Sequoia & Kings Canyon National Parks

National Park Service
U.S. Department of the Interior

Fire and Fuels Management Plan
2009 Annual Update

EA/ FONSI completed in 2003
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2006
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2008

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DESCRIPTION AND PURPOSE OF CROSSWALK

National Park Service policy, articulated in *Directors Order 18 - Wildland Fire Management* (1998) and *Reference Manual-18* (2008), requires that all parks with vegetation capable of supporting fire develop a fire management plan. Chapter 4 of RM-18 (approved in November of 2002) provides a standard outline for such plans.

Using the RM-18 standard outline as a starting point, Sequoia and Kings Canyon National Parks (SEKI) developed an outline that will benefit the fire and fuels program in these parks. While all necessary elements from the standard outline are present, they are organized differently in a way that better reflects the resources, issues, and management program here at SEKI.

The first column of the following table lists all the elements of the standard fire management plan outline from *Reference Manual 18*. The second column of the table lists the section of this *Fire and Fuels Management Plan* where the same information is located.

Elements of Standard ***RM-18*** **Fire Management Plan Outline**	**Location of Same Information in this Fire and Fuels Management Plan**
Table of Contents	Table of Contents
List of Figures	List of Figures and Tables
List of Tables	List of Figures and Tables
Part I - Introduction	
Reasons for developing plan	Chapter 1
Summarize the collaborative processes used to develop the FMP	Chapter 1 and Appendix B
State that plan will implement policies and help achieve resource and fire management goals	Chapter 1
State that plan meets NEPA and other requirements	Chapter 1
Cite authorities for implementing this plan (DO-18)	Chapter 1
Part II - Relationship to Land Management Planning and Fire Policy	
Reference NPS Management Policies	Chapter 1
Relate to unit enabling legislation	
Why unit was established	Chapter 1
Significant resources and values of unit	Chapter 1 and Chapter 8
Describe the park-wide desired conditions and state the goals of the GMP as they relate to fire	Chapter 1 and Appendix C
State the objectives of the unit's Cultural and Natural Resource Management Plan	Chapter 1
State how plan will meet above objectives	Chapter 1
Part III - Wildland Fire Management Strategies	
General Management Considerations – briefly describe how wildland fire will be managed	Chapter 2
Wildland Fire Management Goals – develop and	

Elements of Standard *RM-18* Fire Management Plan Outline	**Location of Same Information in this Fire and Fuels Management Plan**
list the fire management goals	
Wildland Fire Management Options – discuss the	Chapter 1 and 2
range of fire management options to be applied	
Description of Wildland Fire Management	Chapter 3 – Tools #1-8
Strategies by Fire Management Unit	
FMU Identifier	
Physical and biotic characteristics	Chapter 4
Strategic and measurable objectives for FMU	
Management considerations or criteria affecting	
operational implementation	Chapter 4 and Chapter 8
Discuss historic role of fire	Chapter 2 and Chapter 4
Discuss wildland fire situation	
Historical weather analysis	Chapters 4 and Chapter 5
Fire season	
Fuel characteristics/fire behavior	Chapter 9
Fire regime	
Control problems	Chapter 10
Values to be protected	Chapter 10
	Chapter 10
	Chapter 9
	Chapter 10 and Chapter 4
	Chapter 4
Part IV – Wildland Fire Management Program Components	
General Implementation Procedures	Chapter 3
Wildland Fire Suppression	
Range of potential fire behavior	Chapter 10
Preparedness actions	Chapter 3 – Tool #1
Describe fire prevention activities	Chapter 3 – Tool #1
Annual training activities	Chapter 3 – Tool #1
Fire readiness of equipment and supplies	Chapter 3 – Tool #1
Fire weather and fire danger	
Weather stations	Chapter 3 – Tool #1
NFDRS	
Describe step-up staffing plan	
Explain pre-attack plan	Chapter 3 – Tool #1
Initial action	Chapter 3 – Tool #1
Information used to set initial action priorities	
Criteria for the appropriate initial action response	Chapter 3 – Tool #3
consistent with GMP and RMP	
Confinement as an initial action suppression	Chapter 3 and Chapter 4
strategy	
Typical fire response times	
Restrictions and special concerns	Chapter 3 – Tool #3
Issues (tribal, local government, hiring, recycling,	
etc.)	Chapter 3 – Tool #3
Extended attack	Chapter 3 – Tool #3
Determine extended attack needs	Chapter 3 – Tool #3
Implementation plan requirements (WFDSS	
development)	
Complexity decision process for incident	Chapter 3 – Tool #3
management transition	Chapter 3 – Tool #3
Delegation of authority example	
Exceeding existing WFDSS	Chapter 3 – Tool #3
Requirement for minimum impact suppression	
tactics	Appendix K
Describe short and long-term rehabilitation	Chapter 3 – Tool #3

Elements of Standard *RM-18* Fire Management Plan Outline	**Location of Same Information in this Fire and Fuels Management Plan**
guidelines	Chapter 3 – Tool #3
Detail the tracking of records and reports	
Use of wildland fire	Chapter 3 – Tool #3
Objectives of use of wildland fire	
Parameters for informed management decisions	Chapter 3 – Tool #3
Pre-planned implementation procedures	
Describe all implementation procedures that are	Chapter 2 and Chapter 3
not pre-planned	Chapter 3 – Tool #2 and companion EA
include procedures for periodic assessment of fire	
use	Chapter 3 – Tool #2
include requirements for fire use plans and	Chapter 3 – Tool #2
documentation	
Potential impacts of implementation	Chapter 3 – Tool #2
Identify staff positions that must be present to	
implement and manage	Chapter 3 – Tool #2
Public information and interpretation	
Develop a standard outline of contents for a	Chapter 3 – Tool #2
permanent project record	Chapter 3 – Tool #2
Prescribed Fire	
Planning and Documentation	Chapter 3 – Tool #6
Describe annual activities to prepare for and	Chapter 3 – Tool #2
implement the program	
Relate long-term strategy to each FMU and	
display planned burn units	
Identify numbers and kinds of qualified personnel	Chapter 3 – Tool #4 and Chapter 4
necessary	
Define weather, fire behavior and fire effects	Chapter 4 and Appendix A
monitoring associated with prescribed fire	
Provide format for critiques of projects	Chapter 3 – Tool #4 and Appendix B
Reporting and documentation requirements	
Develop historic fuel treatment map of past	Chapter 3 – Tool #7 and Chapter 10
activities	
Explain the local prescribed fire burn plan	
requirements	Chapter 4
Exceeding existing Prescribed Fire Burn Plan	Chapter 3 – Tool #4
Air Quality and Smoke Management	
Describe pertinent air quality issues	Chapter 4
Develop program of action to manage smoke	
Location of Class I airsheds	Chapter 3 – Tool #4 and Appendix O
Description of sensitive areas	
Local and regional smoke management	Chapter 3 – Tool #4
restrictions and procedures	
Non-Fire Fuel Treatment Applications	
Mechanical treatment and other applications	Chapter 3 – Tool #4 and Chapter 8
Annual activities to prepare for implementation	
Equipment and seasonal use restrictions	
Define the effects monitoring required	Chapter 8 and Appendix J
Provide format for critiques	Chapter 8 and Appendix J
Cost accounting	Chapter 3 – Tool #4 and Appendix J
Reporting and documentation requirements	
Annual planned project list	
Emergency Rehabilitation and Restoration	
	Chapter 3 – Tool #5 and Chapter 4
	Chapter 3 – Tool #5

Elements of Standard *RM-18* **Fire Management Plan Outline**	**Location of Same Information in this Fire and Fuels Management Plan**
	Appendix C Chapter 4 Chapter 3 – Tool #5 Chapter 3 – Tool #5 Appendix A Chapter 3 – Tools #2-5
Part V – Organizational and Budgetary Parameters Describe fire organizational structure of the park fire program Fire Pro Funding Relate fire's organization to the rest of the NPS unit's organization Park superintendent responsibility Describe interagency coordination List key interagency contacts by function List and describe all fire-related agreements	 Chapter 6 Chapter 6 Chapter 6 Chapter 3 and Chapter 6 Chapter 6 Chapter 6 Chapter 6
Part VI – Monitoring and Evaluation Short and long-term monitoring program FMH protocols Fire monitoring plan	 Chapter 3 – Tool #7 and Appendix C Chapter 3 – Tool #7 and Appendix C Appendix C
Part VII – Fire Research Summarize previous and ongoing fire research related to unit Summarize fire research that is needed	 Chapter 3 – Tool #8 and Appendix D Chapter 3 – Tool #8 and Appendix D
Part VIII – Public Safety Describe public safety concerns and issues Procedures for mitigating safety issues	 Chapter 7 Chapter 7
Part IX – Public Information and Education Describe public information capabilities and needs to implement program Describe step-up information activities	 Chapter 3 – Tool #6 Chapter 3 – Tool #6
Part X – Protection of Sensitive Resources Summarize archeological/cultural/historic resources requiring special protection Describe actions to prevent or mitigate impacts Describe natural resources or features requiring special protection Describe actions to prevent or mitigate impacts Describe developments, infrastructure, inholdings that require special protection Describe actions to prevent or mitigate impacts	 Chapter 5 and Appendix H Chapters 4 and Chapter 5 Chapter 5 Chapters 4 and Chapter 5 Appendix H Chapters 4 and Chapter 5
Part XI – Fire Critiques and Annual Plan Review	Chapter 4

Elements of Standard *RM-18* **Fire Management Plan Outline**	**Location of Same Information in this Fire and Fuels Management Plan**
Part XII – Consultation and Coordination	Companion EA
Part XIII – Appendices References cited Definitions Species lists NEPA and NHPA compliance Any other unit specific supplemental information (requires annual revision) Fire call-up list Preparedness inventory Cooperative agreements Wildland and Prescribed Fire Monitoring Plan Pre-attack Plan Long-term prescribed fire and hazard fuel reduction plan Fire Prevention Plan Rental Equipment Agreements Contracts for Suppression and Prescribed Fire Resources Burned Area Emergency Stabilization and Rehabilitation Plan	 Chapter 11 Companion EA Companion EA and Appendix B Addendum Appendix P Chapter 6 Appendix C Chapter 3 – Tool #1 and Addendum Appendix A Addendum N/A Chapter 6 Chapter 3

1. Why Write a Plan?

NEED FOR THIS PLAN

Wildland fire has long been recognized as one of the most significant natural processes operating within and shaping Sierra Nevada ecosystems. Virtually all vegetation communities show evidence of fire dependence or tolerance. At the same time wildland fire has the potential to threaten human lives and property. Consequently there is a need to manage wildland fire so that threats to humans and property are reduced, while at the same time restoring and/or maintaining its function as a natural process.

Sequoia and Kings Canyon National Parks have written this *Fire and Fuels Management Plan* to provide long-term direction for achieving park goals related to human safety and ecosystem management. The plan also satisfies the requirements and direction provided in policy, legislative authority, park purpose statements, higher-level planning documents, and natural and cultural resource management objectives. Each one of these components is discussed below.

POLICY

National Park Service policy, articulated in *Directors Order 18 - Wildland Fire Management* (2008) and *Reference Manual-18* (2008), require that all parks with vegetation capable of supporting fire develop a fire management plan.

Other program direction comes from the National Fire Plan (based on Managing the Impact of Wildfires on Communities and the Environment, A Report to the President in Response to the Wildfires of 2000), the 10-Year Comprehensive Strategy (A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment) and the Federal Wildland Fire Management Policy and Program Review (2001).

Policy also directs Sequoia and Kings Canyon National Parks to work cooperatively with their adjacent land management and fire management agencies to implement mutually beneficial projects and programs. This plan provides guidance not only for park staff, but also the parks' neighbors. With clearly stated program goals and objectives, the parks' neighbors will be better able to comment on park planning efforts and provide technical assistance.

LEGISLATIVE AUTHORITY

Authority for carrying out a fire and fuels management program originates with the Organic Act of the National Park System, August 25, 1916. This Act states that the primary goal of the National Park Service is to preserve and protect the natural and cultural resources found on lands under its management in such manner as will leave them unimpaired for future generations. Additional authorities for fire management activities include: 31 U.S. Code 665 (E) (1) (B) which provides the authority to exceed appropriations due to wildland fire management activities; Section 302 (c) (2) of the Federal Property Administration Services Act of 1949, as amended; and Chapter VIII of the 1983 Supplemental Appropriations Act (P.L. 97-257) which deals with contracting for fire protection; and The Reciprocal Fire Protection Act, Act of May 27, 1955 (42 U.S.C. 1856) that authorizes reciprocal agreements with federal, state, and other wildland fire protection organizations.

PURPOSE OF SEQUOIA AND KINGS CANYON NATIONAL PARKS

Sequoia and Kings Canyon National Parks protect a variety of landscapes containing biological and cultural resources in the southern Sierra Nevada of California. They are two separate national parks that were created by acts of Congress fifty years apart. Today these parks are administered as a single unit. Primary purposes of the two parks as expressed in legislation are to preserve the forest resources, particularly the giant sequoia groves, and to protect a vast wilderness for both its scenic and recreational values.

Established September 25, 1890, Sequoia National Park is the second oldest national park in the United States. The campaign to create the park focused on the giant sequoia groves (*Sequoiadendron giganteum*). The October 1, 1890 act also created four-square-mile General Grant National Park to protect the General Grant Tree and surrounding forest.

Since 1890, Sequoia National Park has undergone two major enlargements, both of which added high Sierra lands to the park. In 1926, Congress added the Great Western Divide, Kern headwaters, and Sierra Crest regions. This enlargement, which more than doubled the park's acreage, made it clear that Sequoia National Park would be not only a forest park, but also an alpine park. Included within the enlargement was Mt. Whitney, the highest mountain in the contiguous United States. In 1978, Congress again enlarged Sequoia National Park, this time adding the Mineral King area to the park, which previously had been a part of the Sequoia National Forest. Congress added the basin to the national park with the specific instruction that it would be preserved undeveloped. In 2000, the park was further expanded with the addition of the Dillonwood Grove, a private tract of sequoia grove adjacent to the park's southern boundary within the Tule River watershed. Today, the best known and most appreciated features of Sequoia National Park remain the sequoia groves and the high country.

The small General Grant National Park existed unchanged for fifty years. Then in 1940 Congress created Kings Canyon National Park. In addition to incorporating the four square miles of General Grant National Park and several other adjacent sequoia groves, Kings Canyon National Park also featured the great glacial canyons and scenic alpine headwaters of the South and Middle Forks of the Kings River. Because the new park contained two separate tracts, one featuring giant sequoia trees and the other canyons and alpine scenery, Kings Canyon's dual nature was readily apparent from the beginning. In 1940, as a political compromise, the floors of the park's two great glacial canyons were left outside its boundaries as possible reservoir sites. This situation was resolved in 1965 when Congress added the floors of Kings Canyon and Tehipite Valley to the park.

Sequoia and Kings Canyon National Parks contain resources of geological, biological, cultural, and sociological value. In addition to national park status, the two reservations have also been designated as a unit of the International Biosphere Preserve Program, and 85% of the parks have been designated wilderness. For a detailed description of park resources, please see Chapter 8.

RELATIONSHIP TO HIGHER-LEVEL PLANNING DOCUMENTS

Environmental Assessment

The program described in this plan was developed following guidelines and requirements of the National Environmental Policy Act and National Historic Preservation Act. A companion

Environmental Assessment (EA) provides details on the alternatives considered, and an environmental assessment of the actions described in this document. Any user of this plan must become thoroughly familiar with the EA to fully understand the context and expected impact of the actions implemented by this plan.

General Management Plan

The parks General Management Plan (2007) provides the primary direction for management of natural resources in these parks. The General Management Plan expresses natural resource and fire management goals in a general way that provides the guidance for the development of this Fire Management Plan

The General Management Plan (page 88) states that the parks are to, "Manage wildland fire to address its profound ecological role in park ecosystems and its potential impacts on public safety, health, well-being, and property." The General Management Plan (page 27) specifically identifies that the past exclusion of fire has had significant negative impacts on the park environment and directs fire management to continue the program began in 1968 to restore the natural role of fire. In addressing rapid anthropogenic climatic change, the General Management Plan (page 29) states that, "the resilience of forest to climatic change…can be increased by restoring a more open structure to the forest" and that a, "natural-like fire regime will play an integral role in preserving park landscapes."

Objectives and strategies that accomplish the visions and concepts of the General Management Plan as they pertain to wildland fire are to be identified in the Fire Management Plan.

Wilderness Plan

The parks currently manage wilderness areas under a *Backcountry Management Plan*. That plan will be replaced by a *Wilderness Management Plan* some time after the *General Management Plan* is final. As with the GMP, once the *Wilderness Management Plan* is complete, the *Fire and Fuels Management Plan* will be reviewed for conformity. If there are discrepancies between the two plans, the *Wilderness Management Plan* will take precedence and the *Fire and Fuels Management Plan* will be amended to comply.

Strategic Plan

The parks' *Strategic Plan* outlines specific actions that the parks expect to take to fulfill parkwide goals and objectives. As such, that plan will include specific annual and long term objectives and actions described in the *Resource Management Plan* and *Fire and Fuels Management Plan*.

Natural and Cultural Resources Management Plan

The *Natural and Cultural Resources Management Plan* (RMP) (1999) translates general direction provided in the *Master Plan* (or GMP) into more specific direction and recommendations for management of park resources. Actions detailed in the *Fire and Fuels Management Plan* respond to and help fulfill resource management objectives articulated in the RMP.

The primary resource management goal for fire management is contained in Mission Goal 1a. It states that "natural and cultural resources and associated values are protected, restored, maintained in good condition, and managed within their broader ecosystem and cultural context."

To accomplish the mission goal, the following actions are recommended:

Vegetation
Native plants are preserved as part of natural functioning ecosystems

The giant sequoia groves – particularly Giant Forest – and the ecosystems they occupy are restored, maintained, and protected.

Plant communities that have been altered by fire suppression are restored/maintained through restoration of the natural fire regime to the maximum extent possible.

Vegetation in the parks' Development Zone is restored and/or maintained as a healthy, vigorous vegetative community that approximates the "natural" state, given the constraints of past and present human intervention, while providing a safe environment for human use and enjoyment.

Aquatic/Water
Aquatic and water ecosystems are restored and/or maintained so that physical, chemical, and biotic processes function uninfluenced by human activities

A long-term monitoring program is developed to record ambient conditions and to document changes and trends in physical and chemical characteristics and biotic communities.

Changes within the aquatic environments that are caused by facilities, management activities, or visitor use patterns are located and documented and unnatural changes are mitigated to the extent feasible.

Wildlife
Natural populations of wildlife in which animal behavior and ecological processes are essentially unaltered by human activities are perpetuated

Native animal species and threatened/endangered and sensitive animal species are inventoried, monitored, protected, and restored/maintained over time.

Air Resources
Air quality is restored to natural conditions

Impacts and levels of park air pollution are monitored.

Knowledge about Park Natural Resources
Knowledge of the state of the parks' natural resources continues to grow

Scientific research that promotes an understanding of the parks' resources and the impacts that affect those resources is encouraged.

The general ecosystem elements and processes of the parks, the natural forces controlling them, and the potential for human activities to affect them is increasingly understood.

Prehistoric and Historic Archeological Sites

Actions are taken to protect threatened or adversely impacted significant sites from threats or on-going impacts.

Historic Structures
Actions are taken to protect threatened or adversely impacted historic structures from threats or on-going impacts.

Cultural Landscapes
Actions are taken to protect threatened or adversely impacted significant cultural landscapes from threats or on-going impacts.

Knowledge about Park Cultural Resources
Knowledge of the state of the parks' cultural resources continues to grow

Scientific research that promotes a better understanding of the parks' cultural resources and museum collections is encouraged.

California State Air Quality Planning
Actions taken under this plan will conform to the limits and requirements of the *State Implementation Plan* for attainment of National Ambient Air Quality Standards. Projects implemented under this plan will conform to the legal and procedural requirements of the San Joaquin Valley Unified Air Pollution Control District. Annual and project level plans that involve the use of fire will be reviewed by the District and implemented after consultation with the District. Procedures for District review and permitting, and for implementation of Best Available Control Methods (BACM) are found in Appendix J.

WHAT THIS PLAN WILL DO

Based on the authorities and direction explained above, this plan provides a detailed description of how Sequoia and Kings Canyon National Parks will organize and implement its fire and fuels management program. The *Fire and Fuels Management Plan* will:

Provide overall program direction by stating mission, goals, and objectives.
Describe fire and fuels management tools, prescriptions, and operational procedures.
Designate and describe fire management zones, planning units, and segments.
Describe planning procedures.
Provide guidance on the protection of sensitive resources.
Describe the fire and fuels management organization structure.
Highlight the importance of safety.
Summarize the historical role of fire in the parks and the current wildland fire situation.

The *Fire and Fuels Management Plan* undergoes periodic review as part of a continuing refinement process. The Plan will be reviewed annually and amended as needed to comply with changing policy, law, and circumstances. Topics considered for revision are discussed each spring during the annual fire and fuels management review. Revisions will be made in accordance with DO-18 Wildland Fire Management and RM-18 Wildland Fire Management Reference Manual.

Any significant change in fire management practices identified in this plan will be evaluated by the park Environmental Management Committee (EMC) to determine whether the actions further environmental compliance. Environmental assessments will be prepared for actions that are not covered under the companion *Environmental Assessment* for this plan or are exceptions to categorical exclusions contained in Directors Order 12 - Conservation Planning, Environmental Impact Analysis, and Decision-making.

2. Mission, Goals, and Objectives of Program

Sequoia and Kings Canyon National Parks will institute a multi-strategy approach for the fire and fuels management program consistent with the direction and constraints contained in the companion *Environmental Assessment* (EA). Combining this multi-strategy approach with the park purpose and other guidance outlined in Chapter 1, the parks have developed a concise framework for the fire and fuels management program.

The program is defined by an overarching mission statement, three broad goals, four program objectives, a set of target conditions, and eight primary tools. All of these elements, excluding the target conditions, are visually represented in Table 2-2.

While the tools are introduced here, they are thoroughly discussed in Chapter 3. Target resource conditions are described in detail in the *Fire and Fuels Monitoring Plan* (Appendix C).

MISSION STATEMENT

The fire and fuels management program at Sequoia and Kings Canyon National Parks seeks to benefit park resources and society by restoring and maintaining the natural fire regime in a manner consistent with firefighter and public safety.

GOALS

To accomplish the mission statement above, the parks recognize the necessity of managing three elements - values, hazards, and risks - in wildland fire areas. Defined below, these form the basis for the program's three broad goals:

Protect and restore the parks' ecological, cultural, and social values. Ecological values include vegetation, water, wildlife, natural processes, and air resources. Cultural resource values include prehistoric and historic cultural sites, historic structures, and contemporary structures, both government-owned and private. Social values include park employees, visitors, neighboring communities, and wilderness.

Reduce fire hazards in park ecosystems. Fire hazard is defined as those attributes that affect the ability to control fires, or contribute to extreme fire behavior. Certain elements that contribute to hazardous fire conditions, such as steep slopes and the amount of solar radiation that heats fuels and dries vegetation, cannot be changed by management actions. Fuel conditions, however, can be effectively altered by management actions and are the focus of most hazard fuel reduction activities.

Reduce risk of unwanted wildland fire. Risk is defined as the probability of new fire starts, whether by human or natural ignitions (lightning). Since lightning ignition risk is outside the realm of management control, the focus of the risk portion of the fire management program is to reduce the probability of unwanted human ignitions.

PROGRAM OBJECTIVES

To focus planning and operations, the parks have developed four program objectives that begin to specify the major tasks facing the fire and fuels management staff. Consistent attention to these objectives will achieve the three broad program goals.

1. Manage all unplanned wildland fires appropriately.

Manage all wildland fires, regardless of ignition source or the location of ignition, using strategies and tactics commensurate with protection of human health, safety, and natural and cultural resource values, as described in this approved *Fire and Fuels Management Plan*.

Utilizing existing interagency wildland fire planning procedures, analyze risks and complexities for all ignitions in order to determine those ignitions which can be successfully managed for the benefit of ecological and life/safety values and those that should be suppressed.

2. Plan and implement appropriate treatments to reduce the threat to values from unwanted wildland fire and to restore or maintain ecological values.

Annually, analyze fire hazards, values, and risks so that projects are designed within Fire Management Units (FMUs).

Using GIS and fire behavior models to plan treatments, ecological, life/safety, infrastructure, and cultural resource values will be analyzed and updated yearly through feedback from monitoring and research advances.

Consider and mitigate during the planning phase negative impacts to cultural and natural resources that might result from management operations.

3. Understand the consequences of fire management actions.

Monitor and evaluate the effects of fire and fuels management activities on park natural and cultural resources with particular attention to vegetation, water, wildlife, air, and cultural resources.

Evaluate monitoring information to refine the management activities and objectives, and prescription range values as appropriate.

For vegetation, utilize ecosystem “restoration” and “maintenance” target conditions developed as one benchmark of program success (see Appendix C).

Work to ensure that particulates produced by prescribed and use of wildland fire projects remain within all federal, state, and local air resource objectives by monitoring smoke in cooperation with the San Joaquin Valley Unified Air Pollution Control District.

Identify issues or missing information needs that, once known, will lead to more effective implementation of the parks’ fire and fuels management program.

Conduct research as issues or information gaps are identified through monitoring and evaluation of fire management activities.

Understand public attitudes and political concerns through personal contacts, social science research, and other avenues. Incorporate this information into management decisions as appropriate.

4. Provide current and accurate information on wildland fire and fuels management activities to the public, the park workforce, and cooperating agencies.

Provide interpretive and educational programs designed to enhance public and staff understanding and awareness of fire ecology and wildland fire management.

TARGET CONDITIONS

From the mission, goals, and program objectives above, it is evident that the fire and fuels management program at Sequoia and Kings Canyon National Parks focuses on the restoration and maintenance of natural conditions. But what are some measurable characteristics of natural conditions in the parks?

Since the answer to this question determines the parks' ability to judge success, the parks have been developing specific, measurable benchmarks as a point of reference to determine if the resource conditions resulting from fire management actions are meeting park goals for restoring and maintaining natural conditions.

Target conditions are specific measurable conditions derived from the program objectives listed in Section C above. Target conditions answer the question "what would the resource look like if we achieved our goals?"

There are two different types of targets based on existing ecosystem conditions: vegetation structure targets and process targets. *Structure* refers to elements of vegetation communities that can be described in terms of species present, relative abundance of different species, and the arrangement of these elements across the landscape. *Process* refers to the timing of fires, intervals between fires, and the intensity of fires that occurred under natural conditions. In areas of the parks currently in the restoration phase of the program (areas that are significantly altered by past fire suppression), structural targets are used to assess program success. Once these structural targets are met, the area moves into the maintenance phase of the program and process targets are used to evaluate the program goal achievement.

Table 2-1 – Relationship Between Restoration/Maintenance Phase and Structure/Process Targets.

Strategy Based on Existing Resource Condition	**Elements of Target Conditions**
Restoration Restoring an altered ecosystem to a more natural structure (applied in areas that are significantly altered by past fire suppression)	Structure Targets Species present Relative abundance of species Arrangement of species Age classes
Maintenance Maintaining dynamically evolving ecosystems in restored or unaltered areas by promoting or simulating the natural process (natural fire regime)	Process Targets Timing of fires (seasonality) Intervals between fires Intensity of fires under natural conditions Size of fires

Target conditions are very useful to fire managers during both planning and implementation. For example, if the target condition is a stand density of 20-150 trees/ha and the current conditions on the ground have three times that many trees, then fire managers might use prescribed fire to reduce stand density. For all specific target conditions, see the *Fire and Fuels Monitoring Plan* (Appendix C). Once target conditions are identified, appropriate fire management tools are selected and applied to maintain the natural processes that will shape the area into the future.

The parks have developed preliminary target conditions for different vegetation types. They are based on the best available science, including general park information (Chapter 8 – Description of Sequoia and Kings Canyon National Parks) and current fire history data (Chapter 9 – Historic Role of Fire). This best available science is combined with emerging research data, historic photos, written documents, and expert opinion. It is expected that the target conditions will continue to be refined as future research increases knowledge of past conditions. The target conditions, and the fire and fuels management program as a whole, are constantly evaluated through a comprehensive monitoring program (see Appendix C) and special park analysis tools, like the Fire Return Interval Departure (FRID), discussed in Figure 4-2 in Chapter 4.

The program objectives and target conditions form the basis of Sequoia and Kings Canyon's fire and fuels program. The parks do not arbitrarily set objectives for the number of acres that will be treated with a particular tool (i.e. prescribed fire). Instead, fire managers choose a combination of tools to achieve target conditions. As a result, this fire and fuels program is not defined by the "tools in its toolbox," but rather how restoration and maintenance of natural systems is achieved using these tools.

TOOLS

The key to any successful effort is having access to the right "toolbox." The fire and fuels management program uses the eight tools listed below to accomplish program goals and objectives. These tools are described in detail in Chapter 3.

Preparedness Activities

Response to Wildland Fire

Prescribed Fire

Mechanical Fuel Reduction

Public Information and Education

Monitoring

Research

Table 2-2 – Fire and Fuels Management Program: Mission, Goals, Objectives, and Tools

Fire & Fuels Management Mission Statement	Fire Management Goals	Program Objectives	TOOLS: Preparedness Activities	Response to Wildland Fire	Prescribed Fire	Mechanical Reduction	Information/ Education	Monitoring
"The fire and fuels management program at Sequoia and Kings Canyon National Parks seeks to benefit park resources and society by restoring and maintaining the natural fire regime in a manner consistent with firefighter and public safety."	***Protect and restore the parks' ecological, cultural, and social values.*** Ecological values include vegetation, water, wildlife, natural processes, and air resources. Cultural values include prehistoric and historic cultural sites, historic structures, and contemporary structures, both government-owned and private. Social values include park employees, visitors, neighboring communities, and wilderness. ***Reduce fire hazards in park ecosystems.*** Fire hazard is defined as those attributes that affect the ability to control fires, or contribute to extreme fire behavior. Fuel conditions can be effectively altered by management actions and are the focus of most fuel hazard reduction activities. ***Reduce risk of unwanted wildland fire.*** Risk is defined as the probability of new fire starts, whether by human or natural ignitions (lightning). The focus of the risk portion of the fire program is to reduce the probability of unwanted human ignitions.	1. Manage all unplanned wildland fires appropriately.	X	X				
		2. Plan and implement appropriate treatments to reduce the threat to values from unwanted wildland fire and restore or maintain ecological values.	X		X			
		3. Understand the consequences of fire management actions.				X	X	X
		4. Provide current and accurate information on wildland fire and fuels management activities to the public, our workforce, and cooperating agencies.	X			X		

3. Management Toolbox: Implementation Procedures

According to Chapter 2, the goals and objectives of the fire and fuels management program will be accomplished using eight primary tools (restated below). These tools give fire managers a variety of options when choosing the *response to wildland fire* for different situations. As described in the next chapter, these tools are not assigned to particular Zones or Fire Management Units in the parks (see Chapter 4 for a complete description of Zones, Fire Management Units (FMUs) and Segments). Every Zone will allow the full spectrum of responses, however for each Zone and FMU, certain tools may be more ecologically or socially acceptable based upon that Zone's values, hazards, and risks given the time of year.

This chapter defines each tool separately and outlines how it will be implemented. Special emphasis is on the four tools that involve the presence of fire on the landscape. For these tools (#2-5 below), there is a description of project planning (if applicable), procedures during and after the fire event, staffing needs/responsibilities, documentation/cost tracking, and special considerations. The long-term strategic planning and review process is covered in Chapter 4.

The Management Toolbox Includes:

Preparedness Activities
Response to Wildland Fire
Prescribed Fire
Mechanical Fuel Reduction
Public Information and Education
Monitoring
Research

TOOL #1 – PREPAREDNESS ACTIVITIES

Definition

Preparedness includes all preplanned actions that lead to effective prevention of unwanted fires and the appropriate response to all fire ignitions. The parks work hard to "sharpen" their preparedness activities since many other tools in the toolbox depend on training, fire prevention, fire readiness, etc. Some preparedness actions happen once each year, while others are ongoing.

Training

The parks will offer the required annual safety training for all wildland firefighters who maintain a red card. At minimum, annual training will consist of an 8-hour firefighter safety refresher that must include training on fire shelter care and use. Basic firefighter training (inclusive of S-130/190) will be provided for all employees new to wildland fire. Since there are also experience and training requirements needed for all designated wildland and prescribed fire positions, the parks will offer a variety of ICS and skills-based training classes or send employees off-park to receive required training. Qualifications for all positions will conform to minimum standards established in the *Wildland and Prescribed Fire Qualifications System* publication PMS-310-1. More stringent qualifications may be imposed by the department, agency, or park as needed.

Training needs are determined by the parks Red Card Committee, composed of the park fire management officer, both district fire management officers, the park fuels specialist, the Arrowhead Hotshot superintendent, and fire communications center manager. The current qualification levels of employees are compared to the parks' minimum qualifications list (see Appendix R). The comparison allows the committee to develop a list of training needs. The communications center manager takes this list to the regional training officers meeting to obtain slots in training courses for park employees.

Fitness

All staff involved in firefighting will pass an annual physical fitness test and receive a physical exam as prescribed in national guidance. Fire personnel, who are identified as primary firefighters, will also participate in an ongoing fitness program. The annual fitness test has potential for firefighter injury. Therefore implementation of the test will follow all required procedures and safeguards. The current SOPs for the fitness test can be found in the JHA for the Pack Test.

Fire Prevention

Fire prevention is an important aspect of the parks' preparedness activities. The parks will conduct an active fire prevention program including public messages, inspections, fire use restrictions, and hazard abatement reduction around structures. This program is fully detailed in the *Wildfire Prevention Plan* (Addendum).

Additional prevention activities for the parks will consist of prevention signing, prevention messages through interpreters and staff, and prevention patrols during periods of very high to extreme fire danger. A comprehensive public information and education program is detailed in this chapter, Tool #6. In addition, fire use restrictions and area closures may be necessary. Details can be found in the *Fire Restrictions and Emergency Closure Plan* (Appendix M).

Fire Readiness

Fire readiness is the year-round organized inventory and assessment of equipment and personnel. The parks have developed a summary list of all preparedness activities by month. This comprehensive calendar of preparedness activities is located in the Yearly Readiness Checklist (Appendix S). As part of the readiness program all operations modules and support personnel will be assessed annually through a readiness review and inspection program. Also, mandatory pre- and post-season operations preparedness and review meetings are held each spring and fall.

Weather

The parks have six weather stations that provide daily information. All six stations are Remote Automated Weather Stations (RAWS). While all 6 stations catalogue fire weather either hourly or daily, only 3 stations are used for the parks National Fire Danger Rating System (NFDRS) indices calculations. These stations are located at Cedar Grove, Park Ridge, and Ash Mountain. These three NFDRS stations will be monitored daily throughout fire season.

Stations are located at:

Ash Mountain (manual) – NFDRS models B, F, A [elevation 1,600 feet]
Park Ridge – NFDRS models G, H, U [elevation 7,540 feet]
Cedar Grove – NFDRS models U, G [elevation 4,720 feet]
Wolverton Point – NFDRS models B, F [elevation 5,240 feet]
Sugarloaf – NFDRS models H, U [elevation7,950 feet]
Rattlesnake – NFDRS models H, U [elevation 8,600 feet]

Fire Danger Determination

The parks' fire dispatch office tracks NFDRS fire danger indices and plots them against historical averages. The Energy Release Component (ERC), determined using Model G from the Park Ridge station, assesses relative expected wildland fire behavior for all potential fire use ignitions. The Burning Index (BI), determined using Model B from the Ash Mountain station and Model U from the Cedar Grove station, is used to index suppression response to ignitions at lower elevations.

The parks' daily staffing levels are driven by the park-wide fire danger indices derived by combining ERC from the Park Ridge station with BI values from the Ash Mountain and Cedar Grove stations. A complete description of the process used to ascertain the park-wide fire danger and the staffing logic can be found in the *Preparedness Staffing Plan* (Appendix P).

Each weather station's catalog and associated FireFamily+ runs for the past ten years can be found in Appendix P as well. In addition, seasonal (May through October) FireFamily+ runs for the three stations described in the preceding paragraph are posted in the coordination center along with monthly runs for the current month, as an aid to seasonal comparison of fire danger with past years. Pocket cards are also carried by park fire fighters for the same reason.

The parks will not automatically extinguish natural ignitions based upon Park Ridge ERC values in the very high or extreme category. The combination of values, hazards, and risks as identified for each FMU will determine wildland fire response. While use of wildland fire is not restricted due to fire danger rating classification (very high or extreme indices), prescribed fire ignitions may be restricted.

Preparedness Staffing Plan

After daily fire weather is processed and existing and forecast fire danger conditions are determined, the park will implement preparedness staffing as appropriate. The parks' *Preparedness Staffing Plan* insures that adequate fire staff is on duty for periods of high fire danger. The plan, found in Appendix P, sets guidelines to increase or decrease daily hours worked, numbers of people on duty, etc. The plan also provides a tickler list of tasks to accomplish as fire danger rises.

In general the plan calls for the following staffing:

Staffing Levels 1, 2, and 3: normal tours of duty and number of fire personnel.

Staffing Level 4 and 5: the fire management officer (FMO) or his acting may authorize extended hours and increased staffing for fire crews. The program assistant will activate a preparedness account to cover the costs.

The superintendent or FMO has the ability to raise the staffing level by one for unusual events, such as holiday weekends, that will increase the potential for wildland fire.

Staffing

All park operations modules will operate as "modules" only when they meet national standards for crew module configuration. In other words, a Type 3 engine will only operate as a Type 3 engine when it is staffed by an engine boss plus two firefighters. Such standards will exist for engines, helitack, and fuels crews. Engine and helitack configurations will follow the standards outlined in the Federal Fireline Handbook. In the absence of national standards, park fuels crews will follow park staffing guidelines.

Each of the two districts, Sequoia and Kings Canyon, are expected to be staffed by the district FMO or his/her designated duty officer each day of fire season. Similarly, the park FMO will designate an acting FMO when not available. The fire and aviation communications center will be staffed with at least one person during the burning period for all days in fire season.

Suppression Fire Response Plan

A *Suppression Fire Response Plan* has been developed for use by the parks and its cooperators (Cal Fire – Tulare and Fresno/Kings Units, Sequoia National Forest, and Sierra National Forest). The plan characterizes response for those lands in each of the agencies' jurisdictional areas for which shared response is beneficial. The plan is reviewed annually and undergoes thorough revision every five years. Response levels vary based upon daily fire danger staffing level determinations.

TOOL #2 – RESPONSE TO WILDLAND FIRE

Response to wildland fire is the mobilization of the necessary services and responders to a fire based on ecological, social, and legal consequences, the circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources, and values to be protected.

Fire managers may choose from a wide array of objectives, strategies, and tactics that range from monitoring to aggressive suppression actions providing that the response is consistent with federal policies and laws (i.e., the National Fire Plan, the Wilderness Act) and park level plans and policy (i.e., the Fire and Fuels Management Plan, the parks' wilderness plan). When viable (after considering values, hazards, and risks), these parks will manage unplanned lightning fires as the preferred means to accomplish specific resource management objectives in the Zones and FMUs where restoration and ecological values dominate considerations. If unnatural fuel loads exist, it may be necessary to use fuels management techniques initially to restore an area to a natural range of conditions before using fire as a tool. Utilization of natural ignitions to restore and maintain natural fire regimes was formerly referred to as wildland fire use or simply fire use. Changes in national fire policy in 2008/2009 have eliminated this term. Instead, use of wildland fire is the chosen response when objectives are based on ecosystem restoration and maintenance where wildfire is the primary tool.

A course of action based on the parks' strategic fire management objectives, incident specific objectives, and management requirements will be developed for all wildfires. Preplanned initial actions for each fire management zone will be identified in the parks' response plan and updated annually. The response plan lists the maximum number of resources at a given threat level that would expected to be needed to implement a course of action necessary to meet the objectives and protect the resource values for each Fire Management Unit identified in Chapter 4 of this plan. If the initial actions in the response plan fail to meet the objectives and management requirements for that fire management unit or zone, then a new specific course of action based on the strategic and incident objectives and management requirements will be developed. The process outlining management of an unplanned ignition is found in Appendix B of the 2009 ***Guidance for Implementation of Federal Wildland Fire Management Policy*** (Addendum).

The Wildland Fire Decision Support System (WFDSS) Response Levels (RL-1through 3 based upon complexity) will be used to document the course of action for all unplanned ignitions. WFDSS provides a framework for assessing preplanned response, data gathering and situation analysis (i.e. firefighter and public safety, internal and external values which are enhanced or require protection, management objectives, safety, climatology and weather, fuel conditions, and fire behavior) consistent with the parks' Land/ Resource Management Plans and the Fire Management Plan.

The *response to wildland fire* ranges from monitoring with minimal on-the-ground disturbance to intense suppression actions on some or all perimeters of the fire. The response will vary from fire to fire and even along the perimeter of a fire.

Unplanned fire is reported: What do we do?

When a fire is reported, the parks will take the following actions:

Notify the appropriate duty officer
Locate the fire

Initiate the pre-planned response, size-up fire, and determine cause: The parks' response plan will be used to identify the range of initial actions to all wildland fires. The response plan is designed to consider values to be protected, risks, hazards, forecasted fire danger, and ecological benefit.

If the fire is determined to be a human caused ignition: Initial action on human caused fire will be to suppress the fire at the lowest cost with the fewest negative consequences with respect to firefighter and public safety. Confine/contain/control strategies will be considered. If the initial actions are unsuccessful, then a RL-2 or RL-3 WDFSS will be completed to document the selected course of action.

If the fire is determined to be a natural ignition: Initial actions for natural ignitions will be determined based upon potential complexity, climatology and projected fire behavior, natural and cultural resource effects

Fire, as a critical natural process, has been integrated into land and resource management plans and activities on a landscape scale. Response to wildland fire is based on ecological, social, and legal consequences of fire, the circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources, and values to be protected dictate the appropriate course of action.

A wildland fire may be concurrently managed for one or more objectives and objectives can change as the fire spreads across the landscape (over space and time). Objectives are affected by changes in fuels, weather, topography; varying social understanding and tolerance; and involvement of other governmental jurisdictions having different missions and objectives.

Firefighter and public safety is the first priority in every fire management activity.
Sound risk management is a foundation for all fire management activities. Risks and uncertainties relating to fire management activities must be understood, analyzed, communicated, and managed as they relate to the cost of either doing or not doing an activity. Net gains to the public benefit will be an important component of decisions.

For example, a fire that poses unacceptable risks to firefighter safety during a direct suppression response may be managed under confine/contain strategies to address firefighter safety regardless of fire size. Conversely, a fire may be suppressed at the smallest size to limit risks to firefighters, to limit smoke production for public health, or because natural or cultural resources are threatened However, the long-term ecological benefits of fire on the Sierra Nevada landscape, benefits to certain historic resources and landscapes, and a natural fire cycle limiting future fire size and smoke production must also be considered.

All fires will be re-assessed and changes to objectives, strategies and tactics will be made as needed recognizing that the fire's behavior can change geospatially and temporally (over space and time). The rationale for changes in the course of actions will be documented through WFDSS

The course of action will be recommended by the by the park fire management officer or their designee (district fire management officers, fuels specialist), approved by the superintendent, and documented in the WFDSS RL-1-3.

Staffing Needs and Responsibilities

Duty officers for each district will be assigned every day during fire season ensuring appropriate, qualified command staff is available. Additional park staff serving as subject matter experts will be involved in planning as conditions, issues, and fire location dictate. Examples include: district rangers, archeologist, wildlife biologist, roads and trails supervisor, district facility manager, and the fire information and education specialist. Fire complexity and risk will determine staffing needs.

WFDSS RL-1, RL-2 or RL-3 will be used to document the selected course of action and projected cost. If the management complexity of the fire exceeds the capabilities of local resources, the parks will manage the incident through delegation to an Incident Management Team (see Appendix K for a delegation of authority example).

All wildland fires will be assigned a qualified incident commander with the appropriate skills given the incident's complexity.

When the park wide Staffing Level is 3 or higher, firefighters assigned initial action duties will have a 5-minute response time for assignments. Crews will be equipped so that they can leave directly from a project site, prepared for an unsupported 24-hour assignment, without having to return to the station. If the park wide Staffing Level is 4 or higher, the duty officer may authorize extended daily hours. A sixth day of work may be authorized at the discretion of the fire management officer. The hours may be extended, and a seventh day of work may be authorized by the fire management officer if the park wide Staffing Level is 5. Work/rest guidelines will not be violated.

NPS regional staff will be consulted in the development of the selected course of action during national preparedness level 4/5. NPS national staff will be consulted in the development of the selected course of action during national preparedness level 5.

Notify the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) for all ignitions. Coordinate with the district to implement the SJVUAPCD work plan.

Monitor daily PM-2.5 values at Ash Mountain air quality base station as well as installing portable air quality monitoring stations at smoke sensitive sites affected by fires.

Cooperate with state or federal air quality guidelines for tracking particulate matter emissions from fires and to assist with the notification affected communities if necessary (based upon the EPA air quality index (AQI) standards). .

Notify the public about the chosen management response. Use contact lists and communication methods from *Standard Operating Procedures: Fire and Fuels Information* (Addendum). In addition to regular information about project logistics, location, and objectives, use appropriate smoke information and recommendations (see smoke talking points in the *Smoke Communication Strategy*, Appendix I).

Cost Containment All selected courses of action will consider cost containment efforts while also weighing potential risks and benefits. The lowest cost option may not always be the preferred alternative if long-term, cost-effective benefits can be achieved under the selected course of action. Regional director approval is required if the cost for the selected course of action is expected to exceed $2,000,000.00. NPS Director approval is required is the cost for the selected course of action is expected to exceed $10,000,000.00

Continue to reassess the fire situation – During the fire the parks must perform periodic fire assessments. The superintendent must validate that the fire is managed appropriately and will assess if there is a need to change objectives, strategies, or tactics. The frequency of the periodic fire assessment will be indicated on the signature page of the 'Periodic Assessment' form attached to the WFDSS. Signature frequency can range from daily (high complexity, high-risk fires) to weekly or longer (low complexity, low risk fires).

Continue with the course of action until the fire is declared out according to monitoring intensity and frequency guidelines indicated in the WFDSS. If strategic objectives, incident objectives or management requirements are not being achieved, then a new course of action will be developed and implemented. The rationale for the new course of action will be documented using the WFDSS process.

Post-fire: What do we do?

Rehabilitation will follow the parks' Minimum Impact Suppression Tactic (MIST) Guidelines as outlined in the parks if on-the-ground actions are taken to check fire spread. In the event a fire covers large areas, has unnaturally severe effects on natural or cultural resources, or causes major impacts to the parks developed resources (i.e. trail system) a separate *Burned Area Emergency Rehabilitation Plan* or *Burned Area Rehabilitation Plan* will be developed by the Resource Management and Fire Management Offices, and approved by the superintendent. **Assemble monitoring data** as part of the final fire package.

Review incident when deemed appropriate by fire management staff, superintendent, or fire management committee.

Documentation and Cost Tracking

The fire folder will contain copies of all documents as outlined in Appendix Q (Wildland and Fuels Management Reporting Requirements). The folder will include: all planning documents (WFDSS, , and amendments), delegations of authority, monitoring data and summary reports, revalidation and certification documents, fire time reports, maps, photos, and DOI-1202). All expenditures (personnel, aircraft, supplies, and equipment) will be tracked and reported according to the standards established in the Department of the Interior Individual Fire Occurrence Form (DOI-1202). All fire projects will have an appropriate fire management accounting code.

It will be the responsibility of the district fire management officer, or his/her incident commander on the fire to ensure fire report completion. The report is a valuable tool as it provides an historical record of the fire regime for the parks. The DI-1202 is the basic document used by the National Interagency Fire Center (NIFC) to document a fire occurrence.

Special Considerations

The RAWS station at Park Ridge will be utilized for tracking ERC values for fires because of the long history of quality weather data collected at this upper elevation site. This data can be used in programmatic and individual fire analyses of climatological data (i.e. FireFamily+) for fire planning Additional RAWS units in the Sugarloaf drainage, Rattlesnake Creek in the Kern drainage, at Ash Mountain, and at Wolverton Point in the East Fork Kaweah drainage are also available for aiding operational decision making.

TOOL #3 – PRESCRIBED FIRE

Prescribed fires are ignited by management to achieve resource objectives, most often a combination of ecosystem restoration or maintenance objectives and reduction of high hazard fuel loadings. These objectives are not mutually exclusive and usually all prescribed fire operations contain a mix of them. In certain areas of the parks where lightning-caused fires continue to be suppressed, prescribed fire may be used to replace these suppressed natural ignitions.

Prescribed fires must be described in a prescribed fire burn plan. The plan will contain a prescription defining goals, objectives, and treatment methods employed to achieve the objectives (Appendix O). Fuels management prescriptions are detailed in Appendix E.

Prescribed fire may also be used in concert with mechanical treatment. High hazard fuel conditions can be reduced while meeting structural objectives in areas immediately adjacent to infrastructure values or in boundary areas through a mix of mechanical treatment and prescribed fire. Mechanical treatment can be used as the primary method of reaching structural goals while prescribed fire actually removes the hazardous fuels.

Examples:

There is a hazardous accumulation of fuels adjacent to infrastructure values that can be mitigated with the use of prescribed fire. The main objective of the burn operation would be reducing high hazard fuels with ecosystem restoration as a secondary consideration.

There is a drainage that requires restoration of the ecological fire process. There are no infrastructure values or boundary issues. The main objective of the burn would be restoration of ecological processes. The secondary objective would be reducing high hazard fuels.

There is a drainage that has been prescribed burned for ecosystem restoration. For a variety of reasons, several constraints have precluded fire use for ecosystem maintenance. The drainage has missed 1 or 2 fire return intervals and is showing signs of high hazard fuels build-up, species composition shift, and increased stand density. The main objective of the burn would be for ecosystem maintenance purposes.

Planned Treatment - Prescribed Fire: What do we do?

Annually update GIS data according to fuels management accomplishments from the previous year and re-run fuels analysis.

Annually identify areas that need prescribed fire and/or mechanical treatments by evaluating values, hazards, and risks for the three Zones and nine FMUs. The parks geographic information system (GIS) is the primary data storage and analysis system employed to achieve this goal. Where appropriate, treatment across agency boundaries is encouraged and facilitated. This work is an outgrowth of efforts to develop GIS data layers by watershed boundaries across agency jurisdictional boundaries.

Select treatment priorities based upon the analysis of the values, hazards, and risks. Consider managerial capabilities to accomplish treatments given practical limitations in planning, finance, and logistical support. Park prescribed fire targets may be adjusted to plan for no more than two prescribed fire projects per year per fire management unit, while also attempting to limit project duration to no more than 14 days per burn. In addition, use of wildland fire or suppression fires which burn park acreage (over 100 acres) in a fire management unit will factor into the decision to implement planned prescribed fire ignitions in the same fire management unit that year.

Write the annual fuels treatment plan that describes the program for the up-coming field season including descriptions of individual segment preparation and execution needs. Insert this annual plan into a revised *5-Year Fuels Treatment Plan*. This document is completed each spring following consultation with the district management teams, fire management committee review and concurrence, and superintendent approval.

Distribute the *Fuels Treatment Plan* to park staff and cooperators.

Submit the *Fuels Treatment Plan* to the Air District for review. Note that air quality regulations and requirements are dynamic and subject to change. The process described below is in effect at the time of this document's publication. Updated procedures and requirements enacted after the approval date of this plan will be incorporated in annual updates to the *Fire and Fuels Management Plan*. While the District does not have authority to approve or reject this overall *Fuels Management Plan*, it does provide input to the individual prescribed fire burn plan. Air quality concerns remain the major issue affecting prescribed fire treatment.

Assign burn bosses to individual treatment segments. Each burn boss scouts the area and creates preliminary maps of the unit.

Scope park subject-matter experts. Each burn boss consults with park subject-matter experts prior to writing the project plan. The fire management program maintains a list of these subject-matter experts as identified by Division Chiefs and the Fire Management Committee. At a minimum, the consultation is done via email and includes a project map to help the subject-matter experts identify any resource concerns early in the planning process.

Identify the minimum tools required to complete the project if any portion of the burn segment falls within designated wilderness. The use of mechanized equipment in wilderness (including chainsaws and helicopters) must be justified and pre-approved by park management in non-emergency incidents. This analysis process can be documented in the burn plan (completed by the burn boss and signed by the Superintendent) or in an annual wilderness operations program submitted by fire managers.

Complete burn plans by pay period 15 each year giving the park fire management staff, chief ranger, and superintendent adequate time to address any remaining issues associated with the planned prescribed fire.

Submit the burn plan to the Air District for review under Rule 4106. The Air District has up to 30 days to review the burn plan. They are required to inform the parks of concurrence or to request changes at the end of the 30-day period.

Begin field work to prepare for projects.

Request Pre-Ignition Forecasting. No more than seven days prior to the earliest ignition date, a request will be submitted to the Air District to begin long-range smoke dispersal forecasting for the proposed ignition. The District will provide 96, 72, 48-hour outlooks, and 24-hour forecasts on days leading up to the proposed ignition date. The District retains final go/no-go authority until the time of ignition.

Notify the public about the annual project list. At the beginning of fire season, notify local communities, media, businesses, agency partners, and employees about upcoming projects for the year.

Project Implementation: What do we do?

Notify the public about the upcoming ignition. Use contact lists and communication methods from *Standard Operating Procedures: Fire and Fuels Information* (Addendum). In addition to regular information about project logistics, location, and objectives, use appropriate smoke information and recommendations (see smoke talking points in the *Smoke Communication Strategy*, Appendix I).

Monitor weather and fuels against prescriptive criteria. Prescribed burns are ignited when weather conditions are favorable for dispersing smoke away from SSA's, or during conditions that dilute smoke so that impacts to SSA's do not exceed health standards. This will be accomplished by utilizing the most current and comprehensive weather forecasting information available for predicting smoke transport direction and concentration down wind. Fuel moisture is also a high priority prescription element that will be monitored pre-burn. Fuel moisture prescriptions are designed to provide the optimum balance between the need to moderate fire behavior, minimize undesired fire effects on other resource values, and minimize smoke production (drier fuels burn cleaner and produce less pollutants). Fuel moisture information will be obtained and analyzed pre-burn for all significant categories of fuels (litter/duff, 1-, 10-, 100- and 1000-hour fuels) to ensure conformity with the prescription.

Assess effects of other park fire management workload on successful outcome for the burn. Consider the cumulative air quality effects of the upcoming project and any fire use projects (unplanned but managed ignitions) that may already be burning in the parks. If effects cannot be mitigated, postpone the planned burn.

- Obtain superintendent go/no go decision on ignition.
- Seek concurrence from the Air District to proceed with ignition.
- **Hold briefing** and review burn plan operations with burn staff.
- Ignite a test-fire.
- Make final go/no go decision on ignition (burn boss and associates).
- Provide interpretative information if adjacent to visitor-use area.
- Report daily fuel treatment accomplishments to the Air District.
- If the fire exceeds prescription criteria, notify the superintendent of the escape and initiate a *Wildland Fire Decision Support System (WFDSS)*.

Post-fire: What do we do?

- **Rehabilitation** will follow Minimum Impact Suppression Techniques (MIST) as outlined in the parks' *Fire and Aviation Management Operations Guide* (Addendum).
- **Assemble monitoring data** as part of the final fire package.
- **Review incident** when deemed appropriate by fire management staff, superintendent, or fire management committee.
- Report final fuel treatment accomplishments for the project to the Air District.

Staffing Needs and Responsibilities

The district fire management officers are responsible for the implementation of the annual fuels treatment program within their respective areas. They work closely with the park fuels specialist on the development of the annual program and associated *5-Year Fuels Treatment Plan*. A team comprised of district fire management officers, the park fuels specialist, and the fire GIS specialist will meet to compose the plan. District fire management officers will take the lead for each of their districts. The park fuels specialist is responsible for consolidating both district FMOs treatment requests into one coherent park-wide plan. The fuels specialist has final say over the district FMOs regarding treatment priority determination between the districts. District fire management officers are responsible for prescribed burn plan completion.

Each burn will be staffed by an agency-certified burn boss (appropriate to the level required), as well as other staff necessary to conduct the operation safely and efficiently. Individual segment burn plans will comply with requirements described in RM-18. Prescribed fire burning prescriptions can be found in Appendix E. Individual prescribed fire operations can last from one day to several months. Close coordination and strong communication is required between operational overhead, the fire information and education specialist, fire effects and research program staff, general park staff, local air quality control district staff, and dispatchers.

All fire management activities in the parks will rely on tactics that minimize resource damage while maintaining the safety of the public, firefighters, and other personnel. Tactical tools used in Wilderness will be chosen carefully. In cooperation with the Wilderness Management Program, fire managers will complete a minimum tool analysis for all projects in Wilderness requiring mechanized equipment. The "Wilderness and Backcountry Minimum Tool Analysis" worksheet will be an attachment to the burn plan.

Documentation and Cost Tracking

The fire folder will contain copies of all documents as outlined in Appendix Q (Wildland and Fuels Management Reporting Requirements). The folder will include: all planning documents (burn plan and any amendments, smoke permit, incident action plans), monitoring data and summary reports, fire time reports, maps, photos, and DI-1202. All expenditures (personnel, aircraft, supplies, and equipment) will be tracked and reported according to the standards established in the Department of the Interior Individual Fire Occurrence Form (DI-1202). All prescribed fires will have an appropriate accounting code.

It will be the responsibility of the district fire management officer, or his/her burn boss on the fire to ensure fire report completion. The report is a valuable tool as it provides an historical record of the fire regime for the parks. The DI-1202 is the basic document used by the National Interagency Fire Center (NIFC) to document a fire occurrence.

Special Considerations

Climatological weather data analysis is used to assess the probability of season ending weather events as an aid in prescribed fire planning. It is especially important to determine ignition timing for landscape scale burns with minimal control lines due to low social value effects. The closest weather station at a similar elevation often serves as the representative record.

TOOL 4– MECHANICAL FUEL REDUCTION

Mechanical fuel reduction is the use of mechanical equipment (i.e. weed whackers, chainsaws, dozers, rubber tired skidders, chippers, etc.) to cut and remove, or prepare for burning, woody fuels. Mechanical treatments are intended to help in achieving resource management objectives, most often a combination of ecosystem restoration and reduction of high hazard fuel loading objectives. Mechanical treatments must be described in a mechanical treatment plan. The plan will contain a prescription defining goals, objectives, and treatment methods employed to achieve the objectives (Appendix O). Fuels management prescriptions are detailed in

Appendix E. Extensive mechanical treatment, outside the bounds of the companion *Environmental Assessment*, would require further environmental analysis or may be covered under the Healthy Forests Initiative Act.

Mechanical treatment may be used in concert with prescribed fire treatment. High hazard fuel conditions can be reduced while meeting structural objectives in areas immediately adjacent to infrastructure values or in boundary areas through a mix of mechanical treatment and prescribed fire. Mechanical treatment can be used as the primary method of reaching structural goals while prescribed fire actually removes the hazardous fuels.

Examples:

Prescribed fire has been used extensively to reduce fuels and restore natural conditions in a large area uphill from a development. However, the fuels complex immediately adjacent to the structures presents significant prescribed fire control problems and the only practical method for reducing the hazardous fuels adjacent to the structures may be through the use of mechanical techniques and then prescribed burning the slash pile accumulations.

Heavy fuels immediately adjacent to structures, if burned, would cause an unacceptable amount of large trees to be injured or killed resulting in an increase in hazard trees. Mechanical treatment is used before prescribed burning in order to reduce the potential of the burn causing future hazard trees.

Planned Treatment – Mechanical Treatment: What do we do?

Annually update GIS data according to fuels management accomplishments from the previous year and re-run fuels analysis.

Annually identify areas that need prescribed fire and/or mechanical treatments by evaluating values, hazards, and risks for the three Zones and nine FMUs. The parks geographic information system (GIS) is the primary data storage and analysis system employed to achieve this goal. Where appropriate, treatment across agency boundaries is encouraged and facilitated. This work is an outgrowth of efforts to develop GIS data layers by watershed boundaries across agency jurisdictional boundaries.

Select treatment priorities based upon the analysis of the values, hazards, and risks. Consider managerial capabilities to accomplish treatments given any limitations in planning, finance, and logistical support.

Write the annual fuels treatment plan that describes the program for the up-coming field season including descriptions of individual segment preparation and execution needs. Insert this annual plan into a revised *5-Year Fuels Treatment Plan*. This document is completed each spring following consultation with the district management teams, fire management committee review and concurrence, and superintendent approval.

Distribute the *Fuels Treatment Plan* to park staff and cooperators.

Submit the *Fuels Treatment Plan* to the Air District for review. For mechanical treatment work only, the Air District will not need to review plans. They would review prescribed fire plans that would be developed to treat mechanically generated fuels.

Assign project leaders to individual treatment segments. Project leaders scout the area and create preliminary maps of the unit. All NPS owned structures will be protected to a reasonable extent from unplanned fire events by the clearance of hazardous fuels on an annual basis. This hazard abatement work will comply with California Public Resource Code (PRC) 4290. Work will be performed by a combination of park fire crews, park residents, and maintenance groundskeeping crews. In areas where the NPS has jurisdiction over park concessionaires and private property in-holdings, the NPS will require building owners or leasers to comply with PRC 4290.

Scope park subject-matter experts. Each burn boss consults with park subject-matter experts prior to writing the project plan. The fire management program maintains a list of these subject-matter experts as identified by Division Chiefs and the Fire Management Committee. At a minimum, the consultation is done via email and includes a project map to help the subject-matter experts identify any resource concerns early in the planning process.

Identify the minimum tools required to complete the project if any portion of the mechanical segment falls within designated wilderness. The use of mechanized equipment in wilderness (including chainsaws and helicopters) must be justified and pre-approved by park management in non-emergency incidents. This analysis process can be documented in the project plan (completed by the project leader and signed by the Superintendent) or in an annual wilderness operations program submitted by fire managers.

Complete mechanical treatment plans by pay period 15 each year giving the park fire management staff, chief ranger, and superintendent adequate time to address any remaining issues associated with the proposed treatment.

Notify the public about the annual project list. At the beginning of fire season, notify local communities, media, businesses, agency partners, and employees about upcoming projects for the year.

Project Implementation: What do we do?

Notify the public about the upcoming mechanical project. Use contact lists and communication methods from *Standard Operating Procedures: Fire and Fuels Information* (Addendum).

- **Monitor vegetation/fuels** against prescriptive criteria.

- Assess effects of other park fire management workload on successful outcome for the project.
- **Notify the public** about the planned treatment.
- **Hold briefing** and review treatment objectives and operations with treatment staff.
- **Begin implementing project.** All projects involving treatment of fuels adjacent to structures must comply with California Public Resource Code 4290.
- Provide interpretive information if adjacent to visitor-use area.

Post-Project: What do we do?

- **Rehabilitation** will follow Minimum Impact Suppression Techniques (MIST) as outlined in the parks *Fire and Aviation Management Operations Guide* (Addendum). Rehabilitation will be accomplished by the end of the following field season.
- **Assemble monitoring data** as part of the final fire package.
- **Review incident** when deemed appropriate by fire management staff, superintendent, or fire management committee.

Staffing Needs and Responsibilities

The district fire management officers are responsible for the implementation of the mechanical treatment program within their respective areas. They work closely with the park fuels specialist on the development of the annual program and *5-Year Fuels Treatment Plan*. The park fuels specialist is responsible for consolidating both district FMOs treatment requests into one coherent park-wide plan. The fuels specialist has final say over the district FMOs regarding treatment priority determination between the districts. Mechanical hazard fuels abatement standards can be found in Appendix E.

All fire management activities in the parks will rely on tactics that minimize resource damage while maintaining the safety of the public, firefighters, and other personnel. Tactical tools used in Wilderness will be chosen carefully. In cooperation with the Wilderness Management Program, fire managers will complete a minimum tool analysis for all projects in Wilderness requiring mechanized equipment. The "Wilderness and Backcountry Minimum Tool Analysis" worksheet will be an attachment to the mechanical fuel reduction plan.

Documentation and Cost Tracking

The project folder will contain copies of all documents as outlined in Appendix Q (Wildland and Fuels Management Reporting Requirements). The folder will include: all planning documents (treatment plan and any amendments, incident action plans), monitoring data and summary reports, personnel time reports, maps, photos, and fuels accomplishment summary reports. All expenditures (personnel, aircraft, supplies, and equipment) will be tracked and reported according to the standards established in the Department of the Interior Individual Fire Occurrence Form (DI-1202). All projects will have an appropriate accounting code.

It will be the responsibility of the district fire management officer, or his/her project leader to ensure treatment report completion. The report is a valuable tool as it provides an historical record of the fuels treatment history for the parks. At this time DI-1202's cannot be completed for mechanical treatments. They are only completed for projects involving fire occurrence.

Fuels accomplishment reports must be input into the Shared Application Computer System (SACS) for budgetary tracking in FIREPRO.

Special Considerations

Slash fuels that are derived from mechanical treatments and hazard tree removal operations can be burned for disposal purposes. Slash piles that are on NPS lands will be burned by NPS fire personnel and adhere to prescribed fire guidelines whenever the burning is classified by fire management staff as a prescribed fire. Slash piles on private lands will be burned by the property owners, or their agents, through a permit process. Property owners need to submit the form, "Permit for Burning Slash Piles" (Appendix N), through respective district fire management officers for approval by the park superintendent. Contractors working on NPS lands can also use this permit process for disposal of slash piles they generate.

District fire management officers are responsible for the coordination of burning slash piles on NPS lands and overseeing the permit process for slash piles that are burned on private property within park boundaries. Slash pile burning operations will comply with RM-18. Slash produced from mechanical projects may also be chipped in place, or chipped and hauled away from the site as indicated in the individual treatment plans.

TOOL #5 – PUBLIC INFORMATION AND EDUCATION

Sequoia and Kings Canyon National Parks are dedicated to providing high-quality fire *information and education* for identified target audiences (see list below). The Fire Information and Education (FI&E) Program at the parks will emphasize the major goals of the *Fire & Fuels Management Plan* to increase public awareness and support.

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Goals

The FI&E Program has four goals:

GOAL #1 – Offer year-round education on fire ecology, fire history, and fire effects in the southern Sierra. Communicate how fire and fuels management practices meet natural resource management and community protection goals and thus the mission of the National Park Service.

GOAL #2 – Provide accurate and timely incident information for local, regional, and national fire operations as needed.

GOAL #3 – Work with local communities, park residents, and park permittees to promote fire safety, fire prevention, defensible space, fire wise community planning, and fuels management.

GOAL #4 – Build and maintain interagency, educational, and community partnerships to improve fire education activities.

In 2004, the Fire Communications and Education National Program Lead (stationed at the National Interagency Fire Center) finalized the first *NPS Fire Communications and Education Strategy*. This was revised in the spring of 2009 as the Wildland Fire Management Communication Plan. This document describes a national program that will promote NPS wildland fire management and help people understand fire and its role in ecosystems. Additionally, the Communication Plan for Implementation of Federal Fire Policy also informs and guides park level information and education. The Sequoia and Kings Canyon FI&E Program outlined here, while tailored for the local area, complements the national strategy in its vision, goals, and objectives.

Other Important References

While this document provides the philosophy and general direction for the FI&E Program, there are two other important references for fire information work. Specific operational procedures (checklists, fax numbers, email lists, community contacts, etc.) are outlined in *Standard Operating Procedures: Fire and Fuels Information.* The *Smoke Communication Strategy* (Appendix I of the *Fire and Fuels Management Plan*) provides direction for communicating issues related to smoke management.

Staffing

The Fire Information and Education Specialist (in this document referred to as the FIO) is responsible for coordinating the FI&E Program. The success of this program depends on the cooperation and participation of many different partners: Interpretation, Natural Resources, Maintenance, Administration, Fire and Visitor Management, United States Geological Survey (USGS), Sequoia Natural History Association (SNHA), concession employees, and volunteers.

The FIO will serve as the liaison between these different groups to ensure the transfer of information and the consistency of content. When large incidents occur in the parks, the FIO will recruit personnel for specific duties or outside resources will be requested through dispatch procedures. The parks' Public Information Officer (PIO) may perform coordination duties

Key Messages

The FI&E Program will provide target audiences with accurate information about fire management from both the national and local perspective. **The Wildland Fire Education Working Team of the National Wildfire Coordinating Group (NWCG) released** the first national, interagency key messages in 2004. For the first time, all five federal land management agencies are using the same key messages to provide clear and consistent communication facilitating better public understanding. These key messages are broad and leave room for individual agency missions and identity:

- Fire is an essential, natural process.
- Society's influence has altered historic fire cycles, leading to a dangerous build-up of vegetation in our wildlands.
- Land management agencies are committed to a balanced fire program that will reduce risks and realize benefits of fire.
- Fire managers respect the force of fire and take their responsibilities very seriously.
- Improving the health of the land and reducing risks to communities requires partnerships among federal and state agencies, tribal governments, fire departments, communities, and landowners.
- Public education needs to be part of fire management programs.

Interpreters and other park employees will be able to "bring home" the national key messages by providing examples specific to these parks. Using SEKI's long history of fire operations, monitoring, research, and interpretation, the parks will generate engaging stories for the public while maintaining a level of sophistication appropriate to the topics of fire management, ecology, and history.

Target Audiences

The parks have identified six target audiences for fire information and education messages:

- **Park Visitors** (including in-park visitors, internet visitors, and special groups)
- **Park Employees** (including NPS, SNHA, USGS, concessions, and volunteers)
- **Local Communities** (including residents, businesses inside or near the parks, civic groups, and clubs – Badger, Dunlap, Grant Grove, Hume Lake, Kaweah, Lodgepole, Mineral King, Miramonte, Oriole Lake, Pinehurst, Silver City, Squaw Valley, Three Rivers, and Wilsonia)
- **Students/Teachers** (including K-12 students, college students, elder hostel groups, and teachers)
- **Professional Peers** (including other federal, state, and county agencies, professional associations, and academics)
- **Media*** (including print, television, radio, and film) While media is a valuable communication method, it is listed as a target audience due to the amount of time and energy that goes into facilitating interviews, film projects, etc.

Communication Methods

The following methods will be used to communicate with the six target audiences listed above. There are both personal and non-personal methods which will facilitate reaching the greatest number of people. The parks will continue to improve and expand this list.

Personal

Interpretive Programs – Park staff will integrate fire messages into hikes, walks, campfire programs, and special off-site presentations. The FIO will audit these programs to ensure content quality.

Education Programs – Park staff will incorporate fire ecology concepts into standards-based education programs, student field research experiences, and in-class programs.

"The Fire Place: a mobile learning center" – This small cargo trailer houses exhibits and activities about fire ecology, history, and management. It will be used both on- and off-park at special events and during fire incidents.

Employee Training – The FIO will coordinate park-wide employee training sessions to improve staff understanding of the fire and fuels management program. These sessions will be open to NPS, USGS, SNHA, concessions, and volunteers.

Roving – During fire operations, park employees will be stationed in high-use visitor areas, including trails, to answer questions about the current activity and/or explain the fire and fuels management program. Backcountry rangers will also provide information to backpackers about fire operations in their area.

Conference Presentations – Park staff will give peer presentations at conferences about current fire research, planning, or operations. These presentations will share information, generate feedback, and ultimately improve the parks' fire and fuels management program.

Special Events – The parks will, when possible, participate in local events to promote the fire and fuels program. For example, park employees can staff booths at local fairs or host community meetings.

Public Meetings – As needed, the parks will conduct special public meetings related to a specific fire event, planning effort, or to share general program information.

Media Interviews – The FIO, or park representative, will complete in-person or phone interviews for print, radio, and television outlets. When necessary, the FIO will facilitate special media projects (books, documentaries, etc.) by guiding research, scheduling interviews with park staff, and coordinating filming schedules.

Non-Personal

Press Releases / Updates – The FIO will use email, fax, and bulletin boards to distribute press releases / updates for all target audiences as needed.

Publications – The parks will include fire and fuels information in regular park publications (like the park newspaper). The FIO will research, write, and design additional handouts specifically about fire and fuels management such as newspapers, student materials, and brochures.

Visitor Center Exhibits, Waysides, and Bulletin Boards – The parks will maintain and update the interpretive information in visitor centers and wayside exhibits on fire and fuels management. The FIO will maintain permanent and non-permanent bulletin boards both inside and outside the parks.

Community Newsletters – The FIO will write, design, print, and send community newsletters to neighboring residents. The pre-season newsletter will coincide with the beginning of fire season and will give residents information about upcoming projects and events. The post-season mailing in winter provides a "wrap-up" of all fire events and reports project accomplishments.

Success Stories – The FIO will write and design success stories for fire and fuels projects that meet the park's and the National Fire Plan's objectives. These success stories are submitted quarterly to PWR and then to NIFC and are posted to the NPS and NFP webpages. They should also be distributed to park audiences.

Webpage – The parks will maintain a SEKI fire and fuels management webpage called "Fire in the Parks" at www.nps.gov/seki/naturescience/fire.htm . The FIO will enter information about park fires into *Fire News*, a national database that presents information on www.nps.gov/fire. The FIO will also enter information to Inciweb, the recognized interagency database for current fire incident information.

Recorded Phone Message – The FIO will maintain the recorded "Fire Information" message on the main park answering system accessed by calling (559) 565-3341.

Annual Plan by Season

For six to seven months of the year, the FI&E Program is largely in a reactive mode disseminating information about actual fire events. While this is the "nature of the business," the parks must stay focused on larger goals and prevent individual incidents from defining the entire education program.

Table 1 describes the Education Annual Plan which gives year-round direction for the FI&E Program. Depending on the season, certain educational elements are emphasized. Table 1 highlights these emphasis areas and links them to communication methods and target audiences. It is important to remember that this plan is very general and will not prevent the program from engaging in new, innovative methods in the future.

Evaluation

To maintain a successful FI&E Program, the parks will seek evaluation opportunities such as independent surveys of visitors /residents / employees. The parks have completed three formal surveys in the past to assess public support and awareness of fire operations. Two surveys focused on park visitors (Quinn 1988 and Oregon State University 2003) and one survey focused on local residents of Three Rivers, California (Schissler Associates 1999). Additional evaluation of the parks' fire information program was reviewed in 2007 (Sowell and Fiske, Washington State University).

The FIO will also evaluate the FI&E Program by preparing an annual report each year that documents the accomplishments. The parks will forward this annual report to the national communications program in Boise.

Table 3-1 – Education Annual Plan by Season

	Educational Emphasis	**Communication Methods**	**Target Audiences**					
			Park Visitors	Park Employees	Local Communities	Students / Teachers	Professional Peers	Media
Spring	Pre-Season Information	Community newsletter Press releases /updates Webpage Special events / public meetings		*	*		*	*
	Student Education	In-park programs for schools Mobile Learning Center Career days				*		
	Interagency Planning	Interagency work groups Conference presentations					*	
	Recruitment	Job fairs Mobile Learning Center			*	*		
Summer	Incident Information	Press releases / updates Bulletin boards Roving interpretation Mobile Learning Center Recorded phone messages Media interviews / field trips Webpage Special events / public meetings	*	*	*		*	*
	Interpretation	Park-wide interp programs Roving interpretation	*		*			*
	Employee Training	Written materials (handbooks) Training sessions		*				
	Interagency Cooperation	Press releases / updates Incident assistance		*			*	
Fall	Incident Information	Press releases / updates Bulletin boards Roving interpretation Mobile Learning Center Recorded phone messages Media interviews / field trips Webpage Special events / public meetings	*	*	*		*	*
	Interagency Cooperation	Press releases / updates Incident assistance		*			*	
	Student Education	In-park programs for schools Mobile Learning Center				*		
Winter	Post-Season Information	Community newsletter Press releases / updates Webpage Special events / public meetings			*		*	*
	Interagency Planning	Interagency work groups Conference presentations					*	
	Development of New Materials	Printed publications Bulletin boards Promotional items Exhibits / waysides	*	*	*	*	*	*

TOOL #6 – MONITORING

All NPS units that implement fire use and fuels treatment activities must develop short- and long-term ***monitoring programs*** to assess accomplishments and to determine the effects of management activities on cultural and natural resources in the parks (. While the fire and fuels management program is based on a broad array of scientific research that clearly illustrates the important role of fire in the parks' ecosystems (see Chapter 9), monitoring is essential to provide information about the effects of management activities.

Using feedback from ongoing monitoring results, the fire and fuels management program can adapt to changing needs with the best available information. Monitoring is essential to determine if management objectives are achieved, as well as to detect unexpected and undesired consequences of management activities. This monitoring information is especially useful because it is obtained directly from park management activities, and therefore, has direct, local application.

A *Fire and Fuels Monitoring Plan* (Appendix C) has been developed to describe current monitoring efforts and proposed needs and will be updated annually. The *Fire and Fuels Monitoring Plan* covers the four levels of fire monitoring identified in the *NPS Fire Monitoring Handbook* (NPS 2001) including environmental monitoring, fire observation, short-term effects, and long-term effects. The *NPS Fire Monitoring Handbook* provides guidelines for monitoring fire management activities to meet NPS needs. Because the *Fire and Fuels Management Plan* includes mechanical treatment as a tool for fuel and fire manipulation, the monitoring plan also includes protocols for mechanical treatment monitoring. Guidelines for monitoring mechanical treatment are preliminary, with most of the focus on short and long term monitoring, the same as for sites treated with fire.

The parks' *Fire and Fuels Monitoring Plan* applies to monitoring efforts across both spatial and temporal scales, from site-specific up to the landscape-level, and from immediate post-fire to long-term effects. For example, in areas where heavy fuels have accumulated as a result of past fire exclusion, fuels will be monitored to determine when fuel loads have been restored by fire reintroduction. In other areas where fuel and vegetation conditions have not been greatly altered by fire exclusion, or in areas that have been restored, fire frequency, severity, and season will be monitored to insure the long-term maintenance of the historic fire regime. Correspondingly, in areas where mechanical manipulation of fuels is needed (due to presence of human structures) prior to burning of woody debris piles, fuel loads will be monitored as well as vegetation change.

The plan describes the monitoring program by subject matter including weather and fire behavior, fuels, vegetation, cultural resources, and fire regime. Each subject area section outlines monitoring objectives, sampling design (including specific field protocols), locations, and a schedule appropriate for each subject matter area (Appendix C). Monitoring protocols are reviewed at the regional office level to insure that methods are appropriate and funding for monitoring is adequate.

Information from other monitoring efforts will be used to inform the fire and fuels management program where pertinent. For example, results from the parks' Inventory and Monitoring Network Program may be useful to assess the changes occurring in areas of the parks affected by wildland fires and areas where fire has been excluded for long periods.

TOOL #7 – RESEARCH

Natural science ***research*** is and will continue to be an important activity in these parks. It serves several primary purposes in relation to the fire and fuels management program. First, it helps to define both natural fire regimes as well as the range of natural conditions that serve as ecological foundations for the application of fire in park ecosystems. Second, it is used as a tool to evaluate actions used to restore and/or perpetuate desired conditions as contemplated in the policies for management of natural areas in the National Park Service. Third, it can potentially provide feedback and direction for new management strategies that may need to be followed if climate change has significant influences on park ecosystems. This research can have either tactical or strategic applications. Such research will continue to be encouraged and supported in an effort to further improve the parks' fire and fuels management program.

Considerable fire research has been carried out in Sequoia and Kings Canyon National Parks over the past several decades. This work has included a variety of studies in: sequoia-mixed conifer forests (Kilgore 1972, Kilgore and Taylor 1979, Parsons and DeBenedetti 1979, Harvey and others 1980, Stephenson and others 1991; Swetnam and others 1992, 1998; Swetnam 1993; Mutch 1994; Caprio and Swetnam 1995; Stephenson 1994; Miller and Urban 1999, 2000; Stephens and Finney 2002; Knapp et al. 2005; Ferrenburg et al. 2006; Keifer et al. 2006; Knapp and Keeley 2006; Schwilk et al. 2006; Collins et al. 2007a, 2007b; Knapp et al. 2007; North et al. 2007); low elevation foothill communities (Rundel and Parsons 1979, Parsons 1981, Rundel and others 1987; Keeley et al. 2005a, 2005b); and high elevation forests and meadows (Vankat 1970; Kilgore 1971, DeBenedetti and Parsons 1984; Pitcher 1981, 1987; Caprio 2006, in press).

These studies provided a firm justification and basis for the development of the parks' prescribed and use of wildland fire management programs (Bancroft and others 1985). While much is known from these studies, in most cases they have not provided the full level of detail necessary to completely understand natural fire regimes or the long-term effects of variable intensity fires on subtle ecosystem properties.

Research needs and priorities are jointly identified by the Division of Natural Resources and the USGS Sequoia and Kings Canyon Field Station located within the parks. They are documented in the parks' *Natural and Cultural Resources Management Plan* and updated annually. Such research may include in-house studies, interagency or cooperative agreements, contracts, or independent investigations. All fire related research is closely coordinated with fire and fuels treatment operations and fire and fuels monitoring efforts in order to assure maximum application of findings to both the management and interpretation programs. During winter months, fire managers and researchers meet regularly to coordinate future projects and incorporate past research results into the next annual fuels treatment plan. All fire-related research, monitoring, and inventory projects undertaken within a given year are documented in the "Fire Ecology Annual Report".

Most fire research is carried out in close conjunction with the prescribed burning program, utilizing planned burns to the extent possible. On occasion, burns will be carried out specifically to support approved research projects. These might include efforts to study the effects of variable intensity burns, reburns, or burns carried out under specific climatic or prescription variables (e.g. severe drought).

For more detailed information concerning the *Fire and Fuels Research Plan*, see Appendix D.

4. Fire Management Units and the Planning Process

This chapter outlines the planning work that leads to actual project implementation in support of the Fire and Fuels Management Plan. The process is summarized in Figure 4-1. This chapter also describes in detail the parks' Fire Management Zones (hereinafter referred to as "Zones"), Fire Management Units (hereinafter referred to as FMUs), Segments, and Sub-Segments (Table 4-5).

PROJECT PLANNING AND PRIORITIZATION

All planning efforts begin with the identification and description of areas in need of fire management action or attention. Needs are evaluated in light of park values, wildland fire hazards, and risks (Caprio et al, 1997).

Values are divided into three areas: ecological, cultural, and social. Ecological values include vegetation, water, wildlife, natural processes, and air resources. For example, natural fire regimes (a natural process) are assessed through an analysis of the fire return interval departure (FRID). This analysis reflects the number of fires a piece of land has missed based on that area's maximum natural fire return interval (see special FRID explanation in Figure 4-2). FRID is an indicator of condition class (as defined by Hann and Bunnell) and can be directly related to the national reporting standard for condition class. Cultural resource values include prehistoric and historic cultural sites, historic structures, and contemporary structures, both government-owned and private. Social values include park employees, visitors, neighboring communities, and wilderness.

Fire hazard is defined as a fire's resistance to control. Hazard is determined by factors that affect fire behavior. Examples of factors that affect fire hazard include slope, aspect, fuels, and elevation.

Risk, or probability of fire occurrence, includes both human and naturally caused ignitions.

While the most important attributes of value, hazard, and risk are known, others may be identified and incorporated into decision-making in the future. New research and information is constantly considered to increase the parks' ability to apply the best available knowledge to fire and fuels management. Most of the planning analysis is now done using the parks' geographic information system (GIS), although some analysis work has yet to be automated. Needs analyses are updated annually and can reflect the changes in the parks' understanding of values, hazards, and risks, and incorporate new technologies as those evolve.

With the "needs" analysis typically identifying more acres needing attention than are possible to accomplish in any one year, **priorities** have to be selected based on a combination of criteria. Each year, managers will select projects that have a high probability of success, and that move resource and hazard fuel conditions towards the desired status as defined by program goals and objectives. To assist in selecting the most important projects from all the areas needing attention, criteria that help identify the highest priority project areas are identified and assigned numerical weight within the park GIS. These numeric values are then processed through a spatial analysis. An interdisciplinary team analyzes outputs of the analysis, and a final suite of high priority projects is selected for implementation.

Selection criteria used to identify high priority project areas may change over time as new scientific or operational considerations warrant. Though subject to change based on new information, selection criteria for the identification of high priority projects may include:

- Areas where hazard fuel conditions threaten developments, firefighter safety, and boundaries
- Areas of frequent natural or human ignition where preventative actions may be useful in preventing unwanted fire.
- Areas of special ecological or social significance (e.g. Giant Forest grove).
- Core fire management maintenance areas representative of the full range of park vegetation communities and wildlife habitats.
- Areas that are presently in good-to-excellent ecological condition as evaluated by the FRID analysis or similar index (e.g. condition class as defined by Hann and Bunnell).
- Areas at risk of moving to a more compromised FRID condition category (e.g. from moderate to high departure from natural) in the next five years.

