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Analysts Guide to FEEMA for Financial Analysis of Ecosystem Management Activities

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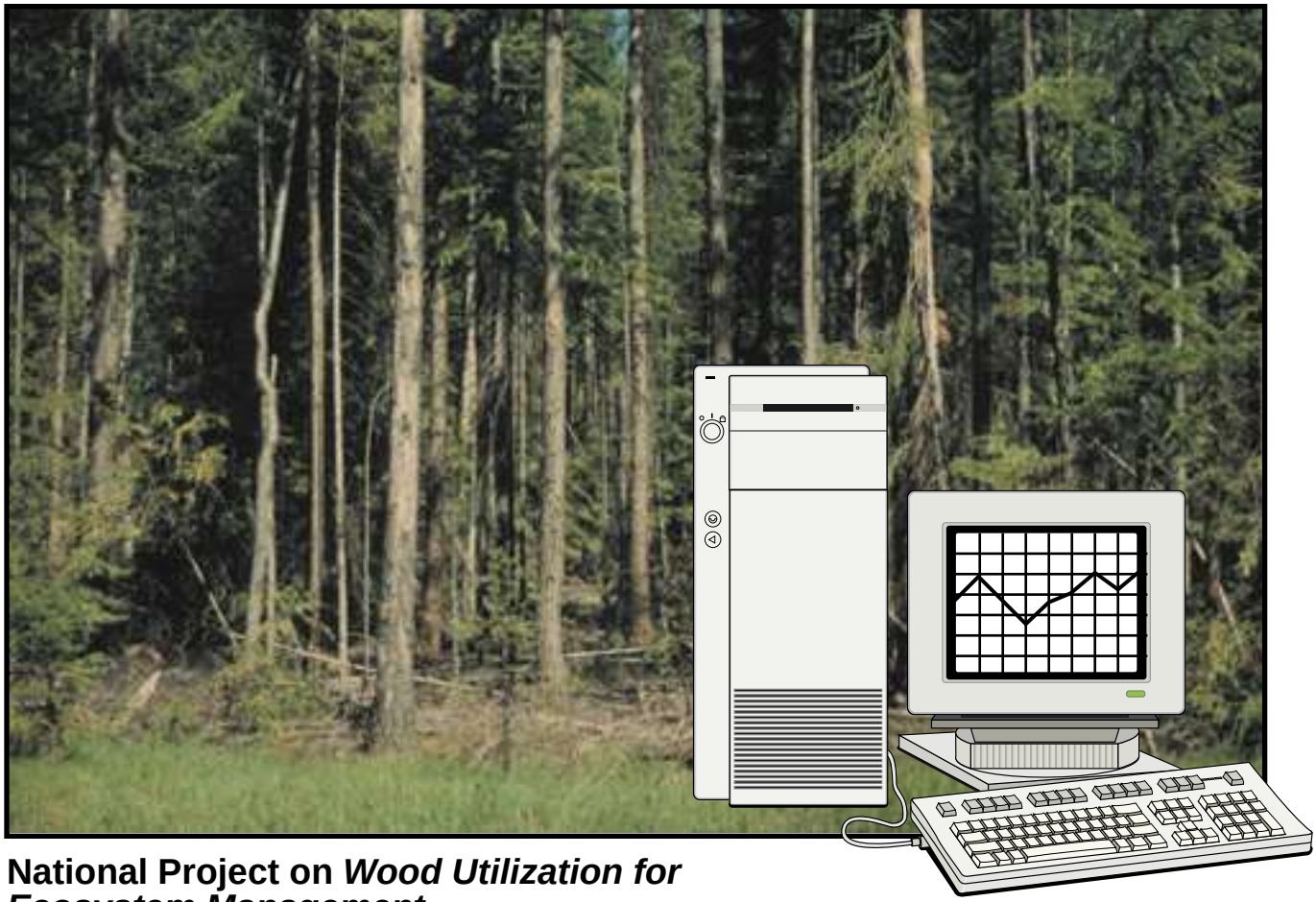

