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Chapter 10 - Evaluating Economic Efficiency

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Evaluations of efficiency are one of the basic types of economic and social analysis and are an integral part of the planning process at the national, regional, and National Forest levels. Economic efficiency evaluations are required for project selection, functional planning, integrated planning, and budget preparation (FSM 1970.3).

Economic efficiency evaluations are essential for management guidelines and analyses of new or improved management technology.

With a range of applications and levels of detail, it is necessary to present concise instructions for making economic efficiency evaluations. This chapter includes instructions and illustrations for the major evaluation techniques.

Economic efficiency evaluations can be presented in two different modes: 1) as part of, or a supplement to, a planning document with objectives, production processes, and perhaps costs and prices, in other parts of the document; and 2) as a separate document with complete information supplied in one place.

11 - Measures

Measures of economic efficiency present problems in terminology and in measurement with which the analyst should be familiar.

11.1 - Use of Terms Economic Efficiency, Cost Efficiency, and Cost Effectiveness

Economic efficiency is a term used to describe how well inputs are used to achieve outputs when all inputs (activities) and all outputs (including market and non-market) are identified and valued. All costs and all benefits to society are included; amounts of each output are not preestablished but are produced in amounts that maximize net public benefits.

Because some outputs and effects cannot be adequately valued in many planning situations and must be handled using constraints in developing planning alternatives, true measures of economic efficiency often cannot be obtained. To call attention to such circumstances, use the term "cost efficiency" to describe an analysis in which some outputs are produced according to their value and others are produced to meet specific levels of public demand and are achieved in the least cost manner.

Cost effectiveness measures how well inputs (activities) in a production process are used to produce a fixed set of outputs. Cost effectiveness analysis is an appropriate form of efficiency analysis under certain conditions. These are:

1. The decision to do the project has been made or is determined to be appropriate in a separate analysis.

2. The benefit stream from all options considered does not vary significantly.

A cost effective analysis approach requires the amount of all relevant outputs and effects to be pre-established. Analysis computes the costs of each alternative set of activities and determines the least cost method.

The kind of analysis that is appropriate depends on the information needed for decisionmaking. Use cost-effectiveness analysis if analysis of benefits is not necessary. This may occur if the analysis of specific activities or projects can be tiered to an earlier plan or programmatic analysis. Further cost improvement of individual projects processes may be accomplished utilizing the technique of value engineering (or value analysis).

Programmatic analyses consider only general locations and average site conditions and individual project information may deviate from these data substantially. If project yield or other benefits deviate markedly or fall outside the range of conditions included in the programmatic analysis, a full cost-efficiency analysis of the project may be required.

11.2 - Measures to Rank Alternatives

The preferred measure to rank alternatives is present net value (sec. 15.1). The following principles and guidelines apply to the use of present net value:

1. In general, when comparing alternatives for managing the same resources in long-term analysis periods, present net values are more appropriate measures of economic efficiency than benefit-cost ratios or internal rate-of-return. Because many analysis in other agencies and the private sector are more familiar with the benefit cost ratio and internal rate-of-return criteria it may also be useful to display these criteria. Many computer programs calculate all three criteria to facilitate such displays.

2. In allocating limited budget funds in short-term analysis periods to implement long-term plans, present net values may not provide unambiguous ranking because programs or projects may differ greatly in scale. In such comparisons, benefit-cost ratios or internal rates-of-return may be more useful (sec. 15.2).

Benefit-cost ratios or internal rate-of-return can also be used in comparing alternative non-resource projects for their cost efficiency. They indicate the economic efficiency in terms of the growth of capital used in investment and operating funds.

Total costs and unit costs are appropriate evaluation criteria in cost effectiveness analysis. Unit costs are the preferred measure when difference exists in the quantity of output flows between alternatives analyzed.

Evaluations of economic efficiency must recognize that it is not possible to express all aspects as quantified measures. Some outputs and inputs cannot be valued. In particular, it may be appropriate to include the possibility of uncertain future developments (FSM 1970.6). In some

cases, it may be useful to employ a separate measure that would rank alternatives subjectively according to the probability of event occurrence or according to the flexibility of response to unforeseen occurrences.

12 - Identifying Inputs, Outputs, and Production Processes

Economic analyses must identify inputs, outputs, and production processes. Inputs are factors of production (land, trees, other raw materials, management, labor); outputs result from production (timber harvested, sediment created, wildlife habitat developed or destroyed). Production processes describe how inputs are transformed into outputs (for example, acre X, when logged, produces 50 MBF net, 400 tons of slash, 3 tons of sediment, and so on).

12.1 - Objectives and Measures for Attainment

Either within a planning document or in a separate efficiency evaluation document, include the objectives of the project and a description of how they are to be attained. The objective statement should include indications of extent, measures of attainment standard, and a time frame (if other than that for the proposed plan or project).

