Analysis of CFI Plot Remeasurement and

Future Harvest Schedules using FVS

Baxter Park Scientific Forest Management Area

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Introduction

This document is intended to capture all the steps undertaken to process the SFMA CFI data and to run the FVS model for the purpose of formulating future harvest schedules. The original intent of this project was to use the Landscape Management System (LMS); however, for numerous reasons not anticipated when the project was conceived in spring, 2009, the use of LMS was deferred in favor of a less data-intensive approach that involves stratification of the CFI plots by their management status, forest type, and harvest history.

CFI Data Analysis

Plot Design and Remeasurement

Beginning in 1996, a network of 115 0.2-acre fixed-radius plots was established on a more-or-less systematic grid across the entire SFMA. During 2008-2009, 111 of these plots were successfully relocated and remeasured. [New plots were installed to replace those not relocated; these were not used for any analysis reported here.] Trees 4.5 inches dbh and larger were tallied on the 0.2-acre plot; all saplings with a measurable dbh below 4.5 inches were tallied on a concentric 0.01-acre plot. A total of 32 plots were partially harvested during the remeasurement interval.

When plots were established, trees were digitally but not physically numbered; during remeasurement, all trees were physically numbered at the stump with tube paint. Previously unnumbered trees were treated as either "missed" in the first measurement or as true "ingrowth." [Note: this distinction was not always obvious; this required a special analysis to separate them.] Although saplings were also numbered in the data file, no attempt was made to actually locate and remeasure these same trees; saplings were simply retallied.

Data recorded on all trees include dbh to the nearest 0.1" (measured at a scribed location with a steel tape) and species (coded using the FVS two-letter abbreviation). Heights were measured on a small subsample at the first occasion, and a larger subsample at remeasurement (nearest foot). At installation, standing dead trees were recorded as FVS code 6; if still standing at remeasurement, they

were coded 8. Harvested trees (i.e., stumps) were coded 7, and a tree value class (FVS codes 1,2,3) was also recorded at remeasurement.

Data Processing

Field data were input into Excel spreadsheets, one for each plot. In December 2009, Wil Mercier, working for Dr. Aaron Weiskittel of the U Maine School of Forest Resources, wrote a script to compile these data into a single table (named **Baxter_tree-data fixed**) of a Microsoft access database (named **Baxter_CFIdata.mdb**). Dr. Weiskittel fit a mixed-effects regression model with both species and species-plot effects to the second-measurement height data (634 measurements of 23 species) to predict heights for the unmeasured trees. The query **PredictHeightsNew** solves this equation for all trees at both occasions using coefficients contained in tables **HtModelNew_sp** and **HtModelNew_sp_plot** .The query **MakeNewTreeTable** merges the measured and predicted heights and creates the master database table **BaxterCFI** which contains all data for both occasions.

Extensive data cleaning was carried out to correct many different kinds of errors and inconsistencies too numerous to list here. First, all saplings (< 4.5" dbh) were extracted to a separate file, because no attempt was made to "match up" these trees in the field. Next, many queries were written to identify illogical remeasurement combinations (negative dbh growth, species changes, etc.). Results were investigated by consulting the original field records, and the records corrected as needed. These worksheets are in a folder *Error Checks* and are compiled into a loose-leaf notebook with corrections noted. *Important: every such change made to the original worksheet data was recorded in the* **Error field in the** **BaxterCFI** *table; no attempt was made to correct the original Excel files, under the assumption that the next remeasurement will produce tally sheets from this database.* We estimate that the vast majority of errors were corrected by this cleaning; however, in a few instances, e.g.: a species change with no notes, we simply relied on the remeasurement record.

To address the issue of whether newly tallied trees were missed at the first measurement, Dr. Weiskittel fit a diameter-growth prediction equation which allowed us to "grow" remeasured dbhs backwards to the plot establishment date, and compare the result to the 4.5" ingrowth threshold. Where the reconstructed dbh was greater than 4.5 (an apparent "miss"), this tree was given a number and added to the first-measurement records at this size. [Coefficients for this model are in database tables **BaxterDGRModel_Plot** and **BaxterDGRModel_Sp.** See the query **Back-grow Missed trees** and its dependent queries to examine this step in detail.] This equation was also used to "grow" harvested trees from their initial dbh to the date of harvest, known exactly from the Block records, in order to determine accretion on harvested trees prior to cutting.

Merchantable and total stemwood volumes were calculated using Honer's equations (coefficients in table **Honer_Volume**; query: **VolumeBACalc**) assuming a 4.6" minimum dbh and a 4.0" merchantable top for all species.

Including dead trees, the master **BaxterCFI** table contains 13,293 records of merchantable-size trees; the corresponding table **Saplings** contains 2,891 tree records. There were 5,343 living merchantable trees

at plot establishment; 3,821 survived to remeasurement, 737 trees were harvested, 785 died, and 730 grew to merchantable size, giving a total of 4,551 living trees at remeasurement.

