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Supplement to the User's Guide for the Stand Prognosis Model—Version 5.0

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THE AUTHOR

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RESEARCH SUMMARY

Version 4.0 of the Prognosis Model was released in September 1981. Since then, a regeneration establishment model has been completed and small-tree increment models have been greatly refined. The COVER model has also been added to predict shrub development and total canopy cover. Thus, the representation of the vegetative component of the stand is basically complete and the Stand Prognosis Model can be linked more readily to models for nontimber resources.

New management options have been added to the system, and an Event Monitor increases the flexibility for scheduling management activities. A compression or classification algorithm enhances program efficiency by combining tree records that are similar with regard to attributes that influence growth predictions. Finally, there have been numerous improvements in the biological models.

This report is a supplement to the user's guide for the Stand Prognosis Model (Wykoff and others 1982). Options that were available in version 4.0 may still be invoked in the manner described in the user's guide. New options, new models, and modifications to existing models are herein described as incorporated in version 5.0.

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INTRODUCTION

Version 5.0 of the Prognosis Model for Stand Development (Stage 1973) was released in July 1984. This version contains many enhancements that follow the release of version 4.0 in September 1981 (Wykoff and others 1982). Biological models were reformulated to correct apparent deficiencies, and submodel parameters were reestimated to take advantage of new data. Options have been added to increase the scope of the program and ease user interaction. In addition, several new extensions have been developed.

In order to maintain a semblance of stability for program users, very few of these changes were incorporated into version 4.0. (Copies of version 4.0 source code were distributed to 29 public and private organizations.) Programming and model formulation errors were corrected and distributed, but version 4.0 produces essentially the same results today that it did when first released.

Developments from the period 1981 through 1984 have been implemented in Prognosis Model version 5.0. These developments include:

- Revision of the small-tree height increment model and the large-tree d.b.h. increment model.

- Replacement of the small-tree d.b.h. increment model, the mortality model, and the crown dubbing procedure.

- Replacement of the procedure for calibrating the large-tree d.b.h. increment and small-tree height increment models so that the average predicted increment matches the average observed increment, regardless of sampling design.

- Modifications to the DESIGN, and THINning options that increase program flexibility.

- Introduction of new options such as NOTREES, HTGSTOP, TOPKILL, COMPRESS, and an Event Monitor.

- Linkages to a western spruce budworm model, a regeneration establishment model, COVER, and a parallel processor.

This supplement to the User's Guide describes differences in the behavior of biological models, provides reference information on using new extensions, and describes new options and modifications to existing options. Benchmarking procedures and results of test runs, including comparisons with version 4.0, will be reported separately. These benchmarks will provide a mechanism for the systematic evaluation of future model changes.

CHANGES IN PREDICTIONS OF TREE DEVELOPMENT

Version 5.0 retains two of the five submodels that were part of version 4.0 (the large-tree height increment and crown change models). Three submodels have been modified or replaced (the mortality model, the small-tree height increment model, and the large-tree d.b.h. increment model). In addition, new models for predicting d.b.h. increment and crown change in small trees (d.b.h. < 3.0 inches) were implemented. New models and modifications are briefly described below. Coefficients are listed for the models that differ from version 4.0 formulations.

Small-Tree Models

Small-tree growth has been modified considerably by changes in the mechanisms for prediction of height increment, d.b.h. increment, and change in crown ratio. The small-tree height increment model (eq. 1) now includes relative tree size effects and has been expanded to apply to additional habitat types. These effects were borrowed from the large-tree d.b.h. increment model that is part of version 4.0 (Wykoff and others 1982). For trees with d.b.h. less than 2 inches, the height increment prediction is based entirely on equation 1. For trees between 2 and 10 inches d.b.h., small- and large-tree height increment predictions are averaged as described for version 4.0.

$$\ln(HTG_2) = HAB + LOC + 0.22157 \cdot SL \cdot \cos(ASP) - 0.12432 \cdot SL \cdot \sin(ASP) - 0.10987 \cdot SL + b_1 \cdot \ln(HT) + b_2 \cdot CCF + b_3 \cdot (BAL/100) \qquad (1)$$

where:

HTG_2 = height increment prediction for trees with d.b.h. less than 3 inches.
HAB = constant term (intercept) that is dependent on habitat type.
LOC = constant term (intercept) that is dependent on location.
ASP = stand aspect (degrees).
SL = stand slope ratio (%/100).
HT = tree height (ft).
CCF = crown competition factor.
BAL = basal area in larger trees (ft^2/acre).
b_1, b_2, b_3 = regression coefficients that are dependent on species (see tables 1 and 2).

Table 1.—Coefficients for the small tree height increment model (see equation 1)

Variable		Species[1]										
		WP	L	DF	GF	WH	C	LP	S	AF	PP	MH
ln(HT)	(b_1)	0.4214	0.2716	0.3907	0.3487	0.3417	0.2354	0.5843	0.2827	0.3740	0.4485	0.2354
CCF	(b_2)	−.0059	−.0065	−.0059	−.0039	−.0039	−.0039	−.0065	−.0039	−.0039	−.0065	−.0039
BAL/100	(b_3)	−.3720	−.4153	−.4004	−.2536	−.3469	−.1201	−.2417	−.2530	−.2296	−.4730	−.2535
Habitat	1	1.2554	1.4058	1.2786	.7835	.8056	.6807	1.0190	.8818	.8521	1.5165	.6807
class	2	1.3759	1.5263	1.3991	.9040	.9261	.8012	1.1392	1.0023	.9726	1.6370	.8012
constants	3	1.1559	1.2908	.9531	.7205	1.0202	.8953	.9852	.7533	.5751	1.2966	.5215
(HAB)[2]	4	1.4700	1.6204	1.0984	.9981			.7202		.7085	1.7311	.8953
	5			1.4932				.8841		1.0667		
	6							1.2336				
Location	1	0.0	same for all species									
class	2	−.0480										
constants	3	−.2785										
(LOC)[3]												

[1]Species codes are defined in appendix A, table 14.
[2]Habitat classes are defined in table 2.
[3]Location classes:
1 Clearwater and Nezperce National Forests
2 St. Joe and Coeur d'Alene National Forests
3 All other Forests.

Table 2.—Index by species to habitat class constants for the small tree height increment model (see equation 1)

Habitat code[1]	Species[1]										
	WP	L	DF	GF	WH	C	LP	S	AF	PP	MH
130	3	3	4	3	1	1	5	1	4	1	3
170	3	3	4	3	1	1	5	1	4	1	3
250	3	3	4	3	1	1	5	1	4	1	3
260	3	3	4	3	1	1	5	1	4	3	3
280	3	3	4	3	1	1	1	1	4	3	3
290	3	3	4	3	1	1	1	1	4	1	3
310	3	3	4	3	1	1	1	1	4	1	3
320	3	3	1	3	1	1	5	1	4	3	3
330	3	3	4	3	1	1	5	1	4	3	3
420	3	1	4	3	1	1	5	1	4	3	3
470	3	1	4	3	1	1	5	1	4	3	3
510	3	1	1	3	1	1	1	1	4	1	3
520	1	1	1	1	1	1	1	1	1	1	1
530	2	2	2	2	2	2	2	2	2	2	2
550	4	4	5	4	3	3	6	4	5	4	4
570	4	4	5	4	3	3	6	4	5	4	4
610	4	4	5	4	3	3	6	4	5	4	4
620	1	1	1	1	1	1	6	1	1	1	1
640	3	3	4	3	1	1	4	1	4	3	3
660	3	3	3	3	1	1	4	1	4	3	3
670	3	3	4	1	1	1	3	1	4	3	2
680	3	3	4	1	1	1	4	1	4	3	3
690	3	3	4	3	1	1	5	1	4	3	3
710	3	3	4	3	1	1	5	1	4	3	3
720	3	3	4	3	1	1	4	1	1	3	3
730	3	3	4	3	1	1	4	1	1	3	3
830	3	3	3	3	1	1	4	3	3	3	3
850	3	3	4	3	1	1	5	1	3	3	3
999	3	3	4	3	1	1	5	1	4	3	3

[1] Habitat and species codes are defined in appendix A tables 13 and 14

In addition, the strategy for predicting diameter increments for small trees was changed. In version 4.0, the large-tree d.b.h. increment model is applied to small trees with the frequent result that trees with unusual proportions are generated (usually, large heights with small d.b.h.'s). The new model is applied only to trees with d.b.h. less than 3 inches, and it predicts d.b.h. directly from height with adjustments for stand density and relative size (eq. 2). The adjustments were developed by analyzing prediction errors from a white pine spacing study in Deception Creek Experimental Forest near Coeur d'Alene, ID.

$$DBH = b_0(HT-4.5)^{b_1} + \left[\frac{AVH}{36}(0.01232 \cdot CCF - 1.75) \cdot RELH\right] \cdot (RELH - 2.0) + 0.65 \qquad (2)$$

where:

DBH = diameter at breast height.

AVH = average height of the 40 trees per acre with the largest d.b.h.'s (top height).

RELH = relative height = $(HT-4.5)/(AVH-4.5)$ $(0 \leq RELH \leq 1.0)$.

b_0, b_1 = regression coefficients that are dependent on species (see table 3).

Finally, the procedure for assigning crown ratio (CR) to small trees was replaced. The new model is based on the logistic equation and predictions are dependent on tree height, tree d.b.h., and stand basal area (eq. 3). Parameters

Table 3.—Coefficients for the model used to predict d.b.h. (inches) for small trees (see equation 2)

Species	b_0	b_1
Western white pine	0.0781	1.1645
Western larch	.0751	1.1176
Douglas-fir	.0828	1.1713
Grand fir	.1155	1.0688
Western hemlock	.0729	1.1988
Western redcedar	.0730	1.2343
Lodgepole pine	.0988	1.0807
Engelmann spruce	.0658	1.3817
Subalpine fir	.0658	1.3817
Ponderosa pine	.2160	1.0049
Mountain hemlock	.0729	1.1988

Table 4.—Coefficients for the model used to assign crown ratio to small trees (see equation 3)

Species	b_0	b_1	b_2	b_3
Western white pine	−0.4432	−0.4845	0.0582	0.00513
Western larch	−.8396	−.1611	.0416	.00602
Douglas-fir	−.8912	−.1808	.0519	.00454
Grand fir	−.6265	−.0614	.0236	.00505
Western hemlock	−.4955	.0	.0036	.00456
Western redcedar	.1185	−.3931	.0278	.00626
Lodgepole pine	−.3247	−.2011	.0422	.00436
Engelmann spruce	−.9201	−.2245	.0325	.00620
Subalpine fir	−.8901	−.1803	.0223	.00614
Ponderosa pine	−.1756	−.3385	.0570	.00692
Mountain hemlock	−.4955	.0	.0036	.00456

were estimated from the data used to develop the small-tree height increment model. For most species, CR increases with increasing d.b.h. and decreases with increasing HT or BA. Western and mountain hemlock, however, are insensitive to changes in d.b.h.

$$CR = \frac{1}{1 + \exp(b_0 + b_1 \cdot DBH + b_2 \cdot HT + b_3 \cdot BA)} \quad (3)$$

where:

BA = stand basal area (ft^2/acre).

b_0, b_1, b_2, b_3 = regression coefficients that are dependent on species (see table 4).

If the inventory does not include some or all crown ratio measurements, this model is used to assign CR for input tree records that are less than 3 inches d.b.h. The model is also used to assign a new CR during the cycle in which the tree attains a 3-inch d.b.h. Thereafter, CR change is predicted as in version 4.0.

Crown ratio does not influence small tree growth predictions and, therefore, no periodic change is simulated. Missing input values are dubbed to provide consistency in program output and to facilitate operation of Prognosis Model extensions such as COVER and the Douglas-fir tussock moth model.

As a result of model changes, predictions of height and d.b.h. increment are sensitive to both relative tree size and overall stand density (fig. 1). This system of models has demonstrated reasonable behavior in tests to date although comparisons with data from larch spacing studies (Milner 1985) show clear

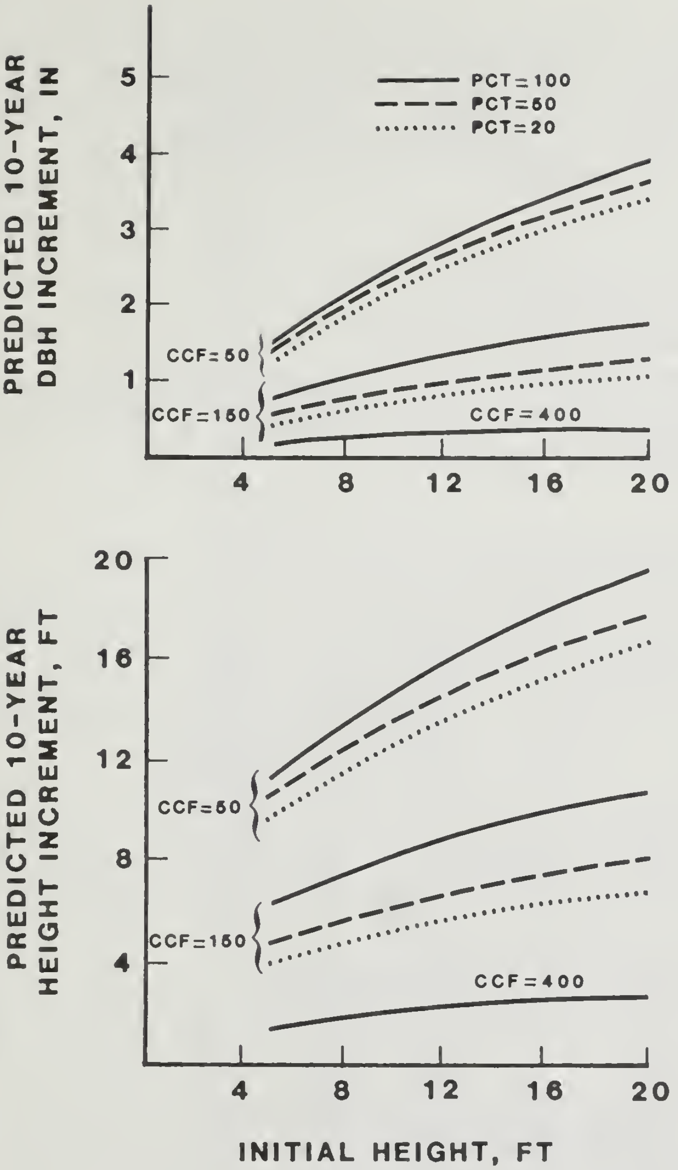


Figure 1.—Height and diameter increment predictions for small trees are sensitive to social position (as indicated by percentile in the basal area distribution, PCT) and to overall stand density (crown competition factor, CCF). Curves shown are for Douglas-fir growing on a western redcedar/*Clintonia* habitat type at 3,700 ft elevation in the Clearwater National Forest.

