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Volume Tables and Point-Sampling Factors

for

Ponderosa Pine in the Black Hills

by Clifford A. Myers

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VOLUME TABLES AND POINT-SAMPLING
FACTORS FOR PONDEROSA PINE IN
THE BLACK HILLS

By

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Central headquarters maintained in cooperation with Colorado State University at Fort Collins.

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Volume Tables and Point-Sampling Factors for Ponderosa Pine in the Black Hills

By

Clifford A. Myers

INTRODUCTION

The tables presented here give values needed to determine the volumes of ponderosa pine (Pinus ponderosa Laws.) in the Black Hills of South Dakota and Wyoming. They provide timber cruisers and growth estimators with the following:

1. Gross volumes in total and merchantable cubic feet.
2. Gross volumes in board feet, International 1/4-inch and Scribner log rules.
3. Point-sampling factors for merchantable cubic feet and board feet.
4. Distribution of board foot volume among the logs of a tree.

Volume on an area may be determined from: (1) measurements of tree diameters and heights, (2) measurements of diameters and of sufficient heights to convert the appropriate volume tables to local volume tables (Chapman and Meyer, 1949), or (3) tree counts obtained by point-sampling.

Sample trees were measured in all areas of commercial ponderosa pine in the Black Hills of South Dakota and Wyoming and the Bear Lodge Mountains of Wyoming.

DEFINITIONS AND STANDARDS

Variables used in the tables, and standards followed in field measurement and computations, are defined as follows:

Diameter breast high (d.b.h.).--Measured to 0.1 inch outside bark 4.5 feet above ground level.² Full-inch diameter classes, with class midpoints at the half-inch marks, were used in the tables (12.5, 13.5, etc.).

Scaling diameter of logs.--Average diameter inside bark to 0.1 inch, measured at the upper (small) end of logs or half-logs. Saw-log diameter classes followed conventional scaling practice, with the class midpoints at whole inches (8.0, 9.0, etc.).

Minimum top diameter of sawtimber trees.--Diameter inside bark 8 inches, which conforms to usual practice in the Black Hills. Logs with a scaling diameter less than 7.6 inches (8-inch class) usually were not included in saw-log volume. A few logs with a scaling diameter of 7 inches were included to satisfy requirements of the 4-foot rule described with the definition of height in logs, below. This also conforms to local practice.

Total height.--Measured to the nearest foot from ground level at the tree base upward to the tip. Forked, stag-topped, or other deformed trees were not included in the sample. Midpoints of the total height classes used in the tables were multiples of 10.0 feet, as 10.0, 20.0, etc.

²Half the heights were measured from average ground level and half from the uphill side of the tree. Variations in positions of d.b.h. and scaling diameters were too small to make significant differences in volumes.

Height in logs.--Measured from the top of a stump 1.0 foot high upward to the limit of saw log utilization. Each tree was divided into as many standard 16.3-foot-long logs as possible. An additional half-log, if present, was taken from the uppermost part of the merchantable length. Portions of the bole above the height of minimum top saw-log diameter were included in the uppermost saw log if the standard length of the log or half-log ended within 4.0 feet above this height. This "4-foot rule" was used to avoid biased negative error in volume (Chapman and Meyer, 1949).

EXPLANATION OF TABLES

The general definitions and standards given apply to all tables. Explanation of each type of table and suggestions for use are presented here.

Volume Tables

Headings and footnotes with each volume table (tables 1, 2, 4, 6, 8, 10) give the volume unit, type of height measurement, utilization standards, and volume equations used in its compilation. Ten-foot or half-log height classes and full-inch diameter classes were used in all tables.

The volume tables were derived from linear regressions in V and D^2H , of the form:

$$V = a + b D^2H,$$

where:

V = gross volume in the appropriate unit

D = diameter breast high outside bark

H = total height in feet or in standard logs and half-logs

a, b = regression constants

Two equations were used to derive each table; the relationship between V and D^2H could not be expressed by a single linear regression over the full range of the basic data. Correlation coefficients (r) of the 12 volume equations ranged from 0.891 (board feet with total height, small trees) to 0.993 (total cubic feet).

The number of logs in a tree shown in the tables is not necessarily the number that will

actually be cut from it. Instead, it is the number of logs between the stump and the height where minimum top diameter is reached. To locate the minimum top, the 4-foot rule explained under the heading "height in logs" should be used.