Many queries were written to calculate accretion, mortality, and ingrowth; to explore this process, focus on the make-table query **MasterTable** (and its resulting table) that compiles per-acre values for every species on every plot. [Note: this table includes many blank lines for species not represented on a given plot; this was done so that Access and other subsequent processing programs treat these as zero (not missing) values for the purpose of calculating valid averages.] Queries that depend on this table were used to extract various summaries of average values by species groups and strata. Resulting datasheets were exported to the Excel workbook file **Master SFMA CFI Graphis (date).xls,** which was used to produce the tables and figures in the Powerpoint summary presented to the Advisory Committee on Feb. 2, 2010.

Stratification

Areas and Plot No by Stratum		
Stratum	SumOfACRES	NumPlots
Benchmark	1833.08	7
EcoReserve	2167.69	8
Gap	1335.67	5
OSR	1941.06	8
PC	12556.5	55
Riparian	4184	16
Undesignated	3377.38	12

Forest Type Plot Count	
ForTyp	CountOfCFI
105	1
121	12
122	1
123	25
124	15
127	2
701	1
801	15
803	1
809	1
901	5

902	4

CFI Results. For the purpose of summarizing the CFI remeasurement results, we elected to stratify the SFMA into 7 different categories based on the field OPCODE1 in the Block Database. Nearly 30% of the SFMA has been allocated to strata not under management; these include the Representative Benchmark Reserves, Larger Ecological Reserves (mainly Boody Brook Natural Area), and Riparian stands. Undesignated blocks comprise another 12%; these are areas which have not been accessed or for which allocations are pending. Strata which have been harvested at least once were collapsed into either uniform partial harvests (PC), overstory removal harvests (OSR), or non-uniform gap or patch harvests (Gap). Relationships between OpCodes and these simplified strata are shown in Appendix B, the **HarvestCodes** table in the database. The table (at left) shows the areas and distribution of CFI plots by these strata, the result of a database query of all block records, linked to each CFI plot's affiliation with a given block as compiled in this database.

FVS Simulations. For the purpose of simulating future stand development using FVS, we felt that some sort of forest typing should be added to this classification. Because there is no current type map for the SFMA, we used the FVS model to "calculate" and assign each plot to an FIA 3-digit forest type code. This is a column in the **FVS_Summary_East** database output table created when running FVS under the Database extension (explained in detail below). The 1xx codes are generally spruce-fir types; code 127 are cedar stands. Codes 8xx are northern hardwoods, and 9xx are aspen-paper birch types. Distribution of the CFI plots for the managed strata are shown in the table at left.

Further, we believed that the harvest history of the previously managed strata was also potentially important in creating future harvest schedules, so all plots were further grouped according to harvest decade (1980s, 1990s, 2000s, 2010 (future entries in Undesignated strata). This allowed us to specify a unique 4-digit field in the output database files (named "Stratum") to permit various management scenarios to be uniquely identified in the output files generated by Compute statements. The first digit defines the harvest stratum (1= PC, 2=OSR, 3=Undesignated); the second digit is the broad forest type (1=SF, 8=NH, 9=IH); the last two digits define the decade of prior harvest (80, 90, 00, or 10).

FVS Simulations

Database Extension Option

Because all the tree and stand data are incorporated into an Access database, using the FVS's Database Extension is an obvious choice. When using this option, the input database contains the basic tree and stand data in the predefined files **FVS_TreeInit** and **FVS_StandInit**, analogous to the Tree List and Stand List files used in a conventional FVS application. These tables are created using the Access Make-table queries **Write_FVS_TreeInit** and **Write_FVS_StandInit**, which both reformat data from existing tables or queries into the requisite formats.

Our implementation of the CFI simulations uses the Database Extension keywords shown in the screenshot below. The purpose of each will be described.
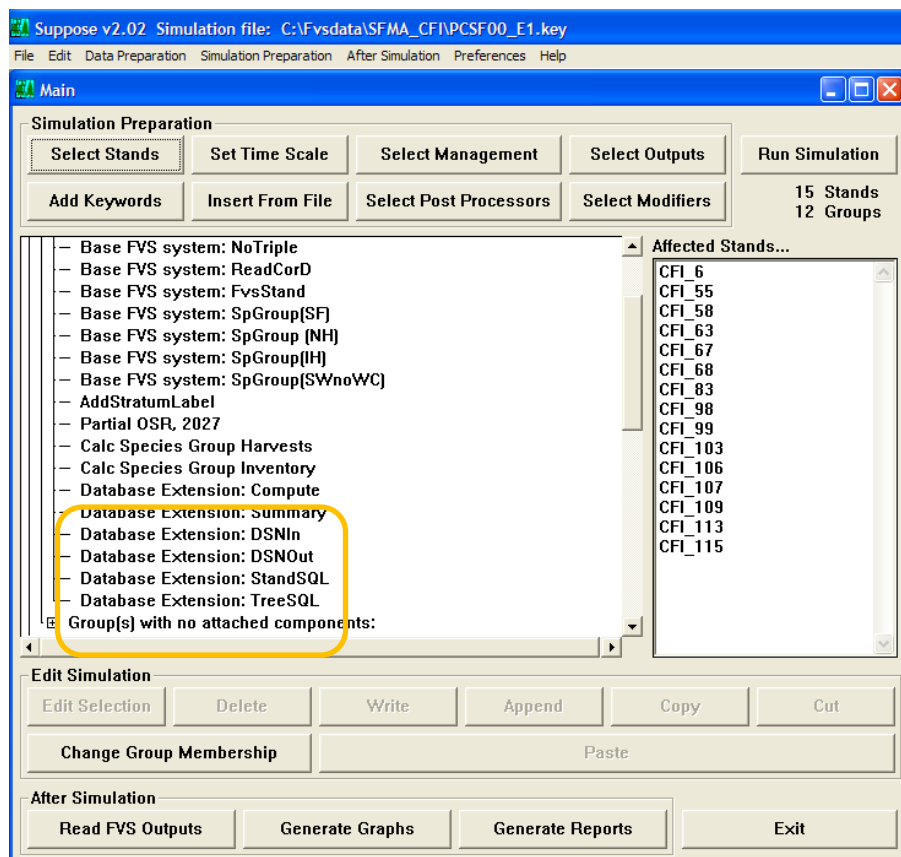
DSNIn: defines the name of the input database (**SFMA_FVS.mdb**) where the tree and stand data are stored.