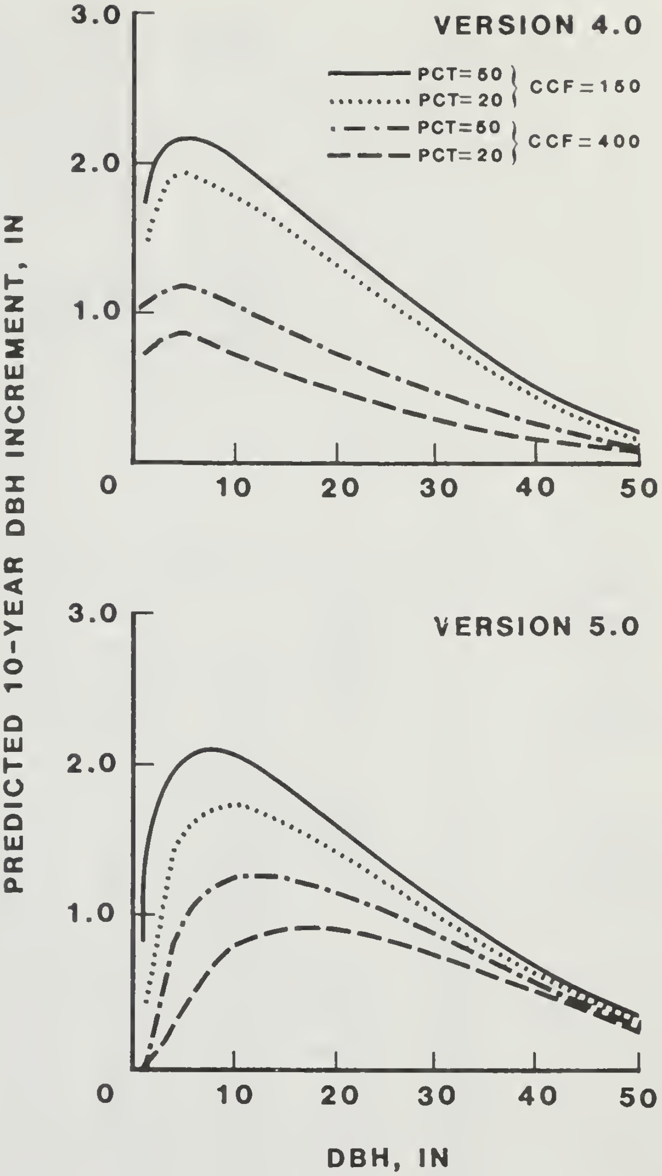


Figure 2.—The most notable differences in large-tree d.b.h. increment predictions are for subordinate trees growing in dense stands. As stand density increases, and as percentile in the basal area distribution decreases, the maximum in the increment curve shifts downward to correspond with larger d.b.h. Conditions displayed are identical to those displayed in Wykoff and others (1982; fig. 29, p. 63).

trends in prediction errors for both height and d.b.h. increment relative to initial spacing. Many of the relationships are based on crude analyses or limited data or both, and the system is at best tenuous. Work is currently underway to further refine the prediction of small tree growth.

D.b.h. Increment for Large Trees

Two changes were made in the version 5.0 large-tree d.b.h. increment model (d.b.h. $\geq$ 3 inches). The ratio, BAL/ln(DBH + 1) allows the magnitude of the relative size effect to vary with d.b.h. In addition, the CCF coefficients vary by habitat class. As a result of these changes, the model is less sensitive to changing d.b.h. and more sensitive to stand density and relative size (fig. 2).

$$
\begin{aligned}
\ln(dds) = {} & HAB + LOC \\
& + b_1 \cdot SL \cdot \cos(ASP) + b_2 \cdot SL \cdot \sin(ASP) + b_3 \cdot SL + b_4 \cdot SL^2 \\
& + b_5 \cdot EL + b_6 \cdot EL^2 + b_7 \cdot \ln(DBH) \\
& + b_8 \cdot CR + b_9 \cdot CR^2 + b_{10} \cdot (BAL/100) + b_{11} \cdot BAL/\ln(DBH + 1) \\
& + b_{12} \cdot DBH^2 + b_{13} \cdot (CCF/100)
\end{aligned} \tag{4}
$$

where:

dds = 10-year change in squared d.b.h.

EL = stand elevation (in hundreds of feet).

CR = ratio of crown length to total tree height.

b_1 through b_{13} = regression coefficients that are dependent on species, b_{12} is dependent on location, and b_{13} is dependent on habitat type (see tables 5, 6, 7, 8, and 9).

Table 5.—Coefficients for the large-tree d.b.h. increment model (see equation 4)

Variables (classes)		Species[1]										
		WP	L	DF	GF	WH	C	LP	S	AF	PP	MH
Habitat	1	1.1558	0.3834	0.4778	0.6676	0.4526	1.6145	0.7740	−0.5884	−0.9639	1.1623	−1.6803
class	2	1.0564	.5129	.1523	.6045		1.3177	.6783	−.2124	−.7242	.7341	−1.5211
constants	3		.4538	.2976				.6445	−.7163	−.5731	.5142	
(HAB)[2]	4		.7132					.3794	−.5395	−.8222		
	5		.2684					.5434		−1.2409		
	6									−1.1075		
Location	1	.1692	.2000	.5036	.4344	.1067	.5007	.4374	.2626	.4206	.2459	.1252
class	2	.0	.0766	.3492	.2834	.4436	.1765	.2111	−.1587	.1407	.5696	.4808
constants	3		.0819	.2196	−.1483	.0	.3174	.1481	.0	−.1300	.4279	.0
(LOC)[3]	4		.3038	.6181	.2020		.0	.0		.0	.0	
	5		.0	.0	.5776							
	6				.0							
SL•Cos(ASP)	(b_1)	.0982	−.2134	−.0456	−.0122	.0828	−.0662	.0032	−.1309	−.1247	−.0998	.1794
SL•Sin(ASP)	(b_2)	.0388	.0343	.0629	−.0460	.1099	.0553	.1299	−.0604	−.0686	.0119	.1336
SL	(b_3)	−.1789	.3352	.7818	1.1702	.0497	.1193	.4655	.6562	.3007	−.0664	.0763
SL^2	(b_4)	.0	−.7022	−1.1238	−1.5201	.0	.0	−.5801	−.9014	−.6222	−.4372	.0
EL	(b_5)	.0352	.0373	.0259	.0092	.0286	−.0018	−.0048	.0626	.0631	.0323	.0852
EL^2	(b_6)	−.00047	−.00043	−.00038	−.00012	−.00042	−.00007	−.00006	−.00071	−.00068	−.00042	−.00094
ln(DBH)	(b_7)	.5644	.5414	.5689	.6881	.6871	.5870	.8950	.7304	.8624	.6610	.8978
CR	(b_8)	1.0834	1.0348	2.0685	1.9397	1.6413	1.2936	1.8556	1.5464	.5204	1.3162	1.2840
CR^2	(b_9)	.0	.0751	−.6236	−.7826	−.2724	.0	−.3639	−.2664	.8624	.0	.0
BAL/100	(b_{10})	.4211	.4364	.5020	.4514	.0	.7460	−.0366	.2564	.0	.0	.0
BAL/ln(DBH+1)	(b_{11})	−2.0827	−2.0326	−2.1159	−1.7681	−.8092	−2.2838	−.4333	−1.1822	−.5127	−1.2588	−.6611
DBH^2	1	−.00044	−.00031	−.00025	−.00027	−.00022	.0	−.00126	−.00013	−.00028	−.00041	−.00048
classes	2	.0	−.00057	−.00037	−.00009	−.00043		−.00217	−.00029	−.00078	−.00044	−.00031
(b_{12})[4]	3			−.00050	−.00064			−.00189	−.00043		−.00014	
	4			−.00057				−.00087				
CCF	1	−.0243	−.1014	−.0905	−.0962	.0	−.0505	−.0558	−.0155	−.0160	−.1042	−.1074
classes	2	−.2489	−.1479	−.1188	−.1954		−.1536	−.1492	−.3839	−.0448	−.8881	
(b_{13})[5]	3	−.0108	−.0544	−.0553	−.0512		−.0940	−.4064	−.0537	−.0739	−.2594	
	4			−.0218				−.1140	−.1516		−.1473	

[1]Species codes are defined in appendix A, table 14.
[2]Habitat classes are defined in table 6.
[3]Location classes are defined in table 7.
[4]DBH-squared classes are defined in table 8.
[5]CCF classes are defined in table 9.

Table 6.—Index by species for the habitat constants in the large-tree d.b.h. increment model (see equation 4)

Habitat code[1]	Species[1]										
	WP	L	DF	GF	WH	C	LP	S	AF	PP	MH
130	2	5	3	2	1	2	5	4	6	1	2
170	2	5	3	2	1	2	5	4	6	1	2
250	2	5	3	2	1	2	5	4	6	2	2
260	2	5	3	2	1	2	5	4	6	3	2
280	2	5	3	2	1	2	1	4	6	3	2
290	2	5	3	2	1	2	2	4	6	2	2
310	2	5	3	2	1	2	1	4	6	2	2
320	2	5	1	2	1	2	5	4	6	3	2
330	2	5	3	2	1	2	5	4	6	3	2
420	2	1	3	2	1	2	5	4	6	3	2
470	2	1	3	2	1	2	5	4	6	3	2
510	2	2	1	2	1	2	2	1	6	2	2
520	1	1	1	1	1	2	2	1	1	2	2
530	1	2	1	2	1	2	3	4	2	2	2
550	1	3	1	2	1	1	3	2	3	1	2
570	1	3	1	2	1	2	3	4	4	1	2
610	1	3	1	2	1	2	3	2	3	1	2
620	1	2	1	2	1	2	3	1	1	3	2
640	2	5	3	2	1	2	4	4	6	3	2
660	2	2	2	2	1	2	4	4	6	3	2
670	1	1	3	1	1	1	3	4	6	3	1
680	1	1	3	2	1	2	4	4	6	3	2
690	2	1	3	2	1	2	5	4	6	3	2
710	2	5	3	1	1	2	5	4	6	3	2
720	2	4	3	2	1	2	4	4	1	3	2
730	2	4	3	2	1	2	4	4	1	3	2
830	2	5	2	2	1	2	4	3	5	3	2
850	2	5	3	2	1	2	5	4	5	3	2
999[2]	2	5	3	2	1	2	5	4	6	3	2

[1]Habitat and species codes are defined in appendix A, tables 13 and 14.
[2]Types grouped with 999 were included in the overall mean for the species.

Table 7.—Index by species for the location constants in the large-tree d.b.h. increment model (see equation 4)

National Forest	Species[1]										
	WP	L	DF	GF	WH	C	LP	S	AF	PP	MH
Bitterroot	2	1	5	6	3	4	4	3	4	1	3
Clearwater	2	1	1	1	3	1	1	1	1	2	1
Coeur d'Alene	2	2	2	2	1	1	1	1	2	2	1
Colville	2	3	3	2	3	2	2	3	2	1	3
Flathead	2	3	3	3	3	2	4	2	3	4	3
Kaniksu	2	2	2	2	3	3	3	3	3	3	3
Kootenai	2	5	3	4	3	4	3	3	4	1	3
Lolo	2	5	5	6	3	2	4	3	4	4	1
Nezperce	2	4	1	2	3	1	2	1	2	3	3
St. Joe	1	1	4	5	2	1	2	1	1	2	2

[1]Species codes are defined in appendix A, table 14.

Table 8.—Index by species for the location-dependent DBH-squared coefficients in the large-tree d.b.h. increment model (see equation 4)

National Forest	Species[1]										
	WP	L	DF	GF	WH	C	LP	S	AF	PP	MH
Bitterroot	1	1	1	1	1	1	1	1	1	1	1
Clearwater	2	1	2	1	1	2	2	2	2	2	1
Coeur d'Alene	2	1	2	1	1	1	2	1	1	2	1
Colville	2	1	2	1	2	1	1	1	2	2	1
Flathead	1	1	3	2	1	1	1	1	1	3	1
Kaniksu	2	1	1	2	1	1	2	3	1	3	1
Kootenai	1	1	4	3	1	2	3	2	2	2	1
Lolo	1	1	1	1	1	1	1	1	1	1	2
Nezperce	1	1	1	2	1	2	4	1	1	1	1
St. Joe	2	2	4	1	2	1	1	1	2	2	2

[1]Species codes are defined in appendix A, table 14.

Table 9.—Index by species for the habitat-dependent CCF coefficients in the large-tree d.b.h. increment model (see equation 4)

Habitat code[1]	Species[1]										
	WP	L	DF	GF	WH	C	LP	S	AF	PP	MH
130	3	3	4	3	1	3	4	4	3	2	1
170	3	3	4	3	1	3	4	4	3	2	1
250	3	3	4	3	1	3	1	4	3	3	1
260	3	3	4	3	1	3	4	4	3	1	1
280	3	3	4	3	1	3	3	4	3	4	1
290	3	3	4	3	1	3	4	4	3	3	1
310	3	3	1	3	1	3	2	4	3	3	1
320	3	3	2	3	1	3	1	4	3	1	1
330	3	3	4	3	1	3	4	4	3	2	1
420	3	3	4	3	1	3	1	4	3	4	1
470	3	3	4	3	1	3	4	4	3	4	1
510	3	3	2	3	1	3	4	3	3	1	1
520	1	1	1	1	1	3	4	3	1	4	1
530	3	3	4	3	1	1	2	1	1	4	1
550	3	3	4	3	1	2	2	1	1	4	1
570	1	3	3	3	1	3	2	3	1	1	1
610	3	3	4	3	1	3	2	3	1	4	1
620	3	2	4	3	1	2	2	1	1	4	1
640	3	3	4	3	1	3	4	4	3	4	1
660	3	1	1	3	1	3	1	2	1	4	1
670	2	3	3	3	1	1	4	4	1	4	1
680	2	3	2	3	1	3	1	1	2	4	1
690	3	1	4	2	1	3	4	4	2	4	1
710	3	1	4	2	1	3	4	4	1	4	1
720	3	3	4	3	1	3	1	1	1	4	1
730	3	3	4	3	1	3	1	1	1	4	1
830	3	3	2	3	1	3	4	4	1	4	1
850	3	3	4	3	1	3	4	4	3	4	1
999	3	3	4	3	1	3	4	4	3	4	1

[1]Habitat and species codes are defined in appendix A, tables 13 and 14.

