This is to certify that the

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EVALUATION OF FIRE MANAGEMENT ACTIVITIES

ON THE NATIONAL FORESTS

presented by

Robert David Gale

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Forestry

Robert J. Martin
Major professor

Date October 12, 1977

EVALUATION OF FIRE MANAGEMENT ACTIVITIES ON THE NATIONAL FORESTS

By

Robert David Gale

A DISSERTATION

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ABSTRACT

EVALUATION OF FIRE MANAGEMENT ACTIVITIES
ON THE NATIONAL FORESTS

By

Robert David Gale

The study evaluates individual practices, procedures and management strategies of the Fire Management organization of the U. S. Forest Service, and examines the appropriateness of achieved results. The purpose is to fulfill a request by the Office of Management and Budget for information regarding the recent escalation of Fire Management expenditures. It is also intended that the material presented in the study will be used for internal improvement of the Fire Management program within the Forest Service. For this reason, the positive aspects of Fire Management have not been highlighted.

A systems approach was devised to categorize Fire Management activities into five areas: 1) Law and Policy; 2) Resource Values; 3) Planning; 4) Managerial Control; and 5) Evaluation. The activities of each of these five subsystems are described and evaluated; and recommendations for improvement are presented.

Emphasis is given to the economic implications of Fire Management activities. An array of physical and fiscal data is presented and evaluated for the ten year period, 1966-75.

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Findings and recommendations of the study include the following.

The laws under which the Forest Service operates with regard to fires are very general, requiring only that some form of protection be provided.

The Agency's fire policies have not kept pace with its rapidly evolving philosophy of managing fires. New policies are needed which take a broader more positive approach to fire.

Forest values are neither adequately assessed or properly used in Fire Management today. Procedures for properly estimating forest values should be established and used as input for determining the level of Fire Management activity and for assessing accomplishment.

The fire planning process is incomplete. An integrated planning process based on appropriate values, resource management objectives and an analysis of viable alternatives needs to be devised.

Within the managerial control area, the current fiscal and statistical information systems need to be revised. Fiscal improvement is particularly needed in the area of suppression funds. More relevant and timely statistical information is also needed.

Additional emphasis is needed in the area of evaluation. Effectiveness evaluations are lacking and need to be added. Also a feedback mechanism from evaluations to other Fire

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Management subsystems and to other Forest Service programs should be developed.

Many of the above findings and recommendations have already been acted upon, and a discussion of these actions is contained.

ACKNOWLEDGMENTS

This thesis is based on a report of the same name produced by the author, a member of the Policy Analysis Staff of the U. S. Forest Service. For the dissertation, the original report has been rewritten and the final two chapters added.

Many Forest Service employees contributed information, ideas, and suggestions. And several submitted staff papers on various aspects of the text. Major contributions were made by Wiley Daniels, Lance Hodgin, Robert White and Rita Thompson.

Doctor Adrian Gilbert, former Director, and Everett Towle, Director of the Policy Analysis Staff, provided direction and counsel during the course of the study.

My graduate committee, Doctors Robert Marty, Robert Manthy, Lee James, and Lawrence Sarbaugh, have been helpful in shaping the former report into a dissertation. My special appreciation goes to Doctor Robert Marty, who provided the necessary advice and counsel throughout my doctorial program.

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I wish to recognize my wife, Nancy, without whose help and sacrifice this dissertation and my previous academic pursuits would not have been a reality.

Robert David Gale

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INTRODUCTION

Background

The major manager of forest fires in the United States is the Forest Service, an agency of the U. S. Department of Agriculture. This agency has three major program areas which are involved with forest fire activities: 1) State and Private Forestry which primarily provides advice and financial support to State agencies and private landholders engaged in forest fire activities; 2) Research which is primarily involved in the development of models, techniques, and equipment for improving the capability of fire managers; and 3) the National Forest System which, through its Fire Management staff, conducts fire operations on the National Forests and, by agreement, on some adjacent lands.

Of the three Forest Service programs involved with fire activities, the National Forest System is by far the largest operating on 200,736,000 acres of land. While approximately 37 percent of these lands are nonforested (e.g., grasslands), all fires on land protected by the Forest Service are generally referred to as forest fires.

To control or manage fires on these lands, the Forest Service has built a large and highly structured organization which it refers to as Fire Management. This organization

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employs between 10,000 and 20,000 people depending on the time of year and fire severity conditions. Fire management on lands protected by the Forest Service, which is what this thesis is limited to, consists of the following programs: 1) fire prevention, 2) fuel modification, 3) fire detection, 4) presuppression activities, and 5) fire suppression.

Fire prevention includes those activities aimed at preventing man-caused fires. It employs such methods as advertising campaigns, one-to-one contact with forest users, and inspecting the equipment and facilities of forest users for fire hazards.

The fuel modification program is composed of three types of activities: fuel maintenance (disposal of logging slash by burning); fuel break construction (creation in the normal forest vegetation of strips or breaks intended to slow down, stop or provide an area from which to begin adverse action against an on-coming fire); and fuel reduction (broadcast burning of large expanses of highly flamable vegetation to reduce flamability of the fuel).

The fire detection program involves those activities required to spot and locate fires. The means employed are: public reports; the traditional fire lookout operation; observation airplanes; and, to a limited degree, infrared detection flights.

The presuppression program involves those preparatory activities necessary to taking suppressive action against

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a fire. These activities include acquiring, distributing and maintaining men and equipment in an action-ready state.

Fire suppression, the program area of Fire Management with which the general public is most familiar, includes those actions required to fight, control, and extinguish an actual forest fire.

Prior to 1972, Fire Management was called Fire Control and its primary mission was to prevent or control all forest fires. In 1971, the Forest Service decided that a broader approach to fires was needed and the concept of increased preparedness, involving increased presuppression activities, began to receive new emphasis. More recently, the philosophy of Fire Management was further expanded to include the reintroduction of fire to its natural role in the forest ecosystem. The use of this "natural role of fire" is accomplished by prescribed burning or by allowing wildfires to burn under predetermined conditions to accomplish specific objectives.

It was with these changes in stated philosophical emhasis that the name change from Fire Control to Fire Management was instituted. However, despite the new name and the stated new philosophy Fire Management, in action, is still very much a control-oriented organization. This is exemplified: 1) by the fact that it still makes fire plans, and attacks all nonpreplanned fires, in accordance with its 10 a.m. and 10 Acre Policies; 2) by the emphasis it is placing

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on continually increasing its presuppression forces and equipment; and 3) by the overall, ever-increasing costs it has been incurring.

Fire Management's largest visible change has been in its presuppression operations. This change has resulted in an increase in expenditures of 134 percent in the past five years. The rationale justifying this increase is based on the idea that, through increased preparedness, a net savings in suppression expenditures will be realized. However, to date, this cause-effect relationship has not been realized. Suppression costs have increased 78 percent.

Statement of Problem

The escalation of fire expenditures in the 1970s prompted the Office of Management and Budget to request that the Forest Service provide information concerning expenditures by Fire Management. Specifically, the Office of Management and Budget (Lynn, April 15, 1975) requested the Forest Service to:

1) Determine what the increases in real costs have been over the FY 1964-75 period and what has accounted for these increases.

2) Determine the desirability of individual practices and procedures based on appropriate factors and values of costs and results.

3) Determine whether management procedures are capable of selecting appropriate fire fighting strategies and limiting use of fire fighting funds to approved activities.

Study Approach

Responsibility for conducting the study was assigned to the Policy Analysis staff unit within the Programs and Legislation Deputy Area of the Forest Service.

In July 1975, representatives of the Office of Management and Budget, the Department of Agriculture, Forest Service Fire Management, and the Policy Analysis staff group met. They agreed that the Office of Management and Budget's request could be satisfied most effectively by the preparation of two reports: a short-term report providing the requested cost information; and a longer-term in-depth study of the decisionmaking processes of Fire Management and the cost-effectiveness implications of fire management procedures.

The short-term study, referred to as Phase I, consisted of a breakdown of deflated fire expenditures from Fiscal Year 1965 through Fiscal Year 1974. The Phase I study (Hodgin, 1976) was completed in July, 1976, and submitted to the Office of Management and Budget. The longer-term effort, dealing with Office of Management and Budget questions two and three, is the subject of this thesis.

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Study Objective and Design

In outlining the approach for this study, a two-pronged goal was visualized: responding to the Office of Management and Budget request and providing information for internal improvement within the Forest Service. A study objective was defined: To analyze the desirability of the individual practices, procedures and strategies of Fire Management and to determine whether present management procedures are capable of selecting appropriate fire fighting strategies and directing proper expenditure of fire fighting funds.

To achieve this objective, it was determined that a model which would illustrate and conceptualize the activities of Fire Management should be developed to promote understanding of the total responsibilities of Fire Management. It was visualized that this model would provide a framework for gathering and analyzing the information necessary to address the objective.

A general systems model was developed, identifying Fire Management subsystems. These subsystems are: Law and Policy; Resource Values; Planning; Managerial Control; and Evaluation. (See Figure 1, page 7.) Each subsystem is the subject of a chapter in this report.

Study Organization

The text of Chapters I through V is organized to present and determine the working effectiveness of each subsystem. Within these chapters, an introductory statement

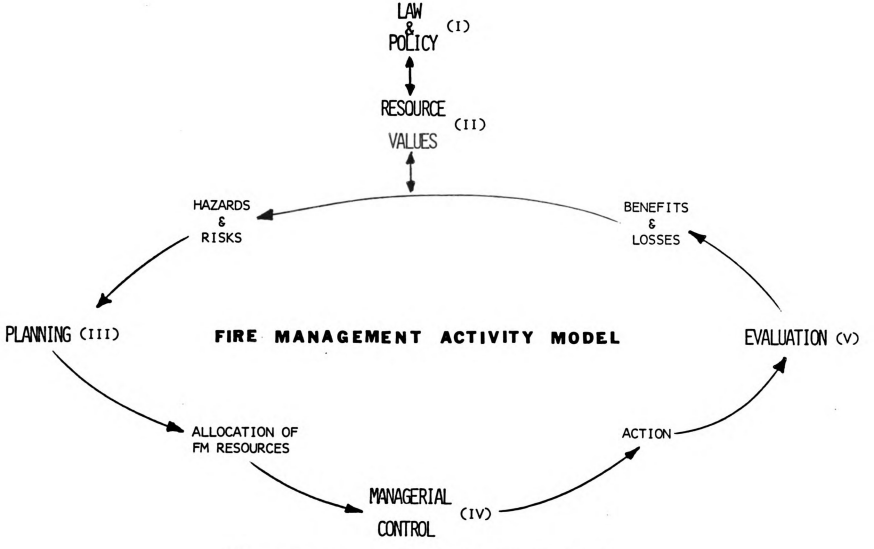

FIGURE 1. FIRE MANAGEMENT ACTIVITY MODEL

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establishes the purpose or theoretical basis for the respective subsystem. The current role of that subsystem in Fire Management activities is discussed. Current procedures and practices are evaluated, and problems or concerns are identified. Concluding remarks summarize study findings, and recommendations are presented.

Chapter VI documents the events which took place regarding the use of the developed evaluation; and Chapter VII summarizes the findings and recommendations of the study and outlines the actions taken on those recommendations.

The study is limited to fire activities within the National Forest System. National Forest fire expenditures were the concern of the Office of Management and Budget, so no attempt was made to examine expenditures or fire activities of Research or State and Private Forestry. Expenditure data were limited to those portions of the National Forest System budget referred to as Protection and Management funds and Fighting Forest Fire funds. Findings of the study may be applicable beyond this scope, however.

While this study was in progress, several related efforts emerged. These include changes in the fire budgeting system, evaluation of the national fire planning process, and most recently development of alternative fire management policies. To the extent possible, this study was coordinated with these other efforts. A discussion of these and related events is contained in Chapter VI.

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I. LAW AND POLICY

Introduction

Before reviewing the laws and policies which direct Fire Management activities of the Forest Service, it is worth reviewing the role each serves. The purpose of laws and policies is to guide decisionmaking; both are expressed in terms of assigned responsibilities, regulations or guides, procedures to follow, and goals to be met. While general constraints or guidelines are set by law, more specific direction to effectuate the intent of the law usually is left to policymakers within administering departments, agencies, and units.

For example, laws direct Federal land management agencies such as the Forest Service to "protect" the various resources on lands under their jurisdiction. The word "protect" is open to a spectrum of interpretations ranging from little to complete protection. Policymakers, therefore, must rely heavily on what is referred to as "intent" -- the intention of the lawmakers who drafted the law. Policies must be consistent with laws; policymakers are responsible for existing policy being in line with the "intent of the law" as perceived by Congress or the Executive.

On occasion, lawmakers have taken it upon themselves to specify in law what is normally thought of as policy, thereby

limiting the role of administrators to program implementation. Lawmakers also frequently assume a policy-formulating role by outlining specific policy they want enacted and including their views in supplemental materials, such as Congressional committee reports, public statements, or correspondence to administrators. Though these do not have the binding effect of law, administrators realize that ignoring them can lead to more rigorous policy specification in later legislation.

In a line and staff organization such as the Forest Service, the head of each administrative unit has decision and policymaking responsibility. In the Forest Service, this is the Chief at the Washington Office level, the Regional Forester at the Regional level, the Forest Supervisor at the Forest level, and the District Ranger at the District level. At any time, policymaking responsibility may be preempted by a higher ranking line officer, or on the other hand, specifically delegated to a subordinate. At all levels, except the District level, there may be associate or deputy positions which have limited line authority (USDA, Forest Service, 1977a, section 1206).

At each level, there are Fire Management staff and technicians responsible for advising and carrying out the fire policies and programs of the line officers. Line direction is provided by manuals, memos, speeches, management reviews, and personal contact.

The situation described above would fit most line and staff organizations. An important point, and one that most

authorities on the topic of organization and management would support, is that in practice most decisions and policies are actually made by staff groups. They accomplish this through drafting policies and decisions, training, formal and informal meetings, memoranda, task forces, activity reviews, and an active grapevine. Only when an issue is politically acute or when a line officer has a particular interest, does line usually exercise its decision and policymaking responsibility.

That line officers do not actually exercise their decision and policymaking responsibility is not necessarily a problem. Because of the magnitude of decisions and policies made, the chief executive could not be expected to have the time or the expertise to make even a majority of the necessary decisions.

The potential for a problem does exist however in the fact that the part of the organization which has no recognized authority (i.e., the staff) is largely providing its own direction. Meanwhile, line has the responsibility of seeing that that direction complies, and is consistent, with the laws and, in some cases, the policies under which the agency has been directed to operate. If communication between line and staff is not optimally maintained, a misdirection of effort may easily result.

The potential for a problem becomes particularly acute when a staff group expands or changes its direction rapidly.

There are some indications that such a problem exists today in Fire Management. This can be illustrated by the following examples.

1) In 1971, when the organization was expanded from Fire Control to Fire Management, an expanded staff role resulted.
2) There is presently a general lack of understanding and participation in fire planning by line officers.
3) There was a failure, at the 1971 Denver Fire Policy meeting, to discuss a policy that resulted in a greatly expanded presuppression role in the 1970s. That policy was the 10 Acre Policy.

The complexity, the associated risks, and the present rigidity of fire policies have caused many line officers to exercise extreme caution in counteracting a Fire Management decision. It has been the bold Forest Supervisor who would intentionally allow a fire to continue to burn into the next burning period. In the past, such actions met with strong criticism. But there now appears to be a strong desire on the part of many line officers and some Fire Management personnel for line officers to assume more of the decision-making responsibility and to incorporate fire management into a total forest management program.

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Current Situation

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Seldom is the word "fire" mentioned in legislation relating to the Forest Service. The Forest Service has had to establish its fire management policies from the implied intent of such words and phrases as "improvement," "protection," and "securing favorable conditions." Intent must also be gleaned from the passage of laws which provide for fire related expenditures such as the law which established a brush disposal fund (16 USC 490) and that which provided funds for "Smokey Bear" prevention campaigns (16 USC 488a). In addition, foresters have used professional judgement to develop policies of fire prevention and fire suppression to best meet what they saw as the needs of managed National Forests.

Several major pieces of legislation influence Forest Service fire policies. In the following discussion of pertinent laws, attention is directed to identifying the degree of flexibility or constraint the laws provide.

The Organic Administration Act of 1897 provides the first indication that forest lands will have a fire program. It states that:

> No National Forest shall be established, except to improve and protect the forest within the boundaries or for the purposes of securing conditions of favorable waterflow, and to furnish a continuous supply of timber for use and necessities of citizens of the United States. (U.S. Congress, 1974b, 16 USC 475)

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From this statement it can be inferred that fire, having an inherent potential for destruction, must be dealt with in any program to "protect the forest." The Organic Administration Act gives the Forest Service great flexibility in determining how to accomplish this protection. It does not specify how to achieve the stated objectives. It does not direct the Agency to suppress all fires. Indeed, in some situations, a type of "fire herding" policy would fit the protection mandate of the legislation. Fire exclusion policies could even be interpreted as nonprotective of some resources such as wildlife habitat, or as producing unfavorable conditions of waterflow in some cases.

In 1908, Congress authorized establishment of the Fighting Forest Fires Supplemental Fund (31 USC 534). This legislation further increased the Forest Service's flexibility in dealing with forest fires by authorizing the expenditure of nonfire appropriations for emergency fire situations. The law requires only that a detailed report be filed with the Government Accounting Office, assuring that funds used under this authority were actually spent for emergency forest fire fighting. Necessitated by the uncertain nature of the forest fire problem, this legislation reinforces the notion that fire control policy should be left largely to the discretion of the Forest Service.

The Clarke-McNary Act of 1927 (16 USC 563-565b) recognized the difficulty of confining fire to politically defined

boundaries and the need to establish a protection program on non-Forest Service lands. The Act provided funds for this purpose to State and private land managers who logically can now be expected to resist any change in National Forest fire policy which would jeopardize the availability of the Federal fire fighting funds on which they have become dependent.

The 1928 McSweeney-McNary Act (16 USC 581) added provisions to the U. S. Code authorizing sutdies and investigations into fires, weather conditions, and forestry economics. By authorizing economic investigations, the McSweeney-McNary Act made it clear that economic considerations were intended to be used in Forest Service decisions. Specifically, the Act directed the Forest Service to undertake scientific investigations on the impact of fire "and to determine and promulgate the economic considerations which should underlie the establishment of sound policies for the management of forest land." (U. S. Congress, 1974b, 16 USC 581)

Further responsibility for using an economic approach was given to the Forest Service by the Multiple Use - Sustained Yield Act of 1960 (16 USC 529). It states that "the National Forests shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes" and "utilized in combinations that will best meet the needs of the American people." The Act further states that "in the administration of the National Forests due consideration shall be given to the relative values of the various resources." (U. S. Congress, 1974 b, 16 USC 529)

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Although for the most part Congress indicates those policies it wishes to specify in the form of authorities for, or procedures regarding, implementation, it has over the years enacted several specific policies into legislation. For example, laws are now on the books authorizing reward payments for information regarding violation of USDA regulations developed to protect forests from fires and authorizing funds to cover losses during fires in National Forests (16 USC 599a).

Further, Congress has established regulations governing the type of hiring and contracting used in fire protection. For example, the Economy Act of June 30, 1932, establishes general guidelines for an agency's purchasing goods and services from other government agencies and from the private sector (31 USC 686). The 1944 Department of Agriculture Organic Act provided for contracting aerial facilities and services for protection of National Forests (16 USC 577a) and for temporary hiring or contracting of personnel services within the USDA (7 USC 2225).

Three general conclusions can be drawn from the laws discussed above.

1) The Forest Service is expected to provide protection of the various resources on National Forest lands.
2) Congress has left fire management policy to the Forest Service and has, without being unduly

restrictive, provided the Forest Service with the necessary authority to determine this policy.

3) Some of the legislation relating to the Forest Service intends that economic rationale, based on resource values, be used as a basis for establishing fire protection levels.

Policy

Policy serves to express the intent of the law and may be defined as any statement that provides program direction. The wording used in a policy statement may be the same as or similar to that used in the law. Policy differs significantly from law only in that policy is more specific and is not legally binding.

The purpose of this section is to consider various policies which are important to the current operation of Fire Management. These policies will be considered one by one; but, before this is done, two points should be emphasized. First, not all policy under which Fire Management operates is included in the Forest Service Manual (USDA, Forest Service, 1977a). Characteristic of the situation that develops with a rapidly evolving program, the Manual has not kept pace with all the policy currently guiding fire management activity.

Secondly, this study does not review all fire management policies but concentrates on those having economic

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implications and those relating to concerns expressed by the Office of Management and Budget and the Department of Agriculture. The policies to be considered include: the Zero Code and prevention, presuppresssion, suppression and fuel management policies.

Zero Code

The first paragraph of the Fire Section of the Forest Service Manual (USDA, Forest Service, 1977a, Section 5100) sets the tone for fire policy in what is known as the Zero Code.

> Forest fires cause serious damage[1] to water, soil, timber, recreation, and forage resources. These resources are indispensible to a growing population. Effective fire control is essential to (1) ensure an adequate supply of usable water by maintaining an adequate cover on upstream watersheds, (2) minimize downstream flood damage, (3) protect wildlife habitat and prevent destruction of forage for both wildlife and domestic stock, (4) ensure a continuous supply of timber, and (5) protect the recreational values of the Forest, so important to the physical and spiritual health of the Nation.

The Zero Code, as it has been interpreted, is a policy of fire control and exclusion to the fullest possible extent. Simply stated, the policy implies that all fires are bad and that all resources need to be protected from fire. It fails to recognize any benefits from fire, or the existence of those resources which do not need total (or any) fire protection.

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on how to construct prevention plans (FSM 5112.1), it is clear that, in contrast to what is stated in the prevention objective (FSM 5110.1), the policy actually is to eliminate or reduce the number of man-caused fires regardless of any economic considerations. The areas of cost and resource values are not referred to in the Manual's directions for analysis of fire prevention needs.

Most of the Forest Service's fire prevention efforts, to date, have utilized advertising campaigns (e.g. "Smokey the Bear"), personal contacts, equipment inspection and hazard reduction practices.

Presuppression

The Forest Service's presuppression policy and program are perhaps the least understood of all its fire activities. Although the presuppression program has changed significantly in size and scope in the 1970s (Figure 2, page 21), relatively little effort has gone into formalizing these changes by including them in the Servicewide directives system.

The Forest Service Manual defines presuppression as:

> . . . work done in advance of fire occurrence to ensure effective suppression action. This preliminary activity includes recruiting and training, planning the organization, maintaining fire equipment and fire control improvements, and procuring equipment and supplies. (USDA, Forest Service, 1977a, section 5120)

For accounting and National fire planning purposes, presuppression also includes program activities such as prevention, detection, and fuel management (hazard reduction).

It would be inaccurate not to mention that the Zero Code continues on for nine pages and discusses the necessity of establishing a tolerable loss level with attention to cost, damages, and coordination with resource managers. However, the specific fire program policies that follow the Zero Code in the 5100 Section of the Forest Service Manual never recover from the Code's initial implication that all fires are bad.

Prevention

The prevention policy, stated in the Fire Section of the Manual, says little about what the policy actually is. Rather, it states:

> Prevention of fires is a job of high priority for all Forest Service personnel. Next to fire suppression, it is the highest priority job of all fire control personnel, District Rangers. . . Each Region will prepare and activate a Regional prevention program.
> (USDA, Forest Service, 1977a, section 5110.20)

The policy is perhaps better expressed in the prevention objective.

> The objective of fire prevention is to eliminate (man-caused) fires. The attainment of this objective is dependent upon the cost of the fire prevention program and the resource values involved.
> (USDA, Forest Service, 1977a, section 5110.1)

Economic logic will support the soundness of the above statement that there is a need to qualify the objective of eliminating man-caused fires by reference to cost and resource values. However, on reviewing the Manual's directions

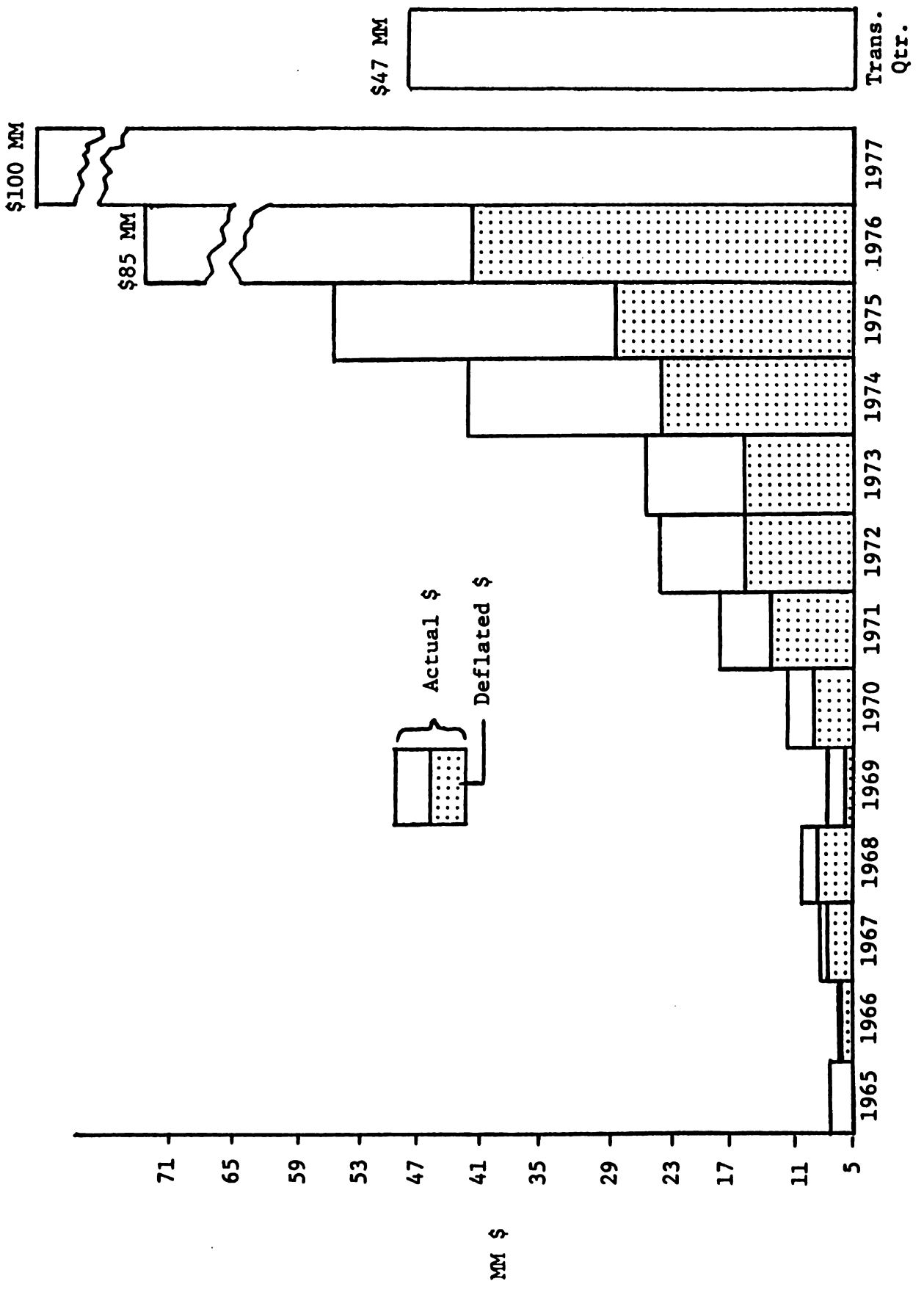

FIGURE 2. PRESUPPRESSION EXPENDITURES (FFF)

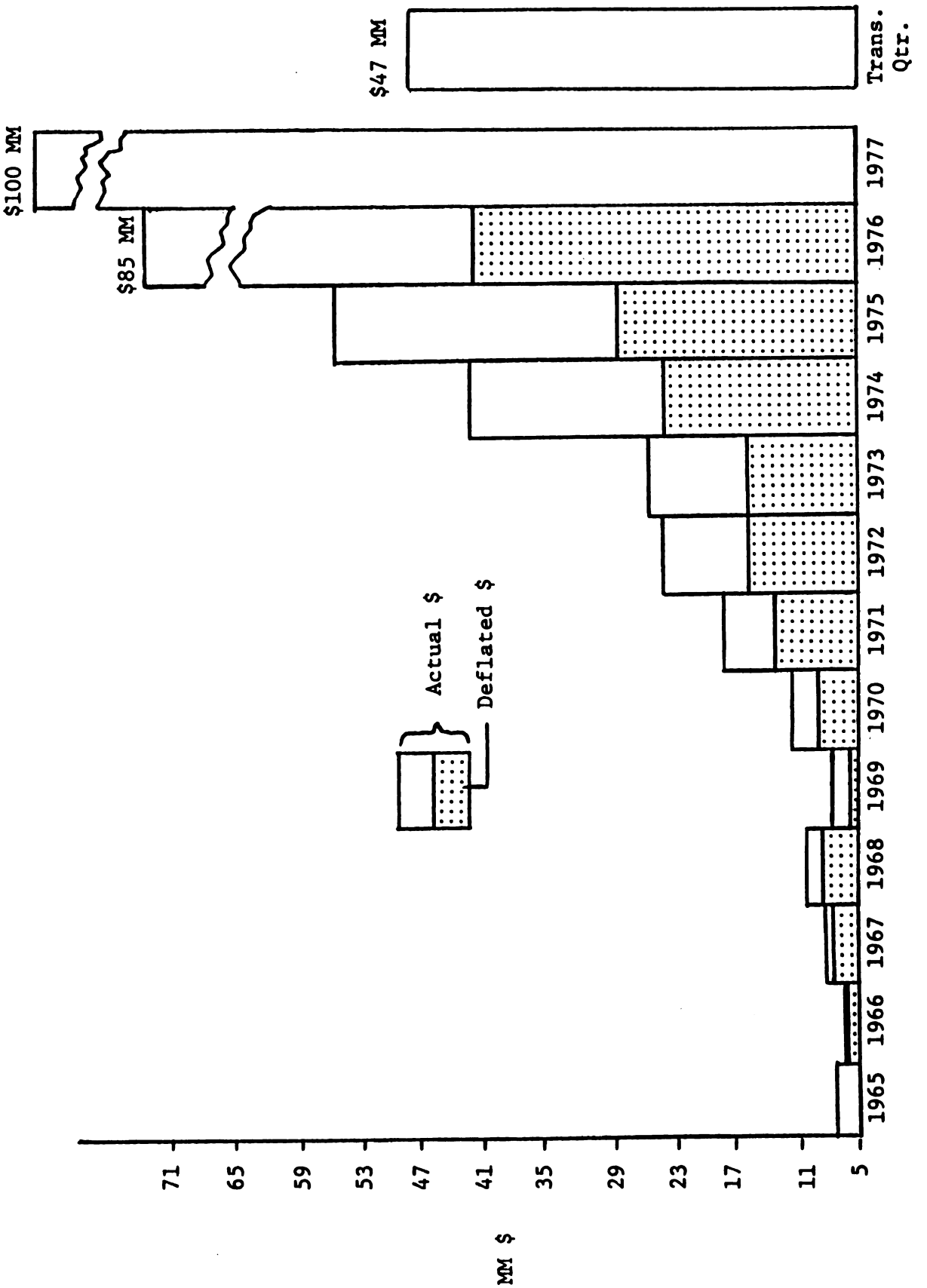

FIGURE 2. PRESUPPRESSION EXPENDITURES (FFF)

For the purpose of this evaluation study, reference is made only to those actions necessary to establish a level of fire protection (e.g. manning, equipment and facility needs).

Presuppression policy, as stated in the Manual, is unclear. Section 5120.2 states that:

> Each Region will organize and maintain an active fire control force in accordance with approved presuppression plans and available funds. (USDA, Forest Service, 1977a)

This statement directs preparation of a plan, but provides little guidance or indication of what this plan is to accomplish.

In 1972, a draft handbook entitled "National Fire Planning" was developed by Fire Management. A concept appears in this handbook which has today become the primary focus of presuppression planning. This concept may be referred to as the "10 Acre Policy" although it is not formally designated as such.

The 10 Acre Policy is to presuppression planning what the 10 a.m. Policy is to fire suppression planning. The 10 a.m. Policy, which requires a sufficient level of activity to suppress all fires which have escaped initial attack before 10 a.m. of the next burning period, is the dominant policy of suppression planning. The 10 Acre Policy requires that presuppression activities be planned and available to hold fires to 10 acres or less.