Volume of nonmerchantable logs below the height of minimum top diameter should be deducted by estimation of scaling diameters, use of taper tables, or according to the percentages in table 13. Volume must not be reduced by tallying fewer logs in the tree. For example, assume that a sound tree 18 inches in diameter has a bole length of 65.2 feet (4 logs) between the stump and the height where diameter inside bark is 8 inches. The tree has a gross volume of 372 board feet Scribner Rule (table 6). The top log is too limby to send to the sawmill. This log contains 9 percent of the board feet in the tree (table 13) and the other logs contain 91 percent. When 9 percent or 33 board feet is deducted, the tree contains 339 board feet. If the tree were tallied as an 18-inch, 3-log tree, it would be incorrectly credited with a volume of 273 board feet.

Point-Sampling Factors

The first five tables of point-sampling factors (tables 3, 5, 7, 9, 11) give the factors for each of numerous combinations of tree diameter and height. Volumes per square foot of basal area were obtained from the equations in the table footnotes. These equations resulted from the division of each volume equation (tables 2, 4, 6, 8, 10) by $0.005454 D^2$, a formula for basal area (B).

Table 12 was derived from the other tables of point-sampling factors. The factor for each height class is the weighted average of the factors in that class given in table 2, 4, 6, 8, or 10. Weights were obtained from random samples of heights and diameters in all areas of commercial ponderosa pine in the Black Hills.

Point-sample cruising for volume can be done in several ways: (1) Diameters and heights of trees counted through the prism or relascope may be measured, (2) diameters

may be estimated and heights measured, or (3) heights of the counted trees may be measured and no record made of tree diameters. The procedure selected will depend on the accuracy desired (relative accuracy usually in the order listed above) and the time and personnel available for the job. Point-sampling factors are provided for each alternative.

The diameter and height of each counted tree may be measured and a volume conversion factor selected for each combination of diameter and height (tables 3, 5, 7, 9, 11). Volume per acre is computed as follows:

1. Multiply the number of counted trees in each diameter-height class by the point-sampling factor for the class.
2. Total the products of step one.
3. Multiply this total by the basal area factor of the prism or other angle gauge used.
4. Divide the product of step three by the number of points sampled on the tract.

Time can often be saved if the heights of the counted trees are measured while diameters are estimated and tallied by broad diameter classes. Inspection of the tables shows that volumes per square foot of basal area often do not differ greatly among trees of a single height class. For example the merchantable volumes of trees 70 feet tall vary from 26.1 to 30.3 cubic feet per square foot as diameter increases from 7 to 27 inches (table 3). Board feet per square foot of basal area changes little with diameter when tree heights are measured in logs (tables 7, 11). Therefore, the increased time spent measuring diameters may not materially increase accuracy.

Measurement of heights with no record made of diameters is recommended when there is little change in volumes per square foot within a height class. Point-sampling factors in table 12, based on height only, will be most useful where the distributions of diameters within height classes approximate those used in preparation of the tables. Differences in the relationship between height and diameter due to differences in site quality or stand density may change the factor for each height class. These changes may be accounted for by computing new factors for each

height class, using tables 3, 5, 7, 9, or 11 and almost the same procedure used to derive a local volume table from a standard table (Chapman and Meyer, 1949). Diameters are plotted over heights, since height will be retained as the measured variable.

The techniques of point sampling have been described in numerous publications. A good discussion of the method was presented by Bonnett (1959). Allen and Mogren (1960) described a simple procedure for determining the number of sampling points, and Afanasiev (1958) listed precautions on the use of point-sampling on small tracts. Basic American references were prepared by Grosenbaugh (1952, 1955, 1958).

Percentage of Tree Board-Foot Volume in Each Log

The board-foot volume in each log-quality class or the volume in cull logs can be determined with the percentages from table 13. Each line in the body of the table gives the distribution of volume among the logs of a tree of specified diameter and merchantable length. For example, in 18-inch, 3-log trees, the butt log contains 53 percent of the board feet, the middle log contains 34 percent, and the top log 13 percent.

Percentages for diameters that are not included in table 13 can be obtained by interpolation.

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ing office.

