....	0″	Increase	4″	2″	.....	0″
28	14′	.....	.....	14′	50	14′	12′	12′	12′
Increase	2″	.....	.....	0″	Increase	4″	3″	1″	0″
30	16′	.....	.....	14′	52	16′	12′	12′	12′
Increase	2″	.....	.....	0″	Increase	4″	3″	1″	0″
32	16′	.....	.....	16′	54	16′	14′	12′	12′
Increase	2″	.....	.....	0″	Increase	5″	3″	1″	0″
34	12′	12′	.....	10′	56	16′	16′	12′	12′
Increase	3″	1″	.....	0″	Increase	5″	3″	1″	0″
36	12′	12′	.....	12′	58	16′	16′	14′	12′
Increase	3″	1″	.....	0″	Increase	5″	3″	2″	0″
38	14′	12′	.....	12′	60	16′	16′	14′	14′
Increase	3″	1″	.....	0″	Increase	5″	3″	2″	0″

This table is intended to be used simply as a guide. The allowances for taper should be varied to conform to the actual taper.

On the National Forests in Alaska and on the west slope of the Cascade Mountains in Washington and Oregon logs up to and including 32 feet long will be scaled as one log; lengths from 34 feet to 64 feet, inclusive, will be scaled as two logs, dividing them at the center as near as may be in even feet, for example: A 34-foot

log will be scaled as a 16-foot and an 18-foot top log. The diameter of the short or butt log may be determined by taking the average of the top and butt diameters of the whole length, or by calipering a 36-foot log will be scaled as two 18-foot logs. This does not apply to lengths including butt cuts. The taper for such lengths can be judged by the scaler. Greater lengths than 64 feet will be scaled as three logs, making the divisions as nearly equal as possible and in even feet, and increasing the diameters according to the taper of the log.

When the logs are scaled as two or more logs, the scale allowed for the separate lengths will be added and the total sum recorded as one log.

While no hard-and-fast rules can be given or followed, certain general principles may be laid down. They must, however, be used with judgment by the scaler and varied wherever the conditions demand. Among the points which must be considered are the size and shape of the logs, the quality as affected by various kinds of defects, the size and location of defect, and the requirements and limitations of markets.

It is assumed that purchasers utilize the maximum amount of material in manufacture. Since the Government can not be held responsible for loss caused by poor equipment or poor management, the scaler will not take them into consideration.

Loss of this character may be caused by too thick slabbing, cutting material too thick or too wide at the main saw; poorly "sized" lumber; excessive "crowding" by the sawyer; poorly kept saws which "run;" waste in edging and trimming through ignorance or carelessness; sawing for a certain class of material regardless of the quantity of waste this involves.

It is important that measurement of lengths be made frequently enough to be sure that logs do not exceed the allowance for trimming specified in the contract.

It usually is sufficient to measure about one log in five or ten for this purpose, but if the scaler finds frequent violations he will measure every log, and all logs overrunning the trimming allowance will be scaled as if 2 feet longer, or 1 foot longer where the contract provides for odd lengths. Penalty scaling will be noted in the scale book against the number of the log so scaled to avoid possible controversy.

Frequent measuring is especially important on small scales where a Forest officer is not always present, because sawyers are more apt to be lax in measuring than when an officer is daily checking lengths.

Logs will be scaled in odd lengths if provided for in the contract.

All diameters will be measured inside the bark at the top end of the log. If logs are not round, scalers will average the greatest diameter inside the bark at the top end of the log, with the diameter at right angles to this. The necessary reduction in diameter will be made for swelling at the scaling end of a log when no lumber can be produced from it.

Diameters will be rounded off to the nearest inch above or below the actual diameter.

Any portion of a log which contains a fault which prevents its manufacture into merchantable lumber is cull, and will not be scaled and charged to the purchaser.

The following defects are most common:

Uniform center or circular rot, circular shake, pin dots, ground or stump rot, cat-face, dote at side of log extending to the bark, burns or defect caused by lightning extending along side of log, defect caused by lightning extending along the log in spiral form, punky or soft sap, deep checks or seams, dote appearing in knots, curve or sweep, crooks, crotches, and blue sap.

In general, a log containing sufficient sound material to saw out a quantity of lumber equal to one-third of its contents as given by the scale rule is termed "merchantable."

The term "sound material" is here used to signify such material as will produce lumber grading not below No. 3 common, or the lowest grade commonly merchantable. Supervisors will, wherever advisable, furnish scalers with specifications of No. 3 common lumber, or the lowest grade commonly merchantable, from the grading rules of the recognized lumber associations in the vicinity of their forests. These may, if advisable, be confined or altered to meet the local demands. The scaler is not expected to be a grader, but the grading rules will assist him in determining where to draw the line between merchantable and unmerchantable timber.

Ties may be sold by the piece or they may be actually scaled, or they may be counted and the number multiplied by the average contents. The following contents may be used:

Eight-foot ties, standard face, 33⅓ board feet each, may be used, or 30 ties to the thousand; 8-foot ties, second class, and 6-foot ties, standard face, 25 board feet each, or 40 ties to the thousand.

Shake and single-bolt material will be measured by the cord or by the thousand feet board measure, in accordance with the local custom. As a rule, a cord of shingle bolts may be considered equal to 700 feet board measure.

Lagging may be measured by the cord or linear foot, or by the piece, or, where split lagging is used, by the board feet, each cubic foot counting as 12 board feet.

Poles, posts, piles, converter poles, telephone poles, and stulls may be scaled, sold by the linear foot, or sold by the piece, as circumstances warrant.

When scaled, each stick of timbers, ties, posts, poles, or piles must be stamped on at least one end. Cordwood must be stamped at both top and bottom of each pile and at least twelve pieces in each cord must be stamped.

In large sales, a record of the scale of each log must be kept on file in the office of the supervisor in the book in which it was originally entered. It will be open to inspection by the purchaser at all times, but only in the presence of the supervisor or an officer from the district office.

CUBIC MEASURE.

The use of the cubic foot as a unit of volume in this country has so far been chiefly confined to the measurement of square timber and precious woods and to scientific work in forestry. The cubic foot is the logical and most convenient unit for the measurement of logs which are wholly used or in which the waste is exceedingly small, as, for example, pulp wood, veneer, excelsior, etc. It is obvious that in such cases a unit of measure should be adopted, which will show the full contents of the log. It is unreasonable to measure pulp wood in terms of manufactured lumber. The recent action of the Committee on the Measurement of Logs in Maine that advocated the cubic foot for the measurement of all logs indicates that practical men appreciate the inappropriateness of the old methods of measurement.

A cubic unit, either the cubic foot or cubic meter, ultimately will be in common use for the commercial measurement of timber. This will come about with the increase of the value of timber. When the whole log, including slabs, can be used, the owner can not afford to sell his logs purely on a basis of an estimated product in manufactured boards. If logs are bought according to their solid contents, though they may not cost more, yet the buyer will feel that he pays for the material he wastes and therefore will be more eager to utilize it.

There are a number of methods of determining the solid contents of logs in cubic feet. The two methods in most common use for commercial work are given in this book. Other methods, designed for scientific work, are discussed at length in treatises on forest mensuration.

METHOD OF CUBING LOGS BY THE MEASUREMENT OF THE LENGTH AND OF THE MIDDLE DIAMETERS.

To cube logs, one method requires the measurement of the average diameter of the log at its middle point and the length. The volume of the log is obtained by multiplying the area of the circle corresponding to the middle diameter of the log by the length. Expressed algebraically:

$$V = B_{\frac{1}{2}} \times L,$$

in which V is the volume of the log in cubic feet, $B_{\frac{1}{2}}$ the area of the middle cross section in square feet, and L the length in feet.

EXAMPLE: Suppose a log to have a middle diameter of 15 inches and a length of 30 feet. One finds in a table of areas of circles (giving the diameter in inches and the area in square feet) the area corresponding to 15 inches, namely, 1.227; then $V = 1.227 \times 30 = 36.8$ cubic feet.

This method is very simple, because it requires only two measurements of the log—the diameter at the middle and the length. Tables showing the areas of circles in these units are readily accessible, and also tables showing the cubic contents of logs of different middle diameters and lengths, so that there is no computation necessary. (See table 5.)

METHOD OF CUBING LOGS BY THE MEASUREMENT OF THE LENGTH AND END DIAMETERS.

By this method the diameters of the two ends of the log and its length are measured. The volume is obtained by multiplying the average of the areas of circles that correspond to the end diameters by the length. Expressed as a formula.

$$V=\frac{B+b}{2}L,$$

in which V is the volume of the log in cubic feet, B and b are the areas in square feet that correspond to the diameters of the two ends, and L is the length in feet.

EXAMPLE: A log is 12 feet long and the diameters at the ends are 16 and 18 inches. The areas that correspond to the end diameters are found in a table of circular areas, and used in the formula, as follows:

$$V=\frac{1.396+1.767}{2}\times 12=18.97 \text{ cubic feet.}$$

This method requires one more measurement than the previous and is therefore not as rapid for ordinary work in commercial scaling. It is, however, a very convenient formula for determining the contents of logs where it is not possible to take the measurement at the middle, as on logs piled on a skidway.

TABLE 5.—**Solid Cubic Contents of Logs.**

Length in feet.	AVERAGE DIAMETER IN INCHES.							
	3	4	5	6	7	8	9	10
	CONTENTS IN CUBIC FEET.							
4	0.20	0.35	0.55	0.79	1.07	1.40	1.77	2.18
5	.25	.44	.68	.98	1.34	1.75	2.21	2.73
6	.29	.52	.82	1.18	1.60	2.09	2.65	3.27
7	.34	.61	.95	1.37	1.87	2.44	3.09	3.82
8	.39	.70	1.09	1.57	2.14	2.79	3.53	4.36
9	.44	.79	1.23	1.77	2.41	3.14	3.98	4.91
10	.49	.87	1.36	1.96	2.67	3.49	4.42	5.45
11	.54	.96	1.50	2.16	2.94	3.84	4.86	6.00
12	.59	1.05	1.64	2.36	3.21	4.19	5.30	6.55
13	.64	1.13	1.77	2.55	3.47	4.54	5.74	7.09
14	.69	1.22	1.91	2.75	3.74	4.89	6.19	7.64
15	.74	1.31	2.05	2.95	4.01	5.24	6.63	8.18
16	.79	1.40	2.18	3.14	4.28	5.59	7.07	8.73
17	.83	1.48	2.32	3.34	4.54	5.93	7.51	9.27
18	.88	1.57	2.45	3.53	4.81	6.28	7.95	9.82
19	.93	1.66	2.59	3.73	5.08	6.63	8.39	10.36
20	.98	1.75	2.73	3.93	5.35	6.98	8.84	10.91
21	1.03	1.83	2.86	4.12	5.61	7.33	9.28	11.45
22	1.08	1.92	3.00	4.32	5.88	7.68	9.72	12.00
23	1.13	2.01	3.14	4.52	6.15	8.03	10.16	12.54
24	1.18	2.09	3.27	4.71	6.41	8.38	10.60	13.09
25	1.23	2.18	3.41	4.91	6.68	8.73	11.04	13.64
26	.....	.....	.....	5.11	6.95	9.08	11.49	14.18
27	.....	.....	.....	5.30	7.22	9.42	11.93	14.73
28	.....	.....	.....	5.50	7.48	9.77	12.37	15.27
29	.....	.....	.....	5.69	7.75	10.12	12.81	15.82
30	.....	.....	.....	5.89	8.02	10.47	13.25	16.36
31	.....	.....	.....	6.09	8.28	10.82	13.70	16.91
32	.....	.....	.....	6.28	8.55	11.17	14.14	17.45
33	.....	.....	.....	6.48	8.82	11.52	14.58	18.00
34	.....	.....	.....	6.68	9.09	11.87	15.02	18.54
35	.....	.....	.....	6.87	9.35	12.22	15.46	19.09
36	.....	.....	.....	7.07	9.62	12.57	15.90	19.64
37	.....	.....	.....	7.26	9.89	12.92	16.35	20.18
38	.....	.....	.....	7.46	10.16	13.26	16.79	20.73
39	.....	.....	.....	7.66	10.42	13.61	17.23	21.27
40	.....	.....	.....	7.85	10.69	13.96	17.67	21.82
41	.....	.....	.....	8.05	10.96	14.31	18.11	22.36
42	.....	.....	.....	8.25	11.22	14.66	18.56	22.91

TABLE 5.—**Solid Cubic Contents of Logs**—Continued.

Length in feet.	AVERAGE DIAMETER IN INCHES.							
	11	12	13	14	15	16	17	18
	CONTENTS IN CUBIC FEET.							
4	2.64	3.14	3.69	4.28	4.91	5.59	6.31	7.07
5	3.30	3.93	4.61	5.35	6.14	6.98	7.88	8.84
6	3.96	4.71	5.53	6.41	7.36	8.38	9.46	10.60
7	4.62	5.50	6.45	7.48	8.59	9.77	11.03	12.37
8	5.28	6.28	7.37	8.55	9.82	11.17	12.61	14.14
9	5.94	7.07	8.30	9.62	11.04	12.57	14.19	15.90
10	6.60	7.85	9.22	10.69	12.27	13.96	15.76	17.67
11	7.26	8.64	10.14	11.76	13.50	15.36	17.34	19.44
12	7.92	9.42	11.06	12.83	14.73	16.76	18.92	21.21
13	8.58	10.21	11.98	13.90	15.95	18.15	20.49	22.97
14	9.24	11.00	12.90	14.97	17.18	19.55	22.07	24.74
15	9.90	11.78	13.83	16.04	18.41	20.94	23.64	26.51
16	10.56	12.57	14.75	17.10	19.63	22.34	25.22	28.27
17	11.22	13.35	15.67	18.17	20.86	23.74	26.80	30.04
18	11.88	14.14	16.59	19.24	22.09	25.13	28.37	31.81
19	12.54	14.92	17.51	20.31	23.32	26.53	29.95	33.58
20	13.20	15.71	18.44	21.38	24.54	27.93	31.53	35.34
21	13.86	16.49	19.36	22.45	25.77	29.32	33.10	37.11
22	14.52	17.28	20.28	23.52	27.00	30.72	34.68	38.88
23	15.18	18.06	21.20	24.59	28.23	32.11	36.25	40.64
24	15.84	18.85	22.12	25.66	29.45	33.51	37.83	42.41
25	16.50	19.64	23.04	26.73	30.68	34.91	39.41	44.18
26	17.16	20.42	23.97	27.79	31.91	36.30	40.98	45.95
27	17.82	21.21	24.89	28.86	33.13	37.70	42.56	47.71
28	18.48	21.99	25.81	29.93	34.36	39.10	44.14	49.48
29	19.14	22.78	26.73	31.00	35.59	40.49	45.71	51.25
30	19.80	23.56	27.65	32.07	36.82	41.89	47.29	53.01
31	20.46	24.35	28.57	33.14	38.04	43.28	48.86	54.78
32	21.12	25.13	29.50	34.21	39.27	44.68	50.44	56.55
33	21.78	25.92	30.42	35.28	40.50	46.08	52.02	58.32
34	22.44	26.70	31.34	36.35	41.72	47.47	53.59	60.08
35	23.10	27.49	32.26	37.42	42.95	48.87	55.17	61.85
36	23.76	28.27	33.18	38.48	44.18	50.27	56.75	63.62
37	24.42	29.06	34.10	39.55	45.41	51.66	58.32	65.38
38	25.08	29.85	35.03	40.62	46.63	53.06	59.90	67.15
39	25.74	30.63	35.95	41.69	47.86	54.45	61.47	68.92
40	26.40	31.42	36.87	42.76	49.09	55.85	63.05	70.69
41	27.06	32.20	37.79	43.83	50.31	57.25	64.63	72.45
42	27.72	32.99	38.71	44.90	51.54	58.64	66.20	74.22

TABLE 5.—**Solid Cubic Contents of Logs**—Continued.

Length in feet.	AVERAGE DIAMETER IN INCHES.							
	19	20	21	22	23	24	25	26
	CONTENTS IN CUBIC FEET.							
4	7.88	8.73	9.62	10.56	11.54	12.57	13.64	14.75
5	9.84	10.91	12.03	13.20	14.43	15.71	17.04	18.44
6	11.81	13.09	14.43	15.84	17.31	18.85	20.45	22.12
7	13.78	15.27	16.84	18.48	20.20	21.99	23.86	25.81
8	15.75	17.45	19.24	21.12	23.08	25.13	27.27	29.50
9	17.72	19.63	21.65	23.76	25.97	28.27	30.68	33.18
10	19.69	21.82	24.05	26.40	28.85	31.42	34.09	36.87
11	21.66	24.00	26.46	29.04	31.74	34.56	37.50	40.56
12	23.63	26.18	28.86	31.68	34.62	37.70	40.91	44.24
13	25.60	28.36	31.27	34.32	37.51	40.84	44.31	47.93
14	27.57	30.54	33.67	36.96	40.39	43.98	47.72	51.62
15	29.53	32.72	36.08	39.60	43.28	47.12	51.13	55.31
16	31.50	34.91	38.48	42.24	46.16	50.27	54.54	58.99
17	33.47	37.09	40.89	44.88	49.05	53.41	57.95	62.68
18	35.44	39.27	43.30	47.52	51.93	56.55	61.36	66.37
19	37.41	41.45	45.70	50.16	54.82	59.69	64.77	70.05
20	39.38	43.63	48.11	52.80	57.71	62.83	68.18	73.74
21	41.35	45.82	50.51	55.44	60.59	65.97	71.59	77.43
22	43.32	48.00	52.92	58.08	63.48	69.11	74.99	81.11
23	45.29	50.18	55.32	60.72	66.36	72.26	78.40	84.80
24	47.25	52.36	57.73	63.36	69.25	75.40	81.81	88.49
25	49.22	54.54	60.13	66.00	72.13	78.54	85.22	92.18
26	51.19	56.72	62.54	68.64	75.02	81.68	88.63	95.86
27	53.16	58.90	64.94	71.27	77.90	84.82	91.04	99.55
28	55.13	61.09	67.35	73.91	80.79	87.96	95.45	103.24
29	57.10	63.27	69.75	76.55	83.67	91.11	98.86	106.92
30	59.07	65.45	72.16	79.19	86.56	94.25	102.27	110.61
31	61.04	67.63	74.56	81.83	89.44	97.39	105.67	114.30
32	63.01	69.81	76.97	84.47	92.33	100.53	109.08	117.98
33	64.98	71.99	79.37	87.11	95.21	103.67	112.49	121.67
34	66.94	74.18	81.78	89.75	98.10	106.81	115.90	125.36
35	68.91	76.36	84.18	92.39	100.98	109.96	119.31	129.05
36	70.88	78.54	86.59	95.03	103.87	113.10	122.72	132.73
37	72.85	80.72	89.00	97.67	106.75	116.24	126.13	136.42
38	74.82	82.90	91.40	100.31	109.64	119.38	129.54	140.11
39	76.79	85.03	93.81	102.95	112.52	122.52	132.94	143.79
40	78.76	87.27	96.21	105.59	115.41	125.66	136.35	147.48
41	80.73	89.45	98.62	108.23	118.30	128.81	139.76	151.17
42	82.70	91.63	101.02	110.87	121.18	131.95	143.17	154.85

TABLE 5.—**Solid Cubic Contents of Logs**—Continued.

Length in feet.	AVERAGE DIAMETER IN INCHES.							
	27	28	29	30	31	32	33	34
	CONTENTS IN CUBIC FEET.							
4	15.90	17.10	18.35	19.63	20.97	22.34	23.76	25.22
5	19.88	21.38	22.93	24.54	26.21	27.93	29.70	31.53
6	23.86	25.66	27.52	29.45	31.45	33.51	35.64	37.83
7	27.83	29.93	32.11	34.36	36.69	39.10	41.58	44.14
8	31.81	34.21	36.70	39.27	41.93	44.68	47.52	50.44
9	35.78	38.48	41.28	44.18	47.17	50.27	53.46	56.75
10	39.76	42.76	45.87	49.09	52.41	55.85	59.40	63.05
11	43.74	47.04	50.46	54.00	57.66	61.44	65.34	69.36
12	47.71	51.31	55.04	58.90	62.90	67.02	71.27	75.66
13	51.69	55.59	59.63	63.81	68.14	72.61	77.21	81.97
14	55.67	59.86	64.22	68.72	73.38	78.19	83.15	88.27
15	59.64	64.14	68.80	73.63	73.62	83.78	89.09	94.58
16	63.62	68.42	73.39	78.54	83.86	89.36	95.03	100.88
17	67.59	72.69	77.98	83.45	89.10	94.95	100.97	107.18
18	71.57	76.97	82.56	88.36	94.35	100.53	106.91	113.49
19	75.55	81.24	87.15	93.27	99.59	106.12	112.85	119.80
20	79.52	85.52	91.74	98.17	104.83	111.70	118.79	126.10
21	83.50	89.80	96.33	103.08	110.07	117.29	124.73	132.41
22	87.47	94.07	100.91	107.99	115.31	122.87	130.67	138.71
23	91.45	98.35	105.50	112.90	120.55	128.46	136.61	145.02
24	95.43	102.63	110.09	117.81	125.79	134.04	142.55	151.32
25	99.40	106.90	114.67	122.72	131.04	139.63	148.49	157.63
26	103.38	111.18	119.26	127.63	136.28	145.21	154.43	163.93
27	107.35	115.45	123.85	132.54	141.52	150.80	160.37	170.24
28	111.33	119.73	128.43	137.44	146.76	156.38	166.31	176.54
29	115.31	124.01	133.02	142.35	152.00	161.97	172.25	182.85
30	119.28	128.28	137.61	147.26	157.24	167.55	178.19	189.15
31	123.26	132.56	142.20	152.17	162.48	173.14	184.13	195.45
32	127.23	136.83	146.78	157.08	167.73	178.72	190.07	201.76
33	131.21	141.11	151.37	161.99	172.97	184.31	196.01	208.06
34	135.19	145.39	155.96	166.90	178.21	189.89	201.95	214.37
35	139.16	149.66	160.54	171.81	183.45	195.48	207.88	220.68
36	143.14	153.94	165.13	176.71	188.69	201.06	213.82	226.98
37	147.11	158.21	169.72	181.62	193.93	206.65	219.76	233.28
38	151.09	162.49	174.30	186.53	199.17	212.23	225.70	239.59
39	155.07	166.77	178.89	191.44	204.42	217.82	231.64	245.89
40	159.04	171.04	183.48	196.35	209.66	223.40	237.58	252.20
41	163.02	175.32	188.06	201.26	214.90	228.99	243.52	258.50
42	167.00	179.59	192.65	206.17	220.14	234.57	249.46	264.81

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TABLE 5.—**Solid Cubic Contents of Logs**—Continued.

Length in feet.	AVERAGE DIAMETER IN INCHES.						
	35	36	37	38	39	40	41
	CONTENTS IN CUBIC FEET.						
4	26.73	28.27	29.9	31.5	33.2	34.9	36.7
5	33.41	35.34	37.3	39.4	41.5	43.6	45.8
6	40.09	42.41	44.8	47.3	49.8	52.4	55.0
7	46.77	49.48	52.3	55.1	58.1	61.1	64.2
8	53.45	56.55	59.7	63.0	66.4	69.8	73.3
9	60.13	63.62	67.2	70.9	74.7	78.5	82.5
10	66.81	70.69	74.7	78.8	83.0	87.3	91.7
11	73.49	77.75	82.1	86.6	91.3	96.0	100.9
12	80.18	84.82	89.6	94.5	99.5	104.7	110.0
13	86.86	91.89	97.1	102.4	107.8	113.4	119.2
14	93.54	98.96	104.5	110.3	116.1	122.2	128.4
15	100.22	106.03	112.0	118.1	124.4	130.9	137.5
16	106.90	113.10	119.5	126.0	132.7	139.6	146.7
17	113.58	120.17	126.9	133.9	141.0	148.4	155.9
18	120.26	127.23	134.4	141.8	149.3	157.1	165.0
19	126.95	134.30	141.9	149.6	157.6	165.8	174.2
20	133.63	141.37	149.3	157.5	165.9	174.5	183.4
21	140.31	148.44	156.8	165.4	174.2	183.3	192.5
22	146.99	155.51	164.3	173.3	182.5	192.0	201.7
23	153.67	162.58	171.7	181.1	190.8	200.7	210.9
24	160.35	169.65	179.2	189.0	199.1	209.4	220.0
25	167.03	176.71	186.7	196.9	207.4	218.2	229.2
26	173.71	183.78	194.1	204.8	215.7	226.9	238.4
27	180.40	190.85	201.6	212.6	224.0	235.6	247.5
28	187.08	197.92	209.1	220.5	232.3	244.3	256.7
29	193.76	204.99	216.5	228.4	240.6	253.1	265.9
30	200.44	212.06	224.0	236.3	248.9	261.8	275.1
31	207.12	219.13	231.5	244.1	257.2	270.5	284.2
32	213.80	226.19	238.9	252.0	265.5	279.3	293.4
33	220.48	233.26	246.4	259.9	273.8	288.0	302.6
34	227.17	240.33	253.9	267.8	282.1	296.7	311.7
35	233.85	247.40	261.3	275.7	290.4	305.4	320.9
36	240.53	254.47	268.8	283.5	298.6	314.2	330.1
37	247.21	261.54	276.3	291.4	306.9	322.9	339.2
38	253.89	268.61	283.7	299.3	315.2	331.6	348.4
39	260.57	275.67	291.2	307.2	323.5	340.3	357.6
40	267.25	282.74	298.7	315.0	331.8	349.1	366.7
41	273.93	289.81	306.1	322.9	340.1	357.8	375.9
42	280.62	296.88	313.6	330.8	348.4	366.5	385.1

TABLE 5.—**Solid Cubic Contents of Logs**—Continued.

Length in feet.	AVERAGE DIAMETER IN INCHES.						
	42	43	44	45	46	47	48
	CONTENTS IN CUBIC FEET.						
4	38.5	40.3	42.2	44.2	46.2	48.2	50.3
5	48.1	50.4	52.8	55.2	57.7	60.2	62.8
6	57.7	60.5	63.4	66.3	69.2	72.3	75.4
7	67.3	70.6	73.9	77.3	80.8	84.3	88.0
8	77.0	80.7	84.5	88.4	92.3	96.4	100.5
9	86.6	90.8	95.0	99.4	103.9	108.4	113.1
10	96.2	100.8	105.6	110.4	115.4	120.5	125.7
11	105.8	110.9	116.2	121.5	127.0	132.5	138.2
12	115.5	121.0	126.7	132.5	138.5	144.6	150.8
13	125.1	131.1	137.3	143.6	150.0	156.6	163.4
14	134.7	141.2	147.8	154.6	161.6	168.7	175.9
15	144.3	151.3	158.4	165.7	173.1	180.7	188.5
16	153.9	161.4	168.9	176.7	184.7	192.8	201.1
17	163.6	171.4	179.5	187.8	196.2	204.8	213.6
18	173.2	181.5	190.1	198.8	207.7	216.9	226.2
19	182.8	191.6	200.6	209.8	219.3	228.9	238.8
20	192.4	201.7	211.2	220.9	230.8	241.0	251.3
21	202.0	211.8	221.7	231.9	242.4	253.0	263.9
22	211.7	221.9	232.3	243.0	253.9	265.1	276.5
23	221.3	231.9	242.9	254.0	265.4	277.1	289.0
24	230.9	242.0	253.4	265.1	277.0	289.2	301.6
25	240.5	252.1	264.0	276.1	288.5	301.2	314.2
26	250.1	262.2	274.5	287.2	300.1	313.3	326.7
27	259.8	272.3	285.1	298.2	311.6	325.3	339.3
28	269.4	282.4	295.7	309.3	323.1	337.3	351.9
29	279.0	292.5	306.2	320.3	334.7	349.4	364.4
30	288.6	302.5	316.8	331.3	346.2	361.4	377.0
31	298.3	312.6	327.3	342.4	357.8	373.5	389.6
32	307.9	322.7	337.9	353.4	369.3	385.5	402.1
33	317.5	332.8	348.5	364.5	380.9	397.6	414.7
34	327.1	342.9	359.0	375.5	392.4	409.6	427.3
35	336.7	353.0	369.6	386.6	403.9	421.7	439.8
36	346.4	363.0	380.1	397.6	415.5	433.7	452.4
37	356.0	373.1	390.7	408.7	427.0	445.8	465.0
38	365.6	383.2	401.2	419.7	438.6	457.8	477.5
39	375.2	393.3	411.8	430.7	450.1	469.9	490.1
40	384.8	403.4	422.4	441.8	461.6	481.9	502.7
41	394.5	413.5	432.9	452.8	473.2	494.0	515.2
42	404.1	423.6	443.5	463.9	484.7	506.0	527.8

CONVERTING CUBIC MEASURE TO BOARD MEASURE.

In selling logs by the cubic foot the preceding table would take the place of the log rule, taking the middle log diameter as the average. For convenience, this table could be put on a caliper rule.

The pulp manufacturer would of course ascertain how much pulp he could get from a hundred cubic feet of logs, the shingle manufacturer how many shingles, the veneer manufacturer how many square feet of veneer, and the lumberman how many feet board measure, and the price would be fixed accordingly.

Each manufacturer must finally find for his own mill a converting factor if close calculation is desired, because such items as the width of saw, the product, and the methods of the sawyer will vary the output in different mills. An approximate factor may be found, however, for the same general class of material and product. In the case of lumber (1-inch boards) this factor varies with the diameter of the logs. From mill studies conducted by the Forest Service the averages for a number of mills have been determined. The factors of course apply only to straight, sound logs, since the deduction for defect is made by the scaler in the cubic-foot scale. Hardwoods run a little lower for the larger diameters.

TABLE 6.—**Relation between Solid Contents of 12-foot Logs in Cubic Feet and Saw Cut in 1-inch Boards.**

Middle diameter of log inside bark.	Solid contents.	Actual saw cut in mill tests.[a]			Board feet saw cut per cubic foot of log contents.		
		Band saw,[b] $\frac{1}{8}$-inch kerf, squared on saw.	Band saw,[c] $\frac{3}{16}$-inch kerf, sawed alive.	Gang saw,[d] $\frac{5}{32}$-inch kerf.	Band saw, $\frac{1}{8}$-inch kerf, squared on saw.	Band saw, $\frac{3}{16}$-inch kerf, sawed alive.	Gang saw, $\frac{5}{32}$-inch kerf.
Inch.	*Cu. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*
6	2.4	17	10	16	7.1	4.2	6.6
8	4.2	33	23	30	7.9	5.5	7.1
10	6.5	52	41	47	8.0	6.3	7.2
12	9.4	75	63	66	8.0	6.7	7.0
14	12.8	101	90	89	7.9	7.0	7.0
16	16.8	133	120	117	7.9	7.1	7.0
18	21.2	170	157	150	8.0	7.4	7.1
20	26.2	213	198	192	8.1	7.6	7.3
22	31.7	262	242	241	8.3	7.6	7.6
24	37.7	315	290	.....	8.4	7.7	.....

[a] Saw test for Forest Service in Maine, 1902, by H. D. Tiemann.
[b] Based on 167 logs, largely hemlock, some spruce and pine.
[c] Based on 224 logs, largely spruce, some pine.
[d] Based on 56 logs, largely hemlock, some spruce.

CUBIC CONTENTS OF SQUARE TIMBER IN ROUND LOGS.

The most common methods of determining the cubic contents of square timber that may be cut from round logs is the so-called Two-thirds Rule, and the Inscribed Square Rule.

The Two=thirds Rule.

In the Two-thirds Rule the diameter of the log is taken at its middle point, or the diameters of the two ends of the log are averaged. The diameter of the log is reduced one-third to allow for slab and the remaining two-thirds is taken as the width of the square piece which may be hewed or sawed out of the log. The cubic contents of the squared log are then obtained by squaring this width and multiplying by the length of the log.

This rule gives smaller results than the Inscribed Square Rule, which shows the contents of a square piece that may be exactly inscribed in a cylinder of the same diameter as the log. In support of the Two-thirds Rule it is claimed that there is a certain amount of waste, due to the fact that logs are seldom perfectly round and straight, and that the rule makes approximately the correct allowance for such irregularities.

The Two-thirds Rule is sometimes called the Big Sandy Cube Rule.

The Inscribed Square Rule.

The Inscribed Square Rule gives the cubic contents of square pieces which can be exactly inscribed in cylinders of different sizes. The width of this square piece is usually obtained by multiplying the diameter of the cylinder by 17 and dividing the result by 24, or by multiplying the diameter by 0.7071. This rule of thumb for calculating the width of the inscribed square piece is based on the fact that one side of the square inscribed in a circle 24 inches in diameter is 17 inches long.

The exact mathematical rule for determining the side of a square inscribed in a circle is to square the diameter, divide by 2, and extract the square root. The table following was computed by this method.

Practically the same results are obtained by the Seventeen-inch Rule, which is based on the fact that a 17-inch log will square 12 inches. According to the Seventeen-inch Rule the cubic contents of a log are obtained as follows: Multiply the square of the diameter of the log by its length and divide by the square of 17.

TABLE 7.—Square Timber Cut from Round Logs.

INSCRIBED SQUARE RULE.

Length in feet.	AVERAGE DIAMETER IN INCHES.								
	6	7	8	9	10	11	12	13	14
	CONTENTS IN CUBIC FEET.								
10....	1.3	1.7	2.2	2.8	3.5	4.2	5.0	5.9	6.8
12....	1.5	2.0	2.7	3.4	4.2	5.0	6.0	7.0	8.2
14....	1.8	2.4	3.1	3.9	4.9	5.9	7.0	8.2	9.5
16....	2.0	2.7	3.6	4.5	5.6	6.7	8.0	9.4	10.9
18....	2.3	3.0	4.0	5.1	6.2	7.6	9.0	10.5	12.3
20....	2.5	3.4	4.4	5.6	7.0	8.4	10.0	11.7	13.6
22....	2.8	3.7	4.9	6.2	7.6	9.2	11.0	12.9	15.0
24....	3.0	4.0	5.3	6.7	8.3	10.1	12.0	14.1	16.3
26....	3.3	4.4	5.8	7.3	9.0	11.0	13.0	15.3	17.7
28....	3.5	4.7	6.2	7.9	9.7	11.8	14.0	16.4	19.1
30....	3.8	5.0	6.7	8.4	10.4	12.6	15.0	17.6	20.4
32....	4.0	5.4	7.1	9.0	11.1	13.4	16.0	18.8	21.8
34....	4.3	5.7	7.5	9.6	11.8	14.3	17.0	19.9	23.2
36....	4.5	6.0	8.0	10.1	12.5	15.1	18.0	20.9	24.5
38....	4.8	6.4	8.4	10.7	13.2	16.0	19.0	22.3	25.9
40....	5.0	6.7	8.9	11.2	13.9	16.8	20.0	23.4	27.2
42....	5.3	7.1	9.3	11.8	14.6	17.6	21.0	24.6	28.6
44....	5.5	7.4	9.8	12.4	15.3	18.5	22.0	25.8	30.0
46....	5.8	7.7	10.2	12.9	16.0	19.3	23.0	27.0	31.3
48....	6.0	8.1	10.7	13.5	16.6	20.2	24.0	28.1	32.7
50....	6.3	8.4	11.1	14.1	17.4	21.0	25.0	29.3	34.1
52....	6.5	8.7	11.5	14.6	18.0	21.8	26.0	30.5	35.4
54....	6.8	9.1	12.0	15.2	18.7	22.7	27.0	31.6	36.8
56....	7.0	9.4	12.4	15.7	19.4	23.5	28.0	32.8	38.1
58....	7.3	9.7	12.9	16.3	20.1	24.4	29.0	34.1	39.5
60....	7.5	10.1	13.3	16.9	20.8	25.2	30.0	35.2	40.9
62....	7.8	10.4	13.8	17.4	21.5	26.0	31.0	36.3	42.2
64....	8.0	10.8	14.2	18.0	22.2	26.9	32.0	37.5	43.6
66....	8.3	11.1	14.7	18.5	22.9	27.7	33.0	38.7	44.9
68....	8.5	11.4	15.1	19.1	23.6	28.6	34.0	39.9	46.3
70....	8.8	11.8	15.5	19.7	24.3	29.4	35.0	41.0	47.7
72....	9.0	12.1	16.0	20.2	25.0	30.2	36.0	42.2	49.0
74....	9.3	12.4	16.4	20.8	25.7	31.1	37.0	43.4	50.4
76....	9.5	12.8	16.9	21.4	26.4	31.9	38.0	44.5	51.8

TABLE 7.—**Square Timber Cut from Round Logs**—Continued.

INSCRIBED SQUARE RULE—Continued.

Length in feet.	AVERAGE DIAMETER IN INCHES.							
	15	16	17	18	19	20	21	22
	CONTENTS IN CUBIC FEET.							
10	7.3	8.9	10.0	11.3	12.5	13.9	15.3	16.8
12	8.8	10.7	12.0	13.5	15.0	16.7	18.4	20.1
14	10.2	12.4	14.1	15.8	17.5	19.4	21.4	23.5
16	11.7	14.2	16.1	18.0	20.0	22.2	24.5	26.9
18	13.2	16.0	18.1	20.3	22.3	25.0	27.6	30.2
20	14.6	17.8	20.1	22.5	25.1	27.8	30.6	33.6
22	16.1	19.5	22.1	24.8	27.6	30.1	33.7	37.0
24	17.5	21.3	24.1	27.0	30.1	33.3	36.7	40.3
26	19.0	23.1	26.1	29.3	32.6	36.1	39.8	43.7
28	20.5	24.9	28.1	31.5	35.1	38.9	42.9	47.0
30	22.0	26.6	30.1	33.8	37.6	41.7	45.9	50.4
32	23.4	28.4	32.1	36.0	40.1	44.4	49.0	53.8
34	24.9	30.2	34.1	38.3	42.6	47.2	52.1	57.1
36	26.3	32.0	36.1	40.2	45.1	50.0	55.1	60.5
38	27.8	33.7	38.2	42.8	47.6	52.8	58.2	63.8
40	29.2	35.6	40.2	45.0	50.1	55.6	61.2	67.2
42	30.7	37.3	42.2	47.3	52.6	58.3	64.3	70.6
44	32.2	39.1	44.2	49.5	55.1	61.1	67.4	73.9
46	33.6	40.8	46.2	51.8	57.6	63.9	70.4	77.3
48	35.1	42.6	48.2	54.0	60.1	66.7	73.5	80.6
50	36.6	44.4	50.2	56.3	62.7	69.5	76.6	84.0
52	38.0	46.2	52.2	58.5	65.2	72.2	79.6	87.4
54	39.5	48.0	54.2	60.8	67.7	75.0	82.7	90.7
56	41.0	49.7	56.2	63.0	70.2	77.8	85.7	94.1
58	42.4	51.5	58.2	65.3	72.7	80.6	88.8	97.4
60	43.9	53.3	60.2	67.5	75.2	83.3	91.9	100.8
62	45.3	55.1	62.3	69.8	77.7	86.1	94.9	104.2
64	46.8	56.8	64.3	72.0	80.2	89.9	98.0	107.5
66	48.2	58.6	66.3	74.3	82.7	91.7	101.0	110.9
68	49.7	60.4	68.3	76.5	85.2	94.5	104.1	114.2
70	51.2	62.2	70.3	78.8	87.7	97.2	107.2	117.6
72	52.6	63.9	72.3	81.0	90.2	100.0	110.2	121.0
74	54.1	65.7	74.3	83.3	92.7	102.8	113.3	124.3
76	55.6	67.5	76.3	85.5	95.2	105.6	116.4	127.7

TABLE 7.—**Square Timber Cut from Round Logs**—Continued.

