

A black and white photograph showing three vertical aspen tree trunks in a forest. The trunks are light-colored with characteristic horizontal lenticels and dark, irregular scars from insect damage. The background is filled with dense foliage and other trees, creating a textured, natural setting.

# Volume Tables and Point-Sampling Factors for Aspen in Colorado

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Research Paper RM-232  
Rocky Mountain Forest and  
Range Experiment Station  
Forest Service  
U.S. Department of Agriculture

# Volume Tables and Point-Sampling Factors for Aspen in Colorado<sup>1</sup>

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## **Abstract**

Volume tables present total cubic feet, merchantable cubic feet to 4-inch top, metric equivalents of cubic volume, and board feet Scribner and International 1/4-inch Rules to 6-inch top. Point-sampling factor tables give merchantable volumes per square foot of basal area. Tree heights are expressed as total height and merchantable number of logs.

<sup>1</sup>*This paper supersedes Research Note 63, Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture.*

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## Management Highlights

Eleven tables presented here give values and equations needed to determine the gross volumes of aspen (*Populus tremuloides* Michx.) trees in Colorado. The tables provide:

1. Gross volumes, in cubic feet, of the entire stem.
2. Gross merchantable volumes, in cubic feet, to a 4-inch top.
3. Gross merchantable volumes, in board feet, Scribner and International 1/4-inch Rules, to a 6-inch top.
4. Point-sampling factors giving merchantable volumes in cubic feet and board feet per square foot of basal area.

Sample tree measurements for this study come from previous studies of decay (Davidson et al. 1959; Hinds 1963) and tree volume (Peterson 1961) and the USDA Forest Service Rocky Mountain Region inventory. Trees were sampled on the Arapaho, Roosevelt, Grand Mesa, Uncompahgre, Gunnison, Routt, San Juan, and White River National Forests in Colorado.

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

## Definitions and Standards

**Diameter at breast height (d.b.h.)**—Measured to the nearest 0.1 inch, outside the bark, at 4.5 feet above ground level, on the uphill side of the tree. Full-inch-diameter classes, with class midpoints at the 1/2-inch marks, are used in the tables.

**Total height**—Measured, in whole feet to the nearest foot, from ground level on the uphill side of the tree upward to the tip. Trees forked below utilization limits described below, dead-topped, with excessive limbi-ness, or severely deformed were not included in the sample. The midpoints of total height classes in the tables are multiples of 10 feet.

**Scaling diameter of logs**—Average diameter inside bark to nearest 0.1 inch, measured at the small end of logs or half-logs.

**Minimum top diameters for merchantable volumes**—Minimum top diameter inside bark for computation of merchantable cubic-foot volume was 4 inches. For board-foot volume, a minimum top diameter inside bark of 6 inches was used to conform to local practice. Logs with a scaling diameter smaller than 5.6 inches usually were not included in saw-log volume. A few logs with smaller scaling diameters were included to satisfy the "4-foot rule" described below.

**Merchantable length in logs**—Measured from 1 foot above ground level on the uphill side of the tree, upward to the limit of saw-log utilization. Each tree was sectioned into as many 16.5-foot long logs as possible. An additional half-log, if available, was taken from the uppermost part of the merchantable length. Portions of the bole above the height of minimum top diameter inside bark were included in the uppermost saw-log if the standard log or half-log length ended within 4 feet above this height. This "4-foot rule" was used to avoid a negative bias in volume determination (Chapman and Meyer 1949).

## Explanation of Tables

General definitions and standards given above apply to all tables listed in the appendix. Explanation of each type of table and suggestions for use follow.

## Volume Tables

Headings and footnotes of each volume table (table 1 and even-numbered tables 2 through 10) give units of volume and height measurement, utilization standards, and volume equations used in compilation. Full-inch-diameter classes and 10-foot-height classes or half-log-length classes were used in all tables in American Standard units.

