The Southern Variant

of the

Forest Vegetation Simulator

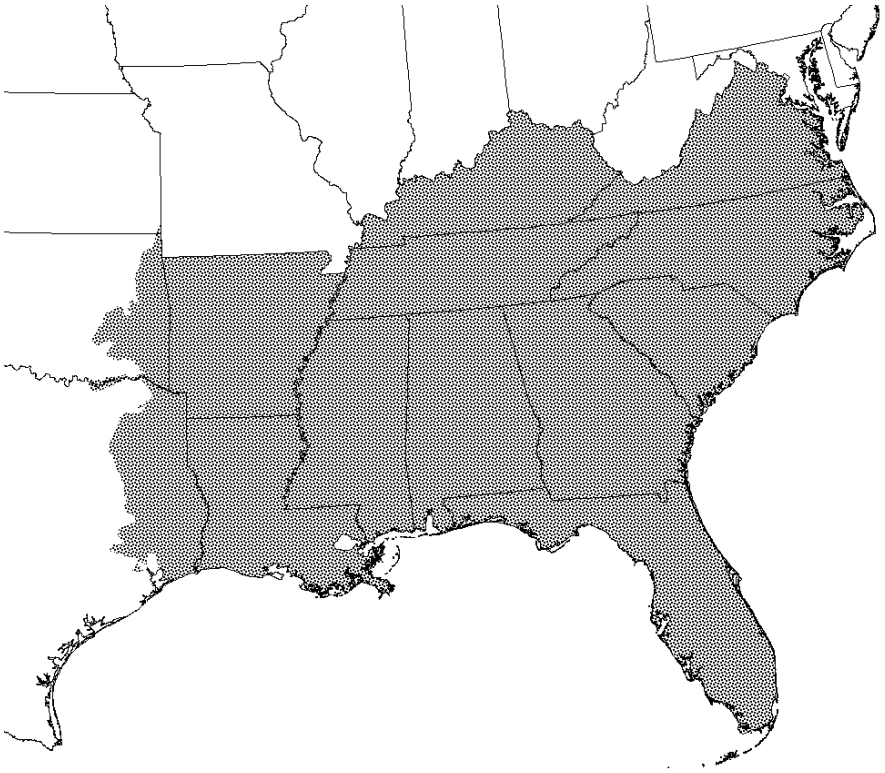

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TABLE OF CONTENTS

I. Introduction

The ***Forest Vegetation Simulator (FVS)*** is an individual-tree, distance-independent growth and yield model. ***Suppose*** is the graphical user interface for FVS (Crookston 1997). FVS will simulate growth and yield for most major forest tree species, forest types, and stand conditions. FVS can also simulate a wide range of silvicultural treatments. Variants of FVS provide growth and yield models for specific geographic areas of the United States. The Southern Variant (SN) applies to the following states (names abbreviated and in order roughly from northeast to southwest): VA, NC, SC, GA, FL, AL, MS, LA, TN, KY AR, TX, and OK.

Prognosis (Stage 1973) is the original model that evolved into the Forest Vegetation Simulator. Stage developed Prognosis for use in the Inland Empire area of Idaho and Montana. In the early 1980s, the National Forest System's (then titled) Timber Management Staff selected the individual-tree, distance-independent model form as the nationally supported framework for growth and yield modeling. Through the following years, the Forest Management Growth and Yield Unit Staff incorporated much of the Prognosis modular structure and capabilities into the national model framework. This model framework is the ***Forest Vegetation Simulator***, or ***FVS***.

The Growth and Yield Unit of the Forest Management Service Center (FMSC) in Fort Collins, Colorado, maintains, supports, develops, and provides training for FVS. The FMSC performs a technology transfer role, working with researchers and National Forests staff from various geographical areas to incorporate their findings into the FVS framework.
There are currently 21 different FVS variants in production use (Figure 1). Each is calibrated to a specific geographic area of the United States. The FMSC is constantly upgrading existing variants and developing additional variants as needed.

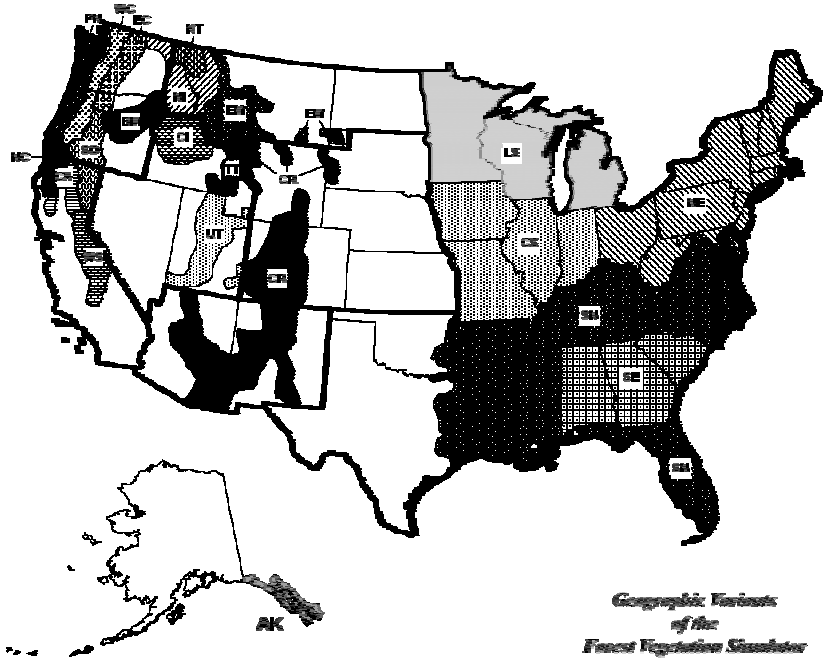

Figure 1. - Geographic Variants of the Forest Vegetation Simulator (SN Var. incl. AL, GA. SC labeled as SE)

Region 8 has two variants, the Southeast Variant (SE) and Southern Variant (SN). The Southeast Variant was the original FVS variant created for the South (1996) and was based on the Southeast TWIGS model, applicable to Alabama, Georgia, and South Carolina. However, there was a need for a variant which covered more area with in Region 8. Using FIA data collected through out the South, the

Southern Varaint was developed using completely new growth equations. The Southern Varaint now covers all of Region 8 including the area previously covered by the Southeast TWIGS variant.

Development of the Southern Variant of FVS began in 1998. Initial testing began in late 1999 and early 2000. Initial testing release was in April 2000. The development of the variant began as a cooperative effort of the Southern Research Station, Southern Regional Office, and the Forest Management Service Center. The variant was developed from Forest Inventory and Analysis (FIA) data from all 13 states of the Southern Region, Forest Service Research data, and data from the Bureau of Indian Affairs. Its geographic coverage is all of Region 8 (see Figure 1). Areas of Texas and Oklahoma not shaded in Figure 1 do not contain FIA plots and is generally not forest land. However, smaller areas of forested land immediately to the west of the shaded area could probably be modeled using this variant. The Growth and Yield Staff of the FMSC developed the variant's relationships from the FIA data and incorporated them into the classic Prognosis/FVS structure.

This document is a technical overview and users guide for the Southern Variant of FVS. It describes the variant's basic model structure, operation, data format, assumptions, and formulae. This document is not a complete user's guide for FVS, nor does this overview describe the Suppose graphical user interface for FVS. Information in the Appendix describes data underlying the variant, as well as controlling variables, codes, and other operating information.

II. Variant Structure

The FVS model has several components that work together to simulate forest growth and management actions. There are three main growth components of the FVS: a large-tree model, a small-tree model, and an establishment model; and, there is a mortality model. FVS treats a stand as the population unit, using forest inventories or stand examination data. Input files include "keywords" that the user can manipulate to simulate different management scenarios (VanDyck 2000, see note on literature citation). There are extensions for FVS variants that estimate the influence of other agents upon tree growth, such as insects and disease. Post-processors are other programs that uses FVS output and for further reporting, display, or analysis. Information about these can be obtained from the Forest Management Service Center website, or by contacting a member of our staff.

III. Variant Execution

This section summarizes FVS operation to provide context for the details in this model overview. Figure 2 displays the major execution steps in FVS.

1. Process keywords and input data--FVS begins by reading keywords to establish location, environment, and stand parameters; then reads the tree record file.
2. Compute initial stand characteristics--FVS computes stand characteristics for the initial year (cycle 0). This is typically the inventory date or the stand regeneration date. Input tree records with missing heights or crown ratios have these dubbed in.
3. Backdate densities and compute calibration statistics--If sufficient large tree diameter increment data is contained in the input tree data (and/or small tree height increment data), FVS backdates the stand one default cycle length; for the SN variant, this is five years. FVS then "grows" the stand back to the inventory date, compares the values from the actual inventory date with simulated values, and computes scale factor adjustments to account for differences in actual and model values.
4. Check event monitor (pre-thin)--FVS continues with the steps it repeats every cycle. FVS checks the Event Monitor keywords and functions to see if the user scheduled any activities based on existing stand conditions at the start of the cycle. Event Monitor capabilities are powerful and very useful for modeling situations and creating variables not covered in standard FVS output. Crookston (1990)

describes Event Monitor functions and processes along with several good examples.

5. Perform thinning--Almost any silvicultural operation imaginable can be structured using one or more thinning keywords in a direct or conditional (If..Then) context.
6. Check event monitor (post-thin)--FVS Event Monitor checks for conditions and scheduled operations that are based on post-thinning activity conditions within the same cycle.
7. Grow large trees--If "large" trees exist in the tree-list, FVS estimates their new diameter (first) and height (second) one growth cycle into the future (default cycle time interval for SN is five years; the user can specify a different time interval length.
8. Grow small trees--FVS estimates small tree height (first) and diameter (second) one growth cycle into the future. FVS uses a weighting procedure to compute tree height increment to obtain a smooth height-growth transition from small to large tree models.
9. Mortality--Following growth estimation, FVS estimates mortality based on individual tree variables such as diameter and crown ratio, and on stand variables such as maximum stand density index or basal area.
10. Insect and disease impacts--If the variant has available extensions to cover specific disease or insect agents, and if the user calls for these, FVS estimates and incorporates these effects. The Southern Varaint does not have any insect and pathogen extensions available. Insect and pathogen effects must be simulated using keywords (see Insect and Pathogen section for further description).
11. Regeneration--FVS adds new seedlings to FVS tree-lists in the regeneration step. Some FVS variants have natural regeneration routines, but most variants, including the Southern Variant, depend on the user to specify the species and number of trees to plant. The Southern Variant has a stump sprouting algorithm, whereby certain species will sprout after a harvest.
12. Crown change--FVS estimates crown ratio change for all trees based on stand density and the trees position in the density distribution.
13. Update stand characteristics and compute volume--After projecting the stand for the growth cycle, FVS computes, summarizes, and records the stand attributes, including volume. Volume is computed using corporate equations from the National Volume Estimation Library.
14. Test for more cycles to be projected--FVS repeats the sequence from the initial" Check Event Monitor", per Figure 2, to this point for each cycle until the specified number of cycles is completed.
15. Final FVS Output file reports and post-processor files--After FVS completes the scheduled cycles, it prints final output file reports and generates files specified by the user for running post-processors, including SVS.

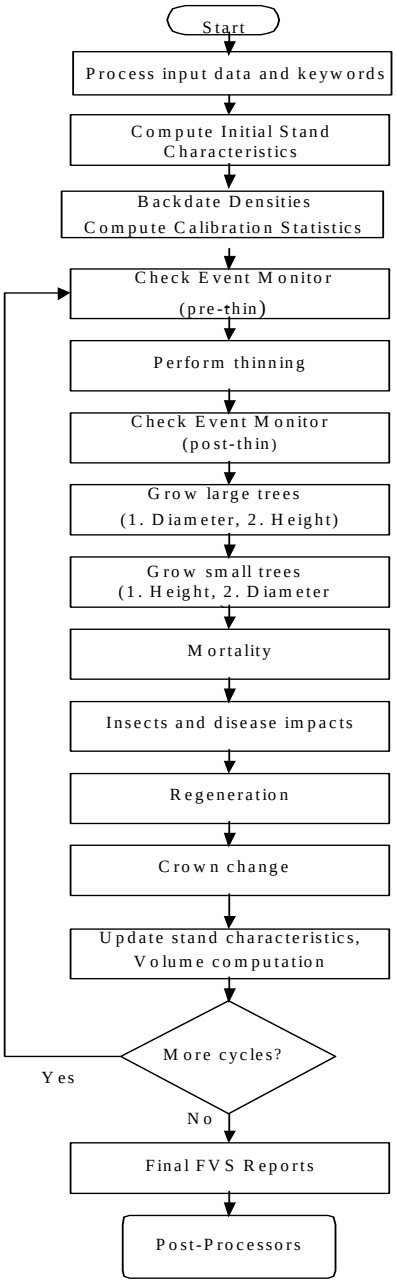

Figure 2. – FVS Program Execution

IV. Variant Control Variables

Species Codes

The Southern Variant includes the following primary tree species or species groups (Table 3). The variant has the ability to translate all of the Eastwide Data Base's (Hansen, et.al. 1992) species codes and FVS alpha-codes to one of the pertinent Southern Variant species codes. Appendix Table A1 has a more complete description of the variant's species. It also shows how all of the species found in the Eastwide Data Base may be included in the model as one of the species or primary species or species groups listed below.

Table 3. – Southern Variant Primary Tree Species Codes (see also Appendix tableA1)

Numeric Code	Alpha Code	FIA Code	Common Name	Scientific Name
1	FR	010	fir sp.	Abies sp.
2	JU	060	redcedar	Juniperus sp.
3	PI	090	spruce	Picea sp.
4	PU	107	sand pine	Pinus clausa
5	SP	110	shortleaf pine	Pinus echinata
6	SA	111	slash pine	Pinus elliottii
7	SR	115	spruce pine	Pinus glabra
8	LL	121	longleaf pine	Pinus palustris
9	TM	123	Table Mountain pine	Pinus pungens
10	PP	126	pitch pine	Pinus rigida
11	PD	128	pond pine	Pinus serotina
12	WP	129	eastern white pine	Pinus strobus
13	LP	131	loblolly pine	Pinus taeda
14	VP	132	Virginia pine	Pinus virginiana
15	BY	221	baldcypress	Taxodium distichum
16	PC	222	pondcypress	Taxodium distichum var. nutans
17	HM	260	hemlock	Tsuga sp.
18	FM	311	Florida maple	Acer barbatum
19	BE	313	boxelder	Acer negundo
20	RM	316	red maple	Acer rubrum
21	SV	317	silver maple	Acer saccharinum
22	SM	318	sugar maple	Acer saccharum
23	BU	330	buckeye, horsechestnut	Aesculus sp.
24	BB	370	birch sp.	Betula sp.
25	SB	372	sweet birch	Betula lenta
26	AH	391	American hornbeam, musclewood	Carpinus caroliniana
27	HI	400	hickory sp.	Carya sp.
28	CA	450	catalpa	Catalpa sp.
29	HB	460	hackberry sp.	Celtis sp.
30	RD	471	eastern redbud	Cercis canadensis
31	DW	491	flowering dogwood	Cornus florida
32	PS	521	common persimmon	Diospyros virginiana
33	AB	531	American beech	Fagus grandifolia
34	AS	540	ash	Fraxinus sp.
35	WA	541	white ash	Fraxinus americana
36	BA	543	black ash	Fraxinus nigra
37	GA	544	green ash	Fraxinus pennsylvanica
38	HL	552	honeylocust	Gleditsia triacanthos
39	LB	555	loblolly-bay	Gordonia lasianthus
40	HA	580	silverbell	Halesia sp.
41	HY	591	American holly	Ilex opaca
42	BN	601	butternut	Juglans cinerea
43	WN	602	black walnut	Juglans nigra
44	SU	611	sweetgum	Liquidambar styraciflua
45	YP	621	yellow-poplar	Liriodendron tulipifera
46	MG	650	magnolia sp.	Magnolia sp.
47	CT	651	cucumbertree	Magnolia acuminata
48	MS	652	southern magnolia	Magnolia grandiflora
49	MV	653	sweetbay	Magnolia virginiana
50	ML	654	bigleaf magnolia	Magnolia macrophylla
51	AP	660	apple sp.	Malus sp.
52	MB	680	mulberry sp.	Morus sp.
53	WT	691	water tupelo	Nyssa aquatica
54	BG	693	blackgum	Nyssa sylvatica
55	TS	694	swamp tupelo	Nyssa sylvatica var. biflora
56	HH	701	eastern hophornbeam, ironwood	Ostrya virginiana
57	SD	711	sourwood	Oxydendrum arboreum

58	RA	721	redbay	Persea borbonia
59	SY	731	sycamore	Platanus occidentalis
60	CW	740	cottonwood	Populus sp.
61	BT	743	bigtooth aspen	Populus grandidentata
62	BC	762	black cherry	Prunus serotina
63	WO	802	white oak	Quercus alba
64	SO	806	scarlet oak	Quercus coccinea
65	SK	812	southern red oak	Quercus falcata var. falcata
66	CB	813	cherrybark oak, swamp red oak	Quercus falcata
67	TO	819	turkey oak	Quercus laevis
68	LK	820	laurel oak	Quercus laurifolia
69	OV	822	overcup oak	Quercus lyrata
70	BJ	824	blackjack oak	Quercus marilandica
71	SN	825	swamp chestnut oak	Quercus michauxii
72	CK	826	chinkapin oak	Quercus muehlenbergii
73	WK	827	water oak	Quercus nigra
74	CO	832	chestnut oak	Quercus prinus
75	RO	833	northern red oak	Quercus rubra
76	QS	834	Shumard oak	Quercus shumardii
77	PO	835	post oak	Quercus stellata
78	BO	837	black oak	Quercus velutina
79	LO	838	live oak	Quercus virginiana
80	BK	901	black locust	Robinia psuedoacacia
81	WI	920	willow	Salix sp.
82	SS	931	sassafras	Sassafras albidum
83	BW	950	basswood	Tilia sp.
84	EL	970	elm	Ulmus sp.
85	WE	971	winged elm	Ulmus alata
86	AE	972	American elm	Ulmus americana
87	RL	975	slippery elm	Ulmus rubra
88	OS	001 *	Softwoods, misc.	
89	OH	004 *	Hardwoods, misc.	
90	OT	999	unknown or not listed	

*The Forest Inventory and Analysis (FIA) code listed for these species is not a current valid code for the Eastwide Data Base

Location Codes

Location codes relate to the Region, National Forest, and Ranger District where the stand is located (Table 7). The Southern Variant uses this information to select the appropriate volume equations for the stand. The code is in the format RFFDD, where R is the region number, FF is the forest number, and DD is the ranger district number. If a location code is not entered or an incorrect code is entered, the default code is 80106, National Forests in Alabama, Talledega Ranger District

Table 7. – Location Codes for the Southern Variant

Proclaimed National Forest	District	Location Code
National Forests in Alabama	Bankhead	80101
	Conecuh	80103
	Oakmulgee	80104
	Shoal Creek	80105
	Talledega	80106
	Tuskegee	80107
Daniel Boone	Morehead	80211
	Stanton	80212
	Berea	80213
	London	80214
	Somerset	80215
	Stearns	80216
	Redbird	80217
Chattahoochee-Oconee	Armuchee	80301
	Toccoa	80302
	Brasstown	80304
	Tallulah	80305
	Chattooga	80306
	Cohutta	80307
	Oconee	80308
Cherokee	Hiwassee	80401
	Nolichucky	80402
	Ocoee	80403
	Tellico	80404
	Unaka	80405
	Watuga	80406
National Forests in Florida	Apalachicola	80501

	Lake George	80502
	Osceola	80504
	Seminole	80505
	Wakulla	80506
Kisatchie	Catahoula	80601
	Evangeline/Vernon	80602
	Kisatchie	80603
	Winn	80604
	Caney	80605
National Forests in Mississippi	Bienville	80701
	Desoto	80702
	Homochitto	80704
	Chickasawhay	80705
	Delta	80706
	Holly Springs	80707
	Tombigbee	80717
George Washington/Jefferson NFs	Deerfield	80801
	Dry River	80802
	James River	80803
	Lee	80804
	Pedlar	80805
	Warm Springs	80806
	Blacksburg	80811
	Clinch	80812
	Glenwood	80813
	Mt. Rogers	80814
	New Castle	80815
	Wythe	80816
Quachita	Choctaw	80901
	Caddo	80902
	Cold Springs	80903
	Fourche	80904
	Jessieville	80905
	Kiamichi	80906
	Mena	80907
	Oden	80908
	Poteau	80909
	Womble	80910
	Winona	80911
	Tiak	80912
Ozark & St. Francis NFs	Sylamore	81001
	Buffalo	81002
	Bayou	81003
	Pleasant Hill	81004
	Boston Mountain	81005
	Magazine	81006
	St. Francis	81007
National Forests in North Carolina	Cheoah	81102
	Croatan	81103
	Appalachian	81104
	Grandfather	81105
	Highlands	81106
	Pisgah	81107
	Tusquitee	81109
	Uwharrie	81110
	Wayah	81111
Francis Marion & Sumter NFs	Enoree/Tyger	81201
	Andrew Pickens	81202
	Long cane	81203
	Wambaw/Witherbee	81205
National Forests in Texas	Angelina	81301
	Davy Crockett	81303
	Sam Houston	81304
	Cado/LBJ	81308

Ecological Unit

The Southern Variant currently uses Ecological Unit Codes (EUC) at the Subsection level (Table 8) as a means of distinguishing between major geographic areas within the South. Currently this distinction is done at the Province level of the EUC structure. Tree diameter growth models for some species in the Southern Variant vary by EUC. In the future, if differences in tree growth are demonstrated at other EUC levels, especially of smaller scale (e.g., Sectional or Subsectional), in different southern eco-regions, these differences may be calibrated into the models. For now, it is important to use these

ecological unit codes. Results will differ between mountain and other areas for certain species (e.g., yellow-poplar). The default EUC value is 231Dd, Quartzite and Talladega Slate Ridge, if no EUC or an incorrect EUC is entered in the data.

Table 8. - Ecological Classification Codes (EUC) of the Southern Region (From "Ecological Units of the Eastern United States", Keys, et.al. 1995)

EUC	SUBSECTION NAME	EUC	SUBSECTION NAME
221Db	Piedmont Upland	232Bf	Florida Central Highlands
221Eb	Teays Plateau	232Bg	South Coastal Plains
221Ha	Rugged Eastern Hills	232Bh	Gulf Southern Loam Hills
221Hc	Southwestern Escarpment	232Bi	The Plains
221Hd	Sequatchie Valley	232Bj	Southern Loam Hills
221He	Low Hills Belt	232Bk	Southern Clay Hills
221Ja	Rolling Limestone Hills	232Bl	Lower Loam and Clay Hills
221Jb	Sandstone Hills	232Bm	Lower Clay Hills
221Jc	Holston Valley	232Bn	Lower Loam Hills
222Ab	Central Plateau	232Bo	Border Sand Hills
222Ag	White River Hills	232Bp	Wiregrass Plains
222Ah	Elk River Hills	232Bq	Sand Hills
222Al	Black River Ozark Border	232Br	Atlantic Southern Loam Hills
222Am	Springfield Plain	232Bs	Floodplains and Terraces
222An	Springfield Plateau	232Bu	Southwestern Loam Hills
222Cb	Northern Deep Loess Hills and Bluffs	232Bv	Northern Loam Plains
222Cc	Deep Loess Hills and Bluffs	232Ca	Upper Terraces
222Cd	Clay Hills	232Cb	Lower Terraces
222Ce	Northern Loessial Hills	232Cc	Okefenokee Uplands
222Cf	Northern Pontotoc Ridge	232Cd	Okefenokee Swamp
222Cg	Upper Loam Hills	232Ce	Coastal Marsh and Island
222Ch	Ohio and Cache River Alluvial Plain	232Cf	Bacon Terraces
222Da	Interior Western Coalfields	232Cg	Flatwoods Floodplains and Terraces
222Db	Lower Ohio-Cache-Wabash Alluvial plains	232Ch	Tidal Area
222Dc	Outer Western Coalfields	232Ci	Pamlico and Albemarle Sounds and Barrier Islands
222Dd	Marion Hills	232Cj	Chesapeake Bay
222De	Crawford Uplands	232Da	Immokalee Rise
222Dg	Southern Dripping Springs	232Db	Gulf Coastal Lowlands
222Di	Lesser Shawnee Hills	232Dc	Gulf Coast Flatwoods-Bays and Barrier Islands
222Dj	Northern Dripping Springs	232Dd	Mobile Bay, Sounds and Islands
222Ea	Eastern Highland Rim	232De	Florida Gulf Coastal Bays and Islands
222Eb	Eastern Karst Plain	232Ea	Gulf Coast Prairies
222Ec	Outer Nashville Basin	232Eb	Gulf Coast Marshes and Inland Bays
222Ed	Inner Nashville Basin	232Ec	Lake Ponchartrain
222Ee	Highland Rim-Hilly and Rolling	232Ed	Gulf Coast Bays and Islands
222Ef	Tennessee-Gasper Valley	232Ee	Lake Borgne, Sounds and Islands
222Eg	Western Pennyroyal Karst Plain	232Fa	Southern Loam Hills
222Eh	Penneroyal Karst Plain	232Fb	Southwest Flatwoods
222Ei	Western Knobs	232Fc	Sabine Alluvial Valley
222Ej	Eastern Knobs Transition	232Fd	Neches Alluvial Valley
222Ek	Mitchell Karst Plains	232Fe	Piney Woods Transition
222En	Kinniconick and Licking Knobs	232Ga	Eastern Beach and Lagoons
222Eo	The Cliffs	232Gb	Eastern Beach and Dunes
222Fa	Outer Bluegrass	232Gc	Okeechobee Plain
222Fb	Inner Bluegrass	232Gd	Kissimmee River
222Fc	Western Bluegrass	234Aa	Southern Mississippi River Alluvial Plain
222Fd	Northern Bluegrass	234Ab	Crowleys Ridge
222Ff	Scottsburg Lowland	234Ac	White and Black Rivers Alluvial Plain
231Aa	Midland Plateau Central Uplands	234Ad	Baton Rouge Terrace
231Ab	Piedmont Ridge	234Ae	Arkansas Grand Prairie
231Ac	Schist Plains	234Af	Atchafalaya Alluvial Plain
231Ad	Lower Foot Hills	234Ag	Arkansas Alluvial Plain
231Ae	Charlotte Belt	234Ah	Macon Ridge
231Af	Carolina Slate	234Ai	Red River Alluvial Plain
231Ag	Schist Hills	234Aj	Bastrop Ridge
231Ah	Granite Hills	234Ak	Opelousas Ridge
231Ai	Opelika Plateau	234Al	Teche Terrace
231Aj	Mica Rich Plateau	234Am	St. Francis River Alluvial Plain
231Ak	Lynchburg Belt	234An	North Mississippi River Alluvial Plain
231Al	Northern Piedmont	251Ea	Scarped Osage Plains
231Am	Triassic Uplands	251Ec	Central Tallgrass
231An	Western Coastal Plain-Piedmont Transition	251Ed	Elk Prairie

231Ao	Southern Triassic Uplands	251Fb	Eastern Flint Hills
231Ap	Triassic Basins	251Fc	Southern Flint Hills
231Ba	Black Belt	255Aa	Cross Timbers-Cherokee Prairies
231Bb	Interior Flatwoods	255Ab	Central Oklahoma Cross Timbers
231Bc	Upper Clay Hills	255Ac	Central Red Rolling Prairies
231Bd	Upper Loam Hills	255Ad	Southern Oklahoma Grand Prairies
231Be	Transition Loam Hills	255Ae	Cross Timbers and Central Rolling Red Prairies
231Bf	Floodplains and Terraces	255Af	Cross Timbers - Southern Oklahoma
231Bg	Northern Loessial Hills	255Ag	Red River Alluvial Plain
231Bh	Deep Loess Hills and Bluffs	255Ah	Texas Eastern Cross Timbers
231Bi	Deep Loess Plains	255Ai	Texas Grand Prairie
231Bj	Jackson Hills	255Aj	Texas Western Cross Timbers
231Bk	Southern Pontotoc Ridge	255Ak	Southwestern Timbers
231Bl	Jackson Prairie	255Ba	Blackland Prairie
231Ca	Shale Hills and Mountain	255Ca	Texas Claypan Savannah
231Cb	Sandstone Plateau	255Cc	Interior Savannah
231Cc	Table Plateau	255Cd	Interior Blackland Prairie
231Cd	Sandstone Mountain	255Ce	Trinity Alluvial Valley
231Ce	Moulton Valley	255Cf	Blackland Prairie
231Cf	Southern Cumberland Valleys	255Cg	Southern Texas Claypan Savannah
231Cg	Sequatchie Valley	255Da	Texas Coastal Prairies
231Da	Chert Valley	255Db	Brazos and Brazonia Alluvial Valley
231Db	Sandstone-Shale and Chert Ridge	255Dc	Marshes-Inlands Bays-and Barrier Islands
231Dc	Sandstone Ridge	255Dd	Southern Texas Coastal Prairies and Savannah
231Dd	Quartzite and Talladega Slate Ridge	411Aa	Lake Okeechobee
231De	Shaley Limestone Valley	411Ab	Everglades
231Ea	South Central Arkansas	411Ac	Southern Slope
231Eb	Southwestern Arkansas	411Ad	Atlantic Coastal Ridge
231Ec	Ouachita Alluvial Valleys	411Ae	Coastal Lowlands-Tidal Marshes and Bays
231Ed	Sabine Alluvial Valley	411Af	Big Cypress Spur
231Ee	Southern Oklahoma Subsection	411Ag	Florida Keys and Biscayne Bay
231Ef	Piney Woods Transition	M221Aa	Ridge and Valley
231Eg	Sand Hills	M221Ab	Great Valley of Virginia
231Eh	Southern Loam Hills	M221Ba	Northern High Allegheny Mountains
231Ei	Southwest Flatwoods	M221Bd	Eastern Allegheny Mountain and Valley
231Ej	South Central Arkansas Flatwoods	M221Be	West Allegheny Mountain and Valley
231Ek	Southwestern Arkansas Blackland Prairies	M221Ca	Western Coal Fields
231El	Trinity Alluvial Valley	M221Cb	Eastern Coal Fields
231Em	Red River Alluvial Plain	M221Cc	Black Mountains
231En	East Texas Timberlands-Cross Timbers	M221Cd	Southern Cumberland Mountains
231Fa	Gulf Coast Praries	M221Ce	Pine and (The) Cumberland Mountain
231Fb	Marshes and Inland Bays	M221Da	Northern Blue Ridge Mountains
231Ga	Eastern Arkansas Valley and Ridges	M221Db	Central Blue Ridge Mountains
231Gb	Mount Magazine	M221Dc	Southern Blue Ridge Mountains
231Gc	Western Arkansas Valley and Ridges	M221Dd	Mestasedimentary Mountains
232Ad	Western Chesapeake Uplands	M222Aa	The Boston Mountain
232Ba	Fragipan Loam Hills	M222Ab	Boston Hills
232Bb	Southern Loessial Plains	M231Aa	Fourche Mountains
232Bc	Cintronelle Plains	M231Ab	West Central Ouachita Mountains
232Bd	Southern Deep Loess Hills and Bluffs	M231Ac	East Central Ouachita Mountains
232Be	Florida Northern Highlands	M231Ad	Athens Piedmont Plateau

Site Index Species and Site Index

The Southern Variant recognizes certain species as valid site index species. The variant also bounds the minimum and maximum site index values for all of the variant's species. Table 9 displays the species that are acceptable site index species (shaded) as well as the acceptable site index range for each species. These are the species that the Forest Inventory and Analysis Units for the Southern states recognized as valid site index species, and upon which other site index relationships are based (see Table 12 and the section on Site Index Transformations in this document). The site index curves are all based on total tree height and a base age of 50 years.

The variant uses default values if the model reads an invalid site index species and/or if a site index value is outside the acceptable range. If a species other than one of these is entered, the model defaults to white oak (WO) as the site index species. If a site index value outside the acceptable range is

detected, the model defaults to the minimum or the maximum value of the range, depending on whether the value is greater than or less than the range.

