National Park Service
U.S. Department of the Interior

Fire and Fuels Management Plan

Sequoia & Kings Canyon National Parks

Final Printing: January 2004
Annual Revision: May 2005

Table of Contents

List of Figures and Tables

List of Figures

List of Tables

Crosswalk Between RM-18 and This Plan

Description and Purpose of Crosswalk

National Park Service policy, articulated in *Directors Order 18 - Wildland Fire Management* (1998) and *Reference Manual- 18* (2002), 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	
A. Reasons for developing plan	Chapter 1
B. Summarize the collaborative processes used to develop the FMP	Chapter 1 and Appendix B
C. State that plan will implement policies and help achieve resource and fire management goals	Chapter 1
D. State that plan meets NEPA and other requirements	Chapter 1
E. Cite authorities for implementing this plan (DO-18)	Chapter 1
Part II - Relationship to Land Management Planning and Fire Policy	
A. Reference NPS Management Policies	Chapter 1
B. Relate to unit enabling legislation	
1. Why unit was established	Chapter 1
2. Significant resources and values of unit	Chapter 1 and Chapter 8
C. Describe the park-wide desired conditions and state the goals of the GMP as they relate to fire	Chapter 1 and Appendix C
D. State the objectives of the unit's Cultural and Natural Resource Management Plan	Chapter 1
E. State how plan will meet above objectives	Chapter 1
Part III - Wildland Fire Management	

Elements of Standard *RM-18* Fire Management Plan Outline	Location of Same Information in this *Fire and Fuels Management Plan*
Strategies	
A. General Management Considerations – briefly describe how wildland fire will be managed	Chapter 2
B. Wildland Fire Management Goals – develop and list the fire management goals	Chapter 1 and 2
C. Wildland Fire Management Options – discuss the range of fire management options to be applied	Chapter 3 – Tools #1-8
D. Description of Wildland Fire Management Strategies by Fire Management Unit	Chapter 4
1. FMU Identifier	
a) Physical and biotic characteristics	Chapter 4 and Chapter 8
b) Strategic and measurable objectives for FMU	Chapter 2 and Chapter 4
c) Management considerations or criteria affecting operational implementation	Chapters 4 and Chapter 5
d) Discuss historic role of fire	Chapter 9
e) Discuss wildland fire situation	
1) Historical weather analysis	Chapter 10
2) Fire season	Chapter 10
3) Fuel characteristics/fire behavior	Chapter 10
4) Fire regime	Chapter 9
5) Control problems	Chapter 10 and Chapter 4
6) Values to be protected	Chapter 4
Part IV – Wildland Fire Management Program Components	
A. General Implementation Procedures	Chapter 3
B. Wildland Fire Suppression	
1. Range of potential fire behavior	Chapter 10
2. Preparedness actions	Chapter 3 – Tool #1
a) Describe fire prevention activities	Chapter 3 – Tool #1
b) Annual training activities	Chapter 3 – Tool #1
c) Fire readiness of equipment and supplies	Chapter 3 – Tool #1
d) Fire weather and fire danger	Chapter 3 – Tool #1
1) Weather stations	
2) NFDRS	
e) Describe step-up staffing plan	Chapter 3 – Tool #1
3. Explain pre-attack plan	Chapter 3 – Tool #1
4. Initial attack	
a) Information used to set initial attack priorities	Chapter 3 – Tool #3
b) Criteria for the appropriate initial attack response consistent with GMP and RMP	Chapter 3 and Chapter 4
c) Confinement as an initial attack suppression strategy	Chapter 3 – Tool #3
d) Typical fire response times	Chapter 3 – Tool #3
e) Restrictions and special concerns	Chapter 3 – Tool #3
f) Issues (tribal, local government, hiring, recycling, etc.)	Chapter 3 – Tool #3
5. Extended attack	
a) Determine extended attack needs	Chapter 3 – Tool #3
b) Implementation plan requirements	Chapter 3 – Tool #3

Elements of Standard *RM-18* Fire Management Plan Outline	Location of Same Information in this *Fire and Fuels Management Plan*
(WFSA development)	
c) Complexity decision process for incident management transition	Chapter 3 – Tool #3
d) Delegation of authority example	Appendix K
6. Exceeding existing WFIP	Chapter 3 – Tool #3
7. Requirement for minimum impact suppression tactics	Chapter 3 – Tool #3
8. Describe short and long-term rehabilitation guidelines	Chapter 3 – Tool #3
9. Detail the tracking of records and reports	Chapter 3 – Tool #3
C. Wildland Fire Use	
1. Objectives of wildland fire use	Chapter 2 and Chapter 3
2. Parameters for informed management decisions	Chapter 3 – Tool #2 and companion EA
3. Pre-planned implementation procedures	Chapter 3 – Tool #2
4. Describe all implementation procedures that are not pre-planned	Chapter 3 – Tool #2
a) include procedures for periodic assessment of fire use	Chapter 3 – Tool #2
b) include requirements for fire use plans and documentation	Chapter 3 – Tool #2
5. Potential impacts of implementation	Chapter 3 – Tool #2
6. Identify staff positions that must be present to implement and manage	Chapter 3 – Tool #2
7. Public information and interpretation	Chapter 3 – Tool #6
8. Develop a standard outline of contents for a permanent project record	Chapter 3 – Tool #2
D. Prescribed Fire	
1. Planning and Documentation	
a) Describe annual activities to prepare for and implement the program	Chapter 3 – Tool #4 and Chapter 4
b) Relate long-term strategy to each FMU and display planned burn units	Chapter 4 and Appendix A
c) Identify numbers and kinds of qualified personnel necessary	Chapter 3 – Tool #4 and Appendix B
d) Define weather, fire behavior and fire effects monitoring associated with prescribed fire	Chapter 3 – Tool #7 and Chapter 10
e) Provide format for critiques of projects	Chapter 4
f) Reporting and documentation requirements	Chapter 3 – Tool #4
g) Develop historic fuel treatment map of past activities	Chapter 4
h) Explain the local prescribed fire burn plan requirements	Chapter 3 – Tool #4 and Appendix O
2. Exceeding existing Prescribed Fire Burn Plan	Chapter 3 – Tool #4
3. Air Quality and Smoke Management	
a) Describe pertinent air quality issues	Chapter 3 – Tool #4 and Chapter 8
b) Develop program of action to manage smoke	
i. Location of Class I airsheds	Chapter 8 and Appendix J
ii. Description of sensitive areas	Chapter 8 and Appendix J
iii. Local and regional smoke management restrictions and procedures	Chapter 3 – Tool #4 and Appendix J
E. Non-Fire Fuel Treatment Applications	
1. Mechanical treatment and other	

Elements of Standard *RM-18* Fire Management Plan Outline	Location of Same Information in this *Fire and Fuels Management Plan*
applications	
a) Annual activities to prepare for implementation	Chapter 3 – Tool #5 and Chapter 4
b) Equipment and seasonal use restrictions	Chapter 3 – Tool #5
c) Define the effects monitoring required	Appendix C
d) Provide format for critiques	Chapter 4
e) Cost accounting	Chapter 3 – Tool #5
f) Reporting and documentation requirements	Chapter 3 – Tool #5
g) Annual planned project list	Appendix A
F. Emergency Rehabilitation and Restoration	Chapter 3 – Tools #2-5
Part V – Organizational and Budgetary Parameters	
A. Describe fire organizational structure of the park fire program	Chapter 6
B. Fire Pro Funding	Chapter 6
C. Relate fire's organization to the rest of the NPS unit's organization	Chapter 6
D. Park superintendent responsibility	Chapter 3 and Chapter 6
E. Describe interagency coordination	Chapter 6
F. List key interagency contacts by function	Chapter 6
G. List and describe all fire-related agreements	Chapter 6
Part VI – Monitoring and Evaluation	
A. Short and long-term monitoring program	Chapter 3 – Tool #7 and Appendix C
B. FMH protocols	Chapter 3 – Tool #7 and Appendix C
C. Fire monitoring plan	Appendix C
Part VII – Fire Research	
A. Summarize previous and ongoing fire research related to unit	Chapter 3 – Tool #8 and Appendix D
B. Summarize fire research that is needed	Chapter 3 – Tool #8 and Appendix D
Part VIII – Public Safety	
A. Describe public safety concerns and issues	Chapter 7
B. Procedures for mitigating safety issues	Chapter 7
Part IX – Public Information and Education	
A. Describe public information capabilities and needs to implement program	Chapter 3 – Tool #6
B. Describe step-up information activities	Chapter 3 – Tool #6
Part X – Protection of Sensitive Resources	
A. Summarize archeological/cultural/historic resources requiring special protection	Chapter 5 and Appendix H
1. Describe actions to prevent or mitigate impacts	Chapters 4 and Chapter 5
B. Describe natural resources or features requiring special protection	Chapter 5
1. Describe actions to prevent or mitigate	Chapters 4 and Chapter 5

Elements of Standard *RM-18* Fire Management Plan Outline	**Location of Same Information in this *Fire and Fuels Management Plan***
impacts	
C. Describe developments, infrastructure, inholdings that require special protection	Appendix H
1. Describe actions to prevent or mitigate impacts	Chapters 4 and Chapter 5
Part XI – Fire Critiques and Annual Plan Review	Chapter 4
Part XII – Consultation and Coordination	Companion EA
Part XIII – Appendices	
A. References cited	Chapter 11
B. Definitions	
C. Species lists	Companion EA
D. NEPA and NHPA compliance	Companion EA and Appendix B
E. Any other unit specific supplemental information (requires annual revision)	
1. Fire call-up list	Addendum
2. Preparedness inventory	Appendix P
3. Cooperative agreements	Chapter 6
F. Wildland and Prescribed Fire Monitoring Plan	Appendix C
G. Preattack Plan	Chapter 3 – Tool #1 and Addendum
H. Long-term prescribed fire and hazard fuel reduction plan	Appendix A
I. Fire Prevention Plan	Addendum
J. Rental Equipment Agreements	N/A
K. Contracts for Suppression and Prescribed Fire Resources	Chapter 6
L. Burned Area Emergency Stabilization and Rehabilitation Plan	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* (1998) and *Reference Manual- 18* (1999), 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*), and the 10- Year Comprehensive Strategy (*A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment*).

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 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.

Master Plan/General Management Plan

The parks *Master Plan* (1971) provides the primary direction for management of natural resources in these parks. The *Master Plan* expresses natural resource goals in a general way but does not provide detailed implementation strategies. The parks' *Master Plan* is currently undergoing major revision and will become a *General Management Plan* (GMP). The expected completion date for the GMP is 2004. Once that plan is completed, the *Fire and Fuels Management Plan* will be reviewed for conformity with the GMP. If there are discrepancies between the two plans, the GMP direction will take precedence and this plan will be amended to comply.

The *Master Plan* (pg. 10) states that *"fire has been an important element in the environment of this locality since time immemorial. Fire, therefore, should be restored to its natural role in the environment. However, an efficient organization must be maintained to prevent and contain fires that may endanger human life and property."*

There are three objectives of the parks' *Master Plan* that pertain to fire management:

- *Coordinate research and management efforts to identify and apply actions necessary to restore and/or perpetuate desirable environmental conditions as contemplated in the policies for management of natural areas.*
- *Natural science research is and will continue to be an important activity in these parks and will be encouraged.*
- *Fire and other natural agents must be skillfully restored to the park ecosystems. Restoration of natural environmental processes is particularly essential in the sequoia groves, high mountain meadows, and some lakes and streams.*

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:

1. Provide overall program direction by stating mission, goals, and objectives.
2. Describe fire and fuels management tools, prescriptions, and operational procedures.
3. Designate and describe fire management zones, planning units, and segments.
4. Describe planning procedures.
5. Provide guidance on the protection of sensitive resources.
6. Describe the fire and fuels management organization structure.
7. Highlight the importance of safety.
8. 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.

Amendments will be evaluated by the park Environmental Management Committee (EMC) to determine whether the actions described in the amendment require 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:

1. **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.
2. **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.
3. **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 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 wildland fire use 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.