The volume tables were developed from linear regressions of  $V$  and  $D^2H$  or  $D^2L$  of the form:

$$V = a + bD^2H \text{ or } V = a + bD^2L$$

where:

$V$  = gross volume inside bark in the appropriate unit

$D$  = d.b.h. outside bark in inches

$H$  = total height in feet

$L$  = merchantable length in standard logs and half-logs

$a, b$  = regression coefficients

Graphs of  $V$  versus  $D^2H$  or  $D^2L$  for all volume rela-

tionships indicated a slight nonlinear trend. Two linear regression equations were used to cover the full range of the basic data. Unfortunately, the linear regression equations for board-foot volumes gave negative estimates for small values of  $D^2H$ . To correct this, the volume of a half-log with minimum top diameter of 6 inches inside bark has been substituted as described in the footnotes for tables 4 and 8.

The number of logs in a tree shown in tables 6 and 10 is not necessarily the number that will actually be cut from it. It is the number of logs between the 1-foot above ground level and the height of minimum top diameter. Volume of nonmerchantable logs below the height of minimum top diameter should be deducted from tree volume by: (1) estimation of scaling diameters and deduction of appropriate log volumes, or (2) use of taper tables to determine scaling diameters and deduction of log volumes. Volume should not be reduced by tallying fewer logs in the tree.

### Point-Sampling Factors

Odd-numbered tables from tables 3 through 11 give point-sampling factors for combinations of tree d.b.h. and height or merchantable length. Tabulated volumes per square foot of basal area were obtained from equations given in the table footnotes. These equations were derived by dividing each term of the corresponding tree volume equation by tree basal area in square feet ( $B = 0.0054542D^2$ ).

Point-sample cruising to estimate stand volume can be done in several ways: (1) measure the d.b.h. and height of each tree tallied through the prism, angle gage, or relascope; (2) measure the height of each tallied tree and estimate its d.b.h.; or (3) measure the heights of the tallied trees and make no record of d.b.h.'s. The procedure selected will depend on the precision desired. Relative precision is usually in the order listed above. If the d.b.h. and height of each tallied tree are measured, a volume conversion factor can be selected from the tables or computed from the appropriate equations for each combination of d.b.h. and height.

Volume per acre is then computed as follows:

1. Multiply the number of tallied trees in each d.b.h.-height class by the point-sampling factor for the class.
2. Total the products of step 1.
3. Multiply the total of step 2 by the basal area factor of the angle gage used.
4. Divide the product of step 3 by the number of points sampled on the tract.

Considerable time often can be saved if the heights of tallied trees are measured, while d.b.h.'s are estimated and recorded by broad classes. Inspection of the point-sampling factor tables shows that volumes per square foot of basal area, for trees larger than 12 inches d.b.h., often do not differ greatly among trees of a single height class. The increased time spent measuring d.b.h.'s may not increase precision materially.

When the distribution of d.b.h.'s and heights inventoried indicates there is little change in volume per square foot within a height class, it is recommended that d.b.h.'s not be recorded at all. Point-sampling factors for each height class can be computed using a procedure similar to deriving a local volume table from a standard table (Chapman and Meyer 1949).

The techniques of point sampling have been described in numerous publications (Dilworth and Bell 1971; Grosenbaugh 1958). Procedures for computing tree volumes and point-sampling factors using programmable calculators have been developed by Shepperd (1980).

### Metric Equivalents for Cubic Volume

Tables 12 and 13 are the metric equivalents of tables 1 and 2 for total and merchantable cubic volume, respectively. Equations used in developing the metric tables are given in the footnotes to tables 12 and 13. These equations are conversions (Myers and Edminster 1974) of the equations in American Standard units from tables 1 and 2. The form of the equations is:

$$V_m = a_m + b_m D_m^2 H_m$$

where:

$V_m$  = gross volume inside bark in cubic meters

$D_m$  = d.b.h. outside bark in centimeters

$H_m$  = total height in meters

$a_m, b_m$  = metric conversions of regression coefficients  $a, b$

Table 14 gives point-sampling factors for gross merchantable volume in cubic meters per square meter of basal area. The equations used to develop table 14 were derived by dividing each term of the volume equations of table 13 by tree basal area in square meters ( $B_m = 0.00007854D_m^2$ ).

