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TABLES FOR APPROXIMATING VOLUME GROWTH OF INDIVIDUAL TREES

by

Paul D. Kemp
and M. E. Metcalf

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P. D. Kemp & M. E. Metcalf

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CONTENTS

Page No.

Introduction. 2

Volume growth tables

Ponderosa pine - Western Montana

Table 1 - Annual board-foot (Scribner) growth of trees by diameter class and radial increment. 3

Table 2 - Average annual board-foot (Scribner) growth percent of trees by diameter class and radial increment. 4

Table 3 - Periodic (10 years) board-foot (Scribner) growth of trees by diameter class and radial increment. 5

Western larch - North Idaho

Table 4 - Annual board-foot (Scribner) growth of trees by diameter class and radial increment. 6

Table 5 - Average annual board-foot (Scribner) growth percent of trees by diameter class and radial increment. 7

Table 6 - Periodic (10 years) board-foot (Scribner) growth of trees by diameter class and radial increment. 8

White pine - North Idaho

Table 7 - Annual board-foot (Scribner) growth of trees by diameter class and radial increment. 9

Table 8 - Average annual board-foot (Scribner) growth percent of trees by diameter class and radial increment. 10

Table 9 - Periodic (10 years) board-foot (Scribner) growth of trees by diameter class and radial increment. 11

Ponderosa pine - North Idaho

Table 10 - Annual board-foot (Scribner) growth of trees by diameter class and radial increment. 12

Table 11 - Average annual board-foot (Scribner) growth percent of trees by diameter class and radial increment. 13

Table 12 - Periodic (10 years) board-foot (Scribner) growth of trees by diameter class and radial increment. 14

TABLES FOR APPROXIMATING VOLUME GROWTH OF INDIVIDUAL TREES

By

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Introduction

Foresters are frequently asked: How much has this tree grown in volume in the last 10 years, or, what is the current rate of volume growth? The answer to such questions usually requires rather complex computations. To simplify this task a set of volume growth tables 1/ has been prepared for the following species: ponderosa pine in western Montana, and western larch, western white pine, and ponderosa pine in North Idaho.

These growth tables were derived from average-height volume tables. Application of these tables requires only a diameter determination and a radial growth measurement either (1) number of annual rings in the outer radial inch, or (2) the number of years (rings) in a specified radial increment in inches. Field checks show that the growth of single trees can be determined from the tables within 15 percent of a precise determination two out of three times. The tables express volume growth in three ways:

1. Annual board-foot (Scribner) growth of trees by diameter class and radial increment.

2. Average annual board-foot (Scribner) growth percent of trees by diameter class and radial increment.

3. Periodic (10 years) board-foot (Scribner) growth of tress by diameter class and radial increment.

To facilitate the determination of growth of trees differing in diameter from the midpoint of the class and for growth rates between those indicated, the growth should be plotted over d.b.h. and curved in ordinary cross-section paper. This will not give a precise determination for the individual tree, of course, because it still does not take into account variations from average changes in height, form and bark thickness with changes in diameter. Nevertheless, the curved volumes and tables permit useful approximations of the volume growth of individual trees.

1/ Copies of the 12 tables included in this paper are available in pocket size (5" x 7½") and may be obtained upon request.

Table 1. - Annual board-foot (Scribner) growth of trees by diameter class and radial increment

Ponderosa Pine - Western Montana

D.B.H. (o.b.)	Average tree volume 1/	Volume increase	Gross average annual growth by indicated rings in the outer radial inch											
			4	5	6	7	8	9	10	12	15	20	25	30	40
Inches	Board feet 2/ (Scribner)														
10	33														
12	70	37	9	7	6	5	5	4	4	3	2	2	1	1	1
14	119	49	12	10	8	7	6	5	5	4	3	2	2	2	1
16	184	65	16	13	11	9	8	7	6	5	4	3	3	2	2
18	272	88	22	18	15	13	11	10	9	7	6	4	3	3	2
20	385	113	28	23	19	16	14	13	11	9	8	6	5	4	3
22	528	143	36	29	24	20	18	16	14	12	10	7	6	5	4
24	700	172	43	34	29	25	22	19	17	14	11	9	7	6	4
26	901	201	50	40	33	29	25	22	20	17	13	10	8	7	5
28	1,127	226	56	45	38	32	28	25	23	19	15	11	9	8	6
30	1,374	247	62	49	41	35	31	27	25	21	16	12	10	8	6
32	1,640	266	66	53	44	38	33	30	27	22	18	13	11	9	7
34	1,921	281	70	56	47	40	35	31	28	23	19	14	11	9	7
36	2,213	292	73	58	49	42	36	32	29	24	19	15	12	10	7
38	2,512	299	75	60	50	43	37	33	30	25	20	15	12	10	7
40	2,811	299	75	60	50	43	37	33	30	25	20	15	12	10	7
Diameter increment per year (inches)			.50	.40	.33	.29	.25	.22	.20	.17	.13	.10	.08	.07	.05
Years to attain next higher diameter class			4	5	6	7	8	9	10	12	15	20	25	30	40

