California FORESTRY Note

P.O. Box 944246 Sacramento, CA 94244-2460 Phone 916-445-5571

No. 106 December 1991

VOLUME TABLES AND EQUATIONS FOR YOUNG GROWTH SOFTWOOD AND HARDWOOD SPECIES AT BOGGS MOUNTAIN DEMONSTRATION STATE FOREST

By Dr. Norman H. Pillsbury[1] and Mr. Robert Pryor[2]

1. Professor of Forestry, and Department Head, Natural Resources Management, California Polytechnic State University, San Luis Obispo, California.

2. Forestry Research Associate, Natural Resources Management Department, California Polytechnic State University, San Luis Obispo, California.

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ACKNOWLEDGEMENTS

This project was conducted cooperatively between the Natural Resources Management Department, California Polytechnic State University, San Luis Obispo, and the California Department of Forestry and Fire Protection, Boggs Mountain Demonstration State Forest (BMDSF). Steve Sayers, Manager, at BMDSF provided valuable input into site selection, species composition and distribution. Data entry and analysis were performed at California Polytechnic State University, San Luis Obispo. The final report was condensed for this publication by Gerri Finn, Forestry Aide, BMDSF.

VOLUME EQUATIONS FOR YOUNG GROWTH SOFTWOOD AND HARDWOOD SPECIES AT BOGGS MOUNTAIN DEMONSTRATION STATE FOREST

INTRODUCTION

The following paper briefly summarizes the development of the local and standard volume table developed for BMDSF by Pillsbury and Pryor. Cubic foot and Scribner board foot volume tables and equations are included.

BACKGROUND

Local and standard volume equations for Ponderosa pine (*Pinus ponderosa* Laws), sugar pine (*Pinus lambertiana* Dougl), Douglas-fir (*Pseudotsuga menziesii* (Mirb) Franco), canyon live oak (*Quercus chrysolepis* Liemb.), black oak (*Quercus kelloggii* Newb), and Pacific madrone (*Arbutus menziesii* Pursh) were developed for Boggs Mountain Demonstration State Forest. For the three softwood species, local and standard equations were developed for total volume in cubic feet and Scribner board feet. For the three hardwood species, equations were developed in cubic feet and for two utilization standards: 1) wood volume (WVOL) of a tree included the volume of all segments from stump height to a four inch top minus the bark volume (it does not include the volume of the roots and foliage) and 2) saw-log volume (SVOL) of a tree includes the volume of all segments for trees eleven inches and larger; volume was computed from stump height to a nine inch top outside bark for straight sections eight feet long or longer and excludes roots, bark and foliage.

METHODS

A total of between 36 and 51 trees were measured for each species from stands representing a broad range of environmental, topographic, and site quality conditions. Additionally, sample trees were chosen to represent a broad range of sizes. For softwoods, the diameters ranged from ten inches to 45 inches and heights ranged from 30 to 110 feet. For hardwoods, diameters ranged from four inches to 40 inches and heights from 29 feet to 80 feet.

USE

The local volume table assumes that all variables are uniform except for DBH (diameter breast height). Because of the uniformity needed within the stand when using a local volume table, it is usually only effective for a small area, such as a watershed. In this case, the local volume table is accurate for the State Forest which is 3500 acres. The table could be used as a guide for estimating volume in other stands in this area (Cobb Mtn., southern Lake Co.), but accuracy could not be assured.

The cruiser measures only the DBH when using a local volume table since all other factors (height and form) are assumed to be uniform. Species identification is also necessary since the tables are specific to each species. Measuring only DBH and species identification make for a relatively quick, inexpensive cruise. Accuracy can also be greater than with a standard table since height measurements are often the greatest cause of cruiser error.

The standard table is based on two variables, DBH and height, and all other conditions are assumed uniform; it is more accurate than a local table on a smaller sample. Because the standard table can represent more stands than a local table, it would also be more accurate than the local table on stands off of the State Forest. The cruiser measures the DBH and height and identifies the tree species. The table is not suitable for more than one species or locality.