INSCRIBED SQUARE RULE—Continued.

Length in feet.	AVERAGE DIAMETER IN INCHES.						
	23	24	25	26	27	28	29
	CONTENTS IN CUBIC FEET.						
10....	18.4	20.0	21.7	23.5	25.3	27.2	29.2
12....	22.0	24.0	26.0	28.2	30.4	32.7	35.1
14....	25.7	28.0	30.4	32.9	35.4	38.1	40.9
16....	29.4	32.0	34.7	37.6	40.5	43.5	48.7
18....	33.1	36.0	39.0	42.3	45.6	49.0	52.6
20....	36.7	40.0	43.4	47.0	50.6	54.4	58.4
22....	40.4	44.0	47.7	51.7	55.7	59.9	64.3
24....	44.1	48.0	52.1	56.4	60.7	65.3	70.1
26....	47.8	52.0	56.4	61.1	65.8	70.7	75.9
28....	51.4	56.0	60.7	65.8	70.9	76.2	81.8
30....	55.1	60.0	65.1	70.5	75.9	81.6	87.6
32....	58.8	64.0	69.4	75.2	81.0	87.1	93.5
34....	62.5	68.0	73.7	79.9	86.1	92.5	99.3
36....	66.1	72.0	78.1	84.6	91.1	98.0	105.2
38....	69.8	76.0	82.4	89.3	96.2	103.4	111.0
40....	73.5	80.0	86.8	94.0	101.2	108.8	116.8
42....	77.2	84.0	91.1	98.7	106.3	114.3	122.7
44....	80.8	88.0	95.4	103.4	111.4	119.7	128.5
46....	84.5	92.0	99.8	108.1	116.4	125.2	134.4
48....	88.2	96.0	104.1	112.8	121.5	130.6	140.2
50....	91.9	100.0	108.5	117.5	126.6	136.1	146.1
52....	95.5	104.0	112.8	122.1	131.6	141.5	151.9
54....	99.2	108.0	117.1	126.8	136.7	146.9	157.7
56....	102.9	112.0	121.5	131.5	141.7	152.4	163.6
58....	106.5	116.0	125.8	136.2	146.8	157.8	169.4
60....	110.2	120.0	130.1	140.9	151.9	163.3	175.3
62....	113.8	124.0	134.5	145.6	156.9	168.7	181.1
64....	117.6	128.0	138.8	150.3	162.0	174.1	186.9
66....	121.2	132.0	143.2	155.0	167.0	179.6	192.8
68....	124.9	136.0	147.5	159.7	172.1	185.0	198.6
70....	128.6	140.0	151.8	164.4	177.2	190.5	204.5
72....	132.3	144.0	156.2	169.1	182.2	195.9	210.3
74....	135.9	148.0	160.5	173.8	187.3	201.4	216.2
76....	139.6	152.0	164.8	178.5	192.4	206.8	222.0

TABLE 7.—**Square Timber Cut from Round Logs**—Continued.

INSCRIBED SQUARE RULE—Continued.

Length in feet.	AVERAGE DIAMETER IN INCHES.						
	30	31	32	33	34	35	36
	CONTENTS IN CUBIC FEET.						
10....	31.8	33.4	35.5	37.8	40.1	42.5	45.0
12....	38.1	40.0	42.6	45.4	48.2	51.0	54.0
14....	44.5	46.7	49.8	52.9	56.2	59.6	63.0
16....	50.8	53.4	56.9	60.5	64.2	68.1	72.0
18....	57.2	60.0	64.0	68.1	72.2	76.6	81.0
20....	63.5	66.7	71.1	75.6	80.3	85.1	90.0
22....	69.9	73.4	78.2	83.2	88.3	93.6	99.0
24....	76.2	80.1	85.3	90.8	96.3	102.1	108.0
26....	82.6	86.7	92.4	98.3	104.3	110.6	117.0
28....	88.9	93.4	99.5	105.9	112.4	119.1	126.0
30....	95.3	100.0	106.6	113.5	120.4	127.6	135.0
32....	101.6	106.8	113.7	121.0	128.4	136.1	144.0
34....	108.0	113.4	120.8	128.6	136.4	144.6	153.0
36....	114.3	120.1	127.9	136.2	144.5	153.1	162.0
38....	120.7	126.7	135.1	143.7	152.5	161.7	171.0
40....	127.0	133.4	142.2	151.3	160.5	170.2	180.0
42....	133.4	140.1	149.3	158.8	168.5	178.7	189.0
44....	139.7	146.8	156.4	166.4	176.6	187.2	198.0
46....	146.1	153.5	163.5	174.0	184.6	195.7	207.0
48....	152.4	160.1	170.6	181.5	192.6	204.2	216.0
50....	158.8	166.8	177.7	189.1	200.7	212.7	225.0
52....	165.1	173.5	184.8	196.7	208.7	221.2	234.0
54....	171.2	180.1	191.9	204.2	216.7	229.7	243.0
56....	177.8	186.8	199.0	211.8	224.7	238.2	252.0
58....	184.2	193.5	206.1	219.4	232.8	246.7	261.0
60....	190.5	200.2	213.2	226.9	240.8	255.2	270.0
62....	196.9	206.8	220.3	234.5	248.8	263.7	279.0
64....	203.2	213.5	227.5	242.0	256.8	272.3	288.0
66....	209.6	220.2	234.6	249.6	264.9	280.8	297.0
68....	215.9	226.8	241.7	257.2	272.9	289.3	306.0
70....	222.3	233.5	248.8	264.7	280.9	297.8	315.0
72....	228.6	240.2	255.9	272.3	288.9	306.3	324.0
74....	235.0	246.9	263.0	279.9	297.0	314.8	333.0
76....	241.3	253.5	270.1	287.4	305.0	323.3	342.0

CORD MEASURE.

Firewood, small pulp wood, and material cut into short sticks for excelsior, etc., is usually measured by the cord. A cord is 128 cubic feet of stacked wood. The wood is usually cut into 4-foot lengths, in which case a cord is a stack 4 feet high and wide, and 8 feet long. Sometimes, however, pulp wood is cut 5 feet long, and a stack of it 4 feet high 5 feet wide and 8 feet long is considered 1 cord. In this case the cord contains 160 cubic feet of stacked wood. Where firewood is cut in 5-foot lengths a cord is a stack 4 feet high and $6\frac{1}{2}$ feet long, and contains 130 cubic feet of stacked wood. Where it is desirable to use shorter lengths for special purposes, the sticks are often cut $1\frac{1}{2}$, 2, or 3 feet long. A stack of such wood, 4 feet high and 8 feet long, is considered 1 cord, but the price is always made to conform to the shortness of the measure.

A cord foot is one-eighth of a cord and is equivalent to a stack of 4-foot wood 4 feet high and 1 foot wide. Farmers frequently speak of a foot of cord wood, meaning a cord foot. By the expression "surface foot" is meant the number of square feet measured on the side of a stack.

In some localities, particularly in New England, cord wood is measured by means of calipers. Instead of stacking the wood and computing the cords in the ordinary way, the average diameter of each log is determined with calipers and the number of cords obtained by consulting a table which gives the amount of wood in logs of different diameters and lengths.

TIMBER ESTIMATING.[a]

The purpose of estimating standing timber is to determine the quantity of specific products which can be cut from a definite area, and the estimate usually is made to furnish a basis for purchase or sale. The buyer expects to be able to cut the estimated amount of timber from the tract under the conditions existing at the time

[a] The authors are indebted to Prof. H. H. Chapman, of the Yale Forest School, for assistance in revising this chapter.

of purchase, and the seller wishes to obtain an adequate return for his material. In case of an ordinary lumbering operation where all merchantable material is taken, the quantity of wood products actually cut, as indicated by the log scale, or by measurement on the ground of the logs produced, gives a comparison by which the accuracy of an estimate of standing timber may be judged.

The first products of the forest are: Logs intended for lumber, poles, ties, or posts, and cord wood. With few exceptions the timber is converted into the product which has the greatest stumpage value or readiest sale, and it should be estimated in terms of this product—usually saw logs.

The contents of logs are measured by log rules. No two of the many log rules now in use give equal volumes for logs of identical dimensions, and the extreme variation in the scale of a given lot of logs by different rules may be greater than 20 per cent. And even by the same rule, logs may be scaled closely or very loosely; liberal allowance may be made for defects or practically no allowance at all, according to the training of the scaler or the closeness of utilization.

The closeness with which the timber is utilized will vary in a given stand. As stumpage values increase, the aim will always be to secure more timber by cutting to smaller diameter, by lower stumps, and by utilizing up to a smaller diameter at the top. Species which were at first considered unmerchantable and later become valuable must be estimated. Improved transportation facilities and the introduction of better logging machinery encourage the removal of poorer classes of logs formerly unprofitable. For these reasons estimates have to be revised to correspond with advance in values, and old estimates, even if they were correct when made, are usually too small for present market conditions.

Since there are so many and so various factors influencing the standard of measurement, it is seldom possible to make an estimate of timber which will come closer than within 10 per cent of the actual quantity standing on the ground. Yet an estimate must always be based on the present market conditions, except when the owner plans to hold his timber for an expected improvement in values, and therefore requires an estimate which will include species and sizes not now merchantable.

CONTENTS OF STANDING TREES.

Estimate by the Eye.

Persons who have constant practice in measuring logs and trees are able to estimate the contents of standing trees by a mere superficial inspection. Skilled timber cruisers attain an astonishing degree of accuracy in such estimates, but this estimating of the contents of trees at a glance is possible only to one with special training. The inexperienced cruiser or one who is estimating an unfamiliar species must calculate the contents of standing trees from measured or estimated diameters and by the use of a log rule. It is necessary first to determine the lengths of the logs; then the diameter inside the bark at the top of each log. The scale of each log is obtained from a log rule and the results for the different logs added together for the total scale of the tree. This method involves the ability to estimate diameters at different points up the tree and involves also a knowledge of the thickness of the bark, which varies at different points.

An often-used method is to estimate the length of the merchantable portion of the tree, then estimate its top and base diameters, average these diameters, and determine the contents by the Doyle Rule. If the length of the merchantable portion of a tree is 40 feet, the top diameter 6 inches, and the base diameter 14 inches, the average diameter would be assumed to be 10 inches, and the volume of the log would be, by the Doyle Rule, 90 board feet.

A number of rules of thumb are in existence for estimating the number of board feet in standing trees. The following is a good illustration:

Subtract 60 from the square of the estimated diameter at the middle of the merchantable length of the tree, multiply by 0.8, and the result is the contents in board feet of the average log in the tree; multiply by the number of 16-foot logs for the total scale.

For example, if the estimated merchantable length is 50 feet and the estimated middle diameter is 10 inches, there would be a subtraction of the arbitrary 60 from 100, the square of the diameter, with a remainder of 40. This multiplied by 0.8 gives 32 feet for the average log, and for the three 16-foot logs in the 50 feet of merchantable length gives 96 board feet as the total contents.

Volume Tables.[a]

Volume tables show the average contents of standing trees of different sizes; they are used extensively in estimating timber. They may be made for any desired unit—the cubic foot, board foot, standard, cord—or they may show the contents of trees in ties, poles, shingles, or other product. They are used to estimate the yield of wood and timber standing on specified tracts. Volume tables are intended only for estimating a large number of trees. Compiled from the average of a number of measurements, they are necessarily inaccurate as applied to a single tree. The volumes of individual trees of the same species and same dimensions may vary 20 per cent or more. On the other hand, the average volume of a large number of trees of the same species, having the same height and diameter and growing under the same conditions, is very uniform, and tables showing the average volumes of a large number of felled trees give satisfactory results in estimating the contents of a large number of standing trees.

VOLUME TABLES BY DIAMETER ONLY.

The simplest volume tables show the average contents of trees of different diameters. The total contents of trees of any given diameter are computed by multiplying the number of trees by the average volume given in the volume table for that diameter.

The tables are based on the measurement and computation of volume of a large number of felled trees. The contents of all trees of each diameter are then averaged. Thus an average is obtained of the contents of all 10-inch trees, of all 11-inch trees, and so on up. These averages are grouped together in the form of a table; the value of such a table is proportionate to the number of trees measured to form its basis.

Volume tables by diameters alone are very limited in their application, because trees upon different tracts and on different portions of the same tract vary greatly in height and consequently in volume for the same diameters. Such tables can not be depended on unless it is known that the average height of the

[a] All volume tables are given in the Appendix.

timber to be estimated is the same as that of the trees from which the table was constructed. Frequently the average heights of the trees used in constructing the table are not given, and in this case the table is comparatively worthless. If, for example, the tables were based largely on tall trees, they would not be used where the trees are short. This objection is largely obviated by making local tables for restricted areas on which the general conditions for growth are fairly uniform.

Volume tables for trees grouped by diameters alone are designed primarily for commercial estimating in board measure.

VOLUME TABLES BY DIAMETER AND STANDARD LOG LENGTH.

A further grouping of the trees is necessary for very close determination of volume, because in tables grouped by diameter alone all trees are averaged by diameters regardless of height or length of merchantable timber. Thus one-log trees are averaged with three-log trees, or even five-log trees, of the same diameter. In order to secure greater accuracy, volume tables based on trees grouped by diameters and number of logs were devised. Such tables are in actual use by cruisers in tall timber where a standard log length—for example, 16 feet—may be used in the estimate of the number of logs.

To construct a volume table for trees grouped by diameters and number of logs, a large number of felled trees are measured and their volumes computed. The trees having the same number of logs are then grouped together, and the average volumes of trees of different diameters are determined for one-log, two-log, and three or four log trees. If the volumes do not increase regularly with increase of diameters, the irregularities are evened off by graphic interpolation, in which the actual values are set down on cross-section paper and a curve is plotted to give the average value at each diameter.

The figures are tabulated in a form similar to this:

Volume Table by Diameters and Number of Logs.

LENGTH OF STANDARD LOG, ——— FEET.

[Based on the measurement of ——— trees.]

Diameter breast-high.	One-log trees.	One and one-half log trees.	Two-log trees.	Two and one-half log trees.
Inches.	*Board feet.*	*Board feet.*	*Board feet.*	*Board feet.*

The great objection to this method is that trees are not always cut into logs of the same length. Only seldom, even with very tall trees, are all logs of equal length. A tall white pine may, for example, yield three 16-foot logs and one 12-foot log. If the volume tables are based on 16-foot logs, an inaccurate estimate would result if this were classed as a four-log tree, though this objection is largely obviated by the inclusion of half logs.

VOLUME TABLES BY DIAMETER AND TREE CLASSES.

Tables for trees of different diameters and classes are designed for use in very irregular forests where the trees have grown under varying conditions of density and form of the stand. Such tables are useful particularly in estimating cord wood in second growth hardwood forests. Volume tables based on diameter alone are not accurate for cord-wood work, while those which give separately the volume of the trees with large crowns, those with medium crowns, and with small, give very good results.

VOLUME TABLES BY DIAMETER AND HEIGHT.

The most accurate volume tables are usually considered to be those calculated according to diameters and heights. The European volume tables are based on this principle and are used with satisfactory results, even where considerable accuracy is required.

Even when used in very irregular stands, where the trees differ largely in age and development of crown, such tables are more accurate than volume tables based on diameter alone.

Volume tables based on diameter and height have been constructed for several species in this country and used in the practical work of estimating. They give good results with trees of regular form like the pines and spruces, but with the hardwoods they are not entirely satisfactory unless separate tables are made for different tree classes.

Volume tables may be made for poles, and it would be of great practical value to have tables showing the average length and top diameter of poles yielded by chestnut of different diameters, or the length and middle diameter of piles contained in pitch pines of different sizes.

The purpose of studying the volumes of single trees is to facilitate the compilation of the contents of stands. Occasionally a single tree is sold, and a knowledge of its volume is desired, but ordinarily the single tree is of interest to the woodsman only as it forms a part of a whole stand or forest.

Factors that Affect the Accuracy of Estimates.

Different methods of estimating the contents and value of timber have been developed in various parts of the country. These methods differ in degree of accuracy of results and each is designed for a particular region and set of conditions. Each timber cruiser has his own peculiar method of estimating the contents of a stand of trees. With many the general principle of procedure is the same, but the actual application varies. The reason for this is that accuracy is not so much a matter of method as of judgment, which can be acquired only through practical experience and training. Therefore it is not possible to learn from books how to estimate timber, though a discussion of the various general methods of work should prove helpful.

Standing timber nearly always contains defects. Allowance is made for these defects in various ways, but the cruiser must be able to detect the outward signs of defects, and, from his general knowledge, must decide what percentage of the timber is sound. The personal training of the cruiser also enables him to use his eye

to judge distances, to note the average height and the diameters of trees, and to guess at their average contents.

Accuracy in estimating timber depends primarily on this individual capacity and judgment, and secondarily upon the methods and upon the time which can be given to the work. To obtain the closest possible estimate, three things are essential: First, actually to cover the entire area instead of measuring only a portion of it on the assumption that an average may thus be obtained; second, to count the individual trees instead of merely guessing how many there are on the tract; third, to estimate the actual contents of each separate tree instead of depending upon an average. Since most estimates must be made hurriedly and at moderate expense, it is seldom possible to obtain this maximum accuracy. Hence the value of the trained cruiser who can substitute his judgment for expensive detailed measurements. The same degree of detail will not always give proportionately accurate results. The smaller the area the more carefully the work must be done, since there is less room for averages and generalizations.

The larger and more valuable the individual trees the greater will be the care necessary to secure a close estimate. The more variation in the stand due either to topography or to openings the more work is required to get an accurate result. The less skillful the cruiser the more closely must he cover his territory if he desires an estimate which will compare in accuracy with that of a more experienced man.

DETERMINATION OF THE CONTENTS OF STANDS.

Covering the Whole Area.

Since it is more accurate to cover the entire area than to estimate only a portion of it, timber cruisers endeavor to see all the timber whenever the character of the forest permits.

ESTIMATE BY THE EYE.

Formerly nearly all timber cruisers depended solely on their ability to make an approximate estimate of the amount of timber standing on a tract, after a more or less thorough inspection; and timber was so plentiful and cheap that accuracy was not essential. Usually the cruisers' guess, based on a superficial examination of

the land, was sufficient for the purchaser. In recent years, as the values of land and timber have increased, greater accuracy is required, so that in many sections the estimates are now based on very careful methods, which involve actual counts of trees. Purchasers formerly were satisfied if the estimate underran the real product of the land. But under present conditions a considerable underestimate might keep a buyer from purchasing and thus cause him to lose a chance for profitable investment; while an overestimate, by causing the purchase of land at too high a figure, would bring a loss instead of profit when the trees were cut. There is no uniform method in making an ocular estimate of timber on a given tract. Each cruiser does the work in his own way. Suppose that a township of timber is to be estimated; the cruiser goes over the tract, examines the character of the timber, and then guesses either the total yield or the yield per acre. If the timber is fairly uniform in size and evenly distributed, the estimate may be made in a short time. Usually, however, the timber is not uniform, so that several parts must be estimated separately. Thus, if there is a mountain on the tract, the north slope may be estimated separately from the south slope, the lower slopes separately from the upper slopes, and the different watersheds, swamps, or other special types of land also separately. Some cruisers guess at the total contents of a township or part of a township in million feet or fractions of million feet; others estimate first the yield per acre and multiply by the known or supposed number of acres in the area.

The estimate by the acre is more reliable than the general guess, if the cruiser constantly checks his judgment by laying off sample areas and carefully estimating the timber on them.

There are several methods of laying off rough sample areas without measurement. One way often used by cruisers is to count the trees in a circle that has a radius of 118 feet, or approximately 7 rods, since a circle with this radius covers an area of about 1 acre. In the spruce forests of the northeast 7 rods is about the distance that one can distinguish a tree by its bark. After counting the trees the cruiser estimates the contents of an average tree and multiplies by the number of trees for the yield per acre. A quicker way is to count the trees in a circle with half this radius, or 59 feet, for an area of approximately one-quarter acre, or one of 85 feet radius for a half acre. In case the forest is very open, how-

ever, one should use a whole acre, as the smaller area is less likely to represent average conditions.

Still another method is to count the trees in a narrow strip by pacing off 10 yards, stopping and counting the trees for a distance of 2 rods or 11 yards on each side; then pacing off another 10 yards, again counting the trees, and so continuing until 55 yards have been paced. The area covered, 165 by 66 feet, comprises an area of one-quarter acre; or enough may be paced off to make a half or a whole acre.

There are several ways of estimating the volume of the average trees in these methods of rough sample areas. Some estimate by the eye the average yield per tree. Some estimate the average number of logs per tree, and knowing, from the experience at the local sawmills, the average contents of the logs, determines the average yield of the standing trees. Another way is to select several trees of average size, estimate their volume, and use the average of these as the average yield per tree in the forest. The best that can be said about these methods is that in the hands of a man with a great deal of local experience and opportunity to check his results by seeing tracts which he has estimated actually cut, he may often attain quite close results, provided he diligently examines the entire area. But so great is the chance for error that this so-called ocular estimating is no longer considered sufficiently accurate. It is still used extensively, but with increasing dissatisfaction.

ESTIMATE BY INSPECTION OF EACH TREE.

Most of the accurate methods of estimating used by cruisers in this country are based on a counting or an inspection of every merchantable tree. The simplest method, of course, is to count the merchantable trees, and then to determine the volume of an average tree and multiply this volume by the total number of trees.

In mountain districts where the land is rugged and there is a constantly changing topography the merchantable trees may be scattered as individuals or in small groups, and under these circumstances it is comparatively easy to count the merchantable trees without danger of duplication. If there is a possibility that the trees may be counted more than once, each one when it is

inspected and counted is blazed or otherwise marked. A method that requires greater skill is to estimate the contents of each tree as it is inspected. This plan is followed with large and valuable but defective hardwoods in the Appalachian region. When each watershed or secondary watershed, ridge, plateau, or other type of land is finished, the figures are added together for the total.

A very exact method is to measure each tree with calipers and determine its contents by volume tables, and thus get at the contents of the whole stand. This plan may be used in the measurement of areas as small as 40 acres, to check the accuracy of cruisers, or to make estimates on larger areas.

In comparatively level regions the cruiser may cover his tract by running definite strips of a given width which do not overlap, but which cover the entire area. In very open pine timber trees may be seen and counted easily for 10 rods, or maybe 20 rods, so that by counting on both sides of a straight line a tract of 40 acres could be completely covered by from two to four strips. Ordinarily, however, and especially in summer, brush will prevent accurate counting at distances greater than 5 rods, and this will limit the width of strip to 10 rods. Yet very few cruisers will go 8 times across a "forty" to count every tree in 10-rod strips.

A METHOD OF CRUISING A "FORTY" BY SMALL SQUARES.

Another method of cruising which gives good results is to divide each "forty" into 16 small squares of 2½ acres and to estimate the timber on each square separately. This method was described in an article in Rod and Gun, of Canada, of November, 1901, by A. Knechtel. The following description is essentially the same as given in that article:

The cruiser begins at one corner of a "forty;" for example, at the southwest corner. He paces along the south line 10 rods east and then turns and paces 10 rods north. This brings him to the center of a square 2½ acres in extent, or one-sixteenth of the "forty." Standing at this point he locates by the eye the boundary lines of the square and then estimates the timber upon it, usually by counting the trees and determining their contents from volume tables.

In dense stands, where the trees can not be readily counted, a flag may be placed at the center of the square to guide the cruiser.

He then paces 5 rods south and then 5 rods west, which brings him to the center of the southwest quarter of the square. He estimates this small plot and then paces 10 rods north, where he stands and estimates the northwest quarter of the 2½-acre square. He then paces 10 rods east and estimates the northeast quarter of the square, and then paces 10 rods south and estimates the southeast quarter.

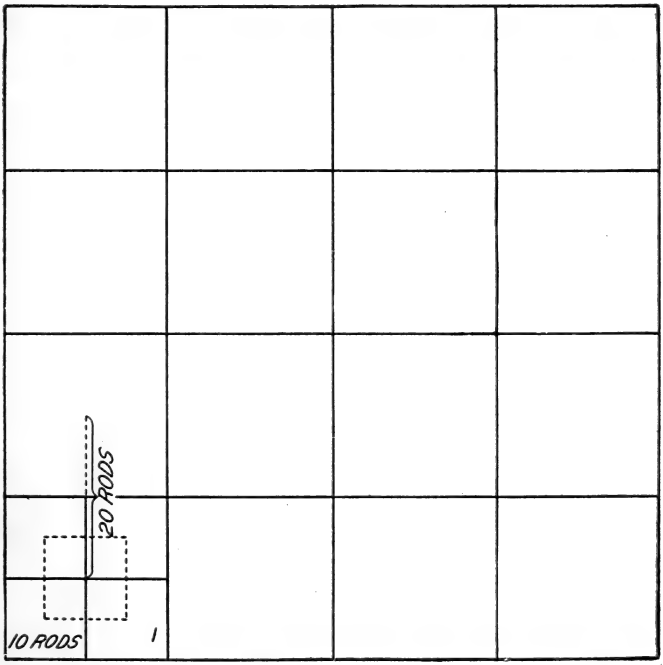


FIG. 1.—The method of cruising by dividing a "forty" into 16 small squares.

Having completed the estimate of one 2½-acre square, he returns to the flag and paces from this point 20 rods north, which is the center of the second 2½-acre square, which he estimates in the same way as before. This operation is continued until four squares have been estimated. The cruiser then takes in hand the tiers of squares directly east of the first series until the 16 squares, or the entire "forty," have been covered. (See fig. 1.)

A METHOD USED IN OPEN WOODS.

In portions of the southern pine belt a less systematic method is used. The cruiser has a compassman who runs a line through the center of the "forty" while he himself, usually mounted, rides back and forth and views, estimates, or, if possible, counts all of the timber on the "forty," being guided by his ability to estimate distances and by the position of the compassman. By the use of the Doyle Rule, the contents of the average tree is guessed at, and the total estimate thus obtained from the count.

Covering Only Part of the Area.

In many regions the brush is so thick that it is useless to attempt to count all the timber; and where the growth is small and the individual tree comparatively unimportant, the labor involved in counting is not justified. When a survey of the whole tract is definitely abandoned, and it is decided to measure accurately only a part of it, the total area of the tract must be known, and also the exact area to be covered by the cruiser. Also the stand on this subarea must typify the stand of the whole tract. Any difference between the two is the chief source of error, and this liability to error can be minimized only by increasing the proportion of the area covered to a point where the resulting average tallies with that of the whole stand.

A METHOD USED IN THE LAKE STATES.

A method in common use by cruisers in the Lake States as giving good results in all classes of timber is as follows: The cruiser through practice is able to judge his pace, so that he takes 2,000 steps to the mile. Starting from the corner of a section, or a forty, he paces along the line of the "forty" a distance of 125 steps, or one-fourth of the length of it; then he turns at a right angle along the center line of one-half of the "forty," and goes 2,000 steps, or the 1 mile to the edge of the section. (Fig. 2.) All the trees are counted on a strip 8 rods wide, or 25 steps on either side of this line across the section. Then on the side of the section opposite to the one on which he started an offset of 250 steps is made, or 40 rods, and a strip run back through the center of the next half. The area of two 500-foot strips in each forty is equal to just 20 per cent of the "forty," or 8 acres. The

estimate for each "forty" then may be obtained by multiplying the strips by five; but to insure greater accuracy in irregular timber the cruiser makes short excursions at definite distances on each strip, going both to right and left far enough to see the timber upon all of the land and to judge as to its uniformity. He then corrects the result obtained on the strip if his observations show him that

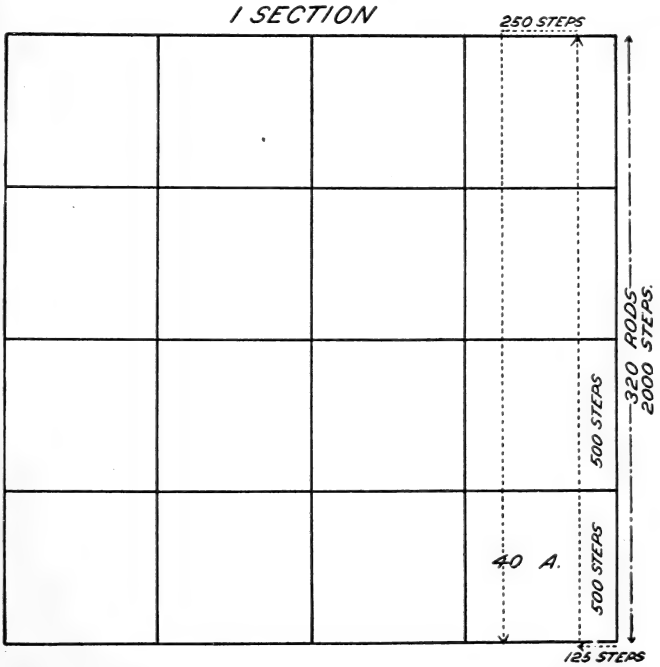


FIG. 2.—A method of making strip surveys that is used in the Lake States.

the remaining timber is either lighter or heavier than that which he has counted and measured.

The volumes of the trees are determined by estimating the number of 16-foot logs in trees of average height, using half logs if necessary and guessing at the contents of the average log, or the number of logs per 1,000 board feet. The tree count will then give the total number of logs and total volume of the stand in board feet.

STRIP SURVEYS.

The principle underlying the use of strip valuation surveys is the measurement of trees on narrow strips distributed systematically over the forest and covering, in the aggregate, a specified proportion of the total area. In the practice of the Forest Service of the United States Department of Agriculture the strip surveys are one chain or 4 rods wide and 10 chains or 40 rods long, so that each covers just one acre, and thus the tree measurements and forest descriptions of each acre may be kept distinct.

A crew of at least three men is required to lay off the strips. One, a tallyman, carries a notebook or tally sheets, and records the species and their diameters as they are called out by two calipermen; he also makes any necessary descriptive notes. The strip is measured lengthways with a surveyor's chain—that is, stretched on the ground. The tallyman carries the forward end and one of the calipermen the other. The trees within an estimated distance of 33 feet (one-half chain) on each side of the chain are then calipered. Then the crew moves forward another chain length and the process is repeated until 10 chains have been measured.

If there are four men in the crew one man lays the direction of the strip with a compass and carries the forward end of the chain, two men caliper the trees, and the fourth makes the records. The compassman directs the work of the crew, and sees that the calipering is accurately done, that no unsound trees are measured, and that the calipermen keep within 33 feet of each side of the chain; also he make the observations for the descriptive notes, which he dictates to the tallyman. As it is difficult for the compassman to direct the course and at the same time make observations of the character of the forest and oversee the work of the others, a fifth man is sometimes added to the crew. This enables the leader of the crew to devote his whole attention to directing the work and making the descriptive notes.

If the trees are to be counted and not measured, two men in the crew are sufficient, one to do the counting, the other to manage the compass and the forward end of the chain, to record the counts, and to take notes on the forest.

DISTRIBUTION OF STRIP SURVEYS.

There are two general methods of distributing the strip surveys over a given tract; first, to lay them off in long strips running across the tract, parallel and equidistant; and second, to locate them as isolated sample areas.

The Forest Service uses the strip method not only to obtain estimates of the merchantable timber, but also to secure a count of the trees not yet merchantable, to make forest maps, and to gather other detailed information necessary for a practical forest working plan. Under these circumstances lines of strip surveys are usually laid off parallel and equidistant, and run across the entire tract. Suppose, for example, that a township in the Adirondacks is to be estimated. The first step is to determine the percentage of the area to be included in the valuation surveys and to make a plan for their distribution. Usually one side of the tract is chosen as a base line and the strips are laid off at right angles to it and at equal distances apart. Stations are marked along the base line to indicate the location of the strips. The crew starts at the first station, near the end of the base line, and runs a line of 10-chain strip surveys across the tract in the chosen direction. At the farther side of the tract the crew chains along the line the distance which is to separate the strips. Then a second line of strip surveys is laid off parallel to the first, and running in the opposite direction, to station No. 2 on the base line. As soon as the base line is reached the crew proceeds to the third station, when a new strip is started parallel to the other two; and so on until the whole tract has been covered.

As the strip method is ordinarily used, the chaining is not done very carefully. For example, the compassman may attach the chain to his belt at the back and in walking forward mark off the distances merely by scratching the surface of the ground with the heel without marking by a pin or stake. Moreover, the chaining usually is not done on a horizontal plane, but the lengths are measured along the ground regardless of the slope. Thus, while a valuation survey run up and down a steep slope will cover an acre of surface, it is less than 10 chains long when projected on a map. Because of this inaccuracy the strips often do not fit precisely into the map, but there is small likelihood of any considerable error from this lack of precision, because the errors in laying off single

acres largely compensate each other. It is only when the chaining is used for a topographic map as well as an estimate that accurate chaining on the horizontal is necessary.

It often happens when a line of strip surveys is run across a given area that the last strip is less than 10 chains in length. Strictly, this should be regarded as a fraction of an acre. Thus, for example, if the last strip is 4½ chains in length, it comprises 0.45 of an acre. When the results of the measurements on this short strip are used, and it is necessary to give figures of stand per acre, they must be divided by 0.45. In practice, however, where the forest is uniform, the whole acre is completed, either by continuing over the line or by turning and finishing inside the line in another direction, in order to facilitate computation and to avoid fractional acres whose results must be converted into terms of whole acres.

PREPARATION OF A FOREST MAP.

The preparation of a forest map often is combined with the estimate. In most cases a contour map is not planned, but rather a map which will show simply the distribution of the timber, the forest types, the location of the roads, streams, and main ridges. Such a map is prepared in the following way: When a strip intersects a road or stream the tallyman notes the point of intersection and also the direction of the road or stream, so that it can afterwards be located on the map. If a road or stream crosses several strips the points of intersection are connected on the map and the exact location thus indicated. When a stream or road is crossed, the tallyman takes any steps necessary to record its character and width. The description of each acre includes the general direction of the slope, and if there is a marked change in the degree of slope in the middle of the acre, that fact and the point of the change are noted. The location of ridges may thus be determined and sketched on a map from the description of each acre.

It is possible, also, to make a map of the forest types, because the description of each acre includes a statement of the type. If an acre crosses from one type into another, this fact is explained on the tally sheet and the point of change is indicated, so that the outlines of the different types may be sketched on the map in the same way as the roads and streams.

The systematic gridironing of a tract, however, would not always be the best plan of distributing the strip surveys. Thus, for example, in mountain country, where the merchantable timber is on certain types of land or slope or in small or very irregular-shaped stands, it is usually better to lay off strip surveys more or less irregularly, in such a way as to obtain an average yield per acre of the type or area under immediate examination. If the timber on a small watershed is to be estimated and the yield per acre along the stream differs materially from that on the slopes, strip surveys must be taken, and the yield per acre determined separately, for each type of forest. The strips are laid off by judgment and not by rule, as in the gridiron method.

In mountainous country the most exact results come from running the strips as far as possible directly up and down the slopes, to cross the different types. Only in this way can a fair average be obtained. Strips run along the bottom of deep coves or ravines to get the average stand in such coves, will in reality measure the very best timber and the result may be an overestimate of the actual stand by 100 per cent. To separately mark the type areas, the strips need not be confined to the type, but, in continuing through successive types the boundaries between types will be noted and separate tally sheets or portions of sheets used for the different types. The area of each type afterwards may be sketched in a map as shown by the intersections of the strips; or the proportion of each type in the strips may be taken to correctly represent that for the whole tract.

MEASUREMENT OF THE TREES.

The strip methods may be used without calipering the trees, but by counting them, or by guessing the contents of each merchantable tree as it is counted. Usually, however, the trees are calipered to the nearest inch at breastheight. Sometimes the trees are grouped into diameter classes of 2 or more inches. Ordinarily one measurement of each tree is taken unless it is obviously eccentric, when two diameters at right angles are measured, and the average is recorded as the diameter. Care must be exercised not to take the measurements below breastheight. A tired man is apt to lower his calipers and measure at 3 or 3½ feet

instead of 4½ feet. With small timber, that averages 6 to 10 inches in diameter, the error due to low measurements is practically negligible, but with large timber it may seriously affect an estimate. In old spruce, careless calipering has added 1 inch to the diameters of 20 per cent of the trees. This means for every 1,000 trees an overestimate of 8,000 feet, or on an average on spruce and hardwood lands about 300 feet per acre. Care also should be exercised to place the calipers at right angles to the axis of the tree. It is obvious that a considerable error may result if the calipers are placed obliquely on the trunk. When there is a bulge or other normal swelling at breastheight, the measurement should be taken just above and not below the obstructions. In tropical countries, or with certain trees, like cypress, where many of the trees are buttressed, the measurement can not be taken at breastheight, and special methods of grouping are used.

In an estimate of merchantable timber only apparently sound marketable trees are included, and frequent errors in estimating come from counting unsound trees. Inexperienced or careless men will measure trees which may appear sound and merchantable, but which are really defective. Great care must be exercised to scrutinize each tree for signs of defect. Usually decay manifests itself by some external sign, such as punk knots, white resin, unhealthy crown, broken top, or dead limbs. A cruiser must know these signs. If he is working in a new country, he should associate with him some local woodsman who is familiar with the character of the timber.

In a great deal of government work trees below the merchantable size and sound trees of species not yet merchantable are measured in connection with preparation of working plans.

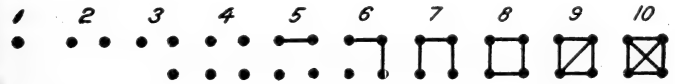
The methods of determining the volume of the trees on the strip surveys are described in later sections.

RECORDING THE MEASUREMENTS.

The diameter measurements are recorded in a tally-sheet notebook. The tally sheet is ruled in columns; the first column shows the diameter classes, by inches or by groups of 2 or more inches, and the other columns are for the various species. A special form of tally sheet used by the Forest Service is bound in books which

will fit a coat pocket but not a hip pocket. The books have stiff board covers, which do away with the old cumbersome and insecure tally-sheet holders.

The trees are tallied by dots and lines, in blocks of ten, as indicated in the following table, which shows the marks corresponding to different numbers:



This method is economical of space and enables the recording of a large number of trees on a single sheet.

NUMBER OF STRIP SURVEYS REQUIRED.

Usually the sample strips should comprise from 5 to 10 per cent of the total area. Sometimes it is possible to include 20 or 30 per cent, but on large tracts from 5 to 10 per cent is considered sufficient. On very large areas of 100,000 or 200,000 acres the strips cover 2 to 3 per cent. In recent work on the National Forests the strips have been run one-quarter or one-half of a mile apart, and thus take 5 per cent or 2½ per cent of the total area.

COMPUTATION OF RESULTS.

After the measurements are secured, the average yield per acre may be computed in two ways:

(1) By computing separately the yield of each acre, and averaging all together; or (2) by constructing a model acre through the adding together of the number of trees of each diameter which occur on all the sample plots and dividing the result by the number of plots, which gives the average number per acre of trees of each diameter. For example, to construct a model acre the average number of 6-inch trees on all the acres measured is calculated; then the average number of 7-inch trees; then of 8-inch trees, of 9-inch trees, etc. The result is a model acre having the average number of trees of each inch diameter. Only one computation of yield is then required, and this will represent the average of all the sample acres.