12.2 - Uncertainty in Production Processes

Analysts express inputs and outputs in the production process as estimated average quantities. Uncertainty exists about these quantities due to such factors as the occurrence of fires, insect and disease outbreaks, and unfavorable weather over a production cycle. This is also true for prices and costs due to various economic conditions, changes in technology, and inflation and deflation. Analysts and decisionmakers cannot be certain of what conditions will prevail in the future.

The correct approach in dealing with this uncertainty is to conduct the economic efficiency analysis using best estimates of all inputs, outputs, prices, and costs. These average values or expected outcomes should be the best currently available for analysis, even though they will not be the ones that actually occur in the future.

The basic recommendation for handling uncertainty is to avoid direct adjustments of values, but instead present some quantitative indication of the range of expected variation in values. Understating benefits, inflating costs, or using an adjusted discount rate are not appropriate because these adjustments conceal the problem of uncertainty (sec. 15.51).

If a great deal of uncertainty exists about the estimates, the analysis can be repeated using other values, a type of sensitivity analysis (sec. 16.1). Simulation techniques have been useful in this regard. An alternative procedure is to calculate a breakeven value (sec. 16.5) for those values for which a great deal of uncertainty exists.

These procedures provide decisionmakers with a best estimate based upon economic efficiency analysis. A statement of how the results would vary as assumptions change should strengthen the basis for choices.

12.3 - Standards for Time Periods

Evaluations should present quantitative schedules of input and output flows expected over time or refer to such schedules in associated documents. The following applies:

1. Time Horizon and Periods. Schedules of inputs (costs) and outputs (beneficial or adverse) should include the significant input and output flows to a common time horizon. The number and length of time periods from the present to the horizon should encompass significant changes in flows of costs and benefits. FSM 1910, 1920, and 1930 specify time periods for various types of Forest Service planning.

Where the length of production processes are unequal, adjust the time stream of costs and benefits to assure comparability, or include estimates of residual values. For example:

a. Use multiples of each prescription. If prescription A has a timeframe of 20 years and prescription B has a timeframe of 30 years, compare a multiple of 3 A's with a multiple of 2 B's, or a 60 year horizon.

OR

b. Assume all alternatives are repeated to infinity by discounting computation.

OR

c. Include a residual value for the land and other resources at the end of a common planning period. Planning systems that use linear programming, such as FORPLAN, often have this feature.

OR

d. Express all present net values as annual equivalent values.

2. Production Process Cycles. Production process cycles span the entire life cycle of the investment. They encompass the set of activities required to establish the vegetation or facilities; maintain the resources, including periodic replacement of major components as needed; recover periodic outputs; and perform cleanup and salvage; and prepare the site or land for another cycle at the end of the process. Activities to remove vegetation, debris, or facilities prior to the start of a cycle are costs of the previous cycle or of developing the land and other resources for production. Specific analyses may encompass all or part of a production cycle. The decision being considered will determine the portion of the production cycle included in the analysis.

12.4 - Standards for Inputs

1. Measure or estimate inputs at the level of detail significant to the type of planning or evaluation conducted. The detail for inputs included will also vary according to the evaluation objective.

2. For analyses of the most cost-efficient activities or their combinations, inputs often need to be specified as quantities of labor, equipment use, and supplies to determine the best combinations. At this level of detail, trends in costs of activities can be projected through trends in the real costs of inputs.

3. In schedules of inputs and outputs for long-range production processes, factor inputs (labor, materials, etc.) need not be specified individually. Combine them into activities or management practices with their collective costs. For project analyses, specify and analyze inputs to a higher level of detail, since site-specific detail is available. Include them as specific activity types, if costs are available, or as specific factors of production such as materials, equipment and labor.

4. Activities or management practices should be specific enough to permit estimation of costs by decision units (such as classes of land), if the cost or production differences significantly affect economic efficiency among decision units.

5. Include activities legally required to protect the environment or maintain land productivity and costs.

12.5 - Standards for Outputs

1. Identify and measure, or estimate, the primary outputs contributing to policy, program, plan or project objectives.

2. Identify and measure, or estimate, outputs jointly provided by the production process, but not controlled for, within the policy, program, plan or project objectives. These may be either positive or negative quantities and either desirable or undesirable products.

3. Measure changes in resource productivity as changes in the future flow of outputs.

4. If outputs are significantly different than the average in terms of quality such that higher or lower values should be assigned, identify and evaluate the magnitude of the difference.

13 - Analyzing Costs

Cost information has two general uses: planning, including long-term strategic plans, project evaluations, and annual budgets; and control, including fiscal control and performance

evaluation. Give consideration to all the uses of cost information when deciding the level of effort to expend in cost development and analyses.

13.1 - Costs of Forest Service Activities

13.11 - Costs to be Considered

In preparing an economic efficiency analysis, include all costs up through that stage of processing at which the benefits are valued or environmental effects are achieved. Consider expenditure costs (costs or inputs for which funds are paid) and it may be appropriate to consider costs of resources or inputs already owned and diverted from other uses.

