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FVS ECON Training Guide

NFS-All Regions

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INTRODUCTION

The Forest Vegetation Simulator (FVS) is the Forest Service, U.S. Department of Agriculture, nationally supported framework for forest growth and yield modeling. The Forest Vegetation Simulator Group of the Forest Management Service Center in Fort Collins, Colorado, maintains, supports, and develops FVS software tools. The FVS staff directly supports the FVS growth and yield model including the Fire and Fuels Extension (FFE) and the database extension (DB) as well as the Suppose Interface and numerous post processors. In addition to these programs, Insect and Pathogen models have been developed through the participation and contribution of various organizations led by Forest Health Protection. The models are supported by the Forest Health Technology Enterprise Team (FHTET), regional Forest Health Protection specialists, and the FVS group.

This training guide has been prepared for the FY 2019 National Forest System. The intent is to give the user a basic understanding of the ECON extension and how it can produce costs and revenue used in the management decision process. During this course, you will learn how to use the Suppose Interface to make economic projections using FVS software. By the end of the course you will be able to perform basic management actions, add economic keywords to simple FVS simulations, and obtain various economic output reports from the base FVS model and its extensions. This course is just an introduction to the ECON extension. To become proficient in the ECON extension, to include FVS usage, you will need to spend additional time outside of class exploring FVS' capabilities and researching the underlying modeling framework. In researching the underlying modeling framework, you will need to refer to three user guides. For general information, you will need to refer to *Essential FVS: A User's Guide to the Forest Vegetation Simulator* (Dixon 2002) and for specific model relationships, i.e. model equations and coefficients, you will need to refer to your variant's variant overview document. To find information specific to the ECON extension, please refer to the *User Guide to the Economic Extension (ECON) of the Forest Vegetation Simulation* (Martin 2009). If you develop questions following this training you are encouraged to contact your local FVS contact or the FVS helpdesk.

This training guide has been designed for use with software and data included in the FVS Software Complete Setup Package dated November 26, 2018. Participants using other software versions may obtain slightly different results from what is presented in this guide. Reference *Appendix AI. Installing FVS Software* from the Region Training Guides for instructions on installing FVS software.

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SESSION 1: REVENUE AND COSTS

This session provides an overview of the basic keywords needed to output information using the ECON extension of FVS. This session will familiarize you with running the ECON extension through the Suppose interface and interpreting FVS model outputs. Following this session, you should be able to produce and understand basic revenue and cost information.

1-1 Simple harvest – calculate Revenue and Cost

The purpose of this exercise is to familiarize you with the basic concepts used in the ECON Extension. In FVS, if you would like to analyze cost/benefits, you will first need to create a harvest or some other management activity that can generate revenue and/or produce costs. Keywords can then be used to produce the desired values used in the decision making process.

In this first exercise, you will explore how harvest revenues and costs are determined using a Douglas-fir stand in the western cascades variant. You will also learn the basic Keywords needed in order to execute the ECON extension. The exercise begins with the clearcut management action followed by assigning values and costs to trees and harvesting procedures. .

Before you begin, make sure the Regional Training dataset, located in the "C:\FVSData\Regional-Training" folder, is the working directory in Suppose. Right Click on Suppose Icon -> Properties -> Shortcut -> Start in. Copy the quoted directory string above into the Start-in field and click Apply to close the Properties window.

The first step is to add the stand to the simulation.

1) Start Suppose by double-clicking the Suppose icon on your desktop.
2) Make sure that no previous simulation is in the memory. The title bar should say *new file* if the memory is clear. If a previous simulation is in memory, click File > New.
3) Click on the [Select Stands] button.
4) In the large Locations box select "Regional Training."
5) In the large Groups box select "Variant=WC."
6) In the large Stands box select "060305402956"
7) At the bottom left corner, click the [Add 1 Stand] button.
    - The area just above the [Add Stand(s)] button should now read "Contents: 1 Stands 4 Groups"
8) Click the [Close] button to close the <Select Simulation Stands> window.

Now change the time scale so the stand will be grown for 100 years starting in 2019.

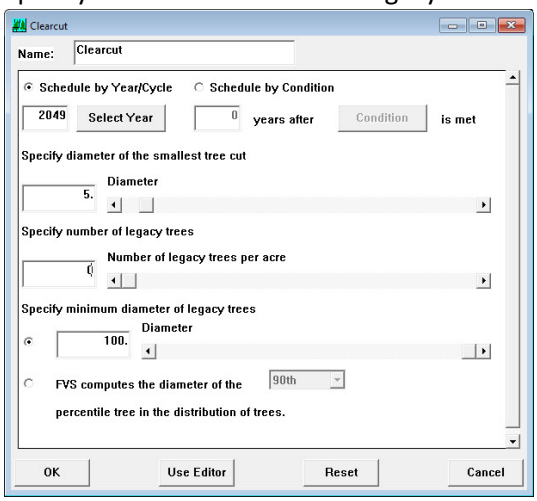
9) Click on the [Set Time Scale] button
10) Change the common starting year from 2014 to 2019. FVS will grow the stand up to the starting year of choice, in this case 2019.
11) Change the common ending year to 2119
    - This will grow the stand from 2019 to 2119 using the common cycle length of 10 years.
    - Note: The default common cycle length is 10 years for the all variants except the Southern and Klamath Mountains variants which have a common cycle length of 5 years. The default number of cycles is 10.
12) Click the [OK] button

Now add a clearcut management action to the stand in 2049.

13) Click on the [Select Management] button
14) Select Regeneration Methods: Even-aged > Clearcut/Coppice.

- This management action will remove all of the trees greater than a user specified diameter (DBH). A residual target may also be set by selecting a minimum diameter and number of legacy trees.
- Another option for this management action is to use the Thinning & Pruning Operations. The cutting efficiency can be reset through the Proportion of trees left field. This allows some smaller trees to be left in the stand. When FVS attempts to cut a tree record, the proportion of trees specified as left is used to determine how many trees per acre represented by the tree record are left standing. If left at the default proportion (0.0), FVS cuts all trees represented by the tree record; that is, the cutting efficiency is set to 1.0 - 0.0 = 1.

15) Enter the parameters for the management action
    - Change the "Schedule by Year/Cycle" field to "2049".
    - Specify diameter of the smallest tree cut: 5
    - Specify number of legacy trees:. 0
    - Specify minimum diameter of legacy trees: 100



16) Click the [OK] button.
17) Close the <Management Actions> window.

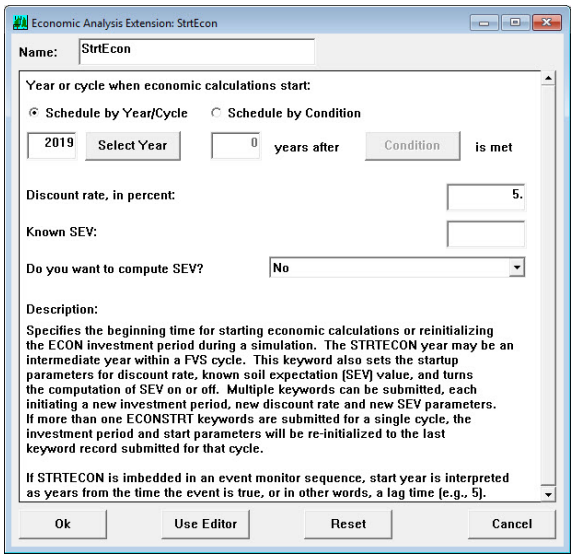
Outputs to track over the entire simulation include the stand summary statistics economic parameters. To view these outputs you will need to tell FVS to create the Economic Analysis Summary Report and the Harvest Volume and Gross Value Report. You will also need to add the "Main Output File" post-processor.

18) Click on the [Select Post Processors] button.
19) Highlight the "Main Output File" post processor.
20) Click the [Include] button. It will now appear in the included post processors section (the middle box).
21) Click the [Close] button to close the <Select Post Processors> window

The economic factors will now be added to the simulation. First, we'll start by initializing the economics extension.