DSNOut: defines the name of the output database (**SFMA_CFI_Out.mdb** in our example) where output tables resulting from the FVS simulations are stored. [Note: it is a good idea to keep the input and output tables separate.]

StandSQL and **Tree SQL**: these keywords insert SQL code into the program stream that reads the Tree and Stand Data. When you select these keywords, Suppose automatically generates the necessary statements in the PARMS format, so all you need to do is simply add them.

Summary: generates the **FVS_Summary_East** table, a predefined table with plot-level mensurational data. [This table contains the calculated FIA Forest Type used in the Stratification described above.]

Compute: creates a blank table to store user-defined variables created in Compute statements. We have created several of these, each of which is described below.

FVS_TreeInit Table

This table contains all the *Remeasurement* tree data (9046 records, including saplings), which is the logical starting point for future projections. In addition to the usual status code, species, dbh and height, we also include 10-year dbh growth for all Accretion trees; these data allow us to calibrate the large-tree diameter growth model very effectively. Because the actual measurement interval varied from 7 to 13 years, the query **FVS_TreeGrowth** first calculated the annual growth rate and then multiplied it by 10 to standardize it to a common interval.

FVS_StandInit Table

This is a very simple query with many blank fields. For all plots the BAF = -5, breakpoint dbh = 4.5", inverse of the fixed-plot size (for saplings) is 100, and site index is set at 50 for Red Spruce, lacking

specific information which was not collected. Although remeasurements were made during 2008 and 2009, the initial year of the simulations was set to 2010 to simplify the subsequent accounting and harvest prescriptions.

Important: the key field linking both files is the variable *Stand_ID*, which must be in both the tree and stand files.

Stand List Files (*.slf)

Although virtually all the information contained in the conventional FVS *.slf file is in the StandInit table, users still need to create a *.slf file and a *.loc file to run a simulation. [The user's manual for the Database Extension does not make this fact clear.] When using the Database Extension, the single purpose of the *.slf file appears to be the definition of Grouping Codes (which are not contained in the StandInit table); these are useful to create common harvest prescriptions and to create stratum-level output tables and many other applications. All other data normally contained in the *.slf file can be blank, as the quantitative information is read from the database.

For the simulations reported here, we created three different *.slf files:

CFI.slf: a basic file that allows users to group plots according to several different one-way classifications by forest type, harvest history, or stratum. Each CFI plot is treated as a separate "stand" and is grown individually, then is combined according to whatever groups may be in effect during a given run.

CFI_Stratum.slf: Here, the Stand_ID is not an individual plot, but a management stratum (Table 1 above; e.g.: PC, OSR, Riparian, etc). This was done to increase the sample size of the tree list in order to develop more robust diameter growth calibration factors.

CFI_Harvest.slf: This file combines the FIA forest type (3 broad categories, SF, NH, IH) with the Harvest history decade to form unique group codes for making future harvest prescriptions.

Other Keywords

Growth: This defines that the value in the DGR (diameter growth) column of the TreeList is a 10-year diameter (not radial) increment PRIOR to the current dbh measurement.

FixMort: This enters 10-year mortality rates for 9 species for which the built-in mortality equations underpredict actual mortality over the remeasurement period. Percentages entered using the PARMS format replace the baseline FVS rates for the entire simulation.