1. Preparedness Activities
2. Wildland Fire Use
3. Wildland Fire Suppression
4. Prescribed Fire
5. Mechanical Fuel Reduction
6. Public Information and Education
7. Monitoring
8. Research

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

<table>
<tr><th rowspan="2">Fire & Fuels Management Mission Statement</th><th rowspan="2">Fire Management Goals</th><th rowspan="2">Program Objectives</th><th colspan="8">TOOLS</th></tr>
<tr><th>Preparedness Activities</th><th>Wildland Fire Use</th><th>Wildland Fire Suppression</th><th>Prescribed Fire</th><th>Mechanical Reduction</th><th>Information/ Education</th><th>Monitoring</th><th>Research</th></tr>
<tr><td rowspan="4">“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.”</td><td rowspan="4">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.</td><td>1. Manage all unplanned wildland fires appropriately.</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. Plan and implement appropriate treatments to reduce the threat to values from unwanted wildland fire and restore or maintain ecological values.</td><td>X</td><td></td><td></td><td>X</td><td>X</td><td></td><td></td><td></td></tr>
<tr><td>3. Understand the consequences of fire management actions.</td><td></td><td></td><td></td><td></td><td></td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>4. Provide current and accurate information on wildland fire and fuels management activities to the public, our workforce, and cooperating agencies.</td><td>X</td><td></td><td></td><td></td><td></td><td>X</td><td></td><td></td></tr>
</table>

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 *appropriate management response* 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:

1. **Preparedness Activities**
2. **Wildland Fire Use**
3. **Wildland Fire Suppression**
4. **Prescribed Fire**
5. **Mechanical Fuel Reduction**
6. **Public Information and Education**
7. **Monitoring**
8. **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 staff, who are identified as primary firefighters, will also participate in an ongoing fitness program. The annual fitness test has potential for firefighter injury, therefore conduct of the test will follow all required procedures and safeguards.

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 Use 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. One station is manual and five 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:
1. Ash Mountain (manual) – NFDRS models B, F, A [elevation 1,600 feet]
2. Park Ridge – NFDRS models G, H, U [elevation 7,540 feet]
3. Cedar Grove – NFDRS models U, G [elevation 4,720 feet]
4. Wolverton Point – NFDRS models B, F [elevation 5,240 feet]
5. Sugarloaf – NFDRS models H, U [elevation7,950 feet]
6. Rattlesnake – NFDRS models H, U [elevation 8,600 feet]

Fire Danger Determination

The parks' fire and aviation coordination center 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 wildland fire use 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 (California Department of Forestry – 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 – WILDLAND FIRE USE

Definition

Wildland fire use (also referred to as *fire use*) is the management of unplanned wildland fires, such as lightning- ignited fires, to accomplish specific resource management objectives. Lightning- caused wildland fires will receive appropriate management responses that give consideration to values, hazards, and risks. Fire use projects are the preferred means for achieving 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 allowing a fire use project.

Wildland fire use projects will be allowed to burn within current and predicted weather/climatological parameters and associated fire behavior that ensure:

1. Fire stays within a delineated area defined in the *Wildland Fire Implementation Plan* (WFIP)
2. Vegetation changes are within an accepted ecological range of values for the affected ecosystem
3. No identifiable threat will occur to significant historic or cultural resources
4. No identifiable threat to life or private property
5. Cooperation with state or federal air quality guidelines for particulate matter.
6. Concurrence of NPS regional staff during national preparedness level 4 and NPS national staff concurrence at preparedness level 5.

Procedures to ensure the results listed above:

1. Monitor weather and associated fire danger along with climatological comparisons to historical averages and past, known fire years.
2. Monitor daily PM- 10 values at Ash Mountain air quality base station as well as installing portable air quality monitoring stations at smoke sensitive sites affected by fire use projects.
3. Complete adequate fire behavior spread predictions for all ignitions. A long- term fire behavior analyst will be used for all Stage III analyses.
4. Consult with park archeologists and natural resource managers.
5. Consult with cooperators on their fire management activity to gauge effects of total fire load on region.
6. Assign sufficient wildland firefighting resources to manage the fire use project. This includes operational and logistical resources for implementation as well as managers and decision-makers.

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. The Minimum Impact Suppression Techniques (MIST) are found in the parks' *Fire and Aviation Management Operations Guide* (Addendum).

Unplanned Fire: What do we do?

All wildland fires will be assessed through the appropriate level of WFIP analysis and the *appropriate management response* will be chosen. The procedures that will be followed are outlined in Chapter 4 of the *Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide* (Addendum). Assessment includes data gathering and situation analysis (i.e. internal and external values which are enhanced or require protection, management objectives, safety, climatology and weather, fuel conditions, and fire behavior). The *appropriate management response* ranges from monitoring with minimal on- the- ground disturbance to intense suppression actions on some perimeters of the fire. The response will vary from fire to fire and even along the perimeter of a fire.

Reported Fire: 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 WFIP Stage I analysis** to determine the *appropriate management response* within two hours of fire confirmation.
    - Decision criteria and risk factors to consider in the Stage I analysis are outlined in Chapter 4 of the *Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide* (Addendum). Parameters requiring in- depth analysis for Sequoia and Kings Canyon often include: off- site impact of air quality, seasonal fire danger/drought and its relation to fire spread (including chances of fire spreading off- park onto other jurisdictions), wildland fire activity on neighboring lands, availability of resources, on- site impacts to cultural and natural resources, and threats to human life. If it is determined that the fire can be managed within the above constraints, then the ignition may be appropriate to manage as a fire use project.
- **Seek concurrence** from the Air District to manage the fire as a fire use project on the day the ignition is confirmed if it is a "no- burn" day.
- **Choose the *appropriate management response*** based on the previous Stage I analysis. In this example, the decision is made to manage the fire for resource benefit because the agency administrator found the potential for complexity, climatology, projected fire behavior, natural and cultural resource effects, and relative risk indicators to be acceptable.
- **Implement the *appropriate management response*** – For fire use projects 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 will manage the incident through delegation to a Fire Use Incident Management Team (see Appendix K for a delegation of authority example).
- **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).
- **Continue to reassess the fire situation** – During a fire use project the parks 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 Stage II or III WFIP analysis, or convert the fire to a wildland fire suppression action. The frequency of the periodic fire assessment will be indicated on the signature page of the 'Periodic First Assessment' form attached to the WFIP. Signature frequency can range from daily (high

complexity, high- risk fires) to weekly (low complexity, low risk fires). If the periodic assessment indicates that the fire can no longer be successfully managed for resource benefit, a Wildland Fire Situation Analysis (WFSA) will be prepared to analyze and document changes in fire management strategy. The WFSA format is also contained in the *Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide* (Addendum).

- **Manage the fire until declared out** according to monitoring intensity and frequency guidelines indicated in the WFIP. At the minimum, periodic ground or aerial reconnaissance will be used to reassess conditions and fire status. 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?

- **Rehabilitation** will follow Minimum Impact Suppression Tactic Guidelines as outlined in the parks *Fire and Aviation Management Operations Guide* (Addendum) 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* 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.

Staffing Needs and Responsibilities

Stage I through III analyses will be completed by district fire management officers or their designates (park fire management officer or fuels specialist staff) with input from the park fire planner or his/her designate. 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 fire information and education specialist. Fire complexity and risk will determine staffing needs.

The parks will allow fire use at all staffing levels (1- 5). All qualified personnel identified in the individual WFIP will be available to complete their identified tasks. The parks' fire monitors will have primary responsibility for staffing fire use fires. When the park wide Staffing Level is 3 or higher, fire monitoring crews will have a 5- minute helispot response time for fire use assignments. Monitoring crews will be equipped so that they can leave directly from a project site without having to return to the station. If the predicted Lightning Activity Level (LAL) is 3 or higher, or if LALs of 3 or more have occurred within the last five days, fire monitors may have extended daily hours. A sixth day of work may be authorized at the discretion of the park fire management officer. The park fire management officer may authorize a seventh day of work for the monitoring crew if the predicted LAL is 4 or higher.

All fire use projects will be managed by a qualified fire use manager (FUMA). Depending upon tactical implementation needs, additional staff may be assigned to the incident. Either burn bosses or incident commanders may be used along with other required staff.

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 (WFIPs, WFSAs, and amendments for either), 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 use 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 fire use 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 use projects. Additional RAWS units in the Sugarloaf drainage, Rattlesnake Creek in the Kern drainage, and at Wolverton Point in the East Fork Kaweah drainage are also available for aiding operational decision making.

TOOL #3 – WILDLAND FIRE SUPPRESSION

Definition

Wildland fire suppression is the management of unplanned wildland fires, including human and lightning ignited fires, to minimize detrimental resource impacts from such fires. Suppressed wildland fires will receive *appropriate management responses* that give consideration to fire values, hazards, and risks. The entire fire, or only a portion of it, may have its spread checked and extinguished dependent upon affected ecological, cultural, or social values, and hazards. It remains a park fire management goal to address the protection of values and hazards pro- actively, thereby allowing for fire use in place of wildland fire suppression whenever possible. For example, if unnatural fuel loads exist which limit the ability to implement fire use projects, it may be necessary to use conservative fuels management techniques initially to restore an area to a natural range of conditions. Once this is done, more park areas will be able to support fire use rather than require wildland fire suppression.

All fire management activities in the parks will rely on tactics which cause a minimum amount of resource damage while maintaining minimal risk to the safety of the public, firefighters, and other personnel. The Minimum Impact Suppression Techniques (MIST) are found in the parks' *Fire and Aviation Management Operations Guide* (Addendum).

Unplanned Fire: What do we do?

All wildland fires will be assessed individually by preparing the appropriate level of a *Wildland Fire Implementation Plan* (WFIP). From this plan the *appropriate management response* will be chosen. The procedures that will be followed are outlined in Chapter 4 of the *Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide* (Addendum). Assessment includes data gathering and situation analysis (i.e. internal and external values which are enhanced or require protection, management objectives, safety, climatology and weather, fuel conditions, and fire behavior). The *appropriate management response* ranges from monitoring with minimal on- the- ground disturbance to intense suppression actions on all perimeters of the fire. The response may vary from fire to fire and even between different sections of the perimeter of a single fire.

Reported Fire: 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 WFIP Stage I analysis** to determine the *appropriate management response* within two hours of fire confirmation. If potential complexity, climatology and projected fire behavior, natural and cultural resource effects, and relative risk indicators are unacceptable to the agency administrator the fire may be fully or partially suppressed (suppressed along a portion of its perimeter). If full suppression is warranted, the Stage I analysis will serve as documentation of the decision. If less than full suppression is warranted, then potential impacts and proposed mitigation measures will be outlined in the WFIP Stage II (and if needed Stage III) analysis.

- **Decision criteria and risk factors to consider** in the Stage I analysis are outlined in Chapter 4 of the *Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide* (Addendum). Parameters requiring in- depth analysis for Sequoia and Kings Canyon often include: off site impact of air quality, seasonal fire danger/drought and its relation to fire spread, availability of resources, on- site impacts to cultural and natural resources, and threats to human life. If any of these parameters suggest a high level of complexity or risk to successful management and cannot be mitigated, then the fire is unwanted.
- **Inform** the Air District regarding suppression actions.
- **Choose the *appropriate management response*** based on the previous Stage I analysis. In this example, the decision is made to suppress the fire because the agency administrator found the potential for complexity, climatology, projected fire behavior, natural and cultural resource effects, and relative risk indicators to be unacceptable. Document the decision using the WFIP. Complexity, risk, and chosen tactical actions will determine the need for additional documentation of actions through a Stage II or III WFIP. For those actions requiring the immediate need of suppression resources, the parks' *Suppression Fire Response Plan* (Addendum) will be activated through the communications center.
- **Implement the *appropriate management response*** – The suppression response may vary from dispatching 2 firefighters or numerous crews to begin aggressive initial attack, to confining the fire to a specific drainage and monitoring its spread by aircraft. All suppression tactics will be based on current and predicted fire behavior given the hazards and associated threats to values. Minimum Impact Suppression Techniques (MIST) will be incorporated into all suppression operations.
- **Notify the public about the chosen management reponse.** 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).
- **Continue to reassess the fire situation** – The district fire management officer must continually validate that the fire is managed appropriately and will assess the need to complete a *Wildland Fire Situation Analysis* (WFSA). Examples of situations that may indicate the need for WFSA completion include: 1) not meeting control objectives by the end of the second burning period, 2) incrementally increasing number of resources to achieve containment objectives, and 3) unexpected fire behavior. Completed WFSAs will allow for the full range of strategic and tactical actions from full suppression on all perimeters to confinement within a drainage or area. If the fire exceeds the capabilities of in- park resources, crews and overhead will be requested from outside the parks based upon the *Suppression Fire Response Plan* developed with park cooperators (Addendum). If the management complexity of the fire exceeds the capabilities of these local resources, the parks will manage the incident through delegation to a Type II or I Incident Management Team (see Appendix K for a delegation of authority example). A separate *Logistics Plan* (Addendum) for extended attack and incidents managed by a Team can be found in the Addendum.
- **Monitor the fire until declared out** – Every fire will receive periodic assessment until declared out.

