United States
Department of
Agriculture

Forest Service

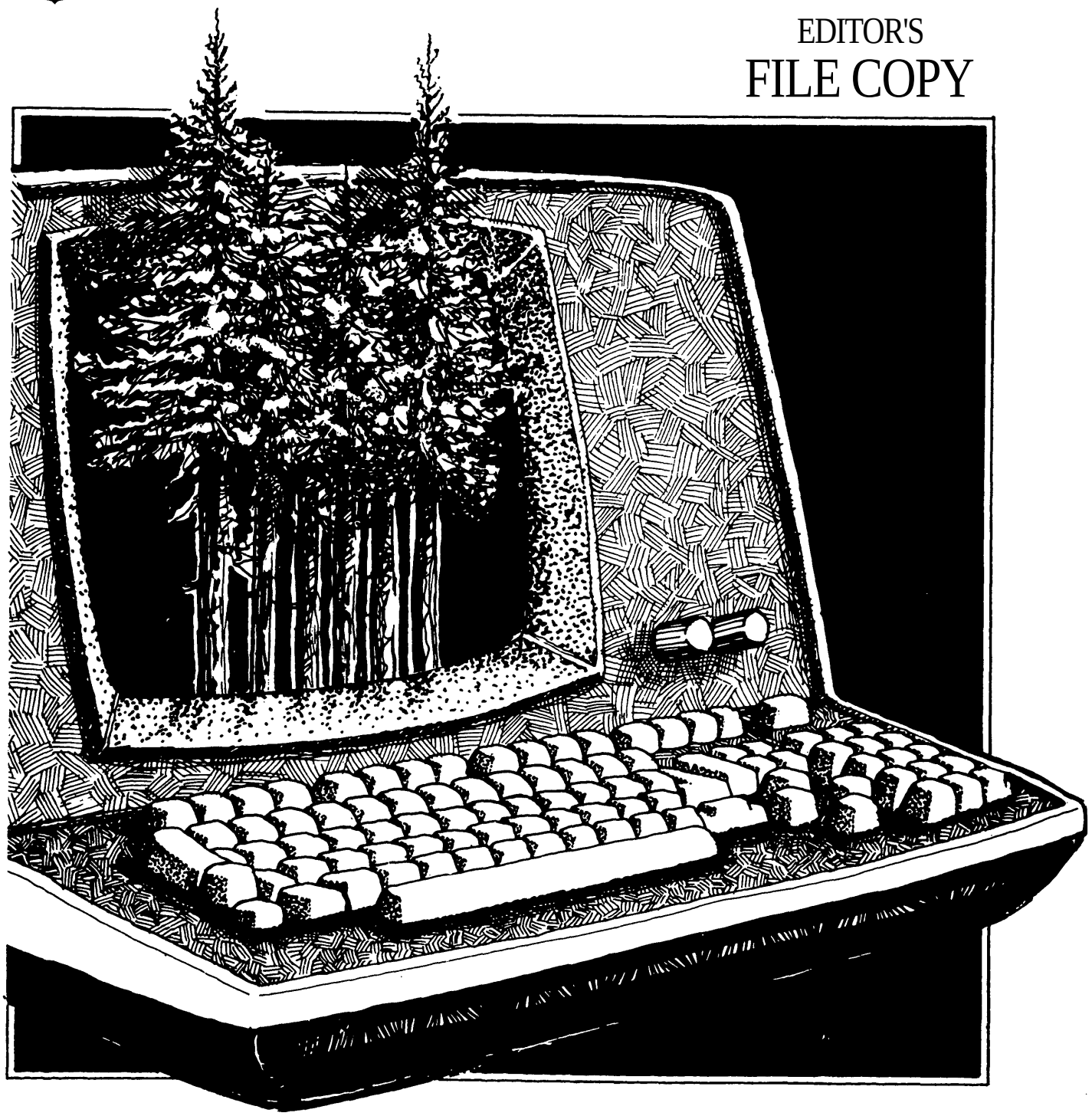
Pacific Northwest
Forest and Range
Experiment Station

General Technical
Report
PNW-175

November 1984

DFSIM WITH ECONOMICS: A Financial Analysis Option for the DFSIM Douglas-Fir Simulator

Roger D. Fight, Judith M. Chittester, and Gary W. Clendenen



Authors

ROGER D. FIGHT is a principal economist and JUDITH M. CHITTESTER is a mathematical statistician at the Forestry Sciences Laboratory, P.O. Box 3890, Portland, Oregon 97208. GARY W. CLENDENEN is a mensurationist at the Forestry Sciences Laboratory, 3625 93rd Avenue S.W., Olympia, Washington 98502.

Abstract

Fight, Roger D.; Chittester, Judith M.; Clendenen, Gary W. DFSIM WITH ECONOMICS: A financial analysis option for the DFSIM Douglas-fir simulator. Gen. Tech. Rep. PNW-175. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1984. 22 p.

A modified version of the DFSIM Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco var. menziesii) growth and yield simulator, DFSIM WITH ECONOMICS, now has an economics option that allows the user to estimate present net worth at the same time a silvicultural regime is simulated. If desired, the economics option will apply a volume adjustment multiplier in yields used in the analysis to reflect application of small-plot research results to average operating conditions or to account for genetics or other local conditions. It can also account for salvage of mortality. Prices can be entered as a table of values or as an equation that can vary with diameter. Logging costs can be entered as a table or can be generated internally for a short-span cable system. Logging costs can vary by diameter and volume harvested. Other harvest-related costs can be included on a per acre basis and also on a unit volume basis. Prices and costs can be trended using an annual percentage rate of change that is applied for a 50-year period.

An interactive program, SIMIN2 WITH ECONOMICS, can be used to prepare the input data in the format required by the DFSIM WITH ECONOMICS program. Both programs are available from the Biometrics Group, Pacific Northwest Forest and Range Experiment Station, Forestry Sciences Laboratory, P.O. Box 3890, Portland, Oregon 97208.

Keywords: Simulation, financial analysis, DFSIM. Douglas-fir (coast).

Contents

Introduction

The Douglas-fir stand simulator (DFSIM) for coast Douglas-fir ***(Pseudotsuga*** menziesii (Mirb.) Franco var. menziesii) (Curtis and others 1981) is now widely used by foresters and silviculturists in forest management planning. The published version (1.0) of the simulator does not have the capability to provide financial analysis of the regimes that are simulated. A user desiring financial information must take the DFSIM results and prepare data input for a separate financial analysis computer program.

