Wilderness Fire Management Planning Guide

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Current fire management policies of Federal land management agencies generally recognize fire as a natural process in many forest and range ecosystems, especially in the West. Consequently, fire is allowed or encouraged to more nearly play its natural role in wildernesses, parks, refuges, and other areas managed in whole or in part to maintain primitive or presettlement conditions. The tasks associated with such policies are collectively known as wilderness fire management.

In this report, wilderness fire management is defined as the deliberate response to and use of fire through the execution of technically sound plans under specific prescriptions for the purpose of achieving stated wilderness management objectives. Four types of manager response to fire are identified: aggressive attack, delayed attack, modified attack, and allowing a fire to burn according to a predetermined prescription. Wilderness fire management planning is the process of determining the appropriate response to accidental fire and the use of manager-initiated fire to accomplish wilderness management objectives.

This report attempts to guide wilderness fire management planning by suggesting a common terminology, examining important planning concepts, and identifying, describing, and discussing essential planning elements.

Among the planning concepts examined are the appropriate planning area, the planning context, and the format and content of the wilderness fire management plan. Special attention is given to the relationship of the wilderness fire management plan to the various other plans that exist in the planning hierarchy of most agencies. The relationship between National Environmental Policy Act (NEPA) requirements and wilderness fire management planning is illustrated using the Forest Service NEPA process as an example.

Wilderness fire management planning is separated into six essential elements in this report:
1. Describing fire and ecosystem interactions
2. Describing special resource and use considerations
3. Defining fire management objectives
4. Delineating fire management units and zones
5. Developing fire management prescriptions
6. Devising a fire management plan

Each of these planning elements is defined and discussed in terms of planning approach, information needs, and methods of presentation. Appropriate examples for actual wilderness fire management plans are presented to illustrate methods.

A summary of current wilderness fire management programs in the National Parks and National Forests is presented as an appendix. A second appendix provides a bibliographic listing of selected references for park and wilderness fire management. References are grouped according to seven subject areas: philosophy, programs, and plans; planning aids and general information sources; fire history; fire occurrence, fire environment, and fire behavior; the role of fire and fire effects; vegetation inventory, classification, and analysis; and ecosystem classification.
INTRODUCTION

The purpose of this report is to guide and aid fire management planning for parks, wildernesses, and other wild, natural, or essentially undeveloped areas. A philosophy and general approach to wilderness fire management planning is emphasized. The intent is not to propose a rigid format or to specify particular methods. Wilderness fire management plans, like the areas they represent, will vary in content, complexity, and scope. Nevertheless, wilderness fire management plans should share a common purpose and uniform planning procedure.

The suggested approach to wilderness fire management planning is essentially a two-step process. The first step involves developing specific fire management objectives based on agency policy, management direction, the physical and biological characteristics of the planning area, the probable ecological effects of fires and the absence of fire, and the likely effects of different fire suppression actions on the environment. The second step is to translate the specific fire management objectives into planned actions for responding to fire or for the use of fire on specific lands within the planning area.

It is important to note that this is a planning guide. It is not a policy implementation guide. Its utility, therefore, is not limited to a particular agency. In other words, this guide was written with the hope that all fire management agencies would find it equally useful as a common reference for fire management planning.

Wilderness fire management is a relatively new activity. A universally accepted terminology is, consequently, lacking. Different terms are often used to identify identical processes. Conversely, identical terms are often used to identify different processes. Definitions are often unrelated to the literal meaning of the terminology. The terms used in this guide are based on standard dictionary definitions. The goal is to provide a terminology that is both logical and easy to understand.

The terminology promulgated here will differ from current terminologies of various land management agencies. Managers and planners are cautioned, therefore, to review agency policy regarding fire management terminology before using the suggested terms in plans or other official documents.

EVOLUTION OF WILDERNESS FIRE MANAGEMENT POLICY

Wilderness Policy

The Wilderness Act\(^1\) requires that lands designated as components of the National Wilderness Preservation System “be administered . . . in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness.” The act defines wilderness “ . . . as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.” An area of wilderness is further defined to mean in the act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man’s work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least 5,000 acres (2,023 ha) of land or is of sufficient size as to make practical its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Fire is a natural force that has helped shape the character of much of the American wilderness. According to Heinselman (1978), full recognition of fire’s role “is only now pervading ecological theory, but it seems clear that many of the forest, grassland, and savanna ecosystems of the primeval American wilderness were fire dependent.” An ecosystem can be called fire dependent if periodic perturbations by fire are essential to the functioning of the system (Heinselman 1978). In such ecosystems “fire initiated and terminated vegetational

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\(^1\) An Act to establish a National Wilderness Preservation System for the permanent good of the whole people, and for other purposes. Public Law 88-557, 88th Congress, S.4, September 3, 1964.
succession; controlled the age structure and species composition of the vegetation; produced the mosaic of vegetation types of the landscape; affected insect and plant pathogen populations; influenced nutrient cycles and energy flows; regulated the biotic productivity, diversity, and stability of the system; and determined the habitats available to wildlife" (Heinselman 1978).

**Fire Management**

Federal land management agencies generally pursued a policy of total fire control at the time the Wilderness Act was enacted. Discovered fires were aggressively attacked and eventually contained and controlled under such a policy. The fire control policy was applied to all lands regardless of classification or primary use. The use of certain fire suppression equipment was, however, often regulated by agency policy in wilderness areas.

The apparent conflict between overall wilderness management direction and fire control objectives was recognized by land managers even though fire control was specifically authorized in the Wilderness Act. There occurred, in fact, a general recognition that fire control activities should, in large part, be dictated by land management objectives on all Federal lands. The policy of fire control gradually changed, therefore, to a policy of fire management (Moore 1974; DeBruin 1976; Kilgore 1976a; Turcott 1979). Several definitions of the term “fire management” have been proposed (Barney 1975; Simard 1976) and other definitions implied (Barrows 1974; Mutch 1977; Heinselman 1978). It is difficult to present a single authoritative definition of fire management because the term is routinely used in two different contexts: a land management philosophy and a land management activity. As a management philosophy, fire management suggests that fire, in an ecological sense as well as in a protective sense, should be considered when developing land and resource management objectives, and that fire-related activities should be designed to accomplish these objectives. As a land management activity, fire management includes all the tasks related to the inclusion of fire considerations in land and resource management plans, protecting forests and rangelands from unwanted fire, and the use of fire to accomplish management objectives.

**Wilderness Fire Management**

Early manifestations of the emerging concept of fire management occurred in the National Parks and in National Forest wildnesses. The National Park Service, responding to direction from Leopold and others (1963) initiated a natural fire program at Sequoia and Kings Canyon National Parks in 1968 (Kilgore 1976b). In 1972, the Chief of the Forest Service approved the agency's first wilderness fire management plan, for a portion of the Selway-Bitterroot Wilderness (Mutch 1974). Wilderness fire management programs have grown steadily since their inception. By 1982, some 6,794,000 acres (2 749 532 ha) were included in natural fire programs in 34 National Parks. Between 1968 and 1981, more than 919 unscheduled (naturally ignited) prescribed fires were allowed to burn 133,967 acres (54 216 ha) of parkland. In addition, 183,674 acres (74 333 ha) were treated by 846 scheduled (manager-ignited) prescribed fires (Kilgore 1983).

Wilderness fire management programs are also expanding on the National Forests. During the period 1972-81, some 8,574,577 acres (3 470 131 ha) were included in 33 approved fire management plans for the western National Forests (Regions 1-6). The total includes 5,785,703 acres (2 341 474 ha) of wilderness and 2,788,874 acres (1 128 657 ha) of nonclassified National Forest land. By the end of the 1981 fire season, 369 unscheduled fires had burned a total of 59,380 acres (24 031 ha) since 1972 (Kilgore 1983).

A complete listing of National Park Service-prescribed fire programs and National Forest wilderness fire programs is included in appendix A.

**DEFINITION**

Wilderness fire management is defined as follows:

Wilderness fire management is the deliberate response to and use of fire through the execution of technically sound plans under specific prescriptions for the purpose of achieving stated wilderness management objectives.

This definition places no preconditions on the practice of fire management. It is meant to encompass all fire-related plans and actions. Often, wilderness fire management is defined only in terms of the reintroduction of fire. Reintroduction implies absence for a period long enough to have become inoperative.

The prior absence or successful exclusion of fire is not recognized as a requirement for wilderness fire management in this report. Some of the legitimate objectives of wilderness fire management are not necessarily related to the prior occurrence and frequency of fire. Examples are visitor safety, protection of private property, boundary considerations, endangered species protection, and habitat management. Also, few wildernesses have experienced total fire exclusion for ecologically significant periods of time. Effective fire control has existed for less than 80 years, a timespan well within the natural fire-free interval of many wilderness vegetation types. Even the most aggressive fire control programs have had notable failures. Many of the fires that have started during periods of very high and extreme fire danger have escaped initial attack and have burned large acreages as fast-spreading, high-intensity, stand-destroying fires. Successful fire control has undoubtedly reduced the acreage burned in many wilderness areas, especially during the past several decades of high-technology fire control. Perhaps the most significant impact of successful fire control has been the nearly total elimination of the easy-to-suppress, slow-spreading, low-intensity surface fire. The vegetative mosaics that resulted over large areas when such fires periodically flared up, ran, and dropped back to the ground in response to changes in weather, topography, and fuel, are generally considered vital to the ecological integrity of most wilderness ecosystems.

Wilderness fire management is often defined in terms of naturally fire-dependent ecosystems. It is essential that fire-dependent ecosystems be identified and that
Wilderness fire management plans reflect such situations where they occur. Wilderness fire management plans can, however, be written for ecosystems that are not fire dependent. Wilderness fire management is an appropriate activity in any wilderness where fire occurs. There are legitimate objectives for wilderness fire management other than the maintenance of fire-dependent ecosystems—for example, the protection from fire of vegetation that is not ecologically dependent on periodic fire.

**IMPLICATION**

The foregoing definition of wilderness fire management is a functional definition. It relates to the important tasks associated with the practice of wilderness fire management: responding to fire, using fire, and executing plans to achieve wilderness objectives. Many wilderness management objectives were achieved by the former practice of fire control. What, then, distinguishes wilderness fire management from wilderness fire control? One answer to this question might be that fire management implies cost effectiveness; that is, the cost of putting a fire out ought not exceed the value of the resources being protected. This is a valid distinction for lands managed for forest products where market prices can be used to evaluate the resource being protected. It does not adequately explain the difference between fire management and fire control for park and wilderness lands. The difference, according to Van Wagner and Methven (1980), is that wilderness fire management implies vegetation management.

It is important to realize that wilderness fire management is in fact vegetation management. It requires, as Van Wagner and Methven (1980) suggest, a vegetation plan that must be ecologically compatible with what can be achieved by managing fire, either through its application or its exclusion. Wilderness fire management planners must decide what kind of vegetation and associated wildlife is to be maintained, enhanced, and discouraged in the planning area. Planners must then determine the kinds of fires and fire frequencies that will produce the desired vegetation. This is no small task. Nonvegetation-related considerations and constraints will usually result in compromise with the ecologically ideal situation. The ideal should, nonetheless, be described as a basis or reference point for wilderness fire management in a given park or wilderness area.

**RESPONSE TO FIRE**

Wilderness fire management was defined previously as the **deliberate response** to and use of fire through the execution of technically sound plans under specific prescriptions for the purpose of achieving stated wilderness management objectives. A deliberate response to fire is a response that results from careful and thorough consideration of consequences. It is a planned response. There are three general ways to respond to a fire: ignore it, attack it, or allow it to burn according to a predetermined plan. Ignoring a fire, or just letting it burn, is nonmanagement; hence it is not an acceptable response.