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). In the event a fire covers large areas, has unnaturally severe effects on natural and/or cultural resources, or causes major impacts to the parks developed resources (i.e. trail system) a separate *Burned Area Emergency Rehabilitation Plan* will be developed by the Resource Management and Fire Management Offices, and be 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.

Staffing Needs and Responsibilities

Stage I through III WFIP analyses and WFSAs will be completed by district fire management officers or their designates (park fire management officer or fuels specialist staff) with input from the park fire planner or his/her designate. Duty officers for each district will be assigned every day during fire season ensuring appropriate, qualified command staff are 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.

When the park wide Staffing Level is 3 or higher, fire operations modules 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 predicted Lightning Activity Level (LAL) is 3 or higher modules may have extended daily hours at the discretion of the fire management officer. A sixth day of work may be authorized at the discretion of the park fire management officer. The hours of the modules may be extended, and a seventh day of work may be authorized by the park fire management officer if the predicted LAL is 4 or higher.

Suppressed wildland fires will be managed by qualified incident commanders with the appropriate skills given the incident's complexity.

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 (WFIPs, WFSAs, and amendments for either), delegations of authority, monitoring data and summary reports, revalidation and certification documents, 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 wildland fires 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. As such, it is important that all fires are documented using this form whether they occur within the park boundaries or park crews responded to a neighboring jurisdiction. This includes natural outs, support actions, and mutual aid responses. The DI- 1202 is the basic document used by the National Interagency Fire Center (NIFC) to document a fire occurrence.

TOOL #4 – PRESCRIBED FIRE

Definition

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, wildland fire use 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 so that the segment burn plan can be written and crews can begin prep work.
- **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.
- **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 Situation Analysis* (WFSA).**

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 #5 – MECHANICAL FUEL REDUCTION

Definition

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 so that the segment's mechanical treatment plan can be written and crews can begin prep work. 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.
- **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 can not 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 #6 – 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 this plan to increase public awareness and support.

Goals

Based on the ecological principles and operational procedures outlined in this *Fire and Fuels Management Plan*, the Fire Information and Education (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 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 permitees to promote fire safety, fire prevention, defensible space, firewise 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) will finalize the first *NPS Fire Communications and Education Strategy*. This document describes a national program that will promote NPS wildland fire management and help people understand fire and its role in ecosystems. 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 Fire Information 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* (Addendum). The *Smoke Communication Strategy* (Appendix I) 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 when the FIO is unavailable.

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) will release the first national, interagency key messages in 2004. For the first time, all five federal land management agencies will use 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:

1. Wildland fire is an essential, natural process.
2. Society's influence has altered historic fire cycles, leading to a dangerous build- up of vegetation in our wildlands.
3. Land management agencies are committed to a balanced fire program that will reduce risks and realize benefits of fire.
4. 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.
5. Public education is necessary to the success 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:

1. **Park Visitors** (including in- park visitors, internet visitors, and special groups)
2. **Park Employees** (including NPS, SNHA, USGS, concessions, and volunteers)
3. **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)
4. **Students/Teachers** (including K- 12 students, college students, elder hostel groups, and teachers)

5. **Professional Peers** (including other federal, state, and county agencies, professional associations, and academics)
6. **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

1. **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.
2. **Education Programs** – Park staff will incorporate fire ecology concepts into curriculum- based education programs, student field research experiences, and in-class programs.
3. **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.
4. **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.
5. **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.
6. **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.
7. **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.
8. **Teacher Workshops** – With the help of interagency and educational partners, park staff will offer teacher workshops that incorporate fire ecology and management issues.
9. **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.
10. **Recorded Phone Message** – The FIO will maintain the recorded "Fire Information" message on the main park answering system accessed by calling (559) 565- 3341.

Non- Personal

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

2. **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.
3. **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.
4. **Community Newsletter** – 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.
5. **Webpage** – The parks will maintain a fire and fuels management webpage that is linked to the main park webpage. *Fire Portal* can be found at http://www.nps.gov/seki/fire/portal/portal.htm. As the name suggests, users of this site can access all kinds of fire information including press releases, fire restrictions, project lists, smoke information, fire planning documents, research papers, GIS maps, and photos.
6. **Scientific Papers** – Park researchers will publish papers in scientific journals and/or periodicals regarding new information from the parks' fire and fuels management program.

Education 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 3- 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 3- 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).

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 Career days				*		
	Interagency Planning	Interagency work groups Conference presentations					*	
	Recruitment	Job fairs Career days			*	*		
Summer	Incident Information	Press releases / updates Bulletin boards Roving interpretation Recorded phone messages Media interviews / field trips Webpage Special events / public meetings	*	*	*		*	*
	Interpretation	Park-wide interp programs Roving interpretation Public workshops	*		*			*
	Employee Training	Written materials (handbooks) Training sessions		*				
	Interagency Cooperation	Press releases / updates Incident assistance		*			*	
Fall	Incident Information	Press releases / updates Bulletin boards Roving interpretation 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				*		
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 Teacher Workshops Visitor center exhibits / waysides	*	*	*	*	*	*

TOOL #7 – 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, wildlife, water, 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 #8 – RESEARCH

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 National Park Service. 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); 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 provided a firm justification and basis for the development of the parks' prescribed and fire use 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 monthly to coordinate future projects and incorporate past research results into the next annual fuels treatment plan. A fire research coordinator within the Division of Natural Resources 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).

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 along with an Environmental Screening Form. 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. The update and annual program must be signed 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

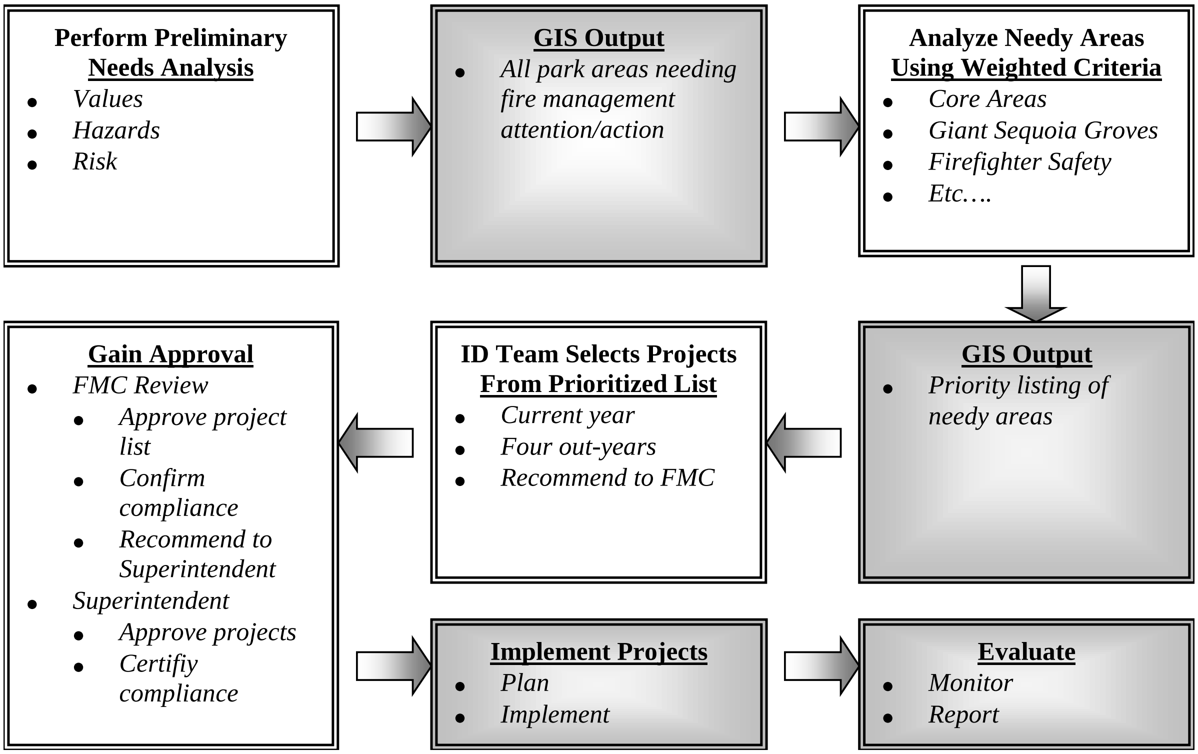


Figure 4-2 – Description of Fire Return Interval Departure (FRID) / Condition Class

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 2001, results of the FRID analysis indicate that 50% 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 31% of the parks' vegetation shows significant deviation from natural conditions and 19% of the parks are considered highly compromised by past fire suppression actions over the past 70 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.