Table 1.--Gross volumes of entire stem in cubic feet, ponderosa pines in the Black Hills of South Dakota and Wyoming

Cubic feet inside bark

Entire stem including stump and top

Total height above ground

Diameter :		Total height in feet										Basis:		
breast height :		10	20	30	40	50	60	70	80	90	100	110	:Trees	
(Inches)		-----												:
----- Volume in cubic feet -----														
1	0.08	0.13	0.18										1	
2	0.17	0.31	0.45	0.58									13	
3	0.30	0.57	0.84	1.11	1.39								22	
4	0.48	0.93	1.37	1.82	2.27								25	
5		1.37	2.04	2.71	3.38								26	
6		1.90	2.84	3.77	4.71	5.64							25	
7		2.52	3.76	5.01	6.25	7.50	8.74						30	
8		3.23	4.83	6.43	8.02	9.62	11.2						30	
9		4.02	6.02	8.02	10.0	12.0	14.1	16.3					29	
10			7.35	9.79	12.2	14.8	17.5	20.3					29	
11			8.81	11.7	14.8	18.1	21.3	24.6	27.9				36	
12			10.4	13.9	17.8	21.6	25.5	29.4	33.2				35	
13			12.1	16.5	21.0	25.5	30.0	34.5	39.0				43	
14				19.2	24.5	29.7	34.9	40.1	45.3	50.5			28	
15				22.2	28.2	34.1	40.0	46.0	51.9	57.9			36	
16				25.4	32.1	38.9	45.6	52.3	59.1	65.8			20	
17					36.3	43.9	51.5	59.1	66.6	74.2			15	
18					40.8	49.2	57.7	66.2	74.6	83.1	91.6		12	
19					45.5	54.9	64.3	73.7	83.1	92.5	102		12	
20					50.4	60.8	71.2	81.6	92.0	102	113		8	
21						67.1	78.5	89.9	101	113	124		7	
22						73.6	86.1	98.6	111	124	136		3	
23						80.4	94.1	108	121	135	149		3	
24						87.5	102	117	132	147	162		4	
25						95.0	111	127	143	159	175		1	
26						103	120	137	155	172	190		2	
27						111	129	148	167	186	204		2	
Basis:														
No. trees	5	35	62	52	80	84	92	52	26	9	0	497		

Block indicates extent of basic data.

Derived from: $V = 0.002213 D^2H + 0.030288$, for D^2H to 6,000

$V = 0.002474 D^2H - 1.557103$, for D^2H larger than 6,000

Standard errors of estimate: ± 9.04 percent; ± 11.63 percent

Diameter classes full-inch; e. g. 20-inch class includes 20.0 to 20.9

Table 2.--Gross merchantable volumes in cubic feet to a 4.0-inch top, ponderosa pines in the

Black Hills of South Dakota and Wyoming

Cubic feet inside bark											
Top diameter 4.0 inches inside bark											
Merchantable stem excluding stump and top											
Stump height 1.0 foot											
Basis:											
No. trees											
3											
41											
49											
80											
84											
92											
52											
26											
9											
0											
436											

Diameter breast height outside bark (Inches)	Total height in feet										Basis: Trees
	20	30	40	50	60	70	80	90	100	110	
----- Volume in cubic feet -----											
5	0.36	1.05	1.75	2.44							26
6	0.91	1.88	2.85	3.82	4.79						25
7	1.55	2.84	4.14	5.43	6.72	8.01					30
8	2.29	3.95	5.61	7.27	8.93	10.6					30
9	3.11	5.19	7.26	9.33	11.4	13.5	15.1				29
10		6.57	9.10	11.6	14.2	16.3	19.0				29
11		8.08	11.1	14.2	16.8	20.0	23.2	26.4			36
12		9.73	13.3	16.5	20.3	24.1	27.8	31.6			35
13		11.5	15.3	19.7	24.1	28.4	32.8	37.2			43
14			18.0	23.0	28.1	33.2	38.2	43.3	48.3		28
15			20.9	26.7	32.4	38.2	44.0	49.8	55.6		36
16			24.0	30.5	37.1	43.6	50.2	56.7	63.3		20
17				34.6	42.0	49.3	56.7	64.1	71.5		15
18				38.9	47.2	55.4	63.6	71.9	80.1	88.4	12
19				43.5	52.7	61.8	71.0	80.1	89.3	98.4	12
20				48.3	58.4	68.6	78.7	88.8	98.9	109	8
21					64.5	75.6	86.8	97.9	109	120	7
22					70.9	83.0	95.2	107	120	132	3
23					77.5	90.8	104	117	131	144	3
24					84.4	98.9	113	128	142	157	4
25					91.7	107	123	139	154	170	1
26					99.2	116	133	150	167	184	2
27					107	125	143	162	180	198	2

Basis:											
No. trees											
3											
41											
49											
80											
84											
92											
52											
26											
9											
0											
436											

Block indicates extent of basic data.