A financial analysis option has been added to the DFSIM stand simulator. With this new version (1.1) of DFSIM (DFSIM WITH ECONOMICS) the user can run the program in batch mode with the same input as for the original program, and the output will be identical to that from the original program; or the user can invoke the financial analysis option, supply the additional input required, and the output will include financial results.

The input file needed to run DFSIM WITH ECONOMICS can be prepared by use of an interactive program designed to assist the user in preparing the input file. Both programs are available from the Biometrics Group of the Pacific Northwest Forest and Range Experiment Station, Forestry Sciences Laboratory, P.O. Box 3890, Portland, Oregon 97208.

We have written this report as an amendment to the original DFSIM user's guide (Curtis and others 1981) and assume that the reade'r is familiar with that publication or has access to it. Definitions, abbreviations, and variable names used in that publication are used here with no further description. The next section of the report describes and illustrates the financial results, and the following section describes the assumptions used and the limitations of the financial analysis option. We then describe and illustrate the input data required for use of the financial analysis option.

Results

Financial analysis results will be consistent with and printed on only one of the DFSIM output tables. They will be printed only if that table is requested. Figure 1 shows the economics output on the table of trees 5.6 inches plus; cubic units are to a 4-inch top. At each harvest the following values are reported:

TRUE DBH The arithmetic mean diameter of the cut trees are opposed to the quadratic mean diameter that is reported elsewhere. It is used because the logging cost equations built into the model are based on arithmetic mean diameter. Two-digit precision is shown only for verifying logging cost calculations.

VOL Volume cut in thousands (M) of the specified volume units. The volume will differ from that reported elsewhere when the mortality salvage option or the volume adjustment multiplier option is used.

POND VALUE Value per thousand volume units of logs delivered to the mill.

LOG COST Stump-to-truck logging cost per thousand volume units.

HAUL COST Cost per thousand volume units of hauling from harvest area to the mill.

OTHER COST All other costs associated with harvesting converted to a cost per thousand volume units.

NET REVENUE Pond value minus the sum of log cost, haul cost, and other cost.

DISC NET REVENUE Net revenue per thousand volume units discounted from time of harvest to time at start of the simulation. This period will equal stand age except when a simulation is for an existing stand. For existing stands the value will be discounted to the age of the existing stand at the start of the simulation.

PNWI Cumulated present net worth from the beginning of the simulation through the current harvest.

PNW2 Cumulated present net worth from the beginning of the second rotation through the age of the current harvest. This will differ from PNWI when values are trended or when a one-time cost at time of the first commercial entry is used. This value is not reported for existing stands.

%VOL. DEAD Percent of volume harvested coming from salvage of mortality.

After the final harvest the following additional values are reported:

SOIL EXPECTATION VALUE This is the present net worth of an infinite series of rotations. It uses the same regime for each rotation and the costs and revenues that have been adjusted by use of the price and cost trends that are specified. It is not reported for existing stands. This value approaches infinity (and becomes meaningless) as the interest rate approaches zero.

MEAN ANNUAL HARVEST This is the cumulative volume including salvage volume divided by the stand age at final harvest.

PERCENT OF **VOLUME FROM MORTALITY SALVAGE** This is the percent of cumulative volume coming from salvage of mortality.

Figure 1.—Sample DFSIM WITH ECONOMICS output.

D F **S I M** VERSION **1.1** PAGE **1**
EXAMPLE DFSIM WITH ECONOMICS
MANAGED YIELD TABU
FOR DOUGLAS–FIR
1.6 INCHES PLUS

SITE INDEX = 125. (50 **YEARS** BH)

STAND ORIGIN --- NATURAL.
STAND **WILL** BE PRECOMMERCIALLY THINNED AT AGE **11.** TO 300. TREES PER ACRE.
FIRST COMMERCIAL THINNING IS WANTED AT AGE 30.
THE NUMBER OF COMMERCIAL THINNINGS SPECIFIED IS 4.
COMMERCIAL THINNINGS ***ARE*** SCHEDULED AT THE FOLLOWING AGES
30. 40. 54. 70.
THE SCHEDULED AGE AT THE HARVEST CUT IS 80.
THE AVERAGE DIAMETER OF ALL CUT **TREES** AT COMMERCIAL THINNINGS MUST BE AT LEAST 8.00 INCHES.
THE BASAL AREA CUT AT EACH COMMERCIAL THINNING MUST BE AT LEAST 20. SQUARE FEET PER **ACRE.**
THE BASAL AREA PER ACRE OF ALL **TREES** 5.6 INCHES PLUS MUST BE AT LEAST 100.0 SQUARE FEET BEFORE THE FIRST COMMERCIAL THINNING ***CAN*** OCCUR.

TOT AGE YRS	BH AGE YRS	HT40 FEET	LOREY HT FEET	DBH INCH	**BASAL** AREA/A SQ FT	TREES PER ACRE	CVTS PER ACRE	CAI NET CVTS	*MAI CVTS* GROSS 1.6+	NET 1.6+	**MAI CV4** **NET** **5.W**	7.6+
30	23											
BEFORE		70.7	64.9	9.70	148.5	289.	3952.	325.	133.	**132.**	120.	113.
CUT				9.14	35.5	78.	932.					
RESIDUAL		70.7	65.4	9.90	113.1	212.	3020.					
SUM CUTS					35.5	78.	932.					
SUM MORTALITY					1.2	**11.**	29.					
40	33											
BEFORE		94.2	87.5	12.82	182.3	204.	6379.	335.	185.	183.	172.	169.
CUT				10.84	45.6	71.	1643.					
RESIDUAL		94.2	88.0	13.76	136.7	132.	4736.					
SUM CUTS					81.1	149.	2575.					
SUM MORTALITY					3.0	19.	90.					
54	***47***											
BEFORE		120.2	113.3	17.46	209.9	126.	9064.	297.	220.	216.	205.	203.
CUT				14.19	41.5	38.	1900.					
RESIDUAL		120.2	113.7	18.68	168.3	88.	7164.					