The 10 acre concept reflects the theory that it is cheaper to keep all fires as small as possible. Two

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developments occurred in the 1970s which emphasized the importance of the concept. First, through the National Fire Planning instructions (USDA, Forest Service, 1972), the 10 Acre Policy became a formal building block in presuppression planning. Secondly, the reduction of the number of fires exceeding 10 acres was popularly embraced as the ultimate goal for which to strive. Presuppression plans in current use on National Forests have been developed in accordance with manpower and equipment needs to achieve this goal. The National Fire Planning instructions direct the Regions to strive for holding 100 percent of the fires to less than 10 acres. Some Regions and Forests saw this as an impossible goal and did not attempt to reach it; others took a more literal interpretation.

The supporting document for the Forest and Rangeland Renewable Resources Planning Act of 1974 (USDA, Forest Service, 1976d) established a new planning level for presuppression forces intended to reduce the number of fires exceeding 10 acres by two percent of the current figures. To accomplish this two percent reduction, a 90 percent increase in presuppression expenditures over the 1976 level is predicted (Figure 3, page 24).

Suppression

Suppressing forest fires has always been a priority job for the Forest Service. The Forest Service has its roots in what was considered the need to prevent destruction of

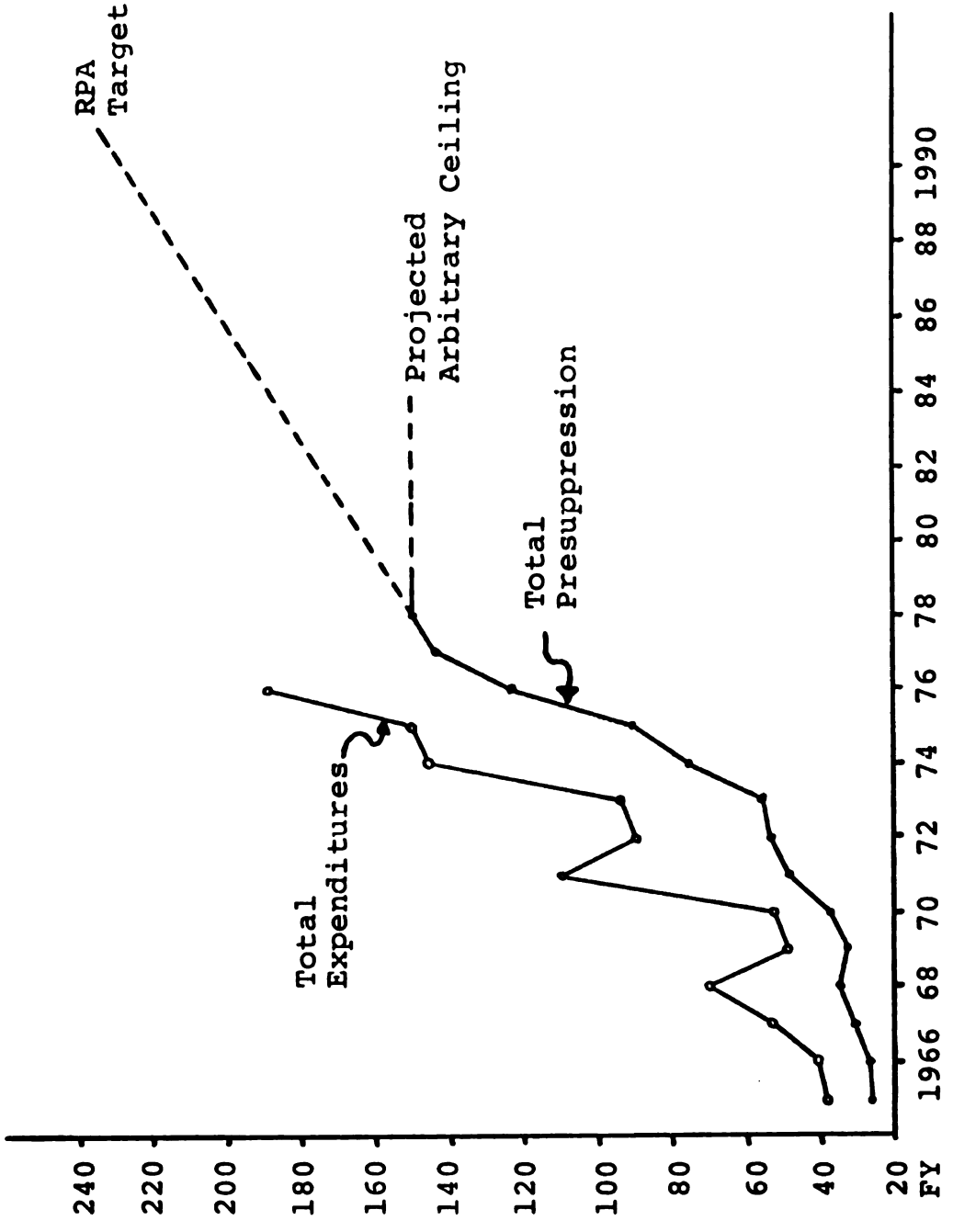

FIGURE 3. CURRENT AND PROJECTED COSTS

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forests by fire and man. Up until the mid-1930s appraisals of tangible forest values were used to determine the amount of emphasis placed on controlling any specific fire; however, in 1935 in the aftermath of several severe fire seasons, Forest Service Chief F. A. Silcox outlined what has become known as the "10 a.m. Policy."

This policy, which has remained pretty much intact since Silcox first stated it, reads:

> Fire suppression will be fast, energetic, thorough, and conducted with a high degree of regard for personal safety. . . . (The fire organization will) organize and activate sufficient strength to control every fire within the first work period. If the fire is not controlled in the first work period, the attack each succeeding day will be planned and executed to obtain control before 10 o'clock the next morning.
> (USDA, Forest Service, 1977a, section 5130.3)

The policy goes on to state that any exceptions to it must be preplanned in advance of the actual fire and can be granted only by the Chief, or Deputy Chief for National Forest Systems.

According to Chief Silcox, the 10 a.m. Policy would provide a "chance for experimentation on a continental scale." (Silcox, May 25, 1935) Thirty-six years later, at a Fire Policy meeting in Denver, the direction of that experiment was reaffirmed as Forest Service policy.

While the decision to establish 10 a.m. as a suppression criterion was arbitrary, it was based on several assumptions and findings (Brown and Davis, 1973). First, a definite action policy with regard to fire suppression is

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needed. Second, aggressive initial action is cheapest in the long run. Third, it is difficult to accurately determine forest values. Finally, there is a need to build and maintain the morale of suppression forces. Although these assumptions may have been valid in 1935, their economic implications today are increasingly in question.

Fuel Management

For years it was thought that, through increased effort and improved techniques, fires could be prevented or at least quickly controlled. While there is evidence that we can stop fires reasonably quickly under some conditions, there is little evidence that we can prevent a given area from eventually burning. Prevention and control efforts have delayed and, in some cases, reduced the frequency of burning. It now appears that the outcome of a vigorous prevention and suppression program is a continual buildup or accumulation of fuels and an eventual, inevitable series of conflagrations. Thus, the Forest Service carries out a program of fuel management.

Fuel management is defined as the manipulation or reduction of fuels to meet forest protection and management objectives while at the same time preserving and enhancing environmental quality. The objective of fuel management is to obtain fuel conditions which permit protection forces, using methods which maintain environmental quality, to meet fire control objectives which have been established to

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ensure a sustained, high productivity level for renewable resources (USDA, Forest Service, 1977a, section 5150.2).

Fuel management policy states that when alternate treatments will accomplish the same fuel management objectives at comparable costs, selection priority will first choose treatment which does not require burning; then treatment which allows the greatest period of time for safe burning; then treatment with a restricted safe burning period; and finally combinations of treatment and extra protection (USDA, Forest Service, 1977a, section 5150.3).

Using fire to manipulate vegetation and alter fuels to achieve various management objectives may be done in two ways: by man igniting a fire or by allowing a natural[1/] fire to continue to burn. In both cases, the Forest Service requires development and approval of a plan prior to the use of fire. The plan contains specific management objectives, identified areas, constraints for burning conditions, and a backup plan in the event the fire escapes the planning area. These requirements clearly distinguish fire by prescription from what is often referred to as a "let burn" policy (i.e., merely sitting back and watching a fire burn).

Analysis

Of Existing Laws

The laws under which Fire Management operates are basically adequate, although there is a need to redefine the uses

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of the supplemental fire fighting funds initially provided by law in 1908. The need for this type of open-end fund was much greater in 1908 when there were limited fiscal and fire data available to use as a basis for estimating needs. Today supplemental funds are still necessary to cover suppression expenses in excess of predicted norms. However, budgeting generally promotes better recordkeeping, accountability, and efficiency of expenditures.

Of Existing Policies

Prevention

Prevention is an important policy to pursue, but it should be more closely related to returns. In order to set realistic prevention goals, it is necessary to know:

-- the cost of preventing an additional fire; and

-- the benefits derived when additional fires are prevented.

Prevention efforts utilizing such methods as land management planning and zoning (e.g., identification of high risk fire areas and the placing of restrictions on types of building materials in fire-prone areas) might produce more returns than current advertising campaigns, inspections, etc.

Presuppression

A significant portion of Fire Management's cost increases in the 1970s can be attributed to the application of the 10 Acre Policy. As stated previously, the National Fire

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Planning instructions (USDA, Forest Service, 1972) direct the Regions to strive for holding 100 percent of the fires at less than 10 acres, and the document supporting the Renewable Resources Planning Act of 1974 (USDA, Forest Service, 1976d) establishes a planning level for presuppression forces that would reduce the number of fires exceeding 10 acres by two percent over the current level. This two percent decrease would involve an estimated 90 percent increase in presuppression expenditures. At the same time, the Resources Planning Act document does not project any decreased suppression costs or any increase in resource output resulting from the nearly doubled presuppression expenditures.

As the data on Table 1, page 30, show, the percentage of fires less than 10 acres in size has changed little in the past five years in spite of increased expenditures during the same period.

Suppression

Although the assumptions on which the 10 a.m. Policy were based may have been valid in 1935, their economic implications today are increasingly in question.

An example which makes this point is the Cane Gully fire in Region 8, reported in an article in Fire Management (Devet, 1975). The fire was not considered to be a threat to the forest; it met the conditions of a pre-determined plan (i.e., DESCON) and was therefore exempt from the 10 a.m. criterion. Under the DESCON plan, the actual fire costs were $62. No

TABLE 1. PERCENT OF FIRES[1] LESS THAN TEN ACRES[2]

CALENDAR YEAR	R-1	R-2	R-3	R-4	R-5	R-6	R-8	R-9	R-10	NFS TOTAL
1965	97.9	96.8	95.9	93.6	97.6	98.0	82.8[3]	89.3[3]	94.1	94.7
1966	94.4	93.2	96.1	92.8	95.4	97.6	81.7	81.7	95.2	92.9
1967	94.9	93.1	94.9	97.4	97.3	97.2	79.0	86.5	90.0	93.1
1968	94.7	94.5	95.0	95.2	94.6	96.8	82.6	86.5	91.7	92.7
1969	95.9	92.6	92.2	96.8	96.1	98.2	79.5	82.7	94.4	91.8
1970	94.7	94.3	95.6	96.1	95.1	97.0	80.4	86.7	100.0	92.9
1971	95.6	93.8	95.2	94.4	96.2	98.0	84.4	87.8	92.3	93.3
1972	98.0	97.0	98.3	96.0	96.5	98.7	86.3	88.0	95.5	95.9
1973	94.7	95.2	96.6	96.4	96.9	98.0	86.1	89.5	94.1	95.4
1974	96.2	94.7	93.4	94.8	96.3	97.7	83.1	87.5	91.9	93.7
1975	98.4	95.3	96.5	98.1	96.7	98.4	83.2	89.2	95.8	94.8
1976										
Mean-All Yrs	96.0	94.6	95.4	95.6	96.3	97.8	82.7	87.4	94.1	93.8/95.7[4]
Mean-Last 5 Yrs	96.6	95.2	96.0	95.9	96.6	98.2	84.6	88.4	93.9	94.7/96.1[4]

1 Includes all fires to which the Forest Service responded.

2 Source: USDA, Forest Service, 1965-1975.

3 Does not include data from R-7 Forests which are added to R-8 and R-9 in 1966. R-7 data for 1965 = 90.3 percent.

4 NFS mean not including R-8 and R-9.

damage was reported and a fuel management objective, worth $146, was accomplished by the fire. It was estimated that the cost of a normal suppression action would have been $250.

The desired output of any suppression action is to maximize the sum of the benefits minus the sum of the costs. This can be expressed:

$$\text{Maximum results} = \overbrace{\Sigma(EV + DA + SA)}^{\text{benefits}} - \overbrace{\Sigma(SC + D)}^{\text{cost}}$$

The equation reads: To maximize results, consider the sum of enhanced values (EV), plus damages averted (DA), plus suppression cost averted (SA), minus the sum of suppression cost (SC), plus actual damages (D). Assessing effectiveness of a suppression activity requires looking at more than the relationship of damages to suppression cost. An analysis of the whole equation should be made. While this is more difficult to assess, it is far more meaningful.

The major problem with the 10 a.m. approach is that it does not consider the benefit aspect of the equation. It merely assumes that benefits will be forthcoming and that the faster the fire is put out the greater the benefits will be. Like most assumptions, when carried to extremes they are no longer valid. The question of the relationship between benefits and suppression costs is ignored. The 10 a.m. Policy does <u>not lead to identifying benefits; it merely assumes they exist</u>.

Fuel Management

For all practical purposes, the section of the Forest Service Manual which deals with fuel management (FSM 5150) describes only the hazard reduction aspect of fire use. There is no section dealing with other more positive aspects of fire use. Thus, the Manual gives a distorted view of current fire use practices, ignoring the use of fire in accomplishing resource management and environmental objectives such as site preparation, silvicultural thinning, insect and disease control, control of undesirable plant species, improvement of range and wildlife habitat, maintenance of forest openings and edge habitat, and improvement of scenic vistas. This role of fire (i.e., developing and maintaining forest ecosystems) accounts for most of the ways in which fire is used today. Alternatives to the use of fire (mechanical devices, herbicides, etc.) are not ecological equivalents and do not achieve the same resource management and environmental objectives while preserving and enhancing environmental quality.

The fuel management section of the Manual needs to be revised to reflect the current situation which, in reality, is a Fire by Prescription[1/] policy. This policy is being practiced today in the form of wildlife habitat improvement, hazard reduction, and exceptions to the 10 a.m. Policy. Since 1972, five areas have been approved for the 10 a.m. exception (Table 2, page 33). The areas include 1.1 million

1 Any controlled use of fire to achieve management objectives.

TABLE 2. AREAS WITH APPROVED EXCEPTIONS TO THE 10 A.M. SUPPRESSION POLICY

UNIT	LAND CLASSIFICATION	EXCEPTION[1/] ACREAGE	YEAR APPROVED
DESCON			
Kisatchie NF	Non-wilderness	84,000	1973
Francis Marion NF	Non-wilderness	249,000	1973
Gila	Wilderness	60,488	1974
White Cap	Wilderness	66,000	1972
Bear Creek	Wilderness	67,000	1973
Teton [2/]	Wilderness	557,000	1975
	Non-wilderness	28,000	1975

1 Total acreage NFS lands = approximately 187 million acres. Total wilderness acreage = approximately 12 million acres.

2 Six additional units are currently under study for 10 a.m. exceptions.

acres, or approximately one-half of one percent of the total acres of forest lands protected.

Fire by prescription has many important implications to future policy. Principally, it represents an alternative to continued expansion of presuppression and suppression.

Summary and Conclusions

The laws under which Fire Management operates are basically adequate. Their intent is that the Forest Service protect resources on National Forest lands. Some pertinent legislation directs that economics and the relative values of resources be considered in protection programs.

Traditionally, the task of setting policy to carry out the intent of laws has been left to the Forest Service. In performing this task, the Forest Service has emphasized the mandate to protect and has given minimum consideration to economics and resource values.

The expression of Fire Management policy has not kept pace with rapidly evolving Fire Management philosophy. At all levels of the Fire Management organization, the desire to change from the role of fire control to fire management is apparent; yet policy statements never quite recover from the implication of the Zero Code that all fires are bad.

In practice, the beneficial effects of fire are being used to accomplish a variety of resource management objectives; however, none of these beneficial effects are recognized in policy. This fact is especially apparent in the

fuel management policy which addresses only hazard reduction. Changing this policy to reflect the use of fire for both fuel alteration and vegetation manipulation (i.e., fire by prescription) would provide a recognized alternative to continued expansion of presuppression and suppression activities and would relate fire management more directly to other resource management needs.

Current fire management policies are basically non-economic, based on the assumption that increased levels of activity produce increased returns. Suppression activity should be assessed according to enhanced values, damages averted, and suppression cost averted (i.e., beneficial effects of fire) in addition to suppression cost and actual damages. Neither the 10 a.m. Policy which states suppression objectives, nor the 10 Acre Policy which states the presuppresion objectives, is related to total Forest Service management and resource values and needs.

Many of the concerns with current policy expressed here are also reflected in other chapters of this report. This interrelatedness of topics is expected in a management system where subsystems are related through information flow and feedback. Specific recommendations relating policy to other fire fire management subsystems (resource values, planning, etc.) are reserved for their appropriate chapter.

In summary, a basic change is needed from the old policies of fire control to policies which will promote the

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use and management of fire. These new policies should do the following:

1) encourage an efficient, effective fire program within the total resource management system;
2) require economic input in the decisionmaking process;
3) provide a protection level responsive to resource and management needs;
4) encourage more active participation by line managers in fire management decisions; and
5) consider responsibilities to private land owners and cooperators on lands adjacent to the National Forest.

Recommendations

Develop new Fire Management policies which provide for a broader, more positive approach to fire, consider economics, and encourage line participation in the decisionmaking process.

II. RESOURCE VALUES

Introduction

In order to understand the significance of resource values to fire management programs, it is important to understand that Fire Management is a service-oriented organization in the Forest Service. As such, it produces secondary outputs. By managing fires (i.e., preventing, suppressing or using fire), the primary outputs of other resource functions may be enhanced or their quantity increased.

To determine the desired amount of fire management service, it is necessary to know: 1) the values that other resource functions place on the resources they produce; 2) the cost of providing the fire management service; 3) the feasibility of providing the fire management service; and 4) a knowledge of other options to enhance the resources or increase their quantity. After weighing these factors, an equitable level of fire management activity can be established.

Values, in addition to their use in helping establish a desired level of service, provide a means through which to measure fire management accomplishments. Knowledge of the resource values involved permits a more nearly accurate assessment of the enhancements, losses, and savings resulting from fire management activities. As indicated in the

previous chapter, it is not accurate to assume that fire management yields benefits in direct proportion to its level of activity.

In using values as a means by which to determine the desired level of fire management activity, it is important that the values involved be carefully assessed. For example, it is agreed that it is necessary to consider public safety when planning for and suppressing fires and, in populated areas, this factor might outweigh all other considerations. However, it is the opinion of this study that there is a tendency to view public safety as a factor which implicitly demands high fire management activity particularly in areas where neither resource values or other needs support a high protection level. A look at the record reveals that the performance of Fire Management in the area of public safety is excellent. Table 3, page 39, indicates that there has not been a public fatality due to fire on National Forest lands in at least 34 years. Private citizens, the record states, are not being killed by forest fires. (Fire fighters, on the other hand, are.) This does not imply that public safety is not a significant objective, but rather that each fire situation should be objectively assessed and public safety should be considered according to the real, rather than the emotionally inflated, need.

On the other hand, in some cases, management objectives for a specific resource might require a protection level in excess of normal resource values. In the case of the Condor

TABLE 3 NATIONAL FOREST FATALITIES

C. Y.	Non Fire			Fire Related Fatalities									
				Private Citizen		Contractor/Permittee			Forest Service Employee				
	Forest Ser. Employee	Visitor	Contractor/ Permittee	Not Fighting Fire	Fighting Fire	Airplane	Helicopter	Fire Fighting	Fire Fighting	Airplane	Helicopter	Other**
19 55	13								2			
56	9							1	12			1
57	1										2	
58	19					5			4			
59	9								9	3		1
60	8				2				5			
61	2								3			
62	8						1	1	8	3		
63	2						1		1			
64	7								1		2	
65	4										2	
66	17								12		1	
67	6							1	4			
68	9					1	3	1	4			
69	10						1				2	
70	12						3		3		4	
71	1					2		1	4			
72	6	242				3	1				5	
73	4	133				1			2			1
74	11	127	39		1	4	1				1	
75	6	107	19			3			1		2	1
*76	6	70	13						3			
	241	679	71	0 ***	3	19	11	5	78	6	21	4

DATA UNAVAILABLE

* to date 9/13/76

** motor vehicle accidents enroute to or from fire

*** Forest Service records were searched back to 1944 and no fatalities were found

in southern California, for example, an all-out protection effort might be mandated to protect the last remnants of this endangered species.

Current Situation

At the present time, two systems for assessing resource values are used. Both equate "values" with "damages" and are briefly described below.

Actual Damages

In the Forest Service Manual (USDA, Forest Service, 1977a), the 5140 section entitled "Damage from Fire," defines and categorizes damages, providing directions for measuring those it lists as tangible. If the directions are followed, a reasonable estimate can be obtained of damage to sawtimber and other marketable wood products, livestock forage, improvements, and equipment. According to section 5140, damages are categorized as "tangible" and "intangible" and examples are listed.

Section 5331 of the Manual, entitled "Fire Trespass", contains procedures for calculating only tangible fire damage (including cost). All procedures presented utilize conservative dollar value estimates, chosen to withstand court tests. At the end of the Fire Trespass section there are provisions for revising the methods of calculating tangible fire damage, including placing supportable dollar values on items heretofore considered intangible.

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Potential Damages

For the 1972 National Fire Planning process, actual measured damages were not considered adequate for fire planning by Fire Management personnel. Therefore, a delphi technique[1/] was instead used to establish potential fire damage classes and assign them values. A set of seven "potential fire damage" classes was developed. This appears in the National Fire Planning instructions (USDA, Forest Service, 1972). The instructions (page 27) define damage potential as "the anticipated loss from a fire burning under 'high' burning conditions. It includes resource loss and improvement loss, such as road damage and reservoir siltation. (It does) not include high value improvements on the land such as summer homes and resort buildings."

The seven damage classes are composed of 48 general resource categories, each of which is assigned to one of the seven damage classes. Classes have an assigned dollar value ranging from $250 per acre (Damage Class 1) to $3,000 per acre (Damage Class 7). See Table 4, pages 42 and 43. Field personnel develop Damage Potential Maps on which each area of a National Forest is assigned to one of the damage classes.

Analysis of Present Resource Valuation Practices

Fire Management today uses values very little in its planning and evaluation activities. A formal process does

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1 A subjectively arrived at conclusion utilizing a group of experts. In this case, the group included Fire Management personnel who used various resource specialists in a limited capacity.

TABLE 4. POTENTIAL FIRE DAMAGE CLASSES[1/]

CATEGORY NUMBER	CATEGORY (PRIMARY USE)	DAMAGE CLASS	AVERAGE $ LOSS & DAMAGE
1	Commercial Development	7	
2	Recreation, Heavy, Diversified	7	3,000
3	Seed Orchard	7	
4	Historical Area	6	
5	Domestic Water	6	
6	Camp and Picnic Area	6	
7	Endangered Species	6	2,400
8	Rare Species Habitat	6	
9	Anadromous Fish (A strip shading stream)	6	
10	Water Influence	6	
11	Experiment Forest	6	
12	Brushfield (Erodible Soil)	6	
13	Power (Water)	5	
14	National Recreation Area	5	
15	Congressional Classified Area	5	
16	Summer Home Area	5	
17	Brushfield (Thin soil)	5	2,000
18	Fisheries	5	
19	Travel Influence Zone	5	
20	Archeological Zrea	5	
21	Botanical Area	5	
22	Scenic Area	4	1,500

1 Source: USDA, Forest Service, 1972.

TABLE 4 (CONTINUED).

23	Winter Game Range (Non-sprouting species)	4	
24	Irrigation (Water)	4	
25	Industry (Water)	4	1,500
26	Timber (Old growth)	4	
27	Land Suitable for Recreation Sites	4	
28	Barometer Watershed	4	
29	Peripheral Species (Fauna)	3	
30	Geologic Areas	3	
31	Timber (Poles)	3	
32	Timber (Second growth)	3	1,000
33	Timber (Reproduction)	3	
34	Timber (Saplings)	3	
35	Game & Non-game (Sprouting species)	3	
36	Non-commercial Forest	2	
37	Winter Sports	2	
38	Wilderness	2	
39	Primitive Area	2	500
40	Seed Production Area	2	
41	Perennial Forb Range	2	
42	Seed Collection Area	2	
43	Range Meadow	1	
44	Conifer, Pinion, Juniper, Broadleaf	1	250
45	Sagebrush	1	
46	Natural Area	1	
47	Brushfield (Non-palatable) Stable Soil	1	
48	Range Grassland	1	

not exist within the Fire Management organization for reviewing actual damage estimates, and the presuppression planning process which utilizes a potential damage input is relatively insensitive to that input. Moreover, there is no link between actual damages and potential damages.

In part, Fire Management's limited use of values can be attributed to its recognition of the inadequacies of the methods it is instructed to use. For example, Fire Management's instructions for categorizing damages and assigning dollar values to them are inadequate and, in some part, inaccurate; its method for determining costs is inadequate; and the dollar values assigned to the potential damage classes exceed actual damage incurred.

Categorizing and Valuing Actual Damages

The FSM 5140 system of categorizing "tangible" and "intangible" damages is inadequate and inaccurate. Most of the types of damages that are listed as intangible are in fact tangible and can be measured by dollars using recognized procedures which have been tested in court. In addition, the narrative in FSM 5140 states that the losses from intangible damages will usually exceed those suffered from tangible damages. The effect of this statement is the message that one does not need to be too concerned about damages because intangible damages, which you cannot measure, will usually be greater than tangible damages, which you can measure. The negative impact of this message is intensified by the wrong assignment of tangible damages to the intangible category.

The Fire Trespass section (FSM 5331) contains procedures for estimating only those damages which have been classified as tangible in section 5140. It ignores the legally accepted procedures for estimating the dollar value of such items as recreation losses, employment losses, environmental degradation, fish and wildlife losses, and loss of life (Mishan, 1976). These procedures should be incorporated into both sections 5140 and 5331.

Assessing Costs

The way in which "costs" are handled in FSM 5140 precludes separating suppression cost from rehabilitation cost. While, in the final analysis, these costs may be additive, they are not synonymous and should not be perceived as such. Further, the aftermath of a fire may be a watershed loss and a watershed rehabilitation cost; yet the directions in FSM 5140, and the associated cross-references to section 2520 dealing with watershed management, refer only to the rehabilitation cost as damage. (This is not intended to imply that rehabilitation cost may not be used as a means of estimating some form of damage.)

Assigning Potential Damage Classes

The dollar values assigned to the potential fire damage classes, as they appear in the National Fire Planning instructions, appear to exceed actual fire damage by a factor of 10. As a part of this study, a test of the validity of the potential damage class figures was conducted. In this

test, potential damage class data were compiled and arrayed by Regions and value classes (Table 5, page 47). Estimates of fire damage and land value data were also collected from several independent sources for comparative purposes. These two sets of data are displayed in Tables 6 and 7, pages 48-49.

When making comparisons between the two sets of data, two points should be kept in mind.

1) Potential damage applies only to that portion of the resource that can be damaged by fire.
2) The independent data in several cases include values which fire cannot damage and, therefore, these data should serve as an upper limit which fire losses could not exceed.

Discussion of the comparisons is appended to this report (Appendix A).

Suggested Framework for Measuring Affectable Values

Thus far in this chapter resource values have been discussed only in terms of damage or potential damage. That the present systems of valuation presently used by Fire Management consider values only in the context of damages has been a major obstruction to establishing a desired level of fire management and to measuring fire management accomplishments. It needs to be recognized that, in some areas, ecological or other benefits result from fire as clearly as benefits result from excluding fire in other areas. Reliable estimates of the benefits as well as the actual damages from

TABLE 5. POTENTIAL DAMAGE BY VALUE CLASS

Value Class	1 $250	2 $500	3 $1000	4 $1500	5 $2000	6 $2500	7 $3000	TOTAL Value	TOTAL Acres	Avg. Value per Acre
Region	($M)	($M)	($M)	($M)	($M)	($M)	($M)	($M)		($)
1	181,124	2,389,619	8,683,404	14,416,557	3,096,980	3,626,615	670,020	33,064	27,020,652	1,224
2	908,150	1,745,373	4,787,560	7,289,142	3,533,056	6,181,878	2,158,236	26,604	21,729,425	1,224
3	1,296,991	969,354	3,157,225	10,425,230	1,814,406	8,401,910	1,946,070	28,011	22,068,233	1,269
4	2,230,766	2,613,118	3,101,067	13,794,306	6,957,296	6,236,875	1,285,062	36,218	32,848,322	1,103
5	270,675	832,318	3,277,436	9,122,349	10,360,706	12,130,658	2,898,300	38,892	23,105,054	1,683
6	68,618	855,090	1,518,851	14,557,706	15,761,652	7,235,953	1,351,518	41,349	24,434,351	1,692
8	4,481	101,444	8,493,589	8,170,809	4,093,940	2,537,045	1,770,843	25,172	17,813,674	1,413
9	26,246	122,038	7,927,844	3,037,522	2,603,848	4,008,980	679,923	18,406	14,378,925	1,280
10				Region 10 does not use this system						
Total F.S.								247,716	183,398,636	1,361

TABLE 6. LAND VALUES VS POTENTIAL DAMAGE VALUES

DESCRIPTION	ESTIMATES OF VALUE/ACRE	POTENTIAL DAMAGE CLASS VALUE/ACRE
Average Federal land value (US Dept of Commerce, 1974)	$ 129	$1,361
Marsh & estuaries as nurseries for commercial fish, sport fish and shellfish (Mattill, 1976)	$2,000	$2,000
Second growth hardwood timberland in northern Wisconsin and upper Michigan (NY Times, 1976)	$ 100	$1,000
Second growth hardwood timber in upper Michigan (Mueller, 1976)	$100-$135	$1,000
Average value of cropland in 48 continguous States (Paulson, 1976) vs average value of Forest Service land	$ 403	$1,361
National Forest System assets including timber, land value, and man-made improvements (Clawson, 1976) vs average value of Forest Service land	$ 225	$1,361
Value (1970 dollars) of non-Federal forest lands in South Carolina, Georgia, Alabama and Texas subject to fire damage (USDA, 1976) vs damage class estimate for Region 8 land	$ 250	$1,413
1972 market value of Federal lands vs average value of Forest Service land	$ 124[1/]	$1,361

[1] Per acre value derived by using $94,147,000,000 (Loomis, 1973) divided by 762,000,000 acres (U. S. Department of Commerce, 1974).

TABLE 7. ACTUAL DAMAGE VS POTENTIAL DAMAGE VALUES

DESCRIPTION	ESTIMATES OF DAMAGE/ACRE	POTENTIAL DAMAGE CLASS VALUE/ACRE
Actual average fire damage in recent years (1970 dollars) to non-Federal forest land in South Carolina, Geogia, Alabama & Texas (USDA, FS, 1976a) vs damage class estimate for all Region 8 land	$ 90	$1,413
Average damage to resources caused by 1971 fire on Coconino N.F. in Arizona (Washington Star, 1971) vs damage class estimate for all Region 3 land	$ 100	$1,269
a) timber resource damage	$ 19	$1,000-1,500
b) watershed damage	$ 81	$1,500-2,400
Average damage to timber resources caused by the Grama Fire in Arizona (Holley, 1974) vs damage class estimate for those lands	$ 205	$1,000-1,500
Fire damage to State and private lands in New Mexico in 1974 (USDA, FS, 1974d) vs damage class estimate for those lands		
a) Big Fire (grass)	$ 5	$1,500-2,400
b) Canadian (timber)	$ 28	$1,000-1,500
c) Sales Fire (timber)	$ 206	$1,000-1,500
d) Guadalupita (timber and watershed)	$1,867	$2,500-3,900
e) Box Fire (timber)	$ 141	$1,000-1,500
f) Golondrinas (timber)	$ 40	$1,000-1,500
g) Salt Fire (grass)	$ 4	$1,000-1,500
1974 fire damage to Uinta Primitive Area, Ashley NF, Utah, from Squaw Basin Fire (6,000 acres) (USDA, FS, 1974a) vs damage class estimate for those lands	$ 0	$ 500

fires are needed to provide a firm base for potential damage and benefit inputs, both for fire planning and for assessing program effectiveness.