Individual Tree Mortality Models

The mortality model now incorporates explicit terms that reflect stand density and tree vigor. In version 4.0, mortality rate was predicted from a regression model, with DBH and DBH^2 used as independent variables. Then, various correction factors were applied to reflect the effect of stand density. The correction factors were derived from yield tables (Haig 1932), published data on carrying capacities of various habitat types (Pfister and others 1977; Daubenmire and Daubenmire 1968), analysis of Northern Region timber management planning inventories, and "best guesses." The stand level models were required because the data used to develop the individual tree models contained limited information on stand density and relative size, and these effects were therefore absent from the final model.

The mortality model used in version 5.0 uses rate estimates (R_a and R_b) that are predicted from two independent equations. R_a (eq. 5) is based primarily on the analysis of permanent sample plots that are maintained by the Intermountain Station (Hamilton in preparation a). Predictions are dependent on habitat type, species, d.b.h., d.b.h. increment, estimated potential d.b.h. increment, stand basal area, and relative diameter (d.b.h./mean stand d.b.h.).

$$R_a = \{1 + \exp[b_0 + b_1 \cdot \sqrt{DBH} + b_2 \cdot \sqrt{BA} + b_3 \cdot g + b_4 \cdot RDBH + (b_5 + b_6 \cdot g) \cdot DBH^{-1}]\}^{-1} \quad (5)$$

where:

R_a = estimated annual mortality rate.

g = periodic annual d.b.h. increment for previous growth period adjusted for differences in potential annual d.b.h. increment indexed by habitat type and National Forest.

RDBH = the ratio of tree d.b.h. to the arithmetic mean stand d.b.h.

b_0 = species dependent constant (see table 10).

b_1 = 0.2223

b_2 = −0.0460

b_3 = 10.0810

b_4 = 0.2463

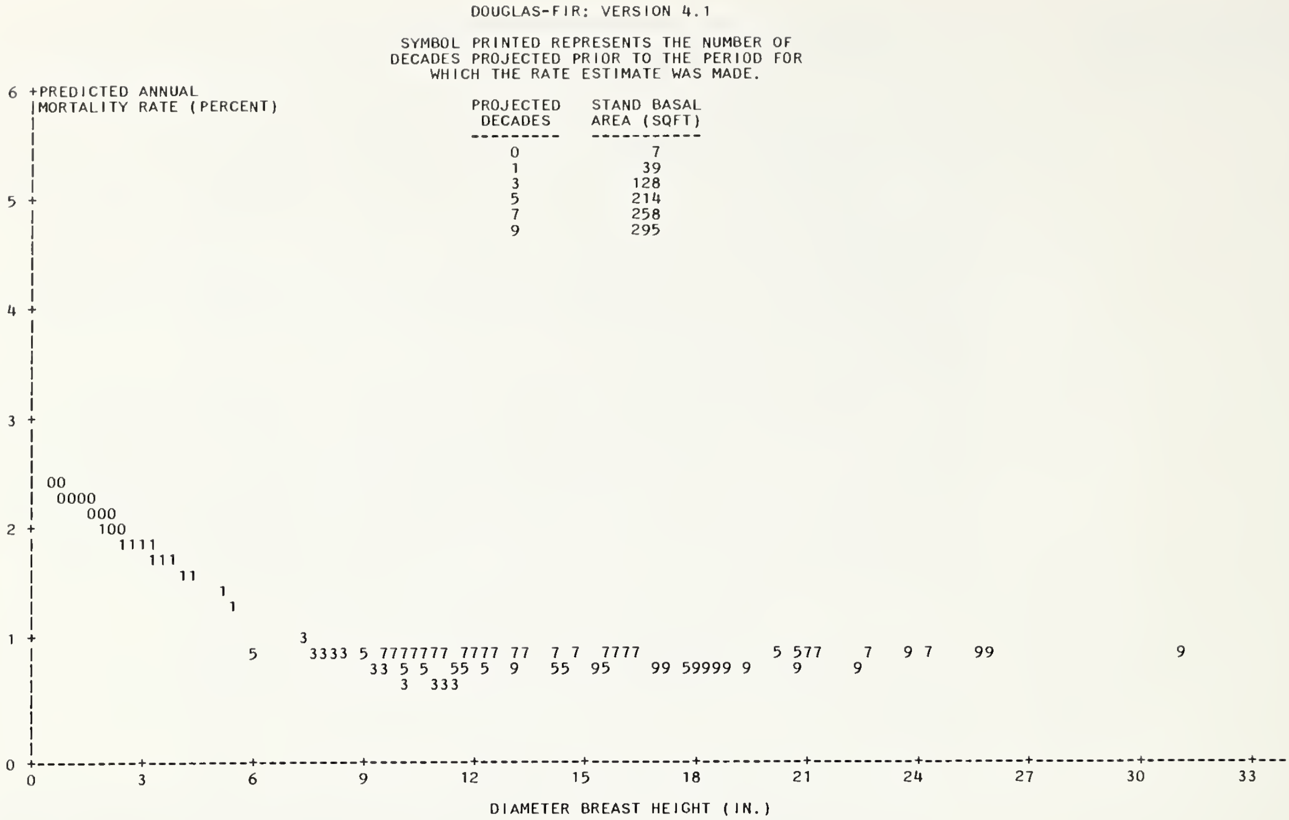
b_5 = −0.5544

b_6 = 6.0713.

R_a is multiplied by a factor based on Reineke's (1933) Stand Density Index that accounts for expected differences in mortality rates on different habitat types and National Forests (Hamilton in preparation b).

Table 10.—Species-dependent constants for the mortality model (see equation 9)

Species	Constant (b_0)
Western white pine	0.0
Western larch	−.1760
Douglas-fir	.3179
Grand fir	.3179
Western hemlock	.6077
Western redcedar	1.5798
Lodgepole pine	−.1206
Engelmann spruce	.9402
Subalpine fir	.2118
Ponderosa pine	.2118
Mountain hemlock	.0



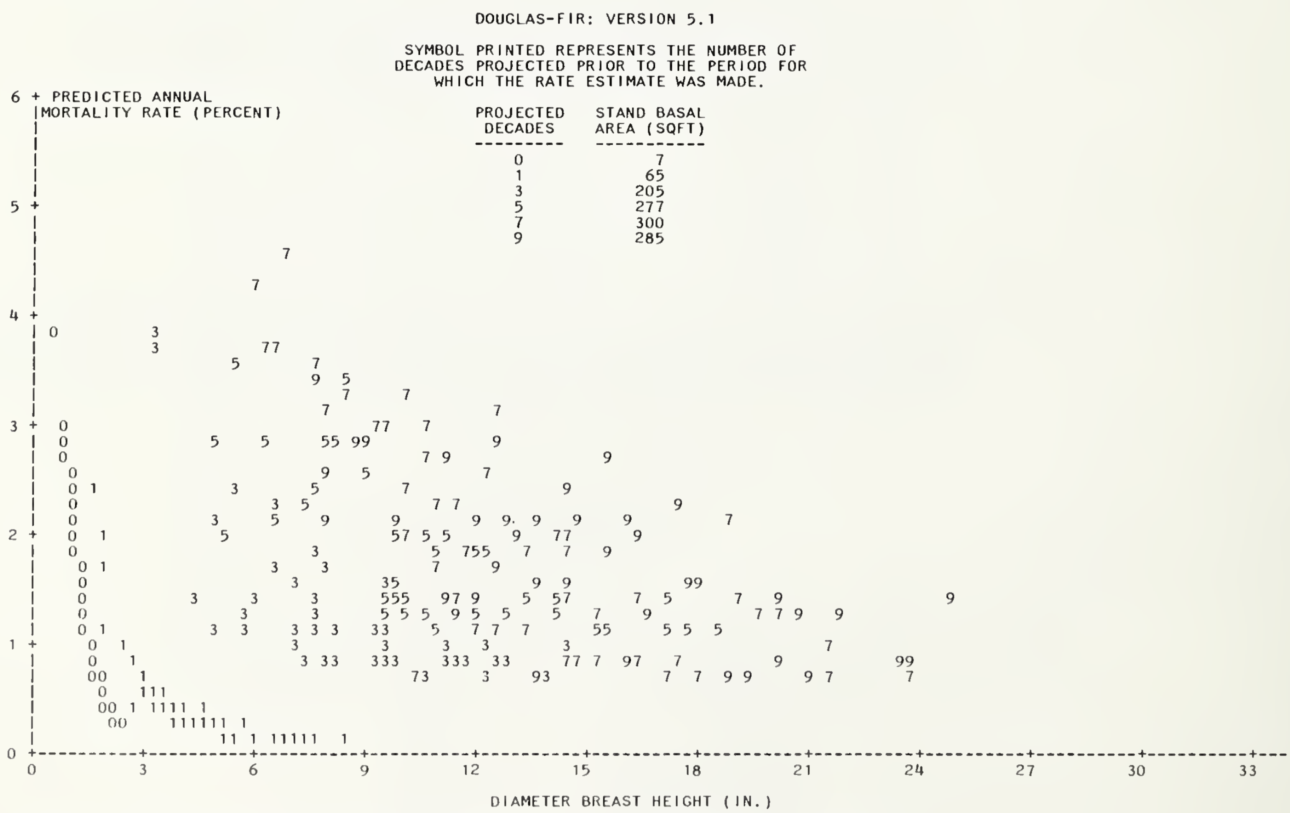


Figure 3.—Predicted annual mortality rate versus d.b.h. for Douglas-fir. The numbers printed represent decades in a long-term projection (1 is the average rate for years 11-20 in the projection; 9 is the average rate for years 90-100 in the projection). Initial stand and site conditions are the same as for figure 1. Figure 3a displays rates projected by version 4.1; figure 3b displays rates projected by version 5.1.

For purposes of predicting mortality rate, d.b.h. and d.b.h. increment are bounded. If d.b.h. is less than 0.5 inch, it is set equal to 0.5 inch; if d.b.h. is less than 1 inch and d.b.h. increment is less than 0.05 inch, d.b.h. increment is set to 0.05 inch.

The second part of the mortality rate estimate, R_b, is dependent on the proximity of stand basal area to the assumed maximum for a site (BAMAX) and on the estimated rate of basal area increment. As stand basal area approaches BAMAX, R_b approaches 1. The calculation of R_b is described by Wykoff and others (1982). As in version 4.0, the value of BAMAX is indexed to habitat type, but the default value may be overridden by the user.

The mortality rate actually applied to a tree is a weighted average of R_a and R_b. The weights applied to the respective estimates are also dependent on the proximity of stand basal area to BAMAX (eq. 6).

$$R_t = W \cdot R_b + (1-W) \cdot R_a \quad (6)$$

where:

R_t = annual mortality rate applied to tree t.

W = BA/BAMAX.

In general, the new mortality model is more sensitive to stand density and to the distribution of size classes (fig. 3) and better reflects the relationships between stand dynamics and management.

Random Effects

In application, random errors are drawn and attached to predictions of large-tree d.b.h. increment, small-tree height increment, and small-tree crown ratio. For all of these variables, the error is assumed to be Normally distributed when the model is transformed so that it is linear in the parameters. The random error is drawn from a Normal distribution on the transformed scale. Random effects are propagated in other models by including d.b.h., crown ratio, or height increment or all three as independent variables.

Interpretation of Input Stockability Data

When nonstockable plots are encountered in a stand inventory, their ratio to total plots is taken to represent the proportion of total stand area that is uninhabitable by trees. In version 4.0, only the value of crown competition factor is adjusted to reflect stockability, resulting in an inconsistent representation of density effects in the increment models. In version 5.0, the stand area used to compute the trees per acre represented by each sample tree is based only on stockable plots. As a result, all stand and tree attributes carried by the program represent stockable area. As described in the section titled "Changes in Program Output," the program output now reports stand attributes on the basis of both total and stockable area.

Calibration of Growth Models

In version 5.0, there is a new procedure for using input growth data to adjust the large-tree d.b.h. increment and small-tree height increment models. The new procedure is designed to eliminate a bias that occurred in version 4.0 when all sample trees were measured for increment. Predictions are made for each growth-sample tree and then observed increment (g_o) is regressed against predicted increment (g_p):

$$g_o = a + b \cdot g_p$$

A prediction is made for every tree to obtain a mean predicted value for the population ($\overline{G}p$). The regression model is used to estimate mean increment for the population ($\hat{\overline{G}}_o$) from the difference between the mean predictions for the population and for the growth sample ($\overline{g}_p$):

$$\hat{\overline{G}}_o = \overline{g}_o + b \cdot (\overline{G}_p - \overline{g}_p)$$

The ratio, $\hat{\overline{G}}_o/\overline{G}_p$ is then used as a multiplicative adjustment to the growth model.

As in version 4.0, the model for each species is calibrated independently. In version 5.0, however, there must be five (instead of two) increment observations before the model for a species will be adjusted. The trees on which d.b.h. increment is sampled must be greater than 3 inches d.b.h. at the start of the growth period.

Attenuation of Model Calibration

The model adjustment that is based on input increment data is attenuated over time. For both the large-tree d.b.h. increment model and the small-tree height increment model, the asymptote for attenuation is defined as the average of 1.0 and the original adjustment to the **d.b.h. increment model**. An exponential decay function is then used to approach the asymptote over time; a value midway between the original adjustment and the asymptote will be attained 25 years after the start of the projection.

Assigning Initial Values for Missing Heights

When the height for a tree is missing (as indicated by a blank or zero input value), a height is assigned from a height-diameter function:

$$HT = \exp[C_0 + C_1 \cdot 1/(DBH + 1)] + 4.5$$

The model parameters are given in the User's Guide to the Stand Prognosis Model (Wykoff and others 1982, p. 52).