The method of computing the contents of a model acre or of any sample acre depends upon whether or not height measurements have been taken. If heights have been disregarded, the computation may be made in the following way:

Make four columns of figures as shown in the accompanying form. In the first column place the diameters, in the second column the number of trees of each diameter, in the third column the average contents of trees of different diameters, and in the fourth column the total contents of all trees of each diameter, which is found by multiplying together the values in the second and third columns. The figures in the fourth column are then added together for the total contents of the acre.

Under ordinary circumstances a crew of 4 men should be able to measure off 30 to 50 acres a day if only the merchantable timber is included. In very open woods this number may be increased. Where small trees are measured and special care is taken in laying off the strips, 20 acres a day, or $2\frac{1}{2}$ miles of line, is about all that a cruiser can measure.

Form for computing the contents of sample plots.

HEMLOCK.			
Diameter breast-high.	Number of trees.	Contents of average tree from volume table.	Total contents.
Inches.		*Board feet.*	*Board feet.*
10	10	45	450
11	11	65	715
12	9	90	810
13	8	118	944
14	8	143	1,144
15	9	175	1,575
16	7	205	1,435
17	6	240	1,440
18	6	275	1,650
			10,163

ESTIMATE BY COUNTING LOGS.

A modification of this method is to make an estimate by counting logs. This consists in going over a given tract by strips 4 rods wide, and their distance apart will depend on the proportion of the area to be covered. The estimated top diameter of each merchantable log is recorded, and, if advisable, the estimated breastheight diameter of each tree. If there is a crew of 2 men, one directs the strip on a compass line and paces the distance, the other records the diameters of the trees and logs. The compass man first paces off a short distance, for example, 10 yards, and waits until the tally man records the trees in that distance and comprised within a 4-rod strip. The tally man records on a tally sheet the estimated breast-high diameter of each tree and the estimated top diameters (inside bark) of each 16-foot log, as shown by the following table:

Summarized record of estimated diameters.

SPRUCE.

[Waterville, N. H. Block, Snow Brook. Compartment, II. Strip, No. 17. Course, N. 8° E. Length, 120 rods.]

Diameter breast-high.	Number of trees.	TOP DIAMETER OF LOGS INSIDE BARK (INCHES).									
		6	7	8	9	10	11	12	13	14	15
		NUMBER OF 16-FOOT LOGS.									
Inches.											
8	12	91	83	68	59	44	33	16	8	8	
9	17										
10	12										
11	22										
12	30										
13	35										
14	15										
15	12										
16	10										

If there are several species, the columns for breasthigh diameter and number of trees may be omitted, and the top diameter arranged vertically, a column for each species. The compass man keeps track of the distance paced, and makes a note of roads and streams that cross the strip, and of any other information required in the cruise. The strips, together with the roads, streams, and other features, may later be platted on a map. A separate tally sheet is used for each strip, or part of strip, for which a separate estimate is required. A new record is made, for instance, when a new watershed is reached, when the compass direction of the strip is changed, or when a different forest type is encountered. If necessary, one man can work alone.

The records enable the determination of the contents of the logs by any desired log rule, the determination of the total number of trees, the average number of logs per tree, the number of trees or logs per thousand board feet, and the yield per acre. One of the advantages of the method is that each tree may be scaled for what it will yield, by discarding the crooked and defective logs. The only reduction necessary from the final total scale is a certain percentage for hidden imperfections not apparent on the standing trees.

In northeastern spruce forests one crew of two men can work over a strip 1½ miles long in a day. If the strips are laid off one-fourth mile apart, this means a cruise of 300 acres per day.

The method requires not only a knowledge of what constitutes a merchantable log, but also the ability to estimate diameters by eye. It requires a trained eye and can not be practiced by a novice. It is open to the further objection that it is very slow. Its chief advantage is that a volume table is not required, and it is equally applicable to all species, forms, and heights of trees.

SYSTEMATIC PLOT METHOD.

The principle of the systematic plot method is the same that underlies the strip methods. Compass lines are run at regular intervals, but instead of measuring a continuous strip, only a part of each strip is measured, in the form of plots spaced at regular intervals along the course. These plots are laid off by the eye,

and may follow the plans described for rough sample plots under estimating by the eye on page 66. They will seldom be run out by compass, as too much time would be lost. The trees in each plot may be calipered, or tallied by the eye, or merely counted, with the selection, by eye, of an average tree, the volume of which can be determined either by the logs contained or from a volume table.

A METHOD USED ON THE PACIFIC COAST.

On the Pacific coast the cruiser, alone or with a compass man, starts from the center of one side of the forty and paces along a compass course across the center of the forty a distance equal to one-tenth of the width of the "forty." Standing here, he lays out by the eye a circular plot containing an acre, as described on page 66, and counts all the trees by species; then for each species he selects an average tree for the plot. The breast-high diameter is measured or estimated, and the top diameter and number of merchantable logs in the tree. The middle diameter is assumed to be the arithmetical mean of the breasthigh and top diameters, and the volume is obtained by the application of the rule of thumb given on page 60.

The cruiser then proceeds in the same direction a distance equal to one-fifth of the width of the forty, and lays off a second plot. Proceeding in this way he measures five circular plots, of an acre each, across the center of the "forty," and these contain 12½ per cent or one-eighth of the total area. A correction factor is applied to the final result if observation shows that the plots are too heavy or too light.

SCATTERED OR ARBITRARY PLOTS.

One of the most rapid methods of estimating is to locate a few plots in timber of average density of stand, run out the boundaries with care, and determine the volume of the stand per acre on the plot by some such careful method as calipering the diameters, measuring the heights, and using a volume table. The average stand thus obtained is assumed to be the stand per acre for that portion of the tract which has similar timber. The difficulties in the way of determining by inspection what constitutes an average stand are somewhat reduced if it is possible to divide the area into

two or more portions, or types, on each of which the stand will be comparatively uniform, but so great is the local variation in stands of timber that it is almost impossible even for experienced men arbitrarily to pick out plots which will truly represent the average stand.

ADVANTAGE OF STRIP SURVEYS.

The chief advantage of strip surveys is that the sample acres represent a good average, inasmuch as they are run straight through the forest and include whatever may be in the course, while arbitrary plots are likely to be located in the best areas and hence give too large results. A second advantage of the strip survey is that it may be made very rapidly and therefore many more sample areas are obtained than is possible with carefully surveyed plots. The third advantage is that the systematic location of the strips enables the preparation of a map.

The one disadvantage of the method is that there is always a chance of error in estimating the width of the strips, but this is not a serious disadvantage if the caliper men are careful.

THE USE OF HEIGHTS IN ESTIMATING.

Next to diameter, height is the most important factor in determining the merchantable contents of a tree. Mistakes in judging height are easily made, especially in unfamiliar timber, or in passing from short to tall timber, or vice versa.

It is customary to average the heights of trees. In methods which depend on number of trees and average volumes, the cruiser judges the average height, or the number of merchantable logs in his average tree, by sizing up the stand during his cruise. At the most, he may separate his timber into two classes—large and small, or by area into one or more types, and use the same average heights for all trees in the class or type.

A more accurate method of using heights in cruising is to determine the average heights of trees of different diameters in the following way: After the trees on a sample acre have been calipered in the usual way the heights of a limited number of trees, generally from three to ten for each species, of different diameters, including small, medium, and large trees, are measured. The cruiser selects for measurement trees which appear to him to be of average height in

their class, whether small, medium, or large. When the height of a tree is measured, the diameter also is noted. After these height measurements have been made a curve is constructed from which a table may be made to show the average height of trees of any diameter. This is done in the following way: On a sheet of cross-section paper (fig. 3) let the vertical lines represent successive diameters at 1-inch intervals, and the horizontal lines successive heights at 1-foot intervals. Assume, for example, that the following measurements were taken for Loblolly Pine:

Diameter in inches	10	15	19	24
Height in feet	75	89	99	101

Mark on the cross-section paper the point where the vertical line running from the diameter point 10 meets the horizontal line running from the height point 75. Mark the points of intersection for the other diameters and heights in the same way. Then draw a regular curve through or as near the points as possible in the way shown in fig. 3. The height corresponding to any diameter may then be read off from this curve. Thus, to find the height of a 16-inch tree, note the point where the vertical line running up from the 16-inch point meets the curve; then from this point of intersection follow the horizontal line to ascertain the height. In the example given the average height of a 16-inch tree is 86 feet.

This method is used to find the contents of sample acres in the following way: Make a table of four columns. In the first column place the diameters; in the second column the number of trees of each diameter given in the first column; in the third column the average height of trees of each diameter, these average heights being obtained from a curve such as has been described; in the fourth column the contents of an average tree from a volume table; in the fifth column the total contents of all trees of each diameter. Then add the fifth column, and the result will be the total contents of the sample acre.

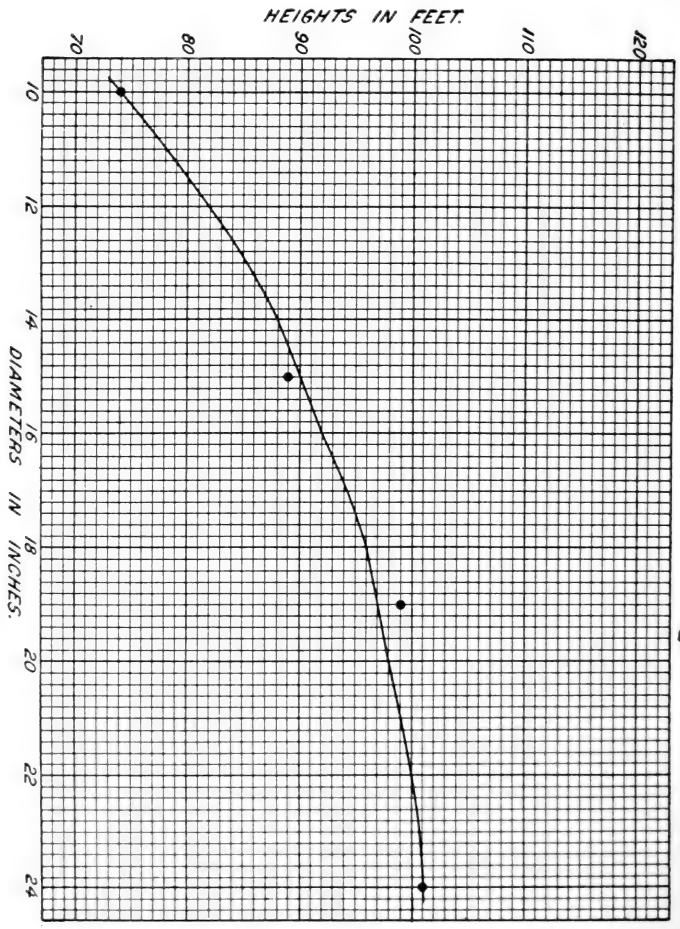


FIG. 3.—Curve showing heights of trees of different diameters.

The following is an example of such a table:

LOBLOLLY PINE.

Diameter breast-high (inches).	Number of trees.	Height (feet).	Contents of average tree from volume table (board feet—Scribner).	Total contents (board feet).
10	8	74	57	456
12	9	82	107	963
14	2	88	175	350
16	3	92	257	771
18	3	96	357	1,071
20	4	98	454	1,816
22	1	100	565	565
				5,992

In hardwood timber and southern pine growing in open scattered stands, there is not only great variation in total height of trees on the same tract but the number of merchantable logs in a tree does not depend alone on its height, but also on the form of the crown and clear length. In very close estimating of valuable timber on tracts as small as 40 trees it may become necessary to tally the merchantable length of every tree on the portion covered.

Some cruisers classify the trees as they measure them into two-log, three-log, four-log trees, etc. They have on their tally sheets several columns for each kind of tree, as follows:

	WHITE PINE.					HEMLOCK.			
Diameter breast-high.	Two-log trees.	Three-log trees.	Four-log trees.	Five-log trees.	Six-log trees.	Two-log trees.	Three-log trees.	Four-log trees.	Five-log trees.

The total amount of timber on the area on which the trees are counted are then determined as follows: Find from a volume table, such as that given on page 181, the amount of timber in an average two-log tree of each diameter, and multiply this amount in each case by the number of trees of the diameter in question. Add together the results thus secured for the total amount of timber in the two-log trees. Make a similar calculation for the three-log trees, or the four-log trees. Then add together the total contents of the two-log, three-log, and four-log trees for the total amount of timber on the area.

Another method is to estimate the total height of each tree when measured and to group the trees in height classes as follows:

WHITE PINE.					
Diameter breast-high.	Under 60 feet.	60 to 80 feet.	80 to 100 feet.	100 to 120 feet.	Over 120 feet.

The total amount of timber on the area may be determined in the way described above, if volume tables exist which give the contents of average trees under 60 feet, 60 to 80 feet, 80 to 100 feet, etc., in height.

If no such tables exist but there are tables for trees of all heights, the cruiser should measure in the woods the average heights of trees under 60 feet, 60 to 80 feet, 80 to 100 feet, etc. He should then compute the average diameter of the counted trees under 60 feet, 60 to 80 feet, 80 to 100 feet, etc. Knowing the diameter and the height of the average tree under 60 feet, its content is secured from a volume table of heights and diameters. This value is then multiplied by the number of trees under 60 feet in height. The contents of the trees 60 to 80 feet, 80 to 100 feet, etc., are found in the same way, and the totals are added together for the total amount of timber on the area.

Except on the very smallest areas, the diameters of more than a small portion of the timber are recorded but seldom, even in the most accurate methods, and it is still more seldom that the height of every tree will be recorded.

A METHOD USED IN SOUTHERN YELLOW PINE.

A method used by the Yale Forest School in yellow pine is intended to combine the advantage of counting the trees on a wide strip with that of a tally of the heights of a large proportion of the trees. Strips on compass lines are run across the tract, on which the trees are counted to a width of 10 rods. Should the crew consist of a compass man and two cruisers, each cruiser takes a 10-rod strip on one side and parallel with the compass man.

In this way 20 rods are covered, and two strips, one through the center line of each half of 40 acres, will cover 50 per cent of the entire area. In ordinary pine timber the cruiser can travel along the outer or farther edge of his strip and thus view the timber outside of the strip, not counted. In hardwoods, swamps, or underbrush, he takes the middle of the strip and counts to a distance of 5 rods on each side.

One cruiser with a compass man could cover 20 rods in open timber, but under all conditions could be sure of only a 10-rod strip, and working alone he could not cover more than 10 rods. One man, or two, running 10-rod strips, would have to run four strips per 40 to equal the accuracy of the double crew, but this would seldom be done. Two strips of 10 rods would give 25 per cent of the area.

The compass man has the same opportunity to make a map and take notes on the topography as he has in other strip systems of estimating. The cruisers record their own tally and for volumes depend on a volume table based on breast-high diameter and merchantable 16-foot logs and half logs. The diameter and merchantable height of every tree on the strip might be tallied, but it was found that equally accurate results were obtained on these wide strips by tallying the dimensions of every fifth tree. In order to avoid the tendency to select too large or small a tree for tallying, it was the rule to tally each time the tree nearest the cruiser. This tallying of 1 tree in 5 instead of every tree enables the crews

to cover nearly twice the area in a day. In making the field records, therefore, the merchantable height as well as the diameter was recorded in the following form:

SPECIES – PINE.

D.B.H.	1 LOG	2 LOGS	2½ LOGS	3 LOGS	ETC.
12	• •				
13	•	• • • •			
14			• •		
15		•		•	
16		•			
ETC.					

FIG. 4.—Method of tallying standard logs and diameters.

Both diameters and heights are judged by the eye, but calipers may be carried, with which to check frequently the measurements.

The accuracy of this method may be slightly increased by tallying, in a class by themselves, the dimensions of every one of the larger trees, instead of only 1 in 5.

If 50 per cent of the area is covered, 10 per cent of the total stand is tallied, and the total estimate is found by computing the contents of the recorded trees and multiplying by 10. This result may be modified by a correction factor if it is evident that the timber not counted differs in stand per acre from that estimated.

An attempt should not be made to apply this system of tallying only 1 tree in 5 or 10 to narrow strips, where only a small per cent of the stand is counted. On a 4-rod strip, the diameters of all trees should be tallied. But where at least 5 per cent, and preferably 10 per cent, of the stand is actually recorded it is seldom necessary to go further and tally the diameters or heights of 50 per cent.

The chief merit of the method is that it enables a cruiser to cover his territory more thoroughly, and at the same time avoid the necessity of guessing at the average heights or volumes of the counted trees.

ACCURATE PLOT SURVEYS.

In certain scientific work it is necessary to determine accurately the contents of sample plots as, for example, in the studies of growth and in the determination of the future yield of forests. Inasmuch as the average woodsman does not have occasion to make such studies, the various methods of determination of the volume of stands is not included in this work.

THE CHOICE OF METHODS FOR ESTIMATING.

For inexperienced men who have not the training necessary to enable them to use ocular methods and judgment, there are but two plans available for estimating timber. First, the 4-rod strip or valuation survey, where the diameters are calipered and heights measured with an instrument and the volumes obtained from a volume table. Second, a modification of this in the form of plots laid out systematically at definite distances on a compass course with all of the trees carefully measured and their volumes computed by volume table. Either of these systems is applicable anywhere in any kind of timber, but the accuracy of the results will depend on the soundness of the timber, care in elimination of dead and worthless trees, per cent of total area covered, accuracy of the volume table used, care with which differences or types in the stands are distinguished, judgment in selecting for measurement average heights with the hypsometer, and care in observing the width of the strip.

Foresters or cruisers with training and ability to use ocular methods, when working alone, will obtain best results by using

wide strips whenever possible. A strip of 8 rods is always possible. The trees upon this strip would all be counted, but on a very wide strip the diameters of only a portion might be tallied. The number tallied should always be equivalent to the stand on a 4-rod strip. Heights would be tallied with the diameter, or, if it is sufficiently accurate, may be averaged. Where it is more convenient and time must be saved the system of using plots is best, either circular or rectangular, and spaced at definite distances. Here either the trees may be counted or the diameters of all of the trees on the plots tallied. The selection of sample plots here and there should be left only to persons of exceptionally good judgment and long training.

Only the most experienced timber cruisers may dipense with both volume tables and a tally of the sizes of the trees, and obtain their results directly by counting and by averaging the contents of the logs or the trees in the stand.

GROWTH OF TREES.

Since there is a marked tendency among timber-land owners to cut their timber with an eye to the future, some knowledge of the growth of forest trees becomes important.

Trees grow by adding each year a layer of wood underneath the bark. Since each year contains only one growing season and the spring and summer part of this layer are not alike, each year's growth, layer, or "annual ring" usually is distinguishable. The central fact of tree growth is that each ring means a year. The exceptions to this are not important enough to merit notice here.

DIAMETER GROWTH.

Some trees grow so slowly that a hand lens is necessary to clearly distinguish the rings, others may have rings a half inch in width. In any case, a little practice improves the ability to note all the rings.

To find the age of a felled tree at any section, then, requires only the accurate counting of the rings. The total age of the tree is shown by the total number of rings at the ground; or the total number of rings on the stump plus the number of years required

to grow as high as the stump. An examination of a number of small trees would give an idea of the time required to grow up to stump height. This varies from one year in trees coming up as stump sprouts to as high as twenty years or more in some Rocky Mountain conifers, for heights of 1 to 3 feet.

Since trees often grow faster on one side than another, the average growth is gotten only by finding the average radius and counting and measuring the rings along it. Thus the radius of the tree may be found at ten, twenty, thirty years, etc., and by doubling these the diameters are found at these ages.

HEIGHT GROWTH.

The height growth is found by counting the rings at different sections and subtracting from the rings at the lowest cut. (If this cut is not at the ground, add an approximate number of years to cover stump height.) Thus a white-pine tree in Minnesota, with a diameter of 30 inches and a height of 110 feet, showed 176 rings on the stump 2 feet from the ground. Adding four years as the time to grow these first 2 feet would show a total age of 176+4, or one hundred and eighty years. At the upper end of the first 16-foot log it showed 165 rings; at the second, 155 rings; at the third, 140 rings; at the fourth, 120 rings; at the fifth, 94 rings. Hence, the first 18 feet (2-foot stump+16-foot log) grew in 180−165, or fifteen years; the first 34 feet (2+16+16) in 180−155, or twenty-five years; the first 50 feet (2+16+16+16) in 180−140, or forty years; the first 82 feet (2+16+16+16+16+16) 180−94, or eighty-six years. The last 28 feet required 180−86, or ninety-four years, for their growth, indicating that the height growth had fallen off rapidly.

VOLUME GROWTH.

Entire Volume.

Since for small variations in diameter and height the contents of trees vary approximately as the sectional area or square of the diameters, a simple method of getting the percentage increase in solid volume of a tree may be given.

Table 8 assumes the same rate of growth for the next inch in diameter as the last 2 inches (1 inch on radius). It requires a measurement of the present diameter excluding bark, and a count of rings in the last inch of radius. This is easily done on logged trees, but on standing timber it requires that trees be notched to at least an inch (or the use of the Pressler increment borer [a]) to get the ring count and bark thickness. When the diameter inside bark is known, and the number of rings in the last radial inch, the volume increment per cent is read from the table. The error for rapid-growing trees is not serious when an approximation only is required. Of course, a number of trees of each diameter should be examined and the average number of rings in the last inch used.

For a stand of trees the table will apply if the stand is divided into diameter classes and examined in that way. There is more chance for error if an average diameter is taken for the entire stand, unless the variation in diameter is not very great.

Again, in dense stands some allowance must be made in figuring volume growth for the loss through the crowding out of some of the trees.

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[a] See page 110 for description of this instrument.

TABLE 8.—Approximate Current Annual Increase in Per Cent of Volume for Trees of Different Diameters When the Average Number of Rings in the Last Radial Inch is Known.

Present diameter of tree (inside bark).	NUMBER OF RINGS IN THE LAST INCH RADIUS.														
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
Inches.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
4	56.3	28.2	18.8	14.1	11.3	9.4	8.0	7.0	6.3	5.6	5.1	4.7	4.3	4.0	3.8
6	36.2	18.1	12.1	9.1	7.2	6.0	5.2	4.5	4.0	3.6	3.3	3.0	2.8	2.6	2.4
8	26.6	13.3	8.9	6.7	5.3	4.4	3.8	3.3	3.0	2.7	2.4	2.2	2.0	1.9	1.8
10	21.1	10.6	7.0	5.3	4.2	3.5	3.0	2.6	2.3	2.1	1.9	1.8	1.6	1.5	1.4
12	17.5	8.8	5.8	4.4	3.5	2.9	2.7	2.2	1.9	1.8	1.6	1.5	1.3	1.3	1.2
14	14.8	7.4	4.9	3.7	3.0	2.5	2.1	1.9	1.6	1.5	1.3	1.2	1.1	1.1	1.0
16	12.9	6.5	4.3	3.2	2.6	2.2	1.8	1.6	1.4	1.3	1.2	1.1	1.0	.9	.9
18	11.4	5.7	3.8	2.9	2.3	1.9	1.6	1.4	1.3	1.1	1.0	1.0	.9	.8	.8
20	10.2	5.1	3.4	2.6	2.0	1.7	1.5	1.3	1.1	1.0	.9	.9	.8	.7	.7
22	9.3	4.7	3.1	2.3	1.9	1.6	1.3	1.2	1.0	.9	.8	.8	.7	.7	.6
24	8.5	4.3	2.8	2.1	1.7	1.4	1.2	1.1	.9	.9	.8	.7	.7	.6	.6
30	6.8	3.4	2.3	1.7	1.4	1.1	1.0	.9	.8	.7	.6	.6	.5	.5	.5
36	5.6	2.8	1.9	1.4	1.1	.9	.8	.7	.6	.6	.5	.5	.4	.4	.4
42	4.8	2.4	1.6	1.2	1.0	.8	.7	.6	.5	.5	.4	.4	.4	.3	.3
48	4.2	2.1	1.4	1.1	.8	.7	.6	.5	.5	.4	.4	.4	.3	.3	.3
54	3.7	1.9	1.2	.9	.7	.6	.5	.5	.4	.4	.3	.3	.3	.3	.2
60	3.4	1.7	1.1	.9	.7	.6	.5	.4	.4	.3	.3	.3	.3	.2	.2
70	2.9	1.5	1.0	.7	.6	.5	.4	.4	.3	.3	.3	.2	.2	.2	.2
80	2.2	1.1	.7	.6	.4	.4	.3	.3	.2	.2	.2	.2	.2	.2	1

Growth—Board Foot Volume.

Table 8 gives an idea of the growth per cent in entire tree volume. For trees up to 4 or 5 inches in diameter the board-foot volume is, of course, zero, and few log rules give board-foot contents for log diameters below 6 inches, which means a tree 7 or 8 inches in diameter (at 4.5 feet from the ground). For small trees the board-foot content shows only about 4 board feet per cubic foot of log; this rises to 8 board feet per cubic foot in large trees. The proportion of waste in bark, top, and stump is also smaller in large trees. For these reasons the board-foot volume growth has an extra increase which requires increasing the per cent given in Table 8. A mill test[a] in white pine, sawing round-edged box boards, showed the following relation between total cubic-foot volume increment and board-foot increment for trees of different diameters with average height growth:

Diameter of tree.	Relation of board foot (box-board sawcut) increment to total volume increment.
Inches.	*Times.*
6	1.4
8	1.2
12	1.2
18	1.1
24	1.0

So that if the volume growth of a tree in round-edged box boards is desired, the growth per cent in the table on page 93 should be increased 1.4 times for 6-inch trees, 1.2 times for 8 to 12 inch trees, and 1.1 times for 18-inch trees, while for 24-inch trees the board-foot growth per cent equals the total volume growth per cent.

[a] Made by L. Margolin for the Forest Service in cooperation with the State of New Hampshire.

The increase in board-foot contents due to growth in loblolly pine shows, according to the Scribner Rule, the following relation to the growth per cent in total volume given in the table on page 93:

Diameter of the tree.	Relation of board foot (Scribner) increment to total volume increment.
Inches.	*Times.*
8	2.1
10	1.4
12	1.2
18	1.1
24	1.1
36	1.0

It is seen that the volume growth per cent, whether taken as total tree volume, saw cut, or Scribner Rule, is almost the same for trees over 18 inches.

In addition to growth in volume, trees increase in value with size faster than the volume indicates, since there is a greater proportion of the better grades of lumber in the larger trees. Thus white pine stumpage in 24-inch trees is worth at least twice that in 12-inch trees. This is an extremely variable factor, however.

Again, stumpage tends to increase in price with time, even were there no increase in growth.

To summarize, then, the profitableness of letting trees grow is determined by the percentage of wood laid on, the extra increase in board-foot product coming with increased size, the larger stumpage price paid for larger material, and the constant tendency for stumpage to increase even without growth. The first two factors may be approximated; the last two can not be dealt with according to fixed rules.

SPECIAL INSTRUMENTS USEFUL TO A WOODSMAN.

It is unnecessary to describe the instruments which are familiar to every woodsman. It is believed, however, that those described in the following pages are not generally known, at least in the form recommended. They will prove useful in many cases to cruisers and other woodsmen. Further information regarding the instru-

ments will be furnished upon application to the Forest Service, Washington, D. C. They may be procured through any first-class dealer in field instruments.

STAFF COMPASS.

This instrument (shown in fig. 5) is used for running lines in the woods. It consists of a compass set on a square base, and has

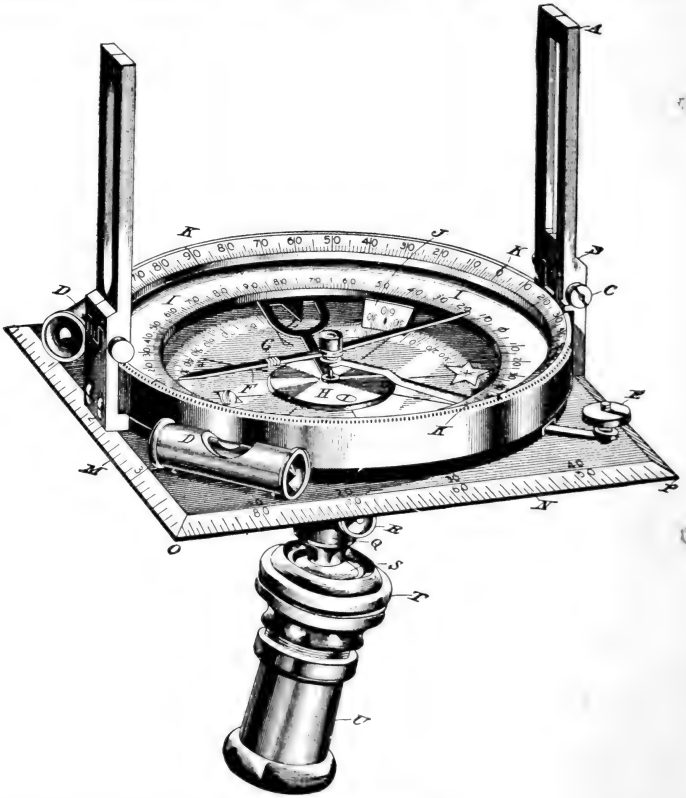

FIG. 5.—Staff compass.

two sights hinged to its opposite sides. A removable support, screwed into the bottom, terminates in a socket, adapting the

instrument to be mounted upon a Jacob staff or upon a tripod. The support also comprises a ball-and-socket joint, by which the compass is leveled with the aid of spirit tubes on two sides, a swivel, which permits the compass to be turned in sighting it, and

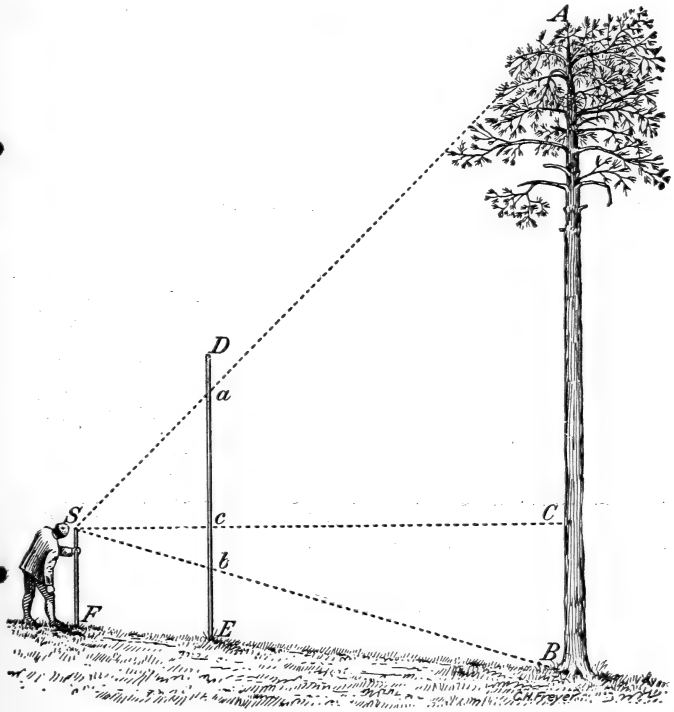

FIG. 6.—Measuring the height of a tree by means of two poles.

a set screw for securing it against turning after sighting. When not in use the sights are folded down and the support unscrewed. When taken apart the entire instrument is in compact form for transportation, and, being made of aluminum, it is not heavy. The price is between $20 and $25, without staff or tripod.

INSTRUMENTS FOR MEASURING HEIGHTS.

There are several methods of determining the height of a standing tree. One of the simplest is to measure the shadow of the tree and the shadow of a straight pole of known length set perpendicular to the earth. Multiply the length of the shadow of the tree by the length of the pole and divide the product by the length of the shadow of the pole. The result will be the height of the tree.

A method used when the sun is not shining is to set two poles in a line with the tree. (See fig. 6.) From a point on one pole sight across the second pole to the base and to the top of the tree. Let an assistant note the points where the lines of vision cross the second pole and measure the distance between these points. Also

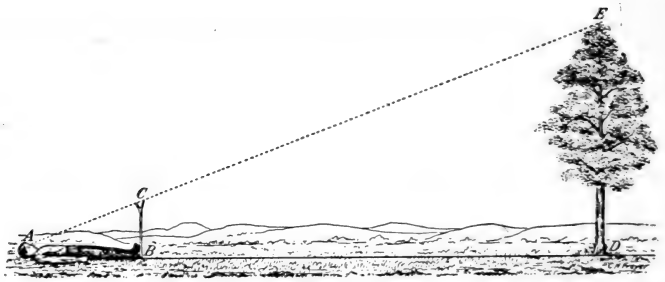

FIG. 7.—Measuring the height of a tree by use of known height to eye of the observer.

measure the distances from the sighting point on the first pole to the base of the tree and to the lowest vision point on the second pole. Multiply the distance between the upper and lower vision points on the second pole by the longer of the other two measurements and divide by the shorter; the result will be the height of the tree.

Example: Let $ab=6$; $Sb=4$; and $SB=30$; then $\frac{6\times30}{4}=45$, height of tree.

Another method sometimes used is as follows: The observer walks to a distance from the foot of the tree about equal to its estimated height. He then lies on his back, stretched at full length (fig. 7), and an assistant notes on a vertical staff erected

at his feet, the exact point where his line of vision to the top of the tree crosses the staff. The height of this point from the ground BC is measured and his own height from his feet to his eyes AB. Then: AB: BC=AD: DE. $DE=\frac{BC\times AD}{AB}$.

Example: Let AB=6; BC=5; AD=60; then $\frac{5\times 60}{6}$=50, height of tree.

Faustmann's Height Measure.

This instrument, shown in figure 8, consists of a skeleton rectangular metal frame having two crossbars at one side of its longi-

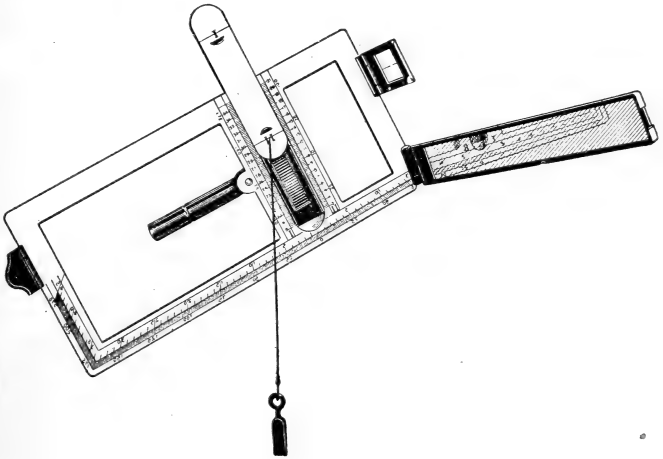

FIG. 8.—Faustmann's height measure.

tudinal center, the frame and bars being in one piece. A slide, reversible end for end and having beveled edges, works in undercut grooves formed in the inner edges of the crossbars. This slide is provided at its ends with thumb notches, and with transversely arranged index marks, designated I and II. A plumb line carrying a plummet is attached to the slide in the center of the index mark II. A retaining spring secured to the back of the frame and bearing against the inner face of the slide holds it in any position

in which it may be set. The left-hand end bar of the frame is furnished with an eyepiece, and the right-hand end bar with an objective, these being made of metal and hinged so as to be folded down out of the way when the device is not in use. A long, narrow mirror, hinged to the frame at a point below the objective, is furnished to reflect a right-hand horizontal scale and a left-hand horizontal scale engraved upon the lower bar of the frame, and meeting at a zero point which is intersected by a line passing through the longitudinal center of the slide. The right-hand scale runs to 75 and the left-hand scale to 225, the latter scale extending upward on the left-hand end bar of the frame. The right-hand crossbar is provided with a vertical scale running upward from zero to 100, and continued on the left-hand crossbar with a scale running upward to 175. These scales are divided in fifths and numbered. The lines forming the scales are equally separated from each other and represent units of distance under any system of measurement that may be adopted. The handle of the device is attached to the left-hand crossbar.

To use the instrument, the observer measures the horizontal distance in feet, yards, or in any other desirable unit, from where he is to stand to the base of the tree. He then sets the slide by one or the other of its two index marks, which is brought into line with the graduation on the vertical scale corresponding to the measurement just secured. If the distance is less than 75, the slide should be set so that the upper end of the plumb line will take a position opposite the required number on the portion of the vertical scale on the right-hand crossbar. If the distance is more than 75, the slide should be pulled out and reversed end for end and adjusted until the index mark at its then lower end is brought opposite the required number on that portion of the vertical scale on the left-hand crossbar. The observer then looks through the eyepiece and objective and brings the hair of the latter into line with the top of the tree. The plumb line is allowed full play and crosses the left-hand horizontal scale. As soon as the plumb line is at rest the number which it crosses is read off in the mirror. This number indicates the height of the tree from the level of the observer's eye to its top. He then sights through the instrument to the base of the tree and reads the number crossed by the plumb

line on the right-hand horizontal scale. This number indicates the distance from the level of the observer's eye to the base of the tree, and is added to the number before secured, which gives the total height of the tree. If the observer should be standing so that the level of his eye is below the base of the tree, he should first determine the height from the level of his eye to the top of the tree, then the height from the level of his eye to the base of the tree, and subtract the last result from the first, which gives the true height of the tree. Cost about $10. (See fig. 9.)

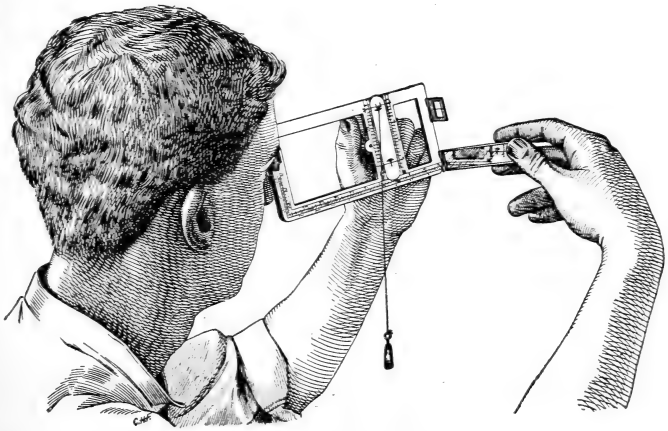

FIG. 9.—Manner of using Faustmann's height measure.

A cheaper form of this instrument has a wooden frame and slide, and scales printed upon strips of paper pasted upon the frame.

Forest Service Standard Hypsometer.

For use on the National Forests, and in its investigative work elsewhere, the Forest Service has adopted a standard hypsometer. The following instructions for its use have been issued:[a]

Stand 100 feet from the base of the tree which is to be measured.

[a] From "Instructions for Making Forest Surveys and Maps," unnumbered circular of the Forest Service, United States Department of Agriculture.

The observer inserts the fingers of his left hand into the loop of leather straps attached to the back of the hypsometer, with both

FIG. 10.—Method of sighting with standard hypsometer.

straps inside of the hand and the instrument on the back of the fingers. Closing the hand enables him to grasp the straps firmly.

The thumb is in such a position as readily to press down the small brass knob which releases the circular pendulum on the inside of case. By an easy motion of the elbow, the small peephole is brought close to the eye of the observer. The square window, directly opposite the peephole, is pointed toward the object whose height is to be determined. The light enters from the large window on the face of instrument.