After annual analyses are completed and priority projects are selected, site specific management actions are then designed which address one, or a combination, of the three categories of values, hazard, and risk.

The specific combination of programmatic directions and management actions vary for the three Zones (described in Section C of this chapter). For instance, the Kings Zone is primarily managed for ecological values since wilderness prevails and the ecological condition appears to be satisfactory in much of the Zone. As a result, the vast majority of natural ignitions will be managed as fire use projects. The Cedar Grove FMU within the Kings Zone was delineated to accommodate additional social values created by the presence of people, structures, and infrastructure at Cedar Grove. These social values modify the ability to use fire use projects, resulting in an increase in the suppression of natural fires in the FMU. This in turn creates a need to apply other fuels management activities to maintain ecosystem health. Finally, individual treatment segments within the Cedar Grove FMU will be identified to describe and apply specific management actions that address values, hazards, or risks.

Since successful projects take several years to plan and implement, annual project prioritization and planning will be conducted within a multi-year frame of reference – generally a five year moving window (the current planning year plus four out-years). This allows the park to anticipate planning, compliance, site preparation, and budget needs for future projects. It also allows the park to develop multi-year strategies that will result in the most efficient operations.

UPDATE, CERTIFICATION, AND REVIEW

Annual Update

Fire and Fuels Management Plan updates will occur each year to incorporate minor changes in terminology, policy, GIS analysis, and new scientific information. Other typical annual update components will include summary statistics from the previous year's fires, changes to the parks'

Preparedness Staffing Plan, and readiness calendars. Another major function of the annual update will be to list specific prescribed fire and mechanical fuel reduction projects proposed for the upcoming season, as well as describe planning and implementation projections for an additional four years.

Program Certification

The fire management officer will present the annual updates and proposed program to the Fire Management Committee by mid-June. The Fire Management Committee will review the proposals and confirm that the changes and actions proposed are within the scope of the companion Environmental Assessment (EA) for the *Fire and Fuels Management Plan*. If the nature of any part of the proposal is found to be outside the scope of the plan's EA, additional environmental compliance will be required for the non-conforming actions. After the Fire Management Committee is satisfied with the proposed program, they will recommend adoption to the superintendent. Updates to the fire management program must be approved by the superintendent prior to implementation.

Periodic Review

Five years after final approval, and every five years thereafter, the *Fire and Fuels Management Plan* will receive thorough review to determine whether it remains adequate to direct future fire and fuels management actions. If significant new information, policy changes, or scientific knowledge (such as new information on the effects of global climate change) needs to be incorporated into the fire and fuels management program resulting in effects or consequences not evaluated in the current EA, the plan and EA will be revised. If no substantial changes to program direction or effects are discovered during the review, the plan may be renewed for an additional five years with proper documentation.

Figure 4-1 – Annual Project Planning and Analysis Flowchart

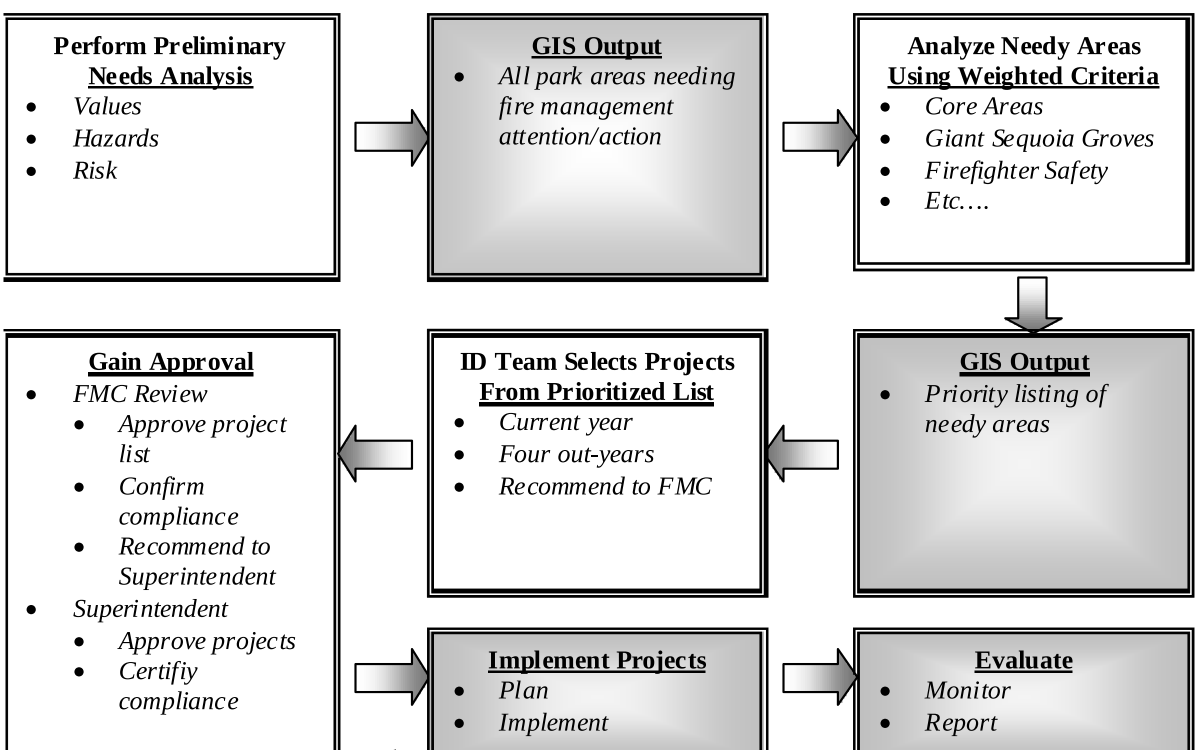


Figure 4-2 – Description of Fire Return Interval Departure (FRID) / Condition Class

Vegetation communities can change dramatically when areas have not been allowed to burn at natural intervals. A geographic information system (GIS) based analysis was used to assess landscape scale change in the ecological condition of vegetation communities in Sequoia and Kings Canyon National Parks. This analysis uses deviations from the natural fire return interval as an indicator of change in natural conditions.

A fire return interval is defined as the number of years between naturally occurring fires at a specific location that is representative of a typical stand of that vegetation. For example, an analysis of fire scar in a stand of ponderosa pine trees might show that natural fire has occurred as frequently as every two years (minimum value) to as infrequently as every six years (maximum value). The mean value for the stand would be four years.

The fire return interval for a given vegetation type can be used in conjunction with fire history maps to determine which park areas have missed natural fires. This information is known as the fire return interval departure (FRID). For example, if fires were suppressed in the above-mentioned stand of ponderosa pine trees for 60 years, the stand would have missed 30 fires based on the minimum fire return interval of 2 years, 15 fires based on the median interval of 4 years, and 10 fires based on the maximum interval of 6 years.

In general, the further vegetation communities depart from their natural fire regimes, the more unnatural conditions prevail and the higher the risk of a stand replacement wildland fire, which is not natural to most Sierran forests. Maximum fire return interval departure (FRID max) represent the most conservative estimate of how severe the deviation from natural conditions might be in terms of fuels and vegetation. Mean fire return interval departure (FRID mean) gives a more moderate view, while the minimum fire return interval departure (FRID min) presents the most extreme indication of how far the stand is from its natural condition. For planning purposes, SEKI uses the most conservative indication of change (FRID max).

The first step is to assign mean and maximum fire return intervals to fire vegetation types (see Table 9-1 in Chapter 9). The second step was to use fire scar, fire history, and fire occurrence data to create a map of when each acre of the park had last burned (Figure 4-3). Fire history maps date back to 1921 for the parks. The final step was to calculate departures from the natural fire interval and create a map that depicts the number of fire cycles missed in each area. (Figure 4-4).

As of the year 2007, results of the FRID analysis indicate that 62% of park vegetation is considered to be in acceptable ecological condition (i.e. little to no deviation from natural fire regime). These areas are expected to remain in acceptable ecological condition as long as the natural fire regime is maintained. Another 22% of the parks' vegetation shows significant deviation from natural conditions and 16% of the parks are considered highly compromised by past fire suppression actions over the past 77 years.

FRID is an indicator of condition class (as defined by Hann and Bunnell) and can be directly related to the national reporting standard for condition class as shown in the diagram below.

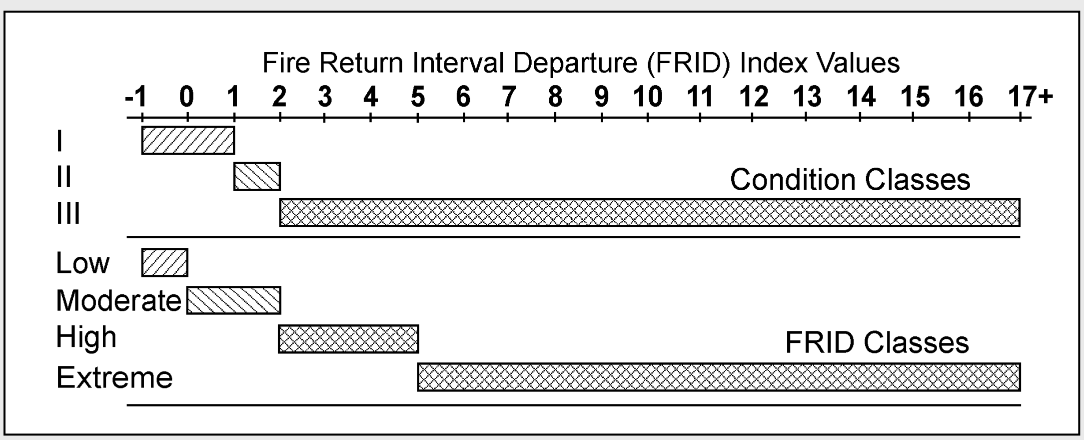


Figure 4-3 – Map of Sequoia and Kings Canyon Fire History

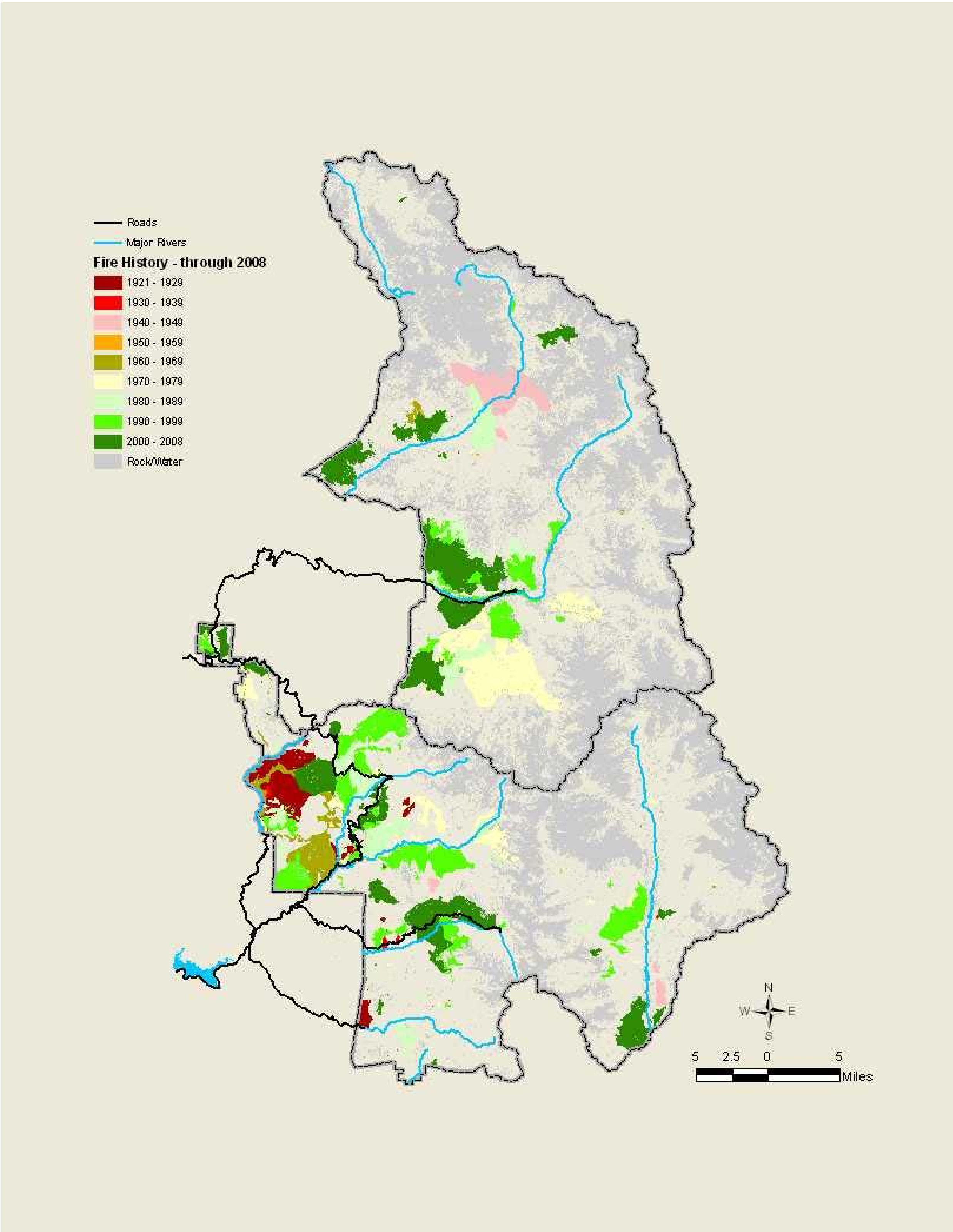
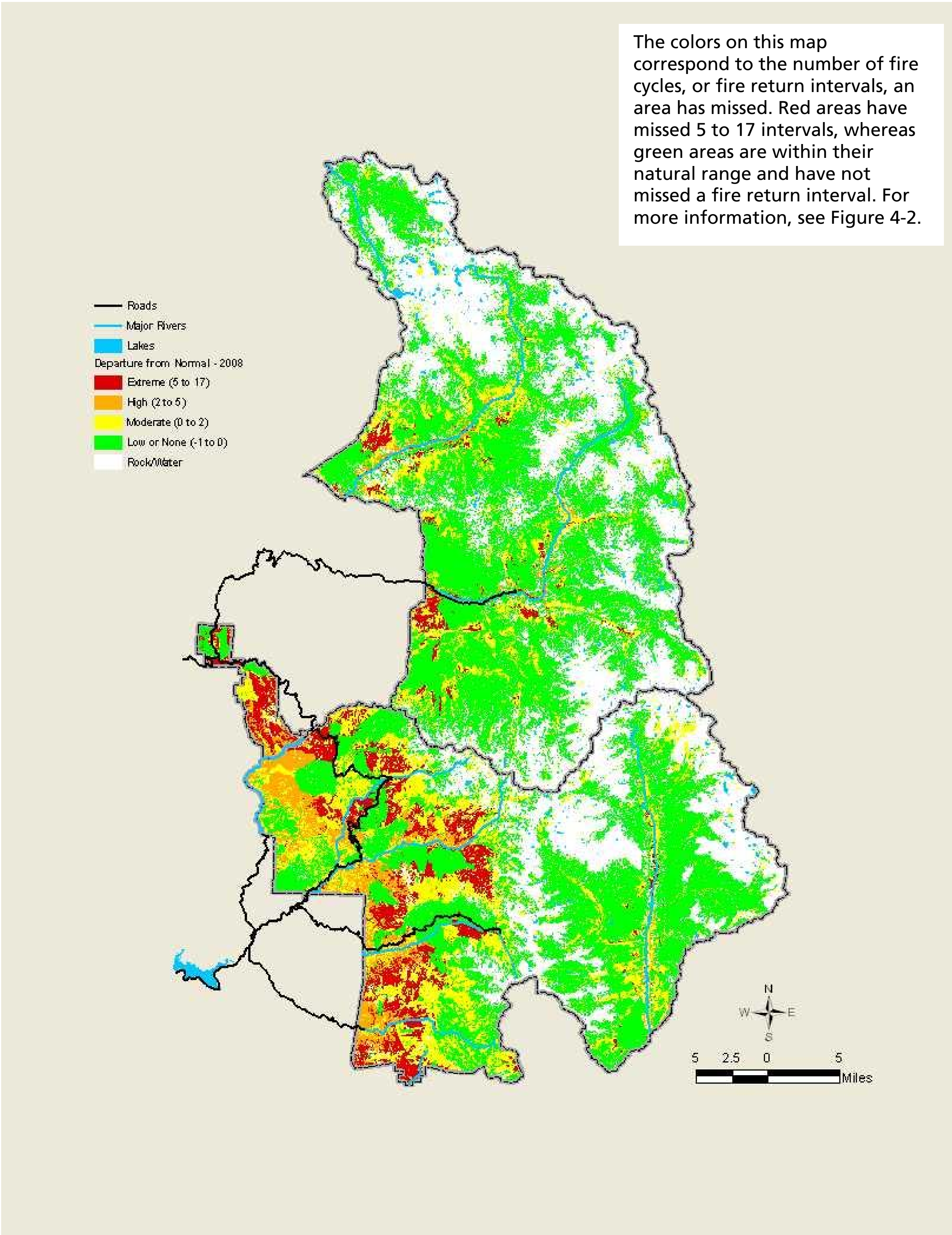


Figure 4-4 – Map of Fire Return Interval Departure (FRID)



FIRE MANAGEMENT ZONES AND UNITS

The parks are divided into three **Fire Management Zones** - the Kings, Kern, and Kaweah (see Figure 4-6). The Zones represent, for the most part, major park watersheds resulting in an ecologically based planning framework for fire management activities. Each Zone has characteristics that allow unified fire and fuels management concepts to be applied within the Zone.

Zones may be subdivided into smaller **Fire Management Units (**see Figures 4-10, 4-11, and 4-12**)**. FMUs are generally sub-watersheds having locally unique values, hazards, and/or risks that affect the specific mix of fuels treatments and fire management activities to be used. Because the FMUs are based on sub-watersheds, ecological integrity and landscape level goals and achievements can be evaluated with some confidence.

FMUs may be further subdivided into **Segments**. Segments are comprised of a portion of a FMU that will receive uniform treatment. Segments are usually defined by natural or human created boundaries that allow for ease of management. Each segment will have a separate action plan developed (burn plan and/or fuels treatment plan). In some cases, segments may be further divided into **Sub-segments** under the same burn plan or fuels treatment plan to allow greater control and flexibility in managing the duration of the project, smoke impacts, or for other purposes.

Table 4-5 – Fire Management Zones, Units, Segments, and Sub-Segments

Planning Unit	Subset of:	Geographic Extent	Designation	
Fire Management Zone	Parks	Major watershed(s)	Kings Kern	Kaweah
Fire Management Unit (FMU)	Fire Management Zone	Sub-watershed	Kings Zone Sierra Crest Cedar Grove Kern Zone Kern	Kaweah Zone Grant Grove North Fork Marble Fork Middle Fork East Fork South Fork
Segment	FMU	Manageable portion of a sub-watershed receiving common treatment under a single burn plan or fuels treatment plan.	Boundaries determined through annual planning process.	
Sub-Segment	Segment	Portion of a segment. Individual project to be treated along with other segments (though perhaps at different times) under a single burn plan or fuels treatment plan.	Boundaries determined through annual planning process and on-the-ground reconnaissance.	

Figure 4-6 – Map of Fire Management Zones

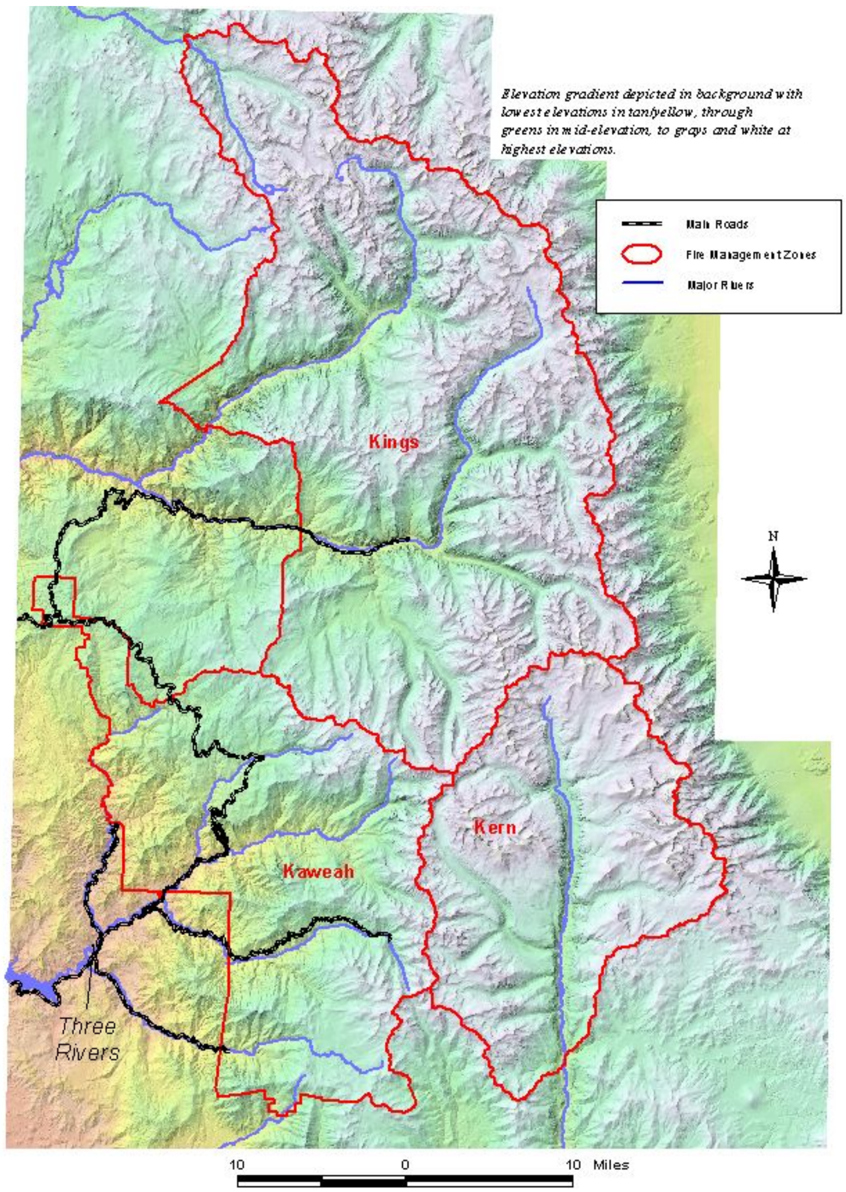


Table 4-7 – Description of Fire Management Zones

Kings Zone	Kern Zone	Kaweah Zone
Description of Zone The Kings Zone encompasses most of Kings Canyon National Park exclusive of the Grant Grove peninsula. It consists primarily of designated wilderness (99%) with the exception of one seasonally operated non-wilderness developed area (Cedar Grove). The Zone encompasses the headwaters of the South and Middle Forks of the Kings River, as well as headwaters of the South Fork of the San Joaquin River. The forks of the Kings River are designated Wild and Scenic. All but three miles of the 135-mile perimeter of the Zone is bounded by NPS or US Forest Service (USFS) wilderness. The three miles of non-wilderness boundary are shared with the USFS managed Giant Sequoia National Monument. The Kings Zone contains two FMUs – Sierra Crest and Cedar Grove. As of 2007, 94% percent of the acres in the Kings Zone were in a "low" or "moderate" FRID class indicating low deviation from natural conditions. The remaining 7% fall into either the high or extreme category. The numbers indicate that vegetation and fuel conditions on most of the acres within the Zone are in fairly good condition, with some focused need for restoration and increased ecosystem maintenance, primarily in and around developments and along NPS/USFS boundaries. The generally good ecological and fuels conditions within the Zone are largely a result of the past 40 years of management. Most of the Zone was included in the original "natural fire zone" designated in the late 1960s and early 1970s. As a result of this designation, most	Description of Zone The Kern Zone consists of 185,569 acres of designated wilderness dominated by the north-south oriented Kern River drainage. The Great Western Divide to the west and the Sierra Nevada crest on the east and north flank the Kern Zone. Elevations in this Zone range from a low of 6,300 feet at the Kern River ranger station, to 14,495 feet at the summit of Mt. Whitney. The potential for fire spread out of the Zone to the north, east, and west is fully constrained by high rocky ridges and passes. Over 50% of the zone is comprised of rock or water, further limiting fire spread within the zone. Fire spread outside park boundaries onto USFS lands to the south and southeast is possible. All USFS lands adjacent to this Zone are designated wilderness and managed by the Inyo and Sequoia National Forests. The vegetation within the Zone consists of long needle pine forest and montane chaparral at the lower elevations. The vegetation grades rapidly with increasing elevation into lodgepole and subalpine conifer forest; with the latter comprising over 50% of the vegetated acreage in the Kern Zone. Over 82% of vegetated acres show little or no deviation from desired conditions as represented by a FRID classification of "low." Only 2% of the vegetated acres show significant deviation from natural conditions as represented by the "high" or "extreme" FRID class. Other than several backcountry ranger stations and numerous trails, the Zone is free from human developments. No private lands occur within the Zone.	Description of Zone The Kaweah Zone is comprised of the various forks of the Kaweah River, as well as the headwaters of the North Fork of the Tule River, several small streams that flow into the Kings River, and a sub-watershed that flows into the Little Kern River. It is managerially the most complex of the three Zones and is subdivided into six FMUs. Topographically most of the Zone faces the San Joaquin Valley to the west and is backed by the Great Western Divide on the east – significant factors in smoke dispersion and air quality issues. As of 2007, the San Joaquin valley is classified as non-attainment for PM-2.5 and ozone. The Kaweah Zone contains most of the parks' infrastructure and developments, all of the parks' giant sequoia groves, and has the greatest diversity of boundary interface issues. The Zone includes five designated or proposed Historic Districts or Landscapes and numerous archeological sites. Due to its proximity to developed areas and typically heavy fuel loads, air quality is a primary concern in all fire management decisions in the Kaweah Zone. The ease of access, ability to detect ignitions, and the presence of extensive developments dating back to the late 19th and early 20th centuries resulted in most of the Kaweah Zone being significantly affected by past fire suppression. Results of those suppression actions are the high fuel loads over a significant portion of the landscape and altered ecosystems. As of 2007, over 34% of the vegetated acres in the Kaweah Zone fall into the "high" or "extreme" FRID classes, indicating extensive deviation from natural conditions. However, because of the compromised ecological state and the high

Kings Zone	Kern Zone	Kaweah Zone
natural ignitions have been managed for resource benefit over the past 40 years. Extensive prescribed burning has also occurred in and around developments in Cedar Grove, further improving overall conditions.	Due to its physical isolation and uniformly good fuel and ecosystem condition, the entire Kern Zone is treated as a single FMU with no subdivisions.	importance of restoring giant sequoia grove conditions in the Kaweah Zone, much of the parks' prescribed fire program has been focused here since 1968. As a consequence of 40 years of proactive fire management, 65% of the vegetated lands are currently in the "low" (34%) or "moderate" (31%) FRID class - indicating improving overall ecological and fuels conditions.
Fire and Fuels Objectives for Zone Restore and maintain natural ecosystem function to the extent possible using prescribed fire, non-fire fuel treatments, and use of wildland fire, with use of wildland fire expected to be used as the primary management tool throughout much of the Zone. Protect visitors, staff, cultural resources, and infrastructure values in the developed area and along NPS/USFS boundary areas through a program of mechanical and prescribed fire treatments.	Fire and Fuels Objectives for Zone Maintain natural ecosystem function to the extent possible using use of wildland fire as the primary management tool throughout the Zone. Protect visitors, staff, park resources, NPS/USFS boundary interface areas, and infrastructure values through implementation of small mechanical fuels management projects and prescribed fire treatments.	Fire and Fuels Objectives for Zone Fully restore and maintain natural ecosystem function to the extent possible using prescribed fire, mechanical fuel treatments, and use of wildland fire. Protect visitors, staff, cultural resources, communities, and infrastructure values in the developed area and along the boundary through a program of fire suppression, mechanical fuel treatments, and prescribed fire treatments. Minimize smoke impacts in local communities and to regional airsheds. Promote increased knowledge through fire research. Offer educational opportunities for the public to observe and/or study fire management.
Size and Composition (Acres)	Size and Composition (Acres)	Size and Composition (Acres)
Vegetation 222,434 Rock/Water 221,187 Total 443,621 Wilderness 99%	Vegetation 110,367 Rock/Water 75,284 Total 185,651 Wilderness 100%	Vegetation 205,522 Rock/Water 30,469 Total 235,991 Wilderness 80%
Values, Hazards, and Risks Each Zone is described below based on six different values: 1) special designations and features, 2) park developments, 3) vegetation, 4) private lands, 5) cultural resources, and 6) boundary interface; along with hazard and risk factors. The values are not in priority order.		

Kings Zone	Kern Zone	Kaweah Zone
Value 1: Special Designations & Features 99% of the Zone is designated wilderness. The South and Middle Forks of the Kings River, from headwaters to the park boundary, are designated as Wild and Scenic Rivers. Cedar Grove contains two buildings on the List of Classified Structures (LCS); the Knapp Cabin and the Cedar Grove storage shed (building #276). The Kings backcountry contains several LCS structures including the Barton-Lackey Cabin, and several “Shorty Lovelace” structures.	Value 1: Special Designations & Features The entire Zone is designated wilderness. In the draft Wild and Scenic River Plan (a component of the draft GMP), the Kern River is considered eligible for Wild and Scenic River status. The parks’ General Management Plan (in revision as of 2002) will determine final eligibility. The Kern Ranger Station, Kern River bridge, and associated features are considered cultural resources on the List of Classified Structures. They require particular protection and consideration in all fire management decisions within the Zone. While not carrying a special designation, the Kern hot spring is a unique geothermal feature that occurs on the canyon floor. This site is an attractive and well-used feature within the Zone.	Value 1: Special Designations & Features See Table 4-9.
Value 2: Park Developments Cedar Grove – This 2,700 acre non-wilderness development zone includes a variety of infrastructure elements including; a road system, 4 campgrounds, a 13-unit hotel, market, concession operated pack station, park offices, maintenance, park and concession employee housing, sewer and water treatment plants, a helispot, two visitor contact stations, and numerous trailheads. A portion of the Kings Wild and Scenic River bisects the developed area.	Value 2: Park Developments Several NPS wilderness ranger stations, along with trails and associated bridges are the sole developments in the Zone.	Value 2: Park Developments See Table 4-9.
Value 3: Vegetation Mid-elevation hardwoods and ponderosa pine communities grade upward with elevation into mixed conifer, red fir, and lodgepole forests, with subalpine conifers dominating near treeline.	Value 3: Vegetation The vegetation within the Zone consists of long needle pine forest and montane chaparral at lower elevations, grading rapidly with increasing elevation into lodgepole and subalpine conifer	Value 3: Vegetation See Table 4-9.

Kings Zone	Kern Zone	Kaweah Zone
Forested areas intermixed with meadows and montane shrublands increase diversity across the Zone. No giant sequoia groves are located in the Kings Zone. Local to widespread invasion of the non-native cheatgrass (Bromus tectorum) has been observed in recently burned areas. Research into cause and effect, and potential management responses is underway.	forest. The latter comprises over 50% of the vegetated acreage within the Zone. Approximately 2,300 acres are meadow communities.	
Value 4: Private Lands None	Value 4: Private Lands None	Value 4: Private Lands See Table 4-9.
Value 5: Cultural Resources There are a number of known archeological sites in the Zone, and potential for unknown surface and subsurface archeological resources. Four historic structures on the List of Classified Structures are in the Cedar Grove FMU and several others exist in the Sierra Crest FMU. All require protection from fire. Refer to Appendix H for a current list of protected structures.	Value 5: Cultural Resources There are known archeological sites in the Zone, and potential for unknown surface and subsurface archeological. Five historic structures or features are on the List of Classified Structures the Kern Zone. All require protection from fire. Refer to Appendix H for a current list of protected structures.	Value 5: Cultural Resources See Table 4-9.
Value 6: Boundary Interface Three miles of boundary are shared with the USFS Giant Sequoia National Monument The remaining Zone boundary is shared with USFS wilderness (Monarch, Jennie Lakes, and John Muir) and the Sequoia-Kings Canyon Wilderness. Adjacent USFS areas are in the process of developing use of wildland fire programs and standards which may increase the ability of the	Value 6: Boundary Interface The entire 80-mile Zone boundary abuts designated or proposed wilderness. Over one-half of the Zone boundary is adjacent to USFS wilderness, though a significant portion of that boundary interface does not have vegetation capable of supporting fire. The remaining portions of the Zone boundary are adjacent to NPS designated or proposed wilderness.	Value 6: Boundary Interface See Table 4-9.

Kings Zone	Kern Zone	Kaweah Zone
park to manage use of wildland fire projects across agency boundaries. Each ignition in areas of continuous cross-boundary fuels will be managed as a unique event between the agencies with close coordination. At the present time most fires will be contained within the park.		
Hazards As of 2007, 94% percent of the acres in the Kings Zone were in a "low" or "moderate" FRID class indicating low deviation from natural conditions. The remaining 6% fall into either the high or extreme category. The numbers indicate that vegetation and fuel conditions on most of the acres within the Zone are in fairly good condition, with some focused need for restoration and increased ecosystem maintenance, primarily in and around developments and along NPS/USFS boundaries. Fuels in Cedar Grove can have high rates of spread under strong canyon wind conditions common in the afternoons during fire season. The presence of developments and wildlands in Cedar Grove's ponderosa pine, black oak, and grass-shrub communities create interface issues and concerns for visitor and staff safety. Continuous vegetation crossing the park boundary onto USFS lands along portions of the western boundary (especially the Crown Valley drainage) reduce opportunities for managing wildland use fires in those areas at the present time. However, the USFS will accommodate use of wildland fire in a number of other areas adjacent to the parks. Implementation of wildland and prescribed fire projects requires coordination and cooperation between agencies. Heavy and/or continuous fuel accumulations along with steep terrain are found Sheep Creek	Hazards As assessed by the FRID model, ecological conditions in the Kern Zone are substantially in their desired condition. Ninety-four percent of the vegetated acres in the Kern Zone are described as mixed conifer forests generally comprised of Red Fir with low-moderate fuel load. Continuous fuels across a limited portion of the southern and southeastern boundary between NPS/USFS lands could conduct fires both into and out of the park. The USFS is willing to accommodate use of wildland fire in areas adjacent to the parks. Implementation of use of wildland fire and prescribed fire projects requires coordination and cooperation between agencies. Ignitions in the vicinity of ranger stations (especially the Kern station), such as occurred in 2003, require special consideration for safety, and for the preservation of infrastructure and cultural resource values. The Kern Canyon can experience strong canyon winds during the fire season. Thunderstorms along the high elevation ridges may create downdrafts.	Hazards See Table 4-9.

Kings Zone	Kern Zone	Kaweah Zone
drainage along the NPS/USFS boundary. Kings Canyon tends to funnel strong up-canyon winds during the day and moderate down-slope winds at night. The development of a strong thermal belt is common in this area.		
Risks Moderate levels of backcountry visitor use combined with vehicular access to the Cedar Grove portion of this Zone increase the risk of human caused fires. Low elevation fuels consisting of long leaf pine, annual and perennial grasses and forbs, and oaks may result in fast moving fires under windy conditions typical of summer afternoons in the canyon. Most human ignitions in this Zone occur in close proximity to the Cedar Grove developments, and along the Rae Lakes trail corridor. Lightning ignited fires are common throughout the vegetated portions of the Zone, most commonly occurring in the Sheep Creek drainage, and in the Roaring River/Sugarloaf watersheds, with some also in Tehipite Valley. Other significant lightning fires have occurred on the south aspect slopes and ridges above Cedar Grove. This includes the 2005 Comb WFU, which burned more than 14,000 acres on USFS and NPS lands within the canyon.	Risks Moderate levels of backcountry visitor use increase the risk of human caused fires, though human caused fires in this zone are rare. Low elevation fuels consisting of long leaf pine, annual and perennial grasses and forbs, and oaks may result in fast moving fires under windy conditions typical of summer afternoons in the canyon. Lightning ignited fires are common throughout the vegetated portions of the Zone, with most occurring on ridges and benches west of the Kern River. This includes the 6,000 acre West Kern WFU, which occurred in 2003 and was managed on both USFS and NPS lands within the canyon.	Risks See Table 4-9.

Table 4-8 – Description of Fire Management Units (FMUs) in Kings and Kern Zones
Note: Due to the number and complexity of FMUs in the Kaweah Zone, those descriptions are found separately in Table 4-9.

Kings Zone		Kern Zone
Sierra Crest FMU	**Cedar Grove FMU**	**Kern FMU**
Description The Sierra Crest FMU consists entirely of designated wilderness, almost entirely contained within a much larger matrix of wilderness managed by the NPS and USFS. All of the South and Middle Forks of the Kings River are designated as Wild and Scenic. Geographically deep glacial canyons divided by rocky alpine ridges characterize the FMU. It is worth noting that nearly 50% of the FMU consists of rock, water, or similar features that dramatically limit fire spread. Fire spread between sub-drainages is rare, and is hindered by extensive rock and other natural features such as rivers and wet meadows. Wilderness use consisting of day hikers, backpackers, and stock parties is heavy in some areas such as the Rae Lakes loop, along the Pacific Crest Trail, and in the Roaring River drainage. Many other areas are seldom visited. Much of the FMU has been managed as a “natural fire zone” since at least 1970, with most lightning ignitions managed for resource benefit. The parks’ largest natural fire event, the 14,000 acre Ferguson fire, occurred in the Roaring River drainage in 1977. Because of the remote location, generally acceptable fuels and ecosystem conditions, and dissected terrain that allow for safe management of long term and widespread fire events, the primary fire management strategy in this FMU is to optimize the use of use of wildland fire consistent with fire management resources, interagency concerns, and air quality issues.	Description Within the greater Kings Zone is the 25,400-acre Cedar Grove FMU. It consists of the 2,700-acre Cedar Grove developed area and two wilderness sub-watersheds adjacent to the park boundary (Sheep Creek and Lewis Creek). The Sheep Creek watershed feeds the potable water system for most Cedar Grove developments. Care is needed in burning this watershed to minimize erosion and sedimentation that will temporarily affect filtration needs for the water system immediately post-burn. While the overall fire and fuels management objectives for the Zone apply in this FMU, due to its proximity to USFS lands, intensive visitor developments, and lower elevation fuels – the mix of management strategies vary from those applied in the greater Kings Zone. The primary difference is a lesser reliance on use of wildland fire, and a consequent increase in the use of prescribed fire and non-fire fuels management strategies to both maintain ecosystem function as well as reduce hazardous levels of fuels in and around developments. Non-fire fuel treatments are intended for use in small focused areas immediately adjacent to developments, boundaries, and infrastructure. Management of wildland fire projects may occur in this FMU, though it is expected to be a rare occurrence in the near term. After the Sheep Creek and Lewis Creek segments are treated with prescribed fire, the probability of allowing use of wildland fire should increase and become the dominant management strategy, subject to the USFS ability and desire to	Description (The Kern Zone and Kern FMU are synonymous. See Kern Zone description in Table 4-7)

<table>
<tr><th colspan="2">Kings Zone</th><th>Kern Zone</th></tr>
<tr><th>Sierra Crest FMU</th><th>Cedar Grove FMU</th><th>Kern FMU</th></tr>
<tr><td></td><td>accept such events across agency boundaries.</td><td></td></tr>
<tr><td>Size and Composition

Vegetation 236,490
Rock/Water 181,727
Total Acres 418.217
Wilderness 100%</td><td>Size and Composition

Vegetation 23,523
Rock/Water 1,876
Total Acres 25,400
Wilderness 90%</td><td>Size and Composition

Vegetation 110,366
Rock/Water 75,284
Total Acres 185,560
Wilderness 100%</td></tr>
<tr><td colspan="3">Actions Common to all Fire Management Units

Human caused fires – other than those intentionally set by NPS staff or park residents under an approved burn plan or permit – will be suppressed under strategies (confine, contain, control) commensurate with firefighter safety and consideration for resource protection from suppression actions.</td></tr>
<tr><td>Multi-Year Projects and Actions

All of the Sierra Crest FMU will be managed for natural process applying use of wildland fire as the primary tool.

Minor firing and burnout operations to manage and contain use of wildland fire projects will be conducted as needed, as will construction of firelines using minimum impact standards.

Use of wildland fire acreage will vary each year depending on number of natural ignitions and final fire size.

Prescribed fire under an approved burn plan may be used along boundary areas to replace suppressed ignitions and maintain the natural fire regime within the zone. Prescribed fire ignitions will be managed to simulate the pattern and spread of natural ignitions.</td><td>Multi-Year Projects and Actions

The Cedar Grove developed area of the FMU will be managed primarily through the use of prescribed fire throughout the valley, and the use of mechanical fuel removal in limited areas along boundaries and around structures. Prescribed fire projects will be planned on a schedule that mimics the natural fire regime.

The majority of the area from the Lewis Creek drainage to the Copper Creek Drainage was restored to its normal fire return interval during the 2005 Comb WFU. This will provide continued opportunity to manage natural ignitions on this slope for resource benefits. Although the 2006 Roaring WFU initiated the process to restore fire to the south side of Kings Canyon, significant challenges remain in managing fire in the Sheep Creek drainage.

As natural fuel conditions, use of wildland fire projects may be considered in all areas of the</td><td>Multi-Year Projects and Actions

All of the Kern FMU will be managed for natural process applying use of wildland fire as the primary tool.

Minor firing and burnout operations needed to manage and contain use of wildland fire projects will be conducted as needed, as will construction of firelines using minimum impact standards.

Use of wildland fire acreage each year will vary depending on number of natural ignitions and final fire size.

Prescribed fire and Use of wildland fire may be used along NPS/USFS boundary areas and maintain the natural fire regime. Prescribed fire ignitions will be managed to simulate the pattern and spread of natural ignitions.

Minor mechanical fuel treatments may be implemented to provide protection of historic</td></tr>
</table>

Kings Zone		Kern Zone
Sierra Crest FMU	**Cedar Grove FMU**	**Kern FMU**
	unit. To implement fire use projects, firing and burnout operations will be conducted as needed to contain the fire, as will construction of firelines using minimum impact standards.	structures in the vicinity of the Kern Ranger Station and around other structures as needed.
Further Compliance Needs The scope of proposed actions and their expected effects are described in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted within this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during the planning phase to ensure adequate protection for site specific species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.	Further Compliance Needs The scope of proposed actions and their expected effects are described in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted in this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during the planning phase to ensure adequate protection for special status species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.	Further Compliance Needs The scope of proposed actions and their expected effects are described in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted in this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during the planning phase to ensure adequate protection for special status species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.

Table 4-9 – Description of Fire Management Units (FMUs) in Kaweah Zone

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
Description While the smallest FMU in the park, the Grant Grove unit contains significant resources including "The Nations Christmas Tree" (the General Grant tree), the largest intact giant sequoia grove (Redwood Mountain), extensive caves, and outstanding accessible wilderness areas. This FMU also contains the most intensively developed area in the parks. The NPS managed Grant Grove developed area completely surrounds Wilsonia; a private community of over 100 seasonally occupied vacation homes. The presence of extensive public and private developments creates classic wildland urban interface conditions. The FMU is long and narrow, and shares most of its 54-mile boundary with the USFS managed Giant Sequoia National Monument. The FMU also shares 1.6 miles of boundary with the State	Description The North Fork FMU is one of the least accessible and most varied FMUs in the Kaweah Zone. The FMU contains a wide range of plant communities - starting with low elevation foothill chaparral, changing to mixed conifer forest containing four giant sequoia groves at mid-elevation, and ranging upward into red fir forest. Other than the main park road bisecting the FMU at mid elevation, development in this unit is limited to a seasonally operated campground (Dorst), a seasonal park residence (Cabin Creek), and the Crystal Cave interpretive site and access road. Few trails penetrate the interior of the FMU. Limited access, extensive boundary exposure, continuous fuels providing connectivity between foothills chaparral and mid-	Description As the second smallest Fire Management unit in the Kaweah Zone, the Marble Fork represents the only watershed that is completely contained within park boundaries. The FMU contains most plant communities, including all or a portion of two sequoia groves, and the largest tree in the world (General Sherman). The Giant Forest grove extends across the Giant Forest plateau into the Middle Fork drainage, and is the only grove in the parks that spans two watersheds. Large portions of the Giant Forest grove are under active restoration in areas of prior development. Fire plays a significant role in the restoration program, and will be returned fully to its natural role at some point in the future (approximately 2010). The unit contains major	Description The Middle Fork is the largest of the Kaweah fire management units encompassing over 75,000 acres, 95% of which are in designated or proposed wilderness. This bowl-shaped drainage contains the lowest elevations in the parks as well as the Great Western Divide at its eastern boundary. The unit includes all of the parks' major plant communities and fuel models. Four sequoia groves are completely contained in the unit, in addition to the southern portion of the Giant Forest grove Developments include the parks' headquarters, employee housing, a visitor center, and campground. The upper two-thirds of the unit are remote wilderness making access difficult. The only road access is the main park highway along the bottom third of the unit.	Description The East Fork fire management unit encompasses some of the most accessible high elevation in the park. Topographically it is a long steep west-facing drainage with high ridges forming the northern and eastern boundary. More open on the southern perimeter across the Hockett Plateau, this drainage ventilates smoke more readily than the Middle Fork. The East Fork contains all the parks' vegetation communities and fuel models, including a dozen distinct giant sequoia groves. The ease of access is due to the Mineral King road that follows up the drainage parallel to the river from the foothills to near tree line. Along the road are various park and private developments and the road corridor itself has been determined eligible as a National	Description The South Fork unit contains twelve giant sequoia groves, including the recently acquired Dillonwood grove. The Dillonwood addition will undergo a separate park planning process, and may include active restoration and fire research opportunities. Having few developments and little road access, the South Fork remains one of the least visited portions of the parks. Developments are limited to a single primitive campground and related entrance road just inside the west park boundary. Ninety-five percent of this unit is in proposed wilderness. Forming the southwest corner of the parks, the South Fork has a high proportion of its boundary shared by other federal agencies and private landowners.

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
of California at Whitaker Forest and one mile of boundary with private lands at Sequoia Lake. As of 2007, 57% of the vegetated acres in the Grant Grove FMU were in "high" or "extreme" FRID classes, indicating a high amount of deviation from desired natural conditions. Of all the FMUs in the park, the Grant Grove FMU has the highest rate of compromised acres. These ecological conditions are correlated with high fuel loads and a dense overstory in the mixed conifer vegetation type dominant within the FMU. An infrequent outbreak of the native Douglas fir tussock moth in 1998-2000 resulted in a high mortality of white fir trees throughout the FMU. The high mortality left behind increased fire fuels in all size classes.	elevation mixed conifer, and steep terrain all present challenges to pro-active fire and fuels management of the North Fork FMU. This unit has the highest proportion of chaparral of all FMUs. Chaparral fuels are generally highly volatile and available to ignite and burn through a large portion of the year. This factor, along with the large amount of external boundary exposure and difficult access strongly influences fire management decisions in the unit. Nearly half of the acres in the FMU are in the high-extreme FRID class, the second highest deviation from desired conditions among all the FMUs in the parks. There is significant potential for rapid large fire development in this unit.	park developments including two campgrounds, employee housing, two visitor centers, visitor lodging and related services, and numerous roads. The unit is bisected in the middle elevations by the major park road – the Generals Highway. The half of the unit above the Generals Highway is completely roadless. The interior of the roadless areas is difficult to access and extremely steep and rugged. Few natural barriers to fire spread occur within the unit or between this unit and adjacent fire management units.	The gateway community of Three Rivers sits at the confluence of the Middle Fork and two other rivers at the bottom of this drainage. Due to the unique topography of this drainage (large bowl shape and high ridges to the east) smoke from fires vents less readily here than in other drainages in the parks. The pooling of smoke results in nighttime drainage of smoke into the community under certain meteorological conditions.	Historic District. Park developments include 2 campgrounds, an entrance station, park housing and administrative functions, and a ranger station. Private developments include numerous cabins on both private and leasehold lands generally grouped into 5 small communities. The road as an ignition source and the risk to interface communities and developments along the road are of particularly high concern when addressing fire management in this unit.	This unit contains most park vegetation communities in the park and has the second highest proportion of chaparral of all FMUs. Difficult access, broken terrain, volatile fuels, and cross boundary fire management concerns pose significant challengers for fire management. This unit has significant potential for rapid large fire development
Size & Composition	Size & Composition	Size & Composition	Size & Composition	Size & Composition	Size & Composition

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
Vegetation 14,698 Rock/Water 563 Total 15,211 Wilderness* 56% *Proposed wilderness.	Vegetation 30,389 Rock/Water 533 Total 30,389 Wilderness* 86% * Includes designated and proposed wilderness.	Vegetation 28,441 Rock/Water 5,157 Total 33,598 Wilderness* 64% *Includes designated and proposed wilderness.	Vegetation 58,605 Rock/Water 14,942 Total 73,547 Wilderness* 90% *Includes designated and proposed wilderness.	Vegetation 42,954 Rock/Water 7,187 Total 50,141 Wilderness* 68% *Includes designated and proposed wilderness.	Vegetation 30,482 Rock/Water 2,088 Total 32,570 Wilderness* 95% *Proposed wilderness.
Each Kaweah FMU is described below based on six different values: 1) special designations and features, 2) park developments, 3) vegetation, 4) private lands, 5) cultural resources, and 6) boundary interface; along with hazard and risk factors. The values are not in priority order.					
Value 1: Special Designations & Features 56% of the FMU is proposed wilderness. Most Grant Grove developments are within the proposed “General Grant National Park National Historic District”. Wilsonia (including some NPS structures) is a National Historic District. The General Grant Tree is designated by presidential proclamation as “the Nation’s Christmas Tree.”	Value 1: Special Designations & Features 86% of the FMU is designated or proposed wilderness. The entire Colony Mill Road (now a trail) is on the List of Classified Structures.	Value 1: Special Designations & Features 64% of the unit is designated or proposed wilderness The General Sherman Tree in Giant Forest grove is the largest tree in the world.	Value 1: Special Designations & Features 90% of the FMU is designated or proposed wilderness. Historic structures include the Southern California Edison flumes and appurtenances.	Value 1: Special Designations & Features 68% of the unit is designated or wilderness The Mineral King road and associated features are eligible for Cultural Landscape designation.	Value 1: Special Designations & Features 95% of the unit is proposed wilderness. Critical habitat for the threatened Little Kern golden trout occurs in the Little Kern watershed in the southeastern portion of the unit.
Value 2: Park Developments	Value 2: Park Developments	Value 2: Park Developments	Value 2: Park Developments	Value 2: Park Developments	Value 2: Park Developments

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
Dense development characterizes the northern segment of the FMU (Grant Grove) including three campgrounds, NPS employee housing, 100+ private homes in the Wilsonia community, 50+ overnight lodging rooms, a market, restaurant, visitor center, and other visitor support facilities. The southern segment of the FMU (Redwood Mountain) contains a few administrative developments and extensive tracts of sequoia groves.	The North Fork is traversed by portions of the primary park road (Generals Highway) as well as the Crystal Cave Road. Other than the heavily traveled Generals Highway the unit has few developments. The seasonally operated Dorst Campground and Crystal Cave comprise the primary focal points for visitor use within the unit.	Most Sequoia National Park developments are in the Marble Fork Unit. These include 2 campgrounds, 2 visitor centers, General Sherman Tree parking and associated developments, the Wuksachi Lodge development, park housing, and a significant commercial center at Lodgepole operated by the park concession. The Generals Highway bisects the unit, and a significant portion of the Crystal Cave road traverses the western end of the Marble Fork FMU.	Park developments in the Middle Fork are clustered primarily along the Generals Highway road corridor. They include park headquarters, administrative pastures, employee housing, a picnic area, and one campground. A significant exception to developments being associated with the road corridor is the Bearpaw backcountry camp located deep in the Middle Fork wilderness and far from any road. This development (including an NPS campground and concession facility) may house 50 or more visitors and employees during the summer months, with no ready means of escape in case of wildfire.	The East Fork contains several private inholdings and communities, as well as 2 campgrounds and numerous administrative developments. The seasonally occupied private cabins are primarily clustered in five different locations throughout the south aspect of the watershed. They range from small rustic cabins to at least one home valued at over 1.5 million dollars. Administrative developments include stables, employee housing, maintenance shops, and a visitor contact station.	Few developments occur in this unit, limited to one rustic campground and a short segment of road leading in from the west. Dillonwood, an addition to the park in 2001, also has several buildings and a network of logging roads that provide access into that area from the south.
Value 3: Vegetation Vegetation is more homogeneous than other FMUs in the Kaweah Zone, containing only eight of the parks 12 vegetation	Value 3: Vegetation This unit has high diversity in vegetation, containing 11 of the parks' 12 vegetation types.	Value 3: Vegetation This unit is similar to the North Fork FMU in vegetation composition, including all twelve vegetation communities found in the parks	Value 3: Vegetation Vegetation in the Middle Fork unit is diverse, containing all 12 vegetation community types found in the parks.	Value 3: Vegetation Vegetation in the East Fork unit is diverse, containing all twelve vegetation community types found in the parks.	Value 3: Vegetation The South Fork unit also contains all 12 vegetation communities, including the largest number of sequoia acres of all park FMUs.

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
communities. It is dominated by mixed conifer forest (68% of vegetated area) with significant tracts of ponderosa pine forest and mid-elevation hardwood. The FMU also contains four giant sequoia grove complexes totaling 2,509 acres, proportionately the highest percentage of sequoia acres of all FMUs in the parks (17% of all Grant FMU acres).	Unit acres are dominated by foothill chaparral at lower elevations, followed by roughly equal components of foothills hardwoods, ponderosa pine forest, and white fir-mixed conifer as elevation increases. It is missing only the subalpine conifer forest community. Four giant sequoia groves occur in the unit over a total of 387 acres.	(though the subalpine component is extremely small). It is dominated by a combination of white fir-mixed conifer and red fir forest, with significant components of ponderosa pine and lodgepole forest. Giant sequoia groves occur on 1,500 acres in two groves. This unit includes most of the Giant Forest grove. The entire Giant Forest grove is functionally managed as part of the Marble Fork FMU.	It is dominated by low elevation foothill chaparral and hardwoods, with a significant component of white fir-mixed conifer forest at the mid-elevations. It contains 4 sequoia groves covering 1,424 acres including a portion of the Giant Forest grove, though that grove is functionally managed as part of the Marble Fork FMU.	It is dominated by the higher elevation red fir forest, as well as a significant component of white fir-mixed conifer. The unit contains eight giant sequoia groves totaling 2,455 acres. It includes one grove, Atwell, which had been partially logged in the late 19th century.	It is dominated by red fir forest (27% of vegetated acres) with significant components of white fir-mixed conifer and lodgepole pine forest. With the recent addition of Dillonwood grove to the park, the unit contains approx. 3,100 acres of giant sequoias across 12 groves.
Value 4: Private Lands Inside the Parks Wilsonia is a defined community with an intermix of over 100 privately owned and NPS tracts. Cabins are primarily seasonal summer use, though a few are occupied year-round.	Value 4: Private Lands Inside the Parks None	Value 4: Private Lands Inside the Parks None	Value 4: Private Lands Inside the Parks None	Value 4: Private Lands Inside the Parks The East Fork contains substantial numbers of private lands and leasehold properties scattered throughout the drainage. Most are arranged in a wildland urban interface configuration and require pro-active management of fuels to afford protection. The properties are:	Value 4: Private Lands None

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
				Oriole Lake (privately owned – approximately 7 properties) Silver City (privately owned – approximately 50 properties) Kaweah Han (privately owned – single owner) Mineral King developed areas (mix of private lands [2 Disney properties], and 40-60 leasehold cabin sites on public lands)	
Value 5: Cultural Resources All areas of the parks may contain unknown surface and sub-surface archeological resources. Since it is impractical to survey 100% of park lands for potential resources prior to ignition, and since fire has the potential to affect all vegetated parklands, protections for detecting and mitigating unknown archeological resources are built into individual project planning documents and standard operating procedures. Significant known archeological and historic resources will be protected from fire damage to the extent feasible given firefighter safety concerns. Due to the sensitive nature of known archeological site information, park cultural resource staff will be consulted on a project-by-project basis and protection of known cultural resources will be built into each project plan as required by the park archeologist. While some known historic resources that may likely interact with fire management actions are listed by FMU below (non-sensitive information), others may yet be unlisted or their status may change over time. When planning projects, also refer to the List of Classified Structures (LCS) and the list of designated and proposed historic districts and landscapes in Appendix H for further information. See also the list of park protected giant sequoia trees and features listed in Chapter 5 of this plan.					
General Grant National Park Historic District (Proposed) Wilsonia National Historic District 5 buildings on the List of	Crystal Cave - trail, gate, generator house (LCS) Cabin Creek structures (LCS) Lost Grove Comfort Station (LCS)	Moro Rock Stairway (LCS) Tharps Log (LCS) Squatters Cabin (LCS) Cattle Cabin (LCS) District Ranger	Ash Mountain Historic District (Proposed) Sycamore Historic District (Proposed) Redwood Meadow Ranger Station and out	Mineral King Road Cultural Landscape District (Eligible) Hockett Meadow Ranger Station (LCS)	Quinn Ranger Station (LCS)

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
Classified Structures (LCS)	Colony Mill road (LCS)	Residence #55 (LCS)	buildings (LCS)		
Value 6: Boundary Interface & Local Community Issues The FMU shares 1.6 miles of its 28 mile external boundary with the State of California at Whitaker Forest, and one mile of boundary is shared with the privately owned Sequoia Lake facility for a total of 2.6 miles of boundary. The remaining external boundary is shared with the USFS Giant Sequoia National Monument and Sequoia National Park. An additional 2 miles of internal boundary separates the Wilsonia community from public parklands. Proper smoke management is a critical concern, especially at night when smoke may pool down-slope in and around the Sequoia Lake and Hume Lake developments outside the park.	Value 6: Boundary Interface & Local Community Issues The North Fork FMU shares over 19 miles of external boundary with a mix of other public (15 miles) and private lands (4 miles). The approximate breakdown is: 4.6 miles – USFS Jennie Lakes Wilderness 2.8 miles - Giant Sequoia National Monument 7.8 miles – Bureau of Land Management 4 miles – Private lands Proper smoke management is a large consideration as the North Fork drains directly into the Three Rivers community, and may result in some smoke pooling in that community at night. Emergency road and facility closures and extreme smoke events may affect local businesses.	Value 6: Boundary Interface & Local Community Issues This unit shares only a small amount of its perimeter, about 0.5 miles, with the USFS Jennie Lakes wilderness. The remainder of the boundary is surrounded by parklands. Proper smoke management is a consideration for operations in this unit, as the Marble Fork drains into the Middle Fork of the Kaweah and may affect park housing areas at Ash Mountain, or the community of Three Rivers under extreme conditions.	Value 6: Boundary Interface & Local Community Issues The Middle Fork FMU shares 5.7 miles of boundary with the Bureau of Land Management and 3.1 miles of boundary with private lands. The Middle Fork presents the most challenging area for smoke management. The deep wide valley surrounded by high elevations ridges and peaks has only one narrow outlet. Under less than optimal conditions, the valley tends to accumulate smoke which may drain down valley at night – carrying smoke into populated areas such as the park housing area at Ash Mountain, and the community of Three Rivers. As Three Rivers is a primary gateway community for park visitors, emergency road	Value 6: Boundary Interface & Local Community Issues The East Fork shares 9 miles of external boundary with other agencies and private landowners. Three miles of boundary are adjacent to the USFS Golden Trout wilderness, and additional 3.5 miles are shared with the Bureau of Land Management, and the remaining 2.5 miles are shared with private landowners. An additional 4 miles (approximate) of boundary separates parklands from privately held lands inside the unit. Proper smoke management is a consideration for all operations in this unit, as the East Fork drains directly into the community of Three Rivers. Due to topography and distance, smoke is less	Value 6: Boundary Interface & Local Community Issues The South Fork FMU has the greatest exposure of external boundary of all Kaweah Zone units. It has over 30 miles of boundary shared with: 4.6 miles – USFS Golden Trout Wilderness 10.2 miles – Giant Sequoia National Monument 7.8 miles – Bureau of Land Management 4 miles – Privately owned lands Proper smoke management is a consideration for fire operations in this unit, as the South Fork drains directly into the community of Three Rivers. Due to topography and distance, smoke is less prone to pool in this drainage, and concentrated nighttime smoke movement into populated areas outside

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
Smoke may also drain northward into the South Fork Kings drainage, affecting visitors and concession facilities (Kings Canyon Lodge on the USFS Hume Lake district, and Cedar Grove developments in Kings Canyon NP.) Emergency closures and extreme smoke events may affect local businesses.			and facility closures as a result of fire operations, events may affect local businesses. Extreme smoke events may result in fewer visitors visiting the area or reducing their stay – with the potential to affect local businesses.	prone to pool in this drainage, and concentrated nighttime smoke movement into populated areas outside of the parks is rare. Emergency road and facility closures during the peak visitor season or extreme smoke events may affect local businesses.	of the parks is rare. Emergency closures during the peak visitor season or extreme smoke events may have a slight affect on local businesses.
Hazards The Grant unit has the largest departure from desired conditions of all the FMUs in the parks. Fully 57% of all acres in the FMU are in the high or extreme FRID classes, which combined with the dominance of mixed conifer fuel models (37% of acres in FM-10); indicate high fuel loads across most areas. Added to already high fuel loads, mortality in white fir resulting from the 1998-2000 Douglas	Hazards The North Fork has the second most altered fuel conditions in the park. Fully 48% of the unit's acres show high or extreme departure from desired conditions. Twenty percent of North Fork acres are in fuel model 10, indicating high fuel loads across much of the unit. Given the dominance of high deviation from natural conditions and the high percentage of the unit consisting of	Hazards The Marble Fork unit has 19% of its acres in a high or extreme FRID class. This is the lowest amount in the Kaweah Zone, and can be partially attributed to the pro-active prescribed fire and fuels management focus this area has received over the past 30 years. Approximately 20% of the acres are in fuel model 10, with the bulk of the remaining acres in high elevation mixed	Hazards Twenty-four percent of the acres in this unit are in a high or extreme FRID class. Wildfires and wildland use fires account for much of the activity that has maintained the unit in the past, though significant portions were also burned in prescribed fires in the late 1970s and early 1980s. High fuel loads associated with fuel	Hazards Similar to the Middle Fork FMU, 25% of East Fork acres are in a high or extreme FRID class. Numerous prescribed fires in this unit since 1995 have contributed to significantly lower fuel loads across critical areas necessary to protecting park developments and private inholdings. High fuel loads associated with fuel model 10 accounts for	Hazards Nearly 35% of the acres in the South Fork are in a high or extreme FRID class. High fuel loads associated with fuel model 10 account for about 21% of the acres in the South Fork. Fuel loads in the recently acquired Dillonwood grove are unknown at this time, though they may be substantial due to past logging activity.

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
fir tussock moth outbreak created a significant new increment in fuel load across much of the FMU. Fuels are continuous within and across park boundaries with few natural boundaries to retard spread. There is high exposure of this unit to external boundaries and ignition sources. Fuel loads are generally unnaturally high across the unit. Developments are generally situated mid-slope with heavy fuels and potential ignition sources below. The northern portion of the unit is extensively road allowing ready access and providing some man-made holding boundaries. The southern portion of the unit has road access along the eastern boundary and is bisected by a rough dirt road, making the interior less accessible with few natural holding	more flammable low elevation fuel types (chaparral and foothills hardwoods) this unit presents significant challenges to pro-active fuels management. In addition to high fuel loads, there is a high degree of continuity between flashy and highly flammable chaparral and foothills and mid-elevation conifer forests. Few effective natural or man-made barriers to fire spread exist. The unit has a high exposure to external boundaries including private lands. Road access is limited. Due to prevailing west aspect and low elevation component, the unit receives full solar radiation throughout the burn period. The terrain is generally steep and rugged.	conifer, somewhat similar to a fuel model 8. Vegetation communities dominating this unit consist of those showing moderate to frequent natural fire return intervals, so consistent attention is needed to maintain and improve conditions.	model 10 accounts for only 11% of the acres in the Middle Fork. Difficult access and smoke dispersal issues make pro-active fuels management challenging in this unit.	only 15% of the acres in the East Fork.	Fuels are continuous within and across park boundaries with few natural boundaries to retard spread. There is high exposure of this unit to external boundaries and ignition sources.

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
boundaries. Steep west aspect slopes leading into mid-slope developed areas and across boundaries are exposed to full solar radiation during the burn period.					
Risks Analysis of past human-caused ignitions shows the Grant FMU having the highest incidence of human caused ignitions in the parks. This is primarily due to dense development, an extensive trail network, and highways through and around the unit. The unit averages 2-4 lightning ignitions per square mile over the 35-year analysis period).	Risks Human ignitions in the North Fork FMU are rare, and generally clustered around developments such as Dorst Campground and the Generals Highway. A low level of lightning ignitions occur in this unit (<2 per square mile over 35-year analysis period), with the highest lightning ignition densities in the elevations above 6,000 feet.	Risks The Marble Fork FMU has the second highest rate of human-caused ignitions in the parks concentrated around developments and roadways. Extensive visitor facilities (especially campgrounds) and administrative developments, roads, and trails account for the higher level of human activity and associated ignitions in this unit. A moderate level of lightning activity occurs in the higher elevations (above 6,000 feet) of this unit, focused on the Silliman Divide, with some lightning ignitions reported in the mid-elevations (4,000-6,000 feet)	Risks Human ignitions in the Middle Fork FMU are focused primarily around the Generals Highway corridor where overheated vehicles are a source of frequent ignition. Recreational use along the lower reaches of the Middle Fork Kaweah also contributes human ignitions in this unit. Lightning ignitions occur at a low to moderate rate primarily following the mid-elevation ridges.	Risks A relatively low rate of human ignitions occurs in the East Fork despite a steep winding road through the unit and numerous campgrounds. Lightning ignitions occur at a moderate to high rate along mid-elevation ridges and on the Hockett Plateau.	Risks Few human caused ignitions have been recorded in the South Fork unit over the past 35 years, though the potential certainly exists. The presence of a campground and hiking trails at low elevations, combined with steep terrain and flashy fuels present significant potential. Lightning ignitions occur at a moderate to high rate, primarily along mid-elevation ridges.

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
Actions Common to all Fire Management Units Human caused fires – other than those intentionally set by NPS staff or park residents under an approved burn plan or permit – will be suppressed under strategies (confine, contain, control) commensurate with firefighter safety and consideration for resource protection from suppression actions.					
Multi-Year Projects and Actions Prescribed fire will be used as the primary tool to fully restore and maintain fuel conditions and ecological function on all undeveloped sites. Treatments will be planned and scheduled to maintain the FMU within the range of natural variability. Mechanical fuel treatments will be used throughout the NPS developed area to reduce fuels, including NPS lands within and around the Wilsonia community. A 200-foot buffer out from developments will be established and maintained. Treatments will be designed to mimic natural forest structure and composition, and will be repeated every 5-15 years as necessary to maintain fire-safe	Multi-Year Projects and Actions At mid and low elevations, prescribed fire will be used as the primary tool to restore and maintain fuel conditions and ecological function. Treatments will be planned and scheduled to maintain the FMU within the range of natural variability. Mechanical fuel treatments will be used throughout and surrounding the NPS developed areas to reduce fuels. A 200-foot buffer out from developments will be established and maintained. Treatments will be designed to mimic natural forest structure and composition, and will be repeated every 5-15 years as necessary to maintain fire-safe conditions. Mechanical	Multi-Year Projects and Actions Prescribed fire and use of wildland fire will be the primary tools used to restore and maintain ecosystem and hazard fuel conditions within acceptable standards in this unit. Mechanical fuel treatments may also be used in areas adjacent to developments and roads. A 200-foot buffer out from developments may be established and maintained. Mechanical treatments will be designed to mimic natural forest structure and composition, and will be repeated every 5-15 years as necessary to maintain fire-safe conditions. Use of wildland fire may be considered throughout the unit in	Multi-Year Projects and Actions Prescribed fire and use of wildland fire will be the primary tools used to restore and maintain ecosystem and hazard fuel conditions within acceptable standards in this unit. Mechanical fuel treatments may also be used in areas adjacent to developments and roads. A 200-foot buffer out from developments may be established and maintained. Mechanical treatments will be designed to mimic natural forest structure and composition, and will be repeated every 5-15 years as necessary to maintain fire-safe conditions. Use of wildland fire may be considered throughout the unit in	Multi-Year Projects and Actions Prescribed fire and use of wildland fire will be the primary tools used to restore and maintain ecosystem and hazard fuel conditions within acceptable standards in this unit. Mechanical fuel treatments may also be used in areas adjacent to private lands and public developments and roads. A 200-foot buffer out from developments may be established and maintained. Mechanical treatments will be designed to mimic natural forest structure and composition, and will be repeated every 5-15 years as necessary to maintain fire-safe conditions. Use of wildland fire may be considered	Multi-Year Projects and Actions Prescribed fire and use of wildland fire will be the primary tools used to restore and maintain ecosystem and hazard fuel conditions within acceptable standards in this unit. Mechanical fuel treatments will be used adjacent to NPS developed areas to reduce fuels. A 200-foot buffer out from developments will be established and maintained. Treatments will be designed to mimic natural forest structure and composition, and will be repeated every 5-15 years as necessary to maintain fire-safe conditions. Mechanical treatments may also be employed along the park

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
conditions. Mechanical treatments may also be employed along the park boundary where the use of prescribed fire alone will constitute an unacceptably high risk to non-park lands or values. When adjoining agency implementation timeframes and management objectives coincide with the parks, fuels projects will be implemented across boundaries on an interagency basis. Use of wildland fire may be considered throughout the unit in places and at times of year that will not pose an unacceptable risk to FMU values. Research burns in portions of the Redwood Mountain grove may be implemented as part of a larger study plan in cooperation with adjacent agencies. The Redwood Mountain grove, with portions managed by three	treatments may also be employed along the park boundary where the use of prescribed fire alone will constitute an unacceptably high risk to non-park lands or values. When adjoining agency implementation timeframes and management objectives coincide with the parks, fuels projects will be implemented across boundaries on an interagency basis. Use of wildland fire may be considered throughout the unit in places and at times of year that will not pose an unacceptable risk to FMU values. Due to the lack of accessibility and absence of natural or man-made boundaries in this unit, the park acknowledges that wildfires may be difficult to manage or contain within this unit. As a result, aggressive initial action consistent with firefighter safety will be a high probability for starts below 5,000’ elevation.	places and at times of year that will not pose an unacceptable risk to FMU values.	places and at times of year that will not pose an unacceptable risk to FMU values.	throughout the unit in places and at times of year that will not pose an unacceptable risk to FMU values.	boundary where the use of prescribed fire alone will constitute an unacceptably high risk to non-park lands or values. When adjoining agency implementation timeframes and management objectives coincide with the parks, fuels projects will be implemented across boundaries on an interagency basis. Use of wildland fire may be considered throughout the unit in places and at times of year that will not pose an unacceptable risk to FMU values. Research burns in portions of the Dillonwood grove may be implemented under approved study plans.

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
different agencies, provides an ideal place to conduct research comparing different management strategies for giant sequoia. In the 1960s Redwood Mountain was the location of significant research documenting the role of fire in giant sequoia systems.	Fires that escape initial action at lower elevations are likely to grow large until intercepting significant natural or man-made boundaries.				
Further Compliance Needs The scope of proposed actions and their expected effects are thoroughly assessed in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted in this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during	Further Compliance Needs The scope of proposed actions and their expected effects are thoroughly assessed in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted in this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during	Further Compliance Needs The scope of proposed actions and their expected effects are thoroughly assessed in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted in this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during	Further Compliance Needs The scope of proposed actions and their expected effects are thoroughly assessed in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted in this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during	Further Compliance Needs The scope of proposed actions and their expected effects are thoroughly assessed in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted in this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during	Further Compliance Needs The scope of proposed actions and their expected effects are thoroughly assessed in the companion Environmental Assessment (EA). All mitigating actions contained in the EA will be implemented for projects conducted in this unit. Cultural resource consultation with the park archeologist will take place during the planning phase for all projects. In addition, mechanical fuel projects will require consultation with park wildlife and plant ecologists during

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
the planning phase to ensure adequate protection for site specific species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.	the planning phase to ensure adequate protection for site specific species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.	the planning phase to ensure adequate protection for site specific species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.	the planning phase to ensure adequate protection for site specific species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.	the planning phase to ensure adequate protection for site specific species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.	the planning phase to ensure adequate protection for site specific species. Other than actions noted above or as contained in the EA, no additional environmental compliance will be required for projects that fall within the scope of projects and effects described in the EA.

Figure 4-10 – Map of Kings Zone Fire Management Units (FMUs)
(The Kings Zone has only two FMUs, called the Sierra Crest FMU and Cedar Grove FMU.)

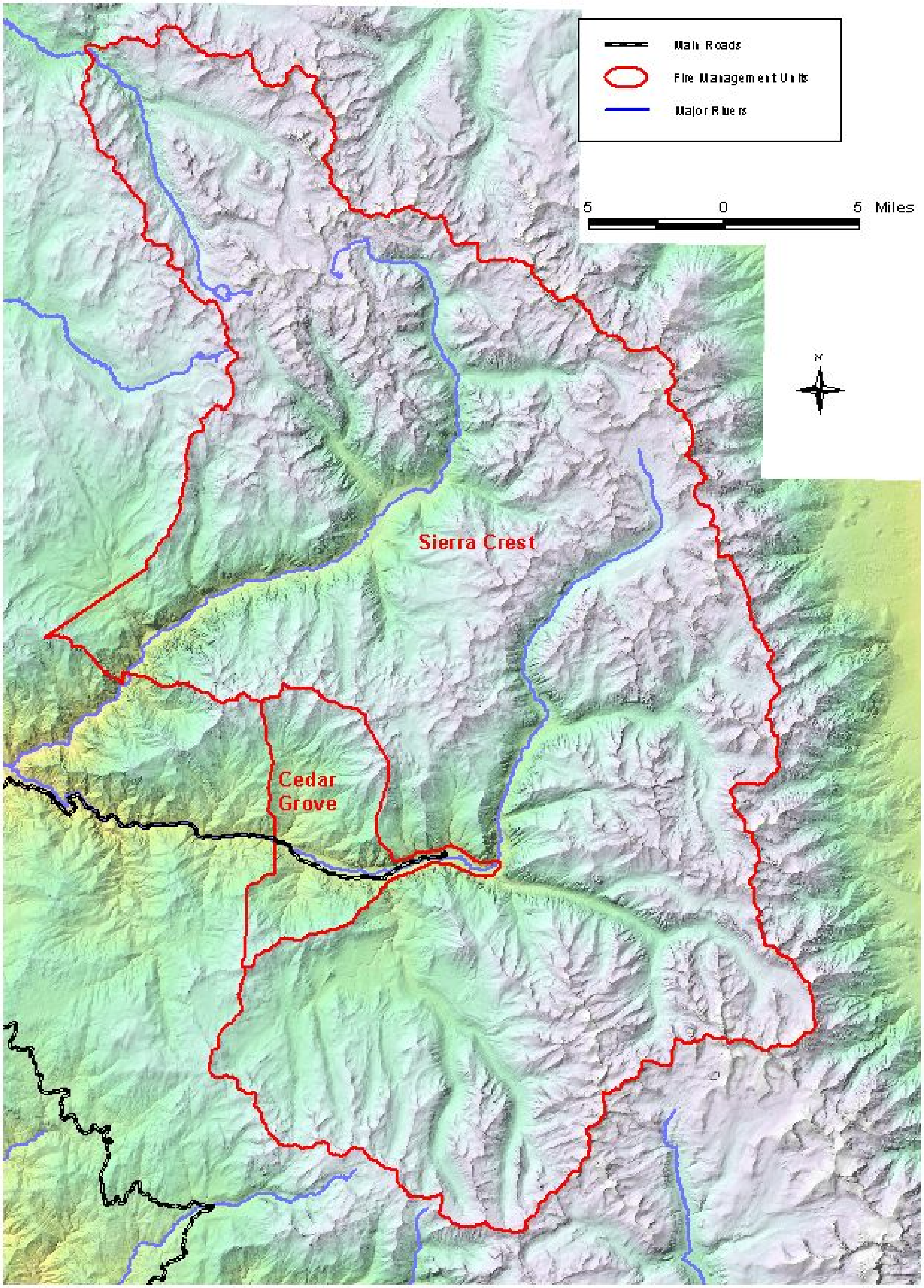


Figure 4-11 – Map of Kern Zone Fire Management Units (FMUs)
(The Kern Zone has only one FMU, called the Kern FMU.)

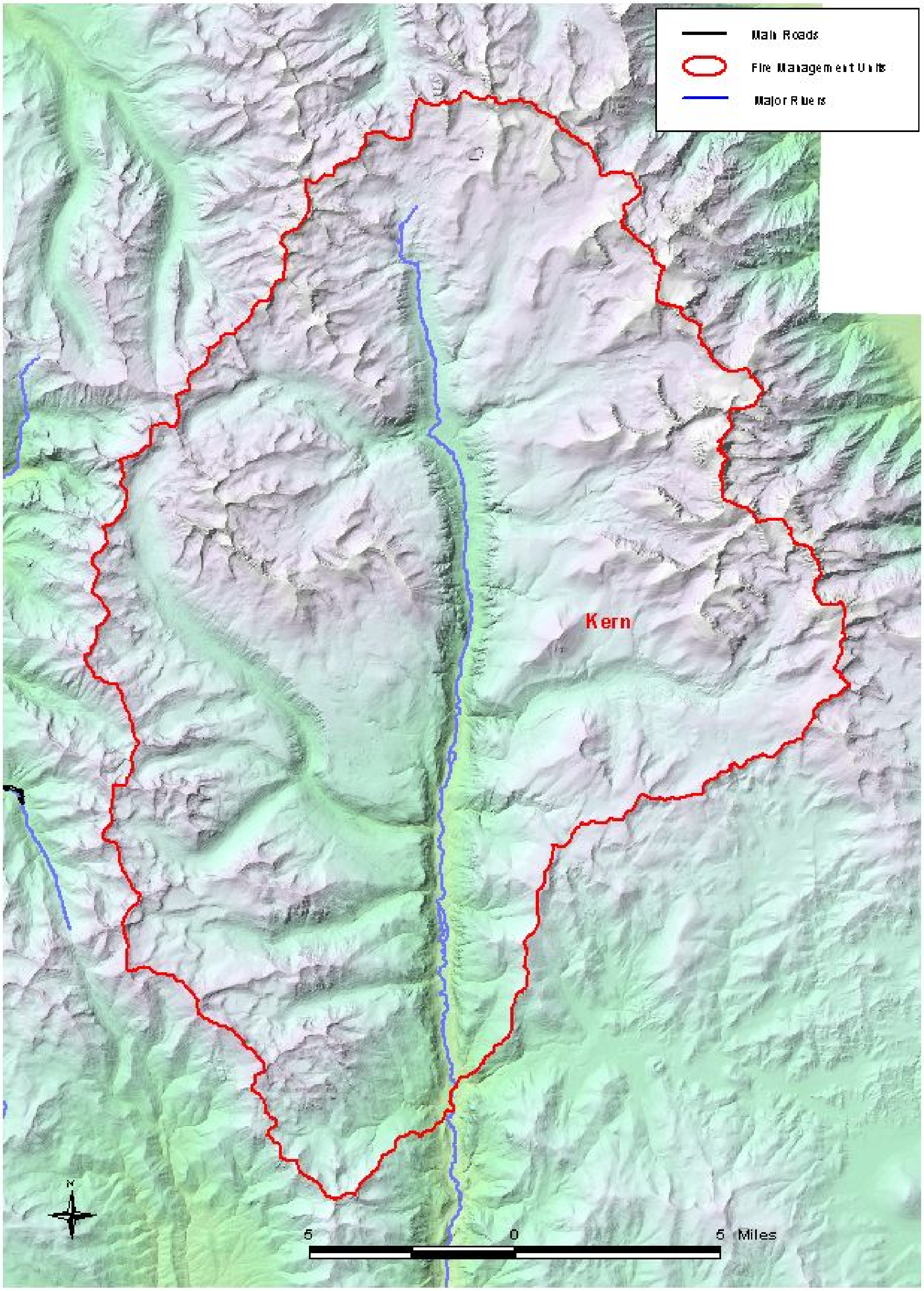
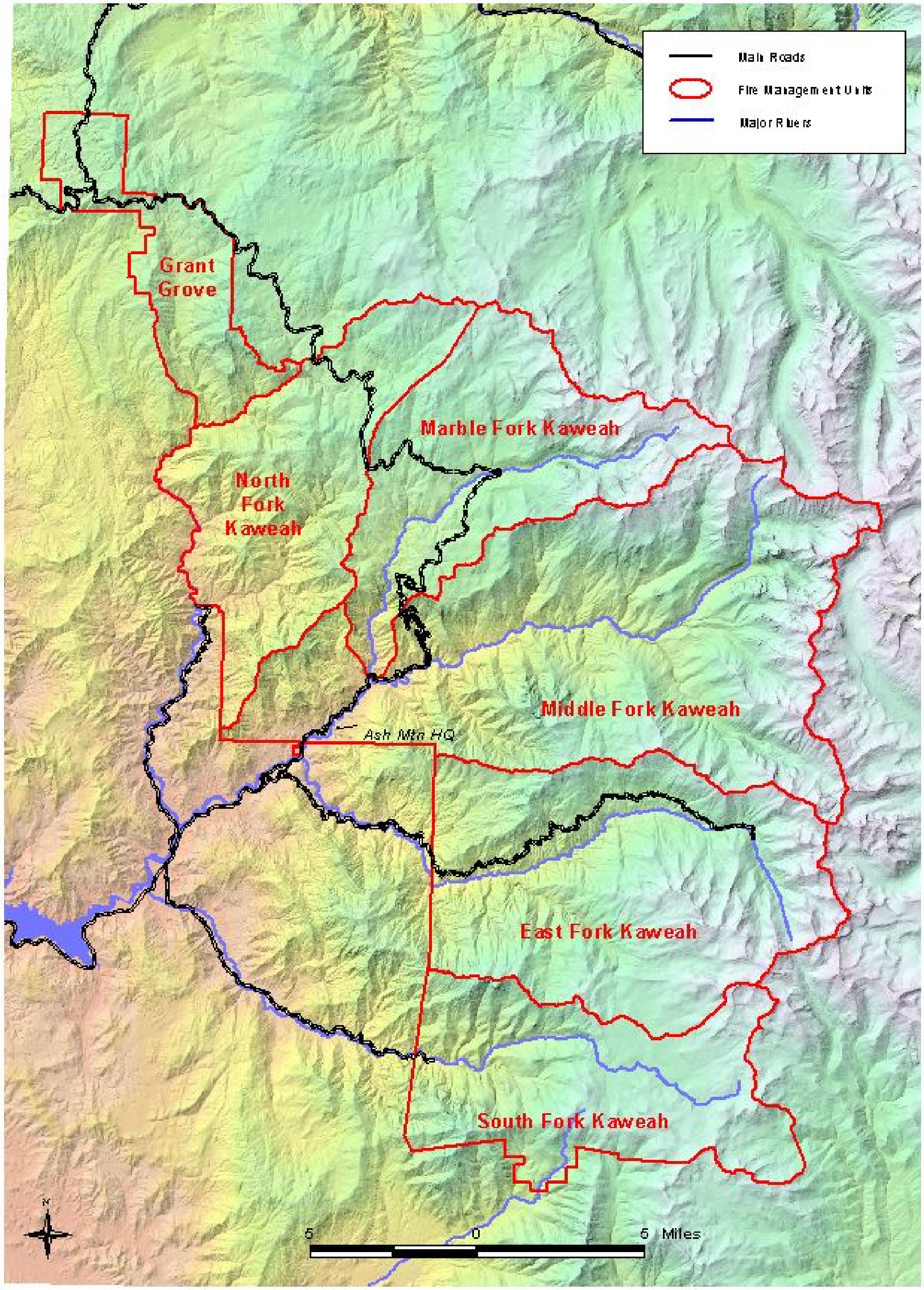


Figure 4-12 – Map of Kaweah Zone Fire Management Units (FMUs)



5. Protection of Sensitive Values

GIANT SEQUOIA ISSUES: MANAGEMENT AND PROTECTION

Thirty-nine giant sequoia groves (11,417 acres) exist as enclaves in the mixed conifer forest within the two parks. In the early years of the parks' history, management made every attempt to exclude fire from the groves. After ~75 years of fire suppression, the loss of fire as a keystone ecological influence produced "unnatural fuel conditions" and changed the forest structure of the groves.