Derived from $V = 0.002297 D^2 H - 1.032297$ for $D^2 H$ to 6,700

$V = 0.002407 D^2 H - 2.257724$ for $D^2 H$ larger than 6,700

Standard errors of estimate: ± 12.03 percent; ± 12.09 percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 3.--Gross merchantable volumes in cubic feet per square foot of basal area, ponderosa pines in the

Black Hills of South Dakota and Wyoming

Cubic feet inside bark Merchantable stem excluding stump and top										Top diameter 4.0 inches inside bark Stump height 1.0 foot	
Diameter :		Total height in feet									
breast height :		20	30	40	50	60	70	80	90	100	110
outside bark :											
(Inches)		<u>Cubic feet</u>									
5	2.2	6.4	10.6	14.8							
6	3.9	8.2	12.4	16.6	20.8						
7	5.1	9.3	13.5	17.7	21.9	26.1					
8	5.8	10.0	14.2	18.4	22.7	26.9					
9	6.3	10.5	14.8	19.0	23.2	27.4	30.7				
10		10.9	15.1	19.3	23.6	27.1	31.5				
11		11.2	15.4	19.6	23.3	27.8	32.2	36.6			
12		11.4	15.6	19.4	23.8	28.2	32.7	37.1			
13		11.6	15.4	19.8	24.2	28.6	33.0	37.4			
14			15.7	20.1	24.5	28.9	33.3	37.7	42.2		
15			15.9	20.3	24.8	29.2	33.6	38.0	42.4		
16			16.1	20.5	25.0	29.4	33.8	38.2	42.6		
17				20.7	25.1	29.5	34.0	38.4	42.8		
18				20.9	25.3	29.7	34.1	38.5	42.9	47.3	
19				21.0	25.4	29.8	34.2	38.6	43.0	47.5	
20				21.1	25.5	29.9	34.3	38.7	43.1	47.6	
21					25.6	30.0	34.4	38.8	43.2	47.6	
22					25.7	30.1	34.5	38.9	43.3	47.7	
23					25.7	30.1	34.6	39.0	43.4	47.8	
24					25.8	30.2	34.6	39.0	43.4	47.9	
25					25.8	30.3	34.7	39.1	43.5	47.9	
26					25.9	30.3	34.7	39.1	43.5	48.0	
27					25.9	30.3	34.8	39.2	43.6	48.0	

Derived from: $V/B = 0.4212 H - 189.2734/D^2$, above dotted line. $V/B = 0.4413 H - 413.9575/D^2$, below dotted line.

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9.

Table 4.--Gross volumes in board feet Scribner Rule, ponderosa pines in the Black Hills of South Dakota and Wyoming

Board feet inside bark Merchantable stem excluding stump and top		Top diameter 8 inches inside bark Stump height 1.0 foot									
Diameter breast height outside bark (Inches)		40	50	60	70	80	90	100	110	120	Basis: Trees
----- Volume in board feet -----											
10		31	34	47	61	75					30
11		43	47	64	80	96	113				52
12		56	62	81	101	120	139				64
13			78	101	123	146	168	198			86
14	70		95	121	147	175	210	244	278		60
15			114	144	175	214	254	293	332		67
16			134	167	212	256	301	345	389		41
17			155	201	251	301	351	401	450		44
18			180	236	292	348	403	459	515		31
19			211	273	335	397	459	521	583		28
20			244	312	381	449	518	587	655		23
21			278	353	429	504	580	655	731		14
22			314	396	479	562	644	727	809	892	12
23			351	441	532	622	712	802	892	982	11
24			391	488	586	684	782	880	978	1,076	12
25			431	537	644	750	856	962	1,068	1,174	9
26				588	703	818	932	1,047	1,161	1,276	10
27				641	765	888	1,011	1,135	1,258	1,382	12
28				696	829	961	1,094	1,226	1,359	1,491	5
29				895	895	1,037	1,179	1,321	1,463	1,605	5
30						1,115	1,267	1,419	1,571	1,722	1
Basis:											
No. trees		10	60	142	169	130	71	32	2	1	617

Block indicates extent of basic data.