Table 9. – Valid site index species (shaded) and site index ranges for the Southern Variant's species.

			Site Index	
Numeric Code	**Character**	**Common name**	**Minimum**	**Maximum**
1	FR	fir sp.	15	100
2	JU	redcedar	15	70
3	PI	spruce	15	80
4	PU	sand pine	35	100
5	SP	shortleaf pine	35	105
6	SA	slash pine	35	105
7	SR	spruce pine	45	90
8	LL	longleaf pine	45	125
9	TM	Table Mountain pine	35	70
10	PP	pitch pine	25	95
11	PD	pond pine	35	105
12	WP	eastern white pine	40	135
13	LP	loblolly pine	40	125
14	VP	Virginia pine	35	95
15	BY	baldcypress	30	120
16	PC	pondcypress	30	120
17	HM	hemlock	35	90
18	FM	Florida maple	35	70
19	BE	boxelder	35	70
20	RM	red maple	35	85
21	SV	silver maple	30	105
22	SM	sugar maple	35	100
23	BU	buckeye, horsechestnut	25	90
24	BB	birch sp.	35	85
25	SB	sweet birch, black birch	35	70
26	AH	American hornbeam,	15	40
27	HI	hickory sp.	25	85
28	CA	catalpa	30	90
29	HB	hackberry sp.	15	90
30	RD	eastern redbud	15	40
31	DW	flowering dogwood	15	45
32	PS	common persimmon	15	70
33	AB	American beech	35	85
34	AS	ash	35	105
35	WA	white ash, American ash	35	95
36	BA	black ash	35	85
37	GA	green ash	35	105
38	HL	honeylocust	25	120
39	LB	loblolly-bay	15	50
40	HA	silverbell	15	65
41	HY	American holly	35	70
42	BN	butternut	35	85
43	WN	black walnut	35	85
44	SU	sweetgum	30	125
45	YP	yellow-poplar	30	135
46	MG	magnolia, sp.	35	125
47	CT	cucumbertree	25	115
48	MS	southern magnolia	35	125
49	MV	sweetbay	15	75
50	ML	bigleaf magnolia	35	125
51	AP	apple sp.	15	40
52	MB	mulberry sp.	15	55
53	WT	water tupelo	30	105
54	BG	blackgum, black tupelo	35	105
55	TS	swamp tupelo, swamp b.gum	35	95
56	HH	eastern hophornbeam,	15	40
57	SD	sourwood	15	70
58	RA	redbay	15	60
59	SY	sycamore	30	120
60	CW	cottonwood	40	125
61	BT	bigtooth aspen	30	90
62	BC	black cherry	35	105
63	WO	white oak	25	115

64	SO	scarlet oak	25	115
65	SK	southern red oak	25	115
66	CB	cherrybark oak, swamp red o.	30	125
67	TO	turkey oak	25	65
68	LK	laurel oak	25	65
69	OV	overcup oak	35	95
70	BJ	blackjack oak	25	65
71	SN	swamp chestnut oak	35	95
72	CK	chinkapin oak	35	75
73	WK	water oak	30	115
74	CO	chestnut oak	25	115
75	RO	northern red oak	25	115
76	QS	Shumard oak	15	125
77	PO	post oak	25	85
78	BO	black oak	25	115
79	LO	live oak	30	65
80	BK	black locust	25	95
81	WI	willow	15	110
82	SS	sassafras	15	80
83	BW	basswood	35	90
84	EL	elm	35	90
85	WE	winged elm	35	90
86	AE	American elm	35	90
87	RL	slippery elm	35	90
88	OS	Softwoods, Misc.	15	55
89	OH	Hardwoods, Misc.	15	55
90	OT	unknown or not listed	15	55

Forest Type

The Southern Variant is unique in how it uses forest type. The forest types that the model recognizes are from the Forest Inventory and Analysis Forest Type Algorithm (Arner, et. al. 1998). The variant calculates forest type from the stand's tree species density data using this algorithm. The calculation occurs every cycle. This feature simulates and summarizes the dynamic nature of stand composition.

Users have the option of accepting the variant's forest type calculations or directing the forest type algorithm to some degree. There are three possibilities:

1. The user can enter one of the valid 3-digit forest types in Table 10. In this case, the variant will use the forest type for the first cycle and calculate a forest type for all of the subsequent cycles.
2. The user can choose to override the forest type calculation feature totally by pre-pending another digit to the forest type codes in Table 10. The extra digit must be pre-pended to the valid 3-digit code. For example, entering "1103" as the forest type code for code 103 – eastern white pine. In this case, the model will use the eastern white pine forest type throughout the simulation.
3. The variant resorts to calculating forest type every cycle if the user does not enter forest type or enters an erroneous code. Table 11 shows a cross-reference between various forest type code systems.

There is a maximum Stand Density Index (SDI) and basal area associated with each of the forest types (Table 10). As the forest type changes, the maximum SDI changes. Users can specify maximum SDI or basal area using the SDIMAX or BAMAX keywords. This maximum will remain in effect until the forest type changes. (For further description of SDIMAX and BAMAX see the Mortality section in this document).

Table 10. – Forest Types of the Southern Variant

Forest Type Code	Forest Type Name	Stand Density Index Maximum *	Basal Area Maximum *
103	Eastern White pine	519	283
104	White pine/hemlock	534	291
105	Eastern Hemlock	458	250
121	Balsam fir	458	250
124	Red spruce/balsam fir	458	250
141	Longleaf pine	390	213
142	Slash pine	436	238
161	Loblolly pine	503	275

162	Shortleaf pine	504	275
163	Virginia pine	495	270
164	Sand pine	363	198
165	Table-mountain pine	413	225
166	Pond pine	475	259
167	Pitch pine	463	252
168	Spruce pine	352	192
181	Eastern redcedar	302	165
401	Eastern white pine/red oak/white ash	458	250
402	Eastern redcedar/hardwood	302	165
403	Longleaf pine/oak	360	196
404	Shortleaf pine/oak	476	259
405	Virginia pine/southern red oak	480	262
406	Loblolly pine/hardwood	476	259
407	Slash pine/hardwood	556	303
409	Other pine/hardwood	494	270
501	Post oak/blackjack oak	381	208
502	Chestnut oak	381	208
503	White oak/red oak/hickory	416	227
504	White oak	430	235
505	Northern red oak	400	218
506	Yellow-poplar/white oak/red oak	439	239
507	Sassafras/persimmon	500	272
508	Sweetgum/Yellow-poplar	441	240
510	Scarlet oak	358	195
511	Yellow poplar	455	248
512	Black walnut	404	220
513	Black locust	296	162
514	Southern scrub oak	302	165
515	Chestnut oak/black oak/scarlet oak	422	230
519	Red maple/oak	476	260
520	Mixed upland hardwoods	438	239
601	Swamp chestnut/cherrybark oak	396	216
602	Sweetgum-Nuttall-willow oak	462	252
605	Overcup oak/water hickory	425	232
606	Atlantic white cedar	302	165
607	Bald cypress/water tupelo	783	427
608	Sweetbay/swamp tupelo/red maple	627	342
701	Black ash/American elm/red maple	415	226
702	River birch/sycamore	421	230
703	Cottonwood	451	246
704	Willow	496	271
705	Sycamore/pecan/American elm	468	255
706	Sugarberry(hackberry)/elm/green ash	415	226
708	Red maple/lowland	447	244
801	Sugar maple/beech/yellow birch	458	250
802	Black cherry	323	176
803	Cherry/ash/yellow-poplar	457	249
805	Hard maple/basswood	486	265
807	Elm/ash/locust	413	225
809	Red maple/upland	554	302
999	Nonstocked	382	208

* Stand density and basal area maximums were derived from analysis of the Forest Inventory and Analysis Data.

Table 11.-Southern variant forest types cross-referenced to other applicable forest types.

FIA Forest Type Nat'l. Code 1/	Forest Type Name	SAF Forest Type Code*	East-wide Data Base Forest Type Code	Old South-East FIA Area Forest Type Code	FS Region 8 Forest Type Code
103	Eastern White pine	21	3	3	3
104	White pine/hemlock	22	4	4	4
105	Eastern Hemlock	23	5	5	5
121	Balsam fir	5	11	11	--
124	Red spruce/balsam fir	33	13	13	7
141	Longleaf pine	70	21	21	21
142	Slash pine	84	22	22	22
161	Loblolly pine	81	31	31	31
162	Shortleaf pine	75	32	32	32
163	Virginia pine	79	33	33	33
164	Sand pine	69	34	34	34
165	Table-mountain pine	45 *	39	39	39
166	Pond pine	98	36	36	36
167	Pitch pine	45	38	38	38
168	Spruce pine	82 *	37	37	37
181	Eastern redcedar (fr. species analysis)	46	35	35	35
401	Eastern white pine/red oak/white ash		41	41	9
402	Eastern redcedar/hardwood	46 *	42	42	11
403	Longleaf pine/oak	71	43	43	--
404	Shortleaf pine/oak	76	44	44	12
405	Virginia pine/southern red oak	78	45	45	16
406	Loblolly pine/hardwood	82	46	46	13
407	Slash pine/hardwood	85	47	47	14
409	Other pine/hardwood		49	49	--
501	Post oak/blackjack oak	40	51	51	51
502	Chestnut oak	44	52	52	52
503	White oak/red oak/hickory	52 *	53	53	53
504	White oak	53	54	54	54
505	Northern red oak	55	55	55	55
506	Yellow-poplar/white oak/red oak	59	56	56	56
507	Sassafras/persimmon	64	--	--	--
508	Sweetgum/Yellow-poplar	87	58	58	58
510	Scarlet oak	44 *	--	--	59
511	Yellow poplar	57	--	--	50
512	Black walnut		--	--	82
513	Black locust	50	--	--	88
514	Southern scrub oak	72	57	57	57
515	Chestnut oak/black oak/scarlet oak	44 *	--	--	60
519	Red maple/oak		--	--	--
520	Mixed upland hardwoods		59	59	--
601	Swamp chestnut/cherrybark oak	91	61	61	61
602	Sweetgum-Nuttall-willow oak	92	62	62	62
605	Overcup oak/water hickery	96	65	65	65
606	Atlantic white cedar (302 may be low)	97	66	66	66
607	Bald cypress/water tupelo	102	67	67	67
608	Sweetbay/swamp tupelo/red maple	104	68	68	68
701	Black ash/American elm/red maple	39	71	71	71
702	River birch/sycamore	61	72	72	72
703	Cottonwood	63	73	73	73
704	Willow	95	74	74	74
705	Sycamore/pecan/American elm	94	75	75	75
706	Sugarberry(hackberry)/elm/green ash	93	63	--	63
708	Red maple/lowland	108	--	--	--
801	Sugar maple/beech/yellow birch	25	81	81	81
802	Black cherry(p.599,AgHB654V.2)	28 *	--	--	70
803	Cherry/ash/yellow-poplar		--	--	--
805	Hard maple/basswood	26	--	--	--
807	Elm/ash/locust		--	--	--
809	Red maple/upland		--	--	--
999	Nonstocked		--	--	--

* Denotes SAF Forest Type that is inconsistent or nonstandard in relation to the National FIA coding system.
A blank entry or an -- entry indicates that no code exists in that system (that I'm aware of) for the Forest Type.
1/ Arner, et.al. 1998. Report from Stocking Committee, June 1996, with Modifications January 1998. Unpublished Report. Forest Inventory and Analysis, Northeastern Research Station, Newtown Square, PA.

V. Variant Relationships

Tree Height Dubbing

If some or all tree records in a FVS input tree list file have a height measurement missing, FVS will estimate the missing height using either the height-diameter relationships of the default Curtis-Arney equation (Curtis 1967,Arney 1985), or, the Wykoff equation (Wykoff et al. 1982:p.51) form. The only time the Wykoff equation is used to estimate missing heights is if the model goes through calibration, otherwise the Curtis-Arney equation form is used. The model will automatically calibrate height for a particular species if there are at least 3 height measurements for that species. This section describes the differences between these two approaches.

The equation for the Curtis Arney functional form, $f_{C\text{-}A}(D)$, is

$$Ht = 4.5 + p_2 e^{-p_3 D_{bh}^{p4}}$$

This functional form is used to compute total tree heights for trees three inches in dbh and larger. Coefficients used for each species are given in Table A2 in the appendix. For diameters less than three inches, the Curtis-Arney equation is combined with a simple linear equation. The equation becomes

$$Ht = 4.51 + \left\{ \frac{\left[4.5 + p_2 e^{-p_3 (3)^{p4}}\right] - 4.51}{3 - D_{BW}} \right\} * D$$

where: D_{BW} = nominal bud width diameter at 4.51 feet (see Appendix Table A2.)

Because of the nonlinear Curtis-Arney equation form, this equation is not calibrated in the manner described for the Wykoff equation described next.

The equation for the Wykoff functional form is:

$$Ht = 4.5 + e^{b_0 + b_1 \left(\frac{1}{D_{bh} + 1} \right)}$$

This equation can be fit to data for a given species with usual linear regression techniques using a linear transformation, which is

$$\ln(Ht - 4.5) = b_0 + b_1 \left(\frac{1}{D_{bh} + 1} \right);$$

The ln term becomes the dependent variable, say y, and the fraction factor with D_{bh} becomes the independent variable, say x, so that the linear form is $y = b_0 + b_1 x$. See Appendix Table A3, for species coefficients.

For the case where three or more trees of a given species have measured heights, it is then possible to re-estimate or calibrate the intercept coefficient b_0 so that the equations vertical position, but not its slope, is adjusted to better fit the local tree height/diameter relationship.

Crown width

Crown width information was gleaned from a variety of sources. Unfortunately, given the 90 species in this variant, information specific to each species seems scarce. Thus, many species have their crown width computed based on the relationship for another species mapped to it. The details for each species are contained in appendix Table 4, which has equation coefficients, mappings, specific literature citations, and some miscellaneous notes.
The equation functional form for all the crown width relationships is

$$CW = b_0 + b_1 * dbh^{b_2}$$

Depending on the species, all of the coefficients are not necessarily used. The crown width relationships are drawn from both forest-grown and open-grown situations depending on what was available and judged usable.

Site Index Transformation

Site index is used as an independent variable in diameter growth relationships, and various other growth functions. Thus, site index or a site index surrogate is needed for each and every species contained in the variant. Since each plot or stand usually has but one site index species, a transformation is needed to infer a site index number for the other species in the plot. The foundation references for this transformation process in the southern variant are Doolittle's (1958) site index comparison for several species in the southern Appalachians and site index equivalency tables (USDA Forest Service 1992) for key site index species in the southern Piedmont and mountains.
Between these two references, the following key species are covered:

Mountains	Piedmont
Yellow-poplar	Yellow-poplar
White oak	White oak
Black oak	Black oak
Northern red oak	Northern red oak
Scarlet oak	Scarlet oak
Shortleaf pine	Shortleaf pine
Chestnut oak	Southern red oak
Pitch pine	
Virginia pine	
Eastern white pine	

Thanks to the references just mentioned, any site index for one of these species can be relatively rigorously transformed into a site index for another of the above species.

However the list of site index species that could be used across the south is much longer than those species shown above. Given data from diverse ownerships, forest types, and locations, the expanded list of legitimate site index species including those above, is shown in Table 12. The same figure shows also the mapping of all non-site index species. All of the non-site species are mapped to 802 (white oak) to provide consistency for the relative site index computation that provides a specific site index number for each species. This does not mean that any or all non-site index species, especially smaller species such as dogwood, assume the same site index number as white oak. All species are assigned a site index number consistent with their size and place in the forest height hierarchy. The details of this computation are described in the section on height growth.

Table 12.-Southern variant site index transformation mappings.

SOUTHERN VARIANT SPECIES LIST--SITE INDEX TRANSFORM MAPPINGS									
Species Identification						Note: Other Upland Oaks = 806, 833, 837			
							Extended Site	Each Estended List	Each of the
Species						Key Primary	Species List	Site Species is	Non-Site Index Species
Code	SN Number	SN Character	Common name	Genus	Species	Site Species	(incl. Primary Sp.)	Mapped to	Species is Mapped to
010	1	FR	fir sp.	Abies	sp.		010	132	
060	2	JU	redcedar	Juniperus	sp.		060	132	
090	3	PI	spruce	Picea	sp.		090	132	
107	4	PU	sand pine	Pinus	clausa		107	132	
110	5	SP	shortleaf pine	Pinus	echinata	110	110	110	
111	6	SA	slash pine	Pinus	elliottii		111	110	
115	7	SR	spruce pine	Pinus	glabra		115	132	
121	8	LL	longleaf pine	Pinus	palustris		121	129	
123	9	TM	Table Mountain pine	Pinus	pungens				802
126	10	PP	pitch pine	Pinus	rigida	126	126	126	
128	11	PD	pond pine	Pinus	serotina		128	110	
129	12	WP	eastern white pine	Pinus	strobus	129	129	129	
131	13	LP	loblolly pine	Pinus	taeda		131	129	
132	14	VP	Virginia pine	Pinus	virginiana	132	132	132	
221	15	BY	baldcypress	Taxodium	distichum		221	621	
222	16	PC	pondcypress	Taxodium	distichum var. nutans		222	621	
260	17	HM	hemlock	Tsuga	sp.		260	110	
311	18	FM	Florida maple	Acer	barbatum				802
313	19	BE	boxelder	Acer	negundo				802
316	20	RM	red maple	Acer	rubrum		316	802	
317	21	SV	silver maple	Acer	saccharinum				802
318	22	SM	sugar maple	Acer	saccharum		318	802	
330	23	BU	buckeye, horsechestnut	Aesculus	sp.				802
370	24	BB	birch sp.	Betula	sp.		370	802	
372	25	SB	sweet birch, black birch	Betula	lenta		372	802	
391	26	AH	American hornbeam,	Carpinus	caroliniana				802
400	27	HI	hickory sp.	Carya	sp.				802
450	28	CA	catalpa	Catalpa	sp.				802
460	29	HB	hackberry sp.	Celtis	sp.				802
471	30	RD	eastern redbud	Cercis	canadensis				802
491	31	DW	flowering dogwood	Cornus	florida				802
521	32	PS	common persimmon	Diospyros	virginiana				802
531	33	AB	American beech	Fagus	grandifolia		531	802	
540	34	AS	ash	Fraxinus	sp.		540	812	
541	35	WA	white ash, American ash	Fraxinus	americana		541	806, 833, 837	
543	36	BA	black ash	Fraxinus	nigra				802
544	37	GA	green ash	Fraxinus	pennsylvanica				802
552	38	HL	honeylocust	Gleditsia	triacanthos				802
555	39	LB	loblolly-bay	Gordonia	lasianthus				802
580	40	HA	silverbell	Halesia	sp.				802
591	41	HY	American holly	Ilex	opaca				802
601	42	BN	butternut	Juglans	cinerea				802
602	43	WN	black walnut	Juglans	nigra				802
611	44	SU	sweetgum	Liquidambar	styraciflua		611	621	
621	45	YP	yellow-poplar	Liriodendron	tulipifera	621	621	621	
650	46	MG	magnolia sp.	Magnolia	sp.				802
651	47	CT	cucumbertree	Magnolia	acuminata		651	806, 833, 837	
652	48	MS	southern magnolia	Magnolia	grandiflora				802
653	49	MV	sweetbay	Magnolia	virginiana				802
654	50	ML	bigleaf magnolia	Magnolia	macrophylla				802
660	51	AP	apple sp.	Malus	sp.				802
680	52	MB	mulberry sp.	Morus	sp.				802
691	53	WT	water tupelo	Nyssa	aquatica				802
693	54	BG	blackgum, black tupelo	Nyssa	sylvatica				802
694	55	TS	swamp tupelo, swamp b.gum	Nyssa	sylvatica var. biflora				802
701	56	HH	eastern hophornbeam,	Ostrya	virginiana				802
711	57	SD	sourwood	Oxydendrum	arboreum				802
721	58	RA	redbay	Persea	borbonia				802
731	59	SY	sycamore	Platanus	occidentalis		731	621	
740	60	CW	cottonwood	Populus	sp.		740	802	
743	61	BT	bigtooth aspen	Populus	grandidentata		743	812	
762	62	BC	black cherry	Prunus	serotina		762	802	
802	63	WO	white oak	Quercus	alba	802	802	802	
806	64	SO	scarlet oak	Quercus	coccinea	806	806	806, 833, 837	
812	65	SK	southern red oak	Quercus	falcata var. falcata	812	812	812	
813	66	CB	cherrybark oak, swamp red o.	Quercus	falcata		813	802	
819	67	TO	turkey oak	Quercus	laevis				802
820	68	LK	laurel oak	Quercus	laurifolia				802
822	69	OV	overcup oak	Quercus	lyrata		822	802	
824	70	BJ	blackjack oak	Quercus	marilandica				802
825	71	SN	swamp chestnut oak	Quercus	michauxii		825	802	
826	72	CK	chinkapin oak	Quercus	muehlenbergii				802
827	73	WK	water oak	Quercus	nigra		827	802	
832	74	CO	chestnut oak	Quercus	prinus	832	832	832	
833	75	RO	northern red oak	Quercus	rubra	833	833	806, 833, 837	
834	76	QS	Shumard oak	Quercus	shumardii		834	621	
835	77	PO	post oak	Quercus	stellata				802
837	78	BO	black oak	Quercus	velutina	837	837	806, 833, 837	
838	79	LO	live oak	Quercus	virginiana				802
901	80	BK	black locust	Robinia	psuedoacacia				802
920	81	WI	willow	Salix	sp.				802
931	82	SS	sassafras	Sassafras	albidum				802
950	83	BW	basswood	Tilia	sp.		950	802	
970	84	EL	elm	Ulmus	sp.				802
971	85	WE	winged elm	Ulmus	alata				802
972	86	AE	American elm	Ulmus	americana				802
975	87	RL	slippery elm	Ulmus	rubra		975	812	
001	88	OS	SOFTWOODS, MISC.						132
004	89	OH	HARDWOODS, MISC.						802
999	90	OT	unknown or not listed						802

Large Tree Diameter Growth Relationships

The concept for the large tree diameter regression originates in the work of Stage and others relating to the original Prognosis model for the Inland Empire (Stage 1973, p.15; Wykoff, Crookston, and Stage 1982, pp.53-62; Wykoff 1990). In general those factors thought to be influential in tree diameter growth fall into several categories. First is the category relating to the individual tree itself which consists of tree current diameter, height, and crown ratio. The second category relates to aggregate attributes of the tree's neighbors. In most cases this consists of stand or plot measures such as basal area per acre, basal area contained in all trees with larger diameter than the subject tree, and proportional height of the tree relative to the average height of the largest diameter trees in the stand. The third category relates to the site environment surrounding the tree. These factors are site index (or some similar fundamental measure of the site's productivity), the slope and aspect of the site, the site's forest type, and the site's general location relative to the geographic range of all sites included in the variant.

The dependent variable whose value is directly determined by regression using some or all of the independent variables is not diameter inside bark, but rather the natural log of a quantity labeled dds. Dds has units of inches-squared (basal area) and is defined as (Wykoff, Crookston, and Stage 1982, p.53)

$$dds = (dib + dg)^2 - dib^2$$

where, dds is change in squared inside-bark diameter (inches squared) during the estimation period (the FVS cycle time interval); dib is diameter inside-bark (inches) at the beginning of the estimation time period; and dg is incremental change in inside-bark diameter (inches) during the estimation period.

After dds has been estimated for a given tree record, it is modified slightly by a random component based on variation in the original data, and by a factor related to the expected decrease in diameter growth of large trees as they mature to senescence. This last effect (senescence) is not accounted for directly in the regression due to the relative scarcity of data for large older trees. Once the dds is predicted and modified, the estimated value of diameter growth inside bark, dg, can be found by solving the dds definition equation above for dg, the result being

$$dg = (dib^2 + dds)^{1/2} - dib$$

In order to predict dds, the functional form of the regression is

$$dds = e^{f(\text{tree, stand, environment, and management variables})}$$

To use this equation as the basis for a linear regression, the natural log is taken of both sides which result in the form shown next. A description of each term is provided to the right and more detail about each term is given after the functional form below. Tables with results and information about the regression (Table A5)and senescence analysis (Table A6) for each species are given in the appendix.

ln(dds)	=	b_0		{intercept--equation constant, modified by categorical variables;
Individual tree variables		+	b_1 * lndbh	natural log of dbh (at beginning of estimation period);
		+	b_2 * dbh2	squared dbh;
		+	b_3 * lncrwn	natural log of percent crown ratio;
Site/stand/plot neighboring tree variables		+	b_4 * hrel	relative height (see below)
		+	b_5 * isiown	site index for the species (see section on site index);
		+	+b_6 * plttbac	plot basal area per acre;
		+	b_7 * pntbalcx	plot basal area in trees larger than subject tree (see below);
Surrounding environment variables		+	b_8 * tanslp	tangent of slope in degrees;
		+	b_9 * fcos	function of slope and cosine of aspect (see below);
		+	b_{10} * fsin	function of slope sine of aspect (see below);
		+	b_{11} * fortype	categorical variable for forest type group (see below);
Management variables		+	b_{12} * ecounit	categorical variable for ecological unit group (see below);
		+	b_{13} * plant	categorical variable (non zero for 5 species) for planted stands.

Diameter at breast height

Dbh at the beginning of each projection cycle is usually the strongest single statistical determinant of diameter growth during the cycle. Using the natural log form, $y = \ln(x)$, where x = dbh, current diameter provides a functional contribution to incremental diameter squared growth that increases, but at a decreasing rate. The second term involving diameter is diameter squared, as in $y = x^2$. The contribution of this term is should always be negative so that as diameter increases, this term acts a "brake" to the increasing effect from the natural log term. In addition, from a purely statistical regression point of view, the algebraic form of these two terms, both involving diameter, reduces greatly the effects of multicollinearity between the two terms.

Crown ratio

Crown ratio is a surrogate measure of tree vigor. In general for most species, increasing crown ratio provides for increasing ability to generate needed nutrients. At some level of crown ratio, depending on species, the crown's ability to contribute nutrients and gas exchange to tree growth is probably matched by the need for nutrients to maintain increasing crown size. Thus, open grown trees with nearly full 100 percent crowns likely do not grow in height or diameter as fast as similarly aged trees in forest settings. The functional term for crown ratio, $y = \ln(x)$, provides an increasing contribution to dds, but at a decreasing rate. This relationship attempts to capture the growth contribution effect of crown ratio.

Relative height

Relative height is defined as the ratio of the subject tree's height to the average height of the per-acre 40 largest diameter trees. The per-acre 40 largest tree heights are taken from the tree list starting with the largest diameter tree, as expanded by trees per acre and including heights of successively lesser diameter trees until a total of 40 trees is included. The heights of these 40 trees are then averaged. The intent of this measure is to capture effects due to canopy competition primarily in terms of light availability, but also due to physical contact (e.g., Oliver and Larson 1990, pp. 207-213).

Site index

Site index is a surrogate variable integrating a variety of effects relating primarily to soil, but also including secondary land form, climate, and water availability

Plot/stand total basal area per acre

This variable directly relates to overall competition and demand for resources by all trees on the site.

Basal area in trees larger

A tree's size relative to neighboring trees also affects its ability to capture resources. Basal area in larger trees (BAL) is a surrogate measure of how much biomass exists in trees with a larger diameter than the subject tree. The most applicable expression of this quantity relates to trees in the immediate vicinity of the subject tree, and the effect from neighboring trees is expected to diminish, all other things equal, as these neighboring trees become farther removed from the subject tree. The metric for this variable is based on a hybrid computation that integrates the point-based total basal area at the point and the diameter distribution of the plot as a whole (Stage and Wykoff 1998, pp. 226-7). In their formulation

$$PBAL = (1.0 - p_{\%\text{-ile}}) * PBA$$

where PBAL is point basal-area-larger; PBA is point total basal area per acre (as distinguished from total stand basal area); and $p_{\%\text{-ile}}$ is the percentile position of the subject tree in the diameter distribution based on the inventory list of all trees on all points in the stand. By using this hybrid point/plot format, the resulting basal area larger has the advantages of being based on the basal area of those trees nearest the subject tree, and at the same time is positioned in a distribution of tree sizes based on a much larger number of trees than are typically found in most inventory points within plots.

Function of slope and aspect

Slope determines in part soil thickness, light availability for part of the tree crown, and water availability effects. The measure of slope used here is the tangent, for example, as in y = tan(x). Slope effects are important in their own right, and as contributing parts of composite slope and aspect variables, fcos and fsin. The function fcos is defined as fcos = tanslp * cos(aspect in degrees), and similarly, the function fsin is defined as fsin=tanslp * sin(aspect in degrees). The intent of both these functions is to capture effects due to exposure to weather and sunlight that depend on slope and aspect (Stage 1973; Wykoff et al. 1982, p.59).

Forest type group

Many tree species in the eastern United States grow with a wide variety of other species, depending on a wide variety and combination of circumstances. For example, the same tree species, all other things equal except growing in two different forest types, might receive different amounts of light because of the different mix of neighboring trees and their respective crown shapes, leaf sizes and densities. These differing circumstances likely affect tree diameter growth in many complex ways. Using forest type attempts to integrate such larger scale forest effects. In fact, this variable is not specifically forest type, but rather one of 11 groups of similar forest types. The forest types that are used in the Southern Variant are defined by Arner et al. (1998) and in turn are based almost entirely on forest types defined by the Society of American Foresters (Arner et al. 1998, p. 18; Eyre 1980). Forest type groups used in the FVS Southern variant, and their respective constituent forest types are shown here.

Lowland hardwoods group (FTLOHD)			
168	Spruce pine	608	Sweetbay/Swamp tupelo/Red maple
508	Sweetgum/Yellow-poplar	702	River birch/Sycamore
601	Swamp chestnut/Cherrybark oak	703	Cottonwood
602	Sweetgum/Nuttall oak/Willow oak	704	Willow
605	Overcup oak/Water hickory	705	Sycamore/Pecan/American elm
606	Atlantic white-cedar	706	Sugarberry/Hackberry/Elm/Green ash
607	Bald cypress/Water tupelo	708	Red maple/Lowland species
Northern hardwoods group (FTNOHD)			
701	Black ash/American elm/Red maple	805	Hard maple/Basswood
801	Sugar maple/Beech/Yellow birch		
Oak-pine group (FTOKPN)			
165	Table-mountain pine	406	Loblolly pine/Hardwood
403	Longleaf pine/Oak	407	Slash pine/Hardwood
404	Shortleaf pine/Oak	409	Other pine/Hardwood
405	Virginia pine/Southern red oak		
Spruce-fir-hemlock-pine group (FTSFHP)			
104	Eastern white pine/Hemlock	121	Balsam fir
105	Eastern hemlock	124	Red spruce/Balsam fir
Upland hardwoods group (FTUPHD)			
103	Eastern white pine	512	Black walnut
167	Pitch pine	513	Black locust
181	Eastern redcedar	519	Red maple/Oak
401	Eastern white pine/Red oak/White ash	520	Mixed upland hardwoods
402	Eastern redcedar/Hardwood	802	Black cherry
506	Yellow-poplar/White oak/Red oak	807	Elm/Ash/Locust
511	Yellow-poplar	809	Red maple/Upland species
Upland oak group (FTUPOK)			
501	Post oak/Blackjack oak	505	Northern red oak
502	Chestnut oak	510	Scarlet oak
503	White oak/Red oak/Hickory	514	Southern scrub oak
504	White oak	515	Chestnut oak/Black oak/Scarlet oak
Yellow pine group (FTYLPN)			
141	Longleaf pine	163	Virginia pine
142	Slash pine	164	Sand pine
161	Loblolly pine	166	Pond pine
162	Shortleaf pine		

The inclusion of the Eastern white pine/Hemlock forest type in the Spruce-Fir-Hemlock-Pine Forest Type Group, and of the Eastern white pine, Pitch pine, and Eastern redcedar forest types in the Upland Hardwoods Forest Type Group, is judgmental based on the ecological descriptions of these types in Eyre (1980).

