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Inland California and Southern Cascades CA) Variant Overview of the Forest Vegetation Simulator

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Limber pine stand in California
(Hazel Gorden, FS-R5)

Inland California and Southern Cascades (CA) Variant Overview of the Forest Vegetation Simulator

Authors and Contributors:

The FVS staff has maintained model documentation for this variant in the form of a variant overview since its release in 1998. The original author was Gary Dixon. In 2008, the previous document was replaced with this updated variant overview. Gary Dixon, Christopher Dixon, Robert Havis, Chad Keyser, Stephanie Rebain, Erin Smith-Mateja, and Don Vandendriesche were involved with this major update. Stephanie Rebain cross-checked information contained in this variant overview with the FVS source code. Relationships for redwood were incorporated in 2021.

FVS Staff. 2008 (revised April 3, 2023). Inland California and Southern Cascades (CA) Variant Overview – Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: U. S. Department of Agriculture, Forest Service, Forest Management Service Center. 86p.

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Quick Guide to Default Settings

Parameter or Attribute	**Default Setting**	
Number of Projection Cycles	1 (10 if using FVS GUI)	
Projection Cycle Length	10 years	
Location Code (National Forest)	610 – Rogue River	
Plant Association Code (Region 5 /Region 6)	0 (Unknown) / 46 (CWC221 ABCO-PSME)	
Slope	5 percent	
Aspect	0 (no meaningful aspect)	
Elevation	35 (3500 feet)	
Latitude / Longitude	Latitude	Longitude
All location codes	42	124
Site Species (Region 5 / Region 6)	DF / Plant Association Code Specific	
Site Index (Region 5 / Region 6)	80 feet / Plant Association Code Specific	
Maximum Stand Density Index (R5 /R6)	Species specific / Plant Association Code specific	
Maximum Basal Area	Based on maximum stand density index	
Volume Equations	National Volume Estimator Library	
Merchantable Cubic Foot Volume Specifications:		
Minimum DBH / Top Diameter	KP	All Other Species
Region 5	6.0 / 6.0 inches	7.0 / 6.0 inches
Region 6	6.0 / 4.5 inches	7.0 / 4.5 inches
Stump Height	1.0 foot	1.0 foot
Merchantable Board Foot Volume Specifications:		
Minimum DBH / Top Diameter	KP	All Other Species
Region 5	6.0 / 6.0 inches	7.0 / 6.0 inches
Region 6	6.0 / 4.5 inches	7.0 / 4.5 inches
Stump Height	1.0 foot	1.0 foot
Sampling Design:		
Large Trees (variable radius plot)	40 BAF	
Small Trees (fixed radius plot)	1/300th Acre	
Breakpoint DBH	5.0 inches	

1.0 Introduction

The Forest Vegetation Simulator (FVS) is an individual tree, distance independent growth and yield model with linkable modules called extensions, which simulate various insect and pathogen impacts, fire effects, fuel loading, snag dynamics, and development of understory tree vegetation. FVS can simulate a wide variety of forest types, stand structures, and pure or mixed species stands.

New "variants" of the FVS model are created by imbedding new tree growth, mortality, and volume equations for a particular geographic area into the FVS framework. Geographic variants of FVS have been developed for most of the forested lands in the United States.

The ICASCA, or CA, variant was completed in 1998 for the forest types of the northern **I**nland **CA**lifornia and **S**outhern **CA**scades regions of California and Oregon. The CA variant overlaps some of the geographic range of the Klamath Mountains (NC) variant. The model includes forty-eight individual species, and additional species are accommodated through "other softwood" and "other hardwood" categories within the model.

Since the variant's completion in 1998, some of the functions have been adjusted and improved as more data has become available, and as model technology has advanced.

To fully understand how to use this variant, users should also consult the following publication:

- Essential FVS: A User's Guide to the Forest Vegetation Simulator (Dixon 2002)

This publication may be downloaded from the Forest Management Service Center (FMSC), Forest Service website. Other FVS publications may be needed if one is using an extension that simulates the effects of fire, insects, or diseases.

2.0 Geographic Range

The CA variant covers forest areas in parts of California and Oregon. This includes all or part of the Klamath, Lassen, Mendocino, Plumas, and Shasta-Trinity National Forests in California, the Illinois Valley (east) Ranger District of the Siskiyou National Forest in Oregon, and the Applegate and Ashland (west) Ranger Districts of the Rogue River National Forest in Oregon. The suggested geographic range of use for the CA variant is shown in figure 2.0.1.

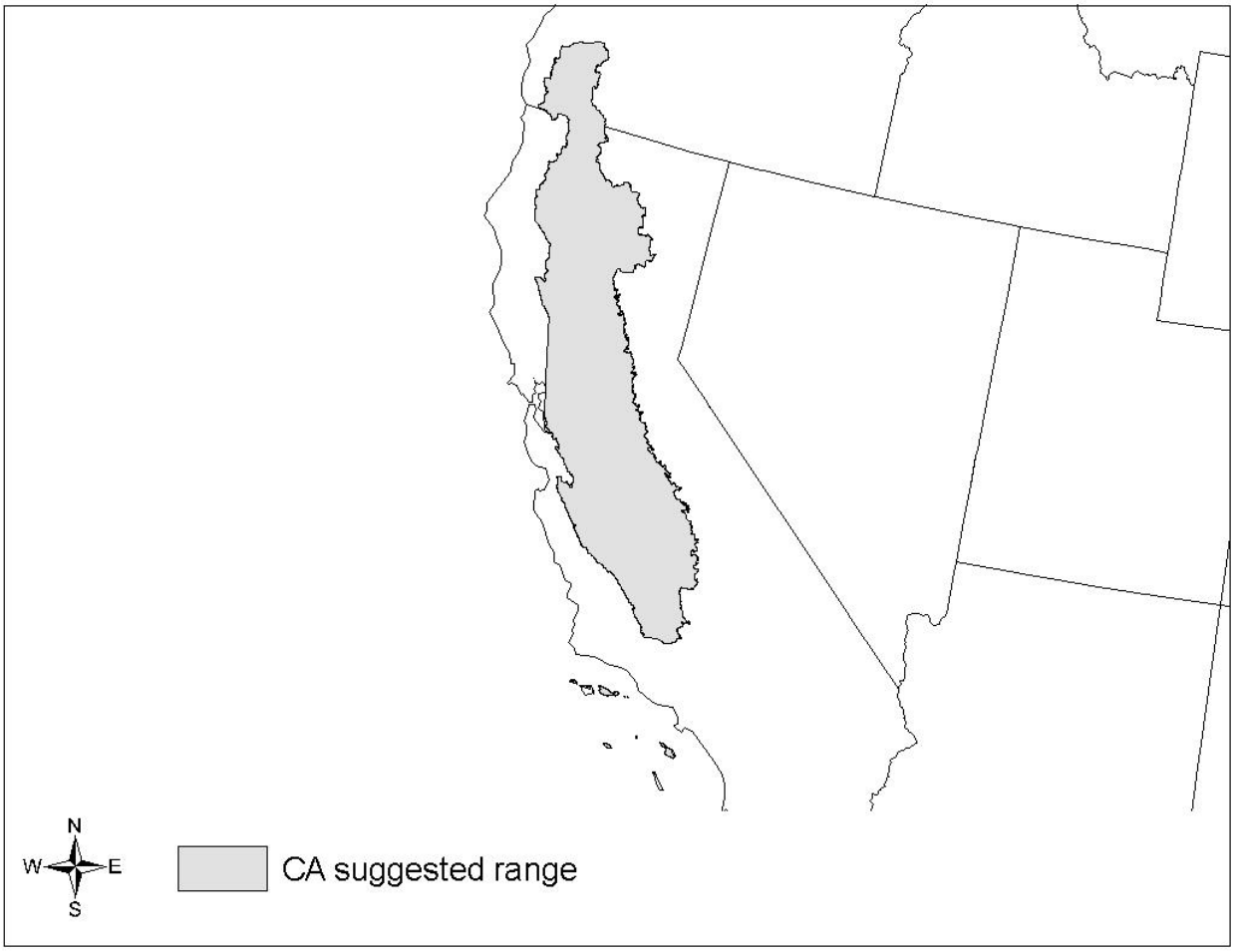

Figure 2.0.1 Suggested geographic range of use for the CA variant.

Within USFS Region 5, the following forests and districts should use the CA variant: Oak Knoll, Salmon River and Scott River districts of the Klamath NF; Almanor and Hat Creek districts of the Lassen NF; Coming and Stonyford districts of the Mendocino NF; and Big Bar, Hayfork, Mt. Shasta, Shasta Lake, Yolla Bolla, and Weaverville districts of the Shasta-Trinity NF (Warbington 2004, based on Spreadsheet provided by Ralph Warbington, R5 Ecosystem Planning Staff, Remote Sensing Lab, http://www.fs.fed.us/r5/rsl/).

3.0 Control Variables

FVS users need to specify certain variables used by the CA variant to control a simulation. These are entered in parameter fields on various FVS keywords available in the FVS interface or they are read from an FVS input database using the Database Extension.

3.1 Location Codes

The location code is a 3- or 4-digit code where, in general, the first digit of the code represents the Forest Service Region Number, and the last two digits represent the Forest Number within that region. In some cases, a location code beginning with a "7" or "8" is used to indicate an administrative boundary that doesn't use a Forest Service Region number (for example, other federal agencies, state agencies, or other lands).

If the location code is missing or incorrect in the CA variant, a default forest code of 610 (Rogue River National Forest) will be used. Location codes recognized in the CA variant are shown in tables 3.1.1 and 3.1.2.

Table 3.1.1 Location codes used in the CA variant.

Location Code	Location
505	Klamath National Forest
506	Lassen National Forest
508	Mendocino National Forest
511	Plumas National Forest
514	Shasta-Trinity National Forest
610	Rogue River National Forest
611	Siskiyou National Forest
518	Trinity National Forest (mapped to 514)
710	BLM Roseburg ADU
711	BLM Medford ADU
712	BLM Coos Bay ADU

Table 3.1.2 Bureau of Indian Affairs reservation codes used in the CA variant.

Location Code	Location
7801	Berry Creek Off-Reservation Trust Land (mapped to 511)
7803	Cold Springs Rancheria (mapped to 511)
7804	Colusa Rancheria (mapped to 508)
7805	Cortina Indian Rancheria (mapped to 508)
7809	Grindstone Indian Rancheria (mapped to 508)
7811	Jackson Rancheria (mapped to 511)
7812	Chicken Ranch Off-Reservation Trust Land (mapped to 511)
7818	Picayune Off-Reservation Trust Land (mapped to 511)
7822	Rumsey Indian Rancheria (mapped to 508)
7823	Shingle Springs Rancheria (mapped to 511)

Location Code	Location
7826	Table Mountain Rancheria (mapped to 511)
7827	Tule River Reservation (mapped to 511)
7829	Mooretown Off-Reservation Trust Land (mapped to 511)
7837	Pit River Trust Land (mapped to 506)
7842	Quartz Valley Reservation (mapped to 505)
7846	Karuk Off-Reservation Trust Land (mapped to 505)
7864	Santa Rosa Rancheria (mapped to 511)
8104	Cow Creek Reservation (mapped to 611)

3.2 Species Codes

The CA variant recognizes 48 species, plus two other composite species categories. You may use FVS species codes, Forest Inventory and Analysis (FIA) species codes, or USDA Natural Resources Conservation Service PLANTS symbols to represent these species in FVS input data. Any valid western species code identifying species not recognized by the variant will be mapped to a similar species in the variant. The species mapping crosswalk is available on the FVS website variant documentation webpage. Any non-valid species code will default to the "other hardwood" category.

Either the FVS sequence number or species code must be used to specify a species in FVS keywords and Event Monitor functions. FIA codes or PLANTS symbols are only recognized during data input and may not be used in FVS keywords. Table 3.2.1 shows the complete list of species codes recognized by the CA variant.

When entering tree data, users should substitute diameter at root collar (DRC) for diameter at breast height (DBH) for woodland species (western juniper).

Table 3.2.1 Species codes used in the CA variant.

Species Number	Species Code	FIA Code	PLANTS Symbol	Scientific Name[1]	Common Name[1]
1	PC	041	CHLA	*Chamaecyparis lawsoniana*	Port Orford cedar
2	IC	081	CADE27	*Calocedrus decurrens*	incense cedar
3	RC	242	THPL	*Thuja plicata*	western redcedar
4	WF	015	ABCO	*Abies concolor*	white fir
5	RF	020	ABMA	*Abies magnifica*	California red fir
6	SH	021	ABSH	*Abies shastensis*	Shasta red fir
7	DF	202	PSME	*Pseudotsuga menziesii*	Douglas-fir
8	WH	263	TSHE	*Tsuga heterophylla*	western hemlock
9	MH	264	TSME	*Tsuga mertensiana*	mountain hemlock
10	WB	101	PIAL	*Pinus albicaulis*	whitebark pine
11	KP	103	PIAT	*Pinus attenuata*	knobcone pine
12	LP	108	PICO	*Pinus contorta*	lodgepole pine
13	CP	109	PICO3	*Pinus coulteri*	Coulter pine

Species Number	Species Code	FIA Code	PLANTS Symbol	Scientific Name[1]	Common Name[1]
14	LM	113	PIFL2	*Pinus flexilis*	limber pine
15	JP	116	PIJE	*Pinus jeffreyi*	Jeffrey pine
16	SP	117	PILA	*Pinus lambertiana*	sugar pine
17	WP	119	PIMO3	*Pinus monticola*	western white pine
18	PP	122	PIPO	*Pinus ponderosa*	ponderosa pine
19	MP	124	PIRA2	*Pinus radiata*	Monterey pine
20	GP	127	PISA2	*Pinus sabiniana*	California foothill pine
21	WJ	064	JUOC	*Juniperus occidentalis*	western juniper
22	BR	092	PIBR	*Picea breweriana*	Brewer spruce
23	GS	212	SEGI2	*Sequoiadendron giganteum*	giant sequoia
24	PY	231	TABR2	*Taxus brevifolia*	Pacific yew
25	OS	299	2TD		other softwood[2]
26	LO	801	QUAG	*Quercus agrifolia*	California live oak
27	CY	805	QUCH2	*Quercus chrysolepsis*	canyon live oak
28	BL	807	QUDO	*Quercus douglasii*	blue oak
29	EO	811	QUEN	*Quercus engelmanni*	Engelmann oak
30	WO	815	QUGA4	*Quercus garryana*	Oregon white oak
31	BO	818	QUKE	*Quercus kelloggii*	California black oak
32	VO	821	QULO	*Quercus lobata*	valley oak
33	IO	839	QUWI2	*Quercus wislizenii*	interior live oak
34	BM	312	ACMA3	*Acer macrophyllum*	bigleaf maple
35	BU	333	AECA	*Aesculus californica*	California buckeye
36	RA	351	ALRU2	*Alnus rubra*	red alder
37	MA	361	ARME	*Arbutus menziesii*	Pacific madrone
38	GC	431	CHCHC4	*Chrysolepis chrysophylla* var. *chrysophylla*	giant chinquapin
39	DG	492	CONU4	*Cornus nuttallii*	Pacific dogwood
40	FL	542	FRLA	*Fraxinus latifolia*	Oregon ash
41	WN	600	JUGLA	*Juglans*	walnut
42	TO	631	LIDE3	*Lithocarpus densiflorus*	tanoak
43	SY	730	PLRA	*Platanus racemosa*	California sycamore
44	AS	746	POTR5	*Populus tremuloides*	quaking aspen
45	CW	747	POBAT	*Populus balsamifera* ssp. *trichocarpa*	black cottonwood
46	WI	920	SALIX	*Salix*	willow
47	CN	251	TOCA	*Torreya californica*	California nutmeg
48	CL	981	UMCA	*Umbellularia californica*	California laurel
49	OH	998	2TB		other hardwood[2]
50	RW	211	SESE3	*Sequioa sempervirens*	redwood

[1]Set based on the USDA Forest Service NRM TAXA lists and the USDA Plants database.

[2]Other categories use FIA codes and NRM TAXA codes that best match the other category.

3.3 Habitat Type, Plant Association, and Ecological Unit Codes

Plant association codes recognized in the CA variant are shown in Appendix A. If an incorrect plant association code is entered or no code is entered, FVS will use the default plant association code, which is 46 (CWC221 ABCO-PSME) for Region 6 forests, and 0 (unknown) in Region 5 forests. In Region 6 forests, plant association codes are used to set default site information such as site species, site indices, and maximum stand density indices. The site species, site index and maximum stand density indices can be reset via FVS keywords. In Region 5 and 6 forests, the plant association codes are used in the Fire and Fuels Extension (FFE) to set fuel loading in cases where there are no live trees in the first cycle. Users may enter the plant association code or the plant association FVS sequence number on the STDINFO keyword, when entering stand information from a database, or when using the SETSITE keyword without the PARMS option. If using the PARMS option with the SETSITE keyword, users must use the FVS sequence number for the plant association.

3.4 Site Index

Site index is used in some of the growth equations in the CA variant. Users should always use the same site curves that FVS uses as shown in table 3.4.1. Table 3.4.2 shows the reference number to be used in selecting site curves from table 3.4.1 for all species in Region 6. If site index is available, a single site index for the whole stand can be entered, a site index for each individual species in the stand can be entered, or a combination of these can be entered. A site index value must be greater than or equal to 8, otherwise the value is considered a R5 site class code, see section 3.4.1.

Table 3.4.1 Site index reference curves used for species in the CA variant.

Reference Number	Reference	BHA or TTA*	Base Age	USFS Region
All Species	Dunning (1942); Dunning & Reineke (1933) or R5 Site class	BHA**	50	5
1	Hann & Scrivani (1987)	BHA	50	6
2	Dolph (1987)	BHA	50	6
3	Dahms (1964)	TTA	50	6
4	Powers (1972)	BHA	50	6
5	Porter & Wiant (1965)	TTA	50	6
6	Krumland and Eng (2005)***	BHA	50	5

* Equation is based on total tree age (TTA) or breast height age (BHA)

** Height at BHA50 should be entered even though the original site curve was a TTA curve

*** Equation form is presented on page 34 and coefficients are provided on page 68

Table 3.4.2 Reference numbers for site index reference curves in Region 6 by species.

Species Code	R6 Reference Number	Species Code	R6 Reference Number
PC	1	LO	5
IC	1	CY	5
RC	1	BL	5
WF	1	EO	5
RF	2	WO	4
SH	2	BO	4
DF	1	VO	4
WH	1	IO	5
MH	2	BM	5
WB	3	BU	4
KP	3	RA	5
LP	3	MA	5
CP	3	GC	5
LM	3	DG	4
JP	1	FL	4
SP	1	WN	5
WP	1	TO	5
PP	1	SY	5
MP	1	AS	5
GP	1	CW	5
WJ	3	WI	5
BR	1	CN	5
GS	6	CL	5
PY	4	OH	5
OS	1	RW	6

In Region 5 forests, site index values can either be entered directly or based on the Region 5 Site Class Code. See section 3.4.1 for Region 5 Site Class information. If site index is missing or incorrect, the site species is set to Douglas-fir with a default site index set to 80. For species not assigned a site index, site index is determined by multiplying the site species site index by the target species adjustment factor located in table 3.4.3.

Table 3.4.3 Region 5 adjustment factors for 50-year site index values in the CA variant.

Species Code	R5 Adjustment Factor	Species Code	R5 Adjustment Factor
PC	0.90	LO	0.57
IC	0.76	CY	0.57
RC	0.90	BL	0.57
WF	1	EO	0.57
RF	1	WO	0.57

Species Code	R5 Adjustment Factor
SH	1
DF	1
WH	0.90
MH	0.90
WB	0.90
KP	0.90
LP	0.90
CP	0.90
LM	0.90
JP	1
SP	1
WP	0.90
PP	1
MP	0.90
GP	0.90
WJ	0.76
BR	0.76
GS	1
PY	0.76
OS	0.9

Species Code	R5 Adjustment Factor
BO	0.57
VO	0.57
IO	0.57
BM	0.57
BU	0.57
RA	0.57
MA	0.57
GC	0.57
DG	0.57
FL	0.57
WN	0.57
TO	0.57
SY	0.57
AS	0.57
CW	0.57
WI	0.57
CN	0.57
CL	0.57
OH	0.57
RW	1

In Region 6 forests, the default site species and site index are determined by plant association codes and shown in Appendix A. If the plant association code is missing or incorrect, the site species is set to Douglas-fir with a default site index set to 92. For species not assigned a site index, site index is determined by first converting the site species site index to a Hann-Scrivani DF site index equivalent. This is done by dividing the site species site index by the site species adjustment factor located in table 3.4.4. Next, the species site index is determined by multiplying the converted site species site index by the species adjustment factor located in table 3.4.4.

Table 3.4.4 Region 6 adjustment factors for 50-year site index values in the CA variant.

Species Code	R6 Adjustment Factor
PC	0.90
IC	0.70
RC	0.80
WF	1
RF	1
SH	1
DF	1
WH	0.95

Species Code	R6 Adjustment Factor
LO	0.28
CY	0.42
BL	0.34
EO	0.28
WO	0.40
BO	0.56
VO	0.76
IO	0.28

Species Code	R6 Adjustment Factor
MH	0.90
WB	0.90
KP	0.90
LP	0.90
CP	0.90
LM	0.90
JP	0.94
SP	1
WP	0.94
PP	0.94
MP	0.90
GP	0.90
WJ	0.76
BR	0.76
GS	1
PY	0.4
OS	0.76

Species Code	R6 Adjustment Factor
BM	0.76
BU	0.56
RA	0.76
MA	0.76
GC	0.76
DG	0.40
FL	0.70
WN	0.40
TO	0.76
SY	0.76
AS	0.40
CW	0.76
WI	0.25
CN	0.25
CL	0.25
OH	0.56
RW	1

3.4.1 Region 5 Site Class

In Region 5 forests, the site index values can either be entered directly or based on the Region 5 site class (0-7) as shown in table 3.4.1.1. Site class codes of 0-5 were adapted for Region 5 by Jack Levitan from Duncan Dunning's site index curves (Dunning 1942, Dunning & Reineke 1933).

If a Region 5 site class is entered, it is converted to a site index for each species within the model using a two-step process. First, the Region 5 site class is converted to a 50-year site index as shown in table 3.4.1.1 (personal communication with Ralph Warbington in March 2008).

Table 3.4.1.1 Region 5 site class values converted into 50-year site index in the CA variant.

Region 5 Site class	(Breast HT Age) 50-year site index
0	106
1	90
2	75
3	56
4	49
5	39
6	31
7	23

Second, site index for an individual species is determined by multiplying the 50-year site index by a species-specific adjustment factor which is shown in table 3.4.3.

3.5 Maximum Density

Maximum stand density index (SDI) and maximum basal area (BA) are important variables in determining density related mortality and crown ratio change. Maximum basal area is a stand level metric that can be set using the BAMAX or SETSITE keywords. If not set by the user, a default value is calculated from maximum stand SDI each projection cycle. Maximum stand density index can be set for each species using the SDIMAX or SETSITE keywords. If not set by the user, a default value is assigned as discussed below. Maximum stand density index at the stand level is a weighted average, by basal area, of the individual species SDI maximums.

In Region 5, the default maximum SDI is set by species or a user specified basal area maximum. If a user specified basal area maximum is present, the maximum SDI for all species is computed using equation {3.5.1}; otherwise, species maximums are assigned from the SDI maximums shown in table 3.5.1.

For Region 5 forests, stand SDI is calculated using the Zeide calculation method (Dixon 2002).

{3.5.1} $SDIMAX_i = BAMAX / (0.5454154 * SDIU)$

where:

$SDIMAX_i$ is the species-specific SDI maximum
BAMAX is the user-specified stand basal area maximum
SDIU is the proportion of theoretical maximum density at which the stand reaches actual maximum density (default 0.85, changed with the SDIMAX keyword)

In Region 6, the default maximum SDI is set based on a user-specified, or default, plant association code or a user specified basal area maximum. If a user specified basal area maximum is present, the maximum SDI for species is computed using equation {3.5.1}; otherwise, the SDI maximum for all species is assigned from the SDI maximum associated with the site species for the plant association code shown in Appendix A. SDI maximums were set based on growth basal area (GBA) analysis developed by Hall (1983) or an analysis of Current Vegetation Survey (CVS) plots in USFS Region 6 by Crookston (2008). Some SDI maximums associated with plant associations are unreasonably large, so SDI maximums are capped at 850.

Table 3.5.1 Region 5 Stand density index maximums by species in the CA variant.