1. Costs of activities required by Forest Service policy, in addition to the costs of activities necessary to produce controlled outputs. These activities include:

    a. Maintaining land productivity, protecting the environment, and assuring public safety.
    b. Protecting and efficiently maintaining resources, roads and other facilities. Specific standards for the most efficient level of road maintenance and fire protection are in FSM 7732.11 and FSM 3100, and FSM 5100 and FSH 5109.19 respectively.

2. Non-Forest Service costs of public agencies, private firms, and individuals, whether co-operators or users of outputs. Examples of these costs are:

    a. When costs are incurred under cooperative arrangements to increase output, include costs up through the processing stage when outputs are valued, such as ranchers' costs installing and maintaining cooperative range improvement treatments, or cooperative funds for brush disposal following timber harvest.

    b. When evaluating differences in logging, transport, and other access costs of forest users, all user costs do not need to be included unless differences in costs are incorporated into output values. Only the cost differences between the proposed and base alternatives, such as the cost savings to loggers and recreation users that result from building a road that reduces distance and traveling time are necessary.

13.12 - Standards for Costs

In valuing inputs:

1. Include all transaction costs, such as required shipping and installation fees.

2. Express costs as real dollar values. Using the appropriate base year, support real cost changes by studies of long-term cost trends (sec. 13.33).

3. Provide a similar degree of detail for resource and production process information. One criteria for recognizing resource classes (such as analysis areas) is identifying differences in treatment or access costs. If resource classes are distinguished in the analyses and differences in treatment and access costs exist among them, develop such differences even if methods are used informally. Analysts should consider if the usefulness of more detailed costs, such as by types of activities or by classes of resources, merits the time and expense of developing more detailed cost data.

13.2 - Fixed and Variable Costs

In analyzing costs, place emphasis on variable costs, which will differ among the alternatives being considered, and thus affect the decision process. Determining which costs are variable differs with short-term or long-term analyses.

13.21 - Distinguishing Variable Costs

Because the continued use, maintenance, replacement, and acquisition of capital assets are decisions of long-term planning, the maintenance of existing assets is a variable cost in long-term analyses. For project planning and analysis, the capital assets to be retained and maintained have been decided by the long-term plan. Thus, the same maintenance of existing assets that was a variable cost in long-term planning is a fixed management cost in project-level analyses.

13.22 - Use of Variable Costs in Analysis

Though both fixed and variable costs are real expenditures, generally only variable costs are needed for a decision to select from a lot of similar alternatives. However, it may be appropriate to document costs that are constant for each alternative in the analysis.

The costs that differ between alternatives in short-term analyses, such as in the selection of treatment methods or in prioritizing projects within a planning cycle, are the variable costs within the relevant range anticipated by the long-term plan.

13.3 - Development of Cost Information

In evaluating the production or management processes included in a project evaluation, the analyst must assign costs to each treatment or activity. These include costs of all specific inputs, such as labor, supplies, equipment, fuel, and other expenditures.

13.31 - Conducting Informal Cost Surveys

Even under favorable circumstances, use of average accounting data will not permit development of detailed cost data by method, resource class, size of tract, or other cost

influencing factors. The most common means of estimating such data, either average unit costs or relative cost factors, is in the form of informal surveys.

13.32 - Using Engineering Cost Estimates

The estimation of treatment costs can be made by estimating the necessary physical units of inputs and then multiplying this by the unit prices, developing the total cost for a treatment. This is a useful technique when heavy equipment is a predominant input. Often the machine productivity rates can be developed from records of equipment scheduling, and the machine costs can be developed from acquisition, fuel, maintenance, and downtime records. (This is the predominant method used in costing engineering projects).

13.33 - Analyzing Cost Trends

Because real values of outputs change over time, economic analyses should also determine whether or not costs have been changing, with all other factors remaining the same. If a trend has persisted, it should be quantified and used to estimate the real change over time.

Often the costs of treatments have increased in proportion to cost components, such as general labor rates of personal income, or to trends in equipment costs. Projections of these rates are available.

Analysts should be familiar with a number of real cost general indexes. Among them are average personal income estimates found in the RPA Assessment, and the index for the cost of government services found in the annual Economic Report of the President.

Statistical analyses of cost trends are complicated by frequent shifts in treatment methods used or average sites treated. A solution would be to average the trend in costs over one or more business cycles, beginning and ending at the same phase in the cycle.

13.4 - Costs in Partial Analysis

Generally, multiple-use planning methods consider all outputs simultaneously in evaluating alternatives. Partial analyses of producing individual outputs--such as timber, recreation, or range--are not necessary in normal planning procedures, but, in some circumstances, it may be necessary to separate the contribution of one or several outputs from the combined flows of costs and benefits of a multiple-use alternative. Legally required analyses, or special analyses to meet issues raised by outside interests, or administrative, or legislative review may be among these circumstances.