With the thumb pressing the release, the sight is taken on the object and the height is read at the same time; or the thumb may be lifted, and the pendulum thus being clamped, the height of the tree may be read through the window.

If the observer stands only 50 feet from the tree the reading must be divided by 2. If he stands 200 feet away it must be multiplied by 2, and proportionately for other distances.

The reading gives the height above the level of the eye. Allowance must be made if the observer's eye is above or below the stump height of the tree.

The notebook and pencil are held in the right hand while an observation is being taken, and the notebook is passed to the left hand when the observation is entered. The hypsometer being on the back of the fingers allows free play for the thumb, palm, and ends of the fingers of the left hand to hold the notebook. In moving from station to station the right hand is then free to assist in getting through the brush or in crossing logs.

The circular pendulum is graduated to tangents. Therefore it may be used to determine the per cent of grade of a road or trail. For this purpose sights may be taken downhill as well as uphill. No conversion of figures is necessary. If the reading is 10 the grade is 10 per cent. (See fig. 10.)

Combined Surveyor's Hand Level and Clinometer.

This instrument (shown in fig. 11) has a telescoping surveyors' hand level of ordinary construction, except that its spirit tube is located above instead of in its main tube, which, however, contains the usual inclined steel mirror and sighting cross wire.

Combined with the hand level is a clinometer comprising a plate screwed to one side of the main tube of the hand level and having engraved upon it a curved right-hand scale and a curved left-hand

scale. These scales are struck from the same center and meet at a zero point, from which they are graduated outward in degrees to 90. A measuring arm, having a spatulate lower end beveled to receive vernier graduations, sweeps these scales. This arm is carried by a short shaft journaled in the upper edge of the plate and concentric with the two curved scales. The outer end of the shaft is furnished with a knurled handwheel, by which the clinometer is operated. The inner end of the shaft carries a frame supporting the tubular case containing the spirit tube of the hand level, the center of the case being cut away to show the bubble in the tube. A jam nut for setting the instrument is applied to the extreme inner end of the shaft, and when turned inward holds the same

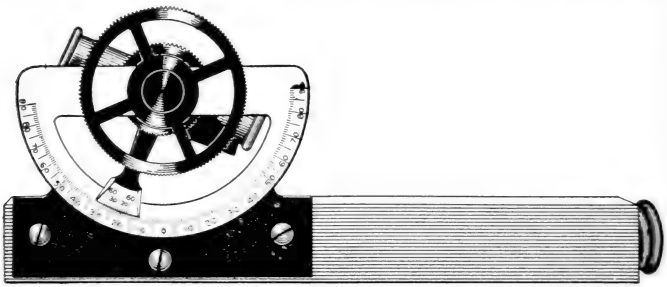

FIG. 11.—Combined surveyor's hand level and clinometer.

against turning. The measuring arm and frame are rigid with the shaft, so that when the same is turned in either direction they turn together and to the same extent, the same as if of one piece. The case stands at a right angle to the measuring arm, so that when the arm is placed at the zero point of the two scales the case will be exactly parallel with the longitudinal axis of the hand level.

A slot formed in the top of the main tube is located in line below the exposed middle portion of the spirit tube and in line above the mirror, and permits the bubble to be reflected in the mirror, which is so narrow and placed so close to the off side of the main tube that it does not interfere with the line of vision through the same and a view of the cross wire.

The hand level is often of use to lumbermen in laying out roads and trails and in locating dams. To use the instrument as a hand level it must first be set by swinging the case containing the spirit tube into line with the main tube. The observer then sights at an object through the tube, which he brings to a level by the bubble reflected in the mirror, and then notes whether or not the object is above or below the cross wire. If the object is in direct line with the cross wire it is on the same level with his eye; otherwise the object is above or below the level of his eye, as the case may be.

The lumberman may also use the hand level in finding the height of a hill, or the height of any point on the slope of a hill, as is necessary in making topographical maps. To find the height of a hill, the observer begins at its base, and after leveling the instrument, sights in the desired direction, and notes the point ahead intersected by the cross wire; he then advances to that point and repeats the operation, and so moves up the hill from point to point until the top is reached. As between each observation he advances a height equal to the distance from the ground to his eye, the height of the hill will be the product of that distance by the number of observations taken.

The instrument may also be used as a clinometer to ascertain the slope of a hill. To do this the observer sights the instrument at an object on the slope which is the same height above the ground as his eye and located above or below where he stands, according as he is sighting up or down the hill. He now uses the handwheel to swing the tubular case until the bubble shows it is level. The measuring arm, which swings with the case, is at the same time swept over one or the other of the two scales, and indicates upon it the slope of the hill in degrees.

If the observer will provide himself with a table of natural tangents, he may use the instrument for measuring the height of trees. He sights the instrument at the top of a tree and turns the handwheel until the bubble shows that the case is level, at which time the measuring arm, which swings with the case, indicates upon the right-hand scale in degrees the angle formed by a line running from the observer's eye to the top of the tree and a horizontal line extending from his eye to the trunk of the tree. He then consults his table of natural tangents, which gives him the

value of the angle secured, expressed as its tangent or percentage. The tangent or percentage of this angle multiplied by the horizontal distance from the observer to the tree gives the height of the tree above the level of the observer's eye. He then sights to the base of the tree, and in the same manner ascertains the angle formed by a horizontal line running from him to the tree and a line running from his eye to the base of the tree. He now consults his table again for the value of this angle expressed as its tangent or percentage and multiplies this value by his horizontal distance from the tree, which gives the height of the tree from the ground to the level of his eye. The figures thus secured are added together, giving the total height of the tree. Cost, $13.

The scales of the instrument are sometimes graduated in tangents or percentages of angles instead of in degrees, in which case the table of tangents is not needed.

A number of other height measures are used in Europe, but a full description of them is not given, as that would make this Handbook too voluminous. The most important instruments are the Brandis height measure, the Weise height measure, the Christen height measure, the Klaussner height measure, and the Winkler height measure.

Several instruments have been devised to measure the diameter of a tree at any desired height. They are of practical use when extremely accurate measurements of standing trees are desired, but will probably not be extensively used by timber cruisers. The names of these instruments are the Breymann dendrometer, the Winkler dendrometer (combined with the Winkler height measure), and the Wimmenauer dendrometer.

CALIPERS FOR MEASURING DIAMETERS.

Calipers are supplied to the trade in a variety of forms, but the form shown in fig. 12 is recommended for its simplicity. It consists of a beam having a scale on both sides, graduated in inches and tenths. This beam is provided at one end with an arm held in place by a bolt and nut which permit it to be detached for convenience of transportation. The beam is provided also with a sliding arm fitted loosely, so as to slide easily over it, but con-

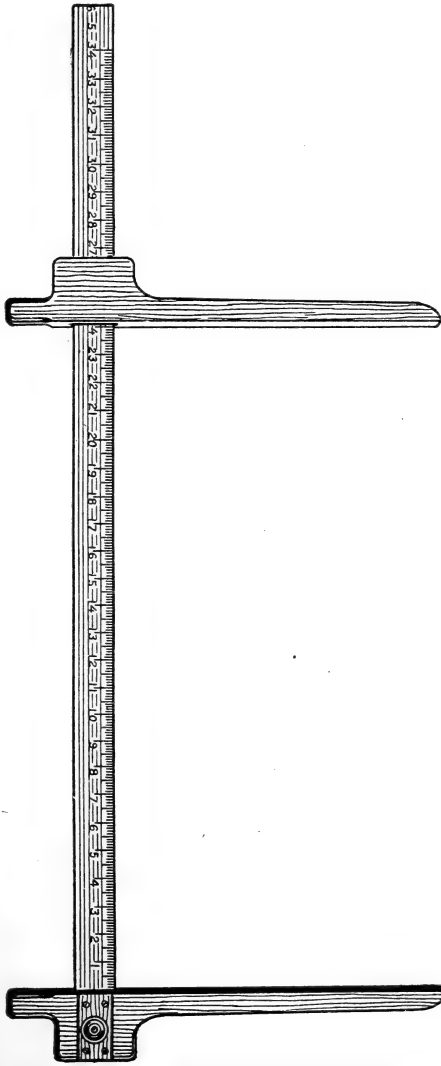

FIG. 12.—Calipers for measuring diameters.

structed so that when pressure is applied to its inner edge, as when it is brought against a tree trunk, it swings into a position in which it is at a true right angle to the beam.

For use in eastern forests the most convenient caliper is one having a beam measuring 36 inches and arms half that length. Cost, $4. In forests where trees over 3 feet in diameter occur a caliper having a beam measuring 50 inches and proportionately long arms should be used.

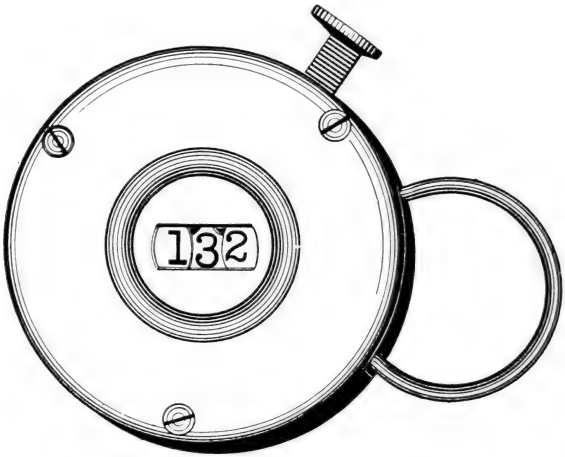

FIG. 13.—Cruiser's tree counter.

Care should be taken to secure calipers made of perfectly seasoned wood, for otherwise they will warp. Calipers graduated to show the contents of logs in board feet or cords are being introduced in many sections of the country.

DIAMETER TAPE.

This is a tape for ascertaining the diameter of very large trees, such as the redwoods of the Pacific coast. It is furnished with special graduations, so that when the girth of a tree has been measured its diameter is read directly from the tape. No cut of this tape is shown.

CRUISER'S TREE COUNTER.

This is a useful device for counting trees in cruising. It consists of a metal box or case about 2 inches in diameter and half an inch thick, containing a mechanism including three numbered wheels, the edges of which are exposed through a small glass disk set in the center of the front of the case. The wheels are turned step by step by a plunger projecting through the edge of the case in position to be operated by the thumb. The box is carried within the palm of the hand and held by a ring through which the middle finger is passed. It counts from 1 to 999, and costs $2.50. (See fig. 13.)

CRUISER'S BARK BLAZER.

One form of this consists of a flat ellipitcal iron plate having its center cut away to receive the hand and provided on one side and near one end with a hook-like gouge offsetting from the plate at such an angle that when struck with a drawing motion into the bark of a tree a clean blaze will be made. Two wooden handle pieces are riveted to the plate on the opposite side from the gouge. (See fig. 14.)

FIG. 14.—Cruiser's bark blazer.

This instrument is useful in spotting trees, in making estimates, and in laying out roads and trails. It is so simple in construction that it may be made by any blacksmith.

THE PRESSLER INCREMENT BORER.

For extracting a solid plug of wood from a standing tree in order to count the rings in the last 1 or 2 inches, with less injury to the tree than cutting a notch for this purpose.

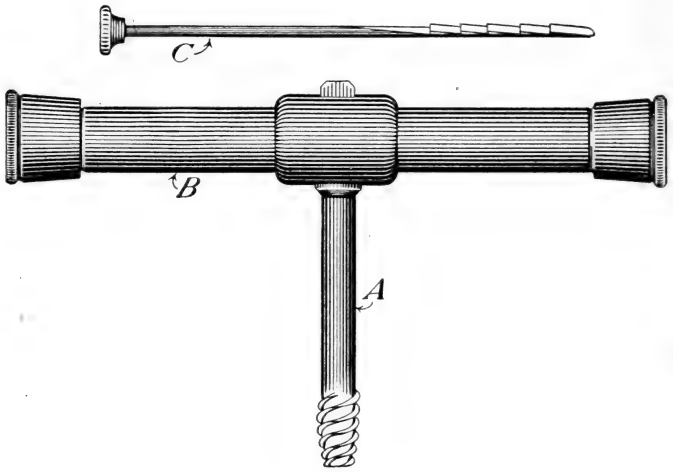

FIG. 15.—Pressler increment borer.

The instrument consists of three essential parts:

A hollow steel auger (A) 3 or 4 inches long, tapering and threaded on one end and a square shank at the other to fit in the square eye of the hollow handle (B). (C) is a pin-shaped wedge with toothed end. The auger and wedge are carried in the hollow handle (which is fitted with screw caps) when not in use.

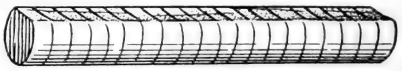

FIG. 16.—Core extracted, showing rings.

In using the instrument it is bored into the tree toward the center. As the thread forces the auger in, the knife edge surrounding the opening of the auger cuts a solid cylinder of wood

which passes up inside the auger. When the proper depth has been bored, the thin wedge (C) is driven into the hollow auger from the shank end and passes between the cylinder of wood and the side of the auger, thus wedging it fast. Then the first twist of the auger, in withdrawing it, breaks off the cylinder of wood even with the inner end and it is withdrawn in the auger. The wedge is then removed, pulling the wood cylinder with it. If this is done carefully, and the wedge has not been driven in too tightly, the wood cylinder will remain unbroken. The cylinder is then laid in a trough of wood (elder is good) hollowed out to receive it and the top shaved off with a sharp knife at right angles to the rings, which makes them easy to count and measure.

APPENDIX.

VOLUME TABLES.

Northeastern Trees.

TABLE 1.—**Aspen or Popple.**[a]

Volume of peeled pulp wood in cubic feet, Plainfield, N. H.

Diameter breast-high.	TOTAL HEIGHT OF TREE (FEET).				Basis.
	50	60	70	80	
	VOLUME OF USED LENGTH (CUBIC FEET).				
Inches.					*Trees.*
5	2.0	2.2	.....	.....	19
6	3.1	3.6	4.5	.....	69
7	4.3	5.3	6.5	7.7	65
8	5.7	7.3	8.8	10.2	58
9	7.1	9.6	11.7	13.4	40
10	.....	12.2	14.9	17.2	15
11	.....	.....	18.3	21.3	13
12	.....	.....	22.3	26.0	8
13	.....	.....	26.8	31.0	2
					289

Reduce to cords by dividing by 90.

[a] Measurements by L. Margolin, U. S. Forest Service in cooperation with the State of New Hampshire, N. H. Forestry Report, 1905-6. Stumps averaged about 1 foot in height.

TABLE 2.—**Beech.**[a]

Volume in board feet saw cut of trees of different diameters showing percentage of different grades, Herkimer County, N. Y.

Diameter breast-high.	Firsts and seconds.	No. 1 common.	No. 2 common (shipping culls).	No. 3 common (mill culls).	Sound 7″ x 9″ x 8′ ties.	Total volume.	Number of trees tallied.
Inches.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Bd. ft.*	
13	2	7	5	35	51	83	12
14	3	7	4	27	59	115	55
15	5	7	4	22	62	142	52
16	6	8	4	20	62	167	56
17	8	8	5	19	60	189	44
18	10	9	5	19	56	211	46
19	14	9	6	20	51	240	25
20	17	9	7	21	46	275	24
21	20	10	6	21	43	314	16
22	21	11	6	22	40	359	5
23	23	12	6	21	38	414	6
24	22	15	6	21	36	473	4
							345

[a] Band and circular saws used. Tallied by E. A. Braniff on the Moose River Lumber Company's mill at McKeever, N. Y., 1904.

TABLE 3.—Paper Birch.[a]

Volume of used length with bark on in cubic feet, southern New Hampshire.

Diameter breast-high.	LENGTH OF TREE USED (FEET).					Basis.
	10	20	30	40	50	
	VOLUME OF USED LENGTH (CUBIC FEET).					
Inches.						*Trees.*
6	2.2	4.1	5.2	6.3	7.5	16
7	2.9	5.2	6.9	8.1	9.7	58
8	3.6	6.6	8.3	10.0	12.1	79
9	4.4	8.0	10.3	12.1	15.1	82
10	5.2	9.8	12.6	14.9	18.0	70
11	6.3	11.6	15.0	17.9	21.4	57
12	7.8	13.7	17.9	21.1	24.9	36
13	.....	15.9	20.9	25.0	28.8	13
14	.....	18.2	24.1	28.9	32.8	10
15	.....	21.0	27.6	32.8	36.9	6
16	.....	.....	31.0	37.0	41.5	.....
						427

Reduce to cords by dividing by 90.

[a] Origin same as aspen or popple table.

TABLE 4.—**Paper Birch.**[a]

Volume in round-edged boards, actual mill cut, southern New Hampshire.

Diameter breast-high.	LENGTH OF TREE USED (FEET).					Board feet per 1 cubic foot of log.	Basis.
	10	20	30	40	50		
	VOLUME OF USED LENGTH (BOARD FEET).[b]						
Inches.						*Number.*	*Trees.*
6	9	17	21	26	31	4.1	16
7	14	24	32	38	46	4.7	58
8	18	34	42	51	62	5.1	79
9	24	43	56	65	82	5.4	82
10	29	55	71	83	101	5.6	79
11	37	67	87	104	124	5.8	57
12	46	81	106	124	147	5.9	36
13	.....	95	125	150	173	6.0	13
14	.....	111	147	176	200	6.1	10
15	.....	130	171	203	229	6.2	6
16	.....	.....	195	233	261	6.3	.....
						5.5	427

[a] Origin same as aspen table.

[b] Sawed into 1¼-inch round-edged boards.

TABLE 5.—**Yellow Birch.**[a]

Volume in board feet saw cut of trees of different diameters showing percentage of different grades, Herkimer County, N. Y.

Diameter breast-high.	Firsts and seconds red.	Firsts and seconds.	No. 1 common.	No. 2 common (shipping culls).	No. 3 common (mill culls).	Sound 7″ x 9″ x 8′ ties.	Total volume.	Number of trees tallied.
Inches.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Bd. ft.*	
13	.....	5	9	10	34	42	59	7
14	.....	7	8	7	39	39	95	16
15	.....	9	8	6	33	44	125	23
16	.....	11	8	5	27	49	146	32
17	.....	13	9	5	21	52	163	32
18	1	15	9	5	19	51	186	57
19	2	17	9	4	21	47	217	50
20	3	18	10	4	22	43	250	39
21	8	18	9	5	22	38	297	40
22	8	20	9	5	22	36	331	46
23	10	21	9	4	23	33	363	25
24	12	22	9	5	23	29	388	37
25	15	23	9	5	23	25	408	30
26	19	22	9	5	23	22	434	24
27	21	22	10	5	23	19	470	28
28	23	22	11	4	23	17	505	16
29	23	22	11	4	25	15	545	4
30	24	22	11	4	26	13	588	12
31	24	23	11	4	29	9	619	4
								522

[a] Band and circular saws used. Tallied by E. A. Braniff on the Moose River Company's mill at McKeever, N. Y., 1904.

TABLE 6.—**Hemlock.**[a]

Volume in board feet, southern New Hampshire.

Diameter breast-high.	HEIGHT OF TREE (FEET).					Board feet per 1 cubic foot of log.	Diameter of last log inside bark.	Basis.
	30	40	50	60	70			
	VOLUME (BOARD FEET).[b]							
Inches.						*Number.*	*Inches.*	*Trees.*
6	5	.....	.....	.....	.....	4.5	4.4	4
7	10	20	30	42	.....	5.0	4.4	17
8	17	28	39	50	.....	5.3	5.1	40
9	26	36	49	60	.....	5.5	5.3	57
10	36	46	59	71	86	5.6	5.7	57
11	47	58	72	86	103	5.6	5.5	41
12	60	72	86	103	123	5.7	6.0	42
13	.....	88	104	124	148	5.7	6.7	17
14	.....	107	125	147	173	5.8	6.1	14
15	.....	126	148	172	204	5.9	6.4	14
16	.....	148	171	200	240	6.1	6.7	6
17	.....	.....	197	233	281	6.2	5.9	8
						5.7		317

[a] Origin same as aspen table.

[b] Actually cut out with a circular saw. One-half of cut went into scantling and the other half into 1-inch boards.

TABLE 7.—**Sugar Maple.**[a]

Volume in board feet saw cut of trees of different diameters, showing percentage of different grades, Herkimer County, N. Y.

Diameter breast-high.	Firsts and seconds.	No. 1 common.	No. 2 common (shipping culls).	No. 3 common (mill culls).	Sound 7″ x 9″ x 8′ ties.	Total volume.	Number of trees tallied.
Inches.	*Per ct.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Bd. ft.*	
13	5	13	5	25	52	81	5
14	5	10	4	18	63	119	14
15	6	10	4	16	64	142	28
16	9	10	4	15	62	162	18
17	13	10	4	16	57	184	34
18	17	10	4	16	53	207	33
19	20	11	4	16	49	232	20
20	24	11	4	16	45	255	28
21	28	11	4	16	41	283	16
22	30	12	5	17	36	319	22
23	32	12	6	18	32	354	18
24	34	12	6	19	29	382	9
25	35	13	6	20	26	410	9
26	36	13	7	21	23	430	4
27	38	14	7	22	19	445	5
28	42	14	7	24	13	447	3
							266

[a] Band and circular saws used. Tallied by E. A. Braniff on the Moose River Lumber Company's mill at McKeever, N. Y., 1904.

TABLE 8.—**Red Oak.**[a]

Volume in board feet, southern New Hampshire.

Diameter breast-high.	LENGTH OF TREE USED (FEET).					Board feet per 1 cubic foot of log.	Basis.
	10	20	30	40	50		
	VOLUME (BOARD FEET).[b]						
Inches.						*Number.*	*Trees.*
5	6	.....	.....	.....	.....	3.6	3
6	9	15	.....	.....	.....	4.0	19
7	14	22	29	34	.....	4.4	73
8	18	30	39	43	.....	4.8	128
9	25	40	49	58	.....	5.1	142
10	31	50	60	73	99	5.4	129
11	37	63	74	90	118	5.5	72
12	44	78	89	110	143	5.7	44
13	54	93	107	132	174	5.8	32
14	65	109	126	160	208	5.9	14
15	.....	124	149	190	243	6.1	10
16	.....	143	173	225	288	6.2	8
17	.....	163	201	262	330	6.4	7
18	.....	181	232	308	378	6.6	1
19	.....	202	265	356	428	6.8	1
20	.....	.....	.....	405	478	7.0	.....
						5.57	683

[a] Origin same as aspen table.

[b] Actual mill cut in 1½-inch round-edged boards, allowing one-eight inch for drying and dressing.

TABLE 9.—Second Growth White Oak.[a]

Volume of cord wood in cubic feet, Hyde Park, N. Y.[b]

Diameter breast-high.	HEIGHT OF TREE (FEET).					Basis.
	20	30	40	50	60	
	VOLUME OF CORD WOOD (CUBIC FEET).[c]					
Inches.						*Trees.*
2	0.2	0.5	.....	.....	.....	32
3	.5	.8	1.1	.....	.....	48
4	.9	1.4	1.8	.....	.....	71
5	.....	2.3	2.7	3.2	.....	61
6	.....	3.4	4.0	4.8	5.7	44
7	.....	4.8	5.7	6.6	7.9	40
8	.....	.....	7.7	9.0	10.6	26
9	.....	.....	.....	11.8	13.6	4
10	.....	.....	.....	15.3	17.3	8
11	.....	.....	.....	19.6	22.6	7
12	.....	.....	.....	24.6	28.0	7
13	.....	.....	.....	.....	32.2	1
						349

[a] Measurements by J. G. Peters, 1905.

[b] This table may be used for other second-growth hardwoods to be cut into cord wood.

[c] These volumes include all the tree that may be utilized for cord wood down to 1 inch in diameter. A cord made up of mixed diameters of second-growth wood is considered to contain 80 cubic feet of solid wood, and this table can be reduced to cords by dividing by 80.

TABLE 10.—Red or Norway Pine.

Volume in board feet by the Minnesota-Scribner Rule, northern Minnesota, cutting to a top diameter of 6 inches.

[Trees under 130 years old, cutting to a breast-high diameter limit of 6 inches.]

Diameter, breast-high.	HEIGHT OF TREE (FEET).					Basis.
	60	70	80	90	100	
	VOLUME (BOARD FEET).					
Inches.						*Trees.*
7	17	24	.....	.....	.....	12
8	29	38	50	.....	.....	17
9	44	53	68	81	94	29
10	61	72	88	104	119	48
11	80	92	110	130	148	52
12	100	114	136	159	180	30
13	120	138	160	189	214	23
14	140	164	189	222	250	22
15	.....	190	220	257	292	9
16	.....	.....	252	296	340	6
17	.....	.....	.....	334	394	5
18	.....	.....	.....	372	450	6
						259

TABLE 11.—Red Pine.[a]

[Over 200 years old.]

Diameter, breast-high.	HEIGHT OF TREE (FEET).				Basis.
	70	80	90	100	
	MERCHANTABLE VOLUME (BOARD FEET).				
Inches.					*Trees.*
10	85	105	.....	.....	17
11	102	126	147	.....	35
12	122	150	177	.....	48
13	144	178	210	.....	61
14	168	208	246	.....	62
15	193	240	284	.....	64
16	220	275	323	383	77
17	250	311	370	435	89
18	282	349	417	490	92
19	317	390	468	551	37
20	355	433	523	616	80
21	396	480	582	685	69
22	.....	530	646	755	61
23	.....	584	715	830	56
24	.....	.....	790	905	39
25	.....	.....	867	986	39
26	.....	.....	951	1,075	26
27	.....	.....	1,041	1,166	12
					964

[a] Table by T. S. Woolsey, jr., 1905.

TABLE 12.—**White Pine.**[a]

Southern New Hampshire.

Diameter, breast-high.	HEIGHT OF TREE (FEET).										Basis.
	30	40	50	60	70	80	90	100	110	120	
	VOLUME (BOARD FEET).[b]										
Inches.											*Trees.*
5	8	12	15	.....	.....	.....	.....	.....	.....	.....	7
6	13	20	23	27	29	.....	.....	.....	.....	.....	41
7	18	28	34	39	44	.....	.....	.....	.....	.....	75
8	24	36	45	53	62	.....	.....	.....	.....	.....	128
9	32	44	56	69	81	93	.....	.....	.....	.....	156
10	41	53	70	85	102	119	138	.....	.....	.....	177
11	....	63	84	103	126	147	168	.....	.....	.....	164
12	....	73	100	125	151	177	200	228	245	.....	146
13	....	84	117	148	180	210	238	270	293	.....	137
14	....	95	137	173	210	243	277	312	348	.....	91
15	....	105	158	200	241	282	321	362	406	.....	61
16	....	.....	181	230	277	323	370	415	470	.....	88
17	....	.....	209	261	313	368	421	471	540	.....	70
18	....	.....	238	297	352	411	475	531	610	688	68
19	....	.....	270	336	393	460	530	598	682	763	44
20	....	.....	302	379	436	506	583	660	750	840	35
21	....	.....	.....	425	480	553	634	720	820	918	23
22	....	.....	.....	.....	522	597	681	779	887	990	16
23	....	.....	.....	.....	566	639	727	834	958	1,065	19
24	....	.....	.....	.....	.....	674	769	889	1,030	1,135	9
25	....	.....	.....	.....	.....	706	809	942	1 105	.....	12
26	....	.....	.....	.....	.....	737	846	994	1,180	.....	11
27	....	.....	.....	.....	.....	.....	.....	1,046	.....	.....	.....
											1,578

[a] Origin of table same as aspen.

[b] The volume given is actual saw cut. Sixty per cent was round-edged and 40 per cent squared, 70 per cent 1-inch boards and 30 per cent 2½-inch plank.

TABLE 13.—White Pine.[a]

Volume in board feet by the Scribner Rule, northern Minnesota.

Diameter, breast-high.	HEIGHT OF TREE (FEET).											Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100	110	120	130	140		
	VOLUME (BOARD FEET).												
Inches.												*Inches.*	*Trees.*
8	20	25	30	35	45	.....	.....	.....	.....	.....	.....	6	129
9	25	35	45	50	60	.....	.....	.....	.....	.....	.....	6	220
10	35	45	55	65	75	90	.....	.....	.....	.....	.....	6	248
11	40	55	65	80	95	110	125	.....	.....	.....	.....	7	279
12	50	65	80	95	115	130	150	.....	.....	.....	.....	7	279
13	55	75	95	115	135	155	175	.....	.....	.....	.....	7	271
14	65	90	110	135	155	180	205	230	.....	.....	.....	7	4
15	....	105	130	155	180	210	235	265	.....	.....	.....	7	246
16	....	120	150	180	210	245	275	300	.....	.....	.....	7	222
17	....	....	170	205	240	280	310	345	.....	.....	.....	8	259
18	....	....	190	235	275	315	355	390	.....	.....	.....	8	202
19	....	....	215	265	310	355	400	440	.....	.....	.....	8	190
20	....	....	....	295	350	400	450	495	535	.....	.....	9	163
21	....	....	....	330	390	450	500	560	600	.....	.....	9	155
22	....	....	....	370	430	500	560	620	670	.....	.....	9	118
23	....	....	....	....	480	550	620	680	730	.....	.....	10	106
24	....	....	....	....	530	610	680	750	810	860	920	10	85
25	....	....	....	....	590	670	750	820	880	950	1,020	10	99
26	....	....	....	....	650	730	810	890	960	1,040	1,110	11	68
27	....	....	....	....	710	800	870	960	1,040	1,130	1,210	11	63
28	....	....	....	....	780	860	940	1,030	1,120	1,220	1,310	11	56
29	....	....	....	....	....	930	1,000	1,100	1,200	1,310	1,410	12	37
30	....	....	....	....	....	1,000	1,070	1,180	1,280	1,400	1,510	12	37
31	....	....	....	....	....	.....	1,140	1,250	1,370	1,490	1,600	12	36
32	....	....	....	....	....	.....	1,210	1,330	1,450	1,570	1,700	12	24
33	....	....	....	....	....	.....	1,280	1,400	1,530	1,660	1,790	13	23
34	....	....	....	....	....	.....	1,350	1,480	1,610	1,750	1,880	13	15
35	....	....	....	....	....	.....	1,420	1,550	1,690	1,830	1,970	13	12
36	....	....	....	....	....	.....	1,490	1,630	1,770	1,910	2,060	13	8
37	....	....	....	....	....	.....	1,560	1,700	1,850	2,000	2,150	13	4
38	....	....	....	....	....	.....	1,630	1,780	1,930	2,080	2,240	13	3
39	....	....	....	....	....	.....	.....	1,860	2,020	2,170	2,330	13	6
40	....	....	....	....	....	.....	.....	1,940	2,100	2,260	2,420	14	3
													3,899

Height of stump 0.5–3.5 feet.

[a] Table by E. S. Bruce, 1905.

TABLE 14.—**Spruce.**

Volume of unpeeled pulp wood in cubic feet, southern New Hampshire.

Diameter breast-high.	HEIGHT OF TREE (FEET).						Basis.
	40	50	60	70	80	90	
	VOLUME (CUBIC FEET).						
Inches.							*Trees.*
5	1.9	2.5	3.0	.....	.....	.....	29
6	3.5	4.2	5.2	6.4	.....	.....	98
7	5.0	6.2	7.5	9.0	.....	.....	128
8	6.6	8.4	10.0	11.7	.....	.....	165
9	8.5	10.8	12.7	14.8	.....	.....	161
10	.....	13.5	15.6	18.0	.....	.....	113
11	.....	16.5	18.8	21.5	.....	.....	78
12	.....	19.5	22.3	25.4	.....	.....	63
13	.....	.....	26.0	29.5	34.5	.....	42
14	.....	.....	30.0	34.0	39.5	.....	55
15	.....	.....	34.5	38.5	44.0	.....	56
16	.....	.....	39.0	43.5	49.0	.....	49
17	.....	.....	43.5	49.0	55.0	63.5	38
18	.....	.....	48.0	54.5	61.0	70.0	44
19	.....	.....	53.0	60.5	67.5	77.0	30
20	.....	.....	58.0	67.0	74.5	83.5	21
21	.....	.....	.....	74.0	82.0	90.5	18
22	.....	.....	.....	81.5	89.0	98.0	16
23	.....	.....	.....	88.5	96.5	106.0	10
24	.....	.....	.....	95.5	104.5	114.0	5
25	.....	.....	.....	102.0	112.0	123.0	2
26	.....	.....	.....	109.0	120.0	131.5	2
27	.....	.....	.....	.....	128.0	140.0	2
28	.....	.....	.....	.....	135.5	148.5	1
							1,226

Stumps varying from ½ to 1½ feet and tops above 4-inch diameter point are excluded.

To reduce to cords divide by 100 or point off two places. Some use 95 cubic feet per cord.

Bark=11 per cent of volume.

TABLE 15.—Spruce.[a]

Volume in board feet by the New Hampshire Rule,[b] Grafton County, N. H.

Diameter breast-high.	HEIGHT (FEET).				
	40	50	60	70	80
	VOLUME (BOARD FEET).				
Inches.					
7	18	25	30	35	.....
8	29	38	45	53	.....
9	42	53	61	71	.....
10	58	67	78	91	.....
11	76	84	94	110	.....
12	96	100	112	130	.....
13	.....	113	130	151	.....
14	.....	129	148	172	194
15	.....	.....	166	195	219
16	.....	.....	186	219	245
17	.....	.....	208	244	275
18	.....	.....	.....	272	305
19	.....	.....	.....	308	343
20	.....	.....	.....	346	400

[a] Table by T. S. Woolsey, jr., 1903.

[b] Cutting to a top diameter limit of 6 inches.

TREES OF THE SOUTHERN APPALACHIAN REGION.

TABLE 16.—Chestnut.[a]

Volume in board feet by the Doyle-Scribner Rule, southern Appalachian region.

Diameter breast-high.	HEIGHT OF TREE (FEET).								Basis.
	50	60	70	80	90	100	110	120	
	VOLUME (BOARD FEET).								
Inches.									*Trees.*
12	30	35	40	50	55	65	.....	.....	8
13	35	45	55	60	75	85	.....	.....	18
14	45	55	65	75	90	100	.....	.....	24
15	55	65	75	90	105	120	.....	.....	34
16	65	80	90	105	125	145	180	.....	43
17	80	95	110	125	145	170	210	.....	36
18	95	110	125	145	165	195	245	.....	77
19	110	125	145	165	190	225	280	.....	91
20	125	145	165	185	215	255	315	.....	63
21	145	165	190	210	240	290	355	.....	57
22	165	185	210	235	270	325	395	.....	71
23	185	205	235	260	305	360	435	.....	59
24	205	230	260	290	340	400	480	.....	69
25	225	255	285	320	380	440	525	.....	55
26	250	280	315	335	420	485	575	670	52
27	275	305	345	395	460	530	625	730	48
28	300	335	380	435	505	580	685	800	47
29	320	360	410	480	555	630	745	870	39
30	345	390	445	520	600	685	810	940	31
31	370	420	480	565	650	745	875	1,020	41
32	390	450	520	605	700	810	950	1,105	38
33	.....	.....	555	640	755	875	1,030	1,210	32
34	.....	.....	.....	680	805	940	1,120	1,320	27
35	.....	.....	.....	715	860	1,010	1,205	1,435	18
36	.....	.....	.....	750	910	1,080	1,290	1,545	19
									1,097

[a] Compiled under direction of Walter Mulford, 1905–6.

TABLE 17.—Chestnut.[a]

Volume in cubic feet of extract wood, southern Appalachian region.

Diameter breast-high	HEIGHT OF TREE (FEET).								Diameter of top outside bark.	Basis.
	40	50	60	70	80	90	100	110		
	VOLUME (CUBIC FEET).									
Inches.									*Inches.*	*Trees.*
6	3.5	4.0	5.0	.....	.....	.....	.....	.....	4.3	1
7	4.5	5.5	6.5	.....	.....	.....	.....	.....	4.9	4
8	5.5	7.0	8.5	10.0	.....	.....	.....	.....	5.4	7
9	7.0	8.5	10.0	12.0	.....	.....	.....	.....	6.0	10
10	8.5	10.5	12.0	14.0	16.0	.....	.....	.....	6.6	25
11	10.5	12.5	14.5	16.5	19.0	.....	.....	.....	7.2	36
12	12.5	14.5	16.5	19.0	22.0	.....	.....	.....	7.8	49
13	14.5	17.0	19.0	22.0	25.5	.....	.....	.....	8.4	56
14	16.5	19.5	22.0	25.0	29.0	33.0	37.5	.....	9.0	47
15	18.5	22.0	24.5	28.5	32.5	37.0	42.0	.....	9.6	42
16	21.0	25.0	28.0	32.5	36.5	41.5	46.5	.....	10.2	70
17	.....	27.5	31.5	36.0	40.5	46.0	51.5	.....	10.8	66
18	.....	30.5	35.0	40.0	45.0	50.5	56.5	.....	11.4	64
19	.....	34.0	38.5	44.5	49.5	55.5	62.5	.....	12.0	82
20	.....	37.5	42.5	48.5	54.5	61.0	68.0	.....	12.7	72
21	.....	41.0	46.5	53.0	59.5	66.5	74.5	.....	13.3	61
22	.....	44.5	51.0	58.0	65.5	72.5	81.0	.....	13.9	76
23	.....	48.0	55.0	63.0	71.5	79.0	87.5	.....	14.5	58
24	.....	52.0	59.5	68.0	77.5	85.5	94.0	.....	15.2	70
25	.....	55.5	64.0	73.5	83.0	92.0	101.0	.....	15.8	53
26	.....	59.5	69.0	79.0	89.5	99.0	108.0	116.0	16.4	53
27	.....	63.5	73.5	84.5	96.0	106.0	115.0	123.0	17.1	48
28	.....	67.5	78.5	90.0	102.5	112.5	122.5	130.5	17.7	39
29	.....	.....	83.0	96.0	109.0	120.0	130.0	138.5	18.3	35
30	.....	.....	88.0	101.5	115.5	127.5	138.5	147.0	18.9	28
31	.....	.....	.....	107.5	122.5	135.0	147.0	156.0	19.5	24
32	.....	.....	.....	113.5	130.5	143.5	156.0	165.5	20.1	27
33	.....	.....	.....	119.5	138.0	152.0	165.5	175.5	20.7	23
34	.....	.....	.....	125.5	145.0	161.0	175.0	186.0	21.3	22
35	.....	.....	.....	131.5	153.0	170.0	185.0	196.5	21.9	13
36	.....	.....	.....	138.0	161.0	180.0	195.0	208.0	22.4	11
37	.....	.....	.....	144.0	169.5	189.0	205.5	219.0	23.0	10
38	.....	.....	.....	.....	179.0	199.0	216.0	232.0	23.5	13
39	.....	.....	.....	.....	188.5	210.0	228.0	245.0	24.0	6
40	.....	.....	.....	.....	199.0	221.0	240.0	257.5	24.6	7
41	.....	.....	.....	.....	212.0	232.0	251.5	269.0	25.1	3
42	.....	.....	.....	.....	223.0	242.5	262.0	280.0	25.7	5
43	.....	.....	.....	.....	233.5	253.5	272.0	290.5	26.2	6
44	.....	.....	.....	.....	244.5	263.5	281.5	300.0	26.7	3
										1,325

Assume 90 solid cubic feet per stacked cord.