Figure 1.—Continued

D F S I M VERSION *1.1* PAGE *2*
EXAMPLE DFSIM WITH ECONOMICS
MANAGED YIELD TABLE
FOR DOUGLAS–FIR
1.6 INCHES PLUS

SITE INDEX = *125. (50* **YEARS** BH)

TOT AGE YRS	BH AGE YRS	HT40 FEET	LOREY HT FEET	DBH INCH	BASAL AREA/A SQ FT	TREES PER ACRE	CVTS PER ACRE	CAI NET CVTS	*MAI CVTS* GROSS 1.6+	*MAI CVTS* NET 1.6+	**MAI CV4** ****NET**** 5.6+	**MAI CV4** ****NET**** 7.6+
SUM CUTS					*122.6*	*187.*	*4475.*					
SUM MORTALITY					*6.1*	*25.*	*217.*					
70	*63*											
BEFORE		*143.1*	*136.6*	*22.63*	*238.5*	*85.*	*11709.*	*266.*	*237.*	*231.*	*220.*	*219.*
CUT				*18.82*	*38.5*	*20.*	*2025.*					
RESIDUAL		*143.1*	*136.8*	*23.67*	*200.0*	*65.*	*9684.*					
SUM CUTS					*161.1*	*207.*	*6500.*					
SUM MORTALITY					*10.4*	*28.*	*422.*					
80	*73*											
HARVEST		*154.7*	*148.8*	*26.23*	*241.5*	*64.*	*12349.*	*254.*	*242.*	*236.*	*225.*	*223.*
SUM CUTS					*402.6*	*271.*	*18849.*					
SUM MORTALITY					*12.9*	*29.*	*549.*					

Figure 1.—Continued

ECONOMICS TABLES UNITS : CV4
COSTS AND REVENUES ARE IN $ PER 1000
PRESENT NET WORTHS ARE IN $ PER ACRE

SALVAGE OF MORTALITY OPTION YES
THE FOLLOWING TABLE OF POND VALUES HAS BEEN ENTERED:

DBH	6.0	24.0	0.0	0.0	0.0	0.0	0.0	0.0
PONDVL	860.0	1490.0	0.0	0.0	0.0	0.0	0.0	0.0

THE FOLLOWING TABLE OF LOGGING COST VALUES HAS BEEN ENTERED:

	INTERMEDIATE LOGGING COST					
DIAM.	VOLUME (M UNITS)					
	.500	1.000	1.500	2.000	5.000	10.000
6.0	723.	663.	630.	606.	546.	535.
8.0	608.	549.	518.	497.	445.	435.
10.0	519.	462.	433.	413.	368.	359.
12.0	448.	392.	364.	345.	307.	298.
14.0	391.	337.	309.	291.	257.	249.
16.0	347.	293.	266.	249.	218.	210.
18.0	433.	332.	289.	264.	220.	208.
20.0	397.	296.	254.	230.	189.	177.
22.0	375.	274.	233.	209.	170.	158.
24.0	366.	266.	225.	201.	162.	151.

THE ABOVE TABLE OF LOGGING COST VALUES WILL BE USED FOR FINAL HARVEST.

THE FOLLOWING VALUES HAVE BEEN INPUT:	VALUE	COST TREND
VOLUME ADJUSTMENT MULTIPLIER	.90	
INTEREST RATE	4.0	
PRICE TREND	1.5	
REGENERATION COST PER ACRE	200.0	1.0
PRECOMMERCIAL THIN COST PER ACRE	100.0	1.0
LOGGING COST MULTIPLIER	1.20	0.0
OTHER PER ACRE THIN COST	50.0	1.0
OTHER PER M UNIT VOLUME THIN COST	0.0	0.0
OTHER PER ACRE FINAL HARVEST COST	30.0	1.0
OTHER PER M UNIT VOLUME FINAL HARVEST COST	0.0	0.0
HAULING COST PERM UNIT VOLUME	150.0	0.0
FIRST HARVEST ROAD COST PER ACRE	0.0	0.0

Figure 1.—Continued

D F **S I** M VERSION *1.1*
EXAMPLE DFSIM WITH ECONOMICS
MANAGED YIELD TABLE
FOR DOUGLAS-FIR
5.6 INCHES PLUS

SITE INDEX = *125. (50* ***YEARS*** BH)

	DBH INCHES	BASAL AREA PER ACRE SQ. FT.	TREES PER ACRE	TOTAL CUBIC FEET PER ACRE	CUBIC FEET PER ACRE 4-INCH TOP
TOTAL AGE *30.*					
BEFORE	*10.3*	*145.0*	*249.*	*3881.*	*3600.*
CUT	*9.4*	*35.2*	*74.*	*916.*	*835.*
RESIDUAL	*10.7*	*109.8*	*176.*	*2965.*	*2765.*
SUM CUTS		*35.2*	*74.*	*916.*	*835.*
SUM MORTALITY				*10.*	

TRUE DBH	VOL	POND VALUE	LOG COST	HAUL COST	OTHER COST	NET REVENUE	DISC NET REVENUE	PNW1	PNW2	%VOL DEAD
8.94	*.75*	*1505.*	*644.*	*150.*	*90.*	*621.*	*191.*	*-163.*	*-176.*	0.0

	DBH INCHES	BASAL AREA PER ACRE SQ. FT.	TREES PER ACRE	TOTAL CUBIC FEET PER ACRE	CUBIC FEET PER ACRE 4-INCH TOP
TOTAL AGE *40.*					
BEFORE	*12.9*	*182.0*	*200.*	*6364.*	*6042.*
CUT	*11.0*	*45.5*	*69.*	*1635.*	*1530.*
RESIDUAL	*13.8*	*136.5*	*131.*	*4729.*	*4512.*
SUM CUTS		*80.7*	*143.*	*2552.*	*2364.*
SUM MORTALITY				*47.*	

TRUE DBH	VOL	POND VALUE	LOG COST	HAUL COST	OTHER COST	NET REVENUE	DISC NET REVENUE	PNW1	PNW2	%VOL DEAD
10.52	*1.38*	*1847.*	*507.*	*150.*	*54.*	*1136.*	*237.*	*163.*	*233.*	0.0

	DBH INCHES	BASAL AREA PER ACRE SQ. FT.	TREES PER ACRE	TOTAL CUBIC FEET PER ACRE	CUBIC FEET PER ACRE 4-INCH TOP
TOTAL AGE *54.*					
BEFORE	*17.5*	*209.9*	*126.*	*9064.*	*8702.*
CUT	*14.2*	*41.5*	*38.*	**1900.**	*1814.*
RESIDUAL	*18.7*	*168.3*	*88.*	*7164.*	*6887.*
SUM CUTS		*122.2*	*181.*	*4452.*	*4178.*

Figure 1.—Continued

EXAMPLE DFSIM WITH ECONOMICS
MANAGED YIELD TABLE
FOR DOUGLAS-FIR
5.6 INCHES PLUS

SITE INDEX = 125. (50 YEARS BH)

	DBH INCHES	BASAL AREA PER ACRE SQ. FT.	TREES PER ACRE	TOTAL CUBIC FEET PER ACRE	CUBIC FEET PER ACRE 4-INCH TOP
SUM MORTALITY				156.	