22) Click on the [Add Keywords] button

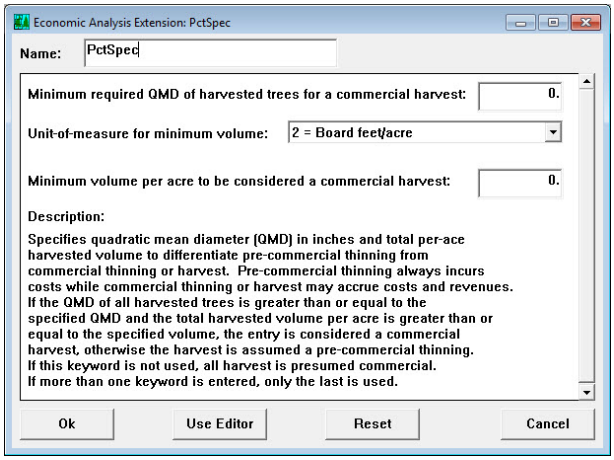
23) Under Extension, click on “Economic Analysis Extension”
24) Under Keyword, highlight “StrtEcon”
25) Click the [Accept] button
    - ➢ StrtEcon specifies the starting time for the economic calculations or reinitializing the ECON investment period during a simulation. In this case, calculations for any discount factors will have 2019 as the base (or current) year.
    - ➢ If the ECON start-year occurs after the first year of a cycle then harvests in that cycle will not be included in ECON calculations because FVS performs harvests in the first year of each cycle.
26) Enter the parameters for the economic calculations
    - Change the “Schedule by Year/Cycle” to “2019”
    - Discount rate: 5
    - Do you want to compute SEV? No



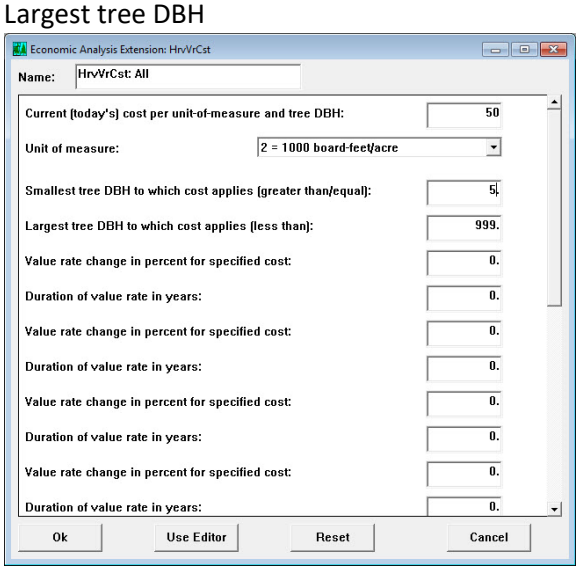
27) Click the [Ok] button

Next, we’ll specify costs and revenues associated with a pre-commercial thinning.

28) Under Keyword, highlight “PctSpec”
29) Click the [Accept] button
    - ➢ Pre-commercial thinning specifications, PctSpec, differentiates between pre-commercial thinning, which always incurs costs, and commercial thinning/harvests, which may or may not incur costs. If QMD and total harvest per acre are greater than the minimums specified, then the entry is considered a commercial harvest.
    - ➢ Values for HrvRvn and HrvVrCst are only applied to harvests when PctSpec specifications are met or exceeded.
30) Enter the parameters for the economic calculations
    - Minimum required QMD for commercial harvest: 0
    - Unit-of-measure: 2
    - Minimum volume/acre for commercial harvest: 0



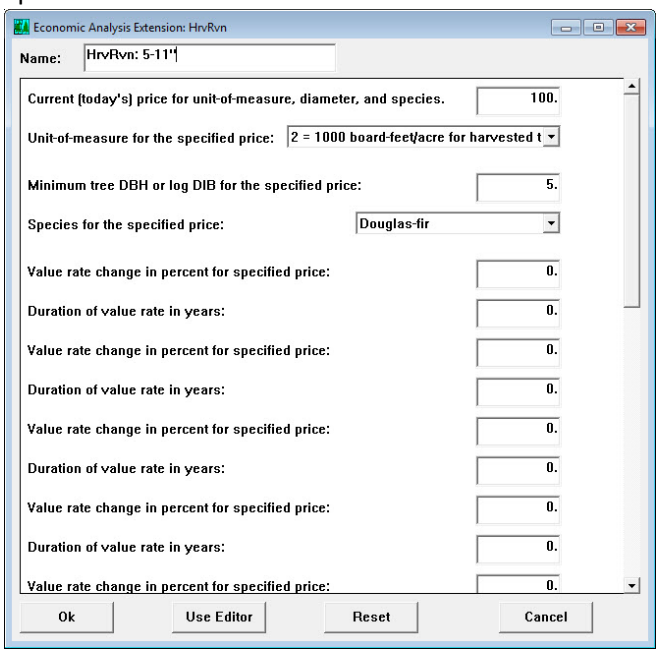
31) Click the [Ok] button
32) Under Keyword, highlight "HrvVrCst"
33) Click the [Accept] button
    - HrvVrCst specifies any commercial thinning or harvest cost
    - For this exercise, we are assuming a cost of $50/MBFT for logging costs. These may include falling, bucking, yarding, loading, etc.
34) Enter the parameters
    - Change Name to "HrvVrCst: All"
    - Current cost for unit-of-measure 50
    - Unit-of-measure 2
    - Smallest tree DBH 5
    - Largest tree DBH 999



35) Click the [Ok] button
36) Under Keyword, highlight "HrvRvn"
37) Click the [Accept] button
    - HrvRvn specifies commercial thinning or harvest price by species and unit-of-measure for up to eight different diameter classes.

- Refer to your area's most up-to-date log prices for more accuracy in computing economic values.
- For this exercise, logs were divided into three size categories.

38) Enter the parameters for 5-11" DBH
    - Change Name to "HrvRvn: 5-11"
    - Current price for unit-of-measure: 100
    - Unit-of-measure 2
    - Minimum tree DBH or log DIB for the specified price 5
    - Species Douglas-fir



39) Click the [Ok] button
40) Under Keyword, highlight "HrvRvn"
41) Click the [Accept] button
42) Enter the parameters 11-21" DBH
    - Chance Name to "HrvRvn: 11-21"
    - Current price for unit-of-measure: 150
    - Unit-of-measure 2
    - Minimum tree DBH 11
    - Species Douglas-fir
43) Click the [Ok] button
44) Under Keyword, highlight "HrvRvn"
45) Click the [Accept] button
46) Enter the parameters for 21"+ DBH
    - Change Name to "HrvRvn: 21+"
    - Current price for unit-of-measure: 250
    - Unit-of-measure 2
    - Minimum tree DBH 21
    - Species Douglas-fir

47) Click the [Ok] button
48) Click the [Close] button to close the <Use FVS Keywords> window
49) Click on the [Run Simulation] button
50) A <Save As:> window will now appear. Type **Econ1-1.key** in the proper box in the File name (PC) window.
51) Click the [Save] button
52) Click the [Run] button

Options Selected by Input Questions

What ECON Extension Keywords are present? _____

FVS Summary Statistics Table Questions

What is the before and after treatment SDI in 2049? _____

What is the before and after treatment BA in 2049? _____

How much merchantable BDFT was harvested? _____

ECON Summary Table Questions

What are the discounted costs/revenues in 2049? _____

What is the Present Net Value (PNV) in 2049? _____

What are the following values in 2049? What does that value tell you?

IRR: _____

B/C Ratio: _____

RRR: _____

How much merchantable BDFT was harvested in this year? _____

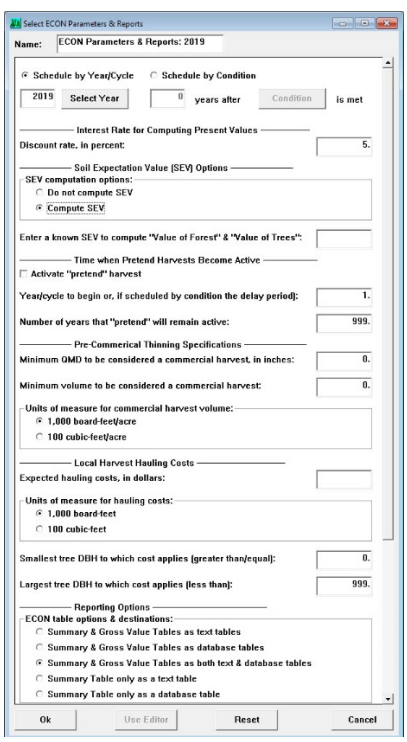
Extra Credit: Try changing the discount rate to see how the costs/revenues are affected.

END of Exercise 1-1

1-2 Economic Parameters and Reports option

One of the main features of Suppose is that it allows users to select pre-defined Outputs that group various Keywords together. These functions help streamline management options by accounting for and condensing required Keywords into one management action. This exercise will highlight the use of the Econ Parameters and Reports output file. By selecting this option, users will bypass the need to select both the StrtEcon and PctSpec keywords.