13.5 - Adjustments for Constant Dollar Values for a Base Year

Use real dollar values for a specific base year for costs and benefits in analyses. Real dollar values, unlike current values, are adjusted for inflation by stating values for each year evaluated

in terms of one base year. To adjust past costs and prices, generally use the GNP implicit price deflator as given in the most recent annual Economic Report of the President and published in the Department of Commerce's Survey of Current Business. These documents are available to the Regional Economist.

For specific cost and budget studies, use price indices for individual cost components, if available.

For regional plans and analyses and for National Forest Plans, use the base year in the most recent RPA assessment or as designated by the Chief.

Analyses should reflect that real price changes in some costs and benefits may occur because their price trends deviate from those of the general economy. Analysts should project expected real price changes, if significant, by output or cost category and by region of the U.S.

The following examples show how the GNP implicit price deflator is used to calculate real dollar values of data from various time periods. For adjusting values to a base year real dollar value, the general formula is:

$$\text{Real Dollar Value} = \frac{\text{Base Year Index Value}}{\text{Index Value for Year Converted}} \times \text{Dollar Value}$$

<u>Example 1</u> - Adjust a $100 cost occurring in 1976 to real dollar value in 1980 dollars.
Index value for Base Year (1980) = 85.7
Index value for Year Converted (1976) = 63.1
Dollar value = $100

$$\text{Real dollar value} = \frac{85.7}{63.1} \times \$100 = \$135.82$$

The value of a $100 cost occurring in 1976 is $135.82 in 1980 dollars.

<u>Example 2</u> - Convert a $100 cost occurring in first quarter 1985 to 1980 dollars.

Index value for Base Year (1980) = 85.7
Index value for Year Converted (1985 first quarter) = 110.2

$$\text{Real dollar value} = \frac{85.7}{110.2} \times \$100 = \$77.77$$

The value of a $100 cost that occurred in the first quarter of 1985 is $77.77 in 1980 dollars.

14 - Assessing Markets and Developing Output Values

Regional price determination studies (FSM 1970.42) should be made to determine output market clearing prices for market areas or subareas. In National Forest planning, market or submarket area prices should be used in analyzing projects or programs. National Forests may need to make additional analyses in preparation for National Forest Plans.

14.04 - Responsibility

Regional offices should coordinate use of output value information at National Forest levels, whether the values are regional or local values developed by special studies.

14.1 - Outputs to be Valued

Determine values only for outputs that are sold or potentially could be sold if the law or Forest Service policy permitted. There are four general situations applicable to estimating values of current and future Forest Service outputs:

1. Local active markets exist for the output as it is produced by the Forest Service.

2. Local active markets for the output do not exist but it is possible to estimate values from market values for the output at a further stage of production or transportation.

3. Local active markets do not exist for the output the Forest Service produces, but markets, even though perhaps weak, exist for similar outputs. This permits estimation of values through comparison appraisals that recognize differences in quality and access.

4. No relevant markets for either similar or further process outputs exist, but it is possible to input values by analytical techniques that rely on user preferential or actions.

5. No relevant markets for either similar or further processed outputs exist and it is impossible to impute values by analytical techniques that rely on user preferences or actions. This case includes outputs such as visual resources and threatened or endangered species.

Outputs may be valued if the first four situations (items 1, 2, 3, or 4) occur in Forest Service planning actions. Do not value outputs for market situation number 5.

Indicate in planning reports and documents that all unit values, especially future values, are only approximations of the worth of the outputs and their use is to assist in placing relative priorities on plan or project alternatives, along with numerous other criteria.

14.11 - Specific Outputs to be Valued

In determining which outputs to value, it is necessary to identify - at what level of detail outputs can or should be measured.

At the national level, defining "sawtimber" as an output may be adequate and appropriate. However, this resource could be redefined to provide more detail by subdivision into "softwood sawtimber" and "hardwood sawtimber", if market values of "softwood sawtimber" and "hardwood sawtimber" are quite different, or costs of production differ significantly. Further

differentiation could include breaking out individual species within these categories. Whatever level of detail is chosen, it follows that everything covered by that definition is a homogeneous economic output.

In deciding on the outputs to be valued, consider the following factors:

1. The degree to which differences in value are accounted for. Is a value placed upon an output like "dispersed recreation" or "softwood sawtimber" adequate or is more detail needed for the analysis?

2. The data bases available and the costs of developing additional data. Are the definitions of outputs and values of outputs comparable? Is it worthwhile to develop more detailed output data or more detailed value data to more effectively use existing information on either outputs or values?

3. Reporting requirements to other organizational levels. Can data be aggregated/disaggregated or translated to meet other possible needs?

4. The degree of precision in cost/price estimates judged to be appropriate by decisionmakers.

Developing values and outputs appropriate to the level of analysis requires coordination and communication between analysts and other resource specialists.

14.2 - Components of a Market Assessment

(FSM 1971.51) A market assessment can be useful in verifying the economic opportunities that may exist with alternative plans, projects, or other proposals. It will usually be conducted as a part of an overall economic base study or economic overview at the Regional and Forest level. It is useful in setting objectives, identifying constraints, and as an aid in determining appropriate values and costs for outputs and inputs.