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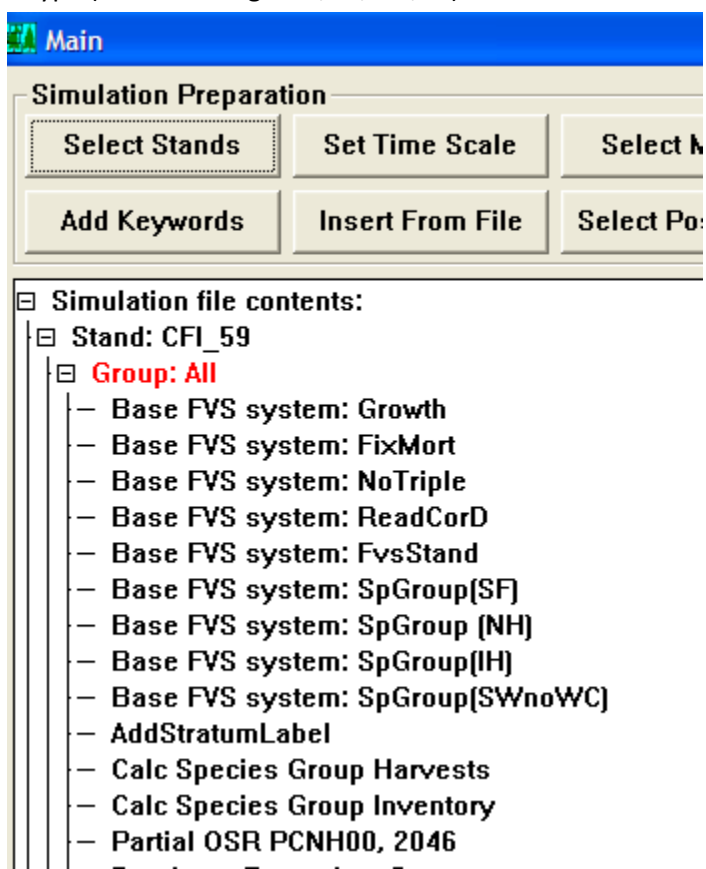
Appendix E is a complete printout of all FixMort statements, showing the dbh-class boundaries over which specific factors apply. These were developed by compiling tables of mortality by 2"dbh class and species (Appendix F), with some smoothing done. Species that do not appear in this Keyword use the baseline rates.

ReadCorD: This keyword enters the diameter-growth calibration factors calculated by the model, using entire strata as a "stand" to expand the sample size (*CFI_Stratum.slf*). The complete Calibration Summary File (*.csf) is reproduced in Appendix D. Note that these are entered using species numbers (not letter codes) which are variant-specific; these codes are given in the CSF file and can be found in the Essential FVS Users manual. To save the results of the diameter calibration exercise, invoke the option "Calibration Summary Statistics" in the Select Post-processors drop-down menu in Suppose.

NoTriple: Suppresses tripling of the tree records.

NoSprout: Suppresses automatic sprouting of a few hardwood species. (Not shown in screenshot above.)

FVSStand: Standard output data postprocessor used to produce average values by whatever groups are invoked during the run. We used this output to develop unique harvest prescriptions for each stratum. We also invoked the spreadsheet option, which produces the PT1 tables in *.CSV format, where * is the first 8 letters of the keyword file name.

SpGroup keywords: These four keywords create standard species groupings which are very useful for both data summary and harvest prescriptions. Here we define 4 groups: Spruce-fir, Northern hardwoods, Intolerant hardwoods, and Softwood species except northern white-cedar. Simply click on any of these keywords to see the specific species within each group.

AddStratumLabel: A Compute statement that assigns a unique 4-digit stratum code (see above) for each simulation. Where the same stratum is treated by multiple entries, a field "Entry" is also defined. For example, the panel at right defines a Partially cut (1) Northern hardwood (8) stratum harvested in the 2000s decade, second entry.


```
Edit - AddStratumLabel

Name:    AddStratumLabel

Variables              Operators

[          ▼]    [          ▼]

....+....1....+....2....+

Compute          0
Stratum=1800
Entry=2
End
```
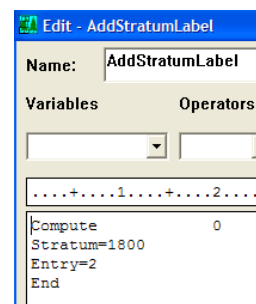
Calc Species Group Harvests, Inventory: these are also Compute statements which use the SpMcDBH function of the Event Monitor to save specific harvest and inventory numbers to the output database Compute table. Each variable name becomes a field (column) in this output table. Each record (row) in this table is the output for a specifc year of a specific simulation (labeled by the Stratum Label above). For example, the zero in the first line after "Compute" indicates to produce output for all years; the 3 in all lines defines the volume units as merchantable cubic; the next numbers

```
.......................................

Compute          0
SFHarv=SpMcDBH(3,SF,0,0.,200.,0.,500.,2)
NHHarv=SpMcDBH(3,NH,0,0.,200.,0.,500.,2)
IHHarv=SpMcDBH(3,IH,0,0.,200.,0.,500.,2)
WPHarv=SpMcDBH(3,WP,0,0.,200.,0.,500.,2)
AllSppHarv=SpMcDBH(3,All,0,0.,200.,0.,500.,2)
End

Compute          0
RSInv=SpMcDBH(3,RS,0,0.,200.,0.,500.,0)
WPInv=SpMcDBH(3,WP,0,0.,200.,0.,500.,0)
WCInv=SpMcDBH(3,WC,0,0.,200.,0.,500.,0)
SFInv=SpMcDBH(3,SF,0,0.,200.,0.,500.,0)
NHInv=SpMcDBH(3,NH,0,0.,200.,0.,500.,0)
IHInv=SpMcDBH(3,IH,0,0.,200.,0.,500.,0)
SWexWCInv=SpMcDBH(3,SWnoWC,0,0.,200.,0.,500.,0)
```

indicate to include all dbhs and heights; and the last number limits the volumes to Harvest (code 2) or Live (code 0) trees. Many other options are obviously possible with this extremely flexible and useful function.