Fire attack can be delayed, aggressive, or modified. Delayed attack means that attack does not immediately follow discovery. A fire that is discovered at night, for example, might not be attacked until daylight. Delayed attack, once it occurs, can be aggressive or modified. Aggressive attack immediately follows discovery and with force sufficient to effect control at the earliest possible time with minimum acreage burned. Modified attack is less than aggressive attack. Suppression forces, techniques, strategy, or some combination of these factors are less than those defined for aggressive attack. The “minimum total” concept applies here (USDI Fish and Wildlife Service 1977). For example, additional acres burned might be acceptable if one uses handtools rather than tractors to build fireline in a wilderness area. Delayed and modified attack, like aggressive attack, should be fast, energetic, thorough, and conducted with regard for personnel safety.

Differentiating between delayed, aggressive, and modified attack emphasizes the strategy of fire attack. Another approach is to emphasize fire attack tactics. Using this approach three different fire responses are available: confine, contain, and control (USDA Forest Service 1981a). To **confine** a fire means to restrict it within boundaries that are either predetermined (pre-attack planning) or determined during the fire. To **contain** a fire means to surround it with a fireline, or firelines if spot fires exist, for the purpose of checking the fire’s spread. To **control** a fire means essentially to put it out. This involves fireline construction, burning out, cooling hot spots, and other actions that remove any threat of subsequent escape.

The final response to fire is allowing it to burn as a prescribed fire. Allowing a fire to burn according to a predetermined plan is synonymous with the deliberate use of fire because both actions result in a prescribed fire. A **prescribed fire** is any fire burning in a predetermined area under predetermined environmental conditions and behaving in a predetermined manner to accomplish a predetermined management objective. Ignition of a prescribed fire can be either scheduled or unscheduled. A **scheduled prescribed fire** is one ignited by the manager at a predetermined time. An **unscheduled prescribed fire** is one that is ignited as a result of an act of God or unauthorized human activity. The time of such ignition is not known in advance.

The terms “planned ignitions” and “unplanned ignitions” are used by many fire managers instead of scheduled and unscheduled prescribed fires. A planned ignition is defined as a fire started by a deliberate management action, whereas an unplanned ignition is defined as a fire started at random by either natural or human causes. The problem with this terminology is that it implies, for example, that a lightning-caused fire allowed to burn under prescription is unplanned. The fact that a prescription exists, under which the fire is burning, contradicts such an implication. The fire in the above example is, in fact, planned (intended, anticipated, expected). Its exact time and place of occurrence are, however, not known in advance, hence the fire is unscheduled. A basic premise in this report is that all prescribed fires, by definition, are planned.
A prescribed fire can, then, be simply defined as any fire that is burning according to prescription. A prescription is a written direction for the use of a therapeutic or corrective agent. A fire prescription is, therefore, a written direction for the use of fire to treat a specific piece of land. The directions contained in a fire prescription consist of predesignated criteria that distinguish a prescribed fire from a wildfire.

A wildfire is any fire that is not a prescribed fire. It is an unwanted fire. A prescribed fire that deviates irrevocably from prescribed conditions (escapes prescription and cannot be quickly brought back into prescription) becomes a wildfire (also called an escaped fire, see below). Fires that receive delayed or modified attack are wildfires, not prescribed fires.

Wildfires that cannot be successfully controlled by initial attack forces, and prescribed fires that escape prescription and burn as wildfires, are called escaped fires. Subsequent action on such fires is based on a plan of action developed as a result of analysis of alternative suppression strategies. An alternative is selected on the basis of total cost effectiveness, public safety, probability of success, protection of property, and the effects of fire and fire suppression on the resources. The results of such escaped fire analysis or situation analysis are not prescriptions and should not be considered as such. The fire, regardless of management action taken following escaped fire analysis, remains a wildfire.

In the case of an escaped prescribed fire, the decision may be to take the limited suppression action necessary to bring the fire back into prescription. If such action is successful, the fire may regain prescribed fire status since it would again meet the definition of a prescribed fire.

NATURAL VERSUS HUMAN IGNITIONS

The type of ignitions appropriate to achieve fire management objectives should be identified during planning. Wilderness has, of course, an esthetic, spiritual dimension. This is reflected in management policies that place strong emphasis on allowing natural process to function while discouraging or prohibiting the use of anything unnatural. Consequently, wilderness management policies generally encourage the prescribed use of natural ignition agents, such as lightning and volcanic eruptions, to accomplish wilderness fire management objectives and generally discourage or prohibit the prescribed use of unauthorized human ignitions (accidental man-caused fires).

Van Wagner and Methven (1980) make a strong argument for the irrelevancy of mode of ignition. They reason that the effect of any fire is quite independent of how it started; the forest, they point out, certainly cannot tell the difference. They suggest that the only worthwhile distinction is between wanted and unwanted fire as determined by management objectives.

Heinselman (1978) cites concern about safety and concern about unnatural ecosystem effects due to prior fire exclusion as the only legitimate reasons for using scheduled prescribed fires. Safety concerns, according to Heinselman (1978), might dictate that only scheduled prescribed fires "be used near the wilderness perimeter, near enclaves of development, in very small wilderness in high visitor use areas, and in ecosystems where it is known that natural fires tend to be high-intensity crown fires or severe and fast-moving surface fires." Such situations exist in many National Park and National Monument wilderness-type areas. An example of unnatural ecosystem effects due to prolonged fire exclusion would be the situation where unnaturally large fuel accumulations occur in forest stands that experience only low-intensity surface fires under a natural fire regime. Unnaturally heavy fuel accumulations can make such stands susceptible to stand-destroying crown fires. Scheduled prescribed fires during moderate burning conditions can reduce fuel accumulations so that subsequent unscheduled ignitions can more nearly play their natural role.

Because parks and wilderness areas are surrounded by boundaries that separate them from areas of different uses, are of limited area, and because their visitors must be protected from uncontrolled fire, a totally natural fire regime is neither possible nor desirable according to Van Wagner and Methven (1980). The objective of perpetuating certain ecosystems within parks and wilderness areas would, they suggest, have to be met by a planned fire regime, probably involving scheduled as well as unscheduled fire. Van Wagner and Methven (1980) feel that the renewal rates and fire cycles would best be set according to the ecology and longevity of the main species, in conjunction with the present age-class distribution and the evidence of fire history. They readily admit that actual locations, numbers, and sizes of fires would be subject to many practical considerations.

Lack of defensible boundaries and typical fire behavior favor the use of scheduled rather than unscheduled prescribed fires to accomplish wilderness fire management objectives in certain northern ecosystems. Alexander and Dubé (1983) cite the example of northern ecosystems characterized by generally flat terrain with continuous fuel, where fires are most often stand-replacing, high-intensity surface or crown fires that defy containment or confinement.

A final situation that often warrants consideration of scheduled versus unscheduled ignitions is the wilderness area traditionally swept by fire originating from a point now outside the wilderness boundary. Fires are now suppressed in the developed lower lying areas that surround many small, high-elevation wildernesses, thereby effectively eliminating any chance of reestablishing a natural fire regime.

Management policies regarding the use of fire to accomplish wilderness fire management objectives are important criteria for planning. Wilderness managers should be aware of these policies before attempting to develop wilderness fire management plans.

PLANNING CONCEPTS

Planning Area

The ideal fire management planning area has distinct topographic boundaries within which any free-burning fire would be naturally contained. The logical planning area for wilderness fire management is the designated
PLANNING HIERARCHY

In most land management agencies planning requirements result in a hierarchy of plans. Plans range from broad, national-level documents, to plans that prescribe specific actions on a specific piece of land. The wilderness fire management plan falls at the lower end of the planning hierarchy. As such, it must respond to direction contained in the next higher level plan. This is an important point. Wilderness fire management planners must assure that wilderness fire management issues are properly identified and that contemplated actions are authorized at all appropriate levels of planning.

Wilderness fire management planning for Federal lands is subject to the requirements of the National Environmental Policy Act (NEPA) of 1969 (Public Law 91-190). NEPA requires that a systematic interdisciplinary approach be used in planning and decision-making that may affect the human environment. The relationship between NEPA requirements and wilderness fire management planning is illustrated using the Forest Service NEPA process as an example (USDA Forest Service 1981b).

DEVELOPING A FIRE MANAGEMENT PLAN USING THE NEPA PROCESS

The fire management plan is developed using guidance contained in existing multiple-use plans, unit plans, forest land management plans, wilderness management plans, and regional guides, as follows:

NEPA Process Outline

1. Environmental analysis
   A. Identify issues, concerns, opportunities
   B. Develop criteria
   C. Data collection
   D. Analyze the situation
   E. Formulate alternatives
   F. Estimate effects
   G. Evaluate alternatives
   H. Identify preferred alternative

2. Documentation

3. Decision

4. Implement and monitor

These are activities the interdisciplinary team, specialists, and line and staff managers will be involved with in developing the environmental assessment for the wilderness fire management plan. The results of the environmental assessment are documented, usually using the standard Council of Environmental Quality (CEQ) format:

Standard CEQ Format

A. Cover sheet
B. Summary
C. Table of contents
D. Purpose of and need for action
E. Alternatives

This section was written by Hugh G. Pangman, Land and Resource Planning Group, Intermountain Region, USDA Forest Service, Ogden, Utah, personal communication, July 1981.
Establishing Scope of the Study

The initial phase of planning is devoted to determining the scope of the study. This process is called “scoping” in the jargon of Forest Service planners (USDA Forest Service 1981b). Both NEPA and fire planning requirements are assessed to assure proper data collection and evaluation at the outset. Some major considerations are:

Objectives.—The land management and wilderness management objectives that will guide fire management planning. The management objectives for the area.

Preliminary alternatives.—Fire management prescriptions for different units within the wilderness. (These are general considerations at this point and are refined as data are collected and evaluated.)

Data collection.—This is concerned with two types of data:

1. Data necessary to evaluate fire management alternatives and to complete the fire management plan.
2. Environmental concerns and public involvement (fig. 1).

The scoping system results in a plan to complete the NEPA process and the wilderness fire management plan.

Other requirements of the NEPA process are contained in agency guidelines and are not repeated here. The intent is to show how NEPA and the fire management plan are interrelated. The environmental assessment is completed before the wilderness fire management plan, although portions of the latter will be completed concurrently. The depth of the environmental assessment will be governed by the complexity of the wilderness being studied and the issues involved, and whether an environmental impact statement is needed. A concept labeled “tiering” (USDA Forest Service 1981b) is relevant here. Essentially, tiering means that general matters covered in environmental impact statements for broad plans can be referenced in subsequent statements for narrower plans. Hence, for example, a discussion of fire management policies included in an environmental statement for a National Forest plan can be referenced rather than repeated in a wilderness fire management plan, environmental statement, or assessment.
CHECKLIST OF ENVIRONMENTAL AND PUBLIC INVOLVEMENT FACTORS

(Name of Action/Proposal)

The following key describes the disposition of the listed factors:
D. Discussed in assessment.
C. Considered in analysis; no further discussion deemed necessary.