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### Appendix

Table 1.—Gross volumes, in cubic feet inside bark, of entire stem including stump and top, aspen in Colorado

d.b.h. inches	Total height (feet) above ground										Basis: trees	
	10	20	30	40	50	60	70	80	90	100		
2	0.1	0.3										0
3	0.3	0.5	0.8	1.1	1.4							0
4	0.4	0.9	1.3	1.8	2.2	2.7						79
5	0.7	1.3	2.0	2.7	3.4	4.0	4.7					106
6		1.9	2.8	3.8	4.7	5.6	6.6	7.5				102
7		2.5	3.7	5.0	6.2	7.5	8.7	10.0				94
8		3.2	4.8	6.4	8.0	9.6	11.2	12.8				84
9			6.0	8.0	10.0	12.0	14.0	16.0				107
10			7.3	9.8	12.2	14.7	17.1	19.6	22.0			96
11			8.8	11.7	14.7	17.6	20.5	23.5	26.4			82
12			10.4	13.9	17.3	20.8	24.3	27.7	30.7			92
13				16.2	20.2	24.3	28.2	31.7	35.1	38.6		78
14				18.7	23.2	27.9	31.9	35.9	39.9	43.9		56
15				21.3	26.7	31.4	35.9	40.5	45.0	49.6		50
16				24.2	29.8	35.0	40.2	45.3	50.5	55.6		37
17					33.1	38.9	44.7	50.5	56.3	62.1		27
18					36.5	43.0	49.5	55.9	62.4	68.9		17
19					40.1	47.3	54.5	61.7	68.9	76.1		14
20					43.9	51.8	59.8	67.8	75.7	83.7		8
21					47.9	56.6	65.4	74.1	82.9	91.7		5
22						61.6	71.2	80.8	90.4	100.0		3
23						66.9	77.3	87.8	98.3	108.7		2
24						72.3	83.7	95.1	106.5	117.8		0
25							90.3	102.7	115.0	127.3		0
Basis: trees	0	5	47	150	162	278	322	138	31	6		1139

Block indicates extent of data.

Computed from:  $V = 0.002219D^2H$  for  $D^2H$  to 12,470;

$V = 0.001896D^2H + 4.0267$  for  $D^2H$  larger than 12,470

Standard errors of estimate:  $\pm 1.25$  cubic feet ( $\pm 11.33\%$  of mean);  $\pm 4.72$  cubic feet ( $\pm 12.97\%$  of mean)

Coefficients of determination: 0.9914; 0.8826

Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 2.—Gross merchantable volumes, in cubic feet inside bark, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 4 inches inside bark. Stump height 1 foot

d.b.h.	Total height (feet) above ground									Basis: trees	
	20	30	40	50	60	70	80	90	100		
<i>inches</i>											
5	0.4	1.1	1.7	2.4	3.1	3.7					106
6	0.9	1.9	2.8	3.7	4.7	5.6	6.5				102
7	1.6	2.8	4.0	5.3	6.5	7.7	9.0				94
8	2.3	3.8	5.4	7.0	8.6	10.2	11.8				84
9		5.0	7.0	9.0	11.0	13.0	14.9				107
10		6.4	8.8	11.2	13.6	16.0	18.4	20.9			96
11		7.8	10.7	13.6	16.5	19.4	22.3	25.2			82
12		9.4	12.8	16.2	19.7	23.1	26.3	29.1			92
13			15.1	19.1	23.1	26.7	30.1	33.4	36.8		78
14			17.5	22.2	26.5	30.4	34.2	38.1	41.9		56
15			20.2	25.4	29.8	34.2	38.6	43.0	47.5		50
16			23.0	28.3	33.3	38.3	43.3	48.3	53.3		37
17				31.4	37.1	42.7	48.3	54.0	59.6		27
18				34.8	41.0	47.3	53.6	59.9	66.2		17
19				38.2	45.2	52.2	59.2	66.2	73.2		14
20				41.9	49.6	57.4	65.1	72.8	80.5		8
21				45.8	54.3	62.8	71.3	79.8	88.2		5
22					59.1	68.4	77.7	87.0	96.3		3
23					64.2	74.3	84.5	94.6	104.8		2
24					69.5	80.5	91.5	102.6	113.6		0
25						86.9	98.9	110.8	122.8		0
Basis: trees	1	18	111	155	278	322	138	31	6		1060

Block indicates extent of data.