TRUE DBH	VOL	POND VALUE	LOG COST	HAUL COST	OTHER COST	NET REVENUE	DISC NET REVENUE	PNW1	PNW2	%VOL DEAD
13.65	1.66	2374.	375.	150.	50.	1800.	216.	522.	593.	1.6

TOTAL AGE 70.

BEFORE	22.6	238.5	85.	11709.	11241.	
CUT	18.8	38.5	20.	2025.	1944.	
RESIDUAL	23.7	200.0	65.	9684.	9296.	
SUM CUTS		160.7	201.	6477.	6123.	
SUM MORTALITY				362.		

TRUE DBH	VOL	POND VALUE	LOG COST	HAUL COST	OTHER COST	NET REVENUE	DISC NET REVENUE	PNW1	PNW2	%VOL DEAD
18.21	1.80	2710.	324.	150.	46.	2190.	141.	775.	846.	2.8

TOTAL AGE 80.

HARVEST	26.2	241.5	64.	12349.	11855.	
SUM CUTS		402.3	265.	18826.	17978.	
SUM MORTALITY				488.		

TRUE DBH	VOL	POND VALUE	LOG COST	HAUL COST	OTHER COST	NET REVENUE	DISC NET REVENUE	PNW1	PNW2	%VOL DEAD
25.55	10.72	3137.	181.	150.	5.	2801.	122.	2078.	2148.	.4

SOIL EXPECTATION VALUE	217'5.
MEAN ANNUAL HARVEST	204.
PERCENT OF VOLUME FROM MORTALITY SALVAGE	.8

Assumptions and Limitations

The user may choose to do the financial analysis in any of the four optional units offered in DFSIM. If CV4 units are selected the results will appear only if the table for trees 5.6 inches plus is requested. If CV6, IV6, or SV6 units are selected, the results will appear only if the table for trees 7.6 inches plus (not shown in this publication) is requested. The economic data used in the financial analysis will be consistent with only one unit of measure. The financial analysis must be done in those units, and the appropriate table must be requested.

Price and cost trends can be specified. The rate specified must be an annual percentage change. That rate will be applied for 50 years. After the 50th year all prices and costs remain constant at the value computed for the 50th year.

If the user does not provide a table of logging costs, the program will generate them from a subroutine developed by Sessions (1979). This subroutine was developed for a 600-ft cable system. Costs are in 1978 dollars. The costs are valid only for CV4 units. This cost subroutine is included primarily to allow the user to see the effect that realistic logging cost relationships have on financial results. For actual application the user must supply logging cost tables that are specific to the conditions being simulated.

The user can specify costs for relevant combinations of average diameter of trees cut and volume per acre removed in the tables of logging costs. Two tables can be used; one for thinnings and one for final harvest. The values used for a particular harvest are determined by a linear interpolation across diameter and volume per acre.

The mortality salvage option is a rough approximation applied to a number (annual mortality) which is based on a weak relationship (Curtis and others 1981, p. 71). If salvage of mortality is ignored in the financial calculations, the implicit assumption is that there is no salvage of mortality or that it has a zero net value. The mortality salvage option is probably an improvement when there is significant anticipated mortality.

Mortality salvage trees are assumed to lose diameter at the following rates:

Year	DBH Loss
0	0
1	2.0
2	4.0
3	5.5
4	6.8
5	8.0
6+	Total loss

These rates are based on Kimmey and Furniss (1943).

Volumes for mortality trees are based on trees of the reduced diameter. The salvage volume for a tree is set to zero if the basal area reduction exceeds 50 percent or if the reduced diameter is less than the user specified minimum merchantable diameter. The salvageable mortality volume is added to the live volume for all further calculations when the mortality salvage option is used.

Results from DFSIM reflect the volume growth of trees on research plots that are of uniform stocking and have not had significant losses from natural or human causes. It is generally accepted that yields in operational situations will be somewhat less than yields predicted from research plots because of nonuniformity of stocking and natural losses not accounted for. Other factors such as genetically improved planting stock may result in expectations of yields exceeding those simulated by DFSIM. The user can make a net adjustment for all relevant factors by specifying a volume adjustment multiplier. All volumes will be multiplied by the volume adjustment multiplier, and the adjusted volumes will be used in all financial calculations and will be reported in the financial output.

Format and Explanation of Input Data

Program SIMIN2 developed by Stephen C. Gaston of International Paper Company assists in the preparation of the input file to run DFSIM.[1] We have modified that program to assist in the preparation of the input file to run DFSIM WITH ECONOMICS. It is written in FORTRAN V for the CDC 6500. The modified program (SIMIN2 WITH ECONOMICS) is available (with permission of International Paper Company) on request along with the modified DFSIM (DFSIM WITH ECONOMICS).

Program SIMIN2 WITH ECONOMICS is an interactive program that sets up a control file for DFSIM WITH ECONOMICS. The program will "step" the user through all DFSIM WITH ECONOMICS options automatically. SIMIN2 WITH ECONOMICS questions are self-explanatory. The program can be used to set up several simulations at a time with timesaving "repeat previous simulation" questions whenever practicable. Variable names are as defined in DFSIM. If a logging cost table input file is used, it must be designated as logical unit 13 prior to executing SIMIN2 WITH ECONOMICS. Logical unit 13 (table of logging costs) for the example in figure 1 is included in appendix 1. More than one table can appear on logical unit 13; each must have a unique five character name in columns 1-5 on the card preceding the table (for example, TAB01 in appendix 1). The rows of the table, read in free format, are the same as DFSIM WITH ECONOMICS card types 15 and 16. The control file is output on logical unit 3.