Ecological land unit

Past experience with developing FVS variants has shown that large scale land areas often have correlative effects upon tree diameter growth. In the west, the large scale areas are usually defined National Forests, or occasionally Ranger Districts. Using National Forests in the eastern United States is more problematic because, unlike most of the interior West, forest cover in the east covers vast acreages not included in the (for the most part) sparsely established and usually noncontiguous National Forest land. Large scale effects likely incorporate climate, geologic history, and geomorphological land form and soil taxa. These are some of the factors included in the classification of land in the eastern US into Ecological Units (Keys et al. 1995). The Ecological Units (EUCs) are hierarchical starting at the largest scale with Domain, and splitting into successively smaller units of Division, Province, Section, and Subsection. Subsectional EUs number in the hundreds (Table 8). At this time without further evidence, including Subsectional or even Sectional EUs as categorical variables would seem to be too

fine a scale to resolve differences in tree diameter growth variation. On a strictly judgment basis, the level of EUs included in the Southern variant is at the Province level, with one Province split in two. The list of Provinces is shown below along with notes explaining the one split Province. If further research and/or evidence shows that tree growth differences are distinguishable at these finer scales, such results can be fit into the growth relationships at that time.

FVS Province Code	EU Province Code and Name (Keys et al. 1995)	
PVM221	M221	Central Appalachian Broadleaf - Coniferous Forest Meadow
PVM222	M222	Ozark Broadleaf Forest - Meadow
PVM231	M231	Ouachita Mixed Forest - Meadow
PVP221	221	Eastern Broadleaf Forest (Oceanic)
PVP222	222	Eastern Broadleaf Forest (Continental)
PVP231A	231	Southeastern Mixed Forest (FVS Atlantic Piedmont)
	A	Southern Appalachian Piedmont Section
	C	Southern Cumberland Plateau Section
	D	Southern Ridge and Valley Section
PVP231B	231	Southeastern Mixed Forest (FVS Gulf Piedmont/Plains)
	B	Coastal Plain Middle Section
	E	Middle Coastal Plains, Western Section
	F	Eastern Gulf Prairies and Marshes Section
	G	Arkansas Valley Section
PVP232	232	Outer Coastal Plain Mixed Forest
PVP234	234	Lower Mississippi Riverine Forest
PVP255	255	Prairie Parkland (Subtropical)
PVP411	411	Everglades

The Southeast Mixed Forest Province is split for FVS purposes into Atlantic and Gulf parts because it seemed that tree growth might be different due to mountain and ocean influence in the Atlantic part, and mainly Gulf influence in the Gulf part. As stated previously, this is strictly a judgment call. Further research could and should be done to either verify these divisions, or classify tree growth variations on some other split of the hierarchy. Classification and regression tree approaches might be useful for this task (Breiman et al. 1984; De' Ath and Fabricius 2000)

Management and plantations

Because the vast majority of data was derived from southern USDA Forest Service FIA sources, as compiled in an Eastwide Data Base (Hansen et al. 1992), one variable in that data base dealt with stand/plot origin as being either Natural or Planted. The assumption used in developing this FVS regression categorical variable is that a Planted stand implies some type of management over and above that done for most Natural stands. Five species out of the 90 in the Southern variant have enough data that includes this variable so that a "management" option is included for sand pine, slash pine, longleaf pine, eastern white pine, and loblolly pine. Unfortunately, not enough data was available for shortleaf pine.

Large Tree Diameter Growth – Bounding Function

During data analysis and regression fitting for the diameter growth model, it became apparent that data for most species was concentrated between small to medium large trees. Data for trees in the very large size classes, given the size range for each respective species, was generally lacking. Thus, given the nature of statistical regression analysis, even weighted analysis, it seemed desirable to establish probable upper size limits for diameter growth and an algorithm for dealing with growth rates for very large trees. The approach taken for the southern variant was to look at two sources of information, the data itself plus, from the literature, mature tree size ranges and maximum sizes.

From the data for each species a percentile table shows the diameter for that species that corresponds to a specific percentile. This presentation format is much like the percentile format used in FVS Stand Composition Table. For example in Appendix Table 6, consider loblolly pine. The number of observations is 92781. Of these, 67 percent are below 11.6 inches, (and of course 33 percent are above 11.6 inches), 95 percent of the observations are below 19.6 inches, and 100 percent of the observations are below 49.5 inches, i.e., 49.5 inches is the size of the maximum tree in the data set. Also in Appendix Table 6, tree sizes are listed as taken from the literature for mature trees and maximum trees (Harlow and Harrar 1968; Burns and Honkala 1990).

The bounding function is applied using the following concepts. For a tree with projected diameter less than the lower diameter bounding limit (see Appendix Table 6, the column second from right), the computed diameter growth is not modified (or arithmetically, the bounding function result is 1.0 and this multiplies the computed growth rate). At the high end of the diameter bounding limits and beyond, the growth rate is multiplied by 0.1. For the range from the low diameter to the high diameter, the bounding function is computed as

$$Dgbmod = 1.0 - 0.9*[(dbh - dbh_{Low}) / (dbh_{High} - dbh_{Low})];$$

where Dgbmod is Diameter Growth Bound Modifier, dbh is tree diameter, and dbh_{Low} and dbh_{High} are the values from Appendix Table 6 for the given species. The value 0.1 represents "best judgment" about the general nature of tree diameter growth for very large, old trees. It is certainly possible that in particular circumstances individual aged trees may still grow faster than what is portrayed here. However, lacking any hard evidence about definitive relationships for trees approaching senescence, this approach is suggested by the data and the tree growth literature. If research is available showing diameter growth relationships for aged, very large trees of the species in this variant, perhaps it could be incorporated into the variant if it fits the format described here.

Height Growth

Logic for large tree height growth estimation follows the approach of Wensel et al. (1987). The two main analytical concepts consist of determining the height growth of every tree as if it were a "best" tree, i.e., a site-type tree, and then determining a modifying factor to be applied which reflects the reduction of "best" height growth in response to own-tree vigor, effects from neighboring trees, and site-related factors.

The most available type of information about height growth of particular tree species is contained in either site index or height growth curves and equations, which depict the relationship between tree age, height, and site index with either height or site index as the dependent variable. Curtis et al (1974) discuss valid technical differences between the two formulations (site index vs. height growth), and why and when it is important to be aware of these differences. However, they conclude in part that "it does not, of course, necessarily follow that these distinctions will always be important in a practical sense". Thus, for our purposes, we consider site curves and height growth curves and corresponding mathematical relationships interchangeably, and regard them both as models of height growth suitable for use in FVS.
The source of height growth/site index information about many of the 90 species (groups) in the Southern variant was facilitated by use of an "anthology" of site/height curves, each with a consistent accompanying mathematical functional form (Carmean, et al. 1989). The functional form for the height growth curve is

$$H = BH + b_1 S^{b_2} (1 - e^{b_3 A})^{b_4 S^{b_5}}$$

In this equation the term for breast height has the value either BH=0 when A is total age and B=4.5 when A is breast-height age. Since all the height growth relationships from Carmean (1989) are based on total tree age, the BH term could effectively be deleted, but is shown here for completeness. This equation is a form of the Chapman-Richards nonlinear function used by Monserud and Ek (1976).

One trait of sigmoid curves including the Chapman Richards function is that they have an asymptote such that the dependent variable approaches but never exceeds the asymptotic value. For our use, we need to know if the measured height of any given tree, given the local site index, exceeds the computed asymptotic maximum height of that tree for any age. For the height function above, the asymptotic maximum value is determined by letting age A approach an arbitrarily large value to be considered as infinity. In that instance the functional form for height becomes (assuming BH=0 for height growth based on total tree age, and given that coefficient b_3 is always < 0)

$$H_{\max} = b_1 S^{b_2}$$

If the measured height is greater than the calculated asymptotic height value, termed maximum height, then this tree is considered to have reached mature height and its height growth is set at 0.1 foot.

Another vital piece of information needed to use this approach is the effective age of the subject tree at the start of the FVS projection. This is not its actual age, which is unknown by FVS. Rather, effective age is simply a time accounting basis determined by knowing the site index and the tree's height. The height equation is solved for effective age, A_{EFF} (again letting BH=0)

$$A_{EFF} = \frac{1}{b_3} \ln \left[1 - \left(\frac{H - BH}{b_1 S^{b_2}} \right)^{\frac{1}{b_4 S^{b_5}}} \right]$$

For most trees in the Southern variant, the routine height growth calculation starts by adding to the current time five years (the default time interval per cycle), and recalculating the estimated "best tree" height five years hence. The "best tree" height growth is obtained by subtracting the trees current height from the estimated future height. It is the "best tree" height growth just calculated that is modified to reflect the tree's vigor, and its competitive position relative to other trees. Height growth is adjusted to cycle length if the user has specified a length other than 5 years. Site and other environmental factors are already taken into account in the site based Chapman-Richards function (Carmean et al. 1989). The Appendix Table A7 contains Chapman-Richards function coefficients for each species in the Southern FVS variant, along with information about "mappings" for species without curves in Carmean, and the maximum and minimum site index values used in the variant.

The number tree species that qualify as "site species" is slightly less than half the number of species in the Southern variant. Each site species was mapped to one of the "master group", as explained in an earlier section, so that no matter what species might ultimately be used as a site species, the site index could be converted to some equivalent for other species. That brings up the question of what about the roughly half of species in the Southern variant that are not considered as "site-species", and why do these species need a site index number attached to them? The reason is tree species not in the expanded site index group (the "other half-plus") also need a height growth model for the "best" trees of the respective species. In other words, every species in the variant needs a height growth estimation model.

The height growth model for each of these species is found by mapping the species to an existing height growth curve. For example, eastern hophornbeam is a "non-site species", and it needs a height growth curve. If this species is mapped to white oak, it is not to say that hophornbeam will achieve white oak height. The only intention of the mapping is that the general mathematical properties of the white oak

equation (for example curve shape) may be suitable for hophornbeam. In order to make sure that the full effect of the white oak height growth equation is not applied to hophornbeam, the relative site index concept is used. In this approach first compute the valid relative site index number for white oak. Assume that white oak site index is 80, and that the range of valid site index curves goes from 50 to 110), Then the relative site index for white oak is defined as = (110-80)/(110-50) = 0.5.

The next step is to use the white oak relative site index to get a site index number for hophornbeam. First, a valid range of "best" tree heights for hophornbeam is needed. For most species this information can be gleaned from the species write-ups in Agriculture Handbook 654, Silvics of North America (Burns and Honkala 1990). The intention is to get some estimate of maximum and minimum heights for a species, in this example hophornbeam. Next, given the mathematical properties of the Chapman-Richards functions Carmean (1989) uses, if one assumes that the maximum height came from a "best" tree growing to very old age on the maximum site for the species, then you can get a rough estimate of what the site number would have to be to make that maximum happen. That number becomes the maximum "site index" number for hophornbeam. (Notice here the quotes around site index. As used in this application, this number is simply a metric used as an independent variable in a height growth equation; it is not a site index in the strict classical forestry sense.) Likewise, a minimum "site index" for the species can be estimated. These maximum and minimum values then define the working range for a realistic estimate of hophornbeam height growth. The specific hophornbeam "site index" value is computed from the same relative index as white oak. For example, if the maximum and minimum hophornbeam values are 30 and 5, and the relative height/site index value is 0.5 (as calculated above), then the hophornbeam site/height index is 5 + (30-5)*(0.5) = 17.5. This is the site number, along with the appropriate time variable, that is entered into the selected height growth equation (in our example, white oak, or alternatively, whichever species equation is deemed suitable for hophornbeam) and height is thus computed within a range of heights that is appropriate for hophornbeam.

Height growth modifying functions

Following the conceptual example of two articles (Ritchie and Hann 1986, Wensel et al. 1987), it is assumed that a useful modifying function would be composed of two parts, one related to tree vigor as expressed by crown ratio, and the other related to neighboring tree competition as depicted by an expression of relative height. The relationships of crown ratio and neighboring tree competition were used to derive the height modifying functions for the Southern variant.

Based on crown ratio:
Scatter plots of tree height growth (y-axis) versus crown ratio (x-axis) for southern data often show an “envelope” upper limit that first increases with crown ratio, then peaks over a broad range from about 40% to 75%, and then decreases somewhat as crown ratio nears 100%. Based on these observations, the assumption is made that when tree crown ratios exceed some upper limit (and this probably varies by species), height growth is reduced. Perhaps this occurs because more photosynthate is used for crown maintenance, and less for terminal leader extension. Oliver and Larson (1990:pp. 75-76) suggest such possibilities in a list of priority uses by the tree for photosynthate. In any case, based on its presence in the data, this relationship is incorporated into a crown ratio modifying factor for tree height growth.

At present, the crown ratio modifying function is simply one relationship for all species. The functional form is based on Hoerl’s Special Function (HSF) (Cuthbert and Wood 1971:p.23).

$$y = ax^b(e^{cx})$$

where y is the modifier value based on tree crown ratio and is constrained to the range {0, 1}; x is the tree crown ratio expressed as a proportion. Its graph is shown in Figure 3. The particular parameters for Hoerl’s function are chosen so that it mimics the increasing height growth with increasing crown ratio

up to crown ratios of about 40-50%. From that point the function exhibits a fairly broad maximum to a crown ratio range of about 70-75%, followed by a decline to a value of about 0.65 at 100% crown ratio. In addition, although the HSF coefficients used result in a segment of the curve slightly greater than 1.0, its use in the Southern Variant is constrained to be equal to or less than 1.0, as shown in the accompanying graph.

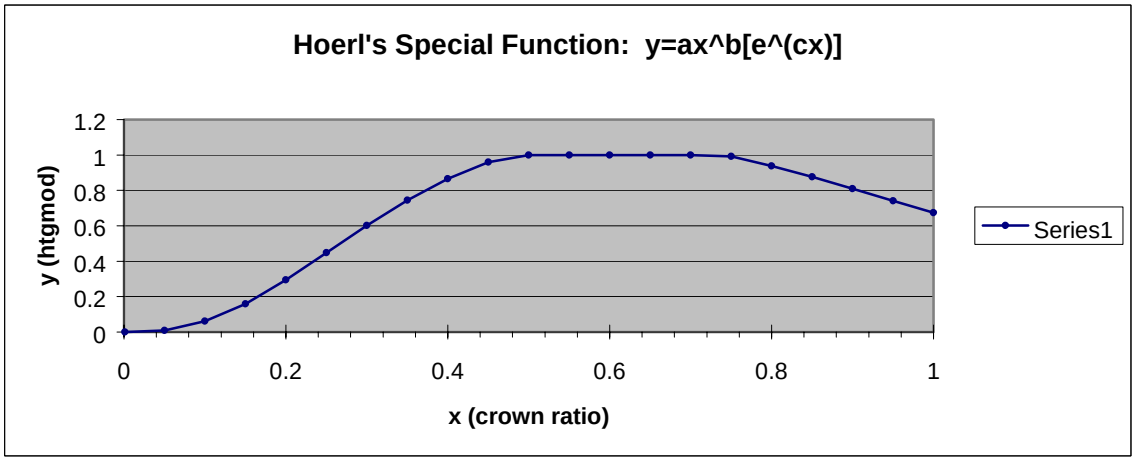

Figure 3.-Height Growth Modifying Function Based on Crown Ratio.

To improve this approach in future versions of the model, Hoerl's function (or another function with the same properties) should be fit so that species, or species group differences in the maximum peak position and shape would be reflected. Also, an analysis should be done to explore the assumption about larger crown ratio associated with moderately reduced height growth.

Based on competition (relative height):
Trees receiving substantial overhead light and adequate side light are those whose crowns have captured space in and above the general crown level or small trees that have taken advantage in canopy gaps, i.e., the dominant and codominant trees whose population furnishes individuals for consideration as site trees. These site-type trees are considered to have height growth at or close to the maximum rates implied by site-based height growth curves. For crowns of trees in the intermediate and suppressed categories, available light decreases accordingly, and height growth decreases along with other growth functions, assuming trees of identical shade tolerance. However, in these respective lower crown class positions, tree species with increasing shade tolerance would also have an increasing competitive advantage. These well known relationships between height growth, relative height, and shade tolerance are also discussed in depth by Oliver and Larson (1990:pp.69-88).

In order to capture these relationships mathematically, the Generalized Chapman-Richards function (GCRF) has five parameters to interactively adjust starting value, slope, and inflection point in accordance with the needs of the modeling task. This GCRF is summarized in Donnelly and Betters (1991) and described more thoroughly in Donnelly et al. (1992). The GCRF is based on a differential equation developed by Pienaar and Turnbull (1973) that has an additional factor, x^{-b}, to attenuate growth of the dependent variable. The differential equation is

$$\frac{dy}{dx} = \frac{rx^{-b}y}{m-1}\left[1-\left(\frac{y}{k}\right)^{m-1}\right]$$

with an initial condition of $y(x_s) = y_{xs}$and the resulting solution function obtained using separation of variables is

$$y = k\left\{1 + \left[\left(\frac{k}{y(x_s)}\right)^{m-1} - 1\right] e^{-\frac{r}{1-b}\left(x^{1-b} - x_s^{1-b}\right)}\right\}^{-\frac{1}{m-1}}$$

where the parameters are k, x_s, m, r, and b to specify, the asymptote, the starting value of x, and the slope and inflection points.

In this figure relative height is defined as the ratio of the particular tree height divided by the average-height-of-the-40-largest-diameter-trees. The range of relative height (x-axis) is from 0 to 1+ and the associated relative height modifier (y-axis) has the range {0-1}. When shade tolerance is considered, it is also desirable, given a particular value of relative height, that the modifying value decreases as shade tolerance decreases. The Generalized Chapman-Richards Functions shown in Figure 4 have these properties. Function parameters are set so that curve trajectories for each major category of shade tolerance are set at approximately equal intervals vertically. Thus, the uppermost curve is for very shade tolerant species and the lowest curve is for very shade intolerant species. Given a specific relative height value, a very shade tolerant tree will be impacted less by the height growth modifier than a very shade intolerant tree.

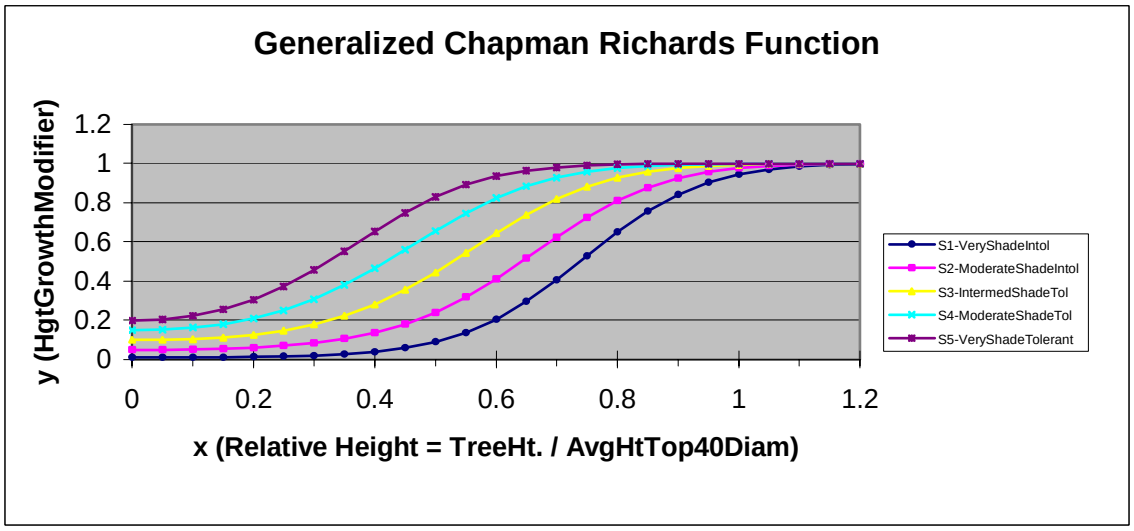

Figure 4.-Height growth modifying function based on relative height and shade tolerance.

It would be desirable to tailor the relationships for relative height using available data to condition the modifier function. The simple example described here, and operational in the southern variant, is the result of judgment that integrates data-based observations and published information. It is possible that the logistic function just described may not be capable of describing more complex relationships in the data, and a more substantial analysis may be needed.

Application of modifying factors:
Given a potential height growth estimate, H_{POT}, and the modifying factors for crown ratio, MF_{CR}, and relative height, MF_{RH}, they can be used several ways. In the Ritchie and Hann (1986) and Wensel et al. (1987) articles, the modifying factors are applied multiplicatively, as in

$$\text{height growth} = H_{POT} * MF_{CR} * MF_{RH}$$

In this application the effect of one modifying factor is amplified by the other. Another approach is to consider the overall effect of the modifying factors as an average. In this formulation, for example, a relatively sharp reduction due to low crown ratio might be partially offset by low reduction due to

relative height. This situation might describe an intermediate crown class tree recently released by an overstory removal. In this formulation

$$\text{height growth} = H_{POT} * (MF_{CR} + MF_{RH})/2$$

Small Tree Height and Diameter Growth

In the traditional Prognosis framework (Stage 1973, Wykoff et al 1982) the small tree model deals with trees whose size ranges from seedlings up to the sapling (3-5 in.) stage. In this traditional framework estimates from the small tree height model are melded with large tree height growth estimates over an overlapping diameter range to assure a smooth transition in height growth estimates from the small tree model to the large tree model. This range can be as small as 1 inch, or as large as 10 inches. depending on species and data considerations.

Having sufficient data to characterize growth relationships in these small size ranges is key to fitting defensible relationships. In fitting the southern variant, data for trees in the diameter range 1-5 inches, and smaller, was at first thought sufficient for about half the 90 species groups. But subsequent experience with fitting relationships and observing results of test projections showed too many instances of small tree height growth not allowing the best trees to follow the site index based height growth curves for the best large trees. Data for the southern variant, as rich as it is for trees about 3 inches and larger dbh, does not have sufficient numbers of observations for the very small trees, especially trees under breast height. In order to cope with this situation, the assumption was made that, in the southern variant at least, the purpose of the small tree height model is to produce trees whose projected heights are sufficient so that the best small trees have the potential to be the best ("site type") large trees.

Thus, the approach for modeling small tree height growth from seedling size up to the range of about 2-5 inches is to use a function based on the specified site index for the species. For height growth curves based on breast-height-age (BHA), a linear function in effect fills in the tree heights from the lower end of the height growth curve down to "zero" height tree germination. If the height growth curve is based on total-tree-age (TTA), some potential exists to use the functional form of the height growth curve involved with the large tree height growth model. However, even when this doesn't work, the linear "fill-in" function approach can still work. To be clear here, there is no claim that these functions depict actual height growth of very small trees under all circumstances. But, they appear to do better at producing "best-tree" height growth estimates, on average, than limited data-based regressions that extend below the range of sufficient data. Once the small tree height growth is estimated, the splining of height growth estimates from the large and small tree height growth models still makes a smooth transition from small tree height growth to large tree height growth models.

Once a height growth is computed so a beginning and ending height for the time interval is available, then the small tree diameter growth is computed. This is done using the inverse of the height diameter relationships discussed earlier to dub in missing heights. The two respective diameter estimates, i.e., at the beginning and end of the current time interval, provide the associated diameter difference and this diameter difference value is slightly randomized, tripled, and adjusted as described in Wykoff et al (1982). This adjusted diameter growth is then added to the end diameter (at the start of the interval) to estimate the projected new diameter at the end of the projection cycle.

Mortality

There are two types of mortality in this variant, background mortality and density related mortality. Background mortality accounts for the occasional mortality in stands when stand density is below a

specified level. Density related mortality, determines mortality rates for individual trees, based on the relationship of the individual stands density to the maximum stand density specified by the default/input.

Background Mortality:

Background mortality is used when the SDI is below 55% of the maximum SDI. The background rate is first calculated annually, and then adjusted to the cycle length using a compound interest formula. Table 13 contains the coefficients for the annual background mortality equation.

$$RI = [1 / (1 + e^{(\beta_0 + \beta_1 * dbh)})] / 2$$

where: RI = annual background mortality
dbh = tree diameter at breast height

$$RIP = 1 - (1-RI)^{yrs}$$

where: RIP = background mortality rate for the current projection cycle
yrs = number of years in current projection cycle

Table 13. Coefficients for the background mortality equation

SN Number	SN Code	Common Name	B_0	B_1	SN Number	SN Code	Common Name	B_0	B_1
01	FR	fir sp.	5.1676998	-0.0077681	46	MG	magnolia sp.	5.1676998	-0.0077681
02	JU	redcedar	9.6942997	-0.0127328	47	CT	cucumbertree	5.9617000	-0.0340128
03	PI	spruce	5.1676998	-0.0077681	48	MS	southern magnolia	5.1676998	-0.0077681
04	PU	sand pine	5.5876999	-0.0053480	49	MV	sweetbay	5.9617000	-0.0340128
05	SP	shortleaf pine	5.5876999	-0.0053480	50	ML	bigleaf magnolia	5.1676998	-0.0077681
06	SA	slash pine	5.5876999	-0.0053480	51	AP	apple sp.	5.9617000	-0.0340128
07	SR	spruce pine	5.1676998	-0.0077681	52	MB	mulberry sp.	5.1676998	-0.0077681
08	LL	longleaf pine	5.5876999	-0.0053480	53	WT	water tupelo	5.9617000	-0.0340128
09	TM	Table Mountain pine	5.5876999	-0.0053480	54	BG	blackgum, black tupelo	5.1676998	-0.0077681
10	PP	pitch pine	5.5876999	-0.0053480	55	TS	swamp tupelo, swamp b.gum	5.9617000	-0.0340128
11	PD	pond pine	5.5876999	-0.0053480	56	HH	eastern hophornbeam,	5.1676998	-0.0077681
12	WP	eastern white pine	5.5876999	-0.0053480	57	SD	sourwood	5.1676998	-0.0077681
13	LP	loblolly pine	5.5876999	-0.0053480	58	RA	redbay	5.1676998	-0.0077681
14	VP	Virginia pine	5.5876999	-0.0053480	59	SY	sycamore	5.9617000	-0.0340128
15	BY	baldcypress	5.5876999	-0.0053480	60	CW	cottonwood	5.9617000	-0.0340128
16	PC	pondcypress	5.5876999	-0.0053480	61	BT	bigtooth aspen	5.9617000	-0.0340128
17	HM	hemlock	5.1676998	-0.0077681	62	BC	black cherry	5.9617000	-0.0340128
18	FM	Florida maple	5.1676998	-0.0077681	63	WO	white oak	5.9617000	-0.0340128
19	BE	boxelder	5.1676998	-0.0077681	64	SO	scarlet oak	5.9617000	-0.0340128
20	RM	red maple	5.1676998	-0.0077681	65	SK	southern red oak	5.9617000	-0.0340128
21	SV	silver maple	5.1676998	-0.0077681	66	CB	cherrybark oak, swamp red o.	5.9617000	-0.0340128
22	SM	sugar maple	5.1676998	-0.0077681	67	TO	turkey oak	5.9617000	-0.0340128
23	BU	buckeye, horsechestnut	5.1676998	-0.0077681	68	LK	laurel oak	5.1676998	-0.0077681
24	BB	birch sp.	5.9617000	-0.0340128	69	OV	overcup oak	5.9617000	-0.0340128
25	SB	sweet birch, black birch	5.1676998	-0.0077681	70	BJ	blackjack oak	5.9617000	-0.0340128
26	AH	American hornbeam,	5.1676998	-0.0077681	71	SN	swamp chestnut oak	5.9617000	-0.0340128
27	HI	hickory sp.	5.9617000	-0.0340128	72	CK	chinkapin oak	5.9617000	-0.0340128
28	CA	catalpa	5.9617000	-0.0340128	73	WK	water oak	5.9617000	-0.0340128
29	HB	hackberry sp.	5.9617000	-0.0340128	74	CO	chestnut oak	5.9617000	-0.0340128
30	RD	eastern redbud	5.1676998	-0.0077681	75	RO	northern red oak	5.9617000	-0.0340128
31	DW	flowering dogwood	5.1676998	-0.0077681	76	QS	Shumard oak	5.9617000	-0.0340128
32	PS	common persimmon	5.1676998	-0.0077681	77	PO	post oak	5.9617000	-0.0340128
33	AB	American beech	5.1676998	-0.0077681	78	BO	black oak	5.9617000	-0.0340128
34	AS	ash	5.1676998	-0.0077681	79	LO	live oak	5.9617000	-0.0340128
35	WA	white ash, American ash	5.9617000	-0.0340128	80	BK	black locust	5.1676998	-0.0077681
36	BA	black ash	5.9617000	-0.0340128	81	WI	willow	5.1676998	-0.0077681
37	GA	green ash	5.1676998	-0.0077681	82	SS	sassafras	5.1676998	-0.0077681
38	HL	honeylocust	5.9617000	-0.0340128	83	BW	basswood	5.1676998	-0.0077681
39	LB	loblolly-bay	5.1676998	-0.0077681	84	EL	elm	5.1676998	-0.0077681
40	HA	silverbell	5.1676998	-0.0077681	85	WE	winged elm	5.1676998	-0.0077681
41	HY	American holly	5.1676998	-0.0077681	86	AE	American elm	5.1676998	-0.0077681

42	BN	butternut	5.9617000	-0.0340128	87	RL	slippery elm	5.1676998	-0.0077681
43	WN	black walnut	5.9617000	-0.0340128	88	OS	SOFTWOODS, MISC.	5.5876999	-0.0053480
44	SU	sweetgum	5.9617000	-0.0340128	89	OH	HARDWOODS, MISC.	5.9617000	-0.0340128
45	YP	yellow-poplar	5.9617000	-0.0340128	90	OT	unknown or not listed	5.9617000	-0.0340128

Density Related Mortality.

In stands with a quadratic mean diameter less than 10 inches, density mortality is based on maximum stand density index (Table 10). The maximum stand density index can be changed for each species using the SDIMAX keyword. If the stand's quadratic mean diameter is greater than 10 inches, then mortality is based on basal area maximums set by the BAMAX keyword. If the user does not set the basal area maximum it is determined from the maximum stand density index at 10 inches dbh.

$$SDI = N(D/10)^{1.605}$$

where: SDI= stand density index
N= number of trees per acre in the stand
D= quadratic mean diameter in the stand

$$BAMAX = SDI \times 0.5454154$$

where: BAMAX= default basal area maximum, if user does not define
SDI= stand density index

Stands with Quadratic Mean Diameter less than 10 inches:
No density-related mortality occurs when the stand density (natural log relationship of trees per acre and diameter) is less than 55% of the maximum SDI. Once the stand density hits 55% of the maximum SDI then density-related mortality begins. When the density is between 55% and 85% of the maximum SDI, the model uses an iterative method to find a linear function and kills trees according to that function. When density hits 85% of the maximum SDI the stand cannot increase in density, and the stand follows the 85% line downwards, therefore decreasing in trees per acre while increasing in diameter. If the initial stand density is between 85-90% of the maximum SDI then the stand is decreased to the 85% level in the first cycle. However if the maximum SDI is greater then 90%, then the maximum SDI is reset so that the initial stand density is at the 85% level. Mortality is then applied as a percentage to each tree record, based on the species tolerance (intolerance). The minimum and maximum stand density percentages can be changed in the SDIMAX keyword.

Stands with Quadratic Mean Diameters greater than or equal to 10 inches:
If a stand's quadratic mean diameter is greater than or equal to 10 inches than the stands basal area maximum is used to determine mortality. If the stands basal area is less than the maximum basal area then mortality is calculated as, the proportion of the stands basal area to the maximum basal area. If the stand basal area reaches the maximum basal area than all of the predicted basal area growth during the cycle is considered mortality. In either situation, the amount of basal area mortality is then converted to trees per acre and applied as a percentage to each tree record.

Insect and Pathogen Impacts

Currently, no extensions have been developed for the Southern variant to model the effects of insects and pathogens. Instead, these impacts are modeled through the use of FVS keyword sets. The two types of insect and pathogens that can be currently modeled are southern pine beetle damage and oak decline. The southern pine beetle has been divided into 3 regions (Appalachian, Coastal, Piedmont) due

to the different hazard ratings that apply to these regions. The keyword sets to model these damaging agents and can be found as a link on the FMSC FVS website.