Species Code	R5 SDI Maximum	Mapped to	Source*
PC	592	Alaska yellow-cedar	Shaw
IC	576		Shaw
RC	762		Shaw
WF	800		PSW
RF	1000		PSW
SH	1000		PSW
DF	570		Shaw
WH	682		Shaw

Species Code	R5 SDI Maximum	Mapped to	Source*
MH	687		Shaw
WB	621		Shaw
KP	679	lodgepole pine	Shaw
LP	679		Shaw
CP	365	Jeffrey pine	PSW
LM	409		Shaw
JP	365		PSW
SP	561		Shaw
WP	272		Shaw
PP	365		PSW
MP	365	ponderosa pine	PSW
GP	214	blue oak	Shaw
WJ	272		Shaw
BR	412	white spruce	Shaw
GS	1052		Shaw
PY	576	incense cedar	Shaw
OS	365	Jeffrey pine	PSW
LO	667	canyon live oak	Shaw
CY	667		Shaw
BL	214		Shaw
EO	214	blue oak	Shaw
WO	440		Shaw
BO	406		Shaw
VO	440	Oregon white oak	Shaw
IO	667	canyon live oak	Shaw
BM	629		Shaw
BU	440	Oregon white oak	Shaw
RA	441		Shaw
MA	515		Shaw
GC	785	tanoak	Shaw
DG	406	California black oak	Shaw
FL	441	red alder	Shaw
WN	283	black walnut	Shaw
TO	785		Shaw
SY	499	sycamore	Shaw
AS	562		Shaw
CW	452		Shaw
WI	447	black willow	Shaw

Species Code	R5 SDI Maximum	Mapped to	Source*
CN	576	incense cedar	Shaw
CL	406	California black oak	Shaw
OH	452	black cottonwood	Shaw
RW	1052		Shaw

*Sources include an unpublished analysis of FIA data by John Shaw (Shaw) and a review of current data/literature by Pacific Southwest Research Station (PSW).

4.0 Growth Relationships

This chapter describes the functional relationships used to fill in missing tree data and calculate incremental growth. In FVS, trees are grown in either the small tree sub-model or the large tree sub-model depending on the diameter.

4.1 Height-Diameter Relationships

Height-diameter relationships in FVS are primarily used to estimate tree heights missing in the input data, and occasionally to estimate diameter growth on trees smaller than a given threshold diameter. In the CA variant, FVS will dub in heights by one of two methods. By default, the CA variant will use the Curtis-Arney functional form as shown in equation {4.1.1} (Curtis 1967, Arney 1985).

If the input data contains at least three measured heights for a species, then FVS can switch to a logistic height-diameter equation {4.1.2} (Wykoff, et.al 1982) that may be calibrated to the input data. FVS will not automatically use equation {4.1.2} even if you have enough height values in the input data. To override this default, the user must use the NOHTDREG keyword to turn calibration on. Coefficients for equations {4.1.1} and {4.1.2} are given in Table 4.1.1.

In the CA variant, the default Curtis-Arney equation used depends on the "spline DBH" (given as *Z*). Values for "spline DBH" are given as *Z* in table 4.1.1.

{4.1.1} Curtis-Arney functional form

$DBH \geq Z$": $HT = 4.5 + P_2 * \exp[-P_3 * DBH \wedge P_4]$
$DBH < Z$": $HT = [(4.5 + P_2 * \exp[-P_3 * Z \wedge P_4] - 4.51) * (DBH - 0.3) / (Z - 0.3)] + 4.51$

{4.1.2} Wykoff functional form

$HT = 4.5 + \exp(B_1 + B_2 / (DBH + 1.0))$

where:

HT	is tree height
Z	is the "spline DBH" shown in table 4.1.1
DBH	is tree diameter at breast height
B_1 - B_2	are species-specific coefficients shown in table 4.1.1
P_2 - P_4	are species-specific coefficients shown in table 4.1.1

Data were available to fit Curtis-Arney and Wykoff height-diameter coefficients for incense cedar, white fir, California red fir, Shasta red fir, Douglas-fir, knobcone pine, lodgepole pine, Jeffrey pine, sugar pine, western white pine, ponderosa pine, California foothill pine, Oregon white oak, California black oak, Pacific madrone, and redwood. Curtis-Arney coefficients for the other species were fit from inventory data from other forests in Region 6. Wykoff coefficients for other species are from the Klamath Mountains (NC) FVS variant.

Table 4.1.1 Coefficients and "spline DBH" for equations {4.1.1} – {4.1.2} in the CA variant.

Species Code	Curtis-Arney Coefficients				Wykoff Coefficients	
	P_2	P_3	P_4	Z	Default B_1	B_2
PC	8532.9026	8.0343	-0.1831	3.0	4.7874	-7.317
IC	695.4196	7.5021	-0.3852	6.0	5.2052	-20.1443
RC	487.5415	5.4444	-0.3801	3.0	4.7874	-7.317
WF	467.307	6.1195	-0.4325	3.0	5.218	-14.8682
RF	606.3002	6.2936	-0.386	3.0	5.2973	-17.2042
SH	606.3002	6.2936	-0.386	3.0	5.2973	-17.2042
DF	408.7614	5.4044	-0.4426	3.0	5.3076	-14.474
WH	263.1274	6.9356	-0.6619	3.0	4.7874	-7.317
MH	233.6987	6.9059	-0.6166	3.0	4.7874	-7.317
WB	89.5535	4.2281	-0.6438	3.0	4.7874	-7.317
KP	101.517	4.7066	-0.954	2.0	4.6843	-6.5516
LP	99.1568	12.13	-1.3272	5.0	4.8358	-9.2077
CP	514.1013	5.5983	-0.2734	3.0	4.7874	-7.317
LM	514.1013	5.5983	-0.2734	3.0	4.7874	-7.317
JP	744.7718	7.6793	-0.3779	5.0	5.1419	-19.8143
SP	944.9299	6.2428	-0.3087	5.0	5.3371	-19.3151
WP	422.0948	6.0404	-0.4525	3.0	5.2649	-15.5907
PP	1267.7589	7.4995	-0.3286	2.0	5.382	-20.4097
MP	113.7962	4.7726	-0.7601	3.0	4.7874	-7.317
GP	79986.6348	9.9284	-0.1013	2.0	4.6236	-13.0049
WJ	60.6009	4.1543	-0.6277	3.0	4.7874	-7.317
BR	91.7438	17.1081	-1.4429	3.0	4.7874	-7.317
GS	595.1068	5.8103	-0.3821	3.0	5.3401	-15.9354
PY	127.1698	4.8977	-0.4668	3.0	4.7874	-7.317
OS	79986.6348	9.9284	-0.1013	3.0	4.7874	-7.317
LO	105.0771	5.6647	-0.6822	3.0	4.6618	-8.3312
CY	105.0771	5.6647	-0.6822	3.0	4.6618	-8.3312
BL	59.0941	6.1195	-1.0552	3.0	4.6618	-8.3312
EO	59.0941	6.1195	-1.0552	3.0	4.6618	-8.3312
WO	40.3812	3.7653	-1.1224	3.0	3.8314	-4.8221
BO	120.2372	4.1713	-0.6113	3.0	4.4907	-7.703
VO	126.7237	3.18	-0.6324	3.0	4.6618	-8.3312
IO	55	5.5	-0.95	3.0	4.6618	-8.3312
BM	143.9994	3.5124	-0.5511	3.0	4.6618	-8.3312
BU	55	5.5	-0.95	3.0	4.6618	-8.3312
RA	94.5048	4.0657	-0.9592	3.0	4.6618	-8.3312

Species Code	Curtis-Arney Coefficients				Wykoff Coefficients	
	P_2	P_3	P_4	Z	Default B_1	B_2
MA	117.741	4.0764	-0.6151	3.0	4.4809	-7.5989
GC	1176.9704	6.3245	-0.2739	3.0	4.6618	-8.3312
DG	403.3221	4.3271	-0.2422	3.0	4.6618	-8.3312
FL	97.7769	8.8202	-1.0534	3.0	4.6618	-8.3312
WN	105.0771	5.6647	-0.6822	3.0	4.6618	-8.3312
TO	679.1972	5.5698	-0.3074	3.0	4.6618	-8.3312
SY	55	5.5	-0.95	3.0	4.6618	-8.3312
AS	47.3648	15.6276	-1.9266	3.0	4.6618	-8.3312
CW	179.0706	3.6238	-0.573	3.0	4.6618	-8.3312
WI	149.5861	2.4231	-0.18	3.0	4.6618	-8.3312
CN	55	5.5	-0.95	3.0	4.6618	-8.3312
CL	114.1627	6.021	-0.7838	3.0	4.6618	-8.3312
OH	40.3812	3.7653	-1.1224	3.0	4.6618	-8.3312
RW	595.1068	5.8103	-0.3821	3.0	5.3401	-15.9354

4.2 Bark Ratio Relationships

Bark ratio estimates are used to convert between diameter outside bark and diameter inside bark in various parts of the model. In the CA variant, bark ratio values are determined using estimates from DIB equations or by setting to a constant value. Equations used in the CA variant are shown in equations {4.2.1} – {4.2.3}. Coefficients (b_1 and b_2) and equation reference for these equations by species are shown in table 4.2.1.

{4.2.1} $DIB = b_1 * DBH^{b_2}$ where $BRATIO = DIB / DBH$

{4.2.2} $DIB = b_1 + (b_2 * DBH)$ where $BRATIO = DIB / DBH$

{4.2.3} $BRATIO = b_1$

where:

BRATIO is species-specific bark ratio (bounded to $0.8 \leq BRATIO \leq 0.99$)
DBH is tree diameter at breast height
DIB is tree diameter inside bark at breast height
b_1 - b_2 are species-specific coefficients shown in table 4.2.1

Table 4.2.1 Coefficients and equation reference for bark ratio equations {4.2.1} – {4.2.3} in the CA variant.

Species Code	b_1	b_2	Equation to use	Equation Source
PC	0.94967	1.0	{4.2.1}	Wykoff et al
IC	-0.0549	0.8374	{4.2.2}	Dolph PSW-368

Species Code	b_1	b_2	Equation to use	Equation Source
RC	0.94967	1.0	{4.2.1}	Wykoff et al
WF	-0.1593	0.8911	{4.2.2}	Dolph PSW-368
RF	-0.1593	0.8911	{4.2.2}	Dolph PSW-368
SH	-0.1593	0.8911	{4.2.2}	Dolph PSW-368
DF	0.903563	0.989388	{4.2.1}	Walters et al
WH	0.93371	1	{4.2.1}	Wykoff et al
MH	0.93371	1	{4.2.1}	Wykoff et al
WB	0.9	0	{4.2.3}	Wykoff et al
KP	0.9329	0	{4.2.3}	Wykoff (avg. of AF, IC, ES, LP, WP)
LP	0.9	0	{4.2.3}	Wykoff et al
CP	-0.4448	0.8967	{4.2.2}	Dolph PSW-368
LM	0.9	0	{4.2.3}	Wykoff et al
JP	-0.4448	0.8967	{4.2.2}	Dolph PSW-368
SP	-0.1429	0.8863	{4.2.2}	Dolph PSW-368
WP	-0.1429	0.8863	{4.2.2}	Dolph PSW-368
PP	-0.4448	0.8967	{4.2.2}	Dolph PSW-368
MP	-0.4448	0.8967	{4.2.2}	Dolph PSW-368
GP	0.9329	0	{4.2.3}	Wykoff (avg. of AF, IC, ES, LP, WP)
WJ	0.94967	1.0	{4.2.1}	Wykoff et al
BR	0.9	0	{4.2.3}	Wykoff et al
GS	0.94967	1.0	{4.2.1}	Wykoff et al
PY	0.9	0	{4.2.3}	Wykoff et al
OS	-0.4448	0.8967	{4.2.2}	Dolph PSW-368
LO	-0.75739	0.93475	{4.2.2}	Pillsbury and Kirkley
CY	-0.19128	0.96147	{4.2.2}	Pillsbury and Kirkley
BL	-0.17324	0.94403	{4.2.2}	Pillsbury and Kirkley
EO	-0.78572	0.92472	{4.2.2}	Pillsbury and Kirkley
WO	-0.30722	0.95956	{4.2.2}	Pillsbury and Kirkley
BO	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
VO	-0.38289	0.93545	{4.2.2}	Pillsbury and Kirkley
IO	0.04817	0.92953	{4.2.2}	Pillsbury and Kirkley
BM	0.0836	0.94782	{4.2.2}	Pillsbury and Kirkley
BU	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
RA	0.075256	0.94373	{4.2.2}	Pil. & Kirk.; Harlow & Harrar
MA	-0.01348	0.98155	{4.2.2}	Pillsbury and Kirkley
GC	0.15565	0.90182	{4.2.2}	Pillsbury and Kirkley
DG	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
FL	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
WN	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
TO	-0.26824	0.95354	{4.2.2}	Pillsbury and Kirkley
SY	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
AS	0.075256	0.94373	{4.2.2}	Pil. & Kirk.; Harlow & Harrar
CW	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
WI	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
CN	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley

Species Code	b_1	b_2	Equation to use	Equation Source
CL	-0.12791	0.96579	{4.2.2}	Pillsbury and Kirkley
OH	-0.26824	0.95767	{4.2.2}	Pillsbury and Kirkley
RW	0.7012	1.04862	{4.2.1}	Castle 2021

4.3 Crown Ratio Relationships

Crown ratio equations are used for three purposes in FVS: (1) to estimate tree crown ratios missing from the input data for both live and dead trees; (2) to estimate change in crown ratio from cycle to cycle for live trees; and (3) to estimate initial crown ratios for regenerating trees established during a simulation.

4.3.1 Crown Ratio Dubbing

In the CA variant, crown ratios missing in the input data are predicted using different equations depending on tree species and size. For all species except giant sequoia and redwood, trees less than 1.0" in diameter and dead trees of all sizes use equations {4.3.1.1} and {4.3.1.2} to compute crown ratio. Equation coefficients are found in table 4.3.1.1.

{4.3.1.1} $X = R_1 + R_2 * HT + R_3 * BA + N(0,SD)$

{4.3.1.2} $CR = ((X - 1) * 10.0 + 1.0) / 100$

where:

CR	is crown ratio expressed as a proportion (bounded to $0.05 \leq CR \leq 0.95$)
HT	is tree height
BA	is total stand basal area
N(0,SD)	is a random increment from a normal distribution with a mean of 0 and a standard deviation of SD
$R_1 - R_3$	are species-specific coefficients shown in table 4.3.1.1

Table 4.3.1.1 Coefficients for the crown ratio equation {4.3.1.1} in the CA variant.

Species Code	R_1	R_2	R_3	SD
PC	7.55854	-0.01564	-0.00906	1.9658
IC	7.55854	-0.01564	-0.00906	1.9658
RC	7.55854	-0.01564	-0.00906	1.9658
WF	8.04277	0.0072	-0.01616	1.3167
RF	8.04277	0.0072	-0.01616	1.3167
SH	8.04277	0.0072	-0.01616	1.3167
DF	8.47703	-0.01803	-0.018140	1.3756
WH	7.55854	-0.01564	-0.00906	1.9658
MH	7.55854	-0.01564	-0.00906	1.9658
WB	6.48981	-0.02982	-0.00928	2.0426

Species Code	R_1	R_2	R_3	SD
KP	6.48981	-0.02982	-0.00928	2.0426
LP	6.48981	-0.02982	-0.00928	2.0426
CP	6.48981	-0.02982	-0.00928	2.0426
LM	6.48981	-0.02982	-0.00928	2.0426
JP	6.48981	-0.02982	-0.00928	2.0426
SP	6.48981	-0.02982	-0.00928	2.0426
WP	6.48981	-0.02982	-0.00928	2.0426
PP	6.48981	-0.02982	-0.00928	2.0426
MP	6.48981	-0.02982	-0.00928	2.0426
GP	6.48981	-0.02982	-0.00928	2.0426
WJ	9.000000	0.000000	0.000000	0.5
BR	8.04277	0.0072	-0.01616	1.3167
PY	6.48981	-0.02982	-0.00928	2.0426
OS	6.48981	-0.02982	-0.00928	2.0426
LO	5.000000	0.000000	0.000000	0.5
CY	5.000000	0.000000	0.000000	0.5
BL	5.000000	0.000000	0.000000	0.5
EO	5.000000	0.000000	0.000000	0.5
WO	5.000000	0.000000	0.000000	0.5
BO	5.000000	0.000000	0.000000	0.5
VO	5.000000	0.000000	0.000000	0.5
IO	5.000000	0.000000	0.000000	0.5
BM	5.000000	0.000000	0.000000	0.5
BU	5.000000	0.000000	0.000000	0.5
RA	5.000000	0.000000	0.000000	0.5
MA	5.000000	0.000000	0.000000	0.5
GC	5.000000	0.000000	0.000000	0.5
DG	5.000000	0.000000	0.000000	0.5
FL	5.000000	0.000000	0.000000	0.5
WN	5.000000	0.000000	0.000000	0.5
TO	5.000000	0.000000	0.000000	0.5
SY	5.000000	0.000000	0.000000	0.5
AS	5.000000	0.000000	0.000000	0.5
CW	5.000000	0.000000	0.000000	0.5
WI	5.000000	0.000000	0.000000	0.5
CN	5.000000	0.000000	0.000000	0.5
CL	5.000000	0.000000	0.000000	0.5

Species Code	R_1	R_2	R_3	SD
OH	5.000000	0.000000	0.000000	0.5

For all species except giant sequoia and redwood, a Weibull-based crown model developed by Dixon (1985) as described in Dixon (2002) is used to predict crown ratio for all live trees 1.0" in diameter or larger. To estimate crown ratio using this methodology, the average stand crown ratio is estimated from stand density index using equation {4.3.1.3}. Weibull parameters are then estimated from the average stand crown ratio using equations in equation set {4.3.1.4}. Individual tree crown ratio is then set from the Weibull distribution, equation {4.3.1.5} based on a tree's relative position in the diameter distribution and multiplied by a scale factor, shown in equation {4.3.1.6}, which accounts for stand density. Crowns estimated from the Weibull distribution are bounded to be between the 5 and 95 percentile points of the specified Weibull distribution. Coefficients for the Weibull distribution were fit to equations from the Klamath Mountains (NC) and West Cascades (WC) variants, with species being matched to the closest curve of another appropriate species. Species index mapping and equation coefficients for each species are shown in tables 4.3.1.2 and 4.3.1.3.

{4.3.1.3} $ACR = d_0 + d_1 * RELSDI * 100.0$

{4.3.1.4} Weibull parameters A, B, and C are estimated from average crown ratio

$A = a_0$
$B = b_0 + b_1 * ACR \quad (B \geq 3)$
$C = c_0 + c_1 * ACR \quad (C \geq 2)$

{4.3.1.5} $Y = 1-\exp(-((X-A)/B)^C)$

{4.3.1.6} $SCALE = 1.5 - RELSDI$

where:

ACR	is predicted average stand crown ratio for the species
RELSDI	is the relative site density index (Stand *SDI* / Maximum *SDI*)
A, *B*, *C*	are parameters of the Weibull crown ratio distribution
X	is a tree's crown ratio expressed as a percent / 10
Y	is a trees rank in the diameter distribution (1 = smallest; ITRN = largest) divided by the total number of trees (ITRN) multiplied by *SCALE*
SCALE	is a density dependent scaling factor (bounded to $0.3 \leq SCALE \leq 1.0$)
CCF	is stand crown competition factor

a_0, b_{0-1}, c_{0-1}, and d_{0-1} are species-specific coefficients shown in tables 4.3.1.2 and 4.3.1.3

Table 4.3.1.2 Mapped species index for the Weibull parameter equations {4.3.1.3} and {4.3.1.4} in the CA variant.

Species Code	Species Index
PC	6
IC	6

Species Code	Species Index
LO	7
CY	7

Species Code	Species Index
RC	6
WF	4
RF	9
SH	9
DF	3
WH	12
MH	12
WB	13
KP	13
LP	17
CP	13
LM	13
JP	10
SP	2
WP	2
PP	10
MP	10
GP	10
WJ	1
BR	1
PY	1
OS	3

Species Code	Species Index
BL	7
EO	7
WO	7
BO	7
VO	7
IO	7
BM	14
BU	16
RA	15
MA	5
GC	16
DG	16
FL	16
WN	16
TO	8
SY	16
AS	16
CW	16
WI	16
CN	16
CL	16
OH	16

Table 4.3.1.3 Coefficients for the Weibull parameter equations {4.3.1.3} and {4.3.1.4} in the CA variant.

Coefficient	Species Index								
	1	2	3	4	5	6	7	8	9
a_0	0	0	0	0	0	0	0	0	0
b_0	0.52909	0.25115	0.52909	0.48464	0.08402	0.29964	0.06607	0.25667	0.16601
b_1	1.00677	1.05987	1.00677	1.01272	1.10297	1.05398	1.10705	1.06474	1.0815
c_0	-3.48211	0.33383	-3.48211	-2.78353	0.91078	-1.0927	2.04714	0.11729	0.9142
c_1	1.3878	0.63833	1.3878	1.27283	0.45819	0.80687	0.1507	0.61681	0.45768
d_0	7.48846	6.92893	7.48846	7.44422	3.64292	5.12357	6.82187	5.95912	6.14578
d_1	-0.02899	-0.04053	-0.02899	-0.04779	-0.00317	-0.01042	-0.02247	-0.01812	-0.02781

Coefficient	Species Index							
	10	11	12	13	14	15	16	17
a_0	0	0	0	0	1	1	0	0
b_0	0.03685	0.25667	0.49085	0.16267	-0.81881	-1.11274	-0.2383	-0.13121
b_1	1.09499	1.06474	1.01414	1.0734	1.05418	1.12314	1.18016	1.15976
c_0	4.0134	0.11729	3.16456	3.2885	-2.36611	2.53316	3.04413	2.59824

c_1	0.04946	0.61681	0	0	1.20241	0	0	0
d_0	6.04928	5.95912	5.48853	6.48494	4.42	4.12048	4.62512	4.89032
d_1	-0.01091	-0.01812	-0.00717	-0.02325	-0.01066	-0.00636	-0.01604	-0.01884

For giant sequioa and redwood, equation {4.3.1.7} and equation {4.3.1.8} are used to compute crown ratio for live trees less than 1" and dead trees of all sizes. For live trees greater than 1", equation {4.3.1.7} and equation {4.3.1.9} are used to compute crown ratio.

{4.3.1.7} $X = -1.021064 + 0.309296 * \ln(H*12/D) + 0.869720 * PRD - 0.116274 * D/QMDPLT$

{4.3.1.8} $CR = 1 / (1 + \exp(X + N(0,SD)))$

{4.3.1.9} $CR = 1 / (1 + \exp(X))$

where:

CR is crown ratio expressed as a proportion (bounded to $0.05 \leq CR \leq 0.95$)
D is tree diameter at breast height
H is tree height
PRD is relative density of the inventory point (point Zeide SDI / point SDI max)
QMDPLT is quadratic mean diameter of the inventory point (constrained to minimum of 1")
N(0,SD) is a random increment from a normal distribution with a mean of 0 and a standard deviation of SD (0.15)

4.3.2 Crown Ratio Change

Crown ratio change is estimated after growth, mortality and regeneration are estimated during a projection cycle. Crown ratio change is the difference between the crown ratio at the beginning of the cycle and the predicted crown ratio at the end of the cycle. Crown ratio predicted at the end of the projection cycle is estimated for live tree records using the Weibull distribution, equations {4.3.1.3}-{4.3.1.6}, for all species except giant sequoia and redwood. For giant sequoia and redwood, crown ratio predicted at the end of the projection cycle is estimated using equations {4.3.1.7) and {4.3.1.9}. Crown change is checked to make sure it doesn't exceed the change possible if all height growth produces new crown. Crown change is further bounded to 1% per year for the length of the cycle to avoid drastic changes in crown ratio. Equations {4.3.1.1} and {4.3.1.2} are not used when estimating crown ratio change.

4.3.3 Crown Ratio for Newly Established Trees

Crown ratios for newly established trees during regeneration are estimated using equation {4.3.3.1}. A random component is added in equation {4.3.3.1} to ensure that not all newly established trees are assigned exactly the same crown ratio.

{4.3.3.1} $CR = 0.89722 - 0.0000461 * PCCF + RAN$

where:

CR is crown ratio expressed as a proportion (bounded to $0.2 \leq CR \leq 0.9$)
PCCF is crown competition factor on the inventory point where the tree is established
RAN is a small random component

4.4 Crown Width Relationships

4.4.1 Region 5 Crown Width

Crown width in Region 5 forests is calculated by using equations {4.4.1.1} – {4.4.1.5}. If a tree has a *DBH* greater than or equal to its threshold diameter (given as DBH_T), then it uses equation {4.4.1.1}, {4.4.1.2}, or {4.4.1.3} depending on the species. If a tree has a *DBH* less than its threshold diameter, then it uses equation {4.4.1.4} or {4.4.1.5} depending on the height of the tree. Coefficients, equation reference, and threshold diameter values for these equations are shown in table 4.4.1.1 by species.