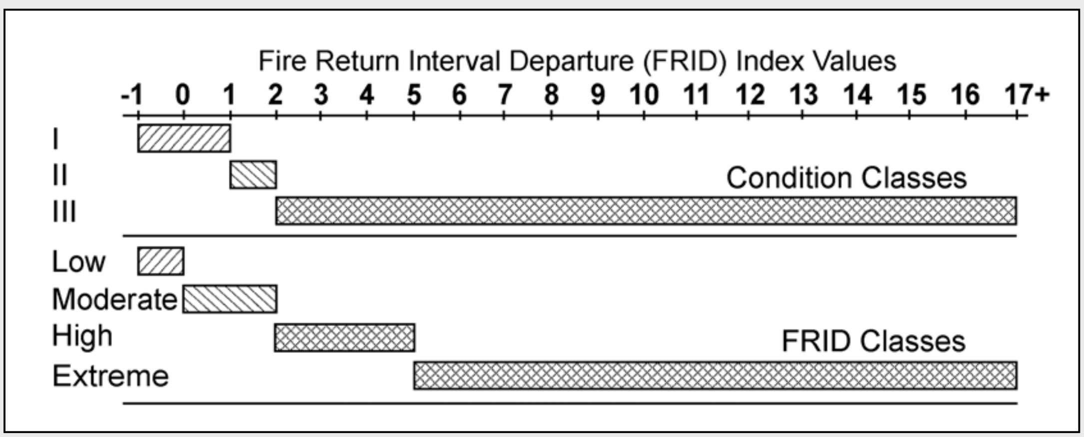


Figure 4-3 – Map of Sequoia and Kings Canyon Fire History

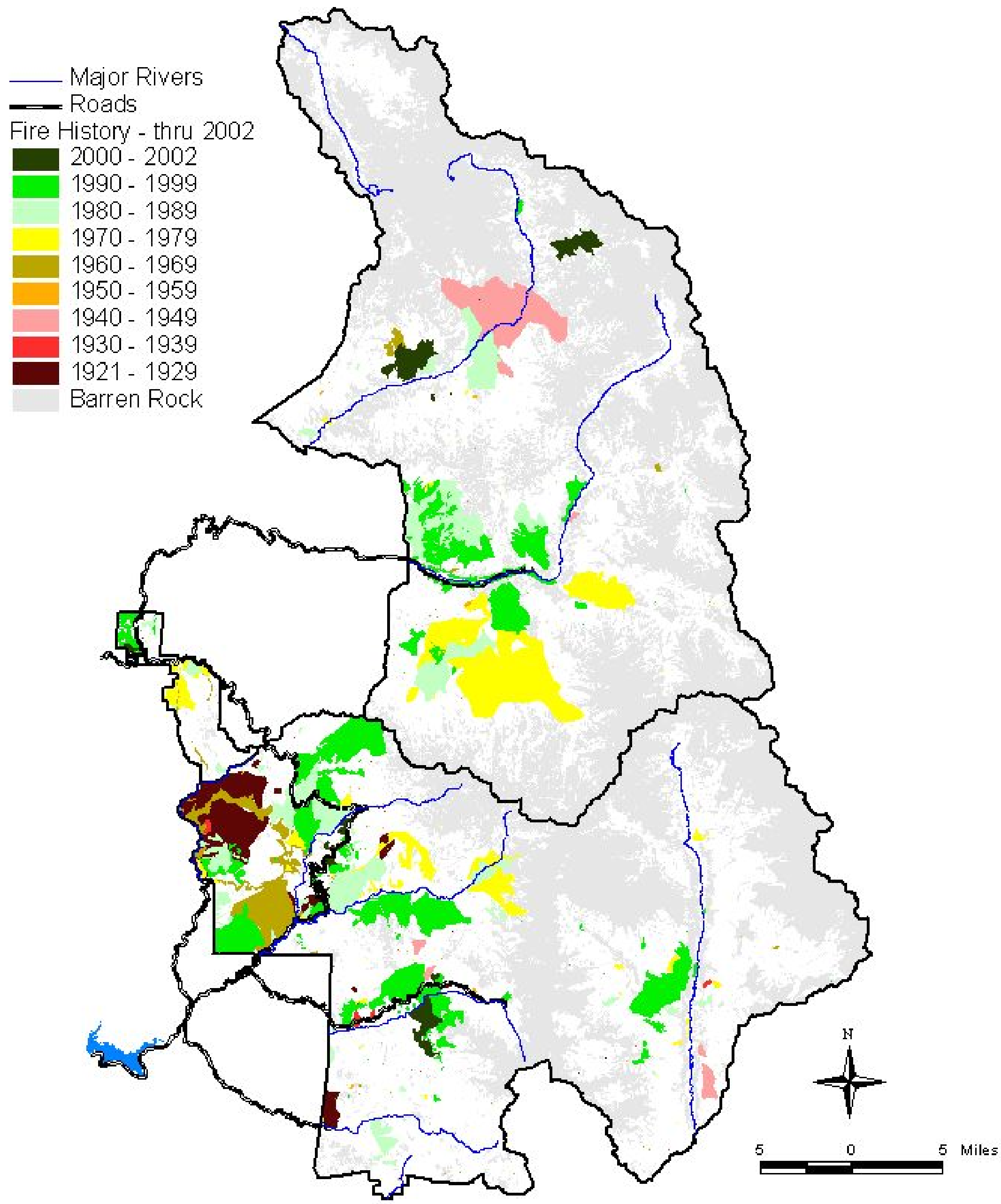
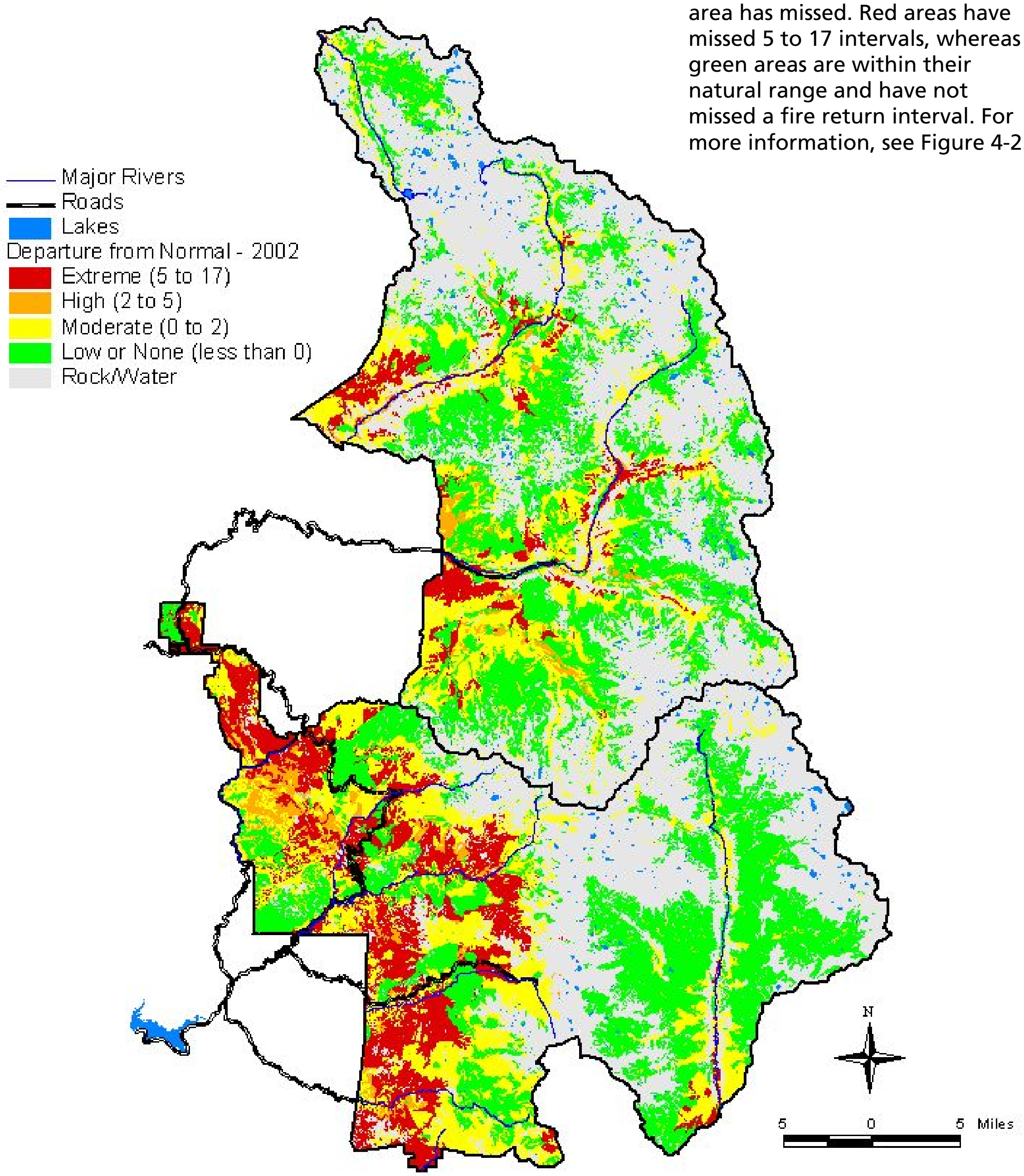


Figure 4-4 – Map of Fire Return Interval Departure (FRID)

The colors on this map correspond to the number of fire cycles, or fire return intervals, an area has missed. Red areas have missed 5 to 17 intervals, whereas green areas are within their natural range and have not missed a fire return interval. For more information, see Figure 4-2.



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	<u>Kings Zone</u> Sierra Crest Cedar Grove <u>Kern Zone</u> Kern	<u>Kaweah Zone</u> 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

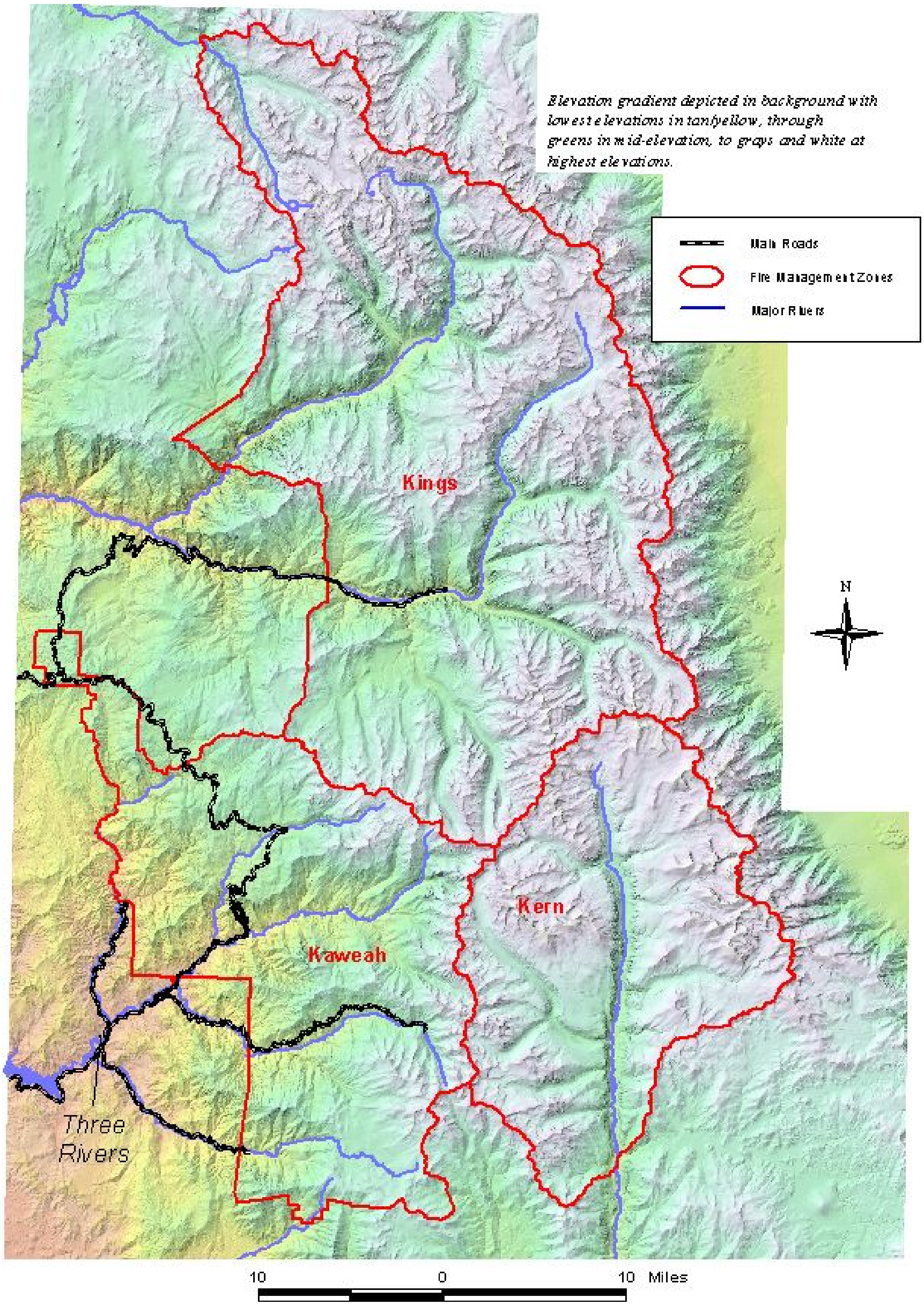


Table 4-7 – Description of Fire Management Zones

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 2001, 87% percent of the acres in the Kings Zone were in a "low" or "moderate" FRID class indicating low deviation from natural conditions. The remaining 13% 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 30 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 83% 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 2002, the San Joaquin valley is classified as severe non-attainment for PM-10 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 2001, over 40% 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 30 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 30 years of proactive fire management, 60% of the vegetated lands are currently in the "low" (24%) or "moderate" (36%) 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 wildland fire use, with wildland fire use 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 wildland fire use 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 wildland fire use. 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) Vegetation 222,249 Rock/Water 221,187 Total 443,436 Wilderness 99%	**Size and Composition (Acres)** Vegetation 89,662 Rock/Water 95,907 Total 185,569 Wilderness 100%	**Size and Composition (Acres)** Vegetation 189,692 Rock/Water 44,601 Total 234,293 Wilderness* 80% *Includes designated & proposed wilderness
Elevation Range	**Elevation Range**	**Elevation Range**

<table>
<tr><th>Kings Zone</th><th>Kern Zone</th><th>Kaweah Zone</th></tr>
<tr><td>4,543 - 14,186 feet</td><td>6,300 – 14,495 feet</td><td>1,400 – 12,600 feet</td></tr>
<tr><td colspan="3">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.</td></tr>
<tr><td>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.</td><td>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.</td><td>Value 1: Special Designations & Features

See Table 4-9.</td></tr>
<tr><td>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</td><td>Value 2: Park Developments

Several NPS wilderness ranger stations, along with trails and associated bridges are the sole developments in the Zone.</td><td>Value 2: Park Developments

See Table 4-9.</td></tr>
</table>

Kings Zone	Kern Zone	Kaweah Zone
and Scenic River bisects the developed area.		
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. 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.	**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 forest. The latter comprises over 50% of the vegetated acreage within the Zone. Approximately 2,300 acres are meadow communities.	**Value 3: Vegetation** See Table 4-9.
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	**Value 6: Boundary Interface** All of the 80-mile Zone boundary abuts designated or proposed wilderness. Over one-	**Value 6: Boundary Interface** See Table 4-9.