Fire policies which, in general, imply that all fires are bad have obscured the need for resource value data. Several other factors have also inhibited the collection of this data.

First, the calculation of damages is regarded as too time consuming. This results in the fact that several Regions merely multiply the dollar values of the potential damage classes by the number of acres burned rather than calculate actual fire damage as prescribed in FSM 5140.

Second, it is commonly believed that procedures are not available for computing the dollar value of most forest resources. An examination of the literature on resource economics and analysis procedures, however, shows that such procedures are, in fact, available.

Third, many feel that information and expertise are not available to provide reliable resource value estimates. The best judges of fire benefits and losses are the various resource specialists already available on each Forest. These specialists can identify damages or benefits relative to their specialties. For questions relating to valuation procedures, they could rely on a handbook or other standard reference, perhaps with a Regional economist available to answer special questions.

And finally, there is some question as to whose responsibility it is to establish resource values. Surely the task should not be left entirely to Fire Management. Resource specialists should provide the primary inputs from their areas of expertise. Fire Management, however, should take the lead and see that the job is carried out to meet fire planning needs.

Following is a discussion of several factors which are integral to a resource value system which provides for benefits as well as damages.

Identifying Components of Value

In order to establish resource values and relate them to the Fire Management program, it is necessary to identify the components of resource values and understand how they may be modified by fire.

Each area of land has some value, which might be called the "onsite value." If a unit of land and all its resources were to be sold or exchanged on the open market, the price it would bring would be approximately equal to its onsite value. This value includes such considerations as mineral value, timber value, esthetic value, and locational value. In short the onsite value, expressed in terms of present net worth, is the sum of all known factors which contribute to the value of an area.

The significance of the onsite value is that it provides a maximum value per acre with which to work. The

resource value protected in a program would seldom equal the onsite value, except possibly when offsite values are added.

In some situations, the land manager needs to be concerned with the potential for affecting offsite values. Offsite values usually involve some form of structural improvement. For example, impact to a watershed increases sediment yields (onsite) and, in turn, decreases storage capacity at some offsite downstream reservoir. (This example is valid only if the storage capacity is being utilized.) Offsite values include only those values which have a direct relationship to onsite values or activities. The sum of onsite and offsite values equals the total resource value which the Forest Service is trying to manage. (Figure 4, page 53)

In most cases total resource value will approximate the sum of those values set in the market place for the individual resources. Onsite and offsite value estimates should not be arbitrarily or inequitably established to meet some specific program needs.

What is unique to the Fire Management program are the resource values it can influence. Total resource values should be divided into those that can be affected by fire management activities and those that cannot. The Fire Management program should be evaluated against affectable values only. A resource such as rockbound minerals would not be included in a list of values influenced by fire management activities, since fire can neither add to nor detract from the value of the minerals.

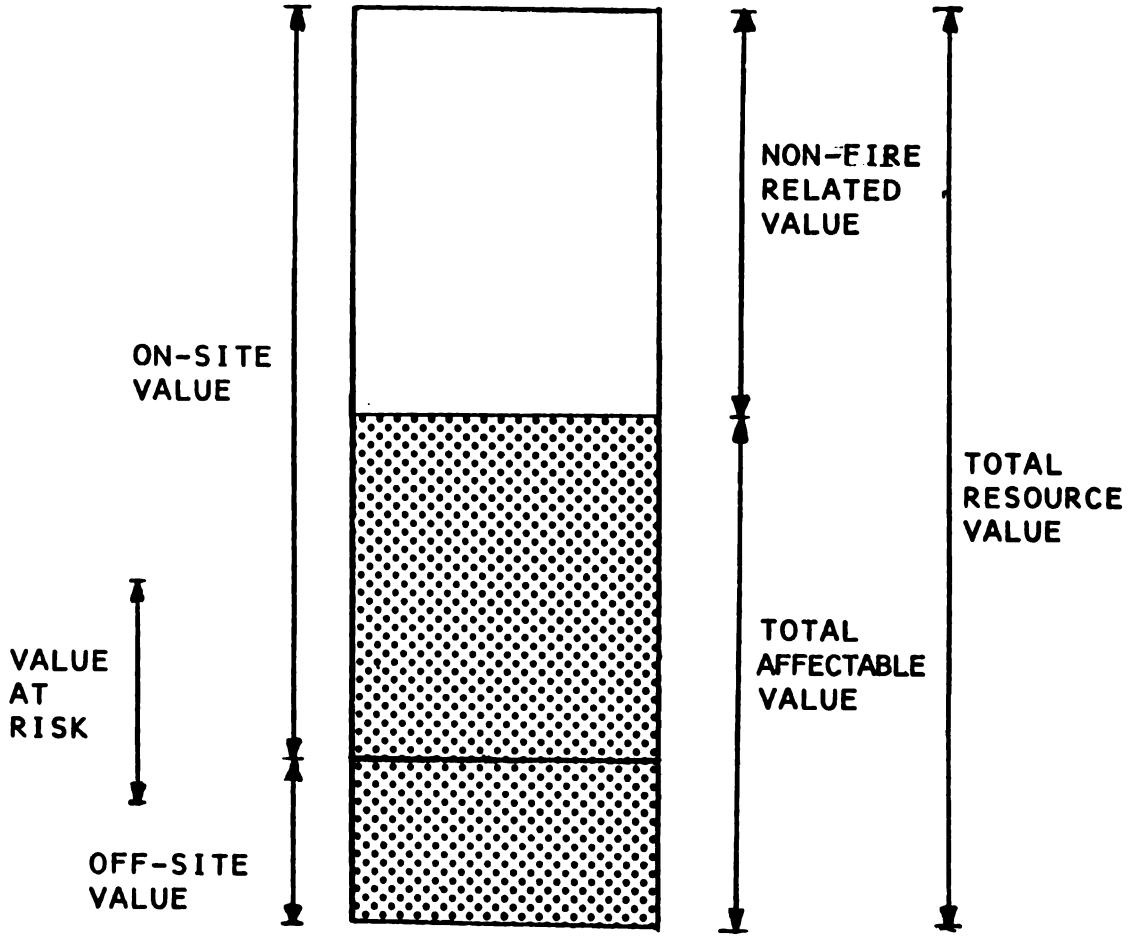

FIGURE 4. FOREST RESOURCE VALUE MODEL

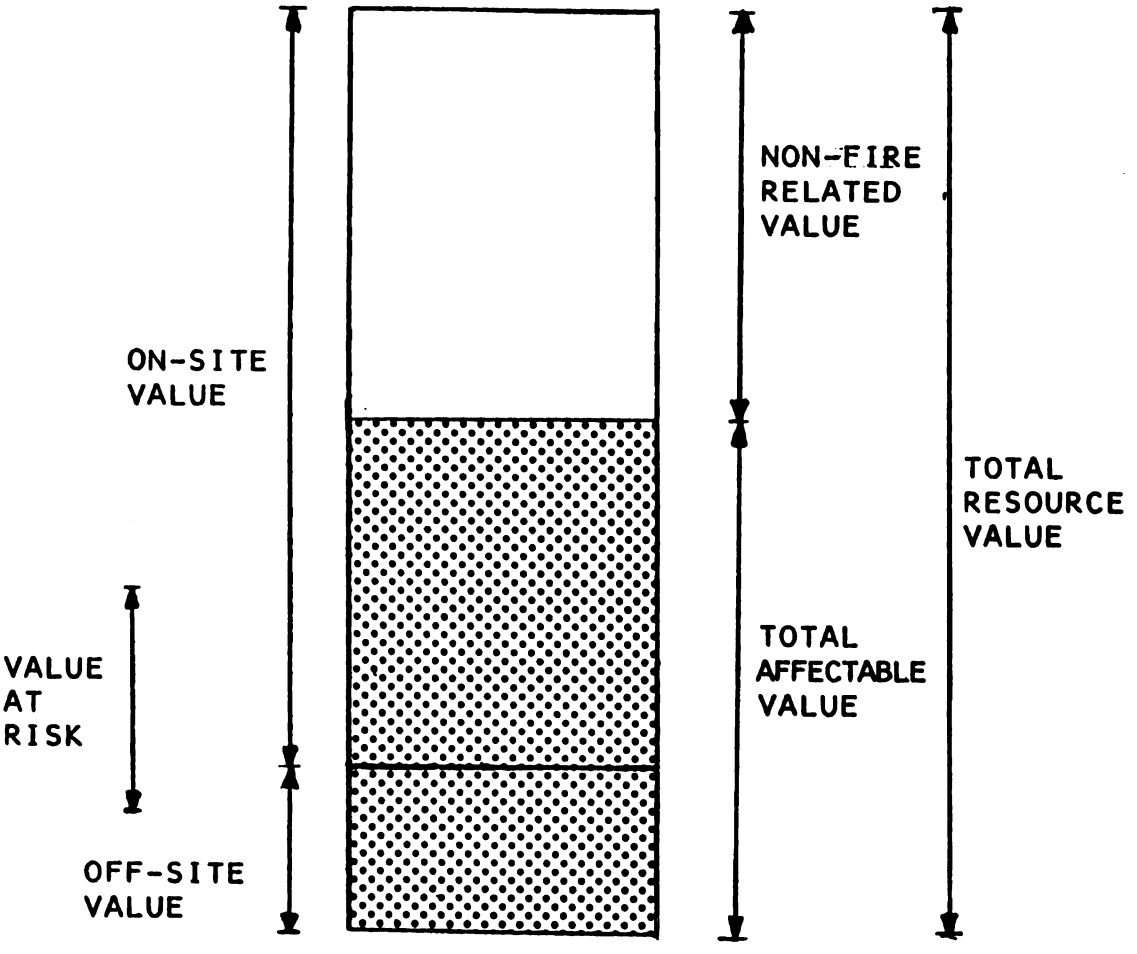

FIGURE 4. FOREST RESOURCE VALUE MODEL

Appraising Forest Resources

Before a resource can be valued the appraiser needs to identify the intended use of that resource. The value of a tree in a summer home area will be different from the value of a tree in a timber sale area; and the methods used to establish those values will differ. If an intended use cannot be established for a resource, then its value is zero. Siltation of a reservoir would not be a loss if the reservoir has unused or excess capacity.

Once the intended use is established, there are several general methods available to establish the values of forest and forest-related resources. At present, appraisals of forest resources seem to be hampered by the belief that nonmarket estimates of resource values are of questionable validity. When the market price of a resource is available and is considered representative, it should be used. However, when it is not, there are several methods for estimating value. These include replacement cost, discounted value, conversion return, and opportunity cost. Discussions of these methods can be found in papers by Robert Marty (1965) and John Crosby (1977). Both papers contain examples relating to forest fire appraisals. The method chosen depends on what is to be estimated and the information available to perform the estimate.

The purpose for appraising forest resources is to identify affectable values. In the event that these values change, for example as a result of fire, the appraisal is

used to quantify that change. Changes in value are of two types: damages and enhancements. There are several items for which to watch when establishing damages.

First, a value that was not previously identified as an affectable value should not be identified as a value lost. Second, when a fire passes through an area, seldom are all of the values at risk affected 100 percent (e.g. a fire in a stand of timber seldom destroys the entire stand). Third, most fires produce some enhancement; these benefits are as important to establish as any other components of the value model.

Only by conducting a complete and accurate appraisal of changes in value following fire can the ability to estimate affectable value and value at risk improve.

Categorizing Values

Values may be either tangible or intangible. Tangible values are those that can be expressed in monetary terms based on actual or simulated market prices or estimates of the cost to repair or replace. Intangible values are those that are not fully measurable although they are recognized as having real value in satisfying human needs. Intangible values cannot be expressed in an analysis and are, therefore, limited to some form of description (Marty, 1965). There are two important points to remember regarding these definitions. First, a value may be physically intangible and be monetarily tangible, or vice versa. The concern here is with the

ability to quantify. Second, because of the availability of information or because of the intended use, in one location a particular value may be tangible while in another location it is intangible.

For management purposes, onsite and offsite values should be recorded separately. Changes in onsite values have an internal impact on National Forest management plans; they directly affect the operation and output of those plans. Changes in offsite values impact the plans and activities of others. When considering changes in value, or effects, recognize that there are two general types, primary and secondary. Primary are those effects resulting directly from a fire, such as the burning of marketable timber. Secondary effects are induced and include, for example, the effect on employment in an industry that is dependent on resources that were destroyed by a fire. Most primary effects will be onsite while secondary effects will usually be offsite.

In summary, tangible values are those that can be assigned a dollar value and entered into an analysis. It is desirable from a management standpoint to record values or changes in value as either onsite or offsite. Changes in value occur in two forms -- primary and secondary -- and changes in value may be damages or enhancements.

Grouping Resource Values

In the initial stages of data gathering and recording, values should be recorded with whatever descriptors seem

appropriate and kept as "pure" as possible. The only grouping advisable at this stage is division into onsite/offsite categories. However, for purposes of summarizing and analyzing data, grouping is necessary for brevity and practicality.

Ideally, groups should meet all informational needs such as the needs of the 1974 Resource Planning Act, the Program Budget, the various functional resources, and Fire Management. However, any grouping tends to obscure information and none ever seems to satisfy all needs.

A sample grouping of resource values is appended (Appendix B). This grouping includes a brief discussion of appraisable items and how to measure them. References cited contain additional information on the "how to" aspects of measurement.

Concept of Risk

A protection program should not be designed to protect the total resource value, nor should it be designed to protect the total affectable value. Rather, the protection objective should be to protect the entire "value at risk"[1/] or some agreed-upon portion of the value at risk.

While risk does not directly reflect the value of the resources at stake, it is an important concept in planning. The word "risk" implies probability. The protection level

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1 That portion of the affectable values that, in all probability, would be lost without any protection organization.

should be based on the values being protected and the risk or chance that the resource will be impacted by fire.

Through accurate measurements and record keeping, an expected value of fire loss can be calculated. This value can be expressed by the following equation.

$$\text{expected fire loss} = (\text{average fire loss}) \times (\text{probability of fire})$$

The expected fire loss would give a sound basis for setting a proper protection level.

The concept of risk recognizes that the degree of protection needed varies over time and depends on the conditions at hand. Also, it implies that the outcome, with or without a given level of protection, is not certain. This uncertainty has two implications. One, the fire organization may man-up to what it predicts will provide 100 percent protection of the value at risk and it may still incur losses. Second, even with no protection program at all, in all probability, a 100 percent loss of the affectable value will not be incurred. This is exemplified by the fact that all National Forest lands did not burn over annually prior to the establishment of a fire protection organization.

Any organization which is designed to protect more than the value at risk may be regarded as overorganized. Any organization designed to protect less than the value at risk may be considered as risk-taking. We may choose any protection level, but if it is less than the value at risk, then the amount of that difference may be referred to as the

"tolerable loss" (i.e., tolerable loss is some value or quantity of resources we have decided to risk losing). Tolerable loss can be established based on the availability of the resource, its value, the cost of protection, or some management objective. Figure 5 (page 60) shows the relationship of tolerable loss to other value components.

Model Flexibility

Values are dynamic. Changes in values may be either damages or enhancements. Once they are incurred, both damages and enhancements affect values at risk, affectable values, onsite and offsite values, and the total resource value. Therefore, at the end of a fire management activity (or time period) that effects significant changes in values (e.g., fuel modification, a wildlife habitat improvement program, or the end of a fire season), it is important to adjust the model. Damages must be subtracted from the affectable value; enhancements must be added. The difference between the net change in value and the value at risk reflects the effectiveness of the fire program. The result of adjusting the model is a new total resource value, a new affectable value, a new value at risk, and eventually a calculation of expected fire loss. New values may suggest changes in the protection level.

Summary and Conclusions

Resource values are neither properly assessed nor used in Fire Management today.

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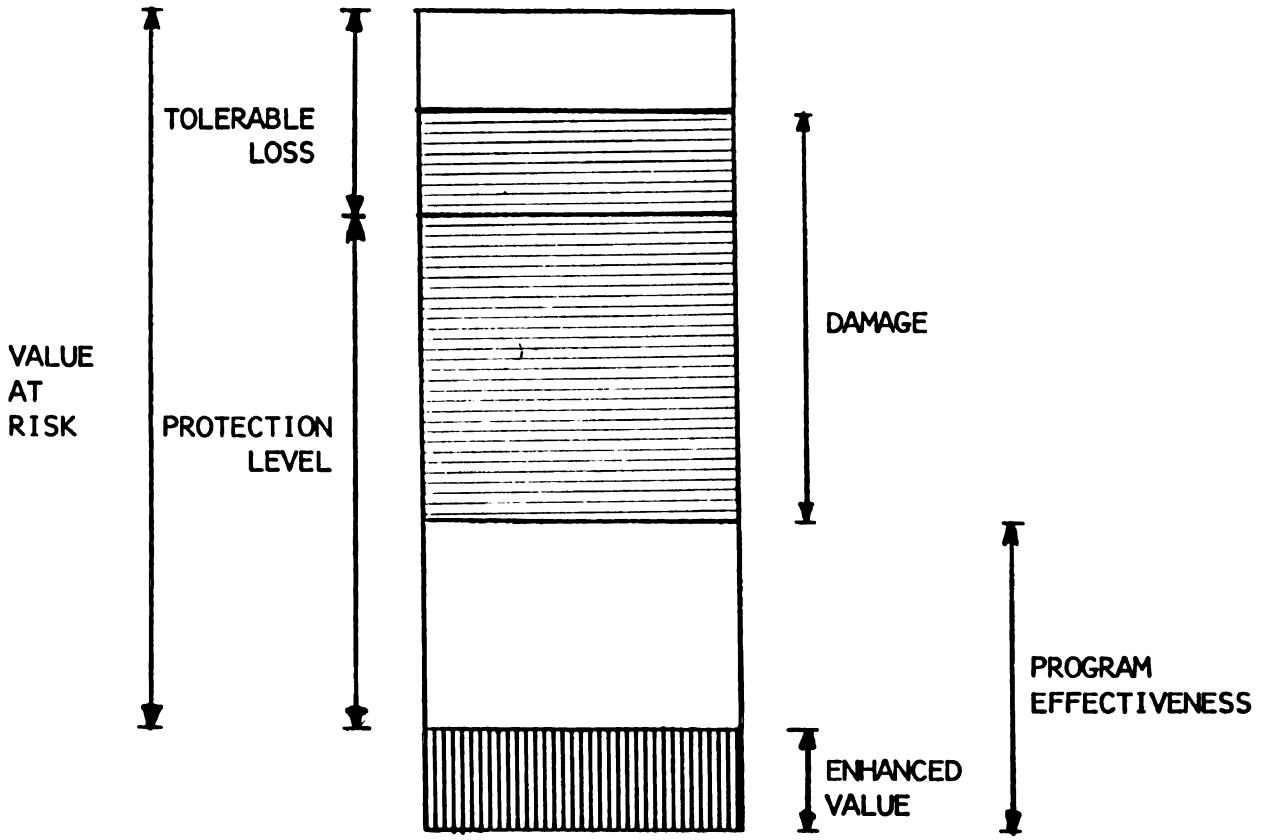

FIGURE 5. MODIFIED VALUE MODEL

Through the proper use of values, Fire Management can establish a link between it and the other resources, and can make visible the benefits of a fire program.

Following are specific conclusions of this chapter.

1. Fire management is a service.
2. Values play a minor role in fire management today.
3. Fire Management does not employ the best available means of establishing values.
4. There is a general lack of faith in existing value data.
5. There is a misconception of tangible values.
6. Benefits from fire are not recognized.
7. Values change and must be re-evaluated periodically.
8. Values provide a means of measuring accomplishment.
9. Accurate measurements of actual fire effects provide a sound basis for predicting fire effects.
10. A clear understanding of all forest values is essential to establishing an appropriate protection level.

Recommendations

Establish procedures for determining reliable estimates of forest values that will be used as input for establishing the level of Fire Management activity and assessing accomplishment.

III. PLANNING

Introduction

The purpose of planning is to avoid surprises. A plan facilitates organizing personnel, equipment, assets, etc., so that people and things are where they are needed when they are needed, in the quantities needed.

Planning is a multistage process. A goal is set, a group of alternatives is created, and each alternative is analyzed to determine if it will or will not effectively lead to the goal. Next an alternative is selected and the plan is implemented. The final step involves checking to see how well the plan worked.

This last stage of planning is very important; once a plan is implemented there must be control, which includes feedback of information about the operation of the plan, and change of plan when needed. There is no such thing as a perfect plan. It is essential, therefore, that when a plan is implemented, it is possible to feedback to the managers what has occurred and what steps must be taken for change (Churchman, 1968).

In the early part of the century, a Forest Supervisor's fire planning needs could be met by reading The Use Book (USDA, Forest Service, 1908). This concise document prescribed in four pages how to establish fire patrols, fight fires, make reports, and properly expend fire funds. Today,

the Supervisor of a typical Forest finds himself administering or complying with at least 15, and in some cases as many as 25, separate and often voluminous fire-related plans. (A list of the types of fire plans is in Appendix C.)

Current Situation

The line officer at each administrative level is responsible for fire planning within the unit he supervises. A Regional Forester, for example, is directed to maintain a Regional Fire Plan. He, in turn, directs each Forest Supervisor to prepare and maintain a Forest Fire Plan. Supervisors direct District Rangers to prepare various fire plans, the type and number corresponding to the needs of the specific area.

Types of Fire Plans

While the exact title and contents of each kind of fire plan vary somewhat among Regions and Forests, there are five general categories: fire prevention plans; fire presuppression plans; fire suppression plans; plans dealing with the use of fire; and plans for special problems or areas.

Fire Prevention Plans

Prevention plans deal with the specifics of contacting and educating the public, eliminating fire hazards, and gaining compliance with regulations and laws. They usually display an analysis of where, how, and when fires start, and the categories of people who start them.

An action plan is generally included, which identifies each important fire prevention task and specifies what is to be done, by whom, and where. These plans generally are maintained at District and Forest levels. Some Regions prepare broad fire prevention plans.

Examples of fire prevention plans are Hazard Reduction Plans, Timber Sale Fire Plans, Red Flag Fire Alert Plans, and Law Enforcement Plans.

The basic objective of fire prevention plans is to attain, or better, par by eliminating all preventable fires especially those caused by inexperienced, negligent, or malicious persons.

Fire Presuppression Plans

Presuppression plans deal with actions to be taken before a fire or fire season occurs. Their common objective is to plan for an available, effective fire control organization -- well trained, equipped, instructed, and supervised -- to handle fire suppression situations.

An example of a type of presuppression plan is the Manning and Specific Action Guide. Prepared for each Forest and District, this plan specifies how many fire crews, prevention people, fire trucks, airplanes, etc., are to be placed on duty according to the current and predicted fire danger rating, computed from the National Fire Danger Rating System (Deeming et al., 1974). In some Regions, these plans are prepared on Form 5100-2 entitled "Integrated Fire Control Organization and Financial Plan".

Other types of presuppression plans include: Detection Plans, Forest Preparedness Plans, Preattack Plans, Regional Protection Manning Plans, Physical Fitness Plans, Fire Training Plans, Regional Mobilization and Demobilization Plans, Fuel Management Plans, and Interagency Plans for Coordination of Logistical Support at the Boise Interagency Fire Center.

Fire Suppression Plans

Suppression plans deal with how people and agencies are organized to cope with fires of different sizes and complexities. An example of a suppression plan is the plan called the Coordinated Fire Situation Plan. This plan prescribes a basic organizational structure for coordinating fire suppression work on a number of major fires occurring simultaneously in a given geographical area.

Other examples include Air Operations Plans, Organization Plans for Project Fires, and Interagency Operations Plans (such as FIRESCOPE).

Plans Dealing with the Use of Fire

The three categories of plans discussed above deal with fire prevention and control. This present category includes several types of fire plans prepared to guide the use of fire. An example is the Prescribed Burning Plan, which includes (a) determination of the objectives for burning (e.g., fuelhazard reduction, site preparation, wildlife habitat enhancement); (b) survey and analysis of

the area to be treated with consideration for the effect on air and water quality, soils and esthetics; (c) prescription for burning (including unit burning plan and firing and holding plan); (d) planned financing; (3) appraisal of results and report of accomplishment. Fuel Management Plans are also considered in this category.

The most detailed plans providing for the use of fire are those approved by the Chief for exceptions to the 10 a.m. policy of control. The plan for the Whitecap Fire Management Area in Idaho's Selway-Bitterroot Wilderness is an example. Under carefully prescribed weather and fuel conditions, lightning fires originating in portions of this 66,000 acre area are permitted to burn until they either go out or until they become a threat to the resources of the land. The objectives of plans such as this include: (1) allowing fire to play a more nearly natural role in the wilderness; (2) allowing wild fire to accomplish resource management objectives; and (3) avoiding expenditures for suppression where feasible.

Plans for Special Problems or Areas

Unique features or values of an area may dictate the need for special fire plans. A wilderness fire suppression plan, for example, specifies alternatives to the use of tractors and other motorized equipment. Another example of a special plan is that which governs fire control activities within the sanctuary of an endangered or threatened animal.

National Fire Planning Instructions

Policy pertaining to fire planning is outlined in the Forest Service Manual (USDA, Forest Service, 1977a) in section 5191. In this section, reference is made to the National Fire Planning instructions, which are issued by the Chief's Office every five or ten years. The most recent instructions were issued in draft form in 1972 and are entitled "National Fire Planning" (USDA, Forest Service, 1972). The National Fire Planning document is the product of an ad hoc task force comprised of Forest Service Fire Management personnel from the Washington Office and from several Regional offices. It is the basis for fire plans now in use throughout the National Forest System. Of the various types of fire plans, presuppression plans are the most directly influenced by the current instructions.

According to introductory material (p. iii) in the National Fire Planning instructions, plans "are aimed to developing an organization where the initial attack, prevention and detection forces are adequate to meet fire problems posed by measured fire danger[1/] 90 percent of the time." (The

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1 Fire danger is measured using a system known as the National Fire Danger Rating System (NFDRS). It was developed in 1972 (Deeming et al., 1974) and was to be a basic input for prevention, presuppression, and suppression action. The rating has two basic components: 1) an expression of risk, called the occurrence index; and 2) an expression of the rate at which a fire will spread, called the burning index. These two components, when multipled together, produce the primary index number known as the fire load index (FLI). The FLI is described as an expression of the effort required to contain all probable fires occurring during a specific time period within a specific rating area.

worst 10 percent of the time requires additional emergency forces which are not considered part of the basic fire protection organization.)

The planning assumptions in the National Fire Planning instructions provide for certain standards of fire prevention, fire discovery, initial action on new fires, and reinforcement action on going fires which permit resource managers to successfully pursue their goals of resource protection and management. These standards are based on the objective of controlling all fires at 10 acres or less. The source of the 10 acre objective is not clear. It probably represents the judgement of fire experts as the "best" all-around size objective for which to plan, considering average spread rates and initial attack force capabilities. While it may be representative of some national average, it is not applicable to all areas and conditions on the National Forests.

The Recommended Renewable Resource Program for 1977 to 2020 (USDA, Forest Service, 1976d), prepared in accordance with the Forest and Rangeland Renewable Resource Planning Act of 1974 (RPA), discusses the generalities of Fire Management activities and identifies Fire Management outputs among the RPA systems. However, the measurable outputs -- number of fires, acres burned, miles of fuelbreaks -- have only limited and indirect relationship with other resource system outputs. Until a direct relationship is developed which establishes the impact of varying levels of Fire Management

activities on resource production, the Renewable Resource Program document is of little value as a fire planning tool.

Analysis of Current Fire Planning

Two positive aspects of the various existing fire plans can be identified.

1) Existing fire plans accomplish the objective of planning, i.e., organization and efficiency. They not only save "wheel spinning," they also save dollars by identifying efficient procedures for tasks such as demobilization of suppression forces.
2) Largely due to its planning efforts, the Forest Service has a significant leadership role in fire management covering a broad spectrum of activities from total mobility, physical fitness and training, to wilderness fire management and equipment development.

The principal shortcoming of the various types of existing fire plans is that they relate poorly to each other or to the resource systems they serve. Each of the plans deals with a specific activity. There is no overriding framework that requires activities and accomplishments in one area of fire management (e.g., hazard reduction) to be reflected in plans for another area. (This shortcoming is readily apparent, for example, in the Manning and Specific Action Guide mentioned above.) Despite the lack of a requirement

to coordinate activities, it should be recognized that some field managers have accomplished this task.

One of the purposes of planning is to establish a basis for funding and expenditures. Yet, as evidenced in Table 8, page 72, the amount of work planned and the amount accomplished often bear little resemblance.

Of far more serious concern is the direction in which the National Fire Planning instructions are leading Fire Management. Almost all (about 97 percent) fire funds appropriated during the past six years have been spent on presuppression and control activities as opposed to activities directed toward meeting long range resource and Fire Management objectives. Substantial increases in presuppression costs have occurred in the 1970s without a reduction in suppression expenditures.

Total presuppression costs in 1972 were $53 million. In 1975, these costs had risen to $92 million; 1976 costs were $124 million. The 1977 Fire Management Fund (presuppression) budget is $143 million.

These expenditures were made in response to fire plans prepared using the National Fire Planning instructions. To fully implement plans and to meet the National Fire Planning objectives of controlling all fires at 10 acres or less, annual recurrent costs would amount to about $235 million, a 90 percent increase over the 1976 level. (Refer back to Figure 3, page 24.)

TABLE 8. FY 1976 FUEL MANAGEMENT ATTAINMENT REPORT*

	FUEL REDUCTION PM FUNDS		FUEL REDUCTION BD FUNDS	
	REPORTED PLANNED ACRES	ACCOMPLISHED ACRES	REPORTED PLANNED ACRES	ACCOMPLISHED ACRES
R- 1	0	5,778**	58,000	65,116
R- 2	230	0	20,500	0***
R- 3	1,485	6,691**	17,400	30,420
R- 4	7,500	1,132***	50,000	49,526
R- 5	6,885	14,119**	28,000	24,584
R- 6	843	7,866**	205,000	182,217
R- 8	93,900	99,003	0	0
R- 9	463	3,187**	14,000	1,847***
R-10	------	------	------	------

* Figures taken from FY 1976 Management Attainment Report prepared by USDA, Forest Service, Washington, D. C.

** Accomplished acres are greater than 200 percent of planned.

*** Accomplished acres are less than 20 percent of planned.

Many resource managers and Fire Management personnel question the validity of the 10 acre objective, indicating that an arbitrary level of forest protection no longer serves resource management needs and land management objectives. While the National Fire Planning instructions take into account seven different resource value classes and apply somewhat different protection levels to each, the instructions fail to solicit and accomodate resource priorities and the document does not relate to economic considerations.

On August 21, 1976, the Chief and Staff requested an analysis of fire planning methods and a study of the effectiveness of the presuppression activity. In response, the Fire Planning Study Team, appointed by the Directors of Fire Management and Program Budgeting and Development, met in Washington and prepared a report entitled: "Evaluating National Fire Planning Methods and Measuring Effectiveness of Presuppression Expenditures" (Gibson, Hodgin, and Rich, 1976). The team's objectives were to: 1) prepare a plan for analyzing fire planning methods; and 2) prepare a plan for studying the effectiveness of presuppression expenditures.

The team found that the "procedures for fire planning appear to be constructed on logical and rational bases; however, due to the quality of several inputs used in the process, the validity of the results is questionable." (Gibson et al., 1976, page 3) The team's recommendations attempt to strengthen the areas where the weak or invalid inputs

exist. Therefore, its first recommendation (page 4) is significant: "Eliminate present objective of controlling all fires at 10 acres or less and develop a system of setting objectives based on output targets derived from land management plans."

The 10 acre presumption is a cornerstone of the current National Fire Planning instructions. If it is to be supplanted by some other system of setting objectives, the entire fire planning procedure would necessarily have to be reevaluated and revised. The recommendation calls for an essential first step in making fire planning supportive of land management goals.

The other recommendations in the report are worthy of consideration in a revision or redesign of the National Fire Planning instructions.

