REGIONAL BIOMASS EQUATIONS USED BY FIA TO ESTIMATE BOLE, BARK, AND BRANCHES

Updated 09-19-2014

BIOMASS OF THE TREE STEM

Tree stem biomass, regardless of whether it is merchantable bole or total stem, is calculated from cubic volume estimates and the wood density factor (in tables below) as follows:

Cubic volume = green cubic volume in cubic feet (ft3)
Wood density = (Specific gravity of a tree species) * (62.4 lbs/ft3)

Weight of water = 62.4 pounds/cubic foot

Biomass of the tree stem (in tons**) =** (cubic foot volume * wood density) / 2000

The tables below contain specific gravity and wood density values for many species.

Softwoods – specific gravity

Code	Species	Specific gravity	Wood density
10	fir spp.	0.36	22.46
11	Pacific silver fir	0.4	24.96
14	bristlecone fir	0.36	22.46
15	white fir	0.37	23.09
17	grand fir	0.35	21.84
19	subalpine fir	0.31	19.34
20	California red fir	0.36	22.46
21	Shasta red fir	0.36	22.46
22	noble fir	0.37	23.09
41	Port-Orford-cedar	0.39	24.34
42	Alaska yellow-cedar	0.42	26.21
50	Cypress spp	0.41	25.58
52	Modoc cypress	0.41	25.58
54	Monterey cypress	0.41	25.58
55	Sargent's cypress	0.41	25.58
62	California juniper	0.45	28.08
64	western juniper	0.45	28.08
65	Utah juniper	0.68	42.43
66	Rocky Mountain juniper	0.45	28.08
72	subalpine larch	0.49	30.58
73	western larch	0.48	29.95
81	incense-cedar	0.35	21.84
90	spruce spp.	0.36	22.46
92	Brewer spruce	0.36	22.46
93	Engelmann spruce	0.33	20.59
98	Sitka spruce	0.33	20.59
100	pine spp.	0.43	26.83
101	whitebark pine	0.43	26.83
102	Bristlecone pine	0.43	26.83
103	knobcone pine	0.39	24.34
104	foxtail pine	0.43	26.83
108	lodgepole pine	0.38	23.71
109	Coulter pine	0.43	26.83
113	limber pine	0.37	23.09
116	Jeffrey pine	0.37	23.09
117	sugar pine	0.34	21.22
119	western white pine	0.36	22.46

Softwoods – specific gravity
(continued)

Code	Species	Specific gravity	Wood density
120	bishop pine	0.45	28.08
122	ponderosa pine	0.38	23.71
124	Monterey pine	0.4	24.96
127	gray pine	0.4	24.96
130	Scotch pine	0.43	26.83
133	singleleaf pinyon	0.43	26.83
137	Washoe pine	0.43	26.83
142	Great Basin bristlecone pine	0.43	26.83
201	bigcone Douglas-fir	0.45	28.08
202	Douglas-fir	0.45	28.08
211	redwood	0.36	22.46
212	giant sequoia	0.34	21.22
231	Pacific yew	0.6	37.44
242	western redcedar	0.31	19.34
251	California torreya	0.41	25.58
263	western hemlock	0.42	26.21
264	mountain hemlock	0.42	26.21
299	Unknown dead conifer	0.41	25.58