YOUNG GROWTH PONDEROSA PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Scribner (bd. ft.) **

DBH (in)	Total Height (feet) 30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
10	24	28	30	33	35	37	39								
12	41	47	52	56	60	64	67								
14	65	74	81	88	94	100	105	110							
16	96	109	120	130	139	148	155	163	170	177	183				
18	135	153	169	183	196	208	219	230	240	249	258	267	275		
20	184	209	230	249	267	283	298	313	326	339	351	363	374		
22	243	275	304	330	353	374	394	413	431	448	464	479	494	508	522
24	313	355	392	425	455	483	508	533	555	577	598	618	637	655	673
26		449	495	537	575	610	642	673	702	729	756	781	805	828	851
28			615	667	714	757	797	835	871	906	938	969	999	1028	1056
30				815	873	926	976	1022	1066	1108	1148	1186	1223	1258	1292
32					1054	1118	1178	1234	1287	1338	1386	1432	1476	1519	1560
34						1335	1406	1473	1537	1597	1654	1709	1762	1813	1863
36							1662	1741	1816	1887	1955	2020	2083	2143	2201
38								2039	2127	2210	2290	2366	2439	2510	2578
40									2470	2567	2660	2748	2833	2915	2995
42											3067	3169	3267	3362	3453

Scribner (bd. ft.) = Scribner board foot volume based on DBH and total tree height.

Table 1

Standard Volume Table *
Total Volume (cu. ft.) **

DBH (in)	Total Height (feet) 30	40	50	60	70	80	90	100	110	120	130	140	150	160	170
10	9	10	11	12	13	14	15								
12	13	15	17	18	20	21	22								
14	19	21	24	26	28	29	31	33							
16	25	29	32	35	37	40	42	44	46	48	50				
18	32	37	41	45	48	51	54	57	60	62	64	67	69		
20	41	47	52	57	61	65	69	72	75	79	81	84	87		
22	51	58	64	70	75	80	85	89	93	97	101	104	108	111	114
24	62	71	78	85	92	97	103	108	113	118	122	127	131	135	139
26		84	94	102	109	116	123	129	135	141	146	151	156	161	166
28			110	120	129	137	145	152	159	166	172	178	184	190	195
30				140	151	160	169	178	186	194	201	208	215	221	228
32					174	185	195	205	215	224	232	240	248	256	263
34						212	224	235	246	256	266	275	284	293	301
36							254	267	279	291	302	312	322	332	342
38								301	315	328	340	352	364	375	386
40									353	367	381	395	408	420	432
42											425	440	455	468	482

Total Volume (cu. ft.) = Total volume in cubic feet based on DBH and total tree height.

Table 2

NOTES:
Black line indicates range of data.

YOUNG GROWTH SUGAR PINE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Scribner (bd. ft.) **

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	13	18	24	31	38	44	52						
12	19	28	37	47	57	68	79						
14	28	40	53	67	82	97	113	129					
16	38	55	73	92	112	132	154	176	199	222			
18	50	72	96	121	147	174	202	232	262	292			
20	64	92	122	154	188	222	258	296	334	373			
22	79	114	152	192	234	277	323	369	417	466			
24	97	140	186	235	286	340	395	452	510	570	631		
26			224	283	345	409	475	544	614	686	760		
28			266	336	410	486	565	646	729	815	903	993	
30				395	481	570	663	758	856	957	1060	1165	
32					558	662	770	881	995	1111	1231	1353	1478
34					643	762	886	1014	1145	1279	1417	1558	1701
36						870	1012	1157	1307	1461	1618	1779	1943
38							1147	1312	1482	1656	1835	2017	2203
40							1292	1478	1670	1866	2067	2272	2481
42								1655	1870	2090	2314	2544	2779
44									2083	2328	2578	2834	3096
46									2309	2581	2859	3143	3432
48										2849	3156	3469	3788

Scribner (bd. ft.) = Scribner board foot volume based on DBH and total tree height.