Kings Zone	Kern Zone	Kaweah Zone
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 wildland fire use programs and standards which may increase the ability of the park to manage wildland fire use 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.	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.	
Hazards As of 2001, 87% percent of the acres in the Kings Zone were in a "low" or "moderate" FRID class indicating low deviation from natural conditions. The remaining 13% 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	**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 by the parks custom fuel model 18 – conifer forests 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 currently considering changes to accommodate wildland fire use in areas adjacent to the parks. Under all present and future scenarios, the implementation of wildland fire use and prescribed fire projects will require considerable coordination and cooperation between agencies. Ignitions in the vicinity of ranger stations (especially the Kern station) 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	**Hazards** See Table 4-9.

Kings Zone	Kern Zone	Kaweah Zone
wildland use fires in those areas at the present time. The USFS is currently considering changes to accommodate wildland fire use in areas adjacent to the parks. Under all present and future scenarios, the implementation of wildland and prescribed fire projects will require considerable coordination and cooperation between agencies. Heavy and/or continuous fuel accumulations occur in the Sheep Creek and Lewis Creek drainages in steep terrain along the NPS/USFS boundary.	along the high elevation ridges may create downdrafts.	
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.	**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.	**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 over 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 10,000 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 wildland fire use consistent with fire management resources, interagency concerns, and air quality issues.	**Description** Within the greater Kings Zone is the 25,630-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 wildland fire use, 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 wildland fire use should increase and become the dominant management strategy, subject to the USFS ability and desire to accept	**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>such events across agency boundaries.</td><td></td></tr>
<tr><td>Size and Composition

Vegetation 199,814
Rock/Water 218,240
Total Acres 418,054
Wilderness 100%</td><td>Size and Composition

Vegetation 22,435
Rock/Water 2,947
Total Acres 25,382
Wilderness 90%</td><td>Size and Composition

Vegetation 89,662
Rock/Water 95,907
Total Acres 185,569
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 wildland fire use as the primary tool.

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

Wildland fire use 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 Sheep Creek and Lewis Creek drainages will initially be managed through the use of prescribed fire, in concert with mechanical fuel removal in limited areas along boundaries to restore natural fuel conditions and fire regime.

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

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

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

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

Prescribed fire under an approved burn plan may be used along NPS/USFS boundary areas to replace suppressed ignitions 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</td></tr>
</table>

Kings Zone		Kern Zone
Sierra Crest FMU	**Cedar Grove FMU**	**Kern FMU**
		implemented to provide protection of historic 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 roaded access is the main park highway along the bottom third	**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 roaded 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 2001, 66% 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. 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. Unwanted fires, once ignited, will be difficult to access and control.	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.	of the unit. 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.	While containing most park vegetation communities, 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, strongly influences fire management decisions in this unit.
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 14,603 Rock/Water 563 Total 15,166 Wilderness* 56% *Proposed wilderness.	Vegetation 30,147 Rock/Water 746 Total 30,893 Wilderness* 86% * Includes designated and proposed wilderness.	Vegetation 26,729 Rock/Water 6,869 Total 33,598 Wilderness* 64% *Includes designated and proposed wilderness.	Vegetation 51,225 Rock/Water 22,270 Total 73,495 Wilderness* 90% *Includes designated and proposed wilderness.	Vegetation 39,741 Rock/Water 10,387 Total 50,128 Wilderness* 68% *Includes designated and proposed wilderness.	Vegetation 27,247 Rock/Water 3,766 Total 31,013 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	**Value 2: Park**	**Value 2: Park**	**Value 2: Park**	**Value 2: Park**	**Value 2: Park**

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
Developments 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.	**Developments** 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.	**Developments** 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.	**Developments** 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.	**Developments** 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.	**Developments** Few developments occur in this unit, limited to one rustic campground and a short segment of road leading in from the west. Dillonwood, a new 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	**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	**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

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
the parks 12 vegetation 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.	found in the parks (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.	of all park FMUs. 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	**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**
				properties are: • 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.

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
General Grant National Park Historic District (Proposed) Wilsonia National Historic District 5 buildings on the List of Classified Structures (LCS)	Crystal Cave - trail, gate, generator house (LCS) Cabin Creek structures (LCS) Lost Grove Comfort Station (LCS) Colony Mill road (LCS)	Moro Rock Stairway (LCS) Tharps Log (LCS) Squatters Cabin (LCS) Cattle Cabin (LCS) District Ranger Residence #55 (LCS)	Ash Mountain Historic District (Proposed) Sycamore Historic District (Proposed) Redwood Meadow Ranger Station and out buildings (LCS)	Mineral King Road Cultural Landscape District (Eligible) Hockett Meadow Ranger Station (LCS)	Quinn Ranger Station (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	**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	**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	**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	**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

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
concern, especially at night when smoke may pool down-slope in and around the Sequoia Lake and Hume Lake developments outside the park. 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.	community at night. Emergency road and facility closures and extreme smoke events may affect local businesses.		community of Three Rivers. As Three Rivers is a primary gateway community for park visitors, emergency road 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.	operations in this unit, as the East 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 of the parks is rare. Emergency road and facility closures during the peak visitor season, or extreme smoke events may affect local businesses.	topography and distance, smoke is less prone to pool in this drainage, and concentrated nighttime smoke movement into populated areas outside 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 66% of all acres in the FMU are in the high or extreme FRID classes, which combined with the dominance of mixed conifer fuel models (50% of acres in FM-10),	**Hazards** The North Fork has the second most altered fuel conditions in the park. Fully 46% of the unit's acres show high or extreme departure from desired conditions. Thirty percent of North Fork acres are in fuel model 10, indicating high fuel loads across	**Hazards** The Marble Fork unit has 31% 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	**Hazards** Thirty-nine 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	**Hazards** Similar to the Middle Fork FMU, 39% 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	**Hazards** Nearly 34% 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 19% of the acres in the South Fork.

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
indicates high fuel loads across most areas. Added to already high fuel loads, mortality in white fir resulting from the 1998-2000 Douglas fir tussock moth 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 roaded allowing ready access and providing some man-made holding boundaries. The southern portion of the unit has road access	much of the unit. Given the dominance of high deviation from natural conditions and the high percentage of the unit consisting of 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 past 30 years. Approximately 20% of the acres are in fuel model 10, with the bulk of the remaining acres in custom model 18. 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.	also burned in prescribed fires in the late 1970s and early 1980s. High fuel loads associated with fuel model 10 account for only 17% of the acres in the Middle Fork. Difficult access and smoke dispersal issues make pro-active fuels management challenging in this unit.	protecting park developments and private inholdings. High fuel loads associated with fuel model 10 account for only 18% of the acres in the East Fork.	Fuel loads in the recently acquired Dillonwood grove are unknown at this time, though they may be substantial due to past logging activity. 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**
along the eastern boundary and is bisected by a rough dirt road, making the interior less accessible with few natural holding boundaries. Steep west aspect slopes leading into mid-slope developed areas and across boundaries are exposed to full solar radiation during the burn period.	The terrain is generally steep and rugged.				
Risks Anaylsis 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 has a low rate of lightning ignitions (2-4 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 moderate level of lightning ignitions occur in this unit (2-7 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	**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**
		this unit, focused on the Silliman Divide, with some lightning ignitions reported in the mid-elevations (4,000-6,000 feet)			
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	**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	**Multi-Year Projects and Actions** Prescribed fire and wildland fire use 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	**Multi-Year Projects and Actions** Prescribed fire and wildland fire use 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	**Multi-Year Projects and Actions** Prescribed fire and wildland fire use 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	**Multi-Year Projects and Actions** Prescribed fire and wildland fire use 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

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
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 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. Wildland fire use 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	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 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. Wildland fire use 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.	maintain fire-safe conditions. Wildland fire use may be considered throughout the unit in places and at times of year that will not pose an unacceptable risk to FMU values.	maintain fire-safe conditions. Wildland fire use may be considered throughout the unit in places and at times of year that will not pose an unacceptable risk to FMU values.	years as necessary to maintain fire-safe conditions. Wildland fire use may be considered throughout the unit in places and at times of year that will not pose an unacceptable risk to FMU values.	maintain fire-safe 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. Wildland fire use 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**
a larger study plan in cooperation with adjacent agencies. The Redwood Mountain grove, with portions managed by three 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.	As a result, aggressive initial attack consistent with firefighter safety will be a high probability for starts below 5,000' elevation. Fires that escape initial attack 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	**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	**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	**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	**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	**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

Kaweah Zone					
Grant Grove FMU	**North Fork FMU**	**Marble Fork FMU**	**Middle Fork FMU**	**East Fork FMU**	**South Fork FMU**
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.	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.	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.	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.	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.	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.

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.)

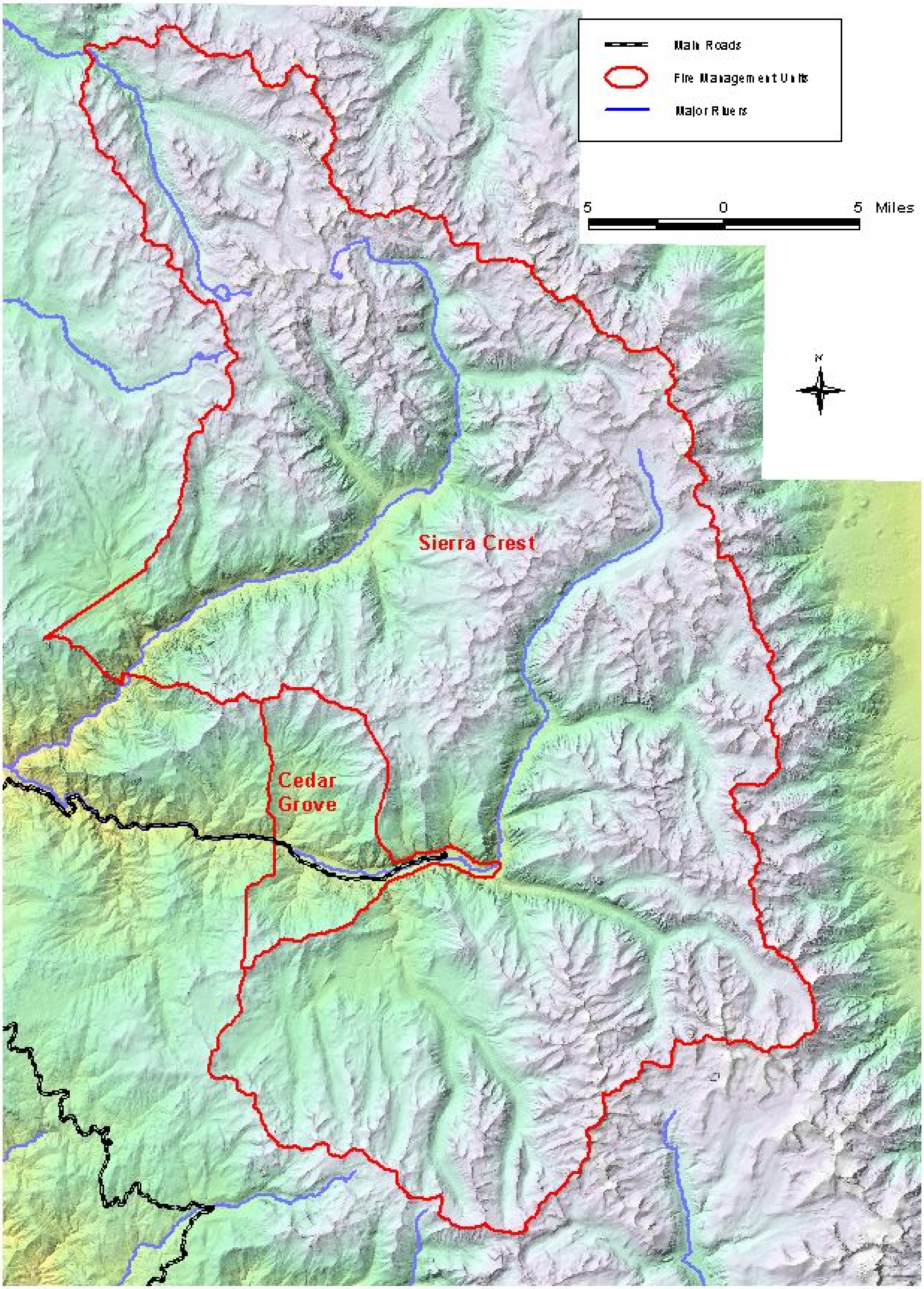


Figure 4-11 – Map of Kern Zone Fire Management Units (FMUs)
(The Kern Zone has only one FMU, called the Kern FMU.)