In response to a request by the Land Management Planning Staff, Jack Carter of the Region 5 Fire Management staff prepared a report entitled "Fire Planning (As Is)" in which he evaluates the fire planning process (Carter, 1977). The first of eight major problem areas identified by Carter concerns the 10 acre objective and its use in the absence of direction from resource managers. The rest of Carter's findings are significant and should be reviewed in any effort to restructure fire planning.

A point not discussed by either the Fire Planning Study Team or by Carter relates to the method by which measured fire danger is actually determined. A problem exists in that

the National Fire Danger Rating System (NFDRS), which is intended to be used to determine the fire danger rating, is only partially used. The National Fire Planning instructions (page 8) state that: "Only the burning index (BI) will be used at this time." The other NFDRS components are to be computed, the instructions say, but not immediately used. As a result, some Regions are basing their manning and other daily fire activity requirements on the BI alone, instead of on the intended fire load index (a primary index number produced by multiplying the BI and the occurrence index). This situation is attributed to a lack of confidence in the derived occurrence index outputs. (Williams, 1976)

The use of only the BI component results in a higher index level and, in turn, higher levels of fire management activity than would be required if the system were applied as it was intended. Results based on a partial use of the system are questionable. If the method of determining the occurrence index needs modification, this should be accomplished as quickly as possible. If this need has not been clearly demonstrated, the system should be strictly adhered to.

A final area which needs recognition is that problems of compatibility between Fire Management and other resource system goals and escalating Fire Management costs in response to an unrealistic planning objective are related. Fire Management plans cannot be fully integrated with other resource management plans until fire expenditures are

displayed as a cost in the accounts of the resources served by Fire Management. When that has been accomplished, a decision can be made by the appropriate line officer concerning whether the resource outputs justify the additional costs of Fire Management.

Summary and Conclusions

Individual fire plans currently being prepared accomplish the objectives of organization and efficiency. However, a general review of the Fire Management planning process is needed to organize the array of different planning documents into several standard plans. These plans should be linked together through some type of accomplishment and adjustment feedback system.

A National Fire Plan needs to be completed. It would serve as the basis for fund allocations, National fire overhead requirements, interregional crew needs, training objectives, and long-term goals. It is essential that the various stages of the process used to determine a National Fire Plan be visible: e.g., long and short-range goals, alternatives, and a feedback system. It is essential that a National Fire Plan reflect a philosophy of fire management rather than just the "control" aspects of the program. A plan deriving its goals and alternatives from resource values, resource management objectives, and cost-benefit analyses would achieve this.

Recommendations

Improve the Fire Management planning process by incorporating: appropriate values, resource management objectives, analysis of the viable alternatives, and integration with other plans.

IV. MANAGERIAL CONTROL

Introduction

Effective program management in any organization necessitates gathering and recording data. Data compilation is not done as an end in itself; data should provide a basis for both financial and managerial accounting which, in turn, show an organization:

-- how well objectives are met from a financial point of view; and

-- how past activities can be used in forming judgements about similar activities in the present and future (Marty, 1974).

Fire Management employs more persons, full and part-time, than any other unit in the Forest Service. About 25 percent of all Forest Service funds go to finance the Fire Management program. Management of a program of this scope is demanding in terms of fiscal and statistical information handling.

Fiscal Management

Background and Current Situation

Fire Management activities are financed from two appropriations, Protection and Maintenance (P&M) and Fighting Forest Fire (FFF) funds. Prior to Fiscal Year 1977,

there were only two appropriation numbers within each account: one for presuppression expenditures; and one for suppression expenditures. The only information on costs that was compiled was whether the expenditure was P&M or FFF, and whether it was presuppression or suppression. No further breakdown into the various fire management activities was possible.

Except for the initial $4.275 million appropriated each year, FFF funding historically has been an unbudgeted item. Expenditures were to be for emergency fire fighting (suppression) situations only. Since 1970, the interpretation of "emergency" has become more liberal. In recent years, FFF expenditures for both presuppression and suppression activities have increased.

In 1972, the Forest Service undertook an extensive fire planning effort to determine the forces necessary for resource protection (see also Chapter III). The original intent of the planning effort was to present a consolidated national fire plan to Congress for funding. Regional fire plans, intended as input to a national plan, were not completed until 1975. Interregional coordination, and subsequent approval at the national level, have not been accomplished; however, Fire Management recently has made organizational adjustments in order to complete the task of preparing a national fire plan.

As each Regional plan was completed, the respective Region began implementation. To fund implementation,

appropriated P&M funds were utilized to the extent they were available; and FFF presuppression funds progressively were used to provide increased manning needs identified in the plan. Cost of implementation varied significantly between Regions. The degree of implementation varied also, according to the aggressiveness of the Region and its willingness to use FFF funds for presuppression activities.

The use of FFF funds for presuppression went from $6 million in 1965 to $11 million in 1970, then from $25 million in 1973 to $85 million in 1976. (Refer to Table 9, page 81.) The increase from 1973 to 1976, discounting inflation and safety factors, is primarily attributable to unregulated implementation of fire plans at the local level. It is not possible to track expenditures to specific presuppression activities, since there was only one FFF presuppression appropriation number.

Concern was expressed by the Assistant Secretary of Agriculture, and from within the Forest Service, over the widespread and unregulated use of FFF funds for presuppression. In response to this concern, the Fiscal and Accounting Management Staff and Fire Management undertook the task of developing and implementing a system to obtain better financial and managerial control. The system is called the Fire Management Fund; the current Fiscal Year 1977 is its first year of use.

The Fire Management Fund (FMF) is an account composed of appropriated P&M fire protection funds and budgeted FFF

TABLE 9. EXPENDITURE INFORMATION

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	Trans. Qtr.	1977 3/
ACTUAL DOLLARS														
F&M - Suppression 2/	(723)	(725)	(1164)	(773)	(730)	(1391)	(572)	(211)	(209)	(51)	(30)			
F&M - Presuppression	22079	22818	23758	24581	25958	27502	28714	29610	31393	35651	36618	38681	12239	43156
F.F.F. - Presuppression	5846	5846	8077	9542	7275	11236	18291	23269	24996	42158	55368	85055	46678	99800
F.F.F. - Suppression	11332	10804	21792	35576	15301	14905	64409	37063	36990	67579	59023	65878	23849	54634
F.F.F. - Carry Over 4/				(600)	—	(1000)	(8100)	(4600)	(4600)	(14983)	(10181)	(31659) 5/	(26252) 5/	57911 6/
F.F.F. - Differential	-0-	864	876	883	709	282	277	173	155	136	45	-0-	-0-	-0-
Total - Presuppression	27925	28664	31835	34123	33233	38738	47005	52879	56389	77809	91986	123736	58917	142956
GRAND TOTAL	39252	40332	54503	70582	49243	53925	111691	90115	93534	145524	151054	189614	82,766	254,431
DEFLATED DOLLARS														
F&M - Presuppression	22079	22153	22625	22348	22380	21321	20809	19870	19497	19916	18680	18869	-	-
F.F.F. - Presuppression	5346	5676	7691	8677	6272	8708	13250	15617	15528	23552	28255	41490	-	-
F.F.F. - Suppression	11322	10489	20755	32344	13188	11553	46672	24876	22975	37746	30114	32126	-	-
F.F.F. - Differential	-0-	840	830	800	610	220	160	120	100	80	23	-0-	-	-
TOTAL	39247	39158	51901	64169	42450	41802	80891	60483	58100	81294	77072	92485	-	-

1/ Thousands of Dollars
2/ Not included in totals or Exhibit E
3/ Estimate based on supplemental request
4/ These expenditures were spent in the listed period, but are carried over for payment from FFF supplemental appropriated funds in the next period. All total expenditures, breakdowns, and graphs have included them in the period they were paid for out of Fire supplemental appropriations, i.e., for the true expenditures for 1973, add the listed carryover amount to the 1973 grand total and then subtract the 1972 carryover amount.
5/ Carryover for both 1976 and the TQ carried over for payment out of FY 1977 supplemental appropriations.
6/ F.F.F.-Presuppression and F.F.F.-Suppression figures listed for FY 1977 are estimates of the money needed to fund FY 1977 activities. They do not include F.F.F. carryover from the previous year, as do the corresponding figures for other years; therefore, the carryover listed for FY 1977 is from 1976 and TQ, not 1977.

funds to finance all presuppression activities. Under the FMF system, the amount of FFF-financed presuppression is restricted to an allocated amount, which is established prior to the beginning of the fiscal year.

To make available cost information which could be related to accomplishments, the FMF system divides presuppression activities into six categories or accounts for budget purposes. These categories include: prevention; detection; attack forces; aviation operations; fuels management; support and facilitating services. Fire suppression activities are still charged directly to the FFF appropriation. There is no breakdown of suppression activities; and all FFF suppression expenditures are recorded to one account number. (An exception to this is a minor amount of P&M appropriated suppression funds.)

Analysis

FFF Carryover

That a problem exists with the current fiscal management system is apparent when the meaning of the FFF carryover is examined.

Each year, a token $4.275 million is appropriated by Congress for emergency fire fighting. Obligations incurred by Fire Management are reported periodically to the Office of Management and Budget, and needs beyond those covered by this appropriation are funded on a deficiency basis. In January, an estimate is made of total expected FFF obligation

for the remainder of the year. This estimate, together with the deficiency funding, is used to request supplemental funding and is included with the subsequent year's budget request. Present instructions call for computing the supplemental funding figure using a three-year average for the estimated period. Obligations through December 31 plus the three-year average determine the supplemental request for the FFF funding appropriation.

The result of this procedure is that, since 1970, Fire Management's supplemental funding request has been low. To provide enough cash to cover expenditures, money is borrowed from another Forest Service account. Forest Service accountants say that this procedure is proper under current legislation; however, it distorts the next fiscal year's FFF obligations, because when the loan is repaid it is recorded as an obligation in the current fiscal year.

With the FFF carryover handled in this manner, considerable searching and calculating are necessary to determine the real fire expenditures of any given year. The present system makes it difficult to determine, and hence to predict, a given year's Servicewide expenditures. One must know the amount of deficit brought forward, what the accounting records show, and the amount of deficit carried forward to the next year. Table 10, page 84, shows the true expenditures of Fire Management over the past 11 years (derived from the method outlined above) and compares these true expenditures to those shown on the Forest Service

TABLE 10. FFF EXPENDITURES ADJUSTED FOR CARRYOVER, $M

FISCAL YEAR	ON RECORD[2]	FFF CARRYOVER[4]	TRUE EXPENDITURES[6]
1965	$ 39,252	0	$ 39,252
1966	40,332	0	40,332
1967	54,503	0	54,503
1968	70,582	600	71,182
1969	49,243	0	48,643
1970	53,925	1,000	54,925
1971	111,691	8,100	118,791
1972	90,115	4,600	86,615
1973	93,534	4,600	93,534
1974	145,524	14,983	155,907
1975	151,054	10,181	146,252
1976	189,614	31,659[3]	211,092
TQ[1]	82,766	26,252[3]	109,018
1977	254,431[3]	------[5]	-------

1 Transition Quarter.
2 Total expenditures, P&M plus FFF (USDA, Forest Service 1965-76 TQ).
3 TQ and 1976 carryover were covered together under the 1977 supplemental appropriation. Total carryover to FY 1977 is $57,911,000.
4 (USDA, Forest Service, 1977b)
5 No figures for carryover since this table was prepared prior to the end of FY 1977.
6 See text for explanation of how derived.

statement of obligations for each Fiscal Year 1965 through 1976. Table 10 also shows the amount of carryover and its increase over the past 11 years.

The Fire Management Fund (FMF)

The Fire Management Fund, effective Fiscal Year 1977, is a step in the right direction toward achieving financial and managerial accountability in the Fire Management program. Two obvious advantages of the FMF are:

1) It centralizes, to the Chief, authority to expend funds establishing tighter financial control on the Fire Management program. This control is accomplished through a budgeted amount for presuppression, agreed-upon nationally, prior to the fire season.
2) There are opportunities, with budgeted presuppression activities, to improve efficiency in management by promoting flexibility within the total fire program. Funds, manpower, and equipment can be shifted interregionally in response to national needs.

The FMF is currently operating under an arbitrarily set expenditure level, or ceiling, which is acceptable as a temporary measure to control escalating expenditures. The ceiling should be replaced with budget authorizations based on a cost-effective national fire plan.

Suppression Expenditure Accounting

At the present time, there is no way of indicating how suppression expenditures are made on a daily basis relative to the behavior of a fire. There is no way of tracking what a given day's expenditures "bought" toward accomplishing the suppression task. And there is no way to account for the effectiveness of various suppression activities relative to physical fire conditions, or in one vegetative type as opposed to another.

Daily suppression expenditures are made without an objective assessment of what total cost might result, or what the returns will be in terms of values saved. With implementation of the Fire Management Fund, returns from specific presuppression activities can be established. Without a similar accounting system for suppression expenditures, actual suppression costs can be neither predicted or measured. It is as important to know about potential cost as it is to be aware of potential damage; in the final analysis, both become a cost to the taxpayer.

To help itemize suppression expenditures, there should be an accounting process which provides for breaking down suppression cost into suppression activity accounts. To achieve this, a means for recording financial information on the Individual Fire Report, Form 5100-29 (Appendix D), is needed. The addition of financial information to Form 5100-29, and getting that information into an automatic

data processing system, would facilitate the estimation and, eventually, the prediction of suppression expenditures at the Forest, Regional and National levels.

The possibility of setting a suppression budget for the "normal" year should be investigated. The bases for a suppression budget could be historical expenditure records, resource values, and management objectives identified in the land management planning process.

A suppression budget would encourage before-the-fact decisions about suppression actions being made in a non-emergency atmosphere. For example, in areas identified in the land management plans as having low affectable values, a manager might plan for less than all out suppression action. (It is assumed that there would be flexibility in this scheme to override planned expenditures when fire conditions warrant.)

Statistical Information Management

Current Situation

The importance of collecting and reporting data on fires was recognized in the National Forest Manual of Regulations and Instructions:

> Carefully made reports on individual fires on Form 929 are the foundation of records on which the major strategy of fire control must depend. Every report needs to be carefully made. Estimates of damage should be made with special care. . . . Progress in fire research is dependent in part on the basic data obtained from individual fire reports. (USDA, Forest Service, 1928, pages 58-A & 61-A)

The basic fire reporting procedure outlined in the National Forest Manual of Regulations and Instructions represented an expansion of that used in the Use Book (USDA, Forest Service, 1908); the procedure in current use is essentially a further expansion. Since 1908, the amount of information collected on individual fires has increased from a statement of acres burned to a two page form (the Individual Fire Report Form 5100-29) requiring 33 entries for a Class A or B fire and 44 entries for a Class C or larger fire. (Form 5100-29 appears in Appendix D.) Information required on Form 5100-29 includes: time of discovery, reporting, attack and control; number of firefighters and other forces utilized; control methods; a description of physical and vegetational features; fuels; weather information; location; and total fire cost.

The Individual Fire Report Form is the basic source of statistical information for an individual fire. A copy of the report is sent to the Regional Office where data from the report are compiled through an automatic data processing program known as FIRSTAT (Fire Statistics). These data are used as a base for the Monthly Fire Report, the Annual Regional Fire Report, and the Annual National Forests Fire Report compiled at the end of each calendar year by the Washington Office.

In addition to Form 5100-29, a written report is required on Class E or larger fires to provide more detail

on control efforts, area burned, and resource damage information.

Analysis

According to section 5180 of the current Forest Service Manual, the purpose of individual fire reports is to provide data for improving administration, fire planning, and research. Fire reports are used to: analyze fire control and results; find ways to improve fire control management; isolate and study problems; and justify financing for adequate fire protection.

The reports are not serving their intended purpose. They do provide data, but the data are not adequate. Problems identified include the following: information provided on costs and damages is insufficient for analytical or accounting uses; the current system does not relate fire to the output potential of other resource systems; data are not reported frequently enough nor in enough detail to assure usability for fiscal planning; the practice of reporting fire statistics on a calendar year, rather than a fiscal year, makes it difficult, or impossible, to make financial analyses of fire activities; and current instructions do not provide adequate procedures for reporting beneficial and non-threatening fires, and fires adjacent to and threatening forest lands.

Costs and Damages

The information on costs and damages provided by the current fire reporting system is insufficient for use in analyses or accounting. On the 5100-29 fire report form, fire cost is reported as one item: total suppression expenditure. In the Annual National Forests Fire Report, cost information is displayed in six "cost class" categories which are so broad they are meaningless, especially when suppression costs are high. In addition, with the present system, cost cannot be related to fire size, spread, vegetative type, or any of the other physical data collected. Damage estimates are not reliable and are not made according to any standard system (see Chapter III). Beneficial effects of fires are not considered in current reporting.

Relationship to Other Resource Systems

The current statistical reporting system does not relate fire to the output potential of other resource systems. Damage to mature timber is reported, but effects on decadent stands, regeneration, or young stands are not reported. There are no provisions for recording either damages or beneficial effects to wildlife habitat, livestock forage, or recreation.

Data Handling and Processing

Reporting times are frequently delayed due to problems encountered in collecting and processing the data. This lag

time results in the Annual National Forests Fire Report being produced too late to be useful for fiscal planning.

In addition, all of the data collected do not get into the automatic data processing system so they are not visible in the various report printouts. Available information which is useful for fire management and research purposes, such as physical site data and vegetation characteristics, is not published and is difficult to retrieve.

Reporting Period

A major evaluation and management problem exists because the report periods used in collecting fire statistics are based on a calendar rather than a fiscal year. Data in the Annual National Forests Fire Report cover a calendar year period so that the data can be used in another report, the Annual Wildfire Statistics report, prepared on a calendar year basis by the Forest Service, State and Private Division of Cooperative Forest Fire Control. The problem is that this calendar year reporting is not compatible with fiscal year financial reporting. Therefore, fire evaluations based on financial data are difficult, if not impossible, to make.

Reporting Procedures

Reporting of non-statistical fires[1/], fires within a protective boundary, and fires on lands adjacent to National

1 Fires not requiring suppression action, or fires not causing damages to natural resources on lands protected by the Forest Service, i.e., non-threatening fires.

Forestswhich threaten National Forest lands is not adequately covered by current instructions. Clearly defined procedures are needed for recording these types of fires and those which have beneficial effects.

Summary and Conclusions

It is anticipated that implementation of the Fire Management Fund this current fiscal year will result in better fiscal control over presuppression expenditures, which have been a concern both within and outside of the Fire Management organization. Likewise, the budgeting of FFF funds will stimulate more careful planning and more efficient utilization of personnel and equipment. However, the arbitrarily set budget ceiling should be replaced with budget authorizations based on a cost-effective national fire plan as soon as that plan is available.

In addition, the cost accounting process needs to be expanded to provide for a breakdown of suppression cost into suppression activity accounts (similar to the FMF for presuppression). From a management accountability standpoint, it is necessary to be able to relate suppression costs to returns, and to be able to measure and predict actual suppression cost relative to values protected.

The statistical reporting system needs to be revised to accomodate and process the types of data necessary for evaluating the Fire Management program. The system devised should be applicable to predicting fire effects, estimating suppression needs, and relating fire management to the output

potential of other resource systems; in general, it should provide for better tracking of fires relative to suppression expenditures. Fiscal data on a per fire day basis are needed to permit analysis of suppression expenditures relative to suppression activity.

Recommendations

Address the accounting and budgeting systems of Fire Management to:

1) Complete and implement an accounting system for fire suppression.
2) Explore possibilities of budgeting the normal suppression load.
3) Adjust the statistical reporting system to provide timely, relevant data.

V. EVALUATION

Introduction

Primary purposes of this chapter are to discuss the role and importance of evaluation; review, critique and suggest some modifications to present evaluation procedures in Fire Management; and to present and discuss some evaluations, not covered in the other chapters, which could be used by Fire Management in the future. This presentation is accomplished by examples of the suggested analytic procedures.

In all viable organizations, evaluation must play an important and active role. The evaluation process directs systematic thinking to a particular activity or program asking what that program is accomplishing and how well it is meeting its objectives. Evaluations also provide a sound basis for helping program managers decide whether to continue in the present manner or make changes.

Evaluations deal with 1) accuracy, 2) efficiency, and 3) effectiveness. Evaluation of accuracy involves inspecting and auditing to see that procedures were properly followed. Evaluation of efficiency attempts to determine how much time, how much money, or how much effort was expended in carrying out a given activity. And evaluation of effectiveness examines an activity in relation to its stated

objective (Marty, 1974). All three types of evaluations are essential.

Harold Hatry (1973), in a book on program evaluation, identifies the following problems commonly encountered in the conduct of an evaluation.

1) Evaluation often tends to focus only on program inputs or management processes rather than on outputs and the quality of service received.
2) The procedures used to gather information are often poor. Thus, the information available may not represent true conditions.
3) The shortage of time and manpower provided for evaluation often prevents meaningful conclusions.

Use of evaluation in a program can usually result in improvements. However, some evaluations become inappropriate because conditions change. Others fail to produce a clear meaning. No one evaluation procedure can answer all questions about a program. Different questions require different procedures; often the viewpoint of an additional evaluation adds clarity and understanding. In any case, the result of an evaluation is not necessarily scientific truth. Many human judgements are involved in selecting, evaluating and presenting the data.

Current Situation

This section will discuss six evaluations currently conducted of the Fire Management program. These include: the Formal Management Review Process; the Individual Fire Analysis; FOCUS; Benefit-Cost Analyses; Fire Management Inspections; and External Reviews.

Several general conclusions can be made regarding the present evaluation system in Fire Management.

1) Fire Management has a strong and effective review and inspection system aimed at improving efficiency.
2) Most evaluations deal only with the efficiency aspects of Fire Management.
3) Evaluations tend to be on an irregular basis.
4) The scope and role of evaluations within Fire Management needs to be expanded.

Formal Management Review Process

The formal Forest Service review system presented in Section 1400 of the Forest Service Manual (USDA, Forest Service, 1977a) is currently under revision. A review of the old inspection system (FSM 1440) reveals that it was very structured and dealt largely with examining adherence to specified procedures and determining the degree of efficiency with which these procedures were carried out. Fire Management was addressed specifically in a section called "General Functional Inspection" (FSM 1448.2).

Formal reviews of Fire Management in the future will be conducted under the Manual's newly revised 1410 section entitled "Management Reviews." FSM 1410 prescribes three types of review. The broadest is the General Management Review (GMR). The GMR is an objective assessment of overall Forest Service performance within the area of the unit being reviewed. Its purpose is "to determine whether or not national objectives, policies and procedures are discharged in a timely manner that results in a cohesive effort toward mutual, correlated goals of the Secretary (and) the Chief. . ." (USDA, Forest Service, 1977a, section 1410). The GMR may recommend a more indepth review of a specific function such as Fire Management.

The second type of management review is the Program Review (PR). It consists of examining a group of closely related activities that meet a common specific objective, such as fire management activities. The purpose is "to determine if all activities that serve the program are coordinated, planned, and managed in a manner which achieves desired quantity and quality of results." (USDA, Forest Service, 1977a, section 1410)

The third type is the Activity Review (AR) which is defined as a review of "any action or group of interdependent actions which have a specific purpose or result." The purpose of the AR is "to determine if all actions of the

activity(ies) are carried out in a desirable and beneficial manner." (USDA, Forest Service, 1977a, section 1410)

The description of the new management review system indicates that it should improve the ability of Forest Service reviews to focus on objectives and results of programs such as those of Fire Management. However, based on an examination of a currently proposed plan for a Fire Management activity review, it appears that these reviews, in practice, may be so broad that they do not accomplish the necessary indepth examination.

Individual Fire Analyses

The Fire Management Section of the Manual states that "Regions will make an analysis each year of selected Class E and Extra Period fires. The number of these analyses is left to the discretion of the Regional Forester, but three or four analyses are regarded as a desirable minimum unless there actually is a smaller number of problem fires during the year." (USDA, Forest Service, 1977a, section 5194.12) These analyses are intended to identify problems and training needs and, as such, they are a significant part of the total evaluation process.

As a part of this study, the author attended the Flat Fire Analysis in Region 5 in 1976. This analysis was the only Individual Fire Analysis conducted in Region 5 for the 1975 season, despite the occurrence of 21 Class E and larger fires.

The review was conducted in a vigorous and professional manner. Many ideas were explored on how to do a better job, with emphasis on questions of efficiency in performing particular tasks. However, few questions were raised concerning the appropriateness of the decisions made, nor were alternative actions explored. It seemed that a basic weakness existed in the process of the fire review: emphasis was on efficiency, rather than on the appropriateness of the course of action taken. If a course of action is wrong, it is of little consolation that it was carried out efficiently.

This shortcoming can be traced to the Forest Service Manual where discussion of the Individual Fire Analysis is contained (FSM 5194.12). Emphasis is directed to questions of how well the system worked. Little emphasis is given to asking whether effective decisions were made.

FOCUS

Forest Service Fire Research has developed a computer simulation model, entitled FOCUS, for evaluating alternative presuppression organizations (Davis, 1976). The model evaluates the type and placement of various combinations of manpower and equipment in terms of the efficiency with which they can suppress fires. The model has had limited application to date, but has been successful in identifying situations where a given presuppression force could be 1) rearranged and its capability increased, or 2) the force reduced while maintaining the same capability to suppress fire.

FOCUS is a step forward in improving the evaluation techniques of Fire Management and should receive greater application. However, it is limited to fire control preparedness and deals primarily with efficiency.

Benefit-Cost Analyses

During the 1970s Fire Management has used the benefit-cost analysis procedure for estimating the potential and actual returns from several types of fire activities (including presuppression effect, project fires, fuel reduction treatment, and fuel break projects). These benefit-cost analyses, however, have been conducted on an irregular basis. Their most extensive use has been in the California Region, where they have been applied to evaluating the effectiveness of presuppression forces and fuel break treatments.

Basically, the analyses are easy to conduct and the results are easily understood. The analysis consists of totaling up all costs and all benefits associated with a project, then comparing the total cost to the total benefits. If the benefits exceed the costs, the project is considered to produce positive returns.

Three common problems occur when using a benefit-cost analysis. These problems were evident in several of the analyses reviewed by this study. First, benefits and costs may be improperly estimated. (Chapter II on Resource Values addresses this problem.) Second, all relative benefits and costs must be included in the analysis. Commonly, some

significant benefits and costs are omitted, which often results in improper conclusions. Third, negative results are as meaningful as positive ones, but not as readily accepted by managers. Two Forests recently reported that a "good" analysis of their presuppression activities could not be made for a particular time period, because the Forest did not have enough fire activity during the period. What they should have concluded was that, for the given time period, the cost of the presuppression force was greater than the benefits derived from having it.

The primary ingredient for a good benefit-cost analysis, and most other analyses, is an objective analyst who can eliminate his concern for the results when establishing the inputs. Objectivity may be the most difficult ingredient to obtain.

Benefit-cost analysis, in summary, is one means of showing program effectiveness and more extensive use of this type of analysis should be encouraged.

Fire Management Inspections

Fire Management conducts a variety of reviews and inspections which are a type of evaluation. These inspections generally concentrate on efficiency and evaluate such things as equipment, training, safety, and facilities. The inspections are usually thorough and effective at improving efficiency.

External Review

Several outside groups conduct or request evaluations of Forest Service activities at various times. These groups include the Department of Agriculture, Office of Management and Budget, Congress, and various public organizations. The Department conducts a formal review known as the Internal Audit. The Office of Management and Budget, on occasion, will request the Department or the Forest Service to conduct a specific evaluation such as the one resulting in this report. These evaluations may cover any facet of an organization.

Evaluation Needs of Fire Management

In addition to continuing, with the above suggested modifications, the evaluation procedures which Fire Management currently uses, it is suggested that the following be instituted or utilized: a Fire Activity Index; a comprehensive statistical analysis system; comparison evaluations; analysis of alternatives; and updating. Some of these suggested procedures have been employed in this current study and the findings are indicated where appropriate.

Fire Activity Index

In any effort to review a fire program on an annual basis, one of the first questions which the analyst or fire manager asks is, "What level of fire activity occurred during a given year?" At present, there is no satisfactory

means of providing a quantitative expression to answer this question.

As part of this study, a methodology was developed to produce an activity index number which would provide this quantitative expression for each Region[1/] and for the Nation as a whole, in the form of a weighted summation of three variables.

The three variables used in deriving the activity index are: the number of fires, the number of acres burned, and the number of Class E and larger fires. These variables were selected for two reasons: 1) they appear to produce reasonable results; and 2) they are readily available. The data are collected regionally on a monthly basis, published annually, and available back to 1908. In calculating the index, the variables are selected from the different Regions, or are summed for the Nation, to produce the index specific to the area desired.

Derived index numbers are weighted summations of the three variables. The use of weighting coefficients is an attempt to place equal importance on all three input variables. Weighting coefficients are derived by: 1) summing the three input variables for the period covered by the data; 2) dividing the larger variable (acres burned) by the number of fires to obtain the first coefficient; and 3) then dividing the original sum of the acres burned by the

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[1] By adjusting the data to a regional sum instead of a national one, the reliability of the intraregional comparison (one year to another in the same Region) is increased.

number of Class E and larger fires to arrive at the second coefficient. The process places some emphasis on acres burned in that the other two variables are adjusted to it.

For convenience, the index numbers which can equal any number from zero to infinity have been divided by 10,000 to reduce their magnitude. In addition, the national index has been further divided by the number of Regions to put it in the same relative magnitude as the regional index numbers.

An example of the calculations necessary to compute the index is found in Appendix E.

The index has one major shortcoming. Forest Service effectiveness in dealing with fires cannot be separated from the effects of fuels, topography, and weather conditions. These conditions, with the exception of weather, become less significant when examining a given year if we accept that fuel, topography, and the Forest Service's ability to deal with fires changes over long time periods, but not significantly from year to year. Accepting the index's shortcomings, several observations can be made. Refer to Table 11, page 105.

First, looking at the coefficient of variation (CV)[1/] one sees the following. 1) The fire activity fluctuates less nationally (CV = 30) than in any individual Region. This suggests that national goals are the most predictable and that planning objectives directed at this level are most likely to

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1 Coefficient of variation is a statistical technique for expressing in percent the amount of variation from the mean for a group of numbers. The technique allows the comparison of groups of numbers of differing magnitude.

TABLE 11. FIRE ACTIVITY INDEX[1/] FOR NATIONAL FOREST PROTECTED LANDS

CALENDAR YEAR	R-1	R-2	R-3	R-4	R-5	R-6	R-8	R-9	R-10	NFS
1965	11	28	65	10	121	42	56	31	0.16	35
1966	89	37	103	118	347	59	60	17	0.11	87
1967	157	12	129	13	167	132	76	16	0.23	70
1968	34	15	106	20	272	119	44	21	0.29	61
1969	20	23	93	11	153	50	43	21	1.34	40
1970	75	20	122	21	374	245	90	13	0.06	98
1971	29	13	157	36	175	57	95	46	0.18	62
1972	27	19	107	45	223	44	32	28	0.09	51
1973	106	33	75	40	249	63	17	8	0.22	58
1974	37	43	234	46	232	45	41	15	0.23	70
1975	9	30	94	13	266	42	44	22	0.10	51
1976[2/]	12	19	131	28	123	33	79	43	0.06	48
MEAN	54	25	117	34	234	82	54	22	0.27	62
STANDARD DEVIATION	47.0	10.2	46.3	31.2	79.0	62.4	24.2	10.4	0.36	18.8
COEFFICIENT OF VARIATION	87%	41%	40%	92%	34%	76%	44%	48%	132%	30%

1 Based on acres burned, total number of fires, and number of Class E and larger fires.

2 Index values for 1976 are based on tentative data and have not been included in the statistics which are calculated below.

be met. 2) Regions 4, 1 and 6, in that order, are least predictable. (Their respective CVs are: 92, 87 and 76.)[1/] Thus, it is difficult to accurately predict the suppression force needs for these Regions. 3) Regions 5, 3, 2 and 8 have fairly consistent levels of activity (CV = 34, 40, 41 and 44 respectively). The planning job should be easier in these Regions.

Second, looking at the means for the Regions as a whole reveals that Region 5 normally has twice the activity of any other Region, and Regions 9 and 2 have the least amount of activity.

Third, examining the National Fire Activity Index since 1965 reveals that 1970 was the worst year, with an FAI of 98; the FAI for 1965 was the lowest (35); and the FAI for 1976 was the lowest since 1969 (48 vs 40).