Table 3

Standard Volume Table *
Total Volume (cu. ft.) **

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	8	9	11	12	14	15	16						
12	11	13	16	18	20	21	23						
14	15	18	21	24	27	29	32	34					
16	20	24	28	31	35	38	41	44	47	50			
18	25	30	35	40	44	48	52	56	60	63			
20	31	37	43	49	54	59	64	69	74	78			
22	37	45	52	59	66	72	78	84	89	95			
24	44	53	62	70	78	85	93	99	106	113	119		
26			73	82	92	100	109	117	124	132	139		
28			84	96	106	116	126	135	144	153	162	170	
30				110	122	133	144	155	166	176	185	195	
32					138	152	164	176	188	200	211	222	232
34					156	171	185	199	212	225	238	250	262
36						192	208	223	238	252	267	280	294
38							231	248	265	281	297	312	327
40							256	275	293	311	329	346	362
42								303	323	343	362	381	399
44									355	376	397	418	438
46									388	411	434	457	479
48										448	473	497	521

Total Volume (cu. ft.) = Total volume in cubic feet based on DBH and total tree height

Table 4

NOTES:
Black line indicates range of data.

YOUNG GROWTH DOUGLAS FIR
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Scribner (bd. ft.) **

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	13	20	27	35	44	53	62						
12	19	29	40	51	64	77	91	106	121				
14	26	40	55	71	88	106	125	145	166	188			
16	35	52	72	93	116	140	165	192	219	248	278		
18	45	67	92	119	148	179	211	245	280	317	355		
20		83	114	148	184	222	263	305	349	394	442	490	
22			139	180	224	271	320	371	425	481	538	598	
24			167	216	269	324	383	445	509	576	645	716	789
26				255	317	383	452	525	601	680	761	845	932
28				297	370	447	528	612	701	793	888	986	1087
30				343	427	515	609	707	809	915	1024	1137	1254
32						589	696	808	925	1046	1171	1300	1434
34						668	790	916	1049	1186	1328	1475	1626
36							889	1032	1181	1335	1495	1660	1831
38							994	1154	1321	1494	1673	1858	2048
40										1661	1861	2066	2278
42										1839	2059	2286	2521

* Scribner (bd. ft.) = Scribner board foot volume based on DBH and total tree height.

Table 5

Standard Volume Table *
Total Volume (cu. ft.) **

DBH	Total Height (feet)												
(in)	30	40	50	60	70	80	90	100	110	120	130	140	150
10	7	9	11	13	15	17	20						
12	9	12	15	18	21	24	27	29	32				
14	12	16	19	23	27	31	34	38	42	45			
16	15	20	24	29	34	38	43	48	52	57	61		
18	18	24	30	35	41	47	52	58	63	69	75		
20		29	35	42	49	56	62	69	76	82	89	96	
22			42	50	57	65	73	81	89	97	104	112	
24			48	57	66	76	85	94	103	112	121	130	139
26				65	76	86	97	107	117	128	138	148	158
28				74	86	98	110	121	133	145	156	168	179
30				83	97	110	123	136	149	162	175	188	201
32						122	137	152	166	181	195	210	224
34						135	152	168	184	200	216	232	248
36							167	185	202	220	238	255	273
38							183	202	222	241	260	280	299
40										263	284	305	326
42										285	308	330	353

Total Volume (cu. ft.) = Total volume in cubic feet based on DBH and total tree height.

Table 6

NOTES:
Black line indicates range of data.

CANYON LIVE OAK
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Wood Volume (cu. ft.) **

DBH	Tree Height (feet)										
(in)	10	20	30	40	50	60	70	80	90	100	110
3	0	0	0	1	1	1	1				
5	1	1	1	2	2	2	2				
7	2	2	3	4	4	5	5	6			
9	3	4	6	7	8	9	10	10	11		
11	4	7	9	11	12	14	15	17	18	19	
13	6	10	13	16	18	20	22	24	26	28	
15		14	18	22	25	28	31	34	37	39	
17		18	24	29	33	37	41	45	49	52	56
19		24	31	37	43	48	54	58	63	68	72
21			39	47	54	61	67	74	79	85	90
23			48	58	67	75	83	91	98	105	112
25					81	91	101	110	119	127	135
27					97	109	120	131	142	152	161
29					114	128	142	155	167	179	190
31					133	149	165	180	195	208	222
33					153	173	191	208	225	241	256
35						198	218	238	257	276	293

Wood Volume (cu. ft.) = all stem and branch wood to a 4" (10 cm) top, excludes stump and bark; excludes foliage and roots.