1) Make sure that Econ1-1.key is the open simulation file. If not, click on File > Open, and open the keyword file.
2) Highlight the “StrtEcon” Keyword in the <Simulation file contents> window
3) Click the [Delete] button in the “Edit Simulation” section
4) Click [Yes]
5) Highlight the “PctSpec” Keyword in the <Simulation file contents> window
6) Click the [Delete] button in the “Edit Simulation” section
7) Click [Yes]
8) Click on the [Select Outputs] button
9) Select **Economic Extension Reports > Select ECON Parameters & Reports**
10) Enter the parameters
    - Change name to “ECON Parameters & Reports: 2019”
    - Change the “Schedule by Year/Cycle” to “2019”
    - Discount rate: 5
    - SEV computation options: Compute SEV
    - Leave default values for the remaining items



11) Click the [Ok] button
12) Close the <Model Outputs> window

Now we are going to show how to move a Keyword in the Simulation file contents window

13) Highlight the “Select ECON Parameters & Reports” in the <Simulation file contents> window
14) Click the [Cut] button in the “Edit Simulation” section
15) Highlight “Clearcut” in the <Simulation file contents> window
16) Select [Paste “Select ECON Parameters & Reports”] in the “Edit Simulation” section
17) Click [Before]
18) Click on the [Run Simulation] button
19) Click the [Save As] button
20) A <Save As:> window will now appear. Type **Econ1-2.key** in the proper box in the File name (PC) window.
21) Click the [Save] button
22) Click the [Run] button

Options Selected by Input Questions

What ECON Extension Keywords are now present? _____

ECON Summary Table Questions

Was there any difference in the ECON output? _____

END of Exercise 1-2

1-3 Adding a pre-commercial thinning to a harvest schedule

The FVS Econ extension allows for both pre-commercial and commercial thinning over the course of a simulation. There are, however, a couple of key factors that must be accounted for when telling the ECON model to distinguish between the two types of thinning.

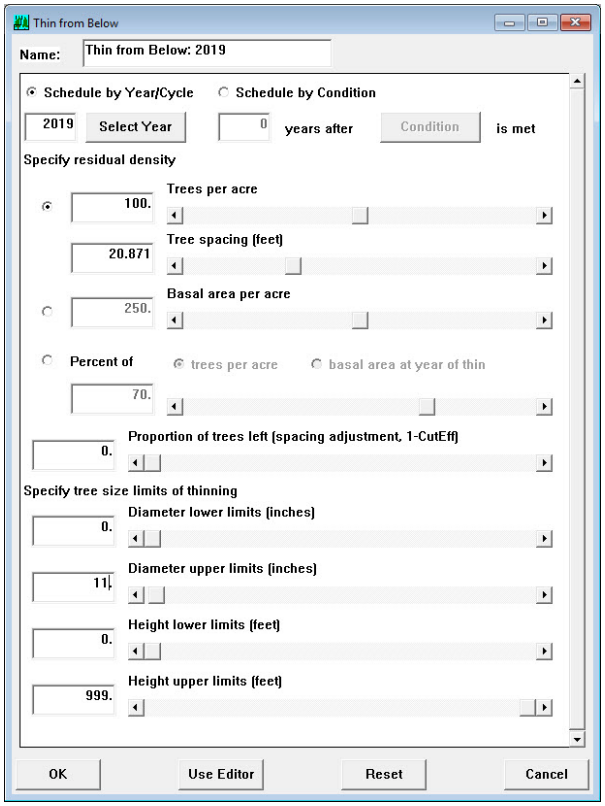
One important point is that each type of thinning has its own Keywords with regards to cost and revenue. Pre-commercial thinning incur costs using the PctFxCst and PctVrCst Keywords. Commercial thinning (or harvest) use the HrvFxCst and HrvVrCst Keywords to incur costs and the HrvRvn Keyword to incur revenue.

This exercise is designed to highlight the distinction between the two types of thinning. We start with the Econ1-2.key simulation and show how to insert a pre-commercial thinning into the existing file contents. After running the simulation we can compare the output to see how the addition of pre-commercial thinning changed the growth of the trees and the economic output.

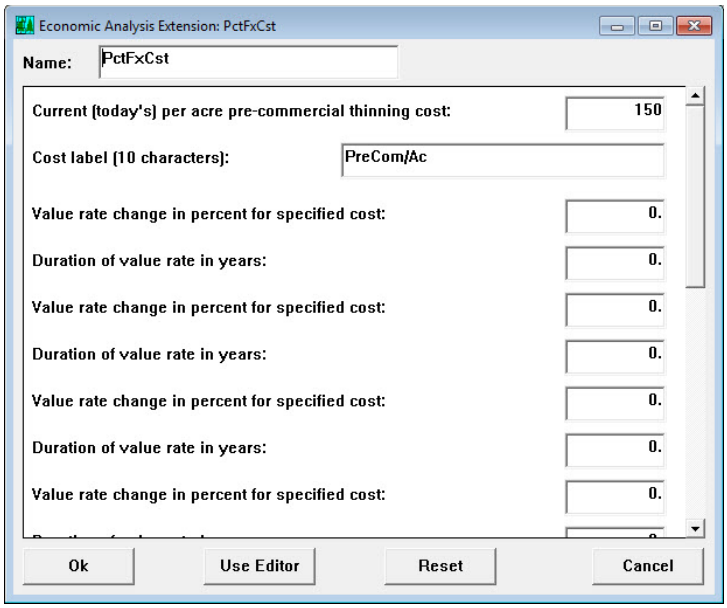
1) Make sure that Econ1-2.key is the open simulation file. If not, click on File > Open, and open the keyword file.

We need to add a pre-commercial thinning and the associated costs per acre to remove the trees.

2) Click on the [Select Management] button
3) Select Regeneration Methods: Thinning & Pruning Operations > Thin from below
    - ➢ This management action will remove all of the trees greater than a user specified diameter (DBH). A residual target may also be set by selecting a minimum diameter and number of legacy trees.
4) Enter the parameters for the management action
    - Change name to “Thin from Below 2019”
    - Change the “Schedule by Year/Cycle” field to “2019”
    - Specify Residual Density -> TPA 100
    - Diameter upper limits: 11
    - Leave default values for the remaining items



5) Click the [OK] button.
6) Close the <Management Actions> window.
7) Click on the [Add Keywords] button
8) Under Extension, click on “Economic Analysis Extension”
9) Under Keyword, highlight “PctFxCst”
10) Click the [Accept] button
    - ➢ PctFxCst is used to specify a per acre pre-commercial thinning cost. Of note, values form this keyword are only applied to harvest when the specifications of the PctSpec keyword are not met.
11) Enter the parameters for the economic calculations
    - Current per acre pre-commercial thinning cost: 150
    - Leave default values for the remaining items



12) Click the [Ok] button
13) Click the [Close] button to close the <Use FVS Keywords> window

In order for FVS to generate costs for a pre-commercial thin, the economic parameters must be updated to show what specifications are required to meet the requirements for a pre-commercial thin. To do this, either a minimum Quadratic Mean Diameter and/or minimum volume must be defined for a commercial harvest. In this case, we will set a minimum QMD of 5”.

14) In the simulations file window, highlight “ECON Parameters & Reports: 2019”.
15) Click on the [Edit Selection] Button.
16) Enter the parameters for the management action
    - Minimum QMD to be considered a comm harvest 5
    - Leave the remaining values the same
17) Click the [Ok] button
18) Click on the [Run Simulation] button
19) Click the [Save As] button
20) A <Save As:> window will now appear. Type **Econ1-3.key** in the proper box in the File name (PC) window.
21) Click the [Save] button
22) Click the [Run] button

Note: regeneration for non-sprouting trees is a user defined action. Since you are removing all of the seedlings/saplings in the 2019 pre-commercial thinning, you may consider adding regeneration in the form of planting or natural regeneration either after the 2019 pre-commercial thinning and/or after the 2049 clearcut. See exercise 3-1 for more info on regeneration.

Options Selected by Input Questions

What new ECON Extension Keywords are present? _____

FVS Summary Statistics Table Questions

What is the before and after treatment SDI in 2049? _____

What is the before and after treatment BA in 2049? _____

How much merchantable BDFT was harvested? _____

How did thinning in 2019 affect the harvest in 2049? _____

ECON Summary Table Questions

What are the discounted costs/revenues in 2049? _____

What is the Present Net Value (PNV) in 2049? _____

How much merchantable BDFT was harvested in this year? _____

How did thinning in 2019 affect the cost/revenues in 2049? _____

How did thinning in 2019 affect the PNV in 2049? _____

Extra Credit: Try changing the date of the harvest to see how a thinning in 2019 will affect PNV at different harvest timings.