[a] Compiled under direction of Walter Mulford, 1905–6.

TABLE 18.—Hemlock.

Volume in board feet by the Doyle-Scribner Rule, southern Appalachian region.

Diameter breast-high.	HEIGHT OF TREE (FEET).								Height of stump.	Diameter (inside bark) of top.	Basis.
	50	60	70	80	90	100	110	120			
	VOLUME (BOARD FEET).										
Inches.									*Feet.*	*Inches.*	*Trees.*
10	10	10	20	.....	.....	.....	.....	.....	2.1	7	6
11	20	20	30	30	.....	.....	.....	.....	2.2	8	3
12	30	40	40	50	50	.....	.....	.....	2.2	8	9
13	40	50	60	70	80	.....	.....	.....	2.3	9	23
14	60	70	80	90	100	120	.....	.....	2.3	9	33
15	70	80	90	110	130	160	.....	.....	2.4	10	59
16	90	100	110	130	160	190	240	.....	2.4	10	64
17	100	120	140	160	190	230	280	.....	2.4	11	65
18	120	140	170	200	230	270	320	.....	2.5	11	77
19	140	170	200	230	270	310	360	410	2.5	12	83
20	170	200	230	260	310	350	410	460	2.5	12	68
21	190	230	260	300	350	400	460	510	2.5	13	80
22	220	260	300	340	400	450	510	570	2.6	13	81
23	250	290	340	390	440	500	560	630	2.6	13	86
24	290	330	390	440	500	560	620	690	2.6	14	67
25	.....	380	430	490	550	620	690	760	2.6	14	81
26	.....	420	480	540	610	680	750	830	2.6	15	62
27	.....	470	530	600	670	740	830	910	2.6	15	64
28	.....	520	590	660	730	810	900	990	2.6	15	67
29	.....	580	640	720	800	890	980	1,080	2.6	16	54
30	.....	630	700	780	870	970	1,070	1,170	2.6	16	34
31	.....	.....	760	850	950	1,050	1,160	1,270	2.7	17	33
32	.....	.....	820	920	1,020	1,140	1,260	1,380	2.7	17	37
33	.....	.....	880	990	1,110	1,240	1,360	1,500	2.7	18	29
34	.....	.....	940	1,060	1,200	1,340	1,470	1,620	2.7	18	33
35	.....	.....	1,000	1,140	1,290	1,440	1,580	1,740	2.7	19	19
36	.....	.....	.....	1,220	1,380	1,540	1,700	1,870	2.7	19	21
37	.....	.....	.....	1,310	1,480	1,650	1,820	2,000	2.7	19	9
38	.....	.....	.....	1,400	1,580	1,760	1,940	2,120	2.7	20	10
39	.....	.....	.....	1,490	1,680	1,870	2,060	2,250	2.8	20	8
40	.....	.....	.....	1,580	1,790	1,980	2,180	2,380	2.8	21	7
41	.....	.....	.....	.....	1,890	2,090	2,300	2,510	2.8	21	5
42	.....	.....	.....	.....	1,990	2,200	2,420	2,640	2.8	22	5
43	.....	.....	.....	.....	2,090	2,320	2,540	2,770	2.8	22	6
44	.....	.....	.....	.....	2,200	2,440	2,670	2,900	2.8	23	4
45	.....	.....	.....	.....	2,300	2,550	2,790	3,030	2.8	23	3
46	.....	.....	.....	.....	.....	2,660	2,910	3,160	2.8	24	1
47	.....	.....	.....	.....	.....	2,780	3,030	3,290	2.8	25	1
48	.....	.....	.....	.....	.....	2,890	3,150	3,420	2.9	25	2
49	.....	.....	.....	.....	.....	3,010	3,270	3,550	2.9	26	1
50	.....	.....	.....	.....	.....	3,120	3,400	3,680	2.9	26	2
											1,402

TABLE 19.—Hemlock.[a]

Volume of bark, in cords, southern Appalachian region.

Diameter breast-high.	Trees 100 feet and under.		Trees over 100 feet.		Diameter breast-high.	Trees 100 feet and under.		Trees over 100 feet.	
	Volume of bark.	Basis.	Volume of bark.	Basis.		Volume of bark.	Basis.	Volume of bark.	Basis.
Inches.	*Cords.*	*Trees.*	*Cords.*	*Trees.*	*Inches.*	*Cords.*	*Trees.*	*Cords.*	*Trees.*
10	0.10	1	.....	.....	31	0.42	8	0.48	18
11	.11	1	.....	.....	32	.43	4	.50	14
12	.11	2	.....	.....	33	.45	7	.52	16
13	.12	5	.....	.....	34	.47	7	.55	13
14	.13	12	.....	.....	35	.48	3	.57	11
15	.14	13	0.18	1	36	.50	.....	.59	14
16	.15	19	.19	1	37	.52	2	.62	6
17	.17	28	.21	2	38	.53	2	.64	9
18	.19	29	.23	6	39	.55	1	.67	4
19	.21	27	.25	6	40	.56	3	.69	2
20	.23	21	.26	7	41	.58	1	.72	3
21	.25	26	.28	10	42	.60	2	.75	4
22	.27	23	.30	12	43	.....	.....	.78	1
23	.29	33	.32	17	44	.....	.....	.81	.....
24	.30	19	.34	11	45	.....	1	.84	.....
25	.32	21	.36	15	46	.....	.....	.87	2
26	.34	18	.38	15	47	.....	.....	.91	2
27	.35	19	.40	19	48	.....	.....	.94	2
28	.37	14	.42	18					
29	.39	6	.44	16					
30	.40	8	.46	19			386		297

[a] Compiled under direction of Walter Mulford, 1905–6.

TABLE 20.—Hickories.[a]

Volume of used length with bark, in cubic feet, from Pennsylvania to southern Mississippi Valley.

Diameter breast-high.	USED LENGTH (FEET).						Basis.
	10	20	30	40	50	60	
	VOLUME (CUBIC FEET).						
Inches.							*Trees.*
5	1.8	.....	.....	.....	.....	.....	5
6	2.5	3.6	.....	.....	.....	.....	19
7	3.2	5.0	.....	.....	.....	.....	26
8	4.0	6.5	.....	.....	.....	.....	43
9	4.8	8.2	10.0	.....	.....	.....	56
10	5.8	10.0	13.0	.....	.....	.....	53
11	6.9	12.0	16.0	.....	.....	.....	55
12	8.0	14.5	20.0	23.5	.....	.....	30
13	9.3	17.0	23.5	28.5	.....	.....	36
14	10.5	20.0	27.5	34.0	.....	.....	36
15	12.0	23.0	32.0	39.0	.....	.....	29
16	14.0	26.5	36.0	45.0	54.0	.....	24
17	15.5	29.5	41.0	51.0	61.0	.....	23
18	17.5	33.0	46.0	58.0	69.0	.....	17
19	19.5	37.0	52.0	64.0	76.0	.....	23
20	21.5	41.0	57.0	71.0	84.0	97.0	22
21	24.0	45.0	63.0	79.0	93.0	107.0	19
22	26.0	50.0	69.0	86.0	102.0	113.0	20
23	28.5	54.0	75.0	93.0	111.0	128.0	25
24	31.0	59.0	81.0	102.0	121.0	139.0	16
25	34.0	64.0	88.0	110.0	130.0	149.0	10
26	36.5	69.0	95.0	119.0	140.0	161.0	12
27	.....	74.0	103.0	128.0	151.0	173.0	8
28	.....	80.0	112.0	137.0	161.0	185.0	3
							610

[a] Measurements by A. T. Boisen, 1907. Mostly shagbark and pignut (Hicoria ovata and glabra).

TABLE 21.—Hickories.

Percentages of bark and sapwood.

Diameter of tree.	Bark.	Sap-wood.
Inches.	*Per cent.*	*Per cent.*
6	21	73
12	17	60
18	15	48
24	14	39
30	13	35

The used volumes above comprise about 48 per cent of the entire tree. Reduce to cords by dividing cubic feet by 90.

TABLE 22.—**Black Oak.**[a]

Volume in board feet by the Doyle-Scribner Rule, southern Appalachian region.

Diameter breast-high.	HEIGHT OF TREE (FEET).								Height of stump.	Diameter of top inside bark.	Basis.
	60	70	80	90	100	110	120	130			
	VOLUME (BOARD FEET).										
Inches.									*Feet.*	*In.*	*Trees.*
14	40	55	.....	.....	.....	.....	.....	.....	2.5	10	1
15	65	90	115	.....	.....	.....	.....	.....	2.2	10	5
16	80	115	140	160	.....	.....	.....	.....	2.5	11	12
17	110	145	170	195	.....	.....	.....	.....	2.3	12	34
18	135	170	200	225	240	270	.....	.....	2.4	12	49
19	150	200	230	255	280	315	.....	.....	2.3	13	74
20	170	225	265	290	320	365	.....	.....	2.4	13	86
21	185	255	295	330	365	420	.....	.....	2.6	14	81
22	200	280	325	365	415	475	555	.....	2.4	15	79
23	.....	305	360	405	465	530	615	.....	2.6	15	58
24	.....	335	390	450	515	595	680	.....	2.4	16	49
25	.....	365	425	495	575	660	755	865	2.6	17	34
26	.....	390	455	540	630	730	835	950	2.6	17	30
27	.....	.....	490	585	685	800	920	1,045	2.3	18	33
28	.....	.....	.....	635	745	870	1,000	1,135	2.3	19	20
29	.....	.....	.....	680	800	935	1,075	1,225	2.3	19	20
30	.....	.....	.....	725	860	1,000	1,145	1,310	2.2	20	19
31	.....	.....	.....	765	915	1,065	1,215	1,375	2.4	21	20
32	.....	.....	.....	810	975	1,125	1,280	1,430	2.3	22	12
33	.....	.....	.....	855	1,035	1,185	1,335	1,480	2.5	23	6
34	.....	.....	.....	900	1,100	1,240	1,390	1,525	2.5	23	4
35	.....	.....	.....	.....	1,150	1,300	1,435	1,570	2.4	24	7
36	.....	.....	.....	.....	1,200	1,350	1,480	1,610	2.2	25	3
37	.....	.....	.....	.....	.....	.....	1,520	1,645	2.8	26	2
38	.....	.....	.....	.....	.....	.....	1,560	1,685	3.5	27	3
											741

[a] Compiled under direction of Walter Mulford—1905–6.

TABLE 23.—Chestnut Oak.[a]

Volume in board feet by the Doyle-Scribner Rule, southern Appalachian region.

Diameter breast-high.	HEIGHT (FEET).								Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100	110		
	VOLUME (BOARD FEET).									
Inches.									*Inches.*	*Trees.*
10	15	20	25	.....	.....	.....	.....	.....	8	.....
11	20	25	30	.....	.....	.....	.....	.....	9	.....
12	25	30	40	50	.....	.....	.....	.....	10	46
13	35	40	50	60	.....	.....	.....	.....	10	50
14	45	55	65	75	90	.....	.....	.....	11	74
15	55	65	80	95	115	.....	.....	.....	11	102
16	70	80	95	115	135	160	.....	.....	12	81
17	.....	95	115	140	160	185	.....	.....	13	101
18	.....	110	135	165	185	215	255	.....	13	102
19	.....	130	160	190	215	245	290	.....	14	92
20	.....	145	185	220	245	280	325	345	14	108
21	.....	.....	210	250	280	315	360	385	15	89
22	.....	.....	235	280	320	355	400	430	16	85
23	.....	.....	265	315	355	400	445	475	16	77
24	.....	.....	295	350	400	445	495	530	17	82
25	.....	.....	.....	385	440	495	545	585	17	80
26	.....	.....	.....	425	490	550	605	645	18	68
27	.....	.....	.....	465	540	605	665	710	19	58
28	.....	.....	.....	510	590	665	730	780	19	54
29	.....	.....	.....	.....	640	730	795	855	20	26
30	.....	.....	.....	.....	690	790	865	935	21	29
31	.....	.....	.....	.....	745	860	940	1,020	21	35
32	.....	.....	.....	.....	800	930	1,025	1,110	22	15
33	.....	.....	.....	.....	.....	1,005	1,115	1,210	23	13
34	.....	.....	.....	.....	.....	1,080	1,210	1,320	23	10
35	.....	.....	.....	.....	.....	1,160	1,305	1,430	24	5
36	.....	.....	.....	.....	.....	.....	1,400	1,530	25	4
37	.....	.....	.....	.....	.....	.....	1,485	1,630	26	2
38	.....	.....	.....	.....	.....	.....	1,565	1,730	26	1
39	.....	.....	.....	.....	.....	.....	.....	1,830	27	.....
40	.....	.....	.....	.....	.....	.....	.....	1,930	28	1
										1,490

[a] Compiled under direction of Walter Mulford—1905–6.

TABLE 24.—**Chestnut Oak.**[a]

Volume of bark in cords, southern Appalachian region.

Diameter breast-high.	Trees 75 feet and under.	Basis.	Trees 75 feet and over.	Basis.	Diameter breast-high.	Trees 75 feet and under.	Basis.	Trees 75 feet and over.	Basis.
Inches.	*Cords.*	*Trees.*	*Cords.*	*Trees.*	*Inches.*	*Cords.*	*Trees.*	*Cords.*	*Trees.*
8	0.03	.....	.....	.....	21	0.19	13	0.18	20
9	.04	1	.....	.....	22	.20	16	.20	25
10	.05	3	0.08	.....	23	.21	11	.22	16
11	.05	7	.08	1	24	.22	10	.24	17
12	.06	17	.08	2	25	.23	4	.26	18
13	.07	29	.09	4	26	.23	6	.28	8
14	.08	36	.09	7	27	.24	4	.30	9
15	.09	40	.09	5	28	.25	.....	.32	5
16	.11	43	.10	9	29	.25	.....	.34	5
17	.12	30	.11	10	30	.26	.....	.36	4
18	.14	38	.12	20	31	.....	.....	.37	8
19	.16	28	.14	14	32	.....	.....	.39	3
20	.17	24	.16	15			360		225

[a] Compiled under direction of Walter Mulford—1905–6.

TABLE 25.—Red Oak.[a]

Volume in board feet by the Doyle-Scribner Rule,[b] southern Appalachian region.

Diameter breast-high.	HEIGHT OF TREE (FEET).							Diameter of top inside bark.	Basis.
	60	70	80	90	100	110	120		
	VOLUME (BOARD FEET).								
Inches.								*Inches.*	*Trees.*
14	55	65	.....	.....	.....	.....	.....	11	4
15	60	80	105	.....	.....	.....	.....	12	9
16	70	95	120	145	.....	.....	.....	12	6
17	85	110	140	170	.....	.....	.....	13	34
18	100	130	160	200	245	.....	.....	14	48
19	120	150	190	230	280	.....	.....	14	55
20	140	175	215	260	315	370	.....	15	65
21	165	200	245	295	355	415	.....	15	82
22	195	230	280	335	400	465	.....	16	86
23	225	265	320	380	445	520	.....	17	65
24	255	300	355	425	495	575	665	17	77
25	285	335	400	470	545	635	730	18	61
26	320	370	440	515	600	695	795	19	90
27	.....	410	485	565	660	760	870	19	74
28	.....	450	525	620	720	830	950	20	89
29	.....	485	570	670	780	900	1,030	20	62
30	.....	525	620	725	850	980	1,120	21	52
31	.....	560	670	785	920	1,065	1 215	22	51
32	.....	600	720	845	990	1,150	1,325	22	41
33	.....	640	770	905	1,070	1,240	1,445	23	57
34	.....	.....	825	970	1,145	1,340	1,570	23	29
35	.....	.....	880	1,040	1,220	1,435	1,680	24	22
36	.....	.....	935	1,110	1,295	1,525	1,770	25	17
37	.....	.....	995	1,180	1,375	1,610	1,855	25	27
38	.....	.....	.....	1,245	1,450	1,685	1,935	26	16
39	.....	.....	.....	1,320	1,525	1,760	2,010	26	18
40	.....	.....	.....	1,390	1,610	1,830	2,085	27	16
									1,253

[a] Compiled under direction of Walter Mulford—1905-6.
[b] Height of stump, 2 feet.

TABLE 26.—White Oak.[a]

Volume in board feet by the Doyle-Scribner Rule, southern Appalachian region.

Diameter breast-high.	HEIGHT OF TREE (FEET).							Basis.
	60	70	80	90	100	110	120	
	VOLUME (BOARD FEET).							
Inches.								*Trees.*
14	55	70	90	115	.....	.....	.....	22
15	80	95	115	140	.....	.....	.....	27
16	100	115	140	165	195	.....	.....	24
17	125	140	165	195	225	.....	.....	32
18	150	165	190	225	260	.....	.....	33
19	175	190	220	255	295	.....	.....	62
20	200	215	250	285	335	400	.....	67
21	225	245	280	320	375	450	.....	81
22	250	275	310	355	415	495	.....	86
23	280	305	340	390	455	545	.....	81
24	305	335	375	425	500	595	.....	87
25	335	365	410	465	545	645	.....	70
26	.....	400	445	505	590	695	865	66
27	.....	435	480	545	635	750	920	55
28	.....	470	520	585	685	805	980	56
29	.....	505	555	630	735	860	1,040	51
30	.....	535	595	675	785	920	1,100	52
31	.....	570	630	720	840	985	1,170	35
32	.....	605	670	765	900	1,060	1,245	31
33	.....	640	705	815	960	1,140	1,335	23
34	.....	675	745	865	1,025	1,230	1,445	14
35	.....	.....	.....	915	1,100	1,330	1,580	4
36	.....	.....	.....	970	1,175	1,445	1,750	10
37	.....	.....	.....	1,020	1,270	1,565	1,920	4
38	.....	.....	.....	.....	1,370	1,690	2,050	4
39	.....	.....	.....	.....	1,485	1,825	2,170	3
40	.....	.....	.....	.....	1,625	1,960	2,295	2
								1,082

[a] Compiled under direction of Walter Mulford—1905-6.

TABLE 27.—Second Growth Yellow Poplar.[a]

Volume in board feet by the Scribner Rule,[b] Fairfax County, Va.

Diameter breast-high.	HEIGHT OF TREE (FEET).							Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100		
	VOLUME (BOARD FEET).								
Inches.								*Inches.*	*Trees.*
7	2	7	12	16	.....	.....	.....	5.9	33
8	5	11	17	23	29	.....	.....	5.9	53
9	9	17	25	32	41	48	.....	6.0	70
10	15	25	35	45	56	67	78	6.1	60
11	22	36	48	61	74	88	100	6.2	74
12	32	50	65	80	94	110	123	6.3	56
13	.....	66	84	101	117	134	148	6.4	41
14	.....	.....	106	124	142	160	177	6.5	24
15	.....	.....	129	150	172	191	212	6.6	20
16	.....	.....	.....	179	202	225	250	6.7	25
17	.....	.....	.....	210	236	264	288	6.8	11
18	.....	.....	.....	.....	274	304	328	7.0	7
19	.....	.....	.....	.....	318	346	374	7.1	6
20	.....	.....	.....	.....	.....	395	428	7.2	.....
									480

[a] Measurements by W. W. Ashe, 1907.
[b] Average height of stump, 1.6 feet.

TABLE 28.—**Second Growth Yellow Poplar.**[a]

Total stem volume in cubic feet including bark, top, and stump. Fairfax County, Va.

Diameter breast-high.	HEIGHT OF TREE (FEET).						Basis.
	50	60	70	80	90	100	
	VOLUME (CUBIC FEET).						
Inches.							*Trees.*
5	4.0	4.8	5.8	.....	.....	.....	3
6	5.2	6.3	7.5	8.6	.....	.....	8
7	6.6	7.9	9.5	10.8	12.2	.....	36
8	8.3	10.0	11.8	13.4	15.0	16.8	52
9	10.3	12.4	14.5	16.4	18.4	20.3	69
10	12.6	15.2	17.6	19.8	22.3	24.6	60
11	15.2	18.3	21.2	23.9	27.0	29.7	73
12	18.3	21.9	25.3	28.8	32.4	35.6	56
13	21.8	25.9	30.0	34.0	38.2	42.0	41
14	26.0	30.5	35.2	39.5	44.1	48.7	24
15	30.8	35.4	40.5	45.1	50.3	55.4	20
16	.....	40.4	45.9	51.0	56.6	62.2	25
17	.....	45.6	51.5	57.4	63.3	69.2	11
18	.....	.....	57.6	63.8	69.9	76.2	7
19	.....	.....	63.9	75.2	76.6	83.2	6
20	.....	.....	.....	76.5	83.2	90.1	.....
							491

For estimating peeled pulp wood the bark deduction is 21 per cent in 6-inch trees and 16 per cent in 18-inch trees. The top and stump form from 18 per cent in 6-inch trees to 10 per cent in 18-inch trees of the total volume. Hence, the total deduction for peeled pulp wood for trees 10 to 18 inches may be placed at 25 to 30 per cent of the volume given in the table.

[a] Measurements by W. W. Ashe, 1907.

TABLE 29.—First Growth Yellow Poplar.[a]

Volume in board feet by the Doyle-Scribner Rule,[b] southern Appalachian region.

Diameter breast-high.	HEIGHT OF TREE (FEET).										Diameter of top inside bark.	Basis.
	60	70	80	90	100	110	120	130	140	150		
	VOLUME (BOARD FEET).											
Inches.											*Inches.*	*Trees.*
12	20	45	55	60	65	.....	.....	.....	.....	.....	8	12
13	40	65	75	80	90	95	.....	.....	.....	.....	9	12
14	65	85	95	105	115	125	.....	.....	.....	.....	10	12
15	85	105	120	130	145	155	.....	.....	.....	.....	10	8
16	105	130	145	160	175	190	200	.....	.....	.....	11	16
17	130	155	175	195	215	230	250	.....	.....	.....	11	34
18	155	185	210	235	255	280	305	330	.....	.....	12	27
19	180	215	250	275	300	335	360	395	.....	.....	13	31
20	205	250	295	320	355	390	420	460	.....	.....	13	38
21	.....	.....	345	370	405	445	485	530	590	.....	14	47
22	.....	.....	400	430	465	510	550	600	665	.....	15	61
23	.....	.....	455	490	530	575	620	670	745	.....	16	58
24	.....	.....	520	550	600	640	690	750	825	900	16	68
25	.....	.....	585	620	670	715	770	830	915	995	17	64
26	.....	.....	655	695	745	795	850	920	1,010	1,095	17	59
27	.....	.....	725	770	820	875	940	1,015	1,105	1,200	18	49
28	.....	.....	800	850	900	960	1,030	1,115	1,210	1,305	19	54
29	.....	.....	875	930	980	1,050	1,130	1,215	1,315	1,415	20	50
30	.....	.....	950	1,010	1,070	1,150	1,230	1,320	1,425	1,530	20	54
31	.....	.....	1,035	1,100	1,165	1,245	1,330	1,430	1,535	1,650	21	44
32	.....	.....	1,125	1,185	1,260	1,345	1,430	1,535	1,650	1,770	22	30
33	.....	.....	1,215	1,275	1,355	1,440	1,535	1,650	1,770	1,890	22	35
34	.....	.....	1,305	1,360	1,450	1,540	1,650	1,770	1,900	2,025	23	35
35	.....	.....	.....	1,450	1,545	1,650	1,765	1,895	2,030	2,170	24	24
36	.....	.....	.....	1,540	1,645	1,760	1,890	2,025	2,160	2,310	25	17
37	.....	.....	.....	1,630	1,745	1,875	2,015	2,155	2,300	2,460	25	13
38	.....	.....	.....	1,720	1,855	1,995	2,150	2,290	2,445	2,600	26	17
39	.....	.....	.....	1,810	1,960	2,115	2,280	2,420	2,585	2,750	27	22
40	.....	.....	.....	1,905	2,070	2,235	2,405	2,555	2,725	2,890	27	13
41	.....	.....	.....	2,005	2,180	2,350	2,530	2,685	2,870	3,035	28	6
42	.....	.....	.....	2,105	2,300	2,475	2,660	2,825	3,010	3,180	29	13
43	.....	.....	.....	.....	2,420	2,600	2,790	2,965	3,145	3,335	30	7
44	.....	.....	.....	.....	2,550	2,730	2,920	3,100	3,285	3,485	30	3
												1,033

[a] Compiled under direction of Walter Mulford—1905–6.

[b] Average height of stump, 3.2 feet.

TABLE 30.—White Pine.[a]

Volume in board feet by the Doyle-Scribner Rule,[b] southern Appalachian region.

Diameter breast-high.	HEIGHT OF TREE (FEET).												Diameter of top inside bark.	Basis.
	60	70	80	90	100	110	120	130	140	150	160	170		
	VOLUME (BOARD FEET).													
Inches.													*Inches.*	*Trees.*
12	40	50	60	75									8.5	6
13	60	70	80	95									9.0	2
14	80	90	100	115	135								9.4	7
15	100	110	125	140	160								9.9	12
16	125	135	150	165	185	230							10.2	20
17	155	165	180	195	220	270							10.6	25
18	185	200	215	230	260	310	360						10.9	25
19	225	240	250	270	300	355	410						11.2	37
20	265	280	295	320	350	400	460						11.5	37
21	310	325	345	370	405	455	515	585					11.8	49
22	355	375	395	425	460	510	565	645					12.1	46
23		425	455	485	515	565	625	710	820				12.4	42
24		480	510	540	580	625	685	775	895	1,040			12.7	48
25		535	575	605	645	690	755	845	980	1,140			13.0	53
26		590	640	675	710	755	820	925	1,060	1,240			13.2	65
27		650	710	745	780	825	895	1,010	1,150	1,345			13.5	55
28		710	780	815	850	900	975	1,095	1,250	1,455	1,680		13.7	55
29			855	890	925	975	1,060	1,190	1,350	1,570	1,785		14.0	54
30			930	965	1,005	1,055	1,145	1,290	1,465	1,680	1,895		14.3	52
31			1,010	1,050	1,085	1,140	1,240	1,390	1,585	1,795	2,005		14.6	49
32			1,095	1,130	1,165	1,230	1,335	1,495	1,695	1,910	2,120	2,300	14.8	49
33			1,180	1,220	1,255	1,325	1,445	1,605	1,815	2,035	2,240	2,420	15.1	42

34	.....	.....	1,270	1,315	1,355	1,430	1,560	1,720	1,925	2,155	2,365	2,550	15.4	40
35	.....	.....	.....	1,415	1,460	1,535	1,665	1,835	2,045	2,290	2,505	2,690	15.7	35
36	.....	.....	.....	1,520	1,555	1,655	1,770	1,945	2,175	2,435	2,650	2,855	16.1	32
37	.....	.....	.....	.....	1,660	1,755	1,880	2,065	2,310	2,580	2,810	3,040	16.4	28
38	.....	.....	.....	.....	.....	1,850	1,985	2,185	2,450	2,730	2,980	3,230	16.9	20
39	.....	.....	.....	.....	.....	1,945	2,095	2,315	2,600	2,885	3,165	3,450	17.3	19
40	.....	.....	.....	.....	.....	2,050	2,195	2,430	2,750	3,050	3,345	3,655	17.8	24
														1,028

[a] Compiled under direction of Walter Mulford, 1905–6.

[b] Average height of stump, 2.3 feet.

SOUTHERN TREES.

TABLE 31.—Second Growth White Ash.[a]

Used volume in cubic feet, Montgomery County, Ind., and Mississippi County, Ark.

Diameter breast-high.	HEIGHT OF TREE (FEET).					Basis.
	10	20	30	40	50	
	VOLUME (CUBIC FEET).					
Inches.						*Trees.*
10	6.5	9.5	12.5	.....	.....	2
11	8.0	11.5	15.5	.....	.....	7
12	10.0	14.0	18.0	22.5	.....	14
13	11.5	16.0	21.0	26.0	.....	13
14	13.5	18.5	24.5	30.0	.....	18
15	15.0	21.0	27.5	34.0	.....	18
16	17.5	24.0	31.0	38.5	46.0	17
17	20.0	27.0	35.0	43.0	51.5	16
18	.....	30.5	38.5	47.5	56.5	12
19	.....	33.5	42.5	52.0	62.0	8
20	.....	37.0	46.5	57.0	68.0	4
						129

[a] Measurements by W. T. Stone, 1908.

TABLE 32.—**Ash.**[a]

Volume in board feet by the Doyle Rule, South Carolina and Arkansas.

Diameter breast-high.	Volume.		Actual used length.		Total height.		Basis.	
	South Carolina.	Arkansas.	South Carolina.	Arkansas.	South Carolina.	Arkansas.	South Carolina.	Arkansas.
Inches.	*Bd. ft.*	*Bd. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Trees.*	*Trees.*
8	.....	10	.....	35	.....	68	.....	9
9	.....	20	.....	43	.....	75	.....	10
10	15	30	30	47	76	81	2	12
11	35	40	33	50	79	86	3	11
12	55	55	35	52	82	90	11	9
13	75	75	38	53	85	94	19	11
14	100	95	40	54	87	96	36	10
15	130	115	42	55	89	98	38	12
16	165	145	44	56	91	100	42	15
17	200	175	45	56	92	102	41	15
18	240	210	46	56	94	104	47	13
19	280	245	47	57	95	105	61	14
20	325	285	47	57	96	106	40	15
21	375	330	48	57	97	107	38	16
22	420	375	48	57	98	109	43	20
23	475	430	48	57	99	110	32	17
24	525	490	49	57	100	111	39	11
25	580	565	49	57	101	112	22	5
26	635	645	49	57	101	113	20	.....
27	690	740	49	57	102	113	22	7
28	750	835	49	57	103	114	18	.....
29	810	945	50	57	104	115	14	.....
30	870	1,055	50	57	104	116	11	1
31	940	.....	50	.....	105	.....	12	.....
32	1,005	.....	50	.....	106	.....	8	.....
33	1,075	.....	50	.....	106	.....	4	.....
34	1,150	.....	50	.....	107	.....	5	.....
35	1,230	.....	50	.....	108	.....	3	.....
36	1,315	.....	50	.....	108	.....	2	.....
37	1,410	.....	50	.....	109	.....	4	.....
38	1,505	.....	50	.....	110	.....	1	.....
39	1,605	.....	50	.....	110	.....	.....	.....
40	1,700	.....	50	.....	111	.....	1	.....
							639	233

[a] South Carolina measurements by K. W. Woodward, 1905; Arkansas measurements by G. M. Homans, 1905.

TABLE 33.—**Cottonwood.**[a]

Volume in board feet by the Doyle Rule, Richland County, S. C., and Bolivar County, Miss.

Diameter breast-high.	Volume.		Used length.		Total height.		Basis.	
	South Carolina.	Mississippi.	South Carolina.	Mississippi.	South Carolina.	Mississippi.	South Carolina.	Mississippi.
Inches.	*Bd. ft.*	*Bd. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Trees.*	*Trees.*
9	5	.....	.....	.....	70	.....	2	.....
10	25	.....	38	.....	76	.....	3	.....
11	45	20	41	31	81	88	4	.....
12	65	40	43	33	86	93	4	10
13	90	60	45	35	90	97	7	18
14	115	85	47	37	94	101	11	15
15	140	115	48	39	98	105	11	14
16	175	145	50	41	101	109	21	10
17	210	180	51	43	103	113	12	10
18	250	225	52	44	105	116	18	10
19	300	275	53	46	106	119	12	10
20	350	340	54	47	108	122	9	10
21	410	405	55	49	109	125	9	10
22	480	480	56	50	110	127	9	15
23	550	560	56	51	111	130	9	13
24	630	645	57	52	112	132	9	18
25	715	735	57	54	113	134	17	22
26	810	820	57	55	114	136	16	26
27	910	910	58	56	115	138	21	24
28	1,015	1,000	58	57	116	140	18	16
29	1,130	1,090	58	58	117	141	17	21
30	1,240	1,175	59	59	118	143	25	16
31	1,350	1,265	59	59	118	144	24	16
32	1,460	1,360	59	60	119	146	24	16
33	1,570	1,450	59	61	120	147	22	15
34	1,670	1,540	59	61	121	148	23	19
35	1,765	1,635	59	61	122	149	30	14
36	1,855	1,725	60	62	123	150	16	15
37	1,950	1,820	60	62	123	151	21	14
38	2,045	1,910	60	62	124	152	28	13
39	2,130	2,005	60	62	125	153	15	12
40	2,210	2,095	60	62	125	153	20	10
41	2,285	2,185	60	62	126	154	10	8
42	2,360	2,275	60	63	127	155	7	10
43	2,420	2,370	60	63	128	156	7	5
44	2,490	2,465	60	63	128	157	7	3
45	2,550	2,560	60	63	129	157	8	6
46	2,610	2,650	60	63	130	158	3	2
47	2,670	.....	60	.....	130	.....	8	.....
48	2,720	.....	60	.....	131	.....	1	.....
50	2,830	.....	60	.....	132	.....	7	.....
52	2,930	.....	.....	.....	132	.....	8	.....
54	3,030	.....	.....	.....	.....	.....	3	.....
56	3,130	.....	.....	.....	.....	.....	4	.....
58	3,230	.....	.....	.....	.....	.....	2	.....
							562	466

[a] South Carolina measurements by K. W. Woodward, 1905; Mississippi measurements by G. M. Homans, 1905.

TABLE 34.—**Bald Cypress.**[a]

Volume in board feet by the Scribner Rule, Maryland and South Carolina.

Diameter outside bark at 20 feet.	NUMBER OF 16-FOOT LOGS.					Basis.
	1	2	3	4	5	
	VOLUME (BOARD FEET).					
Inches.						*Trees.*
6	20	.....	.....	.....	.....	6
7	25	.....	.....	.....	.....	3
8	30	55	.....	.....	.....	7
9	40	70	100	.....	.....	12
10	.....	85	120	.....	.....	20
11	.....	105	145	.....	.....	20
12	.....	125	175	.....	.....	19
13	.....	155	205	260	.....	18
14	.....	185	250	305	335	15
15	.....	225	295	360	395	21
16	.....	265	350	425	465	37
17	.....	315	410	495	540	28
18	.....	365	475	570	625	34
19	.....	415	540	645	715	22
20	.....	470	610	730	820	20
21	.....	525	690	825	935	21
22	.....	580	775	935	1,065	30
23	.....	640	865	1,050	1,205	20
24	.....	700	955	1,165	1,350	23
25	.....	760	1,045	1,285	1,500	16
26	.....	825	1,145	1,415	1,650	19
27	.....	.....	1,250	1,545	1,810	12
28	.....	.....	.....	1,675	1,970	5
29	.....	.....	.....	1,815	2,130	8
30	.....	.....	.....	1,955	2,290	5
						441

No consistent difference in form was discernible in the two States, though the Maryland timber measured was the taller. The table is based on diameter outside bark at 20 feet, since the buttressing is very large and variable at breastheight.

[a] Measurements by W. F. Hubbard, Worcester County, Md., and by C. S. Chapman in Berkeley County, S. C., in 1903–4.

TABLE 35.—**Red Gum.**[a]

Volume in board feet by the Doyle-Scribner Rule, Richfield County, S. C., and New Madrid County, Mo.

Diameter breast-high.	Volume.		Clear length.		Total height.		Basis.	
	South Carolina.	Missouri.	South Carolina.	Missouri.	South Carolina.	Missouri.	South Carolina.	Missouri.
Inches.	*Bd. ft.*	*Bd. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Trees.*	*Trees.*
12	.....	.....	53	32	91	80	.....	.....
13	20	15	55	35	95	85	.....	.....
14	65	45	56	37	99	89	.....	33
15	110	80	57	39	102	92	.....	25
16	155	110	58	40	104	95	9	29
17	200	145	58	42	107	96	12	27
18	250	180	58	43	109	98	27	19
19	300	215	58	44	111	99	42	16
20	350	250	58	46	113	100	54	12
21	405	295	58	47	114	102	73	22
22	460	340	58	49	115	103	68	13
23	515	400	58	51	116	105	86	16
24	570	465	58	52	117	107	70	20
25	625	535	58	53	118	109	69	31
26	685	610	58	53	119	111	65	41
27	745	685	58	54	120	112	58	42
28	805	760	58	54	121	113	48	41
29	875	840	58	54	122	114	27	41
30	955	900	58	54	122	115	33	38
31	1,040	975	58	54	123	116	29	45
32	1,125	1,055	58	55	123	117	15	38
33	1,210	1,145	58	55	124	118	12	43
34	1,300	1,245	58	56	125	119	11	34
35	1,400	1,350	58	56	125	120	6	20
36	1,505	1,465	58	57	126	121	1	31
37	1,620	1,575	.....	.....	.....	.....	8	25
38	1,735	1,675	.....	.....	.....	.....	4	21
39	1,850	1,760	.....	.....	.....	.....	5	18
40	1,960	1,835	.....	.....	.....	.....	4	18
41	2,055	1,900	.....	.....	.....	.....	3	9
42	2,155	1,955	.....	.....	.....	.....	.....	12
43	2,250	2,010	.....	.....	.....	.....	3	5
44	2,340	2,055	.....	.....	.....	.....	1	6
45	2,425	2,115	.....	.....	.....	.....	2	.....
46	2,510	2,165	.....	.....	.....	.....	1	2
47	2,590	2,215	.....	.....	.....	.....	2	3
48	2,670	2,265	.....	.....	.....	.....	1	2
							849	898

[a] Measurements by A. K. Chittenden,

TABLE 36.—**Loblolly Pine.**[a]

Volume in board feet by the Scribner Rule,[b] *South Carolina.*

Diameter breast-high.	HEIGHT OF TREE (FEET).										Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100	110	120	130		
	VOLUME (BOARD FEET).											
Inches.											*Inches.*	*Trees.*
7	5	9	13	.....	.....	.....	.....	.....	.....	.....	6	3
8	11	16	21	.....	.....	.....	.....	.....	.....	.....	6	7
9	17	23	31	39	49	.....	.....	.....	.....	.....	7	10
10	25	32	42	53	65	.....	.....	.....	.....	.....	7	6
11	....	43	54	68	83	103	.....	.....	.....	.....	7	5
12	....	54	68	85	103	126	.....	.....	.....	.....	8	3
13	....	68	86	104	126	152	183	.....	.....	.....	8	18
14	....	....	104	126	151	181	216	260	.....	.....	9	36
15	....	....	124	150	180	214	254	300	.....	.....	9	57
16	....	....	146	176	210	248	294	345	400	.....	10	99
17	....	....	.....	202	242	288	338	385	440	.....	10	112
18	....	....	.....	232	276	330	375	425	480	.....	11	134
19	....	....	.....	260	314	365	420	475	530	.....	11	116
20	....	....	.....	291	350	410	465	525	585	.....	12	113
21	....	....	.....	.....	390	450	515	575	640	710	12	130
22	....	....	.....	.....	425	495	565	630	705	775	13	109
23	....	....	.....	.....	470	545	615	690	770	850	13	96
24	....	....	.....	.....	515	595	670	755	840	930	14	82
25	....	....	.....	.....	560	650	730	820	910	1,015	15	95
26	....	....	.....	.....	605	700	790	890	990	1,100	15	55
27	....	....	.....	.....	655	755	855	965	1,070	1,185	16	50
28	....	....	.....	.....	.....	810	920	1,035	1,150	1,275	17	56
29	....	....	.....	.....	.....	870	985	1,110	1,235	1,370	18	14
30	....	....	.....	.....	.....	925	1,055	1,190	1,325	1,470	18	26
31	....	....	.....	.....	.....	985	1,125	1,270	1,420	1,575	19	16
32	....	....	.....	.....	.....	1,050	1,200	1,355	1,520	1,685	20	10
33	....	....	.....	.....	.....	1,120	1,275	1,445	1,620	1,795	20	7
34	....	....	.....	.....	.....	.....	1,360	1,540	1,725	1,910	21	4
35	....	....	.....	.....	.....	.....	1,445	1,640	1,835	2,030	22	4
36	....	....	.....	.....	.....	.....	1,530	1,740	1,950	2,160	23	6
												1,473

[a] Measurements by T. H. Sherrard, 1902, and C. S. Chapman, 1903.