Physical environment

1. ___Geologic hazard
2. ___Climatic
3. a. ___Soil productivity  b. ___Capability  c. ___Erodibility of soils  d. ___Mass failure
4. a. ___Locatable minerals  b. ___Leasable minerals  c. ___Energy sources
5. ___Visual resource
6. a. ___Archaeological resources  b. ___Historical resources  c. ___Architectural resources
7. ___Wilderness resources
8. a. ___Water quality  b. ___Streamflow regimes  c. ___Flood plains  d. ___Wetlands  e. ___Ground water recharge  f. ___Water rights
9. ___Air quality
10. ___Noise
11. a. ___Potential wildfire hazard  b. ___Role of fire in ecosystem
12. ___Land uses (includes prime farmlands)
13. a. ___Roads  b. ___Trails  c. ___Electrical transmissions  d. ___Communications systems  e. ___Solid waste management  f. ___Sanitary waste  g. ___Rights-of-way  h. ___Land line

Biological factors

14. a. ___Forest (includes diversity)  b. ___Rangeland management  c. ___T and E plants  d. ___Other vegetation types  e. ___Research natural areas potential  f. ___Unique ecosystems (other than RNA)
15. a. ___Wildlife population  b. ___Habitat  c. ___T and E species  d. ___Diversity of animal communities
16. a. ___Fisheries habitat  b. ___Population  c. ___T and E species
17. ___Outdoor recreation resources
18. ___Economic base

Figure 1.—Environmental and public involvement assessment checklist for identifying issues, concerns, and management opportunities.
CHECKLIST OF ENVIRONMENTAL AND PUBLIC INVOLVEMENT FACTOR (con.)

Economic and social factors

19. ___Employment/unemployment
20. ___Housing
21. ___Land use requirements
22. ___Community service requirements
23. a. ___Local government base
b. ___Special service districts base
24. ___Plans and programs of other agencies
25. a. ___Income sources
   b. ___Income accounts
   c. ___Income distribution
26. a. ___Population numbers
   b. ___Minority composition
   c. ___Distribution and density
27. ___Civil rights
28. ___Local cultures
29. ___Personal security
30. ___Education, cultures, and recreation opportunity
31. ___Legal considerations
32. ___Rights-of-way
33. ___Land line

Public involvement

Attach a list of Federal, State, and local agencies, individuals and organizations interested or involved in the proposal, or having information or expertise relative to the project.

Conducted by: ____________________________
   Name(s)
   ____________________________ Date

Approved by: ____________________________
   Name and Title
   ____________________________ Date

Figure 1.—(con.)
**The Plan**

The purpose of wilderness fire management planning is to produce a wilderness fire management plan that reflects management direction for the park or wilderness area. A plan is a detailed formulation (systematized statement) of a program of action. The wilderness fire management plan is, therefore, the primary guide for all fire management actions within the planning area, including response to wildfire and the conduct of prescribed fires.

Wilderness fire management plans usually must be reviewed and approved by those not involved in their development. The rationale for the planned actions must, therefore, be documented. Such documentation is best done in a separate report or in associated environmental assessments or environmental impact statements. If the plan and the supporting rationale are presented in one report, the plan should be a separate and distinct part.

**FORMAT**

The format of wilderness fire management plans is governed by agency requirements, complexity of planned actions, and the creativity of the planner. The important consideration is that the plan be complete, concise, and easy to use.

**CONTENT**

A wilderness fire management plan should include the following four parts:

1. A brief introduction in which related plans and supporting documents are identified,
2. Explicit fire management objectives,
3. A map of the fire management area, with fire management units and zones clearly delineated and identified, and
4. Planned actions (what, when, who, and if appropriate, how) for:
   a. Responding to fire starts,
   b. Suppressing wildfires,
   c. Analyzing escaped fires,
   d. Monitoring prescribed fires,
   e. Igniting and conducting prescribed fires,
   f. Evaluating fire effects,
   g. Preventing unwanted fires,
   h. Presuppression activities,
   i. Protecting visitors from fire injury,
   j. Informing and involving the public,
   k. Notifying appropriate individuals and agencies and reporting fire actions and activities, and
   l. Reviewing and revising the plan.

**WHAT IS AN ADEQUATE PLAN?**

Wilderness ecosystems vary in ecological complexity, environmental stability, and fire potential. Agency policy, user patterns and concerns, as well as management direction and opportunities, vary from area to area. All these factors and others determine the adequacy or scope of the wilderness fire management plan.

The environmental analysis should provide a basis for determining the depth or complexity of the planning effort and the resulting plan. The scoping process indicated earlier integrates public participation and coordination, document research and administrative activities and provides a foundation for environmental analysis. The idea is to provide a means for identifying issues early in the NEPA decisionmaking process to ensure thorough analysis and determine the scope or extent of the analysis (USDA Forest Service 1981b).

**PLANNING ELEMENTS**

Wilderness fire management planning can be separated into six essential elements:

1. Describing fire and ecosystem interactions.
2. Describing special resource and use considerations.
3. Defining fire management objectives.
4. Delineating fire management units and zones.
5. Developing fire management prescriptions.
6. Devising a fire management plan.

The elements are listed in a proper sequence for planning and each depends in part on information developed earlier in the planning sequence. Prescription evaluation and plan revision are not listed as planning elements because they occur after the initial plan has been developed and implemented. These are, however, important elements of the fire management plan. Public involvement is an important part of planning. It is not listed above because it is assumed here that public involvement will occur as part of the environmental analysis process. Subsequent actions directed at public information and involvement are elements of the fire management plan.

Each of the above listed planning elements is defined and discussed in terms of planning approach, information needs, and method of presentation. Selected references to aid wilderness fire management planning are listed in appendix B.

**Fire and Ecosystem Interactions**

The first step in wilderness fire management planning is to describe how the physical and biological characteristics of planning area ecosystems have been and might be affected by fire, the absence of fire, and fire suppression actions. Interactions between fire and other ecosystem components can be identified by delineating and describing planning area ecosystems in relation to their fire situation. Consider this to be a three-step process: (1) classify, describe, and map area ecosystems; (2) describe the fire situation; and (3) identify and describe significant fire-related interactions. (In practice these three steps may not be so clear cut.)

**ECOSYSTEM CLASSIFICATION**

Classification involves grouping similar objects and separating dissimilar objects. Classification brings order to our thinking and communication by systematically naming the objects being classified and showing the relationships among them. The purpose of classification for land management is to organize, communicate, and collect information for decisionmaking.
Identification and delineation of wilderness ecosystems is important because such classification provides (1) a basis for inventorying current resources, (2) a means of transferring experience and knowledge about a studied area to a similar but unstudied area, (3) a framework for assessing local management opportunities and predicting the outcomes of treatments or actions, and (4) a means for communicating among managers, researchers, and the public (Frayer and others 1978).

Ecosystem classification terminology, methods, and approaches are reviewed and evaluated by Pfister (1977) and Bailey and others (1978). Another useful reference is the Guide to Land Cover and Use Classification Systems employed by western governmental agencies (Ellis and others 1977). Additional references are listed in appendix B.

INTEGRATED CLASSIFICATION SYSTEMS

Wilderness fire management planning needs are best served by an integrated approach to ecosystem classification. Enlightened decisions relating to fire use, fire exclusion, and fire control require knowledge of soils, current and potential vegetation, and landform. A fourth component, water, may be equally important in many wilderness areas. According to Driscoll (1980), agency leaders of the Bureau of Land Management, Fish and Wildlife Service, Forest Service, Geological Survey, and Soil Conservation Service endorsed a four-component classification system to be used for renewable resource inventories and assessments (Driscoll and others 1978). The hierarchical components are vegetation, soil, landform, and aquatic (water).

The major four-component ecosystem classifications described in the literature are biophysical land classification (Lacate 1969), ECOCLASS (Corliss and others 1973), modified ECOCLASS (Buttery 1978), and ECOSYM (Henderson and others 1979). To date, none of these classifications have been used in conjunction with wilderness fire management planning efforts. This is mostly due to the still developmental nature of the systems.

Ecosystem classification based on integration of three components has been and is being used for wilderness fire management planning in the Forest Service Northern Region. The Clearwater National Forest portion of the Selway-Bitterroot Wilderness was, for example, stratified into ecological land units (ELU’s) as a first step in fire management planning (Fiman and Thomas 1979). An ELU is defined as an identifiable parcel of land having similar characteristics of landform, soils, and potential vegetation. The ELU in this example is comparable to the land type association (LTA) of the Land Systems Inventory (Wertz and Arnold 1972; Wendt and others 1975; USDA Forest Service 1976). The land system is outlined in figure 2.

A recent land system inventory of the Scapegoat and Danaher portion of the Bob Marshall Wilderness (Flathead, Lolo, Lewis and Clark, and Helena National Forests) in Montana is another example of the application of the land system for wilderness fire management planning (Holdorf and others 1980). Figure 3 is a land type association (LTA) map developed for a portion of the planning area. Land type associations are based on associations of habitat types, soils, and landforms (see fig. 2). Mapping units are designed to produce analysis units with similar response to wilderness management. The principal management practice considered is fire management, but properties influencing wildlife habitat, watershed behavior, and wilderness recreation were also considered.

THE FIRE SITUATION

The second step in defining interactions between fire and other ecosystem components is to describe the fire situation for the planning area. “Fire situation” is an arbitrary term used here to identify fire’s historic role, the current potential for fire, and the probable effect of present and future fire on planning area ecosystems.

FIRE HISTORY

A requirement of wilderness management is to preserve natural conditions. The wilderness fire management planner must therefore understand the role played by fire, if any, in establishing and perpetuating natural conditions. The planner must also determine the probable effect, if any, of past fire exclusion. To understand the role fire has played, planners must determine the fire history of the planning area.

Postglacial Period

Methods for investigating fire history vary according to the time periods of interest. Evidence of fire and its role in determining the composition of forest vegetation during the period following the retreat of glaciers in northern and mountain regions of North America can be obtained from lake and bog sediment cores (Swain 1973; Mehringer and others 1977; Schweger 1978). Wilderness fire management planners rarely have the resources to conduct studies of this type. They should, however, review the ecological, paleoecological, paleobotanical, geological, and related literature for studies that might pertain to planning area ecosystems.

Settlement Period

Journals of early explorers and settlers and investigations of aboriginal fire practices are important sources of fire history. Examples of such sources are Lutz (1959) for Alaska, Reynolds (1959) and Kilgore and Taylor (1979) for the Sierra Nevada region, Lewis (1977, 1978) for northern Alberta, Barrett (1980a, 1980b) for the Northern Rockies, and Shinn (1980) for the inland Pacific Northwest. Such information is usually not detailed enough to develop a fire history for a specific area. The use of early government land survey records to estimate the proportion of stands killed by fire in a 15- to 25-year period preceding the survey for vast areas of presettlement forest is discussed by Lorimer (1980).

Many investigators have developed detailed fire histories dating back to A.D. 1700 or earlier, which actually predates settlement in many areas. The investigators used historical records and techniques for reading tree rings and determining stand origin analysis. Heinselman (1973) describes these techniques and cites their use in developing a fire history for the Boundary Waters Wilderness.
**Figure 2.** The land system (sources: USDA Forest Service 1976; Wendt and others 1975).
Figure 3.—Land type association map for a portion of the Scapegoat and Bob Marshall Wilderness areas, Flathead, Lolo, and Lewis and Clark National Forests (source: Holdorf and others 1980). Land types are: I, forested flood plains; la, wet, grass-sedge meadows; Ib, grass and forested stream terraces; II, glacial cirque basins; III, forested ground moraine; Illa, forested steep lateral moraine; IV, slump land; Va, forested high elevation ridges; Vb, forested smooth residual slopes; Vc, forested moderately dissected residual slopes; Vd, forested and grassland smooth residual slopes; VI, peaks and alpine ridges—sparsely vegetated rock land; VII, forested, cool aspect break lands; VIII, forested, warm aspect break lands.
Arno and Sneck (Davis) (1977) describe a step-by-step method for determining fire history in coniferous forests of the Mountain West. This method is designed to answer the following questions: What were the (1) average, minimum, and maximum intervals between fires in various forest habitat; (2) sizes and intensities of fires; (3) effects of past fire on forest vegetation, particularly stand composition and age class structure; (4) effects of modern fire suppression? Arno and Sneck (Davis) (1977) provide instructions for study area selection, field reconnaissance, sampling fire-scarred trees, and analysis of fire scars and stand data.