In the late 1960s, the parks developed a prescribed fire program to reverse these effects. Fire management objectives focused on fuel reduction to promote sequoia reproduction. Prescriptions used during restoration burns generally produced a low intensity fire by compensating for "unnaturally heavy fuels" with conservative firing techniques, timing, and weather.

In general, the parks' sequoia groves will not be treated differently from the white fir/mixed conifer forest. The sequoia groves will be managed as ecosystems with natural processes, not collections of individual trees. However, this chapter discusses two exceptions to this practice where ***Special Management Areas*** and ***Trees of Special Interest*** (defined below) are given extra attention in relation to fire. The parks will continue to use fire as a management tool; however, care will be taken to minimize the effects of fire on these special areas.

Special Management Areas (SMAs)

Special Management Areas (SMAs) are designed to balance natural process restoration with the need to preserve the important scenic value of the forest in heavily-used portions of groves where there are large numbers of visitors or developments. SMAs will be maintained as features with a managed landscape based on historical appearance.

SMA protection does not exclude all fire or management activities. In these areas, prescribed burning can be done on a small scale to provide for public safety, and to prevent sudden, large-scale scenic changes. Fire management staff will consider prescribed burn unit size, the location of subsequent prescribed burns, and the protection of various scenic resources when planning projects in SMAs. Specific objectives and techniques are outlined later in this chapter.

The parks have two designated SMAs: the 22-acre Grant Tree SMA (Figure 5-1) and the 17-acre Sherman Tree SMA (Figure 5-2). Both areas are defined by previous park documents. The Grant Tree SMA was described in *Effect of Past Management Actions on the Composition and Structure of Vegetation in the Grant Tree Portion of Grant Grove* (Kauper et al 1980). The Sherman Tree SMA was identified in *Special Management Area Visual Resources Management Study for the Sequoia National Park Prescribed Fire Management Program* (Dawson 1987).

Figure 5-1 – Grant Tree Special Management Area

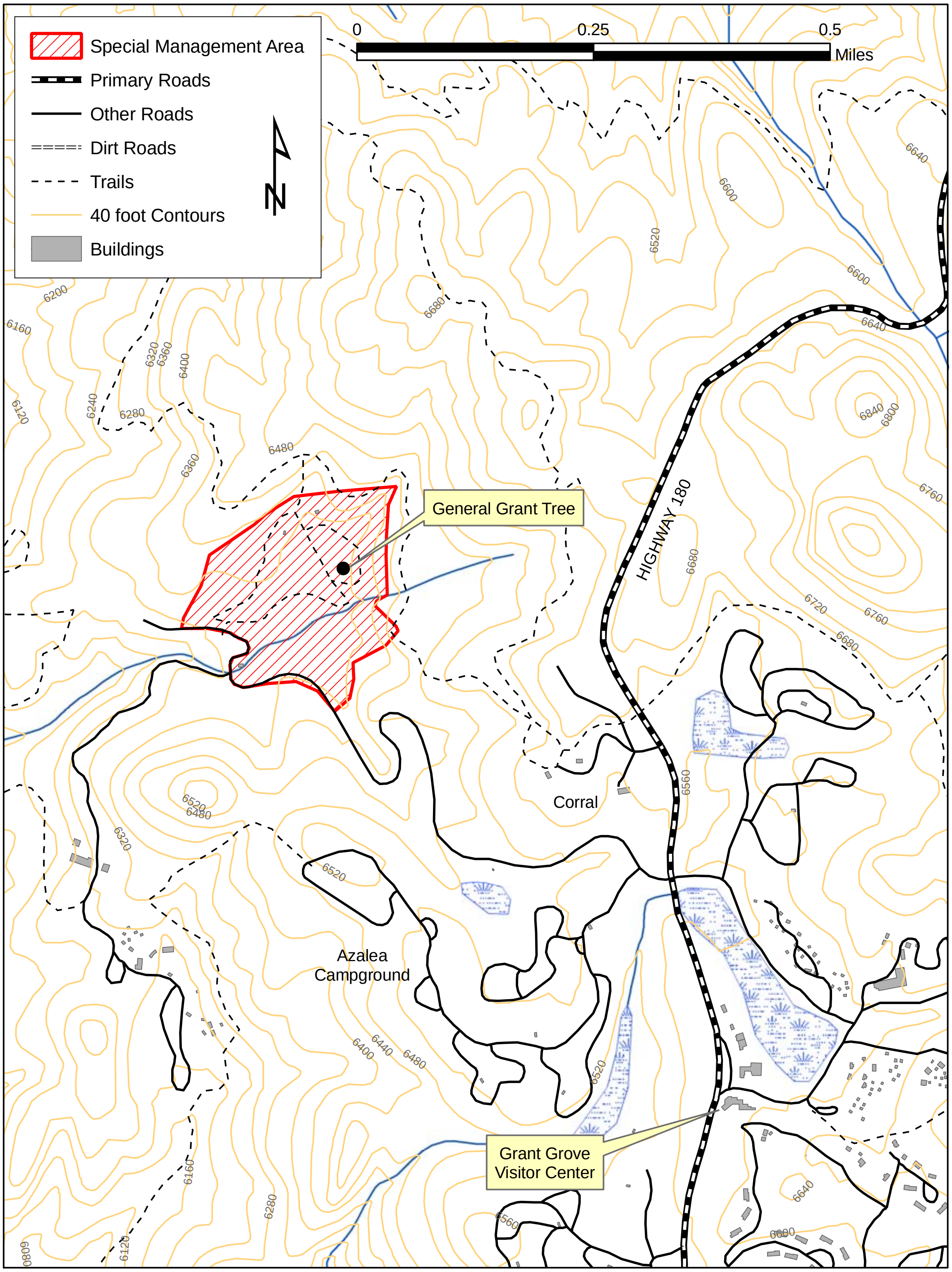
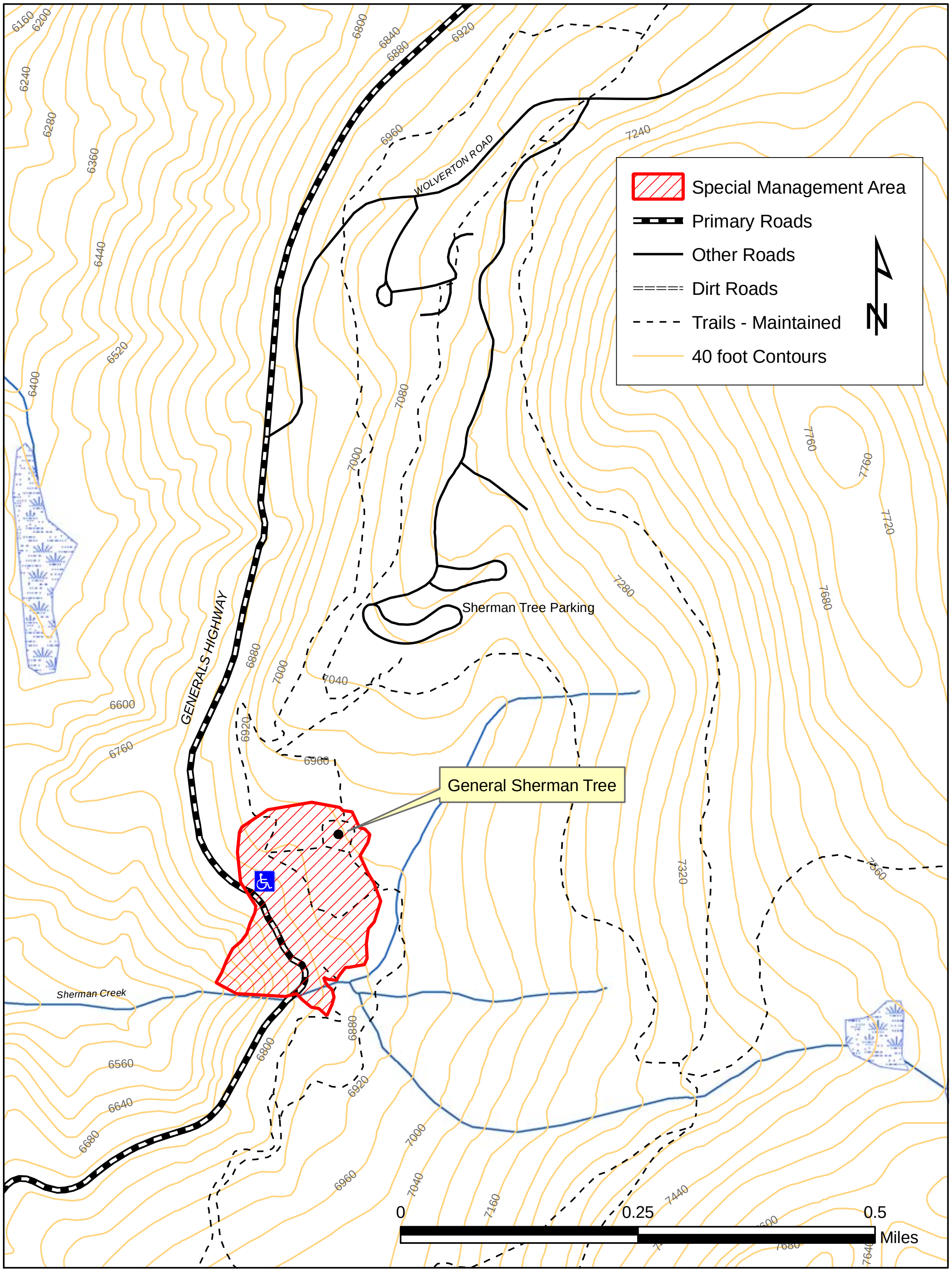


Figure 5-2 – Sherman Tree Special Management Area



TREES OF SPECIAL INTEREST

Purpose

The *Fire and Fuels Management Plan* for Sequoia and Kings Canyon National Parks provides guidance for the protection and management of “trees of special interest” as a part of the parks’ fire management program. Other park programs may also provide special protection to this category of trees. The category “trees of special interest” includes standing trees, groups of standing trees, and tree-related objects (dead snags, down logs, and stumps). The purpose of providing special management to these trees is to increase the likelihood that natural objects of emotional importance to park visitors survive for future enjoyment. Realizing that, being organic objects, they will eventually die or decay.

The protection of trees of special interest does not exclude all fire management activities. The parks will use appropriate techniques (listed later in this chapter) to protect these trees from fire. However, it must be understood that sequoia groves are natural systems and, despite the parks’ best efforts and/or actions, fire may affect a tree of special interest.

Background

Giant sequoias as a species are of considerable ecological value. One of the purposes of the parks is to protect the greater Sierran ecosystem — including the giant sequoia groves — and its natural evolution. But from an ecological perspective, one giant sequoia has essentially the same value as any other. Placing a name on a giant sequoia (or designating it as a tree of special interest) does not make it more significantly ecologically.

“Trees of special interest” are giant sequoias that are significant because of the attention they receive from park visitors. This designation is based primarily on social criteria. These trees (including groups of trees, and tree-related objects as defined above) have captured human interest over time and have generally been recognized with individual names or some other form of special identification.

Cultural Resources

Social significance is distinctly different from cultural significance. The only culturally significant giant sequoia trees are those that have been evaluated against National Register criteria, deemed significant, and therefore listed on the park’s *List of Classified Structures* (Appendix H). The protection and management of LCS structures is outside the scope of the “trees of special interest.”

Criteria for Trees of Special Interest

“Trees of special interest” are standing giant sequoia trees (*Sequoiadendron giganteum*), groups of giant sequoia trees, dead giant sequoia snags, down giant sequoia logs, or giant sequoia stumps. The trees listed in Table 5-3 meet one or more of the following criteria:

- Identified by name on an official park “map and guide” issued since 1980.

- Identified by name within the official trail map series issued by the Sequoia Natural History Association. (The trail maps for Giant Forest and Grant Grove identify specific named trees.)
- Identified by name within the Congress Trail and Grant Tree Trail brochures issued by the Sequoia Natural History Association.
- Identified by name by official NPS-erected signs at some time since 1980.
- Identified by name by official NPS-erected wayside exhibits at some time since 1980.
- Identified as one of the forty largest giant sequoia trees in the world as listed in Flint and Law, *To Find the Biggest Tree*, Sequoia Natural History Association, 2002. Such trees are sometimes not named or are not clearly named (e.g., "Unnamed tree near Ed by Ned").
- Incorporated as a design element of a designated trail (for example, a log that serves as a bridge, or a log with a pedestrian tunnel). Such trees are sometimes not named or are not clearly named (e.g., "unnamed tunnel log on Congress Trail").

It is recognized that the "trees of special interest" list is not static. From time to time, it may become advisable to add or subtract trees from this list. Such changes will be made through update and replacement of the *Policy Statement Defining "Trees of Special Interest."*

Responsibilities

The Chief Ranger and the Chief of Natural Resources will jointly ensure that the trees of special interest listed in Table 5-3 are managed under the procedures specified in this plan. This includes ensuring that burn plans identify appropriate protection measures for any trees of special interest that occur within the burn unit.

The Chief of Natural Resources will ensure that an up-to-date GIS layer of the trees of special interest is maintained.

The Chief Park Interpreter will ensure that an up-to-date cultural resources GIS layer (including any giant sequoias which are on the LCS) is maintained. Giant sequoias will be formally evaluated against National Register criteria when appropriate. Trees found to be eligible through this evaluation process will be included on the LCS and in the GIS layer.

The park-wide policy regarding Trees of Special Interest is contained in a park-wide document called *Policy Statement Defining "Trees of Special Interest"* dated March 2, 2007. This park-wide policy statement is an addendum to the FFMP.

Mitigation Measures: Objectives

For SMAs or identified trees of special interest, park management will strive to meet the following objectives during all fires while maintaining firefighter and public safety:

Strive to prevent excessive bark charring on a tree of special interest: 1) greater than ten feet above the ground, 2) around more than 50 percent of a tree's circumference, 3) on more than 10 percent of trees with a diameter of four feet or greater (at breast height). In certain cases, heavy fuels (e.g. giant sequoia logs at the base of trees) may preclude meeting this objective.

Strive to prevent no more than 30% of total crown scorch on trees of special interest with a diameter of four feet or greater (at breast height). In certain cases, heavy fuels (e.g. giant sequoia logs at the base of trees) may preclude meeting this objective.

Strive to prevent the ignition of fire scars on trees of special interest. Should ignition occur during the smoldering stage of a fire, the scar will be extinguished if safe and practical to do so. In addition, steps will be taken to ensure that there is little or no change in visual character of trees in these areas.

Use ignition techniques that will limit torching and spotting from ladder fuels in the vicinity of a tree of special interest or SMA thereby limiting chances of spot fires igniting in the canopies of trees.

Mitigation Measures: On-the-Ground Techniques

The following techniques will be used to accomplish the objectives above:

1. **Inspecting Fuel Conditions** – Prior to the fire, all trees of special interest in the fire area will be inspected for fuel conditions in a buffer zone 20-feet in diameter around the tree's base. If unnatural accumulations of 1,000 hour fuels (three-inch diameter and greater) are found in this buffer, they will be removed.

Giant sequoia logs, single snags near sequoia trunks, debris from a fallen sequoia top or branch, do not in themselves constitute unnaturally heavy fuels, although the tonnage can be enormous. Such fuels can be left in place to burn, but may radically alter the appearance of neighboring giant sequoias. Taking photographs pre- and post-burn in these areas will document the change in fuels. These pictures, along with shots during the burn, will provide important interpretive and documentary tools to display the area's biological and scenic recovery.

If the tree of special interest is on a slope, fuel will be scattered to the sides of the trees. The fuel will not be scattered above or below the trees, if possible. If space is limited, fuel removed from around a tree may be piled in a clearing or opening.

2. **Inspecting Crown** – Prior to the fire, all trees of special interest in the fire area will be inspected for the probability of ignition in the crown. The probability of ignition in the crown will be considered when choosing operational techniques but will not preclude using fire in the area.

3. **Choosing Ignition Distance** – When determining the appropriate distance to ignite from the base of a tree of special interest, the tree's fire scars and surrounding fuel loading will be considered. Most often, a six-foot separation will be an appropriate distance.

4. **Assessing Need for Fireline** – If needed, a fire line may be placed around a tree of special interest if judgment determines the presence of unnaturally heavy fuels. Generally, such fuels are of larger diameter (>three inch - 1,000-hour fuels) which are principally fallen cedar, fir, and pine trees or unusually heavy litter and duff accumulations. A fireline should not be used if roots deeper than 12" will be uncovered. Surface litter may also be raked from around a tree.

5. **Using Foam or Water** – Foam or water may be applied to the trunk of a tree of special interest if accessible by equipment.

Other Special Considerations for Giant Sequoia Management

Giant Forest Restoration

Guidelines for the Giant Forest restoration include the use of fire within either the "biological" or "landscape" restoration zones (NPS 1995). Goals and objectives of restoration include the recreation of the structure and composition of vegetation within the natural range of variability if development had not taken place and if fire had not been suppressed. Two fire management options have been defined in the plan:

Fuel Manipulation

The removal of buildings and facilities has left large openings in the forest that are lacking in fuels. Fuels may be hauled onto these restoration areas and burned onsite to create the bare, mineral seedbed which fosters sequoia seedlings. The source of fuel will be adjacent forest areas with excessive amounts of limbs, litter, and duff.

Prescribed Fire

Prescribed fire may be utilized to achieve project goals. Fire modifies the composition and structure of the forest by killing some tree species while giant sequoias are fire resistant and tend to survive. Giant sequoias are also a shade intolerant species in which most successful regeneration occurs in open areas with bare mineral soil that are usually created by fire.

Dillonwood Grove

The addition of a large portion (~1,500 ac) of the Dillonwood giant sequoia grove to the parks occurred in 2001. The grove is located adjacent to Sequoia National Park's south boundary in the North Fork of the Tule River drainage. It has been under private ownership since the late nineteenth century and has experienced extensive logging of giant sequoias through the 1940s and non-sequoia species into the 1980s. Incorporation of this new area into park management will require assessment of the area's natural, scientific, cultural, and historical features and how it should be integrated into fire and fuels management planning. Should the grove's separate planning effort resolve that the area will be managed in accord with the rest of the parks' mixed conifer forest (including the use of fire as a research tool); this *Fire and Fuels Management Plan* will apply. If the grove planning effort resolves a management direction for Dillonwood that is outside of the treatments covered in this plan and the companion Environmental Assessment (EA), a separate fire planning and compliance effort will take place.

Table 5-3 – Trees of Special Interest

Grant Tree Special Management Area			
Grant Grove	Arizona Arkansas California Centennial Stump & Log (stump and down log) Connecticut Dead Giant Delaware Fallen Monarch (down log) Florida General Grant Georgia Idaho	Illinois Indiana Iowa Kentucky Lightning Lincoln Maine Maryland Massachusetts Michigan Log (down log) Minnesota Missouri Nevada	New Jersey New Mexico Ohio Oklahoma Oregon Pennsylvania Robert E. Lee Tennessee The Happy Family (group) The Martyr Twin Sisters Vermont Log (down log) Virginia Wyoming
Sherman Tree Special Management Area			
Giant Forest	General Sherman Unnamed tunnel log on accessible trail to Sherman Tree		
Other Trees of Special Interest			
Giant Forest	Adams Auto Log (down log) Bear's Bathtub Black Arch Black Chamber Booker T. Washington Broken Arrow Burial Buttress (down log) Charles Young Chief Sequoyah Chimney (dead snag) Clara Barton Cleveland Column (Near Pershing) Dead Giant Founders (group) Four Guardsmen (group)	Franklin General Lee General Pershing Hamilton House (group) Leaning Lincoln McKinley Monroe Parker (group) Pillars of Hercules Puzzle (down log) Room Roosevelt Senate (group) Sentinel Susan B. Anthony The Cloister (group) The President Three Graces	Triple (group) Telescope (dead snag) Tunnel Log (down log) Washington Unnamed tree near Ed by Ned Unnamed tunnel log on Congress Trail lower loop Unnamed tunnel log on Congress Trail upper loop Unnamed tunnel log on Hazelwood Loop Trail Unnamed tree that acts as a bridge over the Little Deer Creek
Big Stump	Burnt Monarch Mark Twain Stump Pattee Trees (group) Sawed Tree Shattered Giant (down log)		
Redwood Canyon	Barton Post Camp (down log) Fallen Goliath Hart Roosevelt (False Hart) Unnamed tunnel log on Hart Tree Trail		
Garfield	King Arthur		
Atwell Grove	AD Dean Diamond		

Cultural Resources

Cultural resources (both prehistoric and historic) may be impacted to varying degrees by fire and fire management actions. Since these resources are located in a highly flammable environment, unwanted fire effects may not be completely preventable under all circumstances. However, impacts may be managed with appropriate pre-planning, avoidance, and mitigation. Mitigation efforts are designed to prevent the impairment of the parks' known cultural resources, and minimize the chance of adverse impact to unknown sites.

Prehistoric Resources

The effects of fire on prehistoric sites are variable, with particular concerns associated with rock art sites and those sites with dense, surface-visible scatters of obsidian. In general such sites, even those with shallowly buried deposits or features, tend not to be impacted adversely by low intensity fires, while high intensity fire events associated with heavy fuel loads may cause serious impacts such as spalling of rock surfaces, the crazing of cherts or obsidian artifacts, the fracturing of ceramics or potsherds, and the disruption of hydration bands on obsidian surfaces.

Of significant concern is the ground disturbance associated with the placement of staging areas and the construction of firelines necessary to fight or manage fires. These actions have the potential to impact prehistoric resources directly through ground disturbance.

Ethnographic Resources

The effects of fire on ethnographic resources are variable and difficult to identify. Sites with fragile archeological features such as pictographs or petroglyphs would be affected similar to prehistoric resources. Sites where traditional access to particular natural resources of cultural significance (such as plants used for craft production or ceremonial purposes) could be affected as a result of fire (e.g., re-growth and health vs. loss or diminution of the plants) and may result in either positive or negative effects.

The loss or reconfiguration of culturally important landscapes or vistas may occur as a result of fire, especially high intensity wildfire.

Historic Resources

The effects of fire on historic era sites are variable. Located in and around developed areas of the parks, there is particular concern associated with wooden buildings and structures, logging debris (e.g., stumps and shake piles), and mining features (e.g., flumes and trestles). Many other sites are effectively sub-surface in their current appearance and thus relatively protected from adverse impact from fires, especially low intensity burns. Of greatest concern is the placement of staging areas and firelines needed to fight or manage fires. Associated ground disturbance has the potential for direct and adverse impacts on historic sites.

Potential Impact Sources

There are three major fire-related factors that can affect the level of impact to cultural resources: disturbance of the ground, the ability to pre-plan and avoid impacts, and the risk posed by high intensity fire events.

Surface disturbance occurs as a result of the need to construct fireline, fire camps, staging areas, and related facilities. Fire management actions that minimize the need for surface disturbance will have less potential to affect cultural resources.

Pre-planning minimizes potential impacts from fire management actions by allowing consultation and oversight by cultural resource specialists. Tools that rely more heavily on pre-planned fire management actions (such as prescribed fire) allow advance identification and avoidance of significant cultural resources. Conversely alternatives that entail more unplanned or emergency fire events, with little opportunity for advanced planning and clearance for cultural resources, have more potential to impact cultural resources.

High intensity fires have the potential to drive heat pulses deep into the ground and to spall off rock surfaces that may contain rock art. These mechanisms can also negatively affect subsurface and lithic cultural resources. There are opportunities for high intensity fire events in many areas of the parks, though the size and timing of such events vary by alternative. Actions that proactively reduce heavy fuel accumulations through low intensity prescribed fire or through mechanical removal of fuel reduce the risk of damage to cultural resources from high intensity fire.

General Mitigation Process

The park archeologist will review all prescribed burn and mechanical fuel project plans for the presence of known surface resources and shallow subsurface resources in the project area. Combining information on the location and sensitivity of known sites with information on the expected fire operations impacts, fuel loads, and anticipated fire intensity, the archeologist will specify requirements necessary for the protection of significant resources within the project area. These requirements will be documented in each individual burn or mechanical fuel treatment plan.

Fireline construction or any other ground disturbing activity planned for prescribed and mechanical fuel projects will be flagged in advance of any work on the ground, and must receive clearance and approval from the park archeologist prior to the work.

For fire use projects, the park archeologist will be consulted during the development of the WFDSS. Known significant resources requiring protection will be identified in the planning process, and mitigations specified and documented in the plan and implemented as part of the project.

For unwanted fires, the archeologist will be consulted as soon as practical to identify sensitive resources that have the potential to be affected by the fire or by fire management actions. To the extent possible – and considering short timeframes, unpredictable fire behavior, and firefighter and public safety - mitigation measures specified by the archeologist will be implemented as part of the suppression response.

Required mitigation in all cases may include but is not limited to: relocation of firelines away from sensitive sites, line construction to exclude sites, removal of fuels from sensitive sites to reduce fire intensity, installation of hoselays, sprinklers or other water handling devices for direct protection of features, and/or wrapping sites or features with fire protective shelter material. As new cultural resource requirements and standards for protection are developed, they will be adopted and included as an appendix in this document.

Assessing the condition of known resources before project implementation and after the project is complete will provide better information on effects on cultural resources, and feedback on the effectiveness of mitigation practices. These pre/post project inspections are considered part of the project and may be funded from project dollars. More detailed cultural resource monitoring information is included in Appendix C.

WILDERNESS

Approximately 85% of the parks are designated wilderness. As of 2002, another 12% of parklands have been proposed for wilderness designation. By NPS policy, areas proposed for wilderness are managed exactly the same as designated wilderness.

NPS Management Policy 6.3.9 directs that "fire management activities conducted in wilderness areas will conform to the basic purposes of wilderness. The parks' fire management and wilderness plans together will identify the natural and historic roles of fire in the wilderness and will provide a prescription for response to natural and human caused wildfires.

Wildland fire in wilderness will be suppressed when necessary to protect life safety, significant cultural and natural resource values, or to conform to air quality regulatory requirements. Such wildland fire suppression is deemed the minimum requirement.

Actions taken to suppress wildland fire will use the minimum requirement concept and will be conducted in such a way as to protect natural and cultural features and to minimize the lasting impacts of the suppression actions and the fires themselves." A high value will be placed on continuing to assure preservation of wilderness character.

NPS Director's Order 41, Wilderness Preservation and Management (DO-41, Section 5) further states that "under ideal conditions, natural fire should be considered as a fundamental component of the wilderness environment."

In conformity with direction in NPS Management Policy 6.3.9 and NPS Director's Order 41, the natural and historic role of fire in the parks' wilderness has been assessed and documented. In summary, lightning ignited fires have been found to be a natural process and primary driver of natural plant communities throughout the parks' wilderness. Native American use has also been documented, with the influence of such use in shaping vegetation communities largely unknown (see Chapter 9).

All fire management activity in wilderness will be conducted according to minimum impact suppression guidelines found in the parks' Fire and Aviation Management Operations Guide (Addendum). Delegations of authority to incoming fire management teams will require that minimum impact suppression techniques be followed.

The use of chainsaws, portable pumps, and the landing of helicopters, for all fire operations will be considered appropriate as the minimum tool, as will electronic devices including but not limited to global positioning units for mapping and locating fires, and cell phones and portable radios for communications.

When using helicopters, the parks will consider operational periods, amount of flight time, and sensitivity of travel routes. When using stock, the parks will adhere to existing park regulations including party size restrictions and forage area regulations, and will consider the implications of competing for limited forage in relation to private and commercial stock users. Use of both stock and aircraft will be kept to the minimum necessary commensurate with meeting project objectives and providing for firefighter safety.

Burned area emergency rehabilitation plans may be implemented under the direction of a resource advisor following significant fire management actions. Emergency rehabilitation in wilderness will seek to restore areas impacted by fire operations in ways that will restore and preserve wilderness character and conditions. Actions implemented under emergency conditions as part of immediate suppression and stabilization generally do not require pre-approval. Proposals for long term recovery actions will be submitted to the parks Environmental Management Committee, which will recommend and enforce the appropriate level of environmental compliance prior to implementation.

Fire related research and monitoring may occur to document and understand the effects of fire management actions in wilderness. Research and monitoring staff and equipment would create additional transient (short-term, infrequent) impact. Any proposal that required the installation of long term or permanent research or monitoring equipment in the wilderness will require a separate analysis and approval by the parks Environmental Management Committee.

WILD AND SCENIC RIVERS

The park contains two rivers, including the Kern and the South and Middle Forks of the Kings, which were designated as wild and scenic in 1987. Both rivers are contained within park wilderness, with the exception of the lower seven miles of the South Fork Kings which flows through the Cedar Grove developed area. Other rivers have been proposed for Wild and Scenic status through the *General Management Plan*.

The purpose of wild and scenic rivers as stated in legislation (Public Law 100-150) is that designated rivers “shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.”

All segments of the rivers in wilderness are in fire management zones that emphasize perpetuating fire as a natural process. As a result, the fire and fuels management program will not affect the rivers’ free-flowing condition or involve new developments within their corridors.

Fire management tools #2 - #5 (described in Chapter 3) will be used in Wild and Scenic River corridors only to protect and enhance outstandingly remarkable values or to protect life safety, significant cultural and natural resource values, or to conform to air quality regulatory requirements.

All riparian areas, including wild and scenic rivers, will be protected from contamination by fire fighting foams and aerial retardant following guidelines in the *Fire and Aviation Management Operations Guide* (FAMOG). Minimum Impact Suppression Techniques (MIST) detailed in the FAMOG are used throughout the parks and are especially critical to apply in Wild and Scenic River corridors.

Following fire, appropriate burned area rehabilitation measures may be taken to protect or restore outstanding resource values of designated Wild and Scenic Rivers. Rehabilitation following fire in a Wild and Scenic River corridor may be conducted under an approved *Burned Area Emergency Rehabilitation Plan*. Developing such plans during and after fire events is the joint responsibility of the park and incident management team.

6. Organization and Responsibilities

The parks' fire and fuels management organization is spread over three divisions. This arrangement creates an organization structure encouraging communication amongst park staff, benefiting both fire management and park operations affected by fire management actions. The majority of fire management staff is within the Division of Fire and Visitor Management. Fire staff is also in the Division of Natural Resources, and the Division of Interpretation and Cultural Resources (Appendix G).

Communications for the fire and fuels program are also strengthened by the Fire Management Committee and district management teams. The purpose of the committee is to assist the superintendent and the fire management officer in the development, implementation, critique, and review of the fire management program. The FMC does not have decision authority but it makes recommendations on management to the superintendent. The Fire Management Committee (FMC) is chaired by the Chief of Natural Resources. The Committee includes:

- Chief of Natural Resources, Chair
- Chief of Fire and Visitor Management, Deputy Chair
- Fire Management Officer
- Supervisory Natural Resources Mgmt Specialist
- Science Advisor
- Research Scientist (BRD)
- Fire Ecologist
- Public Information Officer
- Safety Manager

In addition, there will be one district ranger, one district facility manager, and one district interpreter. At least one of these must come from the Sequoia Management Team and one from the Kings Canyon Management Team. District managers will generally serve a two-year rotating assignment with their counterparts in the other district.

The two district management teams are composed of district facility managers, district rangers, district FMOs, district interpreters, resource managers, and park concession/planning personnel. Each group works with the district FMOs to formulate the fire and fuels management program thereby minimizing impacts to other park operations or planning activities which could be affected by fire management.

ORGANIZATION ROLES AND RESPONSIBILITIES

Superintendent

- Has ultimate responsibility and accountability for all fire, aviation, and fuels management activities conducted within the park.
- Annually certifies Fire and Fuels Management Plan.
- Approves other plans written within the framework of the FMP (i.e. WFDSS and their periodic validations, burn plans, and mechanical fuels treatment plan).

Chief of Fire and Visitor Management

- Serves a vice-chair of the Fire Management Committee.
- Supervises the parks Fire Management Officer and ensures communication occurs with Chief of Natural Resources, as well as the rest of parks' squad, on fire and fuels management issues.
- Ensures communication occurs within division on fire management issues (between park FMO, district rangers, and wilderness specialist).

Chief of Natural Resources

- Coordinates resource management review of plans for acceptance by superintendent.
- Ensures communication occurs with Chief of Fire and Visitor Management, as well as the rest of parks' squad, on fire and fuels management issues.
- Ensures communication occurs within division on fire management issues (between fire planner, GIS specialist, biologists, and air quality specialist).
- Serves as the chair of the Fire Management Committee.

Fire Management Officer

- Responsible and accountable for providing leadership for the fire and fire aviation management programs in the parks.
- Determines program requirements to implement land use decisions in the Fire Management Plan to meet land management objectives.
- Annually review the Fuels and Fire Management Plan to assure compliance with appropriate policy, standards, and guidelines.
- Ensures coordination with all divisions and FMC on fire planning and operations issues.
- Ensures coordination with external agencies for interagency cooperation in fire and fuels management planning and operations.
- Delegated Limited Authority by the Park Superintendent, as required by Reference Manual 18 and the Interagency Standards for Fire and Aviation Operations, for the following specific responsibilities and actions:
- Take necessary and prudent actions to ensure firefighter and public safety
- Develop, supervise, and implement a program of work based on the principles of a High Reliability Organization.
- Ensure sufficient qualified fire and non-fire personnel are available to support fire operations within the park at a level commensurate with the local and national fire situations.
- Ensure that all staff meets qualifications and standards necessary for the safe and efficient completion of their duties.
- Certify qualifications and issue Red Cards. Document and approve qualification overrides within the IQCS system when supported by compelling evidence.
- Evaluate operational needs to implement the Fire and Fuels Management Plan and request, secure, track, and efficiently expend those funds necessary to implement this plan commensurate with agency and park fiscal policy.

- Negotiate interagency agreements and represent the Park Superintendent on local interagency fire and fire aviation groups.
- Implement fire restrictions as identified in this plan.
- Submit the annual and five-year fuels treatment plans to FMC for review and to the Park Superintendent for approval.
- Oversee the implementation of all fire and fire aviation management activities within the park and assure that all actions are commensurate with standards, policy, and guidelines.
- Delegate specific responsibilities to subordinate supervisors and managers.
- Insure that the safe, efficient, timely, and appropriate response (AMR) is initiated to all wildland fire incidents.
- Provide provisional approval of Response to wildland fires until such time that the park superintendent is provided opportunity to approve or disapprove the planned actions.
- Regularly meet with cooperators to coordinate the safe and efficient use of interagency resources.
- Review fire weather, fire danger, and fire severity conditions and take necessary step-up actions to insure adequate wildland fire response.
- Manage employee fatigue by implementing and enforcing necessary work-rest guideline to include granting administrative leave within the guidelines of the Interagency Incident Business Management Handbook when necessary to assure safe and effective wildland fire operations.
- Provide guidance, training, and decision making authority to subordinate supervisors to insure critical decisions are made in an appropriate and timely manner.
- Serve as the superintendent's representative (Agency Representative) when hosting Incident Management Teams for actions implemented under this FFMP.
- Oversee prescribed fire operations to assure compliance with appropriate policy, standards, and guidelines. Review and recommend burn plans for approval of the superintendent.
- Approve Individual Fire Reports (DI-1202)

Fire Budget Assistant

- Assures costs and expenditures within the Fire and Aviation Management Program are accurately tracked and the fire management officer and program managers are regularly briefed on the current budget status.
- Ensures payroll, personnel actions and travel documentation are completed for the branch.
- Coordinates with regional wildland fire budget representative and park budget officer on budget issues.
- Serves as subject matter expert for all fire business management issues.

Communications Center/Cache Manager (Supervisory Dispatcher)

- Develops, revises, and implements the fire and aviation dispatch and cache management processes.
- Ensures DI-1202 data base for wildland fire responses is current and correctly entered into all appropriate databases. Integrates this work with GIS specialist for GIS analysis.

- Manages wildland fire and all risk qualifications and training database for all park employees.
- Serve as the parks fire and aviation training officer. Represents the parks in interagency settings to facilitate training for fire management. Submits and tracks interagency training nominations.
- Catalogues all weather data for parks' weather stations, manages fire danger rating analyses for parks.
- Coordinates logistical support for all fire/aviation planning and operations.
- Submits and tracks the Incident Status Summary (ICS-209) information as directed by the Park Fire Management Officer or duty officer.

Fuels Management Specialist

- Principal program manager and staff specialist for all fuels management activities within the park.
- Delegated authority by the Fire Management Officer to budget and expend designated funds for fuels management activities commensurate with policy, standards, and guidelines.
- Assures that all fuels management operations are conducted in a safe and efficient manner commensurate with the standards associated with the High Reliability Organization.
- Ensures appropriate fire monitoring is implemented for all fire incidents.
- Responsible for developing and implementing the fuels management programs in direct coordination with district FMOs and with consultation from the Fire Ecologist, Fire GIS Specialist, and Fire Information and Education Specialist. Has decision authority on park priorities for treatments subject to approval by the Fire Management Officer. Formulates annual fuels treatment plan working from the 5-year plan.
- Takes lead on yearly fire GIS analysis planning update.
- Coordinates projects with fuels planners from cooperating agencies.
- Serves as the primary point of contact with San Joaquin Valley Air Pollution Control District and coordinates all fuels management activities with the SJAPCD. Ensures District FMOs and burn bosses comply with park smoke management protocols for all wildland fire and prescribed fire operations.
- Principal staff specialist for wildland fire behavior prediction and analysis, and for climatological data analysis.

Sequoia District FMO

- Program manager responsible for district's wildland fire management program.
- Evaluates the needs for fuel treatment in coordination with the Park Fuels Specialist. Proposes fuels projects and advises the Park Fuels Specialist of issues or problems that could develop as part of any project proposal.
- Represents Fire Management on the Sequoia District Management Team. Presents the annual program of work to the management team. Coordinates the resolution of interdivisional issues within district that are the result of fire management activities and programs.

- Coordinates use of district resources in support of park-wide project/wildland fire priorities.
- Delegated authority by the Fire Management Officer to budget and expend designated funds for district fire management activities commensurate with policy, standards and guidelines.
- Assures that all fire management activities within the district are planned and conducted in a safe and efficient manner commensurate with the standards associated with a High Reliability Organization.
- Delegated the authority of park Aviation Officer and directed to manage the park aviation program for both Sequoia and Kings Canyon National Parks per the parks' Aviation Management Plan and interagency aviation standards and guidelines.
- Coordinates fire management activities with permittees and private inholders in the district.

Kings Canyon District FMO

- Program manager responsible for district's wildland fire management program.
- Evaluates the needs for fuel treatment in coordination with the Park Fuels Specialist. Proposes fuels projects and advises the Park Fuels Specialist of issues or problems that could develop as part of any project proposal.
- Represents Fire Management on the Kings District Management Team. Presents the annual program of work to the management team. Coordinates the resolution of interdivisional issues within district that are the result of fire management activities and programs.
- Coordinates use of district resources in support of park-wide project/wildland fire priorities.
- Delegated authority by the Fire Management Officer to budget and expend designated funds for district fire management activities commensurate with policy, standards and guidelines.
- Assures that all fire management activities within the district are planned and conducted in a safe and efficient manner commensurate with the standards associated with a High Reliability Organization.
- Delegated the authority of Structural Fire Coordinator per RM-58, Structural Fire for both Sequoia and Kings Canyon National Parks. Serves as Chair of the Structural Fire Working Group. Principal coordinator for structural compliance and planning issues within the parks. Programs, tracks, and expends structural fire funds.
- Coordinates fire management activities with permittees and private inholders in the district.

Duty Officer

- Assess all reports of wildland fire within the respective district and determine, initiate, and oversee the response to wildland fire.
- Assure that all actions provide for wildland firefighter and public safety and address values to be protected, commensurate with the Park's Fire Management Plan.
- Delegated the authority to:

- Determine the Response to wildland fire to a wildland fire commensurate with the Park's Wildland Fire Management Plan.
- Determine the appropriate level of response to a wildland fire based on the Park's Wildland Fire Response Plan.
- Authorize and expend overtime.

Responsibilities:

- Oversee all incident operations on wildland fires and insure that all actions are undertaken in a safe, tactically sound, and fiscally responsible manner.
- Serve as the Incident Commander or designate an Incident Command appropriate for the complexity level of the fire.
- Notify the appropriate District Fire Management Officer and the Park Fire Management Officer or their acting of a fire occurring within the district as soon as possible and provide situation updates as necessary.
- Assure the accuracy and consistency of daily ICS-209 data as necessary.

Fire Ecologist

- Principal program manager and staff advisor to the parks fire management program on ecological issues, assuring that the best ecological practices and principles are consistently considered in all fire management decision making.
- Delegated authority by the Fire Management Officer to budget and expend designated funds for fire ecology activities commensurate with policy, standards and guidelines.
- Develops and implements fire effects monitoring program based upon structural and process objectives for the vegetation communities.
- Ensures that results from fire effects monitoring and fire research are integrated into the fire and fuels management program.
- Analyzes and reports results from monitoring data so that fire management operations can be adjusted to better meet structural and process objectives.
- Reviews both annual and five-year fuels treatment programs to assure that ecological needs are adequately addressed as an integral part of the planning process.
- Primary resource advisor (READ) for all wildland fire management activities within the parks and assures that resource concerns are identified and mitigated as required part of the planning process.
- Coordinates fire research needs.
- Summarizes the significant findings of all park fire research in an annual report that is circulated internally and externally.
- Provides supervision and direction to the parks fire effects crew and supervisor.

Air Quality Management Specialist

- Principal staff advisor to the parks fire management program on air quality issues, assuring that air quality issues are adequately addressed as part of the fire management decision making process.
- Coordinates air quality data and information exchange with Fuels Management Specialist as well as coordination with interagency partners.

- Provides quality assurance/quality control and provides direct supervision for the smoke and weather technician.

Fire GIS Specialist

- Primary program manager and analyst for fire related geographic databases within the parks. Assess and assures quality control of fire related geographic databases. Maintains fire databases.
- Sets standards for data collection and storage. Coordinates electronic file management for fire management. Manages electronic data security for fire management.
- Delegated authority by the Fire Management Officer to budget and expend designated funds for fire GIS activities commensurate with policy, standards and guidelines.
- Provides project level spatial analysis and mapping for all fires.
- Provides spatial analysis and map products for fire and fuels management planning.

Fire Information and Education Specialist

- Principal program manager and staff advisor for Fire Information and Education, assuring accurate and cohesive information is provided to the staff and the public in timely manner.
- Coordinates and facilitates the information exchange between program managers and the Fire Management Officer.
- Primary representative for the fire management program to the media and the public.
- Delegated authority by the Fire Management Officer to budget and expend designated funds for fire information and education activities commensurate with policy, standards and guidelines.
- Communicates with internal and external audiences about fire and fuels management program activities. Primary author and/or editor for all public news releases for fire management.
- Coordinates, assembles, and distributes annual updates to the Fire Management Plan.
- Facilitates year-round educational opportunities about fire ecology, history, and management.

FIRE MANAGEMENT FUNDING

The fire and fuels management program funding comes from two sources; FIREPRO and National Park Service ONPS funds. As of 2002, annual program funding from both sources totals approximately $3,000,000 exclusive of fuels treatment project funds, emergency funds for wildland actions, and construction or other special project actions. ONPS funds account for about $500,000 of this figure covering aviation personnel, a program assistant, a fire planner, a district FMO, and the parks' FMO.

INTERAGENCY COORDINATION AND CONTACTS

The following table lists the national, regional, and local agreements that pertain to the implementation of this *Fire and Fuels Management Plan*. Copies of each agreement are filed in the "Fire Agreements" binder in the Fire Management Office.

Table 6-1 – Memorandums of Understanding (MOU), Memorandums of Agreement (MOA), and Operating Plans Related to Fire and Fuels Management Program

Title of Agreement	Cooperators	Key Contacts	Purpose of Agreement
State and Regional			
Master Joint Operations Agreement: Four-Party (MOA)	Bureau of Land Management, California and Nevada National Park Service, Pacific West Region US Forest Service, Regions 4-6 California Department of Forestry and Fire Protection	N/a	Coordinates state-wide wildland fire protection
Cooperative Agreement for Local Government Fire Suppression Assistance to Forest Agencies: Five-Party Agreement (MOA)	State of California, Office of Emergency Services California Department of Forestry and Fire Protection US Forest Service, Regions 5 Bureau of Land Management, California National Park Service, Pacific West Region	N/a	Allows for local government involvement in state and federal wildland fire actions
Cooperative Agreement Among State of California Military Department (MOA)	State of California Military Department California Department of Forestry and Fire Protection Bureau of Land Management, California US Forest Service, Regions 5 National Park Service, Pacific West Region State of California, Office of Emergency Services	N/a	Allows for state activation of military including modular airborne firefighting systems (MAFFS)
National Park Service and California Department of Forestry and Fire Protection Conservation Camp Agreement (MOA)	California Department of Forestry and Fire Protection National Park Service, Pacific West Region	N/a	Directs how to utilize conservation camp crews on fire and fuels operations
Operating Plan for Incident Billing Procedures (MOA)	Bureau of Land Management, California National Park Service, Pacific West Region Bureau of Indian Affairs, Sacramento Area US Forest Service, Pacific Northwest Region US Forest Service, Regions 5 California Department of Forestry and Fire Protection	N/a	Ensures state and federal agencies full and equitable cost recovery for wildland fire operations
Local			

Title of Agreement	Cooperators	Key Contacts	Purpose of Agreement
Central Sierra Operating Plan	Bureau of Land Management, Central California Region National Park Service: Sequoia and Kings Canyon, Yosemite US Forest Service: Eldorado, Giant Sequoia National Monument, Sequoia, Sierra, and Stanislaus California Department of Forestry and Fire Protection: Amador-El Dorado, Tuolumne-Calaveras, Madera-Mariposa-Merced, Fresno-Kings, and Tulare	Jerry McGowan Chief, Fire and Aviation Management Stanislaus National Forest	Operating Plan tiered from the Four-Party Agreement listed above
Fire Management Operating Plan and Non-Emergency Assistance Agreement	National Park Service: Sequoia and Kings Canyon, Yosemite US Forest Service: Inyo, Sequoia, Giant Sequoia National Monument, and Sierra National Forest	Dave Bartlett Fire Management Officer Sequoia and Kings Canyon National Parks Kelly Martin Fire Management Officer Yosemite National Park Robert Sommers Forest Fire Management Officer Inyo National Forest Brent Skaggs Forest Fire Management Officer Sequoia National Forest Curtis Palmer Forest Fire Management Officer Sierra National Forest	Allows for exchange of resources for fire management activities and non-fire emergencies
Operating Plan for the South Central Sierra Interagency Incident Management Teams	US Forest Service: Sierra, Sequoia, Giant Sequoia National Monument, and Stanislaus National Park Service: Sequoia and Kings Canyon, Yosemite Kern County Fire Bureau of Land Management: Central California Region	Martha Johnson Center Manager Sierra National Forest Emergency Coordination Center	Outlines plan for mobilizing Type II Province Team

Title of Agreement	Cooperators	Key Contacts	Purpose of Agreement
Sequoia National Forest Emergency Communications Center Interagency Expanded Dispatch Plan	US Forest Service: Sequoia and Giant Sequoia National Monument Bureau of Indian Affairs: Tulare Reservation National Park Service: Sequoia and Kings Canyon National Parks Bureau of Land Management: Central California Region	Steve Phillips Center Manager Central California Interagency Coordination Center	Outlines plan for setting up expanded dispatch for large incidents
Memorandum of Understanding Between Sequoia and Kings Canyon National Parks, Reedley College, and Sequoia Lake YMCA Camp	National Park Service: Sequoia and Kings Canyon National Parks Reedley College Sequoia Lake YMCA Camp	Dave Bartlett Fire Management Officer Sequoia and Kings Canyon National Parks Wayne Bemis Reedley College Sequoia Lake YMCA Camp Manager	Allows educational exchange between parks and the college through college forestry camp activities on federal lands in the vicinity of Sequoia Lake
Memorandum of Understanding between Sequoia and Kings Canyon National Parks and Three Rivers / Lemon Cove Business Association	National Park Service: Sequoia and Kings Canyon National Parks Three Rivers/Lemon Cove Business Association	Deb Schweizer Fire Information and Education Specialist Sequoia and Kings Canyon National Parks Tom Marshall Three Rivers / Lemon Cove Business Association	Allows for cooperative maintenance of joint bulletin board in Three Rivers
Memorandum of Understanding between San Joaquin Valley Unified Air Pollution Control District and Land Management and Fire Protection Agencies	San Joaquin Valley Unified Air Pollution Control District US Forest Service: Sequoia, Giant Sequoia National Monument, Sierra, and Los Padres National Park Service: Sequoia and Kings Canyon National Parks California State Department of Parks and Recreation Bureau of Land Management: California US Fish and Wildlife Service: San Luis and Kern National Wildlife Refuge Complexes California Department of Forestry and Fire Protection	Ted Strauss San Joaquin Valley Unified Air Pollution Control District	Allows for smoke planning in local Air District

Title of Agreement	Cooperators	Key Contacts	Purpose of Agreement
Interagency Agreement between Inyo National Forest and Sequoia and Kings Canyon National Parks	US Forest Service: Inyo National Park Service: Sequoia and Kings Canyon National Parks	Park Fuels Management Specialist Sequoia and Kings Canyon National Parks	Allows for smoke management monitoring of park fires from Inyo National Forest land
Southern Sierra Geographic Information Cooperative (MOA)	US Forest Service: Sequoia National Forest and Giant Sequoia National Monument National Park Service: Sequoia and Kings Canyon National Parks California Department of Forestry and Fire Protection: Tulare Unit Bureau of Land Management: Central California Region Kern County Fire	Anne Birkholz Interagency Fire Planner Sequoia and Kings Canyon National Parks	Allows for interagency fire and fuels management planning using GIS
Memorandum of Understanding between Tulare County and Sequoia and Kings Canyon National Parks	Tulare County National Park Service: Sequoia and Kings Canyon National Parks	Dave Bartlett Fire Management Officer Sequoia and Kings Canyon National Parks Steve Sunderland Chief, Tulare County Fire Department	Allows for exchange of resources for structural fire and wildland urban interface fires
Southern Sierra Fire Management Officer Group (MOU in draft)	National Park Service: Sequoia and Kings Canyon, Yosemite Bureau of Land Management: Central California Region US Forest Service: Stanislaus, Sierra, Sequoia, Giant Sequoia National Monument, and Inyo	Fire Management Officers for all units	Allows for coordination among federal southern Sierra land management agencies on fire, non-fire, and air quality issues

7. Firefighter and Public Safety

FIRE FIGHTER SAFETY

Wildland fire operations are high risk operations that require all personnel to be mindful in all aspects of their work, including planning and implementation. Our fire program implements safety processes developed within the interagency wildland fire community and based on the work by Dr. Karl E. Weick. The fire program at Sequoia and Kings Canyon strives to be a Highly Reliably Organization. In short our fire program will identify and mitigate risk as part of every action that we take.

The fire staff pursues an iterative process of continual improvement always focused on learning from our past to improve our future. Our goal is an organizational cultural that: 1) Encourages and rewards reporting errors 2) Finds solutions to small emerging failures before larger problems surface and 3) Implements and uses the best practices that result in a safer working environment.

The high risk nature of wildland fire work does not allow any margin for error. If any fire or fuels management action cannot be carried out safely, another action must be utilized. Prevention of injury is the overriding consideration during all operations. It is the responsibility of each and every person involved in an operation to ensure safety. At no time will the protection of resources be placed before the safety of fire management personnel. The Fire Management Office at Sequoia and Kings Canyon National Park outlines safety policy in more detail in the *Fire and Aviation Management Operations Guide* (Addendum).

Using GIS analysis, the parks have identified areas that present high hazard to firefighters (e.g. steep, remote areas having dangerous fuel conditions). In these areas, where firefighter safety mitigations are difficult or impossible to achieve, the park may opt for less aggressive control strategies and accept fire spread over a greater number of acres.

Fire Management Operations Committee

The purpose of this committee is to assist the Fire and Aviation Management Program in the development, implementation, critique, and review of the Fire and Aviation Operations Program. The committee is the focal point of fire management's safety program. The committee does not manage fire operations; it advises on fire and aviation operations.

The committee is comprised of a permanent employee from each of the following modules or programs: Engine 72, Engine 51, Helicopter 552, Arrowhead Hotshots, Fuels Management, Crew 91, and a program manager to serve as the management representative.

The function of the committee is to:

- Serves as the focal point for the Fire Management Organization's goal of being a Learning Organization.

- Monitors fire management operations to detect "weak signals" of failure early in their history.
- The committee will encourage *After Action Reviews* (AARs) to be conducted at the end of each operation period during incident operations.
- Significant events identified during AARs will be documented by the responsible Incident Commander or Module Leader and forwarded to the Chair of the Fire and Aviation Safety Committee for review.
- Significant events or near misses will be documented in an *After Action Review Rollup* (AAR Rollup).
- All AAR Rollups will be reviewed at the End of Season Operations Meeting in November.
- Recommended new *Best Practices* from the AAR Rollups that will improve the fire and aviation management operations.
- Facilitates accident reviews and Safenet/Safecom responses. Fire Management Officer will inform the committee of submitted Safenets/Safecoms and accidents.
- One committee member will serve on the refresher cadre for the purpose of disseminating Lessons Learned and providing orientation to the JHA process.
- Services as the Fire Management Program's Safety Committee as a collateral function.

This committee shall advocate that all operations be carried out in accordance with established safety practices as set by *Reference Manuals 18, 58,* and *60,* the Fireline Handbook (NWCG 410-1), OSHA, the parks' *Risk Management Plan*, policy, and the division safety plan (Addendum).

The committee is not meant to replace the role of fire program managers and first line supervisors, but rather to expand the availability of safety information for firefighters. Program managers and first line supervisors are responsible for the establishment of Job Hazard Analyses (JHAs) which are written descriptions of hazards and corresponding mitigations for fire operations. Program managers will regularly review, modify, and update JHAs. Furthermore, the established JHAs will be readily accessible for crews so they may be able to integrate them into daily operations and projects. Currently, these JHAs are available on the park computer network under *J:./share_docs/fire/safety*.

Wildland Fire Program

Due to many decades of fire suppression, unnatural fuel loads have accumulated in certain areas of the parks creating the potential for dangerous fires. Firefighters will only be allowed on an active wildland fire after receiving proper equipment and training as specified in Reference Manual-18. This includes an annual eight-hour wildland firefighter safety class. The fire management office will coordinate this class and make it available to every firefighter each season. Instructors of this class will be qualified at the strike team level. Employees failing to attend will not be allowed on the fireline until class completion.

Furthermore, wildland firefighters must meet minimum physical standards for their assigned incident position, as defined in NWCG 310-1 "Wildland Qualifications Subsystem Guide." Physical fitness/work capacity tests for wildland firefighters and other fire-qualified employees will consist of the "pack test." Arduous duty medical exams must be taken once every 3 years by wildland firefighters. The exams only include stress EKGs if required by the examining physician or if the employee is over 41 years old.

Aviation Program

The **Park Aviation Manager** (Sequoia District FMO) will manage the parks' aviation program. The two primary hazards for aviation work in the parks are mountainous terrain and the high risk nature of wildland fire and SAR operations. Park staff will primarily mitigate the hazards and reduce the overall risk of aviation missions by: 1) Limiting flights necessary for core park operations 2) Using only qualified personnel to manage aviation operations 3) Following established policies found in the Federal Aviation Administration rules and regulations, the Department of Interior Departmental Manual, and NPS Aviation Management Policy as outlined in Reference Manual #60. Furthermore, the Park Aviation Manager (Sequoia DFMO) will be responsible for establishing and updating the parks' *Aviation Management Plan*.

Structure Fire Program

The **Structure Fire Coordinator** (Kings Canyon DFMO) will manage safety in the structure fire program. Emphasis will be placed on proper training and physical requirements as outlined in National Park Service Director's Order #58. The parks will be careful to distinguish between the requirements for structure and wildland fire. The two types of work are not interchangeable. Wildland firefighters will not be used in structure protection without proper structural fire training, appropriate medical examination, and fitness testing.

PUBLIC AND EMPLOYEE SAFETY

During fire operations or extreme fire danger, fire use restrictions and emergency closures may be needed to ensure public safety (see Appendix M). These restrictions can also reduce the possibility of human-caused fires during seasonal drought or extreme fire conditions. Emergency closures (i.e. trails in a fire area) may be declared by an incident commander to prevent imminent danger. Consultation with the appropriate District Ranger will occur as soon as possible. For longer term restrictions or closures (i.e. Stage 1, Stage 2 fire use restrictions), a special order will be approved by the park superintendent and given wide distribution. For all restrictions and closures signs will be posted and maintained in appropriate areas.

Evacuation plans will be in place and ready in the event of an unforeseen dangerous wildfire. When a fire threatens visitor or employee safety, adjacent ranger districts need to be given as much advance notice as possible in order to achieve orderly evacuation. Park evacuation plans are kept at the district ranger offices and are activated when an emergency dictates the need. The evacuation procedures of park residents are also outlined in these district plans.

During certain fire operations (such as prescribed fires or fire use projects), the parks may decide to keep trails open and allow visitors access to the fire area. If this happens, firefighters and interpreters on scene will answer questions and give safety messages to the public. Firefighters or other park staff may also serve as escorts through fire areas. The parks will supply media representatives with personal protective equipment (PPE) when needed.

8. Description of the Parks

LOCATION AND GEOGRAPHY

Sequoia and Kings Canyon National Parks are located in the eastern part of central California. Park headquarters at Ash Mountain (in Sequoia National Park) are located 175 air miles north of Los Angeles and 215 air miles southeast of San Francisco. Both parks occupy the western slope of the Sierra Nevada, the 400-mile-long mountain range that forms the eastern edge of the California biological and cultural province. Combined acreage for the two parks is 865,257 acres.

Kings Canyon is the northern of the two parks and consists of two sections. The small, detached General Grant Grove section of Kings Canyon National Park preserves several groves of giant sequoia including the General Grant Grove, with the famous General Grant Tree, and the Redwood Canyon/Redwood Mountain Grove, which is the largest remaining natural giant sequoia grove in the world. This section of the park is mostly mixed conifer forest, and is readily accessible via paved highways.

The remainder of Kings Canyon National Park, which comprises over 90% of the total acreage of the park, is located to the east of General Grant Grove and forms the headwaters of the South and Middle Forks of the Kings River and the South Fork of the San Joaquin River. Both the South and Middle Forks of the Kings Rivers have extensive and spectacular glacial canyons. One portion of the South Fork canyon, known as the Kings Canyon, gives the entire park its name. The Kings Canyon, and its developed area, Cedar Grove, is the only portion of the main part of the park that is accessible by motor vehicle. Both the Kings Canyon, and its Middle Fork twin, Tehipite Valley, are glacial “Yosemites” – deeply incised glacial gorges with relatively flat floors and towering granite cliffs thousands of feet high. To the east of the canyons are the high peaks of the Sierra Crest culminating in 14,242-foot-high North Palisade, the highest point in the park. This is classic High Sierra country – barren alpine ridges and glacially scoured lake-filled basins.

Usually snow free only from late June until late October, the high country is accessible only via foot and horse trails. The Sierran crest forms the eastern boundary of the park. Altogether, Kings Canyon National Park contains 716.9 square miles.

Sequoia National Park lies south of Kings Canyon and adjoins it. The park consists of a single unit that rises from the low western foothills to the crest of the Sierra at 14,495-foot-high Mt. Whitney, the highest point in the 48 contiguous states. The western third of the park consists of two natural regions – a zone of foothill vegetation below 5,000 feet, and an extensive band of mixed conifer forest between 5,000 and 9,000 feet. This latter forest contains 32 separate giant sequoia groves, including the famous Giant Forest, which covers three square miles and contains the world’s largest tree – General Sherman. Both the Generals Highway and the Mineral King Road provide vehicular access to this western third of the park. Immediately east of the forest belt is the Great Western Divide, a north-south ridge that runs through the middle of Sequoia National Park. Peaks in the vicinity of the Divide rise as high as 13,802 feet.

The eastern half of the park consists of the alpine headwaters of the North Fork of the Kern River, the glacial trench of Kern Canyon and the Sierra Crest itself, which runs north-south and forms the eastern boundary of the park. All of this area, which comprises approximately two-thirds of Sequoia National Park, is designated wilderness. Like the eastern highlands of Kings Canyon National Park, the eastern portion of Sequoia is a high, cold land of stark beauty. Sequoia National Park contains 632.7 square miles.

The parks contain resources of geological, biological, cultural, and sociological value. In addition to holding national park status, the two reservations have also been designated as a unit of the International Biosphere Preserve Program and 85% of the parks have been designated wilderness.

GEOLOGY AND TOPOGRAPHY

The Sierra Nevada is generally considered to have been formed by the detachment and uplifting of a large portion of the earth's crust resulting in a massive block, or batholith, tilted to the west in a long, moderate slope which is segmented laterally by deep canyons.

In the area of Sequoia and Kings Canyon, the western edge of this fault lies several thousand feet below the level of the San Joaquin Valley, buried beneath the gravel, sand, and mud which has washed down the range. The eastern profile is characterized by a precipitous escarpment plunging from the upper reaches of the block to the Owens Valley below. The rugged topography ranges from 1,500 feet at the southwestern boundary to 14,495 feet at the summit of Mt. Whitney on the eastern crest.

The land surface of the parks has been deeply eroded by stream and glacial action. The South Fork of the San Joaquin River and the Middle and South Forks of the Kings River constitute the major hydrological drainages of Kings Canyon National Park. The canyons of the two forks of the Kings River are two of the deepest in the United States.

All five tributaries of the Kaweah River; North, South, East, Middle and Marble Forks - originate in and drain the western portion of Sequoia National Park. The Kern River drains the eastern portion of the park. Originating along the Great Western and Kings-Kern Divides, the Kern flows south rather than following the westerly flow of other major rivers of the Sierra Nevada.

About 2000 alpine lakes are found throughout the higher portions of the two parks. Most are not deep, as they occupy the shallow rock basins formed by glacial action. Numerous streams drain from high elevation lakes and springs into the larger river canyons.

The fundamental basis of the great tilted block which created the Sierra Nevada is igneous rock; granite in various forms and textures. Massive domes such as Moro Rock and Tehipite Dome are common, as well as perpendicular cliffs, exfoliated slabs, broken talus, rectangular blocks, and huge boulders. Metamorphic rocks such as marble, schist, and quartzite are found throughout most of the parks. J.G. Moore has constructed geologic maps of several quadrangles, as well as discussed other geologic aspects of these parks (Moore and Dodge 1980).

Glacial action has extensively shaped the terrain of the parks. Several large canyons, all exhibiting the typical U-shaped valley, trend westward from the Sierra crest. Glaciers dot the higher elevations and have created the numerous lake basins characteristic of this region.

Moraines outline the courses of the ancient glaciers and mark the extent of ice flows in the canyons.

The two parks contain over 200 known karst features. Several major cave systems have been located, including Lilburn Cave, which is the most extensive in California with over 17 miles of measured passages. The two parks contain some of the wildest and least-impacted caves in the United States.

SOILS

The soils of the parks are primarily granitic in origin. Depths vary from several feet in limited low elevation areas on the western slope, to a very thin or nonexistent soil mantle at higher elevations which resulted from glacial scouring in the alpine and subalpine areas. While no definitive soils map has been made for the parks, Storie (1953) has classified the soils of this general area as upland residuals, which have formed in place by the disintegration and decomposition of the underlying parent rock. Huntington and Akeson (1987) have mapped soils in the Kawaeh drainage.

This upland category is further divided into two groups, which are applicable to these parks. Rolling, hilly-to-steep upland having acid residual soils of good depth to bedrock is common to much of the timbered portion of the parks. These podzolic soils are characterized by depths of three to six feet to bedrock and a moderate to strongly acid reaction. Residual soils of very shallow depth to bedrock are found throughout most of the remainder of the parks, especially at the higher elevations.

CLIMATE

One of the unique characteristics of the Sierra Nevada is its climate. This area enjoys a relatively mild, Mediterranean climate with a distinct winter-spring wet season and an equally distinct summer-fall dry season. Lower elevations are generally warm and clear in winter and hot and dry during the summer, whereas higher elevations are cool during the summer, and cold in the winter.

The average annual temperature at Ash Mountain Headquarters (elevation 1,700 feet) is 63 F, with extremes of 114 F and 17 F having been recorded. Extremes of 91 F and 1 F have been recorded at Giant Forest (elevation 6,409 feet) where cool daytime and evening temperatures prevail during the summer and cold nights and moderate to relatively mild days are common during the winter.

The average annual precipitation in the lower elevation foothills at Ash Mountain is 27 inches. Lodgepole receives an average annual precipitation of around 47 inches, Grant Grove around 42 inches.

Most winter precipitation above 5,000 feet occurs in the form of snow. Mean snow depths at 6,400 feet average 40 inches with 17 inches of water content. Snow infrequently falls at the lower elevations in small amounts; it usually melts within a few days.

The general wind is from the west to southwest. Strong winds are rare at lower and middle altitudes but more common at higher elevations and ridgetops. Thunderhead downdrafts can be both erratic and intense. Canyon winds generally follow the daily pattern of blowing up-canyon during the day and down-canyon during the night.

Fritts and Gordon (1982) note, based on a reconstruction of precipitation patterns using tree rings, that long-term droughts, lasting as long as 60 years, have occurred during the last 400 years in California. They also note that "the period since 1890 has been one of precipitation surplus," relative to the last 400 years.

VEGETATION

Continuously varying climate, soils, and physiography, together with an elevational gradient from 1,500 to over 14,000 feet, support a rich variety of plant communities. For descriptive purposes these ecosystems are categorized primarily on the basis of dominant vegetation and their elevational limits.

In actuality, interrelated and interdependent ecosystems, primarily due to microenvironmental conditions, give this region of the Sierra Nevada a unique diversity.

The parks contain biological resources of the highest level of significance. Congress created Sequoia and General Grant National Parks in 1890 expressly to protect the giant sequoia. The General Sherman Tree, growing in Sequoia National Park's Giant Forest, is generally recognized as the largest sequoia and the largest living tree on earth. Three other trees in the Giant Forest, and the General Grant Tree in Kings Canyon National Park, complete the list of the five largest single organisms (excluding giant fungus and aspen clones) in the world.

Sequoia trees do not grow continuously through the mixed conifer forest belt, but rather in geographically limited areas called groves. In the Sierra Nevada, the only present natural home of the sequoias, the trees grow in roughly 75 separate groves. The 39 named groves in the two parks contain roughly one-third of all naturally occurring sequoias.

The biological resources of the two parks are not limited to the sequoias. Extensive tracts of Sierran mixed conifer forest surround the sequoia groves. This forest belt, which generally clothes the mountains at altitudes between 5,000 and 9,000 feet, covers much of the southern Sierra. On surrounding lands, however, the great majority of this forest zone is being managed for multiple use. As a result, the parks now contain the largest remaining old growth forest in the southern Sierra. This forest is a very significant resource because its largely pristine nature gives it both a high recreational value and a very critical scientific value. Below the conifer forest, in the western portions of the Sierra, are the various plant communities and environments that together constitute the foothill region. Kings Canyon contains very little land within this natural zone; but in Sequoia National Park, the lower canyons of the several forks of the Kaweah River include extensive foothill lands. This environment, typified by blue oak savanna, chaparral, and oak woodland, covers much of lowland Central California outside the parks. However, very little of this non-park land is receiving any protection. In the southern Sierra Nevada, the foothill lands of Sequoia National Park are among the only foothill tracts currently designated for long-term preservation.

The remainder of the parks, most of it above 9,000 feet in altitude, can be described as High Sierra. This environment, which covers nearly as much acreage as the other two parks' environments combined, is a spectacular land of rugged, ice-sculptured alpine ridges and sparsely wooded lake-jeweled basins. As the heart of the largest wilderness area in California, these lands are of very high recreational and scientific significance.

Non-native plants have the potential to displace native plants and alter the structure and processes of native plant communities. Research biologists at the parks have recently completed baseline surveys identifying 190 non-native species within its boundaries. With several highly invasive species currently forming discrete populations within the parks and several poised along the parks' boundaries, a comprehensive management program focused on prevention, early detection and eradication will prevent many species from becoming widespread, ecologically damaging, and expensive problems.

WILDLIFE

The preservation of native wildlife within the two parks results naturally from the habitat protection that the parks afford and adds yet another level of biological significance. While the wildlife found within the parks does not differ significantly from that found naturally on surrounding lands, those lands are mostly undergoing profound changes in development. As a result, the wildlife protection function of the parks is becoming increasingly important. The regional survival of a number of species may ultimately be largely dependent upon the protection the parks provide.

The various plant communities of the parks support a rich diversity of wildlife species as both year-round residents and migratory visitors. Of the vertebrates, the parks are known to have 263 native terrestrial species, and nine more species may be present. Of the native vertebrates, six species are extirpated, and 143 are rare or uncommon. The 263terrestrial vertebrates include four species of fully terrestrial amphibians, 21 species of reptiles, 168 species of birds, and 70 species of mammals. Rather than confining themselves to a single ecosystem, most species range between several of the habitats described. Far-ranging ungulates and predators such as the mule deer, black bear, mountain lion, red-tailed hawk, golden eagle, coyote, the rare wolverine, and fisher occur within its boundaries. The Sierra Nevada bighorn sheep herd, which spends the summer in portions of the alpine and subalpine ecosystems of these parks, is estimated to have approximately 300 individuals and increasing as of 2007.

In addition to native wildlife species found in the parks, people have introduced a few exotic species. The Rio Grande turkey, starling, Virginia opossum, and House sparrow are occasionally seen at lower elevations. The chukar partridge has been observed in the alpine ecosystem. However, the incidence of these exotics is quite low. The beaver has extended its range from U.S. Forest Service land where it was introduced in the 1930s to the adjacent Kern Canyon portion of Sequoia National Park. This animal has had a significant impact on the area through activities such as cutting trees, building dams, and subsequent flooding of meadows.

AQUATIC RESOURCES

These parks contain a rich array of diverse wetlands and deepwater habitats. The entire area has been surveyed and mapped by the U.S. Fish and Wildlife Service as part of the National Wetlands Inventory. Additionally, the parks completed a more detailed and more accurate vegetation maps of the parks in 2007.The primary types of wetlands and deep-water habitats are persistent palustrine emergent (wet meadows), deciduous broad-leaved palustrine scrub-shrub (primarily willow thickets), upper perennial riverine (permanent rivers and streams), lacustrine (lakes), and open-water palustrine (ponds), and intermittent riverine (ephemeral streams). Many of the rivers and streams have riparian areas that are either forested palustrine (e.g., alder) or deciduous broad-leaved palustrine scrub-shrub (e.g., spice bush) along their banks.

Wetlands are some of the most important areas ecologically and also among the most fragile. In the Sierra Nevada Ecosystem Project, aquatic resources were identified as among the most impacted in the Sierra Nevada (SNEP 1996). On the other hand, wetlands are one of the great cleansers of human nutrients. As such, they help mitigate some of the nutrient impacts discussed above, and it is probably because of the responsiveness of wetlands to absorb nutrients that human nutrient enrichment was not found conclusively at high-use backcountry sites.

Water is a powerful attractant for people, and the interface between water and the terrestrial world is often a wetland. Wetlands and deep-water habitats are the stage for many park resource issues, most of which are discussed under the sections on water and native aquatic wildlife. Additional issues not discussed there relate to degradation of biological communities and structural landscapes in wetlands and deep-water habitats. Specific wetland issues include: 1) impacts to wetland flora and fauna as a consequence of grazing by pack stock, 2) impacts to riparian areas due to illegal trespass grazing, 3) destruction of wetland flora due to social trails forming around lakes, 4) exotic wetland flora, 5) degradation of stream banks in high-use areas, 6) disturbance of lake and stream bottoms by swimmers, waders, and anglers, 7) the need for floodplain studies in all developed areas of these parks, and 8) loss of natural fire as a force that influences the composition and structure of some wetlands.

For purposes of distinguishing aquatic fauna from terrestrial fauna, aquatic wildlife is defined as species that depend on occupying either lentic or lotic environments for all or portions of their life. These species may be either fully aquatic or amphibious. Aquatic wildlife does not include species that frequent wetlands or deep-water habitats but which are not obligate occupants of (or dependent on) those environments (e.g., *Microtus longicaudus*).

Of the vertebrates, the parks are known to have 46 native species that fit this definition, and seven more species may be present. Of the 46 native vertebrates, one species (*Rana boylii*) is extirpated, and 33 are rare or uncommon. The 46 vertebrates include five fish taxa, six species of amphibians, three species of reptiles, 30 species of birds, and two species of mammals. One species is federally listed as threatened. Twelve are sensitive species. Sensitive species listings include federal sensitive, California sensitive, California protected, and Forest Service sensitive.

While there have been some studies of aquatic invertebrates (Abel 1977, 1984; Kubly 1983; Bradford *et al*. 1998; Kratz *et al*. 1994; Stoddard 1987; Taylor and Erman 1980; and Knapp et al 2001), known invertebrates have not been compiled into a master list. The broad taxonomic groups studied include both benthic invertebrates (primarily aquatic insects) and zooplankton.

There are no known listed or sensitive aquatic invertebrates in these parks though some species merit special attention due to their scarcity.

The primary threats to native aquatic wildlife include competition and genetic introgression from exotic species. Thirteen vertebrate species have been introduced to the parks' aquatic environments and at least nine of these have become established. At least one aquatic invertebrate and several plants have been introduced into park waters. There is serious concern about the introduction of contaminants, especially biocides and pollutants from internal-combustion engines. Some native aquatic species are declining. There has been some anthropogenic alteration of aquatic habitats and there has been some harvest of select aquatic species.

SENSITIVE SPECIES

Sequoia and Kings Canyon National Parks support remarkably rich and diverse flora and fauna. The parks have over 1,400 taxa of vascular flora. Of these, 40 taxa have been identified as sensitive. The parks also support over 262 taxa of terrestrial vertebrates and 46 aquatic vertebrates. Of these, 47 taxa are considered sensitive.

The term sensitive is applied generally here to include those species that are state or federally listed, are rare or endemic in California, or have a limited distribution. Little is known about the status and habitat requirements of many sensitive species within the parks.

AIR RESOURCES

Air pollution is one of the most serious external threats to Sequoia and Kings Canyon National Parks. The parks have some of the worst air quality in the National Park Service and air pollution threatens the health and welfare of park resources, park staff, and visitors alike. Current research and monitoring indicates that ozone, nitrogen deposition, pesticide drift, and regional haze (particulate matter) pose the most serious threats, though future research may reveal even greater threats as yet unknown. The National Park Service Organic Act and the Clean Air Act mandate that these parks protect park resources and air quality related values from the adverse impacts of air pollution.

Much of the parks' air pollution originates in the San Joaquin Valley and is transported into these parks by prevailing winds (Roberts et. al. 1991). Three main factors contribute to the area's high pollution levels: climate, human activities, and topography. Hot, dry summers create perfect conditions for smog formation. A spread-out, car-dependent society with the highest population growth in the state produces increasing numbers of mobile and small stationary emission sources. Bowl-like topography promotes nightly temperature inversions that trap and concentrate pollutants and subsequently move upslope into the Sierra Nevada.

Unlike many other states, California has few large stationary sources of air pollution; mobile, area, and small stationary sources emit the majority of the state's pollutants. Mobile sources contribute approximately 70% of the precursors to ozone production (2006 California Almanac). Mobile sources and agricultural activities together account for most of the direct PM10 emissions (particulate matter ten microns in diameter or less). Vegetation (especially cotton, alfalfa, beans, tomatoes, pines and oaks) emits up to 70% of the hydrocarbons involved in ozone and organic particle formation.

CULTURAL RESOURCES

In addition to their rich natural diversity the parks preserve a rich, and by definition, unique cultural record of prehistoric and historic sites. It is estimated that seven percent of the parks' collective acreage has been inventoried (surveyed) for the presence or absence of cultural resources. This figure translates into approximately 60,000 acres.

The earliest systematic inventories of cultural resources date from the late 1950s and early 1960s. Previous investigations, including interviews with Native Americans and early settlers, were infrequently conducted; these early investigations tended to focus on the most highly visible sites and included extrapolations of knowledge from outside the parks. However, the compliance inventories of the mid-1960s to 2007 were more widely focused; they have expanded the database of known cultural resources within the parks to 354 prehistoric sites and 135 historic sites. This current database represents the best available information on the range of site types and human activities carried out over time in Sequoia and Kings Canyon National Parks (see Appendix H).

The parks' known cultural resources span a time period of at least 5,000 to 7,000 years. These resources document prehistoric, historic, and even contemporary use throughout much of the parks. The cultural resources run the gamut from well-defined and effectively "permanent" bedrock mortars (grinding holes) to log or lumber structures susceptible to fire to rock art sites to expansive vistas and wild plant resources. Of note, the two latter resource types are used by contemporary Native Americans for spiritual or cultural purposes.

Prehistoric Resources

Prehistoric cultural resources are those human-made sites, structures, features, or objects which pre-date the arrival of European or American explorers or settlers. By definition then, they are synonymous with Native American (American Indian) use. At the time of the first Spanish movements into the Great Central Valley of California (circa 1800), the native groups living in the valley and the western foothills of the Sierra Nevada were the Yokuts and Monache Indians (the latter also being known as the Western Mono). Prehistoric site types within the parks include small villages, campsites, lithic scatters (obsidian mostly), bedrock mortars and basins, caves, stone circles and stone hunting blinds, pictographs and petroglyphs, and dark, midden soils marking the location of long-term human use or settlement.

Ethnographic Resources

Ethnographic resources are recognized as including combinations of natural resources and standard cultural resource types. The distinction traditionally made by agency managers between natural and cultural resources may not apply when focusing on ethnographic resources. These latter resource types can be locales where subsistence or religious (ceremonial) activities are conducted, by either groups or individuals. Ethnographic resources include sites, structures, objects, and landscapes that are assigned cultural significance by traditional users. Ethnographic resources within the parks can include such things as historic villages or campsites, caves, rock art sites, traditional plant gathering areas, graves, landscapes, vistas, and other natural features (e.g., granite monoliths and natural promontories).

Historic Resources

Historic resources are those human-made sites, structures, features, or objects which date from the time of the arrival of European or American explorers and settlers up until the middle of the 20th century (that is, they must be at least 50 years of age). Historic sites, by definition then, can be of Native American association but are most often associated with Euro-American use and occupation.

Aspects of all of the episodes of historic activity in the southern Sierra Nevada can be found in historic sites within the parks. The associated site types include cattle camps, trails, sawmills, logging camps, sequoia stumps, shake piles, hard rock mines and mining features, stone quarries, trash dumps, hydroelectric dams and water flumes, the Colony Mill Road, military campsites, Civilian Conservation Corps-era ranger stations and roads, and, most-recently, NPS-constructed "Mission 66" facilities.

DEVELOPMENTS AND INFRASTRUCTURE RESOURCES

The park has five major developed areas with approximately 1,064 buildings in five sub-district areas. The development zone area in the park is about 1,000 acres in total size. The quality of the buildings range from well planned modern buildings that were adequately designed *for* protection against wildland fires to several hundred old buildings that are at risk of being significantly damaged or destroyed by fires. The total replacement value of the buildings within the park is well above 200 million dollars. Serving the developed areas are about 152 miles of paved and unpaved roads. There are uncounted miles of above ground powerlines and telephone lines within four of the five developed areas that are mostly at risk of significant damage or destruction from unwanted wildland fires.

All five developed areas in the parks have significant wildland/urban intermix fire threats. The fire management program has been working for many years on mitigating these threats by using a combination of mechanical hazard abatement near the buildings and prescribed burning to create wide buffer zones around the developed areas.

9. Historic Role of Fire

PRIOR TO EUROAMERICAN SETTLEMENT

The presence of fire has played a pivotal role in shaping ecosystems and landscapes in the Sierra Nevada for many millennia (Davis and Moratto 1988; Smith and Anderson 1992; SNEP 1996; Anderson and Smith 1997). As a keystone ecological process it governs aspects of ecosystem dynamics such as soil and nutrient cycling, decomposition, successional pathways, vegetation structure and composition, biodiversity, insect outbreaks, and hydrology (Kilgore 1973; SNEP 1996). Historically, fire frequency, size, intensity, and severity varied spatially and temporally across the landscape depending upon number of ignitions, climate, elevation, topography, vegetation, fuels, and edaphic conditions (Skinner and Chang 1996). Fires were a common occurrence on the landscape, often burning for months at a time and reaching large sizes.

Episodic fires performed many ecological functions within Sierran ecosystems prior to Euro American settlement. Frequent surface fires in many vegetation types minimized fuel accumulation while their variable nature helped create diverse landscapes and variable forest conditions (Stephenson et al 1991; SNEP 1996). Fires tended to be of low to moderate severity, with high-severity patches (fire sufficiently intense to kill most large trees) generally restricted to localized areas of a fraction of an acre to several acres–infrequently larger–in size. Extensive research in mixed conifer forests has shown that low intensity surface fires were a common occurrence and tended to keep the forests open (Biswell 1961; Weaver 1967, 1974; Hartesveldt and Harvey 1967; Kilgore 1971, 1972; Harvey et al 1980).

Many species and most communities show clear evidence of adaptation to recurrent fire, demonstrating that fire occurred regularly and frequently. This is particularly true in the chaparral and mixed conifer communities, where many plant species have life history attributes tied to fire for their reproduction or as a means of competing with other biota. Fire damaged or killed some plants, setting the stage for regeneration and vegetation succession. Many plants evolved fire-adapted traits, such as thick bark, and fire-stimulated flowering, sprouting, seed release, and/or germination (Chang 1996). Fire influenced soil and forest floor processes and organisms by consuming organic matter and inducing thermal and chemical changes. It also affected the dynamics of biomass accumulation and nutrient cycling at a variety of spatial scales. These effects in turn influenced habitats, distribution, and occurrence of many species (plants, vertebrates, and invertebrates).

The near exclusion of widespread low- to moderate-severity fire beginning in the latter half of the nineteenth century drastically affected the structure and composition of most Sierra Nevada vegetation, especially low- to middle-elevation forests. The changes are widespread and the effects are still generally poorly understood. The most obvious changes are increases in tree density and changes in biodiversity (Parsons and DeBenedetti. 1979; McKelvey et al. 1996). Shade tolerant species such as white fir have increased in density over shade intolerant species such as Jeffrey pine. Forests today are denser, with a higher proportion of smaller trees, and with an increased dominance by white fir and incense cedar. These changes have increased the levels of fuel, both on the forest floor and “ladder fuels”—small trees, branches, and brush which can carry fire into the canopy. Increases in fuel, coupled with efficient suppression of low and moderate intensity fires, have led to an increase in general fire severity. Crown fires were rare or absent from Sierra sequoia-mixed conifer forests prior to Euro American settlement (Show and

Kotok 1924; Kilgore and Taylor 1979). In contrast, in contemporary forests the probability of extensive crown fire or lethal scorch has increased significantly (Bonnicksen and Stone 1978; Kilgore and Sando 1975). The 1955 McGee and the 1987 Pierce fires in sequoia-mixed conifer illustrate these changes in the fire regime.

FIRE REGIMES

Attributes of pre-Euro American fire regimes can provide vital reference information for understanding changes in ecosystems over the last 150 years and in developing goals for the restoration of fire. The concept of a fire regime allows us to view fire as a multi-faceted variable rather than a single event within an ecosystem (Whelan 1995). Thus areas can be classified as having a certain type of regime that summarizes the characteristics of fires, within some range of variability that can have both spatial and temporal attributes. The idea also allows us to estimate if human activities have altered fire regimes, and to what extent. This information helps facilitate decision making on what management actions are needed to preserve or restore the regime. Fire regimes are normally defined according to specific variables including frequency, severity, season, duration, magnitude, spatial distribution, and type of fire (Gill 1975; Heinselman 1981). These fire regime characteristics may vary through time and across the landscape in response to climatic variation, number of lightning ignitions, topography, vegetation, specific historic events, and human cultural practices (SNEP 1996).