Version 4.0 used a regression procedure to reestimate C_0 and C_1 when there were four or more height observations for a species. In version 5.0, however, C_1 is held constant and the height sample is used to adjust C_0. Thus the level of the curve shifts but shape is retained. By limiting the calibration to the intercept term, the procedure is less vulnerable to a poor choice of height sample trees. If for instance, the height sample contained only large trees with uniform heights, the estimate for C_1 could be positive, resulting in unrealistically tall height estimates for trees with small d.b.h.'s.

Computing Scribner Board Foot Volume with Variable Merchantability Standards

Volume calculations have been modified in version 5.0 to permit specification of variable top diameter for computing board foot volume. The modification was developed by J. E. Brickell, mensurationist with the USDA Forest Service, Northern Region Timber Management staff, Missoula, MT.

Version 4.0 used equations developed by P. D. Kemp (see Wykoff and others 1982, p. 82), with fixed merchantability standards (9-inch minimum d.b.h., 1-foot stump height, and 8-inch minimum top diameter). An additional set of volume equations (Allen and others 1974) predicts board foot volume assuming a 2-inch minimum d.b.h. and a 2-inch minimum top diameter. These two sets of equations can predict volume to a variable top diameter (D_t) if the tree is considered as four segments (fig. 4). Each segment is assumed to be a tree; d.b.h. of each assumed tree is estimated from the known basal diameter of the segment and height is estimated with a height-diameter function.

The first tree segment (S_1) extends from a 1-foot stump height to a height corresponding to a D_t that is greater than 8 inches. The second segment (S_2) extends from the top of S_1 to the height at which D_t is equal to 8 inches. The third segment (S_3) extends from the top of S_2 to a height at which D_t is less than 8 inches but greater than 2 inches. The final segment (S_4) extends from the top of S_3 to the height at which D_t is equal to 2 inches.

Table 11.—Map of species onto volume equations for computing Scribner board foot volume from squared d.b.h. and height = (D^2H). Allen's equations are used when D^2H is less than the transition value. Kemp's equations are used when D^2H is greater than the transition value

Species name	Equation used (Allen and others 1974)	Transitional value of D^2H ($in^2 \times ft$)
Western white pine	Lodgepole pine	16,917
Western larch	Western larch	19,232
Douglas-fir	Douglas-fir	15,764
Grand fir	Grand fir	10,017
Western hemlock	Grand fir	14,884
Western redcedar	Western larch	29,922
Lodgepole pine	Lodgepole pine	4,568
Engelmann spruce	Grand fir	6,025
Subalpine fir	Grand fir	19,426
Ponderosa pine	Douglas-fir	14,034
Mountain hemlock	Grand fir	14,884

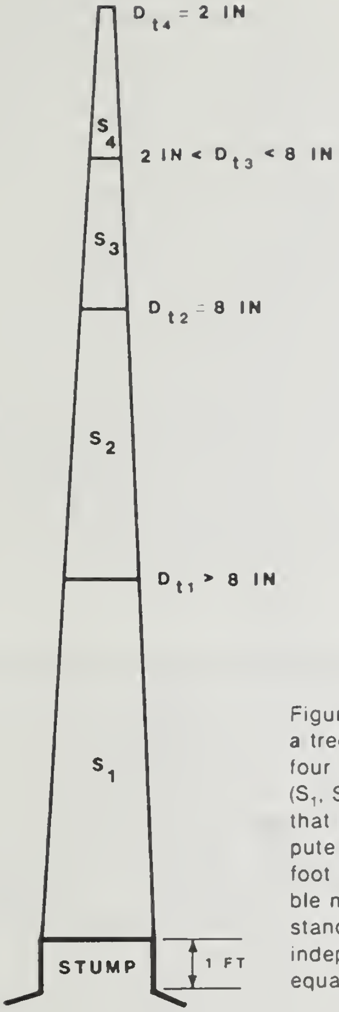


Figure 4.—Diagram of a tree showing the four tree segments (S_1, S_2, S_3, and S_4) that are used to compute Scribner board foot volume to variable merchantability standards using two independent equations.

Allen's and Kemp's equations are both dependent on the product of squared diameter and height (D^2H). For each species, the equations intersect; the point of intersection (T) corresponds to a positive value of D^2H. For D^2H less than T, Allen's equations are used to predict volume to a 2-inch top ($S_1 + S_2 + S_3 + S_4$). If a D_t greater than 2 inches is specified, S_4 is computed with Allen's equation and deducted from the total.

For D^2H greater than or equal to T, Kemp's equation is used to predict volume to an 8-inch top ($S_1 + S_2$). If a D_t greater than 8 inches is specified, Kemp's equation is used again to predict the volume of S_2, which is subtracted from the total. If a D_t of less than 8 inches is specified, ($S_3 + S_4$) and S_4 are estimated with Allen's equation in order to find top volume (S_3), which is added to the total.

Allen's equations were developed only for lodgepole pine, Douglas-fir, western larch, and grand fir. Other species were mapped onto one of these four equations for use in the Prognosis Model. The mapping and the value of D^2H at which Allen's and Kemp's equations give identical results are given in table 11.

Tree Record Compression

Version 5.0 contains a procedure for classifying records into groups that are similar with regard to variables that strongly influence growth predictions. The purpose of this compression algorithm is threefold: (1) to provide space for new records when the regeneration establishment model is called; (2) to eliminate records which, due to thinning or mortality, no longer represent a significant contribution to the stand as a whole; and (3) to reduce the number of tree records so that yield projections are less costly from a computational standpoint, but retain much of the original variation in tree characteristics.

A two-step algorithm is used to compress the tree records (Stage and others in preparation). First, a classification function, which is a weighted linear combination of selected tree attributes (including species, d.b.h., predicted d.b.h. increment, height, crown ratio, and basal area percentile) is used to find the largest gaps in a one-dimensional space. These gaps are used to identify clusters of similar records. In the second step, the larger of the identified clusters (based on the maximum difference in the value of the classification function) are split. Following the second step, the attributes of all of the records in a cluster are averaged to make a single record. Unless the target is changed by the user (see discussion of the COMPRESS keyword) the tree list will be compressed to 150 records.

CHANGES IN FEATURES THAT WERE PART OF VERSION 4.0

Seeding the Random Number Generator

In version 4.0, the random number generator was initialized only at the beginning of the first of several projections in a runstream. As a result, changing the order of projections within a runstream changed the results of the projections. In version 5.0, the random number generator is initialized before each projection so that repeatability of projections is not confounded with their order in the runstream. The sequence of random numbers can be changed by using the RANNSEED record to input a new seed. In version 4.0 there are three seeds; the version 5.0 generator requires only one.

RANNSEED field 1: New seed for random number generator. The seed should be a positive, odd integer value. If otherwise, fractions will be truncated and/or 1 will be added; default = 55329.

Once the RANNSEED record has been used to reseed the random number generator, the input seed will be used to initialize the generator in subsequent projections in the same runstream.

Generating a List of Projected Tree Records

As in version 4.0, a complete list of tree records can be generated for any or all cycles. In addition, the user can now control the dataset reference number for the output file and/or suppress headings. When the no-heading option is selected, a single identification record is printed at the beginning of the list for each cycle. The record contains a flag (the number −999 in columns 1-4), the number of records printed (columns 5-8), and the cycle number (columns 12-13).

TREELIST field 1: The cycle in which a complete list of trees is to be printed. The list is printed at the end of the cycle and the records are updated to include growth for the period. If blank, a list will be generated at the beginning of the projection and at the end of each cycle.

field 2: Dataset reference number for the output tree record file; default = 3.

field 3: Heading suppression indicator. Any numeric entry in this field will prevent headings from being printed; default = print headings.

It is possible to produce more than one tree list in any cycle. For example, if both a printed list and a machine-readable list are desired, a second TREELIST record can be inserted in the runstream to provide a dataset reference number for the machine-readable file:

```
TREELIST            2.0        ƀ          ƀ
TREELIST            2.0        99.0       999.0
```

In this case, the files will be written at the end of cycle 2 and the second file will be directed to unit 99 with headings suppressed.

Additional Flexibility in Field Sampling Procedures

The interpretation of the DESIGN record has been changed so that it is now possible to sample with two sizes of fixed-area plots where choice of plot size is dependent on tree d.b.h. For example, a 1/20-acre plot could be used to sample large trees with a 1/300-acre plot used to sample seedlings and saplings. A negative value entered in field 1 of the DESIGN record is interpreted as the inverse of the plot area from which large trees were sampled. Thus, the above example could be specified by:

```
DESIGN          -20.0     300.0     5.0      ƀ      ƀ      ƀ
```

where 5 inches is used as the breakpoint (BRK) for determination of plot size.

DESIGN field 1: Positive value is interpreted as basal area factor for horizontal angle gauge; negative value is interpreted as the inverse of large-tree fixed plot area; default = 40 (square feet/acre/tree).

field 2: Inverse of small-tree fixed plot area; default = 300 ($acre^{-1}$).

field 3: BRK; default = 5 (inches).

field 4: Number of plots in the stand. If blank, or zero, the number of plots in the stand is determined by counting the numbers of unique plot identification codes on the tree records.

field 5: Number of nonstockable plots in the stand. These include plots falling on rock outcroppings, roads, streams, etc. If blank, count nonstockable plots on tree records (IMC = 8; see discussion of tree records in version 4.0 User's Guide [Wykoff and others 1982]).

field 6: Sampling weight for stand. This weight does not affect the projection but is used in programs that aggregate many projections to produce a composite yield table; default = number of plots.

Tree Records Can Be Completely Removed in Thinning

In version 4.0, no more than 99 percent of any tree record could be removed in any one thinning. This constraint has been removed. The CUTEFF record in version 5.0 can specify a cutting efficiency parameter ranging from 0.01 to 1.0. If 1.0 is specified, and a tree is removed, the tree record will be deleted from the list. The maximum of 1.0 also applies to the cutting efficiency parameter entered on a specific thinning request (see next page).

CUTEFF field 1: Proportion of the trees per acre represented by a record that is eliminated if a tree is designated for removal in any thinning. The value of this parameter must fall between 0.01 and 1.0 or the keyword will be ignored; default = 0.98.

D.b.h. Limits Added to Thinning Options

The thinning keywords that are used to specify a stand density target can now be applied within user-selected d.b.h. limits. Only trees with d.b.h.'s between the selected limits will be removed in a thinning. The minimum and maximum d.b.h. values are entered respectively on fields 4 and 5 of the keyword records.

THINBTA — Thin from below to a trees-per-acre target.

THINATA — Thin from above to a trees-per-acre target.

THINBBA — Thin from below to a basal area-per-acre target.

THINABA — Thin from above to a basal area-per-acre target.

field 1: Year in which thinning is requested; if blank, schedule at start of projection.

field 2: The desired residual stand density (trees per acre or basal area per acre, depending on the keyword). If a residual density is not specified, the thinning request will be ignored.

field 3: The cutting efficiency parameter to be used only with this thinning request. If blank, or outside the range 0.01 - 1.0, use the value specified on the CUTEFF record.

field 4: Smallest d.b.h. to be considered for removal; default = 0.0.

field 5: Largest d.b.h. to be considered for removal; default = 999.0.

As an example, a stand is to be thinned from above to a residual density of 100 trees per acre. In addition, no trees that are less than 16 inches d.b.h. are to be removed. This prescription can be simulated by:

```
THINATA        1984.0        100.0      0.5        16.0      ƀ
```

The d.b.h. limits (16.0 and 999.0 in this example) and the cutting efficiency parameter (0.5 in this example) may constrain the actual removal to less than the specified target. If, in this example, there are 200 trees per acre in 1984, and half of these are greater than 16 inches d.b.h., only 50 trees will actually be removed, leaving a residual stand with 150 trees per acre.

Access to the COVER Extension

In version 5.0, the SHRUB and COVER extensions have been functionally combined, and access to either is provided by inserting the COVER keyword in the runstream for a projection. Keywords associated with COVER are described by Moeur (1985).

COVER field 1: Cycle to begin COVER calculations. Once begun, COVER calculations will be made each cycle until the end of the projection; default = beginning of projection.

field 2: Dataset reference number for COVER output file; default = 18.

In version 4.0, probability of occurrence, cover, and height predictions are made for 16 shrub species on three habitat types (grand fir/*Clintonia*, western redcedar/*Clintonia*, and western hemlock/*Clintonia*). In version 5.0, these equations have been replaced and expanded to represent 31 shrub species on 34 habitat types. The conifer crown width and foliage models are identical in versions 4.0 and 5.0.

Interpreting Stand Information Data

There have been two minor changes in the interpretation of data on the STDINFO record. In version 4.0, when the habitat type code indicates a phase that is not recognized by the model, the habitat code is ignored (model coefficients for type 999 are used). In version 5.0, phase designations are ignored; the code is rounded to habitat type and coefficients for the type are used.

The second change involves assignment of default values when more than one STDINFO record is found in the set of keyword records for a single projection. In version 4.0, the first record is entirely ignored if a second is encountered. Thus, blank fields are assigned the default parameter values indicated in the User's Guide. In version 5.0, blank fields on second and subsequent records are assigned values from data entered on the first record.

The field definitions for the STDINFO record have not changed.

Mortality Multipliers

Parameters have been added to fields 4 and 5 of the MORTMULT record in order to specify a range of d.b.h.'s to which the multipliers will be applied. As in version 4.0, once implemented, the multipliers and diameter limits are in effect for remaining cycles in a projection or until overridden by a subsequent MORTMULT record. Also, only one multiplier and one set of diameter limits can be specified for each species in any cycle.

MORTMULT	field 1:	Cycle in which mortality multiplier is to be applied. Once multipliers take effect, they remain in effect until replaced with a subsequent request. If blank, multipliers take effect at the start of the projection.
	field 2:	Species number (see appendix A, table 14) to which multiplier is to be applied; default = all species.
	field 3:	The value of the multiplier to be used; default = 1.0.
	field 4:	Minimum d.b.h. to which multiplier will be applied; default = 0.0.
	field 5:	Maximum d.b.h. to which multiplier will be applied; default = 999.0.