{4.4.1.1} $DBH \geq DBH_T$: $CW = a_1 + a_2 * DBH$

{4.4.1.2} $DBH \geq DBH_T$: $CW = a_1 * DBH^{a_2}$

{4.4.1.3} $DBH \geq DBH_T$: $CW = a_1 + a_2 * DBH + a_3 * DBH^2$

{4.4.1.4} $HT < 4.5'$ and $DBH < DBH_T$: $CW = HT * s_1$

{4.4.1.5} $HT \geq 4.5'$ and $DBH < DBH_T$: $CW = d_1 + d_2 * DBH$

where:

CW is maximum tree crown width
DBH is tree diameter at breast height
DBH_T is threshold diameter shown in table 4.4.1.1
HT is tree height
s_1, d_{1-2}, and a_{1-3} are species-specific coefficients shown in table 4.4.1.1

Table 4.4.1.1 Coefficients and equation reference for equations {4.4.1.1} – {4.4.1.5} in the CA variant.

Species Code	Equation Used*	DBH_T	d_1	d_2	a_1	a_2	a_3	s_1
PC	{4.4.1.1}	5	3.5	1.1	6	0.6	0	0.7778
IC	{4.4.1.1}	5	3.5	1.192	7.11	0.47	0	0.7778
RC	{4.4.1.1}	5	3.5	1.7	4	1.6	0	0.7778
WF	{4.4.1.1}	5	3.26	1.103	5.82	0.591	0	0.7778
RF	{4.4.1.1}	5	3.5	1.063	6.71	0.421	0	0.7778
SH	{4.4.1.1}	5	3.5	1.063	6.71	0.421	0	0.7778
DF	{4.4.1.1}	5	3.62	1.37	6.81	0.732	0	0.7778
WH	{4.4.1.1}	5	3.5	1.624	4.57	1.41	0	0.7778
MH	{4.4.1.1}	5	3.5	0.852	4.72	0.608	0	0.7778
WB	{4.4.1.2}	5	3.5	0.8496	2.37	0.736	0	0.7778
KP	{4.4.1.1}	5	3.5	1.1	6	0.6	0	0.7778
LP	{4.4.1.2}	5	3.5	0.6492	1.91	0.784	0	0.7778
CP	{4.4.2.2}	5	3.5	1.7618	3.9347	0.7086	0	0.7778
LM	{4.4.1.1}	5	3.5	1.1	6	0.6	0	0.7778
JP	{4.4.1.2}	5	3.5	0.5754	1.52	0.891	0	0.7778

Species Code	Equation Used*	DBH_T	d_1	d_2	a_1	a_2	a_3	s_1
SP	{4.4.1.1}	7.4	3.5	0.338	-1.476	1.01	0	0.7778
WP	{4.4.1.1}	7.6	3.5	0.329	-0.997	0.92	0	0.7778
PP	{4.4.1.2}	5	3.77	0.7756	2.24	0.763	0	0.7778
MP	{4.4.1.1}	5	3.5	1.1	6	0.6	0	0.7778
GP	{4.4.2.2}	5	3.5	1.9108	3.8273	0.7624	0	0.7778
WJ	{4.4.1.2}	5	3.5	1.6684	4.31	0.628	0	0.7778
BR	{4.4.1.1}	5	3.5	2.4	6.5	1.8	0	0.7778
GS	{4.4.1.1}	5	3.5	1.1	6	0.6	0	0.7778
PY	{4.4.1.1}	5	3.5	1.56	4.2	1.42	0	0.7778
OS	{4.4.1.1}	5	3.5	1.1	6	0.6	0	0.7778
LO	{4.4.2.2}	5	2.5	3.2150	5.3732	0.7707	0	0.5556
CY	{4.4.1.1}	5	2.5	2.19	5	1.69	0	0.5556
BL	{4.4.1.2}	5	2.5	2.2175	4.49	0.688	0	0.5556
EO	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
WO	{4.4.1.1}	5	2.5	2.036	3.08	1.92	0	0.5556
BO	{4.4.1.1}	5	2.5	2.7	10	1.2	0	0.5556
VO	{4.4.2.2}	5	2.5	2.2816	4.5628	0.6925	0	0.5556
IO	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
BM	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
BU	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
RA	{4.4.1.1}	5	2.5	2.63	8	1.53	0	0.5556
MA	{4.4.1.1}	5	3.11	1.008	1	1.43	0	0.5556
GC	{4.4.1.3}	5	2.15	1.646	2.98	1.55	-0.014	0.5556
DG	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
FL	{4.4.1.1}	5	2.5	1.22	0.5	1.62	0	0.5556
WN	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
TO	{4.4.1.1}	13.4	2.23	1.63	10	1.05	0	0.5556
SY	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
AS	{4.4.1.1}	5	2.5	1.22	0.5	1.62	0	0.5556
CW	{4.4.1.1}	5	2.5	1.22	0.5	1.62	0	0.5556
WI	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
CN	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
CL	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
OH	{4.4.1.1}	5	2.5	1.4	2	1.5	0	0.5556
RW	{4.4.1.1}	5	3.62	1.37	6.81	0.732	0	0.7778

*Equation refers to the species-specific equation used when $DBH \geq DBH_T$

4.4.2 Region 6 Crown Width

Crown width for Region 6 forests is calculated using equations {4.4.2.1} – {4.4.2.6}, and coefficients for these equations are shown in table 4.4.2.1. The minimum diameter and bounds for certain data values are given in table 4.4.2.2. Equation numbers in table 4.4.2.1 are given

with the first three digits representing the FIA species code, and the last two digits representing the equation source.

{4.4.2.1} Bechtold (2004); Equation 01

$DBH \geq MinD$: $CW = a_1 + (a_2 * DBH) + (a_3 * DBH^2)$
$DBH < MinD$: $CW = [a_1 + (a_2 * MinD) * (a_3 * MinD^2)] * (DBH / MinD)$

{4.4.2.2} Bechtold (2004); Equation 02

$DBH \geq MinD$: $CW = a_1 + (a_2 * DBH) + (a_3 * DBH^2) + (a_4 * CR\%) + (a_5 * BA) + (a_6 * HI)$
$DBH < MinD$: $CW = [a_1 + (a_2 * MinD) + (a_3 * MinD^2) + (a_4 * CR\%) + (a_5 * BA) + (a_6 * HI)] * (DBH / MinD)$

{4.4.2.3} Crookston (2003); Equation 03

$DBH \geq MinD$: $CW = a_1 * \exp(a_2 + (a_3 * \ln(CL)) + (a_4 * \ln(DBH)) + (a_5 * \ln(HT)) + (a_6 * \ln(BA)))$
$DBH < MinD$: $CW = (a_1 * \exp(a_2 + (a_3 * \ln(CL)) + (a_4 * \ln(MinD)) + (a_5 * \ln(HT)) + (a_6 * \ln(BA))))* (DBH / MinD)$

{4.4.2.4} Crookston (2005); Equation 04

$DBH \geq MinD$: $CW = a_1 * DBH^{a_2}$
$DBH < MinD$: $CW = [a_1 * MinD^{a_2}] * (DBH / MinD)$

{4.4.2.5} Crookston (2005); Equation 05

$DBH \geq MinD$: $CW = (a_1 * BF) * DBH^{a_2} * HT^{a_3} * CL^{a_4} * (BA + 1.0)^{a_5} * \exp(EL)^{a_6}$

$DBH < MinD$: $CW = [CW = (a_1 * BF) * MinD^{a_2} * HT^{a_3} * CL^{a_4} * (BA + 1.0)^{a_5} * \exp(EL)^{a_6}] * (DBH / MinD)$

{4.4.2.6} Donnelly (1996); Equation 06

$DBH \geq MinD$ $CW = a_1 * DBH^{a_2}$
$DBH < MinD$ $CW = [a_1 * MinD^{a_2}] * (DBH / MinD)$

where:

BF	is a species-specific coefficient based on forest code shown in table 4.4.2.3
CW	is tree maximum crown width
CL	is tree crown length
CR%	is crown ratio expressed as a percent
DBH	is tree diameter at breast height
HT	is tree height
BA	is total stand basal area
EL	is stand elevation in hundreds of feet
MinD	is the minimum diameter
HI	is the Hopkins Index *HI* = (ELEVATION - 5449) / 100) * 1.0 + (LATITUDE - 42.16) * 4.0 + (-116.39 - LONGITUDE) * 1.25

$a_1 – a_6$ are species-specific coefficients shown in table 4.4.2.1

Table 4.4.2.1 Coefficients for crown width equations {4.4.2.1}-{4.4.2.6} in the CA variant.

Species Code	Equation Number*	a_1	a_2	a_3	a_4	a_5	a_6
PC	04105	4.6387	0.50874	-0.22111	0.17505	0.06447	-0.00602
IC	08105	5.0446	0.47419	-0.13917	0.1423	0.04838	-0.00616
RC	24205	6.2382	0.29517	-0.10673	0.23219	0.05341	-0.00787
WF	01505	5.0312	0.5368	-0.18957	0.16199	0.04385	-0.00651
RF	02006	3.1146	0.578	0	0	0	0
SH	02105	2.317	0.4788	-0.06093	0.15482	0.05182	0
DF	20205	6.0227	0.54361	-0.20669	0.20395	-0.00644	-0.00378
WH	26305	6.0384	0.51581	-0.21349	0.17468	0.06143	-0.00571
MH	26403	6.90396	0.55645	-0.28509	0.2043	0	0
WB	10105	2.2354	0.6668	-0.11658	0.16927	0	0
KP	10305	4.0069	0.84628	-0.29035	0.13143	0	-0.00842
LP	10805	6.6941	0.8198	-0.36992	0.17722	-0.01202	-0.00882
CP	10805	6.6941	0.8198	-0.36992	0.17722	-0.01202	-0.00882
LM	11301	4.0181	0.8528	0	0	0	0
JP	11605	4.0217	0.66815	-0.11346	0.09689	-0.636	0
SP	11705	3.593	0.63503	-0.22766	0.17827	0.04267	-0.0029
WP	11905	5.3822	0.57896	-0.19579	0.14875	0	-0.00685
PP	12205	4.7762	0.74126	-0.28734	0.17137	-0.00602	-0.00209
MP	12702	-2.4909	1.0716	0	0.0648	0	-0.1127
GP	12702	-2.4909	1.0716	0	0.0648	0	-0.1127
WJ	06405	5.1486	0.73636	-0.46927	0.39114	-0.05429	0
BR	09204	2.8232	0.66326	0	0	0	0
GS	21104	3.7023	0.52618	0	0	0	0
PY	23104	6.1297	0.45424	0	0	0	0
OS	11605	4.0217	0.66815	-0.11346	0.09689	-0.636	0
LO	80102	-16.1696	1.7456	0	0.0925	0	-0.1956
CY	80502	0.2738	1.0534	0	0.035	0	-0.1385
BL	80702	2.711	1.5159	0	0.0415	-0.0271	0
EO	80702	2.711	1.5159	0	0.0415	-0.0271	0
WO	81505	2.4857	0.70862	0	0.10168	0	0
BO	81802	1.6306	0.9867	0	0.0556	0	-0.1199
VO	82102	-2.1068	1.9385	0	0.086	0	0
IO	83902	0.7146	1.546	0	0	0	-0.1121
BM	31206	7.5183	0.4461	0	0	0	0
BU	31206	7.5183	0.4461	0	0	0	0
RA	35106	7.0806	0.4771	0	0	0	0
MA	36102	4.9133	0.9459	0	0.0611	0	0.0523
GC	63102	3.115	0.7966	0	0.0745	-0.0053	0.0523

Species Code	Equation Number*	a_1	a_2	a_3	a_4	a_5	a_6
DG	35106	7.0806	0.4771	0	0	0	0
FL	31206	7.5183	0.4461	0	0	0	0
WN	31206	7.5183	0.4461	0	0	0	0
TO	63102	3.115	0.7966	0	0.0745	-0.0053	0.0523
SY	63102	3.115	0.7966	0	0.0745	-0.0053	0.0523
AS	74605	4.7961	0.64167	-0.18695	0.18581	0	0
CW	74705	4.4327	0.41505	-0.23264	0.41477	0	0
WI	31206	7.5183	0.4461	0	0	0	0
CN	98102	2.4247	1.3174	0	0.0786	0	0
CL	98102	2.4247	1.3174	0	0.0786	0	0
OH	31206	7.5183	0.4461	0	0	0	0
RW	21104	3.7023	0.52618	0	0	0	0

*Equation number is a combination of the species FIA code (###) and equation source (##).

Table 4.4.2.2 *MinD* values and data bounds for equations {4.4.2.1}-{4.4.2.6} in the CA variant.

Species Code	Equation Number*	*MinD*	EL min	*EL* max	*HI* min	*HI* max	*CW* max
PC	04105	1.0	2	52	n/a	n/a	49
IC	08105	1.0	5	62	n/a	n/a	78
RC	24205	1.0	1	72	n/a	n/a	45
WF	01505	1.0	2	75	n/a	n/a	35
RF	02006	1.0	n/a	n/a	n/a	n/a	65
SH	02105	1.0	n/a	n/a	n/a	n/a	65
DF	20205	1.0	1	75	n/a	n/a	80
WH	26305	1.0	1	72	n/a	n/a	54
MH	26403	n/a	n/a	n/a	n/a	n/a	45
WB	10105	1.0	n/a	n/a	n/a	n/a	40
KP	10305	1.0	12	49	n/a	n/a	46
LP	10805	1.0	1	79	n/a	n/a	40
CP	10805	1.0	1	79	n/a	n/a	40
LM	11301	5.0	n/a	n/a	n/a	n/a	25
JP	11605	1.0	n/a	n/a	n/a	n/a	39
SP	11705	1.0	5	75	n/a	n/a	56
WP	11905	1.0	10	75	n/a	n/a	35
PP	12205	1.0	13	75	n/a	n/a	50
MP	12702	5.0	n/a	n/a	-69	-4	54
GP	12702	5.0	n/a	n/a	-69	-4	54
WJ	06405	1.0	n/a	n/a	n/a	n/a	36
BR	09204	1.0	n/a	n/a	n/a	n/a	38
GS	21104	1.0	n/a	n/a	n/a	n/a	39
PY	23104	1.0	n/a	n/a	n/a	n/a	30

Species Code	Equation Number*	*MinD*	EL min	*EL* max	*HI* min	*HI* max	*CW* max
OS	11605	1.0	n/a	n/a	n/a	n/a	39
LO	80102	5.0	n/a	n/a	-73	-54	53
CY	80502	5.0	n/a	n/a	-60	-5	49
BL	80702	5.0	n/a	n/a	n/a	n/a	61
EO	80702	5.0	n/a	n/a	n/a	n/a	61
WO	81505	1.0	n/a	n/a	n/a	n/a	39
BO	81802	5.0	n/a	n/a	-47	-8	52
VO	82102	5.0	n/a	n/a	n/a	n/a	47
IO	83902	5.0	n/a	n/a	-60	-5	37
BM	31206	1.0	n/a	n/a	n/a	n/a	30
BU	31206	1.0	n/a	n/a	n/a	n/a	30
RA	35106	1.0	n/a	n/a	n/a	n/a	35
MA	36102	5.0	n/a	n/a	-55	15	43
GC	63102	5.0	n/a	n/a	-55	15	41
DG	35106	1.0	n/a	n/a	n/a	n/a	35
FL	31206	1.0	n/a	n/a	n/a	n/a	30
WN	31206	1.0	n/a	n/a	n/a	n/a	30
TO	63102	5.0	n/a	n/a	-55	15	41
SY	63102	5.0	n/a	n/a	-55	15	41
AS	74605	1.0	n/a	n/a	n/a	n/a	45
CW	74705	1.0	n/a	n/a	n/a	n/a	56
WI	31206	1.0	n/a	n/a	n/a	n/a	30
CN	98102	5.0	n/a	n/a	n/a	n/a	44
CL	98102	5.0	n/a	n/a	n/a	n/a	44
OH	31206	1.0	n/a	n/a	n/a	n/a	30
RW	21104	1.0	n/a	n/a	n/a	n/a	39

Table 4.4.2.3 *BF* values for equation {4.4.2.5} in the CA variant.

Species Code	Location Code	
	610, 710, 711	**611, 712**
IC	0.903	0.821
DF	1.000	0.961
WH	1.000	1.028
MH	0.900	0.900
LP	0.944	0.944
SP	1.048	1.000
WP	1.081	1.000
PP	0.918	0.951
RA	0.810	0.810

*Any *BF* values not listed in Table 4.4.2.3 are assumed to be *BF* = 1.0

4.5 Crown Competition Factor

The CA variant uses crown competition factor (*CCF*) as a predictor variable in some growth relationships. Crown competition factor (Krajicek and others 1961) is a relative measurement of stand density that is based on tree diameters. Individual tree CCF_t values estimate the percentage of an acre that would be covered by the tree's crown if the tree were open-grown. Stand *CCF* is the summation of individual tree (CCF_t) values. A stand *CCF* value of 100 theoretically indicates that tree crowns will just touch in an unthinned, evenly spaced stand. Crown competition factor for an individual tree is calculated using equation {4.5.1} and is based off of crown width calculated using the Region 5 crown width equations in section 4.4.1.

{4.5.1} CCF_t = 0.001803 * *CW*^2

where:

CCF_t	is crown competition factor for an individual tree
CW	is maximum tree crown width
DBH	is tree diameter at breast height

4.6 Small Tree Growth Relationships

Trees are considered "small trees" for FVS modeling purposes when they are smaller than some threshold diameter. The threshold diameter is set to 3.0" for all species in the CA variant.

The small tree model is height-growth driven, meaning height growth is estimated first and diameter growth is estimated from height growth. These relationships are discussed in the following sections.

4.6.1 Small Tree Height Growth

The small-tree height increment model predicts 5-year height growth (*HTG*) for small trees. For all species except giant sequoia and redwood, height growth in the CA variant is estimated by using equations {4.6.1.1} – {4.6.1.4}, and then modified with equation {4.6.1.5} to account for differences in species, site index, and geographic area. Data was not available to fit small-tree height growth models for the CA variant. Equations {4.6.1.1}, {4.6.1.3}, and {4.6.1.4} were taken from the Western Sierras (WS) variant. Equation {4.6.1.2} was derived from equations in Hann and Scrivani (1987) and Ritchie and Hann (1986). Equation reference and adjustment factors are shown in table 4.6.1.1.

{4.6.1.1} Pines

POTHTG = 1.75 * exp(0.7452 – (0.003271 * *BAL*) – (0.1632 * *CR*) + (0.0217 * *CR*^2) + (0.00536* *SI*))

{4.6.1.2} Firs

POTHTG = 1.016605 * *DOHTG* * (1 – exp(-0.426558 * *CR)*) * (exp(2.54119 * (*RELHT*^0.250537 – 1)))
DOHTG = (11.35 + 2.157 * SI) / (29 – 0.05 * SI)

{4.6.1.3} California black oak

POTHTG = exp(3.817 – (0.7829 * ln(*BAL*)))

{4.6.1.4} Tanoak

POTHTG = exp(3.385 – (0.5898 * ln(*BAL*)))

where:

POTHTG	is potential height growth
BAL	is total basal area in trees larger than the subject tree
CR	is crown ratio expressed as a percent divided by 10 for equations {4.6.1.1}, {4.6.1.3}, and {4.6.1.4}; is crown ratio expressed as a proportion for equation {4.6.1.2}
SI	is species site index

For all species except firs, the potential height growth is adjusted based on a species-specific adjustment factor (*X*), and by the site index of the geographic area using equation {4.6.1.5}. A small random deviation (bounded between -0.2 and 0.05) is then added to the predicted height growth to assure a good distribution of estimated height growths.

{4.6.1.5} *HTG* = *POTHTG* * [0.8 + (0.004 * (*SI* – 50))] * X

where:

HTG	is estimated height growth for the cycle
POTHTG	is potential height growth
SI	is species site index
X	is a species-specific adjustment factor shown in table 4.6.1.1

For giant sequoia and redwood, a potential height growth curve is used to estimate small tree height growth. Height growth is computed by subtracting the current predicted height from the predicted height 5 years in the future, as depicted in equation {4.6.1.6}.

{4.6.1.6} *POTHTG* = 2.242202 * *SI* * [1.0 – exp (-0.010742 * *AGE1*)]^ 0.919076

where:

POTHTG	is predicted tree height, used for current and future height growth
SI	is species site index
AGE1	is tree age A*GE1* = 1/ -0.010742 * (ln(1-(*HT*/2.242202/*SI*)^(1/ 0.919076))

Table 4.6.1.1 Equation reference, adjustment factors and diameter range where weighting between small and large tree models occurs in the CA variant.

Species Code	*POTHTG* Equation	Adjustment Factor (X)	X_{min}	X_{max}
PC	{4.6.1.2}	1.0	2.0	4.0
IC	{4.6.1.2}	1.0	2.0	4.0
RC	{4.6.1.2}	0.9	2.0	4.0

Species Code	*POTHTG* Equation	Adjustment Factor (X)	X_{min}	X_{max}
WF	{4.6.1.2}	1.1	2.0	4.0
RF	{4.6.1.2}	1.1	2.0	4.0
SH	{4.6.1.2}	1.1	2.0	4.0
DF	{4.6.1.2}	1.1	2.0	4.0
WH	{4.6.1.2}	0.8	2.0	4.0
MH	{4.6.1.2}	0.9	2.0	4.0
WB	{4.6.1.1}	0.9	2.0	4.0
KP	{4.6.1.1}	1.0	2.0	4.0
LP	{4.6.1.1}	1.0	2.0	4.0
CP	{4.6.1.1}	1.0	2.0	4.0
LM	{4.6.1.1}	1.0	2.0	4.0
JP	{4.6.1.1}	1.0	2.0	4.0
SP	{4.6.1.1}	1.1	2.0	4.0
WP	{4.6.1.1}	1.1	2.0	4.0
PP	{4.6.1.1}	1.0	2.0	4.0
MP	{4.6.1.1}	1.1	2.0	4.0
GP	{4.6.1.1}	0.9	2.0	4.0
WJ	{4.6.1.1}	1.0	2.0	4.0
BR	{4.6.1.2}	0.9	2.0	4.0
GS	{4.6.1.6}	1.0	2.0	10.0
PY	{4.6.1.2}	0.8	2.0	4.0
OS	{4.6.1.1}	1.0	2.0	4.0
LO	{4.6.1.3}	1.1	2.0	4.0
CY	{4.6.1.3}	0.9	2.0	4.0
BL	{4.6.1.3}	1.1	2.0	4.0
EO	{4.6.1.3}	1.1	2.0	4.0
WO	{4.6.1.3}	1.0	2.0	4.0
BO	{4.6.1.3}	1.1	2.0	4.0
VO	{4.6.1.3}	1.0	2.0	4.0
IO	{4.6.1.3}	1.1	2.0	4.0
BM	{4.6.1.4}	1.0	2.0	4.0
BU	{4.6.1.3}	1.0	2.0	4.0
RA	{4.6.1.3}	1.0	2.0	4.0
MA	{4.6.1.4}	1.0	2.0	4.0
GC	{4.6.1.3}	1.0	2.0	4.0
DG	{4.6.1.4}	1.0	2.0	4.0
FL	{4.6.1.3}	1.0	2.0	4.0
WN	{4.6.1.3}	1.1	2.0	4.0
TO	{4.6.1.4}	1.0	2.0	4.0
SY	{4.6.1.3}	1.1	2.0	4.0

Species Code	*POTHTG* Equation	Adjustment Factor (X)	X_{min}	X_{max}
AS	{4.6.1.3}	1.2	2.0	4.0
CW	{4.6.1.3}	1.2	2.0	4.0
WI	{4.6.1.3}	1.1	2.0	4.0
CN	{4.6.1.2}	0.8	2.0	4.0
CL	{4.6.1.4}	1.0	2.0	4.0
OH	{4.6.1.3}	1.0	2.0	4.0
RW	{4.6.1.6}	1.0	2.0	10.0

For all species, a small random error is then added to the height growth estimate. The estimated height growth (*HTG*) is then adjusted to account for cycle length, user defined small-tree height growth adjustments, and adjustments due to small tree height model calibration from the input data.