Note: When FVS writes to the Compute table in the output database, records are simply appended below those from a previous simulation. If you make an erroneous run, data will still be written to this table and will be included with other data that are valid. If this happens, it is a good idea to immediately open this output database Compute table and delete the unnecessary records.

Keyword Component Files (*.kcp)

All these keyword combinations, including all harvest prescriptions, have been saved as *.kcp files, using the Write button on the Suppose interface. These can be added easily to any new simulation by using the "Insert From File" button on the Suppose main interface.

Silvicultural and Harvest Prescriptions

…..add detail here……

Appendix A. Species Groups used to summarize components of change in the CFI data.

SpeciesGroups		
sp	SpGroup	SpGroup2
AB	HW	TH
AE	HW	IH
BA	HW	IH
BC	HW	IH
BF	SW	SF
BP	HW	IH
BS	SW	Wet
BT	HW	IH
EH	SW	PiHe
HH	NC	TH
PB	HW	IH
PR	NC	NC
QA	HW	IH
RM	HW	TH
RO	HW	TH
RP	SW	PiHe
RS	SW	SF
SM	HW	TH
ST	NC	NC
TA	SW	Wet
WA	HW	TH
WC	SW	Wet
WP	SW	PiHe
WS	SW	SF
YB	HW	TH
All	Total	Total

Appendix B. Strata used to summarize CFI data relative to OPCODE1 in the SFMA Block database.

HarvestCodes		
OPCODE1	**Stratum**	**Managed Y/N**
BNCHMRK	Benchmark	No
FHCC	OSR	Yes
FHOSR	OSR	Yes
FHST	OSR	Yes
PHIC	PC	Yes
PHOSR	OSR	Yes
PHPC	Gap	Yes
PHSE	PC	Yes
PHSGS	Gap	Yes
REPRESER	EcoReserve	No
RESERVE	EcoReserve	No
Riparian	Riparian	No
UNDES	Undesignated	Yes

Appendix C. List of plots by Strata used for the summary and analysis of CFI data. [Note: Plots 11 and 14 were re-entered prior to plot remeasurement and should be changed to the OSR stratum.]

Plot Numbers by Stratum

CFI	Stratum
	Benchmark
9	Benchmark
26	Benchmark
36	Benchmark
38	Benchmark
47	Benchmark
49	Benchmark
74	Benchmark
102	Benchmark
	EcoReserve
31	EcoReserve
77	EcoReserve
84	EcoReserve
85	EcoReserve
86	EcoReserve
87	EcoReserve
88	EcoReserve
89	EcoReserve
	Gap
6	Gap
79	Gap
83	Gap
104	Gap
115	Gap
	OSR
4	OSR
20	OSR
42	OSR
61	OSR
62	OSR
70	OSR
80	OSR
82	OSR
91	OSR
	PC
1	PC
2	PC
3	PC
5	PC
8	PC
11	PC

Plot Numbers by Stratum

CFI	Stratum
12	PC
13	PC
14	PC
16	PC
17	PC
18	PC
19	PC
22	PC
24	PC
25	PC
27	PC
28	PC
29	PC
30	PC
32	PC
34	PC
35	PC
37	PC
39	PC
41	PC
44	PC
45	PC
50	PC
51	PC
52	PC
53	PC
55	PC
58	PC
59	PC
60	PC
63	PC
65	PC
66	PC
67	PC
68	PC
76	PC
81	PC
90	PC
93	PC
98	PC
99	PC
101	PC

Plot Numbers by Stratum

CFI	Stratum
103	PC
106	PC
107	PC
108	PC
109	PC
110	PC
111	PC
113	PC
	Riparian
7	Riparian
15	Riparian
21	Riparian
23	Riparian
46	Riparian
54	Riparian
57	Riparian
64	Riparian
69	Riparian
73	Riparian
95	Riparian
97	Riparian
100	Riparian
105	Riparian
112	Riparian
114	Riparian
	Undesignated
10	Undesignated
33	Undesignated
40	Undesignated
43	Undesignated
48	Undesignated
56	Undesignated
71	Undesignated
72	Undesignated
75	Undesignated
78	Undesignated
92	Undesignated
94	Undesignated
96	Undesignated

Appendix D. Printout of file **CFI_StratumUnCorrected.csf**, showing average diameter growth calibration factors ("READCORd Keyword Multiplier", last column) by species and stratum. Values in the **LARGE TREE DIAMETER GROWTH CALIBRATION SUMMARY** (15 species) were rounded and used in the READCORRD keyword. The number before each two-letter species code corresponds to the species number in the READCORRD keyword (e.g., Balsam Fir = species 1, Eastern Hemlock is species 16, etc.)

```
CALIBRATION STATISTICS

GENERATED BY RUNSTREAM : CFI_StratumUC

DATE: 05-05-2010     TIME: 09:54:31    VARIANT: NE TEST


*Model type LD is for large tree diameter growth.

 Model type SH is for small tree height growth.
```