Tree Records

In version 5.0, the interpretation of increment data has changed slightly. With calibration options 1 and 3 (see Wykoff and others 1982, p. 20), increments are input as the difference between two successive d.b.h. or height measurements; the value entered as d.b.h. or height increment is actually a d.b.h. or height—the program automatically performs the subtraction. In version 4.0 with calibration options 1 and 3, input increments of 0 are treated as real measurements and input increments that are exactly equal to the d.b.h. or height measurements are ignored. In version 5.0, only non-zero entries in the increment fields are treated as growth samples regardless of the method used to enter increment data. Further, when increment is computed as the difference between two successive height or d.b.h. measurements, all negative values are rejected.

Point-specific site descriptors have been added to the tree records as an optional input to facilitate the regeneration establishment model. Data that may be entered include slope, aspect, habitat type, topographic position, and site preparation; the coding of these variables is described by Ferguson and Crookston (1984, p. 21). The default tree record format has not changed other than to accommodate the optional point-specific site descriptors.

The optional input is read from the tree records when field 2 of the TREEDATA record is not blank.

TREEDATA field 1: Dataset reference number for tree record input file; default = 2.

field 2: Any numeric value in this field will cause point-specific site descriptors to be read from tree records. Default = point-specific site descriptors are not read.

NEW OPTIONS

Options have been included in version 5.0 that add flexibility to activity schedules, provide better description of the input data, permit variable merchantability standards for computing board foot volume, and afford greater control of growth functions.

Event Monitor

The event monitor schedules management activities conditional on the status of selected stand attributes or the occurrence of certain management activities. The IF record indicates that subsequent records contain information for the event monitor. IF is followed by a logical expression coded on one or more supplemental data records. A THEN record signals the end of the logical expression and is followed by one or more keywords for Prognosis Model activities. An ENDIF record signals the end of event monitor information. For example,

```
IF
(BBA  GT  120)
THEN
THINBBA      ƀ       80
ESTAB
END
ENDIF
```

will result in a thinning from below to 80 ft^2 of basal area followed by a call to the regeneration establishment model each time stand basal area reaches 120 ft^2.

Any activity that can be scheduled normally can be alternatively scheduled with the event monitor; the scheduling date (field 1) on the activity keyword is then interpreted as a delay. If the date entered is 10, the activity will be scheduled 10 years following the first time that the logical expression is true.

Crookston (1985) gives further examples along with complete instructions for coding keywords and logical expressions.

Variable Merchantability Standards for the Board Foot Volume Equations

The BFVOLUME record changes the merchantability standards for the board foot volume equations. The parameters for BFVOLUME are the same as for VOLUME in version 4.0, except that values entered for stump height are ignored. Minimum d.b.h. and minimum top diameter may be changed by cycle for any or all species.

BFVOLUME field 1: Number of the cycle in which new merchantability standards are to take effect; default is beginning of projection.

field 2: Species number (see appendix A, table 14) for the species that is to be affected by the merchantability limits; default is all species.

field 3: Minimum merchantable d.b.h. (inches). Trees with smaller d.b.h. will have no board foot volume. If the number entered here is less than the top diameter (field 4), the value specified for minimum top diameter will be used for minimum d.b.h. as well; default = 6.0 for lodgepole pine, 7.0 for all other species.

field 4: The minimum top diameter (inches); default = 4.5.

Descriptive Statistics for Input Data

An optional output table gives a statistical description of the input data for a projection. This table is requested with the STATS record. Statistics reported include board foot volume, cubic foot volume, trees per acre, and basal area per acre for each species present in the stand. Also given are the mean, standard deviation, coefficient of variation, and confidence limits across sample plots for stand totals of these volume and density measures. Significance level is input in field 1 of the STATS record; the corresponding value of Student's *t* is computed by the program.

STATS field 1: Significance level for computing confidence limits; default = 0.05.

Starting Projections from Bare Ground

With the Establishment Model in place, it is now possible to begin projections without tree records. To do this, a NOTREES record must be inserted in the runstream. There are no associated parameters. The establishment model (Ferguson and Crookston 1984) can then be used to generate a list of seedlings based on stand parameters and proposed treatment strategies.

Compressing the Tree List

When there are many records in the tree list, the record-compression algorithm can reduce the number of records while minimizing loss of within-stand variation in tree attributes that are important for increment prediction. As a result, the number of calculations required for the projection (and the cost of the projection) can be substantially reduced without significant bias. Compression of the tree list is requested with the COMPRESS record; there are four associated parameters:

COMPRESS field 1: Cycle in which tree list will be compressed; default is the beginning of the projection.

field 2: Number of tree records that will remain following compression; default = 150.0.

field 3: Percentage of new records that will be determined by finding the largest gaps in the classification space. Remainder of records will result from splitting the classes with the greatest variation; default = 50.0.

field 4: Any numeric entry will cause debug output to be printed for the compression algorithm; default is no compression debug output.

If COMPRESS is specified for the first or second cycle, the tree records will be subsequently tripled unless NOTRIPLE or NUMTRIP (see Wykoff and others 1982, p. 93) is used to suppress the record tripling feature.

Simulating Top Mortality

Two options were included in version 5.0 to simulate the effects of defoliation by insects when interactive population dynamics models are unavailable. By using the HTGSTOP record, height growth may be set to zero for randomly selected tree records with heights between user-specified limits. The TOPKILL record provides for permanently removing a randomly selected proportion of the top as well. There are five parameters on the HTGSTOP record to indicate timing, species affected, upper and lower height limits, and the probability that the tree will not grow in height. These same five parameters are entered on the TOPKILL record along with a mean and standard deviation for the distribution describing the proportion of total tree height lost to TOPKILL. This distribution is assumed to be Normal, but in no case will a tree's crown ratio be reduced to less than 5 percent or will the maximum change in total height be greater than 25 percent.

HTGSTOP
TOPKILL

- field 1: Cycle in which top-kill and/or growth loss will be simulated; default is first cycle.
- field 2: Species that will be affected; default is all species.
- field 3: Lower limit of range of heights that will be affected; default = 0.0.
- field 4: Upper limit of range of heights that will be affected; default = 0.0.
- field 5: Probability that a tree will experience top-kill or growth loss; default = 0.0.

For TOPKILL record only:

- field 6: Mean of the distribution of the proportion of total tree height lost to top-kill; default = 0.0.
- field 7: Standard deviation of the distribution of the proportion of total tree height lost to top-kill; default = 0.0.

Top damage will only be simulated in the cycle that is specified on the HTGSTOP or TOPKILL record. Periodic infestations can be simulated by including HTGSTOP or TOPKILL records for additional cycles.

CHANGES IN PROGRAM OUTPUT

Although the format of the base model output has not changed greatly in version 5.0, additions to the base model have resulted in new tables. There have also been subtle changes to the output that result from new or expanded options and from changes in the interpretation of input data on the frequency of nonstockable plots.

The regeneration establishment model and the SHRUBS and CANOPY models produce output tables that summarize the operation of these models when they are invoked. These tables are explained in the appropriate User's Manual (Ferguson and Crookston 1984; Moeur 1985). The STATS option produces another new table that displays the distribution of stand attributes by species and by sample plot when more than one plot is used to inventory the stand (fig. 5).

The change in the interpretation of input data on the frequency of nonstockable plots resulted in adjustments to the per-acre values reported for stand attributes. As was earlier described, trees per acre represented by a tree record is now computed on the basis of stockable area. When nonstockable

GENERAL SPECIES SUMMARY FOR THE CRUISE

SPECIES	BOARD FEET	CUBIC FEET	TREES PER ACRE	BA PER ACRE
WESTERN LARCH	904.9	218.9	44.5	16.0
DOUGLAS-FIR	1380.0	419.3	207.0	19.4
GRAND FIR	405.9	339.8	177.9	20.0
WESTERN HEMLOCK	0.0	48.2	17.4	4.0
WESTERN REDCEDAR	0.0	90.4	111.1	9.7
LODGEPOLE PINE	1883.5	506.4	31.8	16.0

DISTRIBUTION OF STAND ATTRIBUTES AMONG SAMPLE POINTS

CHARACTERISTIC	MEAN	STD. DEV.	COEF VAR	SAMPLE	95% CONFIDENCE LIMITS	
TREES PER ACRE	589.65	524.54	0.89	10	214.31	964.99
CUBIC FEET/ACRE	1622.98	922.21	0.57	10	963.09	2282.86
SCRIBNER BF/ACRE	4574.18	3886.39	0.85	10	1793.27	7355.09
BASAL AREA /ACRE	85.13	39.45	0.46	10	56.90	113.36

Figure 5.—Prognosis Model output table produced by the STATS option.

points are present in an inventory, the "STAND COMPOSITION" table (Wykoff and others 1982; fig. 7, pp. 34-35) and the table displaying "ATTRIBUTES OF SELECTED SAMPLE TREES" and "ADDITIONAL STAND ATTRIBUTES" (Wykoff and others 1982; fig. 8, pp. 36-37) now display per-acre stand and tree attributes on the basis of stockable area. The table headings have been modified to reflect the change (figs. 6 and 7). The "SUMMARY STATISTICS" table (Wykoff and others 1982; fig. 9, p. 37) still reports per-acre stand attributes on the basis of total stand area. The table heading, however, has been modified for contrast (fig. 8). The trees per acre reported for each tree record when the TREELIST option is used is still based on total stand area as well.

If nonstockable plots are present in an inventory, the "OPTIONS SELECTED BY DEFAULT" table now reports the ratio of stockable to total plots and the basis for computing per-acre attributes in each of the major tables (fig. 9).

The final change in program output results from the implementation of the regeneration establishment model, the compression algorithm, and the complete removal of tree records in thinning. When tree records are added or deleted, a realignment of the records displayed in the "ATTRIBUTES OF SELECTED SAMPLE TREES" table is necessary. Changes are noted by placing asterisks (**) following the date that records are reselected. An explanatory note is also appended to the table (fig. 7).

CONCLUSIONS

There are substantial changes in program operation and model formulation represented in version 5.0. As a result, the program affords both greater flexibility and improved performance. Permanent sample plots were used to compare version 5.0 with previously available methods of growth projection for Northern Rocky Mountain conifers. Results show that version 5.0 projections of stand attributes have smaller biases and smaller error variances than do projections produced by other methods (Wykoff 1985; Stage in preparation).

STAND CRᴖWTH PROCNDSIS SYSTEM VERSION 5.1 -- INLAND EMPIRE

STAND ID: S248112 MANAGEMENT CDDE: NONE SHELTERWDDD PRESCRIPTION FRDM THE USER'S MANUAL

STAND COMPOSITION (8ASED ON STOCKA8LE AREA)

YEAR	STAND ATTRI8UTES	PERCENTILE PDINTS IN THE DISTRIBUTION OF STAND ATTRIBUTES BY DBH (DBH IN INCHES) 10	30	50	70	9D	100	TOTAL/ACRE DF STAND ATTRI8UTES	DISTRI8UTION OF STAND ATTRI8UTES 8Y SPECIES AND 3 USER-DEFINED SUBCLASSES			
1977	TREES	0.1	D.1	3.2	6.1	8.5	12.7	590. TREES	27.% DF2,	15.% GF2,	15.% CF1,	1D.% C2
	VOLUME:											
	TOTAL	5.8	7.9	9.4	10.0	11.5	12.7	1623. CUFT	24.% LP1,	21.% CF1,	20.% DF1,	12.% L1
	MERCH	8.2	9.4	9.6	10.9	11.5	12.7	1118. CUFT	32.% LP1,	24.% DF1,	15.% L1,	10.% LP2
	MERCH	8.D	9.4	9.6	10.9	11.5	12.7	4574. 8DFT	31.% LP1,	23.% DF1,	17.% L1,	10.% LP2
	REMDVAL	0.1	0.1	0.1	1.2	3.2	10.4	326. TREES	48.% DF2,	28.% GF2,	18.% C2,	4.% L2
	VOLUME:											
	TOTAL	8.0	9.6	9.6	10.4	10.4	1D.4	255. CUFT	47.% LP2,	4D.% DF2,	9.% L2,	4.% C2
	MERCH	9.6	9.6	9.6	1D.4	10.4	1D.4	217. CUFT	51.% LP2,	41.% DF2,	8.% L2,	0.% ---
	MERCH	8.0	9.6	9.6	1D.4	10.4	10.4	911. 8DFT	50.% LP2,	37.% DF2,	13.% L2,	0.% ---
	RESIDUAL	4.0	5.3	6.2	7.9	9.5	12.7	264. TREES	33.% CF1,	19.% C1,	19.% DF1,	13.% L1
	ACCRETION	5.3	6.2	7.9	9.4	1D.9	12.7	91. CUFT/YR	31.% CF1,	25.% DF1,	13.% LP1,	11.% L1
	MORTALITY	6.1	7.9	8.5	9.5	11.5	12.7	13. CUFT/YR	39.% LP1,	25.% L1,	2D.% GF1,	13.% DF1
1987	TREES	5.6	6.8	7.9	9.4	11.2	16.2	242. TREES	33.% CF1,	2D.% C1,	19.% DF1,	12.% L1
	VOLUME:											
	TOTAL	7.3	8.9	9.9	11.6	13.7	16.2	2145. CUFT	28.% GF1,	24.% DF1,	21.% LP1,	12.% L1
	MERCH	7.7	9.4	1D.4	12.0	13.7	16.2	1763. CUFT	26.% CF1,	25.% DF1,	24.% LP1,	13.% L1
	MERCH	7.9	9.4	10.6	12.4	13.9	16.2	7247. BDFT	26.% LP1,	25.% DF1,	24.% GF1,	15.% L1
	ACCRETIDN	6.6	7.7	9.D	11.0	13.1	16.2	116. CUFT/YR	36.% CF1,	22.% DF1,	12.% C1,	12.% WH1
	MDRTALITY	6.8	8.9	9.4	1D.6	12.5	16.2	18. CUFT/YR	36.% LP1,	23.% GF1,	21.% L1,	15.% DF1
1997	TREES	7.2	8.4	9.6	11.1	13.4	19.2	222. TREES	33.% CF1,	21.% C1,	19.% DF1,	11.% L1
	VOLUME:											
	TOTAL	8.4	9.9	11.2	13.4	15.5	19.2	3123. CUFT	31.% CF1,	24.% DF1,	16.% LP1,	10.% L1
	MERCH	8.6	1D.2	11.5	13.4	15.6	19.2	2826. CUFT	31.% GF1,	23.% DF1,	17.% LP1,	11.% L1
	MERCH	9.2	1D.5	11.7	13.5	15.8	19.2	11998. BDFT	30.% CF1,	25.% DF1,	18.% LP1,	11.% L1
	ACCRETION	8.D	9.6	11.1	12.5	15.1	19.2	141. CUFT/YR	41.% CF1,	20.% DF1,	14.% WH1,	13.% C1
	MORTALITY	8.D	9.8	1D.8	12.D	14.3	19.2	28. CUFT/YR	3D.% LP1,	24.% GF1,	2D.% L1,	18.% DF1
2DD7	TREES	8.2	9.9	11.3	12.5	15.4	21.7	2D1. TREES	34.% GF1,	23.% C1,	19.% DF1,	10.% L1
	VOLUME:											
	TOTAL	9.6	11.6	12.8	15.0	17.1	21.7	4248. CUFT	35.% CF1,	23.% DF1,	12.% LP1,	11.% C1
	MERCH	9.9	11.7	13.3	15.1	17.2	21.7	3987. CUFT	35.% CF1,	23.% DF1,	12.% LP1,	11.% WH1
	MERCH	1D.D	11.8	13.4	15.4	17.4	21.7	17703. 8DFT	34.% CF1,	24.% DF1,	12.% LP1,	11.% WH1
	REMOVAL	7.2	10.0	11.2	11.8	13.4	21.6	44. TREES	43.% L1,	32.% LP1,	11.% C1,	10.% DF1
	VDLUME:											
	TOTAL	10.0	11.2	11.8	12.8	14.5	21.6	897. CUFT	55.% LP1,	39.% L1,	3.% DF1,	2.% C1
	MERCH	1D.1	11.3	11.8	12.8	14.5	21.6	828. CUFT	57.% LP1,	40.% L1,	2.% C1,	1.% CF1
	MERCH	10.3	11.3	11.8	13.1	14.7	21.6	3673. BDFT	57.% LP1,	40.% L1,	1.% C1,	1.% GF1
	RESIDUAL	8.2	9.7	11.3	13.3	15.7	21.7	157. TREES	42.% GF1,	26.% C1,	22.% DF1,	10.% WH1
	ACCRETIDN	9.4	11.3	12.6	14.5	17.0	21.7	144. CUFT/YR	42.% GF1,	20.% WH1,	19.% C1,	18.% DF1
	MORTALITY	9.0	11.3	12.7	15.1	17.2	21.7	19. CUFT/YR	46.% CF1,	34.% DF1,	9.% C1,	9.% WH1
2D17	TREES	9.6	11.4	13.1	15.1	17.8	23.3	147. TREES	42.% CF1,	26.% C1,	21.% DF1,	10.% WH1
	VOLUME:											
	TDTAL	11.1	13.1	15.7	17.3	19.2	23.3	4606. CUFT	43.% CF1,	25.% DF1,	16.% WH1,	16.% C1
	MERCH	11.1	13.3	15.9	17.3	19.2	23.3	4397. CUFT	43.% CF1,	25.% DF1,	16.% WH1,	15.% C1
	MERCH	11.4	13.7	16.3	17.6	20.0	23.3	20929. 8DFT	43.% CF1,	26.% DF1,	17.% WH1,	13.% C1
	ACCRETIDN	1D.8	12.9	14.8	16.5	19.2	23.3	169. CUFT/YR	44.% CF1,	23.% WH1,	17.% C1,	15.% DF1
	MDRTALITY	9.9	12.8	14.4	16.5	18.7	23.3	32. CUFT/YR	5D.% GF1,	3D.% DF1,	9.% WH1,	9.% C1