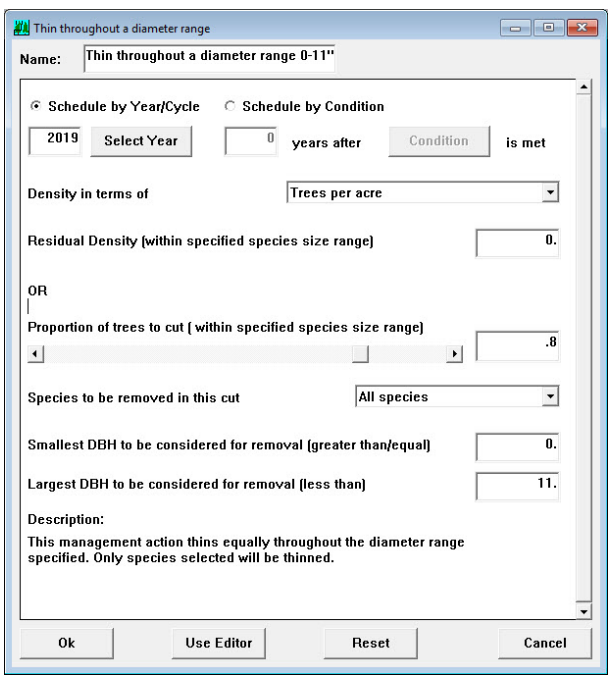
END of Exercise 1-3

1-4 Modifying a pre-commercial thinning to a commercial thinning

FVS can also be used for commercial thinning. This would be associated with a management plan that intends to release larger trees for growth. A commercial thin would incur both costs and revenues. Like stated above in exercise 1-3, there are factors that must be accounted for before certain actions can be applied. The key is to differentiate between the pre-commercial and commercial thinning Keywords.

1) Make sure that Econ1-3.key is the open simulation file. If not, click on File > Open, and open the keyword file.
2) In the simulations file window, highlight the "Thin from Below: 2019" Keyword in the <Simulation file contents> window
3) Click on the [Delete] Button
4) Click [Yes]
5) Click on the [Select Management] button
6) Select Thinning & Pruning Operations > Thin throughout diameter range
7) Enter the parameters for the management action

    - Change name to "Thin throughout a diameter range 0-11"
    - Change the "Schedule by Year/Cycle" field to "2019"
    - Proportion of trees to cut .8
    - Smallest DBH to be considered: 0
    - Largest DBH to be considered: 11
    - Leave default values for the remaining items



8) Click the [OK] button.
9) Close the <Management Actions> window.
10) In the simulations file window, highlight "ECON Parameters & Reports: 2019".

11) Click on the [Edit Selection] Button.
12) Enter the parameters for the management action
    - Minimum QMD to be considered a comm harvest 3
    - Leave the remaining values the same

13) Click the [Ok] button

In order for FVS to realize that a thinning is commercial, it must first meet the one of the minimum requirements of the PctSpec Keyword. By moving the minimum QMD to be considered for harvest down to 3", FVS will now recognize the thinning requested in 2019 as a commercial thinning.

14) Click on the [Run Simulation] button
15) Click the [Save As] button
16) A <Save As:> window will now appear. Type **Econ1-4.key** in the proper box in the File name (PC) window.
17) Click the [Save] button
18) Click the [Run] button

Options Selected by Input Questions

What new ECON Extension Keywords are present? _____

FVS Summary Statistics Table Questions

What is the before and after treatment SDI in 2049? _____

What is the before and after treatment BA in 2049? _____

How much merchantable BDFT was harvested? _____

How did thinning in 2019 affect the harvest in 2049? _____

ECON Summary Table Questions

What are the discounted costs/revenues in 2049? _____

What is the Present Net Value (PNV) in 2049? _____

How much merchantable BDFT was harvested in this year? _____

How did thinning in 2019 affect the cost/revenues in 2049? _____

How did thinning in 2019 affect the PNV in 2049? _____

Do you think the thinning (both comm/pre-comm) were worth it? _____

_____

END of Exercise 1-4

SESSION 2: THE PRETEND KEYWORD

The ECON model can only place value (i.e. cost/benefit) on harvested timber associated with management action keywords. This constraint allows users to only analyze the effects of a harvest at one point in time during a simulation, thereby limiting a manager's ability to compare a management action at various points in time. To overcome this, the ECON model uses the PRETEND keyword.

Session 2 focuses on using the PRETEND keyword to analyze mutually exclusive harvest prescriptions over the course of a single simulation. For these simulations, we will be using a multi-aged, mixed conifer stand from the Miwok District of the Stanislaus National Forest. This stand consists of approximately 600 TPA, mostly white fir and incense cedar. The management prescription will be a shelterwood, where we will leave 10 TPA to aid regeneration.

2-1 Using the Pretend Keyword

In this section, we will focus answering the question: when is the most economically efficient time to harvest? The following exercises will help answer this question by allowing you to analyze the effects of a harvest at various points in time. We do this with the PRETEND keyword. The PRETEND keyword simulates "pretend" harvests in each cycle without affecting future stand composition. In other words, FVS will output economic data if a harvest were to occur in the cycle.

Only harvests resulting from FVS thinning Keywords can accrue revenues and costs. In other words, ECON cannot produce values for standing timber. In order to account for more options with determining revenue and costs, a method was devised to allow for hypothetical harvests. This allows for multiple harvests to be analyzed without altering the stand development or the FVS tree list. Also, hypothetical harvests can be valued without accruing revenues and costs in future cycles.

Before you begin, make sure the Regional Training dataset, located in the "C:\FVSData\Regional-Training" folder, is the working directory in Suppose. The steps are: Right Click on Suppose Icon -> Properties -> Shortcut -> Start in.

The pre-defined even-aged regeneration harvest management actions in Suppose include clearcutting, seed-tree, and shelterwood. In this exercise you will explore using the shelterwood management action. The shelterwood management action may perform a series of cuts (preparatory, shelterwood, and removal) in two- or three-step harvests.

We will also explore using the Editor function to help with inputting multiple harvest revenue/costs. This will not only save time, it will allow you to better manage your dollar values by placing them all in one window. It is important to note, however, that proper spacing will be required to ensure data is read in correctly.

1) Make sure that no previous simulation is in memory. The title bar should say *new file* if the memory is clear. If a previous simulation is in memory, click File > New.
2) Click on the [Select Stands] button.
3) Select the following stand: Regional Training / Variant=WS / 051651109LC0008.
4) At the bottom left corner, click the [Add 1 Stand] button.
5) Close the <Select Simulation Stands> window.
6) Click on the [Set Time Scale] button.
7) Set the time scale for a 100-year projection starting in 2019, i.e. 2019 through 2119.
8) Click the [OK] button.

Enter the harvest

9) Click on the [Select Management] button.
10) Select Regeneration Methods: Even-aged > Shelterwood
11) Change the "Schedule by Year/Cycle" field to "0".
12) Enter the parameters for the management action:
    - Smallest diameter of the smallest tree cut 0
    - Specify number of legacy trees 10
    - Leave all other parameters set to the default values
13) Click the [OK] button

14) Close the <Management Actions> window

Add the economic parameters

13) Click on the [Select Outputs] button
14) Select **Economic Extension Reports > Select ECON Parameters & Reports**
15) Enter the parameters
    - Change name to "ECON Parameters & Reports: All"
    - Change the "Schedule by Year/Cycle" to "0"
    - Discount rate: 3
    - Check the box for Activate "pretend" harvest
    - Leave default values for the remaining items

16) Click the [Ok] button
17) Close the <Model Outputs> window

Add the cost functions

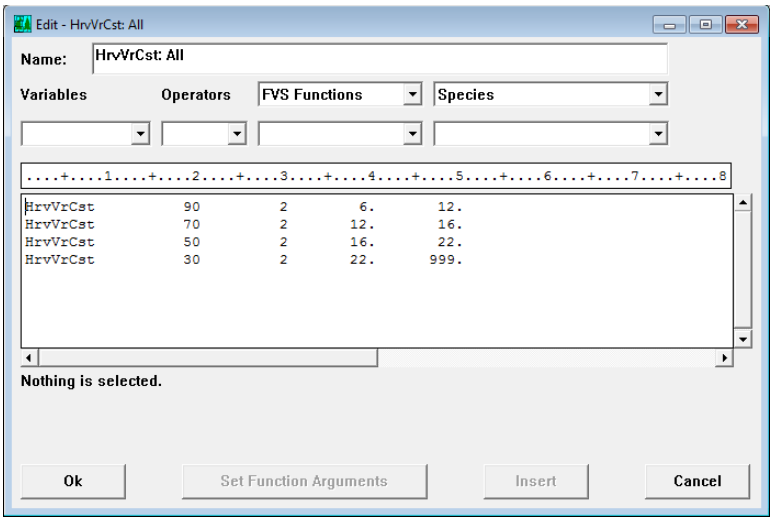
18) Click on the [Add Keywords] button
19) Under Extension, click on "Economic Analysis Extension"
20) Under Keyword, highlight "HrvFxCst"
21) Click the [Accept] button

    - HrvFxCst specifies any commercial thinning or harvest fixed cost
    - For this exercise, we are assuming a cost of $100/acre for logging costs. These may include site prep, road, or any maintenance/cleanup.