Hardwoods – specific gravity

Code	Species	Specific gravity	Wood density
312	bigleaf maple	0.44	27.46
313	boxelder	0.42	26.21
320	Norway maple	0.47	29.33
321	Rocky Mountain maple	0.47	29.33
333	California buckeye	0.33	20.59
341	ailanthus	0.46	28.70
351	red alder	0.37	23.09
352	white alder	0.37	23.09
361	Pacific madrone	0.58	36.19
374	water birch	0.51	31.82
375	paper birch	0.48	29.95
431	golden chinkapin	0.42	26.21
475	curl-leaf mountain-mahogany	0.52	32.45
492	Pacific dogwood	0.58	36.19
500	Hawthorn	0.52	32.45
510	eucalyptus spp.	0.52	32.45
511	Tasmanian bluegum	0.52	32.45
540	ash spp.	0.51	31.82
542	Oregon ash	0.5	31.20
591	American holly	0.5	31.20
600	walnut spp.	0.44	27.46
603	northern California black walnut	0.44	27.46
604	southern California black walnut	0.44	27.46
611	sweetgum	0.46	28.70
631	tanoak	0.58	36.19
661	Oregon crab apple	0.61	38.06
730, 731	California sycamore	0.46	28.70
746	quaking aspen	0.35	21.84
747	black cottonwood	0.31	19.34
748	Fremont cottonwood	0.41	25.58
756,758	mesquite	0.78	48.67
760	cherry and plum spp.	0.47	29.33
763	chokecherry	0.47	29.33
768	bitter cherry	0.47	29.33
771	sweet cherry, domesticated	0.47	29.33
801	California live oak	0.59	36.82
805	canyon live oak	0.7	43.68
807	blue oak	0.59	36.82
811	Engelmann oak	0.59	36.82
815	Oregon white oak	0.64	39.94
818	California black oak	0.51	31.82

Hardwoods – specific gravity
(continued)

Code	Species	Specific gravity	Wood density
821	California white oak	0.55	34.32
826	chinkapin oak	0.59	36.82
839	interior live oak	0.59	36.82
901	black locust	0.66	41.18
920	willow spp.	0.36	22.46
922	black willow	0.36	22.46
926	balsam willow	0.36	22.46
927	white willow	0.36	22.46
981	California-laurel	0.51	31.82
990	desert ironwood	0.52	32.45
997	Russian-olive	0.52	32.45
998	Unknown dead hardwood	0.52	32.45
999	Other or unknown live tree	0.52	32.45

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
11	Pacific silver fir	22	22	22	22	22
14	Bristlecone fir	--	--	--	--	2
15	White fir	1	2	1	2	1
17	Grand fir	2	2	2	2	2
19	Subalpine fir	3	3	3	3	3
20	California red fir	4	--	3	--	4
21	Shasta red fir	4	--	4	--	4
22	Noble fir	5	5	5	5	5
41	Port-Orford-cedar	38	13	13	13	13
42	Alaska-cedar	23	23	23	23	13
50	Cypress	--	--	--	--	13
52	Baker cypress	--	--	--	--	13
54	Monterey cypress	--	--	--	--	13
55	Sargent's cypress	--	--	--	--	13
56	Mcnabb cypress	--	--	--	--	13
62	California juniper	--	--	--	--	16
64	Western juniper	16	16	16	16	16
65	Utah juniper	--	--	--	--	16
66	Rocky mountain juniper	--	--	16	--	16
72	Subablpine larch	--	24	24	24	--
73	Western larch	24	24	24	24	24
81	Incense cedar	12	12	12	12	12
92	Brewer spruce	7	--	7	7	7
93	Engelmann spruce	7	7	7	7	7
98	Sitka spruce	6	6	6	6	6
101	Whitebark pine	11	11	11	11	14
102	Bristlecone pine	--	--	--	--	14
103	Knobcone pine	14	14	14	--	14
104	Foxtail pine	--	--	--	--	14
108	Lodgepole pine	14	14	14	14	14
109	Coulter pine	--	--	--	--	9
113	Limber pine	--	--	14	--	14
116	Jeffrey pine	9	--	9	--	9
117	Sugar pine	10	--	10	--	10
119	Western white pine	11	11	11	11	11
120	Bishop pine	14	--	14	--	14
122	Ponderosa pine	9	9	9	9	9
124	Monterey pine	--	--	--	--	14
127	Gray pine	--	--	--	--	9
133	Singleleaf pinyon	--	--	--	--	14
137	Washoe pine	--	--	--	--	14