Alexander (1979, 1980) and Mastrogiuseppe and others (1983) have developed and maintained a bibliography of fire history studies. This bibliography is a useful resource for identifying available fire history information in North America.

Fire Control Period

Most fires that have occurred since the advent of organized fire control are documented. These fire reports are the major source of fire history information for the period starting about 1900. Maps showing fire locations and the boundaries of large fires that have occurred during the past 80 to 100 years are maintained by some fire control agencies as part of periodic fire planning. These maps are excellent sources of fire history information.

Fire history techniques and fire histories for specific parks and wilderness areas are referenced in appendix B.

FIRE POTENTIAL

Fire potential is an ecosystem’s capability for fire. The traditional concepts of fire risk, fire hazard, and fire danger are incorporated within the concept of fire potential. The important determinants of fire potential are probable fire occurrence, the fire environment, and probable fire behavior. Fire environment refers to the conditions, influences, and modifying forces that control fire behavior (Countryman 1972). The fire environment is composed of three interacting influences: fuels, weather, and topography.

Fire Occurrence

Probable fire occurrence is, for lack of a better method, usually based on past fire occurrence. Individual fire reports are the primary source of information on past fire occurrence. Most fire control agencies have such reports for all known fires since the early 1900’s. Regionwide summaries of fire occurrence for wilderness areas, primitive areas, and wilderness study areas in the Northern Rocky Mountains and in the Southwest are presented by Barrows and others (1977) and by Barrows (1978, 1979).

A useful expression of lightning fire occurrence is lightning fire density (fires per million acres per year; fires per km²/year) by such ecosystem characteristics as cover type and elevation. Fire density values should be derived using the normalizing technique suggested by Bevins and Barney (1980) and Bevins and Jeske (1978).

 Stocks and Hartley (1979) summarized fire occurrence data for Ontario. Their summary includes probability of fires occurring under different levels of fire danger and a map showing fire densities.

Man-caused fire probabilities are more difficult to determine than are lightning fire probabilities. Past occurrence patterns are relevant but are sensitive to fire prevention programs, trail construction and maintenance, and other such factors that affect people’s actions and access.

Roussopoulos and others (1980) have developed a prototype National Fire Occurrence Data Library (NFODL). The NFODL facilitates nationally uniform editing, storage, retrieval, and analysis of wildland fire report data. It is maintained at the USDA Fort Collins Computer Center and now contains all USDA Forest Service Individual Fire Report data since 1970. Provisions have been made to accommodate data from other agencies. The NFODL can be a very useful aid for analyzing fire report data as a basis for predicting future occurrence patterns.

Fire Environment

The fire environment is composed of three interacting influences: fuels, weather, and topography.

Topography includes such elements as slope, aspect, elevation, and configuration. Topography is an element of landform. Topographic information will, consequently, be available if landform analysis was performed as part of ecosystem classification. The primary sources of existing topographic information are aerial photos and topographic maps.

Alexander and Woods (1978) discuss many of the considerations involved in preparing a fire weather climatology for park- and wilderness-type areas. Weather elements influencing planning area ecosystems must be characterized using historic weather data. FIREFAMILY, a computer program that uses historic weather data to predict fireline fire management needs, can be a useful fire management planning tool (Main and others 1982). Wilderness fire planners should summarize weather and climatic data according to the guidelines presented by Finklin (1983).

Fuels occupying planning area ecosystems should be characterized in terms of kind, size, amount, location, and areal extent. Methods used should be consistent with desired precision, which in turn should depend on the cost or consequences of an incorrect fuel-related decision (Hamilton 1978). Methods for characterizing fuels include actual inventory, photoguides, known relationships from existing data, and fuel models.

Brown and others (1982) present procedures for inventorying living and dead surface vegetation.

Photoguides for estimating loadings of natural fuels have been developed for forest types in the Pacific Northwest (Maxwell and Ward 1980a, 1980b), for the Southern Cascades and Northern Sierra Nevada (Blonski and Schramel 1981), and for the Northern Rocky Mountains (Fischer 1981a, 1981b, 1981c, 1981d). Where applicable, the guides can be used to obtain reasonable estimates of fuel loads for less than the cost of fuel inventory. At the same time they provide visual references of fuel situations that can be used when deciding appropriate actions on fire starts.
Known relationships from existing fuel inventory data can be obtained for some forest types from a prototype National Fuels Inventory Library (NFIL) developed by Bevins and Roussopoulos (1980). This library is maintained at the USDA Fort Collins Computer Center. Summaries and analyses of existing fuel inventory data for local areas have been published.

A final method for characterizing fuels is the use of fuel models. The most popular fuel models are those used with the NFDRS (Deeming and others 1977; Anderson 1982).

Albini (1976) cautions that the accuracy with which any particular situation in the field is reproduced by one of these stylized models is highly variable. A recent innovation that may reduce this variability is the BEHAVE computer system (Andrews 1983). BEHAVE provides a capability for trained field personnel to construct fuel models tailored to a site.

Fire Behavior

Probable fire behavior depends on the likely interactions between elements of the various fire environments existing in the planning area. The first step in characterizing probable fire behavior is to identify planning area ecosystems that have similar topography and fuels. Ecosystems may also be stratified according to weather if such site-specific data are available. The next step is to estimate probable fire behavior for each ecosystem or group of ecosystems for the range of probable weather conditions, or for some specific benchmark weather condition.

Estimating probable fire behavior is a critical fire management planning task. It is also a demanding and relatively complex task. Rothermel (1983) has recently produced a manual in which he documents state-of-the-art procedures for estimating the rate of forward spread, intensity, flame length, and size of fires burning in forests and rangelands. Rothermel's procedures have become the generally accepted standard for wildland fire behavior prediction. Rothermel's procedures plus a capability of building site-specific fuel models are packaged in the BEHAVE computer system (Andrews 1983). Although neither system was designed for long-range planning, both can use expected weather or climatological data from an area that, when coupled with an assessment of the fuels and site conditions, can give appraisals of the expected fire behavior.

The National Fire-Danger Rating System (NFDRS) may also be used for planning wilderness fire potential and for monitoring fire potential as the season develops. The NFDRS contains two components and an index that have been used for estimating potential fire behavior. The spread component (SC) integrates the effect of wind, slope, and fuel to predict the forward rate of fire spread. Fuel is characterized by fuel models. The energy release component (ERC) indicates the potential amount of energy that can be released in a passing fire. The ERC reflects the effect of fuel moisture on fire intensity. The SC and ERC combine in the NFDRS to form the burning index (BI). The BI is designed to be a measure of the difficulty of containing a single fire. The BI has been interpreted in terms of fire behavior, controllability, flame length, and fireline intensity (table 1).

There are several subjective methods for estimating fire behavior. The methods are either based on experienced judgment or require experienced judgment in their application, or both. Two such methods are associated with previously described fuel appraisal photoguides.

Maxwell and Ward (1980a, 1980b) include an assessment of fire behavior and suppression difficulty for each photo included in their guide. These assessments are based on fire model predictions for the measured fuel situation shown in the photos.

The photoguides developed by Fischer (1981a-d) provide estimates of rate of spread, intensity, torching, crowning, resistance to control, and overall fire behavior potential. Estimates are made for average bad-day conditions, which are identified in the guides. Fire managers and researchers with experience in prescribed fire and fire control assigned adjective ratings for each fire behavior element according to a uniform set of definitions. Both NFDRS and stylized fuel models are assigned to each photo in these guides.

Fahnestock (1970) developed two keys for appraising fire behavior based on fuel characteristics. One key rates relative potential rates of spread; the other rates crowning potential. Both keys require experienced judgment in use and in interpretation of results.

Another approach to evaluating fire behavior potential is simply to apply knowledge of past fire behavior in specific fuel and vegetative types under known burning conditions. This was the approach used to evaluate potential fire behavior for Fischer's (1981a-d) photo series.

---

**Table 1.** Burning index interpreted in terms of fire behavior, controllability, and fireline intensity (source: Deeming and others 1977)

<table>
<thead>
<tr>
<th>Burning index</th>
<th>Fireline intensity</th>
<th>Flame length</th>
<th>Narrative</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-28</td>
<td>0-50</td>
<td>0-173</td>
<td>2.8</td>
</tr>
<tr>
<td>38</td>
<td>100</td>
<td>346</td>
<td>3.8</td>
</tr>
<tr>
<td>78</td>
<td>500</td>
<td>1 730</td>
<td>7.8</td>
</tr>
<tr>
<td>96</td>
<td>700</td>
<td>2 421</td>
<td>9.6</td>
</tr>
<tr>
<td>108</td>
<td>1,000</td>
<td>3 459</td>
<td>10.8</td>
</tr>
</tbody>
</table>
An overall evaluation of fire potential requires joint consideration of probable fire occurrence and probable fire behavior, given an occurrence.

There is no established method for expressing overall fire potential in a manner that adequately reflects the interrelationships involved. Statistical methods for dealing with probabilities do exist and have been applied to fire management problems (Hirsch and others 1979). Such methods have yet to be worked out for evaluation of fire potential as used herein.

Fire potential can be expressed and mapped as an adjectival rating, or rather two adjectival ratings; one for fire occurrence probability and one for probable fire behavior for some benchmark set of weather conditions. Any of the schemes described for estimating probable fire behavior can be used to derive adjectival ratings of low, moderate, high, and extreme fire behavior. A similar rating can be derived for probable fire occurrence by arbitrarily defining adjectival levels of low and high occurrence. Such an approach would provide eight classes of fire potential ranging from a "low occurrence-low fire behavior" class to a "high occurrence-extreme fire behavior" class.

Techniques for characterizing an area's fire occurrence, fire environment, and probable fire behavior are referenced in appendix B.

An adequate evaluation of fire potential allows the planner to answer the following kinds of questions about the planning area:

1. How many fires are likely to occur in a season and when?
2. What kind of fuels exist and where?
3. What kind of weather conditions are likely to occur at different times during the burning season?
4. How might various fuels burn under the range of likely weather conditions?

Information sources, data collection techniques, and analytical methods that can help answer such questions are included in appendix B.

FIRE EFFECTS

Wilderness fire management planners need to identify fire effects that pertain to planning area ecosystems. To be useful, fire effects must be related to ecosystem classification and fire severity. Emphasis should be on characterizing the general effects of fires of varying severity on plant and animal succession and watershed properties. Fire effects information sources are included in appendix B.

Summarizing Fire Effects

Fire effects information should be summarized in a way that reflects the ecosystem classification used for the planning area and the information needs of the planning effort. Effect of fire on vegetation, for example, can be summarized according to habitat type or cover type to show the effects of fire on plant succession. Habitat type fire groups (Davis and others 1980; Fischer and Clayton 1983; Crane 1983) provide a convenient way to group sites according to a similar response of tree species to fire and a similar postfire succession. Successional diagrams can be constructed for each fire group to show basic trends in structural changes and tree species succession (Kessell and Fischer 1981). The diagrams also show general responses to fires of different intensities and different stages of recovery from the last fire.