1/ The average gross volume from curves based on cruise estimates for some 35,000 ponderosa pines in ponderosa pine stands of western Montana.

2/ The average annual growth in developing 1 inch in radial increment or 2 inches in diametral increment. Data are rounded to the nearest board foot.

Table 2. - Average annual board-foot (Scribner) growth percent 1/ of trees by diameter class and radial increment

Ponderosa Pine - Western Montana

D.B.H. (o.b.)	Volume increase	Gross annual growth percent by indicated rings in the outer radial inch												
		4	5	6	7	8	9	10	12	15	20	25	30	40
Inches	Percent													
12	120	27	21	18	15	15	12	12	9	6	6	3	3	3
14	70	14	14	11	10	9	7	7	6	4	3	3	3	2
16	55	13	11	9	8	7	6	5	4	3	3	3	2	2
18	48	12	10	8	7	6	5	4	3	3	2	2	2	1
20	42	10	8	7	6	5	5	4	3	3	2	2	1	1
22	37	9	8	6	5	5	4	4	3	3	2	2	1	1
24	33	8	6	5	5	4	4	3	3	2	2	1	1	1
26	29	7	6	5	4	4	3	3	2	2	1	1	1	1
28	25	6	5	4	4	3	3	3	2	2	1	1	1	1
30	22	6	4	4	3	3	2	2	2	1	1	1	1	1
32	19	5	4	3	3	2	2	2	2	1	1	1	1	1
34	17	4	3	3	2	2	2	2	1	1	1	1	1	2/
36	15	4	3	2	2	2	2	2	1	1	1	1	1	2/
38	14	3	3	2	2	2	1	1	1	1	1	1	2/	2/
40	12	3	2	2	2	2	1	1	1	1	1	2/	2/	2/

1/ The simple growth percent, that is, the average annual board-foot growth during the period required for a 2-inch diameter increase divided by the volume at the beginning of the period. As indicated in table 1, the periods range from 4 to 40 years. All items are to the nearest whole number.

2/ Less than 1/2 of 1 percent. Items to the left of the heavy line are 1 percent or more.

Table 3. - Periodic (10 years) board-foot (Scribner) growth of trees by diameter class and radial increment

Ponderosa Pine - Western Montana

D.B.H. (o.b.)	16' logs per average tree	Gross 10-year growth 1/ by indicated 10-year radial increment in inches												
		2.50	2.00	1.67	1.43	1.25	1.11	1.00	.83	.67	.50	.40	.33	.25
Inches	Number	Board feet (Scribner)												
12	1.5	70	65	57	50	44	40	37	31	26	20	16	13	10
14.	2.5	101	86	75	66	59	53	49	41	34	26	21	17	13
16	2.2	131	111	99	87	78	71	65	55	45	35	28	23	18
18	2.7	179	153	133	118	105	96	88	74	61	47	38	31	24
20	3.0	236	201	174	154	136	123	113	95	79	60	48	40	30
22	3.3	303	256	220	195	173	156	143	120	98	75	60	49	38
24	3.8	375	315	269	237	209	189	172	144	118	90	72	59	45
26	4.2	448	373	318	278	246	221	201	168	137	104	83	69	52
28	4.5	517	427	362	315	278	249	226	189	153	116	93	77	58
30	4.7	577	473	399	347	305	273	247	206	167	126	101	83	63
32	5.0	629	513	432	374	329	294	266	222	180	135	108	89	67
34	5.2	673	547	459	397	348	311	281	234	189	142	114	94	71
36	5.3	708	573	480	414	363	323	292	243	196	147	118	97	73
38	5.3	733	591	494	425	373	332	299	248	201	150	120	99	75
40	5.2	745	598	498	428	374	332	299	248	200	149	119	98	74

1/ The growth in developing to the midpoint of the indicated diameter class. For example, an average tree now exactly 14 inches d.b.h. outside bark having a 10-year outer radial increment of 1.00 inch will have grown 49 board feet during that 10 years.