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS
--continued—

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
142	Great Basin bristlecone pine	--	--	--	--	14
201	Bigcone Douglas-fir	--	--	--	--	8
202	Douglas-fir	8	8	25	25	8
211	Redwood (when DBH > 39.37 inches)	17	17	17	17	17
211	Redwood (when DBH <= 39.37 inches)	13	13	13	13	13
212	Giant Sequoia (when DBH > 39.37 inches)	17	--	17	--	17
212	Giant Sequoia (when DBH <= 39.37 inches)	13	--	13	--	13
231	Pacific yew	38	13	13	38	13
242	Western redcedar	38	13	13	13	13
251	California nutmeg	--	--	--	--	13
263	Western hemlock	26	26	26	26	15
264	Mountain hemlock	21	21	21	21	21
298	Unknown Conifer	21	21	21	21	21

SOFTWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
11	Pacific silver fir	18	18	18	18	18
14	Bristlecone fir	--	--	--	--	1
15	White fir	1	1	1	1	1
17	Grand fir	1	1	1	1	1
19	Subalpine fir	2	2	2	2	2
20	California red fir	3	--	2	--	3
21	Shasta red fir	3	--	3	--	3
22	Noble fir	3	3	3	3	3
41	Port-Orford-cedar	10	10	10	10	10
42	Alaska-cedar	19	19	19	19	10
50	Cypress	--	--	--	--	10
52	Baker cypress	--	--	--	--	10
54	Monterey cypress	--	--	--	--	10
55	Sargent's cypress	--	--	--	--	10
56	Mcnabb cypress	--	--	--	--	10
62	California juniper	--	--	--	--	13
64	Western juniper	13	13	13	13	13
65	Utah juniper	--	--	--	--	13
66	Rocky mountain juniper	--	--	13	--	13
72	Subablpine larch	--	20	20	20	--
73	Western larch	20	20	20	20	20
81	Incense cedar	10	10	10	10	10
92	Brewer spruce	4	--	4	4	4
93	Engelmann spruce	4	4	4	4	4
98	Sitka spruce	5	5	5	5	5
101	Whitebark pine	9	9	9	9	11
102	Bristlecone pine	--	--	--	--	11
103	Knobcone pine	11	11	11	--	11
104	Foxtail pine	--	--	--	--	11
108	Lodgepole pine	11	11	11	11	11
109	Coulter pine	--	--	--	--	7
113	Limber pine	--	--	11	--	11
116	Jeffrey pine	7	--	7	--	7
117	Sugar pine	8	--	8	--	8
119	Western white pine	9	9	9	9	9
120	Bishop pine	11	--	11	--	11
122	Ponderosa pine	7	7	7	7	7
124	Monterey pine	--	--	--	--	11
127	Gray pine	--	--	--	--	7
130	Scotch pine	11	--	--	--	--
133	Singleleaf pinyon	--	--	--	--	11
137	Washoe pine	--	--	--	--	7
142	Great Basin bristlecone pine	--	--	--	--	11

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
201	Bigcone Douglas-fir	--	--	--	--	6
202	Douglas-fir	6	6	22	22	6
211	Redwood	10	10	10	--	10
212	Giant Sequoia	10	--	10	--	10
231	Pacific yew	10	10	10	10	10
242	Western redcedar	10	10	10	10	10
251	California nutmeg	--	--	--	--	10
263	Western hemlock	23	23	23	23	12
264	Mountain hemlock	24	24	24	24	17
298	Unknown Conifer	24	24	24	24	17

