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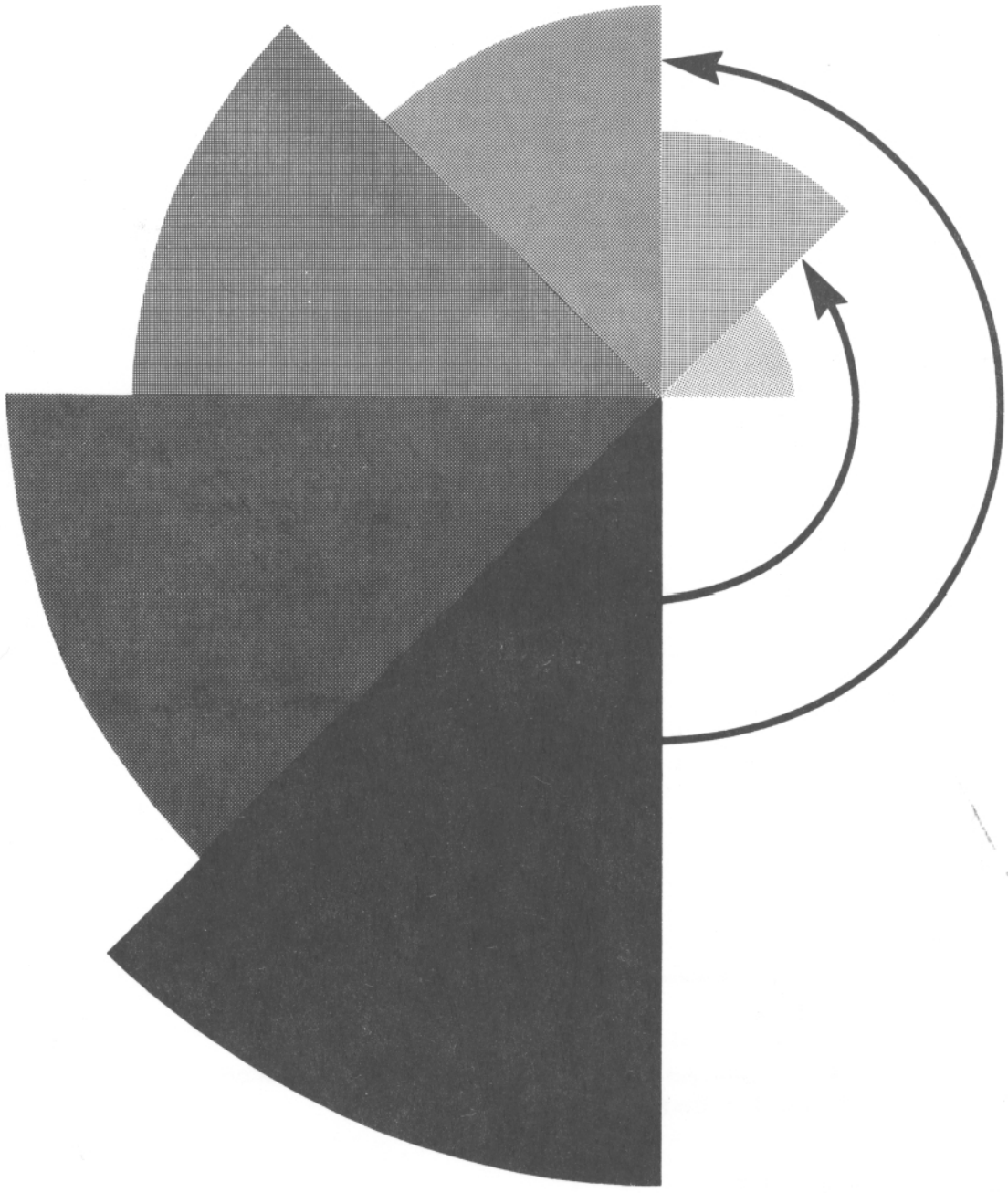
Economic Efficiency in Forest Service Program Development

Robert J. Hrubes



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CONTENTS

The National Forests are administered by nine regional offices of the Forest Service, U.S. Department of Agriculture. The process by which organizational capital--budgets, workforce--is focused and translated into management actions is governed by a complex and linked framework of planning systems. Activities that contribute to the system range from long-term goal identification, such as found in Resources Planning Act (RPA) planning, to setting up work plans for discrete, identifiable sets of actions. The annual program planning and budgeting (PP&B) process provides the link between long-term goals, objectives, and targets and specific work plans for the field units--the National Forests and their Ranger Districts.

Program planning and budgeting, an overlapping 2-year cycle initiated annually, consists of six major steps ranging from development of national direction to budget implementation and feedback evaluations (*fig. 1*). As the shortest-term planning process, PP&B functions to implement long-range plans such as forest land management and RPA plans. Annual expenditures on projects of work, as determined in the PP&B process, should--over the longer term such as a decade--lead to program output levels that meet commitments set forth in RPA and land-management plans (LMP). But the possibility always exists that commitments cannot be met because of limited budgets over an extended period. Consequently, a feedback linkage is needed to ensure that long-range targets are modified when necessitated by the budgetary record.