STAND ID	MGMT ID	MODEL TYPE*	SPECIES NUMBER	SPECIES CODE	NUMBER OF TREE RECORDS	FVS SCALE FACTOR	RATIO STD. ERROR	BAYES WEIGHT	READCORx KEYWORD MULTIPLIER
Riparian	NONE	LD	4	RS	272	0.928	34.650	0.871	0.918
Riparian	NONE	LD	12	WC	186	0.903	35.327	0.868	0.889
Riparian	NONE	LD	1	BF	56	1.159	48.884	0.778	1.209
Riparian	NONE	LD	30	YB	12	0.987	8.425	0.548	0.976
Riparian	NONE	LD	9	WP	12	0.578	16.471	0.884	0.538
Riparian	NONE	LD	26	RM	37	0.958	9.629	0.634	0.935
Riparian	NONE	LD	33	PB	11	0.402	11.734	0.992	0.399
Riparian	NONE	LD	3	WS	17	1.085	32.348	0.627	1.139
Riparian	NONE	LD	43	BA	10	0.186	12.542	1.000	0.186
Riparian	NONE	LD	49	QA	10	0.281	16.755	1.000	0.281
Riparian	NONE	LD	27	SM	8	1.199	4.976	0.722	1.286
Riparian	NONE	SH	4	RS	8	0.130	0.000	0.000	0.130
PC	NONE	LD	4	RS	730	1.509	31.763	0.969	1.529

PC	NONE	LD	12	WC	158	1.390	33.685	0.923			1.429
PC	NONE	LD	9	WP	41	1.064	11.233	0.715			1.091
PC	NONE	LD	26	RM	186	1.093	6.672	0.853			1.110
PC	NONE	LD	1	BF	103	1.988	41.941	0.986			2.007
PC	NONE	LD	33	PB	67	0.404	10.454	0.997			0.403
PC	NONE	LD	30	YB	56	1.269	6.629	0.839			1.328
PC	NONE	LD	49	QA	19	1.009	7.188	0.722			1.012
PC	NONE	LD	27	SM	37	1.278	9.293	0.784			1.367
PC	NONE	LD	16	EH	16	1.478	22.935	0.866			1.570
PC	NONE	LD	40	AB	17	0.853	17.015	0.652			0.784
PC	NONE	LD	3	WS	19	1.062	29.760	0.648			1.097
Benchmark	NONE	LD	4	RS	147	1.014	34.178	0.829			1.017
Benchmark	NONE	LD	26	RM	26	1.267	5.110	0.811			1.339
Benchmark	NONE	LD	27	SM	7	1.525	4.813	0.869			1.625
Benchmark	NONE	LD	1	BF	29	1.566	39.628	0.908			1.639
Benchmark	NONE	LD	16	EH	7	1.210	17.660	0.725			1.301
Benchmark	NONE	LD	12	WC	11	1.624	49.081	0.862			1.755
Benchmark	NONE	LD	30	YB	8	0.759	8.085	0.706			0.677
Benchmark	NONE	LD	40	AB	7	0.945	9.696	0.614			0.912
Benchmark	NONE	LD	3	WS	17	0.823	33.601	0.695			0.756
Benchmark	NONE	LD	9	WP	14	0.890	10.836	0.637			0.833
Benchmark	NONE	LD	49	QA	34	0.760	12.184	0.798			0.709
Benchmark	NONE	LD	33	PB	22	0.509	9.043	0.969			0.498
Benchmark	NONE	LD	50	BP	11	0.267	11.296	1.000			0.267
Ecoreserve	NONE	LD	4	RS	124	1.110	36.665	0.819			1.136
Ecoreserve	NONE	LD	26	RM	58	0.866	7.151	0.775			0.831
Ecoreserve	NONE	LD	33	PB	24	0.313	10.284	1.000			0.313
Ecoreserve	NONE	LD	12	WC	26	1.293	36.513	0.797			1.380
Ecoreserve	NONE	LD	49	QA	13	0.538	11.739	0.937			0.516
Ecoreserve	NONE	LD	1	BF	20	1.028	27.524	0.754			1.037
Ecoreserve	NONE	LD	3	WS	7	1.101	32.582	0.538			1.196
Ecoreserve	NONE	LD	52	BT	16	0.683	12.324	0.822			0.629
Ecoreserve	NONE	LD	30	YB	9	0.829	11.096	0.585			0.726
Ecoreserve	NONE	LD	27	SM	5	2.010	5.698	0.960			2.069