21) Enter the parameters
    - Change Name to "HrvFxCst: All"
    - Current (today's) per acre harvest cost 100
    - Leave default values for the remaining items
22) Click the [Ok] button
23) Under Keyword, highlight "HrvVrCst"
24) Click the [Accept] button
25) Click on [Use Editor] at the bottom of the window
26) Click on the [Proceed] button
27) Enter the following parameters ("HrvVrCst", cost, measure, smallest DBH, largest DBH).

    - Change name to "HrvVrCst: All"
    - HrvVrCst 90 2 6. 12.
    - HrvVrCst 70 2 12. 16.
    - HrvVrCst 50 2 16. 22.
    - HrvVrCst 30 2 22. 999

    Note: Each parameter has a 10 space limit and each variable must be right justified. Refer to the window below for an example.

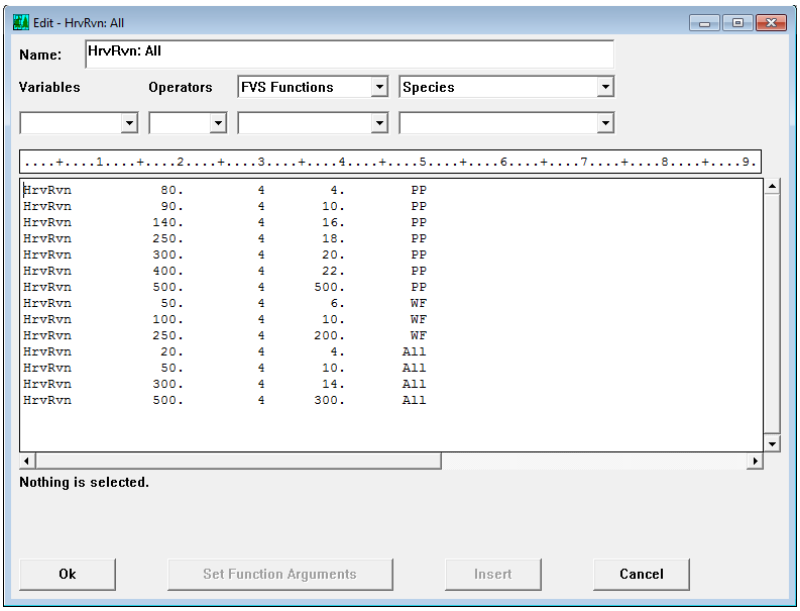


28) Click the [Ok] button

Add the revenue functions

29) Under Keyword, highlight ”HrvRvn”
30) Click the [Accept] button
31) Click on [Use Editor] at the bottom of the window
32) Click on the [Proceed] button
33) Enter the following parameters (HrvRvn, price, measure, smallest DBH, species)

- Change name to “HrvRvn: All”
- HrvRvn 80. 4 4. PP
- HrvRvn 90. 4 0. PP
- HrvRvn 140. 4 16. PP
- HrvRvn 250. 4 18. PP
- HrvRvn 300. 4 20. PP
- HrvRvn 400. 4 22. PP
- HrvRvn 500. 4 500. PP
- HrvRvn 50. 4 6. WF
- HrvRvn 100. 4 10. WF
- HrvRvn 250. 4 200. WF
- HrvRvn 20. 4 4. All
- HrvRvn 50. 4 10. All
- HrvRvn 300. 4 14. All
- HrvRvn 500. 4 300. All



Keep in mind the spacing requirements

34) Click the [OK] button
35) Close the <Use FVS Keywords> window
36) Click on the [Select Post Processors] button.
37) Add the “Main Output File” post processor.
38) Close the <Select Post Processors> window.
39) Click on the [Run Simulation] button.
40) Name the keyword file Econ2-1.key.
41) Click the [Save] button.
42) Click the [Run] button.

This Shelterwood prescription calls for leaving the largest 10 trees by DBH class and harvesting the rest. Since we selected the PRETEND keyword for all cycles, the harvest revenues accrue during each cycle separately. Present Net Value (PNV) at the end of each cycle reflects a “pretend” harvest during that cycle and is independent of other cycles.

Note: ECON results are presented in a similar fashion as the FVS Summary Table, i.e., they are presented in the first year of a cycle. For example, any activities occurring between 2019 and 2028 are displayed in 2019.

FVS provides several measures for evaluating when to harvest and most of these variables can be found in the Summary Statistics Table of the Main Output File. Examples include Stand Density Index (SDI), Basal Area (BA), growth, mortality, etc. The ECON provides additional decision criteria to aid the manager in deciding when is the most efficient, in the case economically efficient, time to harvest.

FVS Summary Statistics Table Questions

In what year does SDI reach its maximum? _____

In what year does the stand reach max culmination of accretion? _____

In what year does the stand reach max merchantable BDFT? _____

ECON Summary Table Questions

In what year is PNV the highest? _____

What are the following values in this year (highest PNV)? What does that value tell you?

IRR: _____

B/C Ratio: _____

RRR: _____

How much merchantable BDFT was harvested in this year? _____

While the economically efficient time to harvest may vary depending on your decision criteria, a general rule is to use the maximum PNV. In this exercise, you should examine how the PNV changes over time and compare that to accretion per year. Notice how PNV reaches its maximum after accretion per year has already started to decline. These factors are partially dependent on the discount rate. Managers must be aware of what discount rate they are choosing and base their choice on sound economic analysis.

Also, be aware that the economically efficient time to harvest may not coincide with the most efficient biologically time to harvest. Foresters will generally work towards a culmination of Mean Annual Increment (MAI) as the most efficient time to harvest. This logic is in line with the Maximum Sustainable Yield (MSY) ideal typically used in Forest Management Plans as a guiding principle in the management of forest resources.

You are encouraged to study to the differences between the two decision criteria for harvesting forested stands. Focus on what some of the driving factors are in reaching the various harvest times.

END of Exercise 2-1

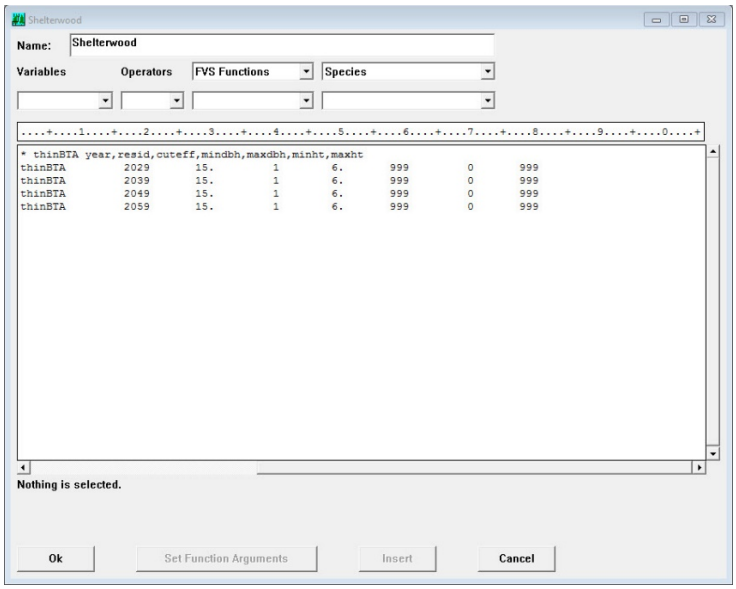
2-2 Soil Expectation Value

We next look into the question: What is the value of the forest land for timber production? To help us answer this question, we will look at Soil Expectation Value (SEV) and how it can affect the decision making process. SEV is the present value of a perpetually repeating series of stand treatments. It reflects the ability of the land (or bare ground) to produce income from timber production. SEV is computed at the end of the investment period or cycle.

The following exercise uses SEV to differentiate among different management prescriptions. We do this by starting with the same initial conditions and then we implement alternate prescriptions each cycle using the PRETEND keyword. The initial condition includes a pre-commercial thinning occurring in 2019. Each cycle thereafter represents an alternative harvest prescription designed to preserve the initial stand condition. Each "pretend" cycle is mutually exclusive of the other prescriptions.

To simplify the procedure, we will use the same cost/revenue values from exercise 2-1. We will also use the same prescription, however, we will only investigate "pretend" simulations in the four cycles after the pre-commercial thinning. The difference is that now we are going to implement a pre-commercial thinning and, using SEV, we will then determine the optimal time to harvest.