Several other comparisons can be made examining trends in such areas as retardant use, manpower, and expenditures utilizing the index to separate out variation due to activity level.

It is suggested that the index be calculated weekly or biweekly in order to assess the progress of fire activity during the season. The index numbers may be thought of as an expression of the environmental conditions of weather, fuels and topography that were encountered and of the effectiveness of Fire Management in responding to those conditions.

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1 Region 10, with a CV of 132, is omitted here because most of the variation over the ten year period is accounted for during one year.

The index would also provide management with a quantitative assessment of a given fire season relative to previous periods or norms. In the event of a need for additional funds, the index could serve as an expression of activity relative to funding needs.

Comprehensive Statistical Analysis

A need for broad comprehensive statistical analysis exists within Fire Management. This analysis should consist of a series of evaluations at all levels, covering prediction, present situation, annual results, and long-term trends. The process should be clearly defined, scheduled on a regular basis, automated as much as possible; and the results should be distributed to field levels as quickly as possible.

A great deal can be learned about a program by examining its growth and related statistics over a period of time. The original OMB request for a study of Fire Management expenditures asked that statistical information be made available for a 10 year period, beginning in 1965. This information was compiled and presented in the Phase I report (Hodgin, 1976). The statistics are reviewed here and a trend analysis technique is employed to interpret them.

As discussed in Chapter IV of this report, physical fire statistics are traditionally recorded on a calendar year basis, while expenditures are recorded on a fiscal year basis. To counter this difficulty, for the purposes of this analysis, expenditure data from a fiscal year is correlated

with the physical data from the previous calendar year which is one numerical unit lower. For simplification, all references in the narrative are to calendar years.

All costs discussed are in terms of dollars deflated to a 1965 base. The deflators used are based on the cost of government purchases of goods and services (Hodgin, 1976).

Most of the comparisons made are between two periods, 1965-69 and 1970-75. There are two reasons for this grouping. First, comparisons of individual years are difficult to understand because of annual fluctuation in fire severity. Second, the two groupings represent two periods of significantly different Fire Management philosophy.

Total Fire Management program costs remained fairly constant from 1965 through 1969, averaging $48 million per year. From 1969 to 1970, costs doubled, at least partially because of the severe 1970 fire season. Throughout the period 1970 to 1975, however, costs averaged $75 million per year, or 57 percent higher than the 1965-69 average.

Presuppression (FFF)[1], one of the two distinct activities within the Fire Management program, averaged $7 million during 1965 to 1969. In 1970, presuppression (FFF) costs increased 50 percent over those of 1969. These costs have increased substantially ever since, with 1975 costs being three times the 1970 level. The average for the 1970-75 period is $23 million, or three times the average for the

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1 In this chapter, where "(FFF)" follows reference to a Fire Management activity, reference is to only that portion of the activity financed by Fighting Forest Fire funds.

1965-69 period. (FFF presuppression expenditures for FY 1977 are currently projected at over $100 million.) Presuppression expenditures, financed by P&M funding, decreased over the same 11 year period by 17 percent.

With an average cost of $18 million, suppression costs, which use mostly FFF funds, show the same relative constancy from 1965 through 1969. During the severe 1970 fire season, FFF suppression costs quadrupled. They dropped 50 percent during 1971, but remained twice as high as the 1969 level. This latter level of suppression spending has been maintained during subsequent years, and the 1970-75 average of $32 million is nearly twice the average for the 1965-69 time period.

The above data are summarized in Table 12, page 110, which compares the 1965-69 and 1970-75 periods. Related statistics are also summarized in this table. (Supportive data for individual years is given in Appendix F.)

Given these increases in presuppression and suppression costs (FFF) between the two time periods, what conclusions can be drawn? Effective program management requires that increasing expenditures be related to something.

To answer this question, a trend analysis of the physical statistics was made. The analysis is appended (Appendix G). In general, the analysis did not show increased achievement commensurate with increased expenditures.

TABLE 12. SUMMARY OF COST AND RELATED STATISTICS[1/]

	AVERAGE 1965-69	AVERAGE 1970-75	PERCENT CHANGE
Total fire management costs[2/] (includes "differential" costs)	$ 47,896	$ 75,054	+ 57
Presuppression (P&M)	$ 22,165	$ 19,606	- 12
Presuppression (FFF)	$ 7,405	$ 22,949	+ 210
Suppression (FFF)	$ 17,666	$ 32,418	+ 84
Number of acres burned	183,468	227,160	+ 24
Damages (M$)	$ 11,300	$ 71,124	+ 529
Number of fires	10,429	13,027	+ 25
Lightning-caused	5,485	6,560	+ 20
Man-caused	4,944	6,467	+ 31
Fire severity index	0.98	1.08	+ 10
Fire activity index	58.60	65.00	+ 11
Acres burned per fire	17.20	17.00	- 1
Damage ($)/acre burned	$ 68	$ 340	+ 400
Natl Forest recreation use (M visitor days)	154,967	185,985	+ 20
Fire size class (acres)			
A (1/4 or less)	6,987	9,332	+ 34
B (.26 - 9)	2,714	2,953	+ 9
C (10 - 99)	581	598	+ 3
D (100 - 299)	77	77	0
E (300 or more)	72	67	- 7

1 Source: Hodgin, 1976. Updated with 1975 data.

2 Thousands of dollars, deflated to 1965 real dollars.

A multiple regression analysis was also used to analyze the overall effect of increased presuppression spending on the level of fire activity. Analysis of data from 1948 through 1966 indicated that presuppression expenditures had a significant effect on reducing both acres burned and the number of Class E fires. For the period 1965 through 1975, however, the statistical relationship is much weaker. It could not be concluded with any degree of confidence that increased presuppression spending during this period had a significant effect on reducing fire losses. Additional discussion on and conclusions of this analysis are appended. (Appendix H)

As has been demonstrated above, the use of trend analysis can be worthwhile in any effort to evaluate existing programs. It is suggested that this technique could be used to further advantage in future Fire Management evaluations.

Comparison Evaluations

Comparing a program to one with similar goals, objectives, or operating characteristics can provide indicators of effectiveness. Some recent correspondence to Forest Service Associate Chief Resler (Tikkala, September 1, 1976) supplied data for comparing Forest Service total presuppression and suppression expenditures with those of other organizations that administer wildlands. (See Table 13, page 112.) While there are many reasons why the comparisons may not be

TABLE 13. 1975 EXPENDITURES

	ACRES PROTECTED	PRESUPPRESSION		SUPPRESSION		TOTAL	
	(M)	(M$)	$/ac	(M$)	$/ac	(M$)	$/ac
States	726,356	N/A[1]		N/A		166,588	.23
NFS[2]	187,506	100,623	.54	42,576	.23	143,199	.77
Interior							
BLM[3]	401,000	19,232[4]	.05	25,357	.06	44,589	.11
BIA[5]	59,099	1,375	.02	5,438	.09	6,813	.12
NPS[6]		980	.04	N/A		N/A	
F&WS[7]		N/A		N/A		N/A	

1 N/A = not available. Most States do not separate expenditures into these categories.

2 National Forest System

3 Bureau of Land Management

4 BLM's presuppression expenditures include everything except suppression expenses.

5 Bureau of Indian Affairs

6 National Park Service

7 Fish and Wildlife Service

totally representative, they nevertheless show that the Forest Service emphasis on presuppression does not appear to have held suppression costs down. The data suggest that the availability of additional presuppression forces has, instead, generated additional suppression expenditures.

Another type of comparison evaluation is an accomplishment evaluation in which what was planned is compared to what was accomplished. Data which would lend itself well to such an evaluation are presented in Table 8, page 72, regarding fuel treatments. Whenever accomplishments are planned or predicted, an evaluation of accomplishment should be scheduled. Accomplishments need not always coincide with what was planned, but discrepancies of any magnitude should be understood and explained.

Analysis of Alternatives

In addition to analyzing projects, procedures are needed for evaluating the program mix. An obvious shortcoming of today's Fire Management organization is its lack of tools to analyze alternative choices in terms of either their predicted or actual effectiveness. (FOCUS accomplishes this to a limited extent by simulating the distribution of presuppression forces and their impact on fire size.)

Each of the three equations that follow may be used to either: 1) calculate results; 2) compare results of alternative program mixes; or 3) compare alternative suppression strategies.

It is stated in Chapters II and III that Fire Management is a service, and that proper measures of resource values are essential for planning and evaluation purposes. In Chapter IV, the need for more adequate cost information is stressed. The question remains, "How are resource values (i.e., values at risk, damage and benefits) and cost information used to assess or predict the effectiveness of Fire Management?" In Chapter I, a measure of suppression effectivenss was suggested by the equation cited immediately below.

Equation (1) $\text{Maximum Results} = \Sigma(EV+DA+SA) - \Sigma(SC+D)$

Where: EV = enhanced values
DA = damage averted
SA = suppression averted
SC = suppression cost
D = damage

In order to examine the effectiveness of Fire Management in its entirety, all prefire costs (prevention, detection, and presuppression) must be added to suppression cost. When all prefire costs are added, the equation becomes:

Equation (2) $\text{Maximum Results} = \Sigma(EV+DA+SA) - \Sigma(SC+D+PFC)$

Where: PFC = prefire costs

To date, some of the data necessary to operate this equation have been lacking. In previous chapters, the how and why of collecting all but the damage averted and suppression averted data have been discussed. These data are difficult to obtain, requiring better prediction techniques than are now available. However, crude estimates can and should be made of these elements of the equation since they form the

data base for extrapolation to areas which were prevented from burning. When sufficient data are available to operate the above equation, benefits of Fire Management can be determined more precisely.

The cost plus loss, or least cost, concept has been around for a some time, but it has never really been implemented. This concept is represented by a simplified version of Equation 2. It is very applicable today, and lends itself well to supporting alternative policies which might replace the present noneconomic (10 Acre and 10 a.m.) approaches.

The cost plus loss concept is common in fire literature. It was first presented in 1916 (Headley, 1916) and later was stated as the overall objective of Forest Service fire control up until 1935. In the 1928 National Forest Manual of Regulations and Instructions, it was stated that: "The objective of fire control is to reduce to a minimum the sum of the cost of fire prevention, presuppression, fire suppression, and the damages caused by fire." (USDA, Forest Service, 1928) With few changes, this concept has continued to be cited and discussed in literature up to the present time. Yet, it appears that it is not fully understood, perhaps accounting for its lack of application.

For instance, the 1928 Manual instructs the user to practice the concept by concentrating on reducing each of the components of the equation (i.e., prevention, presuppression

etc.) to a minimum. This ignores the fact that the intent of the concept is to minimize the sum, not each individual component. For example, to decrease the sum, it might be desirable to increase one of the components (e.g., presuppression or damages).

Another misconception common to all the literature reviewed is that cost and damages always have an inverse relationship, i.e., as one increases, the other always decreases (Figure 6, page 117).

Further, to fully utilize the concept, the objective should be to minimize the sum of cost plus net loss with net referring to the sum of enhancements, minus damages.

Equation (3) Minimum sum = Σ(cost - net loss)

In the cases where enhancements exceed damages (e.g., a fuel treatment), the net "loss" is actually positive. The literature on least cost ignores any enhancement value of fire.

Present policies (10 a.m., 10 Acre) exclude benefits or enhancement values and assume that costs and damages increase exponentially as area burned increases. (For graphic representation, refer to Figure 7, page 118.) Given this assumption, it follows that the harder fires are hit, the smaller they will be, and the sum of cost plus loss will always be minimized.

A more realistic view, supported by the trends in fire size and the increased cost of suppression, is represented by Figure 8, page 118. In referring to that figure, it can be

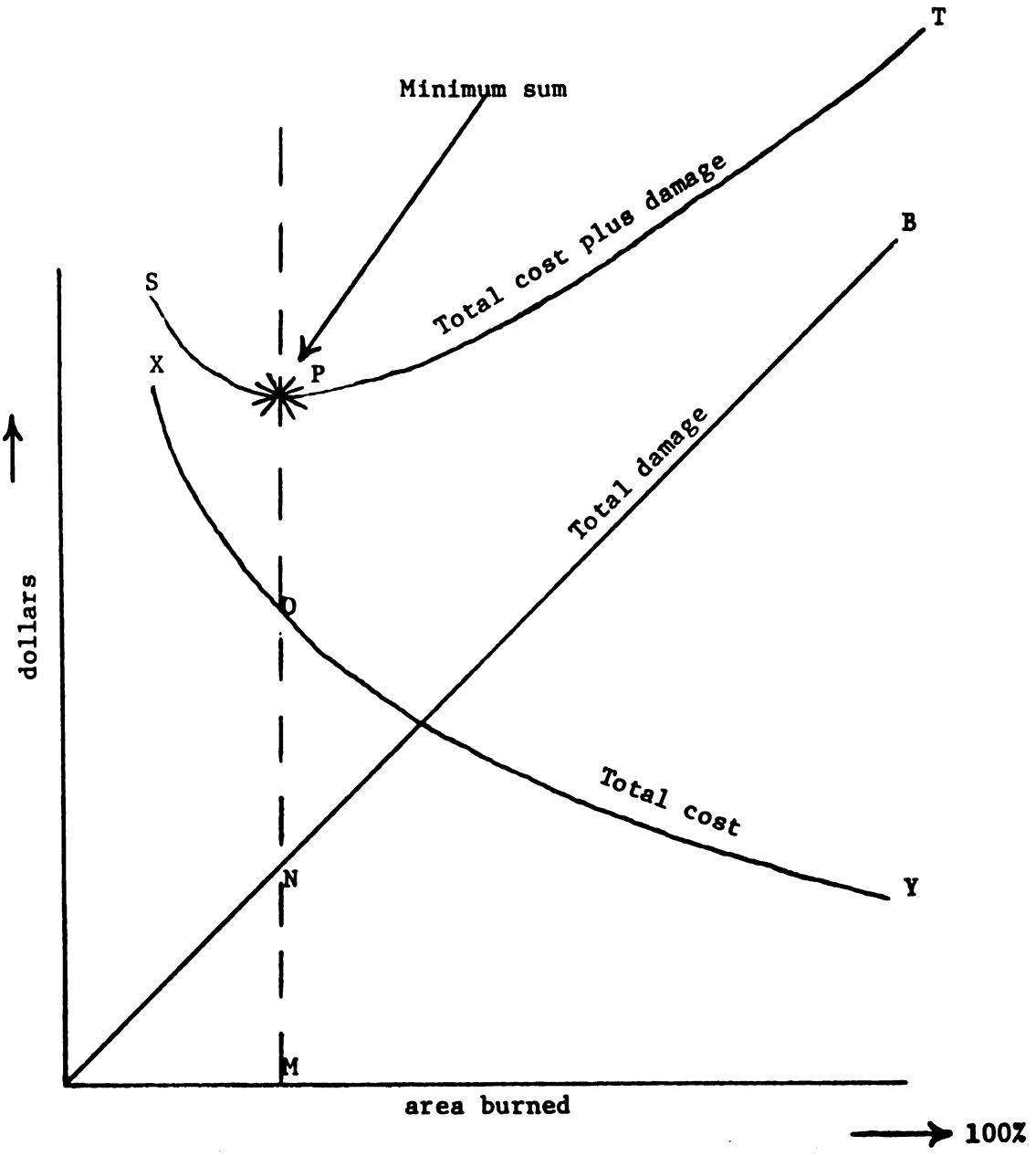

FIGURE 6. TYPICAL LEAST COST DIAGRAM

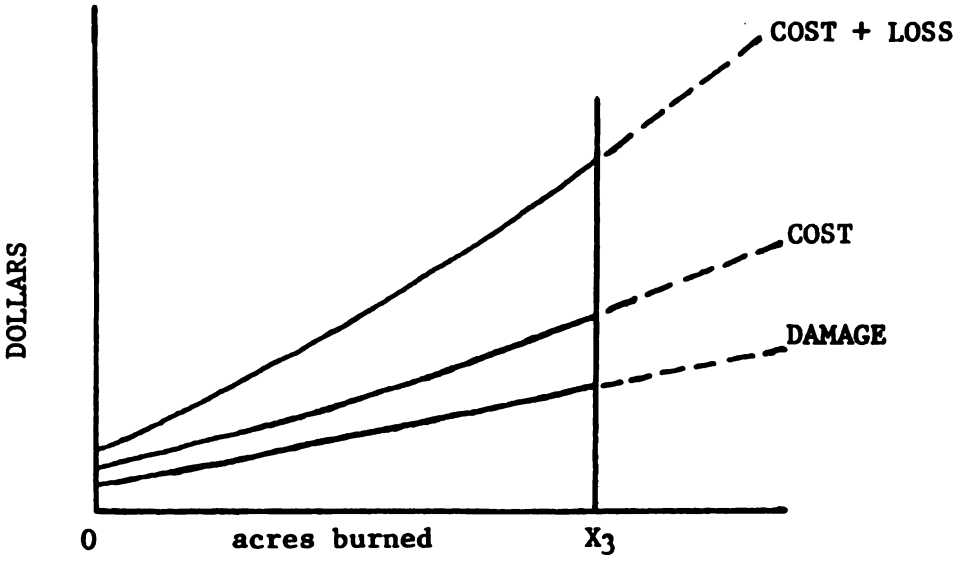

FIGURE 7. LEAST COST (PRESENT THEORY)

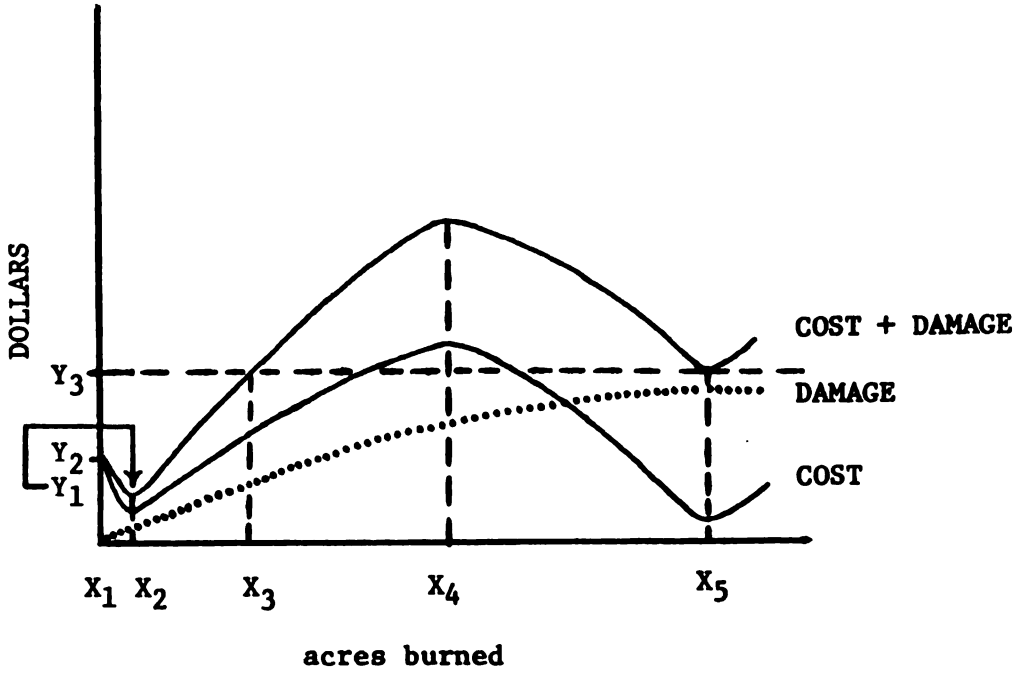

FIGURE 8. LEAST COST (PROPOSED)

seen that the portion between X_2 and X_3 is intended to be the same as that between O and X_3 in Figure 7. Figure 8 suggests that excessive aggression in initial attack results in high cost and low damage (Y_2). Such might be the case where a fire with little potential for damage is attacked with two airtankers and a helitack crew. A less agressive attack with two men and a pickup would result in slightly larger damage but a significantly lower cost plus damage sum (Y_1). Note also that expecting a large acreage such as X_5 for an escape fire gives a minimum cost plus loss over any point between X_3 and X_5. This view was also supported by the DESCON example in Chapter I.

In applying the cost plus net loss concept, the importance of benefits must be recognized. They must be given equal consideration when trying to minimize the sum of cost plus net loss. Figure 9, page 120, is intended to show the added dimension of benefits. It also shows that the curves may be shaped in a variety of ways reflecting time-dependent ecological and meteorological circumstances.

With the last example, the cost plus net loss equation begins to look complicated and, as most fire scientists know, the task of defining the shape of the curves is beyond present capability. However, every point on the curve does not need definition.

A Fire Plans Chief on a fire can usually identify more than one point where a fire might be stopped. The same is

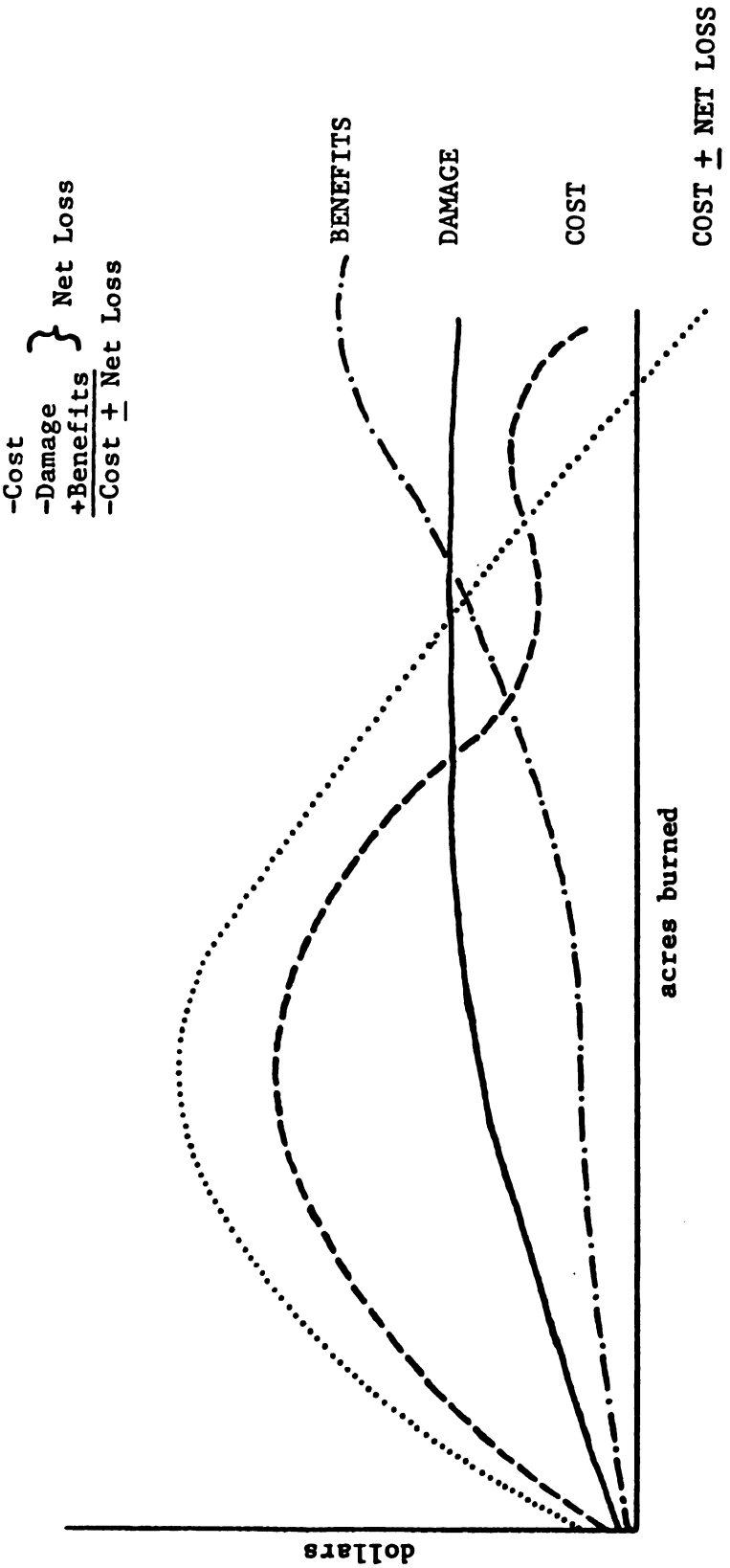

FIGURE 9. COST PLUS NET LOSS

true of a Fire Management Staff Officer on a Forest when he is developing preattack, or other presuppression, plans. Once these points have been identified, the task of calculating points on the horizontal axis is one of simple arithmetic as seen below:

-	cost	
-	damage	net loss
+	benefit	
-	cost	± net loss

For further consideration, an example using cost plus net loss to evaluate alternative program mixes is contained in Table 14, page 122.

Updating

A final and important step in any evaluation process involves updating in the Fire Management system and the programs it serves. Updating should be a formal, structured process which provides for applying the information learned in the evaluation process.

Internally, plans should be adjusted and improved, based on how well they met objectives. Values should be updated and estimates of value at risk improved. Data collection systems should be revised to meet current evaluation needs. And, occasionally, evaluations may indicate and provide the basis for a policy change to reflect new information or management needs.

Externally, the results of Fire Management activities should be available for adjusting the outputs and plans of

TABLE 14. AN EXAMPLE[1] OF LEAST COST PLUS NET LOSS

	ALTERNATIVES			
	A	B	C	D
Prevention	0[2]	200	1,200	3,000
Presuppression	500	1,800	2,000	1,800
Suppression	2,000	2,500	1,200	500
Net Loss	5,000	2,000	1,000	700
Least Cost Plus Net Loss	7,500	6,500	5,400[3]	6,000

1/ This example is a modification of one presented by Brown and Davis (1973).

2/ The figures given are monetary units of expenditure or loss.

3/ Alternative C is the least cost alternative.

the various resources, land management plans, the RPA, and the program budget. When Fire Management accomplishments are available to resource management planning, programming, and budgeting units, the relationship of Fire Management to these external units will be identified.

Summary and Conclusions

Several general conclusions can be made regarding the present evaluation system in Fire Management.

1) Fire Management has a strong and effective review and inspection system aimed at improving efficiency.
2) Most evaluations deal only with the efficiency aspects of Fire Management.
3) Evaluations tend to be on an irregular basis.
4) The scope and role of evaluations within Fire Management needs to be expanded.

In addition to the existing efficiency evaluations, increased effort is needed to identify Fire Management effectiveness. To accomplish this, it is suggested that the following be developed and instituted.

1) A system for rating a fire season and a capability for tracking its progress.
2) A comprehensive statistical analysis system.
3) Additional comparison evaluation procedures.
4) Procedures for evaluating alternatives in Fire Management.

5) Techniques for ensuring updating of evaluation findings into the Fire Management system.

Evaluations presented in this chapter revealed the following concerning the Fire Management program.

1) The least cost theory has not been fully understood.
2) Analysis of Fire Management activities has not shown increased achievement commensurate with increased expenditures.

Recommendations

Develop and implement a comprehensive evaluation system which:

1) includes effectiveness as well as efficiency evaluations; and
2) contains a feedback mechanism to the Fire Management subsystems and other Forest Service programs.

VI. USE OF THE EVALUATION

Introduction

A large bureaucracy, such as the Forest Service, will naturally have a variety of reactions to any evaluation conducted of one of its major programs. This study has been an evaluation of the Forest Service's second largest program, the Fire Management organization. It has been conducted basically from within the Forest Service by the author, a Forest Service employee. Most significantly, perhaps, is the fact that a number of the major findings of the evaluation have been predominantly critical of present Fire Management activities.

This chapter describes some of the activities related to Fire Management which took place during the preparation of this evaluation and after its completion. Special attention will be given to attempting to determine how the findings of this evaluation affected these activities.

It should be stressed that the veiws presented here are the author's alone and therefore are confined to his limited point of view.

It should also be noted that the length of time that this evaluation report has been available is brief, and has

not allowed for full consideration of some of the material. More time is needed to assess the impact of the evaluation, and an even greater amount of time will be necessary to fully understand what changes have occurred.

Fire Management Fund

As a result of work done by members of the Policy Analysis staff group in Phase I (Hodgin, 1976) of the response to the request by the Office of Management and Budget (OMB) that the Forest Service evaluate the escalating expenditures of its Fire Management program, it became apparent that Fire Management's funding and accounting procedures were of very limited value for management control or analytical purposes. (See Chapter IV for discussion.) As a result, it was determined that Phase II of the response to OMB (i.e., this evaluation) should involve an extensive effort to reach a better understanding of funding and accounting needs for Fire Management in an effort to seek possible alternatives. For this purpose, field trips were made by Policy Analysis staff to Forests in four Regions to solicit ideas and information from fire and business management field personnel.

About the time that these field trips were concluded, the Assistant Secretary of Agriculture for Conservation independently became interested in the funding procedures of Fire Management and communicated to the Chief of the Forest Service expressing "his feeling that presuppression activities

including financing for the implementation of the National Fire Plan, should be with regular appropriated (budgeted P&M as opposed to unbudgeted FFF) funds." (McGuire, October 21, 1976) According to the Chief, the Assistant Secretary at the same time indicated that he would also be willing "to entertain a proposal for a shift in the present method of financing presuppression." (McGuire, October 21, 1976) This suggestion not only sanctioned the effort of this evaluation in examining Fire Management's accounting and funding procedures, but it also provided the opportunity for the results of the study's findings to institute change.

As a result of the Assistant Secretary's letter, a Task Force was organized and headed by the Fiscal and Accounting Management staff of the Forest Service to develop an alternate financing proposal. Because of its concern and work up until that time, the Policy Analysis unit was able to play an active role in the development of this alternate financing proposal. The result of the efforts of the Task Force was the Fire Management Fund (FMF).

Chief McGuire, in his memo transmitting instructions to the field for implementing the new FMF, stressed that "the primary purpose of this policy is to get financial and managerial control over the fire management program." (McGuire, October 21, 1976) In part, this purpose was accomplished by the FMF's establishing a budgeted amount to be spent on presuppression. McGuire's transmittal memo, and

its accompanying directive, contained explicit instructions for managing these budgeted funds.

In discussing the institution of the FMF with field personnel (primarily in Region 5 during a recent field inspection of fire activities), the author found what appears to be overwhelming satisfaction at all levels with the fund. A common statement that was heard was that Fire Management expenditure decisions have increased in quantity and improved in quality. This is probably attributable to the fact that there are now a limited amount of dollars available. At the same time, however, there appears to be a pressure to break what is viewed as a ceiling imposed by the FMF on pre-suppression expenditures by finding ways to obtain additional funds.

As in any situation where an innovative change is introduced, this testing of the FMF's stability and the strength of top management's commitment to it is unavoidable. Whether the stated purpose of gaining financial and management control is attained by the FMF will be, to a large extent, determined by the responses made to these challenges.

Whatever the success of the FMF in standing up to its tests in the field, it must still grapple with two items which have been left unresolved. One is the unregulated use of FFF suppression funds. It is the conclusion of this evaluation that suppression funds should be incorporated, in part, into the FMF. (See discussion in Chapter IV.)

The second unresolved issue is acceptance of the FMF concept by the Department of Agriculture and the Office of Management and Budget. Acceptance of the FMF by the Department and by OMB would probably mean an elimination of FFF presuppression funding, with these funds being converted to P&M dollars. This would result in an all-P&M presuppression program requiring Department, OMB and Congressional negotiation and approval through the regular budget process each year.

Fire Planning Study Team

On July 21, 1976, the FMF concept was presented to the Chief and his staff for their approval. During the discussion which preceded approval of the concept, the concern of OMB over escalating fire costs was raised as an issue. The Forest Service's ability to defend the increasing costs was questioned. Consequently, the Chief and his staff decided that an analysis of fire planning and cost-effectiveness of presuppression activities needed to be conducted (Peterson, August 12, 1976).

A study team was appointed by the appropriate Staff Directors. This team consisted of Mr. Lance Hodgin from the Policy Analysis unit, a Field Program Analyst and a Fire Management Field Representative.

The main emphasis of the Fire Planning Study Team centered around a review of the National Fire Planning (NFP) procedures. Several of the recommendations made by the team

in its report (Gibson et al., 1976) are similar to the findings of this author's evaluation study. Specifically, the findings of the two studies concur in such recommendations as the need for: eliminating the 10-Acre Policy and utilizing land management plans for setting protection objectives; strengthening benefit-cost analysis techniques and developing procedures for evaluating effectiveness of the fire programs; and developing a system for determining potential fire damage and benefits based on actual damage and values.