Computed from:  $V = 0.002195D^2H - 0.9076$  for  $D^2H$  to 11,800;

$V = 0.001837D^2H + 3.3075$  for  $D^2H$  larger than 11,800

Standard errors of estimate:  $\pm 1.34$  cubic feet ( $\pm 12.13\%$  of mean);  $\pm 4.66$  cubic feet ( $\pm 13.42\%$  of mean)

Coefficients of determination: 0.9670; 0.8790

Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 3.—Gross merchantable volumes, in cubic feet inside bark per square foot of basal area, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 4 inches inside bark. Stump height 1 foot

d.b.h.	Total height (feet) above ground								
	20	30	40	50	60	70	80	90	100
<i>inches</i>									
5	2.5	6.6	10.6	14.6	18.6	22.7			
6	4.1	8.1	12.2	16.2	20.2	24.2	28.2		
7	5.1	9.1	13.1	17.2	21.2	25.2	29.2		
8	5.7	9.8	13.8	17.8	21.8	25.9	29.9		
9		10.2	14.3	18.3	22.3	26.3	30.3		
10		10.6	14.6	18.6	22.6	26.7	30.7	34.7	
11		10.8	14.8	18.9	22.9	26.9	30.9	34.9	
12		11.0	15.0	19.1	23.1	27.1	30.8	34.2	
13			15.2	19.2	23.2	26.9	30.3	33.6	37.0
14			15.3	19.3	23.1	26.5	29.8	33.2	36.6
15			15.4	19.4	22.7	26.1	29.5	32.8	36.2
16			15.5	19.1	22.4	25.8	29.2	32.5	35.9
17				18.8	22.2	25.6	28.9	32.3	35.7
18				18.6	22.0	25.4	28.7	32.1	35.5
19				18.4	21.8	25.2	28.5	31.9	35.3
20				18.3	21.7	25.0	28.4	31.8	35.1
21				18.2	21.5	24.9	28.3	31.6	35.0
22					21.4	24.8	28.1	31.5	34.9
23					21.3	24.7	28.0	31.4	34.8
24					21.2	24.6	28.0	31.3	34.7
25						24.5	27.9	31.3	34.6

Computed from:  $V/B = 0.40236H - 166.41002/D^2$  for  $D^2H$  to 11,800;  
 $V/B = 0.33689H + 606.42083/D^2$  for  $D^2H$  larger than 11,800  
Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 4.—Gross volumes, in board feet, inside bark Scribner Rule, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 6 inches inside bark. Stump height 1 foot

d.b.h. <i>inches</i>	Total height (feet) above ground								Basis: trees
	30	40	50	60	70	80	90	100	
7	8	8	12	18	24	31			94
8	8	12	21	29	37	45			84
9	10	21	31	41	51	62			107
10	17	30	42	55	67	80	91		96
11	25	40	55	70	84	98	112		82
12	33	51	68	86	102	118	134		92
13		63	83	102	121	140	158	177	78
14		75	97	119	141	163	184	206	56
15		88	113	138	163	188	212	237	50
16		101	130	158	186	214	242	270	37
17			147	179	210	242	274	306	27
18			166	201	237	272	307	343	17
19			185	225	264	303	343	382	14
20			206	250	293	336	380	423	8
21			228	276	323	371	419	467	5
22				303	355	408	460	512	3
23				331	389	446	503	560	2
24				361	423	485	548	610	0
25					460	527	594	661	0
<b>Basis:</b> trees	1	16	88	253	319	138	31	6	852

Block indicates extent of data.

Computed from:  $V = 8$  for  $D^2H$  to 2,500;

$V = 0.011389D^2H - 20.5112$  for  $D^2H$  larger than 2,500 to 8,850;

$V = 0.010344D^2H - 11.2615$  for  $D^2H$  larger than 8,850

Standard errors of estimate:  $\pm 7.1$  board feet ( $\pm 16.73\%$  of mean);  $\pm 27.9$  board feet ( $\pm 19.33\%$  of mean)