Table 4. - Annual board-foot (Scribner) growth of trees by diameter class and radial increment

Western Larch - North Idaho

D.B.H. (o.b.)	Average tree volume 1/	Volume increase	Gross average annual growth by indicated rings in the outer radial inch											
			4	5	6	7	8	9	10	12	15	20	25	30	40
Inches	Board feet 2/ (Scribner)														
12	79														
14	167	88	22	18	15	13	11	10	9	7	5	4	4	3	2
16	265	98	25	20	16	14	12	11	10	8	6	5	4	3	3
18	374	109	27	22	18	16	14	12	11	9	7	5	4	4	3
20	494	120	30	24	20	17	15	13	12	10	8	6	5	4	3
22	625	131	33	26	22	19	16	15	13	11	9	7	5	4	3
24	767	142	35	28	24	20	18	16	14	12	9	7	6	5	3
26	920	153	38	31	25	22	19	17	15	13	10	8	6	5	4
28	1,084	164	41	33	27	23	20	18	16	14	11	8	7	5	4
30	1,259	175	44	35	29	25	22	19	17	15	12	9	7	6	4
32	1,445	186	47	37	31	27	23	21	19	15	12	9	7	6	5
34	1,643	198	49	39	33	28	25	22	20	16	13	10	8	7	5
36	1,853	210	52	42	35	30	26	23	21	17	14	11	8	7	5
38	2,075	222	55	44	37	32	28	25	22	18	15	11	9	7	5
40	2,309	234	59	47	39	33	29	26	23	19	16	12	9	8	6
Diameter increment per year (inches)			.50	.40	.33	.29	.25	.22	.20	.17	.13	.10	.08	.07	.05
Years to attain next higher diameter class			4	5	6	7	8	9	10	12	15	20	25	30	40

1/ The average gross volume from curves based on cruise estimates for 1,957 western larch trees in western larch stands of North Idaho.

2/ The average annual growth in developing 1 inch in radial increment or 2 inches in diametral increment. Data are rounded to the nearest board foot.

Table 5. - Average annual board-foot (Scribner) growth percent 1/ of trees by diameter class and radial increment

Western Larch - North Idaho

D.B.H. (o.b.)	Volume increase	Gross annual growth percent by indicated rings in the outer radial inch											
		4	5	6	7	8	9	10	12	15	20	25	30	40
Inches	Percent													
14	111	28	22	19	16	14	11	11	9	7	6	4	4	3
16	59	15	12	10	8	7	7	6	5	4	3	2	2	1
18	41	10	8	7	6	5	5	4	3	3	2	2	1	1
20	32	8	6	5	5	4	4	3	3	2	2	1	1	1
22	27	7	5	4	4	3	3	3	3	2	1	1	1	1
24	23	6	5	4	3	3	3	2	2	2	1	1	1	1
26	20	5	4	3	3	2	2	2	2	1	1	1	1	2/
28	18	5	4	3	3	2	2	2	1	1	1	1	1	2/
30	16	4	3	3	2	2	2	2	1	1	1	1	1	2/
32	15	4	3	2	2	2	2	1	1	1	1	1	2/	2/
34	14	3	3	2	2	2	2	1	1	1	1	1	2/	2/
36	13	3	3	2	2	2	1	1	1	1	1	1	2/	2/
38	12	3	2	2	2	1	1	1	1	1	1	2/	2/	2/
40	11	3	2	2	2	1	1	1	1	1	1	2/	2/	2/

1/ The simple growth percent, that is, the annual average board-foot growth during the period required for a 2-inch diameter increase divided by the volume at the beginning of the period. As indicated in table 1, the periods range from 4 to 40 years. All items are to the nearest whole number.

2/ Less than 1/2 of 1 percent. Items to the left of the heavy line are 1 percent or more.