National Project on *Wood Utilization for Ecosystem Management*

Abstract

This report describes strategies for using the Financial Evaluation of Ecosystem Management Activities (FEEMA) software. This program was developed as a tool for assessing the financial viability of management activities for removing small trees for manufacture into wood products. Combinations of tree stands, management activities, and contractual requirements can be ranked along a continuum from actions that are unlikely to pay for themselves under any economic conditions to those that are likely to cover their implementation costs. The program can be used early in the planning process to obtain information on the potential net value of alternative strategies or later to assess the financial feasibility of a tentative plan. This report includes information on data input files, validation and interpretation of analysis results, and flexibility of the program.

Keywords: ecosystem management, economic evaluation, stand management

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Introduction

The FEEMA software was developed to assess the financial viability of management activities for removing small trees for manufacture of wood products. The analysis determines whether a particular activity in a given stand might pay for itself, from the perspective of a potential purchaser. Through assessing a series of stands and activities, the user can rank combinations of stands, activities, and contractual requirements along a continuum from actions that are unlikely to pay for themselves under any economic conditions to those that are likely to cover their implementation costs. When FEEMA indicates that a harvest activity will not pay for itself, options might include (1) leaving those stands as they are, (2) combining those stands with others that have enough net value to attract potential buyers, (3) modifying the activity or contractual requirements to increase the net value, or (4) funding the activity as a stand improvement rather than a timber sale.

The FEEMA software is intended for use early in the planning or analysis process, well before preparation of specific timber sales. It is meant to evaluate a set of representative stands to determine how various market conditions, mill types, logging systems, and harvesting requirements affect potential costs and revenues from the viewpoint of a prospective buyer. Information gained from this analysis allows the user to better judge which activities are likely to work in specific stands before initiating the sale planning process. The Help tool in FEEMA provides technical details on how to set up a project and run the model. A tutorial provides a sample analysis to familiarize the user with the program's features.

The purpose of this report is to discuss strategies for using FEEMA to address relevant questions, the data requirements and sources, and limitations for using the model and interpreting results. The FEEMA software, this document, and related documents can be accessed from the Internet at http://www.fs.fed.us/pnw/data/feema.htm.

Analysis Strategy

There are at least two ways in which FEEMA can be used to develop a strategy for managing stands across a landscape. One way is for assessing the feasibility or financial implications of a proposed or tentative plan. Another way is to use the program early in the planning process to obtain information on the potential net value of alternative strategies. In either case, FEEMA can contribute useful information on activity options and tradeoffs between cost considerations and desired ecosystem conditions.

Another use of FEEMA might be to facilitate discussions with local mills and purchasers about the minimum log size and the volume of these logs that their systems can accommodate. Even though a mill may be able to process small-diameter logs, it may not be able to afford to process them in large quantity. Mills are designed for processing an average log diameter that is much larger than the minimum diameter. A high proportion of small logs can have a dramatic effect on manufacturing cost (Wagner and others 1998). Forest managers will have a better understanding of their stand management options if they understand how much it will cost to manufacture a particular size of log.

Another decision with significant cost implications is concerned with the requirements of logging systems. The FEEMA model can be used to explore the cost implications of different logging systems in regard to the size and volume of logs that they can handle.

Overview

The FEEMA analysis is a residual value approach. It is similar to the residual value appraisal process that had been used by the USDA Forest Service for timber sales prior to adoption of the current transactions evidence appraisal process. We used the residual value approach because it allowed us to explicitly consider the variables that affect the

value of timber in specific locations. These variables include species and size of harvested trees, mill or product options, volume and grade yield, product prices, harvesting and hauling costs, and other requirements of a timber harvest contract that cause a purchaser to incur costs. Other variables that affect bid prices for timber that are not considered in this approach include level of competition and expectations of future price changes.