Appendix 2 shows an actual interactive session with SIMIN2 WITH ECONOMICS for the example in figure 1. Each prompt is followed by a response selected by the user. Appendix 3 is a form titled "Input Form for DFSIM WITH ECONOMICS Short Control File." This form can be used to document the input data for a series of simulations; it speeds the process of responding to the SIMIN2 WITH ECONOMICS queries. Not all items on the form are required for every simulation. The ones requested depend on the options selected. The output file, logical unit 3, from SIMIN2 WITH ECONOMICS is shown in appendix 4. This output file is the logical unit 5 control file for DFSIM WITH ECONOMICS. The various subroutines and functions that have been added to the DFSIM program are listed in appendix 5 along with a brief statement of the operation performed by each.

[1] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

If the interactive program is not used to prepare the input data, logical unit 5 can be prepared from the description that follows.

Additions to DFSIM master control card:

Variable name	Format	Columns	Contain	Explanation
ECO	I1	76	0 or b	No financial evaluation option.
			1	Financial evaluation option.
Blank	4x	77-80	bbbb	Blank.

Economics Master Card 1 (Card Type lo).—This economics master card is the first of two master cards used to specify the financial evaluation option. All economics control cards follow DFSIM card type 8 (if used) and precede DFSIM card type 9 (if used). Options selected determine the units for the economics tables, how the pond value prices and the logging costs are to be calculated, and whether the mortality option and the volume adjustment multiplier are used.

Variable name	Format	Columns	Contain	Explanation
Blank	1x	1	b	Blank.
EUNITS	A3	2-4	AAA	Units for economics tables—specify one of the following: CV4,CV6,IV6,SV6.
Blank	I x	5	b	Blank.
PONTAB	I2	6-7	0 or b	No pond value price table. (Coefficients for the pond value equation are given.)
			XX	Number of DBH values in the table (up to 8).
Blank	I x	8	b	Blank.
COSTAB	I1	9	0 or b	No logging cost table is provided. (Program equations are used.) Note: Program equations are valid for CV4 units only.
			1	Logging cost table provided.
			2	Separate final harvest logging cost table provided.
Blank	3x	10-12	b	Blank.
LDI	I2	13-14	0 or b	None.
			XX	Number of rows (DBH) in intermediate logging cost table (up to 12).
Blank	I x	15	b	Blank.
LVI	I2	16-17	0 or b	None.
			XX	Number of columns (volumes) in intermediate logging cost table (up to 12).

Variable name	Format	Columns	Contain	Explanation
Blank	l x	18	b	Blank.
LDF	12	19-20	0 or b	None.
			XX	Number of rows (DBH) in final harvest logging cost table (up to 12).
Blank	l x	21	b	Blank.
LVF	12	22-23	0 or b	None.
			XX	Number of columns (volumes) in final harvest logging cost table (up to 12).
Blank	l x	24	b	Blank.
A	F14.8	25-38	0 or b	Pond value price equation not used. (Pond value price table provided.)
			XX. . .X	First coefficient for pond value price equation.
Blank	l x	39	b	Blank.
B	F14.8	40-53	0 or b	None.
			XX. . .X	Second coefficient for pond value price equation.
Blank	l x	54	b	Blank.
C	F14.8	55-68	0 or b	None.
			XX. . .X	Third coefficient for pond value price equation.
Blank	l x	69	b	Blank.
IMORT	I1	70	0 or b	No mortality option.
			1	Mortality option.
Blank	l x	71	b	Blank.
VAM	F4.2	72-75	XXXX	Volume adjustment multiplier,
Blank	5x	76-80	bbbbb	Blank.

Economics Master Card 2 (Card Type 11).—This economics master card is the second of two master cards used to specify the financial evaluation option. Selections determine the interest rate, the logging cost multiplier, per acre costs, other costs, and whether price and cost trends are provided.

Variable name	Format	Columns	Contain	Explanation
Blank	l x	1	b	Blank.
R	F4.1	2-5	XXXX	Interest rate.
Blank	l x	6	b	Blank.
REGENC	F5.0	7-11	XXXXX	Regeneration cost per acre.
Blank	1x	12	b	Blank.
PCTC	F5.0	13-17	XXXXX	Precommercial thinning cost per acre.
Blank	l x	18	b	Blank.
FC	F5.0	19-23	0 or b	No fertilization selected.
			XXXXX	Number of fertilization rate-cost pairs provided. Must be one pair for each different fertilization rate provided on DFSIM card type 7. A maximum of 9 rate-cost pairs are allowed.
Blank	l x	24	b	Blank.
LCM	F4.2	25-28	XXXX	Logging cost multiplier.
Blank	l x	29	b	Blank.
FHRC	F5.0	30-34	XXXXX	First harvest road cost per acre.
Blank	l x	35	b	Blank.
OATC	F5.0	36-40	XXXXX	Other per acre thinning cost.
Blank	l x	41	b	Blank.
OVTC	F5.0	42-46	XXXXX	Other per M unit volume thinning cost.
Blank	l x	47	b	Blank.
OAHC	F5.0	48-52	XXXXX	Other per acre final harvestcost.
Blank	l x	53	b	Blank.
OVHC	F5.0	54-58	XXXXX	Other per M unit volume final harvest cost.
Blank	l x	59	b	Blank.
HC	F5.0	60-64	XXXXX	Hauling cost per M unit volume.
Blank	l x	65	b	Blank.
INFLAT	I1	66	0 or b	No price or cost trends.
			1	Price or cost trends.
Blank	14x	67-80	bb. . .b	Blank.

Trend Card (Card Type 12).—The trend card is used if the trend parameter INFLAT[11,12] on the second economics master card, column 66, is coded 1. All trends are specified as annual percentage rates of change and apply to a 50-year period.

Variable name	Format	Columns	Contain	Explanation
Blank	1x	1	b	Blank.
PVI	F4.1	2-5	XXXX	Pond value (price) trend.
Blank	1x	6	b	Blank.
RCI	F4.1	7-10	XXXX	Regeneration cost trend.
Blank	1x	11	b	Blank.
PCTCI	F4.1	12-15	XXXX	Precommercial thinning cost trend.
Blank	1x	16	b	Blank.
FCI	F4.1	17-20	XXXX	Fertilization cost trend.
Blank	1x	21	b	Blank.
LCI	F4.1	22-25	XXXX	Logging cost trend.
Blank	1x	26	b	Blank.
FHRCI	F4.1	27-30	XXXX	First harvest road cost trend.
Blank	1x	31	b	Blank.
OAHCI	F4.1	32-35	XXXX	Other per acre harvest cost trend.
Blank	1x	36	b	Blank.
OVHCI	F4.1	37-40	XXXX	Other per M unit volume harvest cost trend.
Blank	1x	41	b	Blank.
HCI	F4.1	42-45	XXXX	Hauling cost trend.
Blank	35x	46-80	bb. . .b	Blank.