Table 7

Standard Volume Table *
Saw-log Volume (cu. ft.) **

DBH	Tree Height (feet)										
(in)	10	20	30	40	50	60	70	80	90	100	110
3	0	0	0	1	1	1	1				
5	1	1	1	2	2	2	3				
7	1	2	3	3	4	5	5	6			
9	2	3	5	6	7	8	9	10	11		
11	3	5	7	9	10	12	13	15	16	18	
13	4	7	10	12	15	17	19	21	23	25	
15		10	13	17	20	23	26	29	31	34	
17		12	17	21	26	30	33	37	41	44	48
19		16	22	27	32	37	42	47	51	56	60
21			26	33	40	46	52	58	63	69	74
23			32	40	48	55	63	70	76	83	90
25					57	66	74	83	91	99	107
27					67	77	87	97	107	116	125
29					78	90	101	113	124	135	145
31					89	103	117	130	142	155	167
33					102	118	133	148	162	176	190
35						133	150	167	183	199	215

Saw-log Volume (cu. ft.) = all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump foliage and roots.

Table 8

NOTES:
Black line indicates range of data.

BLACK OAK
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Wood Volume (cu. ft.) **

DBH (in)	Tree Height (feet) 10	20	30	40	50	60	70	80	90	100	110	120
3	0	1	1	1	2	2						
5	1	1	2	3	4	5	6					
7	1	2	4	5	7	8	10	11				
9	2	4	6	8	10	12	15	17	20			
11	2	5	8	11	14	17	21	24	28			
13	3	7	10	15	19	23	27	32	37			
15		8	13	18	24	29	35	41	46			
17		10	16	23	29	36	43	50	57	65		
19		13	20	28	35	44	52	60	69	78		
21			23	33	42	52	62	72	82	92	103	113
23			27	38	49	60	72	83	95	107	120	132
25				44	56	69	82	96	110	124	138	152
27					64	79	94	109	125	141	157	173
29					72	89	106	123	141	159	177	195
31					81	99	118	138	158	178	198	218
33					90	110	132	153	175	197	220	243
35							145	169	193	218	243	268
37							159	186	212	239	266	294

Wood Volume (cu. ft.) = all stem and branch wood to a 4" top (10 cm); excludes stump, bark, foliage and roots

Table 9

Standard Volume Table *
Saw-log Volume (cu. ft.) **

DBH (in)	Tree Height (feet) 10	20	30	40	50	60	70	80	90	100	110	120
3	0	1	1	1	1	2						
5	1	1	2	3	3	4	5					
7	1	2	4	5	6	7	9	10				
9	2	4	5	7	9	11	13	15	17			
11	2	5	8	10	13	16	19	21	24			
13	3	7	10	14	17	21	25	28	32			
15		9	13	18	22	27	31	36	41			
17		11	16	22	27	33	38	44	50	56		
19		13	19	26	33	40	47	54	61	68		
21			23	31	39	47	55	64	72	80	89	97
23			27	36	46	55	65	74	84	94	103	113
25				42	52	63	74	85	97	108	119	130
27					60	72	85	97	110	123	136	148
29					67	82	96	110	124	139	153	167
31					76	91	107	123	139	155	171	187
33					84	101	119	137	155	172	190	208
35							132	151	171	191	210	230
37							145	166	188	209	231	253

Saw-log Volume (cu. ft.)* = all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump foliage and roots.

Table 10

NOTES.
Black line indicates range of data.

PACIFIC MADRONE
Boggs Mountain Demonstration State Forest

Standard Volume Table *
Wood Volume (cu. ft.) **

DBH	Tree Height (feet)										
(in)	10	20	30	40	50	60	70	80	90	100	110
3	0	0	1	1	1						
5	1	1	2	3	3	4	5				
7	1	2	4	5	6	7	9	10			
9	2	4	6	8	10	12	14	17	19		
11	3	6	9	12	15	18	21	25	28	31	
13		8	12	16	21	25	30	34	38	43	
15		10	16	22	27	33	39	45	51	57	
17		13	20	28	35	42	50	57	65	73	
19		17	25	34	43	53	62	71	81	90	
21			31	42	53	64	75	87	98	110	121
23			37	50	63	76	90	104	117	131	145
25				59	74	90	106	122	138	154	171
27					86	105	123	142	160	179	198
29					99	120	141	163	184	206	228

Wood Volume (cu. ft.) = all stem and branch wood to a 4" (10 cm) top; excludes stump, bark, foliage and roots.