Coefficients of determination: 0.9021; 0.8696

Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 5.—Gross volumes, in board feet inside bark Scribner Rule per square foot of basal area, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 6 inches inside bark. Stump height 1 foot

d.b.h.	Total height (feet) above ground							
	30	40	50	60	70	80	90	100
<i>inches</i>								
7	26	26	38	58	79	100		
8	20	31	52	73	94	115		
9	21	42	63	84	104	125		
10	29	49	70	91	112	133	152	
11	34	55	76	97	117	136	155	
12	39	59	80	101	120	139	157	
13		63	83	102	121	140	159	178
14		66	85	104	123	142	161	180
15		67	86	105	124	143	162	181
16		68	87	106	125	144	163	182
17			88	107	126	145	164	183
18			89	108	127	146	165	184
19			89	108	127	146	165	184
20			90	109	128	147	166	185
21			90	109	128	147	166	185
22				110	129	148	167	186
23				110	129	148	167	186
24				110	129	148	167	186
25					130	149	168	186

Computed from:  $V/B = 1466.75956/D^2$  for  $D^2H$  to 2500;

$V/B = 2.08807H - 3760.63347/D^2$  for  $D^2H$  larger than 2500 to 8850;

$V/B = 1.89648H - 2064.73599/D^2$  for  $D^2H$  larger than 8850

Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 6.—Gross volumes, in board feet inside bark Scribner Rule, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 6 inches inside bark. Stump height 1 foot

d.b.h.	Number of 16-foot logs to 6-inch top										Basis: trees	
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0		
<i>inches</i>												
7	12	18	25	31	37	44						94
8	14	22	30	38	47	55	63					84
9	16	26	36	47	57	67	77	87				107
10	18	31	43	56	68	81	92	103				96
11		36	51	66	81	94	108	121	134			82
12		41	59	77	93	109	125	141	156			92
13		47	68	88	106	125	143	162	180			78
14			77	99	120	142	163	184	206			56
15			87	111	136	160	184	209	233	258		50
16			97	124	152	179	207	235	262	290		37
17				138	169	200	231	262	293	325		27
18				153	187	222	257	292	326	361		17
19				168	207	245	284	322	361	400		14
20				184	227	270	312	355	398	440		8
21				201	248	295	342	389	436	483		5
22					271	322	373	425	476	528		3
23						350	406	462	518	574		2
24						379	440	501	562	623		0
25							476	542	608	674		0
Basis: trees	44	77	85	150	169	184	87	34	21	1	852	

Block indicates extent of data.

Computed from:  $V = 0.227340D^2L + 5.5302$  for  $D^2L$  to 335;

$V = 0.203011D^2L + 13.6705$  for  $D^2L$  larger than 335

Standard errors of estimate:  $\pm 5.8$  board feet ( $\pm 12.23\%$  of mean);  $\pm 25.9$  board feet ( $\pm 17.01\%$  of mean)

Coefficients of determination: 0.9486; 0.8860

Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 7.—Gross volumes, in board feet inside bark Scribner Rule per square foot of basal area, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 6 inches inside bark. Stump height 1 foot

d.b.h.	Number of 16-foot logs to 6-inch top									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
<i>inches</i>										
7	39	60	81	101	122	143				
8	35	56	77	97	118	139	160			
9	32	53	74	95	115	136	157	177		
10	30	51	72	93	113	134	153	172		
11		49	70	91	112	131	149	168	186	
12		48	69	90	109	128	146	165	184	
13		47	68	88	107	125	144	163	181	
14			67	86	105	124	142	161	179	
15			66	85	103	122	141	159	178	197
16			65	84	102	121	139	158	177	195
17				83	101	120	138	157	176	194
18				82	100	119	138	156	175	193
19				81	100	118	137	155	174	193
20				80	99	118	136	155	173	192
21				80	98	117	136	154	173	192
22					98	117	135	154	172	191
23						116	135	153	172	191
24						116	134	153	172	190
25							134	153	171	190