Figure 6.—Stand composition table from the Prognosis Model output. This table was produced by the same set of keyword and tree records that were used for an example by Wykoff and others (1982; fig. 7, pp. 34-35). Note the change in table heading that reflects the change in treatment of stockability data. Note also that a nonstockable plot in the inventory resulted in a change in initial conditions.

Figure 6.— (con.)

2027	TREES	10.6	12.8	15.1	17.2	20.6	27.0	136.	TREES	41.% GF1,	27.% C1,	21.% DF1,	11.% WH1
	VOLUME:												
	TOTAL	12.6	15.1	17.2	19.1	21.6	27.0	5972.	CUFT	43.% GF1,	22.% DFF,	18.% WHF,	16.% C1
	MERCH	12.6	15.1	17.2	19.1	21.6	27.0	5746.	CUFT	43.% GF1,	22.% DF1,	18.% WH1,	16.% C1
	MERCH	12.9	15.4	17.4	19.8	21.7	27.0	28917.	BDFT	44.% GF1,	22.% DF1,	21.% WH1,	13.% C1
	ACCRETION	12.6	14.8	15.9	19.1	21.7	27.D	166.	CUFT/YR	51.% GF1,	21.% WH1,	15.% C1,	13.% DF1
	MORTALITY	11.9	14.3	15.9	18.2	20.9	27.0	42.	CUFT/YR	49.% GF1,	29.% DF1,	11.% WH1,	11.% C1
2037	TREES	11.4	14.8	16.4	18.2	22.3	29.5	126.	TREES	41.% GF1,	28.% C1,	20.% DF1,	11.% WH1
	VOLUME:												
	TOTAL	14.3	16.4	18.2	21.4	23.9	29.5	7211.	CUFT	45.% GF1,	20.% OF1,	19.% WH1,	16.% C1
	MERCH	14.3	16.4	18.2	21.4	23.9	29.5	6975.	CUFT	45.% GF1,	20.% OF1,	19.% WH1,	16.% C1
	MERCH	14.8	16.6	18.7	21.8	24.6	29.5	36029.	BDFT	46.% GF1,	22.% WH1,	20.% OF1,	13.% C1
	REMOVAL	12.1	15.1	16.3	17.1	22.3	29.5	91.	TREES	47.% GF1,	38.% C1,	15.% WH1,	0.% L1
	VOLUME:												
	TOTAL	14.3	16.3	16.9	22.1	22.7	29.5	4823.	CUFT	48.% GF1,	28.% WH1,	24.% C1,	0.% LP1
	MERCH	14.3	16.3	16.9	22.1	24.6	29.5	4652.	CUFT	48.% GF1,	28.% WH1,	24.% C1,	0.% LP1
	MERCH	14.8	16.3	17.1	22.1	24.6	29.5	23823.	BDFT	49.% GF1,	32.% WH1,	19.% C1,	0.% LP1
	RESIDUAL	10.9	12.2	18.7	19.7	22.3	29.5	35.	TREES	72.% OF1,	26.% GF1,	2.% C1,	1.% WH1
	ACCRETION	12.2	18.7	19.3	20.7	22.7	29.5	59.	CUFT/YR	54.% GF1,	43.% OF1,	1.% C1,	1.% WH1
	MORTALITY	10.9	17.6	18.9	19.8	22.3	29.5	15.	CUFT/YR	76.% OF1,	24.% GF1,	0.% WH1,	0.% C1
2047	TREES	12.2	13.7	20.4	21.8	24.0	30.6	32.	TREES	70.% OF1,	27.% GF1,	2.% C1,	1.% WH1
	VOLUME:												
	TOTAL	13.7	20.5	21.8	23.3	24.9	30.6	2829.	CUFT	55.% DF1,	43.% GF1,	1.% WH1,	1.% C1
	MERCH	13.7	20.5	21.8	23.3	24.9	30.6	2760.	CUFT	55.% DF1,	43.% GF1,	1.% WH1,	1.% C1
	MERCH	17.9	20.5	21.8	23.3	24.9	30.6	14633.	BOFT	54.% OF1,	44.% GF1,	1.% WH1,	1.% C1
	ACCRETION	12.9	20.3	21.1	23.3	24.9	30.6	57.	CUFT/YR	50.% OF1,	47.% GF1,	2.% WH1,	2.% C1
	MORTALITY	12.9	19.6	20.5	21.8	24.4	30.6	15.	CUFT/YR	80.% OF1,	19.% GF1,	1.% WH1,	0.% C1
2057	TREES	13.4	15.3	21.6	23.2	25.3	31.4	30.	TREES	69.% OF1,	28.% GF1,	2.% C1,	1.% WH1
	VOLUME:												
	TOTAL	15.3	21.7	23.2	24.9	26.7	31.4	3251.	CUFT	53.% OF1,	45.% GF1,	1.% WH1,	1.% C1
	MERCH	15.3	22.0	23.2	24.9	26.7	31.4	3178.	CUFT	53.% OF1,	45.% GF1,	1.% WH1,	1.% C1
	MERCH	18.6	22.3	23.2	24.9	26.7	31.4	17035.	BOFT	53.% DF1,	45.% GF1,	2.% WH1,	1.% C1

STANO GROWTH PROGNOSIS SYSTEM VERSION 5.1 -- INLANO EMPIRE

STAND ID; S248112 MANAGEMENT COOE: NONE SHELTERWOOD PRESCRIPTION FROM THE USER'S MANUAL

	ATTRIBUTES OF SELECTEO SAMPLE TREES								AOOITIONAL STANO ATTRIBUTES (BASEO ON STOCKABLE AREA)					
YEAR	INITIAL TREES/A %TILE	SPECIES	DBH (INCHES)	HEIGHT (FEET)	LIVE CROWN RATIO	PAST OBH GROWTH (INCHES)	BASAL AREA %TILE	TREES PER ACRE	STAND AGE	QUAORATIC MEAN DBH (INCHES)	TREES PER ACRE	BASAL AREA (SQFT/A)	TOP HEIGHT LARGEST 40/A (FT)	CROWN COMP FACTOR
1977						(10 YRS)								
	10	GF2	0.10	3.00	65	0.00	0.0	90.00						
	30	OF2	0.10	2.00	55	0.00	0.0	90.00						
	50	C2	3.20	17.00	45	0.60	3.0	30.00						
	70	GF1	6.10	38.00	75	1.20	24.8	19.71						
	90	LP1	8.50	59.34	25	0.95	62.4	10.15						
	100	OF1	12.70	67.00	35	1.60	100.0	4.55						
									57	5.1	590.	85.	63.4	104.8
									RESIDUAL:	7.0	264.	71.	64.3	88.0
1987						(10 YRS)								
	10	GF2	1.03	7.54	65	0.85	0.0	0.05						
	30	OF2	0.80	6.18	55	0.61	0.0	0.05						
	50	C2	4.50	23.00	45	1.23	0.0	0.03						
	70	GF1	7.60	47.40	74	1.37	24.9	18.03						
	90	LP1	9.38	66.19	23	0.85	53.8	8.61						
	100	OF1	14.36	76.20	33	1.44	98.4	4.39						
									67	8.6	242.	98.	68.4	117.1
1997						(10 YRS)								
	10	GF2	1.53	10.82	65	0.46	0.0	0.04						
	30	OF2	1.07	8.26	55	0.23	0.0	0.04						
	50	C2	5.68	28.41	55	1.12	0.3	0.03						
	70	GF1	9.19	56.77	72	1.45	23.4	16.75						
	90	LP1	10.15	72.54	19	0.74	40.2	7.08						
	100	OF1	15.84	84.43	30	1.28	96.0	4.18						
									77	10.2	222.	127.	75.6	145.5
2007						(10 YRS)								
	10	GF2	2.04	14.75	65	0.46	0.0	0.03						
	30	DF2	1.52	11.96	55	0.39	0.0	0.02						
	50	C2	7.26	34.05	58	1.50	1.1	0.03						
	70	GF1	11.71	68.37	72	2.31	39.5	15.58						
	90	LP1	11.24	79.52	16	1.06	30.4	5.60						
	100	OF1	17.03	91.58	28	1.03	89.3	3.93						
									87	11.9	201.	154.	78.0	168.4
									RESIOUAL:	12.1	157.	126.	77.0	141.3
2017 **						(10 YRS)								
	10	C1	9.62	45.71	23	1.33	4.6	8.78						
	30	GF1	10.78	74.01	38	0.98	11.6	1.12						
	50	GF1	13.08	70.48	60	1.62	32.4	1.05						
	70	C1	16.10	60.49	68	2.67	57.8	0.72						
	90	GF1	17.59	104.94	59	1.73	76.3	1.72						
	100	DF1	22.53	102.62	30	0.74	98.1	0.25						
									97	13.9	147.	155.	84.3	168.2
2027						(10 YRS)								
	10	C1	9.96	49.92	20	0.32	2.5	8.36						
	30	GF1	12.41	84.32	37	1.49	13.1	0.99						
	50	GF1	13.82	78.18	56	0.67	20.8	0.98						
	70	C1	16.73	65.51	67	0.60	51.2	0.69						
	90	GF1	18.21	111.24	56	0.57	65.1	1.63						
	100	DF1	24.12	108.95	29	1.38	97.9	0.23						
									107	15.6	136.	182.	89.8	189.2
2037						(10 YRS)								
	10	C1	10.53	55.03	19	0.55	2.3	7.69						
	30	GF1	14.48	95.10	36	1.90	14.6	0.92						
	50	GF1	15.07	87.27	54	1.14	16.8	0.84						
	70	C1	17.58	71.00	66	0.80	50.0	0.65						
	90	GF1	19.34	118.69	55	1.03	63.5	1.41						
	100	DF1	24.88	113.61	28	0.66	95.7	0.22						
									117	17.1	126.	200.	96.5	204.7
									RESIDUAL:	17.6	35.	59.	99.6	55.7

(con.)

Figure 7.—Tree and stand attributes table from the Prognosis Model output. As for figure 6, input conditions match those used to produce tables in the example by Wykoff and others (1982; fig. 8, pp. 36-37). Note that the heading has changed to show that per-acre values are based on stockable area and that initial conditions are somewhat different. Note also that when the regeneration establishment model, the compression algorithm, and/or thinning result in the addition or removal of tree records, new tree records are selected for display. The year is flagged with two asterisks (see the year 2047) and an explanatory note is appended to the table.

Figure 7.— (con.)