Pond Value Card 1 (Card Type 13).—This pond value card is the first of two cards used to specify the pond value price table. It is used if the pond value price parameter PONTAB[10,2] on the first economics master card, columns **6-7,** is coded with the number of DBH (rows) in the pond value price table. Up to eight DBH values can be input.

Variable name	Format	Columns	Contain	Explanation
Blank	1x	1	b	Blank.
PONDVL(1,1)	F4.1	2-5	XXXX	DBH value for first entry in the table.
Blank	1x	6	b	Blank.
PONDVL(2,1)	F4.1	7-10	XXXX	DBH value for second entry in the table.
PONDVL(3-8,1)	6(1x,F4.1)	11-40	XXXX	DBH values for up to six additional entries.
Blank	40x	41-80	bb. . .b	Blank.

Pond Value Card 2 (Card Type 14).—This pond value card is the second of two cards used to specify the pond value price table. It is used if the pond value price parameter PONTAB[10,2] on the first economics master card, columns 6-7, is coded with the number of DBH values in the pond value price table. One price associated with each DBH value given on the first pond value card must be input. Up to eight prices can be input.

Variable name	Format	Columns	Contain	Explanation
Blank	l x	1	b	Blank.
PONDVL(1,2)	F5.0	2-6	XXXXX	Price associated with first DBH value.
Blank	l x	7	b	Blank.
PONDVL(2,2)	F5.0	8-12	XXXXX	Price associated with second DBH value.
PONDVL(3-8,2)	6(1x,F5.0)	13-48	XXXXX	Price associated with remaining DBH values.
Blank	32x	49-80	bb. . .b	Blank.

Logging Cost Volumes Card (Card Type 15).—This logging cost volumes card is used if the logging cost parameter COSTAB[10,3] on the first economics master card, column 9, is coded 1 or 2. These volumes in M units can be thought of as the column headings for the logging cost table. Up to 12 volumes may be entered. If COSTAB[10,3] is coded 1 these volumes will be used at both intermediate cutting times and at the final harvest. In this case the number of volumes entered is the value of the column number parameter for the intermediate logging cost table LVI[10,5] on the first economics master card, columns 16-17. If COSTAB[10,3] is coded 2 a second full set of logging cost cards must be entered. In the latter case the number of volumes entered for the second set is the value of the column number parameter for the final logging table LVF[10,7] on the first economics master card, columns 22-23.

Variable name	Format	Columns	Contain	Explanation
Blank	l x	1-5	bbbbb	Blank.
LOGVI(1)	F6.2	6-11	XXXXXX	First volume in M units.
LOGVI(2)	F6.2	12-17	XXXXXX	Second volume in M units.
LOGVI(3-12)	10F6.2	18-77	XXXXXX	Volumes for up to 10 additional entries.
Blank	3x	78-80	bbb	Blank.

Logging Cost DBH and Costs Cards (Card Type 16).—These logging cost DBH and costs cards are used in conjunction with the logging cost volumes card to specify the logging cost table. Include as many of these cards as the value of the row number parameter for the intermediate logging cost table, LDI[10,4], columns 13-14, on the first economics master card; for the final logging cost table, LDF[10,6], columns 19-20.

Variable name	Format	Columns	Contain	Explanation
Blank	l x	1	b	Blank.
LOGDI(1)*	F4.1	2-5	XXXX	Row I DBH.
LOGCI(I,1)*	F6.0	6-11	XXXXXX	Cost associated with first column volume in row I.
LOGCI(I,2)	F6.0	12-17	XXXXXX	Cost associated with second column volume in row I.
LOGCI(I,3-12)	10F6.0	18-77	XXXXXX	Costs associated with remaining volumes in row I.
Blank	3x	78-80	bb...b	Blank.

*If COSTAB[10,3] on the first economics master control card, column 9, is coded 2, the variable names are LOGDF and LOGCF for the second set of logging cost cards.

Fertilization Rate and Cost Card (Card Type 17).—This fertilization rate and cost card is included if the economics fertilization parameter FC[11,4] on the second economics master card, columns 19-23, is coded with the number of fertilization rate-cost pairs. There must be a rate and cost for every rate (quantity) specified on DFSIM card type 7. They are mandatory if a DFSIM card type 7 card is included. Up to nine rate-cost pairs may be entered.

Variable name	Format	Columns	Contain	Explanation
Blank	l x	1	b	Blank.
CNIT(1,1)	F3.0	2-4	XXX	First rate (pounds of nitrogen per acre).
CNIT(1,2)	F4.0	5-8	XXXX	Cost for first rate.
CNIT(2-9,l), CNIT(2-9,2)	8(1x,F3.0, F4.0)	9-72	XXX, XXXX	Rates and costs associated with remaining quantities of nitrogen.
Blank	8x	73-80	bb...b	Blank.

Metric Equivalents

1 inch (in) = 2.54 centimeters
1 foot (ft) = 0.3048 meter
1 square foot (ft^2) = 0.09290 square meter
1 square foot per acre (ft^2/acre) = 0.2296 square meter per hectare
1 cubic foot per acre (ft^3/per acre) = 0.06997 cubic meter per hectare

Literature Cited

Curtis, Robert O.; Clendenen, Gary W.; DeMars, Donald J. A new stand simulator for coast Douglas-fir: DFSIM user's guide. Gen. Tech. Rep. PNW-128. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1981.** 79 p.

Kimmey, J. W.; Furniss, R. L. Deterioration of fire-killed Douglas-fir. Tech. Bull. 851. Washington, DC: U.S. Department of Agriculture; **1943.** 61 p.

Sessions, Julian. Effects of harvesting technology upon optimal stocking regimes of forest stands in mountainous terrain. Corvallis, OR: Oregon State University; **1979.** 259 p. Ph. D. dissertation.