Computed from:  $V/B = 41.68167L + 1013.92605/D^2$  for  $D^2L$  to 335;  
 $V/B = 37.22097L + 2506.41169/D^2$  for  $D^2L$  larger than 335  
Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 8.—Gross volumes, in board feet, inside bark International ¼-inch Rule, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 6 inches inside bark. Stump height 1 foot

d.b.h.	Total height (feet) above ground								Basis: trees	
	30	40	50	60	70	80	90	100		
<i>inches</i>										
7	9	9	12	20	27	35				94
8	9	13	23	33	43	52				84
9	11	23	35	47	60	72				107
10	19	34	49	64	78	93	108			96
11	28	46	63	81	99	117	134			82
12	38	59	80	101	122	141	160			92
13		73	97	122	144	166	188	210		78
14		88	116	143	168	193	218	243		56
15		104	135	164	193	222	251	279		50
16		121	155	187	220	253	285	318		37
17			175	212	248	285	322	359		27
18			197	238	279	320	361	402		17
19			219	265	311	356	402	447		14
20			243	294	344	394	445	495		8
21			268	324	379	435	490	546		5
22				356	416	477	538	598		3
23				389	455	521	587	654		2
24				423	495	567	639	711		0
25					537	615	693	771		0
<b>Basis:</b>										
<b>trees</b>	1	16	88	253	319	138	31	6		852

Block indicates extent of data.

Computed from:  $V = 9$  for  $D^2H$  to 2,570;

$V = 0.013472D^2H - 25.5968$  for  $D^2H$  larger than 2,570 to 11,460;

$V = 0.011989D^2H - 8.6015$  for  $D^2H$  larger than 11,460

Standard errors of estimate:  $\pm 11.3$  board feet ( $\pm 17.09\%$  of mean);  $\pm 36.0$  board feet ( $\pm 18.37\%$  of mean)

Coefficients of determination: 0.9169; 0.8377

Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 9.—Gross volumes, in board feet inside bark International ¼-inch Rule per square foot of basal area, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 6 inches inside bark. Stump height 1 foot

d.b.h.	Total height (feet) above ground							
	30	40	50	60	70	80	90	100
<i>inches</i>								
7	29	29	40	65	89	114		
8	23	34	59	83	108	133		
9	22	47	72	96	121	146		
10	32	56	81	106	130	155	180	
11	39	63	88	113	137	162	186	
12	44	69	93	118	143	166	188	
13		73	98	122	145	167	189	211
14		76	101	124	146	168	190	212
15		79	103	125	147	169	191	213
16		82	104	126	148	170	192	214
17			105	127	149	171	193	215
18			105	127	149	171	193	215
19			106	128	150	172	194	216
20			106	128	150	172	194	216
21			106	128	150	172	194	216
22				129	151	173	195	217
23				129	151	173	195	217
24				129	151	173	195	217
25					151	173	195	217

Computed from:  $V/B = 1650.10451/D^2$  for  $D^2H$  to 2,570;  
 $V/B = 2.47003H - 4693.03478/D^2$  for  $D^2H$  larger than 2,570 to 11,460;  
 $V/B = 2.19816H - 1577.04824/D^2$  for  $D^2H$  larger than 11,460  
Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 10.—Gross volumes, in board feet inside bark International ¼-inch Rule, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 6 inches inside bark. Stump height 1 foot

d.b.h.	Number of 16-foot logs to 6-inch top										Basis: trees	
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0		
<i>inches</i>												
7	13	20	28	35	43	50						94
8	15	25	34	44	54	63	73					84
9	17	29	41	54	66	78	90	102				107
10	20	35	50	64	79	94	109	123				96
11		41	58	76	94	111	129	147	162			82
12		47	68	89	110	131	151	169	187			92
13		54	78	103	127	151	172	193	214			78
14			90	118	146	171	195	219	244			56
15			102	134	164	191	219	247	275	303		50
16			115	151	182	214	245	277	308	340		37
17				166	202	237	273	308	344	379		27
18				183	223	262	302	342	381	421		17
19				201	245	289	333	377	421	465		14
20				219	268	316	365	414	462	511		8
21				239	292	346	399	453	506	560		5
22					318	376	435	493	552	611		3
23						408	472	536	600	664		2
24						441	511	580	650	719		0
25							551	627	702	777		0
Basis: trees	44	77	85	150	169	184	87	34	21	1		852

Block indicates extent of data.