1) Make sure that Econ2-1.key is the open simulation file. If not, click on File > Open, and open the keyword file.
2) Highlight the "Shelterwood" Keyword in the <Simulation file contents> window
3) Click the [Delete] button in the "Edit Simulation" section
4) Click [Yes]
5) Click on the [Set Time Scale] button
6) Change the Common ending year to 2069
7) Click the [Ok] button
8) Click on the [Select Management] button
9) Select Thinning & Pruning Operations > Thin from below
10) Enter the parameters for the management action
    - Change the "Schedule by Year/Cycle" field to "2019".
    - Specify residual density Trees per Acre 300
    - Specify Diameter lower limits: 0
    - Specify Diameter upper limits: 999
11) Click the [OK] button.
12) Close the <Management Actions> window.
13) Click on the [Select Management] button.
14) Select Regeneration Methods: Even-aged > Shelterwood
15) Click on [Use Editor] at the bottom of the window
16) Click on the [Proceed] button
17) Enter the following parameters (thinBTA year, resid, cuteff, min DBH, max DBH, minht, maxht)
    - thinBTA 2029 15. 1 6. 999 0 999
    - thinBTA 2039 15. 1 6. 999 0 999
    - thinBTA 2049 15. 1 6. 999 0 999
    - thinBTA 2059 15. 1 6. 999 0 999



18) Click the [OK] button
19) Close the <Management Actions> window
20) Highlight the "ECON Parameters & Reports" keyword in the <Simulation file contents> window
21) Select [Edit Selection] in the "Edit Simulation" section.
22) Enter the parameters
    - SEV computation options: Compute SEV
    - Year/Cycle to begin 5
    - Leave default values for the remaining items
23) Click the [Ok] button
24) Click on the [Run Simulation] button.
25) Name the keyword file Econ2-2.key.
26) Click the [Save] button.
27) Click the [Run] button.

FVS Summary Statistics Table Questions

In what year does SDI reach its maximum? _____

In what year does the stand reach max culmination of accretion? _____

In what year does the stand reach max merchantable BDFT? _____

ECON Summary Table Questions

In what year is SEV is the highest? _____

In what year is PNV the highest? _____

What are the following values in this year? What does that value tell you?

IRR: _____

B/C Ratio: _____

RRR: _____

How much merchantable BDFT was harvested in this year? _____

Why do you think PNV and SEV have different years for their respective maximum values? _____

_____

You should now take a moment to note the difference between PNV and SEV. Both provide discounted values to the present so that comparisons can be made in management practices. There are, however, differences between the two.

PNV takes all cash flows (costs/revenues) and discounts them to the present so that you can compare "apples to apples". This is important because if you are trying to compare net revenues of harvests that occur at different points in the future, you need to have a comparable baseline with which to make the comparison. In this case we discount to the present.

SEV, on the other hand, takes into account the value of the lands ability to produce revenue (in the form of future tree growth) over time. SEV is the economic value of bare land for timber production. Another way to look SEV is as the PNV of a rotation repeated in perpetuity. This means there are a couple of assumptions, namely that the stand will have the same rotation length, management plan, and costs over time.

END of Exercise 2-2

2-3 Value of forest and Value of Trees

Our next question is: When should an existing stand be replaced with a future prescription? To answer this question we first need a known SEV for a desired management prescription (in perpetuity). For simplicity, we will take the maximum SEV from the previous exercise. At this point we know what management action we desire, the length of the rotation into perpetuity, and the bare land value (SEV) associated with this plan.

Now we will determine the best time to start the rotation. This is called the "Value of Forest", the economically efficient time to convert the existing stand to the desired future repeating management prescription. "Value of Forest" is the PNV plus the discounted known SEV for the future prescription.

We will also consider the question: What is the value of the standing trees? We can think of this as the estimated value of "immature" trees separate from the land in each cycle. This is called the "Value of Trees", the PNV of cash flows from managing the existing stand assuming replacement of the existing stand by a perpetually repeating management prescription represented by a known SEV. Or, more simply, "Value of Trees" is the "Value of Forest" less SEV.

"Value of Trees" may be important to land managers if they are considering land exchanges or they are interested in valuing damaged timber, say from a fire, for example. This value depends on the planned or expected harvest year when considering the value today.

We will begin the follow exercise by adding the maximum SEV to the previous example.

1) Make sure that Econ2-2.key is the open simulation file. If not, click on File > Open, and open the keyword file.
2) Highlight the "ECON Parameters & Reports" keyword in the <Simulation file contents> window
3) Select [Edit Selection] in the "Edit Simulation" section.
4) Enter the parameters
    - SEV computation options: Do not compute SEV
    - Enter a known SEV to compute… 420
    - Leave default values for the remaining items
5) Click the [Ok] button
6) Click on the [Run Simulation] button.
7) Name the keyword file Econ2-3.key.
8) Click the [Save] button.
9) Click the [Run] button.

ECON Summary Table Questions

In what year is "Value of Forest" the highest? _____

In what year is "Value of Trees" the highest? _____

How much merchantable BDFT was harvested in this year? _____

How do "Value of Forest" and "Value of Trees" help your future decisions? _____

END of Exercise 2-3

SESSION 3: UNEVEN-AGED MANAGEMENT

Like we discussed in Session's 1 and 2, the ECON model is an effective tool when trying to dynamically value management prescriptions. This is especially true when looking at when is the best time to harvest. So far, we have addressed this question using only even-aged management. Now we will show how the ECON model can determine value using uneven-aged management.

Session 3 will address two types of uneven-aged management: individual tree selection and group selection. Each of these management actions have unique styles and may require various keywords to complete the harvest. These methods are addressed in the Regional training guides and there are numerous exercises to help users better understand the techniques required to properly execute uneven-aged management in FVS. We will expand on those examples below by adding economic parameters and evaluating the various outcomes.

3-1 Uneven-aged Management: Individual tree selection with Thin to Q-Factor

In this section, we will look at how to simulate a periodic individual tree selection management action plan using economic measures. We will do this using the Thin to Q-Factor management action. Thin to Q-Factor represents uneven-aged management by approximating a reverse-J diameter distribution.

Thin to Q-Factor allows users to select a residual density target within pre-determined diameter classes specified by basal area per acre, trees per acre, or stand density index. FVS does this using a Q-Factor, *a value that, when multiplied by the desired number of trees in a diameter class, gives the desired number of trees in the adjacent class of smaller diameter trees*.

The following exercise will simulate a Thin to Q-Factor management action in 2019. We will set the target residual density to 60 sqft basal area and use a Q-Factor of 1.3. Next, we will try to find an economically efficient prescription for perpetually maintaining our Thin to Q-factor condition. This will be accomplished by using the Pretend keyword to determine what year the maximum SEV occurs.

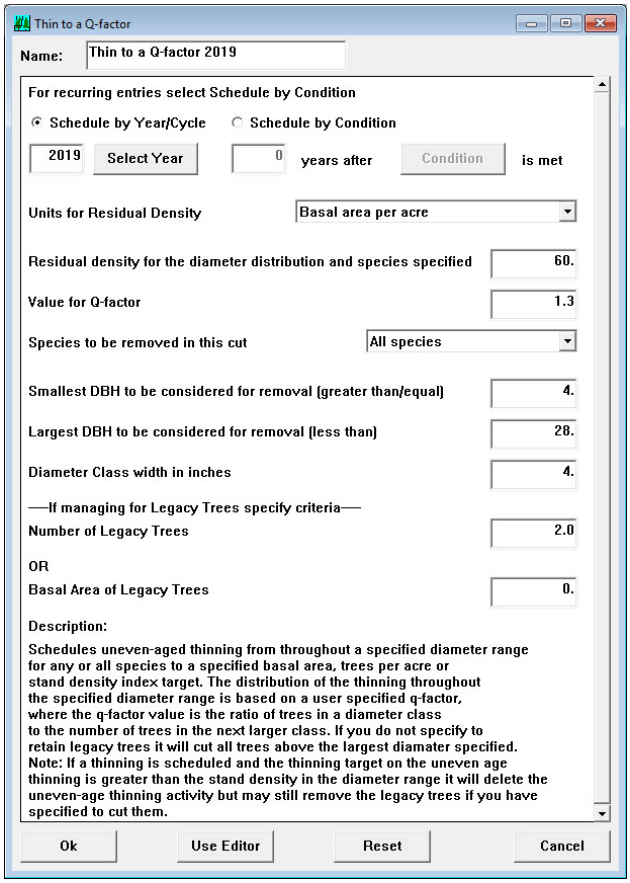
We will also explore using the Editor function to facilitate inputting multiple harvest revenue/costs. This will not only save time, it will allow you to better manage your monetary values by placing them all in one window. It is important to note, however, that proper spacing will be required to ensure the data are read in correctly.