The focus of this report is the process and associated analyses that lead to the development and selection of the annual program at the regional level, because it is at the regional program formulation stage where tradeoffs among alternative program funding levels are initially addressed. Examination was focused on three representative Forest Service Regions: the Southwest (R-3), Pacific Southwest (R-5), and Southern (R-8). The study was designed to determine the extent to which formal consideration is given to arriving at an economically efficient program. Field interviews were concentrated on four program areas: nonsale reforestation, nonsale timber stand improvement, wildlife habitat improvement, and forest administration and other construction (FA&O). No attempt was made to document exhaustively the decision and analysis processes for all program areas that comprise regional-level program formulation.

Other studies pertaining to program development and budgeting have or are being conducted by the Forest Service. The most recent effort is the National Productivity Improvement Study of PP&B conducted by a Productivity Improvement Team (PIT) (U.S. Dep. Agric., Forest Serv. 1982a). Although similar in subject matter, the study reported here differs from the PIT study in a fundamental manner. The PIT study addresses efficiency in terms of the organizational costs associated with the process of arriving at annual program budgets. The study tried to identify means of assuring a more cost-efficient operation of the process, with efficiency defined as the least possible impact on organizational resources (for example, person-hours of effort and disruption of other activities). But the PIT study did not concern itself with the efficiency of the resource decisions and associated actions that are implicit in an annual program budget, the definition of efficiency that is of concern in this present study. While this study made no attempt to directly assess the efficiency of past resource decisions, it did attempt to determine the extent to which current analyses (if any), conducted as part of the PP&B process, contribute to efficient resource decisions.

METHODS

Decision Criteria

This study is concerned primarily with the efficiency--total benefits less total costs--of resource decisions. This orientation is in response to the objective voiced by R. Max Peterson, Chief of the Forest Service, of increasing the productivity of Forest Service programs. Beyond the Chief's current concern, direction to consider program costs and associated benefits is found in various legislation such as the RPA and the National Forest Management Act (NFMA). Section 1930.2 of the Forest Service Manual states that "The objective of program development and budgeting is to ensure ... effective allocation of funds, targets and employment ceilings." What does "effective allocation" mean in this context? Coupled with the Chief's concern and associated direction, it clearly means that the allocations should maximize net benefits, subject to other considerations. But, efficiency is only one of several valid criteria that should play a role in annual program formulation. The other considerations that help shape, in varying degrees, program allocations respond to factors both internal and external to the Forest Service. They include:

Program balance--Within a program area, there exists a traditional concern over the equity of the geographical

disbursement of funds. It is generally held within the agency that each field unit deserves some minimum funding level. The distribution of program benefits among forest users and recipients is considered, also.

Temporal stability--In deference to workforce management and the welfare of employees who might be displaced, pronounced changes in program funding over a short time period are generally disfavored. Concern for the welfare of program beneficiaries outside the agency also contributes towards a tendency to favor no changes.

Political feasibility--Closely related to the motivations behind temporal stability are concerns for the public responses to Forest Service actions. Political feasibility considerations also favor avoiding change. Political feasibility should be defined broadly enough to include the reactions of Forest Service employees to changes in program allocations. Construction programs for FA&O are particularly sensitive to political considerations.

The extent to which these other considerations preclude or modify the attainment of efficient resource allocations in the sampled regions will be discussed later. On a region-by-region basis, it is a question of the relative weights attached to each decision criterion, both explicitly as formal decision elements and implicitly through the structures of the program development processes.

In each of the three study regions, the program analysis and formulation phases of PP&B were investigated through field interviews with Regional Office (RO) personnel and review of national and regional program planning documents. Interviews were conducted in September and October 1982. Two basic observations emerged from the interviews and associated documentation:

