WESTSIDE CASCADES VARIANT
of the
Forest Vegetation Simulator

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March 1997

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INTRODUCTION

The Forest Vegetation Simulator (FVS) is an individual tree, distance independent growth and yield model. It can portray a wide variety of forest types and stand structures ranging from even-aged to uneven-aged, and single to mixed species in single to multi-story canopies. The FVS was originally called Prognosis (Stage, 1973) and developed for use in the Inland Empire area of Idaho and Montana. New "variants" of the FVS result when tree growth and mortality equations for a particular geographic area are imbedded in the FVS framework. In addition, FVS models are available that incorporate various insect and disease extensions. For example, the West Cascade variant has separate extensions that incorporate western spruce budworm and western root disease. Dwarf mistletoe effects are included in the base FVS model; however, an extension allows more complex processing of dwarf mistletoe effects (Hawksworth et al. 1995).

Geographic variants of the FVS have been developed for many areas in the United States. Figure 1 shows the location of the Westside Cascades FVS variant in relation to all FVS variants. The area included in this variant runs along the western slopes of the Cascade Mountains from the Canadian border south through Washington and Oregon to the area just north of the Interstate 5 leg from Grants Pass to Medford, Oregon.

Data for this variant came from the following National Forests: Mt. Baker-Snoqualmie, Gifford Pinchot, Mt. Hood, Willamette, Umpqua, and the Cascade Range portion of the Rogue River. This variant includes parts of several physiographic provinces as defined in Franklin and Dyrness (1973). From the north these include the Northern Cascades (Wash.), the Southern Washington Cascades, the Western Cascades (Ore.), and the High Cascades (Ore.). It applies to 37 specific tree species found principally in the <u>Tsuga heterophylla</u>, the <u>Abies amabilis</u>, and the <u>Tsuga mertensiana</u> forest zones.

THE DATA BASE

Sources

Data to develop the WC variant come from the following sources, listed along with each principal reference governing their collection.

Gifford Pinchot National Forest
- 1981 Inventory (USDA Forest Service 1981)

Mt. Baker-Snoqualmie National Forest
- 1976 Inventory (USDA Forest Service 1976)
- 1987 Managed Stand Survey (USDA Forest Service 1987)

Mt. Hood National Forest
- 1970 Inventory (USDA Forest Service 1968)
- 1971 Inventory (USDA Forest Service 1971)
- 1986 Inventory (USDA Forest Service 1986)
- 1987 Managed Stand Survey (USDA Forest Service 1987)

Rogue River National Forest
- 1980 Inventory (USDA Forest Service 1980)

Umpqua National Forest
- 1968, 1969 Inventories (USDA Forest Service 1968)
- 1980 Inventory (USDA Forest Service 1980)

Willamette National Forest
- 1971 Inventory (USDA Forest Service 1971)
- 1981 Inventory (USDA Forest Service 1981)
- 1987 Managed Stand Survey (USDA Forest Service 1987)

Assembly and Editing

The first step in the analysis was to convert all data to a common format using the same codes, and delete nonusable observations.

Even though formats and exact data content differed somewhat, the following generic list shows the approximate type of data needed. The data fall into categories related to general environment, the stand, and the tree.

1. An indication of location that includes ownership, Forest, or Unit. Possibly useful for looking at locational differences.

2. Information about elevation, slope, aspect, site species and site index, etc. that relate to a stand's productivity and "microclimate".

3. Data that allow the computation of stand basal area, basal area in all trees larger than a given tree, crown competition factor, stand density index, and related measures of density.

4. Information about individual trees such as species, diameter, diameter growth, height, height growth, and crown ratio.

The typical inventory file contains, for each plot or stand, one or more header records with plot information. These are followed by records for individual trees or like-groups of trees. This information for all plots or stands is converted in one or more steps to growth sample tree (GST) files. Each GST file contains records for one species. Further, each GST record contains not only all pertinent data for a specific tree, but also all necessary data describing the stand and location surrounding the specific tree. These GST files are the input data for statistical regressions and other analysis techniques used to produce the functional relationships for the variant.

A major requirement for each GST record is to have a measure of that tree species' site index. In mixed species stands measured site index is based almost always on one species with dominant or codominant heights. Production of a GST file for each species requires the transformation of site index for the "site species" into each species' equivalent "own site index".

Data Codes and Distribution

Table 1 shows the codes used in this variant to designate each of the National Forests included. Table 2 shows the species codes and sample sizes used in the Westside Cascades variant. In addition, table 2 lists the FIA codes, the FVS two-character species codes, and the FVS species index numbers that correspond to those in the list found in the FVS Keyword Reference Guide (Teck 1996a). Where the number of observations are zero or small, that species is typically included with another similar species. In table 2, for example, Sitka spruce is combined with Engelmann spruce. In addition, several species were grouped together. These are identified by lower-case letters (a, b, c, etc.). Thus, "*a" denotes that California red fir and Shasta red fir are considered together for modeling purposes and either should be identified by 05 or RF. However, some species are grouped together even though their combined numbers are still too low to allow explicit regression fitting. For example, as denoted by "f" in the observation column of table 2, California black oak is grouped with Oregon white oak and should be identified as WO or 28. Any species not included in the first 37 species in table 2 is included as "other" species 39.

Tables 2a-h are extensions of table 2 and are expressed in percent of total observations for each relevant species. The species included in each table are those for which regressions were fit and correspond to those marked with an * in table 2.

Site Index and Site References

Site index literature references, base age, and tree age measure are shown in table 3. Site index references used in FVS WC for many of the species listed in table 3 differed from that used in the various inventories. Any species whose inventory site index reference is different from that used in FVS was transformed from its original base to the selected model site index base listed in table 3. Operation of the Westside Cascades variant assumes that site indices are determined according to the specifications in the appropriate reference given here for FVS. Or, alternatively, that site indices taken in the field, if based on a different reference than shown here, are transformed in a suitable translator program to the appropriate site index base given in table 3.

If site index is not taken as part of the field procedures in a stand/plot or is otherwise not available, newly established defaults set site index based on the R6 plant association ecoclass code identified for the the stand. For example, a stand whose ecoclass code is CHS124 (TSHE/BENE-GASH = w.hemlock/dwarf Or. grape-salal) (Halverson et al. 1986:p.62) has a default site index of 93, based on western hemlock (Wiley 1978:b.h.age,50yrs). A complete list of the ecoclass codes, their associated default site indices, and other information is contained in table A1 in the appendix. Site index references used in Region 6 plant association ecology publications are often different than the site index references used in FVS. Thus, it is important to note that site indices in appendix table A1 are based on the site references used in the FVS WC variant and are the equivalent of site indices in the original ecology references.

MODEL OPERATION

This section presents a brief overview of FVS operation to provide the context for the following details about the relationships fitted to the WC data. Figure 2 provides an outline of the major execution steps in FVS.

FVS first reads and checks keywords, then reads the tree record file (if there is one). Next, it computes stand characteristics that appear in the reports for the initial year. This is typically the inventory date or the stand regeneration date. Then FVS backdates all stand attributes to 10 years prior to the inventory date, grows this stand back to the inventory date, compares the values from the actual inventory date with simulated values and computes calibration statistics to better match simulated values with actual values over the 10-year period.

Next, FVS begins the steps that are repeated every cycle. The Event Monitor keywords and functions are checked to see if any activities are to be scheduled based on existing stand conditionsat the start of the cycle. Then thinning occurs if scheduled, followed by a check again of the Event Monitor for scheduling activities based on post-harvest conditions within the same cycle. Event Monitor capabilities are powerful and very useful for modeling situations and creating variables not covered in standard FVS output. See Crookston (1990) who describes Event Monitor functions and processes along with several good examples.

At this point if any large trees exist in the treelist, FVS computes in order their new diameter, height, and crown relationships 10 years in the future (or to whatever time interval is specified). Next, FVS computes in order small tree height, diameter, and crown relationships. Note that for all size trees, FVS computes height increment using both large and samll tree logic. However, in all FVS variants an overlap diameter zone exists between tree sizes considered large and small so that computed values of tree height increment are splined by a weighting procedure to obtain a smooth height growth transition from small to large tree models.

Following growth estimation, mortality is computed based on background rates, and on rates determined by tree variables such as diameter and crown ratio, and by stand variables such as basal area maximum.

Effects from biological change agents such as insects and pathogens are next considered in the simulation if an appropriate FVS insect or pathogen extension is used.

Next, new seedlings are added to treelists in the regeneration step. Some FVS variants have routines to automatically simulate natural regeneration, but most variants depend on the user to specify amount and species to be planted or germinated.

The stand now has been projected one cycle (10 years usually) and its remaining attributes including volume are computed, summarized, and recorded. As figure 2 indicates, the sequence from initial Event Monitor check to this point is repeated during each cycle. When no more cycles are scheduled, FVS prints final parts of its output and completes any files necessary for use by post processors.

FUNCTIONAL RELATIONSHIPS AND RELATED DATA ANALYSIS

This section discusses development and operation of essential FVS functions that are unique to the Westside Cascades variant. The following sections are related to steps shown in figure 2.

Stand Characteristics-Initial and Updated

This section discusses several miscellaneous functions. These processes are used later in the cycle to compute initial stand characteristics or to compute updated stand characteristics as shown in figure 2. Some of these functions may also be used in other sections such as large tree diameter growth. So although these functions are not listed specifically in figure 2, they play vital parts in functions that are shown.

Bark Ratio

Bark ratios are used to convert between inside and outside bark diameters (inside bark dbh = outside bark dbh * bark ratio). In FVS, diameters are reported as outside bark while diameter growth is computed inside bark. In the Westside Cascades variant, one of three functional forms depending on species describes the relation of dib as the dependent variable to dbh as the independent variable. Coefficients for these equations are shown in table 4.

$$D_{ib} = b_1 D_{ob}^{b_2} \tag{1}$$

$$D_{ib} = b_1 + b_2 D_{ob} \tag{2}$$

$$D_{ib} = b_1 D_{ob} \tag{3}$$

and

$$Bark\ ratio = \frac{D_{ib}}{D_{ob}} \tag{4}$$

where:

D_{ob} = diameter outside bark;
D_{ib} = diameter inside bark;
b_1 and b_2 = coefficients from table 4.

Default Tree Height Dubbing

With recent changes to the West Cascades variant (see Growth & Yield Bulletin No. 333, dated 3/13/97) the height dubbing process now uses equations based on data from the Region 6 Permanent Plot Grid Inventory. Roy Mita (FMSC, Ft. Collins) used these data to fit with nonlinear regression techniques a "Curtis-Arney" functional form (Curtis 1967, Arney 1985). These equations compute tree height given tree dbh. The default logic in WC now uses these equations unless the user specifically elects to use the previous Wykoff functional form.

More specifically, the default logic now incorporates the following steps. For trees 3-inches dbh and greater without measured heights in the treelist, their height is computed using the Mita coefficients (see tables A2-A7 in the appendix) in the nonlinear Curtis-Arney functional form.

$$HT = 4.5 + p_2 e^{-p_3 D_{bh}^{p_4}} \qquad (5a)$$

Dubbed heights for trees less than 3-inches dbh are computed with a linear function splined to the lower end of the Curtis-Arney function. This linear segment of the overall H-D curve applies down to 0.3-inches dbh with an assumed height of 4.5 feet. 0.3-inches is the assumed budwidth of the leader on a tree that has just achieved breast-height. If the computed tree height is less than 4.5 feet, then height is set to 4.5 feet. By convention, seedling trees with a dbh of 0.1 are assigned a height of 1.01 feet.

Lastly, and this applies to either the default or the elective mode of height dubbing, if a tree is coded as having topkill, height is set at 80 percent of the predicted height for an equivalent sound tree.

Elective Tree Height Dubbing

Users may elect to have FVS fit a tree height-diameter equation to data in the FVS treelist for the stand/plot. The equation that is fitted is the Wykoff et al. (1982:p.51) height equation. To use this option, use the NOHTDREG keyword and place a "1" in field two. In order for this to work, at least three trees of each species to be processed must have measured diameters and heights. Note that in this dubbing option, the split between large and small trees is five inches, not three inches as in the Curtis-Arney default option. Further details are in the following discussion.

Trees GE 5 Inches

The result of the Wykoff model fitting process within FVS is that b_0 in equation 5b is recalculated and replaces the b_0 coefficient in table 5. In the event that measured heights would lead to a negative b_0 coefficient, the Wykoff fitting process is abandoned and the tree height is determined from the "Curtis-Arney" functional form (eq. 5a) using the Mita coefficients. This can happen, for example, when enough larger diameter trees in a stand are shorter than smaller diameter trees.

$$HT = 4.5 + \exp(b_0 + b_1/(D_{bh} + 1.0)) \qquad (5b)$$

where:

HT = total tree height in feet

D_{bh} = diameter at breast high

b_0 and b_1 = coefficients from table 5b.

Trees LT 5 Inches

Even when electing to fit tree heights for large trees, as just discussed, small trees are never fit to local data. Logic for estimating missing heights of trees less than five inches dbh is somewhat more complicated than that for larger trees. The functional forms for two groups of species are shown in equations 6a and 6b.

For tree species codes 16, 21-29, 34-39 the equation for height is simply

$$H = b_1 + b_2D + b_3CR + b_4D^2 + b_5; \qquad (6a)$$

where b_1 is the intercept term;
b_2-b_4 are slope terms for their respective variables;
b_5 is a "dummy" variable to signify managed or unmanaged stands;
D is diameter at breast height in inches; and
CR is crown ratio expressed as a percent (0-100).

For tree species codes 1-14, 17-20, and 30-33, the equation for height is computed as just shown in eq. 6a and then used in an exponential, as

$$H = exp^H \qquad (6b)$$

This last equation should be considered in the FORTRAN coding sense, not in the algebraic sense. Thus, in equation 6b, for the appropriate species, H is first computed by equation 6a, then this value is used as the exponent in equation 6b to finally get height H. The coefficient values for equation 6 are shown in table 6.

One species, ponderosa pine (tree species code 15), has an individual equation which applies to trees less than four inches dbh,

$$H = 8.31485 + 3.03659*D - 0.59200*JCR,$$

where D is diameter at breast height and JCR is the crown ratio code set at a value of 6. Ponderosa pine trees 4 inches dbh and larger have their dubbed heights computed with the Wykoff model.

Finally, just as in the default mode, if the computed height of a tree is less than 4.5 feet, then H is set to 4.5 feet. Seedlings with diameter typically set to 0.1 inch, have their height set to 1.01 feet.

Crown Competition Factor (CCF)

CCF for trees greater than 1-inch d.b.h. is calculated using equations derived from Paine and Hann (1982). In their paper, Paine and Hann present equations for crown width as a function of dbh.

$MCW = a_0 + a_1 * D_{bh},$

where MCW is maximum crown width. The equation for MCW is substituted into an expression for maximum crown area, i.e., the vertical projection of crown area onto a horizontal plane at ground level under the tree.

$$MCA = \pi\left(\frac{MCW}{2}\right)^2 = \frac{\pi}{4}\left(a_0^2 + 2a_0a_1d_{bh} + a_1^2d_{bh}^2\right) \tag{8}$$

This individual tree crown area expression is then put in terms of percentage of an acre. So percentage tree crown competition factor, PCTCCF, is

$$PCTCCF = \frac{\pi \cdot 100}{4 \cdot 43560}\left(a_0^2 + 2a_0a_1d_{bh} + a_1^2d_{bh}^2\right) \tag{9}$$

After simplifying and introducing new symbols, the final form for individual tree CCF is

$$PCTCCF = r_1 + r_2d_{bh} + r_3d_{bh}^2 \tag{10}$$

where $k = 100B/(4x43560) = 1.80303x10^{-3}$;
$r_1 = ka_0^2$;
$r_2 = 2ka_0a_1$; and
$r_3 = ka_1^2$.

CCF for small trees (trees less than one inch dbh) is estimated with the equation

$$PCTCCF = d_{bh} * (r_1 + r_2 + r_3) \tag{11}$$

Stand CCF is the sum of the PCTCCFs for all trees.

Table 7 shows the resulting r_i coefficients for the percentage tree crown competition factor that are used in FVS WC.

Crown Width

Recently, new crown width data were obtained from R6's Permanent Plot Grid Inventory. These data are the basis for refitted crown width equations that are used for describing crown widths associated with individual live, dead, or cut tree records in FVS treelists (called for by a TREELIST or CUTLIST keyword).

The functional form for trees greater than 4.5 feet. is a simple power function, $CW = aD^b$, where CW is crown width in feet, D is tree Dbh, and a and b are coefficients determined by regression. For trees less than or equal to 4.5 feet height, the relationship is CW = rH, where H is tree height and r is a ratio of crown width to height. Coefficients for tree species in the WC variant are provided in table 8.

Missing Crown Ratio

If a tree record has no crown ratio, crown ratio is dubbed using one of three algorithms depending if the tree is newly established via regeneration, is established with dbh less than one inch, or is established with dbh one inch or greater.