1) Make sure that no previous simulation is in memory. The title bar should say *new file* if the memory is clear. If a previous simulation is in memory, click File > New.
2) Click on the [Select Stands] button.
3) Select the following stand: Regional Training / Variant=SO_R5 / 0509544322110.
4) At the bottom left corner, click the [Add 1 Stand] button.
5) Close the <Select Simulation Stands> window.
6) Click on the [Set Time Scale] button.
7) Set the time scale for a 100-year projection starting in 2019, i.e., 2019 through 2119.
8) Click the [OK] button.

Enter the harvest

9) Click on the [Select Management] button.
10) Select Regeneration Methods: Uneven-aged > Thin to a Q-Factor
11) Click on the radio button to the left of “Schedule by Condition”.
12) Click on the [Condition] button
13) Change the Condition library to “Periodically starting in year”
14) Set the Beginning year to 2019
15) Change the “Years before condition can be tested after being found true:” to 0
16) Click the [Ok] button.
17) Enter the parameters for the management action:
    - Change name to “Thin to a Q-factor 2019”
    - Units for residual density — Basal Area per acre
    - Residual Density — 60
    - Value for Q-Factor — 1.3
    - Species to be removed in this cut — All

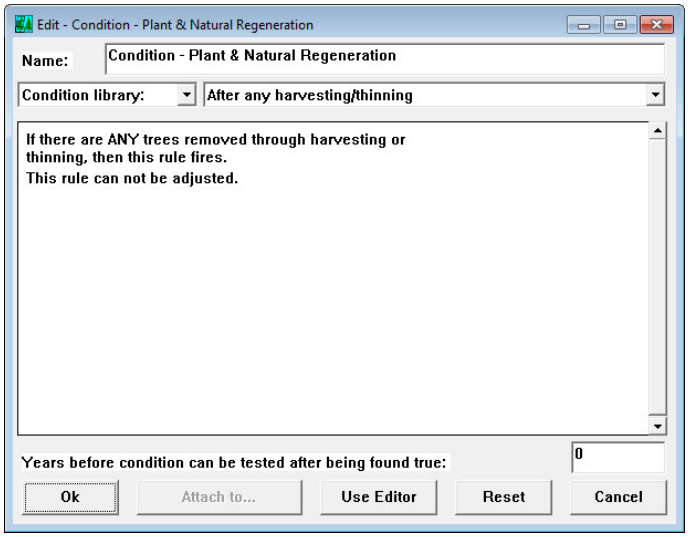
- Smallest DBH for removal 4.0
- Largest DBH for this removal 28
- Diameter class width 4.0
- Number of Legacy Trees 2.0



18) Click the [OK] button

Enter planting

19) Select Planting & Natural Regeneration > Plant/Natural with Partial Estab Model
20) Turn sprouting off by clicking the Sprouting radio button next to “Off”
21) Make sure the radio button next to “Schedule by Condition” is selected in the Date of disturbance section.
22) Click on the [Condition] button
23) Change Condition Library to “After any harvesting/thinning”
24) Years before condition can be tested after being found true 0



25) Click [OK]
26) Change the Planting/Natural done to "0" year(s) after the date of disturbance.
27) Enter the parameters for the first species:
    a. Type — Natural
    b. Species — Ponderosa/Jeffrey pine
    c. Trees/acre — 100
    d. Percent survival — 100
    e. Shade code — Uniform distribution
    f. Leave all other fields set to the default values
28) Enter the parameters for the second species:
    g. Type — Natural
    h. Species — Incense-cedar
    i. Trees/acre — 50
    j. Percent survival — 100
    k. Shade code — Uniform distribution
    l. Leave all other fields set to the default values
29) Enter the parameters for the third species:
    m. Type — Natural
    n. Species — White fir
    o. Trees/acre — 50
    p. Percent survival — 100
    q. Shade code — Uniform distribution
    r. Leave all other fields set to the default values
30) Click the [Ok] button
31) Close the <Management Actions> window

Add the economic parameters

32) Click on the [Select Outputs] button
33) Select **Economic Extension Reports > Select ECON Parameters & Reports**
34) Enter the parameters

- Change name to “ECON Parameters & Reports: 2019”
- Change the “Schedule by Year/Cycle” to “2019”
- Discount rate: 3
- SEV computation options Compute SEV
- Check the box for Activate “pretend” harvest
- Leave default values for the remaining items

35) Click on the [Ok] button
36) Close the <Model Outputs> window.

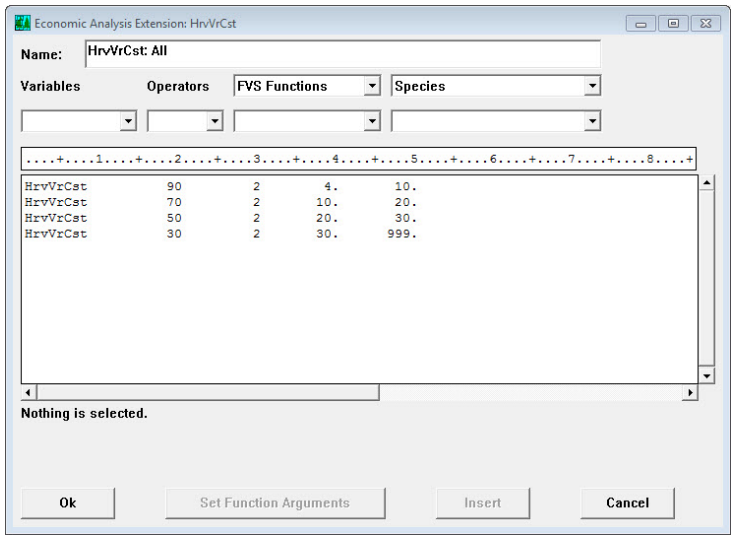
Add the cost functions

37) Click on the [Add Keywords] button
38) Under Extension, click on “Economic Analysis Extension”
39) Under Keyword, highlight “HrvFxCst”
40) Click the [Accept] button
41) Enter the parameters

- Change Name to “HrvFxCst: All”
- Current (today’s) per acre harvest cost 100
- Leave default values for the remaining items

42) Click the [Ok] button
43) Under Keyword, highlight “HrvVrCst”
44) Click the [Accept] button
45) Click on [Use Editor] at the bottom of the window
46) Click on the [Proceed] button
47) Enter the following parameters (“HrvVrCst”, cost, measure, smallest DBH, largest DBH).

- Change name to “HrvVrCst: All”
- HrvVrCst 90 2 4. 10.
- HrvVrCst 70 2 10. 20.
- HrvVrCst 50 2 20. 30.
- HrvVrCst 30 2 30. 999.

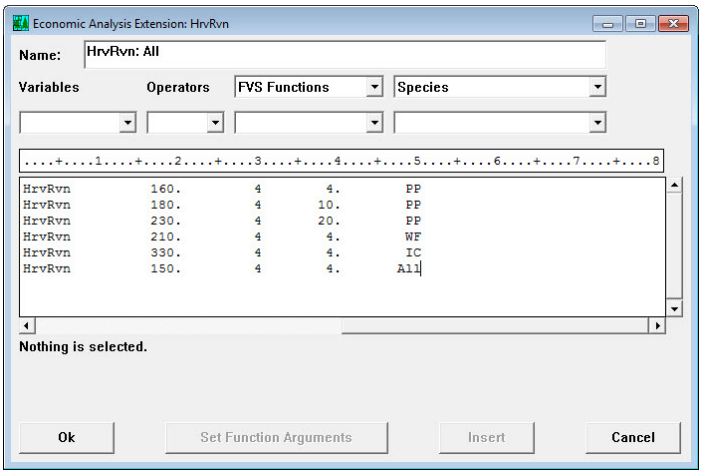


48) Click the [Ok] button

Add the revenue functions

49) Under Keyword, highlight ”HrvRvn”
50) Click the [Accept] button
51) Click on [Use Editor] at the bottom of the window
52) Click on the [Proceed] button
53) Enter the following parameters (HrvRvn, price, measure, smallest DBH, species)

- Change name to “HrvRvn: All”
- HrvRvn 160. 4 4. PP
- HrvRvn 180. 4 10. PP
- HrvRvn 230. 4 20. PP
- HrvRvn 210. 4 4. WF
- HrvRvn 330. 4 4. IC
- HrvRvn 150. 4 4. All



54) Click the [Ok] button

55) Close the <Use FVS Keywords> window
56) Click the [Select Outputs] button
57) Select Base FVS Extension > Build Standard Treelist and Cutlist.
58) Leave the default values.
59) Click the [Ok] button
60) Close the <Model Outputs> window.
61) Click on the [Select Post Processors] button.
62) Add the "Main Output File" post processor.
63) Click the [Include] button
64) Add the "Stand and Stock Tables" post processor.
65) Click the [Include] button
66) Close the <Select Post Processors> window.
67) Click on the [Run Simulation] button.
68) Name the keyword file Econ3-1.key.
69) Click the [Save] button.
70) Click the [Run] button.