Height growth estimates from the small-tree model are weighted with the height growth estimates from the large tree model over a range of diameters (X_{min} and X_{max}) in order to smooth the transition between the two models. For example, the closer a tree's *DBH* value is to the minimum diameter (X_{min}), the more the growth estimate will be weighted towards the small-tree growth model. The closer a tree's *DBH* value is to the maximum diameter (X_{max}), the more the growth estimate will be weighted towards the large-tree growth model. If a tree's *DBH* value falls outside of the range given by X_{min} and X_{max}, then the model will use only the small-tree or large-tree growth model in the growth estimate. The weight applied to the growth estimate is calculated using equation {4.6.1.7}, and applied as shown in equation {4.6.1.8}. The range of diameters where this weighting occurs for each species is shown above in table 4.6.1.1.

{4.6.1.7}

$DBH \leq X_{min}$: $XWT = 0$
$X_{min} < DBH < X_{max}$: $XWT = (DBH - X_{min}) / (X_{max} - X_{min})$
$DBH \geq X_{max}$: $XWT = 1$

{4.6.1.8}

Estimated growth = [(1 - *XWT*) * *STGE*] + [*XWT* * *LTGE*]
Giant sequoia and redwood estimated growth = [(1 - *XWT*) * ((*STGE+LTGE*)/*2.0)*] + [*XWT* * *LTGE*]

where:

XWT is the weight applied to the growth estimates
DBH is tree diameter at breast height
X_{max} is the maximum *DBH* where weighting between small and large tree models occurs
X_{min} is the minimum *DBH* where weighting between small and large tree models occurs
STGE is the growth estimate obtained using the small-tree growth model

LTGE is the growth estimate obtained using the large-tree growth model

4.6.2 Small Tree Diameter Growth

As stated previously, for trees being projected with the small tree equations, height growth is predicted first, and then diameter growth. So both height at the beginning of the cycle and height at the end of the cycle are known when predicting diameter growth. Small tree diameter growth for trees over 4.5 feet tall is calculated as the difference of predicted diameter at the start of the projection period and the predicted diameter at the end of the projection period, adjusted for bark ratio. Diameter growth is predicted with the height-diameter equations shown in section 4.1 inverted so diameter is a function of height. For all species except giant sequoia and redwood, diameter growth of all small trees is a weighted average of the small and large tree predictions when the *DBH* is between 1.5" and 3.0". Diameter growth estimates for giant sequoia and redwood are weighted with the diameter growth estimates from the large-tree model when DBH is between 2" and 7", in a similar manner to the weighting explained in section 4.6.1. By definition, diameter growth is zero for trees less than 4.5 feet tall.

4.7 Large Tree Growth Relationships

Trees are considered "large trees" for FVS modeling purposes when they are equal to, or larger than, some threshold diameter. This threshold diameter is set to 3.0" for all species in the CA variant.

The large-tree model is driven by diameter growth meaning diameter growth is estimated first, and then height growth is estimated from diameter growth and other variables. These relationships are discussed in the following sections.

4.7.1 Large Tree Diameter Growth

The large tree diameter growth model used in most FVS variants is described in section 7.2.1 in Dixon (2002). For most variants, instead of predicting diameter increment directly, the natural log of the periodic change in squared inside-bark diameter (ln(*DDS*)) is predicted (Dixon 2002; Wykoff 1990; Stage 1973; and Cole and Stage 1972). For variants predicting diameter increment directly, diameter increment is converted to the *DDS* scale to keep the FVS system consistent across all variants.

In the CA variant, a single equation form is used to estimate large-tree diameter growth in every species except giant sequoia and redwood. The equation form for giant sequoia and redwood is shown in equation {4.7.1.2), and the equation for all other species is shown in equation {4.7.1.1}. Coefficients for these equations are shown in tables 4.7.1.2 and 4.7.1.4. The tanoak estimate is modified by equation {4.7.1.3} to convert the 5-year estimate into a 10-year estimate.

In the CA variant, each species is mapped into a species index as shown in table 4.7.1.1. The coefficients for each species for equation 4.7.1.1 will depend on the species index of the subject species.

{4.7.1.1} Used for all species except giant sequoia and redwood

$\ln(DDS) = b_1 + (b_2 * EL) + (b_3 * EL\text{^}2) + (b_4 * \ln(SI)) + (b_5 * \sin(ASP)) + (b_6 * \cos(ASP)) + (b_7 * SL) + (b_8 * SL\text{^}2) + (b_9 * \ln(DBH)) + (b_{10} * CR) + (b_{11} * CR\text{^}2) + (b_{12} * DBH\text{^}2) + (b_{13} * BAL / (\ln(DBH + 1.0))) + (b_{14} * PCCF) + (b_{15} * RELHT) + (b_{16} * \ln(BA)) + (b_{17} * BAL)$

{4.7.1.2} Used for giant sequoia and redwood

$DI = \exp(-3.502444 + (0.185911 * \ln(DBH)) + (-0.000073 * DBH\text{^}2) + (-0.001796 * PBAL) + (-0.42078 * PRD) + (0.589318 * \ln(CR)) + (0.415435 * \ln(SI)) + (-0.000926 * SL) + (-0.002203 * (SL) * \text{COS}(ASP)))$

{4.7.1.3} Modifying equation for tanoak

$\ln(DDS) = \ln(\exp(DDS) * 2.0)$

where:

DDS	is the square of the 10-year diameter growth increment
DI	is 10-year outside bark diameter growth increment
EL	is stand elevation in hundreds of feet
SI	is species site index (for mountain hemlock only, *SI* = *SI* * 3.281)
ASP	is stand aspect
SL	is stand slope
CR	is crown ratio expressed as a proportion
DBH	is tree diameter at breast height
BAL	is total basal area in trees larger than the subject tree
PBAL	is point basal area in trees larger than the subject tree
PCCF	is crown competition factor on the inventory point where the tree is established
RELHT	is tree height divided by average height of the 40 largest diameter trees in the stand
BA	is total stand basal area
PRD	is relative density of the inventory point (point Zeide SDI / point SDI max)b_1 is a location-specific coefficient shown in table 4.7.1.2
b_2- b_{17}	are species-specific coefficients shown in table 4.7.1.4

Table 4.7.1.1 Mapped species index for each species for large-tree diameter growth in the CA variant.

Alpha Code	Species Index	Alpha Code	Species Index
PC	1	LO	10
IC	1	CY	10
RC	1	BL	10
WF	2	EO	10
RF	3	WO	10
SH	3	BO	10
DF	4	VO	10
WH	7	IO	10
MH	7	BM	10
WB	6	BU	10

Alpha Code	Species Index
KP	5
LP	6
CP	5
LM	5
JP	9
SP	7
WP	8
PP	9
MP	9
GP	5
WJ	5
BR	2
GS	12
PY	5
OS	9

Alpha Code	Species Index
RA	10
MA	11
GC	11
DG	11
FL	10
WN	10
TO	13
SY	10
AS	10
CW	10
WI	10
CN	5
CL	10
OH	10
RW	12

Table 4.7.1.2 b_1 values by location class for equation {4.7.1.1} in the CA variant.

Location Class	Species Index						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1	-3.428338	-2.108357	-2.073942	-1.877695	0.564402	-2.058828	-2.397678
2	-3.966547	0	-1.943608	-2.099646	0	-1.596998	0
3	0	0	0	-2.211587	0	0	0
4	0	0	0	-1.955301	0	0	0
5	0	0	0	-2.078432	0	0	0

Location Class	Species Index					
	8	**9**	**10**	**11**	**12**	**13**
1	-1.626879	-2.922255	-1.958189	-3.3447	0	-0.94563
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0

Table 4.7.1.3 Classification of location class by species index and location code in the CA variant.

Location Code	Species Index												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
505 – Klammath	1	1	1	1	1	1	1	1	1	1	1	1	1
506 – Lassen	1	1	1	2	1	1	1	1	1	1	1	1	1
508 – Mendocino	1	1	1	2	1	1	1	1	1	1	1	1	1
511 – Plumas	1	1	2	1	1	2	1	1	1	1	1	1	1
514 – Shasta-Trinity	2	1	1	3	1	1	1	1	1	1	1	1	1
610 – Rogue River	1	1	1	4	1	1	1	1	1	1	1	1	1
611 - Siskiyou	1	1	1	5	1	1	1	1	1	1	1	1	1
710 – Roseburg	1	1	1	4	1	1	1	1	1	1	1	1	1
711 – Medford	1	1	1	4	1	1	1	1	1	1	1	1	1
712 – Coos Bay	1	1	1	5	1	1	1	1	1	1	1	1	1

Table 4.7.1.4 Coefficients (b_2- b_{17}) for equation {4.7.1.1} in the CA variant.

	Species Index						
Coefficient	**1**	**2**	**3**	**4**	**5**	**6**	**7**
b_2	0	0.0301	0.0248	-0.0141	0	0	0
b_3	0	-0.00030732	-0.00033429	0.00024083	0	0	0
b_4	0.820451	0.365679	0.492695	0.759305	0	0.566946	0.963375
b_5	0	0.09735	0.13918	0.018681	0.951834	0	-0.014463
b_6	0	-0.315227	-0.444594	-0.151727	0.64987	0	-0.280294
b_7	0	-0.206267	0	-0.339369	0	0	-0.581722
b_8	0	0	0	0	0	0	0
b_9	0.950418	1.182104	1.186676	0.716226	1.077154	1.218279	0.88615
b_{10}	1.815305	2.856578	2.763519	3.272451	-0.276387	3.167164	1.47865
b_{11}	0	-1.093354	-0.871061	-1.642904	1.063732	-1.568333	0
b_{12}	-0.0002385	-0.0006362	-0.0004572	-0.0002723	0	-0.0014178	-0.0002528
b_{13}	-0.005433	-0.005992	-0.003728	-0.008787	0	0	-0.006263
b_{14}	-0.000779	-0.001014	0	-0.000224	0	-0.000338	0
b_{15}	0	0	0	0	0	0	0
b_{16}	-0.000016	-0.058039	-0.122905	-0.028564	0	-0.267873	-0.129146
b_{17}	0	0	0	0	-0.000893	0	0

Coefficient	**8**	**9**	**10**	**11**	**12**	**13**
b_2	0	-0.003784	0.0049	0	0	0
b_3	0	0.0000666	-0.00008781	0	0	0
b_4	0.7243	1.011504	0.213526	1.334008	0	0.00659
b_5	-0.562259	0	0	0	0	-0.03587
b_6	-0.17951	0	0	0	0	-0.19935
b_7	-0.544867	0	0	0	0	0.7353
b_8	0	0	0	0	0	-0.99561
b_9	0.825682	0.73875	1.310111	0.955569	0	0.99531
b_{10}	1.675208	3.454857	0.271183	0	0	2.08524
b_{11}	0	-1.773805	0	0	0	-0.98396
b_{12}	-0.0000731	-0.0004708	-0.0003048	0	0	-0.000373
b_{13}	-0.002133	-0.013091	0	-0.005893	0	-0.00147
b_{14}	0	-0.000593	-0.000473	0	0	-0.00018
b_{15}	0	0	0	0	0	0.50155
b_{16}	-0.203636	-0.131185	0	-0.408462	0	0
b_{17}	0	0	0	0	0	0

4.7.2 Large Tree Height Growth

For all species except giant sequoia and redwood, large tree height growth equations in the CA variant are based on site index curves. Species differences in height growth are accounted for by entering the appropriate curve with the species specific site index value. Region 6 forests use

site curves as shown in section 3.4. Region 5 forests use Dunning/Levitan site curves shown in equation {4.7.2.6}.

In the CA variant, each species is mapped into a species index as shown in table 4.7.2.1. The coefficients and equations used for each species will depend on the species index of the subject species.

Table 4.7.2.1 Mapped species index for each species for height growth in the CA variant.

Species Code	Species Index	Species Code	Species Index
PC	3	LO	9
IC	3	CY	9
RC	3	BL	9
WF	3	EO	9
RF	5	WO	7
SH	5	BO	7
DF	3	VO	7
WH	3	IO	9
MH	5	BM	10
WB	6	BU	7
KP	6	RA	10
LP	6	MA	9
CP	6	GC	9
LM	6	DG	7
JP	4	FL	7
SP	3	WN	10
WP	4	TO	8
PP	4	SY	10
MP	4	AS	10
GP	4	CW	10
WJ	6	WI	10
BR	3	CN	10
PY	7	CL	10
OS	3	OH	10

Using a species site index and tree height at the beginning of the projection cycle, an estimated tree age is computed using the site index curves. Estimated current height (ECH) and estimated future height (H10) are both obtained using the equations shown below. Estimated current height is obtained using estimated tree age at the start of the projection cycle and site index. Estimated future height is obtained using estimated tree age at the start of the projection cycle plus 10-years and site index. Height increment is obtained by subtracting estimated current height from estimated future height, then adjusting the difference according to tree's crown ratio and height relative to other trees in the stand.

Region 6 Forests use equations 4.7.2.1 through 4.7.2.5 for all species.

{4.7.2.1} Used for species index 3 and 4

$H = (((SI - 4.5) * TOPTRM / BOTTRM) + 4.5) * 1.05$
$TOPTRM = 1 - \exp(-\exp(b_0 + (b_1 * \ln(SI - 4.5)) + (b_2 * \ln(A))))$
$BOTTRM = 1 - \exp(-\exp(b_0 + (b_1 * \ln(SI - 4.5)) + (b_2 * \ln(50))))$

{4.7.2.2} Used for species index 5

$H = ((SI - 4.5) * (1 - \exp(-X * A^{b_1}))) / (1 - \exp(-Y * 50^{b_1})) + 4.5$
$X = (SI * TERM) + (b_4 * TERM^2) + b_5$
$TERM = A * b_2 * \exp(A * b_3)$
$Y = (SI * TERM2) + (b_4 * TERM2^2) + b_5$
$TERM2 = 50 * b_2 * \exp(50 * b_3)$

{4.7.2.3} Used for species index 6

$H = SI * [b_0 + (b_1 * A) + (b_2 * A^2)] * 1.10$

{4.7.2.4} Used for species index 7

$H = [SI * (1 + (b_1 * TERM)) - (b_0 * TERM)] * 0.70$
$TERM = SQRT(A) - 7.0711$

{4.7.2.5} Used for species index 8, 9, and 10

$H = [SI / (b_0 + (b_1 / A))] * 0.80$

where:

H	is estimated height of the tree
SI	is species site index
A	is estimated age of the tree
$b_0 - b_5$	are species-specific coefficients shown in table 4.7.2.2

Table 4.7.2.2 Coefficients ($b_0 - b_5$) for height-growth equations in the CA variant.

	Species Index							
Coefficient	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
b_0	-6.21693	-6.54707	0	-0.0968	6.413	0.204	0.375	0.649
b_1	0.281176	0.288169	1.51744	0.02679	0.322	39.787	31.233	17.556
b_2	1.14354	1.21297	1.41512E-06	-9.309E-05	0	0	0	0
b_3	0	0	-0.0440853	0	0	0	0	0
b_4	0	0	-3049510.	0	0	0	0	0
b_5	0	0	0.000572474	0	0	0	0	0

Region 5 forests use the Dunning/Levitan site curve { 4.7.2.6} for all species.

{4.7.2.6} Dunning/Levitan site curves

$A > 40$: $H = D_1 + D_2 * \ln(A)$
$A \leq 40$: $H = D_3 * A$

where:

H is estimated height of the tree
A is estimated age of the tree
$D_1 – D_3$ are coefficients based on Region 5 site codes shown in table 4.7.2.3

Table 4.7.2.3 Coefficients for the Dunning/Levitan site curves, nominal site index by site class, and range of Region 6 site values for which the coefficients are used in the CA variant.

Region 5 Site Class	Nominal Site Index	Site Index Range Used	D_1	D_2	D_3
0	106	99+	-88.9	49.7067	2.375
1	90	83 - 98	-82.2	44.1147	2.025
2	75	66 - 82	-78.3	39.1441	1.65
3	56	53 - 65	-82.1	35.416	1.225
4	49	45 - 52	-56	26.7173	1.075
5-7	39	0 - 44	-33.8	18.64	0.875

For both Region 5 and Region 6 forests, potential 10-year height growth (*POTHTG*) is calculated by using equation {4.7.2.8}. Then, modifiers are applied to the height growth based upon a tree's crown ratio (using equation {4.7.2.9}) and relative height (using equation {4.7.2.10}). Equation {4.7.2.11} calculates a height-growth modifier by combining the crown ratio and relative height modifiers. Final height growth is calculated using equation {4.7.2.12} as a product of the modifier and potential height growth. The final height growth is then adjusted to the length of the cycle.

{4.7.2.8} $POTHTG = H10 – ECH$

{4.7.2.9} $HGMDCR = 1 – \exp(-4.26558 * CR)$

{4.7.2.10} $HGMDRH = \exp [2.54119 * (RELHT^{0.250537} – 1.0)]$

{4.7.2.11} $HTGMOD = 1.016605 * HGMDCR * HGMDRH$

{4.7.2.12} $HTG = POTHTG * HTGMOD$

where:

POTHTG is potential height growth
H10 is estimated height of the tree in ten years
ECH is estimated height of the tree at the beginning of the cycle
HGMDCR is a height growth modifier based on crown ratio
HGMDRH is a height growth modifier based on relative height and shade tolerance
HTGMOD is a weighted height growth modifier
CR is crown ratio expressed as a proportion
RELHT is tree height divided by average height of the 40 largest diameter trees in the stand (bounded $RELHT \leq 1$; $RELHT = 1$ if crown competition factor on the inventory point where the tree is located is less than 100)

Equation {4.7.2.13} is used to predict 10-year height increment for giant sequoia and redwood. The final height growth is then adjusted to the length of the cycle.

{4.7.2.13} *HTG* = exp(1.412947+ (-0.000204 * *DBH*^2) + (0.31971 * ln(*DBH*)) + (0.394005 * ln(*SI*))
+ (-(0.399888 * (ln(*DG10*)) + (-0.451708 * ln(*HT*))

where:

HTG	is 10-year height growth increment
DBH	is diameter at breast height
SI	is species site index
DG10	is 10-year outside bark diameter growth increment
HT	is total tree height

A height growth bounding function is used to ensure tree heights do not exceed the height maximum of giant sequoia and redwood. The bounding function is applied using the following concepts. For a tree with height less than the lower height-bounding limit, the height growth modifier is set to 1.0. For a tree with a height greater than or equal to the lower height-bounding limit and less than the upper height-bounding limit, a height growth modifier is computed using equation {4.7.2.14}. For a tree with a height greater than the upper height-bounding limit, the height growth modifier is set to 0.1. The lower bounding limit was determined from the height growth fitting data and the upper bounding limit was determined from literature. The final height increment estimate is multiplied by the bounding function, equation {4.7.2.15}.

{4.7.2.14} *HGBND* = 1.0 – ((*HT* - HTLO) / (*HTHI- HTLO*))

{4.7.2.15} *HTG* = *HTG* * *HGBND*

where:

HGBND	is height growth bounding modifier, limited to $0.1 \leq HGBND \leq 1.0$
HT	is total tree height (ft)
HTLO	is the lower height-bounding limit (217 ft)
HTHI	is the upper height-bounding limit (380 ft)

5.0 Mortality Model

The CA variant uses an SDI-based mortality model as described in Section 7.3.2 of Essential FVS: A User's Guide to the Forest Vegetation Simulator (Dixon 2002, referred to as EFVS). This SDI-based mortality model is comprised of two steps: 1) determining the amount of stand mortality (section 7.3.2.1 of EFVS) and 2) dispersing stand mortality to individual tree records (section7.3.2.2 of EFVS). In determining the amount of stand mortality, the summation of individual tree background mortality rates is used when stand density is below the minimum level for density dependent mortality (default is 55% of maximum SDI), while stand level density-related mortality rates are used when stands are above this minimum level.

The equation used to calculate individual tree background mortality rates for all species is shown in equation {5.0.1}, and this is then adjusted to the length of the cycle by using a compound interest formula as shown in equation {5.0.2}. Species mapping and coefficients for these equations are shown in tables 5.0.1 and 5.0.2. The overall amount of mortality calculated for the stand is the summation of the final mortality rate (*RIP*) across all live tree records.

{5.0.1} $RI = [1 / (1 + \exp(p_0 + p_1 * DBH))] * 0.5$

{5.0.2} $RIP = 1 - (1 - RI)^{\wedge}Y$

where:

RI	is the proportion of the tree record attributed to mortality
RIP	is the final mortality rate adjusted to the length of the cycle
DBH	is tree diameter at breast height
Y	is length of the current projection cycle in years
p_0 and p_1	are species-specific coefficients shown in table 5.0.1

Table 5.0.1 Mapped species index for each species for the mortality model in the CA variant.

Species Code	Species Index	Species Code	Species Index
PC	3	LO	3
IC	3	CY	3
RC	3	BL	3
WF	3	EO	3
RF	3	WO	3
SH	3	BO	3
DF	2	VO	3
WH	4	IO	3
MH	4	BM	3
WB	1	BU	3
KP	1	RA	3
LP	5	MA	3
CP	1	GC	3
LM	1	DG	3

Species Code	Species Index
JP	6
SP	1
WP	1
PP	6
MP	6
GP	6
WJ	3
BR	4
GS	7
PY	3
OS	3

Species Code	Species Index
FL	3
WN	3
TO	3
SY	3
AS	3
CW	3
WI	3
CN	3
CL	3
OH	3
RW	7

Table 5.0.2 Coefficients used in the background mortality equation {5.0.1} in the CA variant.

Species Index	p_0	p_1
1	6.5112	-0.00525
2	7.2985	-0.01291
3	5.1677	-0.00777
4	9.6943	-0.01273
5	5.9617	-0.03401
6	5.5877	-0.00535
7	2.5968	0.51261

When stand density-related mortality is in effect, the total amount of stand mortality is determined based on the trajectory developed from the relationship between stand SDI and the maximum SDI for the stand. This is explained in section 7.3.2.1 of EFVS.

Once the amount of stand mortality is determined based on either the summation of background mortality rates or density-related mortality rates, mortality is dispersed to individual tree records in relation to a tree's percentile in the basal area distribution (*PCT*) using equation {5.0.3}. This value is then adjusted by a species-specific mortality modifier (representing the species' tolerance) to obtain a final mortality rate as shown in equation {5.0.4}.

The mortality model makes multiple passes through the tree records multiplying a record's trees-per-acre value times the final mortality rate (*MORT*), accumulating the results, and reducing the trees-per-acre representation until the desired mortality level has been reached. If the stand still exceeds the basal area maximum sustainable on the site the mortality rates are proportionally adjusted to reduce the stand to the specified basal area maximum.

{5.0.3} *MR* = 0.84525 – (0.01074 * *PCT*) + (0.0000002 * *PCT*^3)

{5.0.4} *MORT* = *MR* * *MWT* * 0.1

where:

MR is the proportion of the tree record attributed to mortality (bounded: 0.01 ≤ *MR* ≤ 1)

PCT is the subject tree's percentile in the basal area distribution of the stand

MORT is the final mortality rate of the tree record

MWT is a mortality weight value based on a species' tolerance shown in table 5.0.3

Table 5.0.3 *MWT* values for the mortality equation {5.0.4} in the CA variant.

Species Code	*MWT*	Species Code	*MWT*
PC	0.6	LO	1.0
IC	0.6	CY	1.0
RC	0.6	BL	1.0
WF	0.55	EO	1.0
RF	0.5	WO	1.0
SH	0.5	BO	1.0
DF	0.65	VO	1.0
WH	0.65	IO	1.0
MH	0.75	BM	0.8
WB	0.9	BU	0.8
KP	0.9	RA	1.0
LP	0.9	MA	0.8
CP	1.1	GC	0.8
LM	0.9	DG	0.8
JP	0.85	FL	0.8
SP	0.7	WN	0.8
WP	0.75	TO	0.55
PP	0.85	SY	0.8
MP	0.85	AS	0.8
GP	1.1	CW	0.8
WJ	1.1	WI	1.0
BR	0.65	CN	1.0
GS	0.8	CL	1.0
PY	0.55	OH	1.0
OS	0.65	RW	0.8

6.0 Regeneration

The CA variant contains a partial establishment model which may be used to input regeneration and ingrowth into simulations. A more detailed description of how the partial establishment model works can be found in section 5.4.5 of the Essential FVS Guide (Dixon 2002).

The regeneration model is used to simulate stand establishment from bare ground, or to bring seedlings and sprouts into a simulation with existing trees. Sprouts are automatically added to the simulation following harvest or burning of known sprouting species (see table 6.0.1 for sprouting species).

Table 6.0.1 Regeneration parameters by species in the CA variant.