Regeneration

Regeneration in the southern variant originates from two sources. The primary one being seedlings introduced into the projection by the user via Establishment extension keywords. The other being stump sprouts of species that are cut and exhibit this characteristic (stump spouting can be omitted using the NOSPROUT keyword).

User-Initiated Regeneration

For newly established trees, using the PLANT or NATURAL keywords, the trees will grow from the date planted (regeneration can occur anytime within a cycle) until the end of the cycle. In the Southern variant, the equations used to grow the trees in this first cycle are based on the small tree growth model. Newly established trees are passed to the FVS tree list at the end of the cycle in which they are planted.

Sprouting

Stump sprouting species are typically hardwoods, although not exclusively as seen in the table below. Sprouting, as defined and used in FVS variants, occurs when a tree is cut. Table 14 lists the stump sprouting species in the southern variant.

Table 14. – Stump sprouting species (shaded) in the Southern Variant.

Numeric Code	Character	Common name	Numeric Code	Character	Common name
1	FR	fir sp.	40	HA	silverbell
2	JU	redcedar	41	HY	American holly
3	PI	spruce	42	BN	butternut
4	PU	sand pine	43	WN	black walnut
5	SP	shortleaf pine	44	SU	sweetgum
6	SA	slash pine	45	YP	yellow-poplar
7	SR	spruce pine	46	MG	magnolia, sp.
8	LL	longleaf pine	47	CT	cucumbertree
9	TM	Table Mountain pine	48	MS	southern magnolia
10	PP	pitch pine	49	MV	sweetbay
11	PD	pond pine	50	ML	bigleaf magnolia
12	WP	eastern white pine	51	AP	apple sp.
13	LP	loblolly pine	52	MB	mulberry sp.
14	VP	Virginia pine	53	WT	water tupelo
15	BY	baldcypress	54	BG	blackgum, black tupelo
16	PC	pondcypress	55	TS	swamp tupelo, swamp b.gum
17	HM	hemlock	56	HH	eastern hophornbeam,
18	FM	Florida maple	57	SD	sourwood
19	BE	boxelder	58	RA	redbay
20	RM	red maple	59	SY	sycamore
21	SV	silver maple	60	CW	cottonwood
22	SM	sugar maple	61	BT	bigtooth aspen
23	BU	buckeye, horsechestnut	62	BC	black cherry
24	BB	birch sp.	63	WO	white oak
25	SB	sweet birch, black birch	64	SO	scarlet oak
26	AH	American hornbeam,	65	SK	southern red oak
27	HI	hickory sp.	66	CB	cherrybark oak, swamp red o.
28	CA	catalpa	67	TO	turkey oak
29	HB	hackberry sp.	68	LK	laurel oak
30	RD	eastern redbud	69	OV	overcup oak
31	DW	flowering dogwood	70	BJ	blackjack oak
32	PS	common persimmon	71	SN	swamp chestnut oak
33	AB	American beech	72	CK	chinkapin oak
34	AS	ash	73	WK	water oak
35	WA	white ash, American ash	74	CO	chestnut oak
36	BA	black ash	75	RO	northern red oak
37	GA	green ash	76	QS	Shumard oak

38	HL	honeylocust	77	PO	post oak
39	LB	loblolly-bay	78	BO	black oak

Crown Ratio 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 original Prognosis crown change algorithm (Wykoff et al 1982) is structured much like the diameter growth model discussed earlier. In the research environment if its development, the results apparently were adequate for the Inland Empire Prognosis model of that time. Later however, wider application of Prognosis (now FVS) variants with varying data sets pointed to the need for an alternative formulation (Dixon 1985).

The key to an alternative approach is that distribution of crown ratios within a stand is assumed to follow a Weibull distribution (Johnson and Kotz 1970:p.250). In turn attributes of the Weibull distribution for crown ratio are related to stand density. Thus, the following steps form the basis for modeling crown ratio change. If a Weibull distribution is to describe crown ratios, then the mean stand crown ratio is needed and this statistic is related to a metric based on 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 1 percent per year to avoid unrealistic changes from one cycle to the next. Steps in this process are described below.

Estimating Mean Crown Ratio

For each species, the first set of computations is to set up a table of number of observations by Relative SDI class and Crown ratio class. With this information, mean crown ratio is computed as a weighted average of crown ratio percent, where the weighting is by number of observations for each crown ratio percent, all within a given relative SDI class. When these computations are complete, the information is available to relate mean crown ratio (MCR) to Relative SDI (RSDI) for each species.

Graphs of data points showing MCR as the dependent variable (y-axis) and RSDI as the independent variable (x-axis) for all 90 species groups (actually 87 species groups, since 3 species groups, sequence numbers 88-90, are miscellaneous defaults) showed the potential for a variety of functional forms to describe the relationship MCR = f(RSDI). All of them are "linearizable" so that linear regression is applicable. RSDI (relative SDI) is defined as the current SDI / maximum SDI. Maximum SDI in the Southern variant is based on forest type and its computation is described elsewhere in this overview. Functional forms tried in the fitting of the MCR/RSDI regression are shown below with y being MCR and x being RSDI:

Hoerl's Special Function (Cuthbert and Wood 1971)

$y = ax^b e^{cx}$, which is linearizable to ln(y) = ln(a) + b*ln(x) + c*x;

Power Function

$y = ax^b$, which is linearizable to ln(y) = ln(a) + b*ln(x);

Exponential Function

$y = ae^{cx}$, which is linearizable to ln(y) = ln(a) + c*x;

Linear Function

$y = a + cx$, which is linear in its own form;

Semilog (base 10) Function

$y = a + b\ log_{10}(x)$;

Inverse (hyperbolic) Function

$$\frac{1}{y} = a + b\left(\frac{1}{x}\right).$$

For each species, all six functional forms were fit, the one with the highest "R-squared" becoming the initial choice for use in the variant. Each of these initial choices was screened to insure that, highest R^2 or not, the functional form reliably depicts the relationship between MCR and RSDI. Appendix Table A8 shows the coefficients resulting from the various regressions.

Mean Crown Ratio and the Weibull Parameters

Next, the Weibull function parameters, a, b, and c, are related to the Mean Crown Ratio. The Weibull distribution is described by its probability density function shown next (Johnson and Kotz, 1970).

$$f_x(x) = \frac{c}{b}\left(\frac{x-a}{b}\right)^{c-1} e^{-\left(\frac{x-a}{b}\right)^c}.$$

However, the cumulative distribution form of this equation,

$$F_x(x) = 1 - e^{-\left(\frac{x-a}{b}\right)^c},$$

is the form used in the FVS code. The "a" (location) coefficient is usually set to a constant although if data indicates, it could be a function. For the southern variant, data indicated that parameter c (shape) also is "constant". The "b" (scale) coefficient is estimated as a linear function of mean crown ratio, shown below.

$b = b_0 + b_1 * MCR$

where MCR = estimated mean stand crown ratio.

Once the Weibull distribution is specified, FVS uses Weibull's cumulative distribution function in an algorithm to assign crown ratios to individual trees. This process is best expressed by Dixon (1985):

> "The first step is to estimate the mean stand crown ratio from Stand Density Index. Next, the Weibull distribution parameters are estimated from the mean stand crown ratio. Individual trees are then assigned a crown ratio from the specified Weibull distribution. At the current time, a crown ratio is picked from the Weibull distribution according to the tree's basal area percentile…" "As the growth and yield projection continues through time, the SDI values change, as does a tree's basal area percentile. As the SDI values change, so does the Weibull distribution from which crown ratio values are drawn. The change in crown ratio from one projection cycle to the next is obtained by subtracting the crown ratios picked from the appropriate [respective] Weibull distributions. This change value is bounded to avoid drastic changes from one cycle to the next, but to date, this has not been a problem."

The net effect from the 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. Coefficients for these sets of functions are in Appendix Table A9.

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VII. Appendix

A1. Southern variant species related to East-wide Database species

Primary species are for the direct model input and are tracked by the variant's reporting functions. Related species are the Eastwide Database species that are associated with the primary species.

The related species are modeled as the associated primary species. Related species are not tracked explicitly by the variant nor are they available for report display.

Eastwide Database groups are also displayed. They are for post-processor reporting use only. Southeast Variant codes are displayed for reference only. B.Lilly 7/98

Primary Species				Related Species				EWDB Species Groups	
SN Number	SN Character	FIA Code	SN Species List.Common name	SPP Code	EWDB Common Name	Genus	Species	Group Code	Species group name
1	FR	10	fir sp.	10	fir sp.	Abies	sp.	6	Spruce and balsam fir
				12	balsam fir	Abies	balsamea	6	Spruce and balsam fir
				16	Fraser fir	Abies	fraseri	9	Other softwoods
2	JU	60	Juniper sp.	43	Atlantic white-cedar	Chamaecyparis	thyoides	9	Other softwoods
				60	redcedar	Juniperus	sp.	9	Other softwoods
				67	southern redcedar	Juniperus	silicicola	9	Other softwoods
				68	eastern redcedar	Juniperus	virginiana	9	Other softwoods
				241	northern white-cedar	Thuja	occidentalis	9	Other softwoods
3	PI	90	spruce sp.	90	spruce	Picea	sp.	6	Spruce and balsam fir
				97	red spruce	Picea	rubens	6	Spruce and balsam fir
4	PU	107	sand pine	107	sand pine	Pinus	clausa	3	Other yellow pines
				130	Scotch pine	Pinus	sylvestris	3	Other yellow pines
5	SP	110	shortleaf pine	110	shortleaf pine	Pinus	echinata	2	Loblolly and shortleaf pine
6	SA	111	slash pine	111	slash pine	Pinus	elliottii	1	Longleaf and slash pine
7	SR	115	spruce pine	115	spruce pine	Pinus	glabra	3	Other yellow pines
8	LL	121	longleaf pine	121	longleaf pine	Pinus	palustris	1	Longleaf and slash pine
9	TM	123	Table Mountain pine	123	Table Mountain pine	Pinus	pungens	3	Other yellow pines
10	PP	126	pitch pine	126	pitch pine	Pinus	rigida	3	Other yellow pines
11	PD	128	pond pine	128	pond pine	Pinus	serotina	3	Other yellow pines
12	WP	129	eastern white pine	129	eastern white pine	Pinus	strobus	4	Eastern white and red pine
13	LP	131	loblolly pine	131	loblolly pine	Pinus	taeda	2	Loblolly and shortleaf pine
14	VP	132	Virginia pine	132	Virginia pine	Pinus	virginiana	3	Other yellow pines
15	BY	221	baldcypress	221	baldcypress	Taxodium	distichum	8	Cypress
16	PC	222	pondcypress	222	pondcypress	Taxodium	distichum var. nutans	8	Cypress
17	HM	260	hemlock sp.	260	hemlock	Tsuga	sp.	7	Eastern hemlock
				261	eastern hemlock	Tsuga	canadensis	7	Eastern hemlock
				262	Carolina hemlock	Tsuga	caroliniana	7	Eastern hemlock
18	FM	311	Florida maple	311	Florida maple	Acer	barbatum	16	Hard maple
19	BE	313	boxelder	313	boxelder	Acer	negundo	26	Other soft hardwoods
				315	striped maple	Acer	pensylvanicum	28	Noncommercial
				319	mountain maple	Acer	spicatum	28	Noncommercial
20	RM	316	red maple	316	red maple	Acer	rubrum	17	Soft maple
21	SV	317	silver maple	317	silver maple	Acer	saccharinum	17	Soft maple
22	SM	318	sugar maple	314	black maple	Acer	nigrum	16	Hard maple
				318	sugar maple	Acer	saccharum	16	Hard maple
23	BU	330	buckeye, horsechestnut sp.	330	buckeye, horsechestnut	Aesculus	sp.	26	Other soft hardwoods
				331	Ohio buckeye	Aesculus	glabra	26	Other soft hardwoods
				332	yellow buckeye	Aesculus	octandra	26	Other soft hardwoods
				333	buckeye(except 331, 332)	Aesculus	sp.	26	Other soft hardwoods
24	BB	370	birch sp., other	370	birch sp.	Betula	sp.	27	Other hard hardwoods

				371	yellow birch	Betula	alleghaniensis	15	Yellow birch
				373	river birch	Betula	nigra	26	Other soft hardwoods
				375	paper birch	Betula	papyrifera	26	Other soft hardwoods
25	SB	372	sweet birch	372	sweet birch	Betula	lenta	27	Other hard hardwoods
26	AH	391	American hornbeam, musclewood	391	American hornbeam, musclewood	Carpinus	caroliniana	28	Noncommercial
27	HI	400	hickory sp.	400	hickory sp.	Carya	sp.	14	Hickory
				401	water hickory	Carya	aquatica	14	Hickory
				402	bitternut hickory	Carya	cordiformis	14	Hickory
				403	pignut hickory	Carya	glabra	14	Hickory
				404	pecan	Carya	illinoensis	14	Hickory
				405	shellbark hickory	Carya	laciniosa	14	Hickory
				407	shagbark hickory	Carya	ovata	14	Hickory
				408	black hickory	Carya	texana	14	Hickory
				409	mockernut hickory	Carya	tomentosa	14	Hickory
28	CA	450	catalpa	450	catalpa	Catalpa	sp.	26	Other soft hardwoods
				451	southern catalpa	Catalpa	bignonioides	28	Noncommercial
29	HB	460	hackberry sp.	460	hackberry sp.	Celtis	sp.	26	Other soft hardwoods
				461	sugarberry	Celtis	laevigata	26	Other soft hardwoods
				462	hackberry	Celtis	occidentalis	26	Other soft hardwoods
30	RD	471	eastern redbud	471	eastern redbud	Cercis	canadensis	28	Noncommercial
31	DW	491	flowering dogwood	491	flowering dogwood	Cornus	florida	27	Other hard hardwoods
32	PS	521	common persimmon	521	common persimmon	Diospyros	virginiana	27	Other hard hardwoods
33	AB	531	American beech	531	American beech	Fagus	grandifolia	18	Beech
34	AS	540	ash	540	ash	Fraxinus	sp.	21	Ash
35	WA	541	white ash	541	white ash	Fraxinus	americana	21	Ash
				546	blue ash	Fraxinus	quadrangulata	21	Ash
36	BA	543	black ash	543	black ash	Fraxinus	nigra	21	Ash
37	GA	544	green ash	544	green ash	Fraxinus	pennsylvanica	21	Ash
38	HL	552	honeylocust	551	waterlocust	Gleditsia	aquatica	27	Other hard hardwoods
				552	honeylocust	Gleditsia	triacanthos	27	Other hard hardwoods
39	LB	555	loblolly-bay	555	loblolly-bay	Gordonia	lasianthus	26	Other soft hardwoods
40	HA	580	silverbell	580	silverbell	Halesia	sp.	26	Other soft hardwoods
				581	Carolina silverbell	Halesia	carolina	26	Other soft hardwoods
41	HY	591	American holly	591	American holly	Ilex	opaca	27	Other hard hardwoods
42	BN	601	butternut	601	butternut	Juglans	cinerea	26	Other soft hardwoods
43	WN	602	black walnut	602	black walnut	Juglans	nigra	25	Black walnut
44	SU	611	sweetgum	611	sweetgum	Liquidambar	styraciflua	19	Sweetgum
45	YP	621	yellow-poplar	621	yellow-poplar	Liriodendron	tulipifera	24	Yellow-poplar
46	MG	650	magnolia sp., other	650	magnolia sp.	Magnolia	sp.	26	Other soft hardwoods
47	CT	651	cucumbertree	651	cucumbertree	Magnolia	acuminata	26	Other soft hardwoods
48	MS	652	southern magnolia	652	southern magnolia	Magnolia	grandiflora	26	Other soft hardwoods
49	MV	653	sweetbay	653	sweetbay	Magnolia	virginiana	26	Other soft hardwoods
50	ML	654	bigleaf magnolia	654	bigleaf magnolia	Magnolia	macrophylla	28	Noncommercial
51	AP	660	apple, plum, cherry sp.	660	apple sp.	Malus	sp.	28	Noncommercial
				760	cherry, plum spp.	Prunus	sp.	28	Noncommercial
				761	pin cherry	Prunus	pensylvanica	28	Noncommercial
				763	chokecherry	Prunus	virginiana	28	Noncommercial
				764	plums, cherries (except 762)	Prunus	sp.	28	Noncommercial
				766	wild plum	Prunus	americana	28	Noncommercial
52	MB	680	mulberry sp.	680	mulberry sp.	Morus	sp.	27	Other hard hardwoods

				681	white mulberry	Morus	alba	27	Other hard hardwoods
				682	red mulberry	Morus	rubra	27	Other hard hardwoods
53	WT	691	water tupelo	691	water tupelo	Nyssa	aquatica	20	Tupelo and black gum
				692	ogeechee tupelo	Nyssa	ogeche	28	Noncommercial
54	BG	693	blackgum	693	blackgum	Nyssa	sylvatica	20	Tupelo and black gum
55	TS	694	swamp tupelo	694	swamp tupelo	Nyssa	sylvatica var. biflora	20	Tupelo and black gum
56	HH	701	eastern hophornbeam, ironwood	701	eastern hophornbeam, ironwood	Ostrya	virginiana	28	Noncommercial
57	SD	711	sourwood	711	sourwood	Oxydendrum	arboreum	28	Noncommercial
58	RA	721	redbay	721	redbay	Persea	borbonia	26	Other soft hardwoods
59	SY	731	sycamore	731	sycamore	Platanus	occidentalis	26	Other soft hardwoods
60	CW	740	cottonwood	740	cottonwood	Populus	spp.	22	Cottonwood and aspen
				742	eastern cottonwood	Populus	deltoides	22	Cottonwood and aspen
				744	swamp cottonwood	Populus	heterophylla	22	Cottonwood and aspen
61	BT	743	bigtooth aspen	743	bigtooth aspen	Populus	grandidentata	22	Cottonwood and aspen
62	BC	762	black cherry	762	black cherry	Prunus	serotina	26	Other soft hardwoods
63	WO	802	white oak	802	white oak	Quercus	alba	10	Select white oaks
64	SO	806	scarlet oak	806	scarlet oak	Quercus	coccinea	13	Other red oaks
65	SK	812	southern red oak	812	southern red oak	Quercus	falcata var. falcata	13	Other red oaks
				817	shingle oak	Quercus	imbricaria	13	Other red oaks
66	CB	813	cherrybark oak, swamp red oak	813	cherrybark oak, swamp red oak	Quercus	falcata var. pagodaefolia	11	Select red oaks
				830	pin oak	Quercus	palustris	13	Other red oaks
67	TO	819	turkey oak	819	turkey oak	Quercus	laevis	28	Noncommercial
				840	bluejack oak	Quercus	incana	28	Noncommercial
68	LK	820	laurel oak	820	laurel oak	Quercus	laurifolia	13	Other red oaks
69	OV	822	overcup oak	822	overcup oak	Quercus	lyrata	12	Other white oaks
70	BJ	824	blackjack/bear/scrub oak	816	bear oak, scrub oak	Quercus	ilicifolia	28	Noncommercial
				824	blackjack oak	Quercus	marilandica	28	Noncommercial
				899	scrub oak	Quercus	sp.	28	Noncommercial
71	SN	825	swamp chestnut oak	825	swamp chestnut oak	Quercus	michauxii	10	Select white oaks
72	CK	826	chinkapin oak	826	chinkapin oak	Quercus	muehlenbergii	10	Select white oaks
73	WK	827	water oak	804	swamp white oak	Quercus	bicolor	10	Select white oaks
				827	water oak	Quercus	nigra	13	Other red oaks
				828	Nuttall oak	Quercus	nuttallii	13	Other red oaks
				831	willow oak	Quercus	phellos	13	Other red oaks
74	CO	832	chestnut/bur oak	823	bur oak	Quercus	macrocarpa	10	Select white oaks
				832	chestnut oak	Quercus	prinus	12	Other white oaks
75	RO	833	northern red oak	833	northern red oak	Quercus	rubra	11	Select red oaks
76	QS	834	Shumard oak	834	Shumard oak	Quercus	shumardii	11	Select red oaks
77	PO	835	post/Durand oak	808	Durand oak	Quercus	durandii	20	Tupelo and black gum
				835	post oak	Quercus	stellata	12	Other white oaks
				836	Delta post oak	Quercus	stellata var. mississippiensis	12	Other white oaks
78	BO	837	black oak	837	black oak	Quercus	velutina	13	Other red oaks
79	LO	838	live oak	838	live oak	Quercus	virginiana	12	Other white oaks
80	BK	901	black locust	901	black locust	Robinia	psuedoacacia	27	Other hard hardwoods
81	WI	920	willow	920	willow	Salix	sp.	26	Other soft hardwoods
				922	black willow	Salix	nigra	26	Other soft hardwoods
82	SS	931	sassafras	931	sassafras	Sassafras	albidum	26	Other soft hardwoods
83	BW	950	basswood, sp.	950	basswood	Tilia	sp.	23	Basswood
				951	American basswood	Tilia	americana	23	Basswood
				952	white basswood	Tilia	heterophylla	23	Basswood

84	EL	970	elm, other	970	elm	Ulmus	sp.	26	Other soft hardwoods
				973	cedar elm	Ulmus	crassifolia	26	Other soft hardwoods
				974	Siberian elm	Ulmus	pumila	26	Other soft hardwoods
				976	September elm	Ulmus	serotina	26	Other soft hardwoods
				977	rock elm	Ulmus	thomasii	27	Other hard hardwoods
85	WE	971	winged elm	971	winged elm	Ulmus	alata	26	Other soft hardwoods
86	AE	972	American elm	972	American elm	Ulmus	americana	26	Other soft hardwoods
87	RL	975	slippery elm	975	slippery elm	Ulmus	rubra	26	Other soft hardwoods
88	OS	1	other softwoods	1	other softwood sp.			9	Other softwoods
89	OH	4	other hardwood sp.	4	other hardwood sp.			28	Noncommercial
				341	ailanthus	Ailanthus	altissima	28	Noncommercial
				355	serviceberry	Amelanchier	sp.	28	Noncommercial
				367	pawpaw	Asimina	triloba	28	Noncommercial
				381	chittamwood, gum bumelia	Bumelia	lanuginosa	28	Noncommercial
				421	American chestnut	Castanea	dentata	27	Other hard hardwoods
				422	Allegheny chinkapin	Castanea	pumila	26	Other soft hardwoods
				500	hawthorn	Crataegus	sp.	28	Noncommercial
				571	Kentucky coffeetree	Gymnocladus	dioicus	27	Other hard hardwoods
				641	Osage-orange	Maclura	pomifera	28	Noncommercial
				712	Paulownia, Empress tree	Paulownia	tomentosa	26	Other soft hardwoods
				925	Chinese tallowtree	Sapium	sebiferum	28	Noncommercial
				935	American mountain-ash	Sorbus	americana	28	Noncommercial
				981	sparkleberry	Vaccinium	arboreum	28	Noncommercial
				983	chinaberry	Melia	azedarach	28	Noncommercial
				984	water-elm	Planera	aquatica	28	Noncommercial
				985	smoketree	Cotinus	obovatus	28	Noncommercial
90	OT	999	unknown or not listed	999	unknown or not listed			28	Noncommercial

A2. Tree height dubbing/Curtis-Arney equation coefficients

Species	Sequence	Alpha				Curtis-Arney Coefficients			Uses coeff.	Bud width
Code	Number	Character	Common name	Genus	Species	p2	p3	p4	from species	diameter
10	1	FR	fir sp.	Abies	sp.	2163.9468	6.2688	-0.2161	90	0.1
60	2	JU	redcedar	Juniperus	sp.	212.7933	3.4715	-0.3259		0.2
90	3	PI	spruce	Picea	sp.	2163.9468	6.2688	-0.2161		0.2
107	4	PU	sand pine	Pinus	clausa	3919.9952	6.8731	-0.1906		0.5
110	5	SP	shortleaf pine	Pinus	echinata	444.0922	4.1188	-0.3062		0.5
111	6	SA	slash pine	Pinus	elliottii	1087.1014	5.1045	-0.2428		0.5
115	7	SR	spruce pine	Pinus	glabra	333.3146	4.1311	-0.3709		0.5
121	8	LL	longleaf pine	Pinus	palustris	98.5608	3.8993	-0.8673		0.5
123	9	TM	Table Mountain pine	Pinus	pungens	691.5412	4.1980	-0.1857		0.5
126	10	PP	pitch pine	Pinus	rigida	208.7773	3.7281	-0.4109		0.5
128	11	PD	pond pine	Pinus	serotina	142.7468	3.9726	-0.5871		0.5
129	12	WP	eastern white pine	Pinus	strobus	2108.8442	5.6595	-0.1856		0.4
131	13	LP	loblolly pine	Pinus	taeda	243.8606	4.2846	-0.4713		0.5
132	14	VP	Virginia pine	Pinus	virginiana	926.1803	4.4621	-0.2005		0.5
221	15	BY	baldcypress	Taxodium	distichum	119.5749	4.1354	-0.7963		0.2
222	16	PC	pondcypress	Taxodium	distichum var. nutans	162.6506	3.2080	-0.4788		0.2
260	17	HM	hemlock	Tsuga	sp.	266.4562	3.9931	-0.3860		0.2
311	18	FM	Florida maple	Acer	barbatum	603.6736	3.9896	-0.2165		0.2
313	19	BE	boxelder	Acer	negundo	287.9446	3.2767	-0.2662		0.2
316	20	RM	red maple	Acer	rubrum	268.5564	3.1143	-0.2941		0.2
317	21	SV	silver maple	Acer	saccharinum	80.5118	26.9833	-2.0220		0.2
318	22	SM	sugar maple	Acer	saccharum	209.8555	2.9528	-0.3679		0.2
330	23	BU	buckeye, horsechestnut	Aesculus	sp.	630.9505	4.5109	-0.2683		0.3
370	24	BB	birch sp.	Betula	sp.	170.5253	2.6883	-0.4008		0.1
372	25	SB	sweet birch, black birch	Betula	lenta	68.9223	43.3383	-2.4445		0.1
391	26	AH	American hornbeam,	Carpinus	caroliniana	628.0209	3.8810	-0.1539		0.2
400	27	HI	hickory sp.	Carya	sp.	337.6685	3.6273	-0.3208		0.3
450	28	CA	catalpa	Catalpa	sp.	190.9797	3.6928	-0.5273	740	0.3
460	29	HB	hackberry sp.	Celtis	sp.	484.7530	3.9393	-0.2600		0.1
471	30	RD	eastern redbud	Cercis	canadensis	103.1768	2.2170	-0.3596		0.2
491	31	DW	flowering dogwood	Cornus	florida	863.0501	4.3856	-0.1481		0.1
521	32	PS	common persimmon	Diospyros	virginiana	488.9349	4.0650	-0.2718		0.2
531	33	AB	American beech	Fagus	grandifolia	526.1393	3.8923	-0.2259		0.1
540	34	AS	ash	Fraxinus	sp.	251.4043	3.2692	-0.3591		0.2
541	35	WA	white ash, American ash	Fraxinus	americana	91.3528	6.9961	-1.2294		0.2
543	36	BA	black ash	Fraxinus	nigra	178.9308	4.9286	-0.6378		0.2
544	37	GA	green ash	Fraxinus	pennsylvanica	404.9692	3.3902	-0.2551		0.2
552	38	HL	honeylocust	Gleditsia	triacanthos	778.9357	4.2076	-0.1873		0.1
555	39	LB	loblolly-bay	Gordonia	lasianthus	265.7423	3.5904	-0.3523		0.2
580	40	HA	silverbell	Halesia	sp.	2620.5855	5.8499	-0.1803		0.2
591	41	HY	American holly	Ilex	opaca	1467.6435	5.3344	-0.1740		0.1
601	42	BN	butternut	Juglans	cinerea	285.8798	3.5214	-0.3194		0.3
602	43	WN	black walnut	Juglans	nigra	93.7104	3.6575	-0.8825		0.4
611	44	SU	sweetgum	Liquidambar	styraciflua	290.9055	3.6240	-0.3720		0.2
621	45	YP	yellow-poplar	Liriodendron	tulipifera	625.7697	3.8732	-0.2335		0.2
650	46	MG	magnolia sp.	Magnolia	sp.	585.6609	3.4197	-0.1766		0.2

651	47	CT	cucumbertree	Magnolia	acuminata	660.1997	3.9208	-0.2112		0.2
652	48	MS	southern magnolia	Magnolia	grandiflora	139.3315	2.8998	-0.4851		0.2
653	49	MV	sweetbay	Magnolia	virginiana	184.1932	2.8457	-0.3695		0.2
654	50	ML	bigleaf magnolia	Magnolia	macrophylla	366.4745	2.8733	-0.1820		0.2
660	51	AP	apple sp.	Malus	sp.	574.0201	3.8637	-0.1632		0.2
680	52	MB	mulberry sp.	Morus	sp.	750.1823	4.1426	-0.1594		0.2
691	53	WT	water tupelo	Nyssa	aquatica	163.9728	2.7682	-0.4410		0.2
693	54	BG	blackgum, black tupelo	Nyssa	sylvatica	319.9788	3.6731	-0.3065		0.2
694	55	TS	swamp tupelo, swamp b.gum	Nyssa	sylvatica var. biflora	252.3567	3.2440	-0.3334		0.2
701	56	HH	eastern hophornbeam,	Ostrya	virginiana	109.7324	2.2503	-0.4130		0.2
711	57	SD	sourwood	Oxydendrum	arboreum	690.4918	4.1598	-0.1861		0.2
721	58	RA	redbay	Persea	borbonia	257.0533	3.4047	-0.3029		0.2
731	59	SY	sycamore	Platanus	occidentalis	644.3568	3.9205	-0.2144		0.1
740	60	CW	cottonwood	Populus	sp.	190.9797	3.6928	-0.5273		0.1
743	61	BT	bigtooth aspen	Populus	grandidentata	66.6489	135.4826	-2.8862		0.1
762	62	BC	black cherry	Prunus	serotina	364.0248	3.5599	-0.2726		0.1
802	63	WO	white oak	Quercus	alba	170.1331	3.2782	-0.4874		0.2
806	64	SO	scarlet oak	Quercus	coccinea	196.0565	3.0067	-0.3850		0.2
812	65	SK	southern red oak	Quercus	falcata var. falcata	150.4300	3.1327	-0.4993		0.1
813	66	CB	cherrybark oak, swamp red o.	Quercus	falcata	182.6306	3.1290	-0.4639		0.1
819	67	TO	turkey oak	Quercus	laevis	2137.5756	5.8091	-0.1559		0.2
820	68	LK	laurel oak	Quercus	laurifolia	208.2300	3.1383	-0.3716		0.1
822	69	OV	overcup oak	Quercus	lyrata	184.0856	3.4954	-0.4621		0.2
824	70	BJ	blackjack oak	Quercus	marilandica	157.4829	3.3892	-0.3915		0.2
825	71	SN	swamp chestnut oak	Quercus	michauxii	281.3413	3.5170	-0.3336		0.2
826	72	CK	chinkapin oak	Quercus	muehlenbergii	72.7907	3.6707	-1.0988		0.1
827	73	WK	water oak	Quercus	nigra	470.0617	3.7889	-0.2512		0.1
832	74	CO	chestnut oak	Quercus	prinus	94.5447	3.4203	-0.8188		0.2
833	75	RO	northern red oak	Quercus	rubra	700.0636	4.1061	-0.2139		0.2
834	76	QS	Shumard oak	Quercus	shumardii	215.0009	3.1420	-0.3907		0.1
835	77	PO	post oak	Quercus	stellata	765.2908	4.2238	-0.1897		0.1
837	78	BO	black oak	Quercus	velutina	224.7163	3.1165	-0.3598		0.2
838	79	LO	live oak	Quercus	virginiana	153.9588	3.1135	-0.3895		0.2
901	80	BK	black locust	Robinia	psuedoacacia	880.2845	4.5964	-0.2182		0.1
920	81	WI	willow	Salix	sp.	408.2772	3.8181	-0.2721		0.1
931	82	SS	sassafras	Sassafras	albidum	755.1038	4.3950	-0.2178		0.1
950	83	BW	basswood	Tilia	sp.	293.5715	3.5226	-0.3512		0.1
970	84	EL	elm	Ulmus	sp.	1005.8067	4.6474	-0.2034		0.1
971	85	WE	winged elm	Ulmus	alata	1001.6729	4.5731	-0.1890		0.1
972	86	AE	American elm	Ulmus	americana	418.5942	3.1704	-0.1896		0.1
975	87	RL	slippery elm	Ulmus	rubra	1337.5472	4.4895	-0.1475		0.1
1	88	OS	softwoods, misc.			212.7933	3.4715	-0.3259	60	0.2
4	89	OH	hardwoods, misc.			109.7324	2.2503	-0.4130	701	0.2
999	90	OT	unknown or not listed			31021.3555	8.3959	-0.1037		0.2