Derived from $V = 0.012331 D^2 H - 34.167170$, for $D^2 H$ to 16,000

$V = 0.016318 D^2 H - 99.212720$, for $D^2 H$ larger than 16,000

Standard errors of estimate: ± 19.64 percent; 15.61 percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 6.--Gross volumes in board feet Scribner Rule, ponderosa pines in the Black Hills of South Dakota and Wyoming

Board feet inside bark Merchantable stem excluding stump and top		Number of 16-foot logs to 8-inch top											Top diameter 8 inches inside bark Stump height 1.0 foot	
Diameter breast height outside bark (Inches)	:	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	:	
		Volume in board feet											Basis: Trees	
10	:	31	45	60	75								30	
11	:	37	54	72	89	107							52	
12	:	43	64	84	105	126	146	167					64	
13	:	50	74	98	122	146	170	194	218				86	
14	:	57	85	113	141	168	196	224	252				60	
15	:		97	129	160	192	224	256	287				67	
16	:		110	146	182	218	254	290	327				41	
17	:		123	164	204	245	285	327	375	423			44	
18	:		137	183	228	273	318	372	425	479			31	
19	:		152	203	253	303	360	419	479	538	598		28	
20	:		168	224	279	338	404	469	535	601	666	732	23	
21	:		185	246	307	377	450	522	594	666	739	811	14	
22	:			340	419	498	577	656	735	814	893		12	
23	:			375	462	548	634	721	807	893	980		11	
24	:			413	507	601	694	788	882	976	1,070		12	
25	:			452	554	655	757	859	960	1,062	1,164		9	
26	:			493	602	712	822	932	1,042	1,151	1,261		10	
27	:			535	653	771	890	1,008	1,126	1,244	1,362		12	
28	:				706	833	960	1,087	1,214	1,341	1,468		5	
29	:					896	1,032	1,168	1,304	1,440	1,576		5	
30	:					1,107	1,253	1,398	1,543	1,689			1	
Basis:	:													
No. trees	:	24	61	102	98	106	80	74	38	28	6	0	617	

Block indicates extent of basic data.

Derived from: $V = 0.264267 D_H^2 + 1.737800$, for D_H^2 to 1,200

$V = 0.312649 D_H^2 - 56.188070$, for D_H^2 larger than 1,200

Standard errors of estimate: ± 13.22 percent; ± 11.58 percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 7.--Gross volumes in board feet Scribner Rule per square foot of basal area, ponderosa pines

in the Black Hills of South Dakota and Wyoming

Board feet inside bark Merchantable stem excluding stump and top										Top diameter 8 inches inside bark Stump height 1.0 foot													
Diameter :		Number of 16-foot logs to 8-inch top																					
breast height :		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0											
outside bark :		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0											
(Inches)		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0											
-----Board feet-----														-----									
10	51	76	100	124																			
11	51	75	99	124	148																		
12	50	75	99	123	147		172	196															
13	50	74	99	123	147		171	196	220														
14	50	74	98	123	147		171	195	220														
15		74	98	122	147		171	195	219														
16		74	98	122	147		171	195	220														
17		74	98	122	146		171	196	224	253													
18		74	98	122	146		171	199	228	257													
19		74	98	122	146		174	202	231	260	288												
20		73	98	122	147		176	205	233	262	291	319											
21		73	98	122	150		178	207	236	264	293	322											
22				123	152		180	209	238	266	295	324											
23				125	153		182	211	239	268	297	325											
24				126	155		183	212	241	269	298	327											
25				127	156		185	213	242	271	299	328											
26				129	157		186	215	243	272	301	329											
27				130	158		187	216	244	273	302	330											
28					159		188	217	245	274	303	331											
29							189	217	246	275	303	332											
30								218	247	276	304	333											

Derived from $V/B = 48.4538 H + 318.6285/D^2$, above dotted line.

$V/B = 57.3247 H - 10302.1764/D^2$, below dotted line.