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
312	Bigleaf maple	--	29	--	29	--
313	Boxelder	--	29	--	29	--
320	Norway maple	--	--	--	--	--
321	Rocky Mountain maple	--	--	--	--	--
333	California buckeye	--	--	--	--	--
341	Tree of heaven	20	--	20	--	--
351	Red alder	20	20	20	20	20
352	White alder	20	20	20	20	20
361	Pacific madrone	--	34	--	34	--
374	Water birch	27	27	27	27	27
375	Paper birch	27	27	27	27	27
431	Golden chinkapin	--	32	--	--	--
475	Curlleaf mountain-mahogany	--	--	--	--	--
492	Pacific dogwood	29	29	29	29	--
500	Hawthorn	37	37	37	37	--
510/511	Eucalyptus	--	--	--	--	--
542	Oregon ash	--	39	--	39	--
547	Velvet ash	--	--	--	--	--
590	Holly	27	27	27	27	27
600	Walnut	--	--	--	--	--
603	N. California black walnut	--	--	--	--	--
604	S. California black walnut	--	--	--	--	--
611	Sweetgum	--	--	--	--	20
631	Tanoak	--	--	--	--	--
660	Apple	37	37	37	37	--
661	Crab apple	37	37	37	37	--
730/731	California sycamore	37	37	37	37	--
746	Quaking aspen	18	18	18	18	18
747	Black cottonwood	28	28	28	28	28
748	Fremont poplar	--	--	--	--	18
756	Honey mesquite	--	--	--	--	--
758	Screwbean mesquite	--	--	--	--	--
760	Cherrys	27	27	27	27	27
763	Common chokecherry	27	27	27	27	35
768	Bitter cherry	27	27	27	27	27
771	Sweet cherry	27	--	--	--	--

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF BARK

(continued)

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
801	California live oak	--	--	--	--	--
805	Canyon live oak	--	--	--	--	--
807	Blue oak	--	--	--	--	--
811	Englemann oak	--	--	--	--	--
815	Oregon white oak	--	35	--	35	--
818	California black oak	--	--	--	--	--
821	California white oak	--	--	--	--	--
826	Chinkapin oak	--	--	--	--	--
839	Interior live oak	--	--	--	--	--
850	Oak-evergreen	--	--	--	--	--
901	Black locust	--	--	--	29	--
920	Willows	34	34	34	34	--
922	Black willow	--	--	--	--	--
926	Balsam willow	34	--	--	--	--
927	White willow	34	34	--	--	--
929	Weeping willow	--	--	34	--	--
981	California-laurel	--	--	--	--	--
990	Desert ironwood	--	--	--	--	--
997	Russian-olive	--	29	--	29	--
998	Unknown hardwood	20	20	20	20	--
999	Unknown Tree	39	39	39	39	--

Hardwood volume for SPECIES 312, 313, 320, 333, 361, 431, 492, 542, 600, 603, 604, 631, 801, 805, 807, 811, 815, 818, 821, 826, 839, 901, 920, 922, 981, 997 are calculated with Pillsbury equations in western Oregon, western Washington and California; this means that total stem volume includes branches and bark, thus bark biomass and live branch biomass are not available as separate components of biomass. Refer to the Volume Equation document for species assignments to individual equations.

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
312	Bigleaf maple	--	27	--	27	--
313	Boxelder	--	16	--	16	--
321	Rocky Mountain maple	--	--	--	--	--
333	California buckeye	--	--	--	--	--
341	Tree of heaven	16	--	16	--	--
351	Red alder	16	16	16	16	16
352	White alder	16	16	16	16	16
361	Pacific madrone	--	28	--	--	--
374	Water birch	25	25	25	25	25
376	paper birch	25	25	25	25	25
431	Golden chinkapin	--	29	--	--	--
475	Curlleaf mountain-mahogany	--	--	--	--	--
492	Pacific dogwood	16	16	16	16	--
500	Hawthorn	16	16	16	16	--
510	Eucalyptus	--	--	--	--	28
542	Oregon ash	--	16	--	16	--
590/591	Holly	26	26	26	26	26
600	Walnut	--	--	--	--	--
603	N. California black walnut	--	--	--	--	--
604	S. California black walnut	--	--	--	--	--
611	Sweetgum	--	--	--	--	16
631	Tanoak	--	--	--	--	--
661	Oregon crabapple	16	16	16	16	--
730, 731	California sycamore	--	--	--	--	--
746	Quaking aspen	14	14	14	14	14
747	Black cottonwood	15	15	15	15	15
748	Fremont poplar	--	--	--	--	5
755	Mesquite	--	--	--	--	--
756	Honey mesquite	--	--	--	--	--
758	Screwbean mesquite	--	--	--	--	--
760	Cherry	25	25	25	25	25
763	Common chokecherry	25	25	25	25	16
768	Bitter cherry	25	25	25	25	25
771	Sweet cherry	25	--	--	--	--