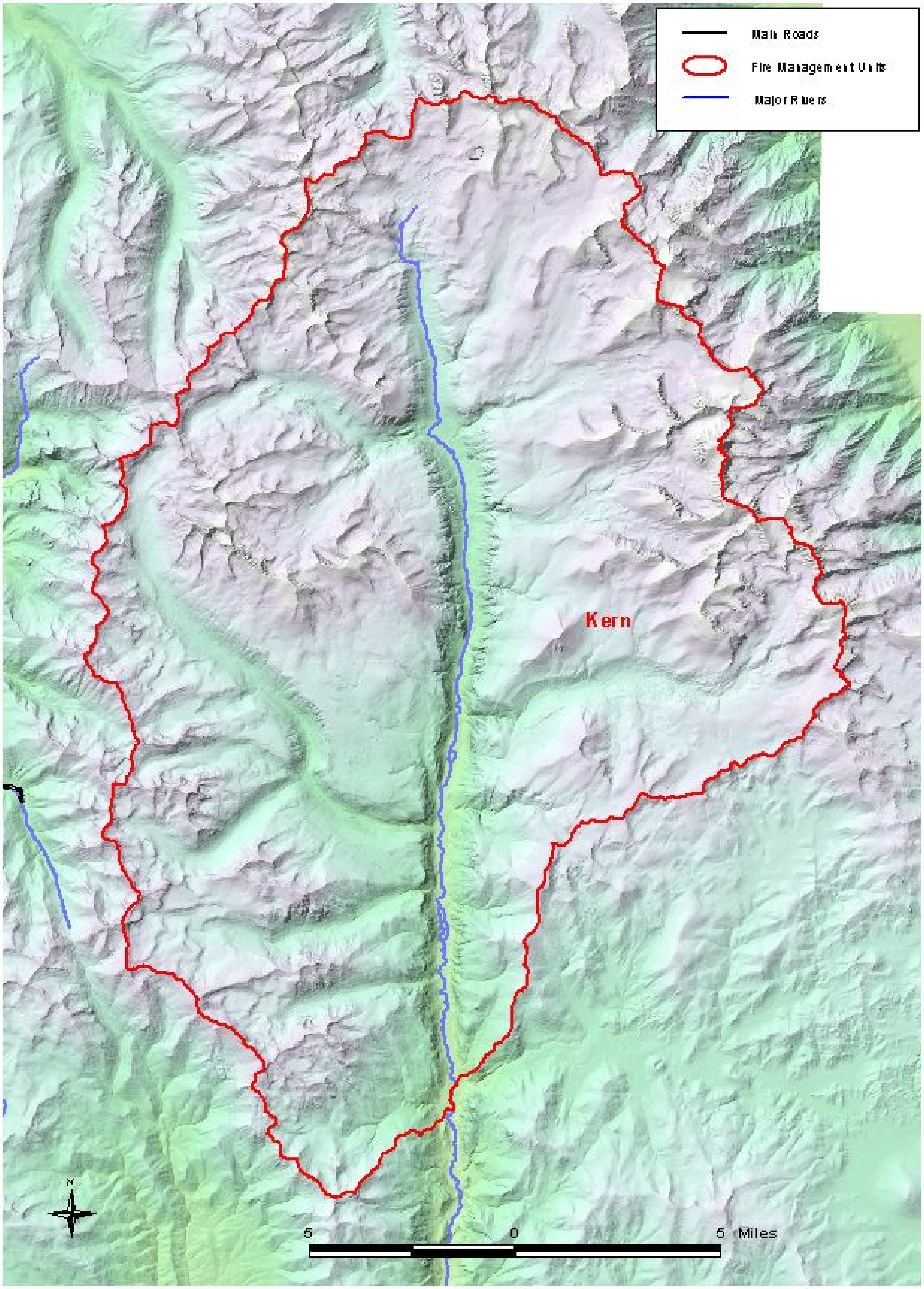
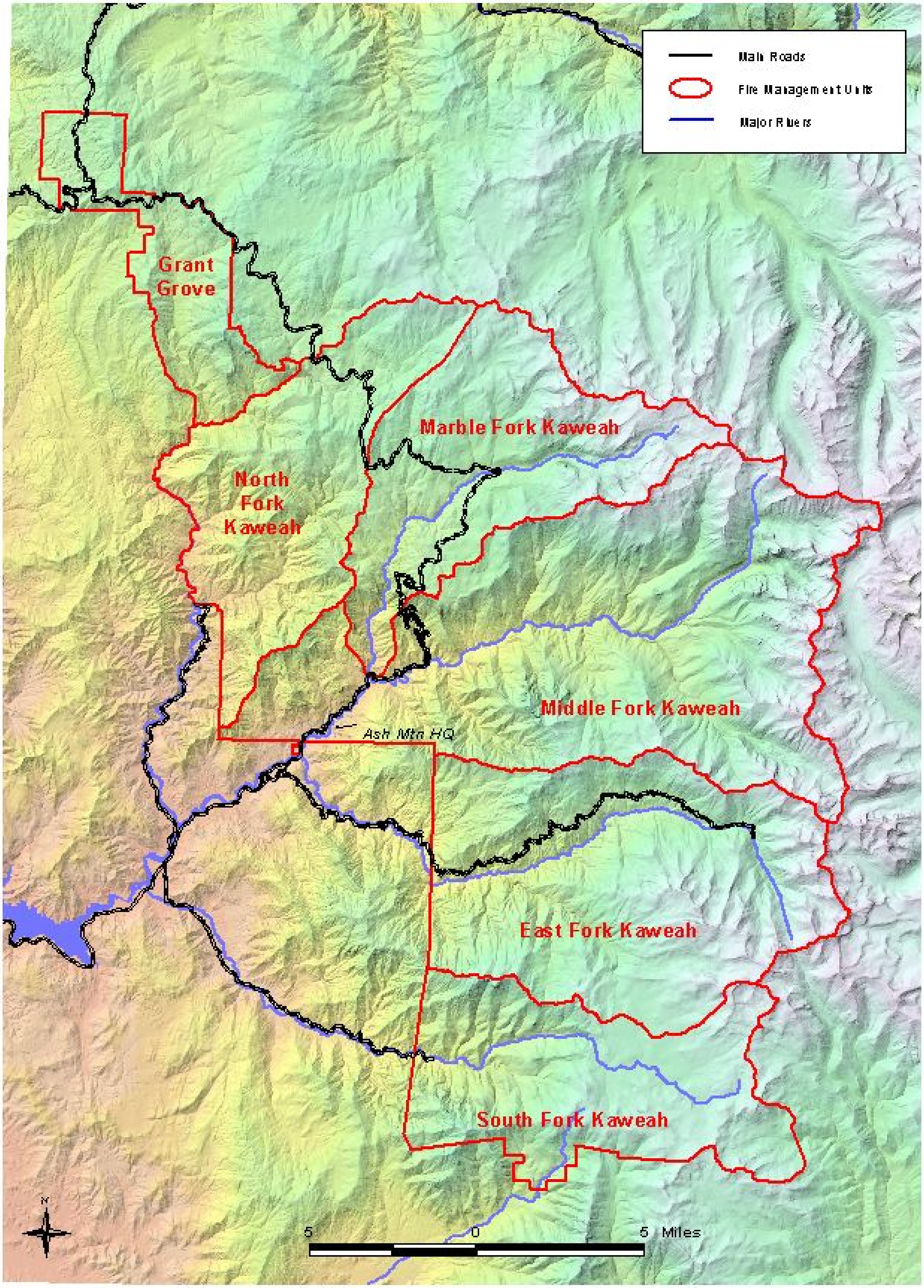


Figure 4-12 – Map of Kaweah Zone Fire Management Units (FMUs)



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 who 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). Both SMA boundaries will undergo a review in 2005 to validate their accuracy especially after recent modifications in visitor infrastructure in the Sherman Tree area. This work will be undertaken by the Branch of Fire and Aviation in conjunction with the Division of Natural Resources. Changes will be presented to the Superintendent for approval.

Figure 5-1. Grant Tree Special Management Area

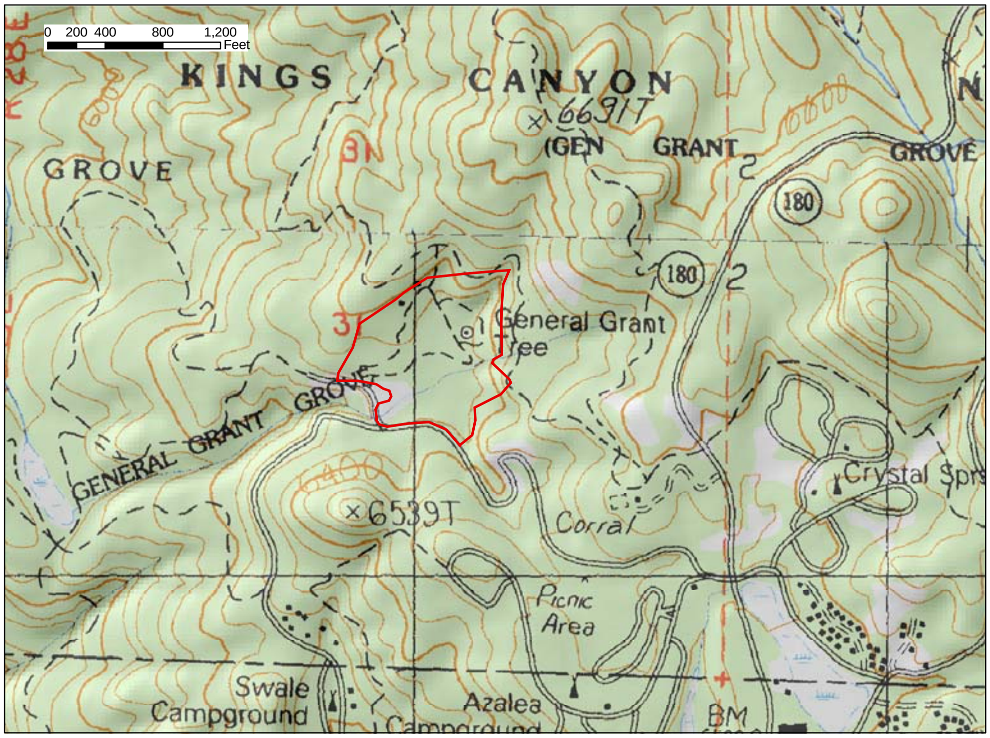
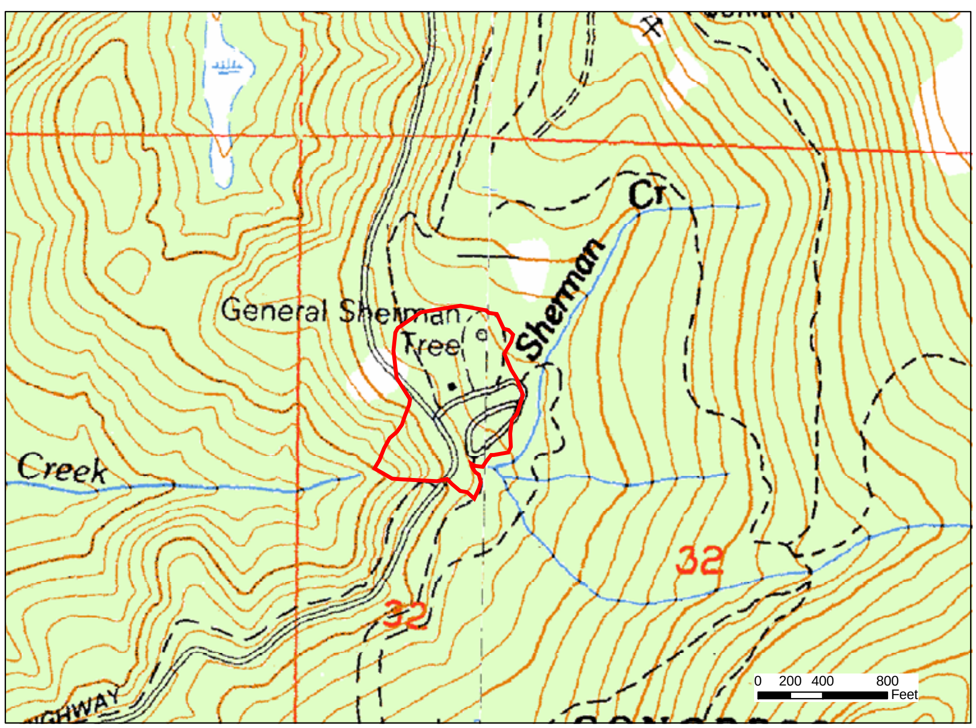


Figure 5-2. Sherman Tree Special Management Area



Trees of Special Interest

In April 2005, the parks finalized the *Policy Statement Defining Trees of Special Interest*. In that document, "trees of special interest" are significant because of the attention they receive from park visitors. This designation is based entirely on social criteria; no ecological significance is conferred. Trees in this category are giant sequoia trees (including living trees, snags, logs, or stumps) or groups of giant sequoia trees that have captured human interest over time and been recognized with individual names or some other form of special identification.