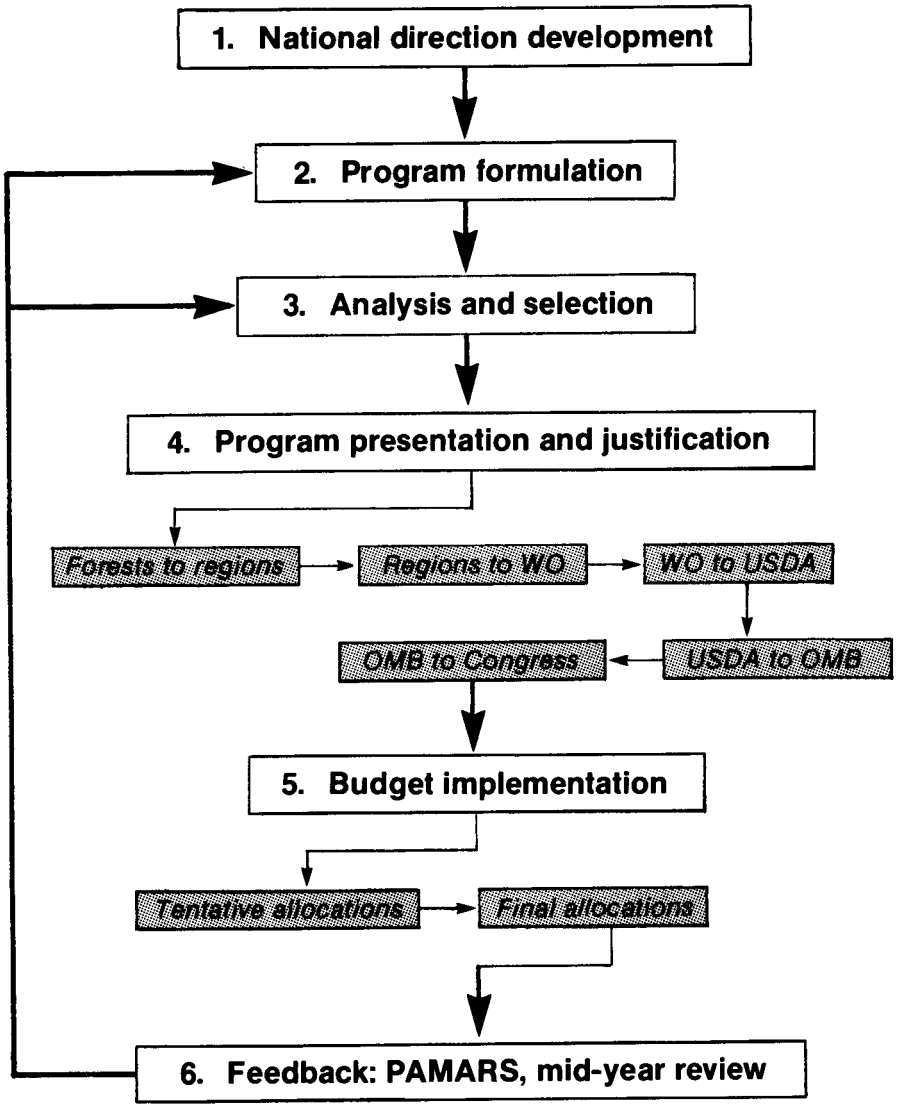

Figure 1--Program planning and budgeting include six major steps ranging from development of national direction to budget implementation and feedback evaluations.

• A wide variation exists across regions in the structure (procedural and organizational) for program formulation and in the type and extent of analysis supporting program formulation. Within a region, wide variation also exists across program areas in the type and extent of supporting analysis.

• The level of economic analysis is generally limited and insufficient to investigate adequately the relative economic efficiency of alternative programs.

Interviewees generally recognized the shortcomings of current analyses and a desire to upgrade the level of economic analysis that supports program formulation in their region.

To facilitate a discussion, the three regions' approaches to program formulation will be compared with an idealized approach that is not now used but, if used, would assure sufficient consideration of the relative economic efficiency of alternative programs. By presenting the discussion in this format, the variability in current approaches and their inadequacies can be more easily revealed.

A Model for Efficient Program Allocations

For reasons of clarity, the planning problem is rephrased from "program formulation" to "project selection." The task is to select a set of projects within a set of program areas (for example, timber, range, wildlife) that will comprise a regional annual program of work. Associated with a regional program, as defined by a set of projects, is an overall budget level and a set of targets and spending limits that are specific to program areas. Alternative regional programs, each with a different budget level, targets and spending limits, are elaborated. It is assumed that the candidate projects from which a program will be selected are themselves efficiently designed to accomplish the desired results at minimum cost. The process by which this is assured is "project evaluation" and falls outside the scope of this study.

At the regional level, targets and spending limits are set by the Washington Office (WO), but they may not be stipulated for all program areas. For purposes of this model, WO-derived targets and spending limits are treated as exogenously set parameters. Generally, however, targets and spending limits should reflect a negotiation between the regions and the WO that includes a consideration of their effects on efficiency. This is important because targets and spending limits reduce the discretion or latitude in the selection of projects that could comprise an efficient (net benefit maximizing) program.

The problem of project selection is formulated as a 0-1 integer program where the objective function involves the selection of projects from the set of all candidate projects that will maximize the difference between benefits and costs subject to targets (lower bounding constraints) and spending limits (upper bounding constraints). In this theoretical example are I subunits (forests), J program areas on each forest, and up to K candidate projects for each program area on each forest. Maximize:

$$\sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{k=1}^{K} X_{ijk} (X_{ijk} Q_{ijk} - Ci_{jk}) \qquad (1)$$

subject to:

Program area-specific targets

$$\sum_{i=1}^{I} \sum_{k=1}^{K} Xi_{jk} C_{ijk} \geq T_j \qquad (2)$$

Program area-specific spending limits

$$\sum_{i=1}^{I} \sum_{k=1}^{K} Xi_{jk} C_{ijk} \leq B_j \qquad (3)$$

Region-wide budget limit

$$\sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{k=1}^{K} Xi_{jk} C_{ijk} \leq B \qquad (4)$$

All $X_{ijk} = 0,1$, a set of control variables restricted to 0-1 integer space, one variable for each candidate project in the region.

The 0-1 stipulation on the X_{ijk}'s requires that projects be fully funded (selected) or not at all. Each candidate project has associated with it an output level, Q_{ijk}, and a total cost, C_{ijk}. Associated with outputs are unit valuations (for example, prices or shadow prices), V_{ijk}, that should approximate the marginal social valuation of each output. An implicit assumption in this mathematical programing formulation is that the projects (columns of the matrix) are independent. In reality, complete independence of projects is not the situation. Some timber management, roading, and developed recreation projects, for instance, may be interdependent. Because of these violations, the IP solution is best viewed as an approximation of the optimal (that is, economically efficient) selection of projects.

Each integer program conforming to this general formulation can have a unique combination of values for B, B_j's, and T_j's. Therefore, it is a straightforward iterative process to generate alternative regional annual programs. (The term, program, in the context of mathematical programing should not be confused with its use in the context of program planning.) The currently favored approach to generate a set of incrementally augmented regional programs that build upon a base level is easily modeled through a succession of solutions to the integer program, beginning with the base (lowest) levels for B, B_j's, and T_j's and then increasing the levels of these parameters. To assure that projects are selected sequentially, the projects selected for a lower-level program, such as the base program, can be prewired into the solution for the higher-level (that is, greater funding and target levels) program by constraining the appropriate X_{ijk}'s to equal 1.