The basic steps of the FEEMA analytical approach are as follows:

1. Trees are bucked into mill-length logs for user-specified types of products: manufactured products, such as lumber, veneer, and chips, or unprocessed logs.
2. If multiple product options are specified for a log, FEEMA allocates the log to the option with the highest net value per unit volume.
3. Product volume and grade recovery are estimated for each log from volume and grade recovery equations included in the program.
4. Gross value of each log is determined from user-specified prices and from estimated recovery by product grade (or log volume if the analysis is restricted to log pricing).
5. Manufacturing costs are estimated from manufacturing cost tables supplied with the program or provided by the user; these costs are subtracted from gross value to estimate net value at the mill (manufacturing costs are not considered in the case of log pricing).
6. Harvesting, hauling, and other user-supplied harvest-related costs are subtracted from net value at the mill to estimate net value of standing timber.
7. Results of analysis can be viewed in various ways and in various levels of detail.

Data Required for Model

Stand

The FEEMA software puts a value on only those trees that are selected for removal. Therefore, only data on cut trees are required. Trees not designated for cutting can be included in the data file as long as they are marked as no-cut trees. The minimum information required for each cut tree is species, diameter at breast height (DBH), total tree height, and expansion factor. The model will estimate missing data for tree height if there are at least three trees of that species with specified heights and the resulting height prediction equation passes some minimal test of reasonability. A sample of three trees is the absolute minimum for prediction, although a larger sample spread across the range of diameters is preferable. The program will fit a linear equation for predicting the total height of any trees of that species for which tree height is not available. If a linear equation does not seem appropriate, the user can estimate values for the missing tree height data and insert the predicted values into the file. For an evaluation of such equations, see Martin and Flewelling (in press). If some tree height data are missing, it may be desirable to include in the file trees not designated to be cut so that these stand data can be used to improve the tree height prediction equation.

FEEMA recognizes three sets of species codes, which are listed in the Help tool. Although any of these sets can be used, sets should not be mixed within a stand file. To fit the height estimation equation for missing data, the program uses only trees designated by the same species code; other trees of the same species designated by a different species code will be ignored. If species codes are mixed, the program could generate two or more separate height estimation equations for the same species.

The stand file includes a column for indicating dead trees. The value of recently (≤3 years) dead trees of some species can be assessed for some products. Dead trees for which there are no recovery equations can be priced only as logs.

Recovery

Volume recovery for products is based on mill recovery studies conducted by the USDA Forest Service, Pacific Northwest (PNW) Research Station. The most common volume recovery equations predict the volume of primary product per unit log volume, with log small-end diameter (SED) and taper as the independent variables. In some cases taper is not used, and in other cases the prediction is just the mean volume recovery from the recovery study. The Recovery tool in the program allows the user to view the volume recovery equations and provides a form for calculating recoveries for sample logs.

Grade recovery for products is based on the same set of PNW Research Station mill recovery studies. Equations predict the proportion of product in each specified grade category. One grade in each set of grade proportions is found by subtraction from 1 to ensure that the proportions will sum to 1. Equations that predict grade proportions generally use some form of SED. In some cases, grade proportions do not vary by diameter and mean values are used.

The PNW Research Station mill recovery studies were conducted over a period of three decades. Study methods, mill efficiencies, and the resource evolved during that time. In some cases, grade and volume recovery for a product and species are derived from different studies to provide the most relevant information for the situation under analysis. Since these studies are essentially independent data sets, any detailed comparisons of differences should be accepted

cautiously because differences will have confounded in them sources of variation that are not controlled between studies.