A3. Tree height dubbing/Wykoff equation coefficients

							TRADITIONAL(WKT): H = f(D)				AUGMENTED WITH SITE INDEX(WKA): H = f(D, SI)					
						Uses coeff.	inter-	dbh				INTER	DBH	SITE INDEX		
Species	SN Number	SN				from	cept	coeff.				CEPT	COEFF	COEFF		
Code	Number	Character	Common name	Genus	Species	species	WKT_INT	WKT_DBH	WKT_EDF	WKT_RSQ	WKA_RMSE	WKA_INT	WKA_DBH	WKA_SIO	WKA_EDF	WKA_RSQ
10	1	FR	fir sp.	Abies	sp.	260	4.5084	-6.0116	1210	0.8566	0.2659	4.3145	-5.9881	0.0028	1209	0.8604
60	2	JU	redcedar	Juniperus	sp.		4.0374	-4.2964	4894	0.7528	0.2669	3.9141	-4.2422	0.0016	4893	0.7545
90	3	PI	spruce	Picea	sp.	260	4.5084	-6.0116	1210	0.8566	0.2659	4.3145	-5.9881	0.0028	1209	0.8604
107	4	PU	sand pine	Pinus	clausa		4.2899	-4.1019	1548	0.7267	0.2443	3.8379	-4.0187	0.0072	1547	0.7405
110	5	SP	shortleaf pine	Pinus	echinata		4.6271	-6.4095	27943	0.6518	0.2127	4.1044	-5.859	0.0064	27942	0.7024
111	6	SA	slash pine	Pinus	elliottii		4.6561	-6.2258	23724	0.796	0.1825	4.2628	-5.8727	0.0047	23723	0.8156
115	7	SR	spruce pine	Pinus	glabra		4.7258	-6.7703	903	0.6959	0.205	4.3853	-6.5595	0.0034	902	0.7102
121	8	LL	longleaf pine	Pinus	palustris		4.5991	-5.9111	9864	0.7551	0.1801	4.3019	-5.6329	0.0034	9863	0.7831
123	9	TM	Table Mountain pine	Pinus	pungens		4.2139	-4.5419	290	0.7066	0.2066	3.9471	-4.5435	0.0055	289	0.7317
126	10	PP	pitch pine	Pinus	rigida		4.3898	-5.7183	872	0.6704	0.2593	4.3039	-5.695	0.0015	871	0.6721
128	11	PD	pond pine	Pinus	serotina		4.5457	-6.8	3004	0.8553	0.2187	4.0081	-6.4242	0.0083	3003	0.8746
129	12	WP	eastern white pine	Pinus	strobus		4.609	-6.1896	2746	0.8795	0.2374	4.4293	-6.1731	0.0023	2745	0.8822
131	13	LP	loblolly pine	Pinus	taeda		4.6897	-6.8801	99785	0.7242	0.2263	4.3057	-6.4478	0.0038	99784	0.7427
132	14	VP	Virginia pine	Pinus	virginiana		4.4718	-5.0078	10964	0.7007	0.2347	4.2421	-4.8933	0.0031	10963	0.7074
221	15	BY	baldcypress	Taxodium	distichum		4.6171	-6.2684	6957	0.6572	0.2417	4.5291	-6.1753	0.0009	6956	0.6598
222	16	PC	pondcypress	Taxodium	distichum var. nutans		4.4603	-5.0577	7032	0.8428	0.258	4.2393	-4.9924	0.0034	7031	0.8507
260	17	HM	hemlock	Tsuga	sp.		4.5084	-6.0116	1210	0.8566	0.2659	4.3145	-5.9881	0.0028	1209	0.8604
311	18	FM	Florida maple	Acer	barbatum		4.3164	-4.0582	517	0.8277	0.2513	4.1605	-3.9815	0.0019	516	0.8294
313	19	BE	boxelder	Acer	negundo		4.2378	-4.108	1544	0.647	0.287	4.1487	-4.019	0.001	1543	0.6477
316	20	RM	red maple	Acer	rubrum		4.3379	-3.8214	33433	0.8169	0.2423	4.2646	-3.7926	0.001	33432	0.8174
317	21	SV	silver maple	Acer	saccharinum		4.5991	-6.6706	289	0.4582	0.2777	4.7809	-6.721	-0.0022	288	0.4645
318	22	SM	sugar maple	Acer	saccharum		4.4834	-4.5431	2975	0.7626	0.2241	4.2904	-4.5058	0.0026	2974	0.7684
330	23	BU	buckeye, horsechestnut	Aesculus	sp.		4.5697	-5.7172	316	0.8226	0.2175	4.443	-5.6964	0.0017	315	0.824
370	24	BB	birch sp.	Betula	sp.		4.4388	-4.0872	2362	0.8098	0.1983	4.3108	-4.0188	0.0016	2361	0.8122
372	25	SB	sweet birch, black birch	Betula	lenta		4.4522	-4.5758	125	0.2736	0.2348	4.5545	-4.5794	-0.0015	124	0.2775
391	26	AH	American hornbeam,	Carpinus	caroliniana		3.855	-2.6623	4301	0.6024	0.2663	3.7866	-2.628	0.0008	4300	0.6029
400	27	HI	hickory sp.	Carya	sp.		4.5128	-4.9918	26590	0.7834	0.2493	4.1863	-4.8144	0.0042	26589	0.7942
450	28	CA	catalpa	Catalpa	sp.	740	4.9396	-8.1838	1016	0.6732	0.2194	4.3113	-7.5846	0.0066	1015	0.713
460	29	HB	hackberry sp.	Celtis	sp.		4.4207	-5.1435	4738	0.5503	0.2656	4.3128	-5.0914	0.0012	4737	0.552
471	30	RD	eastern redbud	Cercis	canadensis		3.7512	-2.5539	542	0.4903	0.2804	3.7751	-2.5615	-0.0003	541	0.4904
491	31	DW	flowering dogwood	Cornus	florida		3.7301	-2.7758	10034	0.5158	0.274	3.6784	-2.7571	0.0007	10033	0.5162
521	32	PS	common persimmon	Diospyros	virginiana		4.4091	-4.8464	1505	0.7874	0.3091	4.0018	-4.5614	0.0049	1504	0.7956
531	33	AB	American beech	Fagus	grandifolia		4.4772	-4.7206	5842	0.7823	0.2515	4.2372	-4.6186	0.003	5841	0.7873
540	34	AS	ash	Fraxinus	sp.		4.4819	-4.5314	6363	0.8615	0.2365	4.1811	-4.4783	0.0042	6362	0.8655
541	35	WA	white ash, American ash	Fraxinus	americana		4.5959	-6.4497	2114	0.3798	0.2573	4.2222	-6.2428	0.0048	2113	0.4218
543	36	BA	black ash	Fraxinus	nigra	544	4.6155	-6.2945	4293	0.3884	0.2606	4.1878	-6.0689	0.0049	4292	0.4203
544	37	GA	green ash	Fraxinus	pennsylvanica		4.6155	-6.2945	4293	0.3884	0.2606	4.1878	-6.0689	0.0049	4292	0.4203
552	38	HL	honeylocust	Gleditsia	triacanthos		4.3734	-5.3135	631	0.3769	0.2909	3.8542	-4.9565	0.0062	630	0.4266
555	39	LB	loblolly-bay	Gordonia	lasianthus		4.4009	-5.056	1731	0.7922	0.2628	3.9609	-4.9606	0.0066	1730	0.8026
580	40	HA	silverbell	Halesia	sp.		4.4931	-4.6501	100	0.8847	0.2025	3.9811	-4.4475	0.0068	99	0.9039
591	41	HY	American holly	Ilex	opaca		4.0151	-4.3314	4208	0.7546	0.2909	3.9622	-4.3104	0.0007	4207	0.7548
601	42	BN	butternut	Juglans	cinerea	602	4.5018	-5.6123	1043	0.5131	0.2613	4.3108	-5.5226	0.0025	1042	0.5209
602	43	WN	black walnut	Juglans	nigra		4.5018	-5.6123	1043	0.5131	0.2613	4.3108	-5.5226	0.0025	1042	0.5209
611	44	SU	sweetgum	Liquidambar	styraciflua		4.592	-5.1719	45362	0.839	0.2484	4.4378	-5.0161	0.0014	45361	0.8423
621	45	YP	yellow-poplar	Liriodendron	tulipifera		4.6892	-4.9605	20307	0.8479	0.1826	4.5324	-4.8392	0.0016	20306	0.8531
650	46	MG	magnolia sp.	Magnolia	sp.	652	4.4004	-4.7519	997	0.7838	0.2577	4.1971	-4.6635	0.0025	996	0.787
651	47	CT	cucumbertree	Magnolia	acuminata		4.6067	-5.203	405	0.8283	0.1877	4.4325	-5.1486	0.0022	404	0.8325
652	48	MS	southern magnolia	Magnolia	grandiflora		4.4004	-4.7519	997	0.7838	0.2577	4.1971	-4.6635	0.0025	996	0.787
653	49	MV	sweetbay	Magnolia	virginiana		4.3609	-4.1423	7764	0.8292	0.2459	4.1683	-4.0308	0.0024	7763	0.8317
654	50	ML	bigleaf magnolia	Magnolia	macrophylla	652	4.4004	-4.7519	997	0.7838	0.2577	4.1971	-4.6635	0.0025	996	0.787
660	51	AP	apple sp.	Malus	sp.		3.9678	-3.251	81	0.6604	0.3008	3.9212	-3.2382	0.0006	80	0.6606
680	52	MB	mulberry sp.	Morus	sp.		3.9613	-3.1993	583	0.4238	0.3214	3.8682	-3.1505	0.0011	582	0.4252
691	53	WT	water tupelo	Nyssa	aquatica		4.433	-4.5383	7055	0.5968	0.2819	4.2493	-4.4617	0.0023	7054	0.5999
693	54	BG	blackgum, black tupelo	Nyssa	sylvatica		4.3802	-4.7903	12320	0.8274	0.2822	4.0808	-4.5799	0.0036	12319	0.8325
694	55	TS	swamp tupelo, swamp b.gum	Nyssa	sylvatica var. biflora		4.4334	-4.5709	21179	0.8274	0.2638	4.1611	-4.4757	0.0038	21178	0.831
701	56	HH	eastern hophornbeam,	Ostrya	virginiana		4.0322	-3.0833	993	0.6221	0.2537	3.8302	-2.9514	0.0023	992	0.6267
711	57	SD	sourwood	Oxydendrum	arboreum		4.1352	-3.745	6513	0.7278	0.2503	4.0378	-3.7006	0.0013	6512	0.7289
721	58	RA	redbay	Persea	borbonia		4.0965	-3.925	2259	0.7138	0.266	3.9714	-3.8978	0.0018	2258	0.7154
731	59	SY	sycamore	Platanus	occidentalis		4.6355	-5.2776	2022	0.5408	0.242	4.4506	-5.1597	0.0017	2021	0.5561

740	60	CW	cottonwood	Populus	sp.		4.9396	-8.1838	1016	0.6732	0.2194	4.3113	-7.5846	0.0066	1015	0.713
743	61	BT	bigtooth aspen	Populus	grandidentata	740	4.9396	-8.1838	1016	0.6732	0.2194	4.3113	-7.5846	0.0066	1015	0.713
762	62	BC	black cherry	Prunus	serotina		4.3286	-4.0922	3509	0.7703	0.2525	4.065	-3.9507	0.0034	3508	0.7762
802	63	WO	white oak	Quercus	alba		4.5463	-5.2287	28794	0.792	0.1963	4.297	-5.0976	0.0033	28793	0.8016
806	64	SO	scarlet oak	Quercus	coccinea		4.5225	-4.9401	6303	0.7914	0.1788	4.3418	-4.8664	0.0024	6302	0.7988
812	65	SK	southern red oak	Quercus	falcata var. falcata		4.5142	-5.2205	14135	0.7802	0.2064	4.2202	-4.9903	0.0036	14134	0.7901
813	66	CB	cherrybark oak, swamp red o.	Quercus	falcata		4.7342	-6.2674	4365	0.6521	0.1955	4.3313	-5.9581	0.0044	4364	0.6825
819	67	TO	turkey oak	Quercus	laevis		3.9365	-4.4599	4140	0.7395	0.2727	3.6203	-4.4462	0.0059	4139	0.7497
820	68	LK	laurel oak	Quercus	laurifolia		4.4375	-4.6654	8771	0.8402	0.2279	4.1316	-4.5375	0.004	8770	0.8474
822	69	OV	overcup oak	Quercus	lyrata		4.571	-6.0922	3055	0.6212	0.2165	4.2405	-5.9586	0.0039	3054	0.6433
824	70	BJ	blackjack oak	Quercus	marilandica		3.9191	-4.3503	4481	0.7463	0.3049	3.7805	-4.2747	0.002	4480	0.748
825	71	SN	swamp chestnut oak	Quercus	michauxii		4.6135	-5.7613	1574	0.8097	0.2284	4.3255	-5.5878	0.0033	1573	0.8171
826	72	CK	chinkapin oak	Quercus	muehlenbergii		4.342	-5.1193	873	0.3892	0.261	4.083	-5.0726	0.0038	872	0.4129
827	73	WK	water oak	Quercus	nigra		4.5577	-4.9595	26052	0.8116	0.2307	4.1037	-4.5713	0.0051	26051	0.8281
832	74	CO	chestnut oak	Quercus	prinus		4.4618	-4.8786	12630	0.7236	0.1834	4.2015	-4.747	0.0036	12629	0.7484
833	75	RO	northern red oak	Quercus	rubra		4.5202	-4.8896	8635	0.7033	0.2009	4.1936	-4.8033	0.0042	8634	0.7277
834	76	QS	Shumard oak	Quercus	shumardii		4.6106	-5.438	525	0.67	0.2151	4.2387	-5.0205	0.0033	524	0.7136
835	77	PO	post oak	Quercus	stellata		4.2496	-4.8061	15919	0.5402	0.2642	3.8569	-4.6043	0.0054	15918	0.5747
837	78	BO	black oak	Quercus	velutina		4.4747	-4.8698	10400	0.6543	0.2211	4.0945	-4.734	0.005	10399	0.6753
838	79	LO	live oak	Quercus	virginiana		4.2959	-5.3332	3309	0.8637	0.2342	3.9509	-5.199	0.0052	3308	0.8708
901	80	BK	black locust	Robinia	psuedoacacia		4.4299	-4.992	2221	0.5552	0.2891	4.2721	-4.8979	0.002	2220	0.5591
920	81	WI	willow	Salix	sp.		4.4911	-5.7928	2288	0.4906	0.3213	4.0876	-5.3897	0.0046	2287	0.5011
931	82	SS	sassafras	Sassafras	albidum		4.3383	-4.5018	1703	0.7493	0.2998	4.0208	-4.2722	0.0038	1702	0.7553
950	83	BW	basswood	Tilia	sp.		4.582	-5.0903	830	0.807	0.2069	4.4622	-5.0639	0.0015	829	0.8088
970	84	EL	elm	Ulmus	sp.		4.3744	-4.5257	3838	0.8514	0.2442	4.1371	-4.4469	0.0032	3837	0.8545
971	85	WE	winged elm	Ulmus	alata		4.5992	-7.7428	2714	0.4679	0.2517	4.099	-7.4777	0.0061	2713	0.527
972	86	AE	American elm	Ulmus	americana		4.6008	-7.2732	2150	0.504	0.241	4.3456	-7.1811	0.003	2149	0.5182
975	87	RL	slippery elm	Ulmus	rubra		4.6238	-7.4847	845	0.4922	0.2577	4.3885	-7.3729	0.0027	844	0.5039
1	88	OS	softwoods, misc.			126	4.3898	-5.7183	872	0.6704	0.2593	4.3039	-5.695	0.0015	871	0.6721
4	89	OH	hardwoods, misc.				3.9392	-3.4279	1522	0.523	0.3622	3.9695	-3.4542	-0.0004	1521	0.5231
999	90	OT	unknown or not listed				3.9089	-3.0149	741	0.429	0.3711	4.0769	-3.1117	-0.002	740	0.4324

A4.-Crown width equation information

Species	SN	SN				Uses coeff.	Equation Coefficients			O=Open		
Code	Number	Code	Common name	Genus	Species	from species	b0	b1	b2	F=For.	Lit. Ref.	Notes
10	1	FR	fir sp.	Abies	sp.		0.327	5.116	0.5035	O	Ek 1974	
60	2	JU	redcedar	Juniperus	sp.	241	3.496	1.093	1	O	Ek 1974	
90	3	PI	spruce	Picea	sp.		3.594	1.963	0.882	O	Ek 1974	
107	4	PU	sand pine	Pinus	clausa	121	0.3707	2.1583	1	O	Smith et al. 1992	Table 2(metric);converted to Eng.
110	5	SP	shortleaf pine	Pinus	echinata		2.966	1.4038	1	F	Gering 1995	
111	6	SA	slash pine	Pinus	elliottii	121	0.3707	2.1583	1	O	Smith et al. 1992	Table 2(metric);converted to Eng.
115	7	SR	spruce pine	Pinus	glabra	121	0.3707	2.1583	1	O	Smith et al. 1992	Table 2(metric);converted to Eng.
121	8	LL	longleaf pine	Pinus	palustris		0.3707	2.1583	1	O	Smith et al. 1992	Table 2(metric);converted to Eng.
123	9	TM	Table Mountain pine	Pinus	pungens	110	2.966	1.4038	1	F	Gering 1995	
126	10	PP	pitch pine	Pinus	rigida	110	2.966	1.4038	1	F	Gering 1995	
128	11	PD	pond pine	Pinus	serotina	121	0.3707	2.1583	1	O	Smith et al. 1992	Table 2(metric);converted to Eng.
129	12	WP	eastern white pine	Pinus	strobus		1.62	3.197	0.7981	O	Ek 1974	
131	13	LP	loblolly pine	Pinus	taeda		2.966	1.4038	1	F	Gering 1995	
132	14	VP	Virginia pine	Pinus	virginiana	110	2.966	1.4038	1	F	Gering 1995	
221	15	BY	baldcypress	Taxodium	distichum v. distichum	241	3.496	1.093	1	O	Ek 1974	
222	16	PC	pondcypress	Taxodium	distichum v. nutans	241	3.496	1.093	1	O	Ek 1974	
260	17	HM	hemlock	Tsuga	sp.		0.523	1.632	1	O	Ek 1974	
311	18	FM	Florida maple	Acer	barbatum	316	0	4.776	0.7656	O	Ek 1974	
313	19	BE	boxelder	Acer	negundo	316	0	4.776	0.7656	O	Ek 1974	
316	20	RM	red maple	Acer	rubrum		0	4.776	0.7656	O	Ek 1974	
317	21	SV	silver maple	Acer	saccharinum	316	0	4.776	0.7656	O	Ek 1974	
318	22	SM	sugar maple	Acer	saccharum		0.868	4.15	0.7514	O	Ek 1974	
330	23	BU	buckeye, horsechestnut	Aesculus	sp.	400	1.0887	2.0769	1	F	Gering 1995	
370	24	BB	birch sp.	Betula	sp.	375	3.639	1.953	1	O	Ek 1974	
372	25	SB	sweet birch, black birch	Betula	lenta	375	3.639	1.953	1	O	Ek 1974	
391	26	AH	American hornbeam,	Carpinus	caroliniana	972	3.36	0.776	1	F	Francis 1986	Table 3.
400	27	HI	hickory sp.	Carya	sp.		1.0887	2.0769	1	F	Gering 1995	
450	28	CA	catalpa	Catalpa	sp.	318	0.868	4.15	0.7514	O	Ek 1974	
460	29	HB	hackberry sp.	Celtis	sp.		6.61	0.486	1	F	Francis 1986	Table 3.
471	30	RD	eastern redbud	Cercis	canadensis	316	0	4.776	0.7656	O	Ek 1974	
491	31	DW	flowering dogwood	Cornus	florida	316	0	4.776	0.7656	O	Ek 1974	
521	32	PS	common persimmon	Diospyros	virginiana	316	0	4.776	0.7656	O	Ek 1974	
531	33	AB	American beech	Fagus	grandifolia	318	0.868	4.15	0.7514	O	Ek 1974	
540	34	AS	ash	Fraxinus	sp.	541	2.326	2.839	1	O	Ek 1974	
541	35	WA	white ash, American ash	Fraxinus	americana		2.326	2.839	1	O	Ek 1974	
543	36	BA	black ash	Fraxinus	nigra	544	3.1	0.771	1	F	Francis 1986	Table 3.
544	37	GA	green ash	Fraxinus	pennsylvanica		3.1	0.771	1	F	Francis 1986	Table 3.
552	38	HL	honeylocust	Gleditsia	triacanthos	602	4.901	2.48	1	O	Ek 1974	
555	39	LB	loblolly-bay	Gordonia	lasianthus	602	4.901	2.48	1	O	Ek 1974	
580	40	HA	silverbell	Halesia	sp.	602	4.901	2.48	1	O	Ek 1974	
591	41	HY	American holly	Ilex	opaca	316	0	4.776	0.7656	O	Ek 1974	
601	42	BN	butternut	Juglans	cinerea	602	4.901	2.48	1	O	Ek 1974	
602	43	WN	black walnut	Juglans	nigra		4.901	2.48	1	O	Ek 1974	
611	44	SU	sweetgum	Liquidambar	styraciflua		2.35	0.735	1	F	Francis 1986	Table 3.
621	45	YP	yellow-poplar	Liriodendron	tulipifera		2.9924	1.7122	1	F	Gering 1995	
650	46	MG	magnolia,sp.	Magnolia	sp.	621	2.9924	1.7122	1	F	Gering 1995	

651	47	CT	cucumbertree	Magnolia	acuminata	621	2.9924	1.7122	1	F	Gering 1995	
652	48	MS	southern magnolia	Magnolia	grandiflora	621	2.9924	1.7122	1	F	Gering 1995	
653	49	MV	sweetbay	Magnolia	virginiana	621	2.9924	1.7122	1	F	Gering 1995	
654	50	ML	bigleaf magnolia	Magnolia	macrophylla	621	2.9924	1.7122	1	F	Gering 1995	
660	51	AP	apple sp.	Malus	sp.	316	0	4.776	0.7656	O	Ek 1974	
680	52	MB	mulberry sp.	Morus	sp.	316	0	4.776	0.7656	O	Ek 1974	
691	53	WT	water tupelo	Nyssa	aquatica	544	3.1	0.771	1	F	Francis 1986	Table 3.
693	54	BG	blackgum, black tupelo	Nyssa	sylvatica	544	3.1	0.771	1	F	Francis 1986	Table 3.
694	55	TS	swamp tupelo, swamp b.gum	Nyssa	sylvatica v. biflora	544	3.1	0.771	1	F	Francis 1986	Table 3.
701	56	HH	eastern hophornbeam,	Ostrya	virginiana	972	3.36	0.776	1	F	Francis 1986	Table 3.
711	57	SD	sourwood	Oxydendrum	arboreum	972	3.36	0.776	1	F	Francis 1986	Table 3.
721	58	RA	redbay	Persea	borbonia	621	2.9924	1.7122	1	F	Gering 1995	
731	59	SY	sycamore	Platanus	occidentalis	318	0.868	4.15	0.7514	O	Ek 1974	
740	60	CW	cottonwood	Populus	sp.		2.934	2.538	0.8617	O	Ek 1974	
743	61	BT	bigtooth aspen	Populus	grandidentata		0.075	5.577	0.5996	O	Ek 1974	
762	62	BC	black cherry	Prunus	serotina		0.621	7.059	0.5441	O	Ek 1974	
802	63	WO	white oak	Quercus	alba		3.5	1.7	1	F	Minckler [&G] 1970	Good site; codominant trees
806	64	SO	scarlet oak	Quercus	coccinea		3.3	1.8	1	F	Minckler [&G] 1970	Avg site; codominant trees
812	65	SK	southern red oak	Quercus	falcata v. falcata	833	5.3	1.6	1	F	Minckler [&G] 1970	Good site; codominant trees
813	66	CB	cherrybark oak, swamp red o.	Quercus	falcata v. pagodifolia	806	3.3	1.8	1	F	Minckler [&G] 1970	Avg site; codominant trees
819	67	TO	turkey oak	Quercus	laevis	806	3.3	1.8	1	F	Minckler [&G] 1970	Avg site; codominant trees
820	68	LK	laurel oak	Quercus	laurifolia	831	1.33	0.832	1	F	Francis 1986	Table 3.
822	69	OV	overcup oak	Quercus	lyrata		3.95	0.709	1	F	Francis 1986	Table 3.
824	70	BJ	blackjack oak	Quercus	marilandica	837	1.6	1.7	1	F	Minckler [&G] 1970	Avg site; codominant trees
825	71	SN	swamp chestnut oak	Quercus	michauxii	802	3.5	1.7	1	F	Minckler [&G] 1970	Good site; codominant trees
826	72	CK	chinkapin oak	Quercus	muehlenbergii	823	0.942	3.539	0.7952	O	Ek 1974	
827	73	WK	water oak	Quercus	nigra	831	1.33	0.832	1	F	Francis 1986	Table 3.
832	74	CO	chestnut oak	Quercus	prinus	802	3.5	1.7	1	F	Minckler [&G] 1970	Good site; codominant trees
833	75	RO	northern red oak	Quercus	rubra		5.3	1.6	1	F	Minckler [&G] 1970	Good site; codominant trees
834	76	QS	Shumard oak	Quercus	shumardii	833	5.3	1.6	1	F	Minckler [&G] 1970	Good site; codominant trees
835	77	PO	post oak	Quercus	stellata	822	3.95	0.709	1	F	Francis 1986	Table 3.
837	78	BO	black oak	Quercus	velutina		1.6	1.7	1	F	Minckler [&G] 1970	Avg site; codominant trees
838	79	LO	live oak	Quercus	virginiana	831	1.33	0.832	1	F	Francis 1986	Table 3.
901	80	BK	black locust	Robinia	psuedoacacia	602	4.901	2.48	1	O	Ek 1974	
920	81	WI	willow	Salix	sp.	972	3.36	0.776	1	F	Francis 1986	Table 3.
931	82	SS	sassafras	Sassafras	albidum	316	0	4.776	0.7656	O	Ek 1974	
950	83	BW	basswood	Tilia	sp.		0.135	3.703	0.7307	O	Ek 1974	
970	84	EL	elm	Ulmus	sp.	972	3.36	0.776	1	F	Francis 1986	Table 3.
971	85	WE	winged elm	Ulmus	alata	972	3.36	0.776	1	F	Francis 1986	Table 3.
972	86	AE	American elm	Ulmus	americana		3.36	0.776	1	F	Francis 1986	Table 3.
975	87	RL	slippery elm	Ulmus	rubra	972	3.36	0.776	1	F	Francis 1986	Table 3.
1	88	OS	softwoods, misc.			241	3.496	1.093	1	O	Ek 1974	
4	89	OH	hardwoods, misc.			316	0	4.776	0.7656	O	Ek 1974	
999	90	OT	unknown or not listed			316	0	4.776	0.7656	O	Ek 1974	