Data Requirements

To identify the set of projects that will comprise a regional annual program of work with this approach, data must be gathered on each candidate project for direct costs (necessary funding), outputs, and value of outputs (net of environmental costs). Because projects across all program areas are ultimately competing for the same budget dollars, their benefits must be directly comparable. Ideally, contribution to society's well-being (social utility) should be the object of measurement, as approximated by some combination of market artifacts (prices) and estimation based on professional expertise. It is not an easy task but one that is necessary for cross-project comparisons.

Additionally, information is needed to establish targets and spending limits. Because this task is accomplished by the WO, national-level priorities are given primary consideration. At the national level, an analysis must be made to arrive at a preferred and feasible distribution of targets and dollars among the nine Forest Service regions. This process, of equal significance to its regional-level counterpart, was not examined in this study.

Solution Characteristics

With this problem formulation, a solution algorithm is free to select projects that meet the targets and spending limits without regard to their distribution among the forests in the region. All projects within a program area regardless of location can compete against each other on their merits (net benefits) in the selection process. The order or priority by which projects are selected is determined by their contribution to the net benefit of the entire regional program. Projects with the greatest net benefit are selected first. Accordingly, the last project selected within a program area on a forest would not have a net benefit contribution lower than a nonselected project from that forest or any other forest. The net benefit contribution of the last project selected on each forest, therefore, would tend to be approximately equal, within a program area. If spending limits are not binding (that is, do not influence the solution), the equality of the marginal (last selected) project extends across program areas. This result is equivalent to the equimarginal principle (first-order conditions) of economic optimization found in a continuous, as against integer, problem formulation. The larger the number, and the smaller the size of candidate projects, the more closely will the solution fit these characteristics. With large projects, lower priority but smaller projects may be selected to conform to spending limits.

The projects selected under this formulation would maximize the economically definable net benefits to society of budget expenditures for resource programs in the region being analyzed. But criteria other than economic efficiency are not considered. For this reason, there is no assurance that such a regional annual program would be desirable or operationally feasible. It is likely that some forests would have no projects selected for funding within a program area. As will be discussed, criteria such as equity and stability, that are manifested in distributional specifications on project selection, are an important component of program formulation in the sampled regions.

Beyond documenting these nonefficiency considerations and demonstrating how they fit into or modify the theoretical model, an important question broached in this paper--but one that must be answered by agency policymakers--is this: *To what extent should efficiency be sacrificed in order to respond to other considerations?*

RESULTS

In general, the program planning processes of the three regions do not assure that projects are selected with regard to economic efficiency. If the net benefit maximizing formulation were used in these regions, the resulting programs would probably look much different from those currently generated. That is, the regions are currently accepting a cost in terms of foregone net benefits. Two basic reasons for departure from the efficient solution are (1) other, nonefficiency considerations impose requirements on project selection that limit the feasible range of net benefit maximization, and (2) the regions are not fully or properly using the discretion that remains for pursuing economically efficient programs.

Limits on Project Selection

Programing considerations that partially determine the annual selection of projects are generated both internally and externally to the agency. Appropriately, the program planning process at the regional level should respond to regional and local considerations that cannot be reflected in WO-generated targets and spending limits. Washington Office directives are defined in terms of program area totals without concern for the breakdown within a program area. The result is that projects are selected for inclusion in the annual program for a variety of reasons.

At lower levels of program funding, concern for a geographically balanced program has the single greatest effect on project selection. In all three study regions, every effort is made to select those projects the forest staffs submit as their base (minimum)-level program. Regional personnel think it organizationally and politically undesirable to generate a regional program in which some forests are not receiving a minimally sufficient level of funding (and project selection) in each program area. Other arguments for at least minimum-level programs on each forest are that they are necessary to (a) assure that multiyear programs such as plantations needing timber stand improvement are not aborted, (b) meet legal requirements, and (c) provide necessary support to other activities such as land manage-

ment planning. The projects making up a minimum-level program, therefore, are prewired into the selection process and are generally not required to withstand tests such as comparing their net benefits with those of other candidate projects. Ideally, the forests will submit minimum-level projects that compare favorably with their other projects, but it is not a requirement and not always the situation. By assuring that minimum-level projects submitted by the forests will be selected, the regions are also allowing for local-level priorities and issues to be considered in the programing process. Forests can be fairly assured that their highest priority projects will be funded if they are submitted as part of the minimum level. But, this fact further diminishes the likelihood that minimum-level projects will be the most efficient.

The desire for a geographically balanced program is, in part, a reflection of concerns over disruption of workforces and the costs of relocating employees to accommodate changing funding levels. These concerns, combined with an organizational tendency to do business in a way that "doesn't make waves," result in a tendency to favor program allocations that are not a significant departure from the previous year. To the extent that a geographically unbalanced program may be the most economically efficient, regional programs that reflect balance and minimal change from previous years result in opportunity costs of foregone net benefits. Examples of where it may be more efficient to simply ignore some forests in the selection of projects within a program area can be found in all three study regions. In Region 8, it is widely recognized that the coastal plain forests have a clear competitive advantage over forests in the Appalachian region in the production of timber. A similar situation exists with the forests of northern versus central California. To maintain, in the name of balance, at least a minimum-level timber management program on some Appalachian and Sierra Nevada forests is, perhaps, economically inefficient.