Product Price

Prices are required for all the products that are produced in a scenario. Some prices, but not all, are available in a quarterly report of production, prices, employment, and trade (Warren 1997). Prices based on this quarterly report will typically be for a period 9 or more months prior to publication of the report. Because FEEMA was specifically designed to address issues related to the feasibility of removing small-diameter trees, we are developing another set of prices that we believe are more appropriate than the quarterly report prices. Because wide widths are not produced from small trees, it is more appropriate to use grade prices that include only the narrower widths that are commonly produced from small logs. These prices will be made available on a periodic basis at the same Web site where the FEEMA software is located. Other sources of price data may need to be sought to use FEEMA for purposes that require up-to-the-minute accuracy in pricing or precision for specific parcels. FEEMA includes a tool, Veneer Prices, that can be used to convert prices ($/MSF) for 1/10- or 1/6-in. veneer to a 3/8-in. basis. (See Table 1 for metric conversion factors.)

Log Price

To price logs instead of manufactured products or to price both logs and products, the user must supply prices by log species and diameter. Because FEEMA was designed as a tool for the early planning stages of ecosystem management activities, it focuses on valuation of the small logs expected to be removed during those activities. Log grades are not used in FEEMA because there is little grade differentiation for small logs. Log diameter and taper (in volume recovery equations) and log diameter (in grade recovery equations) capture most of the information related to value that can be gleaned from the data available at this stage of analysis.

For log pricing, FEEMA supplies a table of prices for each log on a cubic foot basis. Since it is customary to price logs by diameter class, there is no interpolation between the user-specified diameter price points. This approach is perhaps most appropriate when the log market is well established and log prices can be obtained directly from relevant mills in the area. If logs are priced per ton, the $/ton-to-$/CCF tool can be used to convert these prices to prices per hundred cubic feet (CCF). The Log Volume tool menu can be used to compute log volumes in cubic feet from log diameter and length measurements.

Table 1—Metric conversion factors

inch/pound unit	metric unit
1 inch (in.)	2.54 centimeter (cm)
1 foot (ft)	0.305 meter (m)
1 square foot (ft^2)[a]	0.093 square meter (m^2)
1 cubic foot (ft^3)	0.028 cubic meter (m^3)
1 ton	0.907 tonne

[a]In the text, MSF is thousand square feet.

Manufacturing Cost

Manufacturing cost data for particular mills or companies are generally regarded as proprietary. Preliminary generalized cost information that varies by diameter for stud mills and random-length dimension mills is derived from data developed by Wagner and others (1998). The costs have been developed from three perspectives. The first perspective uses a 25% return on invested capital, which represents a full normal return on risky investments. The second perspective uses a 10% return on invested capital, which represents what might be regarded as a minimum return expected from investments in an ongoing concern. The third perspective includes a 0% return in invested capital. This perspective includes only the variable operating costs and represents the costs that a mill would have to cover to break even in the short run. Mills might resort to this type of cost setting in a crisis situation; they could not expect to stay in business indefinitely on this basis because they could not afford to maintain their plant and equipment. The cost table included in the sample problem is based on a 10% return on investment. It lacks manufacturing costs for some products. The user can use that table or data from other sources. For example, local mills may be willing to provide cost relationships for local conditions. Manufacturing costs are estimated on a log by log basis. The value for a particular log is interpolated from the diameter cost points to obtain a cost for the specific log diameter.

Harvesting Cost

FEEMA is very flexible in its treatment of harvesting costs: options range from entering a single number for all harvesting-related costs to developing tables of harvesting costs that can be accessed as needed. A useful strategy to consider is to develop sets of tables for stump-to-truck costs for relevant harvesting systems that vary by tree size and amount harvested per acre. Tables constructed in this way can be used for many scenarios. Tree size can be expressed by average diameter or by average volume per tree. Amount harvested per acre can be expressed by hundred cubic feet per acre or number of trees per acre. Thus, harvesting can be expressed in four combinations of ways. It is not necessary to use this detailed approach, however. A single cost per acre or hundred cubic feet can be entered for the harvesting cost for a scenario. The Interpolation tool shows how FEEMA interpolates the values in the logging cost table to obtain the cost for a specific combination of tree size and amount harvested.