For newly established trees an initial crown ratio (CR) is computed based on crown competition factor.

CR = 0.89722 - 0.0000461 * PCCF,

where PCCF is the point crown competition factor. A random factor is added to this initial value and the intermediate value checked so that if falls between 0.2 and 0.9. Finally, the value is rounded to an integer code between 20 and 90.

ICR(I) = 100.0*CR + 0.5.

For trees in the input data less than 1-inch dbh, expected crown ratio is a function of species, height, and basal area. The initial crown ratio is computed as

CR = BCR0(IISPC) + BCR1(IISPC)*H + BCR2(IICPC)*TBA,

where H is tree height, TBA is current total stand basal area, and BCRn and IISPC are defined in table 9. This initial crown ratio estimate has a random component added and the result is bounded between 0.05 and 0.95.

Crown ratio for trees in the input data with dbh 1-inch or greater is estimated using a Weibull function as described in a later section about computation of changes in crown ratio.

Large Tree Growth Submodel

In the large tree submodel, the order of computation for tree attributes is first diameter increment, then height increment, and finally crown change.

Diameter Increment

As described by Wykoff et al. (1982:53-65) and Wykoff (1986:p.5-8), large tree diameter growth is estimated by fitting a log linear regression to a set of predictive variables. These predictive variables fall into two groups. First are those describing factors that remain constant during the simulation such as the general location of the stand, its topographic setting, and its site index; second are those describing the dynamic biological attributes of the subject tree, or of its relation to neighboring trees, or of the stand as a whole. Equation 12 below shows the particular variables and their group.

	Coefficients and terms	Variable	FVS array name
$\ln(dds) =$			(12)
Stand variables constant during simulation:			
	$b_{01} * \ln(SI)$	Site index	DGSITE
+	$b_{02} * ELEV$	Elevation (100ft)	DGEL
+	$b_{03} * (ELEV)^2$	Elev. squared	DGEL2
+	$b_{04} * SLOPE$	Slope proportion	DGSLOP
+	$b_{05} * (SLOPE)^2$	Slope squared	DGSLSQ
+	$b_{06} * SL*Cos(ASPECT)$	Slope with cos(aspect-rad.)	DGCASP
+	$b_{07} * SL*Sin(ASPECT)$	Slope with sin(aspect-rad.)	DGSASP
+	$b_{08} * FOREST$	Location "dummy" var.	DGFOR
Tree/Stand biological variables dynamic during simulation:			
+	$b_{09} * D^2$	Dbh squared, by loc.	DGDSQ
+	$b_{10} * \ln(D)$	Dbh, nat. log form	DGLD
+	$b_{11} * CR$	Crown ratio, proportion	DGCR
+	$b_{12} * CR^2$	Crown ratio squared	DGCRSQ
+	$b_{13} * \ln(BA)$	Stand basal area (BA)	DGLBA
+	$b_{14} * BA$	Stand basal area	DGBA
+	$b_{15} * BAL$	BA, lg. trees (BAL)	DGBAL
+	$b_{16} * BAL/\ln(1+D)$	BAL modified by Dbh	DGDBAL
+	$b_{17} * PCCF$	Pt. crown comp. fctr.	DGPCCF
+	$b_{18} * RELHT$	TreeHt/AvgHt-40 largest dbh	DGHAH

Table 10 lists the coefficients by species or species group for the terms in equation 12.

The dependent variable in this functional form, ln(dds), is the natural log of change-in-diameter-growth squared. In alternate terminology, dds is delta diameter squared, where delta in this usage is the Greek letter commonly used to denote mathematical change. If dds is multiplied by the appropriate constant, change in tree basal area is obtained. The variable dds is further described by Wykoff et al (1982:p.53).

Not all variables in eq. 12 are used for all species, and two variables are based on categories. These two are location and D^2 variables which use a value that depends on category class. When a variable is not used in the regression for a particular species, its coefficient is zero. As a example of which coefficient value to use, assume our Forest is the Gifford Pinchot (GIP) and the species of interest is western hemlock. From table 10, footnote a, find that western hemlock (FVS-WC species number 19) has a Species Group Index of 09. In the body of table 10, the second section, see that under the FOREST variable, the Gifford Pinchot is listed as 1-GIP. Follow along that line over to the column for Species Group 09, and find that the location coefficient for western hemlock on the Gifford Pinchot NF is -0.298310.

Finally, for red alder growth a special function was established that does not have the same description as that above. All red alder coefficients in table 10 are shown as zero. For red alder, the dds growth function is a decreasing parabola if diameter is less than 18, coupled to a decreasing straight line for diameter greater than 18. Red alder diameter growth goes to zero for trees with 28 inches and larger dbh. However, any tree with diameter growth less than 0.1 inch has its diameter growth set to 0.1 inch, so the effective lower bound is 0.1 inch of growth.

Large Tree Diameter Increment Bounding Function

Dolph and Dixon (1993) point out that any simulator can be used to project beyond the bounds of the underlying development data. Indeed, that is one of the advantages of the simulation approach as long as the bounds are not stretched too far, and as long as the simulator has built-in safeguards to minimize unreasonable results.

The large tree diameter increment bounding function is an example of such a safeguard. Given a tree dbh, the corresponding diameter increment bounding equation is

$$DG_{max} = 7.92\ e^{-0.03dbh} \qquad (13)$$

If predicted diameter growth, DG, is greater than DG_{max}, then DG is set equal to DG_{max}; if less than zero, DG is set to zero. If dbh exceeds 150 in., dbh is set to 150 before maximum DG is computed with equation 13. The coefficients in equation 13 were developed from Douglas-fir data.

Height Increment

The height growth functions used in the FVS West Cascades variant are not similar to those reported by Wykoff and others (1982). In the WC variant, height growth is calculated using a technique of modified potential described by Wensel et al. (1987) and Richie and Hann (1986). These authors constructed site curves and then height growth curves with modifiers based on the same data. In WC, the site curves are those discussed in the section, Site Index and Site References.

Height can be calculated with these site equations given a site index and age. Conversely, given a site and height it is possible to calculate an approximate age for a tree, more appropriately called an effective site age. Potential height growth can then be calculated by incrementing the effective site age by the cycle period length and solving the site index equation for a new height. Height growth is the difference in the heights between the two points in time. For a specific site this growth would be the best expected if the tree follows the site or height growth curve. For example, consider a typical western hemlock, site index 100 (Wiley 1978;p.23). If the tree starts the projection cycle 40 feet tall, its effective breast high site age is 17 years. Ten years later, at an effective site age of 27 (breast high), its height would be 62 feet. Thus, the potential height growth for the 10-year interval is 22 feet.

The one exception in this variant to the potential height logic described above occurs for white fir and grand fir older than a specified maximum advanced age. In this case,

$$POTHTG = 10*(0.2 + 0.00264*SI),$$

where POTHTG is potential height growth and SI is site index.

Regardless of which approach is used to estimate potential height growth, potential growth is usually reduced based on estimates of vigor and the tree's competitive position in the stand. Tree vigor is associated with crown ratio and competitive stand position is associated with suppression effects (if any) due to relative height. These two factors are combined to reduce potential height growth. The modifying factor, X_{mod}, multiplies potential height increment, POTHTG, and varies from 1 to 0, signifying, at the extremes, that a potential height increment is not reduced at all, or that it is to be reduced to zero. The equation for X_{mod} is

$$X_{mod} = a(1 - e^{bCR})(e^{c(RH^{d} - 1)}) \qquad (14)$$

where:

X_{mod} = value of the modifier;
CR = crown ratio as a decimal proportion, i.e., 70%CR -> 0.7;
RH = height of the subject tree divided by the average height of the 40 largest diameter trees in the stand;
a = 1.117148; b = -4.26558; c = 2.54119; d = 0.250537.

This modifier function is similar in concept to the functions discussed by Ritchie and Hann (1986:p.139-141). The factor with crown ratio CR is calibrated to be zero if crown ratio is zero; in this case the modifier would be zero and so would height growth after multiplication of the potential height. Conversely, if CR is one, then its factor is close to 1 in value. The relative height factor works similarly. The RH variable is constrained in the model to be 1 or less. Thus, even though a given tree may be taller than the average height of the 40 largest diameter trees, its relative height value is still 1. However, a tree shorter than the average height of the 40 largest dbh trees will have a relative height less than 1, depending on its height and the average.

Biologically, crown ratio and relative height are likely related. A tree could have a small crown ratio for a variety of reasons, but a likely reason is that it is suppressed with its crown overtopped by neighboring trees. Mathematically however, these two factor terms in equation (14) are independent even though they are related through other parts of the model.

For all species, the conditional estimated 10-year height growth is given by:

$$HTG = POTHTG * X_{mod} \qquad (15)$$

The sum of height at the start of the cycle plus the modified 10-year height growth is next checked in a bounding function to make sure it doesn't exceed the species newly calculated maximum height. If the newly estimated height does exceed this maximum height bound, then height growth is adjusted so that new total height equals maximum height. Finally, if cycle length is different than 10 years, height growth is scaled to the cycle length using a straight ratio adjustment, and then height growth is multiplied by any height growth multipliers entered by FVS keyword. At this point, the revised and modified height growth is added to the old height to give new height.

Crown Changes

Crown ratio for each tree record is predicted at the end of each projection cycle. Crown ratio may increase, decrease, or stay the same depending on growth in the subject tree and on changes in the stand and neighboring trees. The distribution of crown ratios within a stand are assumed to follow a Weibull distribution (Johnson and Kotz 1970:p.250). First, the mean stand crown ratio is estimated from Stand Density Index (Reineke, 1933). Next, Weibull distribution parameters are estimated from mean stand crown ratio. And finally, individual trees are assigned a crown ratio from the specified Weibull distribution based on their rank in the diameter distribution, and scaled by a density dependent scale factor. A detailed description of this technique can be found in Dixon (1985). Change in crown ratio from one projection cycle to the next is obtained from the difference in the crown ratios picked from the appropriate Weibull distributions at the beginning and at the end of the cycle. This change value is bounded to 10 percent to avoid unrealistic changes from one cycle to the next.

Mean stand crown ratio is estimated using equation [17] and the coefficients shown in Table 10.

MCR = d0 + d1 * RSDI [17]

where RSDI (relative SDI) = current SDI / maximum SDI.

Computation of maximum SDI is described in the section discussing mortality. In a recent revision to the WC variant, maximum SDI is determined by plant association and is based on the SDI value of the default site species for the plant association. This information is displayed in table A1 in the appendix.

The Weibull distribution is described by its probability density function shown in equation [18] (Johnson and Kotz, 1970).

$$f_X(x) = \frac{c}{b}\left(\frac{x-a}{b}\right)^{c-1} e^{-\left(\frac{x-a}{b}\right)^{c}} \qquad [18]$$

The "a" (location) coefficient is set to a constant; and the "b" (scale) and "c" (shape) coefficients are estimated as linear functions of mean crown ratio, equations [19] and [20]. Coefficients for estimating these parameters are shown in Table 10. Estimates of the "b" parameter are bounded to values 3.0 or greater, and estimates of the "c" parameter to values of 2.0 or greater.

b = b0 + b1 * MCR [19]

c = c0 + c1 * MCR [20]

where MCR = estimated mean stand crown ratio.

Once the Weibull distribution is specified, code in subroutine CROWN uses the Weibull's cumulative distribution function in an algorithm to assign crown ratios to individual trees. The lower truncation point for choosing crowns from the Weibull distribution is the .05 percentile point. The upper limit is the .95 percentile point, unless a density dependent scale factor is invoked.

The scale factor (equation [21]) is a function of the stand's crown competition factor. Values of SCALE are bounded between 0.3 and 1.0, inclusive.

$$SCALE = [1.0 - 0.00167 * (RELDEN - 100.0)] \qquad [21]$$

where RELDEN = stand CCF.

The net effect from the large tree crown model is to make simulated crown changes responsive to changes in the tree and surrounding stand. For example, with thinning, the crown is expected to lengthen; conversely, if density increases, a given crown is expected to shorten.

Small Tree Submodel

In the small tree submodel, the order of growth estimation is different than in the large tree model being first tree height, then diameter, and then crown changes.

Height Increment

Height increment for the small tree model is computed for all trees. Recall that the large tree model calculates height increment for all trees. The overlap zone defined by diameter allows a weighted average of heights in the zone range so that the height transition is smooth from the small to large tree model. Currently, the transition zone in the WC variant is 3- to 5-inches. These transition zone bounds are used below as examples with the understanding that at some point in the future, they could change.

For small trees, potential height growth is calculated according to the following equation:

$$\text{Potential Height Growth} = CON*(10.2 + 5.05\ (Dummy) - 0.03\ (Point\ CCF))$$

where Dummy = 1 if species = DF; dummy = 0 for all other species;
CON = a constant determined for each species.

Potential growth is then reduced for the effects of density and crown according to the equation:

$$\text{Modifier} = (1 - e^{(-2.0(SATBA-BA)/BA)}) * (\text{Crown Ratio}) * 0.12$$

where SATBA is the stand basal area that effectively inhibits all growth of small trees and Crown Ratio is a coded value 0-9.

A slight random adjustment of up to +/- 10 percent is then added to the prediction. This predicted height growth is for a five-year period. Before proceding, the small tree height growth is adjusted to the simulation cycle length.

In order to make small tree height predictions and large tree height preditions mesh smoothly over the transition diameter range of 3 to 5 inches dbh, a simple weighting procedure combines the two height estimates in the 3- to 5-inch diameter range. Predicted height growth in this range are computed using the following formulas:

$$\text{Weight} = (dbh - \text{minimum } dbh) / (\text{maximum } dbh - \text{minimum } dbh)$$

and

Predicted HTG = (small tree HTG)*(1.0-weight) + (large tree HTG)*weight

where minimum dbh is 3 inches and maximum dbh is 5 inches. If the diameter is less than the minimum shown for that species, weight is set to 0.0; if the diameter is greater than the maximum, weight is set to 1.0.

Diameter Increment

Following the height calculation, diameter growth for trees less than 3-inches dbh is estimated. Diameter outside bark is calculated for the beginning of the projection period, and again for the end of the projection period. Diameter growth, outside bark, is the difference between the two.

When diameter outside bark is calculated at the beginning and end of the projection period, one of two methods is used depending on whether the height-diameter function is calibrated or not. Calibration of the height diameter equation is now turned OFF by default. In this case the equations used to calculate dbh, outside bark, are the Curtis-Arney nonlinear functions discussed earlier in this Overview for height dubbing. However, if the user specified calibration of the height-dbh equations using the NOHTDREG keyword for height dubbing, the Curtis-Arney equations are not used to compute small tree diameter growth. Instead, diameter at the beginning and end of the projection are computed from species specific equations of the form,

$$Diam. = K_i + a_i*CRCODE + b_i*ALHT + c_i*H + d_i*DDUM,$$

where
i = subscript denoting a particular species;
a_i, b_i, c_i, d_i = species specific regression coefficients;
CRCODE = crown ratio code, 0-9;
ALHT = ln(H);
H = tree height (either at start or end of projection period);
DDUM = additional constant applicable to certain species.

Following calculation of diameters outside bark at the beginning and end of the projection period, diameter growth outside bark is converted to diameter increment inside bark using species specific bark factors, and then scaled to the typical 10-year projection interval.

Crown Changes

Crown change during a projection cycle for small trees with dbh one inch or larger is estimated by the same logic as for large trees. Crown ratio for trees with dbh less than one inch is held constant at its initial value until its dbh reaches one inch.

Mortality

Two tree mortality rates are combined in the West Cascades variant. One mortality rate is based solely on individual tree characteristics; another mortality rate is based on stand basal area characteristics relative to a stand basal area maximum. Modifiers are applied for stand density and length of prediction period. The two rates are combined with a basal area weighting formula to get the rate applied to an individual tree record.

After recent upgrades to the WC variant (G&Y Bulletin No. 333, 3/13/97), maximum stand density index (SDImax), which formerly played a significant role in computing crown changes (see eq. 17 and accompanying text), now also enters significantly into mortality logic because it affects maximum basal area. SDImax, like default site index discussed earlier, now has a default value based on plant association ecoclass code. See table A1 in the appendix for a list of default SDImax values by ecoclass code. Basal area maximum is now determined by SDI maximum and thus has a direct effect on how mortality is computed. Basal area maximum is computed as SDImax * 0.5454, since SDImax is the number of asssumed 10-inch trees the stand can support, and 0.5454 comes from 10*10*0.005454.

The basic individual tree relationship may depict either mortality or survival. The predicted dependent variable is a decimal proportion of a tree record. For example, if a survival proportion of 0.975 is predicted for a tree record that represents five 8.5-inch trees in a given cycle, then the next cycle will start with 4.875 (<= 5 * 0.975) trees represented by this particular tree record.