Appendix 1

Logical Unit 13 Example

TAB01

	0.5	1.0	1.5	2.0	5.0	10.
6	723	663	630	606	546	535
8	608	549	518	497	445	435
10	519	462	433	413	368	359
12	448	392	364	345	307	298
14	391	337	309	291	257	249
16	347	293	266	249	218	210
18	433	332	289	264	220	208
20	397	296	254	230	189	177
22	375	274	233	209	170	158
24	366	266	225	201	162	151

Appendix 2
Sample SIMIN2 Run

```
THIS INTERACTIVE PROGRAM GENERATES THE CONTROL FILE INPUT TO RUN DFSIM

QUESTIONS CONCERNING THIS PROGRAM KAY BE DIRECTED TO THE U.S.FOREST SERVICE,
PNW FOREST AND RANGE EXPERIMENT STATION, BIOMETRICS UNIT (503) 231-2063
ANY QUESTIONS ABOUT ECONOMICS DATA SHOULD BE DIRECTED TO:
ROGER FIGHT - PNW (503) 231-2086.



THIS PROGRAM REQUESTS USER SPECIFIED INPUT TO INITIALIZE A DFSIM RUN
PLEASE ENTER INTEGER VALUES (UNLESS OTHERWISE SPECIFIED) IN THE ORDER
REQUESTED, SEPARATED BY COMMAS, AND FOLLOWED BY A CARRIAGE RETURN.
IF YES OR NO IS REQUIRED, DO NOT INSERT LEADING BLANKS.

ENTER A TITLE FOR THIS DFSIM RUN (UP TO 80 COLUMNS)
                          EXAMPLE DFSIM WITH ECONOMICS

WOULD YOU PREFER A LIMITED (SHORTER) CONTROL FILE ? Y

ENTER THE FOLLOWING VARIABLES:
    SITE INDEX (50 YR),
    STAND ORIGIN (0=NATURAL OR SEEDED, 1=PLANTED),
    AGE OF PRECOMMERCIAL THINNING (0=NO PCT),
    STAND OPTION (0=REGIONAL AVERAGE, 1=USER SUPPLIED STAND CONDITIONS),
    COMMERCIAL THINNING (0=NO CT, 1=CT OPTION),
    FERTILIZATION (0=NO FERT, 1=FERT DURING EACH CT, 2=FERT AT USER
         SPECIFIED AGES) 125,0,11,0,1,0

ENTER THE TOTAL STAND TPA AFTER PCT 300

ENTER THE NUMBER OF COMMERCIAL THINNINGS (UP TO 9) 4

ENTER A TOTAL AGE FOR EACH COMMERCIAL THIN 30,40,54,70

SELECT NONE, ONE, OR TWO OF THE FOLLOWING CT OPTIONS:
    USER SUPPLIED D/D RATIO FOR EACH CT
         0=NO
         1=USER SPECIFICATIONS BETWEEN .80 6 1.25
         2=UNRESTRICTED USER SPECIFICATIONS
    USER SUPPLIED RESIDUAL SBA FOR EACH CT
         0=NO
         1=YES
    USER SUPPLIED RESIDUAL TPA FOR EACH CT
         0=NO
         1=YES

  NOTE: A VALUE MUST BE ENTERED FOR EACH OPTION 0,0,0

ENTER THE FOLLOWING FOUR VARIABLES:
    TOTAL STAND AGE FOR EARLIEST POSSIBLE CT
    MINIMUM SBA (TREES > 5.5 DBH) FOR EARLIEST POSSIBLE CT (0=100)
    MINIMUM QMD(NEAREST .1) OF TREES REMOVED (0=8.0)
    MINIMUM BASAL AREA TO BE REMOVED (0=20) 0,0,0,0

ENTER THE ROTATION LENGTH:
    ROTATION AGE (0=ROTATION HEIGHT SUPPLIED)
    AND, HEIGHT AT FINAL HARVEST (0=ROTATION AGE SUPPLIED) 80,0
```

```
ENTER THREE OUTPUT PARAMETERS:
    OUTPUT TABLE TYPES
         0=TREES > 1.5 DBH
         1=ALL TYPES (TREES > 1.5, 5.5, 7.5 DBH)
         2=TWO TYPES (TREES > 1.5 AND 5.5 DBH)
         3=TWO TYPES (TREES > 1.5 AND 7.5 DBH)
    OUTPUT TIMING
         0=OUTPUT TABLES AT CUTTING AGES
         1=OUTPUT TABLES AT CUTTING AGES AND USER SPECIFIED AGES (UP TO 76)
         5=OUTPUT TABLES EVERY YEAR
    NUMBER OF USER SPECIFIED AGES (0=NONE) 2,0,0
DO YOU WANT ECONOMICS TABLES FOR THIS RUN? Y
INDICATE DFSIM UNITS (CV4,CV6,IV6,SV6) CV4
ARE YOU USING A TABLE OF PONDVL PRICES? Y
ENTER # OF DBH VALUES
NO MORE THAN 8 DBH VALUES ARE ALLOWED 2
ENTER DBH VALUES (XX.X)
         6.,24.
ENTER PONDVL VALUES (XXXX.)
         860.,1490.
ARE YOU USING A TABLE OF LOGGING COSTS?
NOTE: THE TABLE FILE MUST BE PREDEFINED AS LOGICAL UNIT 13 BEFORE EXECUTING
SIMIN2. Y
ARE YOU USING A SEPARATE TABLE FOR FINAL HARVEST LOGGING COST VALUES? N
THE INTERMEDIATE HARVEST TABLE WILL ALSO BE USED
FOR FINAL HARVEST LOGGING COSTS

ENTER A 5-CHAR NAME OF INTERMEDIATE HARVEST TABLE TAB01
ENTER # OF DBH VALUES, # OF VOLUMES 10,6

DO YOU WANT TO INCLUDE SALVAGE OF MORTALITY ? Y
ENTER THE FOLLOWING PER ACRE COSTS:
    REGEN COST PER ACRE (XXXX.),
    PRECOM THIN COST PER ACRE (XXXX.),
    FIRST HARVEST ROAD COST PER ACRE (XXXX.),
    OTHER PER ACRE THIN COST (XXXX.),
    OTHER PER ACRE FINAL HARVEST COST (XXXX.),
         200,100,0,50,30
ENTER THE FOLLOWING VARIABLES:
    VOLUME ADJUSTMENT MULTIPLIER (X.XX),
    INTEREST RATE (XX.X),
    LOGGING COST MULTIPLIER (X.XX),
    OTHER PER M UNIT VOL THIN COST (XXXX.),
    OTHER PER M UNIT VOL FINAL HARVEST COST (XXXX.),
    HAULING COST PER M UNIT VOL (XXXX.),
         .90,4.,1.2,0,0,150
DO YOU WANT TO CHANGE PRICES OVER TIME? Y
ENTER POND VALUE PRICE TREND (XX.X) 1.5
DO YOU WANT TO CHANGE CULTURAL TREATMENT COSTS OVER TIME? Y
ENTER THE FOLLOWING RATES: (XX.X)
    REGEN COST TREND,
    PRECOM THIN COST TREND,
    FERT COST TREND.
         1,1,0

DO YOU WANT TO CHANGE HARVEST COSTS OVER TIME? Y
ENTER THE FOLLOWING RATES: (XX.X)
    LOGGING COST TREND,
    FIRST HARVEST ROAD COST TREND,
    OTHER PER ACRE HARVEST COST TREND,
    OTHER PER M UNIT VOL HARVEST COST TREND,
    HAULING COST TREND.
         0,0,1,0,0

DO YOU WISH TO SET UP ANOTHER RUN? N
```