The effect of fire on soils and water is mostly a function of fire severity, slope, soil characteristics, geology, and vegetative cover. Soil and watershed specialists have developed rating systems to predict watershed response to fire and other disturbances based on such criteria as surface erosion hazard, mass wasting potential, stream channel stability, land and stream recovery potential. Examples of such rating systems are provided by Boyer and Dell (1980) for the Pacific Northwest and by Rosgen (n.d.) for the Northern Rockies. Fire management planners should enlist the aid of local soils and watershed specialists to identify and apply local rating systems when applicable. Results of soil and watershed rating systems should be compared to relevant fire effects research to assure validity. Table 2 includes ratings for vegetative and hydrologic recovery rate and erosion hazard for the Scapegoat and Bob Marshall Wildernesses, Mont. Settergren (1969) has summarized much of the existing research on effects of fire on wildland hydrology.

Fire's effect on wildlife is most often manifested through the fire-induced change in vegetation, i.e., habitat. Models designed to predict postfire plant succession can, therefore, be interpreted in terms of wildlife habitat to yield postfire wildlife succession models. Wilderness fire management planners should enlist the aid of wildlife specialists to assist in this task.

Smoke dispersion depends on windspeed and direction and atmospheric instability. Furman's (1979) PRESCRIB and MERG 3 computer programs were designed to provide estimates of the probable occurrence and persistence of poor smoke dispersal conditions. Smoke production depends on fuel loading and the moisture content of the fuels. Wet fuels produce more smoke than dry fuels. Consequently, preseason and postseason fires will usually result in more smoke than those that occur during the fire season.

Mutch and Briggs (1976) discuss smoke as a factor in the maintenance of natural ecosystems.

SUMMARY OF INTERACTIONS

Summarizing fire and ecosystem interactions requires setting down the major elements of the fire situation identified for each ecosystem. Such a summary will aid in identifying important differences in fire history, fire potential, and fire effects (tables 2 and 3). These differences can, in turn, be valuable aids for developing fire management objectives, delineating fire management units and zones, and prescribing appropriate fire management actions.

Holdorf and others (1980) use a series of aerial oblique photos to illustrate planning area ecosystems (land type associations) in the Scapegoat and Bob Marshall Wildernesses, Mont.

Five of the 14 land type associations identified by Holdorf and others (1980) are delineated on the photo in figure 4.
Table 2.—Characterization of the effects of fire on watershed in the Bob Marshall and Scapegoat Wildernesses: Flathead, Lolo, Lewis and Clark, and Helena National Forests, Mont. (source: Holdorf and others 1980)

<table>
<thead>
<tr>
<th>LTA¹</th>
<th>Landform</th>
<th>Slope class</th>
<th>Elevation (Feet)</th>
<th>Dominant aspect</th>
<th>Dominant habitat types</th>
<th>Vegetative fire group²</th>
<th>Vegetative-hydrologic recovery rate³</th>
<th>Fire-induced erosion hazards⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Forested flood plains</td>
<td>0–10</td>
<td>4,500–5,500</td>
<td>None</td>
<td>ABLA/LIBO</td>
<td>9</td>
<td>Rapid</td>
<td>Low</td>
</tr>
<tr>
<td>Ia</td>
<td>Wet, grass-sedge meadows</td>
<td>0–10</td>
<td>4,500–5,200</td>
<td>None</td>
<td>Willow-Sedge-Rush</td>
<td>0</td>
<td>Rapid</td>
<td>Low</td>
</tr>
<tr>
<td>Ib</td>
<td>Grass and forested stream terraces</td>
<td>0–10</td>
<td>4,800–5,200</td>
<td>None</td>
<td>ABLA/VACA, FESC/FEID</td>
<td>7 &amp; 0</td>
<td>Rapid</td>
<td>Low</td>
</tr>
<tr>
<td>II</td>
<td>Glacial cirque basins</td>
<td>0–40</td>
<td>6,000–7,500</td>
<td>N &amp; E</td>
<td>ABLA-PIAL/VASC, ABLA/LUHI</td>
<td>10</td>
<td>Slow</td>
<td>Severe (b)</td>
</tr>
<tr>
<td>III</td>
<td>Forested ground moraine</td>
<td>0–25</td>
<td>4,600–5,600</td>
<td>None</td>
<td>PICEA/VACA, ABLA/VACA</td>
<td>7</td>
<td>Rapid</td>
<td>Low</td>
</tr>
<tr>
<td>IIIa</td>
<td>Forested steep lateral moraine</td>
<td>5–60</td>
<td>5,500–6,800</td>
<td>None</td>
<td>ABLA/MEFE, ABLA/XETE</td>
<td>9</td>
<td>Moderate</td>
<td>Moderate (a)</td>
</tr>
<tr>
<td>IV</td>
<td>Slump land</td>
<td>0–40</td>
<td>5,000–7,500</td>
<td>None</td>
<td>ABLA/XETE, ABLA/MEFE</td>
<td>9</td>
<td>Moderate</td>
<td>Moderate (a)</td>
</tr>
<tr>
<td>Va</td>
<td>Forested high elevation ridges</td>
<td>0–40</td>
<td>6,800–8,000</td>
<td>None</td>
<td>ABLA-PIAL/VASC, ABLA/LUHI</td>
<td>10</td>
<td>Slow</td>
<td>Severe (b)</td>
</tr>
<tr>
<td>Vb</td>
<td>Forested smooth residual slopes</td>
<td>25–60</td>
<td>5,000–6,800</td>
<td>N &amp; E</td>
<td>ABLA/XETE, ABLA/MEFE</td>
<td>7 &amp; 9</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Vc</td>
<td>Forested moderately dissected residual slopes</td>
<td>25–60</td>
<td>5,000–6,800</td>
<td>N &amp; E</td>
<td>ABLA/XETE, ABLA/MEFE</td>
<td>7 &amp; 9</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Vd</td>
<td>Forested and grassland moderately dissected residual slopes</td>
<td>25–60</td>
<td>5,000–6,800</td>
<td>S &amp; W</td>
<td>PSME/FEID, FESC/FEID</td>
<td>5</td>
<td>Slow</td>
<td>Low</td>
</tr>
<tr>
<td>Ve</td>
<td>Forested and grassland smooth residual slopes</td>
<td>25–60</td>
<td>5,000–6,800</td>
<td>S &amp; W</td>
<td>PSME/FEID, FESC/FEID</td>
<td>5</td>
<td>Slow</td>
<td>Low</td>
</tr>
<tr>
<td>VI</td>
<td>Peaks and alpine ridges—sparsely vegetated rock land</td>
<td>60 + 6,000–10,000</td>
<td>All</td>
<td>ABLA-PIAL/VASC + SCREE</td>
<td>10 &amp; 0</td>
<td>Slow</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>VII</td>
<td>Forested, cool aspect break lands</td>
<td>60 +</td>
<td>5,500–7,500</td>
<td>N</td>
<td>ABLA/MEFE</td>
<td>9</td>
<td>Moderate</td>
<td>Moderate (a)</td>
</tr>
<tr>
<td>VIII</td>
<td>Forested, warm aspect break lands</td>
<td>60 +</td>
<td>5,500–7,500</td>
<td>S &amp; W</td>
<td>PSME/FEID, CARU PSME/SYAL + AF/XETE + SCREE</td>
<td>0</td>
<td>Slow</td>
<td>Low</td>
</tr>
</tbody>
</table>

¹LTA = land type association.
²Vegetative-hydrologic recovery: The rating is based on estimated rates of secondary succession for habitat types occurring within the land type association. Recovery is assumed to be a 10 percent or less increase in water yield compared to mature forest cover. The rating considers factors such as evapotranspiration rates, interception losses, and redistribution of snow in forest openings. Rating definitions: rapid—less than 40 years; moderate—40 to 60 years; slow—60 or more years. Refer to Rosgen (n.d., p. 10).
³Vegetative fire group: The rating is based on estimated rates of secondary succession for habitat types occurring within the land type association. Recovery is assumed to be a 10 percent or less increase in water yield compared to mature forest cover. The rating considers factors such as evapotranspiration rates, interception losses, and redistribution of snow in forest openings. Rating definitions: rapid—less than 40 years; moderate—40 to 60 years; slow—60 or more years. Refer to Rosgen (n.d., p. 10).
⁴Fire-caused accelerated erosion hazard: This is a rating of the probability of fire-induced accelerated erosion. Rating considers water, dry creep, and mass movement erosion. The ratings are defined as follows: low—either there is no hazard or the probability is so low that it need not be considered in planning. Generally any accelerated erosion which occurs following fire will not have a measurable effect on water quality. Moderate—accelerated erosion may increase sediment load of streams but not sufficiently to affect downstream fisheries or recreation uses. Some degradation of the esthetic quality of streams occurs and if reservoirs occur downstream, accelerated sediment deposition is an added cost. High—accelerated erosion following fire produces dramatic increases in sediment loads of streams with high probability of adverse effects on fisheries and recreation uses. Sedimentation of reservoirs is an added cost. The rating assumes a fire intense enough to kill overstory vegetation and consume litter and duff layers on most of the burned area. Fires of less intensity can and do occur but will not appreciably affect erosion rates.

Erosive processes considered in making ratings were: (a) slumps and debris avalanches; (b) streambank erosion caused by increased water yield.
Table 3.—Examples of summarizing fire and ecosystems interactions for a portion of the Selway-Bitterroot Wilderness (SBW) (source: Fiman and Thomas 1979)

<table>
<thead>
<tr>
<th>ELU name and number</th>
<th>Acres</th>
<th>Lightning load</th>
<th>Micro-climate</th>
<th>Aspect</th>
<th>Fire potential</th>
<th>Fire cycle</th>
<th>Fire season</th>
<th>ELU name used other SBW fire plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELU No. 1, strongly glaciated uplands</td>
<td>56,450</td>
<td>3.1/yr</td>
<td>Cold-moist</td>
<td>N &amp; E</td>
<td>Low</td>
<td>100–250</td>
<td>Middle July-</td>
<td>Subalpine</td>
</tr>
<tr>
<td>ELU No. 2, frost-churned uplands</td>
<td>101,841</td>
<td>4.0/yr</td>
<td>Cold-moist to cold-dry</td>
<td>S &amp; W all</td>
<td>Medium</td>
<td>100–200</td>
<td>July-September</td>
<td>Rolling landforms Moose Ck Lodgepole ELU West Fork RS</td>
</tr>
<tr>
<td>ELU No. 3, north-facing trough walls</td>
<td>24,799</td>
<td>1</td>
<td>Cold-dry</td>
<td>N</td>
<td>High</td>
<td>150–200</td>
<td>July-September</td>
<td>(Moose Creek, West Fork) North slope communities</td>
</tr>
<tr>
<td>ELU No. 5, south-facing scoured walls</td>
<td>34,114</td>
<td>1</td>
<td>Cold-dry</td>
<td>S</td>
<td>High</td>
<td>15–75</td>
<td>July-September</td>
<td>Ponderosa pine/ Douglas-fir South slope</td>
</tr>
<tr>
<td>ELU No. 6, wet uplands</td>
<td>5,740</td>
<td>1</td>
<td>Cold-wet</td>
<td>all</td>
<td>Low</td>
<td>100–200</td>
<td>July-September</td>
<td>—</td>
</tr>
<tr>
<td>ELU No. 7, riparian</td>
<td>16,076</td>
<td>1</td>
<td>Cold-wet</td>
<td>all</td>
<td>High-low</td>
<td>300–400</td>
<td>July-September</td>
<td>Stream bottom grand fir/cedar Stream bottom Ponderosa pine/ Douglas-fir South slope</td>
</tr>
<tr>
<td>ELU No. 8, stream breaklands, south exposure</td>
<td>15,929</td>
<td>1</td>
<td>Warm-dry</td>
<td>S</td>
<td>High</td>
<td>15–75</td>
<td>May-September</td>
<td>North slope communities</td>
</tr>
<tr>
<td>ELU No. 9, stream breaklands north exposure</td>
<td>5,951</td>
<td>1</td>
<td>Cool-moist</td>
<td>N &amp; E</td>
<td>Medium</td>
<td>150–250</td>
<td>July-September</td>
<td>North slope communities</td>
</tr>
<tr>
<td>ELU No. 10, wet draws and swales</td>
<td>1,414</td>
<td>0</td>
<td>Cool-moist</td>
<td>all</td>
<td>Low</td>
<td>150–250</td>
<td>July-September</td>
<td>—</td>
</tr>
<tr>
<td>ELU No. 11, colluvial slopes</td>
<td>2,560</td>
<td>0</td>
<td>Cool-moist</td>
<td>N &amp; E</td>
<td>Low</td>
<td>150–250</td>
<td>July-September</td>
<td>North slope communities</td>
</tr>
</tbody>
</table>