[b] Average height of stump, 2 feet.

TABLE 37.—**Loblolly Pine.**[a]

Volume in board feet by the Scribner Rule,[b] *Arkansas.*

Diameter breast-high.	HEIGHT OF TREE (FEET).								Diameter of top inside bark.	Basis.
	60	70	80	90	100	110	120	130		
	VOLUME (BOARD FEET).									
Inches.									*Inches.*	*Trees.*
9	45	50	.....	.....	.....	.....	.....	.....	5	2
10	55	70	80	.....	.....	.....	.....	.....	5	6
11	70	85	105	115	.....	.....	.....	.....	6	19
12	90	105	130	145	.....	.....	.....	.....	6	36
13	105	130	155	175	.....	.....	.....	.....	6	48
14	125	150	180	205	235	.....	.....	.....	7	62
15	145	175	210	240	275	.....	.....	.....	7	86
16	165	205	245	275	320	360	.....	.....	8	59
17	.....	235	275	320	360	405	.....	.....	8	66
18	.....	270	310	360	400	460	.....	.....	9	73
19	.....	310	350	400	450	510	.....	.....	9	63
20	.....	350	390	440	500	560	630	.....	10	61
21	.....	390	440	490	550	610	690	.....	10	56
22	.....	.....	490	540	600	670	760	.....	11	48
23	.....	.....	540	600	660	740	820	.....	12	38
24	.....	.....	590	650	720	800	890	.....	13	45
25	.....	.....	650	720	790	880	970	1,080	14	29
26	.....	.....	.....	780	860	950	1,050	1,170	15	22
27	.....	.....	.....	860	940	1,030	1,130	1,260	16	16
28	.....	.....	.....	930	1,020	1,110	1,220	1,360	17	17
29	.....	.....	.....	1,010	1,100	1,200	1,320	1,460	18	16
30	.....	.....	.....	1,090	1,180	1,290	1,420	1,570	19	11
31	.....	.....	.....	.....	1,270	1,390	1,530	1,680	20	10
32	.....	.....	.....	.....	1,360	1,490	1,640	1,800	21	2
33	.....	.....	.....	.....	.....	1,600	1,760	1,930	22	3
34	.....	.....	.....	.....	.....	1,710	1,880	2,070	23	3
										898

The volumes in Arkansas are greater than those in South Carolina.

[a] Measurements by F. E. Olmsted, 1900, and S. J. Record, 1907, in Calhoun, Grant, Jefferson, and Saline counties, Ark.

[b] Average height of stump, 1.9 feet.

TABLE 38.—Longleaf Pine.[a]

Volume in board feet by the Scribner Rule,[b] Coosa County, Ala.

Diameter breast-high.	HEIGHT OF TREE (FEET).									Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100	110	120		
	VOLUME (BOARD FEET).										
Inches.										*Inches.*	*Trees.*
7	5	10	15	.....	.....	.....	.....	.....	.....	6	55
8	10	20	25	.....	.....	.....	.....	.....	.....	6	57
9	20	30	40	50	.....	.....	.....	.....	.....	6	26
10	25	40	55	70	.....	.....	.....	.....	.....	6	13
11	35	50	70	90	110	.....	.....	.....	.....	6	9
12	....	65	90	115	135	.....	.....	.....	.....	6	5
13	....	80	110	135	165	195	.....	.....	.....	6	5
14	....	95	130	160	200	230	.....	.....	.....	7	3
15	....	115	150	190	230	270	310	.....	.....	7	12
16	....	.....	175	220	260	310	350	.....	.....	7	30
17	....	.....	200	250	295	350	400	450	.....	7	33
18	....	.....	225	280	330	390	450	500	.....	8	40
19	....	.....	250	310	370	440	500	560	620	8	34
20	....	.....	.....	350	420	490	560	630	700	8	39
21	....	.....	.....	390	470	550	620	700	780	8	38
22	....	.....	.....	440	520	610	690	780	860	9	37
23	....	.....	.....	490	580	670	770	860	950	9	30
24	....	.....	.....	.....	640	740	850	950	1,050	10	19
25	....	.....	.....	.....	710	820	930	1,040	1,140	10	25
26	....	.....	.....	.....	780	890	1,010	1,130	1,240	11	23
27	....	.....	.....	.....	840	960	1,090	1,220	1,340	11	17
28	....	.....	.....	.....	.....	1,050	1,180	1,310	1,440	12	22
29	....	.....	.....	.....	.....	1,140	1,280	1,410	1,550	12	10
30	....	.....	.....	.....	.....	1,230	1,380	1,520	1,670	13	9
31	....	.....	.....	.....	.....	1,320	1,480	1,630	1,780	13	8
32	....	.....	.....	.....	.....	.....	1,580	1,740	1,900	14	6
33	....	.....	.....	.....	.....	.....	1,690	1,860	2,030	15	4
34	....	.....	.....	.....	.....	.....	1,800	1,980	2,160	16	1
35	....	.....	.....	.....	.....	.....	1,920	2,110	2,200	17	2
36	....	.....	.....	.....	.....	.....	2,030	2,230	2,340	18	2
											614

[a] Measurements by F. W. Reed—1903-4. Based on figures obtained by scaling the trees according to form curves. Sixteen-foot logs were used as far as possible.

[b] Height of stump, 4.5 feet.

TABLE 39.—**Scrub Pine.**[a]

Volume in cubic feet of entire stem (including bark, top, and stump), Montgomery County, Md.

Diameter breast-high.	HEIGHT OF TREE (FEET).						Basis.
	20	30	40	50	60	70	
	VOLUME (CUBIC FEET).						
Inches.							*Trees.*
2	0.3	.....	.....	.....	.....	.....	22
3	.6	0.9	1.2	.....	.....	.....	32
4	.....	1.5	2.0	2.4	.....	.....	15
5	.....	2.2	2.9	3.6	.....	.....	42
6	.....	.....	4.2	5.2	6.3	.....	23
7	.....	.....	5.7	7.2	8.7	10.2	29
8	.....	.....	7.5	9.4	11.3	13.1	22
9	.....	.....	.....	11.6	13.9	16.2	24
10	.....	.....	.....	14.1	16.6	19.2	7
11	.....	.....	.....	16.8	19.6	22.5	8
12	.....	.....	.....	.....	22.6	25.7	4
							228

NOTE.—To reduce volumes of the above table to stacked cords of peeled pulp wood, divided by 116. This allows for stump, top (4-inch), and bark.

To reduce to unpeeled charcoal wood (4-inch top), divide by 105, and for fuel wood (to 2 inches), by 100.

[a] Measurements by W. D. Sterrett—1905.

TABLE 40.—Shortleaf Pine.[a]

Volume in board feet by the Scribner Rule,[b] Calhoun County, Ark.

Diameter breast-high.	HEIGHT OF TREE (FEET).								Diameter of top inside bark.	Basis.
	50	60	70	80	90	100	110	120		
	VOLUME (BOARD FEET).									
Inches.									*Inches.*	*Trees.*
9	40	50	60	.....	.....	.....	.....	.....	6	4
10	45	60	80	95	.....	.....	.....	.....	6	13
11	50	70	95	115	135	.....	.....	.....	7	36
12	65	90	110	135	160	.....	.....	.....	7	41
13	....	105	135	160	190	.....	.....	.....	7	30
14	....	130	160	190	220	250	.....	.....	8	38
15	....	160	190	220	255	285	315	.....	8	31
16	....	.....	225	260	295	330	365	.....	9	37
17	....	.....	260	300	340	380	420	.....	9	25
18	....	.....	300	345	395	435	485	530	10	34
19	....	.....	345	395	450	500	555	605	11	17
20	....	.....	.....	450	510	570	635	695	12	26
21	....	.....	.....	505	575	645	715	785	12	15
22	....	.....	.....	570	640	720	800	875	13	16
23	....	.....	.....	.....	705	795	890	970	14	12
24	....	.....	.....	.....	770	875	980	1,070	15	11
										386

[a] Measurements by S. J. Record—1907.

[b] Average height of stump, 1.7 feet.

WESTERN TREES.[a]

TABLE 41.—Douglas Fir.

Volume in board feet by the Scribner Rule,[b] Idaho and Wyoming.

Diameter breast-high.	HEIGHT OF TREE (FEET).						Diameter of top inside bark.	Basis.
	60	70	80	90	100	110		
	VOLUME (BOARD FEET).							
Inches.							*Inches.*	*Trees.*
8	20	30	.....	.....	.....	.....	6.2	1
9	30	40	60	.....	.....	.....	6.3	7
10	40	60	70	.....	.....	.....	6.5	4
11	60	70	90	110	.....	.....	6.6	23
12	70	90	110	130	.....	.....	6.7	53
13	90	110	130	160	190	.....	6.8	57
14	100	130	150	180	220	.....	6.9	51
15	120	150	170	210	250	.....	7.0	55
16	140	170	200	240	290	.....	7.2	59
17	150	190	230	270	320	.....	7.3	51
18	170	220	250	300	360	400	7.4	64
19	190	240	280	330	400	450	7.5	57
20	210	270	320	370	440	500	7.6	55
21	230	300	350	410	480	550	7.8	57
22	250	330	380	450	530	600	7.9	50
23	.....	360	420	490	580	650	8.0	45
24	.....	390	450	540	630	710	8.2	40
25	.....	420	490	580	690	770	8.3	38
26	.....	450	530	630	750	830	8.5	31
27	.....	480	580	680	810	900	8.6	22
28	.....	520	620	730	870	970	8.8	12
29	.....	.....	670	790	940	1,040	8.9	9

[a] Measurements by P. G. Redington on the Shoshone National Forest, Wyoming, 1905, and J. G. Peters on the Targhee (formerly Henrys Lake) National Forest, Idaho, 1906.

[b] Like western yellow pine, the Rocky Mountain form of Douglas fir shows larger volumes for the same diameter and height than the coast form.

TABLE 41.—**Douglas Fir**—Continued.

Volume in board feet by the Scribner Rule, Idaho and Wyoming—Con.

Diameter breast-high.	HEIGHT OF TREE (FEET).						Diameter of top inside bark.	Basis.
	60	70	80	90	100	110		
	VOLUME (BOARD FEET.)							
Inches.							*Inches.*	*Trees.*
30	.....	.....	720	850	1,010	1,130	9.0	10
31	.....	.....	760	910	1,090	1,220	9.1	16
32	.....	.....	810	980	1,170	1,320	9.2	4
33	.....	.....	.....	1,060	1,260	1,430	9.2	6
34	.....	.....	.....	1,140	1,350	1,540	9.3	2
35	.....	.....	.....	1,220	1,450	1,660	9.3	2
36	.....	.....	.....	1,300	1,550	1,780	9.3	2
37	.....	.....	.....	1,380	1,650	1,900	9.4	2
38	.....	.....	.....	1,460	1,740	2,030	9.4	.....
39	.....	.....	.....	1,540	1,840	2,150	9.4	1
40	.....	.....	.....	1,620	1,940	2,280	9.4	3
								889

TABLE 42.—**Douglas Fir.**[a]

Volume in board feet by the Scribner Rule, west of the Cascade Mountains in Washington and Oregon.

Diameter breast-high.	HEIGHT OF TREE (FEET).								
	50	60	70	80	90	100	110	120	130
	VOLUME (BOARD FEET).								
Inches.									
6	5	10	15	.....	.....	.....	.....	.....	.....
7	10	15	20	25	35	.....	.....	.....	.....
8	15	20	30	35	45	60	.....	.....	.....
9	25	30	40	50	60	75	85	.....	.....
10	30	40	50	60	75	90	110	130	.....
11	40	50	60	75	90	110	130	150	180
12	50	60	75	90	105	125	150	180	210
13	60	70	90	105	125	150	175	200	230
14	70	85	105	125	150	175	200	220	255
15	.....	105	125	150	170	200	225	250	285
16	.....	125	150	175	195	225	250	275	320
17	.....	145	175	200	225	250	280	310	350
18	.....	.....	200	225	250	275	310	340	390
19	.....	.....	.....	250	275	300	340	380	430
20	.....	.....	.....	.....	.....	330	380	420	480
21	.....	.....	.....	.....	.....	360	410	460	520
22	.....	.....	.....	.....	.....	390	450	510	580
23	.....	.....	.....	.....	.....	430	490	560	630
24	.....	.....	.....	.....	.....	470	540	610	680
25	.....	.....	.....	.....	.....	510	590	660	740
26	.....	.....	.....	.....	.....	550	640	720	800
27	.....	.....	.....	.....	.....	600	700	790	870
28	.....	.....	.....	.....	.....	.....	770	850	930
29	.....	.....	.....	.....	.....	.....	840	920	1,000
30	.....	.....	.....	.....	.....	.....	920	980	1,070
31	.....	.....	.....	.....	.....	.....	1,000	1,050	1,140
32	.....	.....	.....	.....	.....	.....	.....	1,120	1,220

[a] Measurements made by E. T. Allen in western Washington, 1899, and by a Forest officer (name not reported) near Dee, in the Mount Hood region of Oregon, 1907; supplemented by measurements on a number of rather large trees by one of the authors on the west base of Mount Rainier, in 1907. Long logs were scaled as two short logs, using 16-foot lengths as much as possible.

TABLE 42.—**Douglas Fir**—Continued.

Volume in board feet by the Scribner Rule, west of the Cascade Mountains in Washington and Oregon—Continued.

Diameter breast-high.	HEIGHT OF TREE (FEET).								
	50	60	70	80	90	100	110	120	130
	VOLUME (BOARD FEET).								
Inches.									
33	.....	.....	.....	.....	.....	.....	.....	1,190	1,290
34	.....	.....	.....	.....	.....	.....	.....	1,270	1,370
35	.....	.....	.....	.....	.....	.....	.....	.....	1,450
36	.....	.....	.....	.....	.....	.....	.....	.....	1,540
37	.....	.....	.....	.....	.....	.....	.....	.....	1,620
38	.....	.....	.....	.....	.....	.....	.....	.....	1,720
39	.....	.....	.....	.....	.....	.....	.....	.....	.....
40	.....	.....	.....	.....	.....	.....	.....	.....	.....
41	.....	.....	.....	.....	.....	.....	.....	.....	.....
42	.....	.....	.....	.....	.....	.....	.....	.....	.....
43	.....	.....	.....	.....	.....	.....	.....	.....	.....
44	.....	.....	.....	.....	.....	.....	.....	.....	.....
45	.....	.....	.....	.....	.....	.....	.....	.....	.....
46	.....	.....	.....	.....	.....	.....	.....	.....	.....
47	.....	.....	.....	.....	.....	.....	.....	.....	.....
48	.....	.....	.....	.....	.....	.....	.....	.....	.....
50	.....	.....	.....	.....	.....	.....	.....	.....	.....
52	.....	.....	.....	.....	.....	.....	.....	.....	.....
54	.....	.....	.....	.....	.....	.....	.....	.....	.....
56	.....	.....	.....	.....	.....	.....	.....	.....	.....
58	.....	.....	.....	.....	.....	.....	.....	.....	.....
60	.....	.....	.....	.....	.....	.....	.....	.....	.....
62	.....	.....	.....	.....	.....	.....	.....	.....	.....
64	.....	.....	.....	.....	.....	.....	.....	.....	.....
66	.....	.....	.....	.....	.....	.....	.....	.....	.....
68	.....	.....	.....	.....	.....	.....	.....	.....	.....
70	.....	.....	.....	.....	.....	.....	.....	.....	.....
72	.....	.....	.....	.....	.....	.....	.....	.....	.....
74	.....	.....	.....	.....	.....	.....	.....	.....	.....
76	.....	.....	.....	.....	.....	.....	.....	.....	.....
78	.....	.....	.....	.....	.....	.....	.....	.....	.....
80	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE 42.—**Douglas Fir**—Continued.

Volume in board feet by the Scribner Rule, west of the Cascade Mountains in Washington and Oregon—Continued.

Diameter breast-high.	HEIGHT OF TREE (FEET).								
	140	150	160	170	180	190	200	210	220
	VOLUME (BOARD FEET).								
Inches.									
6	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	.....	.....	.....	.....	.....	.....	.....	.....	.....
8	.....	.....	.....	.....	.....	.....	.....	.....	.....
9	.....	.....	.....	.....	.....	.....	.....	.....	.....
10	.....	.....	.....	.....	.....	.....	.....	.....	.....
11	.....	.....	.....	.....	.....	.....	.....	.....	.....
12	230	.....	.....	.....	.....	.....	.....	.....	.....
13	250	.....	.....	.....	.....	.....	.....	.....	.....
14	285	320	340	370	420	.....	.....	.....	.....
15	320	350	380	420	470	.....	.....	.....	.....
16	360	390	420	470	520	550	580	625	.....
17	390	440	480	530	580	620	660	710	.....
18	440	480	530	580	640	680	730	780	.....
19	480	530	580	640	710	760	810	875	.....
20	530	590	650	710	770	840	880	950	1,080
21	590	640	710	770	840	920	970	1,030	1,150
22	640	700	770	840	910	980	1,040	1,150	1,210
23	700	770	840	910	980	1,060	1,120	1,200	1,280
24	760	830	910	980	1,060	1,140	1,210	1,290	1,350
25	820	900	980	1,050	1,130	1,220	1,280	1,370	1,450
26	890	970	1,050	1,130	1,210	1,300	1,380	1,460	1,520
27	960	1,040	1,130	1,210	1,290	1,380	1,470	1,560	1,610
28	1,020	1,110	1,200	1,290	1,370	1,475	1,555	1,650	1,700
29	1,090	1,180	1,280	1,370	1,460	1,570	1,650	1,750	1,800
30	1,160	1,260	1,360	1,450	1,540	1,670	1,750	1,830	1,910
31	1,240	1,340	1,450	1,540	1,630	1,760	1,850	1,940	2,020
32	1,320	1,420	1,530	1,630	1,740	1,860	1,970	2,060	2,140
33	1,390	1,510	1,620	1,720	1,820	1,970	2,070	2,170	2,260
34	1,470	1,600	1,720	1,820	1,920	2,080	2,200	2,310	2,400
35	1,560	1,690	1,830	1,930	2,030	2,200	2,340	2,450	2,520

TABLE 42.—**Douglas Fir**—Continued.

Volume in board feet by the Scribner Rule, west of the Cascade Mountains in Washington and Oregon—Continued.

Diameter breast-high.	HEIGHT OF TREE (FEET).								
	140	**150**	**160**	**170**	**180**	**190**	**200**	**210**	**220**
	VOLUME (BOARD FEET).								
Inches.									
36	1,650	1,770	1,910	2,020	2,140	2,320	2,450	2,570	2,650
37	1,740	1,890	2,020	2,130	2,270	2,450	2,580	2,710	2,800
38	1,840	1,980	2,130	2,250	2,390	2,570	2,715	2,850	2,950
39	1,940	2,100	2,240	2,370	2,520	2,700	2,850	2,980	3,100
40	2,060	2,200	2,370	2,500	2,660	2,830	2,980	3,130	3,250
41	2,170	2,320	2,500	2,640	2,800	2,975	3,130	3,270	3,400
42	2,280	2,440	2,620	2,780	2,960	3,120	3,280	3,420	3,570
43	.....	2,570	2,760	2,940	3,100	3,260	3,430	3,570	3,720
44	.....	2,700	2,900	3,100	3,250	3,420	3,580	3,730	3,900
45	.....	2,840	3,060	3,260	3,400	3,570	3,750	3,900	4,050
46	.....	2,970	3,220	3,440	3,550	3,720	3,900	4,050	4,220
47	.....	.....	.....	.....	3,700	3,880	4,070	4,220	4,400
48	.....	.....	.....	.....	3,870	4,050	4,230	4,400	4,570
50	.....	.....	.....	.....	4,200	4,380	4,570	4,750	4,940
52	.....	.....	.....	.....	4,500	4,700	4,906	5,100	5,300
54	.....	.....	.....	.....	4,820	5,040	5,250	5,500	5,700
56	.....	.....	.....	.....	5,150	5,370	5,600	5,850	6,070
58	.....	.....	.....	.....	5,480	5,700	5,950	6,200	6,450
60	.....	.....	.....	.....	5,800	6,050	6,300	6,550	6,850
62	.....	.....	.....	.....	6,100	6,350	6,650	6,900	7,200
64	.....	.....	.....	.....	6,450	6,700	6,950	7,250	7,600
66	.....	.....	.....	.....	.....	.....	.....	.....	8,000
68	.....	.....	.....	.....	.....	.....	.....	.....	8,350
70	.....	.....	.....	.....	.....	.....	.....	.....	8,750
72	.....	.....	.....	.....	.....	.....	.....	.....	9,100
74	.....	.....	.....	.....	.....	.....	.....	.....	9,500
76	.....	.....	.....	.....	.....	.....	.....	.....	9,900
78	.....	.....	.....	.....	.....	.....	.....	.....	10,250
80	.....	.....	.....	.....	.....	.....	.....	.....	10,600

TABLE 42.—**Douglas Fir**—Continued.

Volume in board feet by the Scribner Rule, west of the Cascade Mountains in Washington and Oregon—Continued.

Diameter breast-high.	HEIGHT OF TREE (FEET).						Diameter of top inside bark.	Basis.
	230	240	250	260	270	280		
	VOLUME (BOARD FEET).							
Inches.							*Inches.*	*Trees.*
6	.....	.....	.....	.....	.....	.....	6.0	3
7	.....	.....	.....	.....	.....	.....	6.0	6
8	.....	.....	.....	.....	.....	.....	6.1	21
9	.....	.....	.....	.....	.....	.....	6.2	23
10	.....	.....	.....	.....	.....	.....	6.3	44
11	.....	.....	.....	.....	.....	.....	6.5	33
12	.....	.....	.....	.....	.....	.....	6.7	31
13	.....	.....	.....	.....	.....	.....	6.9	37
14	.....	.....	.....	.....	.....	.....	7.1	24
15	.....	.....	.....	.....	.....	.....	7.4	13
16	.....	.....	.....	.....	.....	.....	7.7	19
17	.....	.....	.....	.....	.....	.....	8.1	17
18	.....	.....	.....	.....	.....	.....	8.5	21
19	.....	.....	.....	.....	.....	.....	8.9	26
20	.....	.....	.....	.....	.....	.....	9.3	28
21	1,200	.....	.....	.....	.....	.....	9.7	20
22	1,270	1,350	.....	.....	.....	.....	10.1	20
23	1,350	1,430	.....	.....	.....	.....	10.5	18
24	1,420	1,500	.....	.....	.....	.....	10.9	23
25	1,520	1,600	.....	.....	.....	.....	11.3	25
26	1,600	1,700	.....	.....	.....	.....	11.7	18
27	1,710	1,800	.....	.....	.....	.....	12.1	19
28	1,810	1,900	.....	.....	.....	.....	12.5	31
29	1,920	2,030	.....	.....	.....	.....	12.9	37
30	2,030	2,140	2,200	.....	.....	.....	13.3	41
31	2,150	2,250	2,340	.....	.....	.....	13.8	36
32	2,270	2,370	2,470	.....	.....	.....	14.2	33
33	2,400	2,500	2,600	.....	.....	.....	14.6	38
34	2,530	2,630	2,750	.....	.....	.....	15.0	36
35	2,650	2,770	2,900	.....	.....	.....	15.4	27

TABLE 42.—**Douglas Fir**—Continued.

Volume in board feet by the Scribner Rule, west of the Cascade Mountains in Washington and Oregon—Continued.

Diameter breast-high.	HEIGHT OF TREE (FEET).						Diameter of top inside bark.	Basis.
	230	240	250	260	270	280		
	VOLUME (BOARD FEET).							
Inches.							*Inches.*	*Trees.*
36	2,800	2,920	3,050	.....	.....	.....	15.8	24
37	2,940	3,070	3,220	.....	.....	.....	16.3	26
38	3,100	3,220	3,370	.....	.....	.....	16.7	30
39	3,240	3,390	3,450	.....	.....	.....	17.2	28
40	3,400	3,550	3,710	3,820	.....	.....	17.6	30
41	3,550	3,720	3,890	4,000	4,100	.....	18.1	22
42	3,730	3,900	4,060	4,190	4,300	.....	18.5	24
43	3,900	4,070	4,260	4,380	4,510	.....	19.0	16
44	4,070	4,250	4,450	4,580	4,720	.....	19.5	18
45	4,250	4,430	4,630	4,770	4,930	.....	20.0	10
46	4,420	4,610	4,830	4,980	5,150	.....	20.4	11
47	4,600	4,800	5,020	5,180	5,360	.....	20.9	12
48	4,790	5,000	5,220	5,400	5,580	.....	21.4	13
50	5,160	5,400	5,620	5,810	6,020	.....	22.4	19
52	5,540	5,790	6,020	6,220	6,460	.....	23.4	20
54	5,930	6,200	6,460	6,660	6,940	.....	24.5	17
56	6,320	6,620	6,870	7,100	7,380	.....	25.5	10
58	6,700	7,050	7,300	7,550	7,850	.....	26.6	6
60	7,100	7,450	7,750	8,000	8,300	8,600	27.7	9
62	7,500	7,900	8,200	8,500	8,800	9,100	28.8	10
64	7,900	8,300	8,600	8,950	9,250	9,600	29.9	6
66	8,350	8,700	9,050	9,400	9,750	10,100	31.0	6
68	8,700	9,150	9,500	9,900	10,300	10,600	32.1	5
70	9,100	9,600	9,950	10,400	10,700	11,100	33.2	8
72	9,550	10,000	10,400	10,900	11,300	11,650	34.3	.....
74	9,950	10,450	10,900	11,400	11,850	12,200	35.4	8
76	10,350	10,850	11,350	11,900	12,400	12,800	36.6	3
78	10,750	11,300	11,850	12,400	12,900	13,400	37.7	3
80	11,200	11,750	12,300	12,900	13,500	14,000	38.8	7
								1,169

TABLE 43.—White Fir.[a]

Volume in board feet by the Scribner Rule, Siskiyou County, Cal.

Diameter breast-high.	HEIGHT OF TREE (FEET).															Basis.
	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	
	VOLUME (BOARD FEET).															
Inches.																*Trees.*
7	5	5	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	41
8	10	15	20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	67
9	15	20	25	40	50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49
10	20	25	35	50	65	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	58
11	25	30	45	60	75	95	.....	.....	.....	.....	.....	.....	.....	.....	.....	56
12	.....	40	55	70	90	115	.....	.....	.....	.....	.....	.....	.....	.....	.....	41
13	.....	50	65	80	105	135	170	.....	.....	.....	.....	.....	.....	.....	.....	46
14	.....	.....	75	95	120	160	200	250	.....	.....	.....	.....	.....	.....	.....	44
15	.....	.....	.....	110	140	185	230	280	340	.....	.....	.....	.....	.....	.....	35
16	.....	.....	.....	125	160	210	260	320	380	.....	.....	.....	.....	.....	.....	28
17	.....	.....	.....	140	180	235	290	350	420	.....	.....	.....	.....	.....	.....	22
18	.....	.....	.....	.....	200	260	320	380	460	530	.....	.....	.....	.....	.....	15
19	.....	.....	.....	.....	.....	284	350	420	500	570	.....	.....	.....	.....	.....	16
20	.....	.....	.....	.....	.....	.....	390	460	540	620	.....	.....	.....	.....	.....	13
21	.....	.....	.....	.....	.....	.....	430	500	590	680	.....	.....	.....	.....	.....	10
22	.....	.....	.....	.....	.....	.....	470	550	640	730	830	940	1,070	.....	.....	12
23	.....	.....	.....	.....	.....	.....	510	600	690	790	900	1,020	1,160	.....	.....	12
24	.....	.....	.....	.....	.....	.....	560	650	740	850	970	1,100	1,260	.....	.....	13
25	.....	.....	.....	.....	.....	.....	.....	700	800	910	1,040	1,190	1,370	.....	.....	8
26	.....	.....	.....	.....	.....	.....	.....	750	860	980	1,120	1,290	1,480	.....	.....	8
27	.....	.....	.....	.....	.....	.....	.....	800	910	1,040	1,200	1,390	1,590	.....	.....	7
28	.....	.....	.....	.....	.....	.....	.....	850	970	1,110	1,280	1,480	1,700	.....	.....	6
29	.....	.....	.....	.....	.....	.....	.....	.....	1,030	1,180	1,360	1,580	1,810	.....	.....	4

30										1,080	1,250	1,450	1,680	1,920			1
31											1,330	1,540	1,780	2,030			3
32											1,400	1,640	1,870	2,130	2,360		4
33											1,480	1,730	1,970	2,240	2,460		5
34												1,830	2,070	2,330	2,570	2,900	2
35												1,920	2,160	2,430	2,670	2,990	3
36												2,020	2,250	2,520	2,770	3,090	
37													2,350	2,610	2,870	3,190	3
38													2,440	2,710	2,970	3,300	2
39													2,540	2,800	3,070	3,400	2
40													2,630	2,890	3,160	3,490	1
41													2,720	2,980	3,250	3,590	1
42													2,810	3,070	3,350	3,680	
43														3,160	3,440	3,780	
44														3,260	3,530	3,870	1
																	639

NOTE.—Trees scaled to 5.7 to 6.6 inches inside bark at top. Stumps 1 to 2 feet high.

[a] Measurements by P. D. Kelleter at McCloud, Cal., 1905.

TABLE 44.—**Western Hemlock.**[a]

Volume in board feet by the Scribner Rule,[b] *west of the Cascades in Washington.*

Diameter breast-high.	HEIGHT OF TREE (FEET).																Diameter of top inside bark.	Basis.
	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200		
	VOLUME (BOARD FEET).																	
Inches.																	*Inches.*	*Trees.*
7	10	15	20	25	30	40	50	60	.....	.....	.....	.....	.....	.....	.....	.....	5.7	6
8	20	25	30	40	50	60	75	90	.....	.....	.....	.....	.....	.....	.....	.....	5.9	22
9	30	35	45	55	65	80	95	115	.....	.....	.....	.....	.....	.....	.....	.....	6.0	36
10	40	50	60	75	90	105	125	140	160	.....	.....	.....	.....	.....	.....	.....	6.1	29
11	50	65	80	95	115	135	155	175	200	.....	.....	.....	.....	.....	.....	.....	6.2	31
12	65	80	100	120	140	160	180	210	230	.....	.....	.....	.....	.....	.....	.....	6.3	30
13	80	100	120	150	170	190	220	240	270	290	.....	.....	.....	.....	.....	.....	6.3	37
14	....	130	150	180	200	230	260	280	310	340	.....	.....	.....	.....	.....	.....	6.3	20
15	....	150	180	210	230	260	300	320	370	400	.....	.....	.....	.....	.....	.....	6.4	23
16	....	.....	210	240	270	300	340	380	430	490	.....	.....	.....	.....	.....	.....	6.4	10
17	....	.....	.....	275	310	340	380	430	495	560	630	.....	.....	.....	.....	.....	6.5	11
18	....	.....	.....	310	340	380	430	485	550	620	700	780	.....	.....	.....	.....	6.6	15
19	....	.....	.....	.....	380	425	480	545	615	690	770	860	.....	.....	.....	.....	6.8	16
20	....	.....	.....	.....	.....	470	530	595	670	750	835	930	.....	.....	.....	.....	7.0	6
21	....	.....	.....	.....	.....	.....	590	660	735	815	905	1,010	1,115	.....	.....	.....	7.3	9
22	....	.....	.....	.....	.....	.....	.....	715	800	895	990	1,100	1,205	1,320	1,430	.....	7.6	4
23	....	.....	.....	.....	.....	.....	.....	780	870	970	1,075	1,180	1,290	1,400	1,510	.....	8.0	4
24	....	.....	.....	.....	.....	.....	.....	830	930	1,040	1,145	1,260	1,375	1,495	1,620	.....	8.5	1
25	....	.....	.....	.....	.....	.....	.....	890	990	1,100	1,220	1,340	1,465	1,590	1,720	.....	9.0	2
26	....	.....	.....	.....	.....	.....	.....	950	1,060	1,170	1,290	1,420	1,550	1,690	1,830	.....	9.7	2
27	....	.....	.....	.....	.....	.....	.....	1,010	1,120	1,240	1,360	1,495	1,635	1,780	1,910	.....	10.4	2
28	....	.....	.....	.....	.....	.....	.....	1,070	1,190	1,320	1,450	1,590	1,730	1,880	2,030	2,180	11.2	.....
29	....	.....	.....	.....	.....	.....	.....	.....	1,250	1,390	1,530	1,670	1,820	1,970	2,120	2,270	12.1	.....

30									1,310	1,460	1,610	1,760	1,910	2,060	2,215	2,365	13.1	2
31									1,370	1,520	1,680	1,835	1,990	2,140	2,300	2,460	14.2	2
32									1,430	1,590	1,750	1,915	2,070	2,230	2,395	2,555	15.4	.....
33									.....	1,680	1,850	2,010	2,160	2,315	2,480	2,640	16.6	1
34									.....	1,745	1,920	2,095	2,260	2,420	2,580	2,735	17.9	4
35									.....	1,820	2,000	2,180	2,340	2,500	2,670	2,830	19.2	.....
36									.....	1,900	2,085	2,265	2,430	2,590	2,755	2,920	20.6	.....
37									.....	.....	2,170	2,350	2,520	2,680	2,850	3,020	21.8	4
38									.....	.....	2,250	2,430	2,610	2,775	2,940	3,110	22.7	3
39									.....	.....	.....	2,540	2,700	2,860	3,080	3,205	23.5	2
40									.....	.....	.....	2,630	2,790	2,960	3,125	3,300	24.1	1
																		335

[a] Measurements by E. T. Allen, 1899. The basis for this table is inadequate, and the volumes for the larger trees must be regarded as approximations only.

[b] Average height of stump, 1.9 feet.

TABLE 45.—**Western Larch.**[a]

Volume in board feet according to the diameter and number of 16-foot logs,[b] *Flathead County, Mont.*

Diameter breast-high.	NUMBER OF 16-FOOT LOGS.						Diameter of top inside bark.	Basis.
	3	4	5	6	7	8		
	VOLUME (BOARD FEET).							
Inches.							*Inches.*	*Trees.*
11	95	140	.....	.....	.....	.....	.....	3
12	105	155	.....	.....	.....	.....	7.3	15
13	120	165	220	.....	.....	.....	7.4	31
14	135	185	240	.....	.....	.....	7.5	93
15	155	205	270	.....	.....	.....	7.6	114
16	175	230	295	380	.....	.....	7.7	119
17	195	260	325	415	.....	.....	7.8	128
18	220	285	365	455	.....	.....	7.9	100
19	240	315	400	490	.....	.....	8.0	93
20	265	345	435	535	645	.....	8.1	127
21	.....	380	475	585	705	.....	8.1	86
22	.....	415	520	635	775	.....	8.1	89
23	.....	450	560	695	840	1,005	8.2	80
24	.....	485	605	745	905	1,085	8.2	79
25	.....	525	655	805	975	1,180	8.2	52
26	.....	565	700	865	1,055	1,275	8.2	32
27	.....	605	755	930	1,130	1,375	8.3	32
28	.....	650	805	995	1,210	1,470	8.3	35
29	.....	.....	855	1,060	1,295	1,565	8.4	17
30	.....	.....	910	1,130	1,385	1,670	8.5	21
31	.....	.....	.....	1,205	1,465	1,770	8.7	12
32	.....	.....	.....	1,280	1,560	1,875	8.8	10
33	.....	.....	.....	1,360	1,650	1,975	9.0	4
34	.....	.....	.....	1,440	1,745	2,085	9.2	8
35	.....	.....	.....	1,525	1,845	2,190	9.4	1

[a] Measurements by L. Margolin—1907.

[b] Allow 5 per cent for breakage and defect. Allow 5 per cent for "butts" when logs are driven to the mill. No allowance for "butts" in railroad logging.

TABLE 45.—**Western Larch**—Continued.

Volume in board feet according to the diameter and number of 16-foot logs, Flathead County, Mont.—Continued.

Diameter breast-high.	NUMBER OF 16-FOOT LOGS.						Diameter of top inside bark.	Basis.
	3	4	5	6	7	8		
	VOLUME (BOARD FEET.)							
Inches.							*Inches.*	*Trees.*
36	.....	.....	.....	1,600	1,945	2,295	9.6	5
37	.....	.....	.....	1,685	2,040	2,395	9.8	3
38	.....	.....	.....	1,770	2,145	2,505	10.0	2
39	.....	.....	.....	1,850	2,240	2,610	10.2	.....
40	.....	.....	.....	1,930	2,340	2,715	10.4	.....
41	.....	.....	.....	2,025	2,440	2,820	10.6	2
42	.....	.....	.....	2,105	2,535	2,925	10.8	.....
43	.....	.....	.....	2,200	2,635	3,025	.....	.....
44	.....	.....	.....	2,295	2,730	3,130	.....	1
								1,394

TABLE 46.—**Western Larch.**[a]

Volume in board feet by the Scribner Rule according to the total height of the tree, Flathead County, Mont.

Diameter breast-high.	HEIGHT OF TREE (FEET).									Diameter of top inside bark.	Basis.
	80	90	100	110	120	130	140	150	160		
	VOLUME (BOARD FEET).										
Inches.										*Inches.*	*Trees.*
12	120	140	.....	.....	.....	.....	.....	.....	.....	7.3	13
13	140	170	190	.....	.....	.....	.....	.....	.....	7.4	32
14	160	190	220	240	260	.....	.....	.....	.....	7.5	92
15	190	220	250	280	310	.....	.....	.....	.....	7.6	113
16	210	250	280	310	350	.....	.....	.....	.....	7.7	119
17	240	270	320	360	390	430	.....	.....	.....	7.8	128
18	260	300	350	390	440	490	.....	.....	.....	7.9	100
19	290	330	380	440	490	540	.....	.....	.....	8.0	93
20	310	370	420	480	530	590	.....	.....	.....	8.1	126
21	340	400	460	520	580	650	.....	.....	.....	8.1	86
22	370	430	500	570	640	710	790	.....	.....	8.1	89
23	.....	470	540	620	700	780	880	.....	.....	8.2	80
24	.....	510	590	670	760	860	970	.....	.....	8.2	79
25	.....	550	630	720	820	930	1,060	.....	.....	8.2	52
26	.....	590	680	770	880	1,000	1,160	.....	.....	8.2	32
27	.....	.....	730	830	950	1,090	1,250	1,410	.....	8.3	32
28	.....	.....	770	890	1,020	1,170	1,340	1,520	.....	8.3	35
29	.....	.....	.....	950	1,100	1,260	1,440	1,630	1,840	8.4	17
30	.....	.....	.....	1,000	1,170	1,350	1,540	1,740	1,960	8.5	21
31	.....	.....	.....	.....	1,260	1,450	1,650	1,860	2,090	8.7	12
32	.....	.....	.....	.....	1,340	1,540	1,750	1,970	2,200	8.8	10
33	.....	.....	.....	.....	1,430	1,640	1,850	2,080	2,320	9.0	6
34	.....	.....	.....	.....	1,510	1,730	1,950	2,200	2,450	9.2	8
35	.....	.....	.....	.....	.....	1,820	2,060	2,310	2,570	9.4	1

[a] Measurements by L. Margolin—1907.