Hamilton and Edwards (1976) describe simulation of individual tree mortality that is based on a logistic function. The general form of the primary equation is

$$R_t = \frac{1}{1 + e^{-f(x)}} \qquad [23]$$

where R_t is a decimal proportion (0-1) of a tree record; and f(x) is some linear function of tree and stand variables and, in some cases, site-based qualitative ("dummy") variables.

In the WC variant this equation is

$$R_{ts} = \frac{1.0}{1.0 + e^{-(a + bD_{bh} + cCR_c + dSP)}} \qquad [24]$$

where R_{ts} is a survival rate rather than a mortality rate;
D_{bh} is tree diameter at breast height;
CR_c is the crown ratio code (0-9);
SP is a {0,1} category variable for species; and
a=-2.10198; b=-0.036595; c=-0.165802; d=-0.987133.

Since equation [24] shows survival rather than mortality, the corresponding mortality rate, R_{tm}, is computed as $R_{tm} = 1.0 - R_{ts}$ This equation uses data from a 12-year interval so, to compute a mortality rate for a different interval, the mortality rate is first transformed to an annual basis. Hamilton's logistic rate is adjusted by a factor based on Reineke's SDI to account for expected differences in diameter growth rates. One factor applies to diameters greater than five inches; another factor to diameters less than or equal to 5 inches.

Wykoff et al. (1982:pp. 73,74) and Wykoff (1986:p.11) discuss how mortality is adjusted as stand basal area increases and approaches an independently estimated basal area maximum. When basal area is much less than maximum, most basal area increment is retained as growing stock. However, for basal area increasingly close to maximum, more basal area growth is offset by mortality. Wykoff et al (1982:p.76) illustrate this in the right half of figure 37 which shows a widening gap between increasing accretion and decreasing net volume increment as stand basal area and mortality increase.

After combination of the two mortality rates on an annual basis (i.e., the individual tree rate and basal area rate), the combined rate is again transformed so that it applies to the number of years in the simulation cycle, typically ten years.

Establishment Submodel

Except for sprouting species, the user must explicitly establish regeneration in the West Cascades variant. This is done by using a subset of the keywords described by (Ferguson and Crookston 1991:p.10) for the regeneration establishment submodel. Thus, natural regeneration as an automatic integral model feature, as described by Ferguson and Carlson (1993), is not currently available for the West Cascades variant. In the West Cascades variant, only the following keywords are operable and effective for regeneration establishment in WC: ESTAB, BURNPREP, MECHPREP, PLANT, NATURAL, PLOTINFO, RESETAGE, OUTPUT, HTADJ, RANNSEED, MINPLOTS, TALLY, TALLYONE, TALLYTWO, and END. Thus, the only method of establishing new trees in the West Cascades variant is explicitly using PLANT or NATURAL keywords keywords in an ESTBLISHMENT keyword sequence. Also, for most applications it is not necessary to use any of the three "tally" keywords. These keywords are also described by Teck (1996a).

The other keywords shown in table 4 of Ferguson and Crookston (1991:p.10) are useful only in the five variants that support automatic integrated regeneration.[1] If these are used in WC simulations, they do not cause explicit error messages, but they don't do or affect anything.

In addition, several of the above listed keywords, for example, PLANT, BURNPREP and MECHPREP, supply information used in economic analysis (i.e., CHEAPO: Horn, et al. 1986).

In the establishment submodel, height is first estimated from information on the PLANT or NATURAL keyword and then modified by random components. Crown ratios are assigned to these newly established trees using the equation

$$CR = (0.89722 - 0.0000461*PCCF + 0.07985*RANN)*100, \qquad [25]$$

where CR is the crown ratio bounded between (20,90); PCCF is the point crown competition factor; and RANN is a random increment bounded between (-1.0,1.0). If TALLY keywords are not used, these trees are passed to the FVS treelist at the first projection cycle boundary following regeneration. Height growth is calculated for the length of time between planting and the end of the projection cycle. Then, diameter growth and crown changes are estimated as part of the small tree model, as described earlier.

The minimum set of regeneration establishment keywords necessary to get a FVS projection from planting trees on bare ground is:

```
NOTREES
ESTAB    date
PLANT    date    16.   400.
END
```

The date (i.e., a year or cycle number) in the ESTAB keyword record is the date of the disturbance or cutting that necessitated planting. The date in the PLANT keyword is the year planting is to be done. The two dates may be the same; they don't have to be. In many cases the date of planting is different than the

[1]The five variants that do support full automatic regeneration are Northern Idaho (NI, aka Inland Empire), Central Idaho (CI), Kootanai-Kaniksu-Tally Lake (KT, aka KOOKANTL), Eastern Montana (EM), and Southeast Alaska/Brit. Col. Coast (AK, aka SEAPROG).

disturbance date but is set in the same cycle as the date of disturbance. Additional detail about timing of establishment is discussed in Ferguson and Crookston (1991).

To ease the inclusion of simple regeneration into FVS simulations, a "keyword" called REGEN can be used within the FVS Submittal System (Teck 1996b). This "keyword" appears as part of the Submittal System MAIN KEYWORD ENTRY SCREEN. By choosing REGEN, the user is asked for parameters describing the intended FVS regeneration keywords. Please note that REGEN is a "keyword" for use only in the Submittal System. REGEN does NOT work in a regular FVS keyword file.

Volume Calculation

Volume algorithms for the West Cascades variant cover the computations for total cubic foot volume, merchantable net cubic foot volume, and merchantable net board foot volume. These three volumes are potentially computed for each tree record, depending on tree size. Net merchantable volumes may not apply to some tree records depending on how the merchantibility limits are set (as defaults or via the VOLUME or BFVOLUME keywords).

Total cubic volume for WC is based on inside-bark diameters calculated by Region 6 Westside taper functions. Form class in WC is currently determined based on species and diameter size class, and on the "West side" of Region 6 describes the bottom 32-foot log. If needed, form class may be changed using Field 6 of the VOLUME keyword (Teck 1996a).

Merchantable cubic foot volume is based on default Minimum Dbh and Minimum Top Diameter, or on the respective specifications entered in Fields 3 and 4 of the VOLUME keyword. Net merchantable cubic volume is obtained by applying a defect correction factor; for example, if the defect correction factor is 0.25, then 25 percent of the volume is defect and the net volume is the remainder after defect volume is subtracted. The defect correction factor is the maximum of three possible correction factors available to the model. The three are 1) the current defect percent from tree record data; 2) the computed linear interpolation value from the MCDEFECT keyword; or 3) the computed log-linear value from the MCFDLN keyword.

Processing for board foot volume is similar in concept, although not in the details. For board foot volume, the BFVOLUME keyword functions the same as the VOLUME keyword for cubic volume. Defect information is included via the BFDEFECT or BFFDLN keywords.

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Table 1. Forest codes used in the Westside Cascades variant.

Forest	Code	Acronym
Gifford Pinchot	603	GIP
Mt. Baker/Snoqualmie	605	MBS
Mount Hood	606	MTH
Rogue River	610	ROR
Umpqua	615	UMP
Willamette	618	WIL

Table 2. Species names and codes used the the Westside Cascade variant.

Species	Scientific Name	FIA code	Species FVS codes		Number of Observ.
Pacific silver fir	Abies amabilis	011	SF	01	3,878*
White fir	Abies concolor	015	WF	02	1,044
Grand fir	Abies grandis	017	GF	03	504*
Subalpine fir	Abies lasiocarpa	019	AF	04	227*
California red fir	Abies magnifica	020	RF	05	44*a
Shasta red fir	Abies magnifica var. shastensis	021	RF	05	515*a
--This slot not in use	currently	---	--	06	
Noble fir	Abies procera	022	NF	07	1,555*
Alaska cedar	Chamaecyparis nootkatensis	042	YC	08	112*b
Western larch	Larix occidentalis	073	YC	08	74*b
Incense cedar	Libocedrus decurrens	081	IC	09	296
Engelmann spruce	Picea engelmannii	093	ES	10	209*c
Sitka spruce	Picea sitchensis	098	ES	10	2*c
Lodgepole pine	Pinus contorta	108	LP	11	898*
Jeffrey pine	Pinus jeffreyi	116	JP	12	0
Sugar pine	Pinus lambertiana	117	SP	13	240
Western white pine	Pinus monticola	119	WP	14	414*
Ponderosa pine	Pinus ponderosa	122	PP	15	432*
Douglas-fir	Pseudotsuga menziesii	202	DF	16	17,250*
Coast redwood	Sequoia sempervirens	211	RW	17	0
Western redcedar	Thuja plicata	242	RC	18	1,354*
Western hemlock	Tsuga heterophylla	263	WH	19	5,008*
Mountain hemlock	Tsuga mertensiana	264	MH	20	3,019*
Bigleaf maple	Acer macrophyllum	312	BM	21	89*
Red alder	Alnus rubra	351	RA	22	125*
White alder	Alnus rhombifolia	352	WA	23	2d
Pacific madrone	Arbutus menziesii	361	WA	23	70d
Western paper birch	Betula papyrifera var. commutata	376	PB	24	0
Giant chinkapin	Castanopsis chrysophylla	431	GC	25	62e
Tanoak	Lithocarpus densiflorus	631	GC	25	1e
Quaking aspen	Populus tremuloides	746	AS	26	0
Black cottonwood	Populus trichocarpa	747	CO	27	8
Oregon white oak	Quercus garryana	815	WO	28	12f
California black oak	Quercus kelloggii	818	WO	28	4f
Juniper	Juniperus occidentalis 060	J	29		0
Subalpine larch	Larix lyallii	072	LL	30	0
Whitebark pine	Pinus albicaulis	101	WB	31	2
Knobcone pine	Pinus attenuata	103	KP	32	0
Pacific yew	Taxus brevifolia	231	PY	33	5
Pacific dogwood	Cornus nuttallii	492	DG	34	0
Hawthorn	Crataegus spp.	500	HW	35	0
Bitter cherry	Prunus emarginata	764	BC	36	0
Willow	Salix spp.	920	WI	37	0
--This slot not in use	currently	---	--	38	
"Other"	Species not listed above	999	OT	39	

"*" marks those species whose large tree (>3 inches) growth relationships were fitted specifically for Westside Cascade areas. Data for these species are also summarized in a series of tables following this one.

"*a" denotes that California red fir and Shasta red fir are considered together for modeling purposes and either should be identified by 05 or RF; similar interpretation for other species with pairs of letters, b-b, c-c, etc.

Tables 2a - 2h. Data distribution by National Forest origin and species code for data used in building the Westside Cascades FVS model. The tables are expressed in percent of total observations for each species and a dash ('-') indicates no data were used from the given Forest-Species combination.

Table 2a. Distribution of samples by National Forest.

	National Forest					
Species	GIP	MBS	MTH	ROR	UMP	WIL
SF	11.7	24.1	32.5	0.0	3.5	28.2
GF	4.3	0.2	34.9	28.3	21.0	11.3
AF	27.8	11.9	18.1	0.9	22.9	18.5
RF	-	-	-	75.3	24.5	0.2
NF	3.5	2.8	31.9	1.5	17.1	43.3
ES	4.3	0.8	13.0	17.0	35.9	29.0
YC	6.8	46.2	18.8	-	-	28.2
LP	5.1	-	30.1	7.8	44.0	12.9
PP	1.9	-	67.1	13.7	15.0	2.3
WP	1.7	0.3	8.6	11.2	45.6	32.7
DF	9.2	4.6	19.8	3.7	23.1	39.6
RC	7.7	23.9	28.4	-	3.2	36.9
WH	8.0	23.5	31.3	1.3	6.2	29.7
MH	2.7	7.2	15.8	3.3	22.0	49.1
MA	7.9	22.5	6.7	-	9.0	53.9
RA	11.2	23.2	52.0	-	6.4	7.2
MISC.HW.	2.6	3.8	35.3	3.4	47.7	7.2

Table 2b. Distribution of samples by crown ratio group.

	Crown Ratio Code								
Species	1	2	3	4	5	6	7	8	9
SF	2.0	8.8	19.3	23.5	19.6	14.4	7.1	4.1	1.3
GF	1.3	7.8	23.4	21.8	19.2	12.5	7.6	4.8	1.6
AF	0.9	6.6	12.3	19.8	15.9	17.6	9.7	12.3	4.8
RF	0.7	7.5	24.7	24.9	22.4	11.4	4.1	3.2	1.1
NF	1.0	12.1	32.9	26.9	11.4	6.1	4.0	4.1	1.6
ES	1.4	5.7	23.3	20.7	19.3	14.6	6.3	6.7	2.0
YC	2.6	13.7	17.1	18.8	15.4	21.4	8.5	2.6	-
LP	4.3	14.8	27.6	21.4	13.3	9.4	4.9	3.2	1.0
PP	2.3	15.7	28.2	22.7	13.4	8.1	5.3	3.7	0.5
WP	1.4	10.9	26.8	26.9	16.5	9.3	5.2	1.8	1.2
DF	1.4	9.9	29.2	29.5	15.7	7.3	3.4	2.8	0.8
RC	4.1	6.6	15.5	16.2	18.5	16.7	14.3	6.1	2.0
WH	1.8	6.7	13.8	21.0	20.1	16.7	11.7	6.0	2.1
MH	0.7	4.9	15.5	21.6	21.4	16.3	10.8	7.0	1.9
MA	2.2	15.7	38.2	20.2	12.4	5.6	3.4	2.2	-
RA	-	12.8	38.4	30.4	12.0	1.6	3.2	1.6	-
MISC.HW.	1.7	17.0	31.1	28.1	11.9	6.4	1.7	1.3	0.9

Table 2c. Distribution of samples by slope code.

Species	Slope Code 1	2	3	4	5	6	7	8	9	0
SF	20.0	17.7	14.2	11.3	10.1	7.7	4.3	2.0	0.5	12.3
GF	24.4	18.3	15.1	9.6	6.0	6.1	1.6	1.9	0.1	16.8
AF	21.1	21.1	7.0	8.4	12.3	2.2	2.6	-	-	25.1
RF	24.3	27.9	20.2	6.3	5.2	5.0	-	-	-	11.1
NF	17.6	17.9	15.8	13.4	7.8	11.4	2.6	2.1	0.4	10.9
ES	20.5	10.3	16.8	10.8	4.5	6.9	4.7	0.8	0.2	24.5
YC	12.0	14.5	9.4	13.7	11.1	14.5	6.0	2.6	0.9	15.4
LP	24.7	12.4	3.3	3.0	1.0	1.0	-	-	-	54.5
PP	25.2	13.2	13.0	7.6	9.7	5.8	2.8	1.6	-	21.1
WP	17.6	19.3	9.0	15.0	6.1	6.7	5.7	3.1	0.6	17.0
DF	12.3	13.5	12.3	12.1	10.3	12.6	10.0	5.3	2.3	9.3
RC	12.7	13.1	11.3	11.0	11.1	8.3	8.1	5.5	3.0	16.0
WH	14.2	11.1	14.1	11.9	11.3	9.7	7.8	4.9	3.6	11.4
MH	23.9	20.7	8.7	8.8	4.3	4.8	2.5	0.6	0.4	25.3
MA	10.1	10.1	6.7	4.5	19.1	9.0	9.0	4.5	7.9	19.1
RA	8.0	10.4	17.6	11.2	11.2	1.6	4.8	4.0	1.6	29.6
MISC.HW.	16.6	17.9	11.1	11.5	6.0	3.8	9.4	4.7	-	19.1

Table 2d. Distribution of samples by aspect code.

Species	Aspect Code 1	2	3	4	5	6	7	8	9
SF	18.6	10.6	11.3	8.1	10.1	8.8	11.6	12.5	8.3
GF	7.8	8.0	8.3	8.7	13.0	15.1	12.3	11.9	15.0
AF	4.8	1.8	10.6	0.9	19.4	13.2	17.2	13.2	18.9
RF	10.4	16.1	11.8	4.1	9.1	8.8	27.2	8.9	3.6
NF	12.4	6.7	12.6	7.9	10.4	12.5	18.6	11.3	7.6
ES	10.7	5.3	7.1	9.5	12.2	13.0	17.8	8.1	16.4
YC	26.5	12.8	5.1	0.9	13.7	8.5	6.8	10.3	15.4
LP	6.7	4.7	4.1	5.4	7.9	11.7	7.8	7.8	43.9
PP	5.6	6.0	6.5	9.7	24.1	16.7	6.5	4.9	20.1
WP	11.8	7.5	15.3	7.0	8.7	14.8	13.1	7.0	14.7
DF	12.8	7.6	9.4	9.4	15.9	11.5	16.6	9.3	7.5
RC	16.0	9.2	7.4	6.0	10.3	6.7	16.8	12.8	14.8
WH	18.4	11.2	10.5	6.1	10.5	11.1	12.6	10.5	9.2
MH	17.9	12.0	7.8	1.9	5.5	6.3	14.6	16.4	17.7
MA	19.1	5.6	1.1	3.4	18.0	7.9	15.7	7.9	21.3
RA	8.0	5.6	10.4	8.8	19.2	9.6	4.8	4.0	29.6
MISC.HW.	5.1	9.4	8.9	12.3	17.0	12.3	11.1	6.8	17.0

Table 2e. Distribution of samples by elevation.