The purpose of providing special management to the objects in this category is to increase the likelihood that objects of emotional importance to park visitors survive for future enjoyment.

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.

The qualification criteria for trees of special interest (shown below) were developed by the Chief of Interpretation and a Research Ecologist with the United States Geological Survey. The trees listed in Table 5- 3 meet these criteria. Nominations for additions to the list should be submitted to the Chief of Natural Resources for consideration. Additions and/or deletions to the trees of special interest list will be approved by the Superintendent. A GIS layer will be created that identifies each tree of special interest. This tool will be useful when creating planning maps for fires.

Trees of special interest must 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 and in use in 2005. (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 and in use in 2005.
- 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 the 2002 edition of Flint and Law's *To Find the Biggest Tree*, Sequoia Natural History Association.

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.

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. <u>**Using Foam or Water**</u> – 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	Illinois	Nevada
	Arkansas	Indiana	New Jersey
	California	Iowa	New Mexico
	Centennial Stump/Log	Kentucky	Ohio
	Connecticut	Lightning	Oklahoma
	Dead Giant	Lincoln	Oregon
	Delaware	Maine	Pennsylvania
	Fallen Monarch	Martyr	Robert E. Lee
	Florida	Maryland	Tennessee
	General Grant	Massachusetts	Twin Sisters
	Georgia	Michigan Log	Vermont Log
	Happy Family	Minnesota	Virginia
	Idaho	Missouri	Wyoming
Sherman Tree Special Management Area			
Giant Forest	General Sherman		
Other Trees of Special Interest			
Giant Forest	Adams	Column (Near Pershing)	Parker (group)
	Auto Log	Dead Giant	Pillars of Hercules
	Bear's Bathtub	Ed by Ned	President
	Black Arch	Founders (group)	Puzzle
	Black Chamber	Four Guardsmen	Room
	Booker T. Washington	Franklin	Roosevelt
	Broken Arrow	General Lee	Senate (group)
	Burial	General Pershing	Sentinel
	Buttress	Hamilton	Susan B. Anthony
	Charles Young	House (group)	Telescope
	Chief Sequoyah	Leaning	Tharps Log
	Chimney	Lincoln	Three Graces
	Clara Barton	McKinley	Triple (group)
	Cleveland	Monroe	Tunnel Log
	Cloister (group)	Near Ed by Ned	Washington
Big Stump	Burnt Monarch		
	Mark Twain Stump		
	Sawed Tree		
	Shattered Giant		
Redwood Mountain	Barton Log		
	Fallen Goliath		
	Hart Tree		
	Roosevelt (False Hart)		
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.

General Fire Effects

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 adveresely 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

1. 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.
2. 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.
3. For fire use projects, the park archeologist will be consulted during the development of the WFIP. 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.
4. 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."

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, that 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 are 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 are within the Division of Fire and Visitor Management. Fire staff are 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 (BRD)
- 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 and fuels management activities. Certifies Fire and Fuels Management Plan and all other plans written within that framework (i.e. WFIPs and their periodic validations, WFSAs, burn plans, and mechanical treatment plans). Approval constitutes the authority to proceed with the actions outlined.

Chief of Fire and Visitor Management

- Reviews all plans and recommends to superintendent.
- 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).
- Serves as Fire Management Committee member.

Chief of Natural Resources

- Reviews all 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 Fire Management Committee chair.

Fire Management Officer

- Responsible for management of parks' fire and aviation programs.
- 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.
- Develops parks' fire program budget annually (FIREPRO) ensuring a cost efficient program.

Fire Budget Assistant

- Ensures program managers construct budgets in all divisions.
- Ensures program managers track costs for fire and aviation programs.
- Ensures personnel actions and travel documentation are completed for the branch.
- Coordinates with regional FIREPRO 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)

- Serves as the primary person to ensure fire and aviation dispatch procedures are developed, revised, and implemented.
- Ensures 1202 data base for wildland fire responses is current. Integrates this work with GIS specialist for GIS analysis.
- Manages wildland fire and all risk qualifications and training database for all park employees. Park fire and aviation training officer.
- Catalogues all weather data for parks' weather stations, manages fire danger rating analyses for parks.

- Ensures logistical support for all fire/aviation planning and operations.

Fuels Management Specialist

- Principal staff specialist for fuels management.
- Ensures appropriate fire monitoring for all fire incidents.
- Responsible for combining the fuels management programs from each district into one park program. Has decision authority on park priorities for treatments. Formulates annual fuels treatment plan working from 5- year plan.
- Takes lead on yearly fire GIS analysis planning update.
- Coordinates projects with fuels planners from cooperating agencies.
- 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

- Responsible for district's wildland fire management program.
- Develops and proposes district's yearly fuels treatment program.
- Coordinates use of district resources in support of park- wide project/wildland fire priorities.
- Manages district fire management budget.
- Manages aviation program for both Sequoia and Kings Canyon National Parks.
- Coordinates fire management activities with permittees and private inholders in the district.

Kings Canyon District FMO

- Responsible for district's wildland fire management program.
- Develops and proposes district's yearly fuels treatment program.
- Coordinates use of district resources in support of park- wide project/wildland fire priorities.
- Manages district fire management budget.
- Manages structural fire program for both Sequoia and Kings Canyon National Parks.
- Coordinates fire management activities with permittees and private inholders in the district.

Fire Program Analysis (FPA) Coordinator

- Manages FPA data for all agencies in FPA #8 fire planning unit.
- Works with United State Geological Survey and southern Sierra fire management officers on developing, maintaining, and using Sierra Wildland Fire Reporting System (SWFRS).

Cache Manager

- Manages logistics in support of all wildland fire management operations.
- Ensures inventory control for all wildland fire and aviation equipment/supplies.
- Participates as required by supervisor in ordering of vehicles.

Natural Resource Management Specialist

- Coordinates environmental analysis and periodic revisions of the *Fire and Fuels Management Plan*.
- Coordinates other environmental analyses for projects outside the scope of the *Fire and Fuels Management Plan*.
- Ensures that results from fire effects monitoring and fire research are integrated into the fire and fuels management program.

Fire Ecologist

- 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.
- Coordinates fire research needs.
- Summarizes the significant findings of all park fire research in an annual report that is circulated internally and externally.

Air Quality Management Specialist

- Park senior air quality specialist.
- Coordinates air quality data and information exchange with Fuels Management Specialist as well as coordination with interagency partners.
- Provides quality assurance/quality control advice for smoke and weather technician.

Fire GIS Specialist

- Maintains fire databases.
- 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

- Communicates with internal and external audiences about fire and fuels management program activities.
- Facilitates year- round educational opportunities about fire ecology, history, and management.
- Serves as liaison with media outlets.

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	Doug Hicks Foothills Division Chief Fresno-Kings Unit Don Kandarian Assistant Forest Fire Management Officer Sierra 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	Bill Kaage Fire Management Officer Sequoia and Kings Canyon National Parks Tom Nichols Fire Management Officer Yosemite National Park Craig Barnes Forest Fire Management Officer Inyo National Forest Aaron Gelobter Forest Fire Management Officer Sequoia National Forest Dave Kohut 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	Carol Coltra 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	Julie Mendenhall 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	Bill Kaage 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	Jody Lyle 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	Hector Gerrera 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	Pat Lineback GIS Specialist 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	Bill Kaage Fire Management Officer Sequoia and Kings Canyon National Parks Gary Marshall Foothills Division Chief Tulare County	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

Firefighting is an inherently dangerous operation that requires all personnel involved to exercise caution and judgment. The dangerous nature of this 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 explosive 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.

Safety Committee

A Fire and Visitor Management division safety committee will address safety issues pertaining to the fire and fuels management office. Members of this committee will include branch chiefs within the division including the fire management officer. 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/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

A qualified aviation manager will manage air operations and assure that they are performed in accordance with 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 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) is 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 has 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 are 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.

Exotic 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 154 exotic 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 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 262 native terrestrial species, and nine more species may be present. Of the native vertebrates, four species are extirpated, and 145 are rare or uncommon. The 262 terrestrial vertebrates include four species of fully terrestrial amphibians, 21 species of reptiles, 168 species of birds, and 69 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 200 individuals as of 2002.

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 by the U.S. Fish and Wildlife Service as part of the National Wetlands Inventory. Therefore, summaries describing the surface area covered by the various wetland taxa are not yet available. 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, acidic and nitrogen deposition, pesticide drift, and regional haze 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.

Most of the parks' air pollution originates in the San Joaquin Valley and is transported into these parks by prevailing winds (Roberts et. al. 1991). Four factors contribute to the area's high pollution levels: climate, lifestyle, population, 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.

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 60% of the ozone pollution (1999 California Almanac). Mobile sources and agricultural activities together account for most of the direct PM10 emissions (particulate matter ten microns in diameter or less). Nitrate, sulfate, and organic particles formed indirectly through conversion of directly emitted pollutants can contribute the majority of the sulfur dioxide emissions. 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 five percent of the parks' collective acreage has been inventoried (surveyed) for the presence/absence of cultural resources. This figure translates into approximately 43,000 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 and tended to focus on the most highly visible sites and included extrapolations of knowledge from outside the parks. The compliance inventories of the mid-1960s to the 1990s have expanded the database of known cultural resources within the parks to 312 prehistoric sites, 110 historic sites, and 169 site leads. This database represents the best available information on the range of site types and human activities carried out over time in the parks (see Appendix H).

In general, the parks' known cultural resources span a time period of at least 3- 5,000 years, and almost certainly longer. These resources document prehistoric, historic, and even contemporary use of park areas. They run the gamut from well- defined and effectively permanent bedrock mortars (grinding holes) to log or lumber structures easily susceptible to loss from fire and decay to rock art sites, expansive vistas, and wild plant resources visited discretely 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 or 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 (aka Western Mono) Indians (as referred to today). Prehistoric site types within the parks include small villages, lithic scatters (marking areas of stone tool production or use such as campsites), midden soils, bedrock mortars and basins, caves, stone circles and hunting blinds, pictographs, and petroglyphs.

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 focussing on ethnographic resources. These latter resource types can be locales where subsistence or religious (ceremonial) activities are conducted, by either groups or individuals, and include associated sites, structures, objects, and landscapes that are assigned cultural significance by traditional users. Ethnographic resources within the parks can include such things as the sites of historic villages or campsites, caves, rock art sites, traditional plant gathering areas, graves, landscapes, and vistas and other natural features (e.g., monoliths and 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 (i.e., at least 50 years of age). Historic sites, by definition then, can be of Native American association but are most often associated with Euroamerican use and occupation. Aspects of all of the episodes of historic activity can be found in historic sites in the parks. The associated site types include cattle camps, trails, sawmills, logging camps, stumps, shake piles, mines, trash dumps, hydroelectric dams and water flumes, the Colony Mill Road, military campsites, Civilian Conservation Corps- era ranger stations and roads, and 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.