Other harvest-related costs such as specified roads tend to be more case-specific. These costs are entered on a case-by-case basis.

Regardless of which approach is used to enter logging costs, the cost data used should be relevant for harvesting the stand in the context of a typical timber sale. For example, it would be misleading to evaluate the harvesting of a single stand by itself if that is not the way timber sales are typically conducted. A more meaningful approach would be to use costs that reflect typical unit sizes, equipment configurations, and portions of fixed costs that relate a typical size of sale.

In an approach for estimating logging costs described by Lee and Johnson (1996), costs are developed per thousand board feet, but this approach could be adapted to develop costs per ton or hundred cubic feet by using the $/ton-to-$/CCF tool.

Log Allocation

The log allocation table can be used to specify available product options for a scenario. First, the user decides whether to price products or logs or some combination of products and logs. Next, the user decides whether to force the model to allocate all logs of a certain species and SED to a particular type of mill or to allow the model to allocate the logs to types of mills based on highest net value per cubic foot. The user must also decide whether to force all logs below some diameter to be made into chips rather than a solid-wood product. Log allocation choices should reflect production opportunities that can realistically occur in the user's area. For example, if there is no market for pulpwood in the area, it may be desirable to exclude chip logs as a product option.

Logs are allocated by SED and five species groups as defined by FEEMA. The final product mix can be affected by prices and manufacturing costs as well as physical log characteristics. If prices and manufacturing costs are not carefully chosen, the results may be unrealistic if the model is allowed to allocate logs to the highest net value.

If data for the log allocation table are improperly specified, FEEMA will fail to place value on some trees. FEEMA permits butt logs of standard lengths only. These lengths are 16.5 or 20.5 ft for lumber logs and unprocessed logs, 17.0 ft for veneer logs, 8.25 ft for stud logs, and 8.0 ft for pulp logs. Suppose the user specifies that all 3- to 5-in. SED logs be allocated to chips and all 5-in. SED logs be allocated to random-length dimension lumber. Although it would appear that all logs would be allocated to one product or the other, a 6-in.-DBH tree would not qualify for either product. When the FEEMA bucking routine measures this tree at 16.5 or 20.5 ft from the stump (the specified length for random-length lumber logs) and finds that the SED < 5 in., the log is rejected for lumber. The program then starts over and measures the tree 8 ft from the stump. When it finds that the SED > 5 in., the log is rejected for chips as well. The source of the problem is the taper between 8 ft and 16.5 or 20.5 ft. The user must keep in mind that the standard lengths are different for different products. This problem will not occur if the user specifies an overlap in SED that takes taper into account. The problem primarily occurs with butt logs where the differences between standard lengths for various products are the greatest, but it can also occur with upper logs. For upper logs, FEEMA considers logs as short as 8.5 ft for lumber and logs as short as 2 ft for pulp on the notion that in reality such logs would remain attached to the previous log even though the model treats them as separate short logs. Note that while these lengths are used to account for the location on the bole during bucking, scaling lengths are used in volume calculations. The scaling lengths are 16 or 20 ft for lumber, 17 ft for veneer, and 8 ft for studs and chips.

Results of Analysis

Validation

Once a scenario has been calculated it should be validated by determining whether the results are reasonable and checking whether unexpected results are comprehensible. The first place to check is the Run Log, which is accessed through the scenario option in the project window, or the View Results tool, which is accessed through the scenario cell. The Run Log tells the user whether values were calculated for missing tree height data and whether calculations for the scenario were successfully completed. The Run Log may also provide information about potential errors such as missing files.