To reflect program balance requirements, the mathematical model developed previously must be modified by the specification of a set of up to I x J additional constraints that stipulate a lower bound on activity on each forest, by program area:

$$\sum_{k=1}^{K} X_{ijk} Q_{ijk} \geq M_{ij} \qquad (5)$$

(M_{ij} = minimum output of program area j on forest i). By adding these constraints, the feasible range of program selection is reduced and the objective function (net benefits) may be compromised. But, by doing so, it is more likely that the resulting project selection will be operationally feasible. Let us add constraint set 5 to the idealized program selection formulation (equations 1-4), recognizing that unconstrained economic efficiency is not likely to result in socially desirable solutions.

At the regional level, the reduction in the discretionary level of project selection is not always in response to explicit and voluntary regional considerations such as maintaining minimum-level programs on each forest. In discussions with regional personnel, for instance, it became apparent that targets passed down from the WO often have the effect of removing from the regions any real opportunity to design programs with regard to efficiency, or any other criterion. When targets are set at prohibitively high levels, the dominant problem becomes one of finding enough projects just to meet the targets. The notion of picking the "best" projects with regard to their efficiency characteristics is essentially irrelevant; any and all available projects that can contribute to meeting the target are needed. In Region 5, for example, the reforestation target passed down from the WO for a recent year was increased by 3000 acres (1215 ha) per year, reflecting Congressional interest in quickly eliminating the nation's reforestation backlog. In recent years, the reforestation rate in this region has been about 12,000 to 15,000 acres (4860 to 6070 ha) per year. Regional timber personnel are scrambling to find enough land available (as judged by forest-level personnel) to meet the increased target level. Efficiency ceases to be a relevant issue in such a situation.

A more general statement of the high target situation is that in some program areas there are limited investment opportunities. Implicit in the concept of economically efficient program selection is the assumption that an excess of investment opportunities (projects) and a constraining spending limit prevent some candidate projects from being funded. The regional experience does not always conform to this structure: sometimes the availability of projects is more limiting than the availability of funds.

Conversely, spending limits can be so constraining that the selection of projects is limited regardless of the number of candidate projects. This is especially true when coupled with minimum-level funding requirements for each forest in a region. When WO-generated spending limits for a program area are very low and the regions seek to continue geographic balance by assuring minimum-level funding, all available funds are used up at the minimum-level, where no efficiency analysis takes place. There is then no opportunity to exercise much discretion in project selection. The wildlife programs in Regions 3 and 5 are current examples of this situation.

In situations of high targets or low funding, or when both exist simultaneously, regional program planners are faced with constraints that severely limit the feasible range of project selection. In fact, the constraints themselves can dictate the solution, effectively removing any discretion in project selection.

Other, externally generated, limiting factors that predetermine, to varying extents, the selection of projects include "earmarked" funds and coordination with plans and programs external to the Forest Service. With timber and wildlife programs, some revenues, by law (for example, Knudsen-Vandenberg funds), must be reinvested on the same geographic area from which they were generated. Similar stipulations hold for a portion of range betterment

monies as administered under the Federal Lands Policy and Management Act of 1976. Obviously, if these types of funds are to be spent, projects designed for the pertinent land areas cannot be tested for their relative economic efficiency against alternative projects on other land areas. Again, the feasible region of project selection is reduced.

The regions' latitude in project selection is also reduced by necessary coordination with other public land management agencies. Resource management problems and issues often cross property lines and require coordinated actions from several agencies. An example is the management of wildlife. Here, the Forest Service is responsible for habitat management while State agencies and the Fish and Wildlife Service, U.S. Department of the Interior, are primarily responsible for the management of the wildlife itself. These other public agencies have developed wildlife management plans (for example, State comprehensive wildlife and fish plans, recovery plans for Federal and State listed species). And for these plans to be fully implemented the Forest Service may be obliged to program supportive actions on pertinent National Forest lands. The result is that the allocation of another block of the annual budget is, in part, predetermined.

The funding (selection) of some projects is influenced by the availability of matching funds supplied by other agencies but available for use on the National Forests if accompanied by Forest Service expenditures. To use these matching funds for which restrictions--such as geographic-use limits, time limits--are included, some projects will require selection over others. The feasible range of project selection, again, is reduced. An example of the matching funds situation is the $1 million of, mostly matching, non-Forest Service funds used annually for fish and wildlife management in Region 5. Most of the funds are spent in cooperation with the California Department of Fish and Game, which has a strong voice as to where the monies are spent.

As indicated by these examples, one of the basic problems of regional program formulation is the high degree to which decisions on project selection are predetermined. Contributing factors range from external matching funds to the internal Forest Service policy of assuring a minimum-level funding for each National Forest. In terms of the descriptive mathematical model, these factors are all represented as additional constraints on the feasible range of project selection. What remains after their specification represents the opportunity to exercise discretionary project selection.