A5. Large tree diameter growth

Species	SN	SN	Common	MISCELLANEOUS INFORMATION			BASE REGRESSION COEFFICIENTS									
Number	Number	Code	Name	MAP TO->	BASE-EUC	BASE-FT	INTERCEP	LNDBHC	DBHC2	LNCRWN	ISIOWN	TANSLP	FCOS	FSIN	HREL	PLTTBAC	PNTBALCX
10	1	FR	fir sp.	SP260	PVM221	FTUPOK	-2.2679	1.4425	-0.0005	0.5685	-0.0012	-0.2414	0.0665	0.0870	-0.4038	-0.0008	-0.0025
60	2	JU	redcedar		PVP231A	FTUPOK	-1.8644	1.4031	-0.0012	0.2736	-0.0004	-0.2320	0.0775	-0.0258	0.1774	-0.0036	-0.0019
90	3	PI	spruce	SP260	PVM221	FTUPOK	-2.2679	1.4425	-0.0005	0.5685	-0.0012	-0.2414	0.0665	0.0870	-0.4038	-0.0008	-0.0025
107	4	PU	sand pine		PVP232	FTYLPN	-3.7915	1.7962	-0.0051	0.9022	-0.0020	0.5014	-1.7881	-1.2315		-0.0053	-0.0032
110	5	SP	shortleaf pine		PVP231B	FTYLPN	-0.0089	1.2382	-0.0012	0.0531	0.0047	-0.7047	0.1277	0.0284	0.0403	-0.0044	-0.0033
111	6	SA	slash pine		PVP232	FTYLPN	-1.6417	1.4611	-0.0025	0.2659	0.0069	-0.0185	-0.1932	-0.2510	0.0691	-0.0029	-0.0049
115	7	SR	spruce pine		PVP232	FTLOHD	-2.4312	1.6917	-0.0009	0.5886	0.0001	-0.3243	0.5269	0.0099	-0.3262	-0.0018	-0.0014
121	8	LL	longleaf pine		PVP232	FTYLPN	-1.3311	1.0981	-0.0018	0.1845	0.0088	0.2252	0.0869	0.1074	0.3880	-0.0022	-0.0029
123	9	TM	Table Mountain pine	SP132	PVP231A	FTYLPN	-2.6008	1.5254	-0.0035	0.6157	0.0010	-0.2178	0.0188	-0.0521	0.0596	-0.0023	-0.0027
126	10	PP	pitch pine		PVM221	FTUPHD	-3.6391	1.3974	-0.0017	0.7394	0.0087	-0.3172	0.0835	0.1507	-0.1932	-0.0023	-0.0022
128	11	PD	pond pine		PVP232	FTYLPN	-2.3531	1.4256	-0.0017	0.4558	0.0079	0.6850	-2.9079	1.6834	-0.1982	-0.0030	-0.0045
129	12	WP	eastern white pine		PVM221	FTUPHD	-3.4978	1.3395	-0.0010	0.7591	0.0042	-0.3727	-0.0852	-0.0356	0.6052	-0.0009	-0.0041
131	13	LP	loblolly pine		PVP232	FTYLPN	0.2222	1.1630	-0.0009	0.0285	0.0050	-0.7593	0.1854	-0.0728	0.0069	-0.0034	-0.0042
132	14	VP	Virginia pine		PVP231A	FTYLPN	-2.6008	1.5254	-0.0035	0.6157	0.0010	-0.2178	0.0188	-0.0521	0.0596	-0.0023	-0.0027
221	15	BY	baldcypress		PVP232	FTLOHD	-1.7360	1.5056	-0.0001	0.1324	0.0040	-0.5606	-0.4281	-0.7395	-0.1196	-0.0005	-0.0008
222	16	PC	pondcypress		PVP232	FTLOHD	-4.2250	1.8317	-0.0006	0.4462	0.0060	2.3567	-8.6391	5.6155	-0.1258	-0.0002	-0.0006
260	17	HM	hemlock		PVM221	FTUPOK	-2.2679	1.4425	-0.0005	0.5685	-0.0012	-0.2414	0.0665	0.0870	-0.4038	-0.0008	-0.0025
311	18	FM	Florida maple		PVP231A	FTLOHD	-1.6858	1.4545	-0.0008	0.2424	0.0044	-0.3398	-0.2049	-0.1471	-0.1408	-0.0033	-0.0019
313	19	BE	boxelder		PVP234	FTLOHD	-0.8710	1.2179	-0.0001	0.2401	0.0000	-0.6132	0.3159	-0.2371	0.0712	-0.0012	-0.0008
316	20	RM	red maple		PVP232	FTLOHD	-2.2605	1.4498	-0.0009	0.3613	0.0034	-0.0976	-0.0698	0.0942	0.2824	-0.0021	-0.0014
317	21	SV	silver maple	SP316	PVP232	FTLOHD	-2.2605	1.4498	-0.0009	0.3613	0.0034	-0.0976	-0.0698	0.0942	0.2824	-0.0021	-0.0014
318	22	SM	sugar maple		PVP222	FTUPOK	-2.3134	1.3501	-0.0008	0.3948	-0.0005	-0.0325	-0.0095	0.0056	0.6318	-0.0014	-0.0015
330	23	BU	buckeye, horsechestnut		PVM221	FTNOHD	-1.8762	1.1970	-0.0008	0.1839	0.0103	-0.1781	0.1872	-0.1085	0.5477	-0.0042	-0.0006
370	24	BB	birch sp.		PVM221	FTLOHD	-1.0921	1.0249	-0.0007	0.2068	0.0024	-0.1928	-0.1124	0.1133	0.4894	-0.0020	-0.0018
372	25	SB	sweet birch, black birch	SP370	PVM221	FTLOHD	-1.0921	1.0249	-0.0007	0.2068	0.0024	-0.1928	-0.1124	0.1133	0.4894	-0.0020	-0.0018
391	26	AH	American hornbeam,		PVP232	FTLOHD	-1.2811	1.3356		0.1111	0.0053	-0.2245	0.0320	-0.1607	-0.2446	-0.0039	-0.0006
400	27	HI	hickory sp.		PVP231A	FTUPOK	-2.7283	1.5484	-0.0008	0.2038	0.0044	-0.2458	0.0558	0.0806	0.5700	-0.0033	-0.0010
450	28	CA	catalpa	SP740	PVP234	FTLOHD	-1.0690	1.1642		0.0843	0.0097	0.0757	-0.6011	-0.7571	0.5013	-0.0010	-0.0013
460	29	HB	hackberry sp.		PVP234	FTLOHD	-0.8332	1.1906		0.1934	-0.0001	-0.1790	0.0397	-0.0716	0.5087	-0.0018	-0.0018
471	30	RD	eastern redbud		PVP231A	FTUPHD	-1.0625	1.1741		0.2399	-0.0059	-0.3918	0.0391	-0.0384	0.4119	-0.0011	-0.0028
491	31	DW	flowering dogwood		PVP231A	FTUPOK	-2.5407	1.2931	-0.0009	0.3685	0.0043	-0.2827	-0.0840	0.1047	-0.6112	-0.0031	-0.0012
521	32	PS	common persimmon		PVP232	FTYLPN	-2.5245	1.4799	-0.0015	0.2892	0.0034	-0.3278	-0.2007	-0.1459	0.2436	-0.0013	-0.0028
531	33	AB	American beech		PVP232	FTUPOK	-1.2519	1.3493	-0.0004	0.1931	-0.0003	-0.3804	0.1604	-0.0884	0.2793	-0.0025	-0.0012
540	34	AS	ash		PVP232	FTLOHD	-2.9545	1.4617		0.3778	0.0071	-0.6197	0.0201	-0.0208	0.1854	-0.0020	-0.0008
541	35	WA	white ash, American ash		PVP222	FTUPOK	-1.3153	1.2163	-0.0001	0.0879	0.0034	0.0183	-0.0011	-0.0216	0.4872	-0.0008	-0.0013
543	36	BA	black ash	SP544	PVP234	FTLOHD	-0.8977	1.2431		0.0902	-0.0005	-0.1581	-0.1382	-0.0812	0.4966	0.0000	-0.0015
544	37	GA	green ash		PVP234	FTLOHD	-0.8977	1.2431		0.0902	-0.0005	-0.1581	-0.1382	-0.0812	0.4966	0.0000	-0.0015
552	38	HL	honeylocust		PVP234	FTLOHD	-0.3149	0.9272		0.1032	0.0030	-0.1078	0.9588	0.8231	0.5384	-0.0012	-0.0025
555	39	LB	loblolly-bay		PVP232	FTLOHD	-2.5146	1.4597	-0.0013	0.6542	-0.0036	-3.4691	-10.1495	1.4044	0.1068	-0.0003	-0.0022
580	40	HA	silverbell		PVM221	FTUPOK	-2.3523	1.7469		0.2915	0.0032	0.3357	-0.6578	0.5858	-1.7716		-0.0008
591	41	HY	American holly		PVP232	FTLOHD	-1.9819	1.4563	-0.0021	0.2152	0.0042	-0.3036	0.2105	-0.1594	-0.4141	-0.0031	-0.0004
601	42	BN	butternut	SP602	PVP222	FTUPHD	-2.3542	1.0502	-0.0002	0.4253	0.0013	0.1334	-0.2097	0.0149	0.6163	-0.0006	-0.0006
602	43	WN	black walnut		PVP222	FTUPHD	-2.3542	1.0502	-0.0002	0.4253	0.0013	0.1334	-0.2097	0.0149	0.6163	-0.0006	-0.0006
611	44	SU	sweetgum		PVP232	FTLOHD	-1.3241	1.3959	-0.0005	0.1455	0.0020	-0.5030	0.1415	0.0035	0.2568	-0.0030	-0.0019
621	45	YP	yellow-poplar		PVP231A	FTUPHD	-2.5134	1.4954	-0.0008	0.5301	0.0007	-0.3218	-0.0016	0.0648	0.1617	-0.0018	-0.0022
650	46	MG	magnolia sp.	SP653	PVP232	FTLOHD	-2.5168	1.4542	-0.0009	0.2523	0.0072	-0.0256	0.1496	0.0324	0.2437	-0.0013	-0.0011
651	47	CT	cucumbertree		PVM221	FTUPOK	-1.2396	1.0634	-0.0001	0.2431	-0.0031	-0.3085	-0.0715	0.2657	0.5332	0.0007	-0.0016
652	48	MS	southern magnolia		PVP232	FTLOHD	-1.4779	1.1265	-0.0003	0.1343	0.0059	0.4057	-0.0636	0.0171	0.5390	-0.0027	-0.0009
653	49	MV	sweetbay		PVP232	FTLOHD	-2.5168	1.4542	-0.0009	0.2523	0.0072	-0.0256	0.1496	0.0324	0.2437	-0.0013	-0.0011
654	50	ML	bigleaf magnolia	SP652	PVP232	FTLOHD	-1.4779	1.1265	-0.0003	0.1343	0.0059	0.4057	-0.0636	0.0171	0.5390	-0.0027	-0.0009
660	51	AP	apple sp.	SP680	PVP231B	FTLOHD	-1.7462	1.2341	0.0000	0.2855	0.0026	-0.8729	-0.0789	-0.0236	0.1806	-0.0017	-0.0001
680	52	MB	mulberry sp.		PVP231B	FTLOHD	-1.7462	1.2341	0.0000	0.2855	0.0026	-0.8729	-0.0789	-0.0236	0.1806	-0.0017	-0.0001
691	53	WT	water tupelo		PVP232	FTLOHD	-2.7218	1.5992	-0.0002	0.3513	0.0018	-0.0233	2.0736	-2.2132	0.1339	-0.0004	-0.0003
693	54	BG	blackgum, black tupelo		PVP232	FTUPOK	-1.5085	1.3064	-0.0006	0.1124	0.0034	-0.2966	-0.1320	-0.0316	0.1212	-0.0025	-0.0010
694	55	TS	swamp tupelo, swamp b.gum		PVP232	FTLOHD	-2.5557	1.3030		0.3193	0.0065	-0.1301	-0.0537	0.1495	-0.1091	-0.0011	-0.0012
701	56	HH	eastern hophornbeam,		PVP232	FTLOHD	-1.4320	1.4523	-0.0015	0.0611	0.0049	-0.4227	-0.2365	0.2011	-0.2089	-0.0031	
711	57	SD	sourwood		PVP231A	FTUPOK	-3.1800	1.3558	-0.0008	0.5322	0.0052	-0.2927	0.0505	-0.0087	0.0770	-0.0024	-0.0008
721	58	RA	redbay		PVP232	FTLOHD	-2.0966	1.2547		0.3441	0.0027	-1.7622	1.2026	0.3839	0.1768	-0.0026	-0.0008
731	59	SY	sycamore		PVP234	FTLOHD	-1.0130	1.2729	-0.0002	0.2345	0.0004	-0.0925	0.4946	-0.3677	0.3325	-0.0003	-0.0016
740	60	CW	cottonwood		PVP234	FTLOHD	-1.0690	1.1642		0.0843	0.0097	0.0757	-0.6011	-0.7571	0.5013	-0.0010	-0.0013
743	61	BT	bigtooth aspen	SP740	PVP234	FTLOHD	-1.0690	1.1642		0.0843	0.0097	0.0757	-0.6011	-0.7571	0.5013	-0.0010	-0.0013

762	62	BC	black cherry		PVP231A	FTUPOK	-2.6100	1.2203	-0.0002	0.5207	0.0039	-0.0717	-0.0282	-0.1807	0.1814	-0.0025	-0.0019
802	63	WO	white oak		PVP231A	FTUPOK	-1.6083	1.4686	-0.0008	0.1395	0.0045	-0.2233	0.0085	-0.0329	0.3584	-0.0028	-0.0023
806	64	SO	scarlet oak		PVP231A	FTUPOK	-2.2843	1.5699	-0.0006	0.2724	0.0051	-0.2043	-0.0049	0.0488	0.2069	-0.0012	-0.0013
812	65	SK	southern red oak		PVP231B	FTUPOK	-0.7836	1.4325	-0.0004	0.0445	0.0030	-0.3121	0.0512	0.1094	0.2414	-0.0033	-0.0019
813	66	CB	cherrybark oak, swamp red o.		PVP231B	FTLOHD	-0.2955	1.2399	-0.0002	0.0206	0.0038	-0.1059	0.1913	-0.3243	0.4315	-0.0023	-0.0018
819	67	TO	turkey oak		PVP232	FTUPOK	-2.6981	1.6221	-0.0017	0.3549	0.0007	-1.0848	-0.1969	0.5146	-0.0339	-0.0028	-0.0029
820	68	LK	laurel oak		PVP232	FTLOHD	-1.5613	1.3355	-0.0004	0.2462	0.0047	-0.7045	0.4218	0.2965	0.3818	-0.0015	-0.0023
822	69	OV	overcup oak		PVP234	FTLOHD	-0.9472	1.3764	-0.0005	0.0997	0.0013	-0.6669	-0.9779	-0.3113	0.4279	-0.0014	-0.0026
824	70	BJ	blackjack oak		PVP232	FTUPOK	-1.9489	1.6114	-0.0008	0.1357	0.0027	-0.0718	-0.1474	0.2419	0.0567	-0.0036	-0.0018
825	71	SN	swamp chestnut oak		PVP232	FTLOHD	-1.3217	1.6405	-0.0003	0.0382	0.0058	-1.2511	-0.3422	0.0778	0.0865	-0.0042	-0.0020
826	72	CK	chinkapin oak		PVP222	FTUPOK	-2.2235	0.9374	0.0002	0.2863	0.0086	-0.0653	-0.0088	0.4719	0.7333	-0.0003	-0.0017
827	73	WK	water oak		PVP232	FTLOHD	-0.8455	1.4884	-0.0003	0.0533	0.0053	-0.1511	0.0735	-0.1657	0.1309	-0.0035	-0.0016
832	74	CO	chestnut oak		PVM221	FTUPOK	-2.9007	1.3474	-0.0005	0.3001	0.0084	-0.1339	-0.0561	0.0039	0.5970	-0.0011	-0.0015
833	75	RO	northern red oak		PVM221	FTUPOK	-2.7326	1.4995	-0.0007	0.3448	0.0046	-0.1749	-0.0425	0.1103	0.4661	-0.0009	-0.0011
834	76	QS	Shumard oak		PVP231B	FTUPOK	-0.3287	1.2825	-0.0004	0.0716	-0.0012	-0.6926	0.1764	0.0692	0.4556	-0.0005	-0.0021
835	77	PO	post oak		PVP231B	FTUPOK	-1.4303	1.2937	-0.0005	0.0479	0.0055	-0.4089	0.0092	0.0545	0.5146	-0.0033	-0.0014
837	78	BO	black oak		PVP222	FTUPOK	-2.3458	1.4503	-0.0007	0.2514	0.0059	-0.3078	-0.0336	0.0548	0.5275	-0.0022	-0.0009
838	79	LO	live oak		PVP232	FTLOHD	-3.6407	1.4485	-0.0002	0.5492	0.0094	-0.0997	-0.1742	-0.1028	0.0737	-0.0032	-0.0008
901	80	BK	black locust		PVM221	FTUPHD	-1.3079	0.9633		0.2686	0.0037	-0.3354	-0.0848	0.1279	0.3967	-0.0019	-0.0017
920	81	WI	willow		PVP234	FTLOHD	-1.1094	1.1871		0.2021	0.0063	-0.1355	-0.0830	0.0595	0.0940		-0.0011
931	82	SS	sassafras		PVP222	FTUPHD	-1.7451	1.3133	-0.0002	0.2010	0.0042	-0.0133	-0.0217	-0.0700	0.5427	-0.0026	-0.0003
950	83	BW	basswood		PVM221	FTNOHD	-1.8481	1.4242	-0.0015	0.2892	0.0035	-0.5801	0.2357	-0.0559	0.2535	-0.0012	-0.0029
970	84	EL	elm		PVP231A	FTLOHD	-2.3562	1.4794	-0.0005	0.4254	0.0028	-1.0010	-0.0645	-0.1466	-0.0834	-0.0031	-0.0014
971	85	WE	winged elm		PVP231B	FTUPOK	-0.7901	0.9497		0.1003	0.0044	-0.4394	0.2722	0.2483	0.3481	-0.0030	-0.0010
972	86	AE	American elm		PVP234	FTLOHD	-0.5107	1.1648		0.1279	0.0005	-0.4465	0.2287	0.0698	0.5165	-0.0031	-0.0015
975	87	RL	slippery elm		PVP231B	FTLOHD	-0.2292	1.0603		0.1168	-0.0018	0.1588	-0.2161	0.0378	0.4304	-0.0013	-0.0021
1	88	OS	softwoods, misc.	SP060	PVP231A	FTUPOK	-1.8644	1.4031	-0.0012	0.2736	-0.0004	-0.2320	0.0775	-0.0258	0.1774	-0.0036	-0.0019
4	89	OH	hardwoods, misc.	SP701	PVP232	FTLOHD	-1.4320	1.4523	-0.0015	0.0611	0.0049	-0.4227	-0.2365	0.2011	-0.2089	-0.0031	
999	90	OT	unknown or not listed		NONE	NONE	-1.6460	1.4477	-0.0022	0.2410	-0.0033	-1.0800	0.1129	0.1584	0.7197		-0.0025

A5. Continued

Species	SN	SN	Common	MISCELLANEOUS INFORMATION			ECOLOGICAL UNIT PROVINCE CATEGORICAL VARIABLE REGRESSION COEFFICIENTS										
Number	Number	Code	Name	MAP TO->	BASE-EUC	BASE-FT	PVM221	PVM222	PVM231	PVP221	PVP222	PVP231A	PVP231B	PVP232	PVP234	PVP255	PVP411
10	1	FR	fir sp.	SP260	PVM221	FTUPOK				-0.1211		0.0225	-0.0977				
60	2	JU	redcedar		PVP231A	FTUPOK	0.1318	0.2179	0.4370	0.0839	-0.0055		0.4907	0.3995	0.9385	1.0882	
90	3	PI	spruce	SP260	PVM221	FTUPOK				-0.1211		0.0225	-0.0977				
107	4	PU	sand pine		PVP232	FTYLPN								0.0000			
110	5	SP	shortleaf pine		PVP231B	FTYLPN	-0.5694	-0.2527	-0.2657	-0.6945	-0.2851	-0.5046		-0.1133	0.1141	0.0925	
111	6	SA	slash pine		PVP232	FTYLPN						-0.0255	0.3241	0.0000	0.3068		-0.3423
115	7	SR	spruce pine		PVP232	FTLOHD							-0.1558		-0.1122		
121	8	LL	longleaf pine		PVP232	FTYLPN						-0.1751	-0.0678	0.0000	0.1233		
123	9	TM	Table Mountain pine	SP132	PVP231A	FTYLPN	-0.1575			-0.1076	-0.0346		0.0251	-0.1509			
126	10	PP	pitch pine		PVM221	FTUPHD				0.0201	-0.2980	0.2367					
128	11	PD	pond pine		PVP232	FTYLPN											-0.2056
129	12	WP	eastern white pine		PVM221	FTUPHD				-0.0656	-0.4507	0.1020		0.0000			
131	13	LP	loblolly pine		PVP232	FTYLPN	-0.0697	0.5820	0.7901	-0.5848	-0.3641	-0.1833	0.2563	0.0000	0.2818	0.2746	
132	14	VP	Virginia pine		PVP231A	FTYLPN	-0.1575			-0.1076	-0.0346		0.0251	-0.1509			
221	15	BY	baldcypress		PVP232	FTLOHD					0.2302	0.4578	0.1545		0.0219	0.2882	-0.0330
222	16	PC	pondcypress		PVP232	FTLOHD											0.1566
260	17	HM	hemlock		PVM221	FTUPOK				-0.1211		0.0225	-0.0977				
311	18	FM	Florida maple		PVP231A	FTLOHD		0.0450	-0.1217		0.2900		0.4169	0.1631	0.4518		
313	19	BE	boxelder		PVP234	FTLOHD	-0.2029	-0.3544	0.3712	-0.2829	-0.2508	-0.3512	-0.1566	-0.2335		-0.0117	
316	20	RM	red maple		PVP232	FTLOHD	-0.0100	-0.1578	-0.0468	0.1717	0.1704	-0.0317	0.1116		0.2839		-0.3401
317	21	SV	silver maple	SP316	PVP232	FTLOHD	-0.0100	-0.1578	-0.0468	0.1717	0.1704	-0.0317	0.1116		0.2839		-0.3401
318	22	SM	sugar maple		PVP222	FTUPOK	-0.0749	-0.2163		0.0648		-0.2072	-0.1459	0.7079	0.2898		
330	23	BU	buckeye, horsechestnut		PVM221	FTNOHD				0.1682	0.0249	0.0298					
370	24	BB	birch sp.		PVM221	FTLOHD		0.3799	-0.5284	0.3068	0.1676	0.1790	0.3654	0.2370	0.4176	1.1518	
372	25	SB	sweet birch, black birch	SP370	PVM221	FTLOHD		0.3799	-0.5284	0.3068	0.1676	0.1790	0.3654	0.2370	0.4176	1.1518	
391	26	AH	American hornbeam,		PVP232	FTLOHD	-0.2607	-0.1704	-0.3148	-0.1147	0.0436	-0.0909	0.0879		0.2154		
400	27	HI	hickory sp.		PVP231A	FTUPOK	0.0341	-0.2217	-0.1727	0.0425	-0.0127		0.1168	0.1138	0.1839	0.4417	
450	28	CA	catalpa	SP740	PVP234	FTLOHD					-0.0106	-0.3803	-0.0913	-0.1460		-0.2272	
460	29	HB	hackberry sp.		PVP234	FTLOHD	-0.4352	-0.1180	-0.4953	-0.3478	-0.3365	-0.3258	-0.1304	-0.2121		-0.2090	
471	30	RD	eastern redbud		PVP231A	FTUPHD	0.1474	0.1844	-0.0703	0.2811	0.3227		0.4521	0.5523	0.2560	0.5764	
491	31	DW	flowering dogwood		PVP231A	FTUPOK	0.1012	0.3529	0.1663	0.2338	0.1046		0.3597	0.0936	0.4882		
521	32	PS	common persimmon		PVP232	FTYLPN	0.1119	-0.0233	0.2895	0.4809	0.2151	-0.0497	0.2494		0.3638	0.3179	
531	33	AB	American beech		PVP232	FTUPOK	-0.1914	-0.3702	-0.1816	-0.1057	0.0932	0.0069	-0.0036		-0.0313		
540	34	AS	ash		PVP232	FTLOHD	0.4248			-0.1818		0.0732					-0.7956
541	35	WA	white ash, American ash		PVP222	FTUPOK	-0.0825	-0.1491	-0.2417	-0.1467		-0.2086	-0.0156	-0.0042	0.1514	-0.0563	
543	36	BA	black ash	SP544	PVP234	FTLOHD	0.1469	-0.4434	-0.4484	-0.1330	-0.0791	-0.1198	-0.1170	-0.0757		-0.0035	
544	37	GA	green ash		PVP234	FTLOHD	0.1469	-0.4434	-0.4484	-0.1330	-0.0791	-0.1198	-0.1170	-0.0757		-0.0035	
552	38	HL	honeylocust		PVP234	FTLOHD	-0.2566	-0.1495	0.0474	-0.3417	-0.2152	-0.3970	0.0959	-0.0788		0.1153	
555	39	LB	loblolly-bay		PVP232	FTLOHD											
580	40	HA	silverbell		PVM221	FTUPOK						-0.2117					
591	41	HY	American holly		PVP232	FTLOHD	-0.1262			-0.2781	-0.1798	0.0196	0.1632		-0.2838	0.9415	
601	42	BN	butternut	SP602	PVP222	FTUPHD	-0.0711	0.3744	-0.0588	-0.0726		-0.0157	0.3496	0.2551	0.2592	0.3525	
602	43	WN	black walnut		PVP222	FTUPHD	-0.0711	0.3744	-0.0588	-0.0726		-0.0157	0.3496	0.2551	0.2592	0.3525	
611	44	SU	sweetgum		PVP232	FTLOHD	0.2148	-0.0271	-0.0987	0.3114	0.2035	-0.0348	0.1154		0.1294	0.4924	
621	45	YP	yellow-poplar		PVP231A	FTUPHD	-0.0350			0.1148	0.2553		0.0954	0.1131	0.1115		
650	46	MG	magnolia sp.	SP653	PVP232	FTLOHD	-1.7212			-0.4387		-0.3169	0.0149		0.1616		
651	47	CT	cucumbertree		PVM221	FTUPOK		-0.3340		0.3262	-0.1580	-0.0890	0.5875	0.5759	0.5730		
652	48	MS	southern magnolia		PVP232	FTLOHD	-0.1840	-0.7080		-0.9474		-0.2563	-0.1816		0.4935		
653	49	MV	sweetbay		PVP232	FTLOHD	-1.7212			-0.4387		-0.3169	0.0149		0.1616		
654	50	ML	bigleaf magnolia	SP652	PVP232	FTLOHD	-0.1840	-0.7080		-0.9474		-0.2563	-0.1816		0.4935		
660	51	AP	apple sp.	SP680	PVP231B	FTLOHD	0.3526	0.1290	0.2436	0.2691	0.0002	-0.2535		-0.1194	0.0324	0.4986	
680	52	MB	mulberry sp.		PVP231B	FTLOHD	0.3526	0.1290	0.2436	0.2691	0.0002	-0.2535		-0.1194	0.0324	0.4986	
691	53	WT	water tupelo		PVP232	FTLOHD					0.1862	-1.0484	0.0318		-0.0546		
693	54	BG	blackgum, black tupelo		PVP232	FTUPOK	-0.0149	-0.2668	-0.2516	-0.0005	0.0588	-0.1168	0.1389		-0.0314	0.3758	
694	55	TS	swamp tupelo, swamp b.gum		PVP232	FTLOHD						0.0182	0.6882		0.2029		
701	56	HH	eastern hophornbeam,		PVP232	FTLOHD	-0.0415	0.1304	0.2129	0.1107	-0.1305	-0.0259	0.0875		0.0184	0.2551	
711	57	SD	sourwood		PVP231A	FTUPOK	0.0124			0.1604	0.0795		0.2953	0.0573	0.4248		
721	58	RA	redbay		PVP232	FTLOHD							0.7121		0.4893		-0.1476
731	59	SY	sycamore		PVP234	FTLOHD	-0.3084	-0.4689	-0.5736	-0.1640	-0.2919	-0.3128	-0.2044	-0.1674		0.1230	
740	60	CW	cottonwood		PVP234	FTLOHD					-0.0106	-0.3803	-0.0913	-0.1460		-0.2272	

743	61	BT	bigtooth aspen	SP740	PVP234	FTLOHD					-0.0106	-0.3803	-0.0913	-0.1460		-0.2272	
762	62	BC	black cherry		PVP231A	FTUPOK	0.2906	0.1635	-0.1114	0.0602	0.0893		0.2399	0.1259	0.2648	1.9013	
802	63	WO	white oak		PVP231A	FTUPOK	-0.1912	-0.1551	-0.1550	-0.0633	-0.0319		0.1647	0.0319	0.0900	0.4487	
806	64	SO	scarlet oak		PVP231A	FTUPOK	-0.2588			-0.0634	-0.0236		0.0676	0.0871			
812	65	SK	southern red oak		PVP231B	FTUPOK	-0.2945	-0.2678	-0.1135	-0.1462	-0.0787	-0.1429		-0.1371	0.0445	0.1894	
813	66	CB	cherrybark oak, swamp red o.		PVP231B	FTLOHD	-0.3030	-0.5682	-0.0018	-0.3014	-0.1064	-0.1392		0.0001	-0.0357	-0.1984	
819	67	TO	turkey oak		PVP232	FTUPOK						-0.1415	0.9875		1.1097	1.4460	
820	68	LK	laurel oak		PVP232	FTLOHD						-0.1847	0.1833		0.2382	0.7681	-1.3285
822	69	OV	overcup oak		PVP234	FTLOHD			-0.5068		0.0749	-0.0835	0.0453	0.0630		-0.0659	
824	70	BJ	blackjack oak		PVP232	FTUPOK	-0.1726	0.1074	-0.0848	0.1272	-0.0667	-0.0525	0.1785		-0.0372	0.3803	-0.7419
825	71	SN	swamp chestnut oak		PVP232	FTLOHD	-0.2524		-0.2785	-0.2016	0.2224	-0.0534	0.0066		0.0076		
826	72	CK	chinkapin oak		PVP222	FTUPOK	-0.0399	-0.1104	-0.1702	0.0246		0.1269	-0.0106	0.7554	0.4719	0.6063	
827	73	WK	water oak		PVP232	FTLOHD	0.1971	0.1081	-0.0614	-0.3432	-0.0563	-0.1135	0.0761		0.1229	0.2497	-0.2618
832	74	CO	chestnut oak		PVM221	FTUPOK				0.1514	0.2000	0.2043	0.2951	0.0856	0.0809	0.5851	
833	75	RO	northern red oak		PVM221	FTUPOK		0.0238	0.0583	0.0434	0.0362	0.1321	0.1632	0.2054	0.4333		
834	76	QS	Shumard oak		PVP231B	FTUPOK	-0.8546	-0.5904	-0.1603	-0.1907	-0.3291	-0.2371		-0.0891	-0.1909	-0.0368	
835	77	PO	post oak		PVP231B	FTUPOK	-0.0426	-0.2526	-0.2437	-0.1630	-0.1605	-0.0485		-0.0812	0.1596	0.1714	
837	78	BO	black oak		PVP222	FTUPOK	-0.1223	-0.1449	-0.1631	0.0219		-0.0486	0.1514	0.0848	0.3698	-0.0520	
838	79	LO	live oak		PVP232	FTLOHD									0.2684		-0.6395
901	80	BK	black locust		PVM221	FTUPHD		-0.1744	0.1705	0.0167	0.0358	0.0479	0.3719	0.1711	0.2405	0.4446	
920	81	WI	willow		PVP234	FTLOHD	-0.3162			-0.3606	0.0314	0.1510	-0.1203	-0.0597		-0.2031	
931	82	SS	sassafras		PVP222	FTUPHD	-0.1096	0.0687	-0.9819	-0.0664		-0.1532	0.0756	-0.0404	0.3340	0.3935	
950	83	BW	basswood		PVM221	FTNOHD		0.0223	0.3788	0.1953	0.1065	-0.1458	-0.1550	-0.0720	0.9203	0.6449	
970	84	EL	elm		PVP231A	FTLOHD	0.3402	-0.3306	0.2617	0.4314	-0.1072		0.0453	0.0361	-0.3189	0.2710	
971	85	WE	winged elm		PVP231B	FTUPOK	0.1178	-0.2358	-0.4359	-0.0362	-0.2291	0.1257		0.0701	-0.0225	0.2354	
972	86	AE	American elm		PVP234	FTLOHD	-0.3127	-0.0970	-0.3616	-0.1274	-0.2937	-0.4137	-0.1275	-0.0431		0.1199	
975	87	RL	slippery elm		PVP231B	FTLOHD	-0.1671	-0.2930	0.0848	-0.2293	-0.2872	-0.0147		-0.0299	0.2100	-0.3603	
1	88	OS	softwoods, misc.	SP060	PVP231A	FTUPOK	0.1318	0.2179	0.4370	0.0839	-0.0055		0.4907	0.3995	0.9385	1.0882	
4	89	OH	hardwoods, misc.	SP701	PVP232	FTLOHD	-0.0415	0.1304	0.2129	0.1107	-0.1305	-0.0259	0.0875		0.0184	0.2551	
999	90	OT	unknown or not listed		NONE	NONE											