Table 6. - Periodic (10 years) board-foot (Scribner) growth of trees by diameter class and radial increment

Western Larch - North Idaho

D.B.H. (o.b.)	16' logs per average tree	Gross 10-year growth 1/ by indicated 10-year radial increment in inches											
		2.50	2.00	1.67	1.43	1.25	1.11	1.00	.83	.67	.50	.40	.33	.25
Inches	Number	Board feet (Scribner)												
14	3.74	164	144	127	115	104	95	88	73	59	44	33	29	22
16	4.42	217	186	157	136	120	108	98	81	66	49	39	32	25
18	4.92	251	207	175	151	134	120	109	90	73	54	44	36	27
20	5.38	278	229	193	167	147	132	120	100	80	60	48	40	30
22	5.75	305	251	211	183	161	144	131	109	88	65	52	43	33
24	5.97	333	273	230	198	175	156	142	118	95	71	57	47	36
26	6.13	360	295	248	214	188	169	153	127	103	77	62	51	39
28	6.21	388	317	267	230	202	181	164	136	110	82	66	54	41
30	6.26	415	339	285	246	216	193	175	145	117	87	70	58	44
32	6.28	443	361	303	261	230	205	186	154	125	93	75	61	47
34	6.32	471	384	323	278	245	218	198	164	133	99	79	65	50
36	6.37	501	408	343	295	259	232	210	174	141	105	84	69	53
38	6.36	531	432	363	312	275	245	222	184	149	111	89	73	56
40	6.53	561	456	383	329	289	259	234	194	157	117	94	77	59

1/ The growth in developing to the midpoint of the indicated diameter class. For example, an average tree now exactly 14 inches d.b.h. outside bark, having a 10-year outer radial increment of 1.00 inch will have grown 88 board feet during that 10 years.

Table 7. - Annual board-foot (Scribner) growth of trees by diameter class and radial increment

White Pine - North Idaho

D.B.H. (o.b.)	Average tree volume 1/	Volume increase	Gross average annual growth by indicated rings in the outer radial inch											
			4	5	6	7	8	9	10	12	15	20	25	30	40
Inches	Board feet 2/ (Scribner)														
10	25														
12	110	85	21	17	14	12	11	9	8	7	6	4	3	3	2
14	210	100	25	20	17	14	13	11	10	8	7	5	4	3	3
16	322	112	28	22	19	16	14	12	11	9	7	6	4	4	3
18	448	126	31	25	21	18	16	14	13	10	8	6	5	4	3
20	591	143	36	29	24	20	18	16	14	12	10	7	6	5	4
22	754	163	41	33	27	23	20	18	16	14	11	8	7	5	4
24	940	186	47	37	31	27	23	21	19	15	13	8	7	6	5
26	1,151	211	53	42	35	30	26	23	21	18	14	11	8	7	5
28	1,389	238	59	47	39	34	30	26	24	20	16	12	10	8	6
30	1,655	266	67	53	44	38	33	30	27	22	18	13	11	9	7
32	1,950	295	74	59	49	42	37	33	30	25	20	15	12	10	7
34	2,275	325	81	65	54	46	41	36	33	27	22	16	13	11	8
36	2,630	355	89	71	59	51	44	39	35	30	24	18	14	12	9
38	3,015	385	96	77	64	55	48	43	39	32	26	19	15	13	10
40	3,429	414	104	83	69	59	52	46	41	34	28	21	17	14	10
Diameter increment per year (inches)			.50	.40	.33	.29	.25	.22	.20	.17	.13	.10	.08	.07	.05
Years to attain next higher diameter class			4	5	6	7	8	9	10	12	15	20	25	30	40

1/ The average gross volume from curves based on cruise estimates for 102,080 white pine trees in white pine stands of North Idaho.

2/ The average annual growth in developing 1 inch in radial increment or 2 inches in diametral increment. Data are rounded to the nearest board foot.

Table 8. - Average annual board-foot (Scribner) growth percent 1/ of trees by diameter class and radial increment