*Ecological land unit (ELU) designation is roughly equivalent to land type association (LTA) as used herein.*
Figure 4.—Five of the land type associations identified in the Scapegoat and Danaher portion of the Bob Marshall Wilderness, Flathead, Lolo, Lewis and Clark, and Helena National Forests, Mont. (source: Holdorf and others 1980.)
Kessell (1976a) used a gradient modeling approach to summarize fire and ecosystem interactions. He developed the Glacier National Park Basic Resource and Fire Ecology Systems Model, which links four major fire management components: (1) a terrestrial site inventory coded from aerial photographs that offers 33 ft (10 m) resolution; (2) gradient models of vegetation and fuel that derive quantitative stand compositional data from the parameters stored in the coded inventory; (3) a fuel moisture and microclimate model that extrapolates base station weather data to remote sites using the parameters stored in the inventory; and (4) fire behavior and fire ecology models that integrate the data from the inventory and models to calculate real-time fire behavior and ecological succession following a fire (Kessell 1976b).

To adequately summarize fire and ecosystem interactions, the planner should answer the following questions for each ecosystem identified based on its fire situation:

1. What is the natural role of fire?
2. How has fire suppression affected physical and biological characteristics?
3. When, where, and what kind of fires are likely to occur?
4. Are fires likely to intrude from an adjoining area?
5. How will future fires of varying intensity affect physical and biological characteristics?
6. How will fire exclusion affect physical and biological characteristics?
7. What environmental impacts are associated with various fire suppression methods and fire management strategies?

**Special Resource and Use Considerations**

Most wildernesses have unique features and permitted uses that require special consideration when planning fire management. Such areas should be identified, described, and mapped. This is often done in a higher level plan. Areas requiring special consideration include:

1. Ecological, archeological, geological, and other features of scientific, scenic, or historical value.
2. Rare, endangered, and threatened plant sites and animal habitats.
3. Administrative sites and improvements.
4. Designated recreation sites.
5. Grazing allotments.
6. Oil, gas, and mineral exploration sites.
7. Non-Federal land within and immediately adjacent to boundaries.

Appropriate specialists (archeologists, geologists, ecologists, wildlife biologists, etc.) should assist in identifying special areas and in appraising probable effects of fire, fire exclusion, and fire suppression.

The important question to be answered is: How might fire or the absence of fire affect ecological, archeologic, geologic, and other features of scientific, scenic, historical, or cultural value?

**Fire Management Objectives**

Wilderness fire management objectives state the planned measurable results desired from a wilderness fire management program. The overall goal toward which wilderness fire management objectives should be aimed is the preservation and enhancement of the wilderness resource through a well-planned and well-executed fire protection and use program that is ecologically sound and cost effective.

Fire management objectives for a specific wilderness planning area depend on the fire-ecosystem interactions, special resource and use considerations identified for the area, and the wilderness management objectives set forth in the wilderness management plan or other appropriate land management plan. As indicated earlier, relevant fire management policy and other direction should be reflected in the wilderness management objectives. If for some reason they are not, they should also be identified and used as a basis for defining specific wilderness fire management objectives.

Defining specific fire management objectives is the critical element in wilderness fire management planning. When this has been done, the remaining planning effort is devoted to developing criteria and devising methods that assure accomplishment of the fire management objectives.

Fire management objectives should be clearly stated and explicit. They should encourage fire use where such use is ecologically sound and beneficial to management objectives. Conversely, fire protection should be required where necessary to assure visitor safety, protect private property, and to avoid undesirable environmental impacts and detrimental effects in terms of the wilderness resource. The following is a list of management goals and associated objectives relevant to many wilderness-type areas:

<table>
<thead>
<tr>
<th>Goals</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allow fire to achieve its natural role.</td>
<td>1. Perpetuate naturally occurring plants and animals.</td>
</tr>
<tr>
<td>Use fire to accomplish desired resource management objectives</td>
<td>2. Perpetuate natural vegetative patterns.</td>
</tr>
<tr>
<td>Protect life, property, and resources from unwanted fire.</td>
<td>3. Maintain &quot;natural&quot; fire regime.</td>
</tr>
<tr>
<td>Avoid unacceptable effect of fire and fire suppression.</td>
<td>1. Restore fire where exclusion has had adverse effects.</td>
</tr>
<tr>
<td></td>
<td>2. Create, maintain, or enhance habitat for threatened, endangered, or desired plants and animals.</td>
</tr>
<tr>
<td></td>
<td>3. Protect recreation, administrative, and other imposed sites.</td>
</tr>
<tr>
<td></td>
<td>4. Protect intermingled and adjacent nonwilderness lands.</td>
</tr>
</tbody>
</table>

---

3Natural means being in accordance with and determined by nature; untouched by the influences of civilization and society.
This list does not exhaust the range of possible wilderness fire management objectives, and some of the listed objectives may be inappropriate for a given wilderness area. But identification of objectives is the first step in fire management. Fire management objectives should flow from the land management plan for the wilderness and should, consequently, be largely developed by wilderness managers and resource specialists. Fire management objectives should include such specifics as what, where, when, and so on. If, for example, an objective is to maintain favorable habitat for a rare species, the objectives should identify the species, describe favorable habitat conditions, and tell how much habitat needs to be maintained.

**Fire Management Units and Zones**

Fire management area (FMA) is, as indicated earlier, the term used to denote a planning unit. Fire management unit (FMU) and fire management zone (FMZ) are terms used to denote parts of a fire management area. Fire management unit and fire management zone are often used as synonyms. They are not so used here. A **fire management unit is a distinct part of the fire management area that can be recognized and mapped from its external features.** A particular drainage within a fire management area is an example of a fire management unit. It is, in a sense, a mini-fire management area. A **fire management zone refers to all the land within a fire management area that has in common a particular characteristic.** The shared characteristic can be physical, biological, or use-related; for example, all the land above 9,000 ft (2,743 m) or all land that comprises critical grizzly bear habitat or grazing allotments.

Fire management units and zones are delineated to help the planner write fire management prescriptions and develop and implement fire management actions. They enable the planner to focus on a particular piece or type of land and make integrating fire-ecosystem interactions, special resource and use considerations, and fire management objectives manageable.

The nature of the fire management area and the associated fire management objectives should determine whether fire management units, fire management zones, or both units and zones are delineated. Fire management zones are often used to divide a small fire management area that has relatively uniform characteristics. Fire management zones are also appropriate when fire management objectives are few and result in relatively simple fire prescriptions. Fire management units are often appropriate for dividing large fire management areas of diverse characteristics and for areas of any size where fire management objectives vary and require complex prescriptions. Both fire management units and fire management zones may be required in certain situations. A likely case would be a large fire management area requiring division into many large fire management units, each of which has several fire management objectives and special resource and use considerations.

Stratification of a wilderness fire management area into fire management units (FMU) and fire management zones (FMZ) depends on area size, physiognomy, ecosystem diversity; the fire situation; presence of unique features, special uses, and improvements; land ownership patterns; and fire management objectives.

**FIRE MANAGEMENT UNITS**

Fire management units should be rather large homogeneous areas with boundaries that are natural barriers to fire spread or that at least provide a reasonable chance for fire containment. Mountain wildernesses can usually be divided into fire management units that correspond to major drainage patterns. Planning areas that lack a pronounced topography can be divided into units based on past fire patterns, major changes in vegetation or fuel type, or other appropriate criteria. Based as they are on external features, fire management units can easily be located on aerial photos.

Wilderness fire management planning and implementation can be based on a fire management unit basis if management units are delineated early in the planning process. Planning can then proceed one unit at a time.

**FIRE MANAGEMENT ZONES**

A fire management zone consists of one or more parcels of land within the planning area; these parcels have common fire management objective(s) that can be satisfied by a common fire management prescription. Fire management zones are usually composed of similar ecosystems having similar fire situations. They may, however, also reflect common special features or use considerations.

Delineating fire management zones is a synthesizing process. The fire management planner must translate wilderness fire management objectives into planned management responses to fire on specific pieces of land within the planning area.

A first step in identifying fire management zones is to aggregate lands on an ecological basis. The next step is to scrutinize the fire situation in ecologically similar units. Probable fire behavior and associated fire effects are key considerations during this step. The evaluation may produce new groups based on even more specific classification. During the next stage, the manager must determine which lands require a fire management strategy that depends on considerations other than physical and biological characteristics and the fire situation. Included in this category are areas of ecological, archeological, geological, and other features of scientific, scenic, or historical value. Other considerations are grazing allotment, mineral lease, wildlife habitat, and private property. Special fire management zones can be created to reflect the special fire management needs of such lands.

The final outcome of this process will be a number of fire management zones, each requiring a unique fire management strategy to accomplish stated fire management objectives for the planning area. Each of these zones should be described and their boundaries mapped. Managers should clearly state fire management objectives and the desired response to fire for each zone.

The number of fire management zones described for a planning area depends on the number of different responses to fire desired and whether or not these
responses are absolute or conditional. In other words, is the desired response required at all times under all burning conditions or does it vary by time of year, weather conditions, or other variables?

Fire management zones usually reflect four primary responses to fire: (1) fire suppression, (2) observation, (3) scheduled prescribed fire, and (4) conditional fire management. Almost every existing wilderness fire management plan, for example, has areas where any fire at any time is undesirable. Such areas can be described as being in automatic fire suppression zones or fire exclusion zones. Other areas where fire is considered undesirable, but where damage potential varies with site or burning conditions, might be designated as falling into delayed attack zones. Fires occurring in such areas may not always need immediate attack. Still other areas where fire is generally unwanted may be designated as modified attack zones in order to prohibit fire suppression techniques deemed unacceptable because of adverse environmental impact. A primary response to fire, total suppression in this example, results in the designation of three fire management zones. Another primary fire response is to allow all fires to burn as unscheduled prescribed fires regardless of time of year, burning conditions, or other variables. Areas for which such a strategy is appropriate can be designated as observation zones. Areas designated for treatment with scheduled prescribed fires might be included in a single scheduled prescribed fire zone.