Species	Elevation (hundred's feet) < 20	20-30	30-40	40-50	50-60	>60
SF	1.1	5.9	30.7	44.4	17.2	0.9
GF	2.0	10.0	29.4	43.3	15.3	-
AF	-	-	5.7	43.2	39.2	11.9
RF	-	0.2	2.5	17.4	64.8	15.2
NF	0.1	0.6	20.3	51.3	25.1	2.6
ES	4.1	20.5	31.8	29.2	14.4	-
YC	-	9.4	41.0	47.0	2.6	-
LP	-	1.2	15.3	40.0	29.2	14.3
PP	1.6	22.0	51.9	23.6	0.2	0.7
WP	2.1	13.8	31.3	28.6	21.9	2.3
DF	8.5	29.1	38.7	21.8	1.9	0.0
RC	13.7	44.2	39.2	2.7	0.1	-
WH	7.1	24.6	49.4	18.6	0.2	-
MH	-	0.1	6.1	29.2	45.6	18.9
MA	52.8	41.6	5.6	-	-	-
RA	44.8	40.0	15.2	-	-	-
MISC.HW.	6.0	34.0	40.0	16.2	3.8	-

Table 2f. Distribution of samples by diameter breast height.

Species	d.b.h. (inches) 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	90+
SF	28.6	38.5	21.0	9.0	2.7	0.3	-	-	-	-
GF	25.1	38.8	21.9	11.6	2.0	0.4	-	0.1	0.1	-
AF	29.5	45.7	20.7	3.1	0.9	-	-	-	-	-
RF	18.8	23.6	25.1	18.4	10.0	3.6	0.5	-	-	-
NF	14.8	33.3	26.5	17.1	7.3	0.9	0.1	-	-	-
ES	16.7	20.6	21.5	16.6	10.3	3.0	0.8	0.6	-	-
YC	21.4	29.9	21.4	17.1	7.7	1.7	0.9	-	-	-
LP	51.7	47.8	0.3	0.1	-	-	-	-	-	-
PP	15.5	19.5	28.7	25.4	10.0	0.7	0.2	-	-	-
WP	10.6	24.2	30.6	17.6	9.9	6.1	0.5	0.6	-	-
DF	10.5	26.2	24.2	17.5	11.5	6.6	2.4	0.8	0.3	0.1
RC	14.5	24.9	21.1	15.0	9.0	5.9	4.9	2.7	1.0	0.8
WH	19.9	32.5	25.4	13.5	6.1	2.0	0.4	0.0	-	-
MH	19.7	41.1	28.9	8.4	1.3	0.4	0.1	-	-	-
MA	48.3	43.8	6.8	1.1	-	-	-	-	-	-
RA	28.0	63.2	8.8	-	-	-	-	-	-	-
MISC.HW.	51.1	33.2	8.1	7.3	-	-	-	-	0.4	-

Table 2g. Distribution of samples by total stand basal area per acre.

	Basal Area (sq ft/acre)							
Species	0-50	51-150	151-250	251-350	351-450	451-550	551-650	651+
SF	0.2	7.0	28.7	39.7	18.5	5.2	0.7	0.2
GF	0.5	14.6	32.0	30.5	16.7	4.6	1.0	-
AF	-	14.1	40.9	33.9	8.4	2.6	-	-
RF	0.5	10.7	20.6	32.2	30.4	5.5	-	-
NF	0.3	7.0	28.6	34.8	23.9	4.2	1.2	0.2
ES	0.2	9.5	29.0	37.3	18.0	4.1	2.0	-
YC	-	9.4	24.8	46.2	10.3	4.3	5.1	-
LP	1.6	34.6	50.2	8.8	4.4	0.4	-	-
PP	3.5	35.9	40.3	14.9	5.6	-	-	-
WP	0.5	14.0	41.9	26.5	12.9	4.4	-	-
DF	0.3	7.9	29.4	34.3	20.0	5.8	1.9	0.4
RC	0.2	4.0	24.9	35.9	23.0	8.6	1.7	1.7
WH	0.2	4.9	25.8	39.2	21.0	7.5	1.2	0.2
MH	0.2	7.9	34.7	39.5	14.9	2.8	0.1	-
MA	1.1	23.6	40.4	24.7	7.9	2.2	-	-
RA	-	20.8	39.2	28.0	10.4	1.6	-	-
MISC.HW.	0.9	20.9	45.6	21.7	9.0	2.1	-	-

Table 2h. Distribution of samples by diameter growth.

	Diameter Growth (inches/10 years)								
Species	<1.0	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.0+
SF	74.6	20.3	4.0	0.9	0.2	-	0.0	-	-
GF	50.8	34.3	10.5	3.0	1.0	0.3	-	-	0.2
AF	77.1	20.3	2.2	0.4	-	-	-	-	-
RF	52.8	35.8	8.7	1.6	1.1	-	-	-	-
NF	51.2	33.6	10.1	2.8	1.7	0.5	0.1	-	0.1
ES	73.4	22.1	3.4	0.6	0.4	-	0.2	-	-
YC	80.3	15.4	3.4	-	0.9	-	-	-	-
LP	82.6	15.2	1.5	0.4	0.2	-	-	-	-
PP	67.4	20.4	6.9	3.3	1.1	0.7	0.2	-	-
WP	67.7	25.1	5.4	1.5	0.4	-	-	-	-
DF	65.8	25.1	5.0	2.2	1.1	0.5	0.2	0.1	0.0
RC	59.6	30.5	7.0	2.1	0.7	0.1	-	-	-
WH	70.6	23.1	4.4	1.4	0.4	0.2	0.0	-	0.0
MH	89.1	9.8	0.9	0.2	0.0	-	-	-	-
MA	55.1	24.7	13.4	5.6	1.1	-	-	-	-
RA	23.2	48.8	21.6	5.6	-	0.8	-	-	-
MISC.HW.	82.5	11.5	4.3	1.3	0.4	-	-	-	-

Table 3. Site curve references for each species fit to data in Westside Cascades FVS variant.

Species FVS codes	Site Index Reference	Base age	Age measure TTA/BHA
SF 01	Hoyer and Herman (1989)	100	BHA
GF 03[1]	Cochran (1979)	50	BHA
AF 04[2]	Alexander (1967)	100	BHA
RF 05	Dolph (1991)	50	BHA
NF 07	Herman et al. (1978)	100	BHA
YC 08	Curtis et al. (1974)	100	BHA
ES 10	Alexander (1967)	100	BHA
LP 11	Dahms (1964)	50	TTA
WP 14[3]	Curtis et al. (1990)	100	BHA
PP 15[4]	Barrett (1978)	100	BHA
DF 16	Curtis et al. (1974)	100	BHA
RC 18	Curtis et al. (1974)	100	BHA
WH 19	Wiley (1978)	50	BHA
MH 20 (METRIC)[5]	Means et al. (1986)	100	BHA
RA 22	Worthington et al.(1960)	50	BHA
LL 30	Cochran (1985)	50	BHA
Misc. Hardwoods[6]	Curtis et al. (1974)	100	BHA

[1]Also for WF 02.

[2]Also for ES 10.

[3]Also for SP 13.

[4]Also for IC 09 and JP 12.

[5]Site indices in this source are in metric units. It is assumed by FVS WC that any SI values for MH are in meters rather than feet.

[6]Includes all the following species: RW 17, BM 21, WA 23, PB 24, GC 25, AS 26, CO 27, WO 28, J 29, WB 31, KP 32, PY 33, DG 34, HW 35, BC 36, WI 37. Species number 38 is not defined for the West Cascades variant, and number 39 is for "other" miscellaneous species not listed in table 2.

Table 4. Coefficients for the bark thickness equations used in the WC variant.

Equation number	Bark ratio index	Coefficient values b_1	b_2	Species equation applies to:	Ref. No.[1]
1	1	0.903563	0.989388	DF, WH, MH, RA, WA, AS, CO, WB, KP, PY, DG, HW, BC, WI, Misc. other species	1
	2	0.904973	1.000000	SF, WF, GF, AF, RF, NF	1
	3	0.809427	1.016866	PP	1
	4	0.859045	1.000000	JP, SP, WP	1
	5	0.837291	1.000000	YC, IC, RW, RC, J	1
2	6	0.08360	0.94782	BM, PB	2
	7	0.15565	0.90182	GC	2
	8	-0.30722	0.95956	WO	2
3	9	0.9	0.0	ES	3
	10	0.9	0.0	LP, LL	3

[1] Sources and computations for the diameter inside bark relationships are tabulated according to their table reference number.

1. Walters et al. (1985); Table 2, p. 3.
2. Pillsbury and Kirkley (1984); Table 2, p. 9. This table is in metric units. To convert to English units, only the constant term needs division by 2.54 cm/in; the slope term is a dimensionless ratio, so it is correct as is.
3. Wykoff et al. (1982); Table 7, p. 50.

Table 5. Coefficients for the large tree (D_{bh} >= 5 in.) height dubbing function in the Westside Cascades variant (eq. 5).

FVS species codes	[1]b_0	b_1
SF (01)	5.288	-14.147
WF,GF (02,03)	5.308	-13.624
AF,RF (04,05)	5.313	-15.321
NF (07)	5.327	-15.450
YC (08)	5.143	-13.497
IC,ES (09,10)	5.188	-13.801
LP (11)	4.865	- 9.305
JP (12)	5.333	-17.762
SP,WP (13,14)	5.382	-15.866
PP (15)	5.333	-17.762
DF (16)	5.288	-14.147
RW (17)	5.188	-13.801
RC (18)	5.271	-14.996
WH (19)	5.298	-13.240
MH (20)	5.081	-13.430
BM (21)	4.700	- 6.326
RA (22)	4.886	- 8.792
WA,PB,GC,AS,CO,WO,J 23,24,25,26,27,28,29	5.152	-13.576
LL,WB,KP,PY 30,31,32,33	5.188	-13.801
DG,HW,BC,WI 34,35,36,37	5.152	-13.576
Other species (38,39)	5.152	-13.576

[1]As discussed in the text, these coefficients for the Wykoff functional form are used only if the user elects to fit the Wykoff model to local stand tree heights. In this case the b_0 coefficient is replaced by the FVS Wykoff fitting process; the b_1 coefficient used is shown in this table. The current FVS logic flow does not use the b_0 coefficient shown in this table in any way. However, in case the reader wishes to graph the original Wykoff functional form for any reason, the b_0 coefficient is provided in this table. The original Wykoff functional form is that used in earlier version of the WC variant.

Table 6. Coefficients for height equations applied to trees less than 5 inches dbh.

FVS Species codes	b_1	b_2	b_3	b_4	b_5
01	1.3134	0.3432	0.0366	0.	0.
02,03	1.4769	0.3579	0.	0.	0.
04	1.4261	0.3334	0.	0.	0.
05,06	1.3526	0.3335	0.0367	0.	0.
07	1.7100	0.2943	0.	0.	0.1054
08,09,10	1.5907	0.3040	0.	0.	0.
11,13,14	0.9717	0.3934	0.0339	0.	0.3044
12,15	1.0756	0.4369	0.	0.	0.
16	7.1391	4.2891	-0.7150	0.2750	2.0393
17,30-33	1.5907	0.3040	0.	0.	0.
18	2.3115	0.2370	-0.0556	0.	0.3218
19	1.3608	0.6151	0.	-0.0442	0.0829
20	1.2278	0.4000	0.	0.	0.
21-29,34-39	0.0994	4.9767	0.	0.	0.

Table 7. Coefficients for the tree crown competition factor relationships in the WC variant.

CCF index number	Species included	Coefficients Percent tree CCF		
		r_1	r_2	r_3
1	13,14	0.0392	0.0180	0.00207
2	22,23	0.03561	0.01365	0.00524
3	16,17	0.0388	0.0269	0.00466
4	1,2,3	0.0690	0.0225	0.00183
5	Not used[1]			
6	8,9,18,29,30	0.0194	0.0142	0.00261
7	Not used			
8	21,24,26-28,33-39	0.0204	0.0123	0.0074
9	5,6	0.0172	0.00876	0.00112
10	12,15	0.0219	0.0169	0.00325
11	Not used			
12	19,20	0.03758	0.01164	0.00361
13	4,7	0.02453	0.00574	0.00134
14	10	0.03	0.0173	0.00259
15	11,31,32	0.02	0.0169	0.00325
16	25	0.0160	0.0083	0.00434

[1]No species in the variant uses this CCF index.

Table 8. Coefficients for tree crown widths based on data from R6 Permanent Plot Grid Inventory.

Species	FVS	$CW=aD^b$		$CW=rD$
FVS	alpha	Trees w/ hghts. > 4.5 ft.		Hgts. <= 4.5 ft.
Index No.	code	"a" coeff.	"b" coeff.	"ratio" coeff.
01	SF	3.9723	0.5177	0.473
02	WF	3.8166	0.5229	0.452
03	GF	4.1870	0.5341	0.489
04	AF	3.2348	0.5179	0.385
05	RF	3.1146	0.5780	0.345
06	Not used.			
07	NF	3.0614	0.6276	0.320
08	YC	3.5341	0.5374	0.331
09	IC	4.0920	0.4912	0.412
10	ES	3.6802	0.4940	0.412
11	LP	2.4132	0.6403	0.298
12	JP	3.2367	0.6247	0.406
13	SP	3.0610	0.6201	0.385
14	WP	3.4447	0.5185	0.476
15	PP	2.8541	0.6400	0.407
16	DF	4.4215	0.5329	0.517
17	RW	4.4215	0.5329	0.517
18	RC	6.2318	0.4259	0.698
19	WH	5.4864	0.5144	0.533
20	MH	2.9372	0.5878	0.253
21	BM	7.5183	0.4461	0.815
22	RA	7.0806	0.4771	0.730
23	WA	7.0806	0.4771	0.730
24	PB	5.8980	0.4841	0.601
25	GC	2.4922	0.8544	0.140
26	AS	4.0910	0.5907	0.351
27	CO	7.5183	0.4461	0.815
28	WO	2.4922	0.8544	0.140
29	J	4.5859	0.4841	0.468
30	LL	2.1039	0.6758	0.207
31	WB	2.1606	0.6897	0.255
32	KP	2.1451	0.7132	0.248
33	PY	4.5859	0.4841	0.468
34	DG	2.4922	0.8544	0.140
35	HW	4.5859	0.4841	0.468
36	BC	4.5859	0.4841	0.468
37	WI	4.5859	0.4841	0.468
38	Not used.			
39	OTher	4.4215	0.5329	0.517

Table 9. Coefficients for crown ratio equations for established trees less than 1-inch dbh.

Crown ratio species index (IISPC)	BCR0(IISPC)	BCR1(IISPC)	BCR2(IISPC)
1	8.042774	0.007198	-0.016163
2	8.477025	-0.018033	-0.018140
3	7.558538	-0.015637	-0.009064
4	6.489813	-0.029815	-0.009276
5	5.0	0.	0.
6	9.0	0.	0.

Species included within each set of crown ratio coeffiecients are:

1: 1 SF, 2 WF, 3 GF, 4 AF, 5 RF, 7 NF, 10 ES
2: 15 PP, 16 DF
3: 8 YC, 9 IC, 17 RW, 18 RC, 19 WH
4: 11 LP, 12 JP, 13 SP, 14 WP, 29 J, 30 LL, 31 WB, 32 KP
5: 20 MH, 21 BM, 22 RA, 23 WA, 24 PB, 25 GC, 26 AS, 27 CO, 33 PY, 34 DG, 35 HW, 36 BC, 37 WI
6: 28 WO

Table 10. Coefficients by FVS species group index for the large tree (D>=3 in.) diameter increment model.