TABLE 46.—**Western Larch**—Continued.

Volume in board feet by the Scribner Rule according to the total height of the tree, Flathead County, Mont.—Continued.

Diameter breast-high.	HEIGHT OF TREE (FEET).									Diameter of top inside bark.	Basis.
	80	90	100	110	120	130	140	150	160		
	VOLUME (BOARD FEET).										
Inches.										*Inches.*	*Trees.*
36	.....	.....	.....	.....	.....	1,910	2,150	2,410	2,680	9.6	5
37	.....	.....	.....	.....	.....	2,000	2,250	2,520	2,790	9.8	3
38	.....	.....	.....	.....	.....	2,090	2,340	2,610	2,900	10.0	3
39	.....	.....	.....	.....	.....	2,180	2,440	2,720	3,000	10.2	.....
40	.....	.....	.....	.....	.....	2,270	2,540	2,820	3,100	10.4	.....
41	.....	.....	.....	.....	.....	.....	.....	2,920	3,210	10.6	1
42	.....	.....	.....	.....	.....	.....	.....	3,000	3,310	10.8	.....
											1,388

Allow 5 per cent for breakage and defect. Allow 5 per cent for "butts" when logs are driven to mill. No allowance for "butts" in railroad logging.

TABLE 47.—**Lodgepole Pine.**[a]

Average number of first (6″ by 8″ by 8′) and second-class railroad ties and of mine props, based on actual cutting, Medicine Bow National Forest, Wyo.

Diameter breast-high.	HEIGHT OF TREE (FEET).										Basis.
	50		60		70		80		90		
	Ties.	Props.	Ties.	Props.	Ties.	Props.	Ties.	Props.	Ties.	Props.	
Inches.	*No.*	*Feet.*	*No.*	*Feet.*	*No.*	*Feet.*	*No.*	*Feet.*	*No.*	*Feet.*	*Trees.*
10	2.0	17	2.3	21	2.5	25	3.0	29	.....	.....	32
11	2.4	13	2.7	18	3.0	21	3.6	25	4.0	28	219
12	2.8	12	3.2	15	3.5	19	4.1	21	4.5	24	292
13	3.3	11	3.6	14	4.0	17	4.7	19	4.9	21	239
14	3.7	11	4.0	13	4.5	15	5.1	17	5.4	19	89
15	4.0	11	4.4	13	5.0	14	5.5	15	5.8	17	23
											894

Ties in the run of diameters were about 25 per cent second class. Props are given in linear feet, to about a 6-inch top. Trees over 15 inches give better returns in lumber.

[a] Measurements by P. G. Redington—1905.

TABLE 48.—**Lodgepole Pine.**[a]

Volume in board feet by the Scribner Rule,[b] *Gallatin County, Mont.*

Diameter breast-high.	HEIGHT OF TREE (FEET).						Basis.
	50	60	70	80	90	100	
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Trees.*
10	50	65	75	90	105	125	495
11	60	75	90	105	125	155	478
12	75	90	105	125	150	185	296
13	90	105	125	145	180	215	146
14	105	125	145	170	215	250	120
15	.....	140	170	200	250	285	113
16	.....	160	195	230	285	315	60
17	.....	.....	225	260	315	350	44
18	.....	.....	250	290	350	385	25
19	.....	.....	275	320	380	420	17
20	.....	.....	300	345	415	460	14
21	.....	.....	.....	375	450	495	2
22	.....	.....	.....	400	490	530	6
23	.....	.....	.....	430	525	565	.....
24	.....	.....	.....	455	560	600	1
							1,817

[a] Measurements by G. E. Tower, 1902, and P. G. Redington, 1905.

[b] Trees scaled to 6 inches in top in log lengths of 10 to 16 feet.

TABLE 49.—**Sugar Pine.**[a]

Volume in board feet by the Scribner Rule,[b] *in California.*

Diameter breast-high.	HEIGHT OF TREE (FEET).										
	40	50	60	70	80	90	100	110	120	130	140
	VOLUME (BOARD FEET).										
Inches.											
8	10	10	.....	.....	.....	.....	.....	.....	.....	.....	.....
9	10	15	20	25	.....	.....	.....	.....	.....	.....	.....
10	15	20	30	40	.....	.....	.....	.....	.....	.....	.....
11	20	25	35	50	70	.....	.....	.....	.....	.....	.....
12	20	30	45	65	85	.....	.....	.....	.....	.....	.....
13	....	40	60	80	100	.....	.....	.....	.....	.....	.....
14	....	45	70	95	120	.....	.....	.....	.....	.....	.....
15	....	....	85	110	140	160	.....	.....	.....	.....	.....
16	....	....	100	130	150	180	210	.....	.....	.....	.....
17	....	....	120	150	180	210	240	280	.....	.....	.....
18	....	....	130	170	200	240	280	320	.....	.....	.....
19	....	....	.....	190	230	270	310	350	.....	.....	.....
20	....	....	.....	210	250	300	340	390	450	.....	.....
21	....	....	.....	.....	280	330	380	430	490	.....	.....
22	....	....	.....	.....	310	360	410	470	540	600	.....
23	....	....	.....	.....	.....	390	450	520	580	650	.....
24	....	....	.....	.....	.....	430	490	560	640	710	.....
25	....	....	.....	.....	.....	470	540	610	690	770	.....
26	....	....	.....	.....	.....	510	580	670	750	840	950
27	....	....	.....	.....	.....	550	630	710	800	910	1,020
28	....	....	.....	.....	.....	590	680	760	870	980	1,110
29	....	....	.....	.....	.....	640	730	820	930	1,060	1,200
30	....	....	.....	.....	.....	680	780	890	1,010	1,140	1,290
31	....	....	.....	.....	.....	720	840	960	1,090	1,230	1,390
32	....	....	.....	.....	.....	770	890	1,020	1,160	1,320	1,490
33	....	....	.....	.....	.....	.....	.....	1,090	1,250	1,410	1,600

[a] Measurements by R. D. Swales, 1901, and A. W. Cooper, 1901–4.

[b] The basis for this table for the larger diameters is too meager for anything beyond a good approximation. The larger part of the data was collected in Butte County, Cal.

TABLE 49.—**Sugar Pine**—Continued.

Volume in board feet by the Scribner Rule, in California—Cont'd.

Diameter breast-high.	HEIGHT OF TREE (FEET).										
	40	50	60	70	80	90	100	110	120	130	140
	VOLUME (BOARD FEET).										
Inches.											
34									1,340	1,510	1,710
35									1,420	1,620	1,830
36									1,520	1,720	1,950
37									1,620	1,830	2,070
38									1,720	1,950	2,210
39									1,830	2,060	2,330
40									1,930	2,180	2,460
41									2,040	2,310	2,590
42									2,160	2,420	2,720
43									2,280	2,550	2,850
44									2,390	2,670	2,980
45									2,510	2,800	3,130
46									2,620	2,930	3,260
47										3,060	3,390
48										3,190	3,520
50										3,420	3,770
52										3,640	4,020
54											4,270
56											
58											
60											
62											
64											
66											
68											
70											
72											
74											
76											

TABLE 49.—**Sugar Pine**—Continued.

Volume in board feet by the Scribner Rule, in California—Cont'd.

Diameter breast-high.	HEIGHT OF TREE (FEET).							Stump height.	Diameter of top inside bark.	Basis.
	150	160	170	180	190	200	210			
	VOLUME (BOARD FEET).									
Inches.								*Feet.*	*Inches.*	*Trees.*
8	.....	.....	.....	.....	.....	.....	.....	2.7	5.8	27
9	.....	.....	.....	.....	.....	.....	.....	2.7	6.0	25
10	.....	.....	.....	.....	.....	.....	.....	2.7	6.1	44
11	.....	.....	.....	.....	.....	.....	.....	2.7	6.3	49
12	.....	.....	.....	.....	.....	.....	.....	2.7	6.4	40
13	.....	.....	.....	.....	.....	.....	.....	2.7	6.5	26
14	.....	.....	.....	.....	.....	.....	.....	2.7	6.6	28
15	.....	.....	.....	.....	.....	.....	.....	2.7	6.7	15
16	.....	.....	.....	.....	.....	.....	.....	2.7	6.8	25
17	.....	.....	.....	.....	.....	.....	.....	2.7	6.9	39
18	.....	.....	.....	.....	.....	.....	.....	2.7	7.1	23
19	.....	.....	.....	.....	.....	.....	.....	2.7	7.4	28
20	.....	.....	.....	.....	.....	.....	.....	2.7	7.7	25
21	.....	.....	.....	.....	.....	.....	.....	2.7	8.0	10
22	.....	.....	.....	.....	.....	.....	.....	2.7	8.4	12
23	.....	.....	.....	.....	.....	.....	.....	2.7	8.8	7
24	.....	.....	.....	.....	.....	.....	.....	2.7	9.3	5
25	.....	.....	.....	.....	.....	.....	.....	2.7	9.7	2
26	.....	.....	.....	.....	.....	.....	.....	2.7	10.2	15
27	.....	.....	.....	.....	.....	.....	.....	2.7	10.8	7
28	.....	.....	.....	.....	.....	.....	.....	2.7	11.3	12
29	.....	.....	.....	.....	.....	.....	.....	2.7	11.9	7
30	.....	.....	.....	.....	.....	.....	.....	2.8	12.5	10
31	.....	.....	.....	.....	.....	.....	.....	2.8	13.1	7
32	1,680	.....	.....	.....	.....	.....	.....	2.8	13.7	8
33	1,800	.....	.....	.....	.....	.....	.....	2.8	14.3	12
34	1,920	2,140	.....	.....	.....	.....	.....	2.8	14.9	7
35	2,050	2,290	.....	.....	.....	.....	.....	2.9	15.5	9
36	2,190	2,460	.....	.....	.....	.....	.....	2.9	16.2	9
37	2,340	2,620	.....	.....	.....	.....	.....	2.9	16.8	9

TABLE 49.—**Sugar Pine**—Continued.

Volume in board feet by the Scribner Rule, in California—Cont'd.

Diameter breast-high.	HEIGHT OF TREE (FEET).							Stump height.	Diameter of top inside bark.	Basis.
	150	160	170	180	190	200	210			
	VOLUME (BOARD FEET).									
Inches.								*Feet.*	*Inches.*	*Trees.*
38	2,490	2,780	.....	.....	.....	.....	.....	3.0	17.4	10
39	2,620	2,950	.....	.....	.....	.....	.....	3.0	18.0	11
40	2,770	3,110	.....	.....	.....	.....	.....	3.1	18.7	7
41	2,910	3,250	.....	.....	.....	.....	.....	3.1	19.3	6
42	3,050	3,390	3,760	.....	.....	.....	.....	3.2	19.9	9
43	3,180	3,550	3,930	.....	.....	.....	.....	3.2	20.5	13
44	3,330	3,700	4,100	.....	.....	.....	.....	3.3	21.1	10
45	3,470	3,840	4,230	4,580	.....	.....	.....	3.4	21.7	6
46	3,600	3,980	4,350	4,720	5,090	.....	.....	3.4	22.4	11
47	3,740	4,090	4,450	4,840	5,240	.....	.....	3.5	22.9	6
48	3,870	4,240	4,600	4,980	5,390	5,830	.....	3.6	23.6	9
50	4,140	4,520	4,900	5,320	5,730	6,140	6,550	3.8	24.8	10
52	4,400	4,810	5,230	5,660	6,100	6,550	6,980	3.9	26.0	13
54	4,670	5,090	5,540	6,000	6,480	6,940	7,410	4.1	27.2	6
56	.....	.....	5,900	6,370	6,850	7,320	7,800	4.3	28.4	7
58	.....	.....	6,270	6,740	7,230	7,730	8,220	4.4	29.5	6
60	.....	.....	.....	7,130	7,630	8,130	8,640	4.6	30.7	5
62	.....	.....	.....	7,550	8,040	8,550	9,050	4.7	31.9	3
64	.....	.....	.....	7,920	8,430	8,930	9,450	4.8	33.0	2
66	.....	.....	.....	8,300	8,830	9,340	9,880	4.9	34.2	2
68	.....	.....	.....	8,680	9,200	9,740	10,290	5.0	35.4	1
70	.....	.....	.....	9,050	9,590	10,150	10,710	5.1	36.6	1
72	.....	.....	.....	.....	9,950	10,520	11,100	5.2	37.7	1
74	.....	.....	.....	.....	10,320	10,910	11,530	5.3	38.9	2
76	.....	.....	.....	.....	10,700	11,310	11,930	5.4	39.9	1
										700

TABLE 50.—**Western White Pine.**[a]

Volume in board feet by the Scribner Rule,[b] *Kaniksu National Forest Idaho.*

[Table based on total height classes.]

Diameter breast-high.	MERCHANTABLE LENGTH (FEET).														Basis.
	30	40	50	60	70	80	90	100	110	120	130	140	150	160	
	VOLUME (BOARD FEET).														
Inches.															*Trees.*
8	35	50	65	80	90	105	....	....	.....	.....	.....	.....	.....	.....	7
9	45	60	75	90	100	120	....	....	.....	.....	.....	.....	.....	.....	40
10	55	70	85	100	120	140	155	....	.....	.....	.....	.....	.....	.....	65
11	65	80	100	120	140	160	175	....	.....	.....	.....	.....	.....	.....	76
12	75	95	115	135	160	180	200	220	.....	.....	.....	.....	.....	.....	104
13	...	110	130	155	180	200	230	250	.....	.....	.....	.....	.....	.....	76
14	...	125	150	180	205	230	260	285	310	.....	.....	.....	.....	.....	107
15	.....	...	170	200	230	260	290	320	350	.....	.....	.....	.....	.....	86
16	.....	...	190	220	255	290	320	360	390	420	.....	.....	.....	.....	80
17	.....	.....	...	240	280	320	360	400	430	470	.....	.....	.....	.....	104
18	.....	.....	.....	....	300	350	390	440	480	530	580	.....	.....	.....	111
19	.....	.....	.....	.....	330	380	430	480	530	590	640	.....	.....	.....	117
20	.....	.....	.....	.....	.....	410	460	520	580	650	700	760	.....	.....	115
21	.....	.....	.....	.....	.....	430	500	570	640	710	770	840	.....	.....	103
22	.....	.....	.....	.....	.....	.....	540	610	690	770	850	930	1,000	.....	94
23	.....	.....	.....	.....	.....	.....	580	660	750	840	930	1,020	1,100	.....	83
24	.....	.....	.....	.....	.....	.....	620	710	800	900	1,000	1,100	1,200	1,300	81
25	.....	.....	.....	.....	.....	.....	.....	760	860	970	1,080	1,190	1,300	1,410	69
26	.....	.....	.....	.....	.....	.....	.....	810	930	1,050	1,170	1,290	1,400	1,520	64
27	.....	.....	.....	.....	.....	.....	.....	860	990	1,120	1,250	1,380	1,500	1,630	65
28	.....	.....	.....	.....	.....	.....	.....	.....	1,060	1,190	1,330	1,470	1,610	1,750	40
29	.....	.....	.....	.....	.....	.....	.....	.....	1,120	1,270	1,420	1,570	1,720	1,870	23

[a] Measurements made in Bonner County, Idaho, under direction of W. N. Millar, 1908.

[b] Scaled to a top diameter inside bark of 6 to 8 inches. Height of stump—2 to 3 feet. All trees scaled as though sound. Loss due to breakage was 4 per cent. Loss due to invisible rot (*Trametes pini*) was 5 per cent.

TABLE 50—**Western White Pine**—Continued.

Volume in board feet by the Scribner Rule, Kaniksu National Forest, Idaho—Continued.

[Table based on total height classes.]

Diameter breast-high.	MERCHANTABLE LENGTH (FEET).														Basis.
	30	40	50	60	70	80	90	100	110	120	130	140	150	160	
	VOLUME (BOARD FEET).														
Inches.															*Trees.*
30									1,180	1,340	1,500	1,660	1,830	1,990	28
31										1,400	1,580	1,760	1,940	2,110	14
32										1,470	1,660	1,850	2,040	2,230	9
33										1,540	1,750	1,950	2,150	2,360	14
34											1,830	2,050	2,270	2,490	6
35											1,920	2,150	2,390	2,630	6
36											2,010	2,260	2,520	2,770	4
															1,791

TABLE 51.—**Western White Pine.**[a]

Volume in board feet by the Scribner Rule,[b] *Kaniksu National Forest, Idaho.*

[Based on 16-foot log classes.]

Diameter breast-high	NUMBER OF SIXTEEN-FOOT LOGS.									Basis.
	2	3	4	5	6	7	8	9	10	
	VOLUME (BOARD FEET).									
Inches.										*Trees.*
8	40	60	85	105						7
9	45	70	95	120						40
10	55	85	110	140	165					65
11	65	95	125	160	190					76
12	75	110	145	180	215	245				104
13		125	165	200	240	280				76
14		145	190	230	270	320	360			107
15		165	215	260	310	360	400			86
16		185	235	290	340	400	450			80
17			255	320	380	450	510	570		104
18			275	350	420	500	570	640		111
19			295	380	460	550	630	720		117
20			320	410	500	600	690	790	880	115
21				430	540	650	760	870	980	103
22				460	580	710	830	960	1,080	94
23				480	620	760	910	1,050	1,190	83
24				510	660	820	980	1,140	1,300	81
25					710	890	1,060	1,240	1,410	69
26					760	950	1,140	1,330	1,520	64
27					810	1,010	1,220	1,430	1,630	65
28						1,080	1,300	1,530	1,750	40
29						1,150	1,390	1,630	1,870	23
30						1,220	1,470	1,730	1,990	28
31							1,550	1,830	2,110	14
32							1,630	1,930	2,230	9
33							1,710	2,030	2,360	14
34								2,140	2,490	6
35								2,250	2,630	6
36								2,360	2,770	4
										1,791

[a] Measurements same as preceding table.

[b] Scaled to a top diameter inside bark of 6 to 8 inches. Height of stump—2 to 3 feet. All trees scaled as though sound. Loss by breakage was 4 per cent. Loss due to invisible rot (*Trametes pini*) was 5 per cent.

TABLE 52.—Western Yellow Pine.[a]

Volume in board feet by the Scribner Rule, Black Hills National Forest, S. Dak.

Diameter breast-high.	HEIGHT OF TREE (FEET).							Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100		
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Inches.*	*Trees.*
8	20	25	.....	.....	.....	.....	.....	6.0	6
9	25	35	45	.....	.....	.....	.....	6.3	4
10	35	45	55	65	.....	.....	.....	6.5	17
11	45	55	70	85	100	.....	.....	6.8	22
12	55	70	90	110	130	.....	.....	7.0	47
13	.....	85	105	130	155	.....	.....	7.3	100
14	.....	105	125	150	185	.....	.....	7.6	200
15	.....	125	150	175	210	245	.....	7.9	214
16	.....	145	175	205	245	285	.....	8.4	225
17	.....	170	200	240	280	325	.....	8.9	146
18	.....	195	230	270	320	375	.....	9.4	146
19	.....	.....	265	310	365	425	.....	10.1	87
20	.....	.....	300	350	405	475	.....	10.8	63
21	.....	.....	340	395	460	530	.....	11.5	50
22	.....	.....	380	440	510	585	650	12.1	32
23	.....	.....	.....	490	565	645	720	12.8	36
24	.....	.....	.....	.....	620	710	800	13.4	13
25	.....	.....	.....	.....	.....	785	880	13.9	11
									1,419

[a] Measurements by Coert DuBois, 1902, and H. M. Curran, 1904.

TABLE 53.—**Western Yellow Pine ("Yellow Pine").**[a]

Volume in board feet by the Scribner Rule,[b] *Coconino National Forest, Ariz.*

Diameter breast-high.	HEIGHT OF TREE (FEET).									Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100	110	120		
Inches.	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Bd. ft.*	*Inches.*	*Trees.*
12	50	60	70	80	.....	.....	.....	.....	.....	8.3	.....
13	60	80	90	100	.....	.....	.....	.....	.....	8.5	23
14	70	90	110	120	140	150	.....	.....	.....	8.7	48
15	90	110	130	150	170	180	190	.....	.....	8.9	91
16	110	130	160	180	200	220	230	240	.....	9.2	117
17	130	160	180	210	230	260	280	290	310	9.4	142
18	160	180	210	240	270	300	320	350	370	9.6	136
19	180	210	250	280	310	350	380	410	430	9.9	135
20	210	250	280	320	360	400	440	470	500	10.1	104
21	240	280	320	370	410	460	500	540	580	10.4	127
22	280	310	360	410	470	520	570	620	670	10.6	135
23	.....	350	410	470	520	590	640	700	760	10.9	103
24	.....	390	450	520	590	660	720	780	850	11.1	105
25	.....	430	500	580	650	730	800	880	950	11.3	85
26	.....	470	550	630	720	800	890	980	1,070	11.6	93
27	.....	.....	610	690	790	880	980	1,080	1,190	11.9	83
28	.....	.....	660	760	860	960	1,080	1,190	1,310	12.1	63
29	.....	.....	.....	820	930	1,040	1,170	1,300	1,440	12.4	51
30	.....	.....	.....	880	1,000	1,130	1,270	1,420	1,570	12.7	42
31	.....	.....	.....	940	1,070	1,220	1,380	1,550	1,720	12.9	21
32	.....	.....	.....	1,010	1,150	1,310	1,490	1,680	1,870	13.2	28
33	.....	.....	.....	.....	1,230	1,410	1,610	1,820	2,020	13.5	22
34	.....	.....	.....	.....	1,310	1,510	1,740	1,960	2,180	13.9	22
35	.....	.....	.....	.....	1,390	1,620	1,870	2,110	2,330	14.3	17
36	.....	.....	.....	.....	1,470	1,720	1,990	2,260	2,500	14.7	13
37	.....	.....	.....	.....	.....	1,810	2,120	2,410	2,660	15.2	6
38	.....	.....	.....	.....	.....	1,900	2,250	2,550	2,820	15.8	4
39	.....	.....	.....	.....	.....	.....	2,390	2,690	2,980	16.4	5
40	.....	.....	.....	.....	.....	.....	2,530	2,840	3,150	17.0	1
											1,822

[a] Measurements by T. S. Woolsey, jr., 1906.

[b] Scaled to 8-inch top inside bark—straight and sound. Allow 3 to 15 per cent for defects. The so-called "black jack" variety requires a further reduction of about 12 per cent, having a smaller volume than the older "yellow pine."

TABLE 54.—Western Yellow Pine.[a]

Volume in board feet—"Yellow Pine"—by the Scribner Rule,[b] Coconino National Forest, Ariz.

[Based on 16-foot logs.]

Diameter breast-high.	NUMBER OF 16-FOOT LOGS.						Basis.
	1	2	3	4	5	6	
	VOLUME (BOARD FEET).						
Inches.							*Trees.*
13	50	80	.....	.....	.....	.....	22
14	60	100	140	190	.....	.....	47
15	70	120	160	210	.....	.....	93
16	80	140	180	240	.....	.....	119
17	100	160	210	270	.....	.....	142
18	120	190	240	310	380	.....	140
19	140	220	270	350	430	.....	138
20	160	250	310	400	490	.....	108
21	.....	290	360	450	550	.....	128
22	.....	330	410	500	610	.....	136
23	.....	380	460	560	680	.....	101
24	.....	420	520	630	760	.....	108
25	.....	470	580	700	840	.....	86
26	.....	530	640	780	920	1,060	95
27	.....	580	710	860	1,010	1,150	85
28	.....	630	790	950	1,100	1,250	65
29	.....	.....	870	1,040	1,200	1,360	54
30	.....	.....	960	1,130	1,300	1,470	43
31	.....	.....	1,050	1,230	1,410	1,590	25
32	.....	.....	1,140	1,340	1,530	1,710	28
33	.....	.....	1,240	1,460	1,660	1,830	21
34	.....	.....	1,340	1,580	1,780	1,960	21
35	.....	.....	.....	1,710	1,910	2,090	14
36	.....	.....	.....	1,830	2,040	2,220	12
37	.....	.....	.....	1,950	2,160	2,340	5
38	.....	.....	.....	2,060	2,280	2,450	3
39	.....	.....	.....	2,160	2,400	2,560	3
40	.....	.....	.....	2,260	2,520	2,670	2
							1,844

[a] Measurements by T. S. Woolsey, jr., 1906.

[b] Trees scaled to 8-inch top inside bark—straight and sound. Allow 3 to 15 per cent for defects. The so-called "black jack" variety requires a reduction of about 12 per cent, having a smaller volume than the older "yellow pine."

TABLE 55.—**Western Yellow Pine.**[a]

Volume in board feet by the Scribner Rule, California and Montana.

Diameter breast-high.	HEIGHT OF TREE (FEET).															Diameter of top inside bark.	Basis.
	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190		
	VOLUME—BOARD FEET.																
Inches.																*Inches.*	*Trees.*
12	15	20	30	45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.8	3
13	20	35	45	60	70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.0	40
14	30	50	60	80	90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.2	58
15	40	65	80	100	120	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.4	67
16	60	80	105	125	150	180	205	.....	.....	.....	.....	.....	.....	.....	.....	10.6	81
17	80	100	130	155	180	215	255	.....	.....	.....	.....	.....	.....	.....	.....	10.9	74
18	100	125	160	190	220	260	305	350	.....	.....	.....	.....	.....	.....	.....	11.1	81
19	.....	155	190	225	260	310	360	415	.....	.....	.....	.....	.....	.....	.....	11.4	58
20	.....	185	225	270	310	360	420	480	535	585	.....	.....	.....	.....	.....	11.7	75
21	.....	215	265	315	360	420	480	545	610	675	.....	.....	.....	.....	.....	12.0	64
22	.....	250	305	360	415	480	550	620	700	765	840	.....	.....	.....	.....	12.4	68
23	.....	290	350	410	475	545	620	700	780	860	940	1,030	.....	.....	.....	12.7	61
24	.....	.....	390	460	530	610	690	780	870	960	1,040	1,140	1,230	.....	.....	13.0	69
25	.....	.....	430	510	590	680	770	870	960	1,060	1,150	1,250	1,340	.....	.....	13.4	68
26	.....	.....	480	560	660	750	850	950	1,060	1,160	1,260	1,360	1,460	.....	.....	13.7	54

27					720	820	930	1,040	1,150	1,260	1,370	1,480	1,580			14.1	60
28					790	890	1,010	1,120	1,240	1,350	1,480	1,600	1,710			14.4	61
29					860	970	1,090	1,210	1,340	1,450	1,590	1,720	1,830			14.8	52
30					930	1,040	1,170	1,290	1,430	1,550	1,700	1,830	1,950			15.2	57
31					990	1,110	1,250	1,380	1,530	1,650	1,810	1,950	2,070			15.5	26
32					1,060	1,190	1,330	1,470	1,630	1,760	1,920	2,060	2,200			15.9	18
33					1,130	1,260	1,400	1,550	1,720	1,870	2,040	2,190	2,330	2,450	2,590	16.3	15
34					1,190	1,330	1,480	1,640	1,820	1,970	2,150	2,320	2,450	2,590	2,730	16.6	17
35						1,410	1,560	1,730	1,910	2,080	2,270	2,440	2,580	2,730	2,880	17.0	14
36						1,480	1,640	1,820	2,010	2,200	2,390	2,580	2,720	2,870	3,020	17.4	6
37						1,550	1,720	1,910	2,110	2,310	2,520	2,720	2,860	3,020	3,170	17.8	10
38						1,630	1,810	2,000	2,210	2,440	2,650	2,860	3,010	3,180	3,340	18.2	2
39						1,700	1,890	2,090	2,310	2,570	2,800	3,020	3,170	3,340	3,500	18.6	6
40						1,770	1,980	2,190	2,420	2,720	2,960	3,180	3,340	3,520	3,670	19.0	7
41									2,530	2,870	3,120	3,340	3,520	3,690	3,840	19.4	3
42									2,650	3,040	3,290	3,510	3,690	3,860	4,000	19.8	8
43										3,210	3,460	3,670	3,860	4,010	4,140	20.2	6
44										3,380	3,630	3,830	4,010	4,160	4,280	20.7	7
45										3,560	3,790	3,980	4,150	4,290	4,420	21.1	7
46										3,720	3,950	4,120	4,280	4,420	4,540	21.5	6
47										3,900	4,100	4,250	4,400	4,540	4,660	21.9	2
48										4,070	4,250	4,380	4,520	4,660	4,780	22.3	2
																	1,313

a Measurements by R. D. Swales, Siskiyou County, Cal., 1901; A. W. Cooper, Butte and Madera counties, Cal., 1904; S. D. Record, Flathead and Missoula counties, Mont., 1904.

Volumes for small trees may be increased considerably by closer utilization in the top, since in some localities 6-inch logs are now taken.

The Montana data were tabulated first separately, which showed no consistent variation from the California trees of the same diameter and height. The Montana measurements were made in a mixed forest with western larch and Douglas fir. Some Montana yellow pine stands will probably require the use of the Arizona or Black Hills volume tables.

TABLE 56.—**Engelmann Spruce.**[a]

Volume in board feet by the Scribner Rule,[b] *Colorado and Utah.*

Diameter breast-high.	HEIGHT OF TREE (FEET).									Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100	110	120		
	VOLUME (BOARD FEET).										
Inches.										*Inches.*	*Trees.*
8	15	20	30	.....	.....	.....	.....	.....	.....	6.2	8
9	15	25	35	50	70	.....	.....	.....	.....	6.3	19
10	20	30	45	60	80	.....	.....	.....	.....	6.4	19
11	25	40	55	70	90	110	.....	.....	.....	6.5	35
12	30	50	65	85	110	135	.....	.....	.....	6.6	45
13	40	60	80	100	130	160	.....	.....	.....	6.7	44
14	50	70	95	120	150	185	220	.....	.....	6.8	51
15	60	80	110	140	170	210	250	.....	.....	6.9	37
16	70	95	125	160	190	240	280	340	.....	7.0	61
17	....	110	140	180	220	270	320	380	.....	7.1	57
18	....	125	160	200	250	300	360	430	.....	7.1	55
19	....	.....	180	225	280	330	400	470	.....	7.2	45
20	....	.....	205	250	310	360	440	520	600	7.2	43
21	....	.....	230	280	340	400	480	560	650	7.3	41
22	....	.....	250	310	370	440	520	610	700	7.4	29
23	....	.....	.....	340	400	480	560	660	760	7.4	21

[a] Measurements by J. H. Foster, on the Gunnison, Leadville, Uncompahgre, and Uinta National Forests, 1907.

[b] Stump height 1.5 to 3.0 feet.

TABLE 56.—**Engelmann Spruce**—Continued.

Volume in board feet by the Scribner Rule, Colorado and Utah—Continued.

Diameter breast-high.	HEIGHT OF TREE (FEET).									Diameter of top inside bark.	Basis.
	40	50	60	70	80	90	100	110	120		
	VOLUME (BOARD FEET).										
Inches.										*Inches.*	*Trees.*
24	....	....	.....	370	430	520	600	710	820	7.5	21
25	....	.....	.....	.....	470	560	650	760	880	7.5	10
26	....	.....	.....	.....	500	600	700	820	950	7.6	11
27	....	.....	.....	.....	540	640	750	870	1,010	7.6	5
28	....	.....	.....	.....	580	680	800	930	1,080	7.6	6
29	....	.....	.....	.....	620	730	850	990	1,150	7.7	4
30	....	.....	.....	.....	660	780	900	1,050	1,220	7.7	4
31	....	.....	.....	.....	.....	830	960	1,120	1,300	7.8	3
32	....	.....	.....	.....	.....	880	1,020	1,190	1,380	7.8	1
33	....	.....	.....	.....	.....	930	1,080	1,260	1,460	7.8	.....
34	....	.....	.....	.....	.....	980	1,140	1,330	1,540	7.9	1
35	....	.....	.....	.....	.....	.....	1,200	1,400	1,620	7.9	.....
36	....	.....	.....	.....	.....	.....	1,260	1,470	1,700	7.9	.....
37	....	.....	.....	.....	.....	.....	.....	1,550	1,780	8.0	.....
38	....	.....	.....	.....	.....	.....	.....	1,630	1,860	8.0	.....
											676

TABLE 57.—Engelmann Spruce.[a]

Volume in board feet by the Scribner Rule,[b] Colorado and Utah.

[Based on merchantable length.]

Diameter breast-high.	MERCHANTABLE LENGTH (FEET). VOLUME (BOARD FEET).										Diameter of top inside bark.	Basis.
	10	20	30	40	50	60	70	80	90	100		
Inches.											*Inches.*	*Trees.*
8	5	20	35	50	.....	.....	.....	.....	.....	.....	6.2	8
9	10	25	40	55	75	.....	.....	.....	.....	.....	6.3	19
10	15	30	50	65	85	.....	.....	.....	.....	.....	6.4	19
11	20	35	55	75	100	130	.....	.....	.....	.....	6.5	35
12	25	45	65	85	115	150	185	.....	.....	.....	6.6	45
13	35	55	75	100	130	170	210	.....	.....	.....	6.7	44
14	45	70	90	115	150	190	235	280	.....	.....	6.8	51
15	....	80	100	130	170	210	255	310	360	.....	6.9	37
16	....	90	115	145	185	235	285	340	390	450	7.0	61
17	....	.....	130	165	210	260	310	370	420	490	7.1	57
18	....	.....	145	180	225	280	340	400	460	530	7.1	55
19	....	.....	160	200	250	300	360	430	490	570	7.2	45
20	....	.....	.....	.....	275	330	400	460	530	610	7.2	43
21	....	.....	.....	.....	300	360	430	500	580	660	7.3	41
22	....	.....	.....	.....	330	400	470	540	630	720	7.4	29
23	....	.....	.....	.....	360	430	510	590	680	790	7.4	21
24	....	.....	.....	.....	390	470	560	650	750	860	7.5	21
25	....	.....	.....	.....	440	520	610	710	820	940	7.5	10
26	....	.....	.....	.....	470	560	670	780	900	1,030	7.6	11
27	....	.....	.....	.....	530	630	730	860	980	1,120	7.6	5
28	....	.....	.....	.....	590	690	810	930	1,070	1,210	7.6	6
29	....	.....	.....	.....	.....	750	880	1,020	1,160	1,310	7.7	4
30	....	.....	.....	.....	.....	810	950	1,100	1,260	1,420	7.7	4
31	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.8	3
												674

[a] Measurements same as preceding.

[b] Height of stump, 1.5 to 3.

GROWTH TABLES.

Little information has been made available for the general public on the question of tree growth. The space here allows only a few summary tables.

The same species of tree may vary in growth considerably in different situations and under different conditions, and therefore the figures given are not accurate for more than one locality or set of conditions. However, the data given were selected to show fair conditions where a selection was possible. "Second growth" frequently shows increased growth, since in a virgin forest trees sometimes are shaded too much when small. The data are sufficient to point out the rapid-growing species and give an approximate idea of the rate of growth.

TABLE 58.—**Approximate Average Rate of Growth for Northern Forests.**

Species.	Locality.	Forest type.	Age 30 years.		Age 50 years.		Age 80 years.		Age 100 years.		Age 150 years.		Age 200 years.	
			Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.
			In.	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*
Arborvitæ	Mich.	Swamp	2.2	15	3.8	28	5.7	34	6.9	38	9.8	45	12.3	50
Aspen	Me.	Mixed hardwood	6.0	45	9.4	65	12.0	76						
Beech[a]	Mich.	do	1.8	19	3.8	35	8.0	68	10.2	73	13.6	74	16.6	75
Birch, paper	Me.	Paper birch, Seedling	5.3	44	8.0	62	10.2	78						
	N. H.	Paper birch, Sprout	5.6	49	7.9	70								
Birch, yellow	N. Y.	Mixed hardwood	2.6	24	4.5	35	7.4	52	9.4	59	14.5	69	19.4	75
Fir, balsam	N. Y.	Dry swamp	2.3	20	5.2	42	7.2	53	7.6	54	8.3	57		
Hemlock[a]	Mich.	Hemlock-hardwood	1.3	9	2.9	20	5.7	37	7.8	45	13.4	63	18.4	73
Maple, sugar[a]	Mich.	Mixed hardwood	1.9	21	3.8	35	7.0	50	9.0	64	14.0	72		
Pine, jack	Minn.	Jack pine—Quality I	6.2	40	8.5	50								
Pine, red	Wis.	Ravine—Quality I	5.8	45	10.3	75	15.3	90	17.6	95	22.6	103	26.1	108
Pine, white	N. Y.	Lower slopes	5.8	42	10.6	60	16.6	82	20.0	92	26.0	106	29.8	115
	Minn.	White and red pine	5.3	48	9.2	71	13.0	82	14.8	85	18.3	91	21.7	96
Spruce, black	Minn.	Swamp			1.1	9	2.6	17	3.0	20	4.1	26	4.7	29
Spruce, red	Me.	Spruce slope	2.4	21	5.3	36	7.2	44						
Tamarack	Minn.	Swamp	2.9	32	5.0	50	6.9	62	7.8	66	11.0	75		

NOTE.—The diameter given is 4.5 feet from the ground.

[a] These species were undoubtedly suppressed for some years.

TABLE 59.—**Approximate Average Rate of Growth for Central Hardwood Forests.**

Species.	Locality.	Forest type.	Age 30 years.		Age 50 years.		Age 80 years.		Age 100 years.		Age 150 years.		Age 200 years.	
			Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.
			In.	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*
Catalpa [a]	Ill.	Farm plantations	9.0	45										
Chestnut	Md.	Hardwood, seedling	6.0	33	11.2	64	17.2	84	20.1	91				
		Hardwood, sprout	9.3	57	13.4	77	18.0	90	19.8	93				
Hickory, mockernut.	Miss.	Mixed hardwood	3.3		6.0		10.5		13.3		20.0		26.0	
Larch, European [a]	Ill.	Farm plantations	8.8	45										
Locust, black	Ky.	Mixed hardwood	7.1	36	11.5	44								
Maple, silver [a]	Ill.	Farm plantations	9.0	55										
Oak, black	Tenn.	Mixed hardwood, seedling.	4.8	35	7.8	52	12.0	61	14.2	68	18.3	78	22.0	85
	Ky.	Mixed hardwood, sprout.	6.9	53	11.3	75	13.8	80	14.4	81				
Oak, chestnut	Tenn.	Mixed hardwood, seedling.	3.3	20	5.6	35	8.8	45	11.0	53	16.0	66	21.0	76
Oak, red	Ky.	Mixed hardwood, sprout.	7.6	56	12.4	76	16.4	86						
Oak, white	Tenn.	Mixed hardwood, seedling.	3.5	27	5.8	84	9.0	56	11.2	65	17.0	82	22.2	92
	Ky.	Mixed hardwood, sprout.	5.6	40	8.7	57	11.2	69	12.2	72	14.4	77		
Walnut, black [a]	Ill.	Farm plantations (moist soil).	8.0	40	12.0	60								
Yellow poplar	Tenn.	Cove (virgin forest)	5.0	39	8.7	60	13.7	81	17.0	90	24.0	100	28.2	105
	Va.	Second growth in open—Quality I—seedling.	9.7	64	15.2	83								

NOTE.—The diameter given is 4.5 feet from the ground.