A5. Continued

Species	SN	SN	Common	MISCELLANEOUS INFORMATION			FOREST TYPE GROUP CATEGORICAL VARIABLE REGRESSION COEFFICIENTS							PLANT.
Number	Number	Code	Name	MAP TO->	BASE-EUC	BASE-FT	FTLOHD	FTNOHD	FTOKPN	FTSFHP	FTUPHD	FTUPOK	FTYLPN	COEFF.
10	1	FR	fir sp.	SP260	PVM221	FTUPOK		-0.0233	0.2949	-0.2717	-0.0043		0.0390	
60	2	JU	redcedar		PVP231A	FTUPOK	0.1288	-0.0202	0.0544		0.0792		0.1443	
90	3	PI	spruce	SP260	PVM221	FTUPOK		-0.0233	0.2949	-0.2717	-0.0043		0.0390	
107	4	PU	sand pine		PVP232	FTYLPN	1.2140		0.7512		1.1400	0.2395		0.1738
110	5	SP	shortleaf pine		PVP231B	FTYLPN	0.1064	0.4550	0.0175		0.0668	-0.0402		
111	6	SA	slash pine		PVP232	FTYLPN	0.3259		0.1162		0.1620	0.4107		0.2276
115	7	SR	spruce pine		PVP232	FTLOHD			-0.0990		0.0723	-0.0551	-0.2369	
121	8	LL	longleaf pine		PVP232	FTYLPN	0.0482		0.0889		0.0867	0.1061		0.1108
123	9	TM	Table Mountain pine	SP132	PVP231A	FTYLPN	-0.0590	0.3258	0.0454	0.0920	-0.0043	-0.0678		
126	10	PP	pitch pine		PVM221	FTUPHD		-0.1102	-0.0104	0.0437		-0.3159	0.1168	
128	11	PD	pond pine		PVP232	FTYLPN	0.1877		0.0444		0.4822	0.2965		
129	12	WP	eastern white pine		PVM221	FTUPHD	-0.5852	-0.0622	-0.0737	-0.1990		0.0220	0.0461	0.0981
131	13	LP	loblolly pine		PVP232	FTYLPN	0.1264	-0.1222	0.0508		0.0637	-0.0169		0.2457
132	14	VP	Virginia pine		PVP231A	FTYLPN	-0.0590	0.3258	0.0454	0.0920	-0.0043	-0.0678		
221	15	BY	baldcypress		PVP232	FTLOHD		-0.0508	-0.2015		0.1949	0.0816	-0.3243	
222	16	PC	pondcypress		PVP232	FTLOHD			-0.1968				-0.2418	
260	17	HM	hemlock		PVM221	FTUPOK		-0.0233	0.2949	-0.2717	-0.0043		0.0390	
311	18	FM	Florida maple		PVP231A	FTLOHD		-0.5811	-0.0494		-0.0219	-0.3235	0.3042	
313	19	BE	boxelder		PVP234	FTLOHD		0.1973	-0.0023	-0.3615	0.2133	-0.0034	-0.2522	
316	20	RM	red maple		PVP232	FTLOHD		-0.0086	-0.0917	-0.2265	-0.1157	-0.2339	0.0000	
317	21	SV	silver maple	SP316	PVP232	FTLOHD		-0.0086	-0.0917	-0.2265	-0.1157	-0.2339	0.0000	
318	22	SM	sugar maple		PVP222	FTUPOK	0.1777	0.0811	-0.0078	0.2683	0.0181		-0.9691	
330	23	BU	buckeye, horsechestnut		PVM221	FTNOHD	0.2765				-0.1584	-0.0660		
370	24	BB	birch sp.		PVM221	FTLOHD		-0.0901	-0.2115	-0.1129	-0.1503	-0.2296	-0.1222	
372	25	SB	sweet birch, black birch	SP370	PVM221	FTLOHD		-0.0901	-0.2115	-0.1129	-0.1503	-0.2296	-0.1222	
391	26	AH	American hornbeam,		PVP232	FTLOHD		0.1071	-0.1848		-0.1450	-0.1259	-0.0240	
400	27	HI	hickory sp.		PVP231A	FTUPOK	0.3071	0.1271	0.0751	0.1637	0.1458		0.0910	
450	28	CA	catalpa	SP740	PVP234	FTLOHD			-0.1226		-0.2272	0.4284	-0.1277	
460	29	HB	hackberry sp.		PVP234	FTLOHD		-0.0209	-0.2270		-0.0466	-0.1422	-0.3732	
471	30	RD	eastern redbud		PVP231A	FTUPHD	-0.1318	-0.1591	0.0815			-0.0913	0.0053	
491	31	DW	flowering dogwood		PVP231A	FTUPOK	0.1937	0.0802	0.2278	-0.2073	0.1234		0.3957	
521	32	PS	common persimmon		PVP232	FTYLPN	0.1403	0.0082	-0.0301		0.0647	-0.0637		
531	33	AB	American beech		PVP232	FTUPOK	0.1399	0.0950	0.1124	0.1915	0.0985		0.3019	
540	34	AS	ash		PVP232	FTLOHD		0.0651	-0.0062	0.2434	0.0098	-0.0418	-0.0491	
541	35	WA	white ash, American ash		PVP222	FTUPOK	0.1121	0.2441	-0.0425		0.1993		0.2562	
543	36	BA	black ash	SP544	PVP234	FTLOHD		0.0035	-0.1088		-0.0186	-0.0855	-0.2794	
544	37	GA	green ash		PVP234	FTLOHD		0.0035	-0.1088		-0.0186	-0.0855	-0.2794	
552	38	HL	honeylocust		PVP234	FTLOHD			-0.2283		-0.1705	-0.1787	-0.3432	
555	39	LB	loblolly-bay		PVP232	FTLOHD			-0.0632		-0.2973		0.0650	
580	40	HA	silverbell		PVM221	FTUPOK		-0.0632			-0.1116			
591	41	HY	American holly		PVP232	FTLOHD		-0.0031	-0.0077		-0.0822	-0.1877	-0.0083	
601	42	BN	butternut	SP602	PVP222	FTUPHD	0.1637	-0.1769	-0.1647	-0.5573		-0.1565	-0.2326	
602	43	WN	black walnut		PVP222	FTUPHD	0.1637	-0.1769	-0.1647	-0.5573		-0.1565	-0.2326	
611	44	SU	sweetgum		PVP232	FTLOHD		0.0576	-0.0908	0.4912	-0.1559	-0.1683	0.0585	
621	45	YP	yellow-poplar		PVP231A	FTUPHD	0.0839	0.0574	-0.0552	-0.5000		-0.0907	0.0539	
650	46	MG	magnolia sp.	SP653	PVP232	FTLOHD		-0.3268	-0.0177		-0.0295	-0.0970	-0.0310	
651	47	CT	cucumbertree		PVM221	FTUPOK	-0.2958	0.0496	-0.3532		0.0084		-0.6272	
652	48	MS	southern magnolia		PVP232	FTLOHD		-0.1533	0.1837	-0.0247	0.0559	0.1096	0.0524	
653	49	MV	sweetbay		PVP232	FTLOHD		-0.3268	-0.0177		-0.0295	-0.0970	-0.0310	
654	50	ML	bigleaf magnolia	SP652	PVP232	FTLOHD		-0.1533	0.1837	-0.0247	0.0559	0.1096	0.0524	
660	51	AP	apple sp.	SP680	PVP231B	FTLOHD		-0.3575	0.0100		-0.0240	-0.0250	0.2725	
680	52	MB	mulberry sp.		PVP231B	FTLOHD		-0.3575	0.0100		-0.0240	-0.0250	0.2725	
691	53	WT	water tupelo		PVP232	FTLOHD			-0.2036		0.0670	0.6968	0.0455	
693	54	BG	blackgum, black tupelo		PVP232	FTUPOK	0.1147	0.0631	0.0767	-0.4480	0.1115		0.2292	
694	55	TS	swamp tupelo, swamp b.gum		PVP232	FTLOHD		0.5808	-0.1165		-0.1107	-0.1953	0.0062	
701	56	HH	eastern hophornbeam,		PVP232	FTLOHD		-0.1546	-0.0871		-0.0711	-0.2042	0.1205	
711	57	SD	sourwood		PVP231A	FTUPOK	0.0767	0.3524	0.0799	-0.1315	-0.0230		0.3004	
721	58	RA	redbay		PVP232	FTLOHD		-1.1994	-0.0228		0.0602	0.3909	-0.0458	
731	59	SY	sycamore		PVP234	FTLOHD		-0.0197	-0.2625		-0.1506	-0.1616	-0.2394	
740	60	CW	cottonwood		PVP234	FTLOHD			-0.1226		-0.2272	0.4284	-0.1277	
743	61	BT	bigtooth aspen	SP740	PVP234	FTLOHD			-0.1226		-0.2272	0.4284	-0.1277	

762	62	BC	black cherry		PVP231A	FTUPOK	0.1816	0.3034	0.1625		0.1461		0.2035	
802	63	WO	white oak		PVP231A	FTUPOK	0.2149	0.1962	0.1070	0.2101	0.1001		0.1549	
806	64	SO	scarlet oak		PVP231A	FTUPOK	0.0820	0.1741	0.0738	-0.1269	0.0891		0.0157	
812	65	SK	southern red oak		PVP231B	FTUPOK	0.1490	0.2015	0.0557		0.0685		0.0480	
813	66	CB	cherrybark oak, swamp red o.		PVP231B	FTLOHD		0.1300	-0.0659		-0.0660	-0.1143	-0.0231	
819	67	TO	turkey oak		PVP232	FTUPOK	-0.0496		0.1674		0.0993		0.1846	
820	68	LK	laurel oak		PVP232	FTLOHD		-0.1277	0.0295		-0.0531	0.0122	0.0307	
822	69	OV	overcup oak		PVP234	FTLOHD		-0.9243	-0.1835		-0.0832	-0.0578	-0.0766	
824	70	BJ	blackjack oak		PVP232	FTUPOK	-0.1232		0.0003		0.1703		-0.0962	
825	71	SN	swamp chestnut oak		PVP232	FTLOHD		-0.2863	0.0768		0.0375	0.0101	0.0882	
826	72	CK	chinkapin oak		PVP222	FTUPOK	0.0861	0.0354	0.0213		0.1115		-0.5189	
827	73	WK	water oak		PVP232	FTLOHD		0.0445	-0.0429		-0.0880	-0.0859	-0.0686	
832	74	CO	chestnut oak		PVM221	FTUPOK	0.2372	0.1360	0.0308	-0.2382	0.0968		0.0536	
833	75	RO	northern red oak		PVM221	FTUPOK	0.1037	0.2080	0.0107	-0.0240	0.1381		0.0523	
834	76	QS	Shumard oak		PVP231B	FTUPOK	0.1400	0.2076	0.0093		0.1325		0.2198	
835	77	PO	post oak		PVP231B	FTUPOK	0.2690	0.4827	0.0428		0.0906		0.0566	
837	78	BO	black oak		PVP222	FTUPOK	0.0497	0.2720	0.0342	-0.1046	0.0718		-0.0444	
838	79	LO	live oak		PVP232	FTLOHD			0.0741		0.0617	0.2298	-0.0430	
901	80	BK	black locust		PVM221	FTUPHD	0.1382	0.1174	-0.0976			-0.0830	-0.0465	
920	81	WI	willow		PVP234	FTLOHD			0.0015		0.0196	0.1650	-0.0014	
931	82	SS	sassafras		PVP222	FTUPHD	-0.0585	0.0140	-0.1395	0.4142		-0.1670	-0.0182	
950	83	BW	basswood		PVM221	FTNOHD	0.0672		0.0082		-0.0335	0.0122	0.1485	
970	84	EL	elm		PVP231A	FTLOHD		-0.0055	-0.2638		-0.0546	-0.2020	0.0720	
971	85	WE	winged elm		PVP231B	FTUPOK	0.2119	0.1126	0.1741		0.1685		0.3640	
972	86	AE	American elm		PVP234	FTLOHD		-0.2211	-0.0196		-0.2106	-0.2372	0.1372	
975	87	RL	slippery elm		PVP231B	FTLOHD		-0.2324	-0.0861		-0.0736	-0.2423	0.1776	
1	88	OS	softwoods, misc.	SP060	PVP231A	FTUPOK	0.1288	-0.0202	0.0544		0.0792		0.1443	
4	89	OH	hardwoods, misc.	SP701	PVP232	FTLOHD		-0.1546	-0.0871		-0.0711	-0.2042	0.1205	
999	90	OT	unknown or not listed		NONE	NONE								

A5. Continued

Species	SN	SN	Common		REGRESSION STATISTICS						
Number	Number	Code	Name	MAP TO->	R^2	_RMSE_	SIGMAR W/75%AD	IN REG. DF	P NO. COEFS	EDF ERROR DF	OBSERV. TOTAL
10	1	FR	fir sp.	SP260			0.4511	18	19	1122	1141
60	2	JU	redcedar		0.7314	0.7063	0.5297	24	25	4107	4132
90	3	PI	spruce	SP260	0.8168	0.6014	0.4511	18	19	1122	1141
107	4	PU	sand pine		0.7102	0.7237	0.5428	14	15	805	820
110	5	SP	shortleaf pine		0.4983	0.665	0.4987	24	25	25983	26008
111	6	SA	slash pine		0.5615	0.7002	0.5251	19	20	18716	18736
115	7	SR	spruce pine		0.6533	0.5822	0.4367	16	17	867	884
121	8	LL	longleaf pine		0.5199	0.588	0.441	18	19	9171	9190
123	9	TM	Table Mountain pine	SP132	0.6088	0.6257	0.4693	21	22	9838	9860
126	10	PP	pitch pine		0.4679	0.7366	0.5525	18	19	716	735
128	11	PD	pond pine		0.5589	0.7894	0.5921	15	16	2574	2590
129	12	WP	eastern white pine		0.8197	0.6583	0.4937	20	21	2581	2602
131	13	LP	loblolly pine		0.5661	0.6249	0.4687	25	26	92287	92313
132	14	VP	Virginia pine		0.6088	0.6257	0.4693	21	22	9838	9860
221	15	BY	baldcypress		0.629	0.7349	0.5511	21	22	6406	6428
222	16	PC	pondcypress		0.769	0.8355	0.6267	13	14	5564	5578
260	17	HM	hemlock		0.8168	0.6014	0.4511	18	19	1122	1141
311	18	FM	Florida maple		0.7805	0.7509	0.5632	21	22	433	455
313	19	BE	boxelder		0.6375	0.7478	0.5608	25	26	1400	1426
316	20	RM	red maple		0.7578	0.7906	0.593	25	26	28376	28402
317	21	SV	silver maple	SP316	0.7578	0.7906	0.593	25	26	28376	28402
318	22	SM	sugar maple		0.7353	0.634	0.4755	23	24	2739	2763
330	23	BU	buckeye, horsechestnut		0.6039	0.7164	0.5373	16	17	260	277
370	24	BB	birch sp.		0.6294	0.7595	0.5696	25	26	2081	2107
372	25	SB	sweet birch, black birch	SP370	0.6294	0.7595	0.5696	25	26	2081	2107
391	26	AH	American hornbeam,		0.6352	0.8042	0.6032	22	23	3490	3513
400	27	HI	hickory sp.		0.7685	0.6658	0.4993	25	26	24378	24404
450	28	CA	catalpa	SP740	0.6943	0.5867	0.4401	18	19	953	972
460	29	HB	hackberry sp.		0.5935	0.7035	0.5276	23	24	4461	4485
471	30	RD	eastern redbud		0.6231	0.727	0.5453	23	24	458	482
491	31	DW	flowering dogwood		0.554	0.7176	0.5382	24	25	7750	7775
521	32	PS	common persimmon		0.801	0.688	0.516	24	25	1194	1219
531	33	AB	American beech		0.7791	0.6407	0.4805	24	25	4928	4953
540	34	AS	ash		0.7893	0.7945	0.5958	19	20	5443	5463
541	35	WA	white ash, American ash		0.5741	0.5638	0.4228	24	25	1964	1989
543	36	BA	black ash	SP544	0.5616	0.6475	0.4856	23	24	3934	3958
544	37	GA	green ash		0.5616	0.6475	0.4856	23	24	3934	3958
552	38	HL	honeylocust		0.5396	0.6243	0.4682	22	23	565	588
555	39	LB	loblolly-bay		0.7142	0.7877	0.5908	13	14	1469	1483
580	40	HA	silverbell		0.7461	0.7995	0.5996	11	12	77	89
591	41	HY	American holly		0.6415	0.7293	0.5469	22	23	3394	3417
601	42	BN	butternut	SP602	0.4484	0.7614	0.571	25	26	915	941
602	43	WN	black walnut		0.4484	0.7614	0.571	25	26	915	941
611	44	SU	sweetgum		0.7063	0.7705	0.5779	25	26	38821	38847
621	45	YP	yellow-poplar		0.7276	0.6908	0.5181	22	23	19184	19207
650	46	MG	magnolia sp.	SP653	0.7654	0.7636	0.5727	20	21	6708	6729
651	47	CT	cucumbertree		0.6358	0.6835	0.5126	22	23	353	376
652	48	MS	southern magnolia		0.7007	0.7604	0.5703	22	23	915	938
653	49	MV	sweetbay		0.7654	0.7636	0.5727	20	21	6708	6729
654	50	ML	bigleaf magnolia	SP652	0.7007	0.7604	0.5703	22	23	915	938
660	51	AP	apple sp.	SP680	0.6627	0.6741	0.5056	24	25	514	539
680	52	MB	mulberry sp.		0.6627	0.6741	0.5056	24	25	514	539
691	53	WT	water tupelo		0.6661	0.7597	0.5698	18	19	6085	6104
693	54	BG	blackgum, black tupelo		0.7403	0.7141	0.5356	25	26	10302	10328
694	55	TS	swamp tupelo, swamp b.gum		0.7122	0.785	0.5888	17	18	17080	17098
701	56	HH	eastern hophornbeam,		0.6178	0.7697	0.5773	23	24	816	840
711	57	SD	sourwood		0.6839	0.673	0.5047	22	23	5666	5689
721	58	RA	redbay		0.6116	0.7583	0.5687	17	18	1935	1953
731	59	SY	sycamore		0.5462	0.7426	0.557	24	25	1867	1892
740	60	CW	cottonwood		0.6943	0.5867	0.4401	18	19	953	972
743	61	BT	bigtooth aspen	SP740	0.6943	0.5867	0.4401	18	19	953	972

762	62	BC	black cherry		0.6902	0.7708	0.5781	24	25	2919	2944
802	63	WO	white oak		0.733	0.5876	0.4407	25	26	27461	27487
806	64	SO	scarlet oak		0.7721	0.5102	0.3827	21	22	5987	6009
812	65	SK	southern red oak		0.7519	0.574	0.4305	24	25	13417	13442
813	66	CB	cherrybark oak, swamp red o.		0.6914	0.5333	0.4	24	25	4214	4239
819	67	TO	turkey oak		0.7567	0.6609	0.4957	18	19	2745	2764
820	68	LK	laurel oak		0.7795	0.7449	0.5586	20	21	8084	8105
822	69	OV	overcup oak		0.6547	0.6211	0.4659	21	22	2938	2960
824	70	BJ	blackjack oak		0.8214	0.6199	0.4649	24	25	3580	3605
825	71	SN	swamp chestnut oak		0.7863	0.655	0.4913	22	23	1481	1504
826	72	CK	chinkapin oak		0.5522	0.6742	0.5056	24	25	806	831
827	73	WK	water oak		0.8233	0.6219	0.4664	25	26	24330	24356
832	74	CO	chestnut oak		0.716	0.5724	0.4293	23	24	12164	12188
833	75	RO	northern red oak		0.7562	0.5397	0.4048	24	25	8376	8401
834	76	QS	Shumard oak		0.7422	0.5433	0.4074	24	25	480	505
835	77	PO	post oak		0.5914	0.647	0.4853	24	25	14816	14841
837	78	BO	black oak		0.7208	0.5625	0.4219	25	26	10093	10119
838	79	LO	live oak		0.7419	0.8846	0.6635	16	17	2899	2916
901	80	BK	black locust		0.5402	0.6916	0.5187	23	24	1966	1990
920	81	WI	willow		0.6677	0.6011	0.4508	19	20	2114	2134
931	82	SS	sassafras		0.8076	0.6005	0.4504	25	26	1551	1577
950	83	BW	basswood		0.6699	0.7328	0.5496	24	25	738	763
970	84	EL	elm		0.7186	0.8595	0.6447	24	25	3205	3230
971	85	WE	winged elm		0.345	0.7048	0.5286	23	24	2270	2294
972	86	AE	American elm		0.5303	0.7152	0.5364	23	24	2000	2024
975	87	RL	slippery elm		0.5061	0.7134	0.535	23	24	767	791
1	88	OS	softwoods, misc.	SP060	0.7314	0.7063	0.5297	24	25	4107	4132
4	89	OH	hardwoods, misc.	SP701	0.6178	0.7697	0.5773	23	24	816	840
999	90	OT	unknown or not listed		0.685	0.7435	0.5576	9	10	629	639

A6. Bounding Functions for Large tree diameter growth

Species	SN	SN Character	Common		DIAMETER PERCENTILES FOR BOUNDING FUNC.--90; 99; MX								D-SIZES IN LITERATURE		BOUND FUNC D-LIMITS	
Number	Number	Code	Name	MAP TO->	DPCTL67	DPCTL75	DPCTL80	DPCTL90	DPCTL95	DPCTL99	DPCTLMX	TOT_OBS	MATURITY	LARGEST	LO = 90th %-ile	HI=.5(99th+MX)
10	01	FR	fir, sp.					12		18	34		18-Dec	34	12	26
60	02	JU	juniper, sp.		7.6	8.6	9.5	11.9	13.9	19.5	28.7	4229	24-Dec	48	11.9	24.1
90	03	PI	spruce, sp.					12		24	52		24-Dec	52	12	38
107	04	PU	sand pine		8.3	9.8	10.6	12.5	14.7	17.3	20.5	824	20-__	24	12.5	18.9
110	05	SP	shortleaf pine		11.7	12.6	13.3	15.3	16.9	20.4	35.3	26136	24-36	48	15.3	27.9
111	06	SA	slash pine		9.6	10.9	11.7	14	16	20	34.8	18845	24-__	36	14	27.4
115	07	SR	spruce pine		15.8	17.2	18.4	20.7	22.7	27.5	37.6	887	24-Dec	48	20.7	32.6
121	08	LL	longleaf pine		12.7	13.6	14.3	15.9	17.4	20.5	28.3	9300	24-30	48	15.9	24.4
123	09	TM	table mountain pine		10.6	11.6	12.4	13.7	15.2	17.7	19.7	247	__-__	28	13.7	18.7
126	10	PP	pitch pine		12.4	13.2	13.8	15.8	17.5	21.7	26.7	735	24-Dec	36-40	15.8	24.2
128	11	PD	pond pine		11.1	12.2	13	15.3	17.2	21.4	36	2591	__-__	37-40	15.3	28.7
129	12	WP	eastern white pine		14.5	16.1	17.3	20.6	23.6	30.2	35.6	2602	24-42	72+	20.6	32.9
131	13	LP	loblolly pine		11.6	13.2	14.2	17.1	19.6	24.8	49.5	92781	24-30	60	17.1	37.2
132	14	VP	virginia pine		9.4	10.2	10.8	12.3	13.7	16.3	23.7	9867	24-Dec	36	12.3	20
221	15	BY	baldcypress		17.3	19.3	20.8	26	35	61	98.5	6522	36-60	144	26	79.8
222	16	PC	pondcypress		10.3	11.6	12.5	15.1	17.6	25	65.7	5578	24-40	__	15.1	45.4
260	17	HM	hemlock		12.4	14.8	16.1	20.5	24.1	33.3	45.3	1156	24-36	72-84	20.5	39.3
311	18	FM	florida maple		6.8	8.6	10.1	13.5	17	23.3	28.8	456	24-30	28-34	13.5	26.1
313	19	BE	boxelder		10.6	11.9	12.9	15.7	17.5	22.5	30.9	1428	24-48	60	15.7	26.7
316	20	RM	red maple		7.8	9.6	10.9	14.5	17.6	23.8	48	28460	18-36	60	14.5	35.9
317	21	SV	silver maple		16.1	18.7	20.1	24.1	27.6	41.8	46.5	284	24-36	84	24.1	44.2
318	22	SM	sugar maple		11.9	13.4	14.6	17.8	21.4	29.5	40.8	2764	24-36	72	17.8	35.2
330	23	BU	buckeye, horsechestnut		12.8	14.6	15.9	20.5	26.2	33.8	36.7	277	24-36	60	20.5	35.3
370	24	BB	birch sp.		12.3	14	15.2	18.8	22.1	28.2	48.5	2117	24-30	54	18.8	38.4
372	25	SB	sweet birch		8.3	9.6	10.4	13.3	14.6	21	28.8	123	24-Dec	60	13.3	24.9
391	26	AH	american hornbeam		5.5	6.3	6.9	8.5	10.1	12.9	21.6	3531	5-10	27	8.5	17.3
400	27	HI	hickory sp.		11.8	13.2	14.2	17.2	20.1	26.9	50.2	24503	24-48	72	17.2	38.6
450	28	CA	catalpa, sp.	740	21.3	23.4	25.6	30.7	34.5	41.3	51.7		36-48	144	30.7	46.5
460	29	HB	hackberry sp.		13.5	15.1	16	18.8	21.5	26.7	39.1	4521	20-36	60	18.8	32.9
471	30	RD	eastern redbud		3.7	4.8	5.1	6.4	7.6	9.1	13.4	483	__-__	__	6.4	11.3
491	31	DW	flowering dogwood		2.6	3.2	3.7	5.2	6	7.6	11.7	7788	3- 8	12	5.2	9.7
521	32	PS	common persimmon		6.3	7.2	8.1	10.2	12.1	17.3	27.4	1226	20-Dec	24	10.2	22.4
531	33	AB	american beech		18.3	20.3	21.8	25.5	28.7	36.1	49.4	4976	24-36	60	25.5	42.8
540	34	AS	ash		8.3	10.4	11.7	15.2	18.4	24.6	36.8	5464	24-36	60	15.2	30.7
541	35	WA	white ash		12.7	14	15	18.2	20.4	25.8	40.9	2000	24-36	84	18.2	33.4
543	36	BA	black ash					18		24	48		18-24	48	18	36
544	37	GA	green ash		14.1	15.6	16.8	20.6	24.1	30.3	43.7	3977	20-36	48	20.6	37
552	38	HL	honeylocust		12.9	14.4	15.2	18.4	22	30.6	35.7	606	24-36	72	18.4	33.2
555	39	LB	loblolly-bay		7.1	8.3	9.3	12.5	15.8	22.7	33.4	1484	6-12	18	12.5	28.1
580	40	HA	silverbell		9.3	10.9	11.7	14.8	15.3	20.5	20.5	89	5-11	36	14.8	20.5
591	41	HY	american holly		3.2	4.2	5.1	7.4	9.7	13.9	20.2	3422	24-36	48	7.4	17.1
601	42	BN	butternut					12		24	36		24-Dec	36	12	30
602	43	WN	black walnut		12.1	13.4	14.2	16.7	19.7	25	40.7	950	24-36	96	16.7	32.9
611	44	SU	sweetgum		10.7	12.2	13.3	16.3	19.2	25.3	53.9	39042	36-48	60	16.3	39.6
621	45	YP	yellow-poplar		14.3	15.6	16.6	19.5	22.2	29	51.7	19259	24-60	120	19.5	40.4
650	46	MG	magnolia, sp.	653	8.9	10.4	11.6	14.4	17.1	22.6	42.4		6-24	36	14.4	32.5
651	47	CT	cucumbertree		12.6	13.9	15.3	17.7	20.8	25.7	28.2	377	36-48	72	17.7	27
652	48	MS	southern magnolia		12.4	14.3	15.7	19.8	24.1	32.7	40.3	941	24-36	84	19.8	36.5
653	49	MV	sweetbay		8.9	10.4	11.6	14.4	17.1	22.6	42.4	6753	6-24	36	14.4	32.5
654	50	ML	bigleaf magnolia	652	12.4	14.3	15.7	19.8	24.1	32.7	40.3		24-36	84	19.8	36.5
660	51	AP	apple sp.		6.5	7.2	8	9	10.3	21.2	21.2	75	__-__	__	9	21.2
680	52	MB	mulberry sp.		8.9	10	10.9	13	15	19	28.1	541	24-Dec	30	13	23.6
691	53	WT	water tupelo		14.6	16.1	17.4	21.4	26.4	39	88.5	6180	36-48	72	21.4	63.8
693	54	BG	blackgum		10.5	12.1	13.3	16.2	19	25	36.6	10410	24-36	60	16.2	30.8
694	55	TS	swamp tupelo		10.3	11.9	13	15.9	18.7	25.5	40.4	17118	24-36	60	15.9	33
701	56	HH	eastern hophornbeam		6.1	6.7	7.2	8.8	9.9	13.1	24	843	6-12	__	8.8	18.6
711	57	SD	sourwood		5.2	5.9	6.4	8.1	9.7	13	20.4	5701	8-12	24	8.1	16.7
721	58	RA	redbay		3.4	4.3	5.2	7.4	9.9	15.9	22.5	1954	24-Dec	24-36	7.4	19.2
731	59	SY	sycamore		17	18.8	20.1	23.6	28.1	41	72.1	1905	36-96	125-175	23.6	56.6
740	60	CW	cottonwood		21.3	23.4	25.6	30.7	34.5	41.3	51.7	984	36-48	144	30.7	46.5
743	61	BT	bigtooth aspen					24		36	60		24-36	60	24	48

762	62	BC	black cherry		7	8.2	9.2	12.3	15.3	22.2	31.6	2962	24-36	84	12.3	26.9
802	63	WO	white oak		13.2	14.7	15.8	18.9	21.8	27.9	57.6	27545	36-48	96	18.9	42.8
806	64	SO	scarlet oak		13	14.3	15.3	17.7	19.7	25	43.9	6015	24-36	48	17.7	34.5
812	65	SK	southern red oak		13.4	15	16.1	19.2	22.3	30.1	54.4	13568	24-36	84	19.2	42.3
813	66	CB	cherrybark oak,		18	19.9	21.4	25.5	30.3	41.2	51.1	4268	36-60	84	25.5	46.2
819	67	TO	turkey oak		3.6	5	6	8.6	10.4	14.5	19.9	2767	__-__	26	8.6	17.2
820	68	LK	laurel oak		13.4	15.7	17.3	22.1	26.2	35.2	61	8140	24-36	84	22.1	48.1
822	69	OV	overcup oak		19.2	21.3	22.6	26.7	31	38	58	2975	24-30	60	26.7	48
824	70	BJ	blackjack oak		8.5	9.6	10.4	13	15.2	19	26.3	3710	__-__	__	13	22.7
825	71	SN	swamp chestnut oak		17.5	19.5	20.9	25.1	29.3	39.4	55	1508	24-36	108	25.1	47.2
826	72	CK	chinkapin oak		13.1	14.5	15.8	19.5	23.6	34.7	39.7	837	24-36	72	19.5	37.2
827	73	WK	water oak		14.4	16.5	18.2	22.9	26.9	36.5	58.7	24558	24-36	72	22.9	47.6
832	74	CO	chestnut oak		14.2	15.8	17	20.4	23.6	31.5	45.2	12201	24-30	84	20.4	38.4
833	75	RO	northern red oak		15.2	16.7	17.9	21.3	24.8	32.3	49.8	8405	24-36	96	21.3	41.1
834	76	QS	shumard oak		16.1	17.9	19	23.1	25.5	34.8	46.3	508	48-60	96	23.1	40.6
835	77	PO	post oak		12.5	13.8	14.8	17.6	20.6	26.5	51.2	14954	24-Dec	48	17.6	38.9
837	78	BO	black oak		14	15.4	16.4	19.3	21.8	27.9	52.4	10136	24-36	84	19.3	40.2
838	79	LO	live oak		20.2	23	25	31.4	37.4	49.1	68.5	2936	36-48	__	31.4	58.8
901	80	BK	black locust		12	13.4	14.5	17.2	19.6	25.9	35.7	2008	24-30	60	17.2	30.8
920	81	WI	willow		16.7	18.8	20	23.8	26.8	33.9	43.6	2185	20-Oct	48-60	23.8	38.8
931	82	SS	sassafras		7.6	8.8	9.5	11.8	14.2	19.5	31.6	1582	8-15	72	11.8	25.6
950	83	BW	basswood		13.8	15.5	16.2	19	22	27.7	36.4	764	24-30	60	19	32.1
970	84	EL	elm		8.6	10.4	12	15.4	18.5	24.8	38	3235	__-__	__	15.4	31.4
971	85	WE	winged elm		9.3	10.3	11.1	13.4	15.8	21.1	26.7	2349	24-__	__	13.4	23.9
972	86	AE	american elm		13.2	14.6	15.8	19.6	23.8	34.8	58.5	2042	24-48	60-130	19.6	46.7
975	87	RL	slippery elm		11.7	13.3	14.6	17.8	20.4	31.3	40.2	799	18-30	80	17.8	35.8
1	88	OS	other softwoods	60	7.6	8.6	9.5	11.9	13.9	19.5	28.7				11.9	24.1
4	89	OH	other hardwoods		7.6	8.8	9.6	12.3	14.5	24.3	42.3	1340			12.3	33.3
999	90	OT	unknown or not listed		6.5	7.1	7.6	9.8	12.4	16.6	24.4	645			9.8	20.5