Variable name		FVS Species Group Indices[a] 1	2	3	4	5	6
Stand variables (constant during simulation):							
ln(SI)	b_{01}	0.534255	0.318254	0.349888	0.684939	0.404010	0.021171
ELEV	b_{02}	-0.048852	-0.003051	-0.003773	-0.069045	-0.023376	0.0
$ELEV^2$	b_{03}	0.000478	0.0	0.0	0.000608	0.0	0.0
SLOPE	b_{04}	0.245548	0.0	0.319956	0.400223	0.0	-2.417953
$SLOPE^2$	b_{05}	0.0	0.0	0.0	0.0	0.0	3.587469
SL*Cos(ASPCT)	b_{06}	0.0	0.0	-0.782418	-0.374512	0.0	-0.272870
SL*Sin(ASPCT)	b_{07}	0.0	0.0	0.022160	-0.207659	0.0	0.389681
FOREST[b]	b_{08}						
1-GIP		-0.619069	-0.643920	-1.888949	-1.401865	-0.589570	0.386013
2-MBS		-0.479015	-0.643920	-1.888949	-1.401865	-0.589570	0.386013
3-MTH		-0.291244	-0.643920	-1.888949	-1.127977	-0.589570	0.386013
4-ROR		0.0	-0.643920	-1.276180	-1.127977	-0.589570	0.386013
5-UMP		-0.420228	-0.643920	-1.888949	-1.127977	-0.589570	0.386013
6-WIL		-0.746419	-0.643920	-1.888949	-1.127977	-0.909553	0.386013
Tree/stand biological variables (dynamic during simulation):							
D^2	b_{09}						
Forest 1-6[c]		[d]-0.0001983	-0.0003137	-0.0002621	-0.0003996	-0.0000596	-0.0003641
ln(D)	b_{10}	0.527758	0.905119	0.993986	0.904253	0.844690	0.593074
CR	b_{11}	2.982807	1.754811	1.522401	4.123101	1.597250	1.618048
CR^2	b_{12}	-1.331331	0.0	0.0	-2.689340	0.0	0.0
ln(BA)	b_{13}	-0.030730	0.0	0.0	0.0	0.0	-0.000088
BA	b_{14}	0.0	0.0	-0.000137	0.0	0.0	0.0
BAL	b_{15}	0.002839	0.0	0.0	0.0	0.0	0.0
BAL/ln(1+D)	b_{16}	-0.011247	-0.005355	-0.002979	-0.006368	-0.003726	-0.013282
PCCF	b_{17}	0.0	0.0	0.0	-0.000471	-0.000257	-0.000118
RELHT	b_{18}	0.0	-0.000661	0.0	0.0	0.0	0.0

Variable name		FVS Species Group Indices[a] 7	8	9	10	11	12
Stand variables (constant during simulation):							
ln(SI)	b_{01}	1.020863	0.139734	0.380416	0.208040	0.252853	1.965888
ELEV	b_{02}	-0.037591	-0.050081	-0.040067	-0.003809	0.0	-0.012111
$ELEV^2$	b_{03}	0.000549	0.000660	0.000395	0.0	0.0	0.0
SLOPE	b_{04}	0.077787	0.0	0.421486	0.411602	0.0	0.0
$SLOPE^2$	b_{05}	-0.215778	0.0	-0.693610	0.0	0.0	0.0
SL*Cos(ASPCT)	b_{06}	-0.080943	0.0	0.0	-0.104495	0.0	0.0
SL*Sin(ASPCT)	b_{07}	-0.038992	0.0	0.0	-0.126130	0.0	0.0
FOREST[b]	b_{08}						
1-GIP		-2.750874	0.412763	-0.298310	-1.052161	-1.310067	-7.753469
2-MBS		-2.787499	0.412763	-0.298310	-1.052161	-1.310067	-7.753469
3-MTH		-2.672664	0.645645	-0.147675	-0.793945	-1.310067	-7.753469
4-ROR		-2.533437	0.412763	-0.006413	-0.793945	-1.310067	-7.753469
5-UMP		-2.693964	0.412763	-0.147675	-1.052161	-1.310067	-7.753469
6-WIL		-2.718852	0.412763	-0.298310	-1.052161	-1.432659	-8.279266
Tree/stand biological variables (dynamic during simulation):							
D^2	b_{09}						
Forest 1-6[c]		-0.0001039	-0.0000644	-0.0001546	-0.0002214	-0.0001323	-0.0001737
ln(D)	b_{10}	0.534138	0.843013	0.722462	0.857131	0.879338	1.024186
CR	b_{11}	1.636854	2.878032	2.160348	1.505513	1.970052	0.459387
CR^2	b_{12}	-0.045578	-1.631418	-0.834196	0.0	0.0	0.0
ln(BA)	b_{13}	0.0	0.0	0.0	0.0	0.0	0.0
BA	b_{14}	-0.000215	0.0	0.0	0.0	-0.000173	0.0
BAL	b_{15}	0.0	0.0	0.0	0.0	0.0	0.0
BAL/ln(1+D)	b_{16}	-0.009363	-0.003923	-0.004065	-0.004101	-0.004215	-0.010222
PCCF	b_{17}	0.0	-0.000552	0.0	-0.000201	0.0	-0.000757
RELHT	b_{18}	0.0	0.0	-0.000358	0.0	0.0	0.0

(Table 10 continued on next page)

(Table 10 continued from previous page)

Variable name		FVS Species Group Indices[a]				
		13	14	15	16	17
Stand variables (constant during simulation):						
ln(SI)	b_{01}	0.0	0.227307	0.244694	0.391327	0.375175
ELEV	b_{02}	0.0	-0.075986	0.0	-0.005414	0.323546
$ELEV^2$	b_{03}	0.0	0.001193	0.0	0.0	-0.003130
SLOPE	b_{04}	0.0	0.0	0.0	-0.066440	0.0
$SLOPE^2$	b_{05}	0.0	0.0	0.0	0.0	0.0
SL*Cos(ASPCT)	b_{06}	0.0	0.085958	-0.023186	0.207853	-0.935870
SL*Sin(ASPCT)	b_{07}	0.0	-0.863980	0.679903	-0.378860	0.202507
FOREST[b]	b_{08}					
1-GIP		0.0	-0.107648	-1.277664	-0.524624	-9.211184
2-MBS		0.0	-0.107648	-1.277664	-0.524624	-9.211184
3-MTH		0.0	-0.107648	-1.277664	-0.524624	-9.211184
4-ROR		0.0	-0.107648	-1.277664	-0.803095	-9.211184
5-UMP		0.0	-0.107648	-1.277664	-0.803095	-9.800653
6-WIL		0.0	-0.098335	-1.178041	-0.803095	-9.211184
Tree/stand biological variables (dynamic during simulation):						
D^2	b_{09}					
Forest 1-6[c]		0.0	0.0	-0.0002536	0.0	-0.0003552
ln(D)	b_{10}	0.0	0.889596	0.816880	0.478504	0.949631
CR	b_{11}	0.0	1.732535	2.471226	1.905011	1.826879
CR^2	b_{12}	0.0	0.0	0.0	0.0	0.0
ln(BA)	b_{13}	0.0	0.0	0.0	0.0	0.0
BA	b_{14}	0.0	-0.000981	-0.000147	-0.000114	0.000040
BAL	b_{15}	0.0	0.0	0.0	0.0	0.0
BAL/ln(1+D)	b_{16}	0.0	-0.001265	-0.005950	-0.004706	-0.005350
PCCF	b_{17}	0.0	0.0	0.0	0.0	0.0
RELHT	b_{18}	0.0	0.0	0.0	0.0	0.0

[a]In the FVS large tree diameter increment model, the species group index numbers are defined as follows; in each code below, xx=yyaa, xx is the FVS species group index number; yy is the FVS species number (see table 2); and aa is the FVS alpha species code (again, see table 2).

01=01SF;
02=02WF/03GF;
03=04AF;
04=07NF;
05=13SP/14WP;
06=12JP/15PP;
07=16DF;
08=18RC;
09=19WH;
10=20MH;
11=09IC/10ES/17RW/30LL/31WB/32KP/33PY;
12=21BM;
13=22RA;
14=23WA/24PB/25GC/26AS/27CO/28WO/29J/34DG/35HW/36BC/37WI/38(Not in use)/39OT;
15=08YC;
16=11LP;
17=05RF.

[b]FOREST is a qualitative variable whose coefficient depends on "forest" location. In the diameter increment logic, and depending on which species and Forest is being simulated, one of the six constants is used.

[c]D^2 (diameter squared) is a continuous variable, but its effect on ln(dds), the dependent variable, also varies by location in a way similar to the FOREST variable.

[d]For only species group 1 (which is silver fir alone), the coefficient is as shown here for all the Forests except the Rogue River NF (#4). The Rogue River NF coefficient is 0.0, and is the only species group/Forest combination that hass this value (0.0).

Table 11. Coefficients for the equation describing mean crown ratio, and for the Weibull distribution.

Crown species group index	FVS indiv. species codes in each group	FVS indiv. species abbrev. in each group	Mean crown ratio coeff.		Weibull function coefficients				
			d_0	d_1	a	b_0	b_1	c_0	c_1
1	1	SF	5.614200	-0.016547	0.0	-0.173100	1.080573	1.062168	0.445799
2	2,3	WF,GF	5.212394	-0.011623	0.0	0.130939	1.093406	1.355139	0.350472
3	4,5	AF,RF	4.860467	-0.006173	1.0	-0.981113	1.092273	1.326047	0.318386
4	7	NF	5.568864	-0.021293	0.0	-0.135807	1.147712	3.017494	0.0
5	13,14	SP,WP	4.279655	-0.002484	0.0	0.019948	1.108738	2.621230	0.186734
6	12,15	JP,PP	5.073273	-0.020988	0.0	-0.036696	1.132792	2.876094	0.0
7	16	DF	5.067560	-0.010484	0.0	-0.082379	1.137459	2.914892	0.0
8	18	RC	5.570928	-0.012043	0.0	0.179839	1.084924	0.122967	0.567784
9	19	WH	5.488532	-0.007173	0.0	0.490848	1.014138	3.164558	0.0
10	20	MH	6.484942	-0.023248	0.0	0.162672	1.073404	3.288501	0.0
11	9,10,17,30-33	IC,ES,RW,LL,WB, KP,PY	5.417431	-0.011608	0.0	0.196054	1.073909	0.345647	0.620145
12	21	BM	4.420000	-0.010660	1.0	-0.818809	1.054176	-2.366108	1.202413
13	22	RA	4.120478	-0.006357	1.0	-1.112738	1.123138	2.533158	0.0
14	23-29,34-39	WA,PB,GC,AS,CO,WO,J, DG,HW,BC,WI,"Other"	4.625125	-0.016042	0.0	-0.238295	1.180163	3.044134	0.0
15	8	YC	5.200550	-0.014890	1.0	-0.811424	1.056190	-3.831124	1.401938
16	11	LP	4.890318	-0.018837	0.0	-0.131210	1.159760	2.598238	0.0

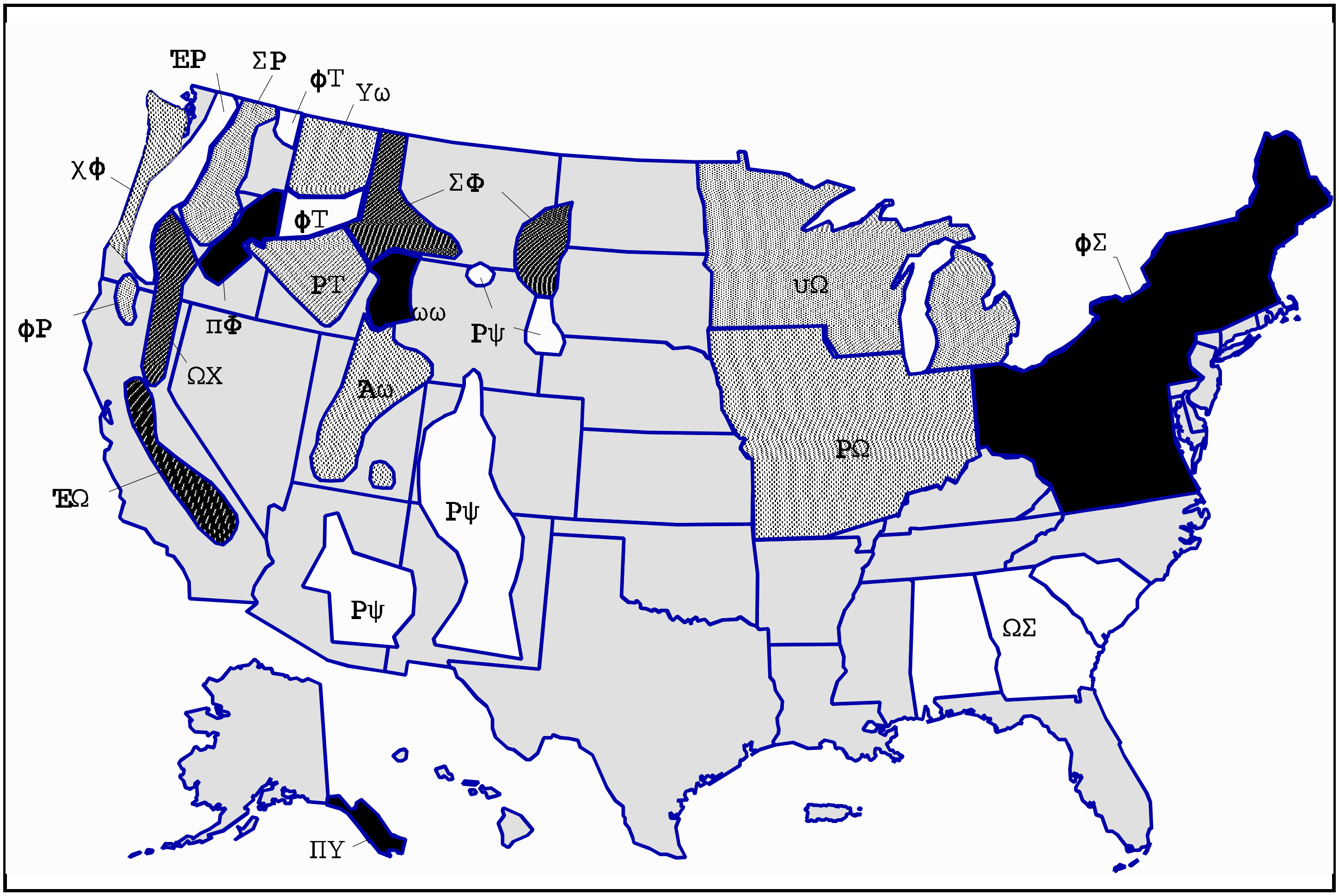

Figure 1. FVS geographic variants and their approximate locations.

```
                        PROCESS KEYWORDS
                           INPUT DATA
                               |
          COMPUTE INITIAL STAND CHARACTERISTICS
                               |
                       BACKDATE DENSITIES
               COMPUTE CALIBRATION STATISTICS
  >------------------->        |
 |                     CHECK EVENT MONITOR
 |                             |
 |                       THIN THE STAND
 |                             |
 |                     CHECK EVENT MONITOR
 |                             |
 |                      GROW LARGE TREES
 |     (In order:  1-Diameter; 2-Height; 3-Crown)
 |                             |
 |                      GROW SMALL TREES
 |     (In order:  1-Height; 2-Diameter; 3-Crown)
 |                             |
 |                          MORTALITY
 |                             |
 |                   INSECT, DISEASE IMPACTS
 |                             |
 |                        REGENERATION
 |                             |
 |              UPDATE STAND CHARACTERISTICS
 |                     VOLUME COMPUTATION
 |                             |
  <--YES---      MORE CYCLES SCHEDULED?
                               |
                               NO
                               |
                      FINAL FVS REPORTS
                               |
        SELECTED POST PROCESSORS (if any chosen)
```

Figure 2. FVS operation sequence.

APPENDIX

Table A1.
Plant Association (Ecoclass) codes used in the West Cascades variant of the Forest Vegetation Simulator

Date of last revision: 03/13/97

Example: If the ecoclass code CDC711 was entered in field 2 of the STDINFO keyword, the default site species would be Douglas-fir, the default site index for Douglas-fir would be 145, and the default Stand Density Index (SDI) for Doublas-fir would be 1104. Default values for all the other species would be generated from these Douglas-fir values. This plant association can be found on page 78 of the plant association reference R6 E 257-B-86. The Growth Basal Area (GBA) for this plant associaton is 400. GBA is not used directly in FVS.
Douglas-fir is species number 16 in the West Cascades variant.