[a] These species were grown in plantations on farm land, and have a correspondingly faster growth than the other forest-grown species. (See For. Ser. Cir. 81.)

TABLE 60.—**Approximate Average Rate of Growth for Southern Forests.**

Species.	Locality.	Forest type.	Age 30 years.		Age 50 years.		Age 80 years.		Age 100 years.		Age 150 years.		Age 200 years.	
			Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.
			In.	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*	*In.*	*Feet.*
Ash, white	Ark	Bottom land	7.8	67	12.1	90	17.5	103	20.3	106	.....	.....	.....	.....
Cedar, eastern red.	Ala	"Forest grown"	5.0	35	9.0	50	14.0	59	.....	.....	.....	.....	.....	.....
Cottonwood	Miss	Bottom land (sprout?)	21.7	126	30.4	143	38.4	152	.....	.....	.....	.....	.....	.....
Cypress, bald	Md	Swamp	3.9	31	7.8	53	15.2	82	20.5	95	35.0	107	.....	.....
Gum, red	S. C	Bottom land	11.2	87	16.8	106	23.4	116	26.9	120	34.2	125	.....	.....
Pine, cuban	S. C	Lowland pine type	6.2	44	10.4	67	15.0	86	17.3	93	21.7	102	25.0	105
Pine, loblolly	S. C	Pine type	10.0	59	15.9	86	21.5	104	24.5	111	30.7	122	.....	.....
Pine, longleaf	S. C	do	3.0	29	6.7	52	12.4	78	15.5	86	20.0	95	23.6	100
Pine, scrub	Md	Pure stand—Dom	6.5	46	8.9	63	.....	.....	.....	.....	.....	.....	.....	.....
Pine, shortleaf	Ark	Pine type	4.2	35	7.5	53	11.9	72	14.6	81	19.8	93	23.4	100

NOTE.—The diameter given is 4.5 feet from the ground.

TABLE 61.—**Approximate Average Rate of Growth for Rocky Mountain Forests.**

Species.	Locality.	Forest type.	Age 30 years.		Age 50 years.		Age 80 years.		Age 100 years.		Age 150 years.		Age 200 years.	
			Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.
			In.	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*
Fir, Douglas	Idaho	Fir slope—Quality I	1.6	8	5.9	35	12.3	63	15.6	72	21.1	86	24.9	93
Pine, lodgepole	Mont.	Lodgepole slope	4.0	40	6.6	60	9.6	70	11.2	73	14.0	76	.....	.....
Pine, western white	Idaho	Bottoms—Quality I	7.8	50	9.5	76	12.8	104	14.5	116	.....	.....	.....	.....
Pine, western yellow	Ariz.	Pure stand	4.3	18	8.1	30	12.0	43	14.0	48	18.7	61	21.6	68
Spruce, Engelmann	Colo.	Dry slope	.....	.....	1.6	....	4.3	....	6.2	....	10.1	60	13.7	75

NOTE.—The diameter given is 4.5 feet from the ground.

TABLE 62.—**Approximate Average Rate of Growth for Pacific Coast Forests.**

Species.	Locality.	Forest type.	Age 30 years.		Age 50 years.		Age 80 years.		Age 100 years.		Age 150 years.		Age 200 years.	
			Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.	Diameter.	Height.
			In.	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*	*In.*	*Ft.*
Fir, Douglas[a]	Wash.	Fir-hemlock (virgin)	7.4	48	13.7	80	20.5	118	24.3	138	31.3	180	37.4	208
		Fir-hemlock (second growth)	10.5	68	14.6	114	.....	.....	.....	.....	.....	.....	.....	.....
Fir, white	Cal.	Plateau, slope, and bottom.	0.7	8	3.9	24	9.0	57	12.2	76	19.5	111	26.0	136
Gum, blue[b]	S. Cal.	Plantations—Quality I—seedlings.	28.0	140	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hemlock, western	Wash.	Pure hemlock (virgin)	3.8	35	7.6	55	12.4	93	15.2	110	21.6	142	27.6	165
		Pure hemlock (second growth)	8.2	62	12.6	96	15.7	122	17.1	132	.....	.....	.....	.....
Pine, sugar	Cal.	Mixed slope (Sierras)	4.1	22	7.8	39	14.4	70	18.7	92	28.2	134	32.4	144
Pine, western yellow	Cal.	Mixed sugar pine	7.1	35	12.2	61	17.8	87	20.9	101	26.5	121	29.7	130
Redwood	Cal.	Moist flat-sprout	10.7	71	14.5	95	.....	.....	.....	.....	.....	.....	.....	.....

[a] The diameter given is 4.5 feet from the ground, except for Douglas fir, which is for a stump height a little higher than 4.5 feet.
[b] An exotic introduced from Australia and widely planted for wind-break and fuel purposes in southern California.

TABLE 63.—**Approximate Time Required to Produce Different Wood Crops.**

Species.	Locality.	Average diameter, 6 inches (posts).	Average diameter, 8 inches (handle, extract, pulp, spool, or fuel wood, props).	Average diameter, 11 inches (ties).	Average diameter, 14 inches (poles and piles).	Average diameter, 18 inches (saw timber).
Northern forests.		*Years.*	*Years.*	*Years.*	*Years.*	*Years.*
Aspen	Me.	30	40	60	.....	.....
Beech [a]	Mich.	.....	80	100	.....	200
Birch, paper	Me.	.....	50	.....	.....	.....
Birch, yellow	N. Y.	.....	85	.....	.....	180
Hemlock [a]	Mich.	.....	100	130	.....	.....
Maple, sugar [a]	Mich.	.....	90	.....	.....	200
Pine, jack	Minn.	30	45	.....	.....	.....
Pine, red	Wis.	32	40	55	75	100
Pine, white	N. Y.	32	40	55	.....	90
Spruce, red	N. Y.	.....	85	.....	.....	.....
Tamarack	Minn.	65	.....	150	.....	.....
Central hardwood forests.						
Chestnut [b]	Md.	20	25	40	55	85
Hickory (mockernut) [b]	Miss.	50	65	.....	.....	135
Oak, black	Ky.	25	35	50	.....	130
Oak, red	Ky.	25	30	45	.....	100
Oak, white	Ky.	35	45	80	.....	160
Poplar, yellow	Tenn., vir. for.	.....	45	.....	.....	110
Poplar, yellow [b]	Va., 2d growth.	20	25	.....	.....	.....
Farm timber plantations.						
Catalpa [b]	Ill.	20	.....	.....	.....	.....
Larch, European [b]	Ill.	23	.....	.....	.....	.....
Maple, silver [b]	Ill.	.....	25	.....	.....	.....
Walnut, black [b]	Ill.	25	35	.....	.....	.....
Cottonwood [b]	Nebr.	.....	18	.....	.....	.....

[a] Species tolerant of shade which should show better results in second growth.
[b] Species growing under favorable conditions when measured.

TABLE 63.—**Approximate Time Required to Produce Different Wood Crops**—Continued.

Species.	Locality.	Average diameter, 6 inches (posts).	Average diameter, 8 inches (handle, extract, pulp, spool, or fuel wood, props).	Average diameter, 11 inches (ties).	Average diameter, 14 inches (poles and piles).	Average diameter, 18 inches (saw timber).
Southern forests.		*Years.*	*Years.*	*Years.*	*Years.*	*Years.*
Ash, white	Ark.	.....	30	45	.....	85
Cedar, eastern red	Ala.	35	45	65	.....	.....
Cottonwood	Miss.	.....	15	.....	.....	30
Cypress	Md.	40	.....	65	75	90
Gum, red	S. C.	.....	.....	30	.....	55
Pine, loblolly	S. C.	20	25	40	55	70
Pine, longleaf	S. C.	.....	.....	75	100	130
Pine, scrub	Md.	30	40	70	.....	.....
Pine, shortleaf	Ark.	.....	55	75	100	130
Rocky Mountain forests.						
Fir, Douglas	Southern Idaho.	50	60	75	.....	125
Pine, lodgepole	Mont.	45	.....	100	.....	.....
Pine, western yellow	Ariz.	40	50	75	.....	150
Pacific coast forests.						
Fir, Douglas	Wash.	25	35	45	50	75
Fir, white	Cal.	.....	75	.....	.....	140
Hemlock, western	Wash.	.....	50	70	.....	125
Pine, sugar	Cal.	40	50	65	.....	100
Pine, western yellow	Cal.	25	35	45	55	80
Redwood	Cal.	20	25	35	50	70

YIELD TABLES.

Dense, even-aged stands of forest trees of different ages have been accurately measured for a number of species and the resulting yields tabulated. These tables show yields exceeding those of average wild forests, but show what is possible when the forest is properly handled. They represent the beginning of American yield tables, which will be of the greatest value as a guide in forest management in the selection of species or in estimating the returns from planting.

TABLE 64.—Birch, Paper—Yield Per Acre—Pure (100 Per Cent) Birch Stands.

PENOBSCOT, PISCATAQUIS, SOMERSET, AND FRANKLIN COUNTIES, ME.

[Data gathered by R. L. Marston for Paper Birch Study, 1903–1907.]

Age.	Quality I.				Quality II.			
	Average diameter breast-high.	Average height.	Total yield.	Yield of trees 6 inches and over, in percentage of total yield.	Average diameter breast-high.	Average height.	Total yield.	Yield of trees 6 inches and over, in percentage of total yield.
Years.	*Inches.*	*Feet.*	*Cu. ft.*	*Per ct.*	*Inches.*	*Feet.*	*Cu. ft.*	*Per ct.*
15	2.3	24	710	0	1.8	21	410	0
20	3.4	33	1,020	4	2.6	28	580	0
25	4.5	41	1,340	27	3.4	34	770	18
30	5.6	48	1,700	46	4.3	40	1,010	35
35	6.4	54	2,090	63	5.0	45	1,290	50
40	7.2	58	2,520	75	5.7	49	1,580	63
45	7.8	62	2,950	85	6.3	53	1,890	73
50	8.4	65	3,340	91	6.8	56	2,220	82
55	8.8	68	3,660	96	7.2	59	2,530	89
60	9.2	70	3,940	98	7.6	61	2,810	94
65	9.6	72	4,190	100	7.9	64	3,060	97
70	10.0	74	4,450	100	8.2	66	3,300	100

NOTE.—These sample plots were taken in unmanaged stands. All plots with a density less than 50 per cent were discarded. All plots containing less than 40 per cent birch were discarded and the remainder reduced to 100 per cent birch by dividing the actual birch yield by the percentages of the total basal area formed by the birch. Hence the table applies only to pure birch stands of average density (quality I, 83 per cent and quality II, 75 per cent). For the yield of a mixed stand, containing, for example, 60 per cent of birch, a corresponding reduction would be made in the yield. The number of trees per acre was exceedingly irregular and was therefore excluded from the table.

The volume given is total stem volume, though the lowest measurement taken in the sample trees was at 4.5 feet, and this disregard for butt swelling makes the yield conservative.

Based on 20 quality I and 26 quality II, sample plots.

TABLE 65.—Pine, Loblolly—Yield Per Acre.[a]

MARYLAND.

[Data gathered by W. D. Sterrett for Loblolly Pine Study, 1907.]

QUALITY I.

Age.	Trees per acre.		Average diameter of dominant trees.	Average height of dominant trees.	Yield.		Percentage of total yield in diameter classes.		
	Dominant.	Total.			Total.	Box boards.[b]	1 to 5 inches.	6 to 9 inches.	10 inches and over.
Years.	*No.*	*No.*	*Inches.*	*Feet.*	*Cu. ft.*	*Bd. ft.*	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*
15	860	1,500	4.9	32	2,100	3,400	65	34	1
20	550	840	6.5	43	3,000	9,000	32	53	15
25	400	560	7.8	52	3,650	15,400	13	59	28
30	310	400	8.9	59	4,200	18,900	4	56	40
35	250	320	9.8	65	4,500	21,800	1	47	52
40	200	260	10.6	70	4,750	24,100	.....	34	66

QUALITY II.

15	1,040	1,840	3.6	28	1,550	1,400	78	22	0
20	750	1,420	4.9	35	2,100	3,800	60	40	0
25	550	1,000	6.1	41	2,700	7,400	39	51	10
30	400	700	7.2	47	3,100	11,300	23	57	20
35	310	500	8.1	52	3,300	14,000	11	58	31
40	250	370	8.9	57	3,550	15,800	5	50	45

NOTE.—This table is based on sample plots of limited area. Extended areas could hardly be counted on for such a uniformly dense stand unless openings were carefully planted up and the forest kept under scientific control. On the other hand, the natural stands contained about 10 per cent of other species, which are left out of the total as a factor of safety.

The yields were approximated by means of white-pine volume tables, and 10 per cent was deducted from the yield in box boards against a possible variation between the volumes of bark in the two species and as a further factor of safety.

This table is based on 48 quality I and 23 quality II, sample plots.

[a] Approximate yield in pure, unmanaged, fully stocked stands on old fields.

[b] Round or "waney" edged boards—saw cut. Square-edged material would show a smaller yield.

TABLE 66.—**Pine, Loblolly—Yield Per Acre—All Types Combined.**

EASTERN TEXAS.

[Data gathered by R. Zon for Loblolly Pine Study, 1903-4.]

Age.	Total.		Within each decade.		Annual average within each decade.	
Years.	*Cubic ft.*	*Board ft.*[a]	*Cubic ft.*	*Board ft.*[a]	*Cubic ft.*	*Board ft.*[a]
10	1,650	.....	1,650	.....	165	.....
20	2,600	6,500	950	.....	95	.....
30	3,200	7,450	600	950	60	95
40	3,700	9,300	500	1,850	50	185
50	4,150	11,900	450	2,600	45	260
60	4,600	14,500	450	2,600	45	260
70	5,000	17,100	400	2,600	40	260

[a] Herring log rule.

TABLE 67.—**Pine, Scrub—Yield Per Acre.**

MONTGOMERY COUNTY, MD.

[Data gathered by W. D. Sterrett for Scrub Pine Study, 1905.]

Age.	Number of trees.	Total stem.	Fire-wood.	Peeled pulp wood.	Basis.
Years.		*Cubic ft.*	*Cords.*	*Cords.*	
15	2,510	1,280	12.8	.....	39 sample plots ¼ to 1 acre each.
20	1,470	2,010	20.1	.....	
25	885	2,510	25.1	.....	
30	625	2,990	29.9	26.0	
35	490	3,450	34.5	30.0	
40	420	3,900	39.0	33.9	
45	380	4,290	42.9	37.3	
50	370	4,650	46.5	40.4	

TABLE 68.—Pine, White—Yield Per Acre.

SOUTHERN NEW HAMPSHIRE.

[Data gathered by L. Margolin for Graded Mill Tallies, 1906.]

QUALITY I.

Age.	Number of trees.	Basal area.	Mean height.	Volume.	Current annual increment.	Mean annual increment.
Years.		*Square ft.*	*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
25	2,430	190	33	3,100	124	124
30	1,840	215	41	4,367	253	145
35	1,250	230	48	5,850	296	167
40	870	238	56	7,033	236	176
45	640	243	64	8,000	193	177
50	510	246	70	8,767	153	175
55	430	249	75	9,475	141	172
60	380	252	80	10,100	125	168
65	340	255	84	10,633	106	164
70	310	258	87	11,100	93	158
75	280	261	90	11,567	93	154
80	260	263	93	12,000	86	150
85	240	266	95	12,383	76	146
90	220	268	97	12,767	76	142

QUALITY II.

25	2,430	163	31	2,700	108	108
30	1,840	183	38	3,700	200	123
35	1,250	195	45	4,850	230	139
40	870	212	52	5,800	190	145
45	640	221	59	6,600	160	147
50	510	228	65	7,300	140	146
55	430	233	71	7,925	125	144
60	380	236	76	8,500	115	142
65	340	238	80	9,000	100	138
70	310	241	84	9,450	90	135
75	280	244	87	9,900	90	132
80	260	247	89	10,300	80	129
85	240	250	91	10,650	70	125
90	220	253	93	11,000	70	122

TABLE 68.—**Pine, White—Yield Per Acre**—Continued.

SOUTHERN NEW HAMPSHIRE—Continued.

[Data gathered by L. Margolin for Graded Mill Tallies, 1906.]

QUALITY III.

Age.	Number of trees.	Basal area.	Mean height.	Volume.	Current annual increment.	Mean annual increment.
Years.		*Square ft.*	*Feet.*	*Cubic ft.*	*Cubic ft.*	*Cubic ft.*
25	2,430	150	28	2,300	.....	92
30	1,840	165	35	3,033	146	101
35	1,250	176	42	3,850	163	110
40	870	185	48	4,567	143	114
45	640	191	54	5,200	126	116
50	510	197	60	5,833	126	116
55	430	201	66	6,375	108	116
60	380	205	71	6,900	105	115
65	340	208	75	7,367	93	113
70	310	211	79	7,817	90	112
75	280	213	83	8,233	83	110
80	260	216	85	8,600	73	107
85	240	218	88	8,917	63	105
90	220	221	89	9,233	63	103

TABLE 69.—**Pine, White (Second Growth)—Yield Per Acre.**

SOUTHERN NEW HAMPSHIRE.

[Data gathered by L. Margolin for Graded Mill Tallies, 1906.]

Age.	Volume.		
	Quality I.	Quality II.	Quality III.
Years.	*Board feet.*	*Board feet.*	*Board feet.*
20	4,600	3,150	1,700
25	8,400	5,900	3,450
30	15,100	10,800	6,550
35	24,950	18,050	11,200
40	33,550	25,000	16,450
45	40,750	31,450	22,150
50	47,450	37,800	27,650
55	52,350	42,550	32,750
60	57,300	47,400	37,500
65	61,850	51,850	41,850
70	65,900	55,800	45,700
75	69,750	59,500	49,250
80	73,300	62,850	52,400
85	76,700	66,000	55,300
90	80,050	69,000	57,950

NOTE.—Volume in board feet is round-edged box board material.

TABLE 70.—Pine, White—Yield Per Acre—Of Thinnings.

SOUTHERN NEW HAMPSHIRE.

[Data gathered by L. Margolin for Graded Mill Tallies, 1906.]

Age.	Quality I.			Quality II.			Quality III.		
	Total thinning per acre.		Trees under 5 inches in diameter breast-high.	Total thinning per acre.		Trees under 5 inches in diameter breast-high.	Total thinning per acre.		Trees under 5 inches in diameter breast-high.
Yrs.	*Cubic feet.*	*Board feet.*	*Cubic feet.*	*Cubic feet.*	*Board feet.*	*Cubic feet.*	*Cubic feet.*	*Board feet.*	*Cubic feet.*
25	1,350	2,000	830	900	750	750	600	.....	600
30	1,730	4,500	660	1,380	3,300	600	1,090	2,200	500
35	1,980	6,800	480	1,680	5,600	450	1,440	4,300	400
40	2,120	8,700	270	1,900	7,500	300	1,640	5,800	300
45	2,240	10,100	60	2,040	8,900	150	1,750	6,900	200
50	2,280	11,200	.....	2,100	9,900	.....	1,800	7,600	80
55	2,280	12,000	.....	2,100	10,400	.....	1,780	8,100	.....
60	2,260	12,300	.....	2,000	10,600	.....	1,700	8,300	.....
65	2,200	12,300	.....	1,850	10,300	.....	1,590	8,200	.....
70	2,100	11,900	.....	1,630	9,500	.....	1,420	7,800	.....
75	1,950	11,100	.....	1,300	8,000	.....	1,200	6,900	.....
80	1,700	9,500	.....	860	5,000	.....	920	5,600	.....
85	.....	.....	.....	200	1,200	.....	650	4,000	.....
90	.....	.....	.....	.....	.....	.....	370	2,300	.....

NOTE.—Volume in board feet is round-edged box board material.

TABLE 71.—Poplar, Yellow—Yield Per Acre.

FAIRFAX COUNTY, VA.

[Data gathered by W. W. Ashe for Second Growth Yellow Poplar Study, 1907.]

Age.	Number of trees per acre, Qualities I and II.[a]			Yield, Quality I.		Yield, Quality II.	
	Under 5 inches.	5 inches and over.	Total.	Trees 5 inches and over.	Trees 7 inches and over (Scribner).	Trees 5 inches and over.	Trees 7 inches and over (Scribner).
Years.				*Cubic feet.*	*Board feet.*	*Cubic feet.*	*Board feet.*
10	930	20	950	50	.....	.....	.....
15	640	160	800	1,000	500	525	.....
20	310	250	560	2,450	3,000	1,250	1,350
25	100	285	385	3,425	8,475	2,065	3,250
30	65	290	355	4,050	11,750	2,750	5,800
35	55	275	330	4,500	13,750	3,250	8,000
40	55	255	810	4,875	15,325	3,625	9,650
45	45	235	280	5,175	16,825	3,900	10,900
50	35	210	245	5,450	18,300	4,100	11,900

[a] No regular difference could be seen in number of trees per acre between Qualities I and II.

MISCELLANEOUS TABLES.

TABLE 72.—Area of Circles in Square Feet.

Diameter.	TENTHS OF INCHES.									
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
	AREA—SQUARE FEET.									
Inches.										
1	0.006	0.007	0.008	0.009	0.011	0.012	0.014	0.016	0.018	0.020
2	.022	.024	.026	.029	.031	.034	.037	.040	.043	.046
3	.049	.052	.056	.059	.063	.067	.071	.075	.079	.083
4	.087	.092	.096	.101	.106	.111	.115	.121	.126	.131
5	.136	.142	.147	.153	.159	.165	.171	.177	.184	.190
6	.196	.203	.210	.216	.223	.230	.238	.245	.252	.260
7	.267	.275	.283	.291	.299	.307	.315	.323	.332	.340
8	.349	.358	.367	.376	.385	.394	.403	.413	.422	.432
9	.442	.452	.462	.472	.482	.492	.503	.513	.524	.535
10	.545	.556	.568	.579	.590	.601	.613	.625	.636	.648
11	.660	.672	.684	.697	.709	.721	.734	.747	.760	.772
12	.785	.799	.812	.825	.839	.852	.866	.880	.894	.908
13	.922	.936	.950	.965	.979	.994	1.009	1.024	1.039	1.054
14	1.069	1.084	1.100	1.115	1.131	1.147	1.163	1.179	1.195	1.211
15	1.227	1.244	1.260	1.277	1.294	1.310	1.327	1.344	1.362	1.379
16	1.396	1.414	1.431	1.449	1.467	1.485	1.503	1.521	1.539	1.558
17	1.576	1.595	1.614	1.632	1.651	1.670	1.689	1.709	1.728	1.748
18	1.767	1.787	1.807	1.827	1.847	1.867	1.887	1.907	1.928	1.948
19	1.969	1.990	2.011	2.032	2.053	2.074	2.095	2.117	2.138	2.160
20	2.181	2.204	2.226	2.248	2.270	2.292	2.315	2.337	2.360	2.383
21	2.405	2.428	2.451	2.475	2.498	2.521	2.545	2.568	2.592	2.616
22	2.640	2.664	2.688	2.712	2.737	2.761	2.786	2.810	2.835	2.860
23	2.885	2.910	2.936	2.961	2.986	3.012	3.038	3.064	3.089	3.115
24	3.142	3.168	3.194	3.221	3.247	3.275	3.301	3.328	3.355	3.382

Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.	Diameter.	Area.
Inches.	*Sq. ft.*	*Inches.*	*Sq. ft.*	*Inches.*	*Sq. ft.*	*Inches.*	*Sq. ft.*	*Inches.*	*Sq. ft.*
25	3.41	32	5.59	39	8.30	46	11.54	53	15.32
26	3.69	33	5.94	40	8.73	47	12.05	54	15.90
27	3.98	34	6.30	41	9.17	48	12.57	55	16.50
28	4.28	35	6.68	42	9.62	49	13.10	56	17.10
29	4.59	36	7.07	43	10.08	50	13.64	57	17.72
30	4.91	37	7.47	44	10.56	51	14.19	58	18.35
31	5.24	38	7.88	45	11.04	52	14.75	59	18.99

TABLE 73.—**Contents of 1-inch Boards of Different Lengths and Widths Given in Board Feet and Twelfths.**

Length.	WIDTH OF BOARD (INCHES).																					
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	CONTENTS (BOARD FEET).																					
Feet.																						
4	1	1^{4}	1^{8}	2	2^{4}	2^{8}	3	3^{4}	3^{8}	4	4^{4}	4^{8}	5	5^{4}	5^{8}	6	6^{4}	6^{8}	7	7^{4}	7^{8}	8
5	1^{3}	1^{8}	2^{1}	2^{6}	2^{11}	3^{4}	3^{9}	4^{2}	47	5	5^{5}	5^{10}	6^{3}	6^{8}	71	7^{6}	7^{11}	8^{4}	8^{9}	92	97	10
6	1^{6}	2	2^{6}	3	3^{6}	4	4^{6}	5	5^{6}	6	6^{6}	7	7^{6}	8	8^{6}	9	9^{6}	10	10^{6}	11	11^{6}	12
7	1^{9}	2^{4}	2^{11}	3^{6}	4^{1}	4^{8}	5^{3}	5^{10}	6^{5}	7	77	8^{2}	8^{9}	9^{4}	9^{11}	10^{6}	11^{1}	11^{8}	12^{3}	12^{10}	13^{5}	14
8	2	2^{8}	3^{4}	4	4^{8}	5^{4}	6	6^{8}	7^{4}	8	8^{8}	9^{4}	10	10^{8}	11^{4}	12	12^{8}	13^{4}	14	14^{8}	15^{4}	16
9	2^{3}	3	3^{9}	4^{6}	5^{3}	6	6^{9}	7^{6}	8^{3}	9	99	10^{6}	11^{3}	12	12^{9}	13^{6}	14^{3}	15	15^{9}	16^{6}	17^{3}	18
10	2^{6}	3^{4}	4^{2}	5	5^{10}	6^{8}	7^{6}	8^{4}	9^{2}	10	10^{10}	11^{8}	12^{6}	13^{4}	142	15	15^{10}	16^{8}	17^{6}	18^{4}	19^{2}	20
11	2^{9}	3^{8}	4^{7}	5^{6}	6^{5}	7^{4}	8^{3}	9^{2}	10^{1}	11	11^{11}	12^{10}	13^{9}	14^{8}	15^{7}	16^{6}	17^{5}	18^{4}	19^{3}	20^{2}	21^{1}	22
12	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
13	3^{3}	4^{4}	5^{5}	6^{6}	77	8^{8}	9^{9}	10^{10}	11^{11}	13	141	15^{2}	16^{3}	17^{4}	18^{5}	19^{6}	207	21^{8}	22^{9}	23^{10}	24^{11}	26
14	3^{6}	4^{8}	5^{10}	7	8^{2}	9^{4}	10^{6}	11^{8}	12^{10}	14	15^{2}	16^{4}	17^{6}	18^{8}	19^{10}	21	22^{2}	23^{4}	24^{6}	25^{8}	26^{10}	28
15	3^{9}	5	6^{3}	7^{6}	8^{9}	10	11^{3}	12^{6}	13^{9}	15	16^{3}	17^{6}	18^{9}	20	21^{3}	22^{6}	23^{9}	25	26^{3}	27^{6}	28^{9}	30
16	4	5^{4}	6^{8}	8	9^{4}	10^{8}	12	13^{4}	14^{8}	16	17^{4}	18^{8}	20	21^{4}	22^{8}	24	25^{4}	26^{8}	28	29^{4}	30^{8}	32
18	4^{6}	6	7^{6}	9	10^{6}	12	13^{6}	15	16^{6}	18	19^{6}	21	22^{6}	24	25^{6}	27	28^{6}	30	31^{6}	33	34^{6}	36
20	5	6^{8}	8^{4}	10	11^{8}	13^{4}	15	16^{8}	18^{4}	20	21^{8}	23^{4}	25	26^{8}	28^{4}	30	31^{8}	33^{4}	35	36^{8}	38^{4}	40
22	5^{6}	7^{4}	9^{2}	11	12^{10}	14^{8}	16^{6}	18^{4}	20^{2}	22	23^{10}	25^{8}	27^{6}	29^{4}	31^{2}	33	34^{10}	36^{8}	38^{6}	40^{4}	42^{2}	44
24	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48
26	6^{6}	8^{8}	10^{10}	13	15^{2}	17^{4}	19^{6}	21^{8}	23^{10}	26	28^{2}	30^{4}	32^{6}	34^{8}	36^{10}	39	41^{2}	43^{4}	45^{6}	47^{8}	49^{10}	52
28	7	9^{4}	11^{8}	14	16^{4}	18^{8}	21	23^{4}	25^{8}	28	30^{4}	32^{8}	35	37^{4}	39^{8}	42	44^{4}	46^{8}	49	51^{4}	53^{8}	56
30	7^{6}	10	12^{6}	15	17^{6}	20	22^{6}	25	27^{6}	30	32^{6}	35	37^{6}	40	42^{6}	45^{4}	48	50^{8}	53^{4}	56	58^{8}	61^{4}	64
32	8	10^{8}	13^{4}	16	18^{8}	21^{4}	24	26^{8}	29^{4}	32	34^{8}	37^{4}	40	42^{8}	45^{4}	48	50^{8}	53^{4}	56	58^{8}	61^{4}	64

In Table 73 the fractions are given in twelfths (small figures), making adding easier. Thus the following 1-inch lumber would be added:

Size.	Contents.
10′ x 7″	$= 5^{10}$
12′ x 10″	$= 10$
12′ x 16″	$= 16$
14′ x 13″	$= 15^{2}$
16′ x 20″	$= 26^{8}$
Total	$= 72\frac{20}{12}$ or $73\frac{8}{3}$ board feet.

If it were 3-inch lumber the total would be multiplied by 3, or a total of 221 board feet.

TABLE 74.—**Compound Interest, or the Amount of 1 Dollar for Different Periods at Different Rates.**

Period.	2 per cent.	3 per cent.	4 per cent.	5 per cent.	6 per cent.
Years.					
1	1.0200	1.0300	1.0400	1.0500	1.0600
2	1.0404	1.0609	1.0816	1.1025	1.1236
3	1.0612	1.0927	1.1249	1.1576	1.1910
4	1.0824	1.1255	1.1699	1.2155	1.2625
5	1.1041	1.1593	1.2167	1.2763	1.3382
6	1.1262	1.1941	1.6253	1.3401	1.4185
7	1.1487	1.2299	1.3159	1.4071	1.5036
8	1.1717	1.2668	1.3686	1.4775	1.5938
9	1.1951	1.3048	1.4233	1.5513	1.6895
10	1.2190	1.3439	1.4802	1.6289	1.7908
11	1.2434	1.3842	1.5395	1.7103	1.8983
12	1.2682	1.4258	1.6010	1.7959	2.0122
13	1.2936	1.4685	1.6651	1.8856	2.1329
14	1.3195	1.5126	1.7315	1.9799	2.2609
15	1.3459	1.5580	1.8009	2.0789	2.3966
16	1.3728	1.6047	1.8730	2.1829	2.5404
17	1.4002	1.6528	1.9479	2.2920	2.6928
18	1.4282	1.7024	2.0258	2.4066	2.8543
19	1.4568	1.7535	2.1068	2.5270	3.0256
20	1.4859	1.8061	2.1911	2.6533	3.2071
21	1.5157	1.8603	2.2788	2.7860	3.3996
22	1.5460	1.9161	2.3699	2.9253	3.6035
23	1.5769	1.9736	2.4647	3.0715	3.8197
24	1.6084	2.0328	2.5633	3.2251	4.0489
25	1.6406	2.0938	2.6658	3.3864	4.2919
26	1.6734	2.1566	2.7725	3.5557	4.5494
27	1.7069	2.2213	2.8834	3.7335	4.8223
28	1.7410	2.2879	2.9987	3.9201	5.1117
29	1.7758	2.3566	3.1187	4.1161	5.4184
30	1.8114	2.4273	3.2434	4.3219	5.7435

TABLE 74.—**Compound Interest, or the Amount of 1 Dollar for Different Periods at Different Rates**—Continued.

Period	2 per cent.	3 per cent.	4 per cent.	5 per cent.	6 per cent.
Years.					
31	1.8476	2.5001	3.3731	4.5380	6.0881
32	1.8845	2.5751	3.5081	4.7649	6.4534
33	1.9222	2.6523	3.6484	5.0032	6.8406
34	1.9607	2.7319	3.7943	5.2533	7.2510
35	1.9999	2.8139	3.9461	5.5160	7.6861
36	2.0399	2.8983	4.1039	5.7918	8.1473
37	2.0807	2.9852	4.2681	6.0814	8.6361
38	2.1223	3.0748	4.4388	6.3855	9.1543
39	2.1647	3.1670	4.6164	6.7048	9.7035
40	2.2080	3.2620	4.8010	7.0400	10.2857
41	2.2522	3.3599	4.9931	7.3920	10.9029
42	2.2972	3.4607	5.1928	7.7616	11.5570
43	2.3432	3.5645	5.4005	8.1497	12.2505
44	2.3901	3.6715	5.6165	8.5572	12.9855
45	2.4379	3.7816	5.8412	8.9850	13.7646
46	2.4866	3.8950	6.0748	9.4343	14.5905
47	2.5363	4.0119	6.3178	9.9060	15.4659
48	2.5871	4.1323	6.5705	10.4013	16.3939
49	2.6388	4.2562	6.8333	10.9213	17.3775
50	2.6916	4.3839	7.1067	11.4674	18.4202
55	2.9717	5.0821	8.6464	14.6356	24.6507
60	3.2810	5.8916	10.5196	18.6792	32.9883
65	3.6225	6.8300	12.7987	23.8399	44.1458
70	3.9995	7.9178	15.5716	30.4264	59.0772
75	4.4158	9.1789	18.9453	38.8327	79.0587
80	4.8754	10.6409	23.0498	49.5614	105.7985
85	5.3828	12.3357	28.0436	63.2544	141.5827
90	5.9431	14.3005	34.1193	80.7304	189.4698
95	6.5617	16.5782	41.5114	103.035	253.5538
100	7.2446	19.2186	50.5049	131.501	339.3125
105	7.9987	22.2797	61.4470	167.833	454.0770
110	8.8312	25.8282	74.7597	214.202	607.6591
115	9.7503	29.9420	90.9566	273.382	813.1867
120	10.7652	34.7110	110.663	348.912	1,088.2280

TABLE 75.—Annuities, or the Amount of 1 Dollar Per Annum at the End of Different Periods at Different Interest Rates.

Period.	2 per cent.	3 per cent.	4 per cent.	5 per cent.	6 per cent.
Years.					
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	2.0200	2.0300	2.0400	2.0500	2.0600
3	3.0604	3.0909	3.1216	3.1525	3.1836
4	4.1216	4.1836	4.2465	4.3101	4.3746
5	5.2040	5.3091	5.4163	5.5256	5.6371
6	6.3081	6.4684	6.6330	6.8019	6.9753
7	7.4343	7.6625	7.8983	8.1420	8.3938
8	8.5830	8.8923	9.2142	9.5491	9.8975
9	9.7546	10.1591	10.5828	11.0266	11.4913
10	10.9497	11.4639	12.0061	12.5779	13.1808
11	12.1687	12.8078	13.4864	14.2068	14.9716
12	13.4121	14.1920	15.0258	15.9171	16.8699
13	14.6803	15.6178	16.6268	17.7130	18.8821
14	15.9739	17.0863	18.2919	19.5986	21.0151
15	17.2934	18.5989	20.0236	21.5786	23.2760
16	18.6393	20.1569	21.8245	23.6575	25.6725
17	20.0121	21.7616	23.6975	25.8404	28.2129
18	21.4123	23.4144	25.6454	28.1324	30.9057
19	22.8406	25.1169	27.6712	30.5390	33.7600
20	24.2974	26.8704	29.7781	33.0660	36.7856
21	25.7833	28.6765	31.9692	35.7193	39.9927
22	27.2990	30.5368	34.2480	38.5052	43.3923
23	28.8450	32.4529	36.6179	41.4305	46.9958
24	30.4219	34.4265	39.0826	44.5020	50.8156
25	32.0303	36.4593	41.6459	47.7271	54.8645
26	33.6709	38.5530	44.3117	51.1135	59.1564
27	35.3443	40.7096	47.0842	54.6691	63.7058
28	37.0512	42.9309	49.9676	58.4026	68.5281
29	38.7922	45.2189	52.9663	62.3227	73.6398
30	40.5681	47.5754	56.0849	66.4388	79.0582
31	42.3794	50.0027	59.3283	70.7608	84.8017
32	44.2270	52.5028	62.7015	75.2988	90.8898
33	46.1116	55.0778	66.2095	80.0638	97.3432
34	48.0338	57.7302	69.8579	85.0670	104.1838
35	49.9945	60.4621	73.6522	90.3203	111.4348
36	51.9944	63.2759	77.5983	95.8363	119.1209
37	54.0343	66.1742	81.7022	101.6281	127.2681
38	56.1149	69.1594	85.9703	107.7095	135.9042
39	58.2372	72.2342	90.4091	114.0950	145.0585
40	60.4020	75.4013	95.0255	120.7998	154.7620
41	62.6100	78.6633	99.8265	127.8398	165.0477
42	64.8622	82.0232	104.8196	135.2318	175.9505
43	67.1595	85.4839	110.0124	142.9933	187.5076
44	69.5027	89.0484	115.4129	151.1430	199.7580
45	71.8927	92.7199	121.0294	159.7002	212.7435

TABLE 75.—**Annuities, or the Amount of 1 Dollar Per Annum at the End of Different Periods at Different Interest Rates**—Cont'd.

Period.	2 per cent.	3 per cent.	4 per cent.	5 per cent.	6 per cent.
Years.					
46	74.3306	96.5015	126.8706	168.6852	226.5081
47	76.8172	100.3965	132.9454	178.1194	241.0986
48	79.3535	104.4084	139.2632	188.0254	256.5645
49	81.9406	108.5406	145.8337	198.4267	272.9584
50	84.5794	112.7969	152.6671	209.3480	290.3359
55	98.5865	136.072	191.159	272.7130	394.1783
60	114.0520	163.053	237.991	353.5840	533.1383
65	131.1250	194.333	294.967	456.7980	719.0966
70	149.9780	230.594	364.290	588.5290	967.9533
75	170.7900	272.630	448.642	756.6540	1,300.9783
80	193.7720	321.363	551.245	971.2290	1,746.6416
85	219.1400	377.857	676.090	1,245.0880	2,343.0450
90	247.1570	443.349	827.983	1,594.6100	3,141.1633
95	278.0850	519.273	1,012.785	2,040.7000	4,209.2300
100	312.2320	607.288	1,237.622	2,610.0300	5,638.5416
105	349.9300	709.323	1,511.175	3,336.6600	7,551.2833
110	391.5590	827.608	1,843.992	4,264.0300	10,110.9850
115	437.5150	964.733	2,248,915	5,447.6400	13,536.4450
120	488.2580	1,123.70	2,741.558	6,958.2400	18,120.4667

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