There are a number of elements that may be considered in a market assessment, depending upon the scope and level of detail appropriate for the overall analysis and type of decision. Some of the elements that might be considered are:

1. Population - composition and change through time.

2. Income - historical levels, relationship to other areas, and trends in expenditures.

3. Past Consumption - historical relationship of various outputs to population and income.

4. Past and Current Production Capacity - relationship of capacity to consumption (e.g. sawmill capacity, base ranch capacity, ski area capacity, etc.).

5. Past and Current Production Technology - relationship of factor inputs to product output over time (e.g. jobs per mbf timber processed, acres per AUM, etc.).

6. Substitution Effects - opportunities for factor input and product output substitutions and their potential effects.

7. Complementary Effects - opportunities for factor inputs and product outputs to be complementary to some other input or output whose demand or supply is changing.

8. Institutional Factors - laws, political jurisdictions, government programs, tariffs, taxes, etc.

9. Transportation Networks - costs of access, shipping, etc.

Compiling and evaluating this type of information can aid the analyst in understanding the markets for outputs and in establishing values for these outputs.

14.3 - Demand Schedules for National Forest Outputs

The Forest Service uses five different approaches for assuming or estimating empirical demand schedules. They are:

1. Fixed value/demand limits.

2. Constructed demand curves.

3. Statistically developed curves including travel cost methodology.

4. Derived demand computation.

Each approach has its limitations and is appropriate to only certain circumstances.

14.31 - Fixed Value/Demand Limit

The fixed value/demand limit approach is the easiest to apply and is widely used and accepted when supported by data on values and likely consumption limits. However, this approach is also subject to the greatest criticism. It is a simple procedure recommended in the absence of better methods.

This approach assumes fixed prices -- that is, for all quantities of output ranging from zero to some upper limit, the estimated price or value level does not vary.

In this approach, the analyst must estimate and project the unit benefit or value for the output over the planning period in real terms. Estimating the quantity to which the benefit per unit applies is crucial in most applications. The objective is to estimate the range beyond which outputs can be considered to have little value through use or consumption. Factors that help determine this range:

1. The estimated "market share" the producing unit now provides and/or expects to continue providing up to unit's production capacity during the planning period.

2. The projected consumption of the output plus an allowance for error.

Obviously, estimation of the quantity interval requires different procedures for different outputs.

14.32 - Constructed Demand Curves

This approach assumes the demand schedule for a forest is not perfectly elastic and the observed price-quantity relationship and zero price-quantity relationship define a linear demand schedule.

The zero price-quantity level is difficult to estimate. For timber, the point has been based on the full capacity of mills in the market area. For recreation, it might be based on total leisure time of local residents.

Problems can exist in the use of the current price-quantity equilibrium point. Use of a low output year would give a different demand curve than a high output year. Therefore, use a long-term average.

The fixed price/demand limit and the constructed demand approaches are tenuous. Neither provides the response of price to quantity changes by the forest. Neither provides satisfying information on the values or benefits associated with varying quantities of output. In addition, the procedures are not suited to projection through time. Do not use either the fixed value/demand limit or constructed demand approach to estimate a price-quantity demand relationship if there are other alternatives.

14.33 - Statistical Demand Equations

Numerous studies of forest output demands, especially for timber, have been made attempting to find the function of quantity demanded (and consumed) with price and other identifying variables.

These models have used annual data, thus the demand relationships are primarily short term.

The econometric techniques used for these studies are technical and should be attempted only by those with the necessary training. Even then, it is generally recommended that such econometric analyses not be made for areas smaller than market areas or for individual classes of owners, such as by National Forests.

14.34 - Computation of Derived Demands

If the demand curve at a further stage of production is known, an analyst can compute the derived demand curve (or elasticity) for a factor of production by several techniques. If the production function requires a constant per-unit input (meaning, the conversion ratio is constant) and the other factors are labor, energy, or supplies freely available (with perfect elasticity) in the local economy, the computation is straight forward.

14.35 - Travel Cost Method

This approach is a standard method used to compute demand schedules for recreation type activities.

The analyst must be aware of potential problems caused by assumptions of this method when designing a travel cost project or using the work of other analysts. These assumptions are:

1. The value given up by the user includes travel cost and the value of time spent in travel. (Time was not included in many older studies.)

2. All users obtain the same total benefit, equal to the travel cost (including value of time) of the marginal user.

3. At the same cost, people in all distance groups having the same demand function would participate at the same rate.

With use of this method, a number of complicating factors have been discovered that may require adjustments to the values:

1. Longer recreation trips may be vacations with a number of intervening stops. This has been partially overcome by excluding a portion of the costs for these stops in computations.

2. Incomes and amounts of leisure time influence the amount of recreation in which families participate.

3. The value of travel time may be as influential as out-of-pocket travel costs. Recent studies show that the value of travel time is approximately one third to one half of the hourly wage rate.