Common fire regime types for major park vegetation communities can be broadly defined as:

<u>Short-interval, low-intensity surface fires</u>: These fires burn regularly and frequently and, as such, rarely allow organic fuels to accumulate to a point where high-intensity fires may develop (van Wagtendonk 1972). Examples would include ponderosa pine and blue oak woodlands.

<u>Moderate interval, stand-replacing fires</u>: These fires occur at moderate frequencies but at high intensities. The principle example within the parks would be chaparral vegetation, where species tend to be sprouters and or obligate seeders. Increasing fire frequencies in this vegetation can result in rapid type conversion.

<u>Variable-interval, variable-intensity surface fires</u>: These fires usually spread slowly and rarely crown. Much of the upper montane red fir forest would fall in this category.

<u>Long-interval, low-intensity surface fires</u>: These fires usually spread slowly or not at all, and rarely burn the crowns or kill stands of overstory trees (Kilgore and Briggs 1972). Examples of this regime type in the Sierra Nevada are the subalpine forests of whitebark pine (*Pinus albicaulis*) and some foxtail pine (*Pinus balfouriana*) stands. The effects of fire vary with species, stand age, and fire intensity.

<u>Long-interval, high-intensity surface fires</u>: These fires burn rarely, but become high-intensity, possibly stand-replacing. For the Sierra Nevada, piñon pine might fit this category.

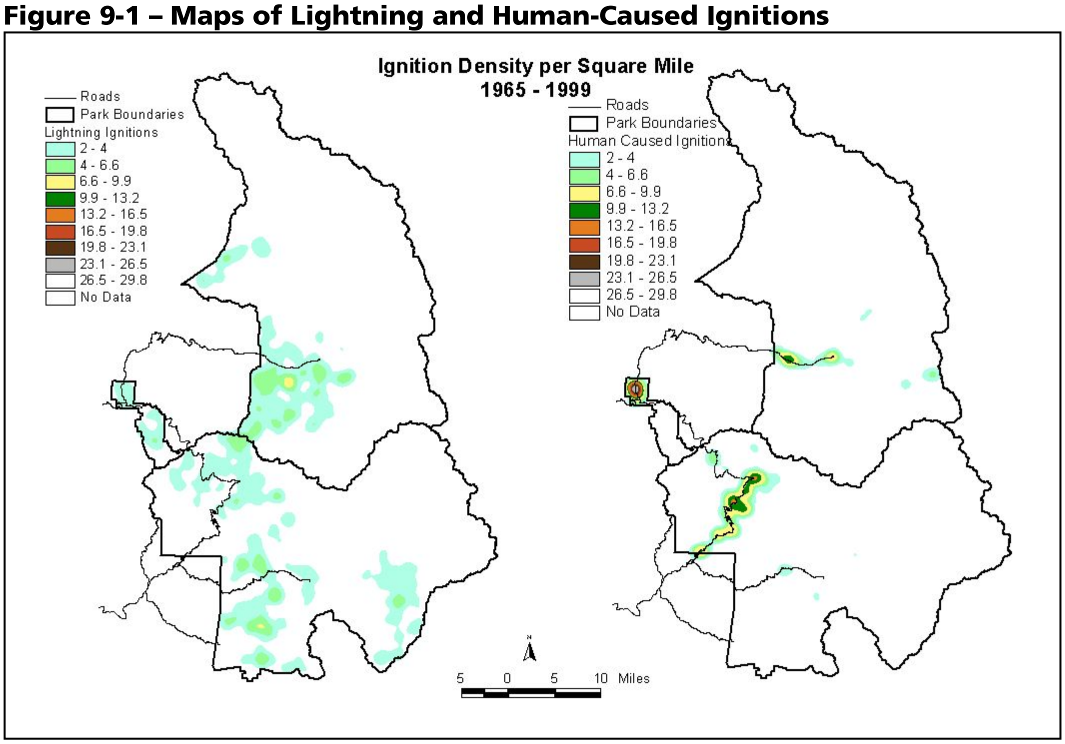
<u>Long-interval, variable intensity fires</u>: These fires are uncommon events and exhibit considerable spatial variability in intensity depending on fuel and weather conditions. Infrequent fires in some lodgepole pine forests (*Pinus contorta* var. *murrayana*) may be characterized by low intensity surface fires or, under severe burning conditions, high severity crown fires.

Lack of fire: Within a specific areas or vegetation types fire probably did not occur or its occurrence was extremely rare and erratic. Examples might include alpine vegetation, western juniper, and isolated foxtail pine stands (stands not connected to lower elevation forests) where, if fire occurred at all, it would usually only burn the single tree that was ignited. Evidence for the long absence of widespread fire in these stands comes from the great age of many individuals of this fire sensitive species and from the extensive amounts of subfossil wood, often exceeding 4,000 years in age, found on the ground (stands such as Alta Peak, Tablelands, or Tawny Point provide examples).

IGNITION SOURCES

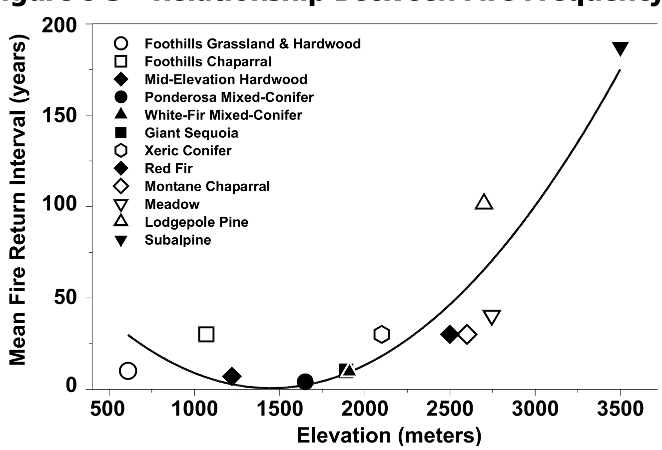
There is considerable spatial variation in contemporary lightning ignition rates within the parks. Based on data from the parks' fire records over the last 70 years (Vankat 1985; NPS GIS data), ignition densities cluster in areas above Cedar Grove, the Kern Canyon, Sugarloaf Valley, and the western slopes of the Great Western Divide (Figure 9-1). Standardizing for land area, lightning ignition rates are lower than expected at lower and at higher elevations and higher than expected at mid elevations particularly in white fir, red fir, and Jeffrey pine vegetation types. However, while contemporary lightning ignition rates are lower in lower elevation conifer areas, areas where historic fire return intervals were the shortest; past fire sizes at these elevations were probably greater than at higher elevations due to greater rates of fire spread.

Figure 9-1 – Maps of Lightning and Human-Caused Ignitions



Ignitions of pre-Euro American settlement fires are usually attributed to either lightning or ignitions by Native Americans. In the Sierra Nevada authors typically refer to a background level of lightning ignitions that were complemented by Native American sources (Lewis 1973; Kilgore and Taylor 1979). However, while there is good evidence that Native Americans started fires from a variety of sources (Reynolds 1959; Lewis 1973) considerable debate remains on the importance of this fire at a landscape scale. This burning undoubtedly influenced vegetation patterns, although probably on a local basis determined by proximity to camping, hunting, or other resource use areas. Within the parks the reasons, timing, and sizes of Native American burning are poorly understood. Current hard historic evidence on the source of fires in the southern Sierra Nevada is too limited to determine the specific importance of either lightning or Native American causes. Actual patterns of fire across the landscape were probably a result of both ignition sources with the importance of each varying between specific vegetation types and locations. However, within the parks it is argued that the number of lightning ignitions could account for the observed pre-settlement fire frequencies if they had not been suppressed and had been allowed to spread (Swetnam et al 1992; Stephenson 1996; Vale 1998). This contrasts with views which suggest that lightning ignitions were not frequent enough to account for the number of fires that occurred in the Sierra prior to Euro American settlement (Reynolds 1959; Vankat 1970; Lewis 1973; Kilgore and Taylor 1979). The former view is supported by an analysis of past fire occurrence, reconstructed using fire scars, and contemporary lightning ignitions in the East Fork watershed (Caprio 2003 unpublished data). For the period from 1750 to 1849 fires were recorded during 75% of the years (25% without fires) while during the contemporary period from 1933 to 1999 lightning ignitions (243 total) were recorded for 79% of the years (21% without ignitions), a similar frequency. While specific locations within the watershed had high pre-Euro American settlement fire frequencies and few recent ignitions there are no apparent barriers to fire spread from areas with high ignition rates. The one exception being conifer forests on Milk Ranch Peak, isolation by chaparral vegetation from the rest of the watershed, but which had very frequent fire and few lightning ignitions

Figure 9-3 – Relationship Between Fire Frequency and Elevation



Fire Frequency

General patterns of pre-Euro American fire frequencies are apparent at several scales within the parks. Variation exists locally, with specific site characteristics, such as productivity, potential for ignition, or other factors, influencing frequency. General patterns are also apparent at large scales. For example, differences in average fire frequency are apparent in different vegetation types (Table 9-2, next page). Additionally, on the west slope of the Sierra, frequencies reconstructed using fire-scarred trees show an inverse relationship between number of fires and elevation (Caprio and Swetnam 1995; Swetnam et al 1998; Caprio 2000). When all available information about fire occurrence for all major vegetation types in the parks (including vegetation types where fire scars are not found) are considered the relationship between fire frequency and elevation has a pronounced "Lazy-J" shaped relationship (Figure 9-3) (Caprio and Lineback 1997). Fire return intervals are longest at higher elevations, shortest in lower mixed conifer forest and appear to again increase in length in lower elevation grass-oak woodland and chaparral vegetation based on current, albeit poor quality, information.

Table 9-2 – Fire Frequencies for Different Vegetation Types.

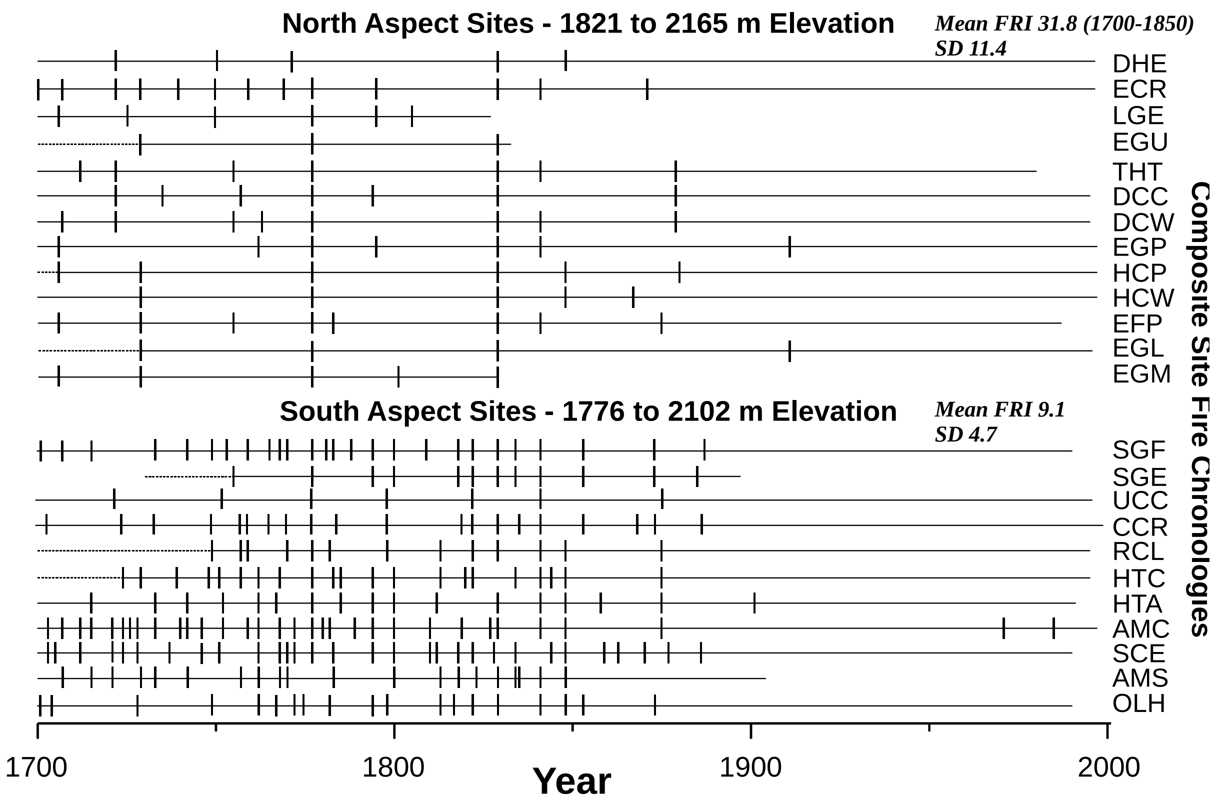
Mean and maximum fire-rtrn intervals for the 12 major classifications in Sequoia & Kings Canyon National Park. Data are for the period prior to 1860 (1870 for subalpine conifer). The primary source(s) for the data are enumerated under "Reference" heading and are listed at the bottom of the table. Fire frequency regime classes for each major vegetation class were based on mean maximum fire-return intervals. The frequency classes were used to reconstruct fire frequency regimes spatially across the park.

Vegetation/Terrain Class (class code #)	Code	Mean	Max.	Freq. Class	Knowledge	Reference
(1) Ponderosa Mixed Conifer	PIPO	4	6	v. high	good	1,2,3,16,177
(2) White Fir Mixed Conifer	ABCO	10	16	high	good	1,2
(3) Red Fir Mixed Conifer	ABMA	30	50	low	poor	1,4,5
(4) Lodgepole Pine Forest	PICO	102	163	v. low	v. poor	5,6,18
(5) Xeric Conifer Forest	XECO	30	50	low	v. poor	5,7,8,17
(6) Subalpine Conifer	SUAL	187	508	v. low	poor	5,9
(7) Foothills Hardwood & Grassland	FHGR	10	17	mod.	v. poor	5,10,11
(8) Foothills Chaparral	FOCH	30	60	low	estimated unknown	12
(9) Mid-Elevation Hardwood	MEHA	7	23	mod.	v. poor	3,19
(10) Montane Chaparral	MOCH	30	75	low	estimated unknown	12
(11) Meadow	MEAD	40	65	low	estimated unknown	8
(14) Giant Sequoia Forest	SEGI	10	16	high	good	13,14,15
(12) Barren Rock	ROCK					
(13) Other (mostly water)	OTHR					
Missing Data	MISS					

1 Caprio and Swetnam 1993, 1994, 1995; **2** Kilgore and Taylor 1979; **3** Stephens 1997, unpublished data in Skinner and Chang996; **4** Pitcher 1981,1987; **5** Caprio unpublished data 2000 ; **6** Keifer 1991**7** Taylor, unpublished data in Skinner and Chang 1996; **8** Skinner, unpublished data in Skinner and Chang 1996; **9** Caprio, Mutch, and Stephenson unpublished data ; **10** Mensing 1992; **11** McClaren and Bartolome 1989; **12** SNEP 1996; **13** Swetnam et al. 1991; **14** Swetnam et al. 1992; **15** Swetnam 1993; **16** Warner 1980; **17** McBride and Jacobs 1980; **18** Sheppard 1984; **19** Stephens 1997

Additionally, within at least some watersheds strong differences in fire frequency exist between aspects. In the Redwood Mountain area, which is sequoia-mixed conifer, fire occurred about every nine years on west-facing slopes and every 16 years on east-facing slopes before 1875 (Kilgore and Taylor 1979). In the East Fork differences are more pronounced with fire 2-3 times more frequent on south than on north aspects at similar elevation sites (Fig. 9-4) (Caprio 2004).

Figure 9-4 – North and South Aspect Fire Frequencies in the East Fork



Another important component of fire frequency statistics is the stochastic variation in fire intervals through time (fire interval distributions) among or within vegetation types. For example, areas with a similar mean fire return interval could have quite different fire interval distributions. One site might have very regular intervals between fires while a second site might have very irregular intervals. Such interval dependent effects of fire events can have significant influences on plant demographics and long-term plant community structure (Whelan 1995; Bond and van Wilgen 1996; Chang 1996).

Magnitude

Fire characteristics, such as intensity and severity, also varied among vegetation types. At lower elevations, little is known about fire regimes in grasslands and oak woodlands due to the lack of fire scarred trees and the replacement of nearly all native herbaceous communities by exotics following initiation of intense grazing in the 1860s (Dilsaver and Tweed 1990). However, descriptions of the vegetation suggest that episodic fast moving surface fires in flashy herbaceous fuels, during the dry summer/fall, probably played a role in these communities (Parsons 1981). Stand replacing fire in chaparral communities today probably differs little from pre-Euro American characteristics although frequencies have probably been altered. In much of the Sierra's sequoia-mixed conifer forest, fires were primarily non-stand replacing surface fires prior to Euro American settlement (Show and Kotok 1924; Kilgore and Taylor 1979; Warner 1980; Pitcher 1987; Caprio and Swetnam 1995). Instances of large stand replacing fires do exist in particular mixed-conifer locations (Caprio et al 1994) but are uncommon. Fires in these areas were dominated by low to moderate severity, with high-severity generally restricted to localized areas (Stephenson et al 1991). Characteristics of past fire appear to have been somewhat different in higher elevation forests. Fire in red fir forest was **typically** non-stand replacing due to the fire resistant bark of this species but significantly sized patches of trees could be killed, particularly on higher elevation north aspects (Pitcher 1981; 1987). Fire in lodgepole pine was generally a patchwork of low intensity surface fire and higher intensity crown fire (mixed severity) depending of specific burning conditions.

Fire Size

The scale of fire prior to Euro American settlement was significantly different from what is typically observed today. Both the frequency of fire occurrence and the frequency of large spreading fires were much greater than today or at any time in the last hundred years. Estimates based on fire history data suggest that from 15,100 to 24,700 acres burned annually within the parks (Caprio and Graber 2000). However, because of the vagaries of climate or number of ignitions, the actual number of acres burned in any given year could have been much greater or much smaller than the average. Coarse reconstructions of actual pre-Euro American settlement fire sizes in the Kaweah's East Fork watershed indicate that up to ~10,400 acres (33%) of the 31,870 acre watershed burned in a given year (this may have been one or more fires in the year 1829) (Caprio 2004). Of interest is that some of these fires also burned in adjacent drainages. For example fires in 1777, 1812, and 1841 are all recorded in the South Fork, East Fork, and Middle Fork of the Kaweah River, indicating potential spread of fires among watersheds. However, most fires in the East Fork were small with a roughly estimated annual area burned of ~800 acres (2.4% of the area).

Fire history reconstructions suggest that variation in fire size also occurred by aspect (Caprio 2001, 2004). Within the East Fork watershed annual area burned prior to Euro American settlement on lower elevation south aspects (5,860 – 7,145 feet elevation) was generally small but regularly interspersed with years when moderate large fires occurred. In contrast, on similar north aspects, most fires seem to have been small but the pattern was punctuated by rare years when large areas burned.

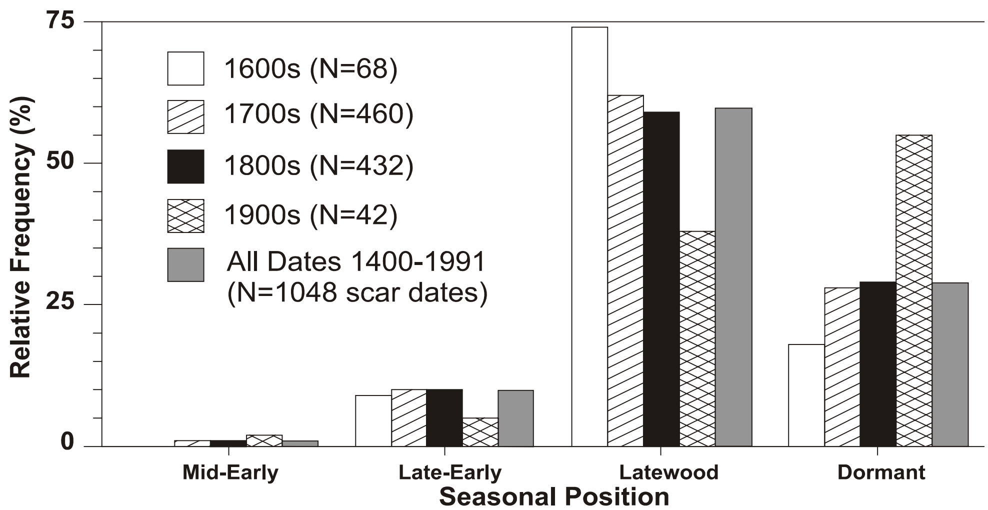
Fire size was probably also related to overall landscape diversity patterns such as vegetation, fuel, and topographic complexity. In course-grained landscapes, such as the highly dissected, rocky high country (upper Kern and Kings River drainages) fires probably tended to be smaller with poor year-to-year synchrony. In contrast, fires were probably larger and more synchronous in fine-grained watersheds such as are found on the west side of the range. Burn patterns in these landscapes would be related to fire conductance among vegetation types and between drainages. For example, in the Kaweah watershed, fires would have the potential to spread for long distances during the long summer/fall dry season. Additionally, drainages such as the Kaweah have strong connections to lower elevation grasslands (now outside the parks) where ignitions could spread rapidly and reach large sizes before spreading into conifer forests.

Seasonality

Season of fire occurrence can have important effects on vegetation and wildlife. Factors that can be important in seasonality are fuel moisture content, phenology of vegetation, or life history patterns of wildlife. Vegetation and wildlife within particular ecosystems have generally adapted to fire within a particular window of time. It has been hypothesized that changes in fire seasonality that go outside the normal range of variability may have adverse impacts. However, recent studies suggest that initial restoration fires may have few or in some cases positive effects

(Knapp et al. 2005, 2006, 2007; Ferrenburg et al. 2006; Schwilk et al. 2006). In the Sierra Nevada pre-Euro American settlement fires generally occurred from the summer through the fall based on analysis of seasonal positions of fire scars in tree rings (Swetnam et al 1992; Caprio and Swetnam 1995) (Figure 9-5). This agrees with current knowledge of contemporary lightning ignition and fire spread patterns (Show and Kotok 1924; Vankat 1985; Sequoia and Kings Canyon fire records).

Figure 9-5 – Seasonal Position of Fire Scars by Century



Effects of Climate

Short-term climatic variation played a very strong role in influencing burn patterns and fire severity in the past. Historically, on the west slope of the Sierra Nevada specific regional fire years have been identified (years in which fires have been recorded at sites from throughout the southern Sierra Nevada). These usually occurred during dry years (Brown et al. 1992; Swetnam et al 1992; Swetnam 1993; Swetnam et al 1998; Taylor and Beatty 2005). The reconstruction of fire size in the East Fork watershed indicates large fires, burning throughout the watershed, primarily occurred during years when prior winters were dry while small to moderate sized fires could occur on south aspects during almost any given year (Caprio 2004). Analysis of millennial length fire histories from giant sequoia also document long-term variation (1,000-2,000 years) in the fire regime associated with climatic fluctuations (Swetnam 1993). These data suggest more frequent but smaller fires during the Medieval Warm Period (A.D. 1000 - 1300) and fewer larger fires during cooler periods (A.D. 500 - 1000 and after A.D. 1300). These fluctuations indicate that characteristics of fire regimes are dynamic over long time periods. Thus long-term management should not be based solely on a static interpretation of the fire regime for a particular unit of land at a given time.

Post-Euro American Settlement Changes

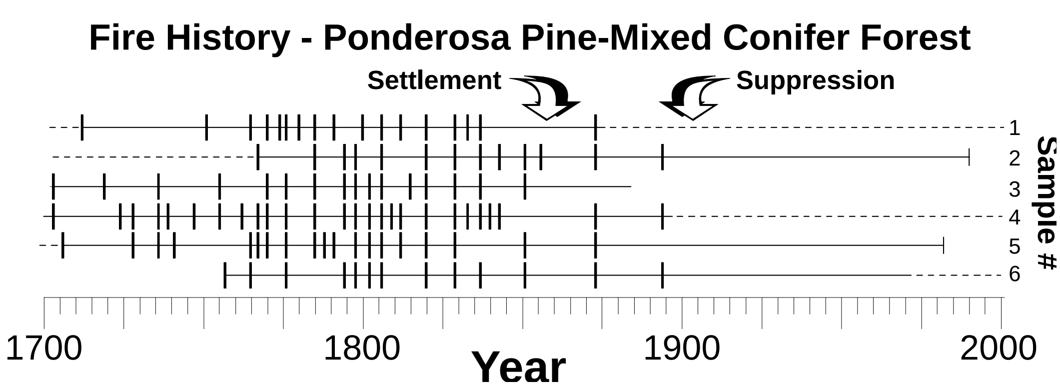
Literature on changes to pre-Euro American fire regimes often suggests that changes in these regimes are largely the result of active fire suppression activities. However, fire history reconstructions show that the most dramatic changes in Sierran fire regimes took place 40 to 70 years prior to the initiation of organized and effective suppression efforts in the first two to three decades of the twentieth century. By far the most dramatic changes appear to be a direct result of initial Euro American utilization and settlement of the southern Sierra between about 1850 and 1880.

Reconstructions of past fire occurrence from fire scarred trees in the parks show several periods of change between 1850 and 1921 (when written fire records for the parks begin). Between about 1850 and 1870 a dramatic decline in fire frequency occurred in nearly all lower to mid-elevation conifer forests. Between about 1870 and 1900 large landscape scale fires continued to burn although at a reduced frequency relative to pre-Euro American levels. Similar changes may have also occurred in lower elevation vegetation but fire history evidence is lacking in these vegetation types. In upper elevation areas, changes are also not apparent during this period due to the long natural fire return intervals. In the first decades of the twentieth century fire on the scale that had occurred prior to 1900 no longer existed.

The initial change in local fire regimes in the 1860s appears to be the result of either: 1) a decline in the influence of Native American populations and/or 2) the impact of intense grazing pressure on fine fuels, particularly at lower elevations, important for fire spread (Vankat 1970; Caprio and Swetnam 1995; Taylor and Beatty 2005).

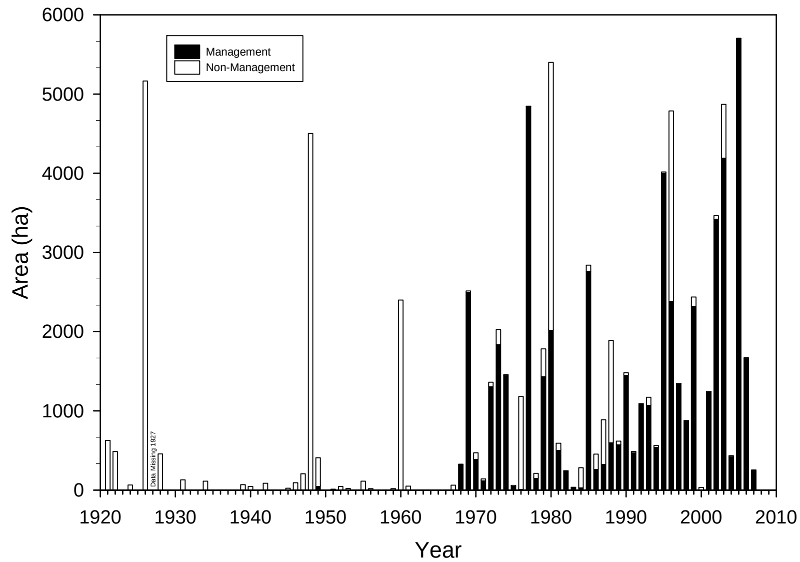
Literature on fire and human impacts on the Sierra Nevada during the latter half of the 19th century often mentions the extent and impact of fires set by sheep herders (Vankat 1977; Beesley 1996; Kinney 1996). The indicated purpose of the burns, set in the fall as the flocks moved out of the mountains, was to improve forage and remove barriers to sheep movement. It is also frequently mentioned that fires were of unnatural intensity (Muir 1877; Muir 1938). However, this picture of large scale burning by shepherds is not supported by fire history sampling that has been carried in the parks or other locations on the western slope of the southern Sierra (Swetnam et al 1992, Caprio and Swetnam 1995; Swetnam et al 1998; Caprio 2004). Of the large number of fire history chronologies developed in this area nearly all show a dramatic decline in fire frequency in about 1860 (Figure 9-6). However, there is evidence of limited anthropogenic burning, particularly around meadows (Caprio in press). While sporadic fires, which continue to appear in the fire scar record up until about 1900, could have been set by shepherds their ignition source(s) remains unknown.

Figure 9-6 – Decline in Fire Frequency Around 1860



Effectiveness of fire suppression in the first half of the twentieth century varied spatially over the landscape. Suppression efforts had their greatest impact in the middle-elevation zones where low- to medium-intensity surface fires were more easily controlled. In contrast, fast-spreading fires typical of chaparral sites were often beyond the control of humans and were less successfully suppressed (Chang 1996). Fire records from in and near the parks show a substantially higher proportion of large fires in grass/oak woodland and chaparral than in mid-elevation conifer forest through the 1930s. Active fire suppression of all fires continued until 1968 when the first large scale prescribed burn was carried out in the parks. This was soon followed by a policy shift that permitted some lightning ignitions to burn naturally. Since 1968 a substantial amount of area has been burned either through active management ignitions or lightning ignitions allowed to burn (Figure 9-7).

Figure 9-7 – Area Burned Through Active Management or Lightning



10. Wildland Fire Management Situation

FIRE SEASON AND HISTORICAL WEATHER SUMMARY

The fire season, as determined by the fire program and budget analysis (FIREPRO), runs from May 15 to October 15, with an average of 50 to 100 fires of all origins occurring during this period. July, August, and September have the highest fire incidence. Weather tends to be clear with daytime temperatures ranging approximately 75° to 85° F at 5,000 feet in elevation and 85° to 105° F at 1,000 feet. Prevailing winds are about five to ten miles per hour from the west and southwest.

The prevailing westerly wind brings marine air into the San Joaquin Valley that is heated and subsequently raised by the steep rise of the Sierra to the east. As a result, afternoon thunderheads are common during the hottest weeks of the year, from mid-July to the end of August. At other times of year, thunderstorm activity is generated by flows of southerly subtropical moisture. Periods of high lightning activity often last three to four days and possibly ignite 10 to 20 or more fires in the 4,000 to 8,000 foot elevations of the parks during one of these periods.

The parks receive their precipitation, depending on elevation, almost entirely from winter cold-front passages from the northwest and west. Virtually no precipitation occurs during the summer and fall, except during thunderstorms. Rarely, tropical storms from the Gulf of Mexico drop as much as four to six inches of rain in a few days during the summer and fall.

The topography of the parks results in a variety of local wind conditions. The diurnal relationship between heating and cooling of slopes and canyons results in local winds that can become significant to fire behavior. Narrow canyons, such as the South Fork of the Kings at Cedar Grove, typically produce summer afternoon up-canyon winds of 10 to 20 mph. Steep slopes result in nighttime down-slope and down-canyon winds. The occurrence of mid-slope thermal belts is common from mid-July to mid-October and can result in fires actively burning well into the night.

Thunderstorms can produce strong, erratic downdraft winds, which follow topographic features and can cause rapid spread of fire in all directions. Another potential source of strong winds is the rare foehn-like mono wind of late summer and fall. These gale force east winds are warm and dry, originating from the Great Basin. The high mountain crests of the Great Western Divide and High Sierra usually prevent these strong winds from reaching the surface within the parks. When these systems are well established, the strong and dry east winds aloft are frequently accompanied with extremely dry conditions and poor nighttime humidity recovery. Maximum relative humidity may not exceed 25% and can actually go down to single digits over night.

The predominate summer weather scenario consists of a high pressure system that settles over the western United States and produces good visibility, high temperatures, low humidities, and atmospheric instability with gusty winds. Relative humidities in the mid-teens and low-twenties are common during these long periods of strong high-pressure dominated weather.

There is some speculation that oscillation in the relative humidity in these parks results from fluctuations in the boundary between the moist marine layer to the west and the dry high-pressure area to the east. As a result, prescribed conditions can disappear quickly, and nighttime humidity recovery may be less than expected when the high pressure dominates.

The atmosphere tends to be unstable during the spring and becomes more stable during the fall. The San Joaquin Valley develops an inversion during the fall as the atmosphere cools, and agricultural "no burn" days below 5,000 feet are common. As the atmosphere over the parks becomes more stable, the probability that smoke will impact a popular vista or a local community becomes more likely.

Steep canyons also develop strong inversions, leading to potentially explosive conditions when they lift, as demonstrated by the 1976 Sphinx Fire in Bubbs Creek canyon in which several hundred acres of brush and timber burned up in the early afternoon of June 29. Smoke in these canyons also affects aviation operations, with smoke not lifting until around 10:00 a.m.

WILDLAND FUELS AND FIRE BEHAVIOR

Fire in the Sierra Nevada plays an important role in determining the structure of the various vegetation types. Each vegetation type has evolved in the presence of a distinct fire regime. The vegetation of the parks generally changes along an elevation gradient. In general, the vegetation types, elevations, behavior, and corresponding fuel models are:

Table 10-1 – Vegetation Types, Elevations, Fire Behavior, and Fuel Models

Vegetation Type	Elevation Range	Fire Behavior	NFFL Model	NFDRS Model
Grassland (montane meadows, etc.)	6,000-11,000'	Rapid Spread Low Intensity	1	L
Grass with Overstory	1,400-6,000'	Rapid Spread Moderate Intensity	2	C
Tall Brush (chamise & manzanita)	1,400-5,000'	Rapid Spread High Intensity	4	B
Low Brush	1,400-6,000'	Moderate Spread Moderate Intensity	5	F
Medium Brush (decadent)	6,000-10,000'	Rapid Spread Moderate Intensity	6	F
Closed Timber (short needle – slow spread)	5,000-11,000'	Slow Spread Moderate Intensity	8	H
Broadleaf Deciduous Hardwood & Long Needle Pine	4,500-7,000'	Moderate Spread, Moderate Intensity	9	W, E
Heavy Timber Litter	4,500-8,000'	Moderate Spread High Intensity	10	G
Low Elevation Short Needle Conifer (SEKI custom model)	6,000-10,000	Slow Spread Moderate Intensity	14	G
High Elevation Short Needle (slow spread) (SEKI custom)	7,500-11,000	Slow Spread Moderate Intensity	18	H

This generalized vegetation continuum varies with changes in aspect and local microclimates (springs, riparian zones etc.). More extensive fires occur in drought years, with the fires spreading into areas normally too wet to burn.

Fuel models are simply mathematical models that describe the properties of live and dead vegetation that contribute to the physics of combustion. The models include parameters such as fuel weight, density, horizontal and vertical continuity, moisture content, and flammability. Fuel models are primarily used to predict fire behavior under different weather and environmental conditions. Currently the Fire Behavior Prediction System (FBPS) contains 13 standard fuel models. The park has created another two custom fuel models to locally describe fuel complexes not well covered by the standard 13 models. National Fire Danger Rating System (NFDRS) fuel models are also used to track seasonal drought and associated fire danger response planning.

The NFDRS fuel model B and Fire Behavior Prediction System (FBPS) fuel models 1 or 2, characterize the oak woodland vegetation. The NFDRS fuel models B or F and FBPS fuel models 4, 5, or 6 characterize the chaparral vegetation. The NFDRS fuel modes C, G or U and FBPS fuel models 2, 9, 8, 10 or custom model 14, characterize the pine dominated mixed conifer vegetation. NFDRS fuel models H or G and FBPS fuel models 8, 10, or custom model 14, characterize the white fir and sequoia dominated mixed conifer vegetation. NFDRS fuel model H and FBPS fuel models 8 or custom model 18 characterize the red fir forest. NFDRS fuel models H or U and FBPS fuel models 8 or custom model 18 characterize the lodgepole pine forest. NFDRS fuel models H or U and FBPS fuel models 8 or custom model 18 characterize the subalpine forest.

Wildland fuels are divided into dead fuel and live fuel types. The former is further divided into fine fuels (< 1/4 inch diameter), medium fuels (>1/4 and <3 inch), and heavy fuels (> 3 inch diameter). As the snow melts, dead fuels are usually saturated. As late as June, the heavy fuels have > 25% moisture content. During the next few months, they steadily dry until a fuel moisture of 7% is reached in late July or early August in the drier areas, such as Cedar Grove. This drying trend is usually followed by a slow increase in fuel moisture (due to humidity, etc.) until the winter precipitation begins. Live fuel moisture in the chaparral community tends to peak as the plants flower in the spring, exceeding 200% moisture content. Live fuel moisture tends to steadily drop as the summer continues, reaching approximately 50% moisture content. Similarly, annual grasses will cure by mid-June.

Fine fuels contribute mainly to fire spread. As the fuels dry out and the rate of spread increases, more of the heavy fuels may be ignited per unit time. Their localized energy produces more noticeable fire effects such as mortality, scorch, and char.

EFFECT OF FIRE SUPPRESSION ON WILDLAND FUELS

Dead fuel loads in the various vegetation types in the parks vary according to fire history, elevation, growth pattern, aspect, and length of growing season. The fire cycle, fuel load, and vegetation type are closely interrelated, and each fire type serves to stabilize and perpetuate a given community. Conditions produced from fire suppression have given rise to new fuel-vegetation complexes that influence fire type, which in turn affects the complex.

Years of fire suppression are thought to have effectively removed the mosaic of various aged burns in the vegetative communities below the red fir forest (< 8000 feet) and have encouraged more extensive fires than occurred prior to Euro American settlement. In the sequoia-mixed conifer and ponderosa pine types, fire acts as a thinning agent (Cooper 1960). In its absence, undergrowth of shade tolerant species results in a continuous ladder of all-aged crowns from surface to overstory. Crown fires, once virtually nonexistent in Sierra forests, are now possible (Kilgore and Sando 1975; Kilgore and Taylor 1979). The fires that occurred historically in the mixed conifer forest are thought to have been generally surface fires. A summary of the fire return interval for each vegetation type that occurs within the parks can be found in Chapter 9. Fire managers in the parks today use an index of how far an area has departed from the fire return interval that is thought to have existed prior to Euro American settlement (see FRID discussion in Chapter 4).

CONTROL PROBLEMS

During the peak of the fire season, fires in the oak woodland fuels are usually controlled early with suppression resources (ground and air) or they burn up into the chaparral fuels.

Fires in the chaparral fuels frequently are beyond direct attack capabilities at the head once they become established. These fires usually burn up to the ridge top and are caught, as they become backing and flanking fires in typically 3-5 days.

Ponderosa pine-mixed conifer fires are often difficult to control during the peak fire season. Ladder fuels (manzanita and incense cedar) in the understory and numerous snags are the main cause of frequent short range spotting due to the torching of trees and rolling material in the receptive fine fuel bed. This fuel type is frequently located in a mid-slope thermal belt causing a longer period of active burning. The long burning period combined with the frequent spot fires can often exhaust initial action resources leading to extended attack (2-5 days).

Fires in the sequoia and white fir-mixed conifer types usually spread slowly through the compact litter layer and rarely escape initial action. Heavy fuel loads, steep slopes, and long burning periods usually cause the few fires that go beyond initial action. The heavy dead-and-down fuel and deep duff layer can lead to extended mop-up operations.

Fires in the red fir forest are rarely difficult to control due to the tightly compacted litter layer and slow fire spread. Fires occurring in the lodgepole pine and subalpine forest can usually be controlled due to the increasing amount of rock and bare ground as elevation increases.

FIRE MANAGEMENT HISTORY

Sources of fires

Thunderstorms account for an average of about 36 fires each year with most of these fires occurring in the mixed conifer type. Of the known lightning fires that have occurred in the parks from 1922 through the present, 95% of them have been less than 10 acres in size. Fire suppression has contributed to the preponderance of small fires; however, since the inception of the fire use program in 1968, approximately 89% of the fires being managed for resource benefit have been less than 10 acres. Most of these fires remained small because of low fuel loadings and natural barriers.

Lightning fire occurrence tends to increase with elevation up through the red fir type. Snags, ridge tops, prominent features, xeric sites, and the west facing slopes are frequent sites of lightning fires. The ridges above Cedar Grove and Kern Canyon, the Sugarloaf Valley, and the western slopes of the Great Western Divide, are areas of frequent fire occurrence during periods of lightning activity (Vankat, 1985).

Human-caused fires may occur almost anywhere and at any time. Most are concentrated around roads, campsites, and trails. Many are the result of accidents such as carelessness with cigarettes or unattended campfires, whereas a few, such as the 2-acre Lost Fire in 2001, are arson caused. Since 1922, approximately 45% of the fires in the parks have been human-caused, mostly in mixed conifer forests.

Fire Suppression

Little is known regarding fire suppression activity prior to the 1890 creation of Sequoia National Park and General Grant National Park (later expanded and renamed Kings Canyon National Park). Undoubtedly some level of suppression occurred by native peoples in pre-Euro American times, and there is some record of miners, sheepherders, and cattlemen extinguishing fires during their heyday beginning in the mid-1850's. Lighter fuel loads and more open forests - a product of frequent pre-settlement fires - probably allowed some level of success to those early suppression efforts. During that period fire control was aided by cattle and sheep which grazed down dry grasses, further reducing opportunity for the rapid spread of understory and grassland fires in many areas. After park designation, a succession of military and civilian stewards continued to suppress most fires with the intention of protecting the big trees from harm. Suppression efforts became dramatically more effective and extensive following the advent of helicopter use in the 1940's and 1950's with full suppression of all fires remaining the official policy through the mid-1960s. During the period of full suppression, fires became progressively more difficult, dangerous, and expensive to control due to the continued build-up of fire fuels across the landscape. During the 1960's research was systematically documenting the beneficial effects of fire on giant sequoia and other species, and recognizing fire as a keystone ecological process perpetuating Sierra Nevada ecosystems.

Since the 1960's it has been park policy to continue to suppress all human caused fires (except those intentionally set by park management) and many lightning ignited fires, while allowing some lightning ignitions to spread under carefully managed conditions.

Prescribed Burning

Concern about the impact of the parks' early fire suppression policy was first expressed for the middle elevation (4,000 to 7,000 feet) mixed conifer forest zone. The buildup of flammable ground fuels, the increase of white fir, the lack of giant sequoia reproduction, and the threat of wildfire to the sequoia groves all indicated the need to reintroduce fire into this zone by prescribed burning.

The prescribed burning program began in 1964 as an experimental research program to study the regeneration of sequoias. Drs. Richard Hartesveldt and Tom Harvey studied the regeneration of sequoias after several research areas were prescribed burned. They found that sequoia seed germination and seedling establishment is strongly related to disturbances of the substrate, the opening of the forest floor to light, and to the proximity of suitable substrate with trees of heavy cone loading (Hartesveldt and Harvey 1967). They also found that higher intensity fires produced even better conditions for seedling survival than light fires.

The experimental research program continued in 1968 when about 800 acres in a red fir forest were burned to study the ecological impact of prescribed fire on fir thickets (Kilgore 1971). Kilgore found that fire reduced the litter, duff, and humus by about 50% and killed many red fir seedlings and saplings. No adverse changes in deer, bird numbers, or water quality were observed.

Since the first experimental research burn in 1968 through 1999, an estimated 549 prescribed burns (49,771 acres) have occurred. For more information on the evolution of the prescribed fire management program see Bancroft et al. (1985).

Use of wildland fire

Concurrent with the implementation of the prescribed fire program, the parks instituted a fire use program in 1968. Natural lightning ignitions managed to restore or maintain ecological conditions and processes have been variously known as "*prescribed natural fires (PNFs)*", "*natural fires*", and are currently called "*use of wildland fire* (generally shortened to just *fire use*)". While the names have changed over time to conform to standardized interagency terminology, the intent and practice of managing natural ignitions have remained constant in these parks. Fire use projects in forested areas of the parks are generally slow burning, low intensity ground fires, which occasionally torch out individual trees, or make brief runs involving local crown fires. This type of fire is most common in higher elevations (> 8,000ft) due to the frequency of lightning strikes. In addition, the red fir, lodgepole pine, and subalpine forest communities found at high elevations are characterized by long-lived, widely spaced, and relatively short trees (Rundel et al. 1977). These forests are thought to have evolved with infrequent low intensity ground fires (Vankat 1970) due to the low temperatures and the short growing season. Because of the longer fire return intervals, these forest communities have not yet resulted in excessive fuel accumulations (Parsons 1977).

Due to the previous characteristics, most of the high elevation forests in the parks have been managed with a fire use emphasis over the last few decades. Since the beginning of the program, the parks have had 486 fires for a total of 42,460 acres. Most of these fires (89%) were less than 10 acres in size and only a few (6.5%) exceeded 100 acres in size. Fewer (2.1%) exceeded 1,000 acres in size. Most fire use projects have occurred in the red fir and subalpine vegetation types.

The largest fire use project in the parks, the Ferguson Fire, burned an estimated 10,420 acres. It started on June 26, 1977, and burned for over four months. It was finally extinguished by snow in November of that year. The period of 1976 to 1977 was one of severe drought in California.

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Appendix

A- Five-Year Fuels Treatment Plan

Table A-1 – Five-Year Fuels Treatment Plan

Fiscal Year	FMU	Project Name	Target Acres	Notes
FY10	Cedar Grove	Hole-in-the-Wall	183	This is a maintenance burn building off of previously burned units within the Cedar Grove FMU.
	East Fork	Fowler Creek	573	This is a restoration burn within the East Fork FMU.
		Mosquito	599	This is a restoration burn within the East Fork FMU.
	Grant Grove	Big Stump East Planning	N/A	This is to plan a mechanical/burning project east of the Big Stump entrance station within the Grant Grove FMU. There may be significant cultural resources present in this unit. Execution is planned for FY11.
		Big Stump West (burning)	63	This is a restoration burn within the Grant Grove FMU west of the entrance station. There may be significant cultural resources in this unit.
		Big Stump West Hand Pile	50	This is part of the above mentioned Big Stump West thinning project.
		Big Stump West Thinning	50	This is a mechanical thinning project west of the Big Stump entrance station within the Grant Grove FMU. There may be significant cultural resources present in this unit.
		Goliath	769	This restoration burn builds off of previously burned units in the Redwood Canyon area within the Grant Grove FMU.
		North Boundary	248	This is a restoration burn building off previously burned units within the Grant Grove FMU.
		Swale West	204	This is a maintenance burn within the Grant Grove FMU.
	Marble Fork	East Halstead	718	This is a maintenance burn within the Marble Fork FMU.
		Guardsman	95	This restoration burn builds off the Wall Spring unit within the Marble Fork FMU.
	Middle Fork	Ash Mountain/Hospital Rock	25	These are annual maintenance burns conducted around the Ash Mountain Headquarter complex within the Middle Fork FMU.
		Bobcat	99	This is a maintenance burn within the Middle Fork FMU.
		Redwood Cabin Hand Pile	6	This is part of the above mentioned Redwood Cabin thinning project.
		Redwood Cabin Thinning	6	This is a mechanical project around the Redwood Cabin area within the Middle Fork FMU.

	North Fork	Cave	272	This restoration burn builds off the 2008 Hidden Fire to treat fuels along the Crystal Cave Road within the North Fork FMU.
	Park Wide	Park Wide Pile Burning	12	This is all the pile burning in both the Sequoia and Kings Canyon Districts.
	South Fork	Dillonwood planning	N/A	This is to plan a mechanical project in the Dillonwood area of the South Fork FMU. Execution is planned for FY11.
FY11	Cedar Grove	West Sentinel	1235	This restoration burn builds off the 2006 Roaring WFU within the Cedar Grove FMU.
		Cedar Grove Valley Floor Omnibus	150 (est.)	This is a maintenance burn building off of previously burned units within the Cedar Grove FMU.
	East Fork	Deer Creek	941	This maintenance burn builds off the Fowler Creek unit within the East Fork FMU.
	Grant Grove	Redwood Mountain	607	This restoration burn builds off of previously burned units in the Redwood Canyon area within the Grant Grove FMU.
		Big Stump East (burning)	116 (est.)	This is a restoration burn within the Grant Grove FMU east of the Big Stump entrance station. There may be significant cultural resources present in this unit.
		Wye	91	This is a maintenance burn within the Grant Grove FMU.
		Big Stump East Thinning	20 (est.)	This is a mechanical thinning project east of the Grant Grove entrance station. There may be significant cultural resources present in this unit.
		Big Stump East Hand Pile	20 (est.)	This is part of the above mentioned Big Stump East thinning project.
		Whitaker	N/A	This is to plan an interagency (USFS) burn in the Redwood Canyon area within the Grant Grove FMU. Execution is planned for FY12.
	Marble Fork	Beetle Rock	326	This restoration burn builds off the Wall Spring and Guardsman units within the Marble Fork FMU.
		West Halstead	965	This maintenance burn builds off the East Halstead unit within the Marble Fork FMU.
	Middle Fork	Ash Mountain/Hospital Rock	25	These are annual maintenance burns conducted around the Ash Mountain Headquarter complex within the Middle Fork FMU.
		Timber Creek	1840	This is a restoration burn within the Middle Fork FMU.
		Huckleberry	256	This is a maintenance burn within the Marble Fork FMU.
	North Fork	Dorst	195	This restoration burn builds off the Cabin Meadow and burn unit to protect the Dorst campground within the North Fork FMU.
	Park Wide	Park Wide Pile Burning	56	This is all the pile burning in both the Sequoia and Kings Canyon Districts.
	South Fork	Dillonwood Thinning	10 (est.)	This is a mechanical thinning project in the Dillonwood developed area of the South Fork FMU.

		Dillonwood Hand Pile	10 (est.)	This is part of the above mentioned Dillonwood thinning project.
FY12	Cedar Grove	Cedar Grove Valley Floor Omnibus	150 (est.)	This is a maintenance burn building off of previously burned units within the Cedar Grove FMU.
		Upper Sheep Creek	1650	This restoration burn builds off the West Sentinel unit within the Cedar Grove FMU.
		West Sheep Creek Planning	N/A	This is to plan an interagency burn (USFS) in the Cedar Grove area of the Cedar Grove FMU. Execution is planned for FY13.
	East Fork	Deadwood	266	This maintenance burn builds off the Davenport unit within the East Fork FMU.
	Grant Grove	Whitaker	532	This is an interagency (USFS) burn in the Redwood Canyon area within the Grant Grove FMU.
		Tower	107	This is a restoration burn building off previously burned units within the Grant Grove FMU.
		Sunset C	387	This is a maintenance burn within the Grant Grove FMU.
		Pan Point Planning	N/A	This is to plan an interagency (USFS) burn within the Grant Grove FMU. Execution is planned for FY13.
	Marble Fork	Circle Meadow	203	This is a Giant Forest maintenance burn within the Marble Fork FMU.
	Middle Fork	Ash Mountain/Hospital Rock	25	These are annual maintenance burns conducted around the Ash Mountain Headquarter complex within the Middle Fork FMU.
		Upper Cliff Creek	1558	This is a restoration near Redwood Cabin within the Middle Fork FMU which builds off the Timber Creek burn. Smoke could be an issue with the town of Three Rivers.
	North Fork	Lost Grove	618	This restoration burn builds off the Cabin Meadow unit to protect the Dorst campground within the North Fork FMU.
	Park Wide	Park Wide Pile Burning	30	This is all the pile burning in both the Sequoia and Kings Canyon Districts.
	South Fork	Dillonwood planning	N/A	This is to plan an interagency burn (USFS) in the Dillonwood area of the South Fork FMU. Execution is planned for FY13.
FY13	Cedar Grove	Cedar Grove Valley Floor Omnibus	150 (est.)	This is a maintenance burn building off of previously burned units within the Cedar Grove FMU.
		West Sheep Creek	1757	This is an interagency (USFS) burn within the Cedar Grove FMU.
	East Fork	Lookout	2441	This is a maintenance burn within the East Fork FMU.
	Grant Grove	Big Baldy	1168	This is a restoration burn building off of previously burned units in the Redwood Canyon area within the Grant Grove FMU.
		Pan Point	347	This is combination restoration and maintenance burn is a joint project with the USFS within the Grant Grove FMU.

		Lion planning	N/A	This is to plan an interagency (USFS) burn within the Grant Grove FMU. Execution is planned for FY14.
	Marble Fork	Long Meadow	605	This restoration burn builds off the Quarry unit within the Marble Fork FMU.
		Suwanee Grove	1884	This maintenance burn builds off the East Halstead unit within the Marble Fork FMU.
	Middle Fork	Ash Mountain/Hospital Rock	25	These are annual maintenance burns conducted around the Ash Mountain Headquarter complex within the Middle Fork FMU.
		Granite Creek	1931	This is a restoration burn which builds off previously burned units within the Middle Fork FMU.
	North Fork	West Dorst	245	This restoration burn builds off previously burned units around Dorst campground within the North Fork FMU.
	South Fork	Dillonwood	1942 (est.)	This is an interagency restoration burn around the Dillonwood area of the South Fork FMU.
FY14	Cedar Grove	Cedar Grove Valley Floor Omnibus	150 (est.)	This is a maintenance burn building off of previously burned units within the Cedar Grove FMU.
	East Fork	Oriole Lake	4422	This is a restoration burn around the Oriole Lake developed area within the East Fork FMU.
	Grant Grove	Lion	292	This is an interagency (USFS) burn within the Grant Grove FMU.
	Marble Fork	Overlook	176	This is a restoration burn building off previously burned units within the Marble Fork FMU.
	Middle Fork	Ash Mountain/Hospital Rock	25	These are annual maintenance burns conducted around the Ash Mountain Headquarter complex within the Middle Fork FMU.
		Buck Creek	2666	This is a restoration burn building off of previously burned units in the Middle Fork FMU.
		Granite Springs	477	This is a restoration burn within the Middle Fork FMU which will be burned in conjunction with the Overlook burn.

B- NEPA and NHPA Compliance

Following National Environmental Policy Act (NEPA) guidelines and NPS policy, a companion environmental assessment evaluates the effects of proposed fire and fuels management actions on the environment. The *Environmental Assessment* and this associated plan were submitted for public review on April 16, 2003, with the comment period ending May 30, 2003.

The following text briefly describes the actions taken develop the plan and evaluate effects.

INTERNAL AND PUBLIC SCOPING

A Scoping Notice was placed in the Federal Register on February 24, 1999 and press releases regarding the planning effort were sent to media outlets in the region at the outset of the planning process. Two internal scoping meetings were held for all park and concession employees, and five additional public scoping sessions were conducted throughout California. Several presentations were made to special interest groups at their request to solicit comments. These groups included the Mineral King Cabin Owners Association and Friends of the South Fork Kings River. A community-wide survey was conducted in the greater Three Rivers area to further assess issues of concern.

INTERAGENCY SCOPING

Adjacent land managers were consulted both through the public notification process and through a separate scoping session held in Fresno in May 1999. The U.S. Fish and Wildlife Service (USFWS) was contacted at the onset of the planning process to ensure proper Section 7 consultation. A list of species to consider was received from the USFWS and used to prepare this document. Prior consultation with USFWS on the effects of prescribed burns on the threatened valley elderberry longhorn beetle is incorporated in this plan (correspondence attached at end of this chapter). The San Joaquin Valley Unified Air Pollution Control District received a separate scoping presentation and a formal written request for comment was sent to the District. No comments were received from the District during the scoping process.

CULTURAL RESOURCES AND NATIVE AMERICAN CONSULTATION

The National Park Service conducted consultation meetings in July of 1999 with a variety of Native American (American Indian) tribal groups and individuals. These meetings were held on both sides of the Sierra Nevada in areas from which Native American groups historically accessed and used lands now subsumed by Sequoia and Kings Canyon National Parks. Information was received from eight separate groups regarding their past and present uses of the parks, with a total of 33 individuals being interviewed. In very general terms, the eastside meetings included Paiute and Eastern Mono groups of the Owens Valley while the westside meetings focused on Yokuts and Western Mono (Monache) groups that traditionally occupied portions of the Great Central Valley and western foothills and slopes of the Sierran range (Van Horn and Burge).

Overall, those groups that shared concerns or comments regarding the parks' fire program were interested in continuing to receive information and in being consulted regarding the planning and implementation of prescribed fires, in particular. A clear interest in recognizing the effects of fire on any number of natural resources was expressed, as these resources hold ongoing importance to tribal members.

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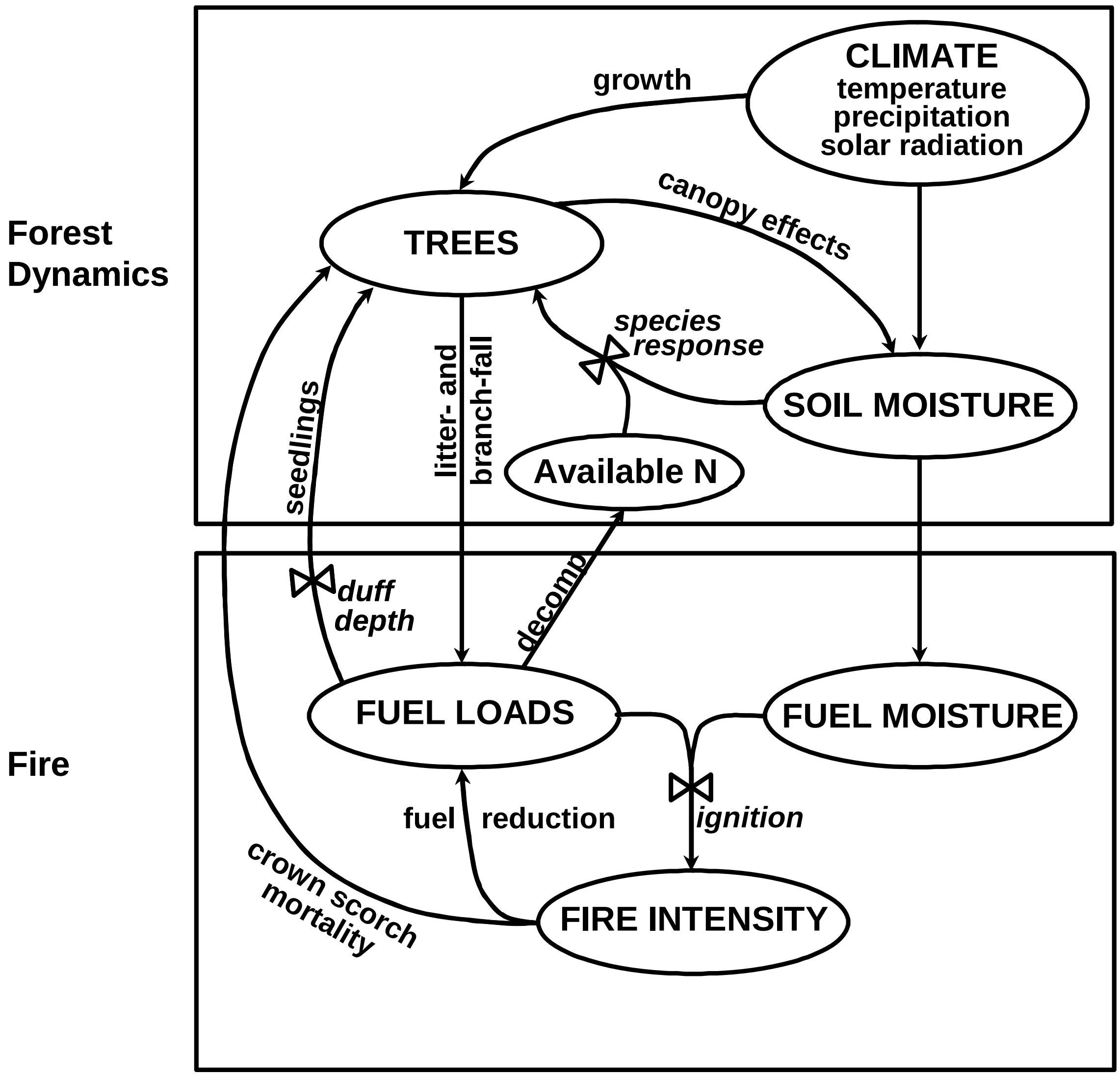
C- Fire Monitoring Plan and Target Conditions

INTRODUCTION

The purpose of the fire monitoring program is to provide effective evaluation of Sequoia and Kings Canyon National Parks' fire management program. The fire monitoring program is designed to determine whether fire and resource management objectives are met, as well as to document any unexpected consequences of fire management activities. The monitoring program continuously informs the staff about results of management activities so that the fire management program can adapt to changing conditions using the best available information. This plan will be reviewed annually and revised as needed.

To determine an efficient monitoring strategy to assess fire management program effectiveness, a basic understanding of the ecosystem components, processes, and linkages is needed. Based upon early fire research results, much of the current fire monitoring program for Sequoia and Kings Canyon National Parks was established prior to development of a formalized ecosystem model. Since then, a general ecosystem model was developed for the parks' Resource Management Plan (NPS 1999). Also, see the Description of NPS Unit (Chapter 8) and the Historic Role of Fire (Chapter 9) for information describing the fire-related components and processes occurring in Sequoia and Kings Canyon National Parks' ecosystems. Figure 1 illustrates the fire, fuel, and stand dynamics relationships that shape forests in the parks. Portions of the fire monitoring program focus on several of the important resource components in this model. Currently, a more detailed ecosystem model is being developed as part of the NPS Inventory and Monitoring Program. The ecosystem model is scheduled to be completed by October 2004.

Figure 1. General model showing relationships of fire, fuel, and forest dynamics in the Sierra Nevada (Miller and Urban 1999).



The parks' formal fire monitoring program began in 1982. The program initially focused on monitoring weather and fire behavior, vegetation, and dead and down surface fuels in giant sequoia groves. Over time, the monitoring program expanded to other vegetation communities as the prescribed fire program progressed. In recent years, it has broadened to include wildlife, water, and fire regime components as program information needs have changed and new management objectives were developed.

While the monitoring program is designed to document changes that occur in areas where fire management activities take place, many factors (e.g. climate, pollution, pathogens) may play a role in ecosystem changes. If the monitoring program detects an unexpected change, a more detailed research project designed specifically to test a hypothesis may be needed to determine the cause of the change. A Research Plan describes past, current, and potential research studies that provide additional information to the fire management program (see Appendix D).

Wherever possible, new information gained will be used to inform and improve the fire monitoring program.

Following a summary of fire-related target conditions and management objectives, this monitoring plan is organized into several sections, each of which addresses a current component of the parks' fire monitoring program or identifies areas for future monitoring efforts. The individual sections describe the identified information need, the management targets/objectives (if developed), the monitoring objectives, and the monitoring design for the following resource components:

Environmental and Fire Conditions

Vegetation and Fuels

Additional Fuels Information for Modeling

Wildlife

Water

Fire Regime

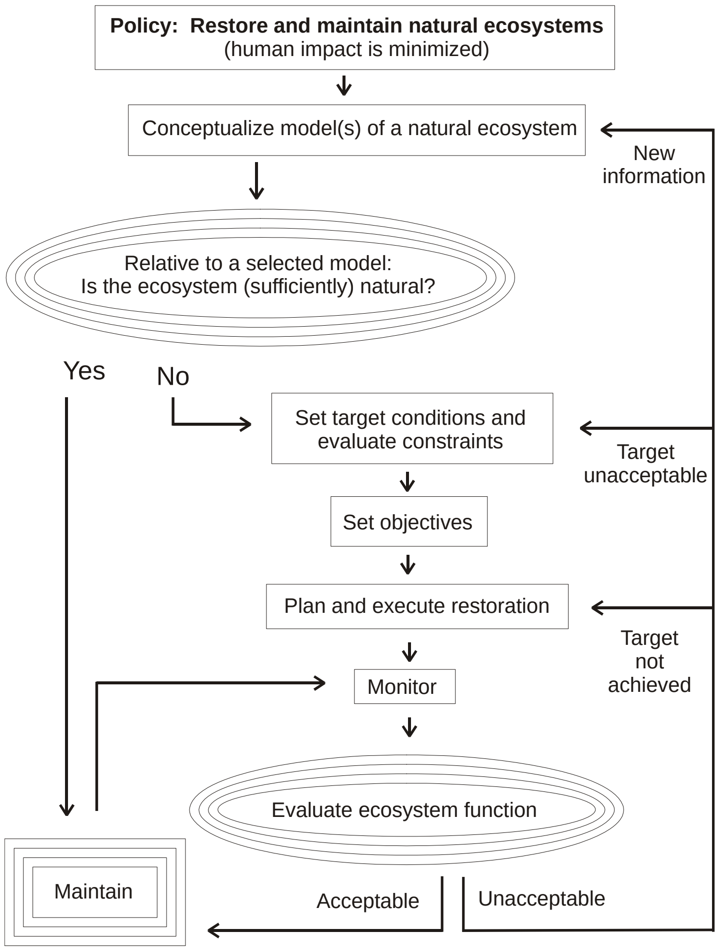
Cultural Resources

Note that Air Quality monitoring is covered separately in Appendix J. Following the individual resource components sections, a brief section on monitoring program integration presents the relationships between the current components, as well as the need and plans for improved future integration.

TARGET CONDITIONS & SPECIFIC MANAGEMENT OBJECTIVES

An adaptive feedback process is used to guide and evaluate the fire and fuels management program (Figure 2). This process begins with policy direction and incorporates the most current information to make knowledge-based management decisions about how best to restore and maintain fire-related natural resource components and processes. These decisions are continuously evaluated based on monitoring results and new research and information is integrated to help guide the management program.

Figure 2 – Model of adaptive feedback process (Keeley and Stephenson 2000).



Fire management program goals and objectives are described in Chapter 2. One program objective is to understand the effects of fire management actions by monitoring and evaluating the effects of fire and fuels management activities on park natural and cultural resources with particular attention to vegetation, water, wildlife, air, and cultural resources. To accomplish this task, specific, measurable benchmarks may be needed as a point of reference to determine if the resource conditions resulting from fire management actions are meeting park goals for restoring and maintaining natural conditions. To answer the question, "What would the resource look like if we achieve our goals?", target conditions are needed to describe resource goals more specifically and to serve as a standard by which to measure fire management program success.

Information used to develop the target conditions includes research data when available, historic photos and written documents, and expert opinion. Target conditions must be periodically evaluated to determine whether they are still realistic and wanted in light of a changing environment. For example, target conditions may be based on our knowledge of past long-term climate conditions, however, future climate changes may preclude achieving these targets. The target conditions will be further refined as new research provides information that increases our knowledge of past, current, and future conditions.

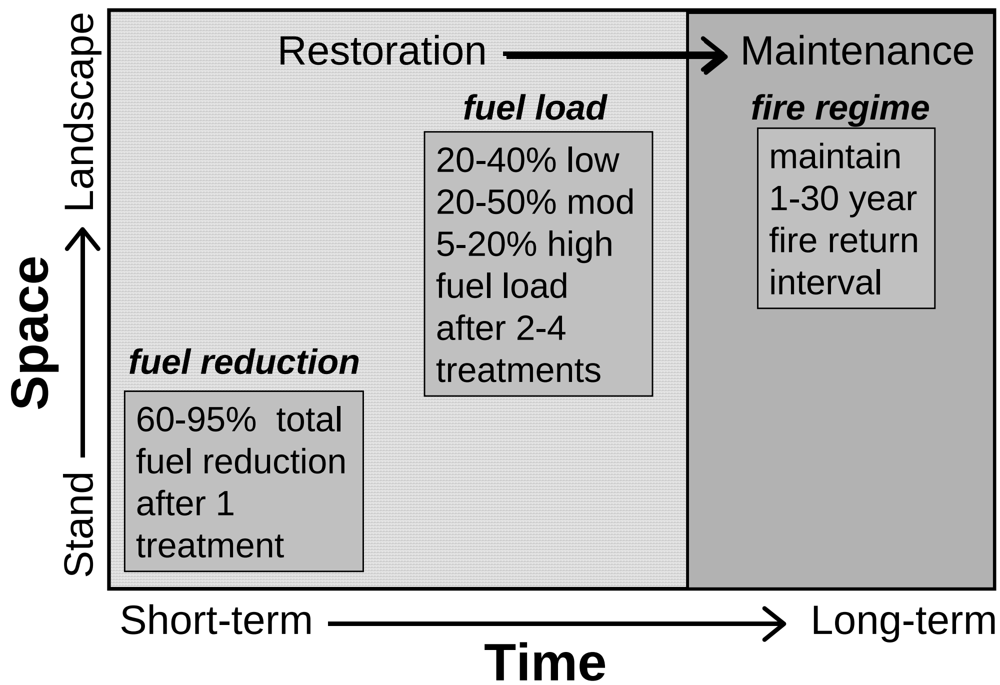
To describe explicitly how to arrive at the target conditions, specific management objectives are developed by adding a method and timeframe to the target conditions. For example, if the target condition is a stand density of 20-250 trees/ha, then the management objective would be to use prescribed fire to reduce stand density to 20-250 trees/ha by 2 years following treatment. Target conditions and specific management objectives for each resource component, where developed, are described in the corresponding individual sections of this monitoring plan.

In areas of the parks currently in the restoration phase of the program, structural targets and objectives are used to assess program success. Once these structural conditions are restored, then the area moves into the maintenance phase of the program and process targets are used to evaluate the program goal achievement. Figure 3 illustrates the changing nature of targets/objectives over time from the restoration phase to the maintenance phase using an example of fuel load objectives.

Like target conditions, management objectives must be evaluated on a regular basis. As the monitoring results become available, they are used to determine if management objectives are achieved and to determine if management activities need to be adjusted. Also at this time, an assessment of whether the management objectives are still desired is warranted in light of ongoing monitoring results and any new information made available.

Some of the monitoring program components that follow have target conditions and specific management objectives defined, while others have only general goals outlined. Part of the next phase of the monitoring program includes identifying additional targets and management objectives, then developing associated monitoring objectives, and refining or adding protocols if necessary. In this way, we can be sure that the monitoring program will adequately assess the success of the fire management program. Any changes or additions will be included in future revisions of this fire monitoring plan.

Figure 3. Objectives change as the fire management program progresses over time and expands in spatial scale.



ENVIRONMENTAL & FIRE CONDITIONS

The first two monitoring levels described in the Fire Monitoring Handbook (FMH; National Park Service 2001), environmental monitoring and fire observations, provide information to guide fire management strategies for wildland and prescribed fires.

Monitoring Goal: Environmental monitoring and fire observations provide the basic background information needed for decision-making before, during, and after fire events.

Monitoring Objectives

1. Collect information on environmental conditions (weather [current and forecasted], fuel model) and fire conditions (name, location, slope, aspect, spread, intensity, smoke transport and dispersal) for all wildland and prescribed fires.

2. Use the information collected in a timely manner to adapt to changing conditions and successfully manage each fire.

Field Measurements

The following information will be collected for all wildland and prescribed fires: location, cause, current size, air temperature, relative humidity, wind speed, wind direction, percent slope, aspect, National Fire Danger Rating System (NFDRS) fuel model appropriate index (energy release component [ERC] or burning index [BI]), representative Fire Behavior Prediction System (FBPS) fuel model, rate of spread, direction of spread, flame length (or relative intensity), perimeter and area growth, and smoke transport and dispersal.

In addition to the data listed above, the following information will be collected for all prescribed fires: live fuel moisture (if applicable), dead fuel moisture (1 hour, 10 hour, 100 hour, 1000 hour, litter, duff) as indicated in the site specific burn plan prescriptions, road or sensitive site visibility, smoke column mixing height, smoke transport and dispersal direction. Smoke particulate data may be collected at smoke sensitive locations as indicated in the site-specific burn plan.

Timing of Monitoring

All prescribed fires will have the environmental conditions monitored at least two weeks in advance of the planned ignition date. On-site weather and fire condition monitoring will occur throughout all active ignition phases of each fire on a schedule determined by the burn boss with consultation from the lead monitor assigned to the fire.

Weather conditions for all wildland fires will be monitored regularly from the time of discovery/ignition and throughout the duration of the fire. The monitoring frequency will be specified in the Wildland Fire Decision Support System (WFDSS) (WFDSS).

Monitoring Site Location

On-site environmental conditions for all prescribed fires will be monitored at a representative location within the burn area, as determined by the burn boss with consultation from the lead monitor assigned to the burn. The weather conditions will be monitored using an existing representative fire weather station or if there is no representative station (as determined by the burn boss), a portable station will be set up on site.

Weather conditions for most wildland fires will be monitored using an existing representative fire weather station. On-site environmental and fire conditions for all wildland fires will be monitored as indicated in the WFDSS.

Data Analysis

Environmental monitoring and fire observations provide the basic background information needed for decision-making. For prescribed fires, the assigned monitor will relay the data to the burn boss and fire management staff on a regular basis (prior to the ignition of a prescribed fire, and at a predetermined interval during the active ignition phase to facilitate proper management). The burn boss will use the information to verify that the fire is within the prescribed conditions and to adjust the timing, quantity and spacing of new ignitions.

Environmental data from wildland fires will be transmitted to the fire use manager or incident commander as soon as possible to facilitate the proper and timely management of the fire. On longer duration fires, the data will be used to create weather, wind and fuel moisture input files needed for fire spread simulation. The outputs from the fire spread projections will be used to estimate the fire's arrival to areas of concern and allow for enough time to plan for the protection or mitigation efforts needed. The parks' fire staff may also use the data to adjust and run risk assessment models.

Data Sheet Examples

Data sheets used to collect information include a weather observation form, fire behavior observation form, smoke observation form, fuel moisture summary form, monitoring report outline, and wildland fire observation summary form (see Attachment 1).

Information Management

All original data sheets and summary reports will be kept in the permanent fire folder located in fire dispatch. Electronic file copies will also be placed in the fire folder when available. The permanent fire folder will be kept in accordance with Appendix Q (Wildland Fire and Fuels Management Reporting Requirements) of the Fire and Fuels Management Plan.

Quality Control

Monitoring personnel will receive appropriate training each season under the direction of the fire monitoring crew supervisor. This training will cover the proper protocols for collection and transmission of environmental and fire conditions data. New monitors will receive a minimum of two training assignments before they can function as a lead monitor. The appropriate supervisor will review all summary reports prior to placement in the fire folder.

Responsible Party

The person in charge of the fire (burn boss, incident commander or fire use manager) is responsible for ensuring that the environmental data is collected, transmitted, acted upon, and filed according to established protocols.

Funding

All fire expenditures (personnel, aircraft, equipment and supplies) that are not covered by existing base accounts will be charged to the appropriate fire account. All expenditures will be tracked and reported according to the standards established in the Department of the Interior Individual Fire Occurrence Form (DOI-1202). All fires will have an appropriate fire management accounting code (suppression, prescribed or fire use).

Management Implications of Monitoring Results

Because environmental and fire condition monitoring is essential background information needed for effective decision making, the success or failure of a fire could very well depend on the proper and timely collection and transmission of this data. When properly executed, feedback from the monitoring of environmental and fire conditions will directly affect how the fire is managed. If a prescribed fire has exceeded the prescribed conditions, the field monitor will notify the burn boss who will limit any new ignitions and evaluate the situation. For wildland fires, the parks' fire managers will use the information to prioritize fires for assignment of critical resources. For example, a wildland fire that is being suppressed might receive more resources quickly if information relayed indicates that the fire is about to spread into a different fuel type that will result in a higher resistance to control. For use of wildland fire projects, the environmental and fire conditions information will be used to help determine the level of monitoring needed for each fire.

VEGETATION AND FUELS

Monitoring levels 3 and 4 of the Fire Monitoring Handbook (FMH; National Park Service 2001), describe short- and long-term monitoring of the effects of fire on fuels and vegetation to guide prescribed fire management strategies. While the standard vegetation and fuels monitoring component applies primarily to prescribed fire, monitoring wildland fire and mechanical fuel removal activities and unburned areas has occasionally occurred when a particular need or opportunity arose.

Monitoring Goal: Vegetation and fuels monitoring provides information needed to determine whether management objectives are met and to detect any unexpected consequences of prescribed burning or other treatments.

Target Conditions

Fire-related vegetation and fuels target conditions for each vegetation type within the parks were developed by a team of scientists and park managers using the best available information about conditions present in the parks during the 1,000 years prior to Euro American settlement. These target conditions are divided into two types of conditions, structural targets for the restoration phase of the program and process targets for the maintenance phase of the program (Table 1). Targets for structure describe attributes of the dominant vegetation and were developed for areas being initially treated with prescribed fire to restore conditions significantly altered by fire exclusion. Structural target conditions were not developed for vegetation types where the structure has not been greatly altered by fire exclusion (e.g. historic fire return intervals are as long as or longer than the period of fire exclusion). Targets for process describe attributes of the historic fire regime and are applied to areas that have not been greatly altered by fire exclusion or areas where conditions have been restored with prescribed fire.

Table 1 – Target conditions by vegetation type. Restoration phase targets (structure) are in unshaded cells and maintenance phase targets (process) are indicated by shaded cells.

Vegetation Type	Fuel Reduction [restoration]	Stand Density by diameter class & spp. comp. [*restoration*]	Fuel Load Distribution (% of landscape) [maintenance]	Gap/Patch Size Distribution (% of landscape) [maintenance]
Ponderosa pine- mixed conifer	60-95% total fuel reduction	50-250 trees/ha <80 cm 10-75 trees/ha 80 cm (50-80% pine, 5-20% fir, 10-20% cedar, 1-10% oak)	20-40% 5-30 tons/acre 20-50% 30-60 tons/ac 5-20% >60 tons/acre	75-95% 0.1-1 ha 5-25% 1-10 ha <1% 10-100 ha (% is percent of landscape)
White fir-mixed conifer	60-95% total fuel reduction	50-250 trees/ha <80 cm 10-75 trees/ha ≥80 cm (40-80% fir, 15-40% pine, 0-20% cedar)	20-40% 5-30 tons/acre 20-50% 30-60 tons/ac 5-20% >60 tons/acre	75-95% 0.1-1 ha 5-25% 1-10 ha <1% 10-100 ha
Giant sequoia-mixed conifer *	60-95% total fuel reduction	50-250 trees/ha <80 cm 10-75 trees/ha ≥80 cm (40-80% fir, 10-40% sequoia, 5-20% pine)	20-40% 5-30 tons/acre 20-50% 30-60 tons/ac 5-20% >60 tons/acre	75-95% 0.1-1 ha 5-25% 1-10 ha <1% 10-100 ha
Subalpine	NA	NA	NA	NA (woodland type)
Xeric conifer / montane chaparral	NA	10-150 trees/ha <80 cm 5-50 trees/ha ≥80 cm (60-80% pine, 20-40% fir)	1-30% 5-10 tons/acre 25-75% 10-30 tons/ac 1-10% >30 tons/acre	NA (woodland/ savannah type)
Red fir	60-95% total fuel reduction	50-500 trees/ha <80 cm 10-75 trees/ha ≥80 cm (70-100% fir, 0-30% pine)	1-25% 5-30 tons/acre 30-70% 30-60 tons/ac 5-20% >60 tons/acre	70-95% 0.1-1 ha 5-30% 1-10 ha <1% 10-100 ha (0-1% <1 yr gaps)
Lodgepole pine	NA	NA	not yet developed	not yet developed
Mid-elevation hardwood	NA	20-200 trees/ha <80 cm 10-50 trees/ha ≥80 cm (50-80% oak, 10-40% pine, 1-10% cedar)	40-60% 5-20 tons/acre 10-40% 20-50 tons/ac 0-15% >50 tons/acre	NA (woodland type)
Oak woodland	NA	20-150 trees/ha 10-50 cm 5-50 trees/ha ≥50 cm (80-100% oak, 0-20% other)	90-95% 0-1 ton/acre 5-10% 1-4 tons/acre	NA (woodland type)
Foothill chaparral	NA	25% 0-20 yr old stands 50% 20-50 yr old stands 25% >50 yr old stands (species composition varies depending on FRI)	NA	0.1 – 2000 ha (same as fire size)

* An additional goal to perpetuate giant sequoias does not currently have specific, quantitative objectives defined, but the monitoring program tracks mature tree mortality and regeneration and recruitment of giant sequoias. In addition to the standard monitoring protocols, projects to track giant sequoia post-burn effects and to monitor sequoia seedling survival in reburns are described in the Additional Projects section below.

Monitoring Objectives

Specific fire-related management objectives that describe how to reach the target conditions were developed (Table 2). Explicit monitoring objectives were then established so that results from the vegetation and fuels monitoring program will be able to provide sufficient information to determine whether the corresponding management objectives have been achieved. The monitoring objectives specify what is to be measured (variables), what time interval to measure, and the level of certainty desired in the results. This information is then used to calculate the minimum sample size necessary to obtain the level of certainty needed in the results.

Table 2 – Vegetation and fuels management objectives and monitoring objectives. Restoration (structure) objectives are in unshaded cells and maintenance (process) objectives are in shaded cells.

Variable and Vegetation Type	Management Objective (restatement of applicable target conditions from Table 1)	Monitoring Objective
<u>Fuel Load</u> ***[restoration]*** **All Forest Types**	Reduce total dead and down fuel load by 60-95% immediately following initial treatment with prescribed fire.	Measure total fuel load with a sample size sufficient to have an 80% probability of detecting at least a 40% reduction in mean total fuel load immediately postburn. A 20% chance that a change will be detected when a real change does not occur is acceptable.
<u>Fuel Load</u> **[*maintenance*]** **Mixed- Conifer Forest**	Use fire to maintain fuel load mosaic across the landscape as follows: 20-40% 5-30 tons/acre 20-50% 30-60 tons/acre 5-20% >60 tons/acre Note: % is percent of landscape for all Mixed-Conifer Forest types.	Measure total fuel load with a sample size sufficient to have an 80% probability of being within 25% of the true mean total fuel load for all time intervals of interest.
<u>Fuel Load</u> ***[maintenance]*** **Red Fir Forest**	Use fire to maintain fuel load mosaic across the landscape as follows: 1-25% 5-30 tons/acre 30-70% 30-60 tons/acre 5-20% >60 tons/acre Note: % is percent of landscape in Red Fir forest.	
Stand Structure ***[restoration]*** **Mixed-Conifer Forest**	Use prescribed fire to restore mixed-conifer forest mean stand density to: 50-250 trees/ha for trees <80 cm DBH 10-75 trees/ha for trees ≥80 cm DBH by 5-years following initial treatment with prescribed fire. Species composition by forest type: Ponderosa pine – 50-80% pine, 5-20% fir, 10-20% cedar, 1-10% oak; White fir – 40-80% fir, 15-40% pine, 0-20% cedar; Giant sequoia – 40-80% fir, 10-40% sequoia, 5-20% pine.	Measure total tree density with a sample size sufficient to have an 80% probability that the 5-year postburn mean total density of trees <80 cm in diameter at breast height (DBH) and trees ≥80 cm DBH is within 25% of the true population means.
Stand Structure **[*restoration*]** **Red Fir Forest**	Use prescribed fire to restore red fir forest mean stand density to: 50-500 trees/ha for trees <80 cm DBH 10-75 trees/ha for trees ≥80 cm DBH by 5-years following initial treatment with prescribed fire. Species composition: 70-100% fir, 0-30% pine.	

<table>
<tr><th>Variable and Vegetation Type</th><th>Management Objective
(restatement of applicable target conditions from Table 1)</th><th>Monitoring Objective</th></tr>
<tr><td>Landscape Pattern [maintenance]

Mixed-Conifer Forest Types</td><td>Use fire to maintain the distribution of gaps/patches across the landscape as follows:
75-95% 0.1-1 ha gaps/patches
5-25% 1-10 ha gaps/patches
<1% 10-100 ha gaps/patches
Note: % is percent of landscape comprised of gaps of each size class.</td><td rowspan="2">Note: Monitoring methods for assessing landscape pattern objectives have yet to be developed. These variables will likely be measured using some type of remote sensing.</td></tr>
<tr><td>Landscape Pattern [maintenance]

Red Fir Forest</td><td>Use fire to maintain the distribution of gaps/patches across the landscape as follows:
70-95% 0.1-1 ha gaps/patches
5-30% 1-10 ha gaps/patches
<1% 10-100 ha gaps/patches</td></tr>
<tr><td>Stand Structure [maintenance]

Brush Types</td><td>Use fire to maintain a shrub stand age structure mosaic across the landscape as follows:
20-30% 0-20 year old stands
40-60% 20-50 year old stands
20-30% >50 year old stands.
Note: species composition varies depending on fire return interval.</td><td>Measure live shrub cover with a sample size sufficient to have an 80% probability of being within 25% of the true pre-burn mean live shrub percent cover.
(Note: This objective may be better monitored by using the time since last fire GIS layer; see Fire Regime section H; species composition may still require plot-level monitoring).</td></tr>
</table>

Target conditions developed for stand structure in brush types focus on maintenance of stand age classes. Since no specific objectives for restoring shrub cover currently exist, the monitoring objective focuses on getting good estimates of the pre-burn shrub cover conditions until further target conditions are developed.