Computed from:  $V = 0.267908D^2L + 5.2059$  for  $D^2L$  to 535;

$V = 0.231473D^2L + 24.6295$  for  $D^2L$  larger than 535

Standard errors of estimate:  $\pm 9.7$  board feet ( $\pm 13.58\%$  of mean);  $\pm 34.6$  board feet ( $\pm 16.18\%$  of mean)

Coefficients of determination: 0.9472; 0.8480

Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 11.—Gross volumes, in board feet inside bark International ¼-inch Rule per square foot of basal area, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 6 inches inside bark. Stump height 1 foot

d.b.h.	Number of 16-foot logs to 6-inch top									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
<i>inches</i>										
7	42	66	91	115	140	164				
8	38	62	87	111	136	161	185			
9	35	60	84	109	133	158	182	207		
10	33	58	82	107	131	156	181	205		
11		56	81	105	130	155	179	204	225	
12		55	80	104	129	153	177	199	220	
13		54	79	103	128	152	173	195	216	
14			78	103	127	149	170	191	212	
15			78	102	125	146	167	189	210	231
16			77	101	123	144	165	186	208	229
17				100	121	142	163	185	206	227
18				98	119	141	162	183	204	225
19				97	118	139	160	182	203	224
20				96	117	138	159	181	202	223
21				95	116	137	158	180	201	222
22					115	136	157	179	200	221
23						135	157	178	199	220
24						135	156	177	199	220
25							155	177	198	219

Computed from:  $V/B = 49.11964L + 954.46831/D^2$  for  $D^2L$  to 535;  
 $V/B = 42.43941L + 4515.68811/D^2$  for  $D^2L$  larger than 535  
Diameter classes full-inch (e.g., 20-inch class includes 20.0 to 20.9 inches d.b.h.)

Table 12.—Gross volumes, in cubic meters inside bark, of entire stem including stump and top, aspen in Colorado

d.b.h.	Total height (meters) above ground									
	3	6	9	12	15	18	21	24	27	30
<i>cm</i>										
6	0.003									
8	.01	0.01								
10	.01	.02	0.02	0.02	0.03					
12	.01	.03	.04	.06	.07	0.06				
14		.04	.06	.08	.09	.11	0.13			
16		.05	.07	.10	.12	.15	.17	0.20		
18		.06	.09	.12	.16	.19	.22	.25		
20		.08	.12	.15	.19	.23	.27	.31		
22		.09	.14	.19	.23	.28	.32	.37		
24			.17	.22	.28	.33	.39	.44		
26			.19	.26	.32	.39	.45	.52	0.58	
28			.23	.30	.38	.45	.53	.60	.68	
30			.26	.35	.43	.52	.60	.69	.78	
32				.39	.49	.59	.69	.79	.87	0.95
34				.44	.55	.66	.78	.87	.97	1.06
36				.50	.62	.75	.86	.96	1.07	1.18
38				.55	.69	.82	.94	1.06	1.18	1.30
40				.61	.77	.90	1.03	1.16	1.29	1.42
42				.68	.84	.98	1.13	1.27	1.41	1.56
44					.91	1.07	1.22	1.38	1.54	1.70
46					.98	1.15	1.33	1.50	1.67	1.85
48					1.06	1.25	1.44	1.62	1.81	2.00
50					1.14	1.34	1.55	1.75	1.96	2.16
52					1.22	1.44	1.66	1.89	2.11	2.33
54					1.31	1.55	1.79	2.02	2.26	2.50
56						1.66	1.91	2.17	2.43	2.68
58						1.77	2.04	2.32	2.59	2.87
60						1.88	2.18	2.47	2.77	3.06
62						2.00	2.32	2.63	2.95	3.26
64							2.46	2.80	3.13	3.47

Block indicates extent of data.