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE
1 = TSME-ABLA2/PONE4						GBA: 253		p. 31
Mountain hemlock-subalpine fir/Newberry's knotweed								R6 TP-08-95
CAF211	TSME	698	MH	14	1	1	20	
2 = TSME-ABLA2/ASLE2						GBA: 196		p. 19
Mountain hemlock-subalpine fir/Cascades aster								R6 TP-08-95
CAF311	TSME	541	MH	15	1	1	20	
3 = TSME-ABLA2/FEVI						GBA: 135		p. 23
Mountain hemlock-subalpine fir/green fescue								R6 TP-08-95
CAG211	TSME	373	MH	12	1	1	20	
4 = TSME/LUHI						GBA: 297		p. 35
Mountain hemlock/Hitchcock's woodrush								R6 TP-08-95
CAG311	TSME	820	MH	17	1	1	20	
5 = TSME-PIAL/LUHI						GBA: 257		p. 47
Mountain hemlock-whitebark pine/Hitchc woodrush								R6 TP-08-95
CAG312	TSME	709	MH	13	1	1	20	
6 = TSME/PHEM-VADE						GBA: 269		p. 43
Mountain hemlock/red mtn heather-delicious huckleb								R6 TP-08-95
CAS211	TSME	742	MH	16	1	1	20	
7 = TSME-ABLA2/JUOC4						GBA: 466		p. 27
Mountain hemlock-subalpine fir/mtn juniper								R6 TP-08-95
CAS411	TSME	1286	MH	12	1	1	20	

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE

8 = PSME-TSHE/BENE GBA: 400 p. 78
Douglas-fir-western hemlock/dwarf Oregon grape R6 E 257-B-86

CDC711	PSME	1104	DF	145	1	1	16

9 = PSME-TSHE/RHMA GBA: 317 p. 82
Douglas-fir-western hemlock/rhododendron R6 E 257-B-86

CDC712	PSME	875	DF	133	1	1	16

10 = PSME-TSHE/GASH GBA: 404 p. 86
Douglas-fir-western hemlock/salal R6 E 257-B-86

CDC713	PSME	1115	DF	138	1	1	16

11 = PSME/HODI-BENE GBA: 311 p. 62
Douglas-fir/oceanspray-dwarf Oregon grape R6 E 257-B-86

CDS211	PSME	858	DF	115	1	1	16

12 = PSME/HODI/GRASS GBA: 312 p. 66
Douglas-fir/oceanspray/grass R6 E 257-B-86

CDS212	PSME	861	DF	121	1	1	16

13 = PSME/HODI-WHMO GBA: 290 p. 70
Douglas-fir/oceanspray-whipple vine R6 E 257-B-86

CDS213	PSME	800	DF	106	1	1	16

14 = PSME/SYMO-WIL GBA: 496 p. 74
Douglas-fir/snowberry (Willamette) R6 E 257-B-86

CDS641	PSME	1369	DF	123	1	1	16

15 = ABAM-TSHE/RHMA-GASH GBA: 276 p. 49
Pac silver fir-W. hemlock/rhododendron-salal R6 E 100-82

CFC251	PSME	762	DF	101	1	1	16

16 = ABAM-ABGR/SMST GBA: 496 p. 98
Pac silver fir-grand fir/false solomonseal R6 E 257-B-86

CFC311	PSME	1369	DF	133	1	1	16

17 = ABAM/TIUN GBA: 315 p. 61
Pac silver fir/coolwort foamflower R6 E 130a-83

CFF152	ABAM	869	SF	120	1	1	1

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE
18 = ABAM/OXOR Pac silver fir/oxalis					GBA: 500			p. 33 R6 E 100-82
CFF153	ABPR	1380	NF	135	1	1	7	
19 = ABAM/TIUN-STRO Pac silver fir/foamflower-rosy twisted stalk					GBA: 501			p. 100 R6 E TP-028-91
CFF154	ABAM	1383	SF	134	1	1	1	
20 = ABAM/ACTR-MBS Pac silver fir/vanilla leaf (Mt Baker/Snoq)					GBA: 410			p. 84 R6 E TP-028-91
CFF250	PSME	1132	DF	155	1	1	16	
21 = ABAM/ACTR-CLUN Pac silver fir/vanilla leaf-queencup beadlily					GBA: 415			p. 57 R6 E 130a-83
CFF253	ABPR	1145	NF	134	1	1	7	
22 = ABAM/XETE-MBS Pac silver fir/beargrass (Mt Baker/Snoq)					GBA: 507			p. 132 R6 E TP-028-91 & Devlin memo
CFF312	ABPR	1399	NF	117	1	1	7	
23 = ABAM/RUPE-BLSP Pac silver fir/five-leaved bramble-deerfern					GBA: 627			p. 98 R6 E TP-028-91
CFF450	ABAM	1730	SF	142	1	1	1	
24 = ABAM/LYAM Pac silver fir/skunkcabbage					GBA: 744			p. 90 R6 E TP-028-91
CFM111	ABAM	2053	SF	134	1	1	1	
25 = ABAM/BENE-MBS Pac silver fir/Oregon grape (Mt Baker/Snoqualamie)					GBA: 242			p. 86 R6 E TP-028-91
CFS110	ABPR	668	NF	109	1	1	7	
26 = ABAM/BENE Pac silver fir/dwarf Oregon grape					GBA: 274			p. 56 R6 E 130a-83
CFS151	TSHE	756	WH	64	1	1	19	
27 = ABAM/GASH-GP Pac silver fir/Salal (Giff Pinchot)					GBA: 324			p. 55 R6 E 130a-83
CFS152	ABAM	894	SF	108	1	1	1	

```
    ALPHA     SCIEN          ALPHA       NUM  SITE FVS  PLANT
     ECO      SITE      MAX  SITE  SITE  IN   SPP  SEQ  ASSOCIATION
    CLASS     CODE      SDI  SPEC  INDX  ECO  FLAG NUM  REFERENCE
 ----------------------------------------------------------------------
   28 = ABAM/GASH-BENE                       GBA: 210   p. 88
   Pac silver fir/salal-Oregon grape                    R6 E TP-028-91

      CFS154     ABAM     580  SF     115    1    1    1
---------------------------------------------------------------------
   29 = ABAM/VAAL-BENE                       GBA: 410   p. 104
   Pac silver fir/Alaska huckleberry-Oregon grape       R6 E TP-028-91

      CFS216     ABAM    1132  SF     124    1    1    1
---------------------------------------------------------------------
   30 = ABAM/VAME-VASI                       GBA: 442   p. 128
   Pac silver fir/big huckleberry-Sitka valerian        R6 E TP-028-91

      CFS221     ABAM    1220  SF      99    1    1    1
---------------------------------------------------------------------
   31 = ABAM/VAME-STRO                       GBA: 546   p. 124
   Pac silver fir/big huckleberry-rosy twisted stalk    R6 E TP-028-91

      CFS222     ABAM    1507  SF     118    1    1    1
---------------------------------------------------------------------
   32 = ABAM/VAME-VAAL                       GBA: 302   p. 126
   Pac silver fir/big huckleberry-Alaska huckleberry    R6 E TP-028-91

      CFS223     ABAM     834  SF     102    1    1    1
---------------------------------------------------------------------
   33 = ABAM/VAME                            GBA: 241   p. 120
   Pac silver fir/big huckleberry                       R6 E TP-028-91

      CFS224     ABAM     665  SF     100    1    1    1
----------------------------------------------------------------------
   34 = ABAM/VAAL-MADI2                      GBA: 643   p. 110
   Pac silver fir/Ak huckleberry-false lily-of-the-val  R6 E TP-028-91

      CFS225     ABAM    1775  SF     126    1    1    1
----------------------------------------------------------------------
   35 = ABAM/VAAL-TIUN-MBS                   GBA: 517   p. 116
   Pac silver fir/Alaska huckleberry-foamflower         R6 E TP-028-91

      CFS226     ABAM    1427  SF     136    1    1    1
----------------------------------------------------------------------
   36 = ABAM/VAME-PYSE                       GBA: 299   p. 122
   Pac silver fir/big huckleberry-sidebells pyrola      R6 E TP-028-91

      CFS229     ABAM     825  SF     108    1    1    1
----------------------------------------------------------------------
   37 = ABAM/VAAL-GASH-MBS                   GBA: 476   p. 108
   Pac silver fir/Alaska huckleberry-salal (Mt B/Snoq)  R6 E TP-028-91

      CFS230     ABAM    1314  SF     101    1    1    1
```

```
   ALPHA     SCIEN          ALPHA       NUM  SITE FVS  PLANT
    ECO      SITE       MAX  SITE  SITE  IN   SPP  SEQ  ASSOCIATION
   CLASS     CODE       SDI  SPEC  INDX  ECO  FLAG NUM  REFERENCE
 ----------------------------------------------------------------------
  38 = ABAM/VAAL-POMU                      GBA: 955   p. 112
  Pac silver fir/Alaska huckleberry-swordfern         R6 E TP-028-91

     CFS231     ABAM    2636  SF     148    1    1    1
-----------------------------------------------------------------------
  39 = ABAM/VAME/XETE                      GBA: 286   p. 66
  Pac silver fir/big huckleberry/beargrass            R6 E 130a-83

     CFS251     ABAM     789  SF      94    1    1    1
-----------------------------------------------------------------------
  40 = ABAM/VAME-XETE-MBS                  GBA: 386   p. 130
  Pac silver fir/big huckleberry-beargrass (Mt B/Snoq) R6 E TP-028-91
                                                      & Devlin memo
     CFS252     ABAM    1065  SF      94    1    1    1
-----------------------------------------------------------------------
  41 = ABAM/VAAL/COCA                      GBA: 407   p. 45
  Pac silver fir/Alaska huckleberry/dogwood bunchberry R6 E 100-82

     CFS253     ABPR    1123  NF     110    1    1    7
-----------------------------------------------------------------------
  42 = ABAM/MEFE                           GBA: 278   p. 64
  Pac silver fir/fool's huckleberry                   R6 E 130a-83

     CFS254     ABAM     767  SF     103    1    1    1
-----------------------------------------------------------------------
  43 = ABAM/VAAL-GASH                      GBA: 294   p. 60
  Pac silver fir/Alaska huckleberry-salal             R6 E 130a-83

     CFS255     ABAM     811  SF     113    1    1    1
-----------------------------------------------------------------------
  44 = ABAM/VAME/CLUN                      GBA: 243   p. 65
  Pac silver fir/big huckleberry/queencup beadlily    R6 E 130a-83

     CFS256     ABAM     671  SF     113    1    1    1
-----------------------------------------------------------------------
  45 = ABAM/VAAL                           GBA: 250   p. 59
  Pac silver fir/Alaska huckleberry                   R6 E 130a-83

     CFS257     ABAM     690  SF     111    1    1    1
-----------------------------------------------------------------------
  46 = ABAM/VAAL-MBS                       GBA: 366   p. 102
  Pac silver fir/Alaska huckleberry (Mt Baker/Snoq)   R6 E TP-028-91
                                                      & Devlin memo
     CFS258     ABAM    1010  SF     116    1    1    1
-----------------------------------------------------------------------
  47 = ABAM/VAAL-XETE-MBS                  GBA: 227   p. 118
  Pac silver fir/Alaska huckleberry-beargrass (MB/SQ)  R6 E TP-028-91
                                                      & Devlin memo
     CFS259     ABAM     626  SF      94    1    1    1
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   ALPHA     SCIEN          ALPHA       NUM  SITE FVS  PLANT
    ECO      SITE      MAX  SITE  SITE  IN   SPP  SEQ  ASSOCIATION
   CLASS     CODE      SDI  SPEC  INDX  ECO  FLAG NUM  REFERENCE
 ------------------------------------------------------------------
  48 = ABAM/VAAL-CLUN-MBS                   GBA: 556   p. 106
  Pac silver fir/AK huckleberry-queen's cup (MB/SQ)    R6 E TP-028-91
                                                       & Devlin memo
     CFS260     ABAM    1535  SF     128    1    1    1
--------------------------------------------------------------------
  49 = ABAM/OPHO                            GBA: 370   p. 62
  Pac silver fir/devil's club                          R6 E 130a-83

     CFS351     ABAM    1021  SF     130    1    1    1
--------------------------------------------------------------------
  50 = ABAM/OPHO-VAAL                       GBA: 585   p. 92
  Pac silver fir/devil's club-Alaska huckleberry       R6 E TP-028-91

     CFS352     ABAM    1615  SF     133    1    1    1
--------------------------------------------------------------------
  51 = ABAM/RHAL-GP                         GBA: 214   p. 63
  Pac silver fir/Cascades azalea (Gifford Pinchot)     R6 E 130a-83

     CFS550     ABAM     591  SF     102    1    1    1
--------------------------------------------------------------------
  52 = ABAM/RHAL/XETE                       GBA: 282   p. 37
  Pac silver fir/Cascades azalea/beargrass             R6 E 100-82

     CFS551     PSME     778  DF      73    1    1   16
--------------------------------------------------------------------
  53 = ABAM/RHAL/CLUN                       GBA: 282   p. 35
  Pac silver fir/Cascades azalea/queencup beadlily     R6 E 100-82

     CFS552     PSME     778  DF      73    1    1   16
--------------------------------------------------------------------
  54 = ABAM/RHAL-VAME                       GBA: 241   p. 96
  Pac silver fir/white rhododendron-big huckleberry    R6 E TP-028-91

     CFS554     ABAM     665  SF      93    1    1    1
--------------------------------------------------------------------
  55 = ABAM/RHAL-VAAL                       GBA: 259   p. 94
  Pac silver fir/white rhododendron-Alaska huckleberry R6 E TP-028-91

     CFS555     ABAM     715  SF      98    1    1    1
--------------------------------------------------------------------
  56 = ABAM/ACCI/TIUN                       GBA: 505   p. 43
  Pac silver fir/vine maple/coolwort foamflower        R6 E 100-82

     CFS651     ABPR    1394  NF     140    1    1    7
-------------------------------------------------------------------
  57 = ABAM/RHMA-BENE                       GBA: 296   p. 55
  Pac silver fir/rhododendron-dwarf Oregon grape       R6 E 100-82

     CFS652     PSME     817  DF     104    1    1   16
```

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE

58 = ABAM/RHMA/XETE GBA: 501 p. 57
Pac silver fir/rhododendron/beargrass R6 E 100-82

CFS653	ABPR	1383	NF	96	1	1	7

59 = ABAM/RHMA-VAAL/COCA GBA: 347 p. 47
Pac silver fir/rhododendron-Ak huckleb/dogwood bunch R6 E 100-82

CFS654	PSME	958	DF	97	1	1	16

60 = TSHE-PSME/HODI GBA: 372 p. 102
Western hemlock-Douglas-fir/oceanspray R6 E 230A-86

CHC212	PSME	1027	DF	120	1	1	16

61 = TSHE-PSME-ARME GBA: 385 p. 105
Western hemlock-Douglas-fir-madrone R6 E 230A-86

CHC213	PSME	1063	DF	105	1	1	16

62 = TSHE/OXOR-WILL GBA: 467 p. 202
Western hemlock/Oregon oxalis (Willamette) R6 E 257-86

CHF111	PSME	1289	DF	158	1	1	16

63 = TSHE/POMU-MTH GBA: 466 p. 73
Western hemlock/swordfern (Mt Hood) R6 E 232A-86

CHF123	TSHE	1286	WH	95	1	1	19

64 = TSHE/POMU-OXOR GBA: 527 p. 75
Western hemlock/swordfern-oxalis R6 E 232A-86

CHF124	TSHE	1454	WH	102	1	1	19

65 = TSHE/POMU-GP GBA: 431 p. 82
Western hemlock/swordfern (Gifford Pinchot) R6 E 230A-86

CHF125	TSHE	1190	WH	96	1	1	19

66 = TSHE/POMU-GASH GBA: 311 p. 54
Western hemlock/swordfern-salal R6 E TP-028-91

CHF133	PSME	858	DF	151	1	1	16

67 = TSHE/POMU-BENE GBA: 543 p. 52
Western hemlock/swordfern-Oregon grape R6 E TP-028-91

CHF134	PSME	1499	DF	154	1	1	16

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE
68 = TSHE/POMU-TITR-MBS					GBA: 555			p. 56
Western hemlock/swordfern-foamflower								R6 E TP-028-91 & Devlin memo
CHF135	TSHE	1532	WH	123	1	1	19	
69 = TSHE/POMU-WILL					GBA: 402			p. 234
Western hemlock/swordfern (Willamette)								R6 E 257-86
CHF151	PSME	1110	DF	159	1	1	16	
70 = TSHE/ACTR					GBA: 402			p. 90
Western hemlock/vanilla leaf								R6 E 230A-86
CHF221	PSME	1110	DF	147	1	1	16	
71 = TSHE/TITR					GBA: 564			p. 80
Western hemlock/coolwort foamflower								R6 E 230A-86
CHF222	PSME	1557	DF	170	1	1	16	
72 = TSHE/TITR-GYDR					GBA: 1121			p. 58
Western hemlock/foamflower-oak fern								R6 E TP-028-91
CHF250	PSME	3094	DF	164	1	1	16	
73 = TSHE/LIBO2					GBA: 525			p. 238
Western hemlock/twinflower								R6 E 257-86
CHF321	PSME	1449	DF	148	1	1	16	
74 = TSHE/ATFI					GBA: 601			p. 72
Western hemlock/ladyfern								R6 E 230A-86
CHF421	PSME	1659	DF	174	1	1	16	
75 = TSHE/LYAM					GBA: 408			p. 68
Western hemlock/American yellow skunkcabbage								R6 E 232A-86
CHM121	PSME	1126	DF	128	1	1	16	
76 = TSHE/GASH-WILL					GBA: 334			p. 230
Western hemlock/salal (Willamette)								R6 E 257-86
CHS111	PSME	922	DF	137	1	1	16	
77 = TSHE/BENE/OXOR					GBA: 514			p. 190
Western hemlock/dwarf Oregon grape/Oregon oxalis								R6 E 257-86
CHS113	PSME	1419	DF	159	1	1	16	