2047 ** (10 YRS)

10	OF1	12.24	91.13	22	1.14	5.2	1.78						
30	OF1	12.89	91.82	18	0.57	11.8	4.76						
50	GF1	20.53	111.80	81	1.66	46.9	2.04						
70	OF1	20.50	117.44	34	0.69	39.7	2.05						
90	GF1	24.95	105.95	76	2.45	92.5	1.11						
100	WH1	30.61	101.65	76	1.03	100.0	0.02	127	19.3	32.	65.	107.5	59.5

2057 (10 YRS)

10	OF1	13.39	98.85	21	1.00	5.1	1.65						
30	OF1	13.92	99.07	17	0.89	11.2	4.11						
50	GF1	22.41	120.58	81	1.72	44.3	1.97						
70	OF1	21.51	122.65	32	0.88	30.3	1.87						
90	GF1	26.74	114.71	76	1.64	94.0	1.10						
100	WH1	31.45	107.06	75	0.78	100.0	0.02	137	20.9	30.	71.	114.6	62.9

** NOTE: OUE TO HARVEST, COMPRESSION, OR REGENERATION ESTABLISHMENT, NEW SAMPLE TREES WERE SELECTEO.

STAND GROWTH PROGNOSIS SYSTEM VERSION 5.1 -- INLAND EMPIRE

SUMMARY STATISTICS (BASED ON TOTAL STAND AREA)

			VOLUME PER ACRE			REMOVALS PER ACRE							GROWTH				IDENTIFIERS	
YEAR	AGE	TREES /ACRE	TOTAL CU FT	MERCH CU FT	MERCH BD FT	TREES /ACRE	TOTAL CU FT	MERCH CU FT	MERCH BD FT	BA/ ACRE SQFT	CCF	TOP HT FT	PRD YRS	ACC CUFT/YR	MOR	STAND SAMPLE WEIGHT	STAND	MGMT
1977	57	536	1475	1016	4158	296	232	198	828	64	80	64	10	82	12	11	S248112	NONE
1987	67	220	1950	1603	6589	0	0	0	0	89	106	68	10	105	16	11	S248112	NONE
1997	77	202	2839	2569	10908	0	0	0	0	115	132	76	10	128	26	11	S248112	NONE
2007	87	183	3862	3624	16094	40	816	753	3339	114	128	77	10	131	17	11	S248112	NONE
2017	97	134	4187	3997	19027	0	0	0	0	141	153	84	10	153	29	11	S248112	NONE
2027	107	124	5429	5224	26289	0	0	0	0	165	172	90	10	151	39	11	S248112	NONE
2037	117	114	6556	6341	32754	83	4385	4229	21658	54	51	100	10	54	14	11	S248112	NONE
2047	127	29	2572	2509	13302	0	0	0	0	59	54	107	10	52	13	11	S248112	NONE
2057	137	27	2955	2889	15486	0	0	0	0	64	57	115	0	0	0	11	S248112	NONE

Figure 8.—Summary statistics table from the Prognosis Model output. Input conditions are the same as displayed in Wykoff and others (1982; fig. 9; p. 37). The table heading was modified to state that statistics are based on total stand area.

```
                              OPTIONS SELECTED BY DEFAULT
-------------------------------------------------------------------------------------------

TREEFMT     (23X,I4,3X, F2.0,I1, A3,F3.1,F2.1,3X,F3.0,T63,F3.0    ,T60,F3.1,T48,  I1,3X, I2,
            2I1,T66,2I1,I3, 2I1)

DESIGN      BASAL AREA FACTOR= 40.0; INVERSE OF FIXED PLOT AREA=  300.0; BREAK DBH=    5.0
            NUMBER OF PLOTS=      11; NON-STOCKABLE PLOTS=      1; STAND SAMPLING WEIGHT=  11.00000
            STAND ATTRIBUTES ARE CALCULATED PER ACRE OF STOCKABLE AREA.  STAND STATISTICS
            IN SUMMARY TABLE ARE MULTIPLIED BY 0.909 TO INCLUDE TOTAL STAND AREA.

-------------------------------------------------------------------------------------------
```

Figure 9.—Prognosis Model output table showing options selected by default. This figure illustrates the message produced when nonstockable plots are encountered in the inventory. Contrast to Wykoff and others (1982; fig. 6, pp. 32-33).

REFERENCES

Allen, G. M.; Adams, D. L.; Prausa, C. R. Preliminary volume table for small trees in northern Idaho. Station Note 21. Moscow, ID: University of Idaho, Forestry, Wildlife, and Range Experiment Station; 1974. 3 p.

Crookston, N. L. User's guide to the event monitor: an addition to the Prognosis Model. General Technical Report INT-196. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1985. 36 p.

Daubenmire, R.; Daubenmire, J. B. Forest vegetation of eastern Washington and northern Idaho. Technical Bulletin 60. Pullman, WA: Washington Agricultural Experiment Station; 1968. 104 p.

Ferguson, D. E.; Crookston, N. L. User's guide to the regeneration establishment model—a Prognosis Model extension. General Technical Report INT-161. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1984. 23 p.

Haig, I. T. Second growth yield, stand, and volume tables for the western white pine type. Technical Bulletin 323. Washington, DC: U.S. Department of Agriculture, Forest Service; 1932. 67 p.

Hamilton, D. A., Jr. Mortality models for managed stands. Moscow, ID: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Forestry Sciences Laboratory; [in preparation a].

Hamilton, D. A., Jr. Spiffy little things: expanding the limits of applicability of a mortality model. Moscow, ID: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Forestry Sciences Laboratory; [in preparation b].

Milner, Kelsey. [Results from unpublished study reported at annual meeting of Inland Northwest Growth and Yield Cooperative; Spokane, WA.] 1985 January. Milltown, MT: Champion Timberlands.

Moeur, M. COVER: a user's guide to the CANOPY and SHRUBS extension of the Stand Prognosis Model. General Technical Report INT-190. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1985. 49 p.

Pfister, R. D.; Kovalchik, B. L.; Arno, S. F.; Presby, R. C. Forest habitat types of Montana. General Technical Report INT-34. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1977. 174 p.

Reineke, L. H. Perfecting a stand-density index for even-aged forests. Journal of Agricultural Research. 46: 627-638; 1983.

Stage, A. R. Prognosis Model for stand development. Research Paper INT-137. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1973. 32 p.

Stage, A. R. Comparison of prognoses with long-term permanent sample plots. Moscow, ID: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Forestry Sciences Laboratory; [in preparation].

Stage, A. R.; Crookston, N. L.; Monserud, R. A. Classification and aggregation as a meta-modeling method for resource response models. Moscow, ID: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Forestry Sciences Laboratory; [in preparation].

Wykoff, W. R. Introduction to the Prognosis Model—version 5.0. In: Van Hooser, D., ed. Growth and yield and other mensurational tricks: Proceedings of a conference; 1984 November 6-7; Logan, UT. General Technical Report INT-193. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1985: 44-52.

Wykoff, W. R.; Crookston, N. L.; Stage, A. R. User's guide to the Stand Prognosis Model. General Technical Report INT-133. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1982. 112 p.

APPENDIX A: SUMMARY OF CODES USED IN THE PROGNOSIS MODEL

Table 12.—Codes for the Forests represented in the Inland Empire version of the Prognosis Model

Forest	Code	Forest	Code
Bitterroot	3	Kaniksu	13
Idaho Panhandle[1]	4	Kootenai	14
Clearwater	5	Lolo	16
Coeur d'Alene	6	Nezperce	17
Colville	7	St. Joe	18
Flathead	10		

[1]The Idaho Panhandle National Forests is an administrative unit that encompasses the Coeur d'Alene, Kaniksu, and St. Joe National Forests. All of the growth models use coefficients for the St. Joe National Forest when the Panhandle is specified.

Table 13.—Codes for habitat types represented in the Inland Empire version of the Prognosis Mode1[1]

Code	Abbreviation	Habitat type name
130	PIPO/AGSP	*Pinus ponderosa/Agropyron spicatum*
170	PIPO/SYAL	*Pinus ponderosa/Symphoricarpos albus*
250	PSME/VACA	*Pseudotsuga menziesii/Vaccinium caespitosum*
260	PSME/PHMA	*Pseudotsuga menziesii/Physocarpus malvaceus*
280	PSME/VAGL	*Pseudotsuga menziesii/Vaccinium globulare*
290	PSME/LIBO	*Pseudotsuga menziesii/Linnaea borealis*
310	PSME/SYAL	*Pseudotsuga menziesii/Symphoricarpos albus*
320	PSME/CARU	*Pseudotsuga menziesii/Calamagrostis rubescens*
330	PSME/CAGE	*Pseudotsuga menziesii/Carex geyeri*
420	PICEA/CLUN	*Picea/Clintonia uniflora*
470	PICEA/LIBO	*Picea/Linnaea borealis*
510	ABGR/XETE	*Abies grandis/Xerophyllum tenax*
520	ABGR/CLUN	*Abies grandis/Clintonia uniflora*
530	THPL/CLUN	*Thuja plicata/Clintonia uniflora*
540	THPL/ATFI	*Thuja plicata/Athyrium filix-femina*
550	THPL/OPHO	*Thuja plicata/Oplopanax horridum*
570	TSHE/CLUN	*Tsuga heterophylla/Clintonia uniflora*
610	ABLA/OPHO	*Abies lasiocarpa/Oplopanax horridum*
620	ABLA/CLUN	*Abies lasiocarpa/Clintonia uniflora*
640	ABLA/VACA	*Abies lasiocarpa/Vaccinium caespitosum*
660	ABLA/LIBO	*Abies lasiocarpa/Linnaea borealis*
670	ABLA/MEFE	*Abies lasiocarpa/Menziesia ferruginea*
680	TSME/MEFE	*Tsuga mertensiana/Menziesia ferruginea*
690	ABLA/XETE	*Abies lasiocarpa/Xerophyllum tenax*
710	TSME/XETE	*Tsuga mertensiana/Xerophyllum tenax*
720	ABLA/VAGL	*Abies lasiocarpa/Vaccinium globulare*
730	ABLA/VASC	*Abies lasiocarpa/Vaccinium scoparium*
830	ABLA/LUHI	*Abies lasiocarpa/Luzula hitchcockii*
850	PIAL-ABLA	*Pinus albicaulis/Abies lasiocarpa*
999	OTHER	

[1]From Pfister and others (1977).

Table 14.—Tree species recognized by the Prognosis Model with default coding conventions

Common name	Scientific name	Default input code	Numeric code
Western white pine	*Pinus monticola*	WP	1
Western larch	*Larix occidentalis*	L	2
Douglas-fir	*Pseudotsuga menziesii*	DF	3
Grand fir	*Abies grandis*	GF	4
Western hemlock	*Tsuga heterophylla*	WH	5
Western redcedar	*Thuja plicata*	C	6
Lodgepole pine	*Pinus contorta*	LP	7
Engelmann spruce	*Picea engelmannii*	S	8
Subalpine fir	*Abies lasiocarpa*	AF	9
Ponderosa pine	*Pinus ponderosa*	PP	10
Mountain hemlock	*Tsuga mertensiana*		11

Table 15.—Aspect codes

Aspect	Azimuth (degrees)	Code
North	337.5 - 22.5	1
Northeast	22.6 - 67.5	2
East	67.6 - 112.5	3
Southeast	112.6 - 157.5	4
South	157.6 - 202.5	5
Southwest	202.6 - 247.5	6
West	247.6 - 292.5	7
Northwest	292.6 - 337.5	8
Level		9

Table 16.—Slope codes

Slope angle (%)	Code
≤ - 5	0
6 - 15	1
16 - 25	2
26 - 35	3
36 - 45	4
46 - 55	5
56 - 65	6
66 - 75	7
76 - 85	8
≥ 86	9

Table 17.—Crown ratio codes

Crown ratio (%)	Code
1 - 10	1
11 - 20	2
21 - 30	3
31 - 40	4
41 - 50	5
51 - 60	6
61 - 70	7
71 - 80	8
≥ 81	9

Table 18.—Interpreting damage codes **(IDCD)**

Code	Interpretation
73	Tree top is missing
74	Tree top is dead
all others	Ignored

Table 19.—Interpreting tree history codes **(ITH)**

Code	Interpretation
5	Tree died during mortality observation period; record is used to backdate density for model scaling, but is not projected.
6,7	Tree died prior to mortality observation period; record is ignored.
9	Special record (planar intercept in Northern Region inventory); record is ignored.
1,2,3,4,8	Various categories of live trees; records are projected.

Table 20.—Interpreting tree value codes (IMC)

Code	Interpretation
1	Desirable tree
2	Acceptable tree
3	Live cull
8	Nonstockable point
All other codes are interpreted as 3	

APPENDIX B: SUMMARY OF KEYWORDS, ASSOCIATED PARAMETERS, AND DEFAULT CONDITIONS

Note: Appendix B contains summaries of keywords that are presented in both the version 5.0 supplement and the original User's Guide (Wykoff and others 1982). For a more detailed description, refer to the page number given beneath each keyword. Numbers preceded by the letter "S" are for either new or updated options and the indicated pages are found in this supplement. Otherwise, refer to the User's Guide.

Rules for Coding Keyword Records

1. All option keywords start in column 1.

2. The numerical values (parameters) needed to implement an option are contained in seven numeric fields that are 10 columns wide. The first parameter field begins in column 11. Values should either be right-justified in the numeric field or be followed by a decimal point.

3. Blank numeric fields are not treated as zeroes. If a blank field is found, the default value will be used. If zeroes are to be specified, they must be punched. Thus, only the numeric values that are different from the default parameter values need to be specified.