Table 11

Standard Volume Table *
Saw-log Volume (cu. ft.) **

DBH	Tree Height (feet)										
(in)	10	20	30	40	50	60	70	80	90	100	110
3	0	0	0	1	1						
5	0	0	1	2	3	3	5				
7	0	1	2	3	5	6	8	11			
9	0	1	3	5	7	10	13	17	21		
11	1	2	4	7	11	15	19	24	30	36	
13		3	6	10	14	20	26	33	41	49	
15		4	8	13	19	26	34	43	53	64	
17		5	10	16	24	33	43	54	67	81	
19		6	12	20	29	40	53	67	82	99	
21			14	24	35	48	63	80	98	119	140
23			17	28	41	57	75	95	116	140	166
25				32	48	66	87	110	136	163	193
27					55	76	100	127	156	188	223
29					63	87	114	145	178	214	254

Saw-log Volume (cu. ft.) = all wood inside bark to a 9" (23 cm) top for segments > 8 ft. (2.5 m) for all trees 11" (28 cm) dbh and larger; excludes stump, foliage and roots.

Table 12

NOTES:
Black line indicates range of data.

LOCAL VOLUME TABLES

YOUNG GROWTH PONDEROSA PINE

DBH"	BD. FT.	CU. FT.
10	33	12
12	60	20
14	98	29
16	150	40
18	220	55
20	308	71
22	419	91
24	555	113
26	718	138
28	911	167
30	1138	199
32	1400	234
34	1702	273
36	2046	315
38	2435	361
40	2873	411
42	3362	465

YOUNG GROWTH SUGAR PINE

DBH"	BD. FT.	CU. FT.
10	31	12
12	53	18
14	85	27
16	127	37
18	180	48
20	247	62
22	329	78
24	427	96
26	543	117
28	678	139
30	834	164
32	1012	192
34	1214	222
36	1440	254
38	1694	289
40	1976	327
42	2287	367

YOUNG GROWTH DOUGLAS FIR

DBH"	BD. FT.	CU. FT.
10	40	13
12	66	19
14	99	27
16	142	37
18	194	48
20	258	61
22	333	76
24	420	93
26	521	111
28	635	132
30	764	154
32	909	179
34	1069	205
36	1246	234
38	1441	265
40	1653	297
42	1884	332

CANYON LIVE OAK

DBH"	CU1	CU2
3	0	0
5	1	1
7	3	3
9	7	5
11	11	9
13	17	14
15	25	20
17	35	27
19	47	36
21	61	47
23	78	59
25	97	73
27	119	89
29	144	107
31	171	127
33	202	149
35	236	173

BLACK OAK

DBH"	CU1	CU2
3	1	1
5	2	2
7	4	4
9	8	8
11	13	12
13	19	18
15	27	25
17	36	33
19	47	43
21	60	54
23	75	66
25	92	80
27	111	96
29	132	113
31	155	131
33	180	151
35	208	173

PACIFIC MADRONE

DBH"	CU1	CU2
3	1	0
5	2	1
7	4	3
9	8	6
11	14	10
13	21	15
15	30	23
17	41	32
19	54	43
21	70	57
23	88	73
25	109	92
27	132	113
29	159	137
31	188	165
33	220	195
35	256	229

BD. FT.= Scribner board foot volume based on DBH.
CU. FT.= Smalian's formula for volume in cubic feet: includes all stem and branch wood plus stump and bark; excludes foliage and roots.
CU1= Wood volume (WVOL): all stem and branch wood to a 4 inch top; excludes stump, bark, foliage, and roots.
CU2= Saw-log volume (SVOL): all wood inside bark to a 9" top for segments > 8' for all trees 11" DBH or larger; excludes stump foliage and roots.