Species Code	Sprouting Species	Minimum Bud Width (in)	Minimum Tree Height (ft)	Maximum Tree Height (ft)
PC	No	0.2	0.5	20.0
IC	No	0.2	0.5	20.0
RC	No	0.2	0.3	20.0
WF	No	0.2	0.8	20.0
RF	No	0.2	0.8	20.0
SH	No	0.2	0.8	20.0
DF	No	0.2	0.8	20.0
WH	No	0.2	0.3	20.0
MH	No	0.2	0.5	20.0
WB	No	0.5	1.2	20.0
KP	No	0.5	1	20.0
LP	No	0.4	1	20.0
CP	No	0.5	1	20.0
LM	No	0.5	1	20.0
JP	No	0.5	1	20.0
SP	No	0.5	0.8	20.0
WP	No	0.3	0.8	20.0
PP	No	0.5	1	20.0
MP	No	0.5	0.8	20.0
GP	No	0.5	1.2	20.0
WJ	No	0.3	1	20.0
BR	No	0.3	0.5	20.0
GS	No	0.3	1	20.0
PY	Yes	0.3	0.3	20.0
OS	No	0.3	0.8	20.0
LO	Yes	0.2	1	20.0
CY	Yes	0.2	0.5	20.0
BL	Yes	0.2	1	20.0
EO	Yes	0.2	1	20.0

Species Code	Sprouting Species	Minimum Bud Width (in)	Minimum Tree Height (ft)	Maximum Tree Height (ft)
WO	Yes	0.2	0.8	20.0
BO	Yes	0.2	1	20.0
VO	Yes	0.2	0.8	20.0
IO	Yes	0.2	1	20.0
BM	Yes	0.2	0.5	20.0
BU	Yes	0.3	0.8	20.0
RA	Yes	0.1	0.8	20.0
MA	Yes	0.1	0.5	20.0
GC	Yes	0.2	0.8	20.0
DG	Yes	0.1	0.5	20.0
FL	Yes	0.3	0.8	20.0
WN	Yes	0.4	1	20.0
TO	Yes	0.2	0.5	20.0
SY	Yes	0.2	1	20.0
AS	Yes	0.1	1.2	20.0
CW	Yes	0.1	1.2	20.0
WI	Yes	0.1	1	20.0
CN	Yes	0.2	0.3	20.0
CL	Yes	0.2	0.5	20.0
OH	No	0.2	0.75	20.0
RW	Yes	0.3	1	20.0

The number of sprout records created for each sprouting species is found in table 6.0.2. For more prolific stump sprouting hardwood species, logic rule {6.0.1} is used to determine the number of sprout records, with logic rule {6.0.2} being used for root suckering species. The trees-per-acre represented by each sprout record is determined using the general sprouting probability equation {6.0.3}. See table 6.0.2 for species-specific sprouting probabilities, number of sprout records created, and reference information.

Users wanting to modify or turn off automatic sprouting can do so with the SPROUT or NOSPROUT keywords, respectively. Sprouts are not subject to maximum and minimum tree heights found in table 6.0.1 and do not need to be grown to the end of the cycle because estimated heights and diameters are end of cycle values.

{6.0.1} For stump sprouting hardwood species

$DSTMP_i \leq 5$: $NUMSPRC = 1$
$5 < DSTMP_i \leq 10$: $NUMSPRC = \text{NINT}(0.2 * DSTMP_i)$
$DSTMP_i > 10$: $NUMSPRC = 2$

{6.0.2} For root suckering hardwood species

$DSTMP_i \leq 5$: $NUMSPRC = 1$
$5 < DSTMP_i \leq 10$: $NUMSPRC = \text{NINT}(-1.0 + 0.4 * DSTMP_i)$

$DSTMP_i$ > 10: *NUMSPRC* = 3

{6.0.3} $TPA_s = TPA_i * PS$

{6.0.4} *PS* = ((70.7857 - 2.6071 * $DSTMP_i$) / 100)

{6.0.5} *PS* = ((99.9 - 3.8462 * $DSTMP_i$) / 100)

{6.0.6} *PS* = (TPA_i / (*ASTPAR* * 2)) * ((*ASBAR* / 198) * (40100.45 - 3574.02 * *RSHAG*^2 + 554.02 * *RSHAG*^3 - 3.5208 * *RSHAG*^5 + 0.011797 * *RSHAG*^7))

{6.0.7} *PS* = ((93.2669 - 0.4303 * $DSTMP_i$) / 100)

where:

$DSTMP_i$	is the diameter at breast height of the parent tree
NUMSPRC	is the number of sprout tree records
NINT	rounds the value to the nearest integer
TPA_s	is the trees per acre represented by each sprout record
TPA_i	is the trees per acre removed/killed represented by the parent tree
PS	is a sprouting probability (see table 6.0.2)
ASBAR	is the aspen basal area removed
ASTPAR	is the aspen trees per acre removed
RSHAG	is the age of the sprouts at the end of the cycle in which they were created

Table 6.0.2 Sprouting algorithm parameters for sprouting species in the CA variant.

Species Code	Sprouting Probability	Number of Sprout Records	Source
PY	0.4	1	Minore 1996 Ag. Handbook 654
LO	0.5	{6.0.1}	See canyon live oak (CY)
CY	0.5	{6.0.1}	Conard 1987 Thornburgh 1990 Paysen et al. 1991
BL	{6.0.4}	{6.0.1}	McCreary et al. 2000 Standiford et al. 2011
EO	0.9	{6.0.1}	Caprio and Zwolinski 1992 Howard 1992
WO	0.9	{6.0.1}	Roy 1955 Gucker 2007
BO	0.9	{6.0.1}	McDonald 1978 McDonald 1990
VO	0.9	{6.0.1}	Howard 1992
IO	0.5	{6.0.1}	See canyon live oak (CY)
BM	0.9	{6.0.2}	Roy 1955 Tappenier et al. 1996 Ag. Handbook 654
BU	0.8	{6.0.1}	Howard 1992

Species Code	Sprouting Probability	Number of Sprout Records	Source
RA	{6.0.5}	1	Harrington 1984 Uchytil 1989
MA	0.9	{6.0.2}	McDonald et al. 1983 McDonald and Tappenier 1990
GC	0.9	{6.0.2}	Harrington et al. 1992 Meyer 2012
DG	0.9	{6.0.1}	Gucker 2005
FL	0.8	{6.0.1}	Sterrett 1915 Ag. Handbook 654
WN	0.8 for DBH < 8”, 0.5 for DBH > 8”	1	Schlesinger 1977 Schlesinger 1989
TO	0.9	{6.0.2}	Harrington et al. 1992 Wilkinson et al. 1997 Fryer 2008
SY	0.7	1	Davis et al. 1989 Esser 1993
AS	{6.0.6}	2	Keyser 2001
CW	0.9	{6.0.2}	Gom and Rood 2000 Steinberg 2001
WI	0.9	1	Ag. Handbook 654
CN	0.8	1	Burke 1975 Howard 1992
CL	0.9	{6.0.2}	Paysen et al. 1991 Ag. Handbook 654
RW	{6.0.7}	{6.0.2}	Neal 1967 Boe 1975 Griffith 1992

Regeneration of seedlings must be specified by the user with the partial establishment model by using the PLANT or NATURAL keywords. Height of the seedlings is estimated in two steps. First, the height is estimated when a tree is 5 years old (or the end of the cycle – whichever comes first) by using the small-tree height growth equations found in section 4.6.1. Users may override this value by entering a height in field 6 of the PLANT or NATURAL keyword; however the height entered in field 6 is not subject to minimum height restrictions and seedlings as small as 0.05 feet may be established. The second step also uses the equations in section 4.6.1, which grow the trees in height from the point five years after establishment to the end of the cycle.

Seedlings and sprouts are passed to the main FVS model at the end of the growth cycle in which regeneration is established. Unless noted above, seedlings being passed are subject to

minimum and maximum height constraints and a minimum budwidth constraint shown in table 6.0.1. After seedling height is estimated, diameter growth is estimated using equations described in section 4.6.2. Crown ratios on newly established trees are estimated as described in section 4.3.1.

Regenerated trees and sprouts can be identified in the treelist output file with tree identification numbers beginning with the letters “ES”.

7.0 Volume

In the CA variant, volume is calculated for three merchantability standards: total stem cubic feet, merchantable stem cubic feet, and merchantable stem board feet (Scribner Decimal C (R5) and Scribner (R6)). Volume estimation is based on methods contained in the National Volume Estimator Library maintained by the Forest Products Measurements group in the Forest Management Service Center (Volume Estimator Library Equations 2009). The default volume merchantability standards and equation numbers for the CA variant are shown in tables 7.0.1-7.0.4.

Table 7.0.1 Volume merchantability standards for the CA variant.

Merchantable Cubic Foot Volume Specifications:		
Minimum DBH / Top Diameter	KP	All Other Species
Region 5	6.0 / 6.0 inches	7.0 / 6.0 inches
Region 6	6.0 / 4.5 inches	7.0 / 4.5 inches
Stump Height	1.0 foot	1.0 foot
Merchantable Board Foot Volume Specifications:		
Minimum DBH / Top Diameter	KP	All Other Species
Region 5	6.0 / 6.0 inches	7.0 / 6.0 inches
Region 6	6.0 / 4.5 inches	7.0 / 4.5 inches
Stump Height	1.0 foot	1.0 foot

Table 7.0.2 Volume equation defaults for each species, at specific location codes, with model name.

Common Name	Location Code	Equation Number	Reference
Port Orford cedar	505, 506, 508, 511, 514	500WO2W081	Wensel and Olsen Profile Model
Port Orford cedar	610, 611	616BEHW000	Behre's Hyperbola
Port Orford cedar	710, 711, 712	B00BEHW081	Behre's Hyperbola
incense cedar	505, 506, 508, 511, 514	500WO2W081	Wensel and Olsen Profile Model
incense cedar	610, 611	616BEHW081	Behre's Hyperbola
incense cedar	710, 711, 712	B00BEHW081	Behre's Hyperbola
western redcedar	505, 506, 508, 511, 514	500WO2W081	Wensel and Olsen Profile Model
western redcedar	610, 611	616BEHW242	Behre's Hyperbola
western redcedar	710, 711, 712	B00BEHW242	Behre's Hyperbola
white fir	505, 506, 508, 511, 514	500WO2W015	Wensel and Olsen Profile Model
white fir	610, 611	I00FW2W093	Flewelling's 2-Point Profile Model

Common Name	Location Code	Equation Number	Reference
white fir	710, 711, 712	B00BEHW015	Behre's Hyperbola
California red fir	505, 506, 508, 511, 514	500WO2W020	Wensel and Olsen Profile Model
California red fir	610, 611	616BEHW020	Behre's Hyperbola
California red fir	710, 711, 712	B00BEHW021	Behre's Hyperbola
Shasta red fir	505, 506, 508, 511, 514	500WO2W020	Wensel and Olsen Profile Model
Shasta red fir	610, 611	616BEHW021	Behre's Hyperbola
Shasta red fir	710, 711, 712	B00BEHW021	Behre's Hyperbola
Douglas-fir	505, 506, 508, 511, 514	500WO2W202	Wensel and Olsen Profile Model
Douglas-fir	610, 611	F06FW2W202	Flewelling's 2-Point Profile Model
Douglas-fir	710, 711	B01BEHW202	Behre's Hyperbola
Douglas-fir	712	B02BEHW202	Behre's Hyperbola
western hemlock	505, 506, 508, 511, 514	500WO2W015	Wensel and Olsen Profile Model
western hemlock	610, 611	616BEHW263	Behre's Hyperbola
western hemlock	710, 711, 712	B00BEHW263	Behre's Hyperbola
mountain hemlock	505, 506, 508, 511, 514	500WO2W015	Wensel and Olsen Profile Model
mountain hemlock	610, 611	616BEHW264	Behre's Hyperbola
mountain hemlock	710, 711, 712	B00BEHW260	Behre's Hyperbola
whitebark pine	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
whitebark pine	610, 611	616BEHW101	Behre's Hyperbola
whitebark pine	710, 711, 712	B00BEHW119	Behre's Hyperbola
knobcone pine	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
knobcone pine	610, 611	616BEHW103	Behre's Hyperbola
knobcone pine	710, 711, 712	B00BEHW108	Behre's Hyperbola
lodgepole pine	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
lodgepole pine	610, 611	616BEHW108	Behre's Hyperbola
lodgepole pine	710, 711, 712	B00BEHW108	Behre's Hyperbola
Coulter pine	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
Coulter pine	610, 611	616BEHW000	Behre's Hyperbola
Coulter pine	710, 711, 712	B00BEHW108	Behre's Hyperbola

Common Name	Location Code	Equation Number	Reference
limber pine	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
limber pine	610, 611	616BEHW113	Behre's Hyperbola
limber pine	710, 711, 712	B00BEHW108	Behre's Hyperbola
Jeffrey pine	505, 506, 508,511, 514	500WO2W116	Wensel and Olsen Profile Model
Jeffrey pine	610, 611	616BEHW116	Behre's Hyperbola
Jeffrey pine	710, 711, 712	B00BEHW116	Behre's Hyperbola
sugar pine	505, 506, 508, 511, 514	500WO2W117	Wensel and Olsen Profile Model
sugar pine	610, 611	616BEHW117	Behre's Hyperbola
sugar pine	710, 711, 712	B00BEHW117	Behre's Hyperbola
western white pine	505, 506, 508, 511, 514	500WO2W117	Wensel and Olsen Profile Model
western white pine	610, 611	616BEHW119	Behre's Hyperbola
western white pine	710, 711, 712	B00BEHW119	Behre's Hyperbola
ponderosa pine	505, 506, 508, 511, 514	500WO2W122	Wensel and Olsen Profile Model
ponderosa pine	610, 611	I00FW2W073	Flewelling's 2-Point Profile Model
ponderosa pine	710, 711, 712	B00BEHW122	Behre's Hyperbola
Monterey pine	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
Monterey pine	610, 611	616BEHW000	Behre's Hyperbola
Monterey pine	710, 711, 712	B00BEHW108	Behre's Hyperbola
California foothill pine	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
California foothill pine	610, 611	616BEHW000	Behre's Hyperbola
California foothill pine	710, 711, 712	B00BEHW108	Behre's Hyperbola
western juniper	505, 506, 508, 511, 514	500DVEW060	Pillsbury and Kirkley Equations
western juniper	610, 611	616BEHW064	Pillsbury and Kirkley Equations
western juniper	710, 711, 712	B00BEHW242	Behre's Hyperbola
Brewer spruce	505, 506, 508, 511, 514	500WO2W015	Wensel and Olsen Profile Model
Brewer spruce	610, 611	616BEHW000	Behre's Hyperbola
Brewer spruce	710, 711, 712	B00BEHW093	Behre's Hyperbola

Common Name	Location Code	Equation Number	Reference
giant sequoia	505, 506, 508, 511, 514	500DVEW212	Pillsbury and Kirkley Equations
giant sequoia	610, 611	616BEHW000	Behre's Hyperbola
giant sequoia	710, 711, 712	B00BEHW211	Behre's Hyperbola
Pacific yew	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
Pacific yew	610, 611	616BEHW231	Behre's Hyperbola
Pacific yew	710, 711, 712	B00BEHW231	Behre's Hyperbola
other softwood	505, 506, 508, 511, 514	500WO2W108	Wensel and Olsen Profile Model
other softwood	610, 611	616BEHW299	Behre's Hyperbola
other softwood	710, 711, 712	B00BEHW999	Behre's Hyperbola
California live oak	505, 506, 508, 511, 514	500DVEW801	Pillsbury and Kirkley Equations
California live oak	610, 611	616BEHW000	Behre's Hyperbola
California live oak	710, 711, 712	B00BEHW800	Behre's Hyperbola
canyon live oak	505, 506, 508, 511, 514	500DVEW805	Pillsbury and Kirkley Equations
canyon live oak	610, 611	616BEHW000	Behre's Hyperbola
canyon live oak	710, 711, 712	B00BEHW800	Behre's Hyperbola
blue oak	505, 506, 508, 511, 514	500DVEW807	Pillsbury and Kirkley Equations
blue oak	610, 611	616BEHW000	Behre's Hyperbola
blue oak	710, 711, 712	B00BEHW800	Behre's Hyperbola
Engelmann oak	505, 506, 508, 511, 514	500DVEW811	Pillsbury and Kirkley Equations
Engelmann oak	610, 611	616BEHW000	Behre's Hyperbola
Engelmann oak	710, 711, 712	B00BEHW800	Behre's Hyperbola
Oregon white oak	505, 506, 508, 511, 514	500DVEW815	Pillsbury and Kirkley Equations
Oregon white oak	610, 611	616BEHW815	Behre's Hyperbola
Oregon white oak	710, 711, 712	B00BEHW800	Behre's Hyperbola
California black oak	505, 506, 508, 511, 514	500DVEW818	Pillsbury and Kirkley Equations
California black oak	610, 611	616BEHW818	Behre's Hyperbola
California black oak	710, 711, 712	B00BEHW800	Behre's Hyperbola
valley oak	505, 506, 508, 511, 514	500DVEW821	Pillsbury and Kirkley Equations
valley oak	610, 611	616BEHW000	Behre's Hyperbola

Common Name	Location Code	Equation Number	Reference
valley oak	710, 711, 712	B00BEHW800	Behre's Hyperbola
interior live oak	505, 506, 508, 511, 514	500DVEW839	Pillsbury and Kirkley Equations
interior live oak	610, 611	616BEHW000	Behre's Hyperbola
interior live oak	710, 711, 712	B00BEHW800	Behre's Hyperbola
bigleaf maple	505, 506, 508, 511, 514	500DVEW312	Pillsbury and Kirkley Equations
bigleaf maple	610, 611	616BEHW312	Behre's Hyperbola
bigleaf maple	710, 711, 712	B00BEHW312	Behre's Hyperbola
California buckeye	505, 506, 508, 511, 514	500DVEW807	Pillsbury and Kirkley Equations
California buckeye	610, 611	616BEHW000	Behre's Hyperbola
California buckeye	710, 711, 712	B00BEHW800	Behre's Hyperbola
red alder	505, 506, 508, 511, 514	500DVEW351	Pillsbury and Kirkley Equations
red alder	610, 611	616BEHW351	Behre's Hyperbola
red alder	710, 711, 712	B00BEHW351	Behre's Hyperbola
Pacific madrone	505, 506, 508, 511, 514	500DVEW361	Pillsbury and Kirkley Equations
Pacific madrone	610, 611	616BEHW361	Behre's Hyperbola
Pacific madrone	710, 711, 712	B00BEHW361	Behre's Hyperbola
giant chinquapin	505, 506, 508, 511, 514	500DVEW431	Pillsbury and Kirkley Equations
giant chinquapin	610, 611	616BEHW431	Behre's Hyperbola
giant chinquapin	710, 711, 712	B00BEHW431	Behre's Hyperbola
Pacific dogwood	505, 506, 508, 511, 514	500DVEW807	Pillsbury and Kirkley Equations
Pacific dogwood	610, 611	616BEHW492	Behre's Hyperbola
Pacific dogwood	710, 711, 712	B00BEHW999	Behre's Hyperbola
Oregon ash	505, 506, 508, 511, 514	500DVEW807	Pillsbury and Kirkley Equations
Oregon ash	610, 611	616BEHW000	Behre's Hyperbola
Oregon ash	710, 711, 712	B00BEHW312	Behre's Hyperbola
walnut	505, 506, 508, 511, 514	500DVEW818	Pillsbury and Kirkley Equations
walnut	610, 611	616BEHW000	Behre's Hyperbola
walnut	710, 711, 712	B00BEHW999	Behre's Hyperbola
tanoak	505, 506, 508, 511, 514	500DVEW631	Pillsbury and Kirkley Equations

Common Name	Location Code	Equation Number	Reference
tanoak	610, 611	616BEHW631	Behre's Hyperbola
tanoak	710, 711, 712	B00BEHW631	Behre's Hyperbola
California sycamore	505, 506, 508, 511, 514	500DVEW818	Pillsbury and Kirkley Equations
California sycamore	610, 611	616BEHW000	Behre's Hyperbola
California sycamore	710, 711, 712	B00BEHW800	Behre's Hyperbola
quaking aspen	505, 506, 508, 511, 514	500DVEW818	Pillsbury and Kirkley Equations
quaking aspen	610, 611	616BEHW746	Behre's Hyperbola
quaking aspen	710, 711, 712	B00BEHW999	Behre's Hyperbola
black cottonwood	505, 506, 508, 511, 514	500DVEW818	Pillsbury and Kirkley Equations
black cottonwood	610, 611	616BEHW747	Behre's Hyperbola
black cottonwood	710, 711, 712	B00BEHW747	Behre's Hyperbola
Willow	505, 506, 508, 511, 514	500DVEW807	Pillsbury and Kirkley Equations
Willow	610, 611	616BEHW920	Behre's Hyperbola
Willow	710, 711, 712	B00BEHW999	Behre's Hyperbola
California nutmeg	505, 506, 508, 511, 514	500DVEW807	Pillsbury and Kirkley Equations
California nutmeg	610, 611	616BEHW000	Behre's Hyperbola
California nutmeg	710, 711, 712	B00BEHW231	Behre's Hyperbola
California laurel	505, 506, 508, 511, 514	500DVEW981	Pillsbury and Kirkley Equations
California laurel	610, 611	616BEHW000	Behre's Hyperbola
California laurel	710, 711, 712	B00BEHW631	Behre's Hyperbola
other hardwood	505, 506, 508, 511, 514	500DVEW801	Pillsbury and Kirkley Equations
other hardwood	610, 611	616BEHW998	Behre's Hyperbola
other hardwood	710, 711, 712	B00BEHW999	Behre's Hyperbola
redwood	505, 506, 508, 511, 514	500WO2W211	Wensel and Olsen Profile Model
redwood	610, 611	616BEHW211	Behre's Hyperbola
redwood	710, 711, 712	B00BEHW211	Behre's Hyperbola

Table 7.0.3 Citations by Volume Model

Model Name	Citation
Behre's Hyperbola	USFS-R6 Sale Preparation and Valuation Section of Diameter and Volume Procedures - R6 Timber Cruise System. 1978.

Model Name	Citation
Flewelling 2-Point Profile Model	Unpublished. Based on work presented by Flewelling and Raynes. 1993. Variable-shape stem-profile predictions for western hemlock. Canadian Journal of Forest Research Vol 23. Part I and Part II.
Pillsbury and Kirkley Equations	Norman H Pillsbury and Michael L Kirkley 1984 Equations for Total, Wood, and saw-Log Volume for Thirteen California Hardwoods. Pacific Northwest Forest and Range Experiment Station Research Note PNW-414.
Wensel and Olsen Profile Model	Wensel, L. C. and C. M. Olson. 1993. Tree Taper Models for Major Commercial California Conifers. Research Note No. 33. Northern Calif. Forest Yield Cooperative. Dept. of Forstry and Mgmt., Univ. of Calif., Berkeley. 28 pp.

Table 7.0.4 Species-specific default form class values for the CA variant.