HARDWOOD BIOMASS EQUATION ASSIGNMENTS

BIOMASS OF LIVE BRANCHES

(continued)

Code	Species	Halfstate				
		WOR	WWA	EOR	EWA	CA
801	California live oak	--	--	--	--	--
805	Canyon live oak	--	--	--	--	--
807	Blue oak	--	--	--	--	--
811	Englemann oak	--	--	--	--	--
815	Oregon white oak	--	--	--	--	--
818	California black oak	--	--	--	--	--
821	California white oak	--	--	--	--	--
826	Chinkapin oak	--	--	--	--	--
839	Interior live oak	--	--	--	--	--
901	Black locust	--	--	--	--	--
920	Willows	--	--	--	--	--
922	Black willow	--	--	--	--	--
926	Balsam willow	16	--	--	--	--
927	White willow	16	16	--	--	--
929	Weeping willow	--	--	16	--	--
981	California-laurel	--	--	--	--	--
990	Desert ironwood	--	--	--	--	--
997	Russian-olive	--	16	--	16	--
998	Unknown hardwood	16	16	16	16	--
999	Unknown Tree	16	16	16	16	--

Hardwood volume for SPECIES 312, 313, 320, 333, 361, 431, 492, 542, 600, 603, 604, 631, 801, 805, 807, 811, 815, 818, 821, 826, 839, 901, 920, 922, 981, 997 are calculated with Pillsbury equations in western Oregon, western Washington and California; this means that total stem volume includes branches and bark, thus bark biomass and live branch biomass are not available as separate components of biomass. Refer to the Volume Equation document for species assignments to individual equations.

BIOMASS OF BARK

All equations produce Biomass of Bark in Kilograms --- to convert to tons multiply by 0.0011023

Log in the equations is = NATURAL LOG

EQUATION 1 BIOPAK EQUATION 379

$$\mathrm{BB} = \frac{\exp\left(2.1069 + 2.7271 \times \log(DBH)\right)}{1000}$$

EQUATION 2 BIOPAK EQUATION 887

$$\mathrm{BB} = 0.6 + 16.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 3 BIOPAK EQUATION 917

$$\mathrm{BB} = 1.0 + 17.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 4 BIOPAK EQUATION 382

$$\mathrm{BB} = \frac{\exp\left(1.47146 + 2.8421 \times \log(DBH)\right)}{1000}$$

EQUATION 5 BIOPAK EQUATION 251

$$\mathrm{BB} = \frac{\exp\left(2.79189 + 2.4313 \times \log(DBH)\right)}{1000}$$

EQUATION 6 BIOPAK EQUATION 845

$$\mathrm{BB} = 1.3 + 12.6 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 7 BIOPAK EQUATION 875

$$\mathrm{BB} = 4.5 + 9.3 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 8 BIOPAK EQUATION 5

$$\mathrm{BB} = \exp\left(-4.3103 + 2.4300 \times \log\left(DBH\right)\right)$$

EQUATION 9 BIOPAK EQUATION 705

$$\mathrm{BB} = \exp\left(-3.6263 + 1.34077 \times \log\left(DBH\right) + 0.8567 \times \log\left(HT\right)\right)$$