4. Residents of each zone differ in behavior, and preferences. Zone averages may mask such variation.

5. It is best to adapt methods to family and group demand, whereas recreation use is by recreation visitor days--or individuals. Counting children the same as adults overstates the values.

6. Length of stay may affect value. People may be willing to pay more per day if they stay one day instead of twenty days.

Despite these difficulties, the travel cost and related survey based methods such as hedonic pricing and contingent valuation are regarded as suitable for approximating recreation-type demands.

14.4 - Projection of Demand

In program planning, land-use planning, and in most project evaluations, estimations of future demand and values are necessary since most benefits will occur in the future. For each output for which markets are assessed, and prices estimated, demand information must be projected over the planning period. But the methods used to project price-quantity demand relationships and the values themselves must be compatible with the current demand analysis.

14.5 - Selection and Adjustment of Output Values

The under lying assumption in the development of program benefits is that the Forest Service will claim the incremental total value of output attributed to management. The increment to total value may arise from changes in units of output or from changes in per unit values. Each output type is assigned values according to its market conditions.

14.51 - Selection of Type of Value

The following accounting stances define the types of values that may be considered dependly upon the perspective of value.

1. <u>Existing - fee accounting stance</u>. These are the values of receipts from purchasers or users. These are not considered the output values, but are used primarily in determining the funds returned to the U.S. Treasury from Forest Service operations. In RPA and other analyses, total anticipated returns to the Treasury are computed for each alternative and displayed in the planning documents. Payments-in-kind, such as the value of conservation practices performed by leases of National Grasslands, are part of the existing fee.

2. <u>Market - clearing price accounting stance</u>. This value uses the market or simulated market price as the value of the output. The only major market where values are represented by prices is timber. In other "markets," such as those for recreation, wildlife, wilderness, and

range, the demand curve may be known or approximated but not the prices which because fees are either not charged or are a portion of estimated marginal willingness to pay. To approximate a value in exchange, use one of the following methods:

Approximate the value by determining the maximum supplier gain as if it were possible to sell the output. The value would be the largest revenue--price multiplied by quantity for any combination of price and quantity. This could be determined by trial and error computation or mathematically if a formula for the demand curve is known.

3. Willingness-to-pay accounting stance. The willingness to pay value of incremental units of a public agency's output is considered the net gain from the sum of the following:

a. Market Clearing Price.

b. Consumer surplus.

14.6 - Standards for Values

Values used or generated in the Forest Service must be comparable, because program analyses add the benefits of several resource outputs. The following standards apply to values assigned in Forest Service analyses:

1. For outputs used off-site, base benefits on output values when they leave the land or production site. For outputs used on-site, value benefits when in use. However, it may be easier to derive some values from those measured after the output leaves the production site. In such cases, to determine final values deduct costs incurred and profits earned after the output leaves from the values achieved at later production or transport stages. Derived or adjusted values of the incremental output are often called "appraised prices" if determined by cost adjustment or called "shadow prices" if computed by mathematical programming.

2. Express benefits in real dollars. The base year is established through the Resources Program and Assessment planning process. For outputs with different quality grades, use the same relative prices over time, unless a separate analysis of value trends by grade have been made.

3. If output quality significantly affects value, estimate unit price differentials in market assessments.

14.7 - Use of Demand and Value Information

The following standards apply in assigning values to the schedule of outputs:

1. For Forest and other local Forest Service plans, use output values and rates of growth in demand established by regional market assessments, unless special studies show these values and rates do not apply in local areas. In the absence of regionally determined values and rates or special studies, use RPA values and rates.

2. Use long-term price-quantity relationships, if established according to approved procedures. Regardless of the price-quantity relationships assumed, long-term planning should not include investments that would expand outputs beyond amounts likely to be consumed. Beyond such levels, additional outputs have diminishing value.

15 - Computing Measures of Economic Efficiency

This section addresses measures of economic efficiency, recommended computational techniques, and preferred terminology. What follows is a version of investment or economic efficiency particularly suited to forestry and land management. Its use in decisionmaking will assure comparable and readily understandable results.

The question of the "best" measure of economic efficiency is controversial. The Forest Service position is that the most appropriate measure depends on which input is most scarce or most limiting for the program or project evaluated. In long-term planning, the scarce resources are either (1) forest and rangeland resource management opportunities being considered, or (2) the investment and operating funds (capital) required to put and keep lands in production.

15.1 - Discounted Measures: Scarce Resource Opportunities

The measures to apply when lands or productive opportunities are limiting assume that other inputs such as capital are potentially available at a cost, even if constrained in certain periods. These measures are:

1. <u>Present net value</u>. Present net value (PNV) is the present benefit value (PVB) of the stream of benefits less the present cost value (PVC) of the schedule of costs. It can be expressed in the following equation:

$$PNV = PVB - PVC$$

2. <u>Equivalent annual income</u>. Equivalent annual income (EAI), also called "average net annual benefit", is similar to PNV, except the value is expressed as an annual flow of income that the PNV would produce if invested at an interest rate equal to the discount rate. It is computed by amortizing the PNV over the life of the project.