Appendix 3
Input Form for DFSIM WITH ECONOMICS Short Control File

Title			
Site index Stand origin Age of PCT Stand option CT option Fertilization option			
Trees per acre			
Number of commercial thinnings			
Commercial thinning ages			
Commercial thinning options d/D ratios Stand basal areas Trees per acre			
d/D ratios			
Stand basal areas			
Trees per acre			
Earliest possible CT Minimum stand basal area Minimum quadratic mean DBH Minimum basal area			
Number of fertilizations			
Ages and rates			
Rotation age Height at rotation			
Output tables Number of user specified ages User specified ages			

Input Form for DFSIM WITH ECONOMICS Short Control File (continued)

Units			
Table of pond values? Yes, number of DBH's DBH's Pond values No, coefficient A Coefficient B Coefficient C			
Table of logging costs? Separate final harvest table? Name intermediate table Number of DBH's, number of volumes Name final harvest table Number of DBH's, number of volumes			
Mortality salvage?			
Regeneration cost PCT cost First harvest road cost Other per acre thinning cost Other per acre final harvest cost			
Number of fertilization rate-cost pairs			
Rate-cost pairs			
Volume adjustment multiplier Interest rate Logging cost multiplier Other per unit volume thinning cost Other per unit volume final harvest cost Hauling cost			
Change pond values? Pond value trend			
Change cultural costs? Regeneration cost trend PCT cost trend Fertilization cost trend			
Change harvest costs? Logging cost trend Road cost trend Acre harvest cost trend Volume harvest cost trend Hauling cost trend			
RESULTS PNWI PNW2 Soil expectation value Mean annual harvest			

Appendix 4
Example of DFSIM Control File

EXAMPLE DFSIM WITH ECONOMICS

```
1 2 5 0 1 1  3 0 0 0 0 0  4  0  0  0 1  80  0  0 0   0 0 0 0   0  0   0 0 0 2 0 1
   30   40   54   70    0    0    0    0    0                                    20
 CV4  2 1   10  6  0  0 0.            0.            0.            1  .90
   40   200   100     0  120     0    50     0    30     0   150 1
  1.5  1.0  1.0  0.0  0.0  0.0  1.0  0.0  0.0
  6.0 24.0
  860. 1490.
       0.50  1.00  1.50  2.00  5.00 10.00
  6.0  723.  663.  630.  606.  546.  535.
  8.0  608.  549.  518.  497.  445.  435.
 10.0  519.  462.  433.  413.  368.  359.
 12.0  448.  392.  364.  345.  307.  298.
 14.0  391.  337.  309.  291.  257.  249.
 16.0  347.  293.  266.  249.  218.  210.
 18.0  433.  332.  289.  264.  220.  208.
 20.0  397.  296.  254.  230.  189.  177.
 22.0  375.  274.  233.  209.  170.  158.
 24.0  366.  266.  225.  201.  162.  151.
END
```

Appendix 5
Description of DFSIM WITH ECONOMICS Program Segments

SUBROUTINE ECON This is the controlling subroutine for the financial evaluation option. Calculates output results for each harvest. Calls LOGC, REVNOW, PONDV, and XMORT. Called by VOLCON.

SUBROUTINE EOUT Outputs the run parameter values for the financial evaluation option at the beginning of the 5.6-inch or 7.6-inch table and the financial summary tables at each harvest. Called by VOLCON.

FUNCTION LOGC Calculates logging cost per M units of volume from user table. Called by ECON.

FUNCTION REVPJOW Calculates logging cost per M units of volume. It is valid for CV4 units only. Called by ECON.

FUNCTION PONDV Calculates pond value price from user table. Called by ECON.

SUBROUTINE XMORT Calculates salvage of mortality option. Called by ECON.

Fight, Roger D.; Chittester, Judith M.: Ciendenen, Gary W. DFSIM WITH ECONOMICS: A financial analysis option for the DFSIM Douglas-fir simulator. Gen. Tech. Rep. PNW-175. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1984. 22 p.

A modified version of the DFSIM Douglas-fir ***(Pseudotsuga*** menziesii (Mirb.) Franco var. menziesii) growth and yield simulator, DFSIM WITH ECONOMICS, now has an economics option that allows the user to estimate present net worth at the same time a silvicultural regime is simulated. If desired, the economics option will apply a volume adjustment multiplier in yields used in the analysis to reflect application of small-plot research results to average operating conditions or to account for genetics or other local conditions. It can also account for salvage of mortality. Prices can be entered as a table of values or as an equation that can vary with diameter. Logging costs can be entered as a table or can be generated internally for a short-span cable system. Logging costs can vary by diameter and volume harvested. Other harvest-related costs can be included on a per acre basis and also on a unit volume basis. Prices and costs can be trended using an annual percentage rate of change that is applied for a 50-year period.

An interactive program, SIMIN2 WITH ECONOMICS, can be used to prepare the input data in the format required by the DFSIM WITH ECONOMICS program. Both programs are available from the Biometrics Group, Pacific Northwest Forest and Range Experiment Station, Forestry Sciences Laboratory, P.O. Box 3890, Portland, Oregon 97208.

Keywords: Simulation, financial analysis, DFSIM, Douglas-fir (coast).

The Forest Service of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

Pacific Northwest Forest and Range
Experiment Station
319 S.W. Pine St.
P.O. Box 3890
Portland, Oregon 97208