In many wilderness fire management planning areas, most lands will fall into one or more conditional fire management zones designed to allow a conditional response to fire, depending on time of year, elevation, burning conditions, and other variables. Such zones are labeled in a variety of ways, depending on external features, vegetation, use considerations, and other factors that best indicate the basis for creating the fire management zone.

The designation of fire management zones and the assignment of lands to fire management zones is interrelated with the development of fire management prescriptions for the zones. This is another case where planning steps are not clear cut. One distinction that can be made between these two tasks is that fire management zones are delineated by the kind of fire desired or expected; fire prescriptions are based on conditions likely to result from the desired or expected fire.

There is an important relationship between fire management zones and fire management units. A properly designated fire management unit imposes an area constraint to fires that may burn within the unit’s boundaries.

Each fire management unit and zone should be delineated on a map of the fire management area. A brief written description of each unit and zone should include information about important fire-ecosystem interactions, special resource and use considerations, and relevant fire management objectives.

**Teton Wilderness Example**

The relationship between fire management unit and fire management zone is reflected in figure 5. This example is from the Teton Wilderness fire management plan.
(Reese and others 1975). The fire management units are areas with recognizable and defensible boundaries, mostly drainage divides. The fire management zones reflect fire management objectives.

Cabinet Wilderness Example

A slightly different approach is shown by figure 6. This example is from the Cabinet Wilderness fire management plan (Schulte and Davis 1980). Two broad fire management zones have been established in the Cabinet Wilderness. These are described below:

1. The high elevation fire management zone covers most of the wilderness. It is characterized by scree habitat types, shrub fields, and stands of scattered trees or clumps of trees in the subalpine zone. While the northwest portion of this area has some dense timber stands, there are no extensive tracts of continuous trees or fuels. Natural landforms, such as slides and rock outcroppings, will act as barriers to fire spread.

2. The remainder of the wilderness has been divided into four fire management units (see footnote 4). They are the Cedar Creek, Granite Creek, East Fork, and Flower Creek fire management units. These units deserve special considerations because of heavy, continuous fuels and dense forest cover.

Also, these units receive considerable use by visitors due to ready access by trails. In addition, the Flower Creek drainage is the municipal watershed for the town of Libby, Mont.

Everglades National Park Example

The terrestrial mainland portion of Everglades National Park is divided into three fire management units, with three subunits (fig. 7). Delineation is based primarily on vegetation and fire ecology.

Fire Management Prescriptions

A fire management prescription is a written direction for dealing with the threat, occurrence, and use of fire within a fire management area, unit, or zone to accomplish land management objectives. Note that the scope of a fire management prescription is broader than that of a fire prescription. A fire prescription is a written direction for the use of fire. Traditional fire prescriptions are usually limited in scope. They primarily deal with the conditions under which a fire will be ignited, ignition techniques, and other factors directly related to the conduct of a burn. A fire management prescription must include necessary direction for the detection, prevention, and suppression of fires as well as for the use of fire.

Fire management prescriptions are usually written for a fire management unit or zone. Sometimes a single prescription will apply to several units with similar characteristics and fire management objectives. A single fire management prescription could conceivably apply to an entire wilderness fire management area, but such a situation is rare. The fire management prescription represents the culmination of fire management planning. Fire and ecosystem interactions, special resource and use considerations, and fire management objectives become manifest in the fire management prescription for a fire management unit or zone. The fire management plan, the final planning element, is a direct result of the fire management prescription(s). The plan tells how fire management prescriptions will be implemented.

The fire management prescription establishes standards upon which fire management decisions may be based. Criteria should be established for all fire management activities necessary to accomplish fire management objectives for the area of land covered by the prescription.

Figure 6.—Fire management units and zones, Cabinet Wilderness, Kootenai National Forest, Mont. (source: Schulte and Davis 1980).
PRESCRIPTION DEVELOPMENT

It is difficult to suggest a step-by-step method for developing fire management prescriptions. Prescriptions that satisfy a given management objective in one planning area may fail to satisfy the same objective in another. No methodology can substitute for an intimate knowledge of the planning area, clear and concise management objectives, and a journeyman’s knowledge of fire suppression, fire behavior, and fire effects. The following approach requires all four of these capabilities.

Partitioning the planning area into fire management zones and units can be an important first step in prescription development because such zoning reduces the often varied landscape to a manageable number of ecological land units and special areas for which prescriptions must be written. Preliminary prescriptions can be developed for each zone based on the fire response desired in each zone. After preliminary prescriptions have been developed, each zone can be evaluated on a fire management unit basis. The lands within a given management unit may fall into a number of fire management zones; within each unit, prescriptions for neighboring zones must be compatible. To illustrate this point, consider a special fire management zone with a prescription that requires total fire suppression and an adjoining downslope zone where the prescription calls for allowing certain fires to burn as unscheduled prescribed fires. Unless there is a natural barrier to fire along their common boundary, these prescriptions could be incompatible. Fire suppression might often be required to keep fire from entering the total suppression zone. This is not cost-effective fire management. As a general rule, prescriptions for adjoining zones should consider the natural fire spread tendency of a free-burning fire given the topography of the management unit. To deal with such situations, fire management zone designations must often be adjusted or preliminary zone prescriptions altered to reflect actual on-the-ground situations within a given fire management unit. It is unrealistic to expect all prescribed fires to remain in prescription unless the prescription is broad enough to allow a fire to encompass all the flammable area in its natural path. It is also unrealistic to depend on control action as a regular means of containing fires within a designated area.
Minimal control or holding action along a well-defined natural barrier to fire spread is the only practical approach to using unscheduled prescribed fire for attaining wilderness management objectives.

Another reason to prescribe fire management on a unit-by-unit basis is that fire management activities such as detection, prevention, and suppression are best prescribed for a homogeneous unit of land that is easily identifiable on the ground.

Suggested procedures for developing prescriptions for scheduled prescribed fires are generally available (Mobley and others 1973; Martin and Dell 1978; Fischer 1978). Such prescriptions should contain directions for responding to unscheduled fire that might occur in areas where prescribed fires are scheduled.

**PRESCRIPTION CRITERIA**

As indicated earlier, fire management zones are based on the planner’s interpretation of acceptable and unacceptable fires with respect to management objectives. To develop fire management prescriptions, the planner must also consider the conditions under which these acceptable and unacceptable fires are likely to occur. A fire management zone may be described, for example, as a zone in which preseason and postseason surface fires of low severity will be allowed to burn. To write a prescription for this zone, criteria must be established for preseason and postseason fires, for low severity fire, and for surface fire. These criteria must be measurable and must be immediately determinable at the time a fire is discovered. Examples of commonly used prescription criteria are elevation, calendar date, and fire danger rating indexes.

Selecting prescription criteria requires knowledge of the relationship between prescription variables and fire behavior. Some useful guides for this purpose are provided by Deeming and others (1977) and Albini (1976). A useful source of information is local records of fire occurrence and fire danger.

**CONSTRAINTS**

Fire management prescriptions are not complete until all constraints not previously considered are identified, defined, and incorporated into the prescription. Common constraints that often apply to wilderness fire management prescriptions have to do with:

**Man-caused fires.**—Agency policy often prohibits the use of accidental man-caused fires to accomplish management objectives.

**Scheduled prescribed fires.**—Agency policy may prohibit or restrict scheduled prescribed fires in wilderness.

**Level of fire activity.**—Prescribed fire programs are often shut down during periods of high fire activity.

**Crew availability.**—Use of unscheduled ignitions to accomplish management objectives is often tied to the availability of fire crews to handle possible escapes.

**Suppression methods.**—A complete ban on certain fire suppression methods and use of certain firefighting equipment is often imposed in wilderness.

**Air quality guides.**—Smoke management plans often restrict or prohibit prescribed fires during periods of poor ventilation.

**Life and property.**—Visitor safety and private property must always be protected.

Additional constraints may exist, depending on the particular situation. It is important to recognize all constraints during planning so that they can be reflected in fire management prescriptions.

**ORGANIZATION AND CONTENT**

The organization and content of fire management prescriptions should reflect the fire management situation on the planning area. Some prescriptions can be quite simple because the fire management activities planned for the area are quite simple. Other prescriptions will be complex. The following suggested outline should handle most situations. Each item (A–C) should be repeated for each management unit.

**SUGGESTED OUTLINE FOR FIRE MANAGEMENT PRESCRIPTION**

1. Fire Management Unit (name or number)
   
   **A. Fire detection.** If special detection needs are indicated, enumerate them and describe criteria for initiating action. If planning area detection is covered in some other fire management plan, cite the plan and summarize pertinent information.

   **B. Fire prevention.** Indicate all special fire prevention actions planned for the unit. Describe criteria for initiating action. If planning area prevention actions are covered in some other fire management plan, cite the plan and summarize pertinent information.

   **C. Presuppression.**

   1. **Preattack.** If the area is covered by a preattack plan, cite the plan and summarize pertinent information. If preattack plan does not exist, preattack procedures should be developed as part of the planning process and described here. Preattack procedures will depend on the fire potential and constraints imposed by fire prescriptions (Aldrich and Mutch 1973). USDA Forest Service preattack planning guides are available for many parts of the United States (for example, USDA Forest Service 1978b; Dell 1972).

   2. **Fuel management.** Planned fuel management actions should be enumerated. In many wildernesses fuel management is limited to slash disposal in conjunction with trail construction and maintenance. Fuel treatment on outside lands along wilderness boundaries may be appropriate in some cases.
3. **Fire prescriptions.** Details on the planned response to a fire occurrence should be described separately for each fire management zone. 

**For each fire management zone** describe:

a. Conditions when fires will be aggressively attacked and suppressed,

b. Conditions when fires will be suppressed, but attack will be less than aggressive,

c. Constraints on fire attack and suppression,

d. Conditions when unscheduled fires will be allowed to burn as prescribed fires,

e. Constraints on allowing unscheduled fires to burn as prescribed fires, and

f. If prescribed fires are scheduled in the fire management zone, fire prescriptions for each planned fire.

Alternative prescriptions for unscheduled prescribed fires can be evaluated with the aid of a computer system designed by Bevins and Fischer (1983a,b). The technique uses historical fire occurrence and weather records to identify ignitions that would meet manager-specified criteria for prescribed fires. Qualifying fires are “allowed to burn” under prevailing weather conditions until extinguished by precipitation or until prescribed conditions are exceeded.

![Decision flow chart for evaluating fires occurring in high elevation fire management zone against prescription criteria, Cabinet Wilderness (see fig. 6), Kootenai National Forest, Mont. (source: Schulte and Davis 1980).](image)

**Figure 8a.** Decision flow chart for evaluating fires occurring in high elevation fire management zone against prescription criteria, Cabinet Wilderness (see fig. 6), Kootenai National Forest, Mont. (source: Schulte and Davis 1980).

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**Fire Management Plan**

Fire management prescriptions tell how to achieve fire management objectives for the planning area. The fire management plan tells who will do what and when and where the fire management objectives will be accomplished.

**DECISION SCHEME**

A major part of the fire management plan is a decision scheme for implementing the fire management prescriptions for the planning area. The decision scheme assures that all prescription criteria and constraints are systematically considered before a response to a fire is selected. It should allow the fire manager to quickly determine if a fire is a wildfire or an unscheduled fire as defined by the fire prescription. The scheme should also indicate, again according to the prescription, what type of attack and suppression methods are appropriate if wildfire is indicated. This same decision scheme, if properly constructed, is used to help determine if a prescribed fire continues to burn within prescription on a daily basis (fig. 8).