Gap	NONE	LD	4	RS	65	1.474	35.704	0.897		1.541
Gap	NONE	LD	26	RM	29	1.067	7.642	0.665		1.102
Gap	NONE	LD	1	BF	20	1.707	43.226	0.925		1.783
Gap	NONE	LD	33	PB	19	0.320	10.895	1.000		0.320
Gap	NONE	LD	49	QA	33	0.851	10.520	0.752		0.807
Gap	NONE	LD	3	WS	9	0.911	16.340	0.708		0.877
OSR	NONE	LD	4	RS	77	1.101	33.103	0.797		1.128
OSR	NONE	LD	43	BA	6	0.226	11.268	1.000		0.226
OSR	NONE	LD	33	PB	41	0.391	9.436	0.997		0.390
OSR	NONE	LD	1	BF	16	1.688	50.893	0.905		1.783
OSR	NONE	LD	49	QA	7	0.935	3.637	0.765		0.916
OSR	NONE	LD	26	RM	32	1.351	4.983	0.858		1.420
OSR	NONE	LD	9	WP	10	1.267	8.619	0.734		1.380
Undesignated	NONE	LD	30	YB	10	1.048	9.766	0.500		1.098
Undesignated	NONE	LD	12	WC	21	1.212	36.684	0.741		1.296
Undesignated	NONE	LD	9	WP	15	1.031	10.248	0.618		1.051
Undesignated	NONE	LD	4	RS	209	1.023	33.750	0.854		1.027
Undesignated	NONE	LD	26	RM	41	0.741	8.995	0.805		0.689
Undesignated	NONE	LD	1	BF	51	1.427	40.354	0.890		1.491
Undesignated	NONE	LD	33	PB	40	0.343	11.941	0.999		0.343
Undesignated	NONE	LD	3	WS	10	1.178	24.312	0.682		1.272
Undesignated	NONE	LD	27	SM	12	1.184	8.050	0.665		1.289
Undesignated	NONE	LD	49	QA	36	0.803	9.633	0.802		0.761
Undesignated	NONE	LD	52	BT	16	0.988	6.266	0.732		0.984
Undesignated	NONE	SH	4	RS	5	0.093	0.000	0.000		0.093

LARGE TREE DIAMETER GROWTH CALIBRATION SUMMARY

			SCALE FACTOR SUMMARY					TOTAL	MEAN
	MODEL						STD		TREE	READCORD
SPECIES	TYPE*		N	MIN	MEAN	MAX	DEV.		RECORDS	MULTIPLIER

```
-------   -----   |   -----   -------   -------   -------   -------   |   -------   ----------

   1  BF   LD   |      7   1.028   1.509   1.988   0.333   |    295      1.637

   3  WS   LD   |      6   0.823   1.027   1.178   0.133   |     79      1.038

   4  RS   LD   |      7   0.928   1.166   1.509   0.231   |   1624      1.267

   9  WP   LD   |      5   0.578   0.966   1.267   0.255   |     92      1.004

  12  WC   LD   |      5   0.903   1.284   1.624   0.263   |    402      1.178

  16  EH   LD   |      2   1.210   1.344   1.478   0.190   |     23      1.488

  26  RM   LD   |      7   0.741   1.049   1.351   0.215   |    409      1.051

  27  SM   LD   |      5   1.184   1.439   2.010   0.347   |     69      1.421

  30  YB   LD   |      5   0.759   0.978   1.269   0.200   |     95      1.148

  33  PB   LD   |      7   0.313   0.383   0.509   0.067   |    224      0.382

  40  AB   LD   |      2   0.853   0.899   0.945   0.065   |     24      0.821

  43  BA   LD   |      2   0.186   0.206   0.226   0.028   |     16      0.201

  49  QA   LD   |      7   0.281   0.740   1.009   0.251   |    152      0.745

  50  BP   LD   |      1   0.267   0.267   0.267   0.267   |     11      0.267

  52  BT   LD   |      2   0.683   0.836   0.988   0.216   |     32      0.806
```

THE FOLLOWING STANDS WERE SUMMARIZED

Riparian   PC   Benchmark

Ecoreserve   Gap   OSR

Undesignated

Appendix E. Keyword component file **MortalityCorrections.kcp** used to increase baseline mortality rates by dbh classes for 9 species. Other species were left unadjusted. Note that this makes repeated use of the FixMort keyword, input using the PARMS format. These rates apply to a 10-year growth period only and replace the base-model estimates. Do not use any other period length in conjunction with these corrections!

```
!!C Base FVS system: FixMort~11 2 -1 ne base @

!!SW BuildExpression

!!P Base FVS system: FixMort~keyword.base.FixMort~.

!!K

*Args: Species, Multiplier, Min DBH, Max DBH, Distribution

* 0=don't 1=add mortality to base model estimate.

FixMort        0        Parms(BF, 0.29, 4., 5., 0, 0)

FixMort        0        Parms(BF, 0.36, 5., 7., 0, 0)

FixMort        0        Parms(BF, 0.44, 7., 9., 0, 0)

FixMort        0        Parms(BF, 0.68, 9., 11., 0, 0)

FixMort        0        Parms(BF, 0.76, 11., 13., 0, 0)

FixMort        0        Parms(BF, 0.7, 13., 99., 0, 0)

FixMort        0        Parms(AB, 0.41, 4., 99., 0, 0)

FixMort        0        Parms(PB, 0.19, 4., 99., 0, 0)

FixMort        0        Parms(WC, 0.10, 4., 99., 0, 0)

FixMort        0        Parms(QA, 0.50, 4., 7., 0, 0)

FixMort        0        Parms(QA, 0.39, 7., 9., 0, 0)

FixMort        0        Parms(QA, 0.35, 9., 11., 0, 0)

FixMort        0        Parms(QA, 0.19, 11., 13., 0, 0)

FixMort        0        Parms(QA, 0.15, 13., 99., 0, 0)

FixMort        0        Parms(RM, 0.13, 4., 9., 0, 0)

FixMort        0        Parms(RM, 0.09, 9., 99., 0, 0)

FixMort        0        Parms(RS, 0.24, 4., 5., 0, 0)

FixMort        0        Parms(RS, 0.15, 5., 7., 0, 0)

FixMort        0        Parms(RS, 0.13, 7., 9., 0, 0)
```

```
FixMort        0       Parms(RS, 0.12, 9., 11., 0, 0)

FixMort        0       Parms(RS, 0.10, 11., 99., 0, 0)

FixMort        0       Parms(WP, 0.023, 4., 99., 0, 0)

FixMort        0       Parms(WS, 0.20, 4., 9., 0, 0)

FixMort        0       Parms(WS, 0.088, 9., 13., 0, 0)

FixMort        0       Parms(WS, 0.25, 13., 99., 0, 0)

!!End
```