In vegetation types where fire exclusion has not greatly altered the structure, target conditions were not developed, therefore, specific management objectives and monitoring objectives have also not been developed for these vegetation types. In addition, monitoring methods for assessing landscape pattern objectives have yet to be developed. Variables such as gap size and distribution across the landscape will likely be measured using some type of remote sensing (e.g. Landsat TM, aerial photography, LIDAR, etc.). Monitoring for other objectives related to maintaining the natural process of fire are discussed in the Fire Regime section (section H) of this plan.

Sampling Design

The sampling design is intended to allow the monitoring objectives to be achieved as efficiently as possible. The vegetation and fuels monitoring program generally follows the NPS Fire Monitoring Handbook (FMH; National Park Service 2001) protocols, with some deviations because the parks' program was initiated prior to the NPS program. Currently, eight monitoring types (combination of vegetation type, fuel model, and burn prescription) exist, of which seven describe the vegetation and fuels located in areas where prescribed burning occurs. One monitoring type is associated with an area burned during use of wildland fire. See Attachment 2 for current monitoring type descriptions.

For each monitoring type, the minimum sample size was calculated to determine the number of plots needed to achieve the monitoring objectives as efficiently as possible. This information, along with the current plots installed and new plots planned, comprises the plot installation plan (Table 3).

Table 3 – Vegetation and fuels monitoring plot installation plan.

Monitoring Type Name	Minimum Sample Size* Total Fuel Reduced.	Density (<80 cm, ≥80cm) or % Cover	Current # of Plots	# of New Plots Planned	Total # of Plots
Ponderosa pine-dominated forest	5	1, #	4	6	10
Low elevation-mixed conifer forest	4	7, 29	5	5	10
White fir-mixed conifer forest	12	3, 7	11	2	13
Giant sequoia-mixed conifer forest	5	10, 9	29	1	30
Red fir forest	#	# , #	6	4	10
Chamise chaparral	-	1	3	0	3
Mixed chaparral	-	2	6	4	10
Montane chaparral‡	‡	‡	4	0	4
TOTAL			**68**	**22**	**90**

Key:

* Minimum sample size was calculated for objective variables. In all forest types, calculations were performed for immediate-postburn total fuel reduction (precision, R=25; confidence level, α= 80%, power=80%, minimum detectable change=40%) and 5-year postburn total tree density for trees <80 cm DBH and ≥80 cm DBH (precision, R=25; confidence level, α=80%). In all brush types, calculations were performed for pre-burn live total shrub cover (precision R=25, confidence level, α=80%).

\# A minimum sample size for this category is not available because it is either not applicable or there are not enough plots or data to calculate.

‡ Monitoring type associated only with USE OF WILDLAND FIRE project; no minimum sample size calculated.

Current Plans by Monitoring Type

Ponderosa pine-dominated forest – Although we only need to install one more plot to reach the minimum sample size, this type is of particular interest regionally and nationally, therefore, we would like to increase the number of plots to ten, if possible. Due to the limited distribution of this type in the park (restricted primarily to Cedar Grove) and the extent of the type already burned, we may have difficulty reaching ten plots. In addition, prescribed fire projects in Cedar Grove have been on hold since 1998 to investigate the role of fire and other factors in a locally severe cheatgrass (Bromus tectorum) invasion.

Low elevation-mixed conifer forest – We are scheduled to install five more plots in this type in order to achieve an initial ten plots with which to calculate the minimum sample size. Based on calculations using the five plots that have reached the 5-year post-burn stage, the number of plots needed to achieve the monitoring objective for smaller diameter tree density is excessive. This number of plots may decrease after the additional plots are installed and the sample size is recalculated.

White fir-mixed conifer forest – We have nearly reached the minimum sample size for this type (12 plots), and we are scheduled to install two more plots in the East Fork Kaweah Fire Management Unit (FMU) in order to have vegetation types better represented within this watershed (three plots), where the program has focused on larger landscape-scale prescribed fire.

Giant sequoia-mixed conifer forest – One more plot is scheduled for installation in the East Fork Kaweah FMU to achieve better representation within the watershed (three plots). Otherwise, we have well exceeded the minimum sample size needed for the monitoring objectives in this type.

Red fir forest – We are planning to install at least four more plots, for a total of ten initial plots. Although six plots have been installed, only two plots have burned and therefore we will calculate minimum sample size when a few more plots have burned.

Chamise chaparral – We have achieved the minimum sample size for this type and do not plan on installing any more plots.

Mixed chaparral – Although we have exceeded the minimum sample size needed in this type, we plan to install four more plots so that the plots are somewhat more geographically distributed.

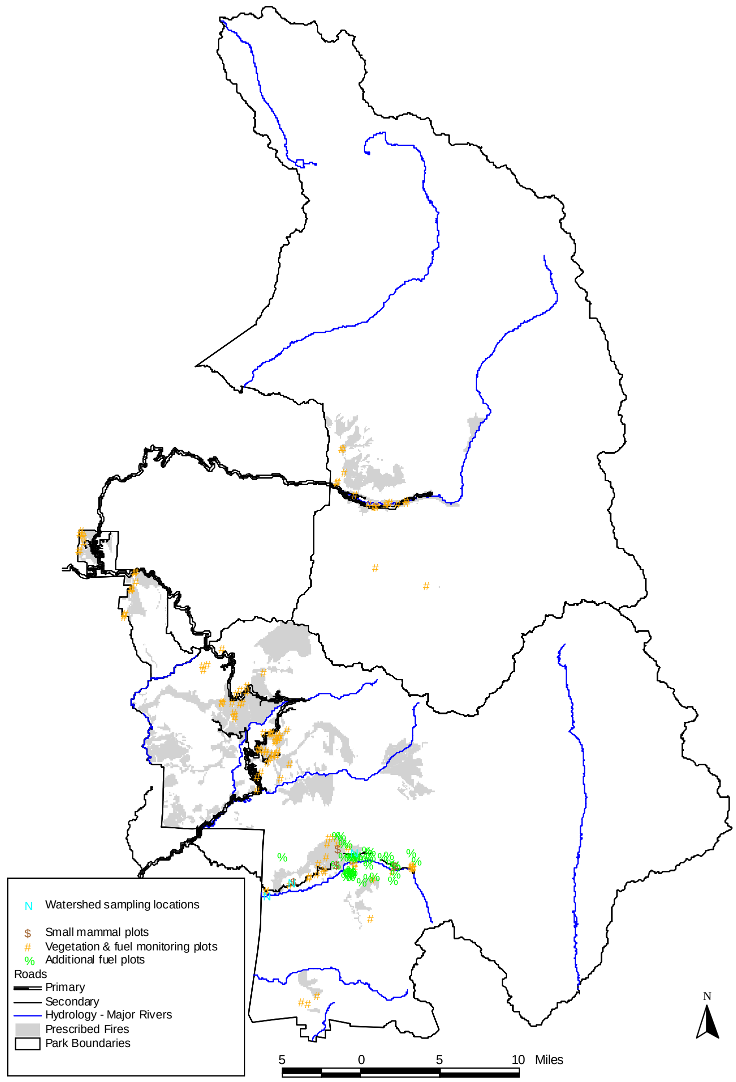
Montane chaparral – Prescribed burning has been limited in this monitoring type in the past. The current plots in this monitoring type were opportunistically installed within a USE OF WILDLAND FIRE project and were all burned in one event. If prescribed burning is carried out in this vegetation type according to the 5-year burn plan (1800 acres), more monitoring plots may be installed.

New Monitoring Types – Several new monitoring types may be needed based on the current 5-year burn plan. These monitoring types include foothill hardwoods and grassland, mid-elevation hardwood forest, and xeric conifer forest. In the past, prescribed burning in these types has been limited, but if the amount of prescribed burning increases according to the current 5-year plan (1600 acres of foothill hardwoods and grassland, 850 acres of mid-elevation hardwood forest, and 2300 acres of xeric conifer forest), we will need to address these types. We have also discussed monitoring in our Ash Mountain development hazard fuel reduction burns primarily to monitor native vs. non-native dynamics. We have not yet had the time to carry out this monitoring as it has not been a high priority, but it may be included in future monitoring efforts. Pilot sampling will occur prior to monitoring in any new vegetation types to be sure that the future monitoring efforts are as efficient and effective as possible.

Plot Distribution

Many of the existing permanent plots were installed prior to the establishment of the FMH program within the region. Little formal documentation exists of the method used for selecting burn units in which these monitoring plots were located prior to 1992. From the information we have, these early plots were randomly located within areas scheduled for burning within the near future and were stratified by monitoring type. Plots installed between 1992 and 1996 were distributed randomly in areas scheduled for burning within the subsequent five years, stratified by monitoring type. Plots installed after 1996 were distributed using a "restricted random" design to avoid spatial clumping of plots. Current plot locations and associated burn unit boundaries, are shown in Figure 4.

Figure 4 – Map of current monitoring plot locations. Burn units shown in shaded areas.



Plots organized by monitoring type and burn unit can be found in Table 4. In the monitoring type heading, the number of plots currently installed, as well as the number of prescribed burn units (# fires) associated with these plots, is included to show the treatment replicates within each monitoring type.

Table 4 – Plot distribution by burn unit and monitoring type.

Burn Unit Year Burned	Monitoring Type							
	FABCO 11 plots 7 fires	FCADE 5 plots 3 fires	FPIPO 4 plots 2 fires	FSEGI 30 plots 18 fires	FABMA 6 plots 4 fires	BADFA 3 plots 1 fire	BARME 6 plots 2 fires	BARPA 4 plots 1 fire
Hercules 1982,*1999	-	-	-	*1,2,3,4	-	-	-	-
Fire Class 1984,*1996	13,14	-	-	11*,12*	-	-	-	-
Garfield 1985	-	-	-	22	-	-	-	-
Muir PNF 1986	34	-	-	30	-	-	-	
Upper Garfield 1986	-	-	-	32	-	-	-	-
Keyhole 1987,*1998	-	-	-	15,24*	-	-	-	-
Tharps 1987,*1998	-	-	-	42*,43	-	-	-	-
Halstead 1987	44,45	-	-	-	-	-	-	-
Buckeye WF 1988	26	-	-	-	-	-	-	-
Huckleberry 1989 ,*1997	53*	-	-	52*	-	-	-	-
Crystal 1989	-	60	-	-	-	-	-	-
Tharps 1990	-	-	-	68	-	-	-	-
Highway 1990	-	-	-	79,80	-	-	-	-
Suwanee 1990	-	-	-	69	-	-	-	-
Grant West 1990	-	-	-	74	-	-	-	-
President SMA 1991	-	-	-	81	-	-	-	-
Tharps 1991	-	-	-	82	-	-	-	-
Deer Creek PNF 1991	-	-	-	87,88	-	-	-	-
Grant West 1992	-	63	-	72,73,75	-	-	-	-
Suwanee 1992	76,77, 78	-	-	70,71	-	-	-	-
Picnic Estates 1993,*1999	-	-	89*	-	-	-	-	-
Hole-in-the-Wall 1993	-	-	90,91 92	-	-	-	-	-
Empire PNF 1994	-	-	-	-	-	-	-	B2,3,4,5
Swale 1995	-	62,65	-	-	-	-	-	-
MK - Atwell 1995	-	94	-	93,95	96,97	-	-	-
MK - Lookout 1997	-	-	-	-	-	B12, 13,14	-	-
MK - Redwood 1997	-	-	-	-	-	-	B10,11	-
MK - Tar Gap 1999	-	-	-	-	101	-	-	-
MK - Redwood	-	-	-	-	-	-	B7,8,9, 15	-

Burn Unit Year Burned	Monitoring Type							
	FABCO 11 plots 7 fires	**FCADE 5 plots 3 fires**	**FPIPO 4 plots 2 fires**	**FSEGI 30 plots 18 fires**	**FABMA 6 plots 4 fires**	**BADFA 3 plots 1 fire**	**BARME 6 plots 2 fires**	**BARPA 4 plots 1 fire**
MK - Tar Gap	-	-	-	-	100,102	-	-	-
MK - Upper Deadwood	105	-	-	-	-	-	-	-
Wuksachi	-	-	-	-	103	-	-	-

Field Measurements

The field measurement protocols follow those found in the NPS Fire Monitoring Handbook (National Park Service 2001) with the following exceptions:

1. The parks' tree size definition is as follows:

Overstory trees are those trees reaching breast height and greater.

Seedling trees are those trees less than breast height.

The parks do not distinguish pole-size trees as defined in the FMH.

These categories have been maintained because: 1) they are standard parkwide definitions used in previous and ongoing research, and 2) they were in place prior to the FMH guidelines and long-term consistency is extremely important. The tree diameter breakdown can be changed relatively easily by data manipulation, if necessary, so that the protocol deviation only affects trees in the seedling size class.

2. During sampling of brush monitoring types, measuring brush density of some of the species proved very difficult. Even for some of the species that are not clonal, distinguishing among individuals can be difficult as the stems grow very close together, often in clumps; determining if the stems are attached or separate can sometimes only be accomplished by excavation. We found that counting individual plants is not repeatable among crew members, leading us to be concerned about the reliability of density measurements for these brush species. We are unable to get repeatable data and are concerned that to do so correctly would require highly disruptive and time-consuming methods (i.e. digging). In addition, our current efforts to develop management objectives for chaparral are focused on brush cover and not density, therefore, we will not collect brush density measurements in these areas unless our management objectives change.

3. The original method used for measuring herbaceous vegetation was a line-intercept method when the program began in 1982, therefore, all plots installed prior to 1989 used this method. All plots installed after 1989 use the current point-line intercept standard method outlined in the FMH (National Park Service 2001). Beginning in 1992, conversion of pre-1989 plots to the new method began by performing both measurement techniques until the plots were burned again, and thereafter switching to the point-line intercept method. In this way,

herbaceous vegetation sampling on all plots will eventually use the same method (point-line intercept).

Timing of Monitoring

All plots currently follow the monitoring frequency recommended in the FMH: pre-burn, immediately postburn, 1-year, 2-years, 5-years, and 10-years postburn or until burned again (National Park Service 2001). Once a monitoring plot is burned again, the same frequency of monitoring is repeated. Deviations to this frequency occurred prior to the existence of the NPS monitoring program when plots installed prior to 1989 were not usually re-measured 2-years postburn. The master plot list (fmhplots.dbf) in the FMH database, lists these individual plot monitoring frequency deviations in the comments field. In addition, occasionally a plot re-measurement was not possible due to late season weather or limited monitoring resources. Again, in these cases, the frequency deviations are listed in the comments field of the FMH database master plot list.

Monitoring Plot Relocation

All monitoring plots are permanently marked with painted rolled-steel bars with labeled tags according to the FMH recommended standards (National Park Service 2001). All plots have written descriptions of their location, hand drawn maps, and are geo-referenced using a GPS unit (a few plots have not yet been geo-referenced but will be on their next visit). The plots will be relocated using a combination of the above references. Copies of all plot location description sheets (FMH-5) are stored with the Regional Fire Effects Monitoring Program Manager in the Pacific West Regional office in Oakland. All updated vegetation and fuels plot locations (UTM coordinates) are stored on the parks' local area network (LAN; j:\data\study_sites\permanent\fire_eff\loc_fmh.dbf .

Data Analysis

Data from the standard vegetation and fuels monitoring program, along with the other projects that supplement the standard program (see Additional Projects section below), provide the following results (bold indicates results related to management objectives):

" dead and down fuel reduction and accumulation

" changes in overstory tree density and species composition by diameter class and condition

" changes in seedling tree density and species composition by height class

" changes in snag density and snag formation/breakdown rates

" changes in shrub density (or cover) and species composition

" changes in cover and species composition of herbaceous vegetation

" changes in ground cover

" changes in species richness

" detection of non-native species

" burn severity

" immediate-postburn effects on trees (maximum bark char and crown scorch heights, percent crown scorch)

" mortality of large pines with and without basal fuel removal

" mortality and survival of postfire-regenerated giant sequoia seedlings following subsequent prescribed fire treatment.

Results for all objective variables are analyzed on an annual basis and presented in the program annual report. Currently, the analyses that are directly tied to specific management objectives in forest monitoring types are:

1. mean total fuel reduction immediately following prescribed fire, and

2. mean stand density (by diameter class and species) five years following prescribed fire.

For fuel reduction objectives, we calculate the 80% confidence interval of the mean percent total fuel reduction (average change of individual plot fuel reduction) to determine whether postburn fuel reduction estimates fall with the range set in the objectives. For stand density objectives, we use the 80% confidence interval of the 5-year postburn stand density to measure whether stand density estimates falls within the targeted range for both tree diameter classes (<80 cm and ≥80 cm). In addition, we examine the species composition (by density) to determine whether it falls within the targeted ranges. While the time period for stand density objectives is five years, we analyze stand density one and two years following prescribed fire in order to evaluate progress towards achieving the targets as the majority of tree mortality occurs during that time period.

Methods to measure landscape pattern are currently under development and when implemented, we will perform analyses to appropriately assess these objectives. Also, as other new objectives are developed, additional corresponding analyses will be warranted.

Additional analyses performed on an annual basis include fuel reduction and accumulation over time by fuel component (litter, duff, and wood) and stand density changes 10 years following prescribed fire. These analyses are useful in helping to determine when areas will be scheduled for subsequent treatment with prescribed fire (e.g. How long after initial treatment before fuel loads approach pre-burn levels?). The long-term analyses are also useful in assessing whether giant sequoia recruitment is occurring in areas burned, important for the parks' goal of perpetuating giant sequoias. Changes in shrub cover by species composition are also analyzed in brush monitoring types while specific objectives for the brush types are still in development.

Due to time limitations, analyses of variables not related to objectives have been consistently performed. Our intention is to analyze additional variables more consistently, with a goal of performing the non-objective-related analyses at least once every three years. Other analyses that should be performed include: shrub and herbaceous cover and species composition changes, species richness, burn severity and ground cover. Analysis of the additional project results (see Additional Project section below) should also occur on a regular basis so that the information can be used for future planning purposes. Each year, the progress made on each project, including any new analyses, will be summarized in a report.

Data Sheet Examples

Data sheets used for monitoring are those found in the FMH, Appendix A (National Park Service 2001). Local modifications of these standardized data sheets are stored in the forms file drawer in the fire effects monitoring program office.

Information Management

The most current copy of the digital database is located on the parks' local area network (j:\data\plants\fire_effects\vegetation_fuels_fmh\primary_data\sekidbf.zip). All raw data sheets (stored in folders by plot) and photographic slide files are located at the fire effects monitoring program office at the parks' Ash Mountain headquarters. The updated database resides on the fire effects crew computer located in the central room of the office (c:\fmh) and are backed up on the Ecologist's computer (c:\fmh) and on zip disks stored in the Division of Natural Resources office mailbox and the Ecologist's residence. Copies of the database files, plot location descriptions and maps, and an annual copy of the digital database are stored with the Regional Fire Effects Monitoring Program Manager in the Pacific West Regional office in Oakland.

All data and work schedules for additional projects (see section below on Additional Projects) are stored on the fire effects crew computer in the central room of fire effects office (c:\projects). Data files are backed up on the parks' LAN (j:\data\plants\fire_effects\sequoia_mortality,sequoia_seedlings, pine_fuel_mitigation, sequoia_heavy_fuel_effects\primary_data). Plot locations for other projects are being obtained and will be added to the permanent plot database on the network.

A report prepared annually summarizes program accomplishments and monitoring results and is distributed to the park staff, the Regional Program Manager, and other interested parties. The annual reports are stored on the parks' LAN (j:\data\plants\fire_effects\vegetation_fuel_fmh\products\annual_reports).

Quality Control

Quality control is of the utmost importance in all aspects of the vegetation and fuels monitoring program. Without high quality data the monitoring program cannot accurately assess whether management objectives are achieved. Therefore, multiple levels of quality control will be performed at all stages of the program using the following techniques:

1) Data Collection

a) Training – At the start of each season, several days of sampling protocol training where each protocol is demonstrated and then each employee performs the protocol. This training is followed by a practice plot session where all protocols are practiced in a real plot setting.

b) Periodic in-field comparisons – A few plots are randomly selected (up to 10%) and for these plots the data are collected independently by two different observers. The data from the independent observations are compared to examine the precision of the data. This technique is most useful to point out areas where measurement error is most problematic and to increase awareness of field protocols where more care is needed in measurement.

c) Field Data Checklist (see Attachment 1) – For each plot visit, a checklist of all field tasks is filled out and the lead monitor makes sure that the checklist is complete and that all completed datasheets are placed in the plot folder before leaving the field site.

2) Data Storage

a) Quality Check Log (Attachment 1) – This log sheet is used to be certain that the data are entered into the database completely and accurately. After each field datasheet is entered into the database, the corresponding entry on the Quality Check Log is checked off, initialed, and dated by the person(s) who performed the data entry. At a later date, the field datasheet (raw data) is independently compared to the database and any errors in data entry are corrected. Each datasheet verified is checked off, initialed, and dated by the person performing the quality check on the Quality Check Log, which is stored with the data in the plot folder as a record of quality control. The Quality Check Log also serves as a place to record any questions or discrepancies found in the data or any information that needs to be gathered during the next visit to the plot.

b) FMH error checking function – Each datasheet entered is checked using the error checking function in the FMH software and any errors found are corrected.

3) Data Analysis

a) Identify anomalies – Any anomalous results which become apparent during data analysis are investigated for potential data errors. First, the corresponding field datasheets are examined for any visible errors and then compared to the database to check for errors in data entry.

b) Repeat analyses – Analyses are repeated in order to be certain that the correct analyses were performed and that the same results are generated.

Program reviews will occur periodically, either every 5 years, or at the request of the park Ecologist (Fire Effects), park Fire Management Officer, or the Regional Program Manager.

Responsible Party

The Lead Biological Science Technician (Fire Effects), in coordination with the Ecologist (Fire Effects) is responsible for hiring and training seasonal fire effects monitors, collecting field data, storing data electronically, performing data quality checks, and assisting with data analysis as needed.

The Ecologist (Fire Effects), in coordination with the Supervisory Natural Resource Management Specialist and the Fire Management Officer, is responsible for developing monitoring objectives, determining the appropriate sampling design, managing the database (including backups and quality control), analyzing the data, and disseminating the results for the vegetation and fuels monitoring program.

Funding

Funding for vegetation and fuels monitoring will be obtained through the fire effects module of the FIREPRO analysis system that analyzes existing and future workload to determine associated staffing and support costs. Individual project accounts will be used to cover any additional time needed beyond base funding to monitor burning plots and immediate postburn visits.

Additional Projects

The following studies complement the parks' network of vegetation and fuels monitoring plots and provide additional information important to the fire management program.

Increasing giant sequoia sample size

Because of their great size, giant sequoia tree density is very low in the standard 20 x 50 m forest plots. To increase the sample size of giant sequoia, we sample all, or a subset of, giant sequoia trees in prescribed burn units in the Giant Forest area prior to and following prescribed burning. Pre- and post-burn methods follow the FMH protocol for overstory tree sampling and can be combined with the FMH database for the Giant sequoia-mixed conifer forest monitoring type. The total number of giant sequoias sampled in this study to date is 983 trees in seven separate units burned between 1993 and 1999. This information will provide a sufficient monitoring sample depth over a long time period with which to assess the long-term effects of prescribed fire on mature giant sequoia trees. Monitoring will continue for trees currently sampled, however, no additional giant sequoias will be added to the sample unless specific reasons warrant it.

Giant sequoia seedling survival in reburns

The issue of subsequent burns, following the initial restoration burn, has recently become timelier. Some areas of the parks where early prescribed burning efforts were concentrated have already surpassed the historic fire return interval without subsequent burning. In some of these areas, giant sequoia regeneration of varying density resulted from the initial burn. Knowledge about fire effects on these young trees following subsequent prescribed burns is critical, especially given the importance of giant sequoias and their fire-dependent regeneration. Plots were installed in reburn areas specifically to assess the reburn mortality/survival of groups of giant sequoia seedlings that established after the initial burn. This information may be helpful for decisions related to reburn scheduling in other areas in the parks.

Sugar pine pre-burn litter/duff removal

Large tree mortality following prescribed fire is a concern for land managers attempting to reduce fuels and restore the process of fire in fire-dependent ecosystems. Pines, including sugar pine seem to be especially susceptible to mortality following fire. Whether this mortality is directly related to returning fire after a long absence in short-return interval regimes, or a combination of fire and other previously existing stressors (e.g. white pine blister rust), is unknown at this time. Whether the current density of large pines falls within the range that would be present if fire regimes had not been disrupted is also unknown. Research scientists from the USDA Forest Service Riverside Fire Lab have found that removing the deep organic layer around trees prior to burning reduces large tree mortality. This type of pre-burn fuel removal may be an option in areas where large tree mortality is an important sociological or ecological issue. To see whether a difference in mortality occurs between trees with fuels removed and trees without fuels removed, and also to test the practicality of methods, fuel has been removed around large sugar pines in several prescribed burn units.

Heavy fuel effects on giant sequoia

As a result of public concern about the visual effects of fire, giant sequoia trees located in restoration prescribed burn units were previously subject to pre-burn fuel removal treatment. Unnaturally heavy fuels had been removed around giant sequoia trees in order to limit bark char and crown scorch on trees four feet or larger in diameter. This study was undertaken to determine the relationship between the amount of heavy fuel and duff surrounding giant sequoia trees prior to burning and the resulting fire effects characteristics after prescribed burning. Sixty giant sequoias in the Atwell Grove were selected and studied prior to burning. Data collected include: in a 25 ft radius around each tree, mapping and tallying 1000-hr fuels and litter and duff depth; depth and width of all fire scars; bark char; crown scorch height; and crown scorch percent. Although the fuel clearance procedures are no longer in place, the results from this study provide information to address issues of fire effects on giant sequoia trees.

Wildland-Urban Interface

In response to the National Fire Plan (2001), Sequoia and Kings Canyon National Parks identified Wildland-Urban Interface (WUI) areas that are treated to reduce the threat of damage to structures (both public and private) from wildland fire. This treatment involves the removal of fuel (both dead and live vegetation) from around the structures and includes mechanical thinning of small trees and brush, piling surface fuels, and burning the resulting piles of fuel removed.

Specifications for the fuel removal work will be located in individual mechanical treatment plans. In order to determine whether the treatments have been effective, pre- and post-treatment monitoring is carried out according to the following general protocols that may be adjusted depending on the project area:

Prior to treatment, permanent plots will be installed along the outside edge of the project area (200 feet from structures) looking back in towards the developed area. Previous experience has shown that 15-20 sample points will generate adequate data to represent the area statistically, and these points should be distributed evenly around the project area. The sample point will be marked by a single rebar stake that will be painted orange to facilitate relocation. The rebar stake will have a tag that identifies the project name and plot number.

A photo series estimate of the total woody fuel load will be taken from this point looking back into the project area with the plot centerline being perpendicular to the outside edge of the project. The photo series estimate will go out from the sample point at 45 degree angles from either side of the stake out for 100 feet. The total fuel load estimate will be recorded along with the plot number.

At each point, 100 feet in to the project area along the plot centerline, a chaining pin will be placed into the ground. A tape measure will be swung around this chaining pin for a radius of

100 feet. All trees less than 40 feet tall within this radius will be recorded. Trees that are close to 40 tall will be measured using a clinometer and tape, to accurately estimate the tree height.

The plot will be reread immediately following the completion of the project to determine if the objectives have been met, and then every 10 years to determine a maintenance schedule. When the total woody fuel load exceeds 12 tons/acre, additional piling of fuels and burning of the piles will occur. When the total number of trees less than 40 feet tall exceeds 25/acre, additional thinning, piling and burning will occur. When maintenance activity occurs, the plots will be reread to assure the treatment objectives are being met. The area will be maintained into the future so that the project objectives are met.

The Fire Monitoring Crew Supervisor, in coordination with the Fuels Specialist and Assistant Fuels Specialist, is responsible for completion of the WUI monitoring work.

In addition to monitoring the treatment objectives (above), comparing the results of mechanical fuel removal with similar areas treated with prescribed fire may provide useful information to evaluate the effects of alternative fire management activities. Up to 3 standard fuel and vegetation monitoring plots will be installed within the project area in order to compare results to those from similar areas treated with prescribed fire. Although only limited information will be gained from such a small sample size, differences in vegetation composition and patterns may be documented and investigated further if necessary. Fuel accumulation rate and tree regeneration will also be documented in the plots. The Lead Biological Science Technician (Fire Effects), in coordination with the Ecologist (Fire Effects), is responsible for implementing this supplementary WUI monitoring.

Due to additional concerns about the potential for non-native plant invasion into disturbed areas, directed surveys may be conducted in the WUI treatment area. With assistance from the parks' exotic plant program staff, the status of pre-treatment presence of non-native plant species may be determined along with any changes that may occur following initial treatment and after further treatment. Specific protocols have not yet been developed.

Management Implications of Monitoring Results

Recent policy and program initiatives recognize that fire reintroduction is important to fire-maintained landscapes to sustain diverse, functioning ecosystems and to prevent damage from uncharacteristically severe fire that is inevitable with fire exclusion in fire prone areas. Information about the results of fire restoration efforts supplied by the monitoring program is critical feedback needed by land managers, policy-makers, and the public.

The accomplishment of hazard reduction and restoration goals depends upon having a monitoring program that is sufficient to determine whether specific fuel reduction and structural restoration objectives are met. The vegetation and fuels monitoring program results provide the information needed to assess whether specific objectives for the prescribed fire program are met with the level of certainty required. The monitoring program provides a consistent and dependable method of documenting the prescribed fire program's objective achievement. If the objectives are not achieved, managers must determine whether management actions need to be adjusted in order to attain objectives or if the management objectives need to be revised given the current situation. The analysis of some additional data not specifically related to management objectives is used to determine if any unexpected consequences of prescribed fire occur.

Each year, the Ecologist (Fire Effects) documents the latest vegetation and fuels monitoring program results in an annual report and, unless no new results are available, presents these results to park managers and local scientists for review in an informal meeting setting. This meeting usually takes place in late winter or early spring. At this time, the group discusses current and preliminary results and makes decisions about any changes needed in either the monitoring program or management activities based on these results. Adaptive change(s) should take place if any of the following are apparent from the monitoring results:

objectives are not sufficiently met

an undesirable trend is occurring

an unexpected result occurs

monitoring methods cannot adequately assess objectives.

Any changes made, such as adjustments to burn prescriptions, changes or additions to monitoring protocols, or modifications of target conditions or management objectives, should be documented at the earliest opportunity in the appropriate section of the Fire and Fuels Management Plan.

ADDITIONAL FUELS INFORMATION FOR MODELING

Recent advances in computer technologies have given managers more tools to help make critical resource management decisions. The development of a Geographic Information System (GIS) based fire spread model called FARSITE, is an example of one of these tools. The FARSITE model, like most models, requires quality-input data in order to produce reliable output. The fuels model and canopy characteristic data are the most important inputs to any fire growth model. Fuel load information is also needed for smoke emissions modeling. These information needs require additional fuels data beyond that which is collected in the current parks' vegetation and fuels monitoring program. Currently, the fuel model map for Sequoia and Kings Canyon National Parks is based on 1970's vegetation maps. In addition to accuracy and quality problems, this map lacks some of the attributes necessary to make the best use of new technology (e.g. canopy bulk density and height to live crown base). A new vegetation and fuels mapping effort for the parks is currently underway and will help to correct the deficiencies of the outdated maps. Until that project is complete, additional fuels information collected allows for improved modeling to assist in fire management decision-making processes.

Monitoring Goal: Additional fuels information provides for the most current and accurate fire behavior and spread and smoke emissions modeling critical for making sound fire management program decisions.

Monitoring Objectives

1. Develop and improve on the Geographic Information System (GIS) data themes used to run fire behavior and smoke modeling programs.

2. Install enough permanent fuels plots in the short-needle and long-needle conifer forests, so that the percent error of the total fuel load estimate is less than 20% (percent error is calculated by dividing the standard error by the mean and multiplying by 100).

Sampling Design

The sampling design is intended to capture the fuel load data necessary to run the fire behavior model and smoke modeling programs as efficiently as possible. The study focuses on the forested areas of the park where the fuels are continuous enough to easily support fire spread, from the ponderosa pine-mixed conifer community (4000-6500 feet) to the red fir forest (8000-10000 feet). Based on previous experience, permanent fuel plots are located in the short-needle (includes sequoias) and long-needle conifer forest types in the following elevation classes: low [" 6500 feet (1982 m)], mid [6500-8000 feet (982-2439 m)], and high [> 8001+ feet (2440 m).

Field Measurements

Permanent fuel plots are established in order to track fuel accumulation over time. The permanent fuel plots are established using the planar intercept method (Brown 1974). The plots consist of four 50 foot transects running north, south, east and west from the center point. Ten litter and duff measurements are taken along each of the 50 foot transects.

Tree basal area is measured at each permanent plot using Basal Area Factor (BAF) prisms. The prism is selected so that a minimum of five trees would be included. The prism is swung 360" around the sampling point and the number of trees that are "in" (edges still touching, not totally offset) is recorded along with the factor number of the prism used. Every other borderline tree is counted. Three overstory trees are selected as being representative of the average diameter "in tree" and their diameter at breast height (DBH) is measured and recorded. An average value is calculated from the three trees measured and used to represent the trees at that sampling point.

The following measurements are also recorded at each permanent plot using a clinometer: overstory tree height, height to live crown base for each distinct canopy layer (dominate, intermediate, understory). Canopy cover is measured with a densiometer and recorded using the following codes: 0=0%, 1= 1-20%, 2= 21-50%, 3= 51-80%, and 4= 81-100%.

Timing of Monitoring

The permanent fuel plots will be re-measured every 5 years to track fuel accumulation over time and within 1 year following a disturbance (usually a fire) and thereafter will follow the 5 year schedule.

Monitoring Plot Relocation

All monitoring plots are permanently marked with painted rolled steel bars (rebar) with labeled tags denoting their plot type and number (e.g. Permanent Fuel Plot #20). All plots have written descriptions of their location, are added to the GIS plot location database each year, and are geo-referenced using a GPS unit. The plots will be relocated using a combination of the above references. Copies of all plot location descriptions are stored in a Permanent Fuel Plot binder in the fire monitoring crew supervisor's office. All updated fuel plot locations (UTM coordinates) are stored on the parks' LAN (j:\data\fire\fuels\gis\pfplocdt.dbf).

Data Analysis

New plots will be installed until we reach our goal of less than 20% error for the total fuel-load estimate for each needle type (short vs. long). We will update the database and GIS themes as new data is acquired.

Data Sheet Examples

Fuel data and stand data field forms have been developed (see Attachment 1).

Information Management

The database is stored on the parks' LAN (j:\data\fire\fuels\gis\MkSum00.xls. All hardcopy files, the digital data files, and digital photo files are located in the fire monitors' office at the parks' Ash Mountain headquarters. The updated data files reside on the Fuels Specialist computer (C:\My Documents\Fuel\MK-Data\MkSum00.xls). The most current copy of the database files are backed up on the fire monitoring crew computer in the main room of the office (C:\Crew\Monitors\FuelLoad\99PFP\Mksum.xls) and on floppy disks.

Quality Control

Quality control is important and will be performed during data collection, data storage, and analysis stages.

Responsible Party

The Fire Monitoring Crew Supervisor, in coordination with the Fuels Specialist, is responsible for training seasonal fire monitors, collecting field data, storing data electronically, performing data quality checks, and assisting with data analysis as needed.

The Fuels Specialist, in coordination with the Supervisory Natural Resource Management Specialist and the Fire Management Officer, is responsible for developing monitoring objectives, determining the appropriate sampling design, managing the database (including backups and quality control), analyzing the data, and disseminating the results.

Funding

Funding for the fuels monitoring will be obtained through the prescribed fire management and fire use modules of the FIREPRO analysis system that analyzes existing and future workload to determine associated staffing and support costs.

Management Implications of Monitoring Results

Improvement in the quality of the fuels related input data needed to run current and future modeling programs will result in a higher degree of confidence in the outputs and ultimately yield a more informed management decision. As we improve the underlying data that feeds the models, the outputs from the model should more closely match reality.

WILDLIFE

Many wildlife species are affected by fire, with significant effects to both the structure and vegetative composition of habitat. Because of these fire-induced changes in habitat and because rodents are sensitive to habitat changes, they make good indicators of wildlife response to individual fires. Changes in rodent populations indicate changes in available food for raptors and forest carnivores that that are either sensitive or simply of public interest (e.g. fisher, martin, goshawk, etc.) since rodents are at the bottom of the food chain. Also, changes in mid-sized mammal occurrence provide limited indication of changes in relative abundance of forest carnivores that may feed on the rodents. Currently, wildlife monitoring does not occur in wildland fire areas but is focused on areas where prescribed fire is the primary management activity.

Monitoring Goal: Provide information useful to determine whether wildlife species diversity is maintained and to evaluate the effects of the prescribed fire program on wildlife populations.

Monitoring Objectives

1. Provide documentation of long-term changes in rodent populations and their habitat following fire under known conditions.

2. Acquire inventory of rodent species and their relative abundance within both common and unique East Fork Kaweah environments (habitats) to facilitate assessment of potential fire effects.

3. Acquire inventory of mid-sized forest carnivores and other mammals of similar size and their relative abundance within East Fork Kaweah environments (habitats) to facilitate assessment of potential fire effects.

4. Maintain an inventory of elderberry shrubs (*Sambucus mexicana*) within the Ash Mountain prescribed fire treatment areas to protect ha - 30 -bitat for the Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).

Sampling Design

Rodent populations were investigated from two perspectives: 1) long-term monitoring of select areas, and 2) serendipity surveys of the most common and unique habitats. The long-term monitoring is intended to document long-term changes in rodent populations and their habitat following fire under known conditions. Serendipity surveys inventory rodent species and their relative abundance within both common and unique environments to facilitate large-scale assessment of potential fire effects.

Long-term Monitoring

Long-term monitoring plots are located in representative examples of the most significant combustible vegetation types in the East Fork Kaweah Drainage. Existing plots are located in mixed chaparral, sequoia grove, westside ponderosa pine forest, and Jeffrey pine forest. Long-term monitoring plots are 1 ha in size (75 m by 135 m with surface distances adjusted for slope). Plots are numbered sequentially 0, 1, 2, 3. Each plot consists of 60 stations positioned at 15-m intervals (Distances are adjusted for slope.). Traps stations are numbered 1 to 6 from bottom to top and 0 through 9 from left to right. 23 x 8 x 9 cm Sherman live traps (40 x 8 x 9 cm Sherman live traps for sites where wood rats are common) are placed within 1m of the trap station marker. The traps are placed on firm substrate. If firm substrate is not available within 1m of the stake, such as where there is deep litter, use the most stable site available. The trap is either flat or the rear is slightly higher than the front of the trap. The bottom of the trap should be nearly flush with the surface of the ground. The trap should not sit below the surface of the earth. A wad of cotton is placed in the rear top corner of the trap. It is pressed in to keep it as far from the entrance as possible and above the trigger. Externally, the trap needs to be insulated if there is any potential for the sun to shine on the trap. This can be done with corrugated cardboard or other insulating materials. The insulation needs to extend beyond the widest dimensions of the trap to prevent the sun hitting the trap at any time of the day.

The traps are baited with a mixture of rolled oats and peanut butter. The bait is mixed so that the flakes of rolled oats are dry and mostly not sticking together. A small handful (large pinch) of bait is thrown into the traps in such a way that bait will concentrate in the rear but be scattered throughout the length of the trap. A thin stream of bait goes out the door for several decimeters.

Serendipity Surveys

For serendipity surveys of rodents, no formal plots exit. The areas surveyed are selected to provide comprehensive coverage of all significant habitats within the drainage. The area should be at least a hectare in size and of uniform habitat. The area should be large enough to eliminate captures from adjacent communities. The size and methods for setting traps are the same as for long-term plots except that spacing is not critical. Rodent traps are distributed loosely at approximately (not measured)15 m intervals. Each trap has a unique number.

For serendipity surveys of medium-sized mammals, no formal plot exists. The habitats being surveyed (except riparian) should consist of at least 50 hectares of similar contiguous habitat. The habitat should be sufficiently extensive to virtually eliminate captures of individuals that are not at least partially dependent on utilization of the habitat being sampled. One or more traps are distributed at sites that appear to be suitable (good access, good cover, away from visitors, etc) for setting traps with no specified spacing. Each trap site has a unique designation. To capture mid-sized mammals, 81 x 26 x 41 cm Tom-A-Hawk live traps (107 x 40 x 52 cm Tom-A-Hawk traps when targeting larger mammals) are placed on firm substrate. If firm substrate is not available, use the most stable site available. The trap is either flat or the rear is slightly lower than the front of the trap. The bottom of the trap should be nearly flush with the surface of the ground. The trap should not sit below the surface of the earth. The trap is completely covered with burlap bags except for the entrance. Before setting any trap, check the trigger and adjust as necessary for proper sensitively to closing. Bait the trap with fish-flavored cat food. Place a lump of bait (size of two walnuts) behind the trigger, and place a trail of bait (peanut-sized lumps) at about one decimeter intervals extending through the trap and about a meter out the door. Every couple of days, the bait needs to be replaced.

Field Measurements

Captured rodents are ear tagged, and minimal recorded information includes tag number, capture location, date, habitat, species, sex, age (adult, subadult, juvenile), weight, hind foot length (first capture), ear notch length (first capture), tail length (first capture), number of trap-nights, and general comments.

At long-term monitoring plots, the minimal habitat data includes shrub and tree species composition, shrub basal diameter, shrub stem density, tree DBH, tree density, slope, aspect, elevation, air temperature, and general site description.

For mid-sized mammals, minimal recorded information includes species, location, date, habitat, number of trap-nights, and general comments.

For elderberry shrubs (*Sambucus mexicana*), monitoring methods are described in the Ash Mountain burn plan (regarding habitat for Valley elderberry longhorn beetle, *Desmocerus californicus dimorphus*).

Timing of Monitoring

Long-term Monitoring

Monitoring on long-term plots occurs during the summer prior to the burn and annually for at least three successive years following the burn. Monitoring event duration normally lasts three to six weeks but can be longer (depending on trapping results). Currently, trapping occurs for four consecutive nights during each week. Monitoring periods require temporal overlap between successive years to permit comparison of population changes from year to year.

Serendipity Surveys

Serendipity surveys generally last approximately 2 weeks with a goal of capturing the common species in areas where we have little understanding of populations present. Similar to long-term monitoring, trapping often occurs for four consecutive nights during each week. If uncommon species occur, survey duration may be increased.

Monitoring Plot Relocation

Long-term Monitoring

GPS coordinates have been field measured for all four corners of each long-term monitoring plot. Plots are marked with rolled steel bars on each corner and at 15 m intervals within using one-quarter inch rolled steel rods that extend approximately one foot above the ground. Each stake is numbered with an aluminum tag.

Serendipity Surveys

For serendipity trapping, a GPS coordinate is either field measured or taken from a map to record the approximate center of the sampling area.

Data Analysis

Plot populations are estimated using a modified Jolly-Seber Method. Postburn population trends are compared to pre-burn population. Postburn populations are compared in successive years. Both catch rates and population estimates are used to evaluate populations. Capture rates at unburned plots in other portions of the drainage help distinguish fire effects from intrinsic rodent population dynamics.

Data Sheet Examples

Data sheets for both plot data and serendipity data have been developed (see Attachment 1).

Information Management

Original data sheets and reports are stored in the office of the Wildlife Ecologist. Photocopies are made of datasheets at the earliest opportunity. The data reside on the Parks' LAN, accompanied by appropriate metadata (j:\data\animals\vertebrates\wildlife_fire_effects\primary_data). Data stored on the Wildlife Ecologist's computer is backed up and stored on a separate medium and generally in a different building (Wildlife Biologist or home).

Quality Control

The accuracy of species identifications and adherence to protocols is achieved through training at the beginning of the season. Crewmembers are not sent to the actual plots for data collection until they have demonstrated competence in doing the required work, unless they are accompanied by someone who is already competent. Periodic field visits by the supervisor serve as intermittent checks on the accuracy and completeness of the data collection effort.

Data is transferred from the data sheets to the digital databases as a team effort. Data is entered and then checked against the data sheets to assure accurate copy. Database accuracy is spot checked by the analyst prior to analysis.

Responsible Party

The parks' Wildlife Ecologist is responsible for planning the annual work, managing the funds, hiring the crews, analyzing the data, and preparing the annual report.

Funding

The data collection and data entry for the monitoring is supported by FIREPRO. Data analysis and reporting is supporting by the parks' Wildlife base account.

Management Implications of Monitoring Results

If monitoring results show large changes, such as losing species or gaining unexpected species, an evaluation is warranted. This evaluation would include determining if current prescriptions are appropriate for the known fire regime of the vegetation type or whether further research is needed to determine the historical fire regime.

WATER

The effects of fire on water quantity and quality and sediment transport are second order fire effects that have important ecosystem consequences. Stream flow and water chemistry monitoring is focused on specific watersheds where prescribed fire is the primary management activity, although wildland fires have occurred in some parts of the study areas.

Monitoring Goal: Evaluate the effects of prescribed fire on water quality and quantity in first order streams as well as across an entire watershed.

Monitoring Objectives

1. Evaluate changes in hydrology following prescribed fire by measuring pre-fire and post-fire continuous stream discharge.

2. Document changes in hydrochemistry by quantifying solute inputs using wet deposition data from the National Acid Deposition Program (NADP) and California Air Resources Board (CARB) collection sites and solute exports using stream discharge and periodic chemical samples.

3. Assess the indirect effect of prescribed fire on erosion and sediment transport that might affect water quality.

Sampling Design

The watershed approach requires that many key aspects of the hydrological and biogeochemical cycles are measured and sampled to get a full understanding of the variability in watershed processes. The Sequoia watershed program has used a holistic approach by establishing co-occurring sites to measure meteorology, stream discharge, and hydrochemistry. Many of the sampling protocols have been in place since the watershed program was initiated in 1982.

Paired watersheds were located in the Middle Fork of the Kaweah drainage. Log Meadow is a mid-elevation (2100 m) montane mixed-conifer catchment dominated by white fir (Abies concolor) and giant sequoia (Sequoiadendron giganteum). Precipitation averages 100 cm annually, approximately half falls as snow during the winter months. Dominant soil types include Pachic and Lithic Xerumbrepts, Xeric Haplohumelts, Aquepts, and Cumulic Haphibrepts. Tharp's (13.1 ha) and Log Creeks (49.8 ha) are paired first- and second-order watersheds, and are instrumented with Stevens Type F Water Level Recorders and Stevens Type A/F Electronic Data Loggers on 3" and 12" Parshall flumes, respectively.

Additional sites were established in 1995 to meet the needs of fire management when a large project in the East Fork of the Kaweah River (originally called the Mineral King Risk Reduction Project) was funded. This project was initiated to determine whether accelerating the application of prescribed fire across an entire watershed was feasible and to document the costs and effects of such a landscape-scale program. Monitoring of hydrology and hydrochemistry of this entire watershed is intended to provide information that may be applicable to other large watersheds.

The East Fork Kaweah watershed encompasses approximately 21,000 ha with elevations ranging from 875 m to 3,750 m. Vegetation within the watershed is diverse, ranging from chaparral and hardwood forests at the lower elevations to mixed conifer and Sequoia forests at mid elevations. Alpine vegetation is found above 3,100 m. Trauger's Creek and Deadwood Creek are the primary focus for the stream chemistry and hydrology study.

Trauger's Creek is a low elevation (1400 m) catchment (106 ha) with mixed chaparral/oak-woodland in a transition zone between the lower mixed-conifer zone and the upper chamise-chaparral zone. The dominant species is California live oak (Quercus, sp.). Incense cedar (Calocedrus decurrens), maple (Acer macrophyllum), California laurel (Umbellularia californica), spicebush (Calycanthus occidentalis), and willow (Salix, sp) are found along the stream corridor. Precipitation is measured by a tipping bucket at Lookout Point, two miles west of the study and is operated by the National Park Service.

Deadwood Creek is a mixed-conifer (2000 m) catchment (100 ha) characterized by white fir (Abies concolor), red fir (Abies magnifica), giant sequoia (Sequoiadendron giganteum), and incense cedar (Calocedrus decurrens). Precipitation measurements for this site are recorded at the Atwell Mill stables, approximately one mile west, by the Army Corps of Engineers.

Field Measurements

Hydrology

Disturbance such as fire can result in dramatic increases in peak and total discharge. Pre- and post-fire hydrologic measurements will allow us to quantify the magnitude of those changes in the study catchments. Continuous discharge records before and after fire will identify any shifts in the magnitude and duration of high flow, as well as reveal changes in base flow. In addition, discharge records are essential for determining mass balances of solutes, necessary for determining the effects of air pollution and climatic change on southern Sierran catchments.

Study watersheds are equipped with data loggers and/or chart recorders that record hourly or daily discharge. Several types of loggers and recorders are used, including Stevens type A/F records and Omni Data loggers. The Middle Fork Kaweah sites are fitted with weirs that provide direct stage-discharge relationships, which were established by the U.S. Geological Survey/Water Resources Division (USGS/WRD) staff. The Log Meadow sites are no longer being monitored but could easily be re-instrumented if desired, provided funds were available. The upper East Fork Kaweah sites are currently maintained by NPS staff. The headwater Marble Fork watersheds are gauged and monitored by UCSB staff. The lower East Fork Kaweah and Marble Fork Kaweah are gauged by Southern California Edison power company. Stage-discharge relationships are being developed for the East Fork Kaweah streams using the salt dilution method.

Hydrochemistry

Mass balance determination for solutes in Sierran streams require the analysis of both precipitation chemistry and stream chemistry. Some of the effects of fire, atmospheric deposition, and climate change on Sierran catchments are determined by evaluating mass balance relationships. In addition, pre- and post-fire hydrochemistry measurements are necessary to quantify the magnitude of changes in streams solute concentrations following fire.

We will use stream chemistry data to determine pre- and post fire base flow and high flow chemistry output and transport patterns in the study watersheds. We will also use these data to monitor the effects of changes in air quality as seen by changes in stream chemistry output.

Stream samples are collected weekly throughout the year. Additional samples are collected during periods of high flow (storm events and snowmelt). This sampling frequency will allow us to look at both inter- and intra-annual variation. Samples are collected and processed according to protocols outlined by Robert Stottlemeyer (1987. Monitoring and quality assurance procedures for the study of remote watershed ecosystems. Special Technical Pub. No 940. American Soc for Testing and Materials. pp. 189-198.). Samples are filtered at the Ash Mountain Water Lab (AMWL) and shipped to the Biogeochemistry Laboratory at the Rocky Mountain Station Experiment Station in Fort Collins, Colorado, for analysis of base cations, ammonium, nitrate, sulfate and phosphorus. A separate filtered sample is shipped to Michigan Technological Institute for dissolved organic carbon analysis. Alkalinity, pH and conductivity are measured at the AMWL.

Timing of Monitoring

Sampling is done throughout the year, monthly for hydrochemistry and continuously for hydrology. Stage heights recorders are placed in the streams and continuous data includes average hourly heights which is then calculated to flow (liters/day or gallons/day). Sampling began in the East Fork Kaweah watershed in 1995 to characterize pre-burn conditions.

Monitoring Plot Relocation

Sampling sites occur at the intersection of the Mineral King Road and Trauger's Creek and at the intersection of the Mineral King Road and Deadwood Creek. Log Meadow sites can be located by map and stream discharge instrumentation. Maps of the Log Meadow sites are stored as hard and electronic copies in the Aquatic Ecologist's office.

Data Analysis

Hydrology results will be used to determine the influence of landscape scale and geomorphology on watershed response to fire. Studies following the Yellowstone fires of 1988 indicated that low order streams are more affected by fire because small watersheds tend to experience fire over a larger percent of the catchment. However, the magnitude and quality of those effects are also influenced by stream gradient, aspect, and riparian area. The pilot study in the mixed-conifer Log Meadow watershed examined the effects of a single fire on a single small (<50 ha), low gradient watershed. In contrast, ongoing landscape-scale burning in the East Fork Kaweah watershed provides a unique opportunity to evaluate fire effects on watersheds at two very different scales: large (ca. 21,000 ha) and small (ca. 100 ha).

Geomorphology, stream characteristics, vegetation, and fire behavior in the East Fork Kaweah watershed differ from those in the Log Meadow watershed. The East Fork Kaweah catchments are larger and steeper (30 - 45% slopes). Trauger's Creek catchment comprises mostly Quercus spp. (rather than conifer forest) and sediments are coarser. These differences allow characterization of a range of watershed responses to fire. Specifically, the effects of fire along an elevational gradient will be evaluated by comparing changes in Trauger's and Deadwood catchments. Post-fire responses in hydrology and hydrochemistry in Deadwood Creek and

Tharp=s Creek (burned in 1990), which have similar vegetation types, will be compared. Additionally, the magnitude of watershed response to fire will be evaluated by comparing post-fire hydrochemistry in smaller catchments (ca. 100 ha) with the East Fork Kaweah drainage as a whole (ca. 21,000 ha).

Hydrochemistry results will determine how fire effects the nitrogen and sulfur cycles in small watersheds, and at what spatial and temporal scale are these effects most pronounced. Previous work at Sequoia National Park has documented chronic deposition of anthropogenic pollutants and a slow, long-term increase in nitrogen deposition. In contrast, the park's pilot study of fire effects on hydrochemistry revealed sharp peaks in post-fire nitrate and sulfate concentrations, far above any level recorded in the absence of fire. Nitrate and sulfate levels have remained elevated for at least five years following our experimental burn.

Analyses will attempt to determine whether these findings are unique in time and space, or if can they be generalized to watersheds of different sizes, vegetation types, gradients, and elevations in the Sierra Nevada. While otherwise undisturbed Sierran streams are not presently suffering chronic acidification, the combined influence of increased atmospheric deposition and elevated post-fire acid anion concentrations might lead to acidification. Determining the importance of antecedent conditions, such as prolonged drought (preceding the pilot study on fire effects) is also of interest. In addition, analyses should help to establish if fires result in permanent (relative to the fire return interval) changes in hydrochemistry.

Information Management

Data management protocols are well established, and will be continued. Existing databases include a master file of hydrochemistry data, daily discharge files for gauged streams, and meteorology files for weather stations at several elevations within the Parks. All data are stored in the Ash Mountain watershed lab computer and backed up daily. Weekly, monthly, and annual tape backups are archived. Weekly off-site backups are maintained. The data will also reside on the Parks' data management system accompanied by appropriate metadata.

Quality Control

The SEKI watershed research program has maintained a standard set of protocols since its inception in 1982. QA/QC procedures, detection limits for analyses, and the results from national audits are documented. Copies of the annual QA/AC reports from the 1980's are in the Aquatic Ecologist's office. The QA/QC reports from the 1990's were included in the annual reports and the latest (2000) is also included in the proposed 5-year watershed plan. In the past, our results have been well within the range of required standards for each study. The watershed lab will continue to participate in semiannual audits.

Responsible Party

The Aquatic Ecologist will be responsible for implementing funded components of the program in collaboration with the fire staff. This position is also responsible for working with the fire staff to obtain funding.

Funding

Currently, only part of this program is funded. The East Fork Kaweah hydrology and hydrochemistry work is currently being funded by FIREPRO. Of the three original Sequoia watershed study sites, the Log Meadow and Elk Creek sites are currently unfunded and the Emerald Lake site is being funded by EOS (NASA global change program). Funding is sought to add a sediment transport component to the program.

Collateral Components

Meteorology

Meteorological data are needed to quantify mass balances, assess intra- and interannual variability in ecosystem process, model ecosystem processes, or determine mechanisms driving patterns. Baseline meteorological data collection will continue at established sites in the Middle Fork Kaweah and East Fork Kaweah watersheds operated jointly by the U.S. Geological Survey/Biological Resources Division (USGS/BRD), National Park Service (NPS), National Oceanic and Atmospheric Association (NOAA), University of California, Santa Barbara (UCSB), and the U.S. Army Corps of Engineers (COE).

Precipitation Chemistry

Analysis of precipitation chemistry is central to determining mass balances of solutes entering Sierran catchments. Many years of continuous data collection are required to quantify inter-annual variation and to identify long-term trends in atmospheric loading. These data will be used to monitor changes in atmospheric deposition and to provide a baseline for the fire studies.

Unfunded Components

Sediment Transport

Increases in erosion and sediment transport are among the most dramatic and potentially deleterious effects on water quality indirectly associated with fire. Sediment transport is not currently a component of the parks' fire monitoring program, however, it has been identified as an important information need and one for which funding is desired. Erosion and sediment transport information is critical to evaluate indirect effects of fire on water quality, an important and timely social issue that would assist in fire management planning. In addition, sediment transport is important to understand ecosystem effects such as changes in stream chemistry and aquatic biota.

Macroinvertebrates

A baseline study of pre-fire aquatic macroinvertebrate assemblages conducted by Ian Chan, University of California, Davis, provides critical information on the current aquatic communities in small Sierran watersheds. The park could use Chan's study as a baseline for post-fire monitoring to track the response and recovery time of communities to fire, while further enriching our understanding of biological diversity along structural and temporal axes. This work would facilitate future fire management planning and enhance the parks' ability to provide fire-effects information to the public.

MANAGEMENT IMPLICATIONS OF MONITORING RESULTS

The striking chemical response of the pilot experimental watershed in Giant Forest to fire led to incorporation of further watershed studies on streams feeding the East Fork of the Kaweah River as an element of the landscape-scale prescribed fire project. This experimental effort to reduce fuels and restore more typical ecological function to an entire watershed provides a valuable opportunity to measure the physical, chemical, and biotic effects of landscape-scale burning on streams, and on the river systems they feed. For example, fire-induced changes in stream chemistry and sediment loading can have significant effects on fisheries and reservoirs, respectively. Alterations in forest structure result in changes in hydrodynamics that can significantly affect the efficiency of water-storage and release systems. Continued monitoring in the East Fork Kaweah will allow us to evaluate recovery rates of affected parameters such as nitrogen and sulfur constituents, pH, and alkalinity.

FIRE REGIME

One of the primary goals of the parks' fire management program is to restore fire as an ecosystem process across the landscape. As a result, we need to both understand the underlying baseline processes and be able to measure the success of the program's efforts at restoring and maintaining this process.

Fire regime can be defined as the interactions–from simple to complex–of a suite of attributes that constitute how fire operates as a process in a particular vegetation type or specific location. The attributes that describe the characteristics of a fire regime include: fire return interval (distribution, mean, minimum, maximum), season of occurrence, fire size and pattern, fire type (surface, crown, etc.), fire intensity (the quantity of heat produced), and fire severity (level of damage to what is affected by fire).

Important modifiers of these attributes include topographic features such as aspect and elevation, climate, and the lag effects of historic biotic events. Taken together, these attributes define fire as a process in a particular location and setting. Ideally the design of a program to monitor the restoration and maintenance of fire regimes would include the evaluation of all these attributes, however, available information is currently limited by our ability to acquire this knowledge and by the associated costs. Due to its landscape-level scope, fire regime monitoring encompasses all fire management activities occurring throughout all areas of the parks including wildland fires (both fire use and suppression fires) and prescribed fire.

Monitoring Goal: Fire regime monitoring provides information to evaluate the cumulative accomplishments of the fire management program in restoring and maintaining the natural fire regime over time across the entire landscape.

Target Conditions

Target conditions for fire return intervals (FRI) and season of fire for each major vegetation type have been determined based on our current knowledge (Table 5). These target conditions represent our best estimate of pre-Euro American settlement fire regimes for these two attributes (FRI and season of fire). Values have been derived from published literature, recent research findings, and local knowledge of park staff.

The range of fire return intervals (minimum to maximum) provides a broad window of possible fire occurrence, while the mean is the arithmetic mean of the fire return interval for the period from 1700 to 1860, the period when fire history reconstructions exist (Caprio and Lineback 1997). R_{max} is the average maximum fire return interval for a given vegetation type (see Caprio and Lineback 1997 for description of calculation) and is a conservative estimate of past fire return interval. Seasonal occurrence of fire under pre-Euro American settlement fire regimes was estimated and divided into categories of summer, early fall, and late fall/early winter seasons. Values are estimates of the percentage of area burned within each of these seasons for each vegetation type.

Table 5 – Target conditions by vegetation type for fire regime attributes (maintenance phase) and estimates of the quality of input information for the target condition values. R_{max} is the average maximum fire return interval.

Vegetation Type	Fire Return Interval Range	Season of Fire (% of area burned)
Ponderosa Pine- Mixed Conifer	1-15 years (mean = 4, R_{max} = 6) quality – good	0-30% Jun-late Aug 50-70% late Aug-Oct 30-50% Oct-Dec
White Fir-Mixed Conifer	1-30 years (mean = 10, R_{max} = 16) quality – good	0-20% Jun-late Aug 40-60% late Aug-Oct 30-50% Oct-Dec
Giant Sequoia-Mixed Conifer	1-30 years (mean = 10, R_{max} = 16) quality – good	0-20% Jun-late Aug 40-60% late Aug-Oct 30-50% Oct-Dec
Subalpine	50-1,500 years (mean = 187, R_{max} = 508) quality – poor	0-5% Jun-Jul 90-100% Aug-Oct 0-5% Nov-Dec
Xeric Conifer	15-60 years (mean = 30, R_{max} = 50) quality – very poor	0-20% Jun-Jul 50-70% Aug-Sep 10-30% Oct-Dec
Red Fir	9-92 years (mean = 30, R_{max} = 50) quality – poor	0-10% Jun-Jul 80-90% Aug-Oct 0-10% Nov-Dec
Lodgepole Pine	9-300 years (mean = 102, R_{max} = 163) quality – very poor	0-10% Jun-Jul 80-90% Aug-Oct 0-10% Nov-Dec

Vegetation Type	Fire Return Interval Range	Season of Fire (% of area burned)
Mid-Elevation Hardwood	1-23 years (mean = 7, R_{max} = 23) quality – very poor	0-30% Jun-late Aug 50-70% late Aug-Oct 30-50% Oct-Dec
Foothills Hardwood & Grassland	1-17 years (mean = 11, R_{max} = 17) quality – very poor	0-5% May-Jun 30-90% Jul-Oct 0-10% Nov-Dec
Foothill Chaparral	10-100 years (mean = 30, R_{max} = 60) quality – estimated *25% 0-20 yr old stands 50% 20-50 yr old stands 25% >50 yr old stands	0-30% Jun B Jul 50-70% Aug B Sep 30-50% Oct B Dec
Montane Chaparral	?-? years (mean = 30, R_{max} = 75) quality – estimated	unknown
Meadow	?-? years (mean = 40, R_{max} = 65) quality – estimated	unknown

*Area of foothills chaparral vegetation in differing age classes was also defined as an alternative measure due to the difficulty in assigning specific FRI.

Monitoring Objectives

1. Track and evaluate the continued implementation of the restoration of fire into park ecosystems, and

2. Determine whether the continued occurrence (maintenance) of fire over the long term, either from natural or human ignition sources, falls within a target range as determined from specific resource objectives (see Table 5).

Sampling Design

Monitoring fire as a process is a relatively new concept for setting resource objectives in fire management planning. Process monitoring has two requirements: 1) a need to understand historic fire regimes which provide historic reference conditions on past processes, and 2) a method of measuring contemporary fire processes which can be compared against the past processes. The greater the precision of the historic and contemporary information the better the quality of the analysis. In most cases the historic process data is the limiting input. Additionally, historic data are nearly always from a specific interval of time in the past, therefore, longer-term variability must be recognized when interpreting this information for planning purposes. For example, reference conditions may shift as a result of long-term changes in the drivers of fire regimes, such as climate.

Over the last 30-40 years, most fire history information has typically been restricted to solely providing descriptive information on what past fire frequencies were like at particular locations. We can now monitor fire as a process because we have, or can obtain, fairly detailed information about past fire regimes for many vegetation types within the parks, particularly using tree-ring reconstruction methods. This detailed, fairly localized information may be applied to larger landscapes using GIS to extend the use of this information for fire management planning.

Our current sampling objects are to obtain pre-Euro American settlement fire regime information from the array of vegetation types that exist in the parks and to understand how the past fire regime varied across the landscape in differing topographic or biotic settings. When carrying out fire history sampling we will utilize standard field sampling and dendrochronological crossdating methods to provide the highest quality information. In some vegetation types alternative methods may be required.

Field Measurements / Baseline Information

Baseline information used in fire regime monitoring is derived from two sources, 1) a historic reference period, usually for a time period prior to Euro American settlement, and 2) from written records of fire occurrence with associated maps for recent decades. The historic reference information is usually the most limiting. It can be obtained from a variety of sources–anecdotal, cultural, and historic accounts or records (maps and photographs), composition and changes in vegetation assemblages and life history attributes of the particular species in relation to fire, plant community age structure, palynological records, or tree-ring based fire histories. Each comes with differing degrees of precision and length of record. Additionally, all may not provide useful information across all vegetation types or for particular locations on the landscape. Currently, the primary source of high quality historical process data is dendrochronological-based fire history reconstructions that can be obtained in many forested vegetation types. Such data has both explicit spatial and temporal precision to at least the annual level.

At present, knowledge about past fire regimes in the southern Sierra Nevada is generally poor with exceptions for specific vegetation types such as giant sequoia-mixed conifer, white fir-mixed conifer, and ponderosa pine-mixed conifer. A review of fire regime data for the parks suggested that good quality data only exists for vegetation types that cover about 26% of the parks (Caprio and Lineback 1997). Additionally, there is a poor understanding about how specific modifiers, such as aspect and slope, affect the fire regime in differing vegetation types.

Baseline fire regime information is needed for the complete array of vegetation types found in the parks. While some of this information can be derived using dendrochronological analysis of fire scars, in many cases other methods or sources of information will be required. In vegetation types where dendrochronological methods can be used, an unbiased inventory approach with good spatial replication would provide the highest quality data. Sampling would be a one-time process–long-term follow-up sampling is not required once the historic data is acquired. For other vegetation types where dendrochronological methods are not feasible, information about past processes will be much less precise and more difficult to obtain.

Timing of Monitoring

A new FRID map will be produced annually as the time since last fire (TSLF) GIS layer is updated with all new fire perimeters after the end of each fire season. Additionally, when new pre-Euro American fire regime information is obtained that results in updated R_{max} values for specific vegetation types these will be incorporated into the annual FRID calculation.

At five year intervals more detailed analyses of trends in restoring and maintaining fire regimes in the Park's will also be performed. These will compare current trends in area burned to: 1) pre-Euro American trends in area burned annually and 2) change in trends over the last five years or some other time interval (see Caprio and Graber (1999) for details of analyses). Output would be either change in annual area burned or change in area within FRID category over the specified time interval.

Data Analysis

The parks' staff have developed an analysis called Fire Return Interval Departure (FRID) that compares pre-settlement fire regimes to recent regimes (a detailed discussion of the FRID analysis is provided in Chapter 4 of the Fire and Fuels Management Plan). Historic data used in this approach are estimates of fire return intervals (FRI) or maximum average fire return intervals. The FRI input is for a specific interval of time prior to Euro American settlement (1700 to 1860), the period prior to changes in vegetation structure/composition and fuels from grazing, changing ignition sources, and active fire suppression. The output provides maps that rank and highlight areas where fire return intervals have diverged the most from Euro American settlement conditions (Caprio et al. 1997; Keifer et al. 2000). The highlighted areas are those locations that have missed the greatest number of projected fire events, and thus are assumed to have the greatest ecological need for fire restoration.

Additional uses of this information are also possible. FRID output can be categorized to highlight locations that have undergone one or more restoration burns and are in need of an additional burn (either restoration of maintenance) due to the elapsed time since the last burn (Keifer et al. 1999). The current fire regime data and FRID analysis have also been used to evaluate the success of the fire management program over the last 30 years (Caprio and Graber 2000). Projections of the historic level of fire occurrence (area burned within each vegetation type) can be estimated from mean FRI. These values can then be compared against actual program achievements to provide feedback to the management program. This feedback can include whether the area burned annually needs to be increased or decreased, or whether different vegetation types need to be emphasized or de-emphasized when carrying out restoration or maintenance burns in locations where the natural role of fire must be restrained.

The season in which each fire burns will also be tracked to determine whether the seasonal aspect of fire regime is maintained in each vegetation type (Table 5).

Information Management

All field collections used to derive fire regime information are archived in the parks or at an approved location. They are primarily composed of partial cross-sections removed from logs, snags, or trees. Collections are currently housed in the Sycamore Lab Shed. All samples are labeled and cataloged in a database located on the fire history computer (office of the Fire

Ecologist/Fire Research Coordinator) and backed up offsite. As a potential source of future reference information about fire in park ecosystems, these collections will have long-term value. Eventually, field evidence about past fire regimes will disappear, both because wood decomposes and through the impact of fire.

Specific sample site data and individual sample tree (sample catalog) data are maintained in database format ("**FH_GRP.DBF" and "**FHTREE.DBF" respectively where the '**' refers to a specific area, for example the East Fork of the Kaweah River is 'MK'). Associated site data (elevation, aspect, vegetation composition, fuel load) in the sample tree databases are periodically summarized ("ALL_SEKI_FH_SITES_VEGSUM") and available as either a database file (".DBF") or Arcview shapefile (".SHP") and an Arcview project ("FIREHIST_VEG_SUM.APR"). Hard copies of all field forms are also maintained in Room 4 of the old Fire Dorm.

Quality Control

An important component of the utilization of pre-Euro American fire regime information or fire history reconstructions is an evaluation of the quality of the information going into the estimates. This is especially important because the information has been derived from many sources and from a variety of locations. Some of these locations are at some distance outside the park, which may affect the applicability to park locations.

Caprio and Lineback (1997) reviewed and evaluated the current quality of fire regime information utilized in the parks' current fire regime monitoring methods using FRID. This ranking was based on a variety of criteria and essentially provided an estimate of confidence in the fire regime target condition values (see Table 4). Ranks varied from estimated (vegetation types where FRI values were estimated) to good. However, all estimates had at least some problems. For example, although many sites have reconstructed fire histories in a particular vegetation type, these sites may be limited to only a single aspect (for example, only south-facing slopes), which may limit their applicability across the whole landscape.

Responsible Party

The Fire Ecologist/Fire Research Coordinator is responsible for providing the most current baseline information used to compare with park fire regime maintenance efforts. The Fire GIS Technician is responsible for annually updating the appropriate GIS layers, in coordination with the Fire Management Office (FMO), and performing the analyses.

Funding

Current efforts to monitor FRI and season of fire occur using FIREPRO funded permanent staff and seasonal staff as requested.

Management Implications of Monitoring Results

Recent utilization of fire regime information has had several significant positive effects on the fire management program within the parks. Application of our current knowledge about FRI in specific vegetation types has provided target intervals of when subsequent burns need to be planned. The FRID analysis has resulted in significant changes in burn planning procedures by providing insight into areas that are most in need of having fire restored and in highlighting areas that have been burned previously but which need a second maintenance burn. Additionally, the information has provided an overall evaluation of how well the prescribed fire program is achieving objectives relative to process goals (see Caprio and Graber 2000). Lastly, as the quality and extent of our knowledge about past fire regimes improves, the value of this information to the fire management program will increase.

CULTURAL RESOURCES

All NPS units that implement use of wildland fire and prescribed fire activities must develop short-term and long-term monitoring programs to assess accomplishments and to determine the effects of the associated management activities on park resources, including cultural resources.

As such, monitoring by way of "post-fire" inventories (ground surveys) of burned-over areas is a critical component of the parks' Fire Management Program. Key direction in designing and applying post-fire inventories is to be found in DO-18 (Fire Management) and DO-28 (Cultural Resource Management).

Monitoring Goal: Cultural resources monitoring provides information needed to determine the effects of fire management activities on cultural resources and to determine the effectiveness of site protection methods. Where feasible, increasing inventories of previously inaccessible areas is an additional goal.

Monitoring Objectives

1. Collect data sufficient to identify the effectiveness of pre-fire cultural resource surveys.

2. Undertake inventories of lands previously inaccessible due to dense brush and vegetation cover.

3. Record new survey results so as to increase the parks' inventory database, thus providing more comprehensive management and research information.

4. Use inventory results to promote compliance with Section 110 of the National Historic Preservation Act (i.e., direction to inventory all federal lands for the presence/absence of cultural resources and to nominate to the National Register of Historic Places all properties that appear to qualify for listing).

Sampling Design

Cultural Resource Specialists will use their discretion and professional judgment, in consultation with the Fire Management Officer, to select specific acreage and methods for conducting post-fire inventories. Of consideration will be the particular features of the burned area or unit in question and the management benefit to cultural resources. In general, stratified, random surveys will be employed to maximize field efforts, with a goal of examining a minimum of 20 percent of pre-fire vegetated areas. Post-fire inventories may be designed to address any combination of the following focuses:

1. Previously inventoried acreage within a prescribed fire unit or wildland fire area as a cross-reference on the efficacy of the pre-fire methods and results.

2. Previously un-inventoried acreage within a prescribed fire unit or wildland fire area.

3. Sampling within identifiable vegetation zones or biotic communities to expand basic knowledge on site patterning and modeling.

4. Selective inventory of areas or features suspected to contain cultural resources but for which little or no data are available.

Field Measurements

Standard levels of recordation will be made for all post-fire inventories, including acres surveyed, survey intensity, and estimates of ground-surface visibility. Site forms (including maps, photographs, and illustrations) will be prepared for each newly recorded site/structure/feature. Isolated Find forms will be completed as appropriate. Updates to previously recorded sites will be completed as justified, with an emphasis on identifying newly exposed surface artifacts or features, expanded site dimensions, any apparent fire effects, and the like.

Timing of Monitoring

Post-fire survey should be undertaken within 60 days of the fire episode. Scheduling should consider the season (e.g., are rains imminent?), with an emphasis on targeting periods when ground visibility is maximized (e.g., before vegetation re-growth obscures ground surface visibility, or, after the first post-fire rain or wind episode sufficient to expose mineral soils).

Monitoring Site Location/Relocation

Cultural Resources Specialists, in consultation with the Fire Management Officer, will identify the location and limits of post-fire surveys. Knowledge of site patterning will be weighed against the effectiveness of the fire episode in exposing ground surfaces. Slopes in excess of 30 percent will generally not be included in the sample, unless specific conditions argue for their inclusion (e.g., caves and rock shelters exposed by the fire). Such areas excluded from examination will not be used in calculating a 20 percent sample universe. Monitoring site locations will be plotted on field maps as part of the pre-field planning. GIS, GPS, and UTM data will be compared to assure the accurate placement of the monitoring sites and to assure that the selected sites are visited in the field.

Data Analysis

Post-fire data stand to enhance the parks' ability to better predict the potential impacts of a fire episode, whether during the planning stages of future prescribed fires or in response to a wildland fire. A report of results will be prepared for each post-fire cultural resource inventory. Minimally, such reports will be shared with the State Historic Preservation Officer, the Park Superintendent, and the Fire Management Officer.

Data Sheet Example

Results will be recorded on standard site forms, including Primary Records, Isolated Find forms, and attachments, as needed (DPR 523; State Historic Preservation Office 1990).

Information Management

Reporting requirements for cultural resource inventory projects can be found in NPS-28. Further, key confidentiality rules apply to archeological and ethnographic resource information as identified in DO-28.

Quality Control

Field personnel and principal investigators will meet the qualification standards found in Appendix E of NPS-28.

Responsible Party

The parks' Cultural Resources Specialist is responsible for coordinating the design, implementation, and reporting of any post-fire inventory project. This individual will work closely with the parks' Fire Management Officer in meeting this requirement.

Funding

All expenditures (personnel, aircraft, equipment and supplies) for monitoring fire effects or the effectiveness of pre-fire protection treatments on cultural resources that are not covered by existing base accounts will be charged to the appropriate fire account. All expenditures will be tracked and reported according to the standards established in the Department of the Interior Individual Fire Occurrence Form (DOI-1202). All fires will have an appropriate fire management accounting code (suppression, prescribed or fire use). Funding for post-fire inventories in previously unsurveyed areas will be sought on an annual basis from a number of sources.

Management Implications of Monitoring Results

Data recovered from the result of post-fire inventories stand to better inform future decisions when planning for prescribed fires or when responding to wildland fires. Increasing the intensity or focus of future inventories may result. Conversely, post-fire inventory data may prove useful in identifying areas or situations where the intensity or focus of cultural resource investigations can be lessened. Monitoring results should serve to increase the parks' effectiveness in meeting its responsibilities for the management of significant cultural resources.

FIRE MONITORING PROGRAM INTEGRATION

The above components of Sequoia and Kings Canyon National Parks' fire monitoring program were developed at different times in response to evolving fire management information needs. In addition, levels of funding for monitoring have varied throughout the program's history. As a result of differences in timing and levels of effort, the components are not as well integrated as they could be and vary in their scale of applicability.

The monitoring program began with environmental and fire conditions, and vegetation and fuels. These components provide information to guide fire management strategies and to assess project and stand-level objectives. Later, the parks' program took a step forward in the direction of large-scale restoration by embarking upon a project to test the feasibility of landscape-scale prescribed fire through treatment of an entire watershed within a relatively short period of time. With potential new issues arising from this larger-scale approach, the wildlife and water components were designed specifically to provide additional information for this watershed project.

While some of these monitoring efforts were focused in the East Fork Kaweah watershed, similar monitoring may be needed in other watersheds to determine whether results are more widely applicable throughout the parks. If this expansion occurs, the monitoring sites should be co-located with existing monitoring sites wherever possible to take advantage of the information provided by ongoing monitoring. Co-locating future monitoring with existing sites will provide more comprehensive information for those sites and result in a more integrated monitoring program.

In addition to a spatial expansion of the program, after several decades of an active prescribed fire program, restoration objectives were achieved in some areas and the need to define new, longer-term objectives arose. These objectives relating to maintaining the natural fire regime are applied both in areas where restoration is achieved and also areas that had not been greatly altered by fire exclusion. These new objectives focus on maintaining aspects of the fire regime that will perpetuate natural ecosystem processes, which in turn will influence future ecosystem component structure (e.g. fuel quantity and arrangement, wildlife habitat, vegetation composition, etc.). Refining the maintenance objectives and developing good measures for these objectives is the focus of the next phase of the fire monitoring program.

Since the development of the parks' fire monitoring program, the National Park Service has initiated a nationwide program to inventory and monitor natural resources (known as the Inventory and Monitoring, or I&M, Program) in parks grouped into 'networks' by eco-regions. Sequoia and Kings Canyon National Parks, is part of the Sierra Nevada Network, along with Yosemite National Park and Devils Postpile National Monument. The Sierra Nevada Network (SNN) has received I &M funding, has implemented inventory projects, and planning is underway for the development of an extensive, long-term monitoring program.

Key to the success of the fire monitoring program is continuing to maintain close ties with the SNN I&M program and with the research community. Results from the I&M program, as well as results from research conducted by the USGS Biological Resources Division, will provide additional useful information. This information, may offer excellent comparative capabilities, especially in areas where naturally-ignited and suppression fires occur, as well as areas where fire has been excluded for unusually long periods, making inferences from the monitoring results more powerful.

To ensure useful comparative analyses are possible, integration with the existing fire monitoring program is critical during the planning and implementation stages of the I&M program to ensure that the necessary information is collected in a useful and compatible way. The parks' fire monitoring program staff has been involved in scoping sessions to determine which of the parks' natural resource elements are most in need of long-term monitoring. Continued collaboration between the I&M and fire monitoring programs will help insure the most efficient use of both programs' funds and efforts, and provide for a more comprehensive and integrated long-term program to monitor the status of the parks' resources.

The various monitoring program staff should work together to take advantage of shared efforts where possible, reduce redundancy, and focus efforts on the highest priorities to provide the parks with the most efficient natural resource monitoring program. Continually identifying new information needs is essential to making sure that the parks are meeting fire-related resource goals as the fire management program evolves. Also, in response to new management objectives, the appropriate monitoring techniques must be developed and implemented.

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REVIEWERS

This plan was prepared by MaryBeth Keifer, Tony Caprio, Harold Werner, Corky Conover, and Tom Burge. The monitoring plan will be reviewed on an annual basis and revised if necessary.

This plan was reviewed by:

Bill Kaage, Fire Management Officer, Sequoia and Kings Canyon National Parks	Date
John Austin, Acting Chief, Division of Natural Resources, Sequoia and Kings Canyon National Parks	Date
Jeff Manley, Natural Resource Management Specialist, Sequoia and Kings Canyon National Parks	Date
Dave Graber, Science Advisor, Sequoia and Kings Canyon National Parks	Date
Paul Reeberg, Fire Effects Program Manager, NPS Pacific West Regional Office	Date
Robin Wills, Fire Ecologist, NPS Pacific West Regional Office	Date

ATTACHMENTS

Attachment 1 – Monitoring forms available.

Monitoring Program Component	Forms	Location of Forms
Environmental and fire conditions	Weather observation Fire behavior observation Smoke observation Fuel moisture summary Monitoring report outline Wildland fire observation summary	FMH, Appendix A (NPS 2001)
Vegetation and fuels	Park Monitoring Type Descriptions (FMH-4) modified FMH data sheets Field Data Checklist Quality Check Log	FMH, Appendix A (NPS 2001) SEKI LAN, j:\data\plants\fire_effects\vegetation_fuels_fmh\products\forms
Additional fuels information for modeling	Fuel data Stand data	SEKI LAN, j:\data\fire\fuels\gis
Wildlife	Plot data Serendipity data	SEKI LAN, j:\data\animals\vertebrates\wildlife_fire_effects\products

Attachment 2. Vegetation and Fuels Monitoring Type Descriptions

FMH-4 Monitoring Type Protocols FMH Data - SEKI Page: 0001

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---------------------------------Description----------------------------------

Monitoring Type Code: FABCO1T08 Date Described: 06/15/00

Monitoring Type Name: White Fir-Mixed Conifer Forest

Preparer: M. Keifer, G. Dempsey

FGDC Association:

FMH-4 Version Title/Description: White fir-mixed conifer forest

Visits Assigned: 00 PR01, 00 PRE, 00 yr02, 00 yr04, 00 yr05, 00 yr10, 01 Post, 01 yr01, 01 yr02, 01 yr05, 01 yr10, 02 Burn, 02 Post, 02 yr01, 02 yr02, 02 yr05

Burn Prescription

Date of Burn (mo-mo)......08-01,11-30 Aspect (deg.).............000-000

Wind Direction (deg.)..... Spread Direction (B/H/F)..H

Fuel (tns/ac)...........20.0-80.0 Herb Moisture (%).......0-0

Live Woody (tns/ac).....0.0-0.0 Midflame Wind (mph).....0.0-10.0

Herbs (tns/ac)..........0.0-0.0 Rate of Spread (ch/hr)..0.0-8.0

Air Temp. (F)...........40-85 Heat per Area (btu/ftý).165.0-225.0

Rel. Humidity (%).......20-60 Fireline Intns (btu/ftý)1.0-35.0

1-hr TLFM (%)...........3-10 Slope (%)..............0-60

10-hr TLFM (%)..........11 Flame Length (ft).......0.0-2.5

100-hr TLFM (%).........12 Flame Zone Depth (ft)...0.0-0.0

1000-hr TLFM (%)........20 Scorch Height (m).......0.0-30.0

Woody Moisture (%)......0-0 Char Height (m).........0.0-0.0

Additional Prescription Information: Tons per acre were estimated.

Management Objectives: Reduce the total fuel load by 60-95% immediately postburn.

Monitoring Objectives: Measure the mean total fuel load with a sample size which will allow us to be 80% confident that our results are within 25% of the true population mean.

Objective Variables: Total fuel load (tons/acre); white fir overstory density

Physical Description: Predominately north and west aspects, though others may apply. Slopes range from 20-60% and are generally mid to upper slope.

Elevation ranges from 4,100 - 7,200 feet. Soil depth ranges from shallow to

very deep. Soils are generally rather coarse textured and acidic.

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Biological Description: Of the total number of white firs (Abies concolor)present, roughly 25% or greater are mature overstory trees (>40cm at DBH). Sugar pine (Pinus lambertiana) and incense cedar (Calocedrus decurrens) will occur in varying amounts. At the higher elevations, associates may also include Jeffrey pine (Pinus jeffreyi) along w/ red fir (Abies magnifica).

Overstory maturity rating is in the medium to high categories. Understory is usually comprised of incense cedar and white fir. There is a distinct absence of oaks of all species, and ponderosa pines (P. ponderosa) are rarely seen within the general vicinity. Total number of live trees within the 20m by 50m area will most likely range between 20 and 100 trees. Numerous trees fall into the intermediate and suppressed categories. The forest floor is typically sparse, with few herbs. Shrubs such as chinquapin (Chrysolepis sempervirens), hazelnut (Corylus cornuta), or Ribes sp. contribute <20% cover.