White Pine - North Idaho

D.B.H. (o.b.)	Volume increase	Gross annual growth percent by indicated rings in the outer radial inch											
		4	5	6	7	8	9	10	12	15	20	25	30	40
Inches	Percent													
12	340	85	68	57	48	43	38	34	28	23	17	13	11	9
14	91	23	18	15	13	11	10	9	8	6	5	3	3	2
16	53	13	11	9	8	7	6	5	4	4	3	2	2	1
18	39	10	8	7	6	5	4	4	3	3	2	2	1	1
20	32	8	6	5	5	4	4	3	3	2	2	1	1	1
22	28	7	5	5	4	3	3	3	2	2	2	1	1	1
24	25	6	5	4	3	3	3	2	2	2	1	1	1	1
26	22	6	4	4	3	3	2	2	2	1	1	1	1	1
28	21	5	4	3	3	3	2	2	2	1	1	1	1	1
30	19	5	4	3	3	2	2	2	2	1	1	1	1	2/
32	18	5	4	3	3	2	2	2	1	1	1	1	1	2/
34	17	4	3	3	2	2	2	2	1	1	1	1	1	2/
36	16	4	3	3	2	2	2	2	1	1	1	1	1	2/
38	15	4	3	2	2	2	2	1	1	1	1	1	2/	2/
40	14	3	3	2	2	2	2	1	1	1	1	1	2/	2/

1/ The simple growth percent, that is, the annual average board-foot growth during the period required for a 2-inch diameter increase divided by the volume at the beginning of the period. As indicated in table 1, the periods range from 4 to 40 years. All items are to the nearest whole number.

2/ Less than 1/2 of 1 percent. Items to the left of the heavy line are 1 percent or more.

Table 9. - Periodic (10 years) board-foot (Scribner) growth of trees by diameter class and radial increment

White Pine - North Idaho

D.B.H. (o.b.)	16' logs per average tree	Gross 10-year growth 1/ by indicated 10-year radial increment in inches											
		2.50	2.00	1.67	1.43	1.25	1.11	1.00	.83	.67	.50	.40	.33	.25
Inches	Number	Board feet (Scribner)												
12	2.75	109	106	103	96	92	89	85	71	57	43	34	28	21
14	4.00	198	185	157	136	121	110	100	83	67	50	40	33	25
16	4.87	254	212	179	155	137	121	112	94	76	56	45	37	28
18	5.47	288	238	201	174	154	138	126	105	84	63	50	42	32
20	5.91	325	269	227	197	175	157	143	119	96	71	57	47	36
22	6.28	369	306	259	224	198	178	163	132	110	82	66	54	41
24	6.57	420	349	295	256	227	204	186	154	125	93	74	61	46
26	6.82	479	397	336	291	257	231	211	175	141	105	84	70	53
28	7.04	542	449	379	329	291	261	238	198	159	119	95	79	60
30	7.30	609	504	425	368	325	292	266	221	178	133	106	88	67
32	7.52	680	561	473	409	362	324	295	245	198	148	118	97	74
34	7.68	753	620	523	452	399	357	325	270	218	163	130	107	81
36	7.87	828	680	573	495	436	391	355	295	238	178	142	117	89
38	8.04	903	740	623	538	474	424	385	320	258	193	154	127	96
40	8.22	977	799	672	580	510	456	414	344	277	207	166	137	103

1/ The growth in developing to the midpoint of the indicated diameter class. For example, an average tree now exactly 14 inches d.b.h. outside bark, having a 10-year outer radial increment of 1.00 inch will have grown 100 board feet during that 10 years.

Table 10. - Annual board-foot (Scribner) growth of trees by diameter class and radial increment

Ponderosa Pine - North Idaho

D.B.H. (o.b.)	Average tree volume 1/	Volume increase	Gross average annual growth by indicated rings in the outer radial inch											
			4	5	6	7	8	9	10	12	15	20	25	30	40
Inches	Board foot 2/ (Scribner)														
10	42														
12	73	31	8	6	5	4	4	3	3	3	2	2	1	1	1
14	123	50	13	10	8	7	6	6	5	4	3	3	2	2	2
16	199	76	19	15	13	11	10	8	8	6	5	4	3	3	2
18	301	102	26	20	17	15	13	11	10	8	7	5	4	4	3
20	429	128	32	26	21	18	16	14	13	11	9	6	5	4	3
22	582	153	38	31	26	22	19	17	15	13	10	8	6	5	4
24	760	178	45	30	30	25	22	20	18	15	11	9	7	6	5
26	962	202	51	40	34	29	25	22	20	17	13	10	8	7	5
28	1,188	226	57	45	38	32	28	25	23	19	15	11	9	8	6
30	1,437	249	62	50	42	36	31	28	25	21	17	12	10	8	6
32	1,707	270	67	54	45	39	34	30	27	22	18	14	11	9	7
34	1,998	291	73	58	49	42	36	32	29	24	19	15	12	10	7
36	2,309	311	78	62	52	44	39	35	31	26	21	16	12	10	8
38	2,639	330	83	66	55	47	41	37	33	27	22	17	13	11	8
40	2,987	348	87	70	58	50	43	39	35	29	23	17	14	12	9
Diameter increment per year (inches)			.50	.40	.33	.29	.25	.22	.20	.17	.13	.10	.08	.07	.05
Years to attain next higher diameter class			4	5	6	7	8	9	10	12	15	20	25	30	40

1/ The average gross volume from curves based on cruise estimates for 12,229 ponderosa pine trees in ponderosa pine stands of North Idaho.