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE
78 = TSHE/BENE/ACTR					GBA: 476			p. 198
Western hemlock/dwarf Oregon grape/vanilla leaf								R6 E 257-86
CHS114	PSME	1314	DF	158	1	1	16	
79 = TSHE/BENE-GASH					GBA: 440			p. 62
Western hemlock/dwarf Oregon grape-salal								R6 E 232A-86
CHS124	TSHE	1214	WH	93	1	1	19	
80 = TSHE/BENE					GBA: 424			p. 93
Western hemlock/dwarf Oregon grape								R6 E 230A-86
CHS125	TSHE	1170	WH	82	1	1	19	
81 = TSHE/BENE/POMU					GBA: 380			p. 64
Western hemlock/dwarf Oregon grape/swordfern								R6 E 232A-86
CHS126	TSHE	1049	WH	89	1	1	19	
82 = TSHE/BENE-GASH-GP					GBA: 381			p. 95
Western hemlock/dwarf Oregon grape-salal (Giff Pin)								R6 E 230A-86
CHS127	PSME	1052	DF	134	1	1	16	
83 = TSHE/GASH-GP					GBA: 317			p. 97
Western hemlock/salal (Gifford Pinchot)								R6 E 230A-86
CHS128	PSME	875	DF	123	1	1	16	
84 = TSHE/GASH-MBS					GBA: 286			p. 40
Western hemlock/salal (Mt Baker/Snoqual)								R6 E TP-028-91 & Devlin memo
CHS129	PSME	789	DF	100	1	1	16	
85 = TSHE/BENE-MBS					GBA: 399			p. 36
Western hemlock/Oregon grape (Mt Baker/Snoq)								R6 E TP-028-91 & Devlin memo
CHS130	PSME	1101	DF	122	1	1	16	
86 = TSHE/GASH-BENE					GBA: 348			p. 42
Western hemlock/salal-Oregon grape								R6 E TP-028-91
CHS135	PSME	960	DF	117	1	1	16	
87 = TSHE/GASH-VAME					GBA: 303			p. 44
Western hemlock/salal-big huckleberry								R6 E TP-028-91
CHS140	PSME	836	DF	89	1	1	16	

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE
88 = TSHE/BENE-CHME						GBA: 273		p. 38
Western hemlock/Oregon grape-little prince's pine								R6 E TP-028-91
CHS141	PSME	754	DF	103	1	1	16	
89 = TSHE/ACCI/ACTR						GBA: 238		p. 56
Western hemlock/vine maple/vanilla leaf								R6 E 232A-86
CHS223	PSME	657	DF	141	1	1	16	
90 = TSHE/CONU/ACTR						GBA: 420		p. 100
Western hemlock/dogwood/vanilla leaf								R6 E 230A-86
CHS224	PSME	1159	DF	142	1	1	16	
91 = TSHE/ACCI-BENE						GBA: 478		p. 34
Western hemlock/vine maple-Oregon grape								R6 E TP-028-91
CHS251	PSME	1319	DF	136	1	1	16	
92 = TSHE/RHMA/XETE-MTH						GBA: 165		p. 83
Western hemlock/rhododendron/beargrass (Mt Hood)								R6 E 232A-86
CHS325	PSME	455	DF	97	1	1	16	
93 = TSHE/RHMA-VAAL/COCA						GBA: 229		p. 81
W hemlock/rhododendron-AK huckleberry/dogwood bunchb								R6 E 232A-86
CHS326	PSME	632	DF	130	1	1	16	
94 = TSHE/RHMA-GASH-MTH						GBA: 299		p. 79
Western hemlock/rhododendron-salal (Mt Hood)								R6 E 232A-86
CHS327	TSHE	825	WH	77	1	1	19	
95 = TSHE/RHMA-BENE-MTH						GBA: 388		p. 77
W hemlock/rhododendron-dwarf Oregon grape (Mt Hood)								R6 E 232A-86
CHS328	TSHE	1071	WH	82	1	1	19	
96 = TSHE/RHMA-GASH-WILL						GBA: 338		p. 222
Western hemlock/rhododendron-salal (Willamette)								R6 E 257-86
CHS351	PSME	933	DF	128	1	1	16	
97 = TSHE/RHMA-BENE-WILL						GBA: 367		p. 214
W hemlock/rhododendron-dwarf OR grape (Willamette)								R6 E 257-86
CHS352	PSME	1013	DF	136	1	1	16	

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE
98 = TSHE/RHMA/XETE-WILL Western hemlock/rhododendron/beargrass (Willamette)						GBA: 298		p. 210 R6 E 257-86
CHS353	PSME	822	DF	122	1	1	16	
99 = TSHE/RHMA/OXOR Western hemlock/rhododendron/Oregon oxalis						GBA: 495		p. 218 R6 E 257-86
CHS354	PSME	1366	DF	135	1	1	16	
100 = TSHE/RHMA/LIBO2 Western hemlock/rhododendron/twinflower						GBA: 447		p. 226 R6 E 257-86
CHS355	PSME	1234	DF	130	1	1	16	
101 = TSHE/OPHO-WILL Western hemlock/devil's club (Willamette)						GBA: 413		p. 182 R6 E 257-86
CHS511	PSME	1140	DF	168	1	1	16	
102 = TSHE/OPHO-ATFI Western hemlock/devil's club-ladyfern						GBA: 276		p. 50 R6 E TP-028-91
CHS513	TSHE	762	WH	101	1	1	19	
103 = TSHE/OPHO/OXOR Western hemlock/devil's club/Oregon oxalis						GBA: 288		p. 69 R6 E 232A-86
CHS522	TSHE	795	WH	93	1	1	19	
104 = TSHE/OPHO/SMST Western hemlock/devil's club/starry solomonseal						GBA: 212		p. 71 R6 E 232A-86
CHS523	PSME	585	DF	156	1	1	16	
105 = TSHE/OPHO/POMU Western hemlock/devil's club/swordfern						GBA: 579		p. 74 R6 E 230A-86
CHS524	TSHE	1598	WH	88	1	1	19	
106 = TSHE/VAAL-OPHO Western hemlock/Alaska huckleberry-devil's club						GBA: 278		p. 90 R6 E 232A-86
CHS611	PSME	767	DF	165	1	1	16	
107 = TSHE/VAME/XETE Western hemlock/big huckleberry/beargrass						GBA: 175		p. 93 R6 E 232A-86
CHS612	PSME	483	DF	90	1	1	16	

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE
108 = TSHE/VAAL/OXOR					GBA: 444			p. 78
Western hemlock/Alaska huckleberry/Oregon oxalis								R6 E 230A-86
CHS613	TSHE	1225	WH	84	1	1	19	
109 = TSHE/VAAL-GASH					GBA: 295			p. 88
Western hemlock/Alaska huckleberry-salal								R6 E 230A-86
CHS614	TSHE	814	WH	81	1	1	19	
110 = TSHE/VAAL/COCA					GBA: 375			p. 86
Western hemlock/Alaska huckleberry/dogwood bunchberry								R6 E 230A-86
CHS615	TSHE	1035	WH	87	1	1	19	
111 = TSHE/VAAL-POMU					GBA: 842			p. 64
Western hemlock/Alaska huckleberry-swordfern								R6 E TP-028-91
CHS625	PSME	2324	DF	154	1	1	16	
112 = TSHE/VAAL-BENE					GBA: 277			p. 62
Western hemlock/Alaska huckleberry-Oregon grape								R6 E TP-028-91
CHS626	PSME	764	DF	110	1	1	16	
113 = TSME/TIUN-STRO					GBA: 174			p. 162
M hemlock/foamflower-rosy twistedstalk								R6 E TP-028-91
CMF250	TSME	480	MH	36	1	1	20	
114 = TSME/CABI					GBA: 134			p. 150
Mountain hemlock/marshmarigold								R6 E TP-028-91
CMF251	TSME	370	MH	14	1	1	20	
115 = TSME/VASC					GBA: 195			p. 73
Mountain hemlock/grouse huckleberry								R6 E 08-95
CMS114	TSME	538	MH	16	1	1	20	
116 = TSME/VAME-GP					GBA: 221			p. 68
Mountain hemlock/big huckleberry (Gifford Pinchot)								R6 E 130-83
CMS210	TSME	610	MH	25	1	1	20	
117 = TSME/VAME/XETE					GBA: 278			p. 67
Mountain hemlock/big huckleberry/beargrass								R6 E 08-95
CMS216	TSME	767	MH	19	1	1	20	

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     ALPHA     SCIEN          ALPHA       NUM  SITE FVS  PLANT
      ECO      SITE       MAX  SITE  SITE  IN   SPP  SEQ  ASSOCIATION
     CLASS     CODE       SDI  SPEC  INDX  ECO  FLAG NUM  REFERENCE
 ---------------------------------------------------------------------
 118 = TSME/VAME/CLUN                       GBA: 303   p. 61
 Mountain hemlock/big huckleberry/queen's cup          R6 E 08-95

     CMS218     TSME     836  MH      20    1    1  20
---------------------------------------------------------------------
 119 = TSME/MEFE                            GBA: 215   p. 39
 Mountain hemlock/fool's huckleberry                   R6 E 08-95

     CMS221     TSME     593  MH      22    1    1  20
------------------------------------------------------------------
 120 = TSME/RHAL                            GBA: 235   p. 51
 Mountain hemlock/Cascades azalea                      R6 E 08-95

     CMS223     TSME     649  MH      21    1    1  20
-------------------------------------------------------------------
 121 = TSME/VAAL                            GBA: 185   p. 164
 Mountain hemlock/Alaska huckleberry                   R6 E TP-028-91

     CMS241     TSME     511  MH      34    1    1  20
------------------------------------------------------------------
 122 = TSME/VAME-VAAL                       GBA: 399   p. 178
 Mountain hemlock/big huckleberry-Alaska huckleberry   R6 E TP-028-91

     CMS244     TSME    1101  MH      29    1    1  20
-------------------------------------------------------------------
 123 = TSME/VAME/XETE-WASH                  GBA: 308   p. 182
 Mountain hemlock/big huckleberry/beargrass (MB/SQ)    R6 E TP-028-91

     CMS245     TSME     850  MH      25    1    1  20
-------------------------------------------------------------------
 124 = TSME/VAME-MBS                        GBA: 363   p. 172
 Mountain hemlock/big huckleberry (Mt Baker/Snoqual)   R6 E TP-028-91

     CMS246     TSME    1002  MH      25    1    1  20
-------------------------------------------------------------------
 125 = TSME/VAME-STRO                       GBA: 512   p. 176
 Mountain hemlock/big huckleberry-rosy twistedstalk    R6 E TP-028-91

     CMS250     TSME    1413  MH      31    1    1  20
-------------------------------------------------------------------
 126 = TSME/VAME-VASI                       GBA: 238   p. 180
 Mountain hemlock/big huckleberry-Sitka valerian       R6 E TP-028-91

     CMS251     TSME     657  MH      25    1    1  20
-------------------------------------------------------------------
 127 = TSME/VAAL-STRO                       GBA: 402   p. 170
 Mountain hemlock/Alaska huckleberry-rosy twistedstalk R6 E TP-028-91

     CMS252     TSME    1110  MH      35    1    1  20
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ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE

128 = TSME/VAAL-CLUN GBA: 191 p. 166
Mountain hemlock/Alaska huckleberry-queen's cup R6 E TP-028-91

CMS253	TSME	527	MH	29	1	1	20

129 = TSME/VAME-RULA GBA: 310 p. 174
Mountain hemlock/big huckleberry-trailing bramble R6 E TP-028-91

CMS254	TSME	856	MH	28	1	1	20

130 = TSME/VAAL-MADI2 GBA: 208 p. 168
M hemlock/Alaska huckleberry-false lily-of-the-valley R6 E TP-028-91

CMS255	TSME	574	MH	29	1	1	20

131 = TSME/PHEM-VADE GBA: 291 p. 156
M hemlock/red heather-blueleaf huckleberry R6 E TP-028-91

CMS350	TSME	803	MH	20	1	1	20

132 = TSME/RHAL-VAAL GBA: 300 p. 158
M hemlock/white rhododendron-Alaska huckleberry R6 E TP-028-91

CMS351	TSME	828	MH	23	1	1	20

133 = TSME/RHAL-VAME GBA: 210 p. 160
Mountain hemlock/white rhododendron-big huckleberry R6 E TP-028-91

CMS352	TSME	580	MH	23	1	1	20

134 = TSME/CLPY-RUPE GBA: 281 p. 152
Mountain hemlock/copperbush-five leaved bramble R6 E TP-028-91

CMS353	TSME	776	MH	20	1	1	20

135 = TSME/OPHO-VAAL GBA: 291 p. 154
Mountain hemlock/devil's club-Alaska huckleberry R6 E TP-028-91

CMS450	ABAM	803	SF	138	1	1	1

136 = TSME/RHMA GBA: 249 p. 57
Mountain hemlock/rhododendron R6 E TP-08-95

CMS612	ABAM	687	SF	78	1	1	1

137 = ABGR/CHUM GBA: 475 p. 96
Grand fir/prince's pine R6 E 257-86

CWF211	PSME	1311	DF	132	1	1	16

ALPHA ECO CLASS	SCIEN SITE CODE	MAX SDI	ALPHA SITE SPEC	SITE INDX	NUM IN ECO	SITE SPP FLAG	FVS SEQ NUM	PLANT ASSOCIATION REFERENCE
138 = ABGR/ARUV Grand fir/bearberry					GBA: 213			p. 90 R6 E 257-86
CWS521	PSME	588	DF	86	1	1	16	
139 = ABGR/BENE Grand fir/dwarf Oregon grape					GBA: 370			p. 92 R6 E 257-86
CWS522	PSME	1021	DF	131	1	1	16	

Tables A2 - A7.

These tables contain for each of the six National Forests represented in the West Cascades variant the coefficients for the "Curtis-Arney" equation. Species in these tables are those found in the Region 6 Permanent Plot Grid Inventory (PPGI) for the National Forests in the WC variant. Thus, each individual species in each table lies in one of three groups: 1) those species that are found both in the WC species list and in the PPGI; 2) those species that are found in the WC species list, but not in substantial numbers in the PPGI; and 3) those species that are not in the WC species list, but that are in the PPGI.

Thus, species in group 2 are listed in the top of each table. Since these species did not have enough observations on a given Forest, coefficients for that given Forest were taken from the species and Forest noted on the right side of the table. Species in group 1 are listed in the bottom of each table. Enough observations existed for each of these species for fitted regressions for the given Forest. Finally, species in group 3 may be found in either the top or bottom of the table. Coefficients for group three species are used to dub in a height for that tree species, but then, since the species is not recognized in the WC species list (see table 2), that particular tree species is considered in the "other" category for other parts of the simulation.

Table A2.
par0603wA.dat : Curtis/Arney eqn parameter file for permanent plot grid data from the Gifford Pinchot (west) NF (11/96), plus coefficients for additional species for FVS routines (03/97).

Curtis/Arney eqn: $Ht = 4.5 + P2*e^{(-P3*DBH^{P4})}$

species	P2	P3	P4		
ABCO	475.169795	6.247243	-0.481237	ABCO	Umpqua
ABMA	375.3819995	6.08804972	-0.47200373	ABSH	Umpqua
LAOC	** grouped w/CHNO				
LIDE	4691.633742	7.467125	-0.198894	LIDE	Willamette
PISI	** grouped w/PIEN				
PIJE	1031.520325	7.66157254	-0.35992884	PIJE	Siskiyou
PILA	702.185554	5.702489	-0.379761	PILA	Willamette
SESE3	409.8810617	6.89077018	-0.56108469	SESE3	Siskiyou
ALRH2	133.7965374	6.4049980	-0.8328755	ARME	Willamette
ARME	** grouped w/ALRH2				
BEPA	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
CACH6	10707.39058	8.46695	-0.18631	CACH6	Willamette
LIDE3	** grouped w/CACH6				
POTR5	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
QUKE	** grouped w/QUGA4				
JUOC	503.6619453	4.9544407	-0.2085181	JUOC	Winema
LALY	503.6619453	4.9544407	-0.2085181	JUOC	Winema
PIAL	89.55353825	4.22808725	-0.64379518	PIAL	Deschutes
PIAT	34749.47359	9.12871308	-0.14169917	PIAT	Siskiyou
CONU4	444.5618441	3.9205235	-0.2396915	CONU4	Willamette
CR__	55.0	5.5	-0.95	QUGA4	regional std
PREM	73.33478314	2.65483736	-1.24600175	PRPE2	Siuslaw
SA__	149.5860859	2.42307614	-0.17996673	SALA5	regional std

ABAM	407.9955890	6.78343308	-0.52251476
ABGR	686.483116	6.539311	-0.374044
ABLA	216.3997761	6.16997747	-0.60172580
ABPR	561.9589245	6.55066637	-0.44603623
ACMA3	179.0705719	3.62383352	-0.57295747
ALRU2	182.3044795	3.66760950	-0.47346352
CHNO	505.2707496	6.47426621	-0.43236693
HARD	34.83300647	2.60295164	-0.53523535
PICO	133.6602762	4.84562797	-0.69707597
PIEN	27357.52121	8.72109108	-0.14070273
PIMO3	3261.830829	7.37166176	-0.25173431
PIPO	1548.414708	6.55027369	-0.26999192
POBAT	178.6441231	4.58518404	-0.67462096
PRPE2	73.33478314	2.65483736	-1.24600175
QUGA4	55.0	5.5	-0.95
PSME	452.3984532	5.96901686	-0.49101547
SALA5	149.5860859	2.42307614	-0.17996673
SOFT	34.83300647	2.60295164	-0.53523535
TABR2	1221.918272	5.81662506	-0.20962058
THPL	531.0072527	5.96433385	-0.40831005
TSHE	465.0810688	6.47723945	-0.49409499
TSME	368.3721987	6.82666530	-0.50703484

Table A3.
par0605.dat : Curtis/Arney eqn parameter file for permanent plot grid data from the Mt. Baker-Snoqualmie NF (03/97), plus coefficients for additional species for FVS routines (03/97).