STANDARD VOLUME EQUATIONS
(total HT in feet, DBH in inches)

SCRIBNER'S (BD. FT.) LOG RULE

SPECIES	EQUATION	R^2	N	SE
Ponderosa pine	$Volume=0.0064579(DBH^{2.92149})(HT^{0.44199})$	0.949	47	0.08599
Sugar pine	$Volume=0.0007872(DBH^{2.32149})(HT^{1.27724})$	0.968	42	0.08087
Douglas-fir	$Volume=0.0009034(DBH^{2.07517})(HT^{1.41405})$	0.904	51	0.12542

SMALIAN'S (CU. FT.) LOG RULE

SPECIES	EQUATION	R^2	N	SE
Ponderosa pine	$Volume=0.0106345(DBH^{2.22642})(HT^{0.46726})$	0.972	48	0.05104
Sugar pine	$Volume=0.0077648(DBH^{1.99122})(HT^{0.67964})$	0.983	42	0.04774
Douglas-fir	$Volume=0.0054341(DBH^{1.67288})(HT^{0.96384})$	0.972	50	0.04835

WOOD VOLUME UTILIZATION STANDARD (WVOL)
(volume in cu. ft.)

SPECIES	EQUATION	R^2	N	SE
Canyon live oak	$Volume=0.0038325(DBH^{2.30212})(HT^{0.65109})$	0.950	34	0.10689
Black oak	$Volume=0.0029447(DBH^{1.68211})(HT^{1.13585})$	0.932	44	0.12517
Pacific madrone	$Volume=0.0022292(DBH^{1.95259})(HT^{1.05501})$	0.939	35	0.11295

SAW-LOG VOLUME UTILIZATION STANDARD (SVOL)
(volume in cu.ft.)

SPECIES	EQUATION	R^2	N	SE
Canyon live oak	$Volume=0.0031659(DBH^{2.08229})(HT^{0.79159})$	0.820	20	0.12513
Black oak	$Volume=0.0038666(DBH^{1.69402})(HT^{1.03846})$	0.893	26	0.06261
Pacific madrone	$Volume=0.0001304(DBH^{1.83452})(HT^{1.76666})$	0.722	17	0.01576

NOTES:
R^2 = the multiple coefficient of determination
N = the sample size
SE = the standard error of the estimate in cubic feet
WVOL = all the stems and branch wood to a 4' top: excludes stump, foliage bark and roots.
SVOL = all wood inside bark to a 9' top for segments 8'+, for all trees 11"+ DBH, excludes stump, foliage and roots.

LOCAL VOLUME EQUATIONS
(DBH in inches)

SCRIBNER'S (BD. FT.) LOG RULE

SPECIES	EQUATION	R^2	N	SE
Ponderosa pine	$Volume=0.0199222(DBH^{3.22022})$	0.946	47	0.08856
Sugar pine	$Volume=0.0310249(DBH^{2.99864})$	0.947	42	0.15013
Douglas-fir	$Volume=0.0836664(DBH^{2.68142})$	0.908	48	0.10241

SMALIAN'S (CU.FT.) LOG RULE

SPECIES	EQUATION	R^2	N	SE
Ponderosa pine	$Volume=0.0363331(DBH^{2.53035})$	0.965	48	0.05737
Sugar pine	$Volume=0.0481061(DBH^{2.39206})$	0.973	43	0.06079
Douglas-fir	$Volume=0.0667147(DBH^{2.27779})$	0.943	50	0.06810

WOOD VOLUME UTILIZATION STANDARD (WVOL)
(volume in cu.ft.)

SPECIES	EQUATION	R^2	N	SE
Canyon live oak	$Volume=0.0197719(DBH^{2.64068})$	0.936	34	0.00427
Black oak	$Volume=0.0388177(DBH^{2.41445})$	0.900	44	0.01527
Pacific madrone	$Volume=0.0310384(DBH^{2.53585})$	0.891	35	0.01527

SAW-LOG VOLUME UTILIZATION STANDARD (SVOL)
(volume in cu.ft.)

SPECIES	EQUATION	R^2	N	SE
Canyon live oak	$Volume=0.0199618(DBH^{2.54959})$	0.772	20	0.14005
Black oak	$Volume=0.0519914(DBH^{2.28068})$	0.836	26	0.13169
Pacific madrone	$Volume=0.0143017(DBH^{2.72298})$	0.544	17	0.20169

NOTES:
R^2 = the multiple coefficient of determination
N = the sample size
SE = the standard error of the estimate in cubic feet
WVOL = all the stems and branch wood to a 4' top: excludes stump, foliage bark and roots.
SVOL = all wood inside bark to a 9' top for segments 8'+, for all trees 11"+ DBH, excludes stump, foliage and roots.