Use of Discretionary Opportunity

Opportunities to incorporate economic efficiency are further lost by the standard practice of before-the-fact disaggregation of the regions' targets and spending limits among the forests. The regions break down their targets and spending limits by specifying and then including forest-level targets and spending limits in the annual program formulation instructions sent to the forests. If a region's reforestation target sent down from the WO is 10,000 acres (4047 ha) for a particular tentative funding level, for example, the region disaggregates the 10,000 acres into targets sent down to the forests. The region's allotment of appropriated funds for that reforestation level is similarly disaggregated. Forest-level targets and spending limits are depicted in the mathematical model as:

Target for j^{th} program area on the i^{th} forest

$$\sum_{k=1}^{K} X_{ijk} Q_{ijk} \geq T_{ij} \tag{6}$$

Spending limit for j^{th} program area on the i^{th} forest

$$\sum_{k=1}^{K} X_{ijk} Q_{ijk} \leq B_{ij} \tag{7}$$

Total spending limit for i^{th} forest

$$\sum_{j=1}^{J} \sum_{k=1}^{K} X_{ijk} Q_{ijk} \leq B_{i} \tag{8}$$

The logic behind this approach has, as its basis, a desire to ensure, in advance, that the forests will submit program proposals that, in total, enable the regions to meet their targets, within the spending limits. The regions set forest-level targets and spending limits such that:

$$\sum_{i=1}^{I} T_{ij} = T_{j} \tag{9}$$

$$\sum_{i=1}^{I} B_{ij} = B_{j} \tag{10}$$

in which:

$$\sum_{j=1}^{J} B_{j} = B \tag{11}$$

Potentially, however, an unnecessarily high price has to be paid when regions use this approach "to cover themselves," so to speak. By casting out forest-level targets, the regions are implicitly making resource allocation decisions without benefit of supporting analysis. Each forest's relative efficiency in producing the various regionally targeted outputs needs to be compared with that of each other forest. It appears that the overriding influence on the breakdown of regional targets into forest targets is the breakdown in the previous year. The targets sent to the forests generally do not change in terms of the relative positioning of each forest in the region (that is, for a program area, forests with high targets generally remain so, relative to the forests with low targets). Although the initial establishment of the relative forest target levels, for some undetermined prior year, may have reflected relative forest productivity, there is no longer any such explicit consideration. The result is that the targets sent down to the forests may lead to a very inefficient distribution of the forests'

contributions in meeting the region's total targeted output for any given program area.

From an efficiency standpoint, it is better not to make before-the-fact resource allocations in the form of forest targets and spending limits. By imposing additional constraints on the feasible range of project selection, the total net benefits of an annual program are reduced. And from the standpoint of ensuring that regional targets and spending limits are met, these constraints are unnecessary. It is much better to distribute the forests' contributions to meet regional output targets according to the forests' relative efficiency of output production. Relative efficiency is defined by the cost-benefit characteristics of candidate projects (subject to lower bound limits reflecting consideration of operational feasibility). Such a distribution is approximated with the integer programing formulation defined by equations 1 through 5. The solution algorithm selects which forests should supply how much in meeting each of the region's output targets within the regional spending limits and program targets. And it is done in a manner that results in maximum net benefits.

Focusing now on the discretionary project selection that does take place, with special attention to the roles played by economic analysis and economic efficiency, the review of the study regions revealed a wide variation in the extent to which economics is used in the annual process of project selection. Variation is found between regions and across functional program areas within a region. No one region is clearly more advanced in the use of economics than the others--each region has its stronger points and weaker points.

A sample of situations at both ends of the spectrum--when economic analysis and efficiency play a dominant role and when they play no role--can effectively describe the variation. Additional sample situations will be discussed where economic analysis is recognized and attempted, but in a fundamentally flawed manner. Because this study was not designed to assess individual performances, the location and personnel of each sample situation discussed are not included.

In two of the three study regions, the annual selection of FA&O construction projects is subject to the most structured decisionmaking with explicit and formal consideration of project benefits and costs. A significant variation exists, however, in the extent to which benefits and costs are considered. And in the third study region, although the significance of relative costs and benefits is generally recognized, there is no formal elaboration of project net benefits or any other attribute. But, in general, each region engages in some form of analysis--either formal or informal--in each of the following areas:

Inventorying and updating of candidate projects:

- Candidate projects are developed and submitted to the RO in an organized and consistent manner.
- Regional personnel have a good understanding of what projects are available for funding.

Evaluation of project benefits and costs:

- The RO has information on each project's economic and other pertinent characteristics.
- Regional personnel give greatest attention to those projects that will generate the highest net benefits.
- Evaluations and analyses range from informal "show-me trips" in one region to formal elaboration of evaluation matrices in another region, known in the Forest Service as Kepner-Tregoe matrices (Kepner and Tregoe 1965).
- Projects are given priority and those with highest priority are funded, down to the spending limit.
- Priorities reflect cost-efficiency and other criteria.
- Analyses, prioritizing, and funding decisions are products of a team approach.

The content and quality of supporting analyses vary widely. The region that relies on informal understanding of the attributes of each candidate project (often by only one member of the RO team) is hardly comparable to those regions that develop formal and quantitative information on each project. But the consistent trait is that in each region the FA&O selection process is at least as competent as the selection process for any other program area within the region. The region with the weakest FA&O selection method generally is also weakest in the other program areas.

Another notable example of a project selection process that has incorporated cost-benefit considerations in a well developed, formalized method is found in range management in one of the three study regions. The procedures adopted avoid some of the shortcomings found in other regions and program areas. All candidate projects, even those of the minimum-level, for instance, are subject to cost-benefit evaluation. Only projects with positive net benefits are eligible for funding. But perhaps the most valuable attribute of their range allotment project selection procedure is the degree to which it is formalized and standardized. As such, it requires a consistent level of analysis of every candidate project. Further, it is a well documented procedure that allows easy tracking of the process and rationale leading to project selection.