Rejection Criteria: Exclude riparian zones, anomalous vegetation patches, monitoring type boundaries, large rock outcroppings or barren areas (>20% of the plot), or areas within 20 meters of physical barriers such as roads or within 5 meters from any trail. Exclude areas where >25% of the overstory trees have been severely damaged by insects such as tussock moths.

Notes (This Entire Monitoring Type): See the notes listed under the FSEGI monitoring type for critical information.

-------------------------------General Protocols--------------------------------

Comments (Deviations, Problems, Omissions), this Version Only: (No information provided)

Preburn Control Plots..............No Herb. Height...............Yes

Herbaceous Density.........No Abbreviated Tags...........Yes

0P/Origin Buried...........No Herbaceous Fuel Load.......No

Voucher Specimens..........Yes Brush Fuel Load............No

Count Dead Branches of Living Plants as Dead.................No

Width "Observed" Transect..10.0m

Herb Transects Sampled.....Q4-Q1 Q3-Q2

Shrub Transects Sampled....Q4-Q1 Q3-Q2

Length One Shrub Transect..50m Width One Shrub Transect...2.0m

Total Shrub Area...........200.0m2

Stakes Installed At........All 17

Burn and Duff Moisture..............Yes Flame Zone Depth...........No

Postburn 100 Points Burn Severity...No Herbaceous Fuel Load.......No

Herb. (FMH-15/17/21).......Yes

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-----------------------------Forest Plot Protocols------------------------------

Overstory Live Tree Damage...........Yes Live Crown Position.........Yes

Dead Tree Damage...........No Dead Crown Position.........Yes

Record DBH Year 1..........Yes

Total Length Sample Area...100.0m Total Width Sample Area.....10.0m

Total Sample Area..........1000.00m2

Quarters Sampled...........1 2 3 4

Minimum allowed DBH........0.1cm Maximum allowed DBH.........999.9cm

Pole-size Live Height................Yes Poles Tagged................Yes

Dead Height................Yes Record DBH Year 1...........Yes

Total Length Sample Area...25.0m Total Width Sample Area.....10.0m

Total Sample Area..........250.00m2

Quarters Sampled...........1

Minimum allowed DBH........2.5cm Maximum allowed DBH.........15.0cm

Seedling Live Height................Yes Seedlings Mapped............Yes

Dead Height................Yes Dead Seedlings..............Yes

Total Length Sample Area...10.0m Total Width Sample Area.....5.0m

Total Sample Area..........50.00m2

Subsample of Quarter.......1

Fuel Load Number of Sampling Planes..4 1 HR Plane Length...........6ft

10 HR Plane Length.........6ft 100 HR Plane Length.........12ft

1000 HR Sound Plane Length.50ft 1000 HR Rotten Plane Length.50ft

Calculate Dominance........Yes

Postburn Overstory Char Height......Yes

Pole-sized Postburn AssessmYes   Pole-sized Char Height......Yes

Severity Transects Sampled.Fuel

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---------------------------------Description----------------------------------

Monitoring Type Code: FABMA1T08 Date Described: 06/15/00

Monitoring Type Name: Red Fir Forest

Preparer: Keifer/Dempsey

FGDC Association:

FMH-4 Version Title/Description: Red fir forest

Visits Assigned: 00 PRE, 00 yr01, 00 yr02, 00 yr05, 01 Post, 01 yr01, 01 yr02,

01 yr05

Burn Prescription

Date of Burn (mo-mo)......08-01,11-30 Aspect (deg.).............0-90

Wind Direction (deg.)..... Spread Direction (B/H/F)..H

Fuel (tns/ac)...........10.0-60.0 Herb Moisture (%).......0-0

Live Woody (tns/ac).....0.0-0.0 Midflame Wind (mph).....0.0-10.0

Herbs (tns/ac)..........0.0-0.0 Rate of Spread (ch/hr)..0.0-8.0

Air Temp. (F)...........40-85 Heat per Area (btu/ftý).165.0-225.0

Rel. Humidity (%).......20-60 Fireline Intns (btu/ftý)1.0-35.0

1-hr TLFM (%)...........3-10 Slope (%)...............0-60

10-hr TLFM (%)..........11 Flame Length (ft).......0.0-2.5

100-hr TLFM (%).........12 Flame Zone Depth (ft)...0.0-0.0

1000-hr TLFM (%)........20 Scorch Height (m).......0.0-30.0

Woody Moisture (%)......0-0 Char Height (m).........0.0-0.0

Additional Prescription Information: (No information provided)

Management Objectives: Reduce the total fuel load by 60-95% immediately postburn.

Monitoring Objectives: Measure the mean total fuel load with a sample size which will allow us to be 80% confident that our results are within 25% of the true population mean.

Objective Variables: Total fuel load (tons/acre); red fir overstory density.

Physical Description: Aspect is most commonly east and north slopes for pure stands of red fir. Slope varies from 0-60% and elevation ranges from 7,000 -

9,500 ft. Soils are often deep sandy loams associated with unglaciated areas, as well as shallower soils.

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Biological Description: Overstory consists primarily of red fir (Abies magnifica), (>40% of the total of all trees present). At its lower limit, red fir is mixed with Jeffrey and sugar pine (Pinus jeffreyi and P. lambertiana) and incense cedar (Calocedrus decurrens). White fir (Abies concolor) individuals may also be present. Where white firs are more common, at least 80% of this species will be <40 cm at DBH, thus leaving the dominance of the stand to the red fir. Western white pine (Pinus monticola), lodgepole pine (Pinus contorta), montane brush and meadows are associated with red fir at its upper limit.

Common understory vegetation includes manzanita (Arctostaphylos spp.), buckbrush

(Ceanothus spp.), gooseberry (Ribes spp.) and chinquapin (Chrysolepsis sempervirens), however, keep in mind that the forest floor is generally much more open than in the lower elevation mixed conifer forests. Few herbaceous plants are present, especially at higher elevations.

Rejection Criteria: Exclude riparian zones, anomalous vegetation patches, monitoring type boundaries, large rock outcroppings or barren areas (>20% of the plot), or areas within 20 meters of physical barriers such as roads or within 5 meters from any trail.

Notes (This Entire Monitoring Type): Read all notes under the FSEGI monitoring

type. (No old style plots apply for the FABMA monitoring type, however.)

-------------------------------General Protocols--------------------------------

Comments (Deviations, Problems, Omissions), this Version Only: See all notes under the FSEGI monitoring type.

Preburn Control Plots.............Yes Herb. Height..............Yes

Herbaceous Density.........No Abbreviated Tags...........Yes

0P/Origin Buried...........No Herbaceous Fuel Load.......No

Voucher Specimens..........Yes Brush Fuel Load............No
Count Dead Branches of Living Plants as Dead.................No

Width "Observed" Transect..10.0m

Herb Transects Sampled.....Q4-Q1 Q3-Q2

Shrub Transects Sampled....Q4-Q1 Q3-Q2

Length One Shrub Transect..50m Width One Shrub Transect...1.0m

Total Shrub Area..........100.0m2

Stakes Installed At........17

Burn and Duff Moisture.............Yes Flame Zone Depth...........No

Postburn 100 Points Burn Severity...No Herbaceous Fuel Load.......No

Herb. (FMH-15/17/21).......Yes

FMH-4 Monitoring Type Protocols FMH Data - SEKI Page: 0003

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-----------------------------Forest Plot Protocols-----------------------------

Overstory Live Tree Damage...........Yes Live Crown Position.........Yes

Dead Tree Damage...........Yes Dead Crown Position.........Yes

Record DBH Year 1..........Yes

Total Length Sample Area...50.0m Total Width Sample Area.....20.0m

Total Sample Area..........1000.00m2

Quarters Sampled...........1 2 3 4

Minimum allowed DBH........0.0cm Maximum allowed DBH.........999.9cm

Pole-size Live Height................No Poles Tagged................No

Dead Height................No Record DBH Year 1...........Yes

Total Length Sample Area...0.0m Total Width Sample Area.....0.0m

Total Sample Area..........0.00m2

Quarters Sampled...........1

Minimum allowed DBH........0.0cm Maximum allowed DBH.........0.0cm

Seedling Live Height................Yes Seedlings Mapped............Yes

Dead Height................Yes Dead Seedlings.............Yes

Total Length Sample Area...25.0m Total Width Sample Area.....10.0m

Total Sample Area..........250.00m2

Quarters Sampled...........1

Fuel Load Number of Sampling Planes..4 1 HR Plane Length...........6ft

10 HR Plane Length.........6ft 100 HR Plane Length.........12ft

1000 HR Sound Plane Length.50ft 1000 HR Rotten Plane Length.50ft

Calculate Dominance........Yes

Postburn Overstory Char Height......Yes

Pole-sized Postburn AssessmNo   Pole-sized Char Height......No

Severity Transects Sampled.Fuel

FMH-4 Monitoring Type Protocols FMH Data - SEKI Page: 0001

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---------------------------------Description----------------------------------

Monitoring Type Code: BADFA1D04 Date Described: 08/17/00

Monitoring Type Name: Chamise Chaparral

Preparer: Keifer/Dempsey

FGDC Association:

FMH-4 Version Title/Description: Chamise chaparral

Visits Assigned: 00 PRE, 01 Post, 01 yr01, 01 yr02

Burn Prescription

Date of Burn (mo-mo)......09-01,02-15 Aspect (deg.)............140-270

Wind Direction (deg.)..... Spread Direction (B/H/F)..H

Fuel (tns/ac)...........0.0-0.0 Herb Moisture (%).......50-150

Live Woody (tns/ac).....0.0-0.0 Midflame Wind (mph).....0.0-8.0

Herbs (tns/ac)..........0.0-0.0 Rate of Spread (ch/hr)..2.0-120.0

Air Temp. (F)...........33-85 Heat per Area (btu/ftý).1570.0-2910.0

Rel. Humidity (%).......20-60 Fireline Intns (btu/ftý)50.0-6330.0

1-hr TLFM (%)...........5-9 Slope (%)..............0-60

10-hr TLFM (%)..........10 Flame Length (ft).......3.0-25.0

100-hr TLFM (%).........11 Flame Zone Depth (ft)...0.0-0.0

1000-hr TLFM (%)........0 Scorch Height (m).......0.0-0.0

Woody Moisture (%)......0-0 Char Height (m).........0.0-0.0

Additional Prescription Information: (No information provided)

Management Objectives: Currently there are no specific objectives for this monitoring type. Generally speaking, the goal is to reduce hazardous amounts of fuel by lessening the % of cover of chaparral brush species while reintroducing fire to its natural role in the community.

Monitoring Objectives: % Cover of Brush.

Objective Variables: Measure the % cover of brush species with a sample size which will allow us to be 80% confident that our results are within 25% of the true population mean.

Physical Description: Generally found below 4,000 feet in elevation, on south and west facing slopes. Little soil is present on the dry, rocky, often steep slopes. May be interspersed with mixed chaparral and oak woodland forest.

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Biological Description: Chaparral dominated by chamise (Adenostoma fasciculatum) 1-3m in height. Associated species contribute very little to cover. Mature stands are quite homogenous and are densely interwoven thus allowing very little opportunity for herbaceous plants to become established.

Rejection Criteria: Exclude riparian zones, anomalous vegetation patches, monitoring type boundaries, large rock outcroppings or barren areas (>20% of the plot), or areas within 20 meters of physical barriers such as roads or within 5 meters from any trail. Exclude areas >1/4 km from the roadway due to safety concerns and slopes over 60%.

Notes (This Entire Monitoring Type): (No information provided)

-------------------------------General Protocols--------------------------------

Comments (Deviations, Problems, Omissions), this Version Only: (No information

provided)

Preburn Control Plots.............No Herb. Height..............Yes

Herbaceous Density.........No Abbreviated Tags...........Yes

0P/Origin Buried...........No Herbaceous Fuel Load.......No

Voucher Specimens..........Yes Brush Fuel Load............No

Count Dead Branches of Living Plants as Dead.................No

Width "Observed" Transect..0.0m

Herb Transects Sampled.....0P-30P

Length One Shrub Transect..30m Width One Shrub Transect...2.0m

Total Shrub Area...........60.0m2

Stakes Installed At........2

Burn and Duff Moisture..............No Flame Zone Depth...........No

Postburn 100 Points Burn Severity...Yes Herbaceous Fuel Load.......No

Herb. (FMH-15/17/21).......Yes

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---------------------------------Description----------------------------------

Monitoring Type Code: BARME1D04 Date Described: 08/17/00

Monitoring Type Name: Mixed Chaparral

Preparer: Keifer, Dempsey

FGDC Association:

FMH-4 Version Title/Description: Mixed chaparral

Visits Assigned: 00 PR01, 00 PRE, 01 Post, 01 yr01, 01 yr02, 01 yr05

Burn Prescription

Date of Burn (mo-mo)......09-01,02-15 Aspect (deg.)............

Wind Direction (deg.)..... Spread Direction (B/H/F)..H

Fuel (tns/ac)...........0.0-0.0 Herb Moisture (%).......50-150

Live Woody (tns/ac).....0.0-0.0 Midflame Wind (mph).....0.0-8.0

Herbs (tns/ac)..........0.0-0.0 Rate of Spread (ch/hr)..2.0-120.0

Air Temp. (F)...........33-85 Heat per Area (btu/ftý).1570.0-2910.0

Rel. Humidity (%).......20-60 Fireline Intns (btu/ftý)50.0-6330.0

1-hr TLFM (%)...........5-9 Slope (%)..............0-60

10-hr TLFM (%)..........10 Flame Length (ft).......3.0-25.0

100-hr TLFM (%).........11 Flame Zone Depth (ft)...0.0-0.0

1000-hr TLFM (%)........0 Scorch Height (m).......0.0-0.0

Woody Moisture (%)......0-0 Char Height (m).........0.0-0.0

Additional Prescription Information: (No information provided)

Management Objectives: No objective has been identified at this time. Our current goal is to reduce brush cover by restoring fire.

Monitoring Objectives: Measure the % cover of brush species with a sample size which will allow us to be 80% confident that our results are within 25% of the true population mean.

Objective Variables: % cover of brush species

Physical Description: Found below 5,000 feet on dry, rocky slopes with little soil. Slopes range from 0-60% and may be fund within a variety of aspects.

Substrate is commonly rocky and dry.

Biological Description: Drought tolerant, sclerophyllous shrubs, 2-4m in height form dense, often impenetrable walls of vegetation which are dominated by mountain whitethorn (Ceanothus cuneatus), Fremontia (Fremontodendron californicum), manzanita (Arctostaphylos kelloggii) and mountain mahogany (Cercocarpus betuloides). Other understory brush associates may include varying amounts of buckeye (Aesculus californica), coffeeberry (Rhamnus spp.) and poisonoak (Toxicodendron diversilobum). Herbaceous plants (Bromus spp., Avena spp.,Vulpia spp., Cryptantha spp., Phacelia spp., Claytonia spp., and Galium spp.)can be uncommon, with diversity increasing during the first few years following fire. Where herbaceous cover is sparse, a layer of leaf litter may have accumulated.

Rejection Criteria: Exclude riparian zones, anomalous vegetation patches, monitoring type boundaries, large rock outcroppings or barren areas (>20% of the plot), or areas within 20m of physical barriers such as roads or w/in 5 m from

any trail. Exclude areas >1/4 km from the road, due to safety concerns as well

as slopes over 60%.

Notes (This Entire Monitoring Type): Notes: % cover is picked up from the OP-30P line. It has been determined that density of individual brush species will not be sampled as it does not relate to any current objectives and poses sampling difficulties. Additional plants are examined (and recorded) in a 5m wide belt along either side of the OP-30P line.

Small tree like shrubs (examples: manzanita, buckbrush, Quercus kelloggii and

Fremontia) are found within some of these plots. Because they are growing more

like shrubs than trees, we are recording their height to the nearest decimeter

even if they go past 2.0 meters.

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------------------------------General Protocols-------------------------------

Comments (Deviations, Problems, Omissions), this Version Only: (No information provided)

Preburn Control Plots..............No Herb. Height...............Yes

Herbaceous Density.........No Abbreviated Tags...........Yes

0P/Origin Buried...........No Herbaceous Fuel Load.......No

Voucher Specimens..........Yes Brush Fuel Load............No

Count Dead Branches of Living Plants as Dead.................No

Width "Observed" Transect..0.0m

Herb Transects Sampled.....0P-30P

Length One Shrub Transect..30m Width One Shrub Transect...1.0m

Total Shrub Area...........30.0m2

Stakes Installed At........2

Burn and Duff Moisture..............No Flame Zone Depth...........No

Postburn 100 Points Burn Severity...No Herbaceous Fuel Load.......No

Herb. (FMH-15/17/21).......No

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---------------------------------Description----------------------------------

Monitoring Type Code: FCADE1T09 Date Described: 06/15/00

Monitoring Type Name: Low Elevation-Mixed Conifer

Preparer: Keifer and Dempsey

FGDC Association:

FMH-4 Version Title/Description: Low elevation-mixed conifer forest

Visits Assigned: 00 PR01, 00 PR02, 00 PRE, 00 yr02, 01 Post, 01 yr01, 01 yr02, 01 yr05, 01 yr10

Burn Prescription

Date of Burn (mo-mo)......07-15,11-30 Aspect (deg.)............180-270

Wind Direction (deg.)..... Spread Direction (B/H/F)..H

Fuel (tns/ac)...........10.0-60.0 Herb Moisture (%).......0-0

Live Woody (tns/ac).....0.0-0.0 Midflame Wind (mph).....0.0-8.0

Herbs (tns/ac)..........0.0-0.0 Rate of Spread (ch/hr)..1.0-18.0

Air Temp. (F)...........40-85 Heat per Area (btu/ftý).320.0-390.0

Rel. Humidity (%).......20-60 Fireline Intns (btu/ftý)4.0-120.0

1-hr TLFM (%)...........5-7 Slope (%)..............0-45

10-hr TLFM (%)..........8 Flame Length (ft).......1.0-4.0

100-hr TLFM (%).........9 Flame Zone Depth (ft)...0.0-0.0

1000-hr TLFM (%)........20 Scorch Height (m).......0.0-30.0

Woody Moisture (%)......0-0 Char Height (m).........0.0-0.0

Additional Prescription Information: (No information provided)

Management Objectives: Reduce the total fuel load by 60-95% immediately postburn.

Monitoring Objectives: Measure the mean total fuel load with a sample size which

will allow us to be 80% confident that our results are within 25% of the true population mean.

Objective Variables: Total fuel load (tons/acre); incense cedar overstory density

Physical Description: Aspect is south or west but can vary widely. Slopes range from 0-60%, and are mid to lower slope. Elevation begins at 4,500 ft and extends to 6,000 ft. Soils are often but now always thin, and barren rock outcrops are common.

Biological Description: Overstory consists of incense cedar (Calocedrus decurrens), often near 1/3 of the area, along with varying amounts of sugar pine Pinus lambertiana), black oak (Quercus kelloggii) and canyon live oak (Q. chrysolepsis). Ponderosa pine does not comprise more than 15% of the overstory, and Jeffrey pine individuals are rarely found in the general area. Mature white fir (>40 cm dbh) comprise less than 10% of the overstory. Overstory maturity rating is in the low to medium range, with many trees falling into the intermediate and suppressed categories. Understory is usually comprised of incense cedar, various oaks and white fir. Total number of live trees usually ranges between 60 and 200 per 20m by 50m area, making these forests typically more dense than those found within the FABCO monitoring type. Shrubs such as manzanita (Arctostaphylos spp.), buckbrush (Ceanothus spp.), gooseberry (Ribes spp.), Rubus spp., Prunus spp., or bear clover (Chamaebatia foliolosa) compose a larger portion of the understory than in higher elevation forests. Herbs are sparse to moderately common.

Rejection Criteria: Exclude riparian zones, anomalous vegetation patches, monitoring type boundaries, large rock outcroppings or barren areas (>20% of the plot), or areas within 20 meters of physical barriers such as roads or within 5 meters from any trail. Exclude areas where >25% of the overstory trees have been severely damaged by insects such as tussock moths.

Notes (This Entire Monitoring Type): Read all notes under the FSEGI monitoring type for all deviations from the FMH protocol.

-------------------------------General Protocols--------------------------------

Comments (Deviations, Problems, Omissions), this Version Only: (No information

provided)

Preburn Control Plots.............Yes Herb. Height...............Yes

Herbaceous Density.........No Abbreviated Tags...........Yes

0P/Origin Buried...........No Herbaceous Fuel Load.......No

Voucher Specimens..........Yes Brush Fuel Load............No

Count Dead Branches of Living Plants as Dead.................No

Width "Observed" Transect..10.0m

Herb Transects Sampled.....Q4-Q1 Q3-Q2

Shrub Transects Sampled....Q4-Q1 Q3-Q2

Length One Shrub Transect..50m Width One Shrub Transect...2.0m

Total Shrub Area..........200.0m2

Stakes Installed At........All 17

Burn and Duff Moisture.............Yes Flame Zone Depth...........No

Postburn 100 Points Burn Severity...No Herbaceous Fuel Load.......No

Herb. (FMH-15/17/21).......Yes

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-----------------------------Forest Plot Protocols------------------------------

Overstory Live Tree Damage...........Yes Live Crown Position.........Yes

Dead Tree Damage...........No Dead Crown Position.........Yes

Record DBH Year 1..........Yes

Total Length Sample Area...50.0m Total Width Sample Area.....20.0m

Total Sample Area..........1000.00m2

Quarters Sampled...........1 2 3 4

Minimum allowed DBH........0.0cm Maximum allowed DBH.........999.9cm

Pole-size Live Height................Yes Poles Tagged................Yes

Dead Height................Yes Record DBH Year 1...........Yes

Total Length Sample Area...25.0m Total Width Sample Area.....10.0m

Total Sample Area..........250.00m2

Quarters Sampled...........1

Minimum allowed DBH........2.5cm Maximum allowed DBH.........15.0cm

Seedling Live Height................Yes Seedlings Mapped............Yes

Dead Height................Yes Dead Seedlings..............Yes

Total Length Sample Area...10.0m Total Width Sample Area.....5.0m

Total Sample Area..........50.00m2

Subsample of Quarter.......1

Fuel Load Number of Sampling Planes..4 1 HR Plane Length...........6ft

10 HR Plane Length.........6ft 100 HR Plane Length.........12ft

1000 HR Sound Plane Length.50ft 1000 HR Rotten Plane Length.50ft

Calculate Dominance........Yes

Postburn Overstory Char Height......Yes

Pole-sized Postburn AssessmYes Pole-sized Char Height......Yes

Severity Transects Sampled.Fuel

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---------------------------------Description---------------------------------

Monitoring Type Code: FPIPO1T09 Date Described: 06/15/00

Monitoring Type Name: Ponderosa Dominated Forest

Preparer: Haggerty/Keifer/Dempsey

FGDC Association:

FMH-4 Version Title/Description: Ponderosa pine dominated forest

Visits Assigned: 00 PR01, 00 PRE, 00 yr01, 00 yr02, 00 yr04, 00 yr05, 00 yr10, 01 Post, 01 yr01, 01 yr02, 01 yr03, 01 yr05, 02 Post, 02 yr01, 02 yr02

Burn Prescription

Date of Burn (mo-mo)......07-15,11-30 Aspect (deg.).............0-0

Wind Direction (deg.)..... Spread Direction (B/H/F)..H

Fuel (tns/ac)...........0.0-0.0 Herb Moisture (%).......0-0

Live Woody (tns/ac).....0.0-0.0 Midflame Wind (mph).....0.0-8.0

Herbs (tns/ac)..........0.0-0.0 Rate of Spread (ch/hr)..1.0-18.0

Air Temp. (F)...........40-85 Heat per Area (btu/ftý).320.0-390.0

Rel. Humidity (%).......20-60 Fireline Intns (btu/ftý)4.0-120.0

1-hr TLFM (%)...........5-7 Slope (%)..............0-45

10-hr TLFM (%)..........8 Flame Length (ft).......1.0-4.0

100-hr TLFM (%).........9 Flame Zone Depth (ft)...0.0-0.0

1000-hr TLFM (%)........20 Scorch Height (m).......0.0-30.0

Woody Moisture (%)......0-0 Char Height (m).........0.0-0.0

Additional Prescription Information: (No information provided)

Management Objectives: Reduce the total fuel load by 60-95% immediately postburn.

Monitoring Objectives: Measure the mean total fuel load with a sample size which will allow us to be 80% confident that our results are within 25% of the true population mean.

Objective Variables: Total fuel load (tons/acre); incense cedar overstory density.

Physical Description: Aspect is south, west, or flat as in canyon bottoms.

Slopes range from 0-30%. Elevation begins at 4,500 with the lower and upper boundaries dependent on aspect. Soils are often but not always thin, and barren rock outcrops are common.

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Biological Description: Overstory consists of at least 15% ponderosa pine (Pinus ponderosa), but often ranges to nearly complete dominance of the plot area.

Incense cedar (Calocedrus decurrens), black oak (quercus kelloggii) and canyon live oak (Q. chrysolepis) are present in varying degrees. Overstory maturity rating is in the medium to high categories. Understory is usually comprised of incense cedar, black oak and canyon live oak. Shrubs such as Manzanita (Arctostphylos spp.), buckbrush (Ceanothus spp.), gooseberry (Ribes spp.), Rubus spp., Prunus spp., Eriogonum spp., or bear clover (Chamaebatia foliolosa) compose a larger portion of the understory than in higher elevation forests.

Herbs are sparse to moderately common.

Rejection Criteria: Exclude riparian zones, anomalous vegetation patches, monitoring type boundaries, large rock outcroppings or barren areas (>20% of the plot), or areas within 20 meters of physical barriers such as roads or within 5 meters from any trail. Exclude areas where >25% of the overstory trees have been severely damaged by insects such as tussock moths.

Notes (This Entire Monitoring Type): Monitoring Type Notes, CRITICAL!: Read all the notes under the FSEGI monitoring type.

------------------------------General Protocols--------------------------------

Comments (Deviations, Problems, Omissions), this Version Only: (No information

provided)

Preburn Control Plots.............Yes Herb. Height..............Yes

Herbaceous Density.........No Abbreviated Tags...........Yes

0P/Origin Buried...........No Herbaceous Fuel Load.......No

Voucher Specimens..........Yes Brush Fuel Load...........No

Count Dead Branches of Living Plants as Dead.................No

Width "Observed" Transect..10.0m

Herb Transects Sampled.....Q4-Q1 Q3-Q2

Shrub Transects Sampled....Q4-Q1 Q3-Q2

Length One Shrub Transect..50m   Width One Shrub Transect...1.0m

Total Shrub Area...........100.0m2

Stakes Installed At........17

Burn and Duff Moisture..............Yes   Flame Zone Depth...........No

Postburn 100 Points Burn Severity...No   Herbaceous Fuel Load.......No

Herb. (FMH-15/17/21).......Yes

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----------------------------Forest Plot Protocols-----------------------------

Overstory Live Tree Damage...........Yes Live Crown Position.........Yes

Dead Tree Damage...........No Dead Crown Position.........Yes

Record DBH Year 1..........Yes

Total Length Sample Area...50.0m Total Width Sample Area.....20.0m

Total Sample Area..........1000.00m2

Quarters Sampled...........1 2 3 4

Minimum allowed DBH........0.0cm Maximum allowed DBH.........999.9cm

Pole-size Live Height................Yes Poles Tagged................Yes

Dead Height................Yes Record DBH Year 1...........Yes

Total Length Sample Area...0.0m Total Width Sample Area.....0.0m

Total Sample Area..........0.00m2

Quarters Sampled...........1

Minimum allowed DBH........2.5cm Maximum allowed DBH.........15.0cm

Seedling Live Height................Yes Seedlings Mapped............Yes

Dead Height................Yes Dead Seedlings.............Yes

Total Length Sample Area...25.0m Total Width Sample Area.....10.0m

Total Sample Area..........250.00m2

Quarters Sampled...........1

Fuel Load Number of Sampling Planes..4 1 HR Plane Length...........6ft

10 HR Plane Length.........6ft 100 HR Plane Length.........12ft

1000 HR Sound Plane Length.50ft 1000 HR Rotten Plane Length.50ft

Calculate Dominance........Yes

Postburn Overstory Char Height......Yes

Pole-sized Postburn AssessmNo   Pole-sized Char Height......No

Severity Transects Sampled.Fuel

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---------------------------------Description----------------------------------

Monitoring Type Code: FSEGI1T08 Date Described: 06/15/00

Monitoring Type Name: Giant sequoia-mixed conifer

Preparer: Haggerty/Keifer/Dempsey

FGDC Association:

FMH-4 Version Title/Description: Giant sequoia-mixed conifer forest

Visits Assigned: 00 PR01, 00 PR02, 00 PRE, 00 Post, 00 yr02, 00 yr04, 00 yr05, 00 yr10, 00 yr20, 01 Post, 01 yr01, 01 yr02, 01 yr03, 01 yr04, 01 yr05, 01 yr08, 01 yr10, 01 yr12, 01 yr99, 02 Post, 02 yr01, 02 yr02, 02 yr05, 02 yr10, 02 yr20, 02 yr99

Burn Prescription

Date of Burn (mo-mo)......07-15,11-30 Aspect (deg.).............1-359

Wind Direction (deg.).....0-359 Spread Direction (B/H/F)..H

Fuel (tns/ac)...........35.0-100.0 Herb Moisture (%).......0-0

Live Woody (tns/ac).....0.0-0.0 Midflame Wind (mph).....0.0-10.0

Herbs (tns/ac)..........0.0-0.0 Rate of Spread (ch/hr)..0.0-8.0

Air Temp. (F)...........40-85 Heat per Area (btu/ftý).165.0-225.0

Rel. Humidity (%).......20-60 Fireline Intns (btu/ftý)1.0-35.0

1-hr TLFM (%)...........3-10 Slope (%)...............0-60

10-hr TLFM (%)..........11 Flame Length (ft).......0.0-2.5

100-hr TLFM (%).........12 Flame Zone Depth (ft)...0.0-0.0

1000-hr TLFM (%)........20 Scorch Height (m).......0.0-30.0

Woody Moisture (%)......0-0 Char Height (m).........0.0-0.0

Additional Prescription Information: (No information provided)

Management Objectives: Reduce the total fuel load by 60-95% immediately postburn. Reduce the total tree density to 50-250 trees/hectare for trees <80 cm DBH and 10-75 trees/hectare for trees >80 cm DBH.

Monitoring Objectives: Measure mean total fuel reduction with a sample size that will allow for 80% confidence in detecting a 40% change in fuel load and accepting a 20% chance of detecting a change that does not truly occur. Measure mean total tree density for trees <80 cm DBH and trees >80 cm DBH with a sample size that will allow for 80% confidence that the results are within 25% of the true population mean.

Objective Variables: Total fuel load (tons/acre); Total tree density by diameter class (trees/hectare)

Physical Description: All aspects. Slopes 20-60%,in drainage bottoms or broad upland basins, or occasionally steep slopes and ridgetops. Elevation from 5,500-8,000 feet. Soil depth ranges from shallow to very deep. Soils are generally rather coarse textured and acidic.

Biological Description: Overstory consists of mature white fir (Abies concolor), sugar pine (Pinus lambertiana), ponderosa pine (P. ponderosa), incense cedar (Calocedrus decurrens) and giant sequoia (Sequoiadendron giganteum). Due to the extreme size of the sequoia trees it is possible that no big trees will fall w/in the 20m by 50m plot area, however, mature trees should at least be within seed rain of the plot location. Overstory maturity is in the medium to high categories. Understory is usually comprised of incense cedar and white fir with occasional black oak (Quercus kelloggii). The forest floor is typically sparse, with few herbs. Shrubs such as chinquapin (Chrysolepis sempervirens), or hazelnut (Corylus cornuta) contribute <20% cover.

Rejection Criteria: Exclude riparian zones, anomalous vetetation patches, monitoring type boundaries, large rock outcroppings or barren areas (>20% of the plot), or areas within 20 meters of physical barriers such as roads or within 5 meters from any trail (exception for very small units). Exclude plots beyond the seed rain of giant sequoias.

Notes (This Entire Monitoring Type): Monitoring Type Notes: Critical! Some of the initial plots installed in this monitoring type were read according to a set of protocol that were in place prior to the implementation of the FMH handbook.

These older protocol will affect any FSEGI plots found from numbers 1-57. To determine if a plot is being monitored using these older methods, look for the

SEKI-RMO Shrub/Major Herb, SEKI-RMO Tagged Tree form. If the forms are present prior to the last visit, but not within the most recent visit, the plots have already been converted to the FMH protocol. If, however, these forms are located in the last visit, you will need to read these plots in the following manner:

VEGETATION: The % of cover for plants is determined by starting at the OP end of the centerline tape and working towards the 50P end. All substrate materials (rock, wood, bole, bare) or plants are recorded if they occupy at least 5 cm worth of space along the center line. If, for example, litter is the substance at the beginning of the tape and it stretches until 1.03m along the tape, that is what gets recorded. Then, from 1.03m to 1.08m a rock may be found. If a plant, rock or other material bisects the top of the tape (transect plane) but occupies less than 5 cm worth of space, it is ignored and the primary substance that is present gets recorded instead. For example, if litter stretches from

0.00 to 1.03m, followed by a plant that covers from 1.03m to 1.04m, the older method would state that litter stretched from 0.00m to 1.04m. Hence, you will find that there is no break in the sequence of numbers being listed in the start-end-start columns. "Start" is where the tape measurement begins for each substance. "End" is the stopping point of the tape for that same item. "Dist" is the distance encompassed by the object.

Note: 1. For SEKI's purpose, on the veg line for both old and new style plots, wood is defined as a chunk of material that is over 3.0 inches in diameter.

Otherwise, smaller pieces of wood get recorded as litter. 2. Though not required by the FMH, SEKI has determined that it will reread the veg lines during postfire visits in order to determine changes in the %cover. 3. When old style plots reach the "reburn" status, the veg line is read both the old style way (described above) as well as according to the new FMH style as outlined in the book.

SEEDLINGS: Whether the FPIPO plots are being read old or new (FMH) style, seedlings should be done in the following manner. (Please note the differences between these protocol and those listed in the FMH. They are intended to increase our accuracy when seedling density is extreme, as well as to make the seedling maps more helpful, time efficient and accurate.)

SIZE CLASS 1: Never map these! Check in the folder to determine what area was sampled previously for SIZE CLASS 1. If it appears that the density is such that we can sample the same area, let's do so. If the previous sample size was very limited due to high density, and this density now appears to be greatly reduced, enlarge the sample area to the largest portion of Q1 that can reasonably be counted. (The reverse is also true. If the whole quarter was done previously but the density is astronomical now, we can lower the sample size.) Recommendations: If there are more than 300 seedlings in all of Q1, sample the 5 x 10m area proximal to the P1 line. If there are more than 300 seedlings in the 5 x 10, sample the four 1 meter square corners of Q1. By

starting your count in the 5x10 you could save yourself a great deal of time should the densities prove to be higher than you originally estimated. Use the information on the modified FMH-14 data sheet to multiply out the subsample that was chosen. Enter your final number into the computer.

SIZE CLASS 2 and GREATER SEEDLINGS: Map and count all class 2 and greater seedling throughout the entire quarter, no matter what their density levels are, even if class 1 seedlings were only counted in the 4 corners! Remember, class 2 and above seedling need to be mapped on a FMH-16. No multiplication factors will be necessary for class 2 seedlings and above because they are always sampled throughout all of quarter 1.

Trees: (both old ((roughly #'s 1-57)) and new style plots ((#57+)): The same basic information has been gathered on trees since the inception of SEKI's program. To make data collection smoother, data is recorded on the FMH-8 form rather than the old SEKI-RMO form for Tagged Trees. The only deviation from FMH protocol is that we do not recognize pole-sized trees in the same manner. At

SEKI, any tree over 1.37 m is considered to be part of the overstory despite what its diameter is. The FMH computer program states that our poles are >2.5

cm but <15.0. This is not true, and the DBASE program we use to analyze trees allows us to identify trees by any size class parameters we desire which is important because some of our "poles" have diameters <2.5 cm. (The FMH software does not allow for flexibility in this matter, so the true differences are noted here for posterity's sake.) These smaller trees are still tagged (at DBH if possible, if not, look for a tag at the base) and are included when considering CPC codes. Hence, code 4 trees are generally quite small.

For FSEGI plots numbered 93+, 12 extra 10 x 25 m quarters were sampled for overstory SEGI trees. The schematic for the layout of these quarters is diagrammed on the direction sheet for plot 93 but it should be noted, that due to the obviousness of these huge trees, no extra rebar or tree tags were put in place to permanently mark this sampling area. Trees that show up w/ quater numbers 5-16 are for our information but do not get entered into the FMH software. Note: The sampling area was enlarged so that more SEGI trees would be captured. Due to their enormous size, a 20m x 50m plot may contain only 1 tree or even less of this species.

BRUSH DENSITY: In the past, brush density was conducted by guessing at what a individual was, or by counting clumps. Repeating these estimates proved to be futile. Hence, in 1997, we modified the brush protocol to fit local vegetation.

Density numbers prior to this time should not be used for purposes of analyses.

The modified FMH-18 (which is evidence of when each plot underwent the protocol change) should be used on all FABCO plots, whether they are old or new style.

Primary differences between this methodology and those listed in the FMH include:

1. Rather than guessing an individual, individual counts are done only when a single plant can truly be identified such as in the case of Cercocarpus, Fremontia and certain species of Arctostaphylos and Quercus.

2. Stem counts (which are not entered into the computer) will be conducted for brush species where telling the individual is not practical. (Examples: Chrysolepsis, Ribes, Adenostoma, Symphoricarpus and some species of Arctostaphylos and Quercus.)

3. Brush that is not practical to count by methods 1 or 2 will be picked up on the veg line only via %cover. Examples: Ceanothus, Prunus emarginata and Chamaebatia foliolosa.

For those Genera which have variable growth forms (Quercus, Arctostaphylos) it will be necessary to check the previous data sheet to determine which method was used. If species other than those listed above are found on a plot, a determination will be made in the field as to which method should be used. Note:

Pre and post fire growth forms were taken into account in developing these protocol.

FUELS: 4 Brown's transects are read on each plot according to protocol described in the FMH and Brown's handbook. Strange exceptions are outlined in the strange plot questions folder in the grey file cabinet in the back room (the one w/ the air conditioner.)

PHOTOS: Photos, where possible, are taken in the following manner using asa 200 speed Ektachrome slide film. Kneel on 1 knee, 10 ft. from the appropriate stake and take a Vertical picture. 8 photos are also taken of the Brown's lines wherein F F1-0 is Fuel transect 1, standing at the centerline. F1-50 is fuel transect 1, standing at the 50 ft. end, looking back at the centerline. Repeat photo: Starting in 1998, 1 photo was taken of each plot from the best location to get an overall view of the plot. Directions on how and where this was taken can be found on the photo sheets or on the white tab on the inside flap of each folder's brown manila jacket. When regular plot stakes were not used, 2 green stakes were used to mark the photo location. Tags on these will state: "Place clipboard here" and "stand here" so as to lessen confusion.

RED FLAG PLOT WARNINGS: Some of the earliest plots had some design error that was discovered upon subsequent visits (wrong size...so it was resized, Brown's lines run backwards etc). When a problem like this was identified, it was typed up on a sheet called the "Red Flag Warning" and inserted into the folder w/ a note on the plot cover, alerting you to the potential pitfall that lurks within.

How the problem was resolved is also included so it is worth your time to thoroughly read over these notes before proceeding.

-------------------------------General Protocols--------------------------------

Comments (Deviations, Problems, Omissions), this Version Only: (No information provided)

Preburn Control Plots..............Yes Herb. Height...............Yes

Herbaceous Density.........No Abbreviated Tags...........Yes

0P/Origin Buried...........No Herbaceous Fuel Load.......No

Voucher Specimens..........Yes Brush Fuel Load............No

Count Dead Branches of Living Plants as Dead..................No

Width "Observed" Transect..10.0m

Herb Transects Sampled.....Q4-Q1 Q3-Q2

Shrub Transects Sampled....Q4-Q1 Q3-Q2

Length One Shrub Transect..50m Width One Shrub Transect...1.0m

Total Shrub Area...........100.0m2

Stakes Installed At........All 17

Burn and Duff Moisture..............Yes Flame Zone Depth...........Yes

Postburn 100 Points Burn Severity...No Herbaceous Fuel Load.......No

Herb. (FMH-15/17/21).......Yes

-----------------------------Forest Plot Protocols------------------------------

Overstory Live Tree Damage...........Yes Live Crown Position.........Yes

Dead Tree Damage...........No Dead Crown Position.........Yes

Record DBH Year 1..........Yes

Total Length Sample Area...50.0m Total Width Sample Area.....20.0m

Total Sample Area..........1000.00m2

Quarters Sampled...........1 2 3 4

Minimum allowed DBH........0.1cm   Maximum allowed DBH.........999.9cm

Pole-size Live Height................No   Poles Tagged................No

Dead Height................No   Record DBH Year 1...........No

Total Length Sample Area...0.0m   Total Width Sample Area.....0.0m

Total Sample Area..........0.00m2

Quarters Sampled...........1

Minimum allowed DBH........2.5cm   Maximum allowed DBH.........15.0cm

Seedling Live Height................Yes   Seedlings Mapped............Yes

Dead Height................Yes   Dead Seedlings.............Yes

Total Length Sample Area...25.0m   Total Width Sample Area.....10.0m

Total Sample Area..........250.00m2

Quarters Sampled...........1

Fuel Load Number of Sampling Planes..4   1 HR Plane Length...........6ft

10 HR Plane Length.........6ft   100 HR Plane Length.........12ft

1000 HR Sound Plane Length.50ft   1000 HR Rotten Plane Length.50ft

Calculate Dominance........Yes

Postburn Overstory Char Height......Yes

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Pole-sized Postburn AssessmNo   Pole-sized Char Height......Yes

Severity Transects Sampled.Fuel

D- Fire and Fuels Research Plan

Natural science research is and will continue to be an important activity in these parks. It serves two primary purposes in relation to the fire and fuels management program. First, it helps to define both natural fire regimes as well as the range of natural conditions that serve as ecological foundations for the application of fire in park ecosystems. Second, it is used as a tool to evaluate actions used to restore and/or perpetuate desired conditions as contemplated in the policies for management of natural areas in the NPS. This research can have either tactical or strategic applications. Such research will continue to be encouraged and supported in an effort to further improve the parks' fire and fuels management program.

Considerable fire research has been carried out in Sequoia and Kings Canyon National Parks over the past several decades. This has included a variety of studies in sequoia-mixed conifer forests (Kilgore 1972, Kilgore and Taylor 1979, Parsons and DeBenedetti 1979, Harvey and others 1980, Stephenson and others 1991; Swetnam and others 1992, 1998; Swetnam 1993; Mutch 1994; Caprio and Swetnam 1995; Stephenson 1994; Miller and Urban 1999, 2000), low elevation foothill communities (Rundel and Parsons 1979, Parsons 1981, Rundel and others 1987), and high elevation forests and meadows (Vankat 1970; Kilgore 1971, DeBenedetti and Parsons 1984; Pitcher 1981, 1987).

These studies have provided a firm justification and basis for the development of the parks' prescribed and natural fire management programs (Bancroft and others 1985). While much is known from these studies, in most cases they have not provided the full level of detail necessary to completely understand natural fire regimes or the effects of variable intensity fires on subtle ecosystem properties.

Research needs and priorities are jointly identified by the Division of Natural Resources and the USGS Southern Sierra Field Station (formerly NPS Research Office) located within the parks. They are documented in the parks' Natural Resources Management Plan and updated annually. Such research may include in-house studies, interagency or cooperative agreements, contracts, or independent investigations. All fire related research is closely coordinated with the fire operations and fire monitoring efforts in order to assure maximum application of findings to both the management and interpretation programs. A Fire Research Coordinator within the Science and Natural Resources Management Division assists in coordinating these efforts. A report is produced annually documenting all fire-related research, monitoring, and inventory projects undertaken within a given year.

Most fire research is carried out in close conjunction with the prescribed burning program, utilizing planned burns to the extent possible. On occasion, burns will be carried out specifically to support approved research projects. These might include efforts to study the effects of variable intensity burns, reburns, or burns carried out under specific climatic or prescription variables (e.g. severe drought).

FIRE RESEARCH NEEDS

Fire research is directed at answering questions related to short-term, specific operational or resource issues or at big picture ecosystem wide problems that may have long-term or far-reaching implications for park management. Specific research questions may be addressed by park staff, staff from other agencies (e.g. USGS), or by outside researchers. Current research needs focus on obtaining a better understanding of spatial and temporal patterns of past fire regimes, the effects of fire intensity and frequency on fuel accumulation and on forest structure and dynamics, and the many effects of variable fire intensities and return intervals, as well as fire suppression, on vegetation, fauna, pathogens and other ecosystem properties. The question of the extent to which contemporary vegetation and fuels vary from their natural range has been difficult to determine yet remains a key factor for guiding fire management decisions. The following specific fire-related research needs have been identified:

Fire and Global Change: Understanding Forest Dynamics, Succession Modeling, Climate and Vegetation History, and Ecology of Sequoia - Mixed Conifer Forests

Aspects of this comprehensive need are currently being addressed by ongoing studies by and through the USGS Research Office. These are addressing vegetation and fire history over millennial time scales, forest structure, fuel accumulation and modeling, effects of variable fire intensity on pathogens and cambium and soil temperatures and various aspects of nutrient cycling. Beyond the continuation and expansion of the above projects, additional research is needed relating to mixed conifer forest fire ecology including expanded studies of fire and vegetation history (in conjunction with larger proposed studies of global change), plant succession and forest dynamic models (to permit testing of predictive outcomes of different climate and management scenarios), and fire spread modeling.

Role of Fire in Sierran Ecosystems

Improve the Reliability of Information Used to Derive Desired Structural/Process Goals

These conditions were established by the November 1998 Sacramento workshop “Setting Resource Objectives for Fire Management Plans”. Defining the desired goals used in this ecosystem management process requires an understanding of basic reference conditions at various landscape levels. Currently our knowledge of these reference conditions is poor, of low resolution, and only provides a broad target window for fire management planning. At this time, of the two goals, past process conditions can probably be more easily and reliably reconstructed.

Structural Goals

These goals include landscape pattern, physical and biological attributes of stand structure, and their drivers. This information need encompasses pre-Euro-American settlement tree ages and age distributions, species diversity, size structure by vegetation type, gap and patch size, shape and arrangement on the landscape, species composition, and burn severity by topographic position. A variety of sources may potentially provide this information including historic photography, TM images, and field investigations. Changes in attributes such as species diversity could be obtained by investigating changes pre-/post-fire, after multiple burns in an area, and by following burns with differences in seasonal timing and burn intervals (also see cross-scale burn severity below).

Process Goals

These goals include an understanding of the attributes of pre-Euro-American settlement fire regimes, drivers of these regimes, and the relationship between these and other agents of change. While considerable fire history sampling has been carried out within the parks (Kilgore and Taylor 1979; Pitcher 1987; Swetnam and others 1992; Swetnam and Caprio 1995; Swetnam and others 1998; Caprio 1999) many significant gaps still exist in our knowledge (Caprio and Lineback 1997). Information needs include obtaining an improved understanding of the historic size, frequency, type, and intensity of fire, and a comparison of the extent of historic fire patterns across the landscape and for the various vegetation types within the parks. Additionally, an evaluation of the constraints imposed by the presence of modern park developments and park neighbors is needed. This information will help define areas where the restoration of the historic fire regime and patterns may be constrained.

Cross-Scale Burn Severity Through Several Burns

Patterns and changes in patterns of burn severity would be examined over time as repeated burns occur on the landscape. This would provide information on spatial and temporal patterns of burn severity and how they change as multiple burns occur. For example, does fire size change between the first and second burns. Specific projects might include looking at fire records and burn maps from the Sugarloaf (SEKI) and/or Illilouette (YOSE) Valleys.

Fire Ecology of Low Elevation Mixed Conifer and Hardwood Forests

Research is needed to better understand the role of fire in the transition zone between the foothill chaparral and the mixed conifer forests. This should include studies of fire history, fuel loading, and vegetation structure and succession, as well as modeling of fuels, fire behavior and fire spread. This key zone between the highly flammable foothill and sensitive sequoia forests is extremely important to the overall fire management strategy of the parks.

Subalpine Forest Fire Ecology

Despite an active program of allowing natural fires to burn in the higher elevations of the Parks little is known about fire history and effects in most of these ecosystems. Such data is needed for lodgepole pine, red fir and other subalpine forest types as well as for subalpine meadows, which comprise a significant portion of the parks' vegetation. Our current knowledge of fire effects in these types is largely confined to studies of limited extent carried out by Kilgore (1972), Pitcher (1980, 1987) or presently underway by Battles and Newburn (2000) and Caprio (2000).

Fire Modeling and Data Needs

Fire Behavior Modeling

Modeling for the prediction of fire behavior, such as the BEHAVE/FARSITE systems, and the development of Geographic Information Surveys for the storage of fuels data

Historic Fire Spread Patterns

Model fire spread patterns of fires originating from ignition starts that have occurred over last X number of years to see whether burn patterns/frequency fir with past patterns or does data suggest Native American burning was important.

Air Quality

Research is needed to determine the number of acres that can be burned without violating air quality regulations. Monitoring equipment is needed to establish baseline particulate loading in park airsheds and what is the contribution of the parks burn program. By knowing how many pounds of particulates or CO are produced per ton of any given fuel, and by studying the indicators of good and bad smoke dispersion days, improved prescriptions may be written for smoke management, as is done for fire behavior and effects.

Watershed Impacts

A better understanding of both transitory and long-term effects on watershed features related to the presence or absence of fire. Included would be hydrologic and sedimentation impacts, stream chemistry, and changes in soils. Studies are needed that provide results from replicated watersheds in a variety of setting such as differing vegetation and parent material.

Wildlife

Several potential research/resource study projects for examining the relationship between fire and wildlife. These include:

Fire or absence of fire and its effects on particular wildlife species. Particular taxa would include terrestrial amphibians, bats, spotted owls, and fishers.

Historic role of fire in maintaining winter range of bighorn sheep in the Kern and Big Arroyo drainages. For example, did fire historically keep areas open that are now very brushy? This could be addressed by either looking at historic photos or by reconstructing the fire history of the area.

What are the effects of tussock moth on forest structure, composition, and fuels relative to prescribed burns? Do these effects differ between areas burned prior to the moth outbreak?

Fire Effects on Sensitive or Endangered Species

Fire effects or the effect of the lack of fire on sensitive or endangered plants and animals within the parks. Wildlife species might include fishers, spotted owls, or Sierra bighorn sheep. For example, recent interest has been expressed on the relationship between fire and bighorn sheep habitat. Potential investigation might include looking at change in habitat and foraging behavior that might occur with future fires and understanding the relationship between fire and sheep habitat in the past (prior to Euro American settlement).

Exotic Plants and Animals and Fire

While dramatic changes in most low elevation grasslands occurred over a century ago new invasions or potential invasions of exotic species are still occurring or threaten. For example, in the last three years the widespread occurrence and dominance of cheatgrass has become apparent. While multiple factors are usually important in the spread, establishment, and dominance of these invasive species fire can sometimes have a significant role. Studies are needed to investigate the role of fire in association with other factors in the spread of established or threatening exotics. In general, studies are needed to determine:

Strategies to detect the presence and changes in exotics over time

what are the interactions between fire and other management practices (roads/stock etc.) on establishment and spread of exotic species

can methods be developed to eliminate particular exotic species or at least retard their spread

Fire Restoration Needs

A long-term examination of fire restoration potential is needed. For example, at what interval can fires occur in various vegetation types and still maintain the character and integrity of the ecosystem. Can we maintain systems that burned at 5-year intervals historically with a 10-year fire return interval? Additionally, how important is the fire return interval distribution of fire (Bond and Wilgen 1996) or the variation in intervals from fire-to-fire? Again can we use patterns that are different from pre-settlement patterns and still maintain ecosystem integrity. These extend the JFS Fire and Fire Surrogates work currently underway within the parks.

Conversion of Sequoia Tree Inventory into Digital Format

An exhaustive inventory of all giant sequoia trees in the parks was carried out under contract in the 1960's and 70's. This data has great potential value to both management and science programs. However, it currently exists only in hard copy form and is of limited utility. Converting the paper database into a digital georeferenced format and georeferencing tree locations would greatly increase the utility of this dataset.

SENSITIVE RESEARCH AREAS

Specific “*Sensitive Research Areas*” may be designated to support particular research projects or objectives. The purpose of these areas is to provide a mechanism for identifying and highlighting areas in the fire planning process where special considerations are required during implementation of burns. These areas would include fire research plots where the effects of variable fire intensities, intervals or fuel conditions might be under study. Plots would be variable sized areas established by the park’s fire monitoring and USGS research programs, university scientists and other federal agencies. One special type of *sensitive research area* would be sites where fire exclusion is called for. These areas will be individually justified and managed according to objectives stated in approved research project plans and be subject to annual or periodic review. These areas would fall into two categories:

Temporary Areas

Sites that may be used for a limited amount of time or set aside to be excluded from one particular burn (these would be most applicable to prescribed fire situations). They might be designated in either unburned areas or in areas that have burned at some point in the recent past. The number of sites would be dynamic on a year-by-year basis. An example would be the Giant Forest Joint Fire Science (JFS) “fire and fire surrogates” study area where several control treatments will be paired with burn treatments. Control areas will be maintained for the life of the study (~5 yr.) but will revert back and be included in any additional fire operations planning with the completion of the study. Examples include:

- Giant Forest Joint Fire Science program plots
- Cheatgrass plots in Cedar Grove

Pitcher Plot #3 - Desired plan: to miss the next prescribed fire in the area. Reason: to act as control for Plots 1 and 2 that were burned during 1999. This will permit effects of the burns in plots 1 and 2 to be more accurately compared to a similar unburned area in which similar long-term data has been collected.

Long-term or Semi-Permanent Areas

Areas where fire is being actively excluded in an effort to evaluate the effects of long-term fire exclusion on ecosystem properties. These would be sites without a definite life span or annual evaluation. Location and designation of these areas will be based on specific criteria such as feasibility of fire control or exclusion and the value of long-term maintenance to the parks research program. An example of such a site would be the 49.8 ha Log watershed in Giant Forest that has been paired with the burned Tharps watershed in several long term studies of acid deposition and fire on ecosystem properties.

E- Fuels Management Prescriptions

MECHANICAL HAZARD FUELS ABATEMENT STANDARDS

Hazard Abatement Adjacent to Structures, Around Developments, and Along Park Boundary Areas

The following standards will be used for hazard fuels abatement projects conducted by park crews on NPS lands.

The removal of exotics should be favored over the removal of native species. Where feasible, exotics should be eliminated while native plants should be pruned or isolated from the ladder effect in order so that they may remain while providing a reasonable level of protection for structures.

There may be sensitive native plants in certain areas and the removal of nesting trees should be done after birds have vacated the nests. Coordinators of abatement projects will need to consult with the park biologist before cutting questionable plant species or nesting trees.

Foothill Areas

In foothill areas where annual grass and shrub species comprise the main hazardous fuels, most mechanical reduction work is done immediately adjacent to structures. The following standards are based on PRC 4290.

Mow or cut dried grass from the sides of structures out to a minimum 30 foot width from the structures in all directions. On steep hillsides mow or cut dried grass out to a distance of up to 100 feet on the downhill portion. Individual live shrubs or trees can remain as long as they are isolated from the ladder effect—the path that fires can travel in order to reach the structure's sides or roof area.

Along the sides of flammable foundations, scrape away fuels down to bare mineral soil. A 2 to 3 foot wide scrape is recommended.

Remove all leaf litter from roofs.

Remove all dead branches within a reasonable distance above roofs (some conifer trees could have dead branches high up in the tree that are not reachable).

Remove all branches or vegetation within 10 feet of chimney outlets.

All fireplace or wood stove chimney outlets must be covered with an ember-arresting screen that has openings no larger than ½ inch in size.

Limb-up all trees 6 to 8 feet above the ground and that are within a minimum area 30 feet out from structures in all directions.

When removing a lateral branch at its point of origin on the trunk or parent limb, the final cut shall be made in branch tissue close to the trunk or parent limb, without cutting into the branch bark ridge or collar, or leaving a stub.

When removing a dead branch, the final cut shall be made just outside the collar of live tissue. If the collar has grown out along the branch stub, only the dead stub shall be removed. The live collar shall remain intact and uninjured.

To prevent damage to the parent limb when removing a branch with a narrow branch attachment, the final cut shall be made from the bottom of the branch up.

Tree branches shall be removed in such manner so as not to cause damage to other parts of the tree. Branches too large to support with one hand shall be pre-cut to avoid splitting or tearing of the bark.

Piles shall be appropriately sized and located in openings far enough away from residual vegetation in order to prevent or minimize scorch.

Piles shall have a minimum height of 3 feet and a maximum height of 6 feet.

Piles shall be located at least 15 feet from any residual green tree in the downhill or side-slope direction from the pile, and at least 20 feet from any residual green tree upslope of the pile.

Piles shall be constructed reasonably compact and free of soil to facilitate burning.

Piles shall also be constructed with enough fine material (less than ¼ inch diameter), such as twigs and needles, to easily ignite and burn the pile.

All piles should have a good base to prevent the pile from toppling.

Piles shall be covered with durable paper prior to precipitation. Water-resistant “Kraft” paper (Clean Burn Kraft Paper – available from http://www.baileys-online.com/store.html) or approved substitute may be used. No plastic material will be used to cover piles. The covering shall be placed over the center of the pile. The paper shall cover a minimum of 75% of the surface of each pile.

Pieces of branch wood shall be placed on the top to secure the paper against reasonable wind events.

Mid-elevation Areas

In mid-elevation areas where timber species comprise the main hazardous fuels, mechanical reduction work is done immediately adjacent to structures and out to about a 200-foot width on average in all directions. On steep slopes the areas downhill or below structures may need mechanical reduction work wider than 200 feet. In timber fuels shaded fuel break techniques are used. The following standards are based on PRC 4290.

Remove flammable vegetation or leaf litter from the sides of structures to 30 feet out from the structures in all directions. Individual live shrubs or trees can remain as long as they are isolated from the ladder effect—the path that fires can travel in order to reach the structure's sides or roof area.

Along the sides of flammable foundations, scrape away fuels down to bare mineral soil. A 2 to 3 foot wide scrape is recommended.

Remove all leaf litter from roofs.

Remove all dead branches within a reasonable distance above roofs (large conifer trees could have dead branches high up in the tree that are not reachable).

Remove all branches or vegetation within 10 feet of chimney outlets.

All fireplace or wood stove chimney outlets must be covered with an ember-arresting screen that has openings no larger than ½ inch in size.

There will be a maximum of 25 trees/acre less than 40 feet in height remaining after the thinning.

All live trees over 40 feet tall will remain uncut. All larger trees remaining will be limbed up to at least 6 to 8 feet above the ground.

When removing a lateral branch at its point of origin on the trunk or parent limb, the final cut shall be made in branch tissue close to the trunk or parent limb, without cutting into the branch bark ridge or collar, or leaving a stub.

When removing a dead branch, the final cut shall be made just outside the collar of live tissue. If the collar has grown out along the branch stub, only the dead stub shall be removed. The live collar shall remain intact and uninjured.

To prevent damage to the parent limb when removing a branch with a narrow branch attachment, the final cut shall be made from the bottom of the branch up.

Tree branches shall be removed in such manner so as not to cause damage to other parts of the tree. Branches too large to support with one hand shall be pre-cut to avoid splitting or tearing of the bark

Felled trees will be limbed and bucked down to an 8-inch top and piled for later burning. Tree boles larger than 8 inches in diameter will be left un-bucked. All tree boles left will remain in contact with the ground. All stumps will be flush cut and added to the burn piles.

Dead & down woody material (1-8 inches in diameter) will be gathered and piled with larger logs limbed and bucked to an 8-inch top and piled for later burning. Tree boles larger than 8 inches in diameter will be left un-bucked.

Piles shall be appropriately sized and located in openings far enough away from residual vegetation in order to prevent or minimize scorch.

Piles shall have a minimum height of 3 feet and a maximum height of 6 feet.

Piles shall be located at least 15 feet from any residual green tree in the downhill or side-slope direction from the pile, and at least 20 feet from any residual green tree upslope of the pile.

Piles shall be constructed reasonably compact and free of soil to facilitate burning.

Piles shall also be constructed with enough fine material (less than ¼ inch diameter), such as twigs and needles, to easily ignite and burn the pile.

All piles should have a good base to prevent the pile from toppling.

Piles shall be covered with durable paper prior to precipitation. Water-resistant “Kraft” paper (Clean Burn Kraft Paper – available from http://www.baileys-online.com/store.html) or approved substitute may be used. No plastic material will be used to cover piles. The covering shall be placed over the center of the pile. The paper shall cover a minimum of 75% of the surface of each pile.

Pieces of branch wood shall be placed on the top to secure the paper against reasonable wind events.

Larger brush patches will have a minimum 20-foot wide path cleared, and the cut material piled for later burning to facilitate future fire line construction located in a defensible area within the treatment area.

Any stumps larger than 8 inches in diameter will be treated with borax to prevent root rot.

The treatment zone will be maintained on a regular and recurring basis.

Established seedlings and saplings will be thinned every 10-15 years to maintain stocking densities at prescribed levels favoring shade intolerant species. The slash generated will be piled and burned.

The 20-foot wide cleared brush zone will be maintained by cutting sprouting brush on a 3-5 year cycle. The cut material will be piled and burned.

Re-accumulations of dead & down woody material will be gathered and piled with larger logs limbed and bucked to an 8-inch top and piled for later burning on a 1-2 year cycle.

Hazard Abatement Along Boundary Areas

Where hazard abatement along park boundary areas needs to be implemented, the treatments will follow the shaded fuel break methodology described above. For brevity reasons those standards are not duplicated here.

PRESCRIBED FIRE BURNING PRESCRIPTIONS

Table E-1 – Prescriptions for Fuel Models 1-5

	Fuel Model 1 Annual Grass Head Fire Wind Upslope	**Fuel Model 1 Annual Grass Backing Fire Wind Upslope**	**Fuel Model 2 Annual Grass with Overstory Head Fire Wind Upslope**	**Fuel Model 2 Annual Grass with Overstory Backing Fire Wind Upslope**	**Fuel Model 4 Tall Brush Head Fire Wind Upslope**	**Fuel Model 5 Low Brush Head Fire Wind Upslope**
Environmental Conditions						
Air Temperature	30–90 f	30-90 f	30-90 f	30-90 f	30-85 f	30-80 f
Relative Humidity	20–80%	20-80%	20-80%	20-80%	20-80%	20-80%
Wind Speed	See Below	See Below	See Below	See Below	See Below	See Below
Slope	0–30%	0-100%	0-30%	0-100%	0-45%	0-35%
Fuel Moisture						
1 Hour Time Lag	5-10% mfws 0-2	3-4% mfws 0-4 5-10% mfws 0-2	6-11% mfws 0-2 12-13% mfws 0-6	4-9% mfws 0-4 10-13% mfws 0-2	5-9% mfws 0-4 10-12% mfws 0-8	5-7% mfws 0-2 8-12% mfws 2-8 w/ live fuel moisture of 100-150%
10 Hour Time Lag	N/A	N/A	7-12% mfws 0-2 13-14% mfws 0-6 15-16% mfws 0-10	5-10% mfws 0-4 11-14% mfws 0-2	6-10% mfws 0-4 11-13% mfws 0-8	6-12% mfws 0-2 9-13% mfws 0-8 w/ live fuel moisture of 100-150%
100 Hour Time Lag	N/A	N/A	8-13% mfws 0-2 14-15% mfws 0-6 16-17% mfws 0-10	6-11% mfws 0-4 12-15% mfws 0-2	7-11% mfws 0-4 12-14% mfws 0-8	N/A
1,000 Hr Time Lag	N/A	N/A	N/A	N/A	N/A	N/A
Live	N/A	N/A	50-100%	50-100%	50-150%	70-150%
Fire Behavior Outputs						
Scorch Height	N/A	N/A	0-30 ft.	0-30 ft.	N/A	N/A
Rate of Spread	2-35 chains/hour	2-8 chains/hour	1-16 chains/hour	1-3 chains/hour	2-120 chains/hour	2-17 chains/hour
Flame Length	0-4 ft.	.5-2 ft.	.5-4 ft.	.5-2.5 ft.	3-25 ft.	1-5 ft.
Heat per Unit Area	55-95 BTU/sq. ft.	100-110 BTU/sq. ft.	255-495 BTU/sq. ft.	255-525 BTU/sq. ft.	1570-2910 BTU/sq. ft.	215-715 BTU/sq. ft.
Fireline Intensity	3-60 BTU/sq. ft./second	4-15 BTU/sq. ft./second	4-145 BTU/sq. ft./second	4-30 BTU/sq. ft./second	50-6330 BTU/sq. ft./second	7-221 BTU/sq. ft./ second

NOTE: These are generalized burning prescription parameters. Fire management staff are responsible for reviewing topography outside the range listed and adjusting ignition pattern and rate of firing in order to meet burn plan objectives. Reduction of scorch can be accomplished as needed generally with nighttime ignition and with humidities higher than 30%.

Table E-2 – Prescriptions for Fuels Models 8-10

	Fuel Model 8 Closed Timber and Short Needle Conifer Head Fire Wind Upslope	Fuel Model 9 Broadleaf Deciduous Hardwoods and Long Needle Pine Head Fire Wind Upslope	Fuel Model 9 Broadleaf Deciduous Hardwoods and Long Needle Pine Backing Fire Wind Upslope	Fuel Model 10 Timber Litter Head Fire Wind Upslope	Fuel Model 10 Timber Litter Backing Fire Wind Upslope
Environmental Conditions					
Air Temperature	30-85 f	30-85 f	30-85 f	30-85 f	30-85 f
Relative Humidity	20-80%	20-80%	20-80%	20-80%	20-80%
Wind Speed	See Below	See Below	See Below	See Below	See Below
Slope	0-60%	0-45%	0-100%	0-45%	0-100%
Fuel Moisture					
1 Hour Time Lag	3-10% mfws 0-10	5-7% mfws 0-6 8-12% mfws 0-8	3-10% mfws 0-4	5-7% mfws 0-6 8-12% mfws 0-8	3-10% mfws 0-4
10 Hour Time Lag	4-11% mfws 0-10	6-8% mfws 0-6 9-13% mfws 0-8	4-11% mfws 0-4	6-8% mfws 0-6 9-13% mfws 0-8	4-11% mfws 0-4
100 Hour Time Lag	5-12% mfws 0-10	7-9% mfws 0-6 10-14% mfws 0-8	5-12% mfws 0-4	7-9% mfws 0-6 10-14% mfws 0-8	5-12% mfws 0-4
1,000 Hr Time Lag	10-40%	10-40%	10-40%	10-40%	10-40%
Live	N/A	N/A	N/A	N/A	N/A
Fire Behavior Outputs					
Scorch Height	0-30 ft.	0-30 ft.	0-30 ft.	0-30 ft.	0-30 ft.
Rate of Spread	0-8 chains/hour	1-18 chains/hour	0-1 chains/hour	1-18 chains/hour	0-1 chains/hour
Flame Length	0-2.5 ft.	1-4 ft.	.5-3 ft.	1-4 ft.	.5-3 ft.
Heat per Unit Area	165-225 BTU/sq. ft.	320-390 BTU/sq. ft.	350-450 BTU/sq. ft.	320-390 BTU/sq. ft.	350-450 BTU/sq. ft.
Fireline Intensity	1-35 BTU/sq. ft. /second	4-120 BTU/sq. ft. /second	4-60 BTU/sq. ft. /second	4-120 BTU/sq. ft. /second	4-60 BTU/sq. ft. /second

NOTE: These are generalized burning prescription parameters. Fire management staff is responsible for reviewing topography outside the range listed and adjusting ignition pattern and rate of firing in order to meet burn plan objectives. Reduction of scorch can be accomplished as needed generally with nighttime ignition and with humidities higher than 30%.

F- GIS and Data Management Plan

Geographic Information Systems (GIS) are an essential tool for a successful fire and fuels management program. The technologies used and capabilities of GIS are evolving rapidly. This section of the *Fire and Fuels Management Plan* describes GIS data management objectives, roles and responsibilities, hardware and software, existing data, data collection and analysis, and interagency collaboration.

It is very important that information be collected according to well-defined standards, managed to protect long-term data integrity, and be made accessible to the staff and public. It should be kept in mind that data management is a dynamic process and this document is subject to an annual review process where changes may be integrated.

This document does not address all fire data management activities at Sequoia and Kings Canyon National Parks, as many of these activities integrate with local parkwide and service-wide protocols, applications, and standards. The SEKI fire management program has begun implementing applicable sections of the Sierra Nevada Data Management Plan (Cook and Lineback, 2006) beginning in FY 2008. This plan offers a guide for park programs and outlines how we intend to implement and maintain data management systems and best practices that optimize the data and information needs of selected programs. It reflects a commitment to ensure the quality, interpretability, security, longevity, and long-term availability of high-quality data and information. This is accomplished through standards and guidelines outlined for:

- Proper work flow and management of data through a projects life cycle
- Data management responsibilities of each person involved with a project
- Quality assurance and quality control measures that should become standard practice
- Documentation of projects (project development summaries and SOPs) and data sets (formal metadata)
- Handling and protection of sensitive data and information
- Dissemination to the public of non-sensitive data and information
- Proper management, archival, and storage of all records and objects associated with projects
- Project organization and tracking
- Document Citation: Cook, R. R. and P. Lineback, 2006. Sierra Nevada Network Data Management Plan. Natural Resource Report NPS/PWR/SIEN/NRR—2006/000. U.S. National Park Service, Three Rivers, California.
- This appendix addresses only those GIS data activities specific to these parks.

GIS DATA MANAGEMENT OBJECTIVES

1) Sufficient data is available to support park fire planning and operations.

2) All significant spatial data within the parks is adequately documented, archived, and secured using appropriate methodologies, tools and technologies.

3) Staff is adequately trained in the use of technologies, standards, and procedures.

4) Access to data and supporting documentation is easy to use, readily retrievable, and well documented through use of available NPS and NIFC software systems and Internet technologies.

5) Data collection and data handling protocols follow approved standard operating procedures, incorporate appropriate standards, and meet best science standards.

6) The parks participate in interagency cross-boundary data development initiatives such as the Southern Sierra Fire Management Officers group (SSFMO) and the Fire Program Analysis (FPA) System, both as a prototype and for actual budget submissions.

ROLES AND RESPONSIBILITIES

Fire GIS Specialist

A permanent GS-9/11 Fire GIS Specialist is duty stationed at SEKI and supervised by the GIS Coordinator under the Division of Natural Resources. This position is funded by fire management. A minimum of 80% of the position supports GIS and fire and fuels management information activities. The Fire GIS Specialist is responsible for providing data, analysis, and services for fire planning and operations and works closely with the fire management staff and the GIS Coordinator. Support is provided to interagency GIS initiatives as needed to support landscape-level GIS data management and analyses. This position also assists with providing GIS and GPS training to park staff, ensures data backups and documentation of data and processes including metadata, resolves technical support questions from staff, and handles basic system administration functions for computer servers and workstations.

GIS Coordinator

The GIS Coordinator manages the GIS fire budget, manages the overall direction for the GIS fire program, coordinates interagency GIS fire initiatives, and provides backup support to the Fire GIS Specialist.

HARDWARE AND SOFTWARE

Computer systems

At SEKI, data management is based on a Windows client-server model for distributing data and information. The parks' IT staff handles the overall administration of this network. The fire management staff has access to this internal network. All park GIS data now resides on a Windows based server within this network, housed in the IT office.

Archiving and Security

All digital data is backed up to the GIS data server. This data server is backed up to tape nightly. Rotating copies of the tapes are stored in a fire safe vault in the administrative offices at Ash Mountain headquarters. In conjunction with the IT staff, the GIS staff is creating standards and procedures for ensuring best data management practices relating to archiving and accessing data. Hardcopy log files are kept in the IT office for the server backups. The Fire GIS Specialist and the GIS Coordinator both have system administrator access to data on the park GIS servers for manipulating and creating datasets, and for granting users access to files.

Software and Data Accessibility

GIS Software

The parks use ESRI's ArcGIS software for GIS processing and mapping. Several extensions to ArcGIS are utilized, such as Spatial Analyst, and 3D Analyst. Arcexplorer is also available for free so that users who do not have access to Arcview can view data.

Image Processing Software

The parks have a license for ERDAS image processing software.

GPS Software

The parks have a copy of Trimbles GPS Analyst software to provide post-processing corrections services for the Trimble GeoXT units the park owns. This license resides on the GIS server and can be accessed by anyone who needs to use this. It runs as an extension to ArcGIS.

NPS Theme Manager

This tool was initially developed by the Alaska region. In FY 1999 the Inventory and Monitoring program began looking at the GIS Theme Manager as a tool for packaging parks base cartography, vegetation, geology, and soils data. The GIS Theme Manager is an ArcGIS extension that facilitates the organization and use of data themes. This tool allows users to create lists of themes that are relevant to particular projects, areas or management issues. It catalogs these themes, so that a user simply selects a theme from a popup list and the Theme Manager adds it to a view along with a descriptive title, displays it with a legend, perhaps adds hotlinks or help files, and links it to metadata. Theme Lists may be maintained on a network location for all park users, created by Service-wide programs, like the Inventory and Monitoring Program and sent out to parks, or individuals may create their own personal lists for their data or specific projects. The GIS Theme Manager wizard guides users through the process, allowing users to easily: create, edit, copy, and delete theme lists. They can also create a set of environment variables for theme source paths, so that theme lists can be shared with other users who may have data stored on different drives or with somewhat different directory structures. The GIS staff maintains a set of theme lists on the parks' internal network for all users to access the major datasets. The Theme Manager and pointers to the theme lists can be installed from the GIS page of the parks intranet website.

Metadata

Digital geo-spatial data will be documented using the FGDC Content Standards for Digital Geo-spatial Metadata, version 2. Currently the GIS staff is using the ArcGIS Metadata tool for creation and maintenance of metadata.

Intranet

Fire has a page on the parks Intranet site to provide a window to some of the most pertinent documents and maps.

Internet

Public access to key fire information and data through the Internet is crucial to educating the public about the fire and fuels management process. Information on the status of the parks' fire program can be reached through the main NPS website for SEKI (www.nps.gov/seki). The parks also publish several geo-spatial databases, including fire data, to the NPS GIS Clearinghouse.

Training

GIS Staff

GIS data management staff needs to keep abreast of the latest technologies in computer software and interagency standards that apply to fire mapping in support of operations and planning.

Other Park Staff

At least one training class in ArcGIS is provided every other year to park staff by the GIS data management staff. GPS training has also been provided on an as-needed basis. Additionally, the GIS staff has provided updates to park staff on various ArcGIS tools, such as the Theme Manager, that improve the efficiency of data access.

EXISTING DATA

Fire data is integrated into parkwide strategies for managing data. A file directory structure standard was completed in 2000 with the purpose of standardizing the organization of documents, databases, imagery, and geospatial data in a distributed client-server environment. This process involved creating a complex empty file structure and then moving existing data, documents, imagery, and metadata into the appropriate directory structure. This file structure hierarchy was implemented at SEKI in 2000. This structure has simplified data access by providing standardized data locations so that tools such as Theme Manager and the Intranet can find these datasets. As part of the Sierra Nevada Network Data Management Plan development, a new draft file directory structure is under development and all important fire-related electronic files will be managed within the framework of this new directory structure beginning in FY 2008.

GIS Data

Format and Projection

All geo-spatial data is currently projected in the UTM coordinate system using the NAD83 datum in Zone 11. Data are available in shapefile, Geodatabase, and Grid formats.

Existing park data

The Fire GIS Specialist maintains a list of geo-spatial data available on the parks' servers. Some data is also available on the internet at the NPS GIS Clearinghouse.

Base Cartographic Data

The Fire GIS Specialist is involved with several projects to develop and maintain other supporting cartographic data, such as building locations, roads, air hazards, etc.

Fire GIS

As per of RM-18, GIS has been used to look at Hazard, Risk, and Values, along with other analyses deemed pertinent to the fire management staff. These layers are derived annually from existing park data such as vegetation and fire history. The types of data and general processes are described in the "Data Collection and Analysis" section below under "Fire Analysis."

Vegetation mapping

The vegetation map is used as a basis to derive many fire analyses. The parks have undertaken a multi-year project to update the current vegetation map. Aerial photography from summer 2001 is now the basis for an improved vegetation layer. The updated vegetation map was completed in January 2007. Additionally, the parks have collaborated with the U.S. Forest Service to use common crosswalks so that seamless vegetation data will be available for fire modeling.

Farsite

Park geo-spatial data has been processed into Farsite landscape files. These data are updated on an annual or as-needed basis and made available on the park network data server. CD-ROMs are also available for Farsite data.

WFMI Data and Ignition Locations

DI-1202 forms are entered into the Boise WFMI system for all wildland fires. This data is retrieved after the end of the year, via extract from the WFMI website, and used to populate GIS tables for fire history. Currently two separate sets of tables are maintained for fire ignition locations, one by GIS and one from the 1202 system. A project was undertaken by the fire GIS

Specialist to validate the existing GIS database with the SACS 1202 database. By maintaining fire ignition locations separate from WFMI, GIS can validate the locations in WFMI. Since SACS was converted to WFMI, several location errors have carried over.

Plot Data

Plots come from a variety of sources and have multiple purposes including fire effects monitoring, fuels monitoring, and fire research. Plot locations are geo-referenced. Associated tabular data is stored on the park network server in the appropriate format and can be cross-linked to the geo-spatial plot locations. Data management of these tables is handled at the park level or at the program level.

DATA COLLECTION AND ANALYSIS

Fire Occurrence

Fire Locations and Verification

Fire locations are reported to fire dispatch in Latitude/Longitude format w/ decimal minutes (i.e., DD MM.99) or UTM. Point locations given on the Fire Report (1202) may not prove to be accurate when placed on a topographic map. GIS will be used to increase the accuracy of fire ignition locations by providing a map of the point location given. The burn boss or incident commander will verify this location. GIS will maintain the point database on the central server.

Fire Size and Digitizing

Fires < 10 acres – Fires less than 10 acres will be captured as point locations and entered into the central GIS database. These points will be buffered into polygons later in the fire history update process. An exception may be made to digitize the actual area if it is determined that this area's location may play a significant role in monitoring (i.e., cheatgrass). All fires will originate as point locations.

Fires ≥ 10 acres – Fires greater than/equal to 10 acres will be digitized from the 7.5' quad hand drawing, or from GPS points gathered at the fire site, either on the ground or from air reconnaissance. The perimeter will be shown on a map for the 1202 fire report. 7.5' topographic maps should NOT be shrunk or enlarged – when possible, submit the original topographic map to GIS for digitizing.

GPS – Where feasible, fire perimeters should be gathered via GPS. This reduces inaccuracies and saves time digitizing.

Fire History

Fire history in the parks was originally compiled through the process of researching and digitizing old maps. There are several types of these old maps. The GIS office produced a set of topographic maps that were used as the original base maps for digitizing into GIS. The Fire Management Office retained a set of maps collectively known as the fire atlas. Both of these sets of maps have been moved to the museum archives. The individual fire records are also located in the museum archives. Currently, fire history is updated digitally by following the processes listed above. The GIS processing protocols are documented on the internal server. The database information attached to the geo-spatial data is entered into an access table from the data received back from the WFMI system, exported to a dbf and joined to the GIS. This process will be updated as described in "WFMI Data and Ignition Locations" earlier in this Appendix.

Fire Analysis

Several types of fire analysis are processed in the early spring following the compilation of fire history from the previous calendar year. Stored with each of these datasets is a processing protocol document available for GIS technicians.

Fuels

A fuels layer is derived by reclassifying vegetation and modifying it based on fire severity and history. Working with an interagency group and the NPS regional fuels specialist, the crosswalks have been completed for the new vegetation map. This includes both the standard 13 models and the new Scott and Burgan models. However, only the 13 standard fuel models are updated each year based on burn severity data from the past year.

Hazard

A hazards layer was derived from a combination of slope, aspect, fuels, and elevation. A group of fire ecologists met with the GIS staff to determination a weighting scheme with the assumption that a factor such as a steep slope would pose a greater risk to control than a south-facing slope.

Risk

Risk data has been created from fire history by generating a point ignition file from either the reported fire start location, or a location derived by GIS from the center point of the GIS database location. The point ignition data can then be categorized into types of risk, such as lightning risk or human-caused ignition risk.

VALUES

Ecological Need for Fire

This process, locally known as FRID (Fire Return Interval Departure) was also developed by fire ecologists and the GIS staff. It uses fire history and the estimated historic fire regime to reclassify vegetation. The known fire history year is subtracted from the current year giving the number of years since fire. This is then compared to the historic fire return interval to determine how much an area has deviated from the return interval. This is a significant planning tool for locating fuel buildup. GIS can identify locations of concern for field reconnaissance.

Knowledge of Historic Fire Regime

Knowledge of historic fire regimes in the parks is an ongoing research project. The fire ecologist has compiled a table from intensive research using tree-ring samples and historic documents. This table is the crux of the fire analysis process. It projects an estimate of the historic fire return interval for each vegetation type in the parks. The current focus of research is distinguishing between fire history on different slope aspects. The results of this research will allow the fire management program to refine its estimate of fire return interval departure.

Landscape Treatment Priority Analysis

By combining several of the analyses listed above, the parks have developed a process to help identify treatment priorities. Hazard, Risk, FRID, Wildland Urban Interface, and the presence of giant sequoia groves are all part of the inputs into this analysis.

Burn Severity

The parks submit a request each year to the USGS's EROS data center to provide burn severity data from Thematic Mapper satellite imagery. The data is fairly course (30 meters pixels) and has difficulty picking up changes in heavy canopy. The fire effects crew reads CBI plots to validate the burn severity data. High and moderate burn severity areas are being used to update the fuels and canopy cover layers. The EROS data center is also working to complete a more comprehensive fire history spanning the depth of the landsat dataset to look at burn severity history for over 20 years.

INTERAGENCY COLLABORATION

The need for fire managers in the southern Sierra Nevada to work collaboratively is increasing. Informed decisions require information on the current status of fires across the regional landscape. As a matter of standard practice the Fire GIS Specialist collaborates with other agencies for data development and coordination.

Statewide Fire History

The parks participate in the statewide fire history database maintained by the California Department of Forestry and Fire (CDF).

SSFMO

The Southern Sierra Fire Management Officers (SSFMO) group was established to support interagency fire management. The Sierra Wildland Fire Reporting System (SWFRS, http://sierrafire.cr.usgs.gov/swfrs) is a web based application whose goal is to provide fire managers with a dynamic, web-based reporting and mapping system identifying the locations of and current status of fires in near real-time. Specific goals identified include:

Provide interactive maps displaying the current fire situation with robust summary report capabilities.

Display remote web cam images and links to smoke monitors in the region.

Minimize redundancy with other fire management applications.

The SSFMO group includes four national forests (Inyo, Sequoia, Sierra, & Stanislaus), two national parks (Sequoia & Kings Canyon and Yosemite), and the Bakersfield Field Office of the Bureau of Land Management.

FPA

The FPA is a national program to develop an interagency fire budget application and fire management planning tool. The partners of the South Sierra FPA planning area include the Bakersfield Field Office of the Bureau of Land Management, Sequoia & Kings Canyon National Parks, Sequoia National Forest, and the Tule River Indian Reservation. Collaborative datasets and interagency fire management alternatives are developed as model inputs for budget analysis. The local planning area has also been identified as a prototype to beta-test the FPA model during development. Working closely with the national development team, local data is entered into the model during development to provide feedback.

G- Organization Charts

Since the fire and fuels management program is comprised of staff members in different divisions, seven organization charts are necessary to understand the organizational structure:

Sequoia and Kings Canyon National Parks & Devils Postpile National Monument

This chart displays the organization of divisions under the Superintendent. Three divisions have positions related to fire and fuels management: 1) Interpretation and Cultural Resources, 2) Fire and Visitor Management, and 3) Natural Resources.

Division of Fire and Visitor Management

This chart displays the organization of the Fire and Aviation branch of the Fire and Visitor Management Division.