One of the recommendations which the Fire Planning Study Team made was undertaken and accomplished by the present evaluation study. To evaluate the effectiveness of presuppression efforts, the study team suggested that a regression model which had been developed and used for the period 1948 to 1966 (Ellis, 1969) be rerun and compared with the results of the past ten years. This task was accomplished and appended to this report (Appendix H).

Perhaps the most valuable contribution which the Fire Planning Study made to the present study is that it offered an acceptable, sanctioned vehicle for surfacing and testing some of the information and ideas that were emerging from this evaluation study. This was possible because of the good rapport and working relationship between members of the two studies. Also the Fire Planning Study Team, for the first time, established non-fire expertise in the area of fire

planning. This expertise proved useful throughout the remainder of this evaluation when questions relating to planning were dealt with.

Policy Task Force

During the January 1977 Regional Foresters and Staff Directors meeting, the Chief of the Forest Service questioned the ability of Fire Management to support the existing level of expenditures (USDA, Forest Service, January, 1977c).

Fire Management accepted the challenge and took the initiative to examine and, if necessary, revise the policies under which it was operating.

A Task Force, consisting of five full-time and four part-time members, was appointed by Fire Management. The author and a representative from Fire Research were the only non-Fire Management representatives on the Task Force. Prior to the formation of the Task Force, a draft of the chapters on Fire "Law and Policy" and "Resource Values" of this evaluation had been completed. This and the fact that the Policy Analysis unit (of which the author is a member) is assigned responsibility for policy analysis, accounted for the inclusion of the author in the Task Force.

The direction given to the Task Force was minimal and thus a great deal of time was spent in developing a problem statement and in analysing the problem. This exhaustive task took the better part of two weeks, but allowed for a free-flow of ideas, criticism and comment. During this

process, much of the information which is contained in this final report was presented and discussed, along with ideas and information of other task force members. This opportunity greatly improved the content and acceptance of this report.

Three basic conclusions emerged from these discussions: 1) that the existing policies as they were being interpreted were not acceptable; 2) policies which moved Fire Management closer to the land management planning process would be more desirable; and 3) the selection of the most appropriate alternatives should be made by the Chief and the Regional Foresters to obtain greater involvement and commitment to Fire Management activities. Four alternative policies were developed; a fifth representing the current policies was defined (See Table 15, page 133).

Throughout the Task Force's functioning, all conclusions reached were supported by the entire team. All alternatives including the existing policies were considered to be viable alternatives. The Task Force made no attempt to select or promote a specific alternative. The Task Force finished its work in early May, 1977, and a decision making session for the Regional Foresters, the Chief and his immediate staff was scheduled for the second week in July.

July Fire Policy Meeting

Following the conclusion of work by the Fire Policy Task Force, and before the July Fire Policy meeting, several actions were accomplished.

TABLE 15. SUMMARY OF ALTERNATIVES[1/]

	A PRESENT SITUATION	B ESCAPE FIRE ANALYSIS
Initial Attack Objective	10 acre fire planning objective with Regional variations.	10 acre fire planning objective with Regional variations.
Escape Fires	Current 10 a.m. Policy.	Control strategy that minimizes cost plus net loss.

	C ZONES	D RELATIVE VALUES
Initial Attack Objective	10 acre fire plan objective except where zones established for modified/ deferred initial attack.	Range of objectives for protection unit based on relative value.
Escape Fires	Alternative B to include management objectives for any zones established.	Alternative B to include consideration of relative value.

	E RESOURCE OUTPUTS
Initial Attack Objective	Range of objectives for protection unit based on resource outputs.
Escape Fires	Alternative B to include impact on resource outputs.

1 Source: Harden, 1977.

First, the Chief directed the Policy Analysis Staff Director to have this fire evaluation study completed prior to the July meeting. Two weeks prior to the meeting, a draft was completed and 40 copies were distributed to Washington Office Staff Directors, Regional Foresters and Fire Management staff.

Second, the Fire Policy Task Force leader prepared a report summarizing the work of that Task Force and presenting the five alternative policies it had outlined (Harden, 1977).

Third, a one-day meeting took place early in June with all of the Regional Fire Staff Directors present. At this meeting, the Fire Policy Task Force summarized its work and presented the alternative policies. The reception of this presentation was generally favorable and the Regional Staff Directors were assigned the responsibility of briefing their Regional Foresters for the up-coming July Fire Policy meeting.

Fourth, a series of briefings starting in mid-June were scheduled for the purpose of conveying the findings of this evaluation to as many people as possible. For these briefings, a paper was prepared which summarized the study's major findings and recommendations. Presentations were given to a wide spectrum of groups and individuals in the Washington Office, beginning with the Deputy Chief for National Forest Systems. At each of these briefings, comments were

solicited many of which ultimately were used to refine this final report.

The Fire Policy meeting itself was a two day meeting held July 12 and 13, 1977. Attendance included the Regional Foresters, the Chief and his immediate staff, and a few selected individuals. The purpose of the meeting was to discuss and consider alternative fire policies in order to reach an agreement on which policy would be followed in the future. The meeting was structured with a half day of presentations, a half day of work groups, a half day of group presentations and discussion, and finally a half day to clarify the agreed-upon policy and its implementation.

During the first half day session a 45 minute presentation and discussion of this evaluation report was conducted. The discussion became fairly controversial. It was noted that most of the meeting participants seemed to be familiar with the content of the paper and had a copy on hand.

The work group session held during the second half of the first day dealt with a set of predetermined questions concerning such topics as delegation of authority, implementation issues, and barriers to change.

A group discussion session was held at the end of the first day and several conclusions emerged. They were: 1) there was general agreement that Alternative E[1/] should eventually be implemented; 2) Alternative E should be rewritten

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1 This stated that present fire plan initial attack objectives would be changed. Protection objectives would be based on resource and land management outputs and their corresponding values. Policy for escape fires would also be changed.

to give it a more positive tone; and 3) an interim policy is needed to solve some of the immediate problems and allow time to implement Alternative E. It was agreed that the interim policy should be structured using Alternative C[1/] as a basis and eliminating the 10 a.m. Policy. The rewritting of Alternatives C and E was assigned to a committee and was completed that evening. The results of this committee effort are shown in Table 16, pages 137 and 138.

The second day began with presentations from the work groups, which were followed by the committee's presentation of the interim policy it had prepared.

At this point, the issue of cost began to emerge with such questions being asked as: "Is cost really an issue?", "Can much be done about cost in the short run?", "Why have costs increased so much more rapidly in some Regions than in others?", and "Might it not increase costs to implement a significant shift in policy?". As the meeting progressed, it became clear that cost was a major concern and ways to reduce costs should be sought as soon as possible.

The remainder of the Fire Policy meeting was spent discussing possible ways to cut costs, defining tasks to be accomplished, and establishing completion dates. Several tasks, including that of determining ways for cutting costs, were designated for the agenda of a national meeting of the Regional Fire Planners scheduled for the following month.

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1 Present fire plan initial attack objectives would be modified for some areas on a zone basis. Present policy for escape fires would also be changed.

TABLE 16. NEW FIRE POLICIES
AS DRAFTED BY THE FIRE POLICY MEETING COMMITTEE

INTERIM POLICY: REWRITE OF ALTERNATIVE C	
Title	None given.
Description	Present fire plan initial attack objectives would be tailored to confinement rather than to 10 acre planning guides. Present policy, direction, and objectives for escape fires would be changed.
Strategy for Initial Attack	Areas where initial attack objectives would be pre-planned and tailored for confinement would be established. For such areas, protection objectives would be based on values, risks, and management objectives. Suppression actions would include appropriate attack and monitoring of fire activity similar to current exception areas. Suppression actions would minimize the cost plus net loss. Until objectives are tailored on all other areas, the current fire plan objectives would remain in effect.
Strategy for Escape Fires	Suppression action for escape fires would be determined in the first work period and would be based, as follows, on FSM 5130.3. When first attack fails, the policy will be to: 1) Promptly analyze the existing situation. 2) Consider and give emphasis in suppressing decisions to alternatives having lease adverse environmental effects. 3) Calculate the probabilities, including spread, and determine manpower and equipment needs. The responsible Forest officer making this calculation shall record his computations and assumptions for later reference.

TABLE 16 (CONTINUED).

LONG TERM POLICY: REWRITE OF ALTERNATIVE E	
Title	Land Management Objectives
Description	Present fire plan initial attack objectives would be based on planned resource and land management outputs. Present policy, direction, and objectives for escape fires would be changed.
Strategy for Initial Attack	Fire related actions would be designed to maintain and enhance the capacity to produce resource and land management outputs identified in land management plans. Fire management plans developed to support land management plans will provide cost effective mix of fire program elements.
Strategy for Escape Fires	Suppression action for escape fires would be determined in the fire management plans developed to support land management plans.

The Fire Policy meeting closed with a general feeling of satisfaction. The Chief expressed his pleasure with the quality of the meeting prework and the organization of the meeting itself.

National Fire Planning Meeting

The national meeting of Regional Fire Planners had originally been scheduled for the Spring of 1977 with one of its primary goals being to address questions raised by the Fire Planning Study Team (Gibson et al., 1976).

A second main goal of the meeting was to be an effort to normalize[1/] Forest and Regional fire plans. To allow the additional consideration of changes in fire planning policy which were expected to result from the July Fire Policy meeting, the National Fire Planning meeting was postponed until August.

The meeting was held in Denver on August 15-19 and was organized and conducted by the Washington Office of Fire Management. Meeting participants included fire planners from the various Regions, a few representatives from Fire Research and several other selected individuals.

Three objectives were identified for the meeting (Mann, July 22, 1977). The first objective was to develop guidelines for the evaluation and revision of existing Regional fire plans. (The revisions are to be completed by December 31, 1977). Some items relevant to this topic which were

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1 A term used to describe the process of eliminating variation between the plans, due to different interpretations of the National Fire Planning instructions.

suggested for consideration included: a) high-cost items on high-cost Forests; b) the need for a National Fire Plan Monitoring Board; and c) the need for more extensive use of Fire Preparedness Plans.

The second objective of the National Fire Planning meeting was to develop guidelines to help revise existing fire plans to meet the initial attack objective of the new Interim Fire Policy (i.e., the planning area concept developed by the July Fire Policy meeting to replace the 10 Acre Policy). These revisions are to be completed by September 30, 1978.

The third objective, to be accomplished by December 1978, was to develop a total fire management planning system responsive to the National Forest Management Act (RPA), zero-based budgeting, resource and land management output objectives, appropriate resource values, and an analysis of viable alternatives. The underlined portion of this objective relates directly to the recommendations made in Chapter III of this evaluation report which had been made available to all meeting participants.

At this writing, the National Fire Planning meeting was in progress. However, the author attended the opening day session and gave a short presentation on the fire evaluation study and its implications for fire planning.

Some of the author's observations during his brief attendance at the meeting might be of some value in judging how the developments from the July Fire Policy meeting were

being communicated. First, most of the National Fire Planning meeting participants had not been involved in the July Fire Policy meeting. Second, there was widespread concern over the actual meaning of the policies developed at the July meeting; and third, there was disagreement over whether cost was really an issue. Hopefully during the remainder of this meeting, a better understanding of the July Fire Policy meeting and its accomplishments will be developed.

Fire Research

Throughout this report, discussion of Forest Service Fire Research activities has been avoided because it was the intention of the evaluation study to deal only with the activities of Fire Management in the National Forest System. However, because of the implication of the report's findings to research activities and vice versa, it seems that it would be useful to discuss the current situation of Fire Research and to briefly mention some of the activities of Fire Research over the past year and how they relate to this report.

Currently, there appears to be a feeling by some fire researchers in the Forest Service that the research background which is necessary to carry out many of the recently proposed changes for Fire Management, does not exist. Consequently, the research organization which generally finds itself advocating change has found itself in a position of having to caution those who want to see change effected.

The fact exists, however, that change is imminent and a pressure is building on the research organization for it to provide information with which to support this change.

Fire Research has taken steps to meet this demand. Two national meetings were held during this past year. The first meeting, attended by fire researchers and several Fire Management staff personnel, was a colloquium held in September, 1976, in Washington, D. C. The primary focus of this meeting was on identifying economic problems in fire management.

At this meeting, the author gave a presentation of some of the material on resource values contained in Chapter II of this report. Several other presentations were given and much of the discussion centered around the need to measure damages, the role of resource values in fire management, and how to better relate fire planning with resource and land management planning. Long and short-term lists were developed by the participants to identify research needs and possible solutions to fire economic and planning problems.

The second meeting, which dealt with the topic of "Fire Planning Research Status and Needs," was held in January, 1977, at Macon, Georgia. That meeting attempted to summarize the state of the art and identified research needs in six areas: 1) physical effects of fire; 2) biological effects of fire; 3) fire behavior consideration in planning; 4) assessment of effectiveness of fire management alternative plans;

5) economic considerations in fire planning; and 6) integration of fire management planning with land management planning (Chandler, March 28, 1977).

These six areas essentially describe the areas of research that are being pursued by Fire Research at this time. The first three areas represent traditional areas of fire research. In the first area, that of fire's physical effects, an expanded effort is underway brought about primarily by a recognition that more information on fire effects is necessary if research efforts in other areas are to be successful.

The last three areas identified are relatively new areas for Fire Research. They have developed rapidly in the past year to meet what is seen as the needs of Fire Management. These areas are particularly relevant to the recommendations made by this evaluation report, and answers to many of the questions raised by the report will ultimately be resolved or refined by research on these topics.

VII. SUMMARY

Introduction

The Office of Management and Budget requested that the Forest Service analyze the desirability of the individual practices, procedures, and strategies of Fire Management and to determine whether present management procedures are capable of selecting appropriate fire fighting strategies and directing proper expenditure of fire fighting funds. This request is the subject of this evaluation study.

During this study several positive aspects of the present Fire Management program were identified. These include fire training activities, the interagency fire coordinating group, and the national leadership role occupied by the Forest Service in fire-related matters. In addition, it became apparent that Fire Management was acting to solve problems which it had identified. These corrective actions include the development of the Fire Management Funds, establishment of a Task Force to review fire planning and the scheduling of fire policy meetings.

One of the stated goals of this evaluation study was to provide information which would lead to internal improvement of the Fire Management program. Therefore, positive aspects of that program have not been covered in any detail;

and, instead, problem areas have been identified and highlighted.

Following are the major findings of the study and their related indicators. A list of recommendations drawn from the study, and an explanation of the actions taken to date on these recommendations, completes the summary.

Findings

LAWS — The Agency is required by law only to protect resources.

- -- Relevant laws are very general.
- -- The laws seldom refer to fire.
- -- Determination of policy is left almost entirely up to the Forest Service.
- -- An economic rationale was intended to be included in establishing fire protection levels.
- -- The laws will permit policy changes.

POLICIES — The expression of Fire Management policy has not kept pace with rapidly evolving Fire Management philosophy.

- -- The most visible program change in the 1970s is an expansion of the fire control effort.
- -- Fire "effects" are presented only as damages.

-- Present policy does not express the beneficial aspects of fire.

-- The desire for change in the Fire Management organization is visible at all levels.

RESOURCE VALUES

Values are neither adequately assessed nor properly used in Fire Management today.

-- Systems presently used to assess values equate values with damages.[1/]

-- Benefits from fire are not recognized.

-- The validity of existing value data is questionable.

-- Values do not play a significant role in establishing Fire Management activity levels.

-- Values do not play a role in evaluating Fire Management activity.

-- Fire Management values are neither representative of nor related back to other resource systems.

PLANNING

The Fire Management planning process is incomplete.

-- The development and analysis of alternatives are not required.

-- Individual fire-related plans are not required to be integrated with one another or with other Forest Service programs.

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1 Values should include: total resource values, damages and benefits, and social values.

The goals and objectives of fire planning do not address resource and management needs.

-- The 10-acre goal is a fire planning goal; it does not relate to resource management needs or priorities.

-- Planning is geared to total protection rather than to resource values and acceptable losses.

-- Identification of the fire management needs of the various resources' programs has been left to Fire Management.

MANAGERIAL CONTROL

The current fiscal and statistical information systems are not adequate for evaluation and management.

-- Data specific to evaluation needs (e.g., a breakdown of suppression expenditures) are not being gathered.

-- Data needed for evaluation and management are not available in a timely and appropriate manner.

-- The current system does not provide for recording beneficial effects of fire.

-- There currently is no integrated system which displays fire management cost relative to resource planning, the RPA program, land management planning, and the program budget.

EVALUATION

Current evaluations concentrate on efficiency (i.e., doing it cheaper, faster, and with less effort) which has limited application to program improvement.

There is a general lack of effectiveness evaluations (i.e., the extent to which we are meeting goals and objectives).

-- Within Fire Management, there is a weak link between evaluations, resource values, planning, policy, and managerial control.

-- Evaluations do not establish a relationship between Fire Management activity and resource management outputs.

-- At the present time, Fire Management returns are not visible.

Recommendations

I. Develop new Fire Management policies which provide for a broader, more positive approach to fire, consider economics, and encourage line participation in the decisionmaking process.

II. Establish procedures for determining reliable estimates of forest values that will be used as input for establishing the level of Fire Management activity and assessing accomplishment.

III. Improve the Fire Management planning process by incorporating: appropriate values, resource management

objectives, an analysis of the viable alternatives, and integration with other plans.

IV. Address the accounting and budgeting systems of Fire Management to:

A. complete and implement an accounting system for fire suppression;

B. explore possibilities of budgeting the normal suppression load; and

C. adjust the statistical reporting system to provide timely, relevant data.

V. Develop and implement a comprehensive evaluation system which:

A. includes effectiveness as well as efficiency evaluations; and

B. contains a feedback mechanism to the Fire Management subsystems and other Forest Service programs.

Action on Recommendations

The first recommendation of the present evaluation study -- that new Fire Management policies be developed -- has largely been accomplished by the July, 1977, Fire Policy meeting. The new policy selected at that meeting remains to be implemented, a task which will require several years before it is fully achieved. The real impact and effectiveness of this new policy will not be known for some time.

The second recommendation of this evaluation -- that procedures be established for determining reliable estimates of forest values -- has received some attention from Fire Research and publications on this topic will probably be forthcoming. Several other sources of information are currently available as discussed in Chapter II. The task remains, however, for Fire Management to evaluate whatever processes are available and to select and formalize the procedure it chooses to implement.

The third recommendation -- that the Fire Management planning process reflect appropriate values, resource management objectives and an analysis of viable alternatives and that it be integrated with other plans -- has been designated as an objective to be accomplished by the National Fire Planning meeting being held August 15-19, 1977, in Denver.

The fourth recommendation of this evaluation study is composed of three parts and identifies problems associated with the accounting and budgeting system, none of which are being actively addressed at this time.

Part A recommends that an accounting system for fire suppression be completed and implemented. This task could be incorporated into the Fire Management Fund.

Part B recommends that possibilities of budgeting the normal suppression load be explored. The same advantages which have been attained by the Fire Management Fund in budgeting presuppression funds (i.e., increased effectiveness

through greater planning and more careful consideration of expenditures) could be realized for most suppression activities as well.

Part C recommends that the statistical reporting system be adjusted to provide timely, relevant data. The problem of timeliness could be solved relatively easily with an adjustment in the mechanics of the fire data reporting system. The question of selecting relevant data, however, should be carefully considered in light of the data needed to support current and proposed changes in Fire Management.

The final recommendation of this evaluation study -- that a comprehensive evaluation system be developed and implemented -- is currently receiving some attention through research efforts and possibly through the National Fire Planning meeting being held on August 15-19, 1977, in Denver.

If Fire Management is to know whether its new policies and developing planning system are successful, it must have a well developed self-evaluation system. Also it will be this evaluation system which provides information to complete the link between Fire Management and the various resource and management systems.

Fire Management is presently in the midst of a severe fire season, a time when it is easy to say that the only good fire is a suppressed fire. But in spite of the

immediate situation, a need for change has been recognized and the institution of this change has begun.

APPENDIX A

COMPARISON OF LAND VALUE ESTIMATES TO POTENTIAL DAMAGE CLASS VALUES

Three independent sources which make estimates of the value of Federal and Forest Service land are cited. The Bureau of Census reports that there are 762 million acres of Federally-owned land, valued at $98.5 billion (U. S. Department of Commerce, 1974). This approximates a value of $129 per acre and includes the value of the land, resources, and improvements. An article in Fortune magazine lists the estimated market value of all Federal land as $94 billion (Loomis, 1973), a value comparable to that of the Bureau of Census. A recent article in Science Magazine (Clawson, 1976) reports that the National Forest System's assets have an average market value of $225 per acre.

On the other hand, using the system for estimating potential fire damage provided in the National Fire Planning instructions (USDA, Forest Service, 1972) the value of Forest lands (which compose only 25 percent of all Federal land) is computed at $246.7 billion or $1,361 per acre.

It is difficult to accept that a value based on potential damage estimates for resources on Forest Service land could be so much greater than these other estimates. It is,

therefore, concluded that the dollar values assigned to the potential damage classes by the National Fire Planning (NFP) instructions are excessive and inaccurate.

The discrepancy between actual and potential damage values can be further accentuated by comparing the average value of cropland with the average potential damage value for National Forest land. Cropland values published by the USDA Economic Research Service range from $72 to $2,852 per acre, with a nationwide average of $403 (Paulson, 1976). Keep in mind that the discrepancy between this figure and the $1,361 per acre figure assigned to Forest Service land by the NFP instructions would be even greater if the damage class value included land and other non-fire damageable values.

Large discrepancies again appear when individual potential damage class estimates are compared to specific land values and estimates of resource damages. For timber the potential damage, according to the NFP instructions, ranges from $1,000 to $1,500 per acre depending on whether second growth or old growth is involved. No other factors are considered in determining this value.

Kimberly-Clark Corporation valued 388,000 acres of its second growth hardwood timberland (including timber value) in northern Wisconsin and Michigan's Upper Peninsula at $100 per acre (Wall Street Journal, 1976). The Cleveland Cliffs Iron Company owns land in the same general area with a similar value, $100 to $135 per acre for the timber

resource alone (Mueller, 1976). In the Southwest, the Coconino National Forest in Arizona estimated that a 3,200 acre fire in 1971 caused timber resource damages of $19 per acre (Washington Star, 1971). The Grama Fire occurred on National Forest land in Arizona in 1974 and caused $205 per acre of timber damage (Holley, 1974).

The NFP values of potential damage to rangeland and watershed value classes also show wide discrepancies to those values obtained through other methods. In New Mexico, in 1974, the actual calculated damage to grassland from two fires which burned 30,500 acres of State land, averaged $4 to $5 per acre (USDA, Forest Service, 1974d) compared to the NFP potential damage class estimate of $250 per acre. Watershed damage to the Coconino National Forest land in Arizona from a 1971 fire was assessed at $81 per acre (Washington Star, 1971) while the NFP potential damage values range from $1,500 to $2,400 per acre, depending on the type of watershed use.

State and private land also show significantly lower actual damage estimates. For four Southern States (South Carolina, Georgia, Alabama, and Texas) the estimated average fire damage (1970 dollars) which has occurred during recent years on non-Federal land is $90 per acre (USDA, Forest Service, 1976a). The comparable average potential damage value class estimate for the Southeastern Region is $1,413, a figure which is 16 times larger.

A smaller, but similar discrepancy exists for resource damages in New Mexico. The spring of 1974 was a particularly bad fire season; several fires on State and private land burned 41,888 acres of range and timberland. Damages were assessed at an average of $344 per acre; and, for individual fires, they ranged from $4 per acre for rangeland to $1,867 per acre for severe damage to prime timberland accompanied by severe watershed damage (USDA, Forest Service, 1974d). Comparing these figures with a potential damage class estimate of $1,269 shows that the NFP potential damage estimate was still four times higher than the average actual damages during this severe fire season.

One resource value class (fisheries) showed no significant discrepancy between potential values identified using the NFP instructions and estimates of actual damages. The total value of South Atlantic and Gulf Coast marshlands and estuaries as fishery nurseries for commercial fish, sport fish, and shellfish catches is calculated at $2,000 per acre (Mattill, 1976). This figure is identical to the Fire Management potential damage estimate for all areas classed as fisheries. However, few Forest Service fisheries are of this type.

Besides the fact that the values assigned by the NFP potential damage class system appear to be excessive, another problem exists in that the system does not allow for significant differences in individual resource values between or within Regions. The timber resource value class is a good example of this. Potential damage values range from $1,000

to $1,500 per acre, depending on whether the timber is old growth or second growth, but not depending on where the resource is located or what kind of timber it is.

In summary, potential damage should bear a direct relationship to measured actual damage and in most cases should be less than the total land value. This relationship is not apparent in the NFP potential damage class system.

APPENDIX B

MEASURABLE RESOURCE VALUE GROUPINGS

The following is a sample grouping of resource values. Each grouping includes a brief discussion of appraisable items and how to measure them.

Wood Products. This group includes all saleable wood items such as timber, pulp, chips and firewood, each measured in its appropriate physical units. The value of mature products is reasonably easy to assess. For immature products or productivity effects, the task of appraisal is more difficult but several methods exist, including those described in section 5330 of the Forest Service Manual (USDA, Forest Service, 1977a).

Range Products. This group includes two types of items. One is forage, measured in AUMs; the other is livestock, measured in kind and number. Both types of range products usually have well established local market values. It is rare that livestock are directly affected by fire. Generally the effect of fire on forage is of short duration (one season) and, in the long run, an increase in value often results.

Wildlife and Fish. This group can be divided in a manner similar to the range products group, according to habitat and to species. The large number of species and their

various habitat requirements make this grouping complex. In assessing wildlife values, critical effects must be identified, i.e., critical habitat or a significant change in population size or structure. To establish the actual value, identify the impact on species number and then assess the value that man places on that species.

Recreation. "The product of the recreation resource is human satisfaction from recreation activities." (Crosby, 1977, p. 14) While satisfaction cannot be directly quantified, the number of people participating in a recreational activity and some expression of what it cost them to participate are generally accepted as a measure of a recreational resource's worth. The basic units of measurement are visitor days, fisherman days and hunter days. Several sources are available for assigning value to these units. These include documents by the Value at Risk Task Force (USDA, Forest Service, 1971a), the Water Resources Council (1973), and the Bureau of Outdoor Recreation (US Department of the Interior, 1976).

Improvements and Equipment. Generally, a present market value for improvements and equipment can be established with little effort. The idea of intended use applies here as well as with other groups. An item which is no longer needed and cannot be sold might be valued as to the cost of its disposal. In this case, a benefit is derived if it is destroyed.

Social Impacts. Several of the other value groupings include items which might be considered social impacts such

as employment and loss of business income. Their actual value is not too difficult to assess provided their indirect relationship with the affectable forest values can be established. However, if an alternate source of employment or income is available, then the relationship is not a significant one and the only impact involved is the cost to change from one alternative to another.

Environmental Effect. This grouping includes such items as watershed degradation (including effects on water quality), esthetics and forest insects and diseases. Some of these impacts may be intangible and should be noted as such. Extreme care should be taken in identifying the fire-related environmental impact, remembering that fire is a natural agent in a forest environment.

Health and Safety. This group includes such items as air and water quality, hazards to life, and accidents. These items usually result in an indirect impact on some activity. The difficulty again is in identifying what is affected.

APPENDIX C

TYPES OF FIRE PLANS

1. Aviation Management Plan
2. Burning Plan
3. Central Dispatching Plan
4. Contingency Fire Plan -- Mountain Pine Beetle
5. Coordinated Fire Situation Plan
6. Deletion Plan
7. Fire Training Plan
8. Forest Fire Plan
9. Fuel Management Plan
10. Hazard Reduction Plan
11. Integrated Fire Control Organization and Finance Plan
12. Law Enforcement Plan
13. Manning and Specific Action Guide
14. Mobilization Plan
15. Operating Plan -- Forest Service and State
16. Organization Plan for Project Fires
17. Physical Fitness Plan
18. Pre-attack Plan
19. Preparedness Plan
20. Protection and Manning Plan

21. Red Flag Alert Plan
22. Regional Fire Plan
23. Smoke Management Plan
24. Special Protection Plans
25. Supplemental Protection Plan
26. Timber Sale Fire Plan
27. Wilderness Fire Management Plan
28. 10 a.m. Exception Plan

APPENDIX D

INDIVIDUAL FIRE REPORT HANDBOOK (FORM 5100-29)

USDA - FOREST SERVICE

INDIVIDUAL FIRE REPORT

FIRE NAME: Jumpoff Joe

RANGER FIRE NO.: 1

MANDATORY ITEMS: CLASS A 1-33 | CLASS B 1-34 | CLASS C to G 1-44

REGION FIRE NO.: 1871

1. State [2-3]	2. County	3. Forest [4-5]	4. District [6-7]	5. Supervisor No. [8-10]
Oregon 36	Linn	Willamette 18	Sweet Home 03	011

6. Fire started on [11]	7. Month [12]	Day [13-14]	Year [15]	8. Watershed No. [16-23]	9. Size Class [24]
National Forest 1	July 7	1	9	17210101	E E

10. Statistical Cause [25]	11. General Cause [26]	12. Specific Cause [27-28]	13. Class of people [29]
Debris burning 5	Timber Harvest 1	R/W burning 16	Permittee 2

	DATE Mo. Day	HOUR	ELAPSED TIME Hours	Min.
14. Origin	7-1	1340	[30-31] 14	
15. Discovered (Item 15 minus 14)	7-1	1345	[32-33] --	[34-35] 5
16. First attack (Item 16 minus 15)	7-1	1346	[36-37] --	[38-39] 1
17. First Reinforcement (Item 17 minus 16)	7-1	1545	[40] 1	[41-42] 59
18. Fire Controlled Item 18 minus 16	7-5	1000	[43-45] 92	
19. Fire Out	9-22	1700		

20. Discovered by (Class) | Location	Forest Service Permittee | Vicinity of Fire [46] 6
21. First Attack by |(Kind) |(Amount)	Tanker 6 men [47-48] 36
22. First Reinforcements (Kind) |(Amount)	Handtools 9 men [49-50] 46
23. Maximum No. Personnel	[51-54] 695
24. Value Class at Origin	[55] 6
25. Fire danger	[56-57] 17
26. Special Weather feature	15 m.p.h "G" [58] 7

27. Slope	[59] 2
28. Aspect	North [60] 0
29. Elevation	1340 [61] 1
30. Cover type - vicinity of origin	H4 [62-63] 23
31. Fuel type - vicinity of origin	M M [64-69] 122
32. Cost Class	$91,500 [70] 6

33. Location

Scale: _____ inches = 1 mile

See attached Map

Location description

a. Township	[71-74] 14S
b. Range	[75-78] 5E
c. Section	[79-80] 11
d. Meridian	
Alternate description for lands not covered by GLO survey	
e. Latitude	[72-75] *-4422-*
f. Longitude	[76-80] *-12214-*

34. Acres burned	NATIONAL FOREST LANDS	OTHER LANDS INSIDE
a. Noncommercial forest	[11-16] ------	[17-21] -----
b. Commercial forest (1) Natural	[22-27] 527	[28-32] -----
(2) Plantation	[33-37] -----	[38-42] -----
c. Nonforest	[43-48] 7	[49-53] -----
35. Volume of timber destroyed (MBM)	[54-59] 2000	[60-64] -----

36. Total area when controlled	[65-70] 534
37. Fuel type prevailing on burned area	[71-76] 1
38. Topography (vicinity of origin)	[77] 7
39. Highest Fire Danger	[78-79] 21
40. Critical Weather Feature	17 "G" [80] 7

Remarks (Continue on reverse if required)

Submitted (Signature)	Date	Approved (Signature)	Date
Smokey Bear [Acting] District Ranger	10-7-69	W. C. Owl [Acting] Forest Supervisor	10-14-69

5100-29 (10-69)

Value of Resources Damaged or Destroyed (Code in hundreds of dollars)		N.F. LANDS (1)		OTHER LANDS (2) INSIDE FS PROTECTION	
		Dollars	Code	Dollars	Code
41. Timber		$194,600	[11-15] 1916		[16-20] -----
42. Other (non-timber)					
a. Watershed		$ 1,000	[21-25] ---10		[26-29] ----
b. Recreation			[30-34] -----		[35-38] ----
c. Range & Wildlife					
d. Improvements		$ 500			
e. Other non-timber					
f. Total non-timber (a to e incl.)		$1,500	[39-43] ---16		[44-48] -----
43. GRAND TOTAL (Items 41 and 42f)					
44. Acres burned by Value Class	Value Class		Acres		Acres
	[49] 6		[50-54] --534		[55-59] -----
	[60] -		[61-65] -----		[66-70] -----
	[71] -		[72-75] ----		[76-79] ----

GPO 881-619

APPENDIX E

EXAMPLE OF FIRE ACTIVITY INDEX CALCULATIONS

RAW DATA

	YEAR	# OF FIRES	ACRES BURNED	# FIRES E AND
	1985	10	1000	5
R-11	1986	5	2000	1
		15	3000	6
	1985	4	500	2
R-12	1986	8	1500	6
		12	2000	8
	1985	14	1500	3
NFS	1986	13	3500	11
		27	5000	14

$$\text{coefficient}_1 = \frac{\text{total ac burned}}{\text{total \# fires}}$$

$$c_1 = \frac{3000}{15} = 200$$

$$\text{coefficient}_2 = \frac{\text{total ac burned}}{\text{total \#E \& > fires}}$$

$$c_2 = \frac{3000}{6} = 500$$

COEFFICIENT

c_1		c_2
200	1	500
167	1	250
185	1	375

c_1 and c_2 are calculated for each unit or Region

(WD) WEIGHTED DATA

2000	+	1000	+	2500	= 5500
1000	+	2000	+	500	= 3500
667	+	500	+	500	= 1667
1333	+	1500	+	2000	= 4833
2593	+	1500	+	1071	= 5164
2407	+	3500	+	3929	= 9836

WD = raw data x coefficient

2000 = 10 x 200
or
2500 = 5 x 500

INDEX NUMBERS

	R-11	R-12	NFS
1985	55	17	36
1986	35	48	41

The weighted sums were divided by 100 to obtain the index numbers. When using actual data, weighted sums are divided by 10,000 to derive the Index. The NFS Index number is further divided by the number of Regions to obtain the National Index.