Computed from:  $V_m = 0.0000320D_m^2H_m$  for  $D_m^2H_m$  to 24,520

$V_m = 0.0000273D_m^2H_m + 0.11402$  for  $D_m^2H_m$  larger than 24,520

Table 13.—Gross merchantable volumes, in cubic meters inside bark, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 10 cm inside bark. Stump height 0.3 m.

d.b.h.	Total height (meters) above ground								
	6	9	12	15	18	21	24	27	30
<i>cm</i>									
14	0.01	0.03	0.05	0.07	0.09	0.10			
16	.02	.05	.07	.10	.12	.14	0.17		
18	.04	.07	.10	.13	.16	.19	.22		
20	.05	.09	.13	.16	.20	.24	.28		
22	.07	.11	.16	.20	.25	.30	.34		
24		.14	.19	.25	.30	.36	.41		
26		.17	.23	.29	.36	.42	.49	0.55	
28		.20	.27	.35	.42	.49	.57	.64	
30		.23	.32	.40	.49	.57	.66	.74	
32			.36	.46	.56	.65	.74	.83	0.91
34			.41	.52	.63	.74	.83	.92	1.01
36			.47	.59	.71	.81	.92	1.02	1.12
38			.52	.66	.78	.90	1.01	1.13	1.24
40			.58	.73	.86	.98	1.11	1.24	1.36
42			.64	.79	.93	1.07	1.21	1.35	1.49
44				.86	1.02	1.17	1.32	1.48	1.63
46				.93	1.10	1.27	1.44	1.61	1.77
48				1.01	1.19	1.37	1.56	1.74	1.92
50				1.09	1.28	1.48	1.68	1.88	2.08
52				1.17	1.38	1.60	1.81	2.03	2.24
54				1.25	1.48	1.71	1.95	2.18	2.41
56					1.59	1.84	2.09	2.33	2.58
58					1.70	1.96	2.23	2.50	2.76
60					1.81	2.09	2.38	2.67	2.95
62					1.92	2.23	2.53	2.84	3.14
64						2.37	2.69	3.02	3.34

Block indicates extent of data.

Computed from:  $V_m = 0.0000316D_m^2H_m - 0.02570$  for  $D_m^2H_m$  to 23,200

$V_m = 0.0000265D_m^2H_m + 0.09366$  for  $D_m^2H_m$  larger than 23,200

Table 14.—Gross merchantable volumes, in cubic meters inside bark per square meter of basal area, merchantable stem excluding stump and top, aspen in Colorado. Top diameter 10 cm inside bark. Stump height 0.3 m

d.b.h.	Total height (meters) above ground								
	6	9	12	15	18	21	24	27	30
<i>cm</i>									
14	0.74	1.95	3.16	4.37	5.57	6.78			
16	1.14	2.34	3.55	4.76	5.96	7.17	8.38		
18	1.40	2.61	3.82	5.03	6.23	7.44	8.65		
20	1.60	2.80	4.01	5.22	6.42	7.63	8.84		
22	1.74	2.95	4.15	5.36	6.57	7.77	8.98		
24		3.05	4.26	5.47	6.67	7.88	9.09		
26		3.14	4.34	5.55	6.76	7.97	9.17	10.38	
28		3.20	4.41	5.62	6.83	8.03	9.24	10.45	
30		3.26	4.46	5.67	6.88	8.09	9.29	10.42	
32			4.51	5.72	6.92	8.13	9.25	10.26	11.27
34			4.55	5.75	6.96	8.11	9.12	10.13	11.14
36			4.58	5.78	6.98	7.99	9.01	10.02	11.03
38			4.60	5.81	6.89	7.90	8.91	9.92	10.93
40			4.62	5.80	6.81	7.82	8.83	9.84	10.85
42			4.64	5.73	6.74	7.75	8.76	9.77	10.78
44				5.67	6.68	7.69	8.70	9.71	10.72
46				5.62	6.63	7.64	8.65	9.66	10.67
48				5.57	6.58	7.59	8.60	9.61	10.62
50				5.53	6.54	7.55	8.56	9.57	10.58
52				5.49	6.51	7.52	8.53	9.54	10.55
54				5.46	6.47	7.48	8.49	9.51	10.52
56					6.44	7.45	8.47	9.48	10.49
58					6.42	7.43	8.44	9.45	10.46
60					6.40	7.41	8.42	9.43	10.44
62					6.37	7.38	8.40	9.41	10.42
64						7.37	8.38	9.39	10.40

Computed from:  $V_m/B_m = 0.40236H_m - 327.23860/D_m^2$  for  $D_m^2H_m$  to 23,200

$V_m/B_m = 0.33689H_m + 1192.50213/D_m^2$  for  $D_m^2H_m$  larger than 23,200