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 8.--Gross volumes in board feet International 1/4-inch Rule, ponderosa pines in the

Black Hills of South Dakota and Wyoming

Board feet inside bark Merchantable stem excluding stump and top										Top diameter 8 inches inside bark Stump height 1.0 foot				Basis: Trees	
Diameter breast height outside bark (Inches)	Total height in feet														
	40	50	60	70	80	90	100	110	120						
----- Volume in board feet -----															
10		38	55	71	88									30	
11	35	55	75	95	114	134								52	
12	49	73	96	120	143	170								64	
13	65	92	120	147	179	210	241							86	
14	82	113	145	181	217	253	288	324						60	
15		136	176	217	258	299	339	380						67	
16		163	209	255	301	348	394	440						41	
17		191	243	295	348	400	452	504						44	
18		222	280	338	396	455	513	571						31	
19		254	319	384	448	513	577	642						28	
20		288	360	431	502	574	645	717						23	
21		324	402	481	560	638	717	795						14	
22		361	447	533	619	705	791	877	963					12	
23		400	494	588	682	776	870	963	1,057					11	
24		441	543	645	747	849	951	1,053	1,155					12	
25		484	594	705	815	926	1,036	1,147	1,257					9	
26			647	766	886	1,005	1,124	1,244	1,363					10	
27			702	831	959	1,088	1,216	1,345	1,473					12	
28			759	897	1,035	1,173	1,311	1,449	1,587					5	
29				966	1,114	1,262	1,410	1,558	1,706					5	
30					1,196	1,354	1,512	1,670	1,828					1	
Basis:															
No. trees	10	60	142	169	130	71	32	2	1					617	

Block indicates extent of basic data.

Derived from $V = 0.015011 D^2H - 44.360460$, for D^2H to 13,000

$V = 0.016991 D^2H - 68.750200$, for D^2H larger than 13,000

Standard errors of estimate: ± 19.95 percent; ± 14.17 percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 9.--Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, ponderosa pinés

in the Black Hills of South Dakota and Wyoming

Board feet inside bark				Top diameter 8 inches inside bark								
Merchantable stem excluding stump and top				Stump height 1.0 foot								
Diameter :				Total height in feet								
breast height :												
outside bark :												
(Inches)				40	50	60	70	80	90	100	110	120
----- Board feet -----												
10					64	91	119	146				
11				49	76	104	131	159	186			
12				58	86	113	141	168	200			
13				65	93	121	148	180	211	242		
14				71	99	126	158	189	220	252	283	
15					104	134	166	197	228	259	290	
16					109	141	172	203	234	265	296	
17					115	146	177	208	239	270	302	
18					119	150	181	212	244	275	306	
19					123	154	185	216	247	278	310	
20					126	157	188	219	250	282	313	
21					128	160	191	222	253	284	315	
22					131	162	193	224	255	287	318	349
23					133	164	195	226	258	289	320	351
24					135	166	197	228	259	291	322	353
25					136	168	199	230	261	292	323	354
26						169	200	231	262	294	325	356
27						170	201	233	264	295	326	357
28						171	203	234	265	296	327	358
29							204	235	266	297	328	359
30								236	267	298	329	360

Derived from $V/B = 2.7523 H - 8133.5644/D^2$, above dotted line.

$V/B = 3.1153 H - 12605.4639/D^2$, below dotted line.

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 10.--Gross volumes in board feet International 1/4-inch Rule, ponderosa pines in the
Black Hills of South Dakota and Wyoming

Board feet inside bark Merchantable stem excluding stump and top										Top diameter 8 inches inside bark Stump height 1.0 foot										:Basis: :Trees
Diameter breast height : outside bark : (Inches)		Number of 16-foot logs to 8-inch top										:Basis: :Trees								
----- Volume in board feet -----														:Basis: :Trees						
10	37	54	71	89											30					
11	44	64	85	106	126										52					
12	51	76	100	124	149	173	198								64					
13	59	88	116	145	173	202	230	259							86					
14	68	101	134	167	200	232	265	298							60					
15		115	153	190	228	265	303	340							67					
16		130	173	215	258	300	343	384							41					
17		146	194	242	290	337	384	433	482						44					
18		163	216	270	323	376	430	485	539						31					
19		181	240	300	358	418	479	539	600	661					28					
20		199	265	331	396	463	530	597	664	731	798				23					
21		219	291	362	436	510	583	657	731	804	878				14					
22				397	478	559	639	720	801	881	962				12					
23				434	522	610	698	786	874	962	1,050				11					
24				472	568	664	759	855	950	1,046	1,142				12					
25				512	616	719	823	927	1,030	1,134	1,237				9					
26				554	665	777	889	1,001	1,113	1,225	1,337				10					
27				597	717	838	958	1,079	1,199	1,320	1,440				12					
28					771	900	1,029	1,159	1,288	1,418	1,547				5					
29						965	1,103	1,242	1,381	1,519	1,658				5					
30							1,180	1,328	1,476	1,624	1,773				1					
Basis:																				
No. trees	24	61	102	98	106	80	74	38	28	6	0				617					

Block indicates extent of basic data.