EQUATION 10 BIOPAK EQUATION 391

$$\mathrm{BB} = \frac{\exp(2.183174 + 2.6610 \times \log(DBH))}{1000}$$

EQUATION 11 BIOPAK EQUATION 899

$$\mathrm{BB} = 1.2 + 11.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 12 (updated) BIOPAK EQUATION 385

$$\mathrm{BB} = \frac{\exp(-13.3146 + 2.8594 \times \log(DBH)) * 1000}{}$$

EQUATION 13 BIOPAK EQUATION 461

$$\mathrm{BB} = 0.336 + 0.00058 \times DBH^2 \times HT$$

EQUATION 14 BIOPAK EQUATION 904

$$\mathrm{BB} = 3.2 + 9.1 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 15 BIOPAK EQUATION 174

$$\mathrm{BB} = \exp(-4.371 + 2.259 \times \log(DBH))$$

EQUATION 16 BIOPAK EQUATION 54

$$\mathrm{BB} = \exp(-10.175 + 2.6333 \times \log(DBH \times \pi))$$

EQUATION 17 BIOPAK EQUATION 394

$$\mathrm{BB} = \frac{\exp(7.189689 + 1.5837 \times \log(DBH))}{1000}$$

EQUATION 18 BIOPAK EQUATION 942

$$\mathrm{BB} = 1.3 + 27.6 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 19

$$\mathrm{BB} = 0.0$$

EQUATION 20 BIOPAK EQUATION 275

$$\mathrm{BB} = \exp(-4.6424 + 2.4617 \times \log(DBH))$$

EQUATION 21 BIOPAK EQUATION 911

$$\mathrm{BB} = 0.9 + 27.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 22 BIOPAK EQUATION 881

$$\mathrm{BB} = 1.0 + 15.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 23 BIOPAK EQUATION 923

$$\mathrm{BB} = 1.8 + 9.6 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 24 BIOPAK EQUATION 893

$$\mathrm{BB} = 2.4 + 15.0 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 25 BIOPAK EQUATION 857

$$\mathrm{BB} = 3.6 + 18.2 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 26 BIOPAK EQUATION 455

$$\mathrm{BB} = -0.025 + 0.00134 \times DBH^2 \times HT$$

EQUATION 27 BIOPAK EQUATION 948

$$\mathrm{BB} = -1.2 + 29.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 28 BIOPAK EQUATION 930

$$\mathrm{BB} = 1.2 + 15.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 29 (Bigleaf maple)

$$ADBH = \frac{(DBH - 0.21235)}{0.94782} \quad 1$$

$$OUTERVOL = 0.0000246916 \times \left(ADBH^{2.354347} \left(HT^{0.69586} \right) \right) \quad 2$$

$$INNERVOL = 0.0000246916 \times \left(DBH^{2.354347} \left(HT^{0.69586} \right) \right) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 30 (California Black Oak)

$$ADBH = \frac{(DBH + 0.68133)}{0.95767} \quad 1$$

$$OUTERVOL = 0.0000386403 \times (ADBH^{2.12635}(HT^{0.83339})) \quad 2$$

$$INNERVOL = 0.0000386403 \times (DBH^{2.12635}(HT^{0.83339})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 31 (Canyon Live Oak)

$$ADBH = \frac{(DBH + 0.48584)}{0.96147} \quad 1$$

$$OUTERVOL = 0.0000248325 \times (ADBH^{2.32519}(HT^{0.74348})) \quad 2$$

$$INNERVOL = 0.0000248325 \times (DBH^{2.32519}(HT^{0.74348})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 32 (Golden Chinkapin)

$$ADBH = \frac{(DBH - 0.39534)}{0.90182} \quad 1$$

$$OUTERVOL = 0.000056884 \times (ADBH^{2.07202}(HT^{0.77467})) \quad 2$$

$$INNERVOL = 0.000056884 \times (DBH^{2.07202}(HT^{0.77467})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 33 (California Laurel)

$$ADBH = \frac{(DBH + 0.32491)}{0.96579} \quad 1$$

$$OUTERVOL = 0.0000237733 \times (ADBH^{2.05910}(HT^{1.05293})) \quad 2$$

$$INNERVOL = 0.0000237733 \times (DBH^{2.05910}(HT^{1.05293})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 34 (Pacific Madrone)