Appendix F. Ten-year mortality by 2" dbh classes for all species represented, listed alphabetically. Used to develop the FixMort mortality adjustments shown in Appendix E.

AB dclass	Live at Beg. <>	Dead 6	Cut 7	Proportion Dead
4	5	3	1	0.38
6	9	6	3	0.40
8	9	3	4	0.25
10	4	5		0.56
12	1	2		0.67
14	3	2		0.40
16		1	1	1.00
18	1			0.00
	32	22	9	0.41

BA dclass	<>	6		
4	1			0.00
6	7			0.00
8	6	3		0.33
10	3			0.00
12	3			0.00
14	1			0.00

BF dclass	<>	6	7	
4	66	27	9	0.29
6	150	84	61	0.36
8	61	48	49	0.44
10	12	26	22	0.68
12	6	19	3	0.76
14		3	1	1.00
16	2	1		0.33
	297	208	145	0.41

BP dclass	<>	6	7	
6	1			0.00
8	5			0.00
10	3			0.00
12	2		1	0.00
14	1	1		0.50
18	1			0.00

BT dclass	<>	6	7	
4	1			0.00
6	5			0.00
8	13	1	1	0.07
10	7	3		0.30
12	3			0.00
14	4		1	0.00

dclass				
16	1			0.00
18	2		1	0.33
22			1	1.00

EH

dclass	<>	6	7	
6	3			0.00
8	4		1	0.00
10	3		2	0.00
12	4	1	1	0.20
14	3		1	0.00
16	3	1		0.25
18	1			0.00
20	2			0.00
22	1			0.00
24	2		1	0.00

PB

dclass	<>	6	7	
4	25	5	4	0.17
6	88	24	24	0.21
8	61	8	15	0.12
10	35	8	17	0.19
12	14	8	6	0.36
14	6	2	2	0.25
16	5	1		0.17
18	2	1		0.33
22			1	
	236	57	69	0.19

QA

dclass	<>	6	7	
6	13	13	15	0.50
8	28	18	22	0.39
10	32	17	30	0.35
12	35	8	24	0.19
14	23	4	10	0.15
16	13	1	6	0.07
18	8	3	2	0.27
20	2		3	0.00
26		1		1.00
	154	65	112	0.30

RM

dclass	<>	6	7	
4	40	3	4	0.07
6	171	25	26	0.13
8	109	17	20	0.13
10	60	7	5	0.10
12	35	1	7	0.03
14	8	2	2	0.20
16	4	1		0.20
18	2	1	1	0.33
20	1			0.00
22	1		1	0.00
	431	57	66	0.12

RS

dclass	<>	6	7	
4	113	36	24	0.24
6	517	91	95	0.15
8	461	68	54	0.13
10	321	42	31	0.12
12	173	19	13	0.10
14	77	7	4	0.08
16	28	2	2	0.07
18	12	3	3	0.20
20	2		2	0.00
22	2			0.00
	1706	268	228	0.14

SM

dclass	<>	6	7	
4	1			0.00
6	9	1	2	0.10
8	16	1	1	0.06
10	13	1	4	0.07
12	9	1	2	0.10
14	6		1	0.00
16	8		2	0.00
18	6			0.00
20	3			0.00
22	1		1	0.00
24	1		1	0.00
	73	4	14	0.05

WC

dclass	<>	6	7	
4	9	1		0.10
6	57	10	7	0.15
8	108	10	5	0.08
10	98	8	6	0.08
12	81	9		0.10
14	51	4	2	0.07
16	14	3		0.18
18	17	1		0.06
20	5	1		0.17
22	1			0.00
	441	47	20	0.10

WP

dclass	<>	6	7	
4	2	2		0.50
6	15	3	2	0.17
8	18		3	0.00
10	16		1	0.00
12	10	1		0.09
14	14			0.00
16	9		3	0.00
18	6		1	0.00
20	4			0.00
22	3	1		0.25
24	1		1	0.00
26	2			0.00
28	1			0.00

| | 101 | 7 | 11 | 0.06 |

WS

dclass	<>	6	7	
4	5	1	1	0.17
6	25	7	8	0.22
8	14	3	15	0.18
10	19	1	13	0.05
12	12	2	8	0.14
14	5		1	0.00
16	2		1	0.00
18	2			0.00
20		2		1.00
24		1		1.00
	84	17	47	0.17