Derived from: $V = 0.312621 D^2H + 2.338510$, for D^2H to 1,100

$V = 0.318669 D^2H - 5.939610$, for D^2H larger than 1,100

Standard errors of estimate: ± 13.18 percent; ± 10.28 percent

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 11.--Gross volumes in board feet International 1/4-inch Rule per square foot of basal area, ponderosa pines in the Black Hills of South Dakota and Wyoming

Board feet inside bark Merchantable stem excluding stump and top				Top diameter 8 inches inside bark Stump height 1.0 foot										
Diameter :				Number of 16-foot logs to 8-inch top										
breast height :														
outside bark :														
(Inches)				1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
----- Board feet -----														
10	61	90	119											
11	61	89	118	147	175									
12	60	89	117	146	175	203	232							
13	60	88	117	146	174	203	232	260						
14		88	117	145	174	203	231	260						
15		88	116	145	174	202	231	260						
16		88	116	145	174	202	231	259						
17		87	116	145	173	202	230	259	289					
18		87	116	145	173	201	231	260	289					
19		87	116	144	172	202	231	260	289	318				
20		87	116	144	173	202	231	260	290	319	348			
21		87	116	144	173	202	231	261	290	319	348			
22				144	173	202	232	261	290	319	348			
23				144	173	203	232	261	290	319	349			
24				144	173	203	232	261	290	320	349			
25				144	174	203	232	261	290	320	349			
26					174	203	232	261	291	320	349			
27					174	203	232	261	291	320	349			
28					174	203	232	262	291	320	349			
29						203	232	262	291	320	349			
30							233	262	291	320	349			
31							233	262	291	320	349			

Derived from: $V/B = 57.3196 H + 428.7697/D^2$, above dotted line.

$V/B = 58.4285 H - 1089.0374/D^2$, below dotted line.

Diameter classes full-inch; e.g. 20-inch class includes 20.0 to 20.9

Table 12.--Gross tree volumes per square foot of basal area by tree height classes only,

Black Hills ponderosa pine

Tree : height : (feet) :	Merchantable cubic feet	Board feet Scribner	Board feet International	Tree : height : (logs) :	Board feet Scribner	Board feet International
20	2.4			1.0	51	61
30	7.9			1.5	75	89
40	13.4	49	56	2.0	99	117
50	18.9	73	86	2.5	123	145
60	23.9	103	122	3.0	147	174
70	28.8	136	160	3.5	173	202
80	33.7	175	203	4.0	202	231
90	38.6	222	247	4.5	238	261
100	43.2	262	286	5.0	269	290
110	47.7	298	322	5.5	298	319
120		333	356	6.0	328	349

Table 13.--Percentage of total board foot volume in each log of a tree,

Black Hills ponderosa pine

D.b.h. (inches) : and : tree height : (logs) :	Position of log in the tree										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0

- - - - - Percent of total tree volume - - - - -

Trees 12 inches d.b.h.:

1.0	100										
1.5	75	25									
2.0	62	--	38								
2.5	49	--	37	14							
3.0	42	--	35	--	23						
3.5	37	--	33	--	21	9					

Trees 18 inches d.b.h.:

2.0	70	--	30								
2.5	62	--	30	8							
3.0	53	--	34	--	13						
3.5	45	--	32	--	18	5					
4.0	41	--	30	--	20	--	9				
4.5	37	--	27	--	22	--	10	4			
5.0	34	--	23	--	22	--	15	--	6		

Trees 24 inches d.b.h.:

3.0	60	--	30	--	10						
3.5	50	--	31	--	16	3					
4.0	42	--	31	--	21	--	6				
4.5	38	--	30	--	20	--	10	2			
5.0	34	--	27	--	21	--	14	--	4		

Myers, Clifford A.

1964. Volume tables and point-sampling factors for ponderosa pine in the Black Hills. U. S. Forest Serv. Res. Paper RM-8, 16 pp. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Volumes are in total cubic feet and cubic feet to a 4.0-inch top, board feet Scribner Rule to an 8-inch top, and board feet International 1/4-inch Rule to an 8-inch top. Tree heights are in feet and numbers of logs. Volume equations are of the form $V = a + bD^2H$. Volumes per square foot of basal area are also included.

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