Kings Canyon District

This chart displays the organization of the Kings Canyon Fire District under the Division of Fire and Visitor Management.

Sequoia District

This chart displays the organization of the Sequoia Fire District under the Division of Fire and Visitor Management.

Fuels Management

This chart displays the organization of the Fuels Management Program under the Division of Fire and Visitor Management.

Division of Interpretation, Education and Partnerships

This chart displays the organization of the fire and fuels management positions within the Division of Interpretation, Education and Partnerships.

Division of Resources Management and Science

This chart displays the organization of the fire and fuels management positions within the Division of Resources Management and Science.

Figure G-1 – Organization Chart for Sequoia & Kings Canyon National Parks and Devils Postpile National Monument

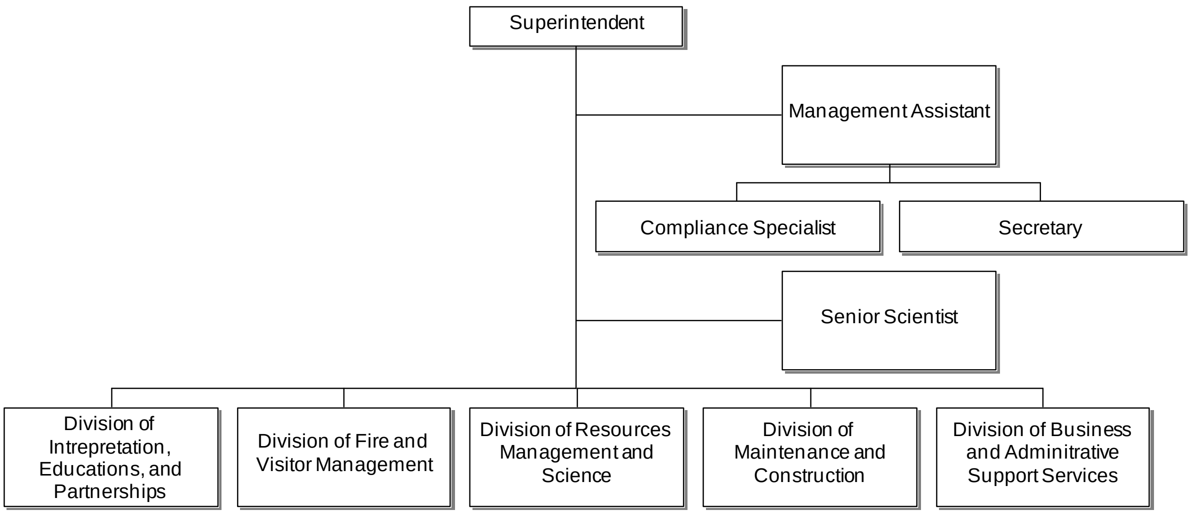
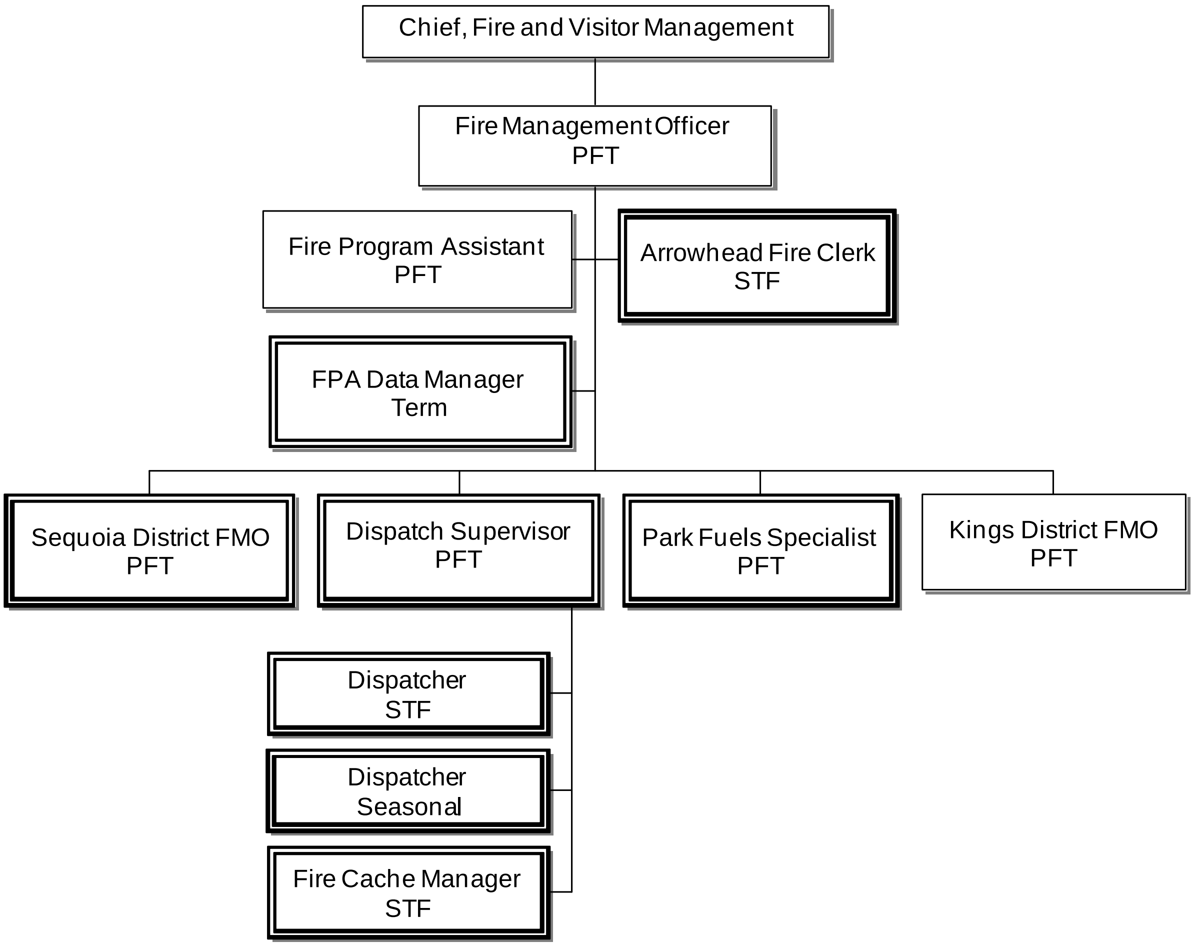


Figure G-2 – Organizational Chart for Division of Fire and Visitor Management



** The positions with double lines are fire-funded. Single lines are ONPS-funded.

Figure G-3 – Organization Chart for Kings Canyon District

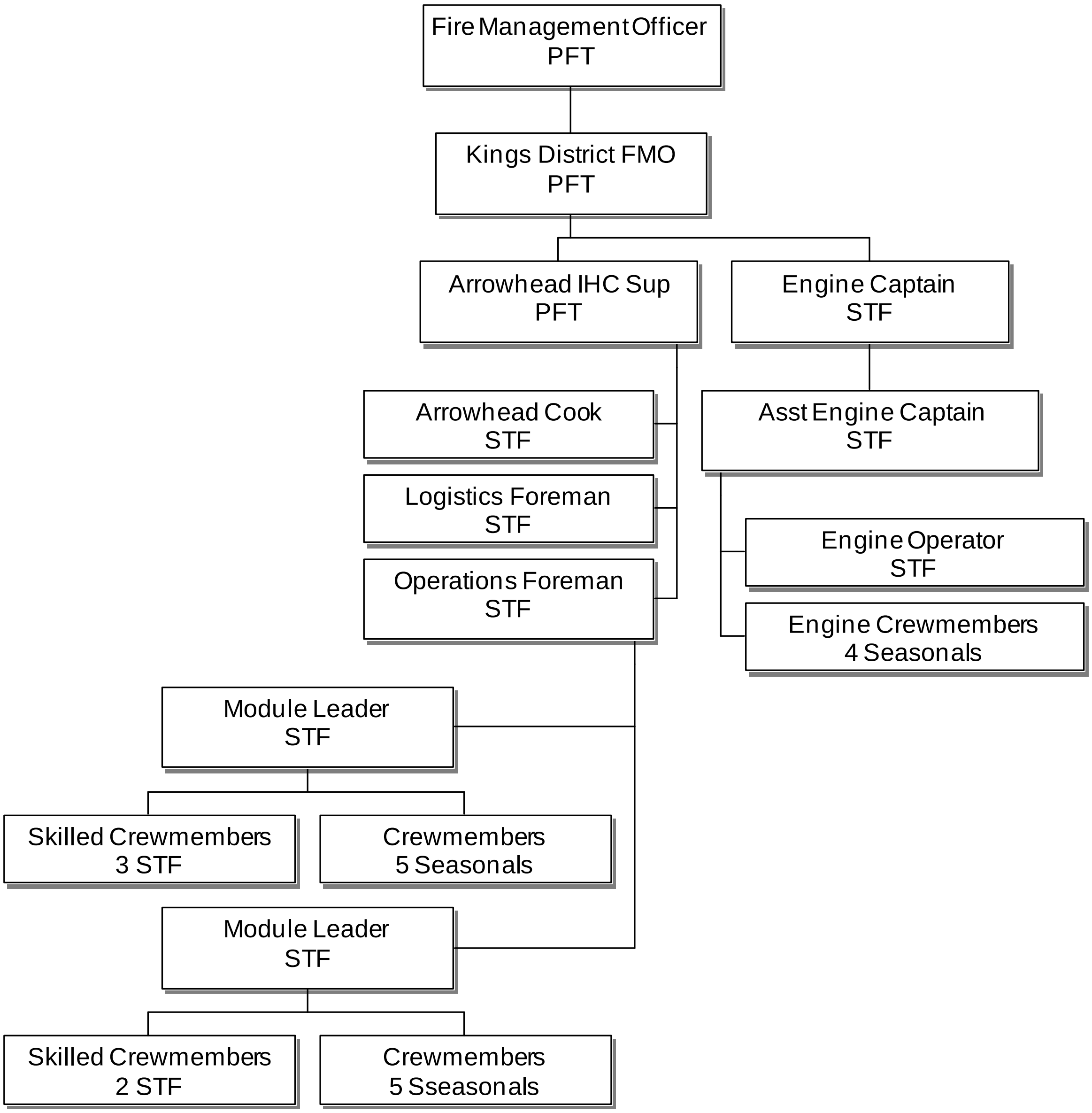
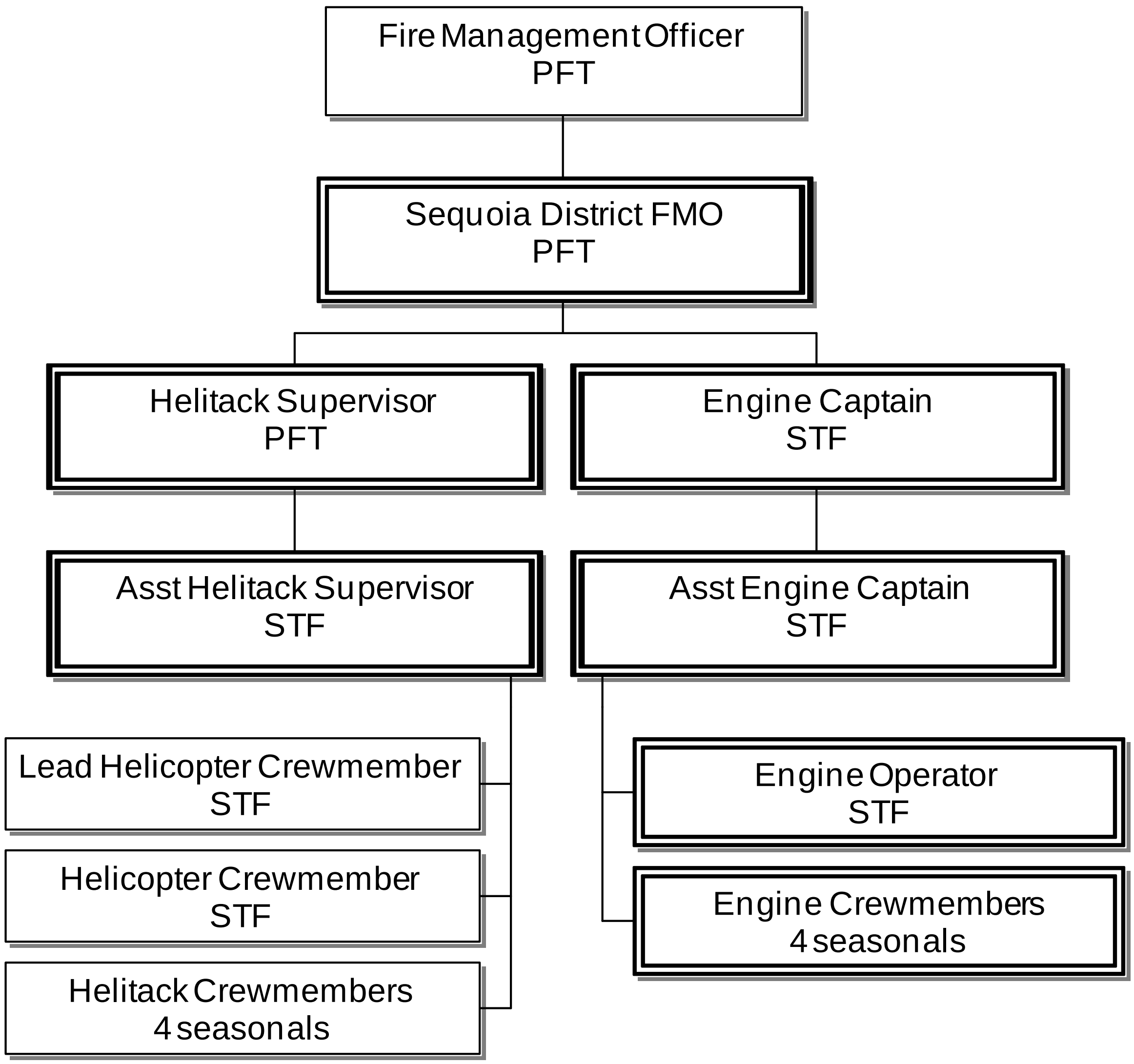


Figure G-4 – Organization Chart for Sequoia District



** The positions with double lines are fire-funded. Single lines are ONPS-funded.

Figure G-5 – Organization Chart for Fuels Management

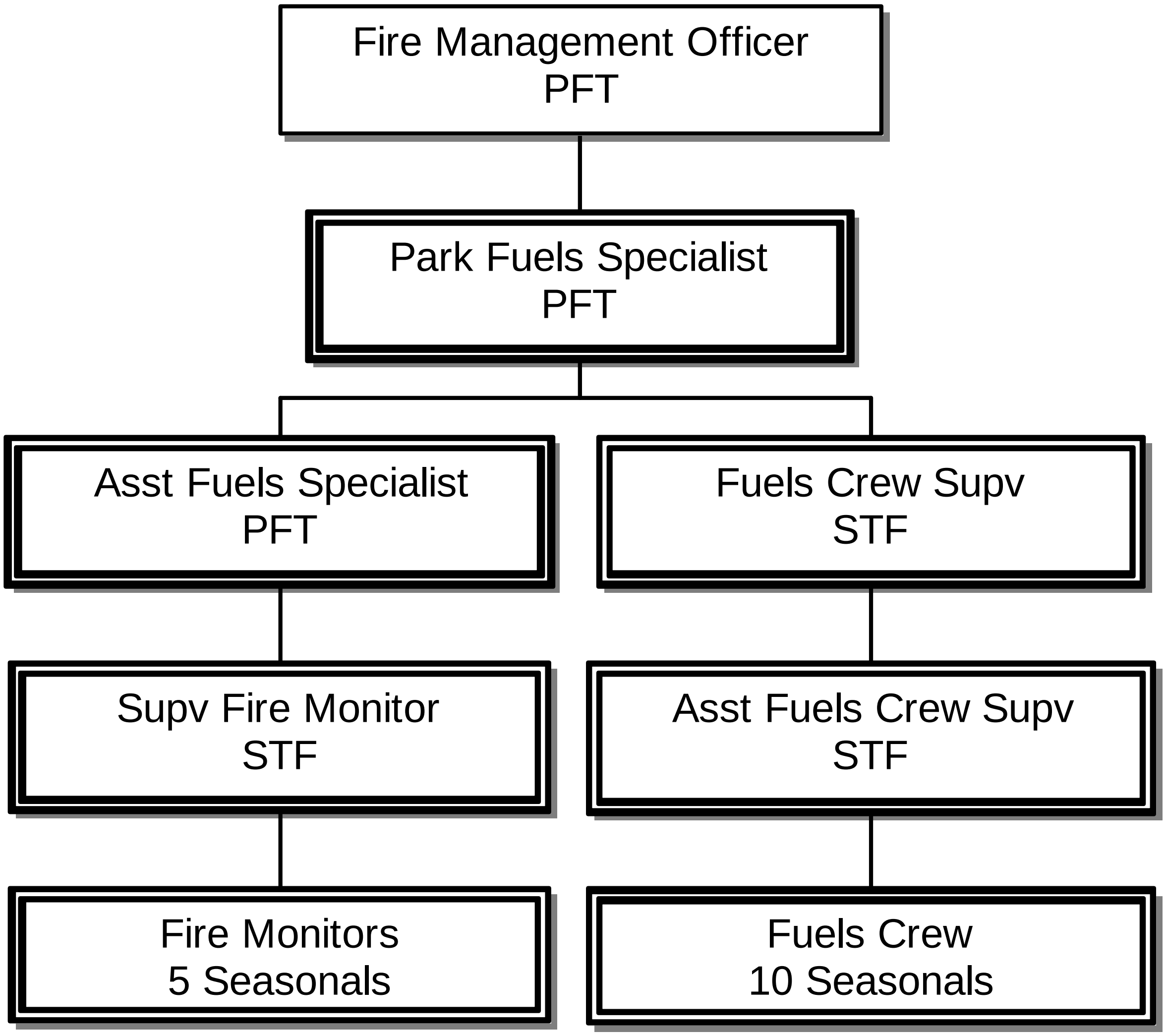


Figure G-6 – Organization Chart for Division of Interpretation, Education and Partnerships

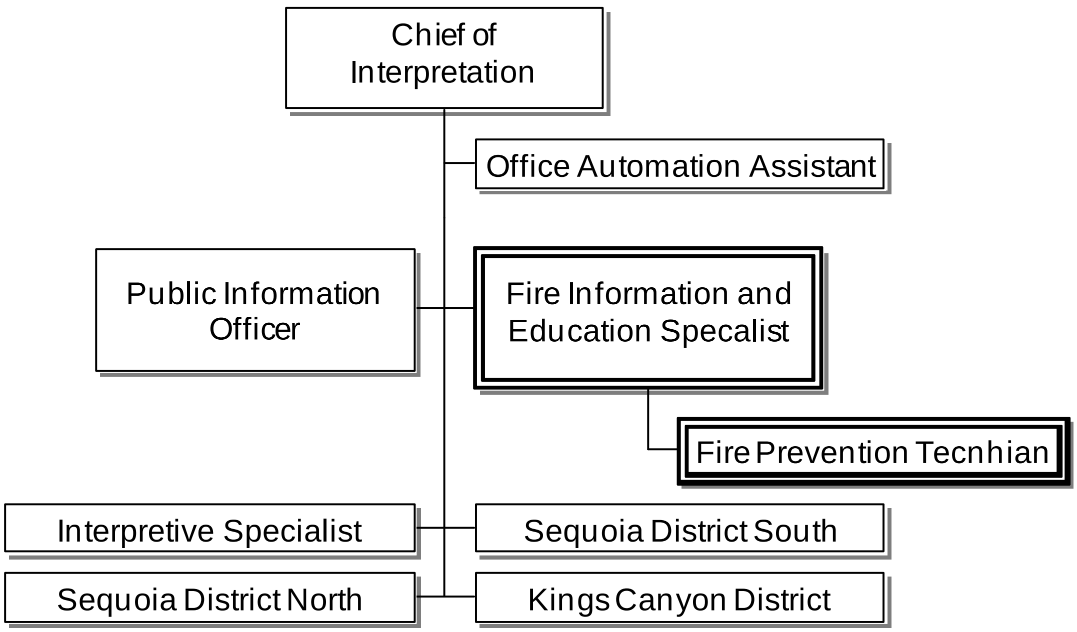
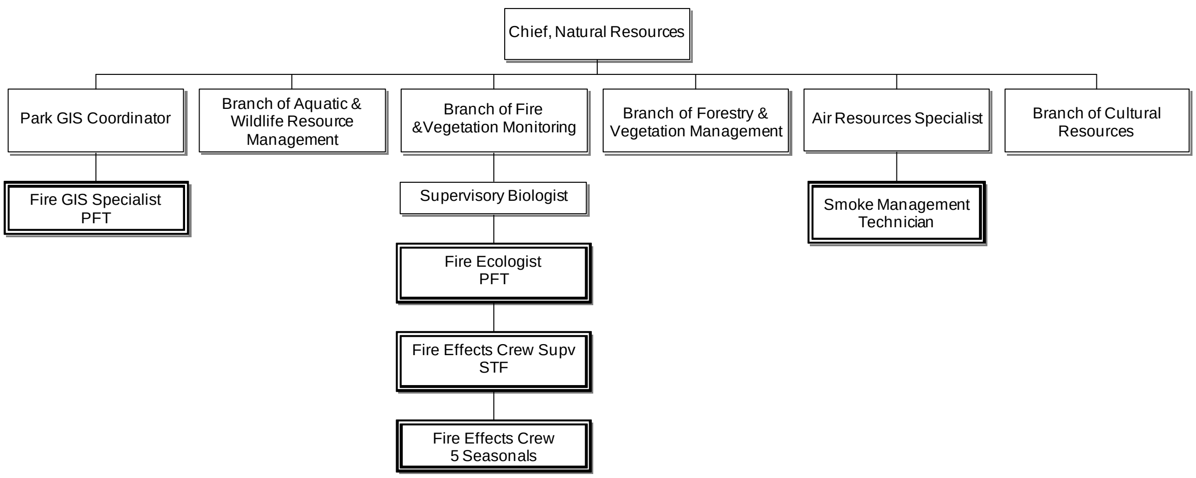


Figure G-7 – Organization Chart for Division of Resources Management and Science



H- List of Classified Structures

Table H-1 – List of Classifies Structures (as of 2004)
Legend for "Management Category" column
SBP & M = Should be Preserved and Maintained
MBP & M = May be Preserved and Maintained

	Structure Name	Structure Number	LCS ID	Management Category	Condition
	Generals Highway	B	057645	SBP & M	Good
	Silliman Creek Culvert	K	058193	SBP & M	Good
	Tunnel Rock	G	058187	SBP & M	Good
	Hospital Rock Stone Water Fountain	J	058192	SBP & M	Good
	Hospital Rock Automobile Watering Stations	H	058141	SBP & M	Poor
	Atwell's Mill	HS-07	005031	SBP & M	Good
	Ash Mountain Entrance Sign	009	005030	SBP & M	Good
	Moro Rock Stairway	013	005026	SBP & M	Good
	Clover Creek Bridge	014	005027	SBP & M	Good
	Barton-Lackey Cabin	016	006046	SBP & M	Good
	Cloud Canyon Shorty Lovelace Cabin	HS-18	009472	SBP & M	Fair
	Vidette Meadow Shorty Lovelace Cabin	HS-23	009507	SBP & M	Fair
	Gardiner Creek Shorty Lovelace Cabin	HS-24	009508	SBP & M	Poor
	Woods Creek Shorty Lovelace Cabin	HS-25	009509	MBP & M	Poor
	Granite Pass Shorty Lovelace Cabin	HS-27	009473	MBP & M	Poor
	Marble Fork Bridge	029	013017	SBP & M	Good
	Quinn Ranger Station	033	005035	SBP & M	Unknown
	Tharp's Log	044	001303	SBP & M	Fair
	Squatter's Cabin	045	001302	SBP & M	Fair
	Cattle Cabin	046	001300	SBP & M	Good
	Giant Forest District Ranger's Residence	055	005028	SBP & M	Fair
	Atwell Mill Ranger Residence	062	056085	SBP & M	Good
	Cabin Creek Ranger Residence	065	005032	SBP & M	Good
	Cabin Creek Dormitory and Garage	066	005033	SBP & M	Good
	Hockett Meadow Ranger Station	075	005021	SBP & M	Good
	Redwood Meadow Ranger Station	102	005023	SBP & M	Good
	Giant Forest Market	104	056084	SBP & M	Good
	Grant Grove Chief Ranger's Residence	108	006038	SBP & M	Fair
	Grant Grove Superintendent's Residence	112	006039	SBP & M	Fair
	Redwood Mountain Ranger Station	115	056123	SBP & M	Good
	Cedar Grove Ranger Station	118	005022	SBP & M	Good
	Hockett Meadow Tack-Storage Room	139	005022	SBP & M	Good
	Giant Forest Village Comfort Station	179	005029	SBP & M	Good
	Pear Lake Ski Hut	204	009474	SBP & M	Good
	Redwood Meadow Tack-Storage Cabin	205A	005024	SBP & M	Good
	Lost Grove Comfort Station	231	056200	SBP & M	Fair
	Grant Grove Warehouse and Maintenance Shop	237	056087	SBP & M	Good
	Atwell Mill Ranger Station Garage	315	056086	SBP & M	Good

	Gamlin Cabin	350	001301	SBP & M	Fair
	Smithsonian Institution Shelter	354	005020	SBP & M	Good
	Muir Hut	355	009510	SBP & M	Unknown
	Knapp Cabin	371	006042	SBP & M	Fair
	Grant Grove Maintenance Mess Hall	111	372557	SBP & M	Good
	Grant Grove Residence	113	372584	SBP & M	Good
	Grant Grove Residence	114	372553	SBP & M	Good
	Grant Grove Residence	116	372565	SBP & M	Good
	Grant Grove Residence	117	372794	SBP & M	Good
	Grant Grove Generator Shed	209	372810	SBP & M	Good
	Grant Grove Maintenance Cabin	243	372561	SBP & M	Good
	Grant Grove Superintendent's Woodshed	245	372590	SBP & M	Good
	Grant Grove Horse Barn	246	372542	SBP & M	Good
	Pine Camp Comfort Station	248	372877	SBP & M	Good
	Sunset Campground Comfort Station	249	376620	SBP & M	Good
	Swale Camp Comfort Station	250	372852	SBP & M	Good
	Grant Grove Comfort Station	251	372473	SBP & M	Fair
	Grant Grove Superintendent's Garage	322	372586	SBP & M	Good
	Crystal Springs Comfort Station	252	372829	SBP & M	Good
	Azalea Camp Comfort Station	257	372839	SBP & M	Good
	Swale Camp Bathhouse	259	372866	SBP & M	Good
	Sunset Campground Bathhouse	260	376639	SBP & M	Good
	Grant Grove Residence Garage	323	372575	SBP & M	Good
	Grant Grove Gas Station		372456	SBP & M	Fair
	Grant Grove Stables Piano Shed		372549	SBP & M	Good
	Grant Grove Lodge Bath House		372506	SBP & M	Good
	Grant Grove Log Cabin	9	372529	SBP & M	Good
	Grant Grove Lodge Duplex Cottages 1 and 2	1-2	372511	SBP & M	Good
	Grant Grove Lodge Duplex Cottages 3 and 4	3-4	375849	SBP & M	Good
	Grant Grove Lodge Duplex Cottage 5 and 6	5-6	375854	SBP & M	Good
	Grant Grove Lodge Duplex Cottage 7 and 8	7-8	375755	SBP & M	Good
	Grant Grove Lodge Rustic Cabin 310	310	372522	SBP & M	Good
	Grant Grove Lodge Rustic Cabin 311	311	375808	SBP & M	Good
	Grant Grove Lodge Rustic Cabin 318	318	375918	SBP & M	Good
	Grant Grove Lodge Tent Cabin 302	302	372525	SBP & M	Good
	Grant Grove Lodge Tent Cabin 303	303	375372	SBP & M	Good
	Grant Grove Lodge Tent Cabin 304	304	375793	SBP & M	Good
	Grant Grove Lodge Tent Cabin 307	307	375430	SBP & M	Good
	Grant Grove Lodge Tent Cabin 308	308	375446	SBP & M	Good
	Grant Grove Lodge Tent Cabin 309	309	373680	SBP & M	Good
	Grant Grove Lodge Tent Cabin 313	313	375492	SBP & M	Good
	Grant Grove Lodge Tent Cabin 317	317	375787	SBP & M	Good
	Grant Grove Lodge Tent Cabin 319	319	365707	SBP & M	Good
	Grant Grove Lodge Tent Cabin 321	321	365713	SBP & M	Good
	Grant Grove Lodge Tent Cabin 324	324	365720	SBP & M	Good
	Grant Grove Lodge Tent Cabin 326	326	375731	SBP & M	Fair
	Grant Grove Lodge Tent Cabin 327	327	365738	SBP & M	Good

	Grant Grove Lodge Tent Cabin 328	328	375741	SBP & M	Good
	Grant Grove Lodge Tent Cabin 329	329	375748	SBP & M	Good
	Grant Grove Meadow Camp Cabin 501	501	372534	SBP & M	Good
	Grant Grove Meadow Camp Cabin 502	502	376750	SBP & M	Good
	Grant Grove Meadow Camp Cabin 503	503	376770	SBP & M	Good
	Grant Grove Meadow Camp Cabin 504	504	376799	SBP & M	Good
	Grant Grove Meadow Camp Cabin 507	507	376814	SBP & M	Good
	Grant Grove Meadow Camp Cabin 508	508	376826	SBP & M	Good
	Grant Grove Meadow Camp Cabin 509	509	376835	SBP & M	Good
	Grant Grove Meadow Camp Cabin 510	510	376842	SBP & M	Good
	Grant Grove Meadow Camp Cabin 511	511	376873	SBP & M	Good
	Grant Grove Meadow Camp Cabin 512	512	376888	SBP & M	Good
	Grant Grove Meadow Camp Cabin 513	513	376903	SBP & M	Good
	Grant Grove Meadow Camp Cabin 514	514	376917	SBP & M	Good
	Grant Grove Meadow Camp Cabin 515	515	376937	SBP & M	Good
	Grant Grove Meadow Camp Cabin 516	516	376950	SBP & M	Good
	Grant Grove Meadow Camp Cabin 517	517	376963	SBP & M	Good
	Grant Grove Meadow Camp Cabin 518	518	377053	SBP & M	Good
	Grant Grove Meadow Camp Cabin 519	519	377063	SBP & M	Good
	Grant Grove Meadow Camp Cabin 520	520	377084	SBP & M	Good
	Grant Grove Meadow Camp Cabin 521	521	377110	SBP & M	Good
	Grant Grove Meadow Camp Cabin 523	523	377155	SBP & M	Good
	Grant Grove Meadow Camp Cabin 524	524	377202	SBP & M	Good
	Grant Grove Meadow Camp Cabin 525	525	377220	SBP & M	Good
	Grant Grove Meadow Camp Cabin 526	526	377228	SBP & M	Good
	Grant Grove Meadow Camp Cabin 527	527	377241	SBP & M	Good
	Linzmeier Cabin	C-11	377510	SBP & M	Good
	Shanab Cabin	C-21	377624	SBP & M	Good
	Barkman Shed	C-24	377650	SBP & M	Fair
	Barkman Cabin	C-25	377763	SBP & M	Fair
	Brown House	C-31	377793	SBP & M	Good
	Bulkley Cabin	C-51	377837	SBP & M	Good
	83690 Park Road	C-91	377868	SBP & M	Fair
	83681 President's Lane	C-108	377906	SBP & M	Fair
	Mineral King Road		378084	SBP & M	Good
	Lookout Point Ranger Residence		378111	SBP & M	Good
	Lookout Point Ranger Station Garage		378116	SBP & M	Good
	Cabin Cove Cabin #2	2	378119	SBP & M	Fair
	Slapjack Creek Automotive Watering Trough		378205	SBP & M	Good
	Traugers Automotive Watering Trough		378208	SBP & M	Good
	Redwood Creek Automotive Watering Trough		378213	SBP & M	Good

I- Smoke Communication Strategy

The purpose of this communication strategy is to provide factual talking points about smoke that can be used during prescribed fires, fire use projects, suppression actions, and fires occurring outside the park. These points will be incorporated into various communication methods employed by the parks in reference to fire and fuels management (i.e. press releases, public meetings, interpretive programs, etc.). For more information on communication methods, please refer to the Public Information and Education section of Chapter 3 in this document and also the *Standard Operating Procedure for Fire and Fuels Information*.

The key to a successful strategy is targeting the right people (audiences) in the right ways (methods) with the right messages (talking points). During a fire incident, there are specific smoke messages that can be integrated into the general fire information effort.

AUDIENCES

- Superintendent and Division Chiefs
- All employees and their families (including NPS, SNHA, USGS, concessions, and volunteers)
- Park visitors (including in-park visitors, internet visitors, and special groups)
- In-park communities – Wilsonia, Silver City, Mineral King cabins, Oriole Lake
- Neighboring communities – Three Rivers, Badger
- San Joaquin Unified Air Pollution Control District

METHODS

During a Fire Incident

Clearly outline the authority given to park supervisors to minimize smoke impacts to their employees. Employees can notify supervisors if they are having adverse impacts from smoke. Alternative work schedules and locations will be arranged where appropriate.

- Hold Open House/Town Meeting for employees and residents in smoke affected areas.
- Operate particulate monitors in affected areas. Be prepared to move or add monitors. Start monitoring early in the incident.
- Provide daily air quality information, which interprets the particulate monitor data.
- Set up a smoke hotline (phone) to handle smoke complaints.
- Leave flyers on employee doorsteps with tips to decrease exposure.
- Post on bulletin boards.
- Disperse information by email, voice-mail, and fax
- Use the park webpage as a vehicle for dispersing daily air quality information.
- Give air quality conditions during the daily weather report on park radio.

Year-round Actions

- Incorporate air quality messages into year-round public outreach: interpretive programs, public meetings, press releases, etc.
- Offer special air quality seminars or trainings to help locals understand regional air issues.

SMOKE TALKING POINTS

In addition to general fire messages/information, the following talking points on smoke should be included in public information. Each talking point includes an example of language that might be used in updates, press releases, articles, presentations, etc. The talking points are organized in groups according to when they will be used (i.e. specific times during the year or different types of incidents): Year-round, Early Fire Season, Announcing a Planned Smoke Event, Responding to an Unplanned Smoke Event, and During Long-Duration Smoke Event. These talking points can be seen "at-a-glance" in a chart at the end of this section.

Year-round

Wildland fire smoke fits into a larger regional air quality situation.

Example: "The scenic vistas in the parks, especially in the summer, are highly obscured by regional haze. Haze is caused when sunlight encounters tiny particles in the air. These

particles may be the result of either natural events or human activities. According to the local Air District, over 95% of the particulate pollution in our area originates from Central

Valley sources (i.e. motor vehicles, industrial fuel burning, manufacturing, and agriculture). Less than 5% comes from wildland fire in the Sierra Nevada" (From SEKI's *"Fire & Fuels Management"* newspaper).

Smoke, like fire, is a natural ecosystem component.

Example: "Is there a bright side to all this talk about smoke? While it is a health concern for humans, plants have adapted to live with smoke just as they have many other natural elements of the environment. Scientists are discovering that some plants might even depend on smoke for their survival. A scientific study looked specifically at the low elevation chaparral plant communities. In the laboratory, scientists exposed various seeds to heat and charring, as in a fire, and certain species remained dormant. When the same seeds were exposed to smoke, germination occurred. While some plants, like the giant sequoia, use heat from fires for seed dispersal, it now appears that other plants rely on smoke for germination" (From SEKI's *"Story of Fire"* newspaper, out of print).

Visitors, residents, and gateway communities should expect to see smoke in Sequoia & Kings Canyon National Parks, particularly in the late summer and early fall.

Example: "Regional haze and localized smoke from fire was historically part of the Sierra Nevada viewscape. Lightning fires that spread naturally burned through the late summer and early fall months and ended with the first significant rain or snow (known as a season ending event). Prior to Euro-American suppression policies, fires ignited in the summer months by lightning storms would burn throughout the late summer and fall in the Sierra Nevada. These fires would slowly smolder with the cooler and shorter days and eventually be extinguished by rain or snow.

Example: "Fire managers in Sequoia & Kings Canyon National Parks take advantage of natural lightning strike fires in an attempt to restore a natural fire cycle and regime in the parks. Smoke from these fires will likely be visible from certain locations in the park, particularly in the late summer and fall. Additionally, the fall months provide excellent prescription windows for fire managers to complete projects that meet the desired community protection and ecological goals of the park."

Early Fire Season

Park managers are sensitive to smoke impacts for visitors and employees.

Example: "The Sequoia and Kings Canyon fire and fuels management program is committed to balancing the needs of park resources and people. While fire has always been a natural part of this ecosystem, our current society presents unique conditions. Today, there are more people than ever living near or visiting Sequoia and Kings Canyon. Every fire management action considers this fact when determining incident objectives."

The parks work closely with the San Joaquin Valley Unified Air Pollution Control District to balance the fire and fuels management program with health and visibility issues.

Example: "The Air District is currently classified as "Serious Non-Attainment" for both ozone and PM-10. To help the district achieve the National Ambient Air Quality Standards, Sequoia and Kings Canyon burns during optimal weather conditions, utilizes optimal ignition techniques, estimates project emissions, projects the anticipated smoke plume path, provides extensive public education/awareness, and coordinates with neighboring land management agencies and air districts."

There are ways for park residents and neighbors to reduce their exposure to smoke.

Example: "Smoke concentrations can be avoided by following a few simple rules. Close windows, doors, and outside vents when it is smoky to prevent accumulations indoors. Run your air conditioner, if you have one. Keep the fresh air intake closed and keep the filter clean. Ventilate your home and work place during periods of little smoke. Avoid physical activities while smoke is dense. Paper masks are designed to trap large dust particles, not the tiny particles found in smoke. These masks will not protect your lungs from smoke."

Example: "Residents of communities affected by smoke from wildland fires and prescribed fires are encouraged to practice good health habits. A healthy immune system is the best protection against the effects of smoke. Immune function is enhanced with regular moderate physical activity, good nutrition, hydration, and adequate rest" (From USDA Forest Service publication *Health Hazards of Smoke: Spring 2001*).

Breathing smoke is not healthy for anyone, but some people are at greater risk.

Example: "People with heart or lung disease, such as congestive heart disease, chronic obstructive pulmonary disease, emphysema or asthma are at greater risk. Children and the elderly are also more susceptible to smoke. These people are advised to use caution and avoid physical activity while heavy smoke is present."

Example: "The risks of occasional exposure to fine particulate and other components of vegetative smoke are minimal for healthy individuals. However, elevated levels of smoke that persist for months or years increase the risk of heart and respiratory disease, especially among the elderly and individuals with pre-existing respiratory or cardiovascular illness" (From USDA Forest Service publication *Health Hazards of Smoke: Spring 2001*).

The *Air Quality Index* (AQI) is one tool that helps managers, employees, and visitors quantify daily air quality conditions.

Example: "Established by the Environmental Protection Agency and adopted by the states, the Air Quality Index (AQI) is a tool for reporting daily air quality conditions (based upon a 24-hours average). Using numeric information from sensors like particulate monitors, the AQI tells you how clean or polluted your air is, and what associated health concerns you should be aware of. The AQI focuses on health effects that can happen within a few hours or days after breathing polluted air. You can think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health danger. The Index identifies six conditions: good (0 to 15), moderate (15 to 40), unhealthy for sensitive groups (40 to 65), unhealthy (65-150), very unhealthy (150-250), and hazardous (over 250)." (Park Visitor Centers have wooden exhibits that display this information daily.)

Announcing a Planned Smoke Event

During prescribed burns, fire managers utilize smoke management techniques.

Example: "The entire burn segment is 925 acres, but is split into two sections for smoke management reasons. A fire line has been constructed inside the segment where the fire can be held if smoke production is a problem. The burn boss plans to ignite 30-40 acres per day to minimize smoke output. This will increase the duration of the smoke event but will decrease the ambient level of smoke at any one time."

Due to the deliberate nature of prescribed fire, audiences can be notified prior to the smoke event about what to expect.

Example: "During the week of ignition, visitors traveling through the area will smell and possibly see smoke. Smoke will likely be visible from [specific location]. The smoke will most likely settle in lower elevations during the early morning."

The park has the ability to monitor particulate levels in Sequoia and Kings Canyon National Parks during smoke events.

Example: "As soon as the park anticipates a smoke event that may affect people, air quality technicians begin operating a Smoke and Weather Monitoring Module. This mobile unit measures particulate levels in the air. Particulates are solid particles produced by things like vehicle emissions, agricultural activities, and fires. The module records levels every hour and then computes a 24-hour average which correlates to the National Ambient Air Quality Standards (NAAQS) established by the Environmental Protection Agency (EPA). During extreme smoke conditions, technicians retrieve data from the module daily."

Some characteristics of smoke accumulation are predictable because they are based on daytime and nighttime winds.

Example: "Up-slope or up-canyon breezes occur during the day which will often take smoke into higher elevations. At night, these winds change direction and bring smoke down-slope to the lower elevations."

Some characteristics of smoke accumulation are not predictable since they are dependent on atmospheric conditions.

Example: "With unstable atmospheric conditions, smoke from wildland fires is mostly lofted up to very high elevations where it disperses. When atmospheric conditions are stable, perhaps with an inversion layer, smoke can be trapped at lower elevations.

Small fires prevent larger fires. Therefore smaller smoke events prevent larger smoke events.

Example: Every acre that burns under favorable conditions helps prevent the larger, unwanted fire and its smoke event."

Responding to an Unplanned Smoke Event

Small natural fires have the potential to become large fires.

Example: "Burning in heavy mixed conifer fuels, the newly discovered [*Name*] Fire has the potential to expand across hundreds of acres over the next several months. This fire was naturally-caused and will be naturally-extinguished with rain or snow. A "season-ending event" bringing more than ½-inch of rain over a 3-day period usually occurs in October."

There are ways of minimizing smoke in a fire use project without suppressing the fire.

Example: "While the park hopes to maximize resource benefits by allowing this fire to spread naturally, managers have at least two ways of reducing smoke in special situations. Hand crews can install fire line in strategic locations to contain certain areas of the fire. In extreme smoke situations, fire managers can drop water on hotspots. Unlike water drops in suppression actions, these drops are not meant to halt fire movement, but slow it down and reduce smoke."

During Long-Duration Smoke Event

Use all of the talking points above and hold an open house/meeting to respond to community, public, and employee needs.

After the Incident

Sequoia & Kings Canyon National Parks appreciate the patience of visitors, residents, and gateway communities during the incident and its associated smoke event.

Example: The fire management program considers smoke management in every step of the program. We know that the mountain communities surrounding the park are affected by our management decisions. We attempt to find a balance in the program that addresses your concerns while also returning natural fire to the landscape to reduce the risk of larger, unwanted fires and to achieve the ecological benefits of natural fire. The parks appreciated your patience and understanding during this period.

Table I-1 – Smoke Talking Points At-A-Glance

Year-round	Early Fire Season	Announcing a Planned Smoke Event	Responding to an Unplanned Smoke Event	During Long Duration Smoke Event	End of Season or After a Smoke Event
1.Wildland fire smoke fits into a larger regional air quality situation.	4. Park managers are sensitive to smoke impacts for visitors and employees.	9. During prescribed burns, fire managers utilize smoke management techniques.	15. Small natural fires have the potential to become large fires.	Hold an open house or a public meeting	Sequoia & Kings Canyon National Parks appreciate the patience of visitors, residents, and gateway communities during the incident and its associated smoke event.
2. Smoke, like fire, is a natural ecosystem component.	5. The parks work closely with the San Joaquin Valley Unified Air Pollution Control District to balance the fire and fuels management program with health and visibility.	10. Due to the deliberate nature of prescribed fire, audiences can be notified prior to the smoke event about what to expect.	16. There are ways of minimizing smoke in a fire use project without suppressing the fire.		
3. Visitors, residents, and gateway communities should expect to see smoke in the parks, particularly in the late summer and early fall.	6. There are ways for park residents and neighbors to reduce their exposure to smoke.	11. The park has the ability to monitor particulate levels in Sequoia & Kings Canyon National Parks during smoke events.			
	7. Breathing smoke is not	12. Some characteristics			

	healthy for anyone, but some people are at greater risk.	of smoke accumulation are predictable because they are based on daytime and nighttime winds.			
	8. The *Air Quality Index* (AQI) is one tool that helps managers, employees, and visitors quantify daily air quality conditions.	13. Some characteristics of smoke accumulation are not predictable since they are dependent on atmospheric conditions.			
		14. Small fires prevent larger fires. Therefore smaller smoke events prevent larger smoke events.			

Other Sources of Information

- Local Air District
- Air Quality Specialist in the park
- California Air Resources Board Public Education Protocol www.arb.ca.gov/smp/progdev/pubeduc/outreach_protocol.htm
- National Interagency Fire Center – www.nifc.gov
- Environmental Protection Agency – www.epa.gov/airlinks/

Example of Materials

The following list identifies some possible materials for public use. Since most of them predate this *Smoke Communication Strategy*, they serve only as examples and are not templates for this document.

- *Do You Smell Smoke?* or *Where there's fire there's smoke* – General description of where smoke is coming from and some simple steps for reducing exposure.
- *Smoke and Your Health* – Questions and answers about wildland fire smoke and health.
- *Smoke Generated by Wildland Fires* –Describes PM-10, the Air Quality Index, and the use of particulate monitors. (example from SEKI)
- *NPS Using Portable Module for Smoke/Weather Monitoring* –Describes the purpose and operation of mobile monitoring stations. (example from SEKI)
- *Smoke Complaint Log* – Sample sheet for cataloging smoke complaints during a fire event. (example from SEKI)

J- Smoke Management Plan

SUMMARY

This *Smoke Management Plan* provides guidelines for park management of smoke from wildland fires. It addresses all requirements set by the San Joaquin Valley Unified Air Pollution Control District (hereinafter called the District).

The parks are within the San Joaquin Valley air basin. The basin is classified as serious non-attainment for two criteria pollutants (particulate matter [PM-2.5] and ozone) as defined by the Federal Clean Air Act. This smoke management plan concentrates upon PM-2.5 as the most significant pollutant produced by wildland fire thereby serving as a marker for other criteria pollutants.

Under the Clean Air Act and the California Air Resources Board (CARB) State Implementation Plan (SIP), the District is required to implement Best Available Control Measures (BACM) in order to meet established deadlines set for complying with PM-2.5 National Ambient Air Quality Standards (NAAQS). BACM is implemented in the air basin by requiring the parks' fire program, and other burners within the air basin, to comply with a series of emission control measures that are some of the most stringent in the nation. The District is currently developing a PM-2.5 Plan (as of May 2009).

In conjunction with other Land Management Agencies, the District has developed *Unified Guidelines and Procedures for Smoke Management* (formerly known as the *Smoke Management Work Plan*) for regulating wildland and prescribed fires. The park *Smoke Management Plan* implements the District plan. In addition, the district has two specific rules pertaining to fire use projects and prescribed fires, Rule 3160 (Prescribed Burning Fee) and Rule 4106 (Prescribed Burning and Hazard Reduction Burning). This *Smoke Management Plan* responds to District procedures and rules contained in their plan. The dynamic nature of air resource management may require annual adjustment to this *Smoke Management Plan*.

The parks are part of an interagency group of wildland fire burners (federal, state, and private) and the District which meets either annually or bi-annually to discuss and seek improvement to basin air quality through improvements in fuels management and associated effects to the air resource. As a group member, the park adheres to all District rules described above.

By carefully managing the timing and location of smoke emissions these parks can meet goals in the *Fire and Fuels Management Plan* and the District's *Unified Guidelines and Procedures* while treating up to 15,000 acres per year of park land. As natural areas are treated and maintained with prescribed fire, wildland fire, and mechanical treatments, the potential amount of smoke emissions will be reduced. Smoke emissions that would otherwise be released during unwanted wildland fire events with accompanying severe smoke impacts to smoke sensitive areas (SSA's), potential harm to life and property, and unnatural alteration of ecosystems will be reduced.

INTRODUCTION TO THE SMOKE MANAGEMENT PLAN

Smoke behavior, and corresponding impacts, is a complex issue involving a number of elements:

- Fuel reduction techniques prior to or instead of burning as a means of emission reduction.
- Amount of fuel loading that will burn.
- Restoration areas have the highest fuel loading, including duff, which mostly burns in the smoldering phase. Maintenance areas have less fuel per acre than restoration areas (including duff loading) leading to a shorter, more discontinuous smoldering phase.
- Location, amount and duration of smoke emissions.
- Type of fire situation and controllability.
- Prescribed burn operations are more controllable and predictable than managing wildland fires for resource objectives. Generally, large unwanted suppression fires are the most uncontrollable and least predictable.
- Time of year smoke is produced.
- Summer conditions often provide the best southwesterly flow and lift for smoke but ozone levels are higher. Spring conditions provide weather events to disperse smoke but fuels are often too wet to burn. Fall conditions provide an excellent window for fuel and fire manageability but weather conditions often do not yield good smoke dispersal conditions.
- Behavior of the smoke plume, which is dependent on elevation and dynamic meteorological conditions.
- Direction and elevation the plume moves and resulting impacts at ground level to people, and impacts to sensitive airsheds, such as wilderness.
- Interaction of smoke from park fires with pollution sources in the San Joaquin valley (including other fires in the area).

This plan will be used to provide direction for the parks smoke management program. The plan directly parallels BACM as mandated by the EPA, CARB, and the District. The plan is based on smoke management principals provided by the national fire management training Smoke Management Techniques, RX-410. Written and verbal procedures that implement this plan will be revised continually as new or better methods become available, along with adjustments in staffing and support needs.

The current park smoke management program is probably one of the most advanced and complex in the nation. The purpose of the program is to serve the goals and objectives of the park *Fire and Fuels Management Plan* while, at the same time, serve the requirements of the Federal Clean Air Act as enforced by CARB through the District. As of 2009 the District was a non-attainment area for PM2.5. In 2004, park fire staff, along with representatives from several land management agencies, worked closely with the District in development of the above mentioned *Unified Guidelines and Procedures*. These guidelines and procedures are reviewed and updated annually by all stake holders.

In 1999, revision to CARB Title 17 forced required changes in District rules. Rule 3160 and 4106, as well as the District *Smoke Management Plan*, arose due to the new Title 17 direction. Rule 3160 describes procedures for assessing fees against acres treated with fire in order to fund District meteorologists and enforcement staff for prescribed fire regulation. Rule 4106 details regulations for permitting, regulating, and coordinating prescribed fire and wildland fires managed for resource objectives within the District area. The District then declared the 1997 MOU and its work plan void following the rule revisions in 2001. The *Unified Guidelines and*

Procedures are now the primary document used as a method to ensure coordination amongst burners and the District.

Much of this S*moke Management Plan* details smoke management techniques and administrative procedures. It is recognized that there exists a large amount of potential smoke emissions within the District due to the past 100 years of land management practices in natural areas. Where lands remain far outside the normal fire regime, unnatural ecosystem structure and processes predominate leading to high fuel accumulations and continuous canopies of vegetation. District staff recognizes these conditions exist and require attention. This plan and District rules and regulations are meant to balance ecosystem needs and air resource needs in order to stabilize ecosystems and reduce the amount of potential emissions over a multi-decade period of time.

REQUIRED DAILY MONITORING

Since 1996, a permanent particulate monitor has been located at Ash Mountain headquarters in Sequoia National Park, near the most populated SSA impacted by park fires, the town of Three Rivers. The monitor is located at the Ash Mountain air quality station. Data (PM-2.5) is collected 365 days per year and catalogued into a database so that baseline particulate loading is produced. Particulate loading for each date can then be compared with historical averages aiding fire managers in comparing current conditions with historical conditions as an aid in prescribed fire treatment and fire use execution.

From 1996 to 2007, the permanent particulate monitor was a TEOM; in 2007 this was replaced with a BAM 1020.

The park is no longer visually monitoring the impact of transport smoke that flows over the eastern crest into the Owens Valley via the Inyo National Forest.

PRESCRIBED FIRE

Planning: What do we do?

Annually identify areas that need prescribed fire and/or mechanical treatments by evaluating values, hazards, and risks for the three Zones and nine Fire Management Units (FMUs).

Select treatment priorities based upon the analysis of the values, hazards, and risks. Consider managerial capabilities to accomplish treatments given practical limitations in planning, finance, operations, and logistical support.

Write the annual fuels treatment plan that describes the program for the up-coming field season including descriptions of individual treatment preparation and execution needs. Insert this annual plan into a revised *5-Year Fuels Treatment Plan*. Burns will be dispersed across the parks in order to spread smoke emissions out over as broad an area as possible. Some areas of the park may not have prescribed burns take place every year in order to provide a break from smoke impacting SSA’s.

Submit the *Fuels Treatment Plan* to the Air District in the spring. Note that air quality regulations and requirements are dynamic and subject to change. Updated procedures and requirements enacted after the approval date of this plan will be incorporated in annual updates to the *Fire and Fuels Management Plan*. Air quality concerns remain the major issue affecting prescribed fire treatment.

Submit the Smoke Management Summary to the Air District for review no later than 7 days prior to ignition under Rule 4106. While as of 2008 the Air District is no longer reviewing burn plans, they must be made available upon request. Burn plans and Smoke Management Summaries will describe the smoke management parameters necessary to provide optimum smoke dispersal based on burn goals and objectives, location, fuel loading and predicted fuels consumption, length of ignition and burn down, and proximity to SSA's. Burn plan contingencies will also include a description of the decision process park management will take to limit smoke impacts if smoke conditions deteriorate in SSA's and the coordination requirements with the District. Minimum safe roadway visibility is described and the mechanism for maintaining safe use of the roads is explained in detail. Smoke management plans will also describe alternatives considered in lieu of burning and earlier treatments employed which have all ready reduced potential emissions. Discussion will provide why alternatives were rejected and how earlier treatments have provided mitigation for current burning. Emissions will be estimated and included in both documents. Smoke Management Summaries must be approved by the Air District before a burn can be implemented. The District may be using the Prescribed Fire Information Reporting System (PFIRS) for submitting Smoke Management Summaries in the future.

Request pre-ignition forecast. Seven days prior to the earliest ignition date, a "Planned Ignition Forecast Advisory" (PIFA) will be submitted to the District to begin long-range smoke dispersal forecasting for the proposed ignition. The District will provide 96-, 72-, and 48-hour outlooks, and 24-hour forecasts on days leading up to the proposed ignition date. The District retains final go/no-go authority until the time of ignition.

Project Implementation: What do we do?

Monitor weather and fuels against prescriptive criteria. Prescribed burns are ignited when weather conditions are favorable for dispersing smoke away from SSA's, or during conditions that dilute smoke so that impacts to SSA's do not exceed health standards. This will be accomplished by utilizing the most current and comprehensive weather forecasting information available for predicting smoke transport direction and concentration down wind. Fuel moisture is also a high priority prescription element that will be monitored pre-burn. Fuel moisture prescriptions are designed to provide the optimum balance between the need to moderate fire behavior, minimize undesired fire effects on other resource values, and minimize smoke production (drier fuels burn cleaner and produce less pollutants). Fuel moisture information will be obtained and analyzed pre-burn for all significant categories of fuels (usually 1-, 10-, 1000-hour and live fuels) to ensure conformity with the prescription.

- Obtain superintendent go/no go decision on ignition.
- Seek concurrence from the Air District to proceed with ignition.
- **Notify the public** about the ignition.
- **Hold briefing** and review burn plan operations with burn staff.
- Ignite a test-fire.
- Make final go/no go decision on ignition (burn boss and associates).

Ignition occurs. Fire Management staff will proactively regulate the number of acres burned each day. Two factors are of critical importance: emissions produced per day and duration of smoke produced. For prescribed fire treatments of forested areas near SSA's, acreage treated in restoration burns may be limited to about 150 acres per day, with twice that acreage for maintenance treatments. This limit serves only as a guide with acreage treated varying due to terrain, proximity to SSA's, fuel conditions (i.e. loading, dryness, fuel model), meteorological conditions, etc. Duration of smoke produced from fires will vary with the fuel type. Timber fires, due to fuel loading inclusive of duff, burn for the longest time periods. With half the duff present on most maintenance burns, duration is significantly reduced. Again, as a general rule, smoke production near SSA's should be kept to less than five days before significant reduction in particulate load production occurs.

Monitoring of meteorology and air quality conditions will begin prior to ignition and follow through ignition completion and burn down of remaining available fuels. Qualified fire personnel will conduct all smoke monitoring. This will be accomplished by visual observations on small fires, short duration fires (e.g. grass fires) and on remote wilderness fires. Personnel will monitor smoke impacts to SSA's and transmit that information to the burn boss to utilize the intelligence gathered to adapt burn execution to avoid unhealthful smoke impacts. On fires in close proximity to SSA's, that may be of long duration or possess heavy fuel loading, mobile E-BAM's with a web based data link may be placed in those SSA's for monitoring purposes. A network of web-cams throughout the Sequoia National Forest with a web based data link is also available for park and District personnel to monitor smoke dispersion.

Dispersion Intelligence. Smoke dispersion potential (the capacity of the atmosphere to absorb and disperse smoke) is carefully evaluated prior to a burn being ignited and during unit execution. Several methods can be utilized:

- Park fire management personnel operate six remote weather stations spread across the parks. The weather data collected provides fire staff with current information used in fire operations planning.
- Standard National Weather Service fire weather forecasts are reviewed for favorable dispersal winds aloft. Generally, ridge winds from the west at 10 to 15 mph are desirable.
- Data provided by various Internet sources provide detailed information on regional weather trends.
- Pre-ignition spot weather forecasts provided by the Weather Service provide detailed smoke dispersal information. Predicted unstable atmospheric conditions are optimal, although fire managers must weigh instability against the ability of fire behavior to become erratic and escape.
- The District's meteorologists provide additional dispersal information for burns at all elevations.
- The park contract helicopter can be used to assess the atmospheric adiabatic lapse rate before and during burn unit execution--which helps with interpreting the capacity of the atmosphere to disperse smoke. Helicopter crew members also conduct visual observations of burn unit smoke dispersal and record the observations.
- Significant test fires will be conducted prior unit ignition to determine that burning goals and objectives will be met, and that smoke dispersion occurs as predicted in the burn plan.

Post-fire: What do we do?

- **Assemble monitoring data** as part of the final fire package.
- For fires larger than 250 blackened acres, complete District smoke management post fire summary report.
- By June of the following year, pay the current District fee for all black acres produced on the burn.

Staffing Needs and Responsibilities

The park fuels specialist is responsible for the implementation of the annual fuels treatment program within their respective areas. Working with the district fire management officers, he/she will assign burn bosses to individual burn units, who must ensure appropriate staff is assigned to each burn. The park fuels specialist or designee will ensure coordination occurs between the District and the burn boss. Fire and aviation dispatch will track all PIFA and spot fire weather forecasts, and serve as an information gatekeeper when burn bosses are assigned and unavailable for telephone conversations with District enforcement staff. The park fuels specialist will act as the check in the system ensuring coordination at the burn plan/smoke management plan phase, execution phase, and post-fire stage occurs.

Documentation and Cost Tracking

The fire folder will contain copies of all documents as outlined in Appendix Q (Wildland and Fuels Management Reporting Requirements). The folder will include: all planning documents (burn plan and any amendments, smoke management plan, incident action plans), monitoring data and summary reports, fire time reports, maps, photos, and WFMI reports. All expenditures will be tracked and reported according to the standards established in the Department of the Interior WFMI reports. It is the responsibility of the burn boss, to ensure WFMI report completion. Acres blackened rather than fire perimeter will be used to assess District Burn fees.

WILDLAND FIRES

Planning: What do we do?

- When a fire is reported, the parks will take the following actions:
- Locate the fire.
- Size up and determine cause.

Complete a Response Level 1 document as part of the Wildland Fire Decision Support System (WFDSS) to determine the appropriate management response with eight hours of fire confirmation.

Per the *Unified Guidelines and Procedures*, notify the District through the Wildland Fire Summary Report Form regardless of size.

Decision criteria and risk factors to consider in the Response Level 1 are outlined in the Guideline for Implementation of Federal Wildland Fire Management Policy (February 2009) Parameters requiring in-depth analysis for the parks will include air quality for those fires with potential to affect SSA's. If it is determined that the fire can be managed within the constraints outlined, the ignition may be appropriate to manage for resource objectives.

Implement the appropriate response. For wildland fires managed for resource objectives this may vary from periodic aerial reconnaissance to on-scene fire monitors. If the management complexity of the fire exceeds the capabilities of local resources, the parks may manage the incident through delegation to a wildland fire incident management team (see Appendix K for a delegation of authority example).

For fires exceeding 10 acres, complete the District Wildland Fire Smoke Management Summary. This summary is similar as outlined for prescribed burns. Most often, smoke management summaries are not needed for those fires requiring only a WFDSS Response Level 1 document because they stay less than 10 acres in size.

Continue to reassess the fire situation. The park must perform periodic fire assessments. The superintendent must continually validate that the fire is managed appropriately and will assess if there is a need for a more detailed WFDSS Response Level 2 or 3, or a shift to control objectives and suppression actions. If air quality drives the need for a WFDSS Response Level 2 or 3, detailed information on mitigation for air quality effects will be contained in the Response Level document, and cross referenced to the smoke management summary for the wildland fire. If a Response Level 3 is determined to be needed, the park will involve the District in the writing of the smoke management section.

Manage the fire until declared dead out according to monitoring intensity and frequency guidelines indicated in the WFDSS documents. At the minimum, periodic ground or aerial reconnaissance will be used to verify the periodic revalidation of the wildland fire response. More in-depth monitoring may be necessary to ensure proper incident management if complexity or risk increases. The parks monitor for wind speed, wind direction, smoke plume rise and dispersal, temperature, humidity, fuel moisture, fire size, and fire behavior (rate of spread, direction of spread, intensity).

Post-fire: What do we do?

- Assemble monitoring data as part of the final fire package.
-
- For fires larger than 250 blackened acres, complete District smoke management post fire summary report.
-
- By June of the following year, pay the current District fee for all black acres produced on the fire.

Staffing Needs and Responsibilities

Response Level 1 through 3 documents will be completed by district fire management officers or their designates (park fire management officer or fuels specialist staff). Additional park staff serving as subject matter experts will be involved in planning as conditions, issues, and fire location dictate. Examples include: district rangers, air quality specialist, archeologist, wildlife biologist, roads and trails supervisor, district facility manager, and fire information and education specialist. Fire complexity and risk will determine staffing needs.

Documentation and Cost Tracking

The fire folder will contain copies of all documents as outlined in Appendix Q (Wildland and Fuels Management Reporting Requirements). The folder will include: all planning documents (Response Level documents and any amendments, smoke management plan, incident action plans), monitoring data and summary reports, fire time reports, maps, photos, and WFMI reports. All expenditures will be tracked and reported according to the standards established in the Department of the Interior WFMI reports. It is the responsibility of the district fire management officer, the wildland fire manager, or the fire Incident Commander to ensure fire report completion. Acres blackened rather than fire perimeter will be used to assess District Burn fees.

BURN PLANNING, ADMINISTRATION AND AUTHORIZATION

Fire and Fuels Management Plan. The park's *Fire and Fuels Management Plan* is the primary controlling document that implements NPS fire policy and direction for the fire management program. The plan implements the intent of Director's Order (DO)-18, the National Park Service's wildland fire management guideline.

Annual Fuels Treatment Program. An annual Fuels Treatment Program Plan is completed each year after extensive internal discussions are conducted throughout the parks involving personnel from several park functional divisions. Interagency planning for joint, cooperative burn projects is also completed during the winter and reflected in the annual plan. The annual plan is reviewed by the Fire Management Committee.

Fuels Treatment Planning. Prescribed burns are planned over a broad area to allow projects to be executed during optimum burning conditions throughout the fire season depending on goals and objectives, location, elevation, aspect, fuel type and proximity to SSA's. Mechanical plans and follow-up burning of mechanical fuels are confined to smaller areas associated with maintenance of defensible spaces surrounding structures or communities. Most burns take place above 6,000 feet elevation. All prescribed burn operations must comply with standard park burning prescriptions that include fuel moisture and environmental conditions.

Responsible Park Officials. The Superintendent is responsible for all government activities occurring on parklands, and approves the fuels treatment plans and wildland fires managed for resource objectives. He/she has full authority to act on any fire situation occurring on parklands. The Chief Ranger is supervised by the Superintendent and is responsible for park fire management. The park Fire Management Officer reports to the Chief Ranger, and oversees the planning and operations of park programs relating to fire and aviation management.

RESPONSIBLE PERSONNEL, ORGANIZATION & QUALIFICATIONS

Qualification System. Park Fire Management staff implement DO-18 training and qualifications standards by assuring that fire management personnel are trained and qualified by following the National Incident Qualification and Certification System. The staff works to assure that adequate numbers of qualified personnel are available to conduct prescribed fire and wildland fire operations. Personnel are qualified in the following positions:

Prescribed Fire Manager - oversees prescribed fire operations program implementation and is supervised by the district duty officer per the SEKI Prescribed Fire Operations Guide (PFOG).

Prescribed Fire Burn Boss - is responsible for on the ground execution of individual prescribed burns and is supervised by the district duty officer per the PFOG.

Firing Boss - is responsible for burn unit ignition and is supervised by the burn boss.

Prescribed Fire Behavior Analyst - is responsible for analyzing potential fire behavior and is supervised by the prescribed fire manager or burn boss depending on incident complexity and need for the position.

Prescribed Fire Monitor - is responsible for fire monitoring and is supervised by the burn boss and is responsible for gathering data about fire weather conditions, fire behavior and fire spread and relaying the information to burn incident personnel.

Firing and holding personnel are supervised by the burn boss and are responsible for igniting the burn segment and holding the fire within established fire lines.

Wildland Fire Manager - oversees wildland fire program implementation and is supervised by the district duty officer.

Incident Commander - is responsible for on the ground execution of individual wildland fires. May be supervised by the Wildland Fire Manager or district duty officer (if wildland fire manager is not needed).

INFORMATION AND AWARENESS

Information about smoke events is distributed to target audiences in accordance with the Public Information and Education section of Chapter 3 in the *Fire and Fuels Management Plan* and the *Standard Operating Procedures for Distributing Fire Information* (Lyle 2002). The latter document contains specific checklists, fax numbers, email lists, community contacts, etc. The Smoke Communication Strategy (Appendix I) provides specific talking points about smoke.

Smoke Complaints Management. Visitor centers and dispatch centers use the *Smoke Information/Complaint Form* to record visitor and employee concerns about fire operations. Information from these forms is immediately transferred to fire managers so that formal complaints can be communicated to the local air district. The forms are collected by the Fire Information Officer and evaluated for special information or outreach needs.

MONITORING AND COMPLIANCE / ENFORCEMENT

On Site. Smoke monitoring is done on all burns by qualified fire personnel. They monitor smoke impacts to SSA's and utilize the intelligence gathered to adapt burn execution to avoid unhealthful smoke impacts. This is accomplished by visual observations and by use of a mobile E-BAM monitor. When used the E-BAM is set-up in SSA's during nearby burn unit execution. The E-BAM records particulate matter (2.5 microns) concentrations. The park has two mobile E-BAM's for this purpose; both of which have a web based data link. A permanent particulate monitor is located at Ash Mountain headquarters near the most populated Smoke Sensitive Area impacted by park prescribed burns—the town of Three Rivers.

Off Site. While the park no longer monitors the impact of transport smoke over the eastern crest into the Owens Valley region, the park does access the network of web-cams managed by the Sequoia National Forest.

The park contract helicopter can be used to conduct visual observations of burn unit smoke dispersal and helicopter crew members record the observations.

Burn Execution Regulation. Individual burn plan smoke management contingencies include a description of the decision process park management will take to limit smoke impacts if smoke conditions deteriorate in SSA's, and are designed to provide outreach to communities impacted by unpredicted smoke or unhealthful smoke impacts.

Notification and coordination with affected air districts occurs on a daily basis throughout the fire season. If there are smoke caused complications during the execution of a fire incident, the affected air district(s) will be notified by phone as soon as practical.

EMISSION INVENTORY

A Fire Management Smoke Emissions Inventory was completed April 19, 1996 per instructions provided by the District for the period 1985 to 1994 and includes projected program through 2010. Annual tracking of actual smoke emissions will be accomplished for prescribed burns and wildland fires managed for resource objectives that are executed during the season. After coming on line, PFIRS may be used to track and display emissions information for the various agencies and air district staff to use as needed.

EMISSION REDUCTION TECHNIQUES

Burning Prescriptions. All prescribed burns must comply with standard park burning prescriptions that include fuel moisture and environmental conditions.

Mechanical Reduction Potential. About 98% of parklands are administered as natural areas with about 85% of parklands managed as designated Wilderness. Mechanical techniques to reduce fuel load prior to prescribed burning is therefore limited by law and administrative policy to only the park developed areas. Mechanical fuel reduction is limited to areas immediately adjacent to developments in order to provide protection of structures or infrastructure from unwanted, damaging fire events.

Fuel Moisture. The primary emission reduction techniques used in park prescribed fire operations is to burn forest floor fuels under the "cool" end of the burning prescription, while still meeting burn unit goals, in order to limit the amount of available fuel that burns, thereby reducing overall emissions. Grass and brush fuel types are burned in the "warm" end of the prescriptions in order to produce a cleaner burn--moist grass and brush produces more emissions since the entire plant is consumed by the fire.

STATE OVERSIGHT

The California Air Resources Board (CARB), as the state air regulatory agency, has the authority to enforce all provisions of the smoke management program through the State Implementation Plan.

K- Delegation of Authority Example

Date: July 28, 2009

Memorandum

To: Incident Commander

From: Superintendent, Sequoia and Kings Canyon National Parks

Subject: *Name of Fire* Delegation of Authority

The Superintendent of Sequoia and Kings Canyon National Parks (SEKI) is responsible for ensuring the protection of park resources and the lives of park visitors and employees. The Superintendent must also act responsibly in dealing with park neighbors. Your expertise in wildland fire management will assist in fulfilling these responsibilities.

Your team's actions will be guided by National Park Service fire management policy, and Aviation Management Directorate aviation policy. In addition, the incident will be managed in accordance with the goals and objectives identified in the SEKI Fire Management Plan. To help communicate such policy so that your fire management efforts are successful, we are providing guidelines below:

You will have management responsibility for the *Name of* wildland fire. SEKI is a prototype park for implementing modifications to the National Fire Policy. As such, your decisions for the *Name of Fire* must reflect this policy directive to include managing a fire for two distinct purposes, and considering the full range of fire tactics (ranging from aggressive suppression to monitoring). This policy considers safety, cost containment, community protection, and the benefits of fire on a landscape as just a few issues to consider when implementing a fire management strategy. A copy of the policy change is attached. Please direct questions regarding this policy implementation to the Agency Administrator. This park is also a pilot site for the Wildland Fire Decision Support System (WFDSS) and you may / will be required to implement the use of this program.

A stage I and II analysis has been prepared. You are responsible for completing a stage III analysis. This package will then serve as guidance for management actions during the incident. The maximum manageable area (MMA) may be on both the Sequoia National Forest and Kings Canyon National Park. Agency representatives are available from both units to aid in stage III development. *(Alternatively, you are responsible for completing the WFDSS and implementing the selected alternative)*

The safety of fire personnel, the public, and our employees is the highest priority during all phases of the incident. It is also important to minimize area closures, to the extent that this does not compromise human safety. To date, we have closed the XX trail from its junction with the YY trail north to its junction with the ZZ trail, a closure of *n* miles. The Kings Canyon district ranger is charged with trails management. He will be consulted regarding changes to trail closures and area closures.

A Kings Canyon trail crew camp is north of the fire on the XX Creek trail just south of *Name of* Pass. Trail camp support is by stock. Work with the agency representative to communicate access conditions to the maintenance division.

You will be operating within Wilderness. Environmental impacts from fire management actions are of greater concern than the total number of acres burned. If holding actions must be executed, please use minimum impact suppression tactics (MIST) commensurate with the resource. For example: 1) foam is kept clear of stream channels, 2) fire lines should not be constructed directly through meadows, and 3) all fire lines will be rehabilitated according to agency policy (approved by the resource advisor).

The *Name of Fire* is near Kings Canyon National Park's Cedar Grove development. Please give special consideration to the impacts and benefits of your operation to the visitors and employees of Cedar Grove. Consult with the agency representative regarding appropriate actions near and inside the Cedar Grove area.

Work with park public information staff to keep park concessionaires, park and forest visitors, employees, cooperators, and neighbors fully informed of your incident team's actions and decisions. Please give us the opportunity to review written materials pertaining to our units before dissemination. In addition, educational opportunities exist on the *Name of* fire. Please work with the parks' fire information and education specialist to ensure these opportunities are met.

The remote nature of the fire coupled with economic efficiency has led to spike camps near the fire and within Cedar Grove campgrounds. Please see that the assigned resources in back country camps are dispersed in order to minimize impacts to natural and cultural resources. Proper food storage procedures must be followed at all locations due to black bear activity.

Manage costs commensurate with the values to be protected. There are beneficial resource values as a result of this fire that should be considered when judging the net benefit to loss ratio. Therefore, your management actions will be informed by resource risk or benefit as well as the range of other factors. This is the case-- especially when using high-cost aviation equipment-- which will be clearly communicated to me and the agency administrator. Cost containment is reflected in the incident goals and strategies. Changes in strategy recommended by this team should fully consider incident costs. Use of alternative management tactics other than direct attack and full perimeter control such as point protection and development of decision trigger points should be seriously considered.

The fire is within the boundary of the San Joaquin Valley Unified Air Pollution Control District. You must work with the parks fire management staff on daily coordination with the Air District. Statewide conference call procedures exist to help with the process.

The Ash Mountain conference room will serve as your ICP location. Helicopter operations can be managed out of the Ash Mountain helibase and Cedar Grove helispot.

All press releases will be coordinated and reviewed by the agency representative for Sequoia and Kings Canyon National Parks.

The parks retain fire detection and management response decision analysis except for the area lying within the *Name of Fire MMA*. We will keep you fully informed regarding fire response outside your MMA and ask that you do the same for areas within your MMA. We expect full consultation should additional starts occur.

We have fire and aviation personnel assigned to the fire and available for your use as well as contract labor crews. We expect you to work with the agency representative so these resources obtain the fire experiences required for career development.

SEKI Park Contacts:

- **Agency Representative** – David Bartlett, Fire Management Officer (559) 565-3160.
- **Resource Advisor** – Tony Caprio, Natural Resources Specialist (559) 565-3126
- **Cultural Resource Advisor** – Tom Burge, Cultural Resource Specialist(559) 565-3139
- **Fire Information** – Deb Schweizer, Fire Information and Education Specialist, (559) 565-3703
- **Logistics** – Gerry Carder, Fire Cache Manager, (559) 565-3163

As of 1800 on *Date*, we are delegating to you the authority to manage the *Name of Fire*. This delegation will remain in effect until the parks receive a return memorandum from you turning authority for management of the fire back to the parks.

Craig C. Axtell, Superintendent

L- Fire Crew Readiness Review

Crew Designator: ____________________________

List Highest Crew Qualifications – Does the crew meet minimum qualifications? Yes No

Name	Highest Qualification
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____
____________________________	____

Have all crew members attended annual wildland fire safety refresher? Yes No

Have all crew members passed arduous duty medical examinations that meet the annual currency requirements? Yes No

Have all crew members passed the annual pack test? Yes No

Have all crew members completed required module level training list below? Yes No

- ☐ Chainsaw Refresher ☐ Map/Compass/GPS ☐ POSH
- ☐ Radio Use ☐ Driving Safety ☐ Ethics/Alcohol Use

Comments (add on back if more space is necessary)

____

I have reviewed the crew's qualifications and certify the crew is available for wildland fire assignment.

Reviewed by: ______________________________ Date: ________________
Crew Leader

Reviewed by: ______________________________ Date: ________________
Program Manager

Concurred by: _____________________________ Date:________________
SEKI Fire Management Officer

M- Fire Restrictions and Emergency Closures

INTRODUCTION

Enforceable fire restrictions and emergency closures can reduce the possibility of human caused wildfires occurring during periods of seasonal drought, when wildfires can cause serious damage to park resources and threaten the safety of park visitors and employees. It is highly unlikely that park areas would need to be closed to public entry because of fire danger reasons alone. Emergency closures for public safety reasons are also made during most fire seasons for certain park areas affected by fire operations.

OBJECTIVES

To restrict the use of fire by the public in defined areas of the parks during periods of high, very high, and extreme fire danger.

To provide park administrative staff with a procedure for making emergency closures for fire prevention and public safety reasons.

To make fire restrictions and emergency closures that comply with the requirements set forth in 36 Code of Federal Regulations, Part 1, section 1.5.

AUTHORITY

Fire restrictions and emergency closures shall be made in compliance with the requirements set forth in 36 Code of Federal Regulations (CFR), sections 1.5 and 2.13(c). For enforcing fire restrictions, this plan serves as the written determination required in section 1.5 (c). Decision memorandum will be approved by the superintendent when fire restrictions are enforced. For enforcing emergency closures for fire prevention or public safety reasons, a Special Order will need to be approved by the park superintendent and given wide distribution. Whenever fire restrictions or area closures are enforced public notice must be given in compliance with 36 CFR, section 1.7.

PROCEDURE FOR ENACTING FIRE RESTRICTIONS

The Fire Management Officer shall have the responsibility to identify areas of the parks where fire restrictions and emergency closures for fire prevention purposes should be implemented. The Fire Management Officer will consider: weather data, fuels data, visitor use trends, on-park fire situation (number of going fires and their potential, probability of new starts, and on-park suppression resource draw-down), current adjoining National Forest fire restrictions and emergency closures, enforcement--SQF, SNF, INF, and regional and national preparedness levels.

Once a need is established for enacting restrictions, the parks will complete the actions outlined in the table below. The same process will be used to reduce or cancel fire restrictions. (Extra columns are provided in the table below to serve as a checklist for documentation during fire season.)

Actions to Enact Restrictions						
The Fire Management Officer will recommend to the Chief Ranger and Superintendent the appropriate Stage Level that should go in to effect.						
The District Fire Management Officers will consult with their respective Management Teams.						
The Fire Information Officer (FIO) will prepare a draft press release announcing and explaining the new restriction.						
A copy of the press release will be approved/signed by the Superintendent and kept in the files as the decision memorandum.						
The FIO will issue the approved press release.						
The FIO will notify all park visitor center information desk personnel.						
The FIO will notify all District Rangers, Sub-District Rangers, and District FMOs.						
The FIO will notify the Wilderness Office.						
The FIO will notify all park entrance stations.						
The FIO will notify park concessionaires.						
The FIO will notify fire dispatchers at Inyo, Sierra, and Sequoia National Forests, and Tulare and Fresno Ranger Units—CAL Fire.						
The FIO will post the new current Stage Level on the park website.						
Fire personnel will coordinate the posting of signs						
Park Dispatch will announce daily the current Stage Level during the morning report broadcast, and put Stage Level information in the written morning report.						

STAGE 1 – MODERATE / HIGH

[See table on next page for exact Stage 1 restrictions.]

Trigger Conditions

Foothills annual grass has cured to about the 6,000-foot level for all exposures.

Fire restrictions for adjoining National Forests are in effect.

National Fire Danger Rating Staffing Class for any Park fire weather station is three or higher.

Signage

Signs will be posted at Hospital Rock and Ash Mountain Picnic Areas, "Swinging Bridge" near Potwisha campground, North Fork trailhead, Middle Fork trailhead, South Fork trailhead, the Indianhead parking area, Roads End trailhead, Hotel Creek trailhead, Don Cecil trailhead, entrance stations, and the Visitor Centers.

STAGE 2 – VERY HIGH / EXTREME

[See table on next page for exact Stage 2 restrictions.]

Trigger Conditions (in addition to Stage 1)

Fire restrictions for adjoining National Forests are in effect.

National Fire Danger Rating Staffing Class for any Park fire weather station is four or five.

Park fire fighting resources are drawn-down fifty percent or more.

Signage

In addition to the locations in Stage 1, signs will be posted at South Fork Campground, Potwisha Campground, Buckeye Campground, Sentinel Campground, Sheep Creek Campground, Canyon View Campground, Moraine Campground, Cedar Grove Village Picnic Area, and all park trailheads.

SPECIAL SIGNAGE DURING 4TH OF JULY

Special "NO FIREWORKS" signs will be posted throughout the Parks seven days prior to, and seven days after the 4th of July holiday. The District Fire Management Officers will coordinate the posting of the signs with Sub-District Rangers.

Table M-1 – Fire Restrictions for Sequoia & Kings Canyon National Parks

Stage Level	Designated Campgrounds	Designated Picnic Areas	Backcountry Travel	Smoking
Stage 1 Moderate/ High	[No restriction]	No wood or barbecue fires in Hospital Rock and Ash Mountain Picnic Areas. Gas or propane stoves are permitted at all elevations.	No wood or barbecue fires below 6,000 feet. Gas or propane stoves are permitted at all elevations.	No smoking below 6,000 feet, except within a developed area, designated campground, an enclosed vehicle, building, or designated smoking area.
Stage 2 Very High/ Extreme	No wood fires or barbecues permitted at low elevation campgrounds including South Fork, Potwisha, Buckeye, Sentinel, Sheep Creek, Canyon View, or Moraine. Wood fires are allowed in high elevation campgrounds in the Grant Grove, Mineral King, and Lodgepole areas (including Dorst). Gas or propane stoves are permitted at all elevations.	No wood or barbecue fires in Hospital Rock, Ash Mountain, and Cedar Grove Village Picnic Areas. Gas or propane stoves are permitted at all elevations.	No wood or barbecue fires permitted at any elevation. Gas or propane stoves are permitted at all elevations.	No smoking at any elevation except within an enclosed vehicle, a building which allows smoking, a campground where wood fires are allowed, or a designated smoking area.

* Private property throughout the parks will be treated the same as a high elevation designated campground.
* Employee housing areas will be treated the same as a high elevation designated campground.

REGULATING ACCESS TO HAZARDOUS AREAS

Coordination between fire overhead and District Rangers and Sub-district Rangers is essential. Fire overhead can recommend to District Rangers action that should be considered. It is the District Ranger's responsibility to determine actual regulatory measures that will be taken to ensure visitor and employee safety on trails, roads, campsites and in developed areas. Fire overhead will coordinate with the District Ranger about who will physically be responsible for making signage postings and physically closing trails or roads.

Most fire operations need only limit access to some front country trails for short periods of time and alternative routes are available to the public. In these cases simply regulating trail use with the use of signs and physically blocking trails is adequate and formal Special Order closures are usually not needed. Special Order closures should be used in situations that involve substantial area, complexity and long duration, such as no other alternative trail routes are available or road access needs to be blocked.

Warning signs should be posted anytime there are fire-caused risks to the public or employees from hazards in a burn area involving trails, roads, campsites and developed areas. Signs must have the following basic information included:

Warning Signs

WARNING

NATURE OF THE HAZARD

STEPS TO TAKE TO AVOID THE HAZARD

Closed Area Signs

DANGER

THE AREA THAT IS CLOSED

THE HAZARD CAUSING THE CLOSURE

Area closure and hazard warning signs require posting outside of the hazard area on routes entering the hazard area. The trail or road should be physically blocked with barricades, on roads, or "trail blocks" made of rope and flagging tape on trails. Hazardous situations may require posting "trail block" personnel if it is likely people may ignore the trail closure--such as backpackers hiking through on long trips may not want to turn back or use alternative routes.

___________________________ __________________

Park Superintendent Date
Sequoia and Kings Canyon National Parks

N- Permit for Burning Slash Piles

Permit Authority: 36 Code of Federal Regulations, sections 1.5, 1.6, 1.7 and 2.13.

Issued To:____

Address: ____

City/State/Zip: ____

Telephone Number(s): ____

Location of Piles: ____

Attach map(s) that show the location of slash piles (if available).

Number of Piles: ____________ Approximate total cubic footage: ____________

Burning Time: shall be confined to the hours between 9:00 AM and 4:00 PM. This permit is valid during the period:

____________________________to ____________________________

This permit is subject to the following terms and conditions.

The burner agrees to begin burning only after receiving verbal permission on the day prior to, or on the day the burn is to commence from the park Fire Management Office, (**559) 565-3164 or 565-3165**. Verbal permission must be received on a daily basis if new pile ignitions are made beyond one day. Burning may be prohibited during periods of high to extreme fire danger and/or due to air quality regulations.