4. All supplemental data records associated with a keyword must be provided if the keyword is used.

5. When two or more conflicting options are specified, the last one specified will be used.

Controlling Program Execution

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
INVYEAR (8)	Specify the starting date for a projection. field 1: Year in which simulation is to begin.	0
NUMCYCLE (8)	Specify the number of cycles in a projection. field 1: Number of cycles to be projected; maximum number of cycles is 40.	1
PROCESS (8)	Marks the end of an input file for a single projection in a runstream and triggers the beginning of the simulation. Must be present or projection will not run.	
STOP (8)	Signal the end of Prognosis Model runstream.	
TIMEINT (8)	Specify the length of any or all projection cycles. field 1: Number of a cycle whose length is to be changed. field 2: Number of years to be simulated in the cycle(s) referenced in field 1.	Change all cycles 10 years

Entering Stand and Tree Characteristics

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
DESIGN (10, S-15)	Enter inventory design parameters.	
	field 1: If positive, basal area factor for variable radius plots; if negative, inverse of fixed area plot for sampling large trees.	40 ft^2/acre/tree
	field 2: Inverse of fixed plot area for measuring small trees.	300 plots/acre
	field 3: d.b.h. separating large from small trees.	5 inches
	field 4: Number of plots used to inventory stand.	Count the plots
	field 5: Number of nonstockable plots in stand inventory.	Count the plots
	field 6: Stand weight for aggregation of projections.	Number of plots
GROWTH (20)	Identify methods used to measure and input mortality and height and diameter increment data.	
	field 1: Method used to measure diameter increment.	0 (past increment)
	field 2: Length of diameter increment measurement period.	10 years
	field 3: Method used to measure height increment.	0 (past increment)
	field 4: Length of height increment measurement period.	5 years
	field 5: Length of mortality observation period.	5 years
MGMTID (11)	Enter an alphanumeric code to identify the silvicultural treatment simulated in a projection. The code does not affect the projection but is printed with each output table and on each line in the summary table. Supplemental record: enter management identifier in first four columns.	Default code is "NONE" (MGMTID record not input); if supplemental record is blank, management identifiers not printed
SPCODES (19)	Identify species codes used on the input tree records.	
	field 1: Numeric code for the species for which the code is to be changed.	Change for all species.
	Supplemental record: Species code or codes, left justified in consecutive 4-column fields. If all codes are replaced, they must be entered in order of numeric code. If only one code is replaced, it is entered in the first 4 columns.	Default values are given in table 14; a blank entry on the supplemental record will be interpreted as a blank
STDIDENT (11)	Enter stand identification code and descriptive title to label the output. Supplemental record: Stand identification code is entered in columns 1-8; title is entered in columns 9-80.	
STDINFO (12,S-17)	Enter data that describe the site on which stand is located.	
	field 1: National Forest on which stand is located.	18 (St. Joe)
	field 2: Stand habitat type code.	260 (PSME/PHMA)
	field 3: Stand age.	0 years
	field 4: Stand aspect code.	9 (level)
	field 5: Stand slope code.	0 (<5%)
	field 6: Stand elevation code.	38 hundred feet
	field 7: Stand site index.	0
TREEDATA (18, S-17)	Read tree data from dataset referenced by the unit number recorded in field 1.	
	field 1: Dataset reference number.	2
	field 2: Indicate that point-specific site descriptors are included with tree records.	No point-specific site descriptors on tree records

(con.)

Entering Stand and Tree Characteristics (Con.)

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
TREEFMT (19)	Provide a format statement that describes the layout of a tree record. Two supplemental records: A FORTRAN execution time format statement.	See table 5, Wykoff and others 1982

Modifying Tree Volume Calculations

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
BFFDLN MCFDLN (24)	Enter species-specific parameters for log-linear form and defect correction equation for board foot volume estimates (BFFDLN) or merchantable cubic foot volume estimates (MCFDLN).	
	field 1: Numeric code for the species for which the equation is to be changed. The default equation supplies a multiplier of 1.0 for each species.	Change all species
	field 2: Intercept term for log-linear equation.	0.0
	field 3: Slope coefficient for log-linear equation.	1.0
BFFDPOLY MCFDPOLY (23)	Enter species-specific parameters for polynomial form and defect correction equation for board foot volume estimates (BFFDPOLY) or merchantable cubic foot volume estimates (MCFDPOLY).	
	field 1: Numeric code for the species for which the equation is to be changed. The default equation supplies a multiplier of 1.0 for all species.	Change all species
	field 2: Intercept term for polynomial equation.	1.0
	field 3: Coefficient for linear term in polynomial equation.	0.0
	field 4: Coefficient for quadratic term in polynomial equation.	0.0
	field 5: Coefficient for cubic term in polynomial equation.	0.0
	field 6: Coefficient for quartic term in polynomial equation.	0.0
BFVOLUME VOLUME (22, S-18)	Redefine the merchantability limits for the merchantable cubic foot volume equation.	
	field 1: Cycle in which limits defined below will be implemented.	Implement at start of projection
	field 2: Numeric code for the species for which limits are to be changed.	Change for all species
	field 3: Minimum d.b.h.	6 inches for lodgepole pine 7 inches for all other species
	field 4: Minimum top diameter.	4.5 inches
	field 5: Stump height.	1 foot
MCFDLN	Parameters same as for BFFDLN.	
MCFDPOLY	Parameters same as for BFFDPOLY.	
VOLUME	Parameters same as for BFVOLUME.	

Specifying Management Activities

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
CUTEFF (21, S-15)	Change the assumed effectiveness of thinning for all thinning activities.	
	field 1: New value for global cutting efficiency parameter.	0.98
MINHARV (22)	Specify minimum acceptable harvest standards for board foot volume, merchantable cubic foot volume, or basal area per acre by cycle.	
	field 1: The cycle in which minimum harvest standards will be applied.	Applied in all cycles
	field 2: The minimum acceptable harvest volume in merchantable cubic feet per acre.	0 ft^3/acre
	field 3: The minimum acceptable harvest volume in board feet per acre.	0 bd ft/acre
	field 4: The minimum acceptable harvest in square feet of basal area per acre.	0 ft^2/acre
SPECPREF (26)	Change the species component of the removal priority formula.	
	field 1: Date at which change is to be implemented.	Implement at start of projection
	field 2: Numeric code for species whose removal priority is to be changed.	Ignore the SPECPREF request
	field 3: Species preference value.	0
TCONDMLT (27)	Change the impact of tree value class on the determination of removal priority.	
	field 1: Date at which change is to be implemented.	Implement at start of projection
	field 2: New tree condition class multiplier.	100
THINABA THINATA (27, S-16)	Schedule thinning from above to a basal area per acre (THINABA) or a trees per acre (THINATA) target.	
	field 1: Date that thinning is scheduled.	Schedule at start of projection
	field 2: The residual stand density.	Ignore the thinning request
	field 3: Cutting efficiency parameter specific to this thinning request.	0.98
	field 4: d.b.h. of smallest tree that will be cut.	0 inches
	field 5: d.b.h. of largest tree that will be cut.	999 inches
THINAUTO (28)	Schedule automatic stocking control. As nearly as is possible, stand density will be maintained within a range determined by the minimum and maximum percentage of normal stocking entered in fields 2 and 3.	
	field 1: Date that automatic stocking control is scheduled to begin.	Begin at start of projection
	field 2: Percentage of normal stocking that defines the lower limit for stand density.	45%
	field 3: Percentage of normal stocking that defines the upper limit for stand density.	60%
	field 4: Cutting efficiency parameter specific to automatic stocking control request.	0.98

(con.)

Specifying Management Activities (Con.)

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
THINBBA THINBTA (27, S-16)	Schedule thinning from below to a basal area per acre (THINBBA) or trees per acre (THINBTA) target.	
	field 1: Date that thinning is scheduled.	Scheduled at start of projection
	field 2: The residual stand density.	Ignore the thinning request
	field 3: Cutting efficiency parameter specific to this thinning request.	0.98
	field 4: d.b.h. of smallest tree that will be cut.	0 inches
	field 5: d.b.h. of largest tree that will be cut.	999 inches
THINDBH (24)	Schedule the removal of a segment of the d.b.h. distribution.	
	field 1: Date that thinning is scheduled.	Scheduled at start of projection
	field 2: Smallest d.b.h. to be removed.	0 inches
	field 3: Largest d.b.h. to be removed.	999 inches
	field 4: Cutting efficiency parameter specific to this request.	0.98
THINPRSC (24)	Schedule prescription thinning. Harvest trees that were marked for removal on the input tree records.	
	field 1: Date that prescription thinning is scheduled.	Scheduled at start of projection
	field 2: Cutting efficiency parameter specific to this thinning request.	0.98

Controlling Program Output

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
COMMENT (48)	Enter a comment that will be reproduced in the Input Summary Table.	
	Supplemental records: Enter your comment using all 80 columns on as many records as desired. Signify the end of your comment by supplying a record with the word "END" entered in the first 3 columns. The 4th column must be blank.	None
ECHOSUM (48)	Request that summary output be copied to a retrievable data storage file.	
	field 1: Dataset reference number for output file.	4
TREELIST (47, S-14)	Print a list of all sample tree records.	
	field 1: Cycle in which tree list is to be printed.	Print tree list in all cycles
	field 2: Dataset reference number.	3
	field 3: If any number is entered in field 3, tree list will be printed without headings.	Print headings

Linkage to Prognosis Model Extensions

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
CHEAPO (86)	Generate output file required for subsequent execution of the CHEAPO economic analysis program. field 1: Dataset reference number for CHEAPO output file.	 11
COVER (86, S-16)	Indicates the start of special keyword input file for the CANOPY and/or SHRUBS extensions. field 1: Cycle to begin COVER calculations. field 2: Dataset reference number for COVER output.	 Beginning of projection 18
DFTM (85)	Indicates start of special keyword input file for the Douglas-fir tussock moth extension.	
END (85)	Indicates end of special keyword input file for any extension.	
ESTAB (86)	Indicates start of special keyword input file for the regeneration establishment extension.	
MPB (85)	Indicates start of special keyword input file for the mountain pine beetle extension.	
WSBW (85)	Indicates start of special keyword input file for the western spruce budworm extension.	

Growth Prediction Modifiers and Special Input/Output Options

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
ADDFILE (95)	Specify a dataset reference number for a supplemental keyword record file. field 1: Dataset reference number.	 None
BAIMULT HTGMULT REGDMULT REGHMULT (94)	Enter multiplier to change prediction of tree basal area increment (BAIMULT), large tree height increment (HTGMULT), small tree diameter increment (REGDMULT), or small tree height increment (REGHMULT). field 1: Cycle in which growth multiplier takes effect. field 2: Numeric code for species to which growth multiplier is to be applied. field 3: Growth multiplier.	 Apply in all cycles Apply to all species 1.0
BAMAX (95)	Modify the maximum basal area used to control mortality predictions. field 1: Maximum basal area.	 See table 17, Wykoff and others (1982)
COMPRESS (S-19)	Reduce the number of tree records used to represent the stand. field 1: Cycle in which tree list will be compressed. field 2: Number of tree records that will remain after compression. field 3: Percentage of new records that will be determined by finding the largest gaps in the classification space; remainder will be determined by splitting the classes with the most variation. field 4: Numeric entry prints debug. Output from compression algorithm.	 Beginning of projection 150 50 No Debug output

(con.)

Growth Prediction Modifiers and Special Input/Output Options (Con.)

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
DATELIST (96)	Instruct program to print date of last revision for Prognosis Model subprograms and common areas.	None
DEBUG (96)	Request printout of the results of most program calculations in any or all cycles. field 1: Cycle in which debug output is to be printed.	Print in all cycles
DGSTDEV (93)	Change the limits of the Normal distribution from which random errors are drawn for increment predictions. field 1: Number of standard deviations that define the bounds of distribution.	2.0
HTGMULT	Parameters same as for BAIMULT.	
HTGSTOP TOPKILL (S-20)	Set height increment to zero or kill top for a random sample of trees. field 1: Cycle in which top-kill or growth loss will be simulated. field 2: Species that will be affected. field 3: Lower limit of range of heights that will be affected. field 4: Upper limit of range of heights that will be affected. field 5: Probability that a given tree will receive top-kill or growth loss. field 6: Mean of the distribution of the proportional total tree height lost to top-kill (TOPKILL record only). field 7: Standard deviation of the distribution of the proportion of total tree height lost to top-kill (TOPKILL record only).	 First cycle All species 0.0 0.0 0.0 0.0 0.0
MORTMULT (94, S-17)	Enter multiplier to change mortality rate predictions. field 1: Cycle in which multiplier takes effect. field 2: Numeric code for species to which multiplier is to be applied. field 3: Mortality multiplier. field 4: d.b.h. of the smallest tree to which multiplier will be applied. field 5: d.b.h. of the largest tree to which multiplier will be applied.	 Apply in all cycles Apply to all species 1.0 0.0 999.0
NOCALIB (90)	Suppress calculation of scale factors for large tree diameter increment model and small tree height increment model.	Calculate scale factors
NOTREES (S-00)	Begin a projection with no tree records. Permits "bare ground" simulations with records generated by the Regeneration Establishment model.	Two tree records must be input or projection will not run
NOTRIPLE (93)	Suppress tree record tripling feature.	Tree records tripled twice
NUMTRIP (93)	Change the number of times tree records will be tripled. field 1: Number of triples.	2.0
RANNSEED (94, S-14)	Reseed the random number generator. field 1: Replacement seed.	55329
READCORD READCORH READCORR (90)	Enter multipliers for the diameter increment model (READCORD), the height increment model (READCORH), or the small tree height increment model (READCORR) that are incorporated prior to model calibration.	

(con.)

Growth Prediction Modifiers and Special Input/Output Options (Con.)

Keyword (page reference)	Keyword use and associated parameters	Default parameter or conditions
	Supplemental record 1: Multipliers for white pine, larch, Douglas-fir, grand fir, western hemlock, western redcedar, lodgepole pine, and Engelmann spruce.	
	Supplemental record 2: Multipliers for subalpine fir, ponderosa pine, and mountain hemlock.	Default value for all multipliers is 1.0
REGDMULT	Parameters same as for BIAMULT.	
REGHMULT	Parameters same as for BIAMULT.	
REUSCORD REUSCORH REUSCORR (91)	Use multipliers that were entered with a READCORD, a READCORH, or a READCORR in a previous projection in the same runstream.	
REWIND (95)	Causes the computer to move the read position pointer to the beginning of the dataset referenced by the unit number entered in field 1. This record is useful when multiple projections are made with the same tree record file in a single runstream.	
	field 1: Dataset reference number.	2
STATS (S-19)	Prepare and print table that describes distribution of input data.	
	field 1: Significance level for computing confidence limits.	0.05
TOPKILL (S-20)	Parameters same as for HTGSTOP.	

Wykoff, William R. Supplement to the user's guide for the Stand Prognosis Model—version 5.0. General Technical Report INT-208. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1986. 36 p.

Differences between Prognosis Model versions 4.0 and 5.0 are described. Additions to version 5.0 include an event monitor that schedules activities contingent on stand characteristics, a regeneration establishment model that predicts the structure of the regeneration stand following treatment, and a COVER model that predicts shrub development and total canopy cover. Program performance has been enhanced by modifications to several of the submodels that predict tree increments.

KEYWORDS: growth and yield, forest management, planning, growth projection, stand models, tree increments, tree mortality

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