A7. Large tree height growth

Species	SN	SN	Common			NC128 Curve	NC128	Map to NC128 Species	NC128 Tree Height (H) Coefficients					LIMITS		For Min SI
Number	Number	Code	Name	Genus	Species	Page:Figure	Species Used	Page:Figure / FIA_Cd	b1	b2	b3	b4	b5	MIN	MAX	at age=2
10	1	FR	fir sp.	Abies	sp.	70:55:00	12		2.077	0.9303	-0.0285	2.8937	-0.1414	15	100	0.5
60	2	JU	redcedar	Juniperus	sp.	73:58:00	68		0.9276	1.0591	-0.0424	0.3529	0.3114	15	70	2.1
90	3	PI	spruce	Picea	sp.	88:73	97		1.3307	1.0442	-0.0496	3.5829	0.0945	15	80	0.5
107	4	PU	sand pine	Pinus	clausa	92:77	107		1.266	1.0034	-0.0365	1.5515	-0.0221	35	100	1
110	5	SP	shortleaf pine	Pinus	echinata	93:78	110		1.4232	0.9989	-0.0285	1.2156	0.0088	35	105	1.3
111	6	SA	slash pine	Pinus	elliottii	99:84	111		1.1557	1.0031	-0.0408	0.9807	0.0314	35	105	2.5
115	7	SR	spruce pine	Pinus	glabra			88:73/090	1.3307	1.0442	-0.0496	3.5829	0.0945	45	90	0.5
121	8	LL	longleaf pine	Pinus	palustris	107:92	121		1.421	0.9947	-0.0269	1.1344	-0.0109	45	125	2.5
123	9	TM	Table Mountain pine	Pinus	pungens			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	35	70	2.7
126	10	PP	pitch pine	Pinus	rigida			139:124/132	1.1204	0.9984	-0.0597	2.4448	-0.0284	25	95	0.5
128	11	PD	pond pine	Pinus	serotina	117:102	128		1.1266	1.0051	-0.0367	0.678	0.0404	35	105	5.1
129	12	WP	eastern white pine	Pinus	strobus	119:104	129		3.2425	0.798	-0.0435	52.0549	-0.7064	40	135	0.5
131	13	LP	loblolly pine	Pinus	taeda	125:110	131		1.1421	1.0042	-0.0374	0.7632	0.0358	40	125	4.7
132	14	VP	Virginia pine	Pinus	virginiana	139:124	132		1.1204	0.9984	-0.0597	2.4448	-0.0284	35	95	0.5
221	15	BY	baldcypress	Taxodium	distichum			36:21/611	1.0902	1.0298	-0.0354	0.7011	0.1178	30	120	2.2
222	16	PC	pondcypress	Taxodium	distichum var. nutans			36:21/611	1.0902	1.0298	-0.0354	0.7011	0.1178	30	120	2.2
260	17	HM	hemlock	Tsuga	sp.	142:127	261		2.1493	0.9979	-0.0175	1.4086	-0.0008	35	90	0.7
311	18	FM	Florida maple	Acer	barbatum			19:4/317	1.0645	0.9918	-0.0812	1.5754	-0.0272	35	70	2.4
313	19	BE	boxelder	Acer	negundo			16:1/316	2.9435	0.9132	-0.0141	1.658	-0.1095	35	70	1.4
316	20	RM	red maple	Acer	rubrum	16:01	316		2.9435	0.9132	-0.0141	1.658	-0.1095	35	85	1.4
317	21	SV	silver maple	Acer	saccharinum	19:04	317		1.0645	0.9918	-0.0812	1.5754	-0.0272	30	105	2
318	22	SM	sugar maple	Acer	saccharum	18:03	318		6.1308	0.6904	-0.0195	10.1563	-0.533	35	100	0.5
330	23	BU	buckeye, horsechestnut	Aesculus	sp.			18:3/318	6.1308	0.6904	-0.0195	10.1563	-0.533	25	90	0.5
370	24	BB	birch sp.	Betula	sp.	21:06	371		6.0522	0.6768	-0.0217	15.4232	-0.6354	35	85	0.5
372	25	SB	sweet birch, black birch	Betula	lenta			21:6/371	6.0522	0.6768	-0.0217	15.4232	-0.6354	35	70	0.5
391	26	AH	American hornbeam,	Carpinus	caroliniana			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	40	2.1
400	27	HI	hickory sp.	Carya	sp.	25:10:00	400		1.8326	1.0015	-0.0207	1.408	-0.0005	25	85	0.5
450	28	CA	catalpa	Catalpa	sp.			29:14/543	4.2286	0.7857	-0.0178	4.6219	-0.3591	30	90	0.6
460	29	HB	hackberry sp.	Celtis	sp.			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	90	2.1
471	30	RD	eastern redbud	Cercis	canadensis			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	40	2.1
491	31	DW	flowering dogwood	Cornus	florida			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	45	2.1
521	32	PS	common persimmon	Diospyros	virginiana			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	70	2.1
531	33	AB	American beech	Fagus	grandifolia	26:11:00	531		29.73	0.3631	-0.0127	16.7616	-0.6804	35	85	0.5
540	34	AS	ash	Fraxinus	sp.			30:15/544	1.6505	0.9096	-0.0644	125.7045	-0.8908	35	105	0.5
541	35	WA	white ash, American ash	Fraxinus	americana	28:13:00	541		4.1492	0.7531	-0.0269	14.5384	-0.5811	35	95	0.5
543	36	BA	black ash	Fraxinus	nigra	29:14:00	543		4.2286	0.7857	-0.0178	4.6219	-0.3591	35	85	0.9
544	37	GA	green ash	Fraxinus	pennsylvanica	30:15:00	544		1.6505	0.9096	-0.0644	125.7045	-0.8908	35	105	0.5
552	38	HL	honeylocust	Gleditsia	triacanthos			65:50/901	0.968	1.0301	-0.0468	0.1639	0.4127	25	120	6
555	39	LB	loblolly-bay	Gordonia	lasianthus			72:57/043	1.5341	1.0013	-0.0208	0.9986	-0.0012	15	50	1
580	40	HA	silverbell	Halesia	sp.			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	65	2.1
591	41	HY	American holly	Ilex	opaca			26:11/531	29.73	0.3631	-0.0127	16.7616	-0.6804	35	70	0.5
601	42	BN	butternut	Juglans	cinerea			31:16/602	1.2898	0.9982	-0.0289	0.8546	0.0171	35	85	3.3
602	43	WN	black walnut	Juglans	nigra	31:16:00	602		1.2898	0.9982	-0.0289	0.8546	0.0171	35	85	3.3
611	44	SU	sweetgum	Liquidambar	styraciflua	36:21:00	611		1.0902	1.0298	-0.0354	0.7011	0.1178	30	125	2.2
621-M	45-M	YP	yellow-poplar(mtn)	Liriodendron	tulipifera	39:24:00	621-M		1.2673	1	-0.0331	1.1149	0.0001	30	135	1.8
621-P	45-P	YP	yellow-poplar(PdmntPlainEtc)	Liriodendron	tulipifera	38:23:00	621-P		1.1798	1	-0.0339	0.8117	-0.0001	30	135	3.9
650	46	MG	magnolia sp.	Magnolia	sp.			42:27/694	1.3213	0.9995	-0.0254	0.8549	-0.0016	35	125	3.6
651	47	CT	cucumbertree	Magnolia	acuminata			52:37/802	1.2866	0.9962	-0.0355	1.4485	-0.0316	25	115	1
652	48	MS	southern magnolia	Magnolia	grandiflora			42:27/694	1.3213	0.9995	-0.0254	0.8549	-0.0016	35	125	3.6
653	49	MV	sweetbay	Magnolia	virginiana			42:27/694	1.3213	0.9995	-0.0254	0.8549	-0.0016	15	75	1.5
654	50	ML	bigleaf magnolia	Magnolia	macrophylla			42:27/694	1.3213	0.9995	-0.0254	0.8549	-0.0016	35	125	3.6
660	51	AP	apple sp.	Malus	sp.			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	40	2.1
680	52	MB	mulberry sp.	Morus	sp.			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	55	2.1
691	53	WT	water tupelo	Nyssa	aquatica	41:26:00	691		1.2721	0.9995	-0.0256	0.7447	-0.0019	30	105	4.1
693	54	BG	blackgum, black tupelo	Nyssa	sylvatica			42:27/694	1.3213	0.9995	-0.0254	0.8549	-0.0016	35	105	3.6
694	55	TS	swamp tupelo, swamp b.gum	Nyssa	sylvatica var. biflora	42:27:00	694		1.3213	0.9995	-0.0254	0.8549	-0.0016	35	95	3.6
701	56	HH	eastern hophornbeam,	Ostrya	virginiana			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	40	2.1
711	57	SD	sourwood	Oxydendrum	arboreum			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	70	2.1
721	58	RA	redbay	Persea	borbonia			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	60	2.1

731	59	SY	sycamore	Platanus	occidentalis			39:24/621-M	1.2673	1	-0.0331	1.1149	0.0001	30	120	1.8
740	60	CW	cottonwood	Populus	sp.	45:30:00	742		1.2834	0.9571	-0.068	100	-0.9223	40	125	0.5
743	61	BT	bigtooth aspen	Populus	grandidentata	47:32:00	743		5.2188	0.6855	-0.0301	50.0071	-0.8695	30	90	0.5
762	62	BC	black cherry	Prunus	serotina	50:35:00	762		7.1846	0.6781	-0.0222	13.9186	-0.5268	35	105	0.5
802	63	WO	white oak	Quercus	alba	52:37:00	upl oak		1.2866	0.9962	-0.0355	1.4485	-0.0316	25	115	1
806	64	SO	scarlet oak	Quercus	coccinea	52:37:00	upl oak		1.2866	0.9962	-0.0355	1.4485	-0.0316	25	115	1
812	65	SK	southern red oak	Quercus	falcata var. falcata	52:37:00	upl oak		1.2866	0.9962	-0.0355	1.4485	-0.0316	25	115	1
813	66	CB	cherrybark oak, swamp red o.	Quercus	falcata	58:43:00	813		1.0945	0.9938	-0.0755	2.5601	0.0114	30	125	0.5
819	67	TO	turkey oak	Quercus	laevis			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	25	65	2.5
820	68	LK	laurel oak	Quercus	laurifolia			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	25	65	2.5
822	69	OV	overcup oak	Quercus	lyrata			60:45/828	1.3295	0.9565	-0.0668	16.0085	-0.4157	35	95	0.5
824	70	BJ	blackjack oak	Quercus	marilandica			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	25	65	2.5
825	71	SN	swamp chestnut oak	Quercus	michauxii			59:44/827	1.3466	0.959	-0.0574	8.9538	-0.3454	35	95	0.5
826	72	CK	chinkapin oak	Quercus	muehlenbergii			52:37/802	1.2866	0.9962	-0.0355	1.4485	-0.0316	35	75	1.4
827	73	WK	water oak	Quercus	nigra	59:44:00	827		1.3466	0.959	-0.0574	8.9538	-0.3454	30	115	0.5
832	74	CO	chestnut oak	Quercus	prinus	52:37:00	upl oak		1.2866	0.9962	-0.0355	1.4485	-0.0316	25	115	1
833	75	RO	northern red oak	Quercus	rubra	52:37:00	upl oak		1.2866	0.9962	-0.0355	1.4485	-0.0316	25	115	1
834	76	QS	Shumard oak	Quercus	shumardii			58:43/813	1.0945	0.9938	-0.0755	2.5601	0.0114	15	125	0.5
835	77	PO	post oak	Quercus	stellata			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	25	85	2.5
837	78	BO	black oak	Quercus	velutina	52:37:00	upl oak		1.2866	0.9962	-0.0355	1.4485	-0.0316	25	115	1
838	79	LO	live oak	Quercus	virginiana			59:44/827	1.3466	0.959	-0.0574	8.9538	-0.3454	30	65	0.5
901	80	BK	black locust	Robinia	psuedoacacia	65:50:00	901		0.968	1.0301	-0.0468	0.1639	0.4127	25	95	6
920	81	WI	willow	Salix	sp.			65:50/901	0.968	1.0301	-0.0468	0.1639	0.4127	15	110	4.7
931	82	SS	sassafras	Sassafras	albidum			73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	80	2.1
950	83	BW	basswood	Tilia	sp.	66:51:00	951		4.7633	0.7576	-0.0194	6.511	-0.4156	35	90	0.5
970	84	EL	elm	Ulmus	sp.			68:53/972	6.4362	0.6827	-0.0194	10.9767	-0.5477	35	90	0.5
971	85	WE	winged elm	Ulmus	alata			68:53/972	6.4362	0.6827	-0.0194	10.9767	-0.5477	35	90	0.5
972	86	AE	American elm	Ulmus	americana	68:53:00	972		6.4362	0.6827	-0.0194	10.9767	-0.5477	35	90	0.5
975	87	RL	slippery elm	Ulmus	rubra			68:53/972	6.4362	0.6827	-0.0194	10.9767	-0.5477	35	90	0.5
1	88	OS	softwoods, misc.					73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	55	2.1
4	89	OH	hardwoods, misc.					73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	55	2.1
999	90	OT	unknown or not listed					73:58/068	0.9276	1.0591	-0.0424	0.3529	0.3114	15	55	2.1

A8. Mean crown ratio equation coefficients

Species	SN	SN Character	Common				Functional Form						
Number	Number	Code	Name	Genus	Species	Map To->	MODEL_1/	_DEPVAR_	INTERCEPT	RSDIMP	LNRSD	L10RSD	INVRSD
10	01	FR	fir sp.	Abies	sp.	CR260LIN	CR010MAP	MCR	63.51	-0.09			
60	02	JU	redcedar	Juniperus	sp.		CR060LIN	MCR	67.64	-2.25			
90	03	PI	spruce	Picea	sp.	CR260LIN	CR090MAP	MCR	63.51	-0.09			
107	04	PU	sand pine	Pinus	clausa		CR107LOG	MCR	54.0462			-18.2118	
110	05	SP	shortleaf pine	Pinus	echinata		CR110LOG	MCR	47.7297			-16.352	
111	06	SA	slash pine	Pinus	elliottii		CR111LOG	MCR	42.8255			-15.0135	
115	07	SR	spruce pine	Pinus	glabra		CR115PWR	LNMCR	4.17		-0.23		
121	08	LL	longleaf pine	Pinus	palustris		CR121LOG	MCR	42.84			-5.62	
123	09	TM	Table Mountain pine	Pinus	pungens		CR123LOG	MCR	45.8231			-13.8999	
126	10	PP	pitch pine	Pinus	rigida		CR126HRL	LNMCR	4.3546	0.0163	-0.503		
128	11	PD	pond pine	Pinus	serotina		CR128HRL	LNMCR	3.8904	0.0478	-0.357		
129	12	WP	eastern white pine	Pinus	strobus		CR129LIN	MCR	51.8	-0.8			
131	13	LP	loblolly pine	Pinus	taeda		CR131HRL	LNMCR	3.8284	0.0172	-0.223		
132	14	VP	Virginia pine	Pinus	virginiana		CR132HRL	LNMCR	4.1136	0.007	-0.331		
221	15	BY	baldcypress	Taxodium	distichum		CR221LOG	MCR	48.2413			-10.1014	
222	16	PC	pondcypress	Taxodium	distichum v.nutans		CR222LOG	MCR	36.0855			-5.4737	
260	17	HM	hemlock	Tsuga	sp.		CR260LIN	MCR	63.51	-0.09			
311	18	FM	Florida maple	Acer	barbatum		CR311LOG	MCR	53.1867			-9.4122	
313	19	BE	boxelder	Acer	negundo		CR313LOG	MCR	61.9643			-22.3363	
316	20	RM	red maple	Acer	rubrum		CR316LOG	MCR	46.1653			-6.088	
317	21	SV	silver maple	Acer	saccharinum		CR317LIN	MCR	42.98	0.55			
318	22	SM	sugar maple	Acer	saccharum		CR318LIN	MCR	48.2	-0.01			
330	23	BU	buckeye, horsechestnut	Aesculus	sp.		CR330LIN	MCR	42.13	-0.1			
370	24	BB	birch sp.	Betula	sp.		CR370HRL	LNMCR	3.7275	0.0282	-0.112		
372	25	SB	sweet birch, black birch	Betula	lenta		CR372HRL	LNMCR	3.8785	0.0171	-0.175		
391	26	AH	American hornbeam,	Carpinus	caroliniana		CR391HRL	LNMCR	3.9904	0.0171	-0.15		
400	27	HI	hickory sp.	Carya	sp.		CR400HRL	LNMCR	3.9939	0.0238	-0.212		
450	28	CA	catalpa	Catalpa	sp.	CR740LOG	CR450MAP	MCR	48.03			-13.21	
460	29	HB	hackberry sp.	Celtis	sp.		CR460LOG	MCR	50.8266			-14.5261	
471	30	RD	eastern redbud	Cercis	canadensis		CR471LOG	MCR	44.5839			-14.0874	
491	31	DW	flowering dogwood	Cornus	florida		CR491LOG	MCR	51.8467			-14.1876	
521	32	PS	common persimmon	Diospyros	virginiana		CR521HRL	LNMCR	3.8415	0.0297	-0.288		
531	33	AB	American beech	Fagus	grandifolia		CR531LOG	MCR	59.09			-4.99	
540	34	AS	ash	Fraxinus	sp.		CR540LIN	MCR	38.26	-0.77			
541	35	WA	white ash, American ash	Fraxinus	americana		CR541HRL	LNMCR	3.7881	-0.0055	-0.063		
543	36	BA	black ash	Fraxinus	nigra	CR544LIN	CR543MAP	MCR	35.49	0			
544	37	GA	green ash	Fraxinus	pennsylvanica		CR544LIN	MCR	35.49	0			
552	38	HL	honeylocust	Gleditsia	triacanthos		CR552PWR	LNMCR	3.82		-0.1		
555	39	LB	loblolly-bay	Gordonia	lasianthus		CR555LIN	MCR	37.83	-0.15			
580	40	HA	silverbell	Halesia	sp.		CR580HRL	LNMCR	4.4653	0.107	-0.834		
591	41	HY	American holly	Ilex	opaca		CR591LIN	MCR	52.05	-0.11			
601	42	BN	butternut	Juglans	cinerea	CR602PWR	CR601MAP	LNMCR	3.91		-0.12		
602	43	WN	black walnut	Juglans	nigra		CR602PWR	LNMCR	3.91		-0.12		
611	44	SU	sweetgum	Liquidambar	styraciflua		CR611HRL	LNMCR	3.8153	0.0055	-0.096		
621	45	YP	yellow-poplar	Liriodendron	tulipifera		CR621PWR	LNMCR	3.87		-0.07		
650	46	MG	magnolia sp.	Magnolia	sp.	CR652LIN	CR650MAP	MCR	44.71	0.4			
651	47	CT	cucumbertree	Magnolia	acuminata		CR651LIN	MCR	42.15	-0.11			
652	48	MS	southern magnolia	Magnolia	grandiflora		CR652LIN	MCR	44.71	0.4			
653	49	MV	sweetbay	Magnolia	virginiana		CR653LIN	MCR	36.5	-0.23			
654	50	ML	bigleaf magnolia	Magnolia	macrophylla	CR652LIN	CR654MAP	MCR	44.71	0.4			
660	51	AP	apple sp.	Malus	sp.		CR660LIN	MCR	55.48	-2.38			
680	52	MB	mulberry sp.	Morus	sp.		CR680LIN	MCR	42.32	-1.08			
691	53	WT	water tupelo	Nyssa	aquatica		CR691LIN	MCR	36.02	-0.3			
693	54	BG	blackgum, black tupelo	Nyssa	sylvatica		CR693LIN	MCR	41.01	-0.21			
694	55	TS	swamp tupelo, swamp b.gum	Nyssa	sylvatica v.biflora		CR694LIN	MCR	41.379	-0.8012			
701	56	HH	eastern hophornbeam,	Ostrya	virginiana		CR701LOG	MCR	52.7207			-11.484	
711	57	SD	sourwood	Oxydendrum	arboreum		CR711LIN	MCR	38.71	-0.1			
721	58	RA	redbay	Persea	borbonia		CR721LIN	MCR	38.03	-0.09			
731	59	SY	sycamore	Platanus	occidentalis		CR731HRL	LNMCR	3.9839	-0.0248	-0.046		
740	60	CW	cottonwood	Populus	sp.		CR740LOG	MCR	48.03			-13.21	
743	61	BT	bigtooth aspen	Populus	grandidentata	CR740LOG	CR743MAP	MCR	48.03			-13.21	

762	62	BC	black cherry	Prunus	serotina		CR762LIN	MCR	45.06	-0.96			
802	63	WO	white oak	Quercus	alba		CR802PWR	LNMCR	4.05		-0.12		
806	64	SO	scarlet oak	Quercus	coccinea		CR806LOG	MCR	51.7			-9.65	
812	65	SK	southern red oak	Quercus	falcata v.falcata		CR812PWR	LNMCR	3.92		-0.09		
813	66	CB	cherrybark oak, swamp red o.	Quercus	falcata		CR813HRL	LNMCR	3.9112	0.0147	-0.17		
819	67	TO	turkey oak	Quercus	laevis		CR819PWR	LNMCR	3.95		-0.02		
820	68	LK	laurel oak	Quercus	laurifolia		CR820LOG	MCR	54.36			-11.3181	
822	69	OV	overcup oak	Quercus	lyrata		CR822LOG	MCR	57.82			-18.45	
824	70	BJ	blackjack oak	Quercus	marilandica		CR824LOG	MCR	56.42			-14.13	
825	71	SN	swamp chestnut oak	Quercus	michauxii		CR825HRL	LNMCR	3.9344	0.0043	-0.085		
826	72	CK	chinkapin oak	Quercus	muehlenbergii		CR826HRL	LNMCR	4.1233	-0.0142	-0.128		
827	73	WK	water oak	Quercus	nigra		CR827HRL	LNMCR	3.9116	0.0509	-0.266		
832	74	CO	chestnut oak	Quercus	prinus		CR832LOG	MCR	54.53			-14.7	
833	75	RO	northern red oak	Quercus	rubra		CR833PWR	LNMCR	3.9		-0.07		
834	76	QS	Shumard oak	Quercus	shumardii		CR834LIN	MCR	46.72	-0.85			
835	77	PO	post oak	Quercus	stellata		CR835LOG	MCR	44.34			-5.23	
837	78	BO	black oak	Quercus	velutina		CR837PWR	LNMCR	4.17		-0.18		
838	79	LO	live oak	Quercus	virginiana		CR838LIN	MCR	49.27	-0.72			
901	80	BK	black locust	Robinia	psuedoacacia		CR901LOG	MCR	49.022			-22.5732	
920	81	WI	willow	Salix	sp.		CR920LIN	MCR	44.5295	-1.0053			
931	82	SS	sassafras	Sassafras	albidum		CR931LIN	MCR	38.85	-0.99			
950	83	BW	basswood	Tilia	sp.		CR950INV	INVMCR	0.0283				-0.012
970	84	EL	elm	Ulmus	sp.		CR970PWR	LNMCR	3.68		-0.02		
971	85	WE	winged elm	Ulmus	alata		CR971LOG	MCR	43.64			-10.03	
972	86	AE	American elm	Ulmus	americana		CR972HRL	LNMCR	3.7366	0.0151	-0.09		
975	87	RL	slippery elm	Ulmus	rubra		CR975HRL	LNMCR	3.8487	0.0276	-0.201		
1	88	OS	softwoods, misc.			CR060LIN	CR001MAP	MCR	67.64	-2.25			
4	89	OH	hardwoods, misc.				CR004HRL	LNMCR	3.78	-0.02	-0.02		
999	90	OT	unknown or not listed				CR999PWR	LNMCR	3.93		-0.15		

1/ HRL = Hoerl's special function; PWR = Power function; EXP = Exponential function (not used); LIN = Linear function; LOG = Semilog function; INV = Inverse function; MAP = function used is for the indicated species in the "Map To" Column.

DEPVAR = Dependent variable; RSDIMP = Relative stand density index class midpoint; LNRSD = Log natural, rel. stand density index; L10RSD = Log, base 10, rel. stand density index; INVRSD = Inverse of Rel. stand density index (1/RSDI).

A9. Mean crown ratio and crown change Weibull parameters

						MAP TO	WEIBULL COEFFICIENTS: A B C			
Species	SN	SN	Common			SPECIES	A	B REGR: B=B0+B1*MCR		C
Number	Number	Code	Name	Genus	Species	LISTED	COEFF.	B0	B1	COEFF.
10	01	FR	fir sp.	Abies	sp.	260	4.0659	-6.8708	1.051	4.1741
60	02	JU	redcedar	Juniperus	sp.		2.4435	-32.4837	1.6503	2.6518
90	03	PI	spruce	Picea	sp.	260	4.0659	-6.8708	1.051	4.1741
107	04	PU	sand pine	Pinus	clausa		4.378	-5.0254	0.962	2.4758
110	05	SP	shortleaf pine	Pinus	echinata		4.6721	-3.9456	1.0509	3.0228
111	06	SA	slash pine	Pinus	elliottii		3.894	-4.7342	0.9786	2.9082
115	07	SR	spruce pine	Pinus	glabra		5	-10.1125	1.0734	3.3218
121	08	LL	longleaf pine	Pinus	palustris		3.9771	14.3941	0.5189	3.7531
123	09	TM	Table Mountain pine	Pinus	pungens	126	3.919	1.2933	0.7986	2.9202
126	10	PP	pitch pine	Pinus	rigida		3.919	1.2933	0.7986	2.9202
128	11	PD	pond pine	Pinus	serotina		4.33	-34.2606	1.7823	3.0554
129	12	WP	eastern white pine	Pinus	strobus		4.6496	-11.4277	1.1343	2.9405
131	13	LP	loblolly pine	Pinus	taeda		4.9701	-14.668	1.3196	2.8517
132	14	VP	Virginia pine	Pinus	virginiana		5	-10.2832	1.1019	2.4693
221	15	BY	baldcypress	Taxodium	distichum		5	-9.8322	1.1062	2.8512
222	16	PC	pondcypress	Taxodium	distichum var. nutans		4.9986	-9.6939	1.074	2.3667
260	17	HM	hemlock	Tsuga	sp.		4.0659	-6.8708	1.051	4.1741
311	18	FM	Florida maple	Acer	barbatum	317	5	-18.634	1.2622	3.6407
313	19	BE	boxelder	Acer	negundo	317	5	-18.634	1.2622	3.6407
316	20	RM	red maple	Acer	rubrum		4.7322	-24.274	1.4587	2.9951
317	21	SV	silver maple	Acer	saccharinum		5	-18.634	1.2622	3.6407
318	22	SM	sugar maple	Acer	saccharum		4.6903	-19.5613	1.2928	3.3715
330	23	BU	buckeye, horsechestnut	Aesculus	sp.	317	5	-18.634	1.2622	3.6407
370	24	BB	birch sp.	Betula	sp.		4.1939	1.25	0.8795	3.15
372	25	SB	sweet birch, black birch	Betula	lenta	370	4.1939	1.25	0.8795	3.15
391	26	AH	American hornbeam,	Carpinus	caroliniana		4.564	0.9693	0.9093	3.054
400	27	HI	hickory sp.	Carya	sp.		5	-29.1096	1.5626	3.531
450	28	CA	catalpa	Catalpa	sp.	740	4.8371	-14.318	1.206	3.7345
460	29	HB	hackberry sp.	Celtis	sp.		4.5671	-49.1736	2.1311	2.9883
471	30	RD	eastern redbud	Cercis	canadensis	701	5	15.0407	0.6546	3.0344
491	31	DW	flowering dogwood	Cornus	florida		4.7093	-9.6999	1.102	2.7391
521	32	PS	common persimmon	Diospyros	virginiana	491	4.7093	-9.6999	1.102	2.7391
531	33	AB	American beech	Fagus	grandifolia		4.6965	-14.3809	1.2016	3.5571
540	34	AS	ash	Fraxinus	sp.		4.0098	-12.7054	1.2224	2.74
541	35	WA	white ash, American ash	Fraxinus	americana		4.8776	-11.6617	1.1668	3.8475
543	36	BA	black ash	Fraxinus	nigra	540	4.0098	-12.7054	1.2224	2.74
544	37	GA	green ash	Fraxinus	pennsylvanica		4.5987	-16.9647	1.3925	3.3601
552	38	HL	honeylocust	Gleditsia	triacanthos		4.9245	-13.3135	1.2765	2.8455
555	39	LB	loblolly-bay	Gordonia	lasianthus		4.1992	-16.8789	1.2949	2.7697
580	40	HA	silverbell	Halesia	sp.	491	4.7093	-9.6999	1.102	2.7391
591	41	HY	American holly	Ilex	opaca	531	4.6965	-14.3809	1.2016	3.5571
601	42	BN	butternut	Juglans	cinerea	602	4.2967	-17.7977	1.3186	3.0386
602	43	WN	black walnut	Juglans	nigra		4.2967	-17.7977	1.3186	3.0386
611	44	SU	sweetgum	Liquidambar	styraciflua		4.635	-39.7348	1.9132	3.0574
621	45	YP	yellow-poplar	Liriodendron	tulipifera		4.9948	-11.109	1.1089	3.8822
650	46	MG	magnolia sp.	Magnolia	sp.	652	5	9.252	0.7899	3.2166
651	47	CT	cucumbertree	Magnolia	acuminata		4.9829	-5.2479	0.9552	3.8219
652	48	MS	southern magnolia	Magnolia	grandiflora		5	9.252	0.7899	3.2166
653	49	MV	sweetbay	Magnolia	virginiana		4.2299	-32.497	1.7316	2.7902
654	50	ML	bigleaf magnolia	Magnolia	macrophylla	652	5	9.252	0.7899	3.2166
660	51	AP	apple sp.	Malus	sp.	762	4.2932	-7.1512	1.0504	2.7738
680	52	MB	mulberry sp.	Morus	sp.	711	4.8677	-22.5591	1.424	2.8686
691	53	WT	water tupelo	Nyssa	aquatica		5	-15.1643	1.2524	3.1645
693	54	BG	blackgum, black tupelo	Nyssa	sylvatica		4.6134	-42.697	1.9983	3.0081
694	55	TS	swamp tupelo, swamp b.gum	Nyssa	sylvatica var. biflora		4.8257	-7.1092	1.0128	2.7232
701	56	HH	eastern hophornbeam,	Ostrya	virginiana		5	15.0407	0.6546	3.0344
711	57	SD	sourwood	Oxydendrum	arboreum		4.8677	-22.5591	1.424	2.8686
721	58	RA	redbay	Persea	borbonia		3.5122	22.2798	0.3081	2.7868
731	59	SY	sycamore	Platanus	occidentalis		4.564	-30.7592	1.6192	3.2836

740	60	CW	cottonwood	Populus	sp.		4.8371	-14.318	1.206	3.7345
743	61	BT	bigtooth aspen	Populus	grandidentata	740	4.8371	-14.318	1.206	3.7345
762	62	BC	black cherry	Prunus	serotina		4.2932	-7.1512	1.0504	2.7738
802	63	WO	white oak	Quercus	alba		5	-16.0927	1.2319	3.5016
806	64	SO	scarlet oak	Quercus	coccinea		5	-4.6551	0.9593	3.834
812	65	SK	southern red oak	Quercus	falcata var. falcata		5	-26.7842	1.603	3.516
813	66	CB	cherrybark oak, swamp red o.	Quercus	falcata		5	-4.2993	1.0761	3.5922
819	67	TO	turkey oak	Quercus	laevis	824	4.1406	13.695	0.6895	3.0427
820	68	LK	laurel oak	Quercus	laurifolia		4.6329	-1.2977	0.9438	3.2263
822	69	OV	overcup oak	Quercus	lyrata		5	11.2401	0.7081	3.5258
824	70	BJ	blackjack oak	Quercus	marilandica		4.1406	13.695	0.6895	3.0427
825	71	SN	swamp chestnut oak	Quercus	michauxii		4.4764	-18.7445	1.3539	3.8384
826	72	CK	chinkapin oak	Quercus	muehlenbergii		5	-7.5332	1.0257	3.1662
827	73	WK	water oak	Quercus	nigra		5	-50.1177	2.1127	3.5148
832	74	CO	chestnut oak	Quercus	prinus		5	-9.7922	1.0728	3.634
833	75	RO	northern red oak	Quercus	rubra		5	-12.4107	1.1363	3.643
834	76	QS	Shumard oak	Quercus	shumardii		5	5.0414	0.8032	3.6764
835	77	PO	post oak	Quercus	stellata		4.7585	-83.4596	3.0817	3.4788
837	78	BO	black oak	Quercus	velutina		5	-6.5883	1.0266	3.5587
838	79	LO	live oak	Quercus	virginiana	822	5	11.2401	0.7081	3.5258
901	80	BK	black locust	Robinia	psuedoacacia		3.5643	-10.5101	1.2176	2.2033
920	81	WI	willow	Salix	sp.		4.8547	-17.1135	1.3108	3.2431
931	82	SS	sassafras	Sassafras	albidum		4.9082	-11.2413	1.1519	2.4971
950	83	BW	basswood	Tilia	sp.		4.2656	-26.6773	1.558	4.4024
970	84	EL	elm	Ulmus	sp.	972	5	1.1421	0.9141	3.0621
971	85	WE	winged elm	Ulmus	alata		4.9367	7.6678	0.9105	3.0303
972	86	AE	American elm	Ulmus	americana		5	1.1421	0.9141	3.0621
975	87	RL	slippery elm	Ulmus	rubra		4.7375	-21.881	1.534	3.3558
1	88	OS	softwoods, misc.			60	2.4435	-32.4837	1.6503	2.6518
4	89	OH	hardwoods, misc.				4.1374	17.2956	0.4987	2.267
999	90	OT	unknown or not listed				4.9041	-2.5097	0.9225	2.7628