If the time horizon is perpetual, the equation is:

$$EAI = PNV * i$$

If the time horizon is N years, the equation for determining equivalent annual income is:

$$EAI = PNV * \frac{i * (1 + i)^N}{(1 + i)^N - 1}$$

3. Soil Expectation Value. Soil Expectation Value (SEV) is the present net value of an infinitely long series of expected net periodic incomes from timber. SEV represents the present value of non-forested land for growing timber, "bare land value", and is the captilized value of an infinite series of timber rotations. Also referred to as the land expectation value or "Faustmann formula" it is calculated as follows:

$SEV=FNV[1/((1+i)^N-1)]$ where...
FNV=Future Net Value or net value at the end of the first rotation
N=Rotation Length
i=Interest Rate

Note that all intermediate costs and benefits must be expressed in terms of the value at the end of the rotation. The explicit assumption is that all future rotations will be identical to the first rotation. The rotation age (N) yielding the maximum SEV is the economically optimum rotation age.

15.2 - Discounted Measures: Scarce Investment Funds

If capital is the scarce resource, and resource opportunities are not limiting, use these other measures to gauge how much the capital earns in proportional terms, or the rate at which the capital 'grows' while invested in the program or project.

1. Benefit/cost ratio. The benefit/cost(B/C) ratio is the present value of benefits (PVB) divided by the present value of costs (PVC). It can simple gauge of the relative efficiency of amounts of investment and operating funds to produce benefits. It is calculated as: B/C = PVB / PVC

2. Internal rate-of-return. The internal rate-of-return (IRR) is the discount rate that makes the present value of benefits (PVB) equal the present value of costs (PVC). That is:

$$PVB = PVC \text{ or } \frac{BV(I)}{(1+i)^I} = \frac{CV(I)}{(1+i)^I}$$

Where BV(I) and CV(I) are benefits and costs values at year I.

Computation of IRR is an iterative process where i is system-atically varied until PVB and PVC are equal. Hand calculation is very laborious, but computer programs with IRR computations are available. Hand calculators with discounting functions also simplify the computations.

3. Composite rate-of-return. Composite rate-of-return (CRR) or 'realizable rate-of-return' is a variation of the internal rate-of-return (IRR) concept. CRR assumes there is a need to consider that the investor would reinvest his intermediate returns to the end of the time horizon.

An opposing view is that the IRR is the weighted average rate of growth of the capital only while invested. Thus, considering a reinvestment rate merely complicates the analysis without adding new information. The Forest Service takes this view and does not recommend computing composite rates-of-return.

15.3 - Relationship Between Benefit/Cost Ratio, Present Net Value, Equivalent Annual Increment and Internal Rate of Return

When the analyst uses several methods to calculate measures of efficiency, the relationships will be as follows: In the abscences of constraints on inputs and outputs or interdependences among the projects being considered.

Comparison of PVB to PVC	B/C Ratio	PNV	EAI	IRR
PVB > PVC	>1	>0	>0	>Discount Rate
PVB = PVC	=1	=0	=0	=Discount Rate
PVB < PVC	<1	<0	<0	<Discount Rate

15.4 - Discount Rates and Handling Inflation and Risk

15.41 - Methods and Standards for Discounting

Discounting is the process of reducing values (costs and benefits) occurring over time to some common period, usually the present. Several programs are available for use in this type of analysis and many calculators have discounting functions.

15.42 - Recommended Discount Rates

1. Forest Service rate. The basic discount rate used to evaluate long-term investments and operations in land and resource management is a real rate of 4 percent which has not included an inflation factor. Analysts should be aware that this rate differs from the rates used in other Federal agencies and for investments other than land and resource management.

2. Office of Management and Budget rate. Since 1969 the basic rate for all Federal agencies not covered by specific legislative requirements or guidelines has been 10 percent. This rate should be used to test the sensitivity of analyses to changes in discount rates. For specific direction on analysis of Forest Service activities see FSM 1971.21.

In financial analyses by industrial and commercial organizations inflation and risk often are handled by adjustment processes similar to discounting. The schedules of benefits and costs thus include current costs not adjusted for losses and the discount rate used includes components representing inflation and risk. In Forest Service practice, as in most other Federal agencies, neither adjusting for inflation or risk in a manner similar to discounting nor including inflation and risk components in the discount rate is recommended (sec. 12.2).

15.43 - Incorporating Inflation

In Forest Service analyses, the values in schedules of benefits and costs should be real values. That is, they should have been adjusted for inflation (if past values) or future values should not be increased for an assumed rate of inflation. If inflation, however, is assumed, and readjustment and discounting are correctly done, the measures of economic efficiency will not be affected in Forest Service analyses. If current values are used, and the analysis adjusts for both an interest rate i and an inflation rate r, the effects of the rates are multiplicative rather than additive. That is, the adjustment factor is:

$$F = \left(\frac{1}{(1+i)^N}\right) * \left(\frac{1}{(1+r)^N}\right) = \left(\frac{1}{((1+i)^N * (1+r))^N}\right)$$

and not:

$$F = \left(\frac{1}{(1+i+r)^N}\right)$$

If the interest and inflation rates are low, and the time horizon is short, the error cause by the additive assumption is small. If not, the error may become substantial.