![Decision flow chart for evaluating fires occurring in Cedar Creek, Granite Creek, and East Fork fire management units against prescription criteria, Cabinet Wilderness (see fig. 6), Kootenai National Forest, Mont. (source: Schulte and Davis 1980).](image)

**Figure 8b.** Decision flow chart for evaluating fires occurring in Cedar Creek, Granite Creek, and East Fork fire management units against prescription criteria, Cabinet Wilderness (see fig. 6), Kootenai National Forest, Mont. (source: Schulte and Davis 1980).
ASSIGNMENT OF RESPONSIBILITY

The plan should identify who is responsible for determining appropriate action regarding fire. Fire management prescriptions and associated decision schemes are guides for decisionmaking. Decisions regarding fire should rarely, if ever, be automatic. Current technology for predicting fire behavior and associated fire effects is imperfect, and the probability of unanticipated burning conditions is great. Decisions must be based on what a fire is actually doing and what it is likely to do, not on some presfire prediction of what it is supposed to do. Fire management decision systems should, consequently, always include diagnosis by experienced fire and resource specialists. The plan should require such diagnosis and specify the level of expertise required of such decisionmakers (fig. 9).

FIRE MONITORING

Assignments and procedures for collecting and reporting the information required to evaluate fire starts in terms of prescription criteria are a part of the plan. Procedures for fire monitoring and qualifications of fire monitors should be included unless established standards apply. Fire monitoring is the act of observing a fire to obtain information on its environment, behavior, and effects for the purpose of evaluating both the fire and its prescription. Fire monitoring provides the information needed to make daily decisions regarding prescribed fires. Fire monitoring also supplies information needed to cope with agency requirements for documenting fire management actions. Information gathered by qualified fire monitors can be used to verify or adjust fire prescriptions. The National Wildfire Coordinating Group has published an excellent guide to assist in the operational monitoring and evaluation of prescribed fires (Van Wagendonk and others 1982).

SCHEDULED PRESCRIBED FIRES

A schedule of all manager-conducted prescribed fires planned for the wilderness is an important part of the plan. Burning plans for these fires should also be included (for example, see Mobley and others 1973; Martin and Dell 1978; Fischer 1978). A separate decision scheme for identifying prescribed conditions for scheduled fires may be desirable.

EVALUATION OF FIRE EFFECTS

The actual effect of a prescribed fire or a wildfire in terms of wilderness fire management objectives is the ultimate test of the fire management prescription. The plan should contain a fire effects evaluation procedure and a procedure to use results of such evaluations to make necessary adjustments of prescriptions. Some examples of wilderness fire evaluations are provided by Collins (1980), Garcia and others (1979), Gochnour and Bailey (1980), Keown (1980), Racine (1979), and USDA Forest Service (1979).
FIRE PREVENTION

Most wilderness fire management prescriptions require suppression of all unauthorized man-caused ignitions. Fire prevention is, therefore, an important wilderness fire management activity. It is better to prevent unwanted fires than to sustain unacceptable loss to the wilderness resource as a result of fire or fire suppression activities. Include wilderness fire prevention activities in the plan.

FIRE PRESUPPRESSION

The manager should identify and describe presuppression activities relevant to the fire management prescription in the plan. Items such as detection, preattack plans, preparedness requirements, mobilization of forces, dispatching procedures, and collection of data for fire danger rating should be included. Include only those items relevant to implementing the fire management program for the wilderness area. If separate presuppression plans apply to wilderness lands the plan should be identified and applicable sections briefly summarized in the fire management plan.

FIRE SUPPRESSION

The plan should indicate fire suppression standards and constraints not included elsewhere and procedures for determining actions when fires escape.

VISITOR SAFETY

The plan should specify all special actions necessary to assure visitor safety when fires are burning in the wilderness area. Examples are information programs at wilderness entrances, signing, trail closures, personal contact of visitors near fires, and evacuation procedures in case an emergency situation develops.

SMOKE MANAGEMENT

Smoke management considerations governing the conduct of the fire management program should be described in the plan. Actions necessary to comply with rules, regulations, and other requirements for maintaining air quality should be identified.
PUBLIC INFORMATION AND INVOLVEMENT

The planned use of fire to accomplish wilderness management objectives is new. Few wilderness fire management prescriptions have been tested over a range of fire conditions. The support of resource managers and the general public is necessary to develop wilderness fire management effectiveness. Wilderness fire management plans should, therefore, outline a program of public involvement and information regarding planned fire management activities in the wilderness. This program should include participation by the Agency, as well as by cooperating Federal and State agencies.

Newlon (1981) identified two major aspects to public involvement in fire management: (1) doing a good technical job of managing fires and (2) telling the public about the good job you are doing. He suggests the following basic steps be considered when planning a public involvement program:

1. Define the issues in legal, ecological, social, and economic terms.
2. Communicate in layman’s English, or in other languages—Spanish, French—as appropriate.
3. Make public involvement an integral part of any plan, program, or project and not a separate procedure.
4. Provide full and timely information about upcoming fire management decisions, and offer many opportunities for the public to be involved in the decisionmaking process.
5. Identify the publics affected by the program or project and help them participate in the planning process.
6. Collect comments from the public, analyze them, and respond to recommendations.
7. Document all public participation; describe how the public’s input was used in the decisionmaking processes.

The skills needed, steps to be considered, and techniques to carry out effective public participation programs are thoroughly discussed in the USDA Forest Service Public Participation Handbook, Parts I and II (USDA Forest Service 1980).

NOTIFICATION AND REPORTING

Requirements for notifying designated agency and cooperator agency officials and filing necessary in-service reports of wilderness fire management activities should be spelled out in the plan. Responsible individuals should be identified by name and position.

REFERENCES


Barrett, S. W. Indians and fire. Western Wildlands. 6(3): 17-21; 1980a.


Barrows, J. S. The challenges of forest fire management. Western Wildlands. 1(3): 3-5; 1974.


Kessell, S. R. Wildland inventories and fire modeling by gradient analysis in Glacier National Park. In:
Proceedings, Tall Timbers fire ecology conference No. 14 and Intermountain Fire Research Council fire and land management symposium; 1974 October 8–10; Missoula, MT. Tallahassee, FL: Tall Timbers Research Station; 1976b: 115-162.


Mutch, R. W. “I thought forest fires were black.” Western Wildlands. 13(3): 16–22; 1974.


## APPENDIX A: PARK AND WILDERNESS FIRE MANAGEMENT PROGRAMS, 1972-81

<table>
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<tr>
<th>Parks and monuments by region</th>
<th>Natural fire zone</th>
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\(^1\)Natural prescribed fire program at Grand Canyon began in 1978.

\(^2\)Rocky Mountain's program suspended in 1978 after Ouzel Fire had to be suppressed.
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<td>REGION 5</td>
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<td>Caribou Wilderness</td>
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<td>Lassen NF</td>
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<td>REGION 6</td>
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<tr>
<td>Eagle Cap Wilderness</td>
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<td>Wallowa-Whitman NF</td>
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35
APPENDIX B: SELECTED REFERENCES FOR PARK AND WILDERNESS FIRE MANAGEMENT PLANNING

Philosophy, Programs, and Plans


Heinselman, M. L. Restoring fire to the ecosystems of the Boundary Waters Canoe Area, Minnesota, and to similar wilderness areas. In: Proceedings, Tall Timbers fire ecology conference No. 10; 1970 August 20–21; Fredericton, NB. Tallahassee, FL: Tall Timbers Research Station; 1970: 9–23.


Murphy, R. W. Experimental burning in park management. In: Proceedings, Tall Timbers fire ecology conference No. 7; 1967 November 9–10; Hoberg, CA. Tallahassee, FL: Tall Timbers Research Station; 1968: 207–216

Mutch, R. W. “I thought forest fires were black!” Western Wildlands. 1(3): 16–22; 1974.


Thompson, G. A. Fires in wilderness areas. In: Proceedings, Tall Timbers fire ecology conference No. 3; 1964 April 9-10; Tallahassee, FL. Tallahassee, FL: Tall Timbers Research Station; 1964: 105-110.


General Planning Aids and Information Sources


Barney, R. J. How to integrate fire with land use planning and management activities—a process. In: Proceedings, rangeland management fire symposium; 1977 November 1-3; Casper, WY. Missoula, MT: University of Montana, School of Forestry, Montana Forest and Conservation Experiment Station; 1978: 85-95.


Fire History


Barrett, S. W. Indians and fire. Western Wildlands. 6(3): 17-21; 1980.


Stewart, O. C. Barriers to understanding the influence of use of fire by aborigines on vegetation. In: Proceedings, Tall Timbers fire ecology conference No. 2; 1963 March 14-15; Tallahassee, FL. Tallahassee, FL: Tall Timbers Research Station; 1963: 117-126.


Fire Occurrence, Fire Environment, and Fire Behavior


Barrows, J. S. Forest fires in the Northern Rocky Mountains. Station Paper No. 28. Missoula, MT: U.S. Department of Agriculture, Forest Service, Northern Rocky Mountain Forest and Range Experiment Station; 1951. 251 p.


Fischer, W. C. Photo guides for appraising downed woody fuels in Montana forests: how they were made. Research Note INT-299. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1981. 12 p.


Roussopoulos, P. J.; Yanick, R. F.; Radloff, D. L. A national fire occurrence data library for management


The Role of Fire and Fire Effects


Griffin, J. R. Pine seedlings, native ground cover, and *Lolium multiflorum* on the Marble-Cone burn, Santa Lucia Range, California. Madrono. 29(3): 177-188; 1982.


Kilgore, B. M. Impact of prescribed burning on a sequoia-mixed conifer forest. In: Proceedings, Tall Timbers fire ecology conference No. 12; 1972 June 8–9; Lubbock, TX. Tallahassee, FL: Tall Timbers Research Station; 1973: 345–375.


Vegetation Inventory, Classification, and Analysis


Henderson, J. A.; Simon, S. A.; Hartvigsen, S. B. Plant community types and habitat types of the Price District, Manti-LaSal National Forest. Logan, UT: Utah State University, Department of Forestry and Outdoor Recreation; 1977b.


Ecosystem Classification


Outlines a procedure for fire management planning for parks; wilderness areas; and other wild, natural, or essentially undeveloped areas. Discusses background and philosophy of wilderness fire management, planning concepts, planning elements, and planning methods.

KEYWORDS: wilderness fire management, natural fire programs, wilderness, fire management, land management planning
The Intermountain Station, headquartered in Ogden, Utah, is one of eight regional experiment stations charged with providing scientific knowledge to help resource managers meet human needs and protect forest and range ecosystems.

The Intermountain Station includes the States of Montana, Idaho, Utah, Nevada, and western Wyoming. About 231 million acres, or 85 percent, of the land area in the Station territory are classified as forest and rangeland. These lands include grasslands, deserts, shrublands, alpine areas, and well-stocked forests. They supply fiber for forest industries; minerals for energy and industrial development; and water for domestic and industrial consumption. They also provide recreation opportunities for millions of visitors each year.

Field programs and research work units of the Station are maintained in:

Boise, Idaho

Bozeman, Montana (in cooperation with Montana State University)

Logan, Utah (in cooperation with Utah State University)

Missoula, Montana (in cooperation with the University of Montana)

Moscow, Idaho (in cooperation with the University of Idaho)

Provo, Utah (in cooperation with Brigham Young University)

Reno, Nevada (in cooperation with the University of Nevada)