Species Code	Behre's Hyperbola Equation Number	Form Class				
		0<DBH<11	11<=DBH<21	21<=DBH<31	31<=DBH<41	DBH>=41
Rogue River NF (610)						
PC	616BEHW000	95	82	76	74	74
IC	616BEHW081	94	94	78	75	74
RC	616BEHW242	95	82	76	75	74
WF*	616BEHW015	96	91	84	83	82
RF	616BEHW020	95	82	76	74	74
SH	616BEHW021	94	90	84	82	81
DF*	616BEHW202	94	87	82	81	81
WH	616BEHW263	91	82	79	78	78
MH	616BEHW264	96	83	79	77	76
WB	616BEHW101	92	92	92	92	87
KP	616BEHW103	95	79	78	78	78
LP	616BEHW108	95	79	78	78	76
CP	616BEHW000	95	95	95	82	82
LM	616BEHW113	95	95	95	82	82
JP	616BEHW116	93	93	86	83	81
SP	616BEHW117	94	90	84	82	82
WP	616BEHW119	94	87	83	82	81
PP*	616BEHW122	93	93	83	81	80
MP	616BEHW000	95	82	79	78	78
GP	616BEHW000	95	95	82	79	78
WJ	616BEHW064	95	95	95	95	95

Species Code	Behre's Hyperbola Equation Number	Form Class				
		0<DBH<11	11<=DBH<21	21<=DBH<31	31<=DBH<41	DBH>=41
BR	616BEHW000	93	89	86	84	84
GS	616BEHW000	95	82	76	74	74
PY	616BEHW231	98	98	98	98	88
OS	616BEHW298	95	95	82	79	78
LO	616BEHW000	95	95	86	82	82
CY	616BEHW000	94	94	85	80	80
BL	616BEHW000	95	95	95	86	86
EO	616BEHW000	95	95	95	86	86
WO	616BEHW815	89	89	89	89	89
BO	616BEHW818	98	88	84	81	81
VO	616BEHW000	95	79	78	76	76
IO	616BEHW000	95	95	95	95	95
BM	616BEHW312	98	84	81	80	79
BU	616BEHW000	95	95	95	95	95
RA	616BEHW351	98	84	81	80	80
MA	616BEHW361	95	86	82	79	79
GC	616BEHW431	95	86	78	76	75
DG	616BEHW492	94	94	85	80	80
FL	616BEHW000	98	88	81	81	80
WN	616BEHW000	95	95	86	82	82
TO	616BEHW631	98	88	80	78	77
SY	616BEHW000	95	95	95	95	95
AS	616BEHW746	98	98	98	98	98
CW	616BEHW747	98	80	78	77	77
WI	616BEHW920	98	98	98	98	98
CN	616BEHW000	95	95	95	95	95
CL	616BEHW000	95	86	82	79	78
OH	616BEHW998	95	95	95	95	95
RW	616BEHW211	82	82	79	78	78
Siskiyou NF (611)						
PC	616BEHW000	94	90	84	82	81
IC	616BEHW081	89	89	75	71	71
RC	616BEHW242	96	83	78	76	76
WF*	616BEHW015	93	93	86	85	85
RF	616BEHW020	92	87	82	80	79

Species Code	Behre's Hyperbola Equation Number	Form Class				
		0<DBH<11	11<=DBH<21	21<=DBH<31	31<=DBH<41	DBH>=41
SH	616BEHW021	96	96	90	87	87
DF*	616BEHW202	93	86	81	80	80
WH	616BEHW263	93	93	90	89	88
MH	616BEHW264	93	89	84	82	81
WB	616BEHW101	91	91	91	91	86
KP	616BEHW103	96	88	86	86	86
LP	616BEHW108	96	88	86	86	85
CP	616BEHW000	91	91	91	86	86
LM	616BEHW113	91	91	91	86	86
JP	616BEHW116	93	93	86	83	81
SP	616BEHW117	96	91	85	84	83
WP	616BEHW119	96	88	84	83	82
PP*	616BEHW122	93	93	83	81	80
MP	616BEHW000	91	86	84	82	82
GP	616BEHW000	91	91	86	84	82
WJ	616BEHW064	91	91	91	91	91
BR	616BEHW000	93	89	86	84	84
GS	616BEHW000	91	86	81	79	78
PY	616BEHW231	88	88	88	88	80
OS	616BEHW298	91	91	86	84	82
LO	616BEHW000	95	95	86	82	82
CY	616BEHW000	95	95	86	82	82
BL	616BEHW000	95	95	95	86	86
EO	616BEHW000	95	95	95	86	86
WO	616BEHW815	95	95	95	95	95
BO	616BEHW818	98	88	84	81	81
VO	616BEHW000	95	79	78	76	76
IO	616BEHW000	95	95	95	95	95
BM	616BEHW312	98	84	81	80	79
BU	616BEHW000	95	95	95	95	95
RA	616BEHW351	91	86	84	82	82
MA	616BEHW361	98	88	84	81	81
GC	616BEHW431	95	86	78	76	75
DG	616BEHW492	98	98	88	84	84
FL	616BEHW000	98	88	81	81	80

Species Code	Behre's Hyperbola Equation Number	Form Class				
		0<DBH<11	11<=DBH<21	21<=DBH<31	31<=DBH<41	DBH>=41
WN	616BEHW000	95	95	86	82	82
TO	616BEHW631	91	91	82	80	79
SY	616BEHW000	95	95	95	95	95
AS	616BEHW746	95	95	95	95	95
CW	616BEHW747	92	83	81	80	80
WI	616BEHW920	92	92	92	92	92
CN	616BEHW000	95	95	95	95	95
CL	616BEHW000	95	86	82	79	78
OH	616BEHW998	95	95	95	95	95
RW	616BEHW211	82	82	79	78	78

*Species whose default volume equation at this location code is not Behre's Hyperbola (see Table 7.0.2).

BLM Locations:		710	711	712
PC	B00BEHW081	73	70	70
IC	B00BEHW081	86	78	78
RC	B00BEHW242	80	78	78
WF	B00BEHW015	87	91	91
RF	B00BEHW021	76	78	75
SH	B00BEHW021	76	78	75
DF	B02BEHW202	89	87	87
WH	B00BEHW263	91	91	92
MH	B00BEHW260	76	70	72
WB	B00BEHW119	80	73	80
KP	B00BEHW108	80	68	80
LP	B00BEHW108	80	68	80
CP	B00BEHW108	80	68	80
LM	B00BEHW108	80	68	80
JP	B00BEHW116	80	70	75
SP	B00BEHW117	91	84	91
WP	B00BEHW119	80	76	80
PP	B00BEHW122	88	85	88
MP	B00BEHW108	80	68	80
GP	B00BEHW108	80	68	80
WJ	B00BEHW242	76	70	60
BR	B00BEHW093	76	74	76
GS	B00BEHW211	76	70	75
PY	B00BEHW231	76	76	70

BLM Locations:		710	711	712
OS	B00BEHW999	76	70	74
LO	B00BEHW800	80	80	80
CY	B00BEHW800	80	80	80
BL	B00BEHW800	80	80	80
EO	B00BEHW800	80	80	80
WO	B00BEHW800	80	80	80
BO	B00BEHW800	80	80	80
VO	B00BEHW800	80	80	80
IO	B00BEHW800	80	80	80
BM	B00BEHW312	84	84	84
BU	B00BEHW800	80	80	80
RA	B00BEHW351	88	88	91
MA	B00BEHW361	81	81	86
GC	B00BEHW431	83	83	86
DG	B00BEHW999	83	83	83
FL	B00BEHW312	84	84	84
WN	B00BEHW999	83	83	83
TO	B00BEHW631	84	84	86
SY	B00BEHW800	80	80	80
AS	B00BEHW999	76	72	75
CW	B00BEHW747	76	72	74
WI	B00BEHW999	75	75	75
CN	B00BEHW231	76	76	70
CL	B00BEHW631	84	84	86
OH	B00BEHW999	76	70	74
RW	B00BEHW211	75	75	75

8.0 Fire and Fuels Extension (FFE-FVS)

The Fire and Fuels Extension to the Forest Vegetation Simulator (FFE-FVS) (Reinhardt and Crookston 2003) integrates FVS with models of fire behavior, fire effects, and fuel and snag dynamics. This allows users to simulate various management scenarios and compare their effect on potential fire hazard, surface fuel loading, snag levels, and stored carbon over time. Users can also simulate prescribed burns and wildfires and get estimates of the associated fire effects such as tree mortality, fuel consumption, and smoke production, as well as see their effect on future stand characteristics. FFE-FVS, like FVS, is run on individual stands, but it can be used to provide estimates of stand characteristics such as canopy base height and canopy bulk density when needed for landscape-level fire models.

For more information on FFE-FVS and how it is calibrated for the CA variant, refer to the updated FFE-FVS model documentation (Rebain, comp. 2010) available on the FVS website.

9.0 Insect and Disease Extensions

The FVS Insect and Pathogen model for dwarf mistletoe has been developed for the CA variant through the participation and contribution of various organizations led by Forest Health Protection. This model is currently maintained by the Forest Management Service Center and regional Forest Health Protection specialists. Additional details regarding this model may be found in chapter 8 of the Essential FVS Users Guide (Dixon 2002).

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11.0 Appendices

11.1 Appendix A: Plant Association Codes

Table 11.1.1 Region 5 plant association codes recognized in the CA variant.

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
1 = 2TE/BEOC2 Conifer/water birch	43014	501 – Manning & Padgett
2 =2TE/ROWO Conifer/wood's rose	43015	501 – Manning & Padget
3 = 2TE/2FORB Conifer/tall forb	43016	501 – Manning & Padgett
4 = 2TE/2FORB Conifer/mesic forb	43017	501 – Manning & Padget
5 = PICO/CASC12 Lodgepole pine/mountain sedge	43031	501 – Manning & Padgett
6 = POTR5/BEOC2 Quaking aspen/water birch	43061	501 – Manning & Padget
7 = POTR5/COSE16 Quaking aspen/redosier dogwood	43062	501 – Manning & Padgett
8 = POTR5/SALIX Quaking aspen/willow	43063	501 – Manning & Padget
9 = POTR5/ROWO Quaking aspen/woods' rose	43064	501 – Manning & Padgett
10 = POTR5/BRCA5 Quaking aspen/California brome	43065	501 – Manning & Padget
11 = POTR5/POPR Quaking aspen/Kentucky bluegrass	43066	501 – Manning & Padgett
12 = POTR5/2FORB Quaking aspen/mesic forb	43067	501 – Manning & Padget
13 = POPUL/BEOC2 Cottonwood/water birch	43071	501 – Manning & Padgett
14 = POPUL/COSE16 Cottonwood/redosier dogwood	43072	501 – Manning & Padget
15 = POPUL/SALIX Cottonwood/willow	43073	501 – Manning & Padgett
16 = POPUL/ROWO Cottonwood/woods' rose	43074	501 – Manning & Padget
17 = POPUL/RHAR4 Cottonwood/fragrant sumac	43075	501 – Manning & Padgett
18 = POPUL Cottonwood (stream bar)	43076	501 – Manning & Padget
19 = ALIN2 Gray alder (bench)	43106	501 – Manning & Padgett
20 = BEOC2/2GRAM Water birch/mesic graminoid	43153	501 – Manning & Padget
21 = BEOC2/EQAR Water birch/field horsetail	43154	501 – Manning & Padgett
22 = BEOC2 Water birch (bench)	43156	501 – Manning & Padget
23 = SAEX/ROWO Narrowleaf willow/woods' rose	43246	501 – Manning & Padgett
24 = SAEX Narrowleaf willow (bench)	43267	501 – Manning & Padget
25 = SALE/CASC12 Lemmons willow/mountain sedge	43261	501 – Manning & Padgett
26 = SALE/2GRAM Lemmons willow/mesic graminoid	43262	501 – Manning & Padget

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
27 = SALE/2FORB Lemmons willow/mesic forb	43263	501 – Manning & Padgett
28 = SALE/2FORB Lemons willow/tall forb	43264	501 – Manning & Padget
29 = SALE Lemmons willow (seep)	43265	501 – Manning & Padgett
30 = SALE Lemmons willow (bench)	43266	501 – Manning & Padget
31 = SALU2/2GRAM Yellow willow/ mesic graminoid	43272	501 – Manning & Padgett
32 = SALU2/2FORB Yellow willow/mesic forb	43273	501 – Manning & Padget
33 = SALU2/ROWO Yellow willow/woods' rose	43274	501 – Manning & Padgett
34 = SALU2/POPR Yellow willow/Kentucky bluegrass	43275	501 – Manning & Padget
35 = SALU2 Yellow willow (bench)	43276	501 – Manning & Padgett
36 = SADR Drummond's willow	43282	501 – Manning & Padget
37 = SALUL/2FORB Pacific willow/mesic forb	43284	501 – Manning & Padgett
38 = SALUL Pacific willow (bench)	43285	501 – Manning & Padget
39 = SALA6/ROWO Arroyo willow/woods' rose	43287	501 – Manning & Padgett
40 = SALA6 Arroyo willow (bench)	43288	501 – Manning & Padget
41 = SALIX/CARO6 Willow/beaked sedge	43289	501 – Manning & Padgett
42 = SALIX/2GRAM Willow/mesic graminoid	43290	501 – Manning & Padget
43 = SALIX/2FORB Willow/mesic forb	43291	501 – Manning & Padgett
44 = SALIX/2FORB Willow/tall forb	43292	501 – Manning & Padget
45 = SALIX/ROWO Willow/woods' rose	43293	501 – Manning & Padgett
46 = SALIX/POPR Willow/Kentucky bluegrass	43294	501 – Manning & Padget
47 = SAWO/CASC12 Wolf's willow/mountain sedge	43304	501 – Manning & Padgett
48 = SAPL2/CASC12 Diamondleaf willow/mountain sedge	43325	501 – Manning & Padget
49 = SAEA/CASC12 Mountain willow/mountain sedge	43327	501 – Manning & Padgett
50 = SAOR/2FORB Sierra willow/tall forb	43328	501 – Manning & Padget
51 = SALIX/2FORB Willow/mesic forb	43329	501 – Manning & Padgett
52 = COSE16 Redosier dogwood	43351	501 – Manning & Padget
53 = COSE16/SALIX Redosier dogwood-willow	43352	501 – Manning & Padgett
54 = PRVI/ROWO Chokecherry/woods' rose	43451	501 – Manning & Padget
55 = ROWO Woods' rose	43500	501 – Manning & Padgett
56 = DAFL3/LIGR Shrubby cinquefoil/gray's licorice-root	43554	501 – Manning & Padget

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
57 = ARCA13/2GRAM Silver sagebrush/graminoid (dry)	43605	501 – Manning & Padgett
58 = ARCA13/2GRAM Silver sagebrush/graminoid (mesic)	43606	501 – Manning & Padget
59 = ARTRT/ROWO Basin big sagebrush/woods' rose	43651	501 – Manning & Padgett
60 = CADO2 Douglas' sedge	43803	501 – Manning & Padget
61 = CASC12 Mountain sedge	43811	501 – Manning & Padgett
62 = DECA18-CANE2 Tufted hairgrass-Nebraska sedge	43872	501 – Manning & Padget
63 = POSE Sandberg bluegrass	43883	501 – Manning & Padgett
64 = DOJE Sierra shootingstar	43905	501 – Manning & Padget
65 = LUPO2-SETR Bigleaf lupine-arrowleaf ragwort	43911	501 – Manning & Padgett
66 = IRMI/2GRAM Western iris/dry graminoid	43915	501 – Manning & Padget
67 = IRMI/2GRAM Western iris/ mesic graminoid	43916	501 – Manning & Padgett
68 = AGST2 Creping bentgrass	43991	501 – Manning & Padget
69 = HOBR2 Meadow barley	43995	501 – Manning & Padgett
70 = CHLA Port Orford cedar	CCOCCO00	510 – Jimerson, 1994
71 = Port Orford cedar/salal (1)	CCOCCO11	510 – Jimerson, 1994
72 = Port Orford cedar/pacific rhododendron-salal(1)	CCOCCO12	510 – Jimerson, 1994
73 = Port Orford cedar/western azalea (1)	CCOCCO13	510 – Jimerson, 1994
74 = Port Orford cedar-western white pine/huckleberry oak (1)	CCOCCO14	510 – Jimerson, 1994
75 = CHLA-ABCO Port Orford cedar-white fir	CCOCFW00	510 – Jimerson, 1994
76 = CHLA-ABCO/QUVA Port Orford cedar-white fir/huckleberry oak	CCOCFW11	510 – Jimerson, 1994
77 = CHLA-ABCO-PIMO3/QUVA Port Orford cedar-white fir-western white pine/huckleberry oak	CCOCFW12	510 – Jimerson, 1994
78 = CHLA-ABCO/RHOB Port Orford cedar-white fir/western azalea	CCOCFW13	510 – Jimerson, 1994
79 = CHLA-ABCO/2FORB Port Orford cedar-white fir/forbs	CCOCFW14	510 – Jimerson, 1994
80 = CHLA-ABCO/QUSA2 Port Orford cedar-white fir/deer oak	CCOCFW15	510 – Jimerson, 1994
81 = CHLA-ABSH/QUSA2-VAME Port Orford cedar-Shasta red fir/deer oak-thinleaf huckleberry	CCOCFW16	510 – Jimerson, 1994
82 = CHLA-PSME/QUVA Port Orford cedar-Douglas-fir/huckleberry oak	CCOCFW17	510 – Jimerson, 1994
83 = CHLA-CADE27-ALRH2 Port Orford cedar-incense cedar-white alder	CCOCFW18	510 – Jimerson, 1994
84 = PSME Douglas-fir	CD000000	513 – Jimerson et al, 1996
85 = PSME-CADE27 Douglas-fir-incense cedar	CD0CCI00	513 – Jimerson et al, 1996
86 = PSME-CADE27/FECA Douglas-fir-incense cedar/California fescue	CD0CCI11	513 – Jimerson et al, 1996

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87 = PSME-PIJE Douglas-fir-Jeffrey Pine	CD0CPJ00	513 – Jimerson et al, 1996
88 = PSME-PIJE/FECA Douglas-fir-Jeffrey pine/California fescue	CD0CPJ11	513 – Jimerson et al, 1996
89 = PSME-ALRU2 Douglas-fir-red alder	CD0HAR00	513 – Jimerson et al, 1996
90 = PSME-ALRU2/ACCI/CLSIS Douglas-fir-red alder/vine maple/Siberian springbeauty	CD0HAR11	513 – Jimerson et al, 1996
91 = PSME-UMCA Douglas-fir-California laurel	CD0HBC00	513 – Jimerson et al, 1996
92 = PSME-UMCA/TODI Douglas-fir-California laurel/Pacific poison oak	CD0HBC11	513 – Jimerson et al, 1996
93 = PSME-UMCA/HODI Douglas-fir-California laurel/ocean spray	CD0HBC12	513 – Jimerson et al, 1996
94 = PSME-CHCHC4 Douglas-fir-giant chinquapin	CD0HGC00	513 – Jimerson et al, 1996
95 = PSME-CHCHC4-LIDE3 Douglas-fir-giant chinquapin-tanoak	CD0HGC11	513 – Jimerson et al, 1996
96 = PSME-CHCHC4/XETE Douglas-fir-giant chinquapin/common beargrass	CD0HGC12	513 – Jimerson et al, 1996
97 = PSME-CHCHC4/RHMA3-GASH Douglas-fir-giant chinquapin/Pacific rhododendron-salal	CD0HGC13	513 – Jimerson et al, 1996
98 = PSME-CHCHC4/RHMA3-MANE2 Douglas-fir-giant chinquapin/pacific rhododendron-Cascade barberry	CD0HGC14	513 – Jimerson et al, 1996
99 = PSME-CHCHC4/RHMA3-QUSA2/XETE Douglas-fir-giant chinquapin/pacific rhododendron-deer oak/common beargrass	CD0HGC15	513 – Jimerson et al, 1996
100 = PSME-CHCHC4-LIDE3/MANE2 Douglas-fir-giant chinquapin-tanoak/cascade barberry	CD0HGC16	513 – Jimerson et al, 1996
101 = PSME-CHCHC4/RHA3-QUSA-GASH Douglas-fir-giant chinquapin/pacific rhododendron-deer oak-salal	CD0HGC17	513 – Jimerson et al, 1996
102 = PSME-ACER Douglas-fir-maple	CD0HMA00	513 – Jimerson et al, 1996
103 = PSME-ACMA3/POMU Douglas-fir-bigleaf maple/western swordfern	CD0HMA11	513 – Jimerson et al, 1996
104 = PSME-ACMA3/PHLE4 Douglas-fir-bigleaf maple/Lewis' mock orange	CD0HMA12	513 – Jimerson et al, 1996
105 = PSME/ACCI-MARE11 Douglas-fir/vine maple-Cascade barberry	CD0HMA13	513 – Jimerson et al, 1996
106 = PSME-QUKE Douglas-fir-California black oak	CD0HOB00	513 – Jimerson et al, 1996
107 = PSME-QUKE Douglas-fir-California black oak (metamorphic)	CD0HOB11	513 – Jimerson et al, 1996
108 = PSME-QUKE Douglas-fir-California black oak (sandstone)	CD0HOB12	513 – Jimerson et al, 1996
109 = PSME-QUKE-QUGA4/2GRAM Douglas-fir-California black oak-Oregon white oak/grass	CD0HOB13	513 – Jimerson et al, 1996
110 = PSME-QUCH2 Douglas-fir-canyon live oak	CD0HOL00	513 – Jimerson et al, 1996
111 = PSME-QUCH2 Douglas-fir-canyon live oak (rockpile)	CD0HOL11	513 – Jimerson et al, 1996
112 = PSME-QUCH2-ARME/TODI Douglas-fir-canyon live oak-Pacific madrone/pacific poison oak	CD0HOL12	513 – Jimerson et al, 1996
113 = PSME-QUCH2-LIDE3 Douglas-fir-canyon live oak-tanoak	CD0HOL13	513 – Jimerson et al, 1996
114 = PSME-QUGA4 Douglas-fir-Oregon white oak	CD0HOO00	513 – Jimerson et al, 1996
115 = PSME-QUGA4/2GRAM Douglas-fir-Oregon white oak/grass	CD0HOO11	513 – Jimerson et al, 1996
116 = PSME-QUGA4/HODI Douglas-fir-Oregon white oak/oceanspray	CD0HOO12	513 – Jimerson et al, 1996

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117 = PSME-LIDE3 Douglas-fir-tanoak	CD0HT000	513 – Jimerson et al, 1996
118 = PSME-LIDE3/WHMO Douglas-fir-tanoak/common whipplea	CD0HT011	513 – Jimerson et al, 1996
119 = PSME-LIDE3/QUVA-HODI Douglas-fir-tanoak/huckleberry oak-oceanspray	CD0HT012	513 – Jimerson et al, 1996
120 = PSME/2SHRUB Douglas-fir/shrub (moist)	CD0SM000	513 – Jimerson et al, 1996
121 = PSME/COCOC Douglas-fir/California hazelnut	CD0SM011	513 – Jimerson et al, 1996
122 = PSME/QUVA Douglas-fir/huckleberry oak	CD0SOH00	513 – Jimerson et al, 1996
123 = PSME/QUVA/LIDEE Douglas-fir/huckleberry oak-tanoak	CD0SOH12	513 – Jimerson et al, 1996
124 = PSME/QUVA-RHMA3 Douglas-fir/huckleberry oak-Pacific rhododendron	CD0SOH13	513 – Jimerson et al, 1996
125 = PIJE Jeffrey pine	CPJ00000	512 – Jimerson et al, 1995
126 = PIJE-CADE27 Jeffrey Pine – Incense cedar	CPJCCI00	512 – Jimerson et al, 1995
127 = PIJE-CADE27-ABCO/QUVA Jeffrey Pine-Incense cedar-white fir/huckleberry oak	CPJCCI11	512 – Jimerson et al, 1995
128 = PIJE-CADE27/QUVA/XETE Jeffrey Pine-Incense cedar/huckleberry oak/common beargrass	CPJCCI12	512 – Jimerson et al, 1995
129 = PIJE-CADE27/CEPU Jeffrey Pine-incense cedar/dwarf ceanothus	CPJCCI13	512 – Jimerson et al, 1995
130 = PIJE-CADE27/CECU Jeffrey Pine-incense cedar/buckbrush	CPJCCI14	512 – Jimerson et al, 1995
131 = PIJE-ABCO/IRIS Jeffrey Pine-white fir/iris	CPJCFW11	512 – Jimerson et al, 1995
132 = PIJE-ABCO/QUSA2/XETE Jeffrey pine-white fir/deer oak/common beargrass	CPJCFW12	512 – Jimerson et al, 1995
133 = PIJE/FEID Jeffrey pine/Idaho fescue	CPJGFI00	512 – Jimerson et al, 1995
134 = PIJE/FEID Jeffrey pine/Idaho fescue	CPJGFI11	512 – Jimerson et al, 1995
135 = PIJE/QUVA-ARNE/FEID Jeffrey pine/huckleberry oak-pinemat manzanita/Idaho fescue	CPJGFI12	512 – Jimerson et al, 1995
136 = PIJE/QUSA2-ARNE/FEID Jeffrey pine/deer oak-pinemat manzanita/Idaho fescue	CPJSOD11	512 – Jimerson et al, 1995
137 = PICO Lodgepole pine	CPL00000	512 – Jimerson et al, 1995
138 = PICO/QUVA Lodgepole pine/huckleberry oak	CPLSOH00	512 – Jimerson et al, 1995
139 = PICO/QUVA-FRCAO4 Lodgepole pine/huckleberry oak-California buckthorn	CPLSOH11	512 – Jimerson et al, 1995
140 = PICO/QUVA/LIDE3 Lodgepole pine/huckleberry oak-tanoak	CPLSOH12	512 – Jimerson et al, 1995
141 = PICO/LIDE3 Lodgepole pine/shrub tanoak	CPLST000	512 – Jimerson et al, 1995
142 = PICO/LIDE3-RHMA3 Lodgepole pine/tanoak-Pacific rhododendron	CPLST011	512 – Jimerson et al, 1995
143 = PILA Sugar pine	CPS00000	512 – Jimerson et al, 1995
144 = PILA-PICO Sugar pine-lodgepole pine	CPSCPL00	512 – Jimerson et al, 1995
145 = PILA-PICO/QUVA-LIDEE Sugar pine-lodgepole pine/huckleberry oak-tanoak	CPSCPL11	512 – Jimerson et al, 1995
146 = PILA-PICO/LIDEE-RHMA3 Sugar pine-lodgepole pine/tanoak-Pacific rhododendron	CPSCPL12	512 – Jimerson et al, 1995