One reason that real values are used instead of current values with inflation assumed is that projecting defensible rates of inflation is extremely difficult, involving many assumptions about economic variables and events outside the economic analysis of the project or program. If there is no advantage in doing so, it is simpler and easier to conduct the analysis in real values.

15.44 - Incorporating Risk and Uncertainty

(Sec. 12.2).

15.5 - Project Level Economic Analysis

There is no set format for economic analyses, though each should have a number of similar components. For each type of frequently performed analysis, such as timber sales, road construction, or vegetation control projects, it would save time to develop locally informal data sheets to aid the collection and analysis of data.

16 - Using Economics to Improve Decision Making

While economics is but one of the factors managers need to consider in the decision process (others being technological, physical/biological, legal and social/political), there are a number of ways economics can be used in the decision process in addition to the traditional efficiency analysis described in sections 12-15. These additional analytical techniques provide the tools necessary to determine the relative economic desirability of proposed policies, programs, plans, or projects and improve the efficiency or effectiveness of proposed alternatives. Additional techniques may also be used by the analyst to examine the implications of changes in assumptions and the relative importance of different assumptions in the calculations of the measures of economic efficiency. As is true with the traditional efficiency analysis, these additional techniques do not provide the final decision itself but rather contribute to the quality of the decision process. It is important for the analyst to provide the decision maker with an understanding of the appropriate use of the different financial, accounting, cash flow, and efficiency evaluations that may be presented.

16.1 - Sensitivity Testing

This analysis is simply an extension of the calculation of the measures of efficiency described in section 15. Sensitivity analysis determines the sensitivity of the efficiency measures to changes in the variables originally used to calculate the measures. These variables may be those over which the Forest Service has no control but may influence the impact of the decision alternatives. They also may be variables that are controlled by the Forest Service and are decision sensitive.

By knowing which variables are in fact important, the decision maker will be better able to judge the relative reliability of the analysis as well as determine where to concentrate additional resources and analysis.

16.2 - Incremental Analysis

An incremental analysis is potentially useful to determine the optimal size or scale of a proposal. If the proposal can be considered as a discrete number of incremental additions to a specified base the optimal size is when the marginal benefits of the last increment exactly equal

the marginal cost. Common examples where incremental analysis may be particularly useful are the determination of the optimal number of trees per acre to plant, the best level of fertilization for a range allotment, or the correct basal area per acre for thinning.

16.3 - Least Cost Treatment Combinations

Once a program alternative has been selected and implementation begins, it is often necessary to make decisions on the best way to accomplish treatments or to build facilities. This can be a major analytical task in the planning of specific projects.

Often in project level planning the objective is known and only the best combination of inputs or specific types of activities to be used requires further analysis. The preferred alternative is the proposal with the lowest cost - either in total or on a per unit basis. Because outputs are not valued this is really a cost effectiveness measure rather than an efficiency measure. In order to avoid analyzing different treatment alternatives for each project, an analyst may want to consider determining which treatment methods or combinations are most cost effective in a range of circumstances.

16.4 - Analysis of Minimum Cost Plus Net Value Change

This is analagous to the maximum present net value criterion and is often referred to the "least cost plus loss criterion". This analysis is particularly useful in determining the efficiency of protection proposals.

Protection outputs are not commodities or on-site uses directly, rather they are measures of net losses of future resource outputs avoided by the protection effort. In many cases, fires, and infestations have positive effects on some resources, and occasionally, such benefits may exceed the losses. For this reason, the term "net value change" is used to refer to the net effect of all changes caused by a casualty occurrence.

The objective of such analysis is to find the level of presuppression effort (usually expressed in terms of cost but the level can be expressed in other terms) for the minimum total cost (prevention effort, suppression effort, and net change in resource values).

Analysis of other types of protection and maintenance programs are simple conceptually, although the terminology may differ. Such analysis requires careful separation of costs into fixed prevention and variable damage control portions, identification and valuation of net value changes in resources (or effectiveness of facilities), and analysis of program increments to arrange them in order of effectiveness. All costs and benefits should be discounted as appropriate.

16.5 - Breakeven Analysis

Breakeven analysis is a particularly useful kind of analysis that can be used when it is difficult or impossible to determine output values (an alternative approach can be used when input costs cannot be determined).

In a breakeven analysis the question - What is the minimum price that will just make the program or project breakeven? - is answered. The breakeven point is the point at which all input costs are just balanced by the total output value. The decision maker can then compare this imputed unit value with the estimates of the value of the output. If significant time periods are involved in the production process, the breakeven analysis should be conducted on a discounted basis. If values are known but costs are not, the alternative formulation for the analysis might be used - How high can cost be before they equal or exceed the value of the output produced?