If the Run Log lists a tree as having no value, the user should verify the reason for that and correct any errors or omissions in input files. Non-FEEMA species that are included in the stand file will appear here. Nothing can be done with these trees because there are no tree profile equations for them. They can be valued only by assigning them a FEEMA species code that will result in them being valued with the data for that species. Another possible reason for having trees with no value assigned to them is that there was no price file or prices were zero for any products that the logs from that tree could have been assigned to. A third possibility is that the log allocation was such that the butt log could not be assigned to any product and the whole tree is shown as a top log in the Log Detail file. This situation occurs when logs do not qualify for any product because the tree is too small. It can also occur when there is no overlap of the maximum SED for a "short" product (stud lumber or chips) and the minimum SED for a "long" product (dimension lumber or veneer), as described in the section on log allocation.

The program allows results to be viewed in many different ways, which can help the user to validate the results. The user can check data on individual logs in the Log Detail file to verify calculations and to learn why the results vary. This file is a Microsoft (Redmond, Washington) Excel spreadsheet. If it is opened as a spreadsheet (rather than viewed in FEEMA), the user can do calculations that may be helpful for checking some detail in the results. Once the user gains confidence in the model and in the ability to set up an analysis, there should be little need or interest in the Log Detail file for most analyses.

Although FEEMA was not designed as an appraisal tool for a sale consisting of multiple stands, the Sum Stands tool can be used to combine the results of several stands to approximate the net return for those combined stands.

Interpretation

Too many variables with unknown statistical properties are combined in an analysis like this to provide probability statements about the results. Some things, however, can be said about the relative reliability of different kinds of comparisons. The strongest comparisons of value are for different sizes of trees of the same species from the same stand allocated to the same products. For these trees, estimation errors will cancel out for the most part, except for those errors related to size differences. At the other extreme are comparisons that involve different species from different stands processed into different products. In such comparisons, estimation errors will include those involved with harvesting cost relationships, species differences, and mill characteristics and practices. Comparisons that include multiple sources of confounding variation should be accepted cautiously. For example, we suspect that the differences in recovery of random-length dimension lumber between common technology and advanced technology relate in part to differences in the character of the logs that were processed in the PNW mill recovery studies. We are conducting further analysis to see if some modification of those recovery equations is appropriate.

Model Architecture

Creative analysts often want software to do things that the software was not specifically intended to do. The following information on model architecture is provided to help the user sort out creative uses that are feasible or practical from those that are likely to lead to frustration or perhaps erroneous results.

- Price and cost data—All prices and costs related to logs are in dollars per hundred cubic feet (CCF), and all prices and costs related to products are in dollars per unit of product. Product units are those typically used in marketing the product, that is, thousand board feet (MBF) for lumber, thousand square feet (MSF) 3/8-in. basis for veneer, and bone dry units (BDU) for chips.
- Product volume and grade recovery—Information on product volume and grade recovery is imbedded in the model. This information can be changed without recompiling the model because it is incorporated in the Logmng.xls file, which can be edited by the user. This is a complex file, and it should not be changed without the commitment to carefully verify that the changed version is performing correctly.
- Species recovery—Tree profile equations are included for all FEEMA species, but not all FEEMA species have recovery data. The "miscellaneous" FEEMA species for which no recovery equations are included can be valued only as logs. FEEMA cannot deal with any other species unless profile equations are provided, which would require source code modifications and additions to the dynamic linked library that contains profile equations.
- Species groups—The grouping of species into species groups for estimating recovery and value is hardwired and cannot be changed by the user.
- Market file data—All market file data can be entered and edited by the user. Some data are provided in files accompanying the program, but they must be evaluated for their applicability to a specific situation. The market input files are intended to be very flexible in accommodating different data. For example, there is a limit on the number of diameter classes that can be used for log prices or manufacturing costs, but the intervals are unrestricted. The harvesting cost table can use either of two definitions for tree size and concentration per acre for a total of four different ways to enter costs. The number of columns and rows is limited, but the intervals are unrestricted. Precision will be increased if the user employs unequal intervals that make the cost differences of similar magnitude rather than equalize the intervals of the independent variables. The number of log-diameter intervals for reporting results is limited, but the intervals are unrestricted.

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