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
147 = PILA-PIMO3 Sugar pine-western white pine	CPSCPW00	512 – Jimerson et al, 1995
148 = PILA-PIMO3/QUVA-GABU2 Sugar pine-western white pine/huckleberry oak-dwarf silktassel	CPSCPW11	512 – Jimerson et al, 1995
149 = PILA-CHCHC4 Sugar pine-giant chinquapin	CPSHGC00	512 – Jimerson et al, 1995
150 = PILA-CHCHC4/Quva-QUSA2 Sugar pine-giant chinquapin/huckleberry oak-deer oak	CPSHGC11	512 – Jimerson et al, 1995
151 = PIMO3 Western white pine	CPW00000	512 – Jimerson et al, 1995
152 = PIMO3-PSME Western white pine-Douglas-fir	CPWCD000	512 – Jimerson et al, 1995
153 = PIMO3-PSME/QUVA-LIDEE Western white pine-Douglas-fir/huckleberry oak-tanoak	CPWCD011	512 – Jimerson et al, 1995
154 = PIMO3/PIMO3 Western white pine/white pine	CPWCFW00	512 – Jimerson et al, 1995
155 = PIMO3-ABCO/QUVA/ANEMO Western white pine-white fir/huckleberry oak/western anemone	CPWCFW11	512 – Jimerson et al, 1995
156 = PIMO3-PICO Western white pine-lodgepole pine	CPWCPL00	512 – Jimerson et al, 1995
157 = PIMO3-PICO/LIDEE-RHMA3 Western white pine-lodglepole pine/tanoak-Pacific rhododendron	CPWCPL11	512 – Jimerson et al, 1995
158 = PIMO3-PILA Western white pine-sugar pine	CPWCPS00	512 – Jimerson et al, 1995
159 = PIMO3-PILA/QUVA-LIDEE Western white pine-sugar pine/huckleberry oak-tanoak	CPWCPS11	512 – Jimerson et al, 1995
160 = LIDE3 Tanoak	HT000000	513 – Jimerson et al, 1996
161 = LIDE3/CADE27 Tanoak-incense cedar	HT0CCI00	513 – Jimerson et al, 1996
162 = LIDE3-CADE27/FECA Tanoak-incense cedar/California fescue	HT0CCI11	513 – Jimerson et al, 1996
163 = LIDE3-CHLA Tanoak-Port Orford cedar	HT0CCO00	513 – Jimerson et al, 1996
164 = LIDE3-CHLA-UMCA/VAOV2 Tanoak-Port Orford cedar-California laurel/California huckleberry	HT0CCO11	513 – Jimerson et al, 1996
165 = LIDE3-CHLA/VAOV2-RHOC Tanoak-Port Orford cedar/California huckleberry-western azalea	HT0CCO12	513 – Jimerson et al, 1996
166 = LIDE3-CHLA/VAOV2 Tanoak-Port Orford cedar/California huckleberry	HT0CCO13	513 – Jimerson et al, 1996
167 = LIDE3-CHLA/MANE2/LIBOL2 Tanoak-Port Orford cedar/Cascade barberry/longtube twinflower	HT0CCO14	513 – Jimerson et al, 1996
168 = LIDE3-CHLA-ALRH2 Tanoak-Port Orford cedar-white alder (riparian)	HT0CCO15	513 – Jimerson et al, 1996
169 = LIDE3-CHLA/ACCI Tanoak-Port Orford cedar/vine maple	HT0CCO16	513 – Jimerson et al, 1996
170 = LIDE3-CHLA/VAPA Tanoak-Port Orford cedar/red huckleberry	HT0CCO17	513 – Jimerson et al, 1996
171 = LIDE3-CHLA/GASH Tanoak-Port Orford cedar/salal	HT0CCO18	513 – Jimerson et al, 1996
172 = LIDE3-CHLA-TSHE/VAOV2 Tanoak-Port Orford cedar-western hemlock/California huckleberry	HT0CCO19	513 – Jimerson et al, 1996
173 = LIDE3-UMCA Tanoak-California laurel	HT0HBC00	513 – Jimerson et al, 1996
174 = LIDE3-UMCA/TODI Tanoak-California laurel/Pacific poison oak	HT0HBC11	513 – Jimerson et al, 1996
175 = LIDE3-UMCA/VAOV2 Tanoak-California laurel/California huckleberry	HT0HBC12	513 – Jimerson et al, 1996
176 = LIDE3-CHCHC4 Tanoak-giant chinquapin	HT0HGC00	513 – Jimerson et al, 1996

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
177 = LIDE3-CHCHC4/GASH Tanoak-giant chinquapin/salal	HT0HGC11	513 – Jimerson et al, 1996
178 = LIDE3-CHCHC4/GASH-RHMA3 Tanoak-giant chinquapin/salal-Pacific rhododendron	HT0HGC12	513 – Jimerson et al, 1996
179 = LIDE3-CHCHC4/RHMA3/XETE Tanoak-giant chinquapin/Pacific rhododendron/common beargrass	HT0HGC13	513 – Jimerson et al, 1996
180 = LIDE3-CHCHC4/PTAQL Tanoak-giant chinquapin/western brackenfern	HT0HGC14	513 – Jimerson et al, 1996
181 = LIDE3-CHCHC4/MANE2 Tanoak-giant chinquapin/Cascade barberry	HT0HGC15	513 – Jimerson et al, 1996
182 = LIDE3CHCHC4/VAOV2-GASH Tanoak-giant chinquapin/California huckleberry-salal	HT0HGC16	513 – Jimerson et al, 1996
183 = LIDE3/ACER Tanoak-maple	HT0HM000	513 – Jimerson et al, 1996
184 = LIDE3-ACMA3/POMU Tanoak-bigleaf maple/swordfern	HT0HM011	513 – Jimerson et al, 1996
185 = LIDE3/ACCI-GASH Tanoak/vine maple-salal	HT0HM012	513 – Jimerson et al, 1996
186 = LIDE3/ACCI Tanoak/vine maple	HT0HM013	513 – Jimerson et al, 1996
187 = LIDE3/QUKE Tanoak-California black oak	HT0HOB00	513 – Jimerson et al, 1996
188 = LIDE3/QUKE Tanoak-California black oak	HT0HOB11	513 – Jimerson et al, 1996
189 = LIDE3-QUCH2 Tanoak-canyon live oak	HT0HOL00	513 – Jimerson et al, 1996
190 = LIDE3-QUCH2 Tanoak-canyon live oak (rockpile)	HT0HOL11	513 – Jimerson et al, 1996
191 = LIDE3-QUCH2/VAOV2 Tanoak-canyon live oak/California huckleberry	HT0HOL12	513 – Jimerson et al, 1996
192 = LIDE3-QUCH2/GASH-MANE2 Tanoak-canyon live oak/salal-Cascade barberry	HT0HOL13	513 – Jimerson et al, 1996
193 = LIDE-QUCH2-QUKE/TODI Tanoak-canyon live oak-California black oak/Pacific poison oak	HT0HOL14	513 – Jimerson et al, 1996
194 = LIDE3-QUCH2/TODI Tanoak-canyon live oak/Pacific poison oak	HT0HOL15	513 – Jimerson et al, 1996
195 = LIDE3-QUCH2/MANE2 Tanoak-canyon live oak/Cascade barberry	HT0HOL16	513 – Jimerson et al, 1996
196 = LIDE3/2SHRUB Tanoak/shrub (dry)	HT0SD000	513 – Jimerson et al, 1996
197 = LIDE3/TODI/LOHIV Tanoak/Pacific poison oak/pink honeysuckle	HT0SD011	513 – Jimerson et al, 1996
198 = LIDE3/MANE2 Tanoak/Cascade barberry	HT0SD012	513 – Jimerson et al, 1996
199 = LIDE3/VAOV2-GASH Tanoak/California huckleberry-salal	HT0SEH12	513 – Jimerson et al, 1996
200 = LIDE3/VAOV2-RHMA3 Tanoak/California huckleberry-Pacific rhododendron	HT0SEH13	513 – Jimerson et al, 1996
201 = LIDE3/2SHRUB Tanoak/shrub (moist0	HT0SM000	513 – Jimerson et al, 1996
202 = LIDE2/COCOC Tanoak/California hazelnut	HT0SM011	513 – Jimerson et al, 1996
203 = LIDE3/QUVA Tanoak/huckleberry oak	HT0SOH00	513 – Jimerson et al, 1996
204 = LIDE3/QUVA-RHMA3 Tanoak/huckleberry oak-Pacific rhododendron	HT0SOH11	513 – Jimerson et al, 1996
205 = LIDE3/GASH-RHMA3 Tanoak/salal-Pacific rhododendron	HT0SSG12	513 – Jimerson et al, 1996
206 = LIDE3/GASH-MANE2 Tanoak/salal-Cascade barberry	HT0SSG13	513 – Jimerson et al, 1996

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
207 = LIDE3/VAOV2 Tanoak/California huckleberry	HT0SEH00	513 – Jimerson et al, 1996
208 = LIDE3/VAOV2 Tanoak/California huckleberry	HT0SEH11	513 – Jimerson et al, 1996
209 = LIDE3/GASH Tanoak/salal	HT0SSG00	513 – Jimerson et al, 1996
210 = LIDE3/GASH Tanoak/salal	HT0SSG11	513 – Jimerson et al, 1996
211 = CADE27-PIPO-PSME/CHFO Incense cedar-ponderosa pine-Douglas-fir/mountain misery	CC0311	502 – Benson (1988)
212 = PIJE-ABCO/POA Jeffrey pine-white fir/bluegrass (granite)	CPJGBW11	502 – Benson (1988)
213 = PIPO-PIJE-ABCO/ACOCO Ponderosa pine-Jeffrey pine-white fir/western needlegrass (ash)	CPJGNG11	502 – Benson (1988)
214 = PIPO-PIJE-QUKE/AMPA2 Ponderosa pine-Jeffrey pine-California black oak/pale serviceberry	CPJSAM11	502 – Benson (1988)
215 = PIPO-PIJE-ABCO/AMPA2-MARE11 Ponderosa pine-Jeffrey pine-white fir/pale serviceberry-creeping barberry	CPJSAM12	502 – Benson (1988)
216 = PIJE-QUKE/RHTRQ Jeffrey pine-California black oak/skunkbush sumac	CPJSBB11	502 – Benson (1988)
217 = PIJE/PUTR2-CELE3/ACOCO Jeffrey pine/antelope bitterbrush-curl-leaf mountain mahogany/western needlegrass	CPJSBB12	502 – Benson (1988)
218 = PIJE/PUTR2-SYORU/POA Jeffrey pine/antelope bitterbrush-Utah snowberry/bluegrass	CPJSBB13	502 – Benson (1988)
219 = PIJE/PUTR2/WYMO Jeffrey pine/antelope bitterbrush/woolly mule-ears	CPJSBB14	502 – Benson (1988)
220 = PIPO-PIJE-PSME/PUTR2/WYMO Ponderosa pine-Jeffrey pine-Douglas-fir/antelope bitterbrush/woolly mule-ears	CPJSBB15	502 – Benson (1988)
221 = PIPO-PIJE-QUKE/POA Ponderosa pine-Jeffrey pine-California black oak/bluegrass (granite)	CPJSBB16	502 – Benson (1988)
222 = PIPO-PIJE/ARTRV-PUTR2 Ponderosa pine-Jeffrey pine/mountain big sagebrush-antelope bitterbrush	CPJSBB17	502 – Benson (1988)
223 = PIPO-PIJE/PUTR2/FEID Ponderosa pine-Jeffrey pine/antelope bitterbrush/Idaho fescue	CPJSBB18	502 – Benson (1988)
224 = PIPO-PIJE/PUTR2/FEID Ponderosa pine-Jeffrey pine/antelope bitterbrush/Idaho fescue (granite)	CPJSBB19	502 – Benson (1988)
225 = PIPO-PIJE/PUTR2/SEINM Ponderosa pine-Jeffrey pine/antelope bitterbrush/lambstongue ragwort (granite)	CPJSBB20	502 – Benson (1988)
226 = PIPO-PIJE/FRRUM/POSE Ponderosa pine-Jeffrey pine/Modoc buckthorn/Sandberg bluegrass	CPJSBB21	502 – Benson (1988)
227 = PIPO-PIJE-ABCO/QUW12 Ponderosa pine-Jeffrey pine-white fir/interior live oak	CPJSBB23	502 – Benson (1988)
228 = PIJE/CELE3 Jeffrey pine/curl-leaf mountain mahogany	CPJSMC11	502 – Benson (1988)
229 = PIPO-PIJE/CELE3/PSSPS Ponderosa pine-Jeffrey pine/curl-leaf mountain mahogany/ bluebunch balsamroot	CPJSMC12	502 – Benson (1988)
230 = PIPO-PIJE/CELE3/BASA3 Ponderosa pine-Jeffrey pine/curl-leaf mountain mahogany/ arrowleaf balsamroot	CPJSMC13	502 – Benson (1988)
231 = PIPO-PIJE-ABCO/QUVA/WYMO Ponderosa pine-Jeffrey pine-white fir/huckleberry oak/woolly mule-ears	CPJSOH11	502 – Benson (1988)
232 = PIJE/ARTRV/FEID Jeffrey pine/mountain big sagebrush/Idaho fescue	CPJSSB11	502 – Benson (1988)
233 = PIPO-PIJE-ABCO/SYAC/WYMO Ponderosa pine-Jeffrey pine-white fir/sharpleaf snowberry/ woolly mule-ears	CPJSSS12	502 – Benson (1988)
234 = PIJE-ABCO/SYORU/PONE2 Jeffrey pine-white fur/Utah snowberry/Wheeler bluegrass	CPJSSY11	502 – Benson (1988)
235 = PIWA/ARNE Washoe pine/pinemat manzanita	CPOSMP11	502 – Benson (1988)
236 = PIWA-ABCO/SYORU/PSJA2 Washoe pine-white fir/Utah snowberry/tuber starwort	CPOSSY11	502 – Benson (1988)

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
237 = PIPO/AMPA2-MARE11/ARCO9 Ponderosa pine/pale serviceberry-creeping barberry/ heartleaf arnica	CPPSAM11	502 – Benson (1988)
238 = PIPO/AMPA2-PRUNU Ponderosa pine/pale serviceberry-prunus	CPPSAM12	502 – Benson (1988)
239 = PIPO-ABCO-PICO/AMPA2 Ponderosa pine-white fir-lodgepole pine/pale serviceberry	CPPSAM13	502 – Benson (1988)
240 = PIPO-ABCO-QUVA/AMPA2 Ponderosa pine-white fir-black oak/pale serviceberry	CPPSAM14	502 – Benson (1988)
241 = PIPO-ABCO/AMPA2-MARE11 Ponderosa pine-white fir/pale serviceberry-creeping barberry	CPPSAM15	502 – Benson (1988)
242 = PIPO-ABCO/AMPA2-CEVE/BROR2 Ponderosa pine-white fir/pale serviceberry-snowbrush ceonothus/Orcutt's brome	CPPSAM16	502 – Benson (1988)
243 = PIPO-CADE27/PUTR2/BASA3 Ponderosa pine-incense cedar/antelope bitterbrush/ arrowleaf balsamroot	CPPSBB11	502 – Benson (1988)
244 = PIPO-QUKE/PUTR2/ACOCO Ponderosa pine-California black oak/antelope bitterbrush/ western needlegrass	CPPSBB12	502 – Benson (1988)
245 = PIPO/CELE3-PUTR2/FEID Ponderosa pine/curl-leaf mountain mahogany-antelope bitterbrush/Idaho fescue	CPPSBB13	502 – Benson (1988)
246 = PIPO/PURT2-CEVE-ARPA6/BROR2 Ponderosa pine/antelope bitterbrush-snowbrush ceanothus-greenleaf manzanita/Orcutt's brome	CPPSBB14	502 – Benson (1988)
247 = PIPO/PURT2-PRUNU/BROR2 Ponderosa pine/antelope bitterbrush-prunus/Orcutt's brome	CPPSBB15	502 – Benson (1988)
248 = PIPO/PUTR2-PRUNU/PSSPS Ponderosa pine/antelope bitterbrush-prunus/bluebunch wheatgrass	CPPSBB16	502 – Benson (1988)
249 = PIPO/PUTR2-RICE/BROR2 Ponderosa pine/antelope bitterbrush-wax current/Orcutt's brome	CPPSBB17	502 – Benson (1988)
250 = PIPO/PUTR2/BASA3 Ponderosa pine/antelope bitterbrush/arrowleaf balsamroot	CPPSBB18	502 – Benson (1988)
251 = PIPO/PUTR2/FEID Ponderosa pine/antelope bitterbrush/Idaho fescue	CPPSBB19	502 – Benson (1988)
252 = PIPO/PUTR2/ACOCO Ponderosa pine/antelope bitterbrush/western needlegrass (pumice)	CPPSBB20	502 – Benson (1988)
253 = PIPO-ABCO/CEVE/ACOCO Ponderosa pine-white fir/snowbrush ceonothus/western needlegrass	CPPSBB21	502 – Benson (1988)
254 = PIPO-ABCO/PUTR2-ARPA6/ACOCO Ponderosa pine-white fir/antelope bitterbrush-greenleaf manzanita/western needlegrass	CPPSBB22	502 – Benson (1988)
255 = PIPO/ARTRV/FEID Ponderosa pine/mountain big sagebrush/Idaho fescue	CPPSSB11	502 – Benson (1988)
256 = PSME-PIPO/TODI Douglas-fir-ponderosa pine/Pacific poison oak	DC0811	502 – Benson (1988)
257 = PSME-PIPO/CHFO/POCOC Douglas-fir-ponderosa pine/mountain misery/Sierra milk wort	DC0812	502 – Benson (1988)
258 = PSME-PINUS-QUCH2/CEIN3 Douglas-fir-pine-canyon live oak/deerbrush	DC0813	502 – Benson (1988)
259 = PSME-ABCO-LIDE3/PTAQL Douglas-fir-white fir-tanoak/western brackenfern	DC0911	502 – Benson (1988)
260 = PSME-CONU2-LIDE3/COCOC/GAAP2 Douglas-fir-mountain dogwood-tanoak/California hazelnut/ stickywilly	DH0711	502 – Benson (1988)
261 = PIPO-ABCO/CEVE3-CEPR Ponderosa pine-white fir/tobaccobrush-squawcarpet	PC0611	502 – Benson (1988)
262 = PILE-PIMO3/QUVA-ARNE2 Sugar pine-western white pine/huckleberry oak-pinemat manzanita	QS0111	502 – Benson (1988)
263 = ABCO-PSME-LIDE3/COCOC White fir-Douglas-fir-tanoak/California hazelnut	WC0911	502 – Benson (1988)
264 = ABCO-PSME/????/???? White fir-Douglas-fir-mountain dogwood/bush chinquapin	WC0912	502 – Benson (1988)
265 = ABCO-PSME/SYACC-????/???? White fir-Douglas-fir/sharpleaf snowberry/thimbleberry	WC0913	502 – Benson (1988)
266 = ABCO-PILA/SYAC/CARO5 White-fir-sugar pine/sharpleaf snowberry/Ross' sedge	WC0914	502 – Benson (1988)

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
267 = ABCO-PSME/CHME2 White fir-Douglas-fir/prince's pine	WC0915	502 – Benson (1988)
268 = ABCO-PSME-CADE27/AMPA2 White fir-Douglas-fir-incense cedar/pallid serviceberry	WC0916	502 – Benson (1988)
269 = ABCO-PSME-PIJE/???? White fir-Douglas-fir-Jeffrey pine/rosy everlasting	WC0917	502 – Benson (1988)
270 = PSME-PINUS-CADE27/ASDE6 Douglas-fir-pine-incense cedar/Indian dream	CC0411	
271 = PSME-PILA/LIDEE/PTAQL Douglas-fir-sugar pine/tanoak/western brackenfern	DC1011	
272 = PSME-PILA/LIDEE/TRIEN Douglas-fir-sugar pine/tanoak/broadleaf starflower	DC1012	
273 = PSME-PIPO/FRCAO4/PTAQL Douglas-fir-ponderosa pine/California buckthorn/western brackenfern	DC1013	
274 = PSME-PIPO/CEIN3/COHE2 Douglas-fir-ponderosa pine/deerbrush/variableleaf collomia	DC1014	
275 = PSME-PIPO/FECA Douglas-fir-ponderosa pine/California fescue	DC1015	
276 = PSME-PIPO/QUVA/POMU Douglas-fir-ponderosa pine/huckleberry oak/western swordfern	DC1016	
277 = PSME-PINUS-CADE27/TRBR3 Douglas-fir-pine-incense cedar/forest clover	DC1017	
278 = PSME-PINUS-CADE27/CECU/TRBR3-FECA Douglas-fir-pine-incense cedar/buckbrush/forest clover-California fescue	DC1018	
279 = PSME-PINUS-CADE27/XETE Douglas-fir-pine-incense cedar/common beargrass	DC1019	
280 = PSME/COCOC/POMU Douglas-fir/California hazelnut/western swordfern	DS0911	
281 = PIJE-CADE27/CECU/HECAS2 Jeffrey pine-incense cedar/buckbrush/Shasta heliathella	PG0611	
282 = PIJE-CADE27/MAAQ2/FEID Jeffrey pine-incense cedar/hollyleaved barberry/Idaho fescue	PG0612	
283 = PIJE/CELE3/PSSPS Jeffrey pine/curl-leaf mountain mahogany/bluebench wheatgrass	PG0613	
284 = PIJE/ERPAA2/PHDI3 Jeffrey pine/Parry's rabbitbrush/spreading phlox	PG0614	
285 = PIJE-CADE27/QUVA/ASDE6 Jeffrey pine-incense cedar/huckleberry oak/Indian's dream	PS0911	
286 = ABCO-PSME-PILA/CONU4 White fir-Douglas-fir-sugar pine/Pacific dogwood	WC1011	
287 = PSME-ABCO/RHOC Douglas-fir-white fir/western azalea	WC1012	
288 = PSME-ABCO-PIPO/ARNE/CHUMO2 Douglas-fir-white fir-ponderosa pine/pinemat manzanita/ pipsisseqa	WC1013	
289 = 2TE Mixed conifer series	CX000000	
290 = Mixed conifer dry group	CX0D0000	
291 = Ponderosa pine-mixed conifer/Bolander's bedstraw-milkwort	CX0FBB11	
292 = White fir-mixed conifer/false Solomon's seal-Hooker's fairybells	CX0FFS11	
293 = Ponderosa pine-mixed conifer/rosy everlasting-naked stemmed	CX0FRE11	
294 = White fir-mixed conifer/troul plant	CX0FTP11	
295 = Douglas-fir-mixed conifer/starflower	CX0FWS11	
296 = White fir-mixed conifer/Ross' sedge	CX0GCR11	

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
297 = Douglas-fir-mixed conifer-white alder/Indian rhubarb	CX0HAW11	
298 = Mountain dogwood group	CX0HDP00	
299 = Douglas-fir-mixed conifer-mountain dogwood/California hazel buckwheat	CX0HDP13	
300 = Douglas-fir-mixed conifer-mountain dogwood/trail plant	CX0HDP14	
301 = Douglas-fir-mixed conifer-bigleaf maple/trail plant	CX0HMB12	
302 = QUCH2 Canyon live oak	CX0H0L00	
303 = Ponderosa pine-mixed conifer-canyon live oak/bearclover	CX0H0L15	
304 = Ponderosa pine-mixed conifer/Bolander's bedstraw	CX0H0L16	
305 = Douglas-fir-mixed conifer-canyon live oak/sword fern	CX0H0L17	
306 = LIDE3 Tanoak	CX0HT000	
307 = PSME-2TE-LIDE3/CONU4 Douglas-fir-mixed conifer-tanoak/Pacific dogwood	CX0HT012	
308 = PSME-2TE-LIDE3/CHFO Douglas-fir-mixed conifer-tanoak/mountain misery	CX0HT013	
309 = PSME-2TE-LIDE3/COCOC Douglas-fir-mixed conifer-tanoak/California hazelnut	CX0HT011	
310 = PSME-2TE-LIDE3/IRIS Douglas-fir-mixed conifer-tanoak/iris	CX0HT014	
311 = Mixed conifer moderate group	CX0M0000	
312 = Mixed conifer riparian group	CX0R0000	
313 = Douglas-fir-mixed conifer/serviceberry	CX0SAM12	
314 = Evergreen shrub group	CX0SE000	
315 = White fir-mixed conifer/vine maple-bush chinquapin	CX0SE011	
316 = White fir-mixed conifer/bush chinquapin	CX0SE012	
317 = Ponderosa pine-mixed conifer/shrub canyon live oak, huckleberry oak	CX0SE013	
318 = Ponderosa pine-mixed conifer/huckleberry oak (serpentine)	CX0SE014	
319 = Douglas-fir-mixed conifer/California hazelnut	CX0SHN12	
320 = Douglas-fir-mixed conifer/Sierra laurel	CX0SLS11	
321 = White fir-mixed conifer/mountain alder/sedge	CX0SMA11	
322 = White fir-mixed conifer/mountain alder/monkshood	CX0SMA12	
323 = Bearclover group	CX0SMM00	
324 = Ponderosa pine-mixed conifer/manzanita bearclover	CX0SMM11	
325 = Ponderosa pine-mixed conifer/bearclover/Bolander's bedstraw	CX0SMM12	
326 = White fir-mixed conifer/creeping snowberry/kelloggia	CX0SSS13	