$$ADBH = \frac{(DBH + 0.03425)}{0.98155} \quad 1$$

$$OUTERVOL = 0.0000378129 \times (ADBH^{1.99295}(HT^{1.01532})) \quad 2$$

$$INNERVOL = 0.0000378129 \times (DBH^{1.99295}(HT^{1.01532})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 35 (Oregon White Oak)

$$ADBH = \frac{(DBH + 0.78034)}{0.95956} \quad 1$$

$$OUTERVOL = 0.0000236325 \times (ADBH^{2.25575}(HT^{0.87108})) \quad 2$$

$$INNERVOL = 0.0000236325 \times (DBH^{2.25575}(HT^{0.87108})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 36 (Tanoak)

$$ADBH = \frac{(DBH + 4.1177)}{0.95354} \quad 1$$

$$OUTERVOL = 0.0000081905 \times (ADBH^{2.19576}(HT^{1.14078})) \quad 2$$

$$INNERVOL = 0.0000081905 \times (DBH^{2.19576}(HT^{1.14078})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 37 (Blue oak)

$$ADBH = \frac{(DBH + 0.44003)}{0.95354} \quad 1$$

$$OUTERVOL = 0.0000204864 \times (ADBH^{2.53987}(HT^{0.50591})) \quad 2$$

$$INNERVOL = 0.0000204861 \times (DBH^{2.53987}(HT^{0.50591})) \quad 3$$

$$BB = (OUTERVOL - INNERVOL) \times 35.30 \times DENSFAC / 2.2046 \quad 4$$

EQUATION 38 BIOPAK EQUATION

$$\mathrm{BB} = 3.3 + 9.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 39 BIOPAK EQUATION 936

$$\mathrm{BB} = -1.2 + 24.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

WHERE

Log	= NATURAL LOG
DBH	= DIAMETER OF TREE IN CENTIMETERS
HT	= HEIGHT OF TREE IN METERS
DENSFAC	= DENSITY FACTOR FOR SPECIES
BB	= BIOMASS OF BARK, WEIGHT IN KILOGRAMS, OF THE BARK ON THE TREE BOLE
π	= 3.141593

BIOMASS OF LIVE BRANCHES

All equations produce Biomass of Live Branches in Kilograms --- to convert to tons multiply by 0.0011023

Log in the equations is = NATURAL LOG

Log = natural log

EQUATION 1 BIOPAK EQUATION 889

$$\mathrm{BLB} = 13.0 + 12.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 2 BIOPAK EQUATION 919

$$\mathrm{BLB} = 3.6 + 44.2 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 3 BIOPAK EQUATION 28

$$\mathrm{BLB} = \exp\left(-4.1817 + 2.3324 \times \log\left(DBH\right)\right)$$

EQUATION 4 BIOPAK EQUATION 877

$$\mathrm{BLB} = 16.8 + 14.4 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 5 BIOPAK EQUATION 847

$$\mathrm{BLB} = 9.7 + 22.0 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 6 BIOPAK EQUATION 2

$$\mathrm{BLB} = \exp\left(-3.6941 + 2.1382 \times \log\left(DBH\right)\right)$$

EQUATION 7 BIOPAK EQUATION 702

$$\mathrm{BLB} = \exp\left(-4.1068 + 1.5177 \times \log\left(DBH\right) + 1.0424 \times \log\left(HT\right)\right)$$

EQUATION 8

$$\mathrm{BLB} = \exp\left(-7.637 + 3.3648 \times \log\left(DBH\right)\right)$$

EQUATION 9 BIOPAK EQUATION 901

$$\mathrm{BLB} = 9.5 + 16.8 \times \left(\frac{DBH}{100}\right)^2 \times HT$$

EQUATION 10 BIOPAK EQUATION 459

$$\mathrm{BLB} = 0.199 + 0.00381 \times DBH^{2} \times HT$$

EQUATION 11 BIOPAK EQUATION 907

$$\mathrm{BLB} = 7.8 + 12.3 \times \left(\frac{DBH}{100}\right)^{2} \times HT$$

EQUATION 12

$$\mathrm{BLB} = \exp\left(-4.570 + 2.271 \times \log\left(DBH\right)\right)$$

EQUATION 13 BIOPAK EQUATION 51

$$\mathrm{BLB} = \exp\left(-7.2775 + 2.3337 \times \log\left(DBH \times \pi\right)\right)$$