Options Selected by Input Questions

What ECON Extension Keywords are present? _____

FVS Summary Statistics Table Questions

What is the before and after treatment BA in 2019? _____

Was this what you expected – why or why not? _____

What are the before and after treatment QMD's in 2019? _____

What is the QMD in 2029? _____

Did QMD go in the direction you thought – why or why not? _____

_____

ECON Summary Table Questions

What is the difference between 2019 and the remaining years? _____

_____

What year gives the largest value for Present Net Value (PNV)? _____

What year gives the largest value for Soil Expectation Value (SEV)? _____

Which year would you want to select as your rotation cycle and why? _____

_____

Why is the Internal Rate of Return (IRR) >50.0 for most years? _____

_____

What does Realizable Rate of Return (RRR) tell us? _____

_____

END of Exercise 3-1

3-2 Uneven-aged Management: Group selection using Thin Inventory Points

Next, we will look at how to simulate a periodic group tree selection management action plan using economic measures. We will do this using the Thin points management action. Thin points represents uneven-aged management by approximating a group selection using our plots to represent each group. Thin points management action cuts a proportion of a selected inventory point(s) to be used as group openings. It allows users to select a residual density target within pre-determined diameter classes specified by basal area per acre, trees per acre, or stand density index.

The following exercise will demonstrate a few new economic concepts based on group selection harvest of a stand with four plots (inventory points). First, we will implement a pre-commercial thinning in the current year where we remove all trees below 5" diameter. Then we will remove 25% of the stand over the course of four cycles using our inventory points. Each inventory point (four) will represent 25% of the stand to be removed.

Other important concepts will be addressed in this section. In order for the ECON model to differentiate between a pre-commercial thinning and a commercial harvest, a few economic costs have to be addressed. For example, you may have fixed costs associated with harvests and other fixed costs only associated with a pre-commercial thinning. FVS needs to be told to make sure those costs are only allocated to the proper management action. We will address this using the ECON Parameters & Reports.

1) Make sure that no previous simulation is in memory. The title bar should say *new file* if the memory is clear. If a previous simulation is in memory, click File > New.
2) Click on the [Select Stands] button.
3) Select the following stand: Regional Training / Variant=WC / 060305403030.
4) At the bottom left corner, click the [Add 1 Stand] button.
5) Close the <Select Simulation Stands> window.
6) Click on the [Set Time Scale] button.
7) Set the time scale for a 50-year projection starting in 2019, i.e., 2019 through 2069.
8) Click the [OK] button.

Enter the Thinning

9) Click on the [Select Management] button.
10) Select Thinning & Pruning Operations -> Thin throughout a diameter range
11) Change the parameters for the management action
    - Change name to "Thin from Below 2019"
    - Change the "Schedule by Year/Cycle" field to "2019"
    - Specify Residual Density -> Basal area 0
    - Largest DBH to be considered: 5
    - Leave default values for the remaining items
12) Click the [OK] button

Enter the Thin points management action

13) Select Thinning & Pruning Operations > Thin points
14) Enter the parameters for the Thin points management action:
    - Change name to "Thin Points – Point 1"

- Change the “Schedule by Year/Cycle” field to “2029”
- Point Number or Group 1
- Point thinning residual attribute 2
- Residual target for the attribute specified 0
- Leave default values for the remaining items

15) Click the [OK] button
16) Repeat the same Thin points management action steps for Points 2, 3, and 4. Remember to also increase the “Schedule by Year/Cycle” by 10 years each time, e.g. Thin point 2 = 2039, and so on.

Enter planting

17) Select Planting & Natural Regeneration > Plant/Natural with Partial Estab Model
18) Turn sprouting off by clicking the Sprouting radio button next to “Off”
19) Make sure the radio button next to “Schedule by Condition” is selected in the Date of disturbance section.
20) Click on the [Condition] button
21) Change Condition Library to “After “significant” harvesting/thinning”
22) Change the “Units of measure” to “Basal area”
23) Change “Percent removed” to 25
24) Leave default values for the remaining items
25) Click the [OK] button
26) Enter the parameters for the planted species:
    s. Type Natural
    t. Species Douglas-fir
    u. Trees/acre 150
    v. Percent survival 100
    w. Shade code Uniform distribution
    x. Leave all other fields set to the default values
27) Click the [Ok] button
28) Close the <Management Actions> window

Add the economic parameters

29) Click on the [Select Outputs] button
30) Select **Economic Extension Reports > Select ECON Parameters & Reports**
31) Enter the parameters
    - Change name to “ECON Parameters & Reports: 2019”
    - Change the “Schedule by Year/Cycle” to “2019”
    - Discount rate: 3
    - SEV computation options Compute SEV
    - Minimum volume to be considered commercial harvest 1000
    - Leave default values for the remaining items
32) Click on the [Ok] button
33) Close the <Model Outputs> window.

Add the cost functions

34) Click on the [Add Keywords] button
35) Under Extension, click on “Economic Analysis Extension”
36) Under keyword, highlight “PctFxCst”
37) Click the [Accept] button
38) Enter the parameters
    - Change the name to “PctFxCst: All”
    - Current (today’s) per acre pre-commercial thinning cost 300
    - Leave default values for the remaining items
39) Click the [OK] button
40) Under Keyword, highlight “HrvFxCst”
41) Click the [Accept] button
42) Enter the parameters
    - Change Name to “HrvFxCst: All”
    - Current (today’s) per acre harvest cost 100
    - Leave default values for the remaining items
43) Click the [Ok] button
44) Under Keyword, highlight “HrvVrCst”
45) Click the [Accept] button
46) Click on [Use Editor] at the bottom of the window
47) Click on the [Proceed] button
48) Enter the following parameters
    - Change name to “HrvVrCst: Cut & Transport”
    - Current (today’s) cost per unit-of-measure and tree DBH 200
    - Unit of measure 2
    - Leave default values for the remaining items
49) Click the [Ok] button

Add the revenue functions

50) Under Keyword, highlight “HrvRvn”
51) Click the [Accept] button
52) Click on [Use Editor] at the bottom of the window
53) Click on the [Proceed] button
54) Enter the following parameters (HrvRvn, price, measure, smallest DBH, species)
    - Change name to “HrvRvn: All”
    - HrvRvn 620. 4 5. DF
    - HrvRvn 670. 4 8. DF
    - HrvRvn 700. 4 12. DF
    - HrvRvn 480. 4 5. WH
    - HrvRvn 505. 4 8. WH
    - HrvRvn 525. 4 12. WH
    - HrvRvn 1175. 4 5. RC

- HrvRvn 250. 4 5. All

55) Click the [Ok] button
56) Close the <Use FVS Keywords> window
57) Click the [Select Outputs] button
58) Select Base FVS Extension > Build Standard Treelist and Cutlist.
59) Leave the default values
60) Click the [Ok] button
61) Close the <Model Outputs> window
62) Click on the [Select Post Processors] button.
63) Add the "Main Output File" post processor.
64) Click the [Include] button
65) Add the "Stand and Stock Tables" post processor.
66) Click the [Include] button
67) Close the <Select Post Processors> window.
68) Click on the [Run Simulation] button.
69) Name the keyword file Econ3-2.key.
70) Click the [Save] button.
71) Click the [Run] button.

Options Selected by Input Questions

What ECON Extension Keywords are present? _____

What Keyword sets the boundary (in BFT) between pre-commercial and commercial harvests? _____

FVS Summary Statistics Table Questions

What is the before and after treatment BA _____ & QMD _____ in 2019?

Was there any merchantable BDFT removed in 2019 – where else could you look to verify? _____
_____

Why do you think the BA's and QMD's are going down following each harvest over time? _____
_____

ECON Summary Table Questions

Why is the merchantable BDFT in the ECON Summary Table different than the merchantable BDFT in the Summary Table? _____

_____

In what year does the ECON analysis start? _____

For 2029, show how the discounted cost and revenue were derived from the undiscounted cost and revenue? _____

_____

Why do the successive years contain the previous year's cost and revenue values? _____
_____

_____

Using the information above, show how at least one other year's discounted costs and revenues were derived? _____

_____

How is the Present Net Value calculated (maybe helpful to derive one or two PNV's)? _____

_____

_____

Show how the Soil Expectation Value is derived (again, deriving a couple may be helpful)? _____

_____

_____

Describe the difference between using the Pretend Keyword (ex 3-1) and not using the Pretend Keyword (ex 3-2). _____

_____

_____

END of Exercise 3-2