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
327 = Mixed conifer moist group	CX0W0000	
328 = Douglas-fir-mixed conifer/American dogwood	CX0SDA11	
329 = ABMAS/RHMA Red fir/Pacific rhododendron	RS0511	
330 = ABCO-PILA-ABMAS/PTAQL White fir-sugar pine-red fir/bracken	WC0413	
331 = JUOC/WYMO Western juniper/woolly mule-ears	JC0111	
332 = JUOC Western juniper	JC0112	
333 = TSME Mountain hemlock (steep)	MC0211	
334 = PIJE/QUVA Jeffrey pine/huckleberry oak	PS0811	
335 = PIJE/ARPA6-CEVE Jeffrey pine/greenleaf manzanita-snowbrush ceonothus	PS0812	
336 = PIJE/CECO-ARTR2 Jeffrey pine/whitethorn ceanothus-big sagebrush	PS0813	
337 = POTR5 Quaking aspen (flats)	QC0211	
338 = POTR5 Quaking aspen (uplands)	QC0212	
339 = ABMA California red fir	RC0011	
340 = ABMA/ABCO California red fir/white fir	RC0331	
341 = ABMA-TSME California red fir-mountain hemlock	RC0421	
342 = PIMO3/ARNE Western white pine/pinemat manzanita	RC0511	
343 = PIMO3-PICO Western white pine-lodgepole pine	RC0512	
344 = PIMO3 Western white pine	RC0513	
345 = PICO/HIAL2 Lodgepole pine/white hawkweed	RC0611	
346 = PICO/LIGR Lodgepole pine/Gray's licorice-root	RC0612	
347 = PICO Lodgepole pine	RC0613	
348 = ABMA/ASBO2 California red fir/Bolander's locoweed	RF0411	
349 = ABMA/WYMO California red fir/wooly mule-ears	RF0412	
350 = ABMA/ARNE California red fir/pinemat manzanita	RS0114	
351 = ABCO-PIJE White fir-Jeffrey pine	WC0711	
352 = ABCO-ABMA White fir-California red fir (mixed conifer)	WC0712	
353 = PSME/QUVA Douglas-fir/huckleberry oak	CD0SOH11	507-513 – Jimerson et al, 1996
354 = SESE3 Redwood	CN00000	507-514 – Borchert, Segotta, & Purser
355 = SESE3 Redwood (Gamboa-Sur)	CN00011	507-514 – Borchert, Segotta, & Purser
356 = SESE3/PTAQ-WOFI Redwood/western brackenfern-giant chainfern (steamsides)	CNF0111	507-514 – Borchert, Segotta, & Purser

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
357 = SESE3/POMU-TROV2 Redwood/western swordfern-Pacific trillium (Gamboa-Sur)	CNF0211	507-514 – Borchert, Segotta, & Purser
358 = SESE3/MAFA3-VISAN2 Redwood/California manroot-garden vetch (Gamboa-Sur)	CNF0311	507-514 – Borchert, Segotta, & Purser
359 = SESE3-ACMA3/POCA12 Redwood-bigleaf maple/California polypody (Gamboa)	CNHB011	507-514 – Borchert, Segotta, & Purser
360 = SESE3-LIDE3/CAGL7-IRDO Redwood-tanoak/roundfruit sedge-Douglas iris (Gamboa)	CNHT011	507-504 – Smith
361 = PIPO-ABCO/SYAC Ponderosa pine-white fir/sharpleaf snowberry	CPPSSS11	507-515 – Borchert, Cunha, Krosse, & Lawrence
362 = QUDO Blue oak	HOD00000	507-515 – Borchert, Cunha, Krosse, & Lawrence
363 = QUDO/2GRAM Blue oak/annual grass	HODGA000	507-515 – Borchert, Cunha, Krosse, & Lawrence
364 = QUDO/HOMUL-VIPE3 Blue oak/leporinum barley-Johnny-jump-up	HODGA011	507-515 – Borchert, Cunha, Krosse, & Lawrence
365 = QUDO/LOWR2-NAPU4 Blue oak/Chilean bird's foot trefoil-purple tussockgrass	HODGA012	507-515 – Borchert, Cunha, Krosse, & Lawrence
366 = QUDO/EUSP-PETR7 Blue oak/warty spurge-goldback fern	HODGA013	507-515 – Borchert, Cunha, Krosse, & Lawrence
367 = QUDO/GAAN-LUCO Blue oak/phloxleaf bedstraw-scarlet lupine	HODGA014	507-515 – Borchert, Cunha, Krosse, & Lawrence
368 = QUDO/ERMO7-HOMUL Blue oak/musky stork's bill-leporinum barley	HODGA015	507-515 – Borchert, Cunha, Krosse, & Lawrence
369 = QUDO/DEPA2-PHIM Blue oak/San Bernardino larkspur-imbricate phacelia	HODGA016	507-515 – Borchert, Cunha, Krosse, & Lawrence
370 = QUDO/LUCO-MEAL12 Blue oak/scarlet lupine-foothill clover	HODGA017	507-515 – Borchert, Cunha, Krosse, & Lawrence
371 = QUDO/AMME12-PLNO Blue oak/common fiddleneck-rusty popcornflower	HODGA018	507-515 – Borchert, Cunha, Krosse, & Lawrence
372 = QUDO/EREL6/LOWR2-PLER3 Blue oak/longstem buckwheat/Chilean bird's-foot trefoil-dotseed plantain	HODGA019	507-515 – Borchert, Cunha, Krosse, & Lawrence
373 = QUDO/COSP-RILE2 Blue oak/spinster's blue eyed Mary-wireweed	HODGA020	507-515 – Borchert, Cunha, Krosse, & Lawrence
374 = QUDO/CEMOG/BOIN3-LIAF Blue oak/birchleaf mountain mahogany/hoary bowlesia-San Francisco woodland-star	HODGA021	507-515 – Borchert, Cunha, Krosse, & Lawrence
375 = QUDO/RICA/BRDI3 Blue oak/hillside gooseberry/ripgut brome	HODGA022	507-515 – Borchert, Cunha, Krosse, & Lawrence
376 = QUDO-QUWI2/2GRAM Blue oak-interior live oak/grass	HODHOI00	507-515 – Borchert, Cunha, Krosse, & Lawrence
377 = QUDO-QUWI2/LICY3 Blue oak-interior live oak/mission woodland-star	HODHOI11	507-515 – Borchert, Cunha, Krosse, & Lawrence
378 = ADFA Chamise	SA000000	511 – Gordon & White, 1994
379 = ADFA/ERFA2-SAAP2 Chamise/Eastern Mojave buckwheat-white sage	SA0SB000	511 – Gordon & White, 1994
380 = ADFA/SAME3 Chamise/black sage	SA0SBS00	511 – Gordon & White, 1994
381 = ADFA-CEGRP Chamise-desert ceanothus	SA0SCC00	511 – Gordon & White, 1994
382 = ADFA-CECR Chamise-hoaryleam ceanothus	SA0SCH00	511 – Gordon & White, 1994
383 = ADFA-CETO-CYBI Chamise-woolyleaf ceanothus-mission manzanita	SA0SCT00	511 – Gordon & White, 1994
384 = ADFA-CECU Chamise-buckbrush	SA0SCW00	511 – Gordon & White, 1994
385 = ADFA-ARGL4 Chamise-bigberry manzanita	SA0SMB00	511 – Gordon & White, 1994
386 = ADFA-ARGL3 Chamise-Eastwood's manzanita	SA0SME00	511 – Gordon & White, 1994

FVS Sequence Number = Plant Association Description	Alpha Code	Reference
387 = ERFA2-SAAP2 Eastern Majove buckwheat-white sage	SB0SSW00	511 – Gordon & White, 1994
388 = CEMOG Birchleaf mountain mahogany	SBM00000	511 – Gordon & White, 1994
389 = CECR Hoaryleaf ceanothus	SCH00000	511 – Gordon & White, 1994
390 = ARGL4 Bigberry manzanita	SMB00000	511 – Gordon & White, 1994
391 = ARGL3 Eastwood's manzanita	SME00000	511 – Gordon & White, 1994
392 = QUCH2 Canyon live oak	SOC00000	511 – Gordon & White, 1994
393 = QUW12 Interior live oak	SOI00000	511 – Gordon & White, 1994
394 = QUW12-CELE2 Interior live oak-chaparral whitethorn	SOISCL00	511 – Gordon & White, 1994
395 = QUW12-QUCH2 Interior live oak-canyon live oak	SOISOC00	511 – Gordon & White, 1994
396 = QUW12-QUBE5 Interior live oak-scrub oak	SOISOS00	511 – Gordon & White, 1994
397 = QUBE5 Scrub oak	SOS00000	511 – Gordon & White, 1994
398 = QUBE5-ADFA Scrub oak-chamise	SOSSA000	511 – Gordon & White, 1994
399 = QUBE5-CEMOG Scrub oak-birchleaf mountain mahogany	SOSSBM00	511 – Gordon & White, 1994
400 = QUBE5-CEOL-HEAR5 Scrub oak-hairy ceanothus-toyon	SOSSCH00	511 – Gordon & White, 1994
401 = QUBE5-CELE2 Scrub oak-chaparral whitethorn	SOSSCL00	511 – Gordon & White, 1994
402 = ADSP Redshank	SR000000	511 – Gordon & White, 1994
403 = ADSP-ADFA Redshank-chamise	SR0SA000	511 – Gordon & White, 1994
404 = ARCA11 Coastal sagebrush	SSC00000	511 – Gordon & White, 1994
405 = ARCA11-ERFA2 Coastal sagebrush-Eastern Majave buchwheat	SSCSB000	511 – Gordon & White, 1994
406 = ARCA11-SAME3 Coastal sagebrush-black sage	SSCSSB00	511 – Gordon & White, 1994

Table 11.1.2 Region 6 plant association codes recognized in the CA variant.

FVS Sequence Number = Plant Association Description	Alpha Code	Site Species	Site Index*	Max. SDI*	Source*	Reference
407 = PSME-ABCO-PIJE Douglas-fir-white fir-Jeffrey pine	CDC411	DF	85	899	H	Aztet and Wheeler (1984)
408 = PSME-ABCO-PIPO Douglas-fir-white fir-ponderosa pine	CDC412	DF	87	1155	H	Aztet and Wheeler (1984)
409 = PSME-ABCO Douglas-fir-white fir	CDC421	DF	72	720	C	Aztet and Wheeler (1984)
410 = PSME-ABCO/HODI Douglas-fir-white fir/creambush oceanspray	CDC431	DF	96	765	C	Aztet and Wheeler (1984)
411 = PSME-ABCO/BENE Douglas-fir-white fir/dwarf Oregongrape	CDC432	DF	93	1193	H	Aztet and Wheeler (1984)
412 = PSME-PIPO Douglas-fir-ponderosa pine	CDC511	DF	101	735	C	Aztet and Wheeler (1984)

FVS Sequence Number = Plant Association Description	Alpha Code	Site Species	Site Index*	Max. SDI*	Source*	Reference
413 = PSME-PIJE Douglas-fir-Jeffrey pin	CDC521	DF	71	595	C	Aztet and Wheeler (1984)
414 = PSME/DEPAUPERATE Douglas-fir/depauperate	CDF911	DF	70	670	C	Aztet and Wheeler (1984)
415 = PSME-LIDE3/GASH Douglas-fir-tanoak/salal	CDH111	DF	86	845	H	Aztet and Wheeler (1984)
416 = PSME/RHMA Douglas-fir/Pacific rhododendron	CDH112	DF	92	800	C	Aztet and Wheeler (1984)
417 = PSME-LIDE3-PILA Douglas-fir-tanoak-sugar pine	CDH121	DF	97	720	C	Aztet and Wheeler (1984)
418 = PSME-LIDE3 Douglas-fir-tanoak	CDH131	DF	81	1098	H	Aztet and Wheeler (1984)
419 = PSME-LIDE3-QUCH Douglas-fir-tanoak-canyon live oak	CDH141	DF	86	780	C	Aztet and Wheeler (1984)
420 = PSME-LIDE3/RHDI Douglas-fir-tanoak/poison oak	CDH142	DF	82	1050	C	Aztet and Wheeler (1984)
421 = PSME-QUSA Douglas-fir-Sadler oak	CDH511	DF	95	1087	H	Aztet and Wheeler (1984)
422 = PSME/RHDI-BEPI Douglas-fir/poison oak-Piper's Oregongrape	CDS111	DF	77	655	C	Aztet and Wheeler (1984)
423 = PSME/RHDI Douglas-fir/poison oak	CDS112	DF	67	630	C	Aztet and Wheeler (1984)
424 = PSME/BENE Douglas-fir/dwarf Oregongrape	CDS511	DF	93	635	C	Aztet and Wheeler (1984)
425 = PSME/BERE Douglas-fir/creeping Oregongrape	CDS521	DF	85	670	C	Aztet and Wheeler (1984)
426 = TSHE-CHLA Western hemlock-Port Orford cedar	CHC111	DF	117	1215	C	Aztet and Wheeler (1984)
427 = TSHE-THPL/HIGH ELEV Western hemlock-western redcedar/high elevation	CHC412	DF	108	945	C	Aztet and Wheeler (1984)
428 = TSHE-THPL Western hemlock-western redcedar	CHC461	DF	146	1105	C	Aztet and Wheeler (1984)
429 = TSHE-ABCO Western hemlock-white fir	CHC611	DF	119	890	C	Aztet and Wheeler (1984)
430 = TSHE-UMCA Western hemlock-California laurel	CHH111	DF	106	650	C	Aztet and Wheeler (1984)
431 = TSHE-QUSA Western hemlock-Sadler oak	CHH511	DF	108	1152	H	Aztet and Wheeler (1984)
432 = TSHE/GASH Western hemlock/salal	CHS131	DF	61	1050	C	Aztet and Wheeler (1984)
433 = TSHE/RHMA Western hemlock/Pacific rhododendron	CHS331	DF	102	1145	C	Aztet and Wheeler (1984)
434 = TSME/POPU Mountain hemlock/skunkleaf polemonium	CMF211	SH	74	555	C	Aztet and Wheeler (1984)
435 = PIPO-PSME Ponderosa pine-Douglas-fir	CPC411	DF	76	720	H	Aztet and Wheeler (1984)
436 = PIJE-PIMO Jeffrey pine-western white pine	CPC511	JP	52	420	C	Aztet and Wheeler (1984)
437 = PIJE/FEID Jeffrey pine/Idaho fescue	CPG141	JP	57	200	C	Aztet and Wheeler (1984)
438 = PIJE-QUVA Jeffrey pine-huckleberry oak	CPH411	JP	60	470	C	Aztet and Wheeler (1984)
439 = PIJE/CEPU Jeffrey pine/dwarf ceanothus	CPS321	JP	58	364	H	Aztet and Wheeler (1984)
440 = PIJE/GRASS Jeffrey pine/grass	CPS611	JP	57	340	H	Aztet and Wheeler (1984)

FVS Sequence Number = Plant Association Description	Alpha Code	Site Species	Site Index*	Max. SDI*	Source*	Reference
441 = PIMO/XETE Western white pine/beargrass	CQF111	WF	33	436	H	Aztet and Wheeler (1984)
442 = ABMAS/POPU Shasta red fir/skunkleaf polemonium	CRF211	SH	57	675	C	Aztet and Wheeler (1984)
443 = ABMAS/SHEEP Shasta red fir/sheep(grazing destroyed understory plants)	CRF311	SH	50	319	H	Aztet and Wheeler (1984)
444 = ABMAS-QUSA Shasta red fir-Sadler oak	CRH111	SH	81	470	C	Aztet and Wheeler (1984)
445 = ABMAS/SYMO Shasta red fir/creeping snowberry	CRS211	SH	91	755	C	Aztet and Wheeler (1984)
446 = CHLA-QUVA Port Orford cedar-huckleberry oak	CTH111	DF	87	1309	H	Aztet and Wheeler (1984)
447 = CHLA-ACMA Port Orford cedar-bigleaf maple	CTH211	DF	87	760	C	Aztet and Wheeler (1984)
448 = CHLA/BENE/ACTR Port Orford cedar/dwarf Oregongrape/vanillaleaf	CTS111	DF	85	1348	H	Aztet and Wheeler (1984)
449 = CHLA/BENE/LIBOL Port Orford cedar/dwarf Oregongrape/western twinflower	CTS112	DF	92	370	C	Aztet and Wheeler (1984)
450 = CHLA/GASH Port Orford cedar/salal	CTS211	DF	83	990	C	Aztet and Wheeler (1984)
451 = CHLA/GABU Port Orford cedar/box-leaved silktassle	CTS311	DF	87	660	C	Aztet and Wheeler (1984)
452 = ABCO-PSME White fir-Douglas-fir	CWC221	DF	92	815	C	Aztet and Wheeler (1984)
453 = ABCO-PSME/BENE White fir-Douglas-fir/dwarf Oregongrape	CWC231	DF	95	785	C	Aztet and Wheeler (1984)
454 = ABCO-PSME/HODI White fir-Douglas-fir/creambush oceanspray	CWC232	DF	89	675	C	Aztet and Wheeler (1984)
455 = ABCO-PSME/DEPAUPERATE White fir-Douglas-fir/depauperate	CWC233	DF	78	988	H	Aztet and Wheeler (1984)
456 = ABCO-PIPO White fir-ponderosa pine	CWC241	DF	84	930	C	Aztet and Wheeler (1984)
457 = ABCO-PIBR/VAME White fir-Brewer spruce/thin-leaved huckleberry	CWC521	DF	57	899	H	Aztet and Wheeler (1984)
458 = ABCO-PIBR/GAOV White fir-Brewer spruce/slender salal	CWC522	DF	95	874	H	Aztet and Wheeler (1984)
459 = ABCO-PIBR/CHUM White fir-Brewer spruce/western prince's-pine	CWC523	DF	69	335	C	Aztet and Wheeler (1984)
460 = ABCO-CHLA White fir-Port Orford cedar	CWC611	DF	99	1399	H	Aztet and Wheeler (1984)
461 = ABCO-CHLA/DEPAUPERATE White fir-Port Orford cedar/depauperate	CWC612	DF	99	1399	H	Aztet and Wheeler (1984)
462 = ABCO-ABMAS/RIBES White fir-Shasta red fir/currant	CWC721	WF	77	665	C	Aztet and Wheeler (1984)
463 = ABCO-ABMAS/ROGY White fir-Shasta red fir/baldhip rose	CWC722	DF	89	1349	H	Aztet and Wheeler (1984)
464 = ABCO-ABMAS/SYMO White fir-Shasta red fir/creeping snowberry	CWC723	DF	81	945	C	Aztet and Wheeler (1984)
465 = ABCO-TABR White fir-Pacific yew	CWC811	DF	96	695	C	Aztet and Wheeler (1984)

FVS Sequence Number = Plant Association Description	Alpha Code	Site Species	Site Index*	Max. SDI*	Source*	Reference
466 = ABCO-CHNO White fir-Alaska cedar	CWC911	WF	65	1641	H	Aztet and Wheeler (1984)
467 = ABCO/HERB White fir/herb	CWF911	DF	89	670	C	Aztet and Wheeler (1984)
468 = ABCO-LIDE3 White fir-tanoak	CWH312	DF	93	815	C	Aztet and Wheeler (1984)
469 = ABCO-ACGL White fir-Rocky Mountain maple	CWH413	DF	108	654	H	Aztet and Wheeler (1984)
470 = ABCO-QUSA/CHUM White fir-Sadler oak/western prince's-pine	CWH511	DF	93	1337	H	Aztet and Wheeler (1984)
471 = ABCO-QUSA/BENE-PAMY White-fir Sadler oak/dwarf Oregongrape-Oregon boxwood	CWH521	DF	96	470	C	Aztet and Wheeler (1984)
472 = ABCO-QUSA/BENE White fir-Sadler oak/dwarf Oregongrape	CWH522	DF	105	560	C	Aztet and Wheeler (1984)
473 = ABCO-QUSA-CACH White fir-Sadler oak-golden chinquapin	CWH531	DF	94	810	C	Aztet and Wheeler (1984)
474 = ABCO/SYMO White fir/creeping snowberry	CWS331	DF	92	695	C	Aztet and Wheeler (1984)
475 = ABCO/BENE White fir/dwarf Oregongrape	CWS523	DF	101	900	C	Aztet and Wheeler (1984)
476 = LIDE3-SESE2 Tanoak-coast redwood	HTC111	DF	125	820	C	Aztet and Wheeler (1984)
477 = LIDE3-TSHE Tanoak-western hemlock	HTC211	DF	103	870	C	Aztet and Wheeler (1984)
478 = LIDE3-CHLA Tanoak-Port Orford cedar	HTC311	DF	98	890	C	Aztet and Wheeler (1984)
479 = LIDE3-ABCO-ACCI Tanoak-white fir-vine maple	HTC411	DF	90	865	C	Aztet and Wheeler (1984)
480 = LIDE3-ABCO Tanoak-white fir	HTC412	DF	99	970	C	Aztet and Wheeler (1984)
481 = LIDE3-QUCH Tanoak-canyon live oak	HTH111	DF	96	735	C	Aztet and Wheeler (1984)
482 = LIDE3-QUCH/BENE Tanoak-canyon live oak/dwarf Oregongrape	HTH112	DF	83	650	C	Aztet and Wheeler (1984)
483 = LIDE3-UMCA Tanoak-California laurel	HTH211	DF	110	810	C	Aztet and Wheeler (1984)
484 = LIDE3-ACCI Tanoak-vine maple	HTH311	DF	104	595	C	Aztet and Wheeler (1984)
485 = LIDE3/VAOV2-GASH Tanoak/evergreen huckleberry-salal	HTS111	DF	107	910	C	Aztet and Wheeler (1984)
486 = LIDE3/VAOV2 Tanoak/evergreen huckleberry	HTS112	DF	116	915	C	Aztet and Wheeler (1984)
487 = LIDE3/RHMA Tanoak/Pacific rhododendron	HTS221	DF	111	830	C	Aztet and Wheeler (1984)
488 = LIDE3/RHMA-VAOV2 Tanoak/Pacific rhododendron-evergreen huckleberry	HTS222	DF	93	815	C	Aztet and Wheeler (1984)
489 = LIDE3/RHMA-GASH Tanoak/Pacific rhododendron-salal	HTS223	DF	68	840	C	Aztet and Wheeler (1984)
490 = LIDE3/BENE Tanoak/dwarf Oregongrape	HTS311	DF	95	805	C	Aztet and Wheeler (1984)
491 = LIDE3/BENE-RHDI Tanoak/dwarf Oregongrape-poison oak	HTS312	DF	96	785	C	Aztet and Wheeler (1984)

FVS Sequence Number = Plant Association Description	Alpha Code	Site Species	Site Index*	Max. SDI*	Source*	Reference
492 = LIDE3/GASH Tanoak/salal	HTS321	DF	102	970	C	Aztet and Wheeler (1984)
493 = LIDE3/GASH-RHMA Tanoak/salal-Pacific rhododendron	HTS331	DF	90	610	C	Aztet and Wheeler (1984)
494 = LIDE3/GASH-BENE Tanoak/salal-dwarf Oregongrape	HTS341	DF	109	935	C	Aztet and Wheeler (1984)
495 = LIDE3/RHDI-LOHI Tanoak/poison oak-hairy honeysuckle	HTS411	DF	79	730	C	Aztet and Wheeler (1984)
496 = LIDE3/RHCA Tanoak/California coffeeberry	HTS511	DF	50	450	C	Aztet and Wheeler (1984)

*Site index estimates are from GBA analysis. SDI maximums are set by GBA analysis (Source=H) or CVS plot analysis (Source=C).

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