The range allotment selection procedure evaluates project effectiveness in terms of three criteria: economic efficiency, environmental quality, and social impacts. Both market and nonmarket values are incorporated into a calculus that results in numerical indices by which projects are ranked. Benefits, costs, and associated project attributes--such as environmental quality benefit rating--are computed and recorded on standardized forms. The entire procedure has been incorporated as a range allotment project effectiveness handbook (U.S. Dep. Agric., Forest Serv. 1982b). In large part, this handbook could be generalized to apply to all program areas.

Conversely, the annual process of program formulation (project selection) in some program areas provides little or no recognition of the efficiency aspects of program funding, as defined by measures such as net benefits. In these

instances, the procedures by which funds are programed among the forests in a region are also usually ill-defined and informal. The dominant criterion governing program formulation seems to be a combination of giving to the forests what they request and essentially continuing the funding patterns of the previous year. When changes from the previous year are required, the general tendency is to increase or decrease the funding to each forest by the same percentage--an arbitrary, simple, and amicable approach that ignores the relative efficiency of programs in some forests over the same programs in other forests.

The direction to the forests generally is also sketchy, resulting in inconsistent project submittals. Some forests, by putting together better packages for submission to the region, have a better chance for funding. Economic attributes, such as unit costs, do not play a part in the process. Although this type of approach to project selection probably, over time, recognizes gross situations of comparative advantage for some forests over others in producing the desired outputs for the program area in question, the chances for significant inefficiencies in programing are high.

Most program areas examined in the three study regions fall in a middle ground where attempts are made to incorporate some elements of economic logic into project selection, but often in a flawed manner. Two of the most common areas where improper procedures are followed are (1) identification and measurement of program outputs and benefits, and (2) marginal adjustments in funding levels.

The first common problem area concerns the definition of unit costs. Two of the three study regions gather information on project unit costs and use these indices in project selection. But the manner in which unit costs are defined in some program areas fail to identify the relevant output from which costs per unit should be constructed. The best examples are in the timber management program: reforestation and timber stand improvement (TSI). The relevant average cost figure for comparing the efficiency of alternative projects is the cost per unit of output generated. In both reforestation and TSI, the appropriate output is the volume of marketable timber ultimately produced as a result of actions taken (investments) in those areas. But in the study regions, unit costs are defined in terms of the cost per acre treated, either with TSI or reforestation. Although it may be tempting to view an acre treated as the output and, hence, benefit of a TSI or reforestation investment, it is not the product that translates directly to the benefit to consumers and to society. The benefit to society is not a "treated acre" but the usable products generated by treating that acre. With timber management investments, the relevant output is the timber volume generated. To ignore the benefit side of the ledger can lead to inappropriate investment decisions (that is, inappropriate project selections). The costs per acre treated of a particular TSI project may be low relative to other projects, but if that project is not likely to result in the greatest increases in marketable timber, other projects may be a better investment.

Perhaps part of the current resistance to defining unit costs in the appropriate manner results from the difficulties in estimating the input-output relationships that translate acres treated to timber volume generated. These production relationships are complex because of variables such as the long time periods involved that result in significant degrees of uncertainty. If the usable product of treated acres is defined as the marketable volume of timber that actually can be offered for sale, the production relationships are further complicated by the complexities of the allowable harvest scheduling procedures. But these problems should not be considered insurmountable; to cut off the analyses at the input stage (acres treated) because of estimation difficulties should be considered unacceptable.

Another common problem area is the treatment of funding levels at the margin. Two examples of this situation were observed in the study regions. A common practice is to prorate program funding level changes, within a program area, by a constant percentage across all forests in a region. Suppose WO direction states that the regional program funding for level 1, for instance, is to be 15 percent less than the previous year. Commonly, regions elaborate that program by reducing the spending limit (funding level) by 15 percent on each forest. It is a procedure easily administered at the region and considered equitable by the forests. But from the standpoint of an economically efficient program, it is better to meet the 15 percent overall funding reduction by cutting funding on the least productive (least efficient) forests, thereby protecting the budgets of the forests with comparatively efficient projects. The object is to adjust the forests' funding levels so that marginal net benefits are approximately equal, across forests, where marginal net benefits are defined by the last project funded.

The failure to conform to the equimarginal net benefit principle was also observed in one region's timber management program. When selecting projects to comprise a given regional program level (for example, level 0, 1, 2, . . .), the highest priority project from each forest is selected before lower priority projects from any forest are considered. This procedure of selecting all projects of the same priority level before considering lower priority projects is followed until the overall program funding level is reached. From an efficiency standpoint, two problems result from this approach: the forests' rankings of their candidate projects may not be coincident with a ranking on the basis of net benefits; the regions' practice of funding all priority 1 projects before any priority 2 projects, and so on, ignores the strong possibility that a lower priority project on one forest may have greater net benefits than higher priority projects on other forests. Even if it is decided to accept each forest's priority ranking, it should be possible to select, for example, priority project 1 through 4 on one forest and only the first priority project on another forest.