EQUATION 14 BIOPAK EQUATION 944

$$\mathrm{BLB} = 1.7 + 26.2 \times \left(\frac{DBH}{100}\right)^{2} \times HT$$

EQUATION 15 BIOPAK EQUATION 932

$$\mathrm{BLB} = 2.5 + 36.8 \times \left(\frac{DBH}{100}\right)^{2} \times HT$$

EQUATION 16

$$\mathrm{BLB} = \exp\left(-4.5648 + 2.6232 \times \log\left(DBH\right)\right) - BF$$

where: $$\mathrm{BF} = \left(\exp\left(-4.5648 + 2.6232 \times \log\left(DBH\right)\right)\right) \times \frac{1}{\left(2.7638 + 0.062 \times DBH^{1.3364}\right.}$$

EQUATION 17

$$\mathrm{BLB} = \exp\left(-5.2581 + 2.6045 \times \log\left(DBH\right)\right)$$

EQUATION 18 BIOPAK EQUATION 883

$$\mathrm{BLB} = 4.5 + 22.7 \times \left(\frac{DBH}{100}\right)^{2} \times HT$$

EQUATION 19 BIOPAK EQUATION 925

$$\mathrm{BLB} = 5.3 + 9.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 20 BIOPAK EQUATION 895

$$\mathrm{BLB} = 20.4 + 7.7 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 21 BIOPAK EQUATION 446

$$\mathrm{BLB} = 0.626 + 0.00079 \times DBH^2 \times HT$$

EQUATION 22 BIOPAK EQUATION 859

$$\mathrm{BLB} = 12.6 + 23.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 23 Weyerhaeuser Co Equation

$$\mathrm{BLB} = 0.047 + 0.00413 \times DBH^2 \times HT$$

EQUATION 24 BIOPAK EQUATION 913

$$\mathrm{BLB} = 4.2 + 17.4 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 25 BIOPAK EQUATION 950

$$\mathrm{BLB} = -0.6 + 45.1 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 26 BIOPAK EQUATION 938

$$\mathrm{BLB} = 8.1 + 21.5 \times \left(\frac{DBH}{100} \right)^2 \times HT$$

EQUATION 27 Snell et.al 1983, bigleaf maple

$$\mathrm{BLB} = \exp\left(4.0543553 + 2.1505 \times \log\left(DBH\right)\right)\left(1 - \frac{1}{\left(4.6762 + 0.0163 \times DBH^{2.039}\right)}\right) \Big/ 1000$$

EQUATION 28 Snell et.al 1983, pacific madrone

$$\mathrm{BLB} = \exp\left(3.0136553 + 2.4839 \times \log\left(DBH\right)\right)\left(1 - \frac{1}{(1.6013 + 0.1060 \times DBH^{1.309})}\right) \Big/ 1000$$

EQUATION 29 Snell et.al 1983, giant chinkapin

$$\mathrm{BLB} = \exp\left(3.1980553 + 2.2699 \times \log\left(DBH\right)\right)\left(1 - \frac{1}{1.6048 + 0.2979 \times DBH^{0.6828}}\right) \Big/ 1000$$

WHERE

Log = NATURAL LOG
DBH = DIAMETER OF TREE IN CENTIMETERS
HT = HEIGHT OF TREE IN METERS
BLB = BIOMASS OF LIVE BRANCHES,
WEIGHT IN KILOGRAMS, OF THE WOOD AND BARK OF LIVE BRANCHES IN THE CROWN
π = 3.141593