Curtis/Arney eqn: Ht = 4.5 + P2*e^(-P3*DBH^P4)

species	P2	P3	P4		
ABCO	475.169795	6.247243	-0.481237	ABCO	Umpqua
ABMA	375.3819995	6.08804972	-0.47200373	ABSH	Umpqua
LAOC	** grouped w/CHNO				
PISI	** grouped w/PIEN	(Note: MBS had very few obs of both PIEN & PISI)			
LIDE	4691.633742	7.467125	-0.198894	LIDE	Willamette
PIJE	1031.520325	7.66157254	-0.35992884	PIJE	Siskiyou
PILA	702.185554	5.702489	-0.379761	PILA	Willamette
PIPO	1181.724378	6.69805372	-0.31514874	PIPO	Umpqua
SESE3	409.8810617	6.89077018	-0.56108469	SESE3	Siskiyou
ALRH2	133.7965374	6.4049980	-0.8328755	ARME	Willamette
ARME	** grouped w/ALRH2				
BEPA	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
CACH6	10707.39058	8.46695	-0.18631	CACH6	Willamette
LIDE3	** grouped w/CACH6				
POTR5	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
QUGA4	59.42136339	5.31783750	-1.03668061	QUKE	Rogue River
QUKE	** grouped w/QUGA4				
JUOC	503.6619453	4.9544407	-0.2085181	JUOC	Winema
LALY	503.6619453	4.9544407	-0.2085181	JUOC	Winema
PIAL	89.55353825	4.22808725	-0.64379518	PIAL	Deschutes
PIAT	34749.47359	9.12871308	-0.14169917	PIAT	Siskiyou
CR__	55.0	5.5	-0.95	QUGA4	regional std
PREM	73.33478314	2.65483736	-1.24600175	PRPE2	Siuslaw
SA__	149.5860859	2.42307614	-0.17996673	SALA5	regional std

ABAM	476.6344187	6.48388415	-0.46850215
ABGR	727.8110407	5.46484948	-0.34347433
ABLA	495.7841367	6.53015525	-0.41096187
ABPR	2067.858633	6.84940821	-0.25903517
ACMA3	293.1105242	3.73384840	-0.34576345
ALRU2	1089.504545	5.19969063	-0.25661407
CHNO	181.4540100	6.57858085	-0.65670034
CONU4	444.5618441	3.9205235	-0.2396915
GENER	34.83300647	2.60295164	-0.53523535
PICO	121.1391747	12.6622940	-1.2981049
PIEN	211.7961990	6.70151614	-0.67386306
PIMO3	433.780681	6.331809	-0.49884
PISI	453.8096043	4.12052258	-0.27923080
POBAT	290.3332275	5.28008853	-0.58456563
PRPE2	73.33478314	2.65483736	-1.24600175
PSME	536.7367740	5.58034965	-0.41013003
SOFT	34.83300647	2.60295164	-0.53523535
TABR2	175.8646800	5.08900087	-0.46238105
THPL	422.9704325	5.73435483	-0.42665422
TSHE	319.373722752	6.39620455	-0.56981000
TSME	547.9487181	7.13718447	-0.42203466

Table A4.

par0606wa.dat : Curtis/Arney eqn parameter file for permanent plot grid data from the Mt. Hood (west) NF (11/96), plus coefficients for additional species for FVS routines (03/97).

Curtis/Arney eqn: Ht = 4.5 + P2*e^(-P3*DBH^P4)

species	P2	P3	P4		
ABCO	475.169795	6.247243	-0.481237	ABCO	Umpqua
ABMA	375.3819995	6.08804972	-0.47200373	ABSH	Umpqua
CHNO	** grouped w/LAOC				
PISI	** grouped w/PIEN				
PIJE	1031.520325	7.66157254	-0.35992884	PIJE	Siskiyou
PILA	702.185554	5.702489	-0.379761	PILA	Willamette
PIPO	1181.724378	6.69805372	-0.31514874	PIPO	Umpqua
SESE3	409.8810617	6.89077018	-0.56108469	SESE3	Siskiyou
ALRH2	133.7965374	6.4049980	-0.8328755	ARME	Willamette
ARME	** grouped w/ALRH2				
BEPA	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
CACH6	10707.39058	8.46695	-0.18631	CACH6	Willamette
LIDE3	** grouped w/CACH6				
POTR5	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
QUGA4	59.42136339	5.31783750	-1.03668061	QUKE	Rogue River
QUKE	** grouped w/QUGA4				
JUOC	503.6619453	4.9544407	-0.2085181	JUOC	Winema
LALY	503.6619453	4.9544407	-0.2085181	JUOC	Winema
PIAT	34749.47359	9.12871308	-0.14169917	PIAT	Siskiyou
CR__	55.0	5.5	-0.95	QUGA4	regional std
PREM	73.33478314	2.65483736	-1.24600175	PRPE2	Siuslaw
SA__	149.5860859	2.42307614	-0.17996673	SALA5	regional std

ABAM	223.3491920	6.3964175	-0.6565570
ABGR	432.2186440	6.29412400	-0.50275900
ABLA	290.5141898	6.4142801	-0.4723555
ABPR	247.7348313	6.18301060	-0.63352110
ACMA3	76.51700553	2.21069592	-0.63650686
ALRU2	484.4590725	4.5712860	-0.3642857
CONU4	403.3220502	4.32712596	-0.24217220
LAOC	255.4637950	5.55773700	-0.60536400
LIDE	4691.633742	7.46712500	-0.19889400
PIAL	73.91471600	3.96296700	-0.82769700
PICO	139.7159036	4.0091431	-0.7080246
PIEN	206.3210600	9.12271300	-0.82806000
PIMO3	1333.817639	6.62190117	-0.31204507
POBAT	178.6441231	4.58518404	-0.67462096
PRPE2	73.33478314	2.65483736	-1.24600175
PSME	949.1045502	5.8481842	-0.3251462
SOFT	34.83300647	2.60295164	-0.53523535
TABR2	77.22071502	3.51807589	-0.58938253
THPL	1560.684786	6.232785	-0.254133
TSHE	317.8257317	6.8286623	-0.6033683
TSME	2478.098792	7.076229	-0.245582

Table A5.

par0610A.dat : Curtis/Arney eqn parameter file for permanent plot grid data from the Rogue River NF (11/96), plus coefficients for additional species for FVS routines (03/97).

Curtis/Arney eqn: Ht = 4.5 + P2*e^(-P3*DBH^P4)

species	P2	P3	P4		
ABAM	380.250492	7.305850	-0.576214	ABAM	Umpqua
ABGR	432.218644	6.294124	-0.502759	ABGR	Willamette
ABMA	375.3819995	6.08804972	-0.47200373	ABSH	Umpqua
ABPR	483.375072	7.244315	-0.511129	ABPR	Willamette
LAOC	** grouped w/CHNO				
PISI	** grouped w/PIEN				
SESE3	409.8810617	6.89077018	-0.56108469	SESE3	Siskiyou
THPL	617.762180	5.521309	-0.350777	THPL	Umpqua
ALRU2	** grouped w/ARME				
BEPA	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
LIDE3	** grouped w/CACH6				
POTR5	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
POBAT	178.6441231	4.58518404	-0.67462096	POBAT	regional std
QUGA4	** grouped w/QUKE				
JUOC	503.6619453	4.9544407	-0.2085181	JUOC	Winema
LALY	503.6619453	4.9544407	-0.2085181	JUOC	Winema
PIAL	89.55353825	4.22808725	-0.64379518	PIAL	Deschutes
CR__	55.0	5.5	-0.95	QUGA4	regional std
PREM	73.33478314	2.65483736	-1.24600175	PRPE2	Siuslaw
SA__	149.5860859	2.42307614	-0.17996673	SALA5	regional std

species	P2	P3	P4	
ABCO	907.5143819	6.44785104	-0.35762520	Cascade stratum
ABCO	253.9245643	6.61389559	-0.59126017	Siskiyou stratum
ABLA	5185.987898	8.75808395	-0.22646232	
ABSH	771.6581896	6.30572257	-0.34981167	
ACMA3	143.9993959	3.51243438	-0.55113923	
ALRH2	88.183839	2.840395	-0.73434446	
ALRU2	88.183839	2.840395	-0.73434446	
ARME	123.2106704	4.12502636	-0.55459914	
CACH6	83.74563952	8.33163314	-1.04803324	
CHNO	97.77693073	8.82017287	-1.05341291	
CONU4	403.3220502	4.32712596	-0.24217220	
HARD	34.83300647	2.60295164	-0.53523535	
LIDE	2245.574146	7.19886438	-0.24004190	
PIAT	4421.457694	7.05674490	-0.19395462	
PIBR	5185.987898	8.75808395	-0.22646232	
PICO	115.8918540	4.99986021	-0.90056542	
PIEN	155.0	9.122713	-0.828060	
PIJE	1000.0	6.55027369	-0.26999192	
PILA	1631.376405	6.47900057	-0.25694993	
PIMO3	1143.625356	6.19129929	-0.30958662	
PIPO	1548.414708	6.55027369	-0.26999192	
PRPE2	2.71834177	-0.58577845	-0.31948208	
PSME	540.9410192	5.67964991	-0.40366798	
QUCH2	59.09411756	6.11953882	-1.05521968	
QUGA4	55.0	5.5	-0.95	
QUKE	59.42136339	5.31783750	-1.03668061	
SALA5	149.5860859	2.42307614	-0.17996673	
SOFT	34.83300647	2.60295164	-0.53523535	
TABR2	127.1698195	4.89770723	-0.46684325	
TSHE	263.1274006	6.93561997	-0.66185271	
TSME	233.6986879	6.90592828	-0.61662569	

Table A6.
par0615a.dat : Curtis/Arney eqn parameter file for permanent plot grid data from the Umpqua NF (11/96), plus coefficients for additional species for FVS routines (03/97).

Curtis/Arney eqn: Ht = 4.5 + P2*e^(-P3*DBH^P4)

species	P2	P3	P4		
ABGR	432.218644	6.294124	-0.502759	ABGR	Willamette
ABMA	375.3819995	6.08804972	-0.47200373	ABSH	Umpqua
ABPR	483.375072	7.244315	-0.511129	ABPR	Willamette
LAOC	** grouped w/CHNO				
PISI	** grouped w/PIEN				
PIJE	1031.520325	7.66157254	-0.35992884	PIJE	Siskiyou
SESE3	409.8810617	6.89077018	-0.56108469	SESE3	Siskiyou
ALRH2	** grouped w/ARME				
BEPA	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
LIDE3	** grouped w/CACH6				
POTR5	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
POBAT	178.6441231	4.58518404	-0.67462096	POBAT	regional std
QUKE	** grouped w/QUGA4				
JUOC	503.6619453	4.9544407	-0.2085181	JUOC	Winema
LALY	503.6619453	4.9544407	-0.2085181	JUOC	Winema
PIAL	89.55353825	4.22808725	-0.64379518	PIAL	Deschutes
CR__	55.0	5.5	-0.95	QUGA4	regional std
PREM	73.33478314	2.65483736	-1.24600175	PRPE2	Siuslaw
SA__	149.5860859	2.42307614	-0.17996673	SALA5	regional std
ABAM	380.250492	7.305850	-0.576214		
ABCO	475.169795	6.247243	-0.481237		
ABLA	133.868923	6.7798338	-0.7374968		
ABSH	375.3819995	6.08804972	-0.47200373		
ACMA3	106.029640	3.882129	-0.782904		
ALRU2	88.183839	2.840395	-0.73434446		
ARME	105.129343	5.134093	-0.789344		
CACH6	1076.427111	6.146548	-0.282170		
CHNO	97.77693073	8.82017287	-1.05341291		
CONU4	202.9745242	3.2935884	-0.3232760		
FRLA	97.77693073	8.82017287	-1.05341291		
GENER	34.83300647	2.60295164	-0.53523535		
HARD	34.83300647	2.60295164	-0.53523535		
LIDE	1899.320765	6.941819	-0.255303		
PIAT	4421.457694	7.05674490	-0.19395462		
PICO	127.571355	6.345480	-0.864123		
PIEN	206.32106	9.122713	-0.82806		
PILA	544.372106	6.880436	-0.463792		
PIMO3	433.780681	6.331809	-0.49884		
PIPO	1181.724378	6.69805372	-0.31514874		
PRPE2	73.33478314	2.65483736	-1.24600175		
PSME	316.128318	5.965874	-0.574755		
QUCH2	59.09411756	6.11953882	-1.05521968		
QUGA4	55.0	5.5	-0.95		
QUKE	59.42136339	5.31783750	-1.03668061		
SALA5	149.5860859	2.42307614	-0.17996673		
SOFT	34.83300647	2.60295164	-0.53523535		
TABR2	139.072707	5.206229	-0.540866		
THPL	617.762180	5.521309	-0.350777		
TSHE	608.609785	6.087504	-0.416327		
TSME	393.980941	6.393031	-0.475098		

Table A7.
par0618a.dat : Curtis/Arney eqn parameter file for permanent plot grid data from the Willamette NF (11/96), plus coefficients for additional species for FVS routines (03/97).

Curtis/Arney eqn: $Ht = 4.5 + P2*e^{(-P3*DBH^{P4})}$

species	P2	P3	P4		
ABCO	475.169795	6.247243	-0.481237	ABCO	Umpqua
ABMA	375.3819995	6.08804972	-0.47200373	ABSH	Umpqua
LAOC	** grouped w/CHNO				
PISI	** grouped w/PIEN	(Note: MBS had very few obs of both PIEN & PISI)			
LIDE	4691.633742	7.467125	-0.198894	LIDE	Willamette
PIJE	1031.520325	7.66157254	-0.35992884	PIJE	Siskiyou
SESE3	409.8810617	6.89077018	-0.56108469	SESE3	Siskiyou
ALRH2	** grouped w/ARME				
BEPA	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
LIDE3	** grouped w/CACH6				
POTR5	1709.722864	5.88874834	-0.22861721	POTR5	Gifford Pinchot east
QUKE	** grouped w/QUGA4				
JUOC	503.6619453	4.9544407	-0.2085181	JUOC	Winema
LALY	503.6619453	4.9544407	-0.2085181	JUOC	Winema
PIAT	34749.47359	9.12871308	-0.14169917	PIAT	Siskiyou
CR__	55.0	5.5	-0.95	QUGA4	regional std
PREM	73.33478314	2.65483736	-1.24600175	PRPE2	Siuslaw
SA__	149.5860859	2.42307614	-0.17996673	SALA5	regional std
ABAM	237.918902	7.794835	-0.726082		
ABGR	432.218644	6.294124	-0.502759		
ABLA	133.8689230	6.7798338	-0.7374968		
ABPR	483.375072	7.244315	-0.511129		
ACMA3	160.217059	3.304424	-0.529880		
ALRU2	10099.72087	7.63746	-0.16208		
ARME	133.7965374	6.4049980	-0.8328755		
CACH6	10707.39058	8.46695	-0.18631		
CHNO	97.77693073	8.82017287	-1.05341291		
CONU4	444.5618441	3.9205235	-0.2396915		
GENER	34.83300647	2.60295164	-0.53523535		
HARD	34.83300647	2.60295164	-0.53523535		
LIDE	4691.633742	7.467125	-0.198894		
PIAL	73.914716	3.962967	-0.827697		
PICO	105.4453476	7.9693730	-1.0915635		
PIEN	206.321060	9.122713	-0.828060		
PILA	702.185554	5.702489	-0.379761		
PIMO3	514.157519	6.300447	-0.465144		
PIPO	1181.724378	6.69805372	-0.31514874		
POBAT	178.6441231	4.58518404	-0.67462096		
PRPE2	73.33478314	2.65483736	-1.24600175		
PSME	439.119534	5.817647	-0.485445		
QUGA4	55.0	5.5	-0.95		
SOFT	34.83300647	2.60295164	-0.53523535		
TABR2	139.072707	5.206229	-0.540866		
THPL	1012.126678	6.095743	-0.308285		
TSHE	395.497562	6.422230	-0.531987		
TSME	192.960876	7.387592	-0.723095		