DISCUSSION

This report has addressed the ways that current program planning procedures diverge from an idealized approach in which economic efficiency is the dominant concern. But economic efficiency is not the only consideration that can or should validly influence annual project selection. The decision as to the priority that should be attached to various considerations--for example, efficiency, equity, stability, political feasibility--is ultimately the responsibility of Forest Service policymakers. But it seems apparent, on the basis of the findings of this study and the stated concerns of the Forest Service Chief, that regions must begin to place more emphasis on the economic efficiency of annual programs. And this increased emphasis must be associated with valid procedures.

The level of importance that should be attached to economic efficiency cannot be determined in this paper. It is appropriate, however, to suggest as a minimum that regions can and should estimate the costs of responding to other considerations in terms of net benefits foregone by not giving exclusive consideration to economic efficiency. Such costs can be estimated by initially formulating programs with exclusive regard to economic efficiency, as outlined by the mathematical model in this paper. These "economically efficient programs," which serve as a starting point, can then be modified to include other criteria that are judged to merit consideration in program planning. By initially developing this "unconstrained" program as part of a sequential program planning process, it is possible to easily identify the extent to which efficiency is sacrificed (as measured by reductions in net benefits) because of other considerations. In the context of the 0-1 integer programing formulation that has been outlined here, this is done by resolving the solution algorithm with the specification of additional, nonefficiency induced constraints. The extent to which nonefficiency induced constraints should be part of the formulation must be determined by Forest Service policymakers.

Aside from the issue of generally upgrading economic efficiency as a decision criterion, attention must focus on reducing the variability in the quality of economic analysis across regions and program areas. A primary reason for greater consistency in the quality of analyis [sic] is that, ideally, the same types of analyses should be conducted at the WO level; the WO-to-regions disaggregation is analogous to the region-to-forests disaggregation. For regions to be fairly compared in the process of establishing regional program spending levels and targets, the WO needs to have consistent economic data from each region.

The current variation in the extent and quality of economic analysis in the field is evidence that WO direction needs to be modified. A review of program budget development instructions for Fiscal Year (FY) 1984 and FY 1985 reveals that instructions on economic analysis are sketchy, at best, with little continuity between years. The economic analysis instructions appear to be written by noneconomists; general concepts are crudely and, occasionally, inaccurately discussed with no accompanying direction to the field as to how the analyses are to be conducted. In contrast to the concerns voiced by the Chief, the FY 1985 instructions contain less detail and a generally reduced sense of importance towards economic analysis than do the FY 1984 instructions.

In talking with regional program planning personnel, the presence and influence of WO economic analysis direction was barely noticeable. Section 8.6 of the FY 1984 instructions states: "Subunits must build program submittals based on economic efficiency and effectiveness." As has been discussed in this paper, considerable improvement is needed in the regions' conformance to this directive. The direction and guidance from the WO must have stronger control and enforcement mechanisms to assure conformance. And perhaps even more important, the WO must provide more assistance to the field in the form of technical guidance so that the analyses can be effectively carried out. The deficiency is not found in the regions' acceptance of the policy of economic analysis as a crucial element in resource decisionmaking but in the ability of the regions to implement the policy.

Specifically, the WO needs to provide guidance on technical issues essential to annual project selection, such as how to carry out various economic analyses and how to set up a program planning framework that responds to economic efficiency. Well developed and established guidelines would also lead to greater consistency across program areas and regions. Currently, all regions have a regional economist position, but not in all regions is the position assigned to the program planning and budgeting staffs. And even in the regions where it is, the staff economists are working almost exclusively on land mangement [sic] planning (forest plans) and RPA planning with little or no time devoted to annual program planning. As the workload associated with the current wave of forest plans subsides, the regional economists may have more time to devote to annual program planning.

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The Forest Service, U.S. Department of Agriculture, is responsible for Federal leadership in forestry. It carries out this role through four main activities:

- Protection and management of resources on 191 million acres of National Forest System lands.
- Cooperation with State and local governments, forest industries, and private landowners to help protect and manage non-Federal forest and associated range and watershed lands.
- Participation with other agencies in human resource and community assistance programs to improve living conditions in rural areas.
- research on all aspects of forestry, rangeland management, and forest resources utilization.

The Pacific Southwest Forest and Range Experiment Station

- Represents the research branch of the Forest Service in California, Hawaii, and the western Pacific.

Hrubes, Robert J. **Economic efficiency in Forest Service program development.** Gen. Tech. Rep. PS W-75. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1984. 9 p.

This report analyzes the procedures used in three regions of the Forest Service, U.S. Department of Agriculture, for selecting the projects that constitute their annual program budget. Personnel at the Southwest (R-3), Pacific Southwest (R-5), and Southern (R-8) Regions were interviewed during September and October 1982. Of special concern was the extent to which analytical methods are used that include an explicit and formal consideration of the relative costs and benefits of alternative program allocations. Current program development and budget processes were found to allow only limited discretion for efficient allocation of funds in many program areas. Contributing factors include both internal policy and practices that unnecessarily limit programing discretion and external commitments beyond the ready control of the agency. Where discretion does exist to develop annual regional programs with greater regard to economic efficiency, regions and program areas varied widely in the extent to which the opportunities are exercised. Deficiencies in internal policy direction, in the availability and consistency of project data, and in composition of planning staff are seen as contributing factors. A conceptual framework is developed that is designed to elaborate regional program alternatives that maximize the net benefits of program budget expenditures subject to regional targets and spending limits.

Retrieval Terms: program planning, economic efficiency, project selection