2/ The average annual growth in developing 1 inch in radial increment or 2 inches in diametral increment. Data are rounded to the nearest board foot.

Table 11. - Average annual board-foot (Scribner) growth percent 1/ of trees by diameter class and radial increment

Ponderosa Pine - North Idaho

D.B.H. (o.b.)	Volume increase	Gross annual growth percent by indicated rings in the outer radial inch												
		4	5	6	7	8	9	10	12	15	20	25	30	40
Inches	Percent													
12	74	18	15	12	10	9	8	7	6	5	4	3	2	2
14	68	17	14	11	10	9	8	7	6	5	3	3	2	2
16	62	15	12	10	9	8	7	6	5	4	3	2	2	2
18	51	13	10	9	7	6	6	5	4	3	3	2	2	1
20	43	11	9	7	6	5	4	4	4	3	2	2	1	1
22	36	9	7	6	5	4	4	4	3	2	2	2	1	1
24	31	8	6	5	4	4	3	3	3	2	2	1	1	1
26	27	7	5	4	4	3	3	3	2	2	1	1	1	1
28	23	6	5	4	3	3	3	2	2	2	1	1	1	1
30	21	5	4	3	3	3	2	2	2	1	1	1	1	1
32	19	5	4	3	3	2	2	2	2	1	1	1	1	2/
34	17	4	3	3	2	2	2	2	1	1	1	1	1	2/
36	16	4	3	3	2	2	2	2	1	1	1	1	1	2/
38	14	3	3	2	2	2	2	1	1	1	1	1	2/	2/
40	13	3	3	2	2	2	1	1	1	1	1	1	2/	2/

1/ The simple growth percent, that is, the annual average board-foot growth during the period required for a 2-inch diameter increase divided by the volume at the beginning of the period. As indicated in table 1, the periods range from 4 to 40 years. All items are to the nearest whole number.

2/ Less than 1/2 of 1 percent. Items to the left of the heavy line are 1 percent or more.

Table 12. - Periodic (10 years) board-foot (Scribner) growth of trees by diameter class and radial increment

Ponderosa Pine - North Idaho

D.B.H. (o.b.)	16' logs per average tree	Gross 10-year growth 1/ by indicated 10-year radial increment in inches											
		2.50	2.00	1.67	1.43	1.25	1.11	1.00	.83	.67	.50	.40	.33	.25
Inches	Number	Board feet (Scribner)												
12	1.57	72	62	53	46	40	35	31	25	20	15	12	10	8
14	2.66	98	81	71	63	58	53	50	42	34	25	20	17	13
16	2.99	131	126	110	97	89	81	76	64	51	38	30	25	19
18	3.64	203	178	153	135	121	110	102	85	69	51	41	34	26
20	4.10	268	230	196	172	153	139	128	106	86	64	51	42	32
22	4.29	332	281	239	208	185	167	153	127	103	77	61	50	38
24	4.55	395	331	281	244	216	195	178	148	119	89	71	58	44
26	4.85	456	380	321	279	247	222	202	168	135	101	81	67	50
28	5.17	517	428	361	313	277	248	226	188	151	113	90	75	56
30	5.31	576	475	400	346	306	274	249	207	167	125	99	82	62
32	5.37	632	519	437	377	332	297	270	225	181	136	108	89	68
34	5.46	686	561	472	407	358	320	291	242	195	146	116	96	73
36	5.45	737	602	506	436	384	343	311	258	208	156	124	103	78
38	5.39	787	641	538	464	408	364	330	274	221	165	132	109	83
40	5.38	833	678	569	490	431	384	348	289	233	174	139	115	87

1/ The growth in developing to the midpoint of the indicated diameter class. For example, an average tree now exactly 14 inches d.b.h. outside bark, having a 10-year outer radial increment of 1.00 inch will have grown 50 board feet during that 10 years.

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