The burner agrees to only burn slash piles that are made of naturally occurring, vegetative fuels that are derived from fire hazard fuel reduction or hazard tree removal projects. No manufactured materials shall be burned including all kinds of construction materials.

The burner must not burn during very hot and dry periods when winds are strong enough that burning would be considered unsafe. (Example: wind keeps leaves in motion or extends a light flag or cloth).

The fire shall be confined within cleared fuel breaks or barriers adequate to prevent it from escaping control. The burner will maintain the ability to suppress any spot fires.

The fire shall be attended at all times by at least one prudent and responsible person who will maintain control of the fire.

This permit does not relieve the permit holder of any responsibility concerning reasonable and ordinary care to prevent damage to the property of others or injury to persons as prescribed by law.

In addition to this permit, the burner is required to obtain an annual "*permit for pile burning in hazard reduction and prescribed burning*" from the San Joaquin Valley Unified Air Pollution Control District. Burning shall only be conducted on approved burn days, and only during daylight hours. Burn day information is available through the Air District via a recorded message at 877-429-2876. The Air District has the authority to independently investigate reports of nuisance smoke, regardless of permit status. Violators may be fined. Annual burning permits may be obtained from; NPS Grant Grove Fire Station, Cal Fire Stations in Squaw Valley, Sand Creek, Badger, and Three Rivers.

Additional terms:

____

I agree to comply with the terms and conditions of this permit.

Signed: ____Date: _______________
Applicant

CAUTION: YOU CAN BE HELD LIABLE FOR ESCAPED FIRES INCLUDING DAMAGE AND SUPPRESSION COSTS. VIOATIONS OF ANY BURNING PERMIT TERMS OR CONDITIONS ARE A VIOLATION OF FEDERAL LAWS AND RENDERS THE PERMIT NULL AND VOID.

****

Approved by:____Date:______________
Park or District Fire Management Officer

Original copy to Fire Dispatch.

Copy to: permit holder, District Fire Management Officer, and District Ranger.

O- Templates for Prescribed Burn Plans and Mechanical Plans

PRESCRIBED FIRE PLAN

Administrative Unit Sequoia & Kings Canyon National Parks

Prescribed Fire Name Prescribed Fire Burn Plan Template

Prepared by

Name &Qualification/Currency Date

Technical Review by

Name & Qualification/Currency Date

Recommended By

Parks Fuels Management Specialist Date

Recommended By

District Fire Management Officer Date

Recommended By

Park Fire Management Officer Date

Recommended By

Chief Ranger Date

Complexity Rating

Minimum RXB Requirement

Approved By

Agency Administrator Date

Note: Text with this gray highlight throughout elements 4-21 is boiler plate text that can be and is normally used in all burn plans. The preparer must still review the text to ensure its relevance and accuracy.

EXECUTIVE SUMMARY

Include a brief 1-2 paragraph synopsis describing the purpose and justification of the project, connection with the overall management of the unit, and description of how it implements the Fire Management Plan. Include things such as the size, location, scheduling, costs, fire return interval, fire history, maintenance versus restoration, and any specific/critical impacts/issues the plan addresses.

ELEMENT 1: AGENCY ADMINISTRATOR GO/NO-GO PRE-IGNITION APPROVAL CHECKLIST

Instructions: The Agency Administrator's GO/NO-GO Pre-Ignition Approval is the intermediate planning review process (i.e. between the Prescribed Fire Complexity Rating System Guide and Go/No-Go Checklist) that should be completed before a prescribed fire can be implemented. The Agency Administrator's Go/No-Go Pre-Ignition Approval evaluates whether compliance requirements, Prescribed Fire Plan elements, and internal and external notifications have been or will be completed and expresses the Agency Administrator's intent to implement the Prescribed Fire Plan. If ignition of the prescribed fire is not initiated prior to expiration date determined by the Agency Administrator, a new approval will be required.

YES	NO	KEY ELEMENT QUESTIONS
		Is the Prescribed Fire Plan up to date? Hints: amendments, seasonality.
		Will all compliance requirements be completed? Hints: cultural, threatened and endangered species, smoke management, NEPA.
		Is risk management in place and the residual risk acceptable? Hints: Prescribed Fire Complexity Rating Guide completed with rational and mitigation measures identified and documented?
		Will all elements of the Prescribed Fire Plan be met? Hints: Preparation work, mitigation, weather, organization, prescription, contingency resources
		Will all internal and external notifications and media releases be completed? Hints: Preparedness level restrictions
		Will key agency staff be fully briefed and understand prescribed fire implementation?
		Are there any other extenuating circumstances that would preclude the successful implementation of the plan?
		Have you determined if and when you are to be notified that contingency actions are being taken? Will this be communicated to the Burn Boss?
		Other:

Recommended by: ______________________________

FMO/Prescribed Fire Burn Boss Date

Approved by: ______________________________

Agency Administrator Date

Approval expires (date) ____________________

ELEMENT 2: PRESCRIBED FIRE GO/NO-GO CHECKLIST

	YES	NO
A. Has the burn unit experienced unusual drought conditions or does it contain above normal fuel loadings which were not considered in the prescription development? If NO proceed with checklist below, if YES go to item B.		
B. Has the prescribed fire plan been reviewed and an amendment and technical review been completed; or has it been determined that no amendment is necessary? If YES to any, proceed with checklist below, if NO, STOP.		

YES	NO	QUESTIONS
		Are ALL pre-burn prescription parameters met?
		Are ALL smoke management specifications met?
		Has ALL required current and projected fire weather forecast been obtained and are they favorable?
		Are ALL planned operations personnel and equipment on-site, available, and operational?
		Has the availability of ALL contingency resources been checked and are they available?
		Have ALL personnel been briefed on the project objectives, their assignment, safety hazards, escape routes, and safety zones?
		Have all the pre-burn considerations identified in the Prescribed Fire Plan been completed or addressed?
		Have ALL the required notifications been made?
		Are ALL permits and clearances obtained?
		In your opinion, can the burn be carried out according to the Prescribed Fire Plan and will it meet the planned objective?

If all the questions were answered "YES" proceed with a test fire. Document the current conditions, location, and results

Burn Boss Date

ELEMENT 3: COMPLEXITY ANALYSIS SUMMARY

PRESCRIBED FIRE NAME			
ELEMENT	RISK	POTENTIAL CONSEQUENCE	TECHNICAL DIFFICULTY
1. Potential for escape			
2. The number and dependence of activities			
3. Off-site Values			
4. On-Site Values			
5. Fire Behavior			
6. Management organization			
7. Public and political interest			
8. Fire Treatment objectives			
9. Constraints			
10. Safety			
11. Ignition procedures/ methods			
12. Interagency coordination			
13. Project logistics			
14. Smoke management			

COMPLEXITY RATING SUMMARY	
	OVERALL RATING
RISK	
CONSEQUENCES	
TECHNICAL DIFFICULTY	
SUMMARY COMPLEXITY DETERMINATION	
RATIONALE: This rationale must be identical to the rationale at the end of the complexity analysis on page 38.	

ELEMENT 4: DESCRIPTION OF PRESCRIBED FIRE AREA

Physical Description.

Location

County, State.

Township, Range, Section, AND/OR

UTM Zone, Easting, Northing (approximate mid-point of the unit), AND/OR

Longitude, Latitude (approximate mid-point of the unit in decimal degrees / NAD83)

Size: self-explanatory; if segmented, include acreages of all individual segments.

Topography.

Upper and lower elevation range.

Slope maximum, minimum, average.

Aspect(s).

Project Boundary. Describe the unit boundaries in relationship to the cardinal directions.

Wilderness Status? Designated / Recommended / Study Area / Eligible / Non-wilderness (circle one).

Vegetation/Fuels Description.

On-site fuels data

Describe the composition of the vegetation types and fuel characteristics (loading, continuity, arrangement, etc). List the predominant species (with both common and Latin names) in the over and understory along with the corresponding fuel model. Include any pertinent history (i.e. large bug kills, past human practices, etc.) contributing to the current vegetative component.

List the percentage of the unit that is comprised of each fuel model. (As of 2009 SEKI switched to the Scott and Burgan fuel models. This information can be found on the burn unit's fuels map.)

Vegetation Type	Scott and Burgan Fuel Model	Estimated Acres	Estimated Tons Per Acre

Total Estimated Project Tons:

Average Tons Per Acre:

Identify where the above tons per acre were derived from. This will usually be done by using the closest match of the Scott and Burgan fuel models to the NFFL fuel models and then using the "Fuel_loading_seki_feb_2008" spreadsheet located on the J drive. Include the footnote from the spreadsheet to indicate how the tons per acre were derived.

Adjacent fuels data

Describe the vegetation and fuels outside the unit if they differ significantly from inside the burn unit. Include fuel models.

Description of Unique Features:

Identify all sensitive species and features. Include cultural resource mitigation/clearance procedures and attach documentation of consultation with Park Archeologist as required. If sensitive features require protection, describe in detail how this will be accomplished.

The Burn Boss will report to the park archeologist the discovery of cultural artifacts.

Identify all trees of special interest and whether the burn is located in or near a Special Management Area. Include any necessary mitigations.

Refer to the appropriate appendix for the completed Wilderness and Backcountry Minimum Tool Analysis as required.

Maps: (see attached project, vicinity, smoke dispersal, and other maps as required)

ELEMENT 5: OBJECTIVES

Objectives:

Safety objectives:

Resource and prescribed fire objectives:

Education objectives:

Special features objectives:

Specific objectives for the above categories shall be stated in quantifiable and measurable terms with a time element. Objective categories are not necessarily limited to the above. Goals may be included in this section as well.

ELEMENT 6: FUNDING

Cost:

Item	Planning	Preparation	Execution	Evaluation
Personnel				
Equipment (mileage, rental)				
Aircraft				
Supplies (non-rolling stock)				
Phase Costs				

Total Estimated Cost: (does not include base 8 salary paid out of non-project accounts) ________

Estimated Cost Per Acre:________________________

Estimated costs much match the allocated funding requested for the burn. (Check with the Park Fuels Specialist.)

Funding source: (i.e. – hazardous fuels versus WUI) Include the project PWE (i.e. – H12, W12, etc).

ELEMENT 7: PRESCRIPTION

These are generalized prescription parameters. The burn boss is responsible for addressing topographic features outside the range listed in order to meet their burn objectives (usually accomplished by varying the firing pattern, sequence and rate of ignition).

Environmental Prescription:

See the SEKI Fire and Fuels Management Plan, Appendix E for prescriptions. SEKI prescriptions are developed for the NFFL fuel models. Use the NFFL fuel model prescription which is the closest match to the new Scott and Burgan fuel models. (The vegetation itself has not changed, only the fuel model name; therefore the NFFL prescriptions are still valid.) Prescriptions should be based on the predominant fuel model(s) and should include temperature, relative humidity, wind speed, and fuel moistures for the appropriate size classes. Depending on the fuel model, prescriptions may be for both head and backing fire spreads.

Fire Behavior Prescription:

These must match the fire behavior outputs from BEHAVE runs based on the environmental prescription and should include at a minimum rate of spread, flame length, scorch height (if appropriate), and mortality (if appropriate). BEHAVE runs should be ran with the new Scott and Burgan fuel models and should include runs for both head and backing fire spreads at the hot and cool end of the prescription to get the entire range of outputs.

NOTE: Outputs for the Adequate Holding Resources Worksheet will require “size”, “contain”, “spot”, and “ignite” BEHAVE runs.

ELEMENT 8: SCHEDULING

Ignition Time Frames/Season(s): self-explanatory

Projected Duration: self-explanatory, include burn down times.

Constraints: Dates when burn will not be conducted:

- No-burn day as determined by San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD).
- National or Regional Preparedness Levels preclude new prescribed fires unless approval given by regional and national offices.
- Burn area is not in prescription.
- Holiday weekends unless approved by the Park Superintendent.

ELEMENT 9: PRE-BURN CONSIDERATIONS AND WEATHER

Considerations:

On Site:

Describe fireline preparation, hoselays, snagging, warning signs, fuel moisture sampling, spot weather forecast, trail closure notification, etc, with an approximate timeline.

Off Site

Include the requirement of an Incident Action Plan, logistics (ensure discussion of minimum requirement / minimum tool as applicable), smoke coordination, standard notifications, etc, with an approximate timeline.

Method and Frequency for Obtaining Weather and Smoke Management Forecast(s):

Describe the spot weather forecast process for the burn.

Notifications:

Include Fire Information Officer, Visitor Centers, Concessionaires, Ranger Stations, Wilderness Office, Fee Office, local media, Air District, trail closures, local cooperators, adjacent landowners where appropriate, etc.

ELEMENT 10: BRIEFING

Briefing Checklist:

- Burn Organization
- Burn Objectives
- Description of Prescribed Fire Area
- Expected Weather & Fire Behavior
- Communications
- Ignition plan
- Holding Plan
- Contingency Plan
- Wildfire Conversion
- Safety and Medical Plan
- Aerial Ignition Briefing (if Required)

ELEMENT 11: ORGANIZATION AND EQUIPMENT

Positions:

Specify MINIMUM number and type of resources needed. What is written here MUST BE FOLLOWED when actual implementation/operation of the burn occurs. List all the minimally required overhead by position. It is allowable to have two organizations, one for the hot end and one for the cold end. If this is done, it is important to define what constitutes the hot versus cold end. The resources listed in this section must meet the needs of the Adequate Holding Resources Worksheet (Appendix E).

Include an organization chart.

Equipment: related directly to operations in general terms (it is not necessary to include specific amounts of hose, fittings, etc.)

Supplies: related to logistics in general terms (it is not necessary to include specifics).

ELEMENT 12: COMMUNICATION

Radio Frequencies

Command Frequency(s): list the anticipated frequency(s) and tones with a disclaimer that they are subject to change the day of the burn.

Tactical Frequency(s): list the anticipated frequency(s) with a disclaimer that they are subject to change the day of the burn. Include a frequency for traffic control if necessary.

Air Operations Frequency(s): list the anticipated frequency(s) with a disclaimer that they are subject to change the day of the burn.

Telephone Numbers:

Identify required phone numbers such as fire dispatch, fire information, park dispatch, Visitors Centers, Ranger Stations, Concessionaires, Air District, Wilderness Office, Fee Office, adjacent landowners, etc.

ELEMENT 13: PUBLIC AND PERSONNEL SAFETY, MEDICAL

Safety Hazards:

Refer to the attached JHA's (prescribed burning and hazard tree in Appendix D). Identify significant hazards affecting both the public and firefighters. Typical hazards are snags, smoke concerns, roadways, steep terrain, aerial ignition, etc.

Measures Taken to Reduce the Hazards:

Address the use of PPE, briefings, proper communication, appropriate red cards for positions, work/rest guidelines, driving regulations, warning signs, specific traffic plans, etc.

Emergency Medical Procedures:

Reference the use of EMT's and the chain of command for notification of injuries. Ensure it is understood that medicals are handled by the Park Dispatch (Law Enforcement) even if they occur on a prescribed burn. Attach and refer to a completed ICS-206 Medical Plan (which would be used in the IAP) as Appendix G.

Emergency Evacuation Methods:

Reference ground transportation methods and air transportation opportunities. Refer to the attached completed ICS-206 Medical Plan in Appendix G.

Emergency facilities:

Refer to the attached completed ICS-206 Medical Plan in Appendix G.

ELEMENT 14 TEST FIRE

Planned location:

Identify parameters associated with the test fire and what specific results will be observed. Allow for flexibility in regards to location.

Test Fire Documentation:

Weather conditions on-site will be documented by the fire monitors and included in the post-burn monitoring report.

Test fire results will be documented by the fire monitors and included in the post-burn monitoring report. Documentation of the test fire timing and success will be done by the Burn Boss on an ICS-214 unit log and communicated to fire dispatch.

ELEMENT 15: IGNITION PLAN

Firing Methods (including Techniques, Sequences and Patterns):

In 1-2 paragraphs, indicate whether this is hand and/or aerial ignition (with aerial ensure minimum requirement / minimum tool is addressed). Discuss which technique or combination (i.e. – strip, spot lighting, ring firing, etc.) will be used. Describe the firing sequence and expected firing team stagger in general terms. Allow for flexibility throughout the discussion.

Devices:

List the devices needed for ignition.

Ignition Staffing:

Discuss firing teams, firing boss, use of firing team leaders, etc. Refer to the burn organization chart in element 11. Allow for flexibility.

ELEMENT 16: HOLDING PLAN

General Procedures for Holding:

Describe holding procedures in general terms. Allow for flexibility.

Critical Holding Points and Actions:

List the critical holding point(s) and any mitigations that will be in place.

Minimum Organization or Capabilities Needed:

This section should be linked to what is listed in element 11. Include reference to the appropriate documentation based on BEHAVE runs (Appendix F), line production rates, etc, for what resources are needed. While the Adequate Holding Resources Worksheet (Appendix E) is now optional, it may in fact be the easiest form to use for documentation. If the worksheet is used, attach it as an appendix and refer to it here. It is allowable to have two organizations, one for the hot end and one for the cold end. If this is done, it is important to define what constitutes the hot versus cold end.

ELEMENT 17: CONTINGENCY PLAN

Trigger Points:

If holders are experiencing control problems such as more slopovers or spot fires than they can handle or control problems in more than one area simultaneously, this should trigger the activation of this contingency plan. Other events which could trigger a contingency activation include such things as adverse smoke impacts to sensitive targets or exceeding prescription parameters on the hot end. Activation of the contingency plan does not automatically constitute an escape or conversion to a wildfire.

The Burn Boss will make the decision when to activate the contingency plan.

In the event this occurs, the Burn Boss will document this action and notify fire dispatch and the Fire Management Officer.

Actions Needed:

In the event the contingency plan is activated due to holding problems, the additional resources listed below may be ordered to assist holders in bringing the perimeter back under control. Ignition will cease at an appropriate cut off point. All other resources assigned to the burn will be assigned either suppression or holding duties. After control objectives are achieved, the Burn Boss may elect to release the contingency resources if control is no longer deemed a problem.

Refer to element 19 concerning actions to be taken if smoke management necessitates activating the contingency plan.

C. Additional Resources and Maximum Response Time(s):

Contingency resources are no longer required to be on site with the NPS. List all needed resources by type with required response times based on fire behavior expected at the hot end of the prescription in element 7. It is allowable to have two contingency lists, one for the hot end and one for the cold end. If this is done, it is important to define what constitutes the hot versus cold end.

Due to the remote locations of many of the burns at SEKI, ensure that contingency time frames are realistic and allow for delayed responses.

If no contingency resources are listed, justify thoroughly through the use of the Adequate Holding Resources Worksheet (Appendix E).

ELEMENT 18: WILDFIRE CONVERSION

Wildfire Declared By:

The Burn Boss will make the declaration of a wildfire and document this action. The burn will be declared a wildfire if the on-site and contingency resources are unable to contain or confine any spot fires and/or slopovers by the end of the next burning period. Additional resources will be ordered as necessary from local fire agencies or from out of the area through fire dispatch. The escape will be managed under the Incident Command System. All suppression actions will be done using minimum impact suppression tactics whenever feasible in accordance with the Fire and Aviation Management Operations Guide (FAMOG).

IC Assignment:

If a spot fire or slopover occurs, the Holding Supervisor(s) will lead the suppression actions and oversee operational aspects under the direction of the Burn Boss as the Incident Commander. If the Burn Boss does not have the appropriate qualification for the complexity of the wildfire, the Duty Officer will order a qualified Incident Commander. The Duty Officer in conjunction with the Burn Boss will determine if the escape and prescribed burn can be managed as one incident. If not, an additional Incident Commander will need to be ordered.

Notifications:

Fire dispatch will be notified immediately of significant spotting, slopovers, or escape. Burn personnel will go through the park communications center to notify fire dispatch after hours. The Burn Boss will immediately notify the Duty and Fire Management Officers of the change in status from prescribed burn to a wildfire. The Chief Ranger, Park Superintendent, and the regional fire management office will be immediately notified by fire dispatch of the change in the burn's status.

Extended Attack Actions and Opportunities to Aid in Fire Suppression:

If the fire is declared a wildfire, ignition will cease and all fire personnel will become holding and/or suppression forces. Firing, holding, and monitoring bosses will account for their personnel and be assigned to a division of the fire with their crews by the Burn Boss. A tactical chain of command will be pre-identified by the Burn Boss at the initial briefing.

A Wildland Fire Decision Support System document (WFDSS) will be completed to aid in the selection of management alternatives/objectives. The WFDSS document completion will involve fire management staff, ranger staff from the affected district, and resource management staff at a minimum. Should an external management team be ordered to manage the suppression action, the Superintendent will issue a Delegation of Authority. The suppression Incident Commander will report directly to the Fire Management Officer unless otherwise directed in the delegation.

ELEMENT 19: SMOKE MANAGEMENT AND AIR QUALITY

Compliance:

Per the local interagency Smoke Management Work Plan, the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) will be notified of the burn in the preceding spring. The smoke management summary will be submitted for approval to the Air District a minimum seven days in advance.

List the estimated emissions in the following table (data must be obtained by using the SJVUAPCD Emissions Reporting Form located on the J drive).

Estimated Emissions (in tons)

Fuel Type	Acres	Tons per acre	PM10	PM2.5	NOX	SO2	VOC	CO

Permits to be Obtained:

One week prior to the targeted ignition date, a Planned Ignition Forecast Advisory (PIFA) will be requested from the Air District. At this time the Fuels Management Specialist or designee will begin participation in the daily smoke management conference call and work directly with the Air District to receive the approval to proceed with ignition.

Air District staff will be consulted about the execution of the burn before ignitions take place, including new ignitions that would occur after breaks in firing of a day or more. On a no burn day, no new ignition will occur unless needed for safety and holding purposes, or after approval is obtained from the Air District. SEKI fire staff will discuss the fire situation with the Air District on a regular basis or when there are significant changes with the burning operation and conditions.

Smoke Sensitive Receptors:
List the smoke sensitive areas within 15 miles of the burn on the following table.

Smoke Sensitive Area	Distance From Burn Unit	Compass Direction From Burn Unit	Population	Critical Receptors

Potential Impacted Areas:

- Describe any potential impacts to the above listed smoke sensitive areas. Include the following:
- Estimated Smoke Emission Time Period:
- Desirable Smoke Dispersal Transport Winds Direction and Speed:
- Undesirable Smoke Dispersal Transport Winds Direction and Speed:
- Estimated Day Time Smoke Plume Direction and Potential Impact:
- Estimated Night Time Smoke Plume Direction and Potential Impact:
- Logging of Information Requests and Smoke Complaints:

All contacts will be recorded at Park Visitor Centers and dispatch centers. Receiving parties will determine whether the contact is for the purpose of information or to lodge a formal complaint against the park.

The Burn Boss will be notified of all contacts and consult with the Duty Officer regarding Air District notification in case of formal complaint. The Burn Boss will review complaints and coordinate with the Fire Information Officer in contacting complaining parties to discuss the nature of the complaints. Complaints will be investigated by fire staff to determine the severity of the situation causing the complaint and will determine mitigation steps needed to solve the problem. This information will be given to the Air District as soon as possible.

Mitigation Strategies and Techniques to Reduce Smoke Impacts:

If smoke impacts become a major issue affecting management of the fire, ignition will cease until conditions that are more favorable for smoke dispersion develop. Topography and firefighter safety will limit or prevent the use of mid-slope containment lines or check lines to halt burning operations. Consequently, the fire may be allowed to back through the unit at a slow rate of spread. If appropriate, the ignition pattern will be regulated to reduce smoke production. The need for aggressive mop-up will be evaluated and implemented as needed in order to mitigate an established smoke impact problem. The impacts to natural resources will need to be weighed against the benefits of aggressive mop-up.

Minimum acceptable visibility and speed limits, or traffic control, for all public roadways will be enforced by speed limit signs or traffic controllers. Any compromised roadway conditions should be relayed to the Burn Boss immediately, day or night, on shift or off shift.

Road Control Guideline for Two Lane, Two Way Road, Day Light Hours:

Posted Speed Limit	Minimum Acceptable Visibility
10 mph	56 feet if less than 56 feet begin one-way traffic control
15 mph	100 feet
25 mph	216 feet
35 mph	370 feet
45 mph	566 feet

Road Control Guideline for Two Lane, Two Way Road, Night Time Hours:

Posted Speed Limit	Minimum Acceptable Visibility
10 mph	112 feet if less than 112 feet begin one-way traffic control
15 mph	200 feet
25 mph	432 feet
35 mph	740 feet
45 mph	1132 feet

Refer to Element 20, section E for smoke monitoring procedures.

ELEMENT 20: MONITORING

Fuels Information Required and Procedures:

Describe the procedures for sampling dead and live fuel moistures before and during the burn in the necessary size classes. Emphasis will usually be on 1,000 hour and live fuels.

One hour fuel moisture will be calculated every hour during ignition by the Lead Fire Monitor to ensure the burn is within prescription.

Weather Monitoring (Forecasted and Observed) Required and Procedures:

Identify the nearest RAWS station.

Spot weather forecasts will be requested for each day of ignition. The Lead Fire Monitor will take weather observations every hour (or more frequently if requested by the Burn Boss) during the ignition and burn down phases of the burn. Weather observations will include temperature, relative humidity, wind speed and direction, and any significant cloud cover such as cumulus. All weather observations will be documented and broadcasted over the tactical radio frequency.

Fire Behavior Monitoring Required and Procedures:

The Lead Fire Monitor will be responsible for recording fire behavior observations such as flame length, rates of spread, flame zone depth, torching, etc. Fire monitors will determine the frequency of fire behavior observations.

Monitors will maintain constant communication with the Burn Boss, Firing, and Holding Supervisors to ensure safe operations when working within the burn. At no time will Fire Monitor safety be compromised for data collection. It will be at the discretion of the Burn Boss whether or not Fire Monitors will be allowed within the burn unit. Monitors **will** coordinate all activities with the Burn Boss.

Monitoring Required To Ensure That Prescribed Fire Plan Objectives Are Met:

The Burn Boss and Lead Fire Monitor will be responsible for monitoring whether burn objectives are being met during the ignition phase. This includes dead and down fuel reduction, limiting mortality in larger size class timber, and inducing mortality in the shrubs.

Identify any Fire Effects plots in the burn unit and who will read them.

Smoke Dispersal Monitoring Required and Procedures:

Smoke observations will be monitored and documented on a minimum hourly basis by the Lead Fire Monitor on a smoke observation form along with weather conditions and fire behavior observations during daylight hours. Any significant change in smoke emissions or column/plume behavior will be reported to the Burn Boss. The Smoke Technician or designee will canvas the local area at first light to determine whether there were any adverse impacts to smoke sensitive areas overnight.

Indicate whether an E-BAM will be used for smoke monitoring and where it will be set up.

ELEMENT 21: POST-BURN ACTIVITIES

Post-Burn Activities That Must Be Completed:

Any necessary rehabilitation of temporary firelines and trails will be completed once the Burn Boss has declared the threat of escape to be non-existent. All firelines and roadways will be surveyed post burn for hazards caused by the burn operation. Any saw cuts will be flush-cut and cuts will be buried or disguised. Line construction and minimum impact suppression techniques will be utilized to rehabilitate the impacts per the FAMOG. All flagging will be removed and all trash will be picked up

Documentation will include:

Fire Dispatch will maintain a fire file with the burn plan, dispatch log, resource orders, spot weather forecasts, OF-288 and CTR forms, Prescribed Ignition Forecast Advisory (PIFA), Incident Action Plans, and Unit Logs. Fire Effects monitoring staff will maintain the fire effects data.

The Burn Boss will maintain an ICS-214 Unit Log.

The Lead Fire Monitor will prepare and submit an individual report that summarizes weather, fire behavior, and smoke observation data within two weeks after the fire.

The Burn Boss will prepare an Individual Fire Report, through the Wildland Fire Management Information (WFMI) System, within 10 days after declaring the fire out. All fire records will be stored according to standard procedure.

The Fuels Management Specialist will prepare a project accomplishment report in the National Fire Plan Operational Reporting System (NFPORS) within 5 days of ignition/project completion.

Attachments to the Prescribed Fire Plan

Maps
1. Vicinity
2. Project
3. Smoke Trajectory

Technical Review Checklist
Complexity Analysis
Job Hazard Analyses
1. Prescribed Burning
2. Hazard Trees

Adequate Holding Resources Worksheet (if used)
Fire Behavior Modeling Documentation or Empirical Documentation (i.e. – BEHAVE runs)
Medical Plan (Example)
Wilderness and Backcountry Minimum Tool Analysis (if needed)
Park Review Comments

MAPS

IMPORT ALL MAPS DIRECTLY ON THE PAGES FROM THE J DRIVE

Vicinity Map:

Project Map:

Smoke Trajectory Map

TECHNICAL REVIEWER CHECKLIST

Technical Reviewer Checklist

PRESCRIBED FIRE PLAN ELEMENTS:	S /U	COMMENTS
Signature page		
GO/NO-GO Checklists		
Complexity Analysis Summary		
Description of the Prescribed Fire Area		
Objectives		
Funding		
Prescription		
Scheduling		
Pre-burn Considerations and Weather		
Briefing		
Organization and Equipment		
Communication		
Public and Personnel Safety, Medical		
Test Fire		
Ignition Plan		
Holding Plan		
Contingency Plan		
Wildfire Conversion		
Smoke Management and Air Quality		
Monitoring		
Post-burn Activities		
Appendix A: Maps		
Appendix C: Complexity Analysis		
Appendix D: Agency specific job hazard analysis		
Appendix E: Fire Prediction Modeling Runs or Empirical Evidence		
Other		

S = Satisfactory **U = Unsatisfactory**

Recommended for Approval Not Recommended for Approval

Technical Reviewer Qualification and currency (Y/N Date

COMPLEXITY ANALYSIS

Prescribed Fire Complexity Rating System Guide Worksheet

Instructions: This worksheet is designed to used with the Prescribed Fire Complexity Rating descriptors on Page 6.

Project Name Number

Complexity elements:

Potential for Escape

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

The Number and Dependency of Activities

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Off-Site Values

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

On-Site Values

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Fire Behavior

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Management Organization

Risk	Rationale
Preliminary Rating: Low Moderate High	
Final Rating: Low Moderate High	
Potential Consequences	Rationale
Preliminary Rating: Low Moderate High	
Final Rating: Low Moderate High	
Technical Difficulty	Rationale
Preliminary Rating: Low Moderate High	
Final Rating: Low Moderate High	

Public and Political Interest

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Fire Treatment Objectives

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Constraints

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Safety

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Ignition Procedures/Methods

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Interagency Coordination

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Project Logistics

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

Smoke Management

Risk	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Potential Consequences	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	
Technical Difficulty	Rationale
Preliminary Rating: *Low Moderate High*	
Final Rating: *Low Moderate High*	

COMPLEXITY RATING SUMMARY

RISK	OVERALL RATING
POTENTIAL CONSEQUENCES	OVERALL RATING
TECHNICAL DIFFICULTY	OVERALL RATING
SUMMARY COMPLEXI TY RATING	
RATIONALE	

This rationale must be identical to the rationale on the complexity analysis on page 6.

Prepared by Date

Approved by Agency Administrator Date

AGENCY SPECIFIC JOB HAZARD ANALYSES

SEKI JOB HAZARD ANALYSIS

SEKI JOB HAZARD ANALYSIS			
Job Description: Prescribed Burning			Date of last update: 11/07/03
Division with primary responsibility for this JHG: Fire and Aviation	Last updated by: Georgia Dempsey	Reviewed by: Ben Jacobs	Approved by: Dave Bartlett

Required standards and general notes:	Standard firefighting orders, 18 watch out situations; LCES; jobs are conducted by task book standards and agency training
Required personal protective equipment:	Full firefighter PPE to include Nomex clothing over cotton underclothes; gloves, fire boots, hard hats, eye protection, ear protection, IA pack, headlamp, fusees, fire shelter, chaps when needed
Typical tools and equipment:	Standard firefighting tools; fusees, drip torches, fire shelter, fire engines, mark III pumps, hoses and hose lays, hand held radios

Activity	Potential Hazards	Safe Action or Procedure
Planning and writing burn plans	Errors in fire behavior runs, not ensuring that resources are on hand in the event of an escape; making sure you have personnel who are qualified to carry out each phase of the burn	Double check burn plans and fire behavior data; run all plans through the formalized sign off process so errors can be caught prior to ignition; check on resources in contingency plan to ensure that they are available to help as stated; make sure current information and technology is used properly; make sure that each person assigned to a task is qualified for the position held; trainee positions will be under the direct supervision of appropriately certified individuals.
Pre-Ignition Phase	Weather/fuel conditions that are out of prescription; Not enough resources on hand to safely conduct the burn as planned; Safety talk not given or incomplete; PPE missing	Make sure that weather and fuel conditions fall within acceptable parameters as defined by the burn plan; Check to make sure that burn and contingency staffing is adequate; Safety talk should include information on current and expected weather, escape routes, safety zones, communication procedures, contingency planning, local hazards and fire behavior; Ensure that all staff on the burn are in full PPE, if not, they need to be dismissed from the burn
Test Burn Phase	Fire behavior is out of expected norms thus causing concern over the ability to hold the burn; drip torch fuel is mixed incorrectly either being too hot, or not hot enough; test burn immediately jumps holding lines. Threats: losing the fire thus endangering fire fighters, visiting public and property. Problems: smoke inhalation, burns, exhaustion	If test burn does not go well and fire behavior exceeds expected behavior, the burn boss should halt ignitions, review weather and fire behavior conditions and make a determination on whether the burn should be conducted. To safeguard against hot fuel mix, always make sure drip torch is assembled correctly with loop pointing towards ground; adjust fuel amounts and conduct a small test burn by dripping a small amount of fuel onto the ground and then carefully igniting the spot to see how the fuel reacts. If the fuel is either too hot, or not hot enough, replace fuel. If fire immediately jumps the lines, cease ignition and concentrate efforts on extinguishing the fire. Avoid working midslope and sucking fumes as much as possible. Use good work rest ratio, and call for contingency help to avoid exhaustion. LCES should be used at all times to ensure that no one gets burned. Personnel should be well trained in shelter deployment techniques.

Ignition Phase	Not understanding directions, role or how to do the job you were assigned; Getting out of touch w/ crew, burn boss or current weather information due to communications problems; Being threatened with fire hazards such as snags (possible death or traumatic injury), extreme or erratic fire behavior (burns, smoke inhalation, or death); causing extreme fire conditions by not following ignition patterns established by burn boss; exposure to fire or elements due to getting lost on fire	Have employees repeat directions back to make sure that they were clearly understood; ask employees outright if they understand their mission and how to safely accomplish it; go over plan in detail during briefing. Communications training should be conducted each season so that each employee feels comfortable using park hand held radios. They must be trained in how the radio works, channel selection, volume, priorities, and basic trouble shooting procedures. During the safety briefing, the channels being used need to be stated clearly. Known hazards should be discussed in detail with extra attention paid to explaining info. on lookouts, communications, escape routes and safety zones and snags. Standard navigation procedures, using a map and compass, should be taught to personnel. Working on the buddy system principal will also help to eliminate getting lost. Showing people the unit, on a map, during the briefing should also help to safely orient firefighters. IA packs should contain such safety items as water, matches, space blanket and extra food.
Holding Phase	Burns or smoke inhalation caused from holding actions; cuts caused from use of firefighting equipment; back strains from carrying heavy gear or improper starting techniques for pull cord equipment; loss of hearing or vision; crushing injuries caused from falling trees	Burns and smoke inhalation can be avoided by good use of LCES, correct placement of holding line w/ particular attention to using midslope lines as little as possible and constantly watching the weather and fire behavior for unusual changes; Cuts can be avoided by careful use of tools, tool guards, spacing techniques and use of safety equipment such as chaps, fire boots, gloves and hard had; Back strains can be mitigated by using proper bending and lifting techniques, stretching prior to work, and using sound procedures for starting large pieces of equipment; Earplugs and safety goggles should be worn whenever running equipment, or hazards such as slapping branches are a problem. Snag hazards should be identified, flagged and monitored carefully from a safe distance. Medical plan will be covered in the briefing and first aid gear will be carried by designated crew members to assist w/ first aid.
Long Work Shifts During Burn	Fatigue, mental and physical stresses;	All personnel will drink water, eat food and take appropriate breaks; shifts should adhere to national standards and work/rest ratios should be adhered to; personnel will take advantage of physical training to be prepared for arduous duty to lessen fatigue related accidents
Monitoring Phase	Crushing injuries from snags; burns from hot stump holes; driving injuries to and from fire	Snag hazards will be identified as much as possible and flagged; briefings to new crews will include information on snags and other hazards; PPE will assist in protecting from burns; driving injuries will be avoided by following the safe driving guidelines

JOB HAZARD ANALYSIS (JHA)		Date: 11-16-05	X New JHA Revised JHA
Organization/Park Unit: Sequoia and Kings Canyon National Parks	Division: Fire and Aviation Management	Branch: N/A	Location: United States
JOB TITLE: Working in the Vicinity of Hazard Trees		JHA Number:	Page ___1___of ___6__
Job Performed By: Personnel in the Field	Analysis By: Fire Operations Safety Committee	Supervisor: Dave Allen	Concurred By: Joel Metcalfe

Required Standards:	Interagency Standards for Fire and Fire Aviation Operations (Redbook); Fireline Handbook; Incident Response Pocket Guide; Class A,B,C Faller Task Book.
General Notes:	The intent of this JHA is to be used for chain saw/cross cut saw operations, fire suppression, prescribed fire operations and other wildland fire related work activities. This JHA should be utilized any time personnel are in the field around hazardous trees, live or dead. This JHA only identifies the hazards and safe actions associated with working in the vicinity of potential hazard trees and specific hazard trees that have been identified. It does not analyze the other hazards associated with the work activity.
Required Personal Protective Equipment:	Wear agency approved hard hats whenever working in forested environments. Utilize all wildland fire PPE when performing wildland and prescribed operations, or as otherwise required. These include boots, fire shelter, hard hat, goggles/safety glasses, yellow aramid shirts, aramid trousers and leather gloves. Personnel who are exposed to noise levels in excess of 85 decibels, such as chain saw operators, are required to utilize ear plugs/hearing protection. In addition, all chain saw operators must wear chain saw chaps. Additional PPE may be required by local conditions, material safety data sheets and/or JHAs. See the Interagency Standards for Fire and Fire Aviation Operations for additional information.
Tools and Equipment:	Wildland fire hand tools (shovel, pulaski, etc.), chain saws/cross cut saws, saw service/repair kits, fuel and bar oil containers, axes and wedges, flagging, handheld radios, spare batteries for radios, first aid kits. For the sake of brevity, throughout the remainder of this JHA the term “chain saw” is used to refer to “chain saws and/or cross cut saws” unless otherwise specified.

Activity/Sequence of Job Steps	Potential Hazards/ Injury sources	Safe Action or Procedure
Pre-work/Preseason Activities	None	Contact Park Forester to determine areas of the park where there are hazard trees from disease bug kill or any other cause of mortality of groups of trees: 1. Identify high risk tree species in your particular area. These are generally trees that are more susceptible to heart rot, root rot or have shallow roots. 2. Where information is available, identify geographic areas where high concentrations of potential hazard trees are likely to exist. 3. Where information is available, obtain updates on current forest health trends and problems areas in your vicinity.
Refresher Training	None	1. During annual wildland fire and chain saw operator refresher training, provide updates, as available on current forest health trends and problem areas in the local area.

JHA - CONTINUATION SHEET	JHA Number: 2005-01	Page ___2__of ___6__

Activity/Sequence of Job Steps	Potential Hazards/ Injury sources	Safe Action or Procedure
		2. Brief employees on recognition of hazard tree indicators, use of assessment techniques and appropriate risk mitigation measures. An excellent reference for hazard tree information is found at: http://www.fs.fed.us/r1/projects/haztree_index.shtml. Check for websites that contain regional specific information such as http://www.fs.fed.us/r5/spf/publications/fhp-pp-presentations.shtml for California.
Pre-work Briefing/Tailgate Safety Session	None	1. Brief employees on work assignment and objectives. 2. Insure required PPE is being utilized. 3. Review applicable JHAs, Material Safety Data Sheets (MSDS), hazard tree indicators and mitigation measures including LCES (lookouts, communications, escape routes and safety zones). Refer to attachment at end of this JHA. 4. Provide information on environmental conditions and forecasts (such as strong and/or gusty winds) that could affect hazard tree risks. 5. Identify trigger points/decision points as warranted for conditions such as strong winds. 6. Brief employees on the plan that would be executed in the event of a serious employee illness/injury that would require medical evacuation.
Size-up of Worksite Conditions	Struck by falling tree, tree limbs or other debris from tree.	1. Maintain situational awareness and utilize the risk management process. Refer to the Incident Response Pocket Guide or the Fireline Handbook for a description of the risk management process. 2. Look up, down and all around for hazard tree indicators and high risk tree species. Refer to attachment at the end of this JHA. 3. Pay particular attention to burning trees and trees with dead or broken tops, dead or broken limbs, hung-up trees, trees with severe leans and other signs of significant weakness. 4. Stay alert for environmental conditions that could increase hazard tree risks. These include strong/gusty winds, steep slopes and obscured visibility (such as smoke or limited daylight) that inhibits visibility of tree tops. 5. Tree felling at night should be avoided whenever possible and should only occur when there is adequate lighting and the entire tree including the tree top and surrounding area can be seen by the faller. 6. Communicate hazards to crew members, implement LCES and other hazard control measures.

JHA - CONTINUATION SHEET	JHA Number: 2005-01	Page __3___of ___6__

Activity/Sequence of Job Steps	Potential Hazards/ Injury sources	Safe Action or Procedure
Locating Fireline	Struck by falling tree, tree limbs or other debris from tree.	1. Utilize the most qualified personnel on scene to scout and flag fireline. 2. Locate fireline in areas with the least amount of potential hazard trees, as long as other fireline safety risks are not increased to an unacceptable level. 3. Perform an initial size-up of potential hazard trees from a safe distance as determined by an assessment of onsite conditions such as steepness of slope, number and density of trees in vicinity and potential for "domino effect", stability of trees, wind conditions and other applicable variables. Approach trees as warranted to conduct additional assessment. 4. Insure LCES is in place when conducting the assessment in close proximity to potential hazard trees. Assess potential hazard trees to determine if a live tree or snag should be identified as a hazardous tree. Refer to assessment techniques in the attachment at end of this JHA. 5. Flag or otherwise mark all identified hazard trees.
Fireline Construction	Struck by falling tree, tree limbs or other debris from tree.	1. Mitigating the risks of identified hazard trees will precede line construction. Mitigation may be accomplished by avoiding, felling or eliminating through other means (blasting, burning, heavy equipment, etc.). 2. All personnel other than the faller, and the swamper if necessary, will keep a safe distance away from identified hazard trees. 3. The safe distance will be determined by an assessment of onsite conditions. As an example, the safe distance in flat terrain for one isolated snag in a brush field with no potential for a "domino effect" may be 1 tree length. In contrast, the safe distance on the down slope side of a large dense snag patch on very steep slopes may be in excess of 5 tree lengths. 4. If the identified hazard tree cannot be safely removed, the area will be flagged off and fire personnel in the area will be notified to avoid the area. 5. If dozers or other heavy equipment are assigned to fireline construction, personnel will stay a safe distance away as determined by an assessment on onsite conditions. 6. Continue to maintain situational awareness and utilize LCES and the risk management process.

JHA - CONTINUATION SHEET	JHA Number: 2005-01	Page __4___of ___6__

Activity/Sequence of Job Steps	Potential Hazards/ Injury sources	Safe Action or Procedure
Falling Hazard Trees	Struck by falling tree, tree limbs or other debris from tree.	1. Fallers have the responsibility to say "NO" and walk away from any situation they determine to be an unacceptable risk. 2. Avoid felling trees during high or gusty winds, when lightning activity is occurring or if visibility of tree tops and surrounding area is obscured by darkness, smoke, fog or other conditions. 3. Limit personnel at the base of the tree to the feller, certified for the appropriate size class, and the swamper when necessary. 4. Implement LCES. Identify swamper, and as necessary, other personnel as lookouts. Confirm clear communications. Pre-identify multiple escape routes and safety zones. 5. Size up the tree considering the tree species, height, diameter, lean, soundness, previous fire damage, fire currently in tree, split or broken top, "widow makers" and other hazard tree indicators. Bore tree if necessary to determine soundness. 6. Clear escape routes and work area. Walk out and clear the intended lay. 7. Fell tree using established falling procedures. Refer to faller Task Books, other applicable JHAs and any agency specific requirements. 8. As tree begins to fall, watch top and move quickly away. If tree movement compromises the primary safety zone, use an alternate. 9. Watch for falling tree tops and limbs for at least 30 seconds after tree hits the ground.
Mop-up	Struck by falling tree, tree limbs or other debris from tree.	1. Perform an initial size-up of potential hazard trees from a safe distance as determined by an assessment of onsite conditions such as steepness of slope, number and density of trees in vicinity and potential for "domino effect", stability of trees, wind conditions and other applicable variables. [Follow agency policy if more stringent requirements have been established.] Approach trees as warranted to conduct additional assessment. 2. Insure LCES is in place when conducting the assessment in close proximity to potential hazard trees. Assess potential hazard trees to determine if a live tree or snag should be identified as a hazardous tree. Refer to assessment techniques in the attachment at end of this JHA. 3. Flag or otherwise mark all identified hazard trees. 4. Conduct risk assessment of the need to mop-up to meet fire control objectives versus the hazards associated with felling the hazard trees and conducting mop-up operations.

JHA - CONTINUATION SHEET	JHA Number: 2005-01	Page __5___of ___6__

Activity/Sequence of Job Steps	Potential Hazards/ Injury sources	Safe Action or Procedure
		5. Mitigating the risks of identified hazard trees will precede mop-up work. Mitigation may be accomplished by avoiding, felling or eliminating through other means (blasting, burning, heavy equipment, etc.). 6. All personnel other than the faller (certified at the appropriate class) and, if necessary, the swamper will keep a safe distance away from identified hazard trees. [Follow agency policy if more stringent requirements have been established.] 7. If the identified hazard tree cannot be safely removed, the area will be flagged off and fire personnel in the area will be notified to avoid the area. 8. Continue to maintain situational awareness and utilize LCES.
ICP, Camps, and Other Comparable Temporary Facilities	Struck by falling tree, tree limbs or other debris from tree.	1. Potential hazard trees in and around ICPs, camps and sleeping areas must be assessed. Refer to hazard tree indicators and assessment process identified in other sections of this JHA. 2. Identified hazard trees will be mitigated prior to use of the area for camps and other temporary fire facilities. 3. If identified hazard trees cannot be safely felled or otherwise eliminated, the temporary facility will be reconfigured in such a manner that all personnel will be located a safe distance away from identified hazard trees. [Follow agency policy if more stringent requirements have been established.] Flag off or otherwise prevent entry to locations where the identified hazard trees may fall and notify all personnel of the "hazard – no entry areas".

Potential Hazard Tree Indicators

NOTE: Trees with the indicators below are not all highly hazardous but should be carefully examined to assess the danger.

Indicators – Entire Tree

- Snags – standing dead tree or part of dead tree
- Moderate to severe lean (especially recent)

Crown Indicators

- Loss of needles & leaves
- Discoloration/dieback
- Thinning crown
- Stressed cone crop

Limb Indicators

- Dead/cracked/broken branches
- Fallen limbs on ground
- Rot or conks
- Cavities and cankers
- Mistletoe branches

Bole, Stem, Butt Indicators

- Dead/broken tops
- Forked/multiple tops
- Bole swelling
- Cracks or splits
- Cavities and cankers
- Rot or conks
- Wounds/damage – mechanical or fire
- Loose bark

Root & Tree Base Indicators

- Sprung roots – mounded soil or exposed roots
- Compaction & erosion
- Damage from previous fire(s)
- Wind-throw
- Basil resin flow
- Rot or conks
- Cracks or splits

Other Indicators

- Smoke or fire is visible in tree
- Area experiencing insect and/or disease infestations

Assessment Techniques – Potential Hazard Trees

NOTE: Potential hazard trees should be carefully inspected from top to bottom, including soil next to base of the tree. The assessment must include all sides (360°) of tree. Binoculars can aid in evaluating indicators higher in the tree. Much of hazard tree assessment is subjective and dependent on the skill level and experience of the inspector.

- Look for indicators of hazard and assess the degree of severity. Consider severity versus probability.
- Try to determine if decay or rot is associated with the hazard indicators, which makes failure more likely.
- Thump, bore, and dig as needed to assess conditions not immediately visible.
- Striking bole with a solid object (such as flat end of axe) will aid in hearing the hollow sound of a tree with advanced decay. Boring a tree will also reveal how sound the wood is.
- Digging around the roots may reveal if they are green & sound or are they dead, rotten, burned off or otherwise damaged.
- Evaluate wind (especially wind speed and variability in wind direction)
- What other safety hazards exist (uncontrolled fire, steep slopes, obscured visibility, aviation operations, power lines, etc.)?

Risk Mitigation Measures – Identified Hazard Trees

- Utilize LCES (Lookouts, Communications, Escape Routes & Safety Zones) whenever working in the vicinity of hazard trees.
- Eliminate identified hazard trees (consider all techniques such as saw, burn, blast, cable, heavy equipment).
- Use traffic control when felling trees in the vicinity of roads, trails, firelines, etc.
- Ensure that felling operations do not endanger nearby workers. Avoid working down slope of felling activities.
- If unable to eliminate an identified hazard tree, it should be flagged and avoided.
- Identified hazard trees that can't be eliminated must be communicated to all other employees working in the area.
- Reassess situation as conditions change.

JHA Analysis Interagency Task Group

Paul Chamberlin – U.S. Fish & Wildlife Service
Al King – National Park Service
John Pronos – U.S. Forest Service
Brit Rosso – National Park Service
Louis Rowe – National Park Service

Federal Fire and Aviation Safety Team

Rod Bloms – U.S Fish & Wildlife Service
John Gould – Bureau of Indian Affairs
Ed Hollenshead – U.S. Forest Service
Al King – National Park Service
Michelle Ryerson – Bureau of LandManagement

ADEQUATE HOLDING RESOURCES WORKSHEET

Slopover containment resource needs are determined by analyzing the worst case slop over scenario, based on the location along the burn perimeter that poses the most threat of a slopover. Potential spread and fire intensity was calculated for this location using environmental inputs from the hot end of the burning prescription using BEHAVE. The output information provided by the BEHAVE run is then used along with the standard fire line production rates found in the 2004 Fireline Handbook (pages A30-A32) to determine the resources that would be needed to contain the slop over at established time intervals.

Fire Behavior Fuel Model		Specific Conditions	Construction Rate in Chains per Person per Hour**	Chains of Hose lay per Crew Hour					Type 1 Hand Crew Scrape*	Type2 Hand Crew Scrape*
				# persons in engine crew						
				1	**2**	**3**	**4**	**5+**		
1	Short Grass	grass	4	6	12	24	35	40	30	18
		tundra	1	2	8	15	24	30	9	5
2	Open Timber	all	3	3	7	15	21	25	24	16
3	Tall Grass	all	0.7	2	5	10	14	16	5	3
4	Chaparral	Chap.	0.4	2	3	8	15	20	5	3
		Pocosin	0.7	2	4	10	15	18	4	2
5	Brush (2 ft.)	all	0.7	3	6	12	16	20	6	4
6	Dormant Brush/Hardwood Slash	black spruce	0.7	3	6	10	16	20	7	5
		others	1	3	6	12	16	20	6	4
7	Southern Rough	all	0.7	2	5	12	16	20	4	2
8	Closed Timber Litter	conifers	2	3	8	15	20	24	7	5
		hardwoods	10	10	30	40	50	60	40	24
9	Hardwood Litter	conifers	2	3	7	12	18	22	28	16
		hardwoods	8	8	25	40	50	60	40	24
10	Timber Litter	all	1	3	8	12	16	20	6	4
11	Light Logging Slash	all	1	3	8	12	16	20	15	9
12	Medium Logging Slash	all	1	3	5	10	16	20	7	4
13	Heavy Logging Slash	all	0.4	2	4	8	15	20	5	3

*Sustained line production rates of 20-person crews for Construction, Burnout, and Holding in chains per hour. Allowances have been made in production rates for rest periods and cumulative fatigue.

** These rates are to be used for estimating initial action productivity only. DO NOT use these rates to estimate sustained line construction, burnout, and holding productivity. Initial action may consist of scratch line construction and hot spotting.

Discussion and Assumptions

Discussion:

Discuss the primary area of concern and fuels adjacent to the unit. Indicate that the analysis was run on a worst case scenario or justify why if it wasn't. Refer to the attached BEHAVE runs for support documentation.

Assumptions used for the analysis:

List all the assumptions and why these assumptions were used. Because there are currently no production rates for the Scott and Burgan fuel models, include a reference and justification for the production rates used from the above table.

Recommendations

Describe the overall recommendations.

Prepared By:_________________________Date:___________________

ADEQUATE HOLDING RESOURCES WORKSHEET FOR PRESCRIBED FIRE

Project Name: ____________________ Fuel Models Inside Project Area:__________ Acres: _____________
Prepared By/Date: ______________________________Fuel Models Outside Project Area: ________________

Characteristics	Output type	Modeling Predictions COOL END RX	Modeling Predictions HOT END RX	Unit of Measure
CRITICAL FIRE INPUTS	1 Hr Fuel Moisture			%
	Wind Speed			MPH
	Slope			%
KEY FIRE BEHAVIOR OUTPUTS	Rate of Spread (ROS)			ch/hr
	Fireline Intensity			BTU/ft/sec
	Flame Length			Feet
	Probability of Ignition			%
	Spotting Distance			Miles
	Scorch Height			Feet
FIRE SIZE	Projection Time			Hours
	Forward Spread			Chains
	Backward Spread			Chains
FIRE CONTAINMENT	Method Of Attack			Head/Rear
	Max Escape Target			Acres
	Max Containment Time			Hours
	Total Line Building Rate			Ch/hr
1. Choose greater total line building rate from inside and outside the project area				Ch/hr
2. Estimate potential number spot fires or slopovers at one time:				
3. TOTAL LINE BUILDING RATE NEEDED (multiply line 1 times line 2)				Ch/hr

Production Rates: (circle)   Ease of Access: POOR-FAIR-GOOD-EXCELLENT

(Refer to fireline handbook other sources and local knowledge)

On Site Organization	Total # Planned On Burn	Total # Dedicated to Prescribed Fire	Total # Available for Spot Fire or Slopover Control		Line Building Production Rates		Spot Fire or Slopover Line Building Capacity
Overhead				X		ch/hr	
Firing Crew				X		ch/hr	
Holding				X		ch/hr	
Other Personnel				X		ch/hr	
Engine (Crew of 5)				X		ch/hr	
Dozer (Size)				X		ch/hr	
Other				X		ch/hr	
Other				X		ch/hr	
Other				X		ch/hr	
4. TOTAL CAPACITY							
3. TOTAL LINE BUILDING RATE NEEDED (from table above)							
5. DETERMINATION OF ADEQUATE HOLDING RESOURCES (Line 4 minus Line 3)						ch/hr	

If number on line 5 is positive then adequate holding forces will be available. If number is negative, more holding resources are needed.

FIRE BEHAVIOR MODELING DOCUMENTATION OR EMPIRICAL DOCUMENTATION (I.E. – BEHAVE RUNS)

ATTACH BEHAVE RUNS HERE

NOTE: BEHAVE runs should back up the rationale for the Adequate Holding Resources Worksheet and support the fire behavior outputs in the prescription in element 7. If not all the BEHAVE runs are attached, indicate where they can be located.

MEDICAL PLAN (EXAMPLE)

MEDICAL PLAN	Incident Name	Date Prepared	Time Prepared	Operational Period

5. Incident Medical Aid Station			
Medical Aid Stations	Location	Paramedics Yes	No
Qualified EMTs	Throughout burn unit		
NPS Rangers	Request via Dispatch		

6. Transportation				
A. Ambulance Services				
Name	Address	Phone	Paramedics Yes	No
Three Rivers/Exeter	Request via CDF	559-734-7477		
Lodgepole	Request via Dispatch			
Mineral King	Request via Dispatch			
Grant Grove	Request via Dispatch			
Cedar Grove	Request via Dispatch			

B. Incident Ambulances			
Name	Location	Paramedics Yes	No

7. Hospitals								
Name	Address	Travel Time Air	Ground	Phone	Helipad Yes	No	Burn Center Yes	No
Kaweah Delta	Visalia			559-625-2211		X		X
VMC	Fresno			559-459-4000	X		X	

8. Medical Emergency Procedures

Prepared by (Medical Unit Leader)	10. Reviewed by (Safety Officer)

WILDERNESS AND BACKCOUNTRY MINIMUM TOOL ANALYSIS

Background:
Section 4(c) of the Wilderness Act states: " . . .except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act (including measures required in emergencies involving the health and safety of persons within the area), there shall be . . **no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area**."

Section 6.3.5 of NPS Management Policies 2006 states that the Minimum Requirement concept will be a two step process to [1] determine if the management action is necessary "for administration of the area as wilderness and does not cause a significant impact to wilderness resources and character; and [2] the techniques and types of equipment needed to ensure that impacts on wilderness resources and character are minimized." Also: "When determining minimum requirements, **the potential disruption of wilderness character and resources will be** considered before, and **given significantly more weight than, economic efficiency and convenience."**

Section 5.14 Administration, of SEKI's Backcountry Management Plan (which covers both Wilderness and non-wilderness backcountry and is NEPA compliant), provides guidance on how park managers are to treat the above generally prohibited actions of Section 4(c) of the Wilderness Act. Specifically treated are Radio communications (5.14.2.1), helicopters (5.14.2.2), mechanized trail maintenance equipment (5.14.2.3), Cabins (5.14.2.4), Administrative camps (5.14.2.5), Administrative Stock Use (5.14.2.6), NPS backcountry crews (5.14.2.7), and NPS personnel (5.14.2.8). Section 5.14.3 also provides reference to the Administrative Use Guideline Addendum (January 1985) which provides further clarification on administrative and management actions occurring in SEKI's Wilderness and backcountry.

Section 5.16 Scientific Study and Impact Monitoring, of SEKI's Backcountry Management Plan, provides guidance on how park managers are to conduct "scientific study and monitoring" in Wilderness and backcountry areas.

The 2007 Record of Decision for the 2006 General Management Plan and FEIS states:

"The parks' designated wilderness and other areas managed as wilderness are zoned to reflect the varying intensities of use of different areas. In heavily traveled zones, there exist engineered trails and bridges, food lockers, designated campsites, and toilets to protect park resources, while in less-used areas, amenities are minimal or non-existent. A new subsection, below in italics, entitled "Decision-making Process for Facilities within Backcountry and Wilderness Zones," is added to the GMP/FEIS (Vol.1, Page 67) to clarify the action.

This General Management Plan is a programmatic plan. The GMP provides conceptual guidance for park managers about the kinds of resource conditions, visitor services, and visitor experiences that best fulfill the mission of these parks. The listing of categories of "appropriate facilities" within the individual zone prescriptions serves only to exemplify the types of facilities that may now exist or that the parks may wish to consider at some point in the future. For a new facility to be considered, or for an existing facility to be repaired or replaced within the Major Trails, Secondary Trails, or Cross-Country Areas zones, the parks would conduct the appropriate level of compliance under the National Environmental Policy Act (i.e., Categorical Exclusion, EA or EIS). Incorporated into any such compliance would be appropriate *consideration of the Wilderness Act (Minimum requirement analysis), the Endangered Species Act and the National Historic Preservation Act. Further, installation of or repairs to facilities would have to comply with any prescriptions contained in the action alternatives considered in this plan. Only facilities that undergo additional site-specific compliance and that comply with all applicable legal and planning requirements would be constructed or repaired."*

Analysis:
If you are proposing an action, you must complete the analysis below – no action as described above is to occur in wilderness unless this form has been completed and approved (use additional sheets if more space is needed).

Describe the action you wish to take (e.g. helicopter flight, chainsaw use, install resource monitoring equipment, etc.), **not** a general project description. Please **provide detailed estimates on HOW MANY TIMES AND WHEN** (day/week/moth) the action will occur on this project (e.g. 3 helicopter landings, or rock drill will be used on 4 days, etc. **the more detail, the better**):

Answer the following questions:
Does the purpose of this action meet Minimum Requirements, that is, does it support: a)Visitor Enjoyment and Recreation (e.g. trail system and camping), b) Resource Protection and Visitor Management (e.g. ranger stations, toilets, communication systems), or c) Resource Management and Research (e.g. monitoring, inventorying, pertinent research, restoration, barriers for protection) per SEKI's MD-049?

Why is this action necessary (e.g. movement of heavy/bulky materials, safety, time sensitive, trail closed by snow or logs, sensitive park resources, stock not available, maximum resource protection)?

Did you pursue other Wilderness Act compatible alternatives (e.g. hand tools, stock, foot)? Why were they determined to not be feasible?

If this action is not taken will wilderness resources be at risk (e.g. social trails created, over-use of grazing resources, illegal camping, bear management problems, critical snow surveys not taken, erosion, resource depredations, human waste/pollution problems, etc.)?

Will alternate means of accomplishing the action provide for resource degradation (e.g. trail or meadow impacts from increased stock use, increased erosion from use trails)?

What wilderness resources might be at risk as a result of this action (e.g. character, soundscapes)?

(Note: some of this can be mitigated with proper scheduling.)

Is the action necessary at the time it is scheduled, i.e. can it be accomplished at a later date without utilizing a generally prohibited 4(c) action?

What other aspects, that are relevant to protecting wilderness character and resources, have been considered in this analysis?

Approvals and Routing:

Printed name and signature of submitting program manager	Date
Recommended by (Division Chief)	Date
Approved by Superintendent	Date

NOTE: Upon receiving all above signatures, route original to Wilderness Coordinator for administrative record.

PARK REVIEW COMMENTS

Burn Plan Name:

Please note comments you have concerning this prescribed burn plan.

Park Fuels Management Specialist

District Fire Management Officer:

Park Fire Management Officer:

Chief Ranger:

Superintendent:

MECHANICAL TREATMENT PLAN

National Park Service

Sequoia and Kings Canyon National Parks

Mechanical Fuels Treatment Plan

PROJECT NAME: MECHANICAL PLAN TEMPLATE

Prepared by: Date: ________

Recommended by: ____________________________Date: ________
District Ranger

Recommended by: ____________________________Date: ________
District FMO

Recommended by: ____________________________Date: ________
Park Fire Management Officer

Recommended by: ____________________________Date: ________
Chief Ranger

Recommended by: ____________________________Date: ________
Natural Resources Management Specialist (Fire)

Recommended by: ____________________________Date: ________
Chief, Resources Management & Fire Management Committee Chair

Recommended by: ____________________________Date: ________
Chief, Cultural Resources and Interpretation

Approved by: ________________________________Date: ________
Park Superintendent

For information about this project contact:
Fire Management Office 559-565-3164/3165
FAX 559-565-3797
24-Hour Park Dispatch 559-565-3341

EXECUTIVE SUMMARY

A brief discussion describing the purpose and justification of the project, connection with the overall management of the unit, potential impacts and mitigations, use of contracted resources, and description of how it implements the fire management plan.

Description of the Fuels Treatment Area

General Area Description (narrative)

Location (county, legal, lat/long and/or UTM, Fire Management Zone or Unit)

Geographic Attributes (project size, elevation range, slope range, aspect range)

Description of Project Boundaries (define geographic, natural, and human features to be used as the project boundary)

Vegetation Types (fuel model, fuel loading, fire regime, condition class)

Wilderness Status? Designated / Recommended / Study Area / Eligible / Non-wilderness (Choose one)

Vicinity Map (attached as an appendix)

Project Map (attached as an appendix)

Vegetation Type	Fuel Model NFFL	Estimated Acres	Estimated Tons Per Acre

Total Estimated Pre-Project Tons:

Tons per acre estimate based on Photo Series for Quantifying Fuels and Assessing Fire Risk in Giant Sequoia Groves, 1997; and Photo Series for Quantifying Natural Forest Residues in Sierra Nevada.

Goals and Objectives

Include the purpose and goals of the non-fire treatment plan, as stated in park management and supporting management plans (i.e. – Resource Management Plan, Vegetation Management Plan, Cultural Landscape Plan, Endangered Species Recovery Plan, etc.) Specific objectives of the non-fire treatment should be stated in quantifiable and measurable terms. If the purpose of the treatment is to change fire behavior, at least one objective should address predicted changes in fire behavior after the project is completed.

Example 1: "This treatment is intended to reduce flame lengths to less than 4 feet to allow direct attack of the fire by hand crews when fine dead fuel moistures are 4% and eye level wind speed is 10 miles per hour."

Example 2: "This treatment is intended to allow a prescribed fire to be conducted to reduce surface fuels with a prescription of 6% fine dead fuel moisture and eye level wind speed of 5 miles per hour without causing any type of crown fire."

Cost

Estimated total costs for the planning, preparation, implementation, and evaluation phases of the project. Estimate funds that will be used for contracting purposes.

ESTIMATED FINAL COST/ACRE:

Scheduling

Give an approximate time for all phases of the project to be initiated and completed. Note any dates, seasons, or conditions when work may not be performed (hints: nesting bird season, inclement weather; weekends or holidays).

Statement of Work:

Identify methods, role and responsibilities, coordination and special considerations needed.

Protection of Sensitive Features

Identify treatment and mitigations needed to protect cultural sites, threatened and endangered species, or other sensitive features (trees of special interest, wilderness area status, special management areas, etc.) Include compliance with all applicable NEPA and NHPA requirements.

Public and Personnel Safety

Describe public and personnel safety and emergency procedures. Identify safety hazards on and outside the project area, measures taken to reduce or mitigate those hazards, and Emergency Medical Service personnel assigned. Describe the medical plan, and include or refer to pertinent JHA's.

Interagency Coordination and Public Information

Identify actions, timelines, and responsibilities for interagency and intra-agency coordination and public involvement.

Media releases and public notice postings

Notifications – list of appropriate individuals, agencies, and the public to receive notifications.

Collaboration – identify roles and responsibilities of private and government partners.

Monitoring

Monitoring practices must measure treatment effectiveness. At a minimum, non-fire fuels treatments must be monitored for pre-treatment and post treatment conditions, at a level sufficient to determine whether the objectives of the treatment were met. See RM-18, Chapter 11 for specific guidance.

Post Project Rehabilitation

Describe any necessary rehabilitation of disturbances that will be undertaken resulting from management activities of the project. These typically include equipment and human travel corridor restoration, minor fence repairs, and other mitigation actions that are pre-identified in the Non-Fire Treatment Project Plan.

Post Project Reports

Identify what reports associated with this project will be completed, when, and by whom.

Appendices

Items to be reviewed/signed and attached with the non-fire treatment plan, including maps, pre and post treatment photo series representations, monitoring plot detail, reviewer comments, and location of electronic files or GIS layers.

Park Review Comments

Project Name:

Please note comments you have concerning this project plan.

Fire Management Officer

Division of Visitor and Fire Management

Division of Resources Management and Science

Division of Interpretation and Partnerships

Superintendent:

Other:

P- Preparedness Staffing Plan

STAFFING LEVEL I

Ash Mtn. Area	Grant Grove/Lodgepole Areas	Cedar Grove Area
BI 0-51	ERC 0-36	BI 0-34

Staffing

Normal tours of duty and number of fire crew personnel.

Operations

Entrances – Fire danger rating and road signs reflect the highest adjective class reported.

All Fire Crews-Maintain readiness.

STAFFING LEVEL II

Ash Mtn. Area	Grant Grove/Lodgepole Areas	Cedar Grove Area
BI 52-144	ERC 37-54	BI 35-47

Staffing

Normal tours of duty and number of fire crew personnel.

Operations

Entrances – Fire danger road signs reflect the highest adjective class reported.

All Fire Crews – Maintain readiness.

STAFFING LEVEL III

Ash Mtn. Area	Grant Grove/Lodgepole Areas	Cedar Grove Area
BI 145-219	ERC 55-72	BI 48-64

Staffing

Normal tours of duty and number of fire crew personnel.

Operations

Entrances – Fire danger rating road signs reflect the highest adjective class reported.

All Fire Crews – Maintain readiness.

STAFFING LEVEL IV

Ash Mtn. Area	Grant Grove/Lodgepole Areas	Cedar Grove Area
BI 220-240	ERC 73-77	BI 65-69

Staffing

Extended hours and increased staffing for all fire crews will be authorized by the Duty Officer.

All fire crew members may work their sixth day.

All fire crews may augment crew staffing with 2 additional firefighters.

Operations

If extended periods of high staffing levels occur then fire staff will review the need for implementing fire use restrictions.

Entrances – Fire danger rating road signs reflect the highest adjective class reported.

All Fire Crews – Maintain readiness.

New slash pile burns are prohibited.

STAFFING LEVEL V

Ash Mtn. Area	Grant Grove/Lodgepole Areas	Cedar Grove Area
BI 241+	ERC 78+	BI 70+

Staffing

Extended hours and increased staffing for all fire crews will be authorized by the Duty Officer.

All fire crew members may work their sixth day.

All fire crews may augment crew staffing with 2 additional firefighters.

May order cover engines for any engines off-park. Consult with park FMO and Duty Officers.

Operations

If extended periods of high staffing levels occur then fire staff will review the need for implementing fire use restrictions.

Entrances – Fire danger rating road signs will reflect the highest adjective class reported.

All Fire Crews – Maintain readiness.

New slash pile burns are prohibited.

(2003 version)

Q- Wildland Fire and Fuels Management Reporting Requirements

y-14

Memorandum

To:	Burn Bosses & Fire Monitors
From:	Prescribed Fire Technician
Through:	Fire Management Officer
Subject:	Prescribed Fire Operations Documentation
	Paperwork Reduction

ANNUAL PRESCRIBED FIRE PROGRAM DOCUMENT

Two or three prescribed fire planning meetings are held each winter – one for Kings and Sequoia Districts and one with Forest Service personnel. The information gathered in the planning meetings is presented in the annual SEKI prescribed fire program document which is used as a basis for annual proposed program review by the park management team and approval by the superintendent. Copies are distributed to area supervisors and Burn Bosses. Detailed descriptions of the units and maps are included along with operational issues identified in the planning meetings.

PRESCRIBED FIRE OPERATIONS DOCUMENTATION

Burn Boss Responsibilities

Burn Bosses are responsible for completion of Burn Unit Plans, Unit Logs, Individual Fire Reports (DI-1202), and performance ratings. Cost tracking forms and Post Burn Reports are no longer required. Burn Bosses need to make sure that unit preparation and execution support is coordinated with District Rangers and FMO, and that adequate documentation is provided to Fire Dispatch during burn unit execution. Burn Bosses will provide daily fire situation updates to Fire Dispatch by radio, telephone, fax, or email.

Burn Unit Plan

One plan should be written for all "active" segments within a unit – this saves on duplication of effort and time spent getting the document reviewed and approved. The plan is good until all segments are executed or there are major changes in unit/segment planning. The Burn Boss has the final say on control line location. New prescriptions are being developed for long duration burns – the prescription will be weighted on climate conditions and fuel moisture. For short duration burns the current prescriptions are valid. A burn plan form is available on the park network under J:/share_docs/plans/fire/burn_plans. There are significant changes to the form based on new permitting requirements enforced by the San Joaquin Valley Unified Air Pollution Control District. Burn Bosses must use this new form from now on.

Unit Log

For use in tracking decision and significant actions/events during execution. Attach originals to Individual Fire Report and send to FMO.

Individual Fire Report

For NPS reporting purposes, geographically distinct segments within a unit need to be documented on separate Individual Fire Reports. We tried to reduce workload by combining segments into one report but were advised by NPS Boise that we need to separate them in order for SEKI to receive full funding for the fire program.

Thorough Individual Fire Reports take the place of Post Burn Reports and narratives should be detailed.

Provide a chronological narrative of events and decisions.

Use the monitoring data collected to compare what actually happened on the fire to burn unit objectives. Describe, based on monitoring data and your experience, how the fire met objectives. If objectives were not met, explain the problems encountered that prevented meeting objectives.

Attach 7.5 minute maps showing daily fire spread or ignition information, and final fire perimeter.

Unit Log originals should be included with Individual Fire Reports and sent directly to Fire Dispatch within 10 days after declaring the fire out.

Trainee Performance Ratings

Burn Bosses are responsible for completion of Individual Performance Ratings (ICS Form 226) or Task Books for trainees. Task Books are initiated through coordination with FMO.

Fire Monitor Responsibilities

Fire Monitors

Fire monitor reports with lengthy narratives are no longer required by FMO – summaries used for programmatic analysis by FMO will be initiated at RMO discretion. Fire Monitors need to gather thorough observation information on several forms and maps are prepared for all prescribed fire incidents they are assigned to (see list below). If designated Fire Monitors are not assigned to a burn unit then it is the Burn Boss' responsibility to thoroughly document burn unit execution using the same forms. Monitors need to provide copies of all forms to Burn Bosses within a timely manner. All original forms and maps are sent to Fire Dispatch for inclusion in the fire files. Monitors on fire (typically prescribed fire or fire use projects) where there is not a Burn Boss on site will update Fire Dispatch daily with information based on the Wildland Fire Record form by radio, telephone, fax, or email.

Fire Effects Monitors

Fire effects monitoring protocols are supervised by one park fire ecologist. Plots records remain with the ecologist. FMO works with the ecologist to archive fire effects records.

Smoke and Weather Monitoring Technician

The Smoke and Weather Monitoring Technician compiles data from various observation sensors, archives the data and compiles hard copies into data packages for several prescribed fire operations each fire season.

List of Monitoring Forms

(items 1-5 available from FMO)

- Dead Fuel Moisture Determination
- Live Fuel Moisture Determination
- Fire Weather and Fire Behavior Observations
- Smoke Observations
- Wildland Fire Observations Record
- Maps showing daily fire spread or ignition, and including locations of fire observations.

Fire Dispatch Responsibilities

Fire Dispatch is responsible for compiling fire planning documents, situation and observation data into individual fire files, and documents fire situation information using the form: Interagency Report of Incident and Dispatch Action. Fire Dispatch also maintains daily fire situation information in several interagency computer systems.

Fire Information Officer Responsibilities

The Fire Information Officer is responsible for compiling media releases and news articles about fire operations and sending copies to Fire Dispatch. The FIO also coordinates communications about park fire operations with employees through use of email systems.

REPORTS

- The Fire Management Office is responsible for completion of the following:
- Annual prescribed fire accomplishment reports into the NPS Wildland Fire Management Computer System (WFMCS)
- Entering Individual Fire Reports in WFMCS
- Annual SEKI Fire Summary
- Annual SEKI Air Operations Summary

ARCHIVES

The Park Archaeologist supervises the archiving of individual fire files and other important fire history documents into park archives. FMO staff prepares the files following the archaeologist's direction.

R- Fire Staffing & Minimum Qualifications

The following list is intended to be the park-wide minimum qualifications staffing that supports the average annual on-park fire work load. The list does not include career development, off-park support or special assignments—except for Arrowhead Hotshots.

Functional Area	Minimum	Who?
Command		
FUMA	3 from the following list	FMO / DFMOs / RX Spec. / Fire Planner
ICT3	3	FMO / DFMOs
ICT4	9	All Hand Crew and Engine Crew Captains and Helicopter Managers on the HELITACK Crew
ICT5	13	All fire crew first line supervisors, C-91 Squad Bosses, and Helicopter Managers on the HELITACK Crew
IOF3	2	PIO / FIO
RXB1	4 from the following list	FMO / DFMOs / RX Spec. / Fire Planner
RXB2	10 from the following list	FMO / DFMOs / RX Spec. / Fire Planner / All STF Engine Captains / C-91 Leader / Fire Monitor Squad Leader / H-552 Captain
RXM1	3 from the following list	FMO / DFMOs / RX Spec. / Fire Planner
RXM2	3 from the following list	FMO / DFMOs / RX Spec. / Fire Planner
Finance		
EQTR	1	FMO Budget Assistant
PTRC	4	Kings Dist. Ranger Time Keeper / Sequoia Dist. Ranger Time Keeper / FMO Budget Asst. / A-6 Clerk
TIME	1	FMO Budget Asst.
Logistics		
ORDM	1	Fire Cache Manager
RCDM	1	Fire Cache Manager
Operations		
AFUS	3	H-552 Captain and Helicopter Managers on the HELITACK Crew
CRWB	5	Crew 91 Leader / H-552 Captain and Helicopter Managers on the HELITACK Crew / Fire Monitor Squad Leader
DIVS	4	FMO / DFMOs / RX Spec.
ENGB	6	All Engine Captains, Asst. Engine Captains
FALB	13	2 on each engine / 6 on C-91 / 3 on HELITACK / 3 on the monitoring squad
FALC	9	All Engine Captains / Crew 91 Leader and Squad Bosses/ H-552

		Captain
First Responder	7	All STF Engine Captains / H-552 Captain and Helicopter Managers on the HELITACK Crew / C-91 Leader and Squad Bosses
HEB2	2	DFMO Sequoia / H-552 Captain
HECM	5	H-552 Crew
HEMG	3	H-552 Captains and Helicopter Managers on the HELITACK Crew
RXI1	5	FMO / DFMOs / RX Spec. / Fire Planner
RXI2	10 from the following list	FMO / DFMOs / RX Spec. / Fire Planner / All STF Engine Captains / C-91 Leader / Fire Monitor Squad Leader / H-552 Captain
STAM	4	A-6 Clerk / Procurement / Maintenance
Planning		
FBAN	1	RX Spec.
FEMO	5	Fire Monitor Squad
LTAN	1	RX Spec.
SCKN	4	Kings Dist. Ranger Time Keeper / Sequoia Dist. Ranger Time Keeper / FMO Budget Asst. / A-6 Clerk
Arrowhead Hotshots		
CRWB	5	Superintendent 6 / Foreman (2) / Module Leader (2)
EMT-B	2	Skilled Firefighter / Crew Member FALC
FALC	3	Foreman / Module Leader / Skilled Firefighter
FFT1	5	Skilled Firefighter (5)
FFT2	10	Crew Members
HECM	2	Skilled Firefighter / Crew Member
ICT3	2	Superintendent 6 / Operations Foreman
ICT4	3	Logistics Foreman / Module Leader (2)
ICT5	5	Skilled Firefighter (5)
STCR	2	Superintendent 6 / Operations Foreman

S- Yearly Readiness Checklist

This checklist is a summary of major fire management activities.

YEAR-ROUND

Return any and all defective equipment to the Ash Mountain fire cache.

JANUARY

- Complete annual work plan for fire program managers.
- Determine in-park fire training needs and establish training dates. This includes basic training (S-130, 190, 211, 212, and the fire refresher).
- Continue Ash Mountain Fire Cache requisition and replacement of equipment and supplies.
- Complete previous year's data summary reports for fire monitoring.
- Update fire history and WIFMI database in GIS.
- Complete all annual fire reports and required reports.

FEBRUARY

- Begin seasonal employee hiring process (Firefighters and Fire Monitors).
- Recruit prospective staff
- Assist in teaching basic fire training at the Porterville Adult School

MARCH

- Continue seasonal hiring process.
- Begin work capacity testing (pack test).
- Re-inventory Ash Mountain Fire Cache.
- Begin clean-up, maintenance, servicing and restocking of all fire vehicles.

APRIL

- Initiate annual physical fitness testing.
- Complete seasonal hiring process and track administrative progress with new seasonal employees.
- Complete operations meetings with local cooperators.
- Conduct annual spring operations meeting.
- Continue inventory of Ash Mountain fire cache and restock if necessary. Prepare for summer issues.

MAY

- Early May – EOD of seasonal employees.
- Continue clean-up, maintenance, servicing, and restocking of all fire management vehicles.
- Ash Mountain Cache – Begin summer issue of PPE and crew equipment.
- Conduct multiple 8 hour fire refresher sessions throughout the parks.
- Begin daily vehicle readiness checks.
- Prescribed burning of approved units in prescription.
- Activate the Ash Mountain Helibase.
- Prescribed burn plans completed for Superintendent's signature.
- Module Leaders submit updated red card information. (experience/training)
- Green-Up the Cedar Grove and Park Ridge RAWS and perform annual maintenance.
- Begin collecting fire weather observations and calculating fire danger ratings.
- Start issuing red cards to all fire staff employees.
- Complete all required pre-season wildland fire training (S-130, 190, 211, 212, and the 8-hour refresher) including Basic Aviation Safety.
- Complete engine, patrol vehicle, and station inventory and restock as necessary.
- Complete Readiness Review Appendix L.
- Begin fuel moisture sampling (as required, ongoing).

JUNE

- EOD of the park contract helicopter.
- Insert and set up the Sugarloaf and Rattlesnake RAWS.
- Establish additional fuel loading plots (as required, ongoing).
- Complete all non-fire related training (POSH, defensive driving, SEKI orientation, Update training, etc.)
- Continue mechanical hazard fuel reduction projects.
- Prescribed burn preparation activities.
- Prescribed burning of approved units in prescription.
- Activate all sub-district helispots.
- Conduct employee fire extinguisher use training during safety stand-down.

JULY

- Continue mechanical hazard fuel reduction projects.
- Prescribed burn preparation activities.
- Prescribed burning of approved units in prescription.
- Continue fuel moisture and fuel loading sampling.
- Conduct weekly and/or daily training sessions on safety, engine operations, chainsaws, portable pumps, and helicopter use.

AUGUST

- Continue daily fire readiness check of vehicles, equipment, and PPE.
- Continue daily and weekly informal training.
- Continue proficiency training.
- Continue mechanical hazard fuel reduction projects.
- Prescribed burn preparation activities.
- Continue fuel moisture and fuel loading sampling.
- Prescribed burning of approved units in prescription.

SEPTEMBER

- Continue daily fire readiness check of vehicles, equipment, and PPE.
- Continue daily and weekly informal training.
- Continue proficiency training.
- Continue mechanical hazard fuel reduction projects.
- Prescribed burn preparation activities.
- Continue fuel moisture and fuel loading sampling.
- Prescribed burning of approved units in prescription.

OCTOBER

- Continue daily fire readiness checks of vehicles, equipment, and PPE.
- Continue daily and weekly informal training.
- Continue mechanical hazard fuel reduction projects.
- Winterize all sub-district helispots.
- Continue fuel moisture and fuel loading sampling.
- Complete fuel loading data entry.
- Re-inventory engines, patrol vehicles, and station facilities. Prepare deficiency list for replacement items.
- Prescribed burn preparation activities.
- Prescribed burning of approved units in prescription.
- Begin end-of-season vehicle and power equipment winterizing.
- All fire crew leaders-submit updated experience and training (IQCS employee update form) to fire dispatch for yourself and your crewmembers.
- Remove the Sugarloaf and Rattlesnake RAWS from the backcountry.

NOVEMBER

- Prescribed burn preparation activities.
- Prescribed burning of approved units in prescription.
- Continue winterizing all patrol vehicles, pumps, chainsaws, and PPE.
- Final closure of the Cedar Grove Fire Station.
- Perform quality checks of fuels data.
- Prepare and submit monitoring crews' annual reports.
- Attend annual end of season operations meeting.

DECEMBER

- Send out chainsaws/pumps for maintenance.
- All Individual Fire Reports (DI-1202) completed and entered into WIFMI.
- Prepare requisitions for Ash Mountain Fire Cache and vehicle inventory restocking.
- Analyze and summarize fuel loading data collected during the season.
- Issue Forestry Technician seasonal job announcement.

T- Addendum

Suppression Fire Response Plan

Logistics Plan, Sequoia and Kings Canyon National Parks. In development/draft 2002. Located in Fire Management Office.

Fire and Aviation Management Operations Guide, Sequoia and Kings Canyon National Parks. 2001. Located in Fire Management Office.

Letters of Agreement (LOA) and Memorandums of Understanding (MOU) binder

Wildfire Prevention Plan: An Operating Plan of the Park Fire Management Program, Sequoia and Kings Canyon National Parks. 1993. Located in Fire Management Office.

Risk Management Plan, Sequoia and Kings Canyon National Parks. 1998. Located in park Safety Office.

Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide

Aviation Management Plan, Sequoia and Kings Canyon National Parks. 2001 (Draft). Located in Fire Management Office.

Standard Operating Procedures for the Communication Center

Emergency Equipment Rental Agreement binder

Standard Operating Procedures: Fire & Fuels Information, Sequoia & Kings Canyon National Parks. Located in the Fire Information and Education Specialist's office.

Guidance for Implementation of Federal Wildland Fire Management Policy:
http://www.nifc.gov/policies/guidance/GIFWFMP.pdf