APPENDIX F

STATISTICAL DATA FOR INDIVIDUAL YEARS

This appendix contains a detailed breakdown of fiscal and physical data relating to Forest Service fire management for the years 1965 to the present. Most of this data was gathered during the initial stages of the evaluation and also appears in the Phase I report (Hodgin, 1976). Figure 12, page 170, and Table 17, page 167, of this appendix appeared in the text as Figure 2, page 21, and Table 9, page 81 respectively. They have been reproduced here to provide easier reference and comparison to associated data.

TABLE 17. EXPENDITURE INFORMATION

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	Trans. Qtr.	1977 [3]
ACTUAL DOLLARS														
P&M - Suppression [2]	(723)	(725)	(1164)	(773)	(730)	(1391)	(572)	(211)	(209)	(51)	(30)			
P&M - Presuppression	22079	22818	23758	24581	25958	27502	28714	29610	31393	35651	36618	38681	12239	43156
F.F.F. - Presuppression	5846	5846	8077	9542	7275	11236	18291	23269	24996	42158	55368	85055	46678	99800
F.F.F. - Suppression	11332	10804	21792	35576	15301	14905	64409	37063	36990	67579	59023	65878	23849	54634
F.F.F. - Carry Over [4]				(600)	—	(1000)	(8100)	(4600)	(4600)	(14983)	(10181)	(31659) [5]	(26252) [5]	57911 [6]
F.F.F. - Differential	-0-	864	876	883	709	282	277	173	155	136	45	-0-	-0-	-0-
Total - Presuppression	27925	28664	31835	34123	33233	38738	47005	52879	56389	77809	91986	123736	58917	142956
GRAND TOTAL	39252	40332	54503	70582	49243	53925	111691	90115	93534	145524	151054	189614	82,766	254,431
DEFLATED DOLLARS														
P&M - Presuppression	22079	22153	22625	22348	22380	21321	20809	19870	19497	19916	18680	18869	-	-
F.F.F. - Presuppression	5346	5676	7691	8677	6272	8708	13250	15617	15528	23552	28255	41490	-	-
F.F.F. - Suppression	11322	10489	20755	32344	13188	11553	46672	24876	22975	37746	30114	32126	-	-
F.F.F. - Differential	-0-	840	830	800	610	220	160	120	100	80	23	-0-	-	-
TOTAL	39247	39158	51901	64169	42450	41802	80891	60483	58100	81294	77072	92485	-	-

1/ Thousands of Dollars
2/ Not included in totals or Exhibit E
3/ Estimate based on supplemental request
4/ These expenditures were spent in the listed period, but are carried over for payment from FFF supplemental appropriated funds in the next period. All total expenditures, breakdowns, and graphs have included them in the period they were paid for out of Fire supplemental appropriations, i.e., for the true expenditures for 1973, add the listed carryover amount to the 1973 grand total and then subtract the 1972 carryover amount.
5/ Carryover for both 1976 and the TQ carried over for payment out of FY 1977 supplemental appropriations.
6/ F.F.F.-Presuppression and F.F.F.-Suppression figures listed for FY 1977 are estimates of the money needed to fund FY 1977 activities. They do not include F.F.F. carryover from the previous year, as do the corresponding figures for other years; therefore, the carryover listed for FY 1977 is from 1976 and TQ, not 1977.

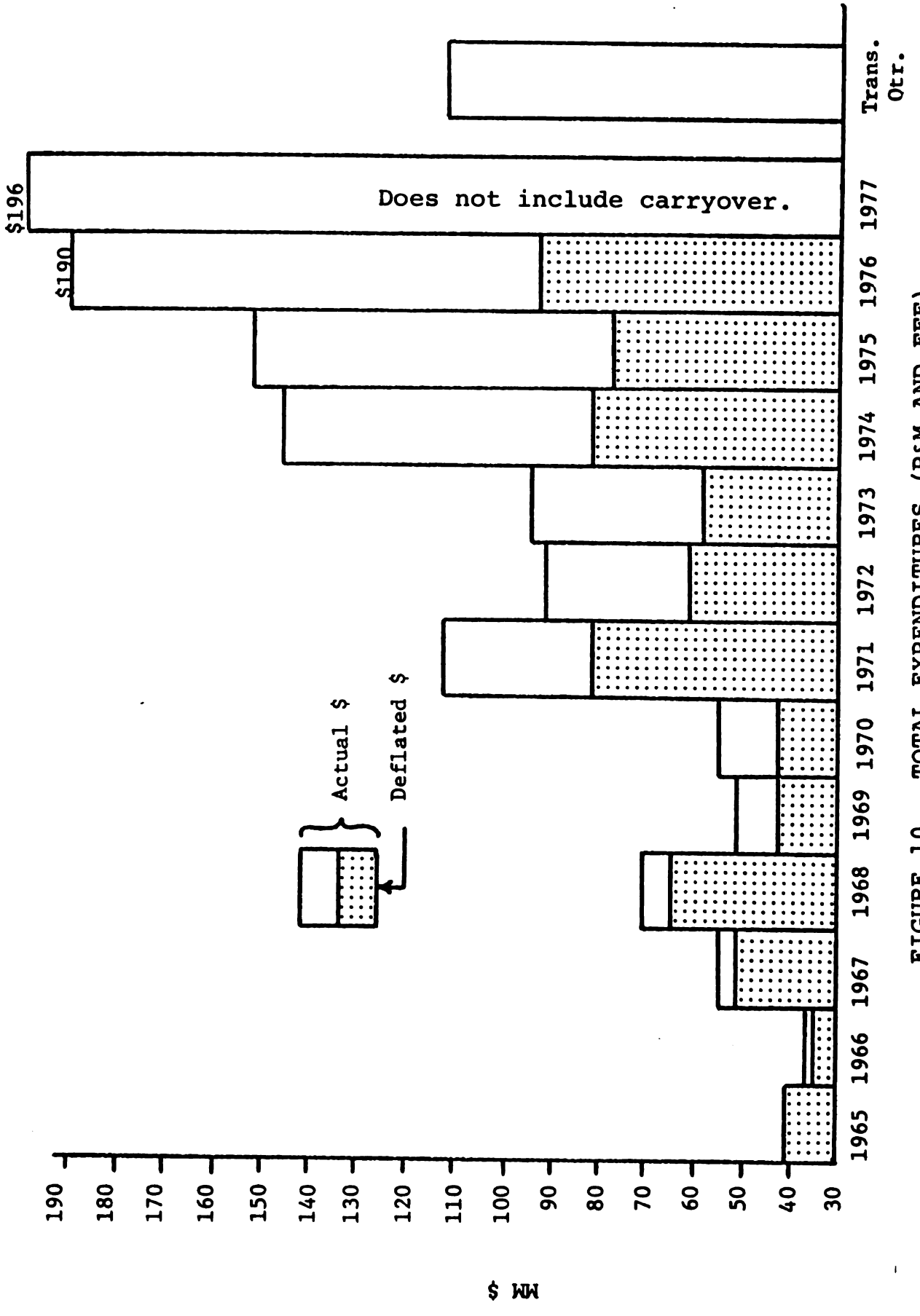

FIGURE 10. TOTAL EXPENDITURES (P&M AND FFF)

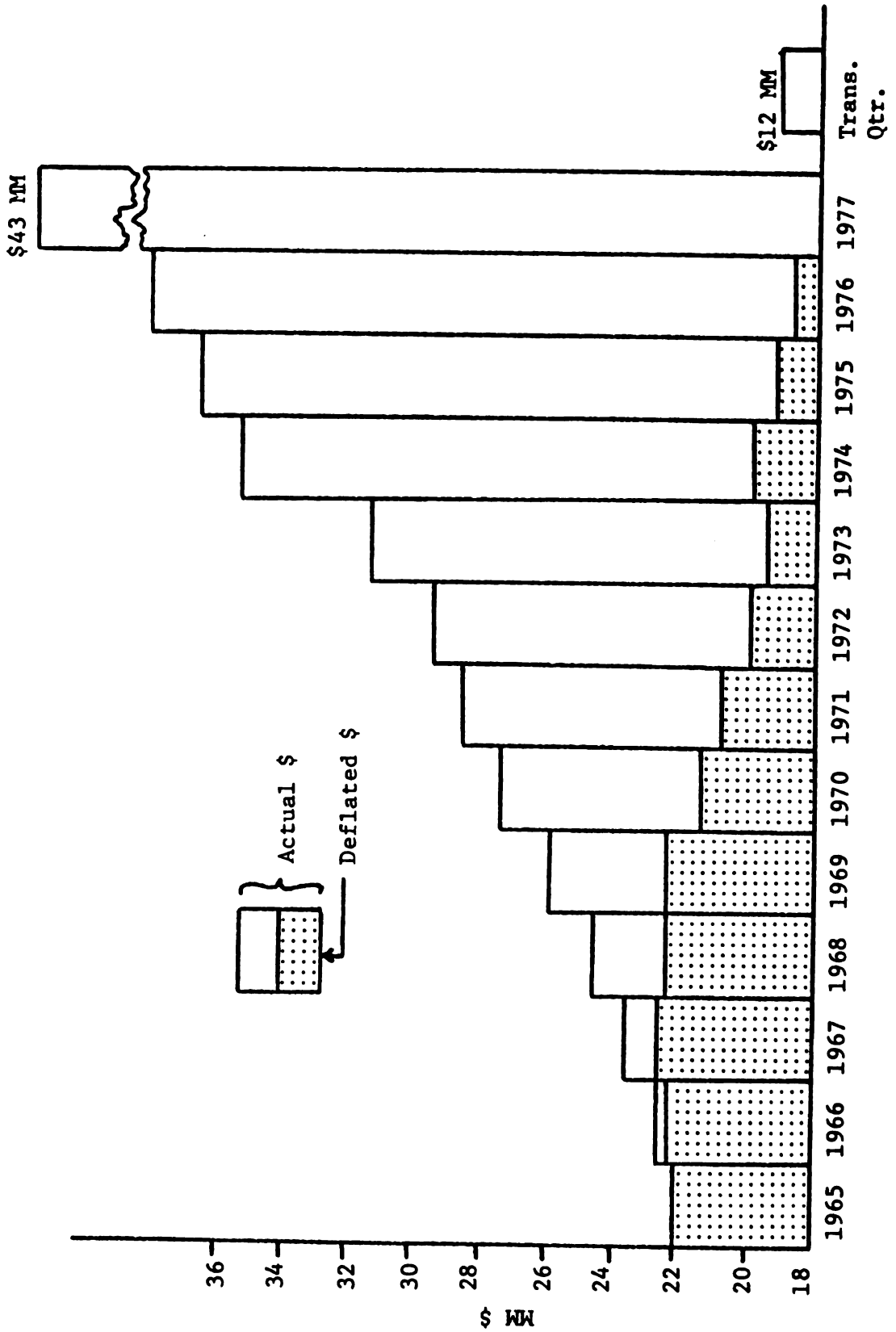

FIGURE 11. PRESUPPRESSION EXPENDITURES (P&M)

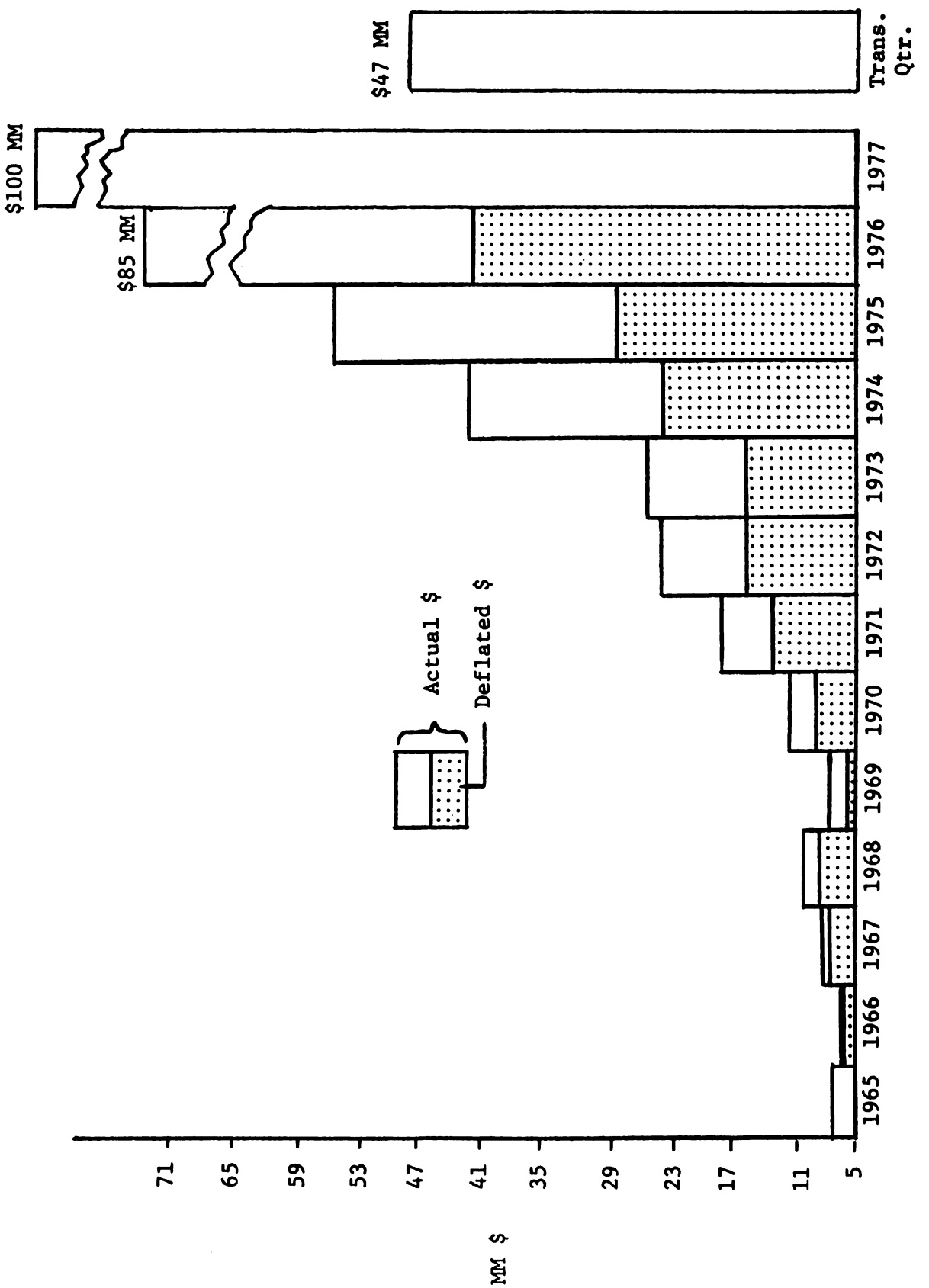

FIGURE 12. PRESUPPRESSION EXPENDITURES (FFF)

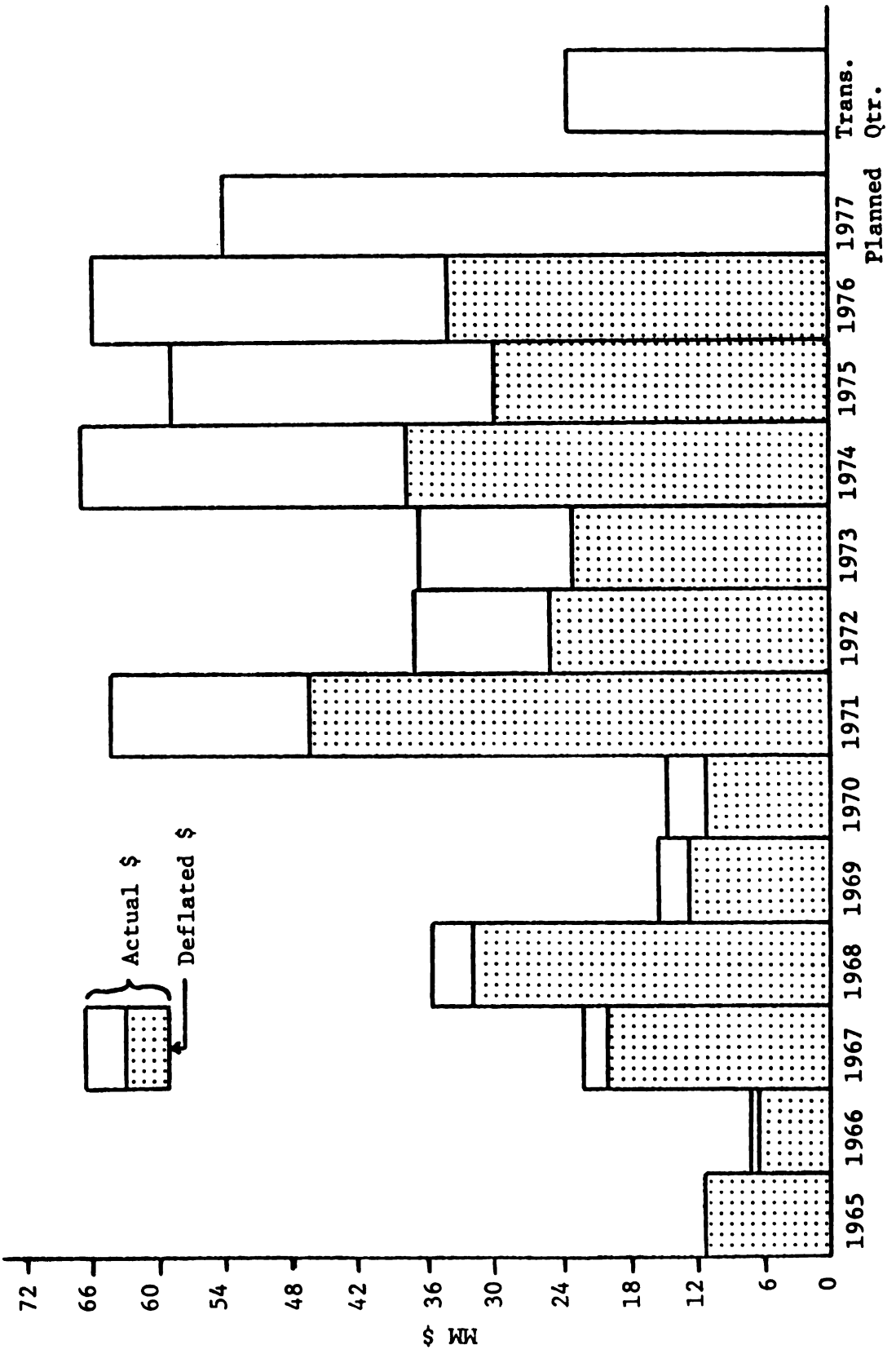

FIGURE 13. SUPPRESSION EXPENDITURES (FFF)

TABLE 18. NATIONAL STATISTICAL FIRE INFORMATION

	1965	1966	1967	1968	1969	Average (65-69)	1970	1971	1972	1973	1974	1975	Average (70-75)
Damages (M$)	2331	12099	19522	10998	11552	11300	111275	52892	37010	78759	109155	37657	71124
Acres Burned	75150	332921	204106	212420	92126	183468	519978	171867	116703	168692	208721	177002	227160
Damage/Acre Burned	31	36	96	52	125	68	24	308	317	467	523	213	340
Number of Fires:													
Lightning-Caused	5243	5858	6790	4808	4726	5485	7804	5876	8406	5777	6601	4893	6559
Man-Caused	4122	5387	4981	4923	5308	4944	7172	6363	5748	6648	6937	5929	6466
Total	9365	11245	11771	9731	10034	10429	14976	12239	14154	12425	13538	10822	13026
Acres Burned per Fire	8.1	29.6	17.3	21.8	9.2	17.2	34.7	14.0	8.2	13.6	15.4	16.4	17.0
Size Class (Acres):													
A (1/4 or less)	6573	7503	8034	6312	6503	6985	10300	8356	10806	9231	9542	7754	9332
B (.26-9)	2293	2940	2922	2708	2708	2714	3616	3057	2773	2627	3145	2500	2958
C (10-99)	414	617	630	552	691	581	865	659	471	451	672	468	598
D (100-299)	49	75	92	84	86	77	109	92	56	52	95	55	77
E (300-999)	* 36	* 110	* 93	* 75	* 46	* 72	47	41	30	42	52	26	40
F (1000-4999)							29	27	15	7	25	13	19
G (5000 +)							10	7	3	15	7	6	8
E&F&G(1970-74)-E(1965-69)							(86)	(75)	(48)	(64)	(82)	(45)	(67)

* Records of 1965-1969 lumped Classes E, F, and G together.

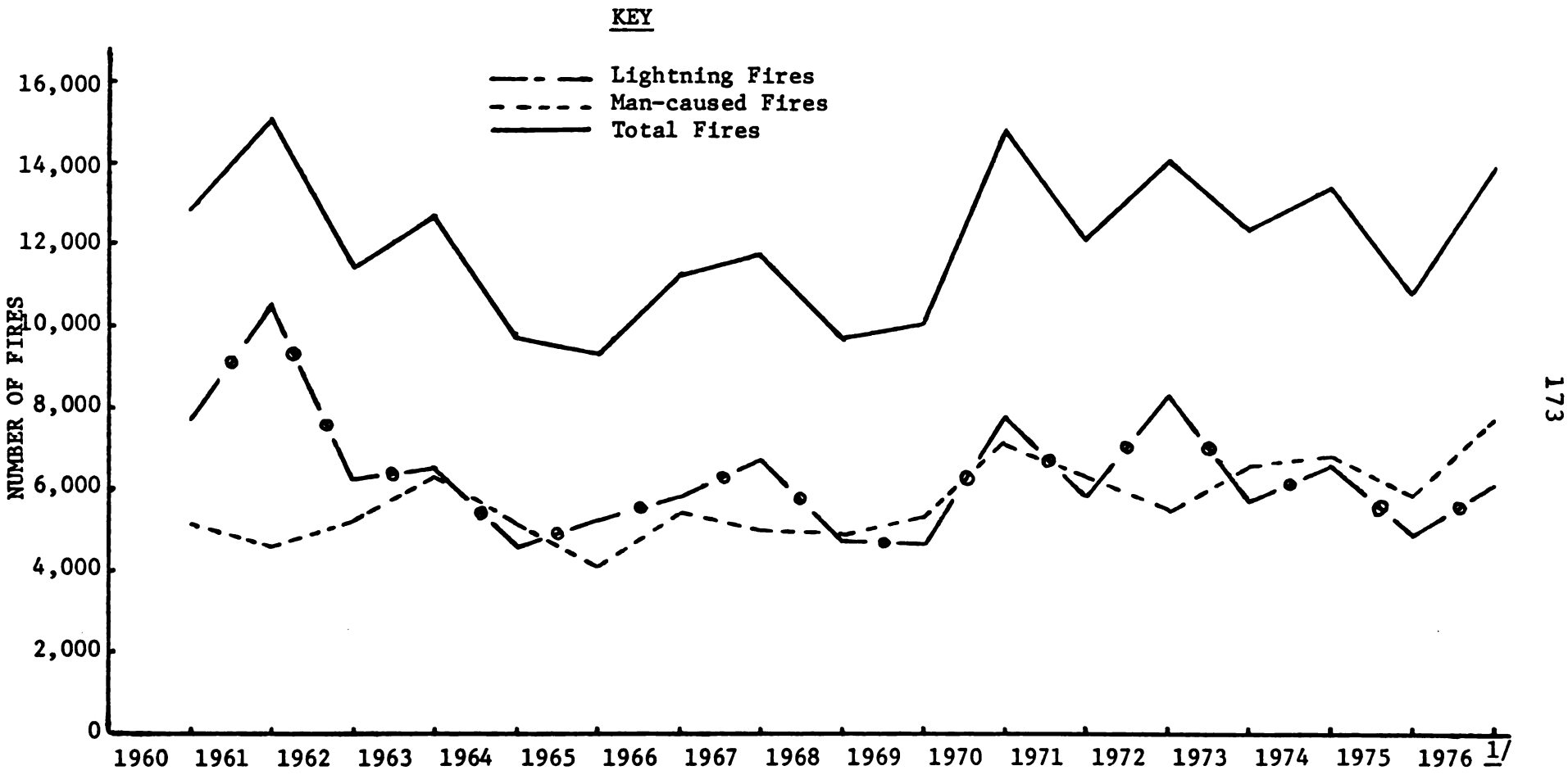

FIGURE 14. FIRES TO WHICH FOREST SERVICE RESPONDED

1/ Tentative figures as of January 31, 1977.

TABLE 19. FIRE SEVERITY INDEX[1/]

Region	R-1	R-2	R-3	R-4	R-5	R-6	R-8	R-9	NFS	
1965	.546	.630		.828	.776	1.1		1.158	.840	
1966	.972	1.253	1.21	1.677	.865	1.441		1.124	1.220	
1967	1.354	.739	.91	.834	.864	1.725		1.036	1.066	Avg. .98
1968	.614	.804	.91	.830	.737	.387		1.067	.764	
1969	1.54	1.290	.77	1.099	.963	.728		.645	1.005	
1970	1.092	1.270	1.29	1.129	2.164	.555		.974	1.211	
1971										
1972	1.201	.835	.65	.593	1.59	.799		.538	.887	Avg. 1.08
1973	1.235	.516	2.17	1.065	1.765	.819		.176	1.107	
1974	.207	.698	4.05	.869	1.506	.619		.204	1.165	
1975	.053	.777	3.40	.986	1.341	.280		.224	1.009	
1976	.110	.358	3.15	.599	2.556	.112		.416	1.043	
Mean	.811	.834	1.851	.955	1.375	.779		.687	1.029	

1/ Index was developed by Cooperative Fire Management at Boise, Idaho, using Fire Weather Station data (Lancaster, 1977).

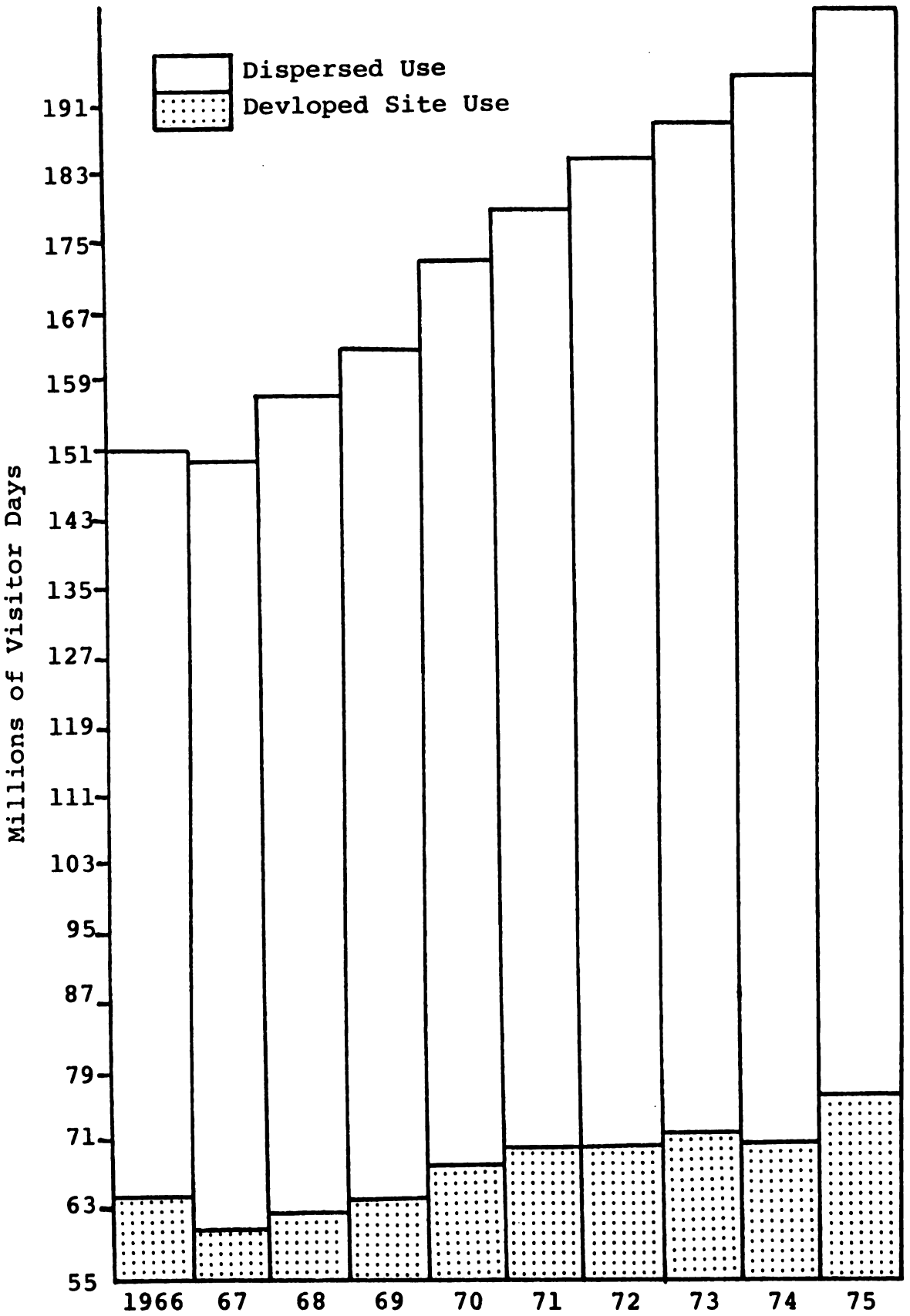

FIGURE 15. NATIONAL FOREST RECREATION USE

Source: Hodgin, 1976

APPENDIX G

TREND ANALYSIS OF FIRE ACTIVITY

Fire statistics change over time and trends can often be identified in these changes. Analysis of these trends can yield useful information upon which to make management decisions. Here four examples are given which utilize trend analyses to support or refute relationships between statistical groupings and/or managerial hypotheses.

Relating Number of Fires and Acres Burned to Average Fire Size

The most commonly referred to fire statistics are acres burned, numbers of fires, and average size of fire. The average number of fires for the period 1970-75 increased 24 percent above the average for 1965-69. The average number of acres burned increased by a similar amount. Despite these changes, the average fire size (17 acres) remained constant. (See Table 12, page 110.)

Examination of the fire size class distribution for both periods provides an explanation as to why the average fire size stayed constant. The number of fires falling into the Class C or larger categories remained about the same in 1970-75 as in 1965-69, with the most significant change being a seven percent reduction in the number of fires in the Class E

or larger category. In the 1970-75 period Class A fires increased 34 percent over the previous period and Class B fires increased only nine percent.

Another way of looking at what happened is to examine the size class distribution of the number of fires in the earlier period and compare its composition with that of the later period. The change in the number of fires in the Class C or larger categories accounted for one percent of the total change in the number of fires between the two periods, with the same size classes accounting for eight percent of the total number of fires during 1965-69. Class A had 66 percent of the total number of fires during 1965-69 and claimed 90 percent of the increase. Class B had 26 percent of the fires for 1965-69 and its increase amounted to only nine percent of the total increase between the two periods. Therefore, 99 percent of the increase between the two periods resulted from an increase in the number of fires less than 10 acres in size. Most of the shift to smaller fires resulted from a shift from the Class B to the Class A category.

Depending on weather changes and visitor use changes between the two periods, the increase in the number of smaller fires in the more recent time period could simply reflect the results of increased detection. The Forest Service may now be detecting more small fires that in the past would have burned out by themselves.

Influence of Climatic Changes on Fire Activity

It is hypothesized that variations in climatic conditions might have had some effect on the fire activity for the 1965-69 and 1970-75 time periods. Examination of a compilation of Fire Severity Indexes (Table 19, page 174) developed by the Cooperative Fire Management unit in Boise, Idaho (Lancaster, 1977), provides data with which to test this hypothesis. The Fire Severity Index numerically represents the fire weather severity for each Region during each year. Table 19, page 174, presents the most complete Regional Indexes available to date. They were based on Fire Weather Station information obtained within each Region.

The average national index for the period 1965-69 is 0.98, while the average for 1970-75 is 1.08, or only ten percent higher (most of which is accounted for by the year 1970). From these data, it does not appear that climatic conditions changed enough to imply that they directly influenced fire activity. Nor can the inference be made that had the Forest Service not drastically increased its level of fire control spending, the level of fire activity would have been much worse.

Influence of Dispersed Recreation Use on Number of Man-Caused Fires

More and more people are now visiting National Forests particularly to participate in dispersed recreation activities (Figure 15, page 175). Approximately 20 percent more

"dispersed recreation users" visited the National Forests during 1970-75 than during 1966-69. It has been argued that because of the increase in dispersed recreation use, a corresponding increase will result in the number of man-caused fires. To cope with these increases, an increase in expenditures in the areas of prevention, detection, and suppression is sought.

To test these hypotheses, there is data available. For the 1966-75 time period, it can be shown how the number of man-caused fires has changed (Figure 14, page 173). During the 1970-75 period, there were 31 percent more man-caused fires than in the 1966-69 period; but lightning fires were also 20 percent higher. Increased detection or a slight increase in the severity of climatic conditions (see discussion above) may explain the 20 percent increase in lightning fires and may also explain 20 percent of the increase in man-caused fires. The 11 percent difference is an estimate of the actual increase in man-caused fires independent of the possible increase from improved detection. Thus, at the most, it might be concluded that 20 percent more people in the forests have resulted in 11 percent more man-caused fires.

Influence of Damages on Fire Expenditures

Attempts are often made to justify Fire Management's cost increases during the 1970-76 time period on the basis of higher damages resulting from higher resource values. Damage to forest land burned during the 1970-75 period

(Table 12, page 110) averaged five times higher than damages for 1965-69. The total number of acres burned, however, increased by only 24 percent. Together these increases resulted in a four-fold increase in the average damage per acre in 1970-75 over 1966-69.

These figures seem to support the necessity for increased Fire Management expenditures except for the fact that the damage values for the 1970-75 period may be highly overestimated. The discussion presented in Chapter II suggests that Fire Management's potential damage class values, put into use in 1972, may be as much as 10 times higher than those provided by other sources. The same magnitude of error may easily have transferred to the recorded fire damages during the years after 1972 and could very easily explain the large increase in damage values for the latter (1970-75) period.

Thus, based on an examination of damage values alone, the analysis did not identify a need for increases in Fire Management expenditures for the 1970-75 period.

APPENDIX H

DISCUSSION OF MULTIPLE REGRESSION ANALYSIS OF PRESUPPRESSION SPENDING EFFECTIVENESS

The intent was to compare separate analyses of the two time periods, 1948-66 and 1965-75, to see if there is any difference between them in the effectiveness of presuppression spending.

A multiple regression analysis of the period 1948-66 (Ellis, 1969) showed that annual fire activity could be explained as a function of several, supposedly independent variables. Of all the relationships tested, the two best ones related the total number of acres burned inside boundaries protected by the National Forest and the number of Class E fires to the following independent variables: 1) total number of fires, 2) severity of fires, 3) presuppression expenditures, and 4) inherent differences between Regions. Acres burned and the number of Class E fires are both considered to be indicators of the level of fire activity. The listed independent variables, while not totally independent, are the best ones available from the data base. The analysis showed that increases in presuppression spending had a significant effect in reducing the acreage burned and the number of Class E fires.

A multiple regression analysis of the data available for the period 1965-75 (using the above variables) showed that the statistical relation between presuppression spending and the reduction in either the number of acres burned or the number of Class E fires was much weaker than it had been for the 1948-66 period. In fact, it cannot be said with any degree of confidence that increased presuppression spending for this period had a significant effect on reducing fire losses.

One relationship, which was tested for the period 1965-75, proved to be quite strong. This relationship hypothesized that presuppression spending could be explained as a function of the total number of fires, the Fire Severity Index, inherent differences between Regions and the numerical value of the calendar year. The resulting equation explained 86 percent of the variation in presuppression expenditures and is much stronger statistically than any of the other relationships for either time period. It shows that presuppression spending and the Fire Severity Index appear to be positively related nationally. However, the variable which accounts for the largest part of the increased presuppression expenditures in the regression analysis is that of calendar years. This analysis suggests that the consistant annual increase in expenditures each year accounts for the present high cost rather than some change in fire severity. (Remember, the expenditures in the data base are deflated dollars.) The effect of the number of fires was

not statistically significant considering the effects of the other variables.

Table 20, page 184, of this appendix suggests that in some Regions (notably R-5 and R-6) there is little relation between presuppression spending and the Fire Severity Index for the 1965-76 time period. Figure 16, page 185, and Figure 17, page 186, suggest that the strong upward trend in presuppression spending can be attributed to increased spending in Regions 3, 5 and 6.

TABLE 20. PRESUPPRESSION EXPENDITURES PER ACRE[1/]

CY	REGIONS 1	2	3	4	5	6	8	9	10
1965	.10	.05	.09	.02	.45	.16	.21	.11	.005
1966	.14	.05	.09	.03	.49	.17	.22	.12	.006
1967	.26	.05	.09	.09	.46	.22	.23	.10	.005
1968	.14	.05	.11	.09	.45	.18	.21	.09	.036
1969	.16	.04	.13	.09	.43	.20	.23	.18	.010
1970	.15	.04	.24	.09	.47	.24	.28	.09	.007
1971	.16	.06	.32	.11	.46	.24	.24	.09	.009
1972	.15	.05	.19	.11	.49	.31	.18	.08	.006
1973	.20	.06	.38	.12	.56	.41	.22	.19	.007
1974	.15	.05	.29	.11	.67	.47	.22	.10	.007
1975	.18	.05	.51	.12	.86	.55	.43	.12	.008

1 In 1965 dollars per year per protected acre.

Source: Ellis, 1977

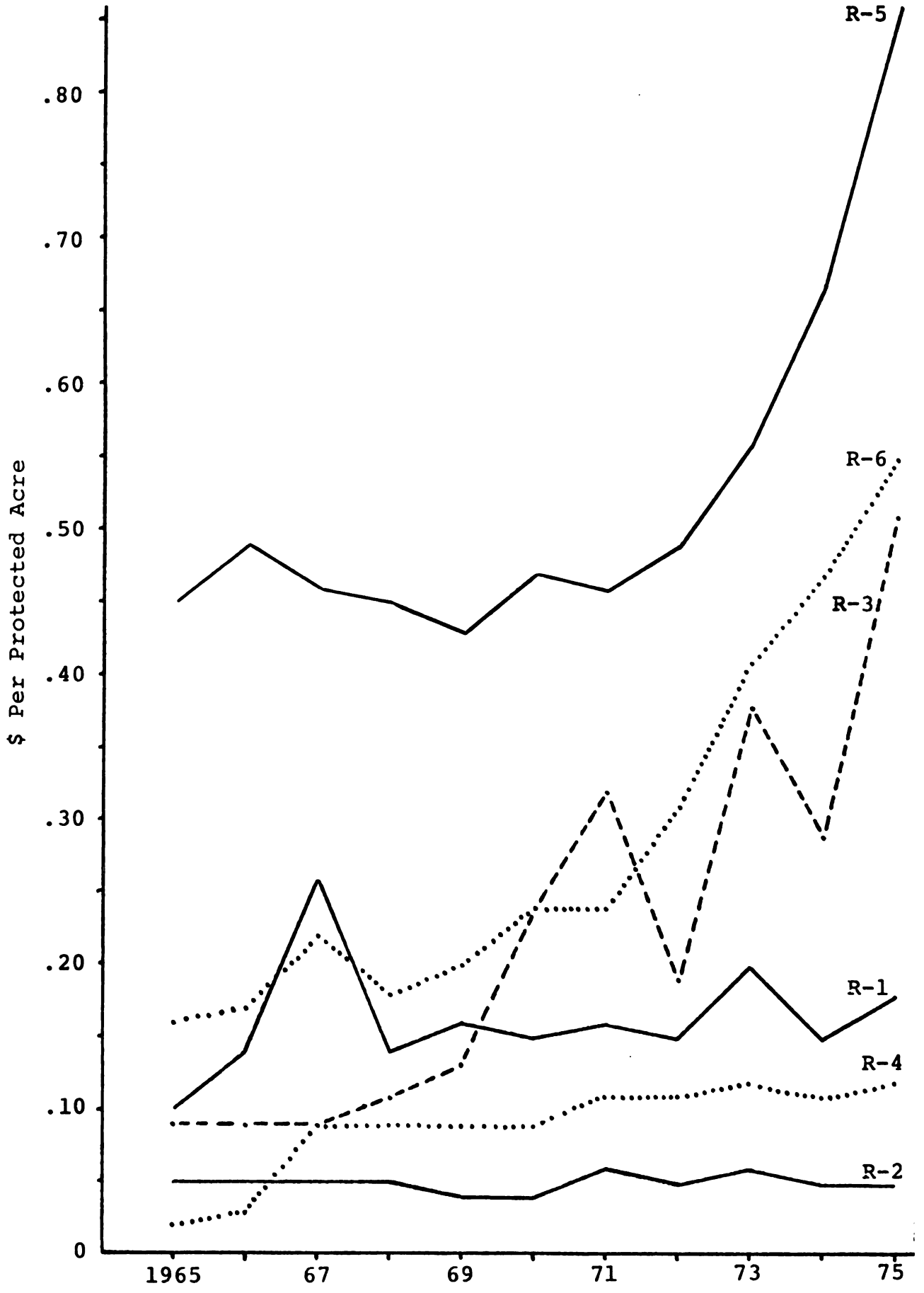

FIGURE 16. PRESUPPRESSION EXPENDITURES FOR SELECTED REGIONS

Source: Ellis, 1977.

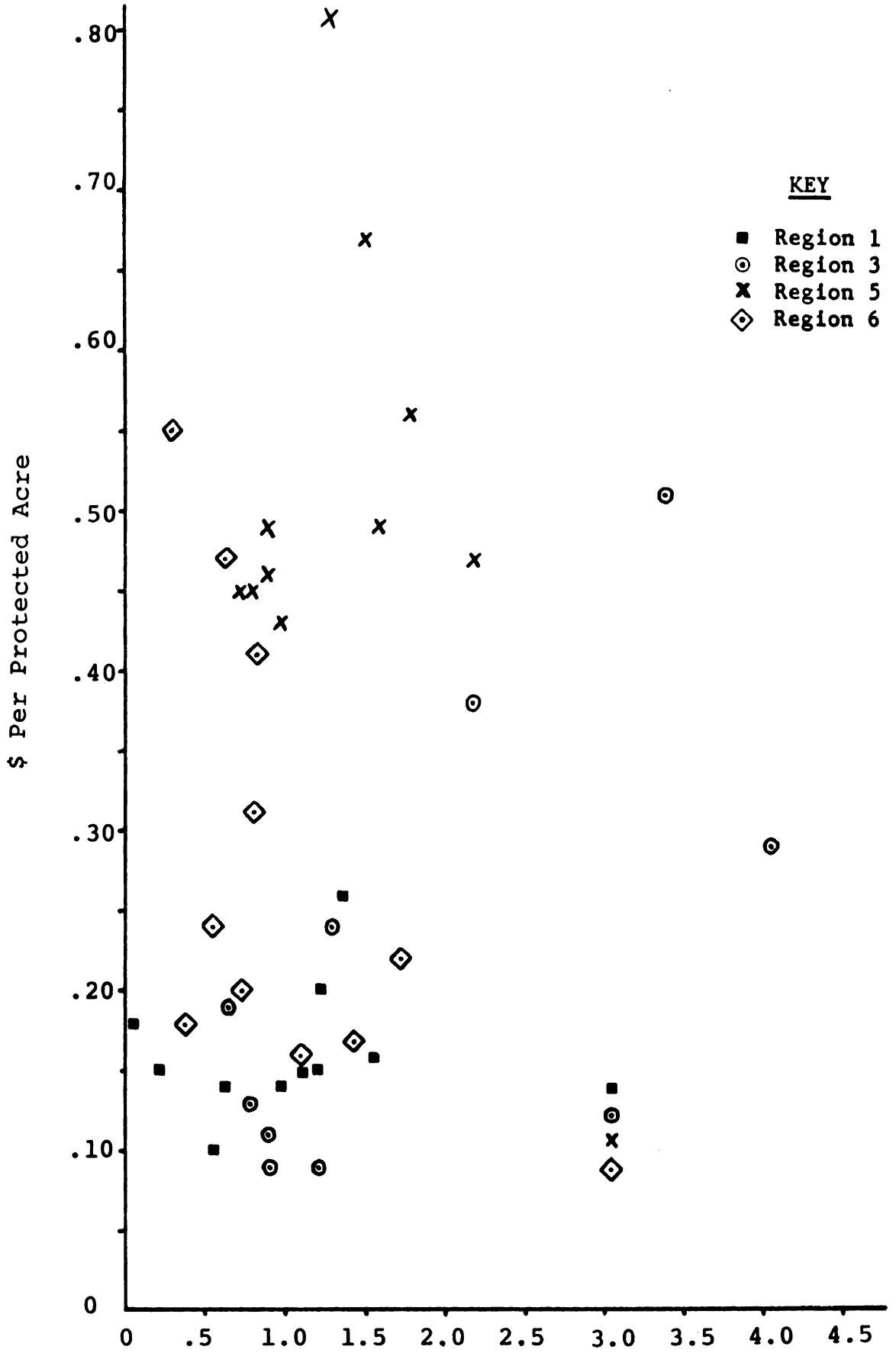

FIGURE 17. PRESUPPRESSION EXPENDITURE COMPARED TO FIRE SEVERITY FOR SELECTED REGIONS

Source: Ellis, 1977.

TABLE 21. REGIONAL FIRE DATA, 1965-1975

REG	F C Y Y	TOT. FIRES INSIDE NO.	ACRES BURNED INSIDE ACRES	TOT. FIRES FOUGHT NO.	NO. CL. E NO.	ACRES PRO- TECTED 1000 ACRES	EXPENDITURES PRE- SUPP. ----$1000----	SUPP.	NO. CL. G NO.	REVISED SEV. INDEX INDEX
01	6665	0707	000666	0709	00	29178	3013	742		0.546
01	6766	1542	035779	1564	14	28943	4123	3222		0.972
01	6867	1833	082086	1851	22	28896	7453	16338		1.354
01	6968	0804	008764	0819	06	28937	4038	1592		0.614
01	7069	0861	003102	0875	02	28752	4689	1806		1.540
01	7170	1797	018450	1818	14	28756	4212	4715	00	1.092
01	7271	1022	007507	1039	03	27650	4333	1729	00	
01	7372	1264	002430	1279	03	28618	4435	1908	00	1.201
01	7473	1783	031343	1806	22	28466	5666	7816	02	1.235
01	7574	1405	007254	1437	04	27181	3966	2614	00	0.207
01	7675	0570	000483	0577	00	26695	4848	1196	00	0.053
02	6665	0322	020001	0342	02	24166	1171	382		0.630
02	6766	0720	007633	0766	11	23573	1171	758		1.253
02	6867	0381	003475	0392	02	24123	1120	392		0.739
02	6968	0445	003311	0451	03	24126	1216	346		0.804
02	7069	0448	005920	0458	06	24708	1083	876		1.290
02	7170	0512	007863	0528	03	25748	1148	1149	00	1.270
02	7271	0669	004511	0682	02	24690	1413	703	00	
02	7372	0553	004022	0560	04	24070	1264	299	01	0.835
02	7473	0525	005118	0538	01	23039	1325	788	00	0.516
02	7574	0957	011353	0980	10	23366	1178	820	00	0.698
02	7675	0564	013350	0577	05	23491	1087	924	00	0.777
03	6665	1734	013822	1952	08	22410	2105	1321		
03	6766	1797	031510	1803	15	24778	2259	1744		1.210
03	6867	1532	039556	1537	23	25778	2234	2291		0.910
03	6968	1604	043237	1611	13	25778	2913	2163		0.910
03	7069	1696	026048	1713	14	24470	3241	2029		0.770
03	7170	2680	029524	2698	17	23098	5555	6076	01	1.290
03	7271	2867	056260	2913	19	22987	7431	5198	04	
03	7372	3152	037125	3180	05	24474	4654	1510	01	0.650
03	7473	2402	020097	2425	05	22707	8632	6172	02	2.170
03	7574	3077	105419	3123	28	23007	6742	3166	05	4.050
03	7675	2413	025279	2425	10	21026	10744	4709	01	3.400
04	6665	0523	001979	0329	01	32818	657	582		0.828
04	6766	1291	061374	1340	25	32568	1089	3725		1.677
04	6867	0884	001643	0889	01	32661	3020	1423		0.834
04	6968	0852	000378	0863	06	32670	2849	1051		0.830
04	7069	0684	001969	0691	01	32680	2922	789		1.099
04	7170	1009	004038	1019	03	32858	3070	1520	00	1.129
04	7271	0944	011565	0954	08	32925	3663	1311	01	
04	7372	1550	014051	1566	08	33435	3676	2705	00	0.593
04	7473	1139	008858	1157	11	32811	3875	2672	01	1.065
04	7574	1085	017100	1095	10	32247	3630	2501	00	0.869
04	7675	0883	001522	0906	01	32636	3885	1094	00	0.986

TABLE 21 (CONTINUED).

REG	F Y	C Y	TOT. FIRES INSIDE NO.	ACRES BURNED INSIDE ACRES	TOT. FIRES FOUGHT NO.	NO. CL. E NO.	ACRES PRO-TECTED 1000 ACRES	EXPENDITURES PRE-SUPP. ----$1000----	EXPENDITURES SUPP. ----$1000----	NO. CL. G NO.	REVISED SEV. INDEX INDEX
05	6665		2027	009278	2082	10	24143	10892	5586		0.776
05	6766		1882	162002	1938	29	24143	11789	6628		0.865
05	6867		2218	019403	2293	17	24143	11047	5413		0.864
05	6968		1915	089625	2032	28	24118	10800	4869		0.737
05	7069		2169	019645	2250	14	24118	10346	5419		0.963
05	7170		2248	266657	2386	07	24118	11222	11186	08	2.164
05	7271		1814	033181	1899	19	23888	11103	6551	01	
05	7372		2887	039599	2976	20	23888	11623	10289	01	1.590
05	7473		2715	067550	2859	21	23458	13251	11074	08	1.765
05	7574		2565	043594	2656	24	24022	16039	7664	01	1.506
05	7675		2015	109294	2101	21	24022	20541	13612	05	1.341
06	6665		1872	003209	1902	03	25392	4166	1709		1.100
06	6766		1415	013286	1458	06	25392	4393	2609		1.441
06	6867		2296	026243	2338	17	25387	5619	8717		1.725
06	6968		1670	039640	1708	13	25387	4550	3332		0.387
06	7069		1544	011491	1572	04	24964	4953	1984		0.728
06	7170		3329	160911	3384	09	24964	6094	22920	01	0.555
06	7271		1713	007512	1738	06	24964	6023	5013	00	
06	7372		2417	002942	2462	02	24872	7786	4346	00	0.799
06	7473		2069	026329	2099	02	24561	9994	6315	02	0.819
06	7574		2030	004128	2061	03	25240	11826	4459	00	0.619
06	7675		1900	003405	1922	03	25664	14039	4685	00	0.280
08	6665		1260	019811	1279	07	12873	2707	521		
08	6766		1411	016238	1444	09	12873	2791	590		
08	6867		1680	025561	1738	10	12092	2741	418		
08	6968		1405	015545	1440	04	11955	2560	264		
08	7069		1699	016786	1752	02	12108	2801	499		
08	7170		2217	027863	2266	12	12105	3370	911	00	
08	7271		2028	028451	2055	14	12257	2924	255	00	
08	7372		1355	009906	1375	02	13452	2424	169	00	
08	7473		0924	006203	0927	00	12492	2776	805	00	
08	7574		1422	014723	1453	03	13052	2920	669	00	
08	7675		1370	018288	1389	03	10982	4677	1295	00	
09	6665		0715	006343	0736	05	16510	1758	168		1.158
09	6766		0895	005059	0911	01	16510	1949	225		1.124
09	6867		0700	005973	0713	01	16210	1691	140		1.036
09	6968		0754	006571	0711	02	16351	1468	122		1.067
09	7069		0697	006894	0705	02	16475	1336	109		0.645
09	7170		0848	004672	0858	00	16652	1571	457	00	0.974
09	7271		0918	022793	0933	04	16730	1521	180	01	
09	7372		0729	006615	0734	04	16566	1346	77	00	0.538
09	7473		0573	003089	0579	00	15758	1462	568	00	0.176
09	7574		0685	005043	0696	01	14860	1539	406	00	0.204
09	7675		0894	006086	0901	02	14969	1844	359	00	0.224

TABLE 21 (CONTINUED).

REG	F Y	C Y	TOT. FIRES INSIDE NO.	ACRES BURNED INSIDE ACRES	TOT. FIRES FOUGHT NO.	NO. CL. E NO.	ACRES PRO-TECTED 1000 ACRES	EXPENDITURES PRE-SUPP. ----$1000----	SUPP.	NO. CL. G NO.	REVISED SEV. INDEX NO. INDEX
10	6665		0034	000041	0034	00	20850	113	14		
10	6766		0021	000040	0021	00	20850	117	17		
10	6867		0019	000166	0020	00	20850	102	2		
10	6968		0036	000162	0036	00	20850	759	202		
10	7069		0018	000271	0018	01	21296	215	16		
10	7170		0018	000000	0019	00	20670	138	11	00	
10	7271		0026	000087	0026	00	20670	186	3	00	
10	7372		0022	000013	0022	00	21013	133	5	00	
10	7473		0033	000105	0034	00	20906	153	114	00	
10	7574		0035	000107	0037	00	21251	157	23	00	
10	7675		0024	000014	0024	00	21251	170	8	00	

Source: Ellis, 1977.

BIBLIOGRAPHY

Baker, J. O., Jr. 1975. Wilderness fire management: policy development and implementation. M. S. Thesis, Colorado State University, Boulder.

Brown, Arthur A. and Kenneth P. Davis. 1973. Forest Fire: Control and Use. McGraw-Hill, Inc., New York, NY.

Carter, Jack (Fire Management Staff). 1977. Fire planning (as is). USDA, Forest Service, Region 5, San Francisco, CA.

Chandler, Craig C. (Director, Fire Research). 1977. Memo to attendees of Project Leaders Conference. Subject: National fire research. File Designation: 1360. March 28, 1977. USDA, Forest Service, Washington, DC.

Churchman, C. West. 1968. The Systems Approach. Dell Publishing Co., Inc., New York, NY.

Clawson, Marion. 1976. The national forests. Science Magazine, Vol. 191, pp. 762-777.

Crosby, John S. 1977. A guide to the appraisal of wildfire damages, benefits, and resource values protected. Forest Service Research Paper NC-142. USDA, Forest Service, North Central Forest and Range Experiment Station, St. Paul, MN.

Davis, James B. and Robert L. Irwin. 1976. Focus: a computerized approach to fire management planning. Journal of Forestry, Vol. 74, No. 9, pp. 615-618.

Davis, Kenneth P. and Arthur A. Brown. 1973. Forest Fire: Control and Use. McGraw-Hill, New York, NY.

Deeming, John E., James W. Lancaster, Michael A. Fosberg, R. William Furman and Mark J. Schroeder. 1974. National fire danger rating system. Forest Service Research Paper RM-84. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Devet, David D. 1975. Wildfire used to achieve land management objectives. Fire Management, Vol. 36, No. 1. US Government Printing Office, Washington, DC.

Ellis, Thomas H. Evaluating national fire planning methods
1977 and measuring effectiveness of presuppression expenditures. USDA, Forest Service, Forest Products Lab, Madison, WI.

_____. Multiple regression estimates of the
1969 effectiveness of national forest fire control expenditures. USDA, Forest Service, Division of Programs and Special Projects, Washington, DC.

Gale, Robert D. (Policy Analysis Staff). Calculation of
1976 fire damages. In memo to A. Gilbert. USDA, Forest Service, Washington, DC.

Gibson, H. P., Lance F. Hodgin and John L. Rich. Evaluating
1976 national fire planning methods and measuring effectiveness of presuppression expenditures. USDA, Forest Service, Washington, DC.

Greentree Associates. Integrating fire into land management
1977 planning. Report submitted to USDA, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT.

Harden, Charles. Fire policy meeting: Fire Management pre-
1977 work. USDA, Forest Service, Fire Management Staff, Washington, DC.

Hatry, Harry P., Richard E. Winnie and Donald M. Fisk. Prac-
1973 tical Program Evaluation for State and Local Government Officials. The Urban Institute, Washington, DC.

Headley, Roy. Fire suppression district 5. USDA, Forest
1916 Service.

Hodgin, Lance F. National forest fire prevention and control
1976 expenditures (Phase 1). Updated February, 1977. USDA, Forest Service, Policy Analysis Staff, Washington, DC.

Holley, H. Tom. Trespass report narrative: Grama fire. USDA,
1974 Forest Service, Apache-Sitgraves National Forest, Springerville, AZ.

Lancaster, Wally. Interim work on fire severity index. USDA,
1977 Forest Service, Cooperative Fire Management, Boise, ID.

Loomis, Carol J. An annual report for the federal govern-
1973 ment. Fortune Magazine, May, 1973.

Lynn, James T. (Director, OMB). Letter to Honorable Earl
1975 Butz, Secretary of Agriculture. April 15, 1975. Executive Office of the President, Office of Management and Budget, Washington, DC.

Mann, James F. (National Fire Planning Officer for Fire
1977 Management Staff). Memo to participants. Subject: National Fire Management Team. File Designation: 1360. July 22, 1977. USDA, Forest Service, Washington, DC.

Marty, Robert J. Fire damage appraisals: economic concepts
1965 underlying their development and use. USDA, Forest Service, Washington, DC.

_____. Study materials, NR 450, Natural Resource
1974 Administration. Michigan State University, East Lansing, MI.

Mattill, John. Pricing a swamp. Technical Review, July/
1976 August, 1976, Vol. 78, No. 8.

McGuire, John R. (Chief of the Forest Service). Memo to
1976 Regional Foresters. Subject: Proposal for financing the fire presuppression job. File Designation: 6510. October 21, 1976. USDA, Forest Service, Washington, DC.

Mishan, E. J. Cost-Benefit Analysis. Praeger Publishing
1976 Co., New York, NY.

Mueller, James H. Testimony concerning Seney Wildlife Refuge
1976 fire before the US House of Representatives, Committee on Merchant Marine and Fisheries, Subcommittee on Fisheries, Wildlife Conservation and the Environment, September 15, 1976.

New York Times. Kimberly-Clark may sell control of 388,000
1976 acres. July 9, 1976. New York, NY.

Paulson, Morton C. Profits from plowshares, National Obser-
1976 ver, September 18, 1976.

Peterson, R. Max (Deputy Chief for Programs and Legislation).
1976 Memo to Regional Foresters R-8 and 9. Subject: Preparation of plans for analysis of fire planning methods. File Designation: 6520. August 12, 1976. USDA, Forest Service, Washington, DC.

Silcox, F. A. (Chief of the Forest Service). Memo to Region-
1935 al Foresters. Subject: Fire suppression policy. File Designation: Fire. May 25, 1935. USDA, Forest Service, Washington, DC.

Simard, A. J. Wildland fire management: the economics of
1976 policy alternatives. Forestry Technical Report No. 15. Canadian Forestry Service, Forest Fire Research Institute, Ottawa, Canada.

Tikkala, Willard R. (Director, Cooperative Forest Fire
1976 Protection Staff). Letter to Rex Ressler, Associate Chief of the Forest Service. Subject: Fire fighting costs. File Designation: 6520. September 1, 1976. USDA, Forest Service, Washington, DC.

U. S. Congress. United States Code, Title 31 - Money and
1976 Finance, Section 686. West Publishing Co., St. Paul, MN.

_____. 93rd . The Forest and Rangeland Renewable
1974a Resources Planning Act of 1974. Public Law 93-378, 5.2296, August 17, 1974.

_____. United States Code, Title 16 - Conservation,
1974b Sections 475 through 686. West Publishing Co., St. Paul, MN.

_____. United States Code, Title 7 - Agriculture,
1973 Section 2225. West Publishing Co., St. Paul, MN.

USDA, Forest Service. Forest Service Manual. Washington,
1977a DC.

_____. Testimony concerning FY 1977 supple-
1977b mental appropriation request before the US House of Representatives, Subcommittee of the Committee on Appropriations. Washington, DC.

_____. Meeting notes of the January Regional
1977c Foresters and Staff Directors meeting, January, 1977.

_____. An approach to determining cost effec-
1976a tiveness and economic value of expenditures for wildland fire control. Southeastern Area, State and Private Forestry, Atlanta, GA.

_____. Management attainment report for FY
1976b 1976. Washington, DC.

_____. 1976c RPA: a supplemental appendix. Washington, DC.

_____. 1976d RPA: recommended renewable resource program, 1977-2020. Washington, DC.

_____. 1975a Annual fire report. Region 3, Albuquerque, NM.

_____. 1975b Potential policy issues in fire management. RPA Staff Paper. Washington, DC.

_____. 1974a National forests fire report. Washington, DC.

_____. 1974b Principal laws relating to Forest Service activities. Agriculture Handbook No. 453. US Govt Printing Office, Washington, DC.

_____. 1974c Squaw Basin Fire. In ID team summary and reports. Washington, DC.

_____. 1974d Ten days in June. Southwestern Region, Albuquerque, NM.

_____. 1972 National fire planning -- instructions. (Draft) Washington, DC.

_____. 1971a A model for the determination of wildland resource values. US Govt Printing Office, Washington, DC.

_____. 1971b Fire policy meeting: Denver, Colorado, May 12-14, 1971. Washington, DC.

_____. 1971c Individual Fire Report Handbook, FSH 5109.14. Washington, DC.

_____. 1965-75 National forests fire report, Washington, DC.

_____. 1965-76 1965-76 TQ. Statement of obligations for each fiscal year. Washington, DC.

_____. 1928 The National Forest Manual of Regulations and Instructions. Washington, DC.

_____. 1908 The Use Book: Regulations and Instructions for Use of the National Forests. US Govt Printing Office, Washington, DC.

U. S. Department of Commerce, Bureau of the Census. 1974 The U. S. Fact Book. No. 95. Washington, DC.

U. S. Department of the Interior, Bureau of Outdoor Recrea-
1976 tion. Evaluation of public willingness to pay user charges for use of outdoor recreation areas and facilities. Washington, DC.

Wall Street Journal. Kimberly-Clark may sell control of 388,000
1976 acres. July 9, 1976. New York, NY.

Washington Star. Fire crew contains 3,200 acre blaze. Ap-
1971 ril 16, 1971. Washington, DC.

Water Resources Council. Water Resources Planning Act (P.
1973 L. 89-80). Water Resources Council: water and related land resources -- establishment of principles and standards for planning. Federal Register, Vol. 38, No. 174, Part III, September 10, 1973. US Govt Printing Office, Washington, DC.

Williams, Don. Subsystem II resource values. Region 1,
1976 Missoula, MT.