Periodic fires performed many ecological functions within Sierran ecosystems prior to Euroamerican 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 portions (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 Euroamerican 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- Euroamerican 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:

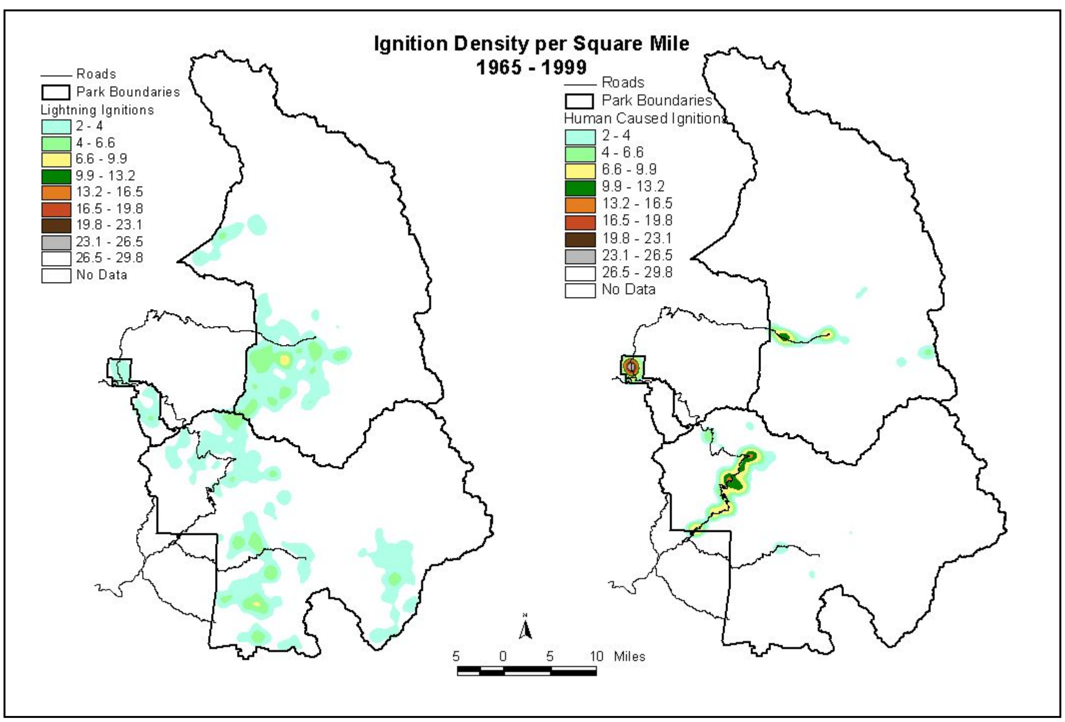
- <u>Short- interval, low- intensity surface fires</u>: These fires burn regularly and frequently and, as such, rarely allow organic fuels to accumulate to a point where high- intensity fires may develop (van Wagtendonk 1972). Examples would include ponderosa pine and blue oak woodlands.
- <u>Moderate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

- Long- interval, variable intensity fires: These fires are uncommon events and exhibit considerable spatial variability in intensity depending on fuel and weather conditions. Infrequent fires in 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 few particular areas fire probably did not occur or its occurrence was extremely rare and erratic. Examples might include alpine vegetation and isolated foxtail pine stands (stands not connected to lower elevation forests) where if fire occurred 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

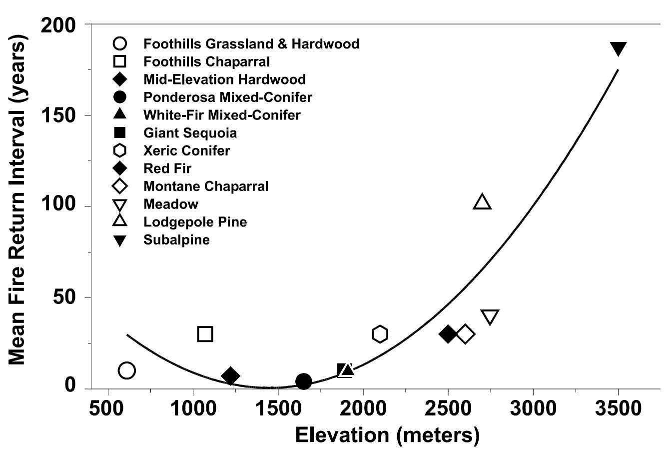
Contemporary lightning ignition rates within the parks have considerable spatially variation. Based on data from the parks' fire records over the last 70 years (Vankat 1985; NPS GIS data), ignition densities cluster in areas above Cedar Grove, the Kern Canyon, Sugarloaf Valley, and the western slopes 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, 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- Euroamerican 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 Euroamerican 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 2000 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 very similar frequency. While specific locations within the watershed had high pre- Euroamerican settlement fire frequencies and few recent ignitions there are no apparent barriers to fire spread from areas with high ignition rates.

Figure 9-3 – Relationship Between Fire Frequency and Elevation



Fire Frequency

General patterns of pre- Euroamerican 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.

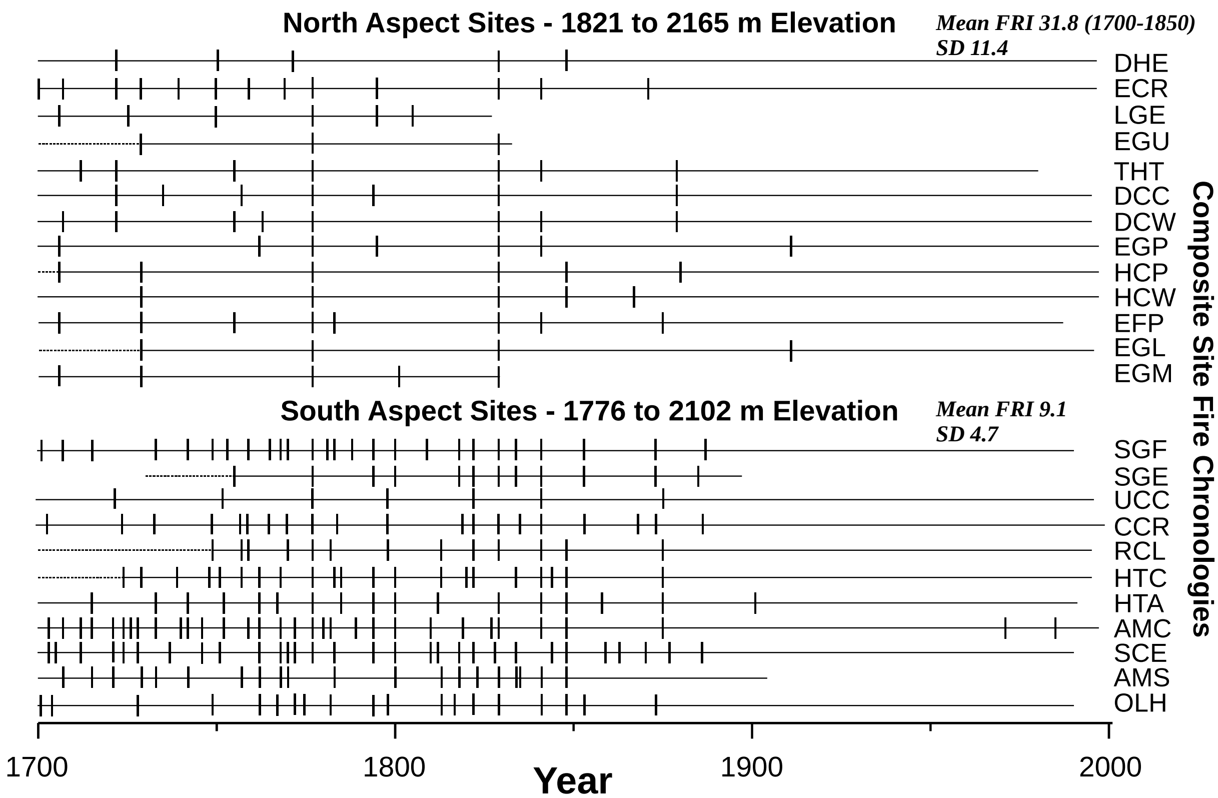
Mean and maximum fire-return intervals for the 12 major classifications in Sequoia & Kings Canyon National Park. Data are for the period prior to 1860 (1870 for subalpine conifer). The primary source(s) for the data are enumerated under "Reference" heading and are listed at the bottom of the table. Fire 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 Chang 1996; **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 2000).

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- Euroamerican 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 Euroamerican 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). 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 depending of specific burning conditions.

Fire Size

The scale of fire prior to Euroamerican 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- Euroamerican 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 2000). 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 were small with a roughly estimated annual area burned of ~800 acres (2.4% of the area) in the East Fork.

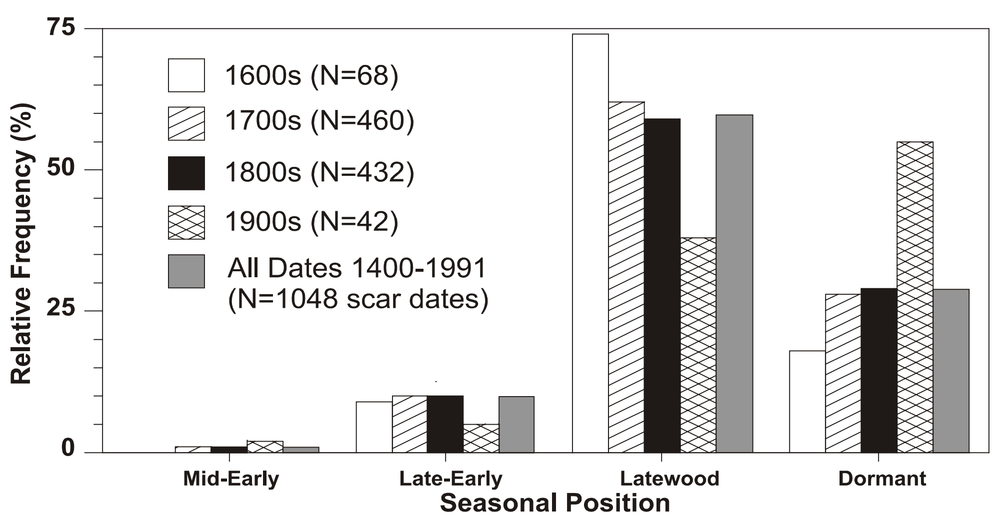
Fire history reconstructions suggest that variation in fire size also occurred by aspect (Caprio 2001, in review). Within the East Fork watershed annual area burned prior to Euroamerican settlement on lower south aspects (5,860 – 7,145 feet elevation) was generally small but regularly interspersed with 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. Changes in seasonality that go outside the normal range of variability may have adverse impacts. In the Sierra Nevada pre- Euroamerican 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). 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 2000). 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-EUROAMERICAN SETTLEMENT CHANGES

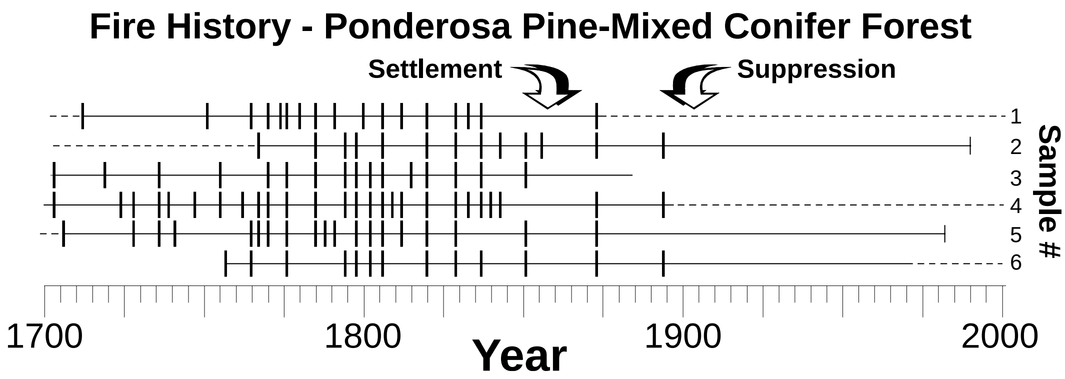
Literature on changes to pre- Euroamerican fire regimes often suggests that changes in these regimes are largely the result of active fire suppression activities. However, fire history reconstructions show that the most dramatic changes in Sierran fire regimes took place 40 to 70 years prior to the initiation 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 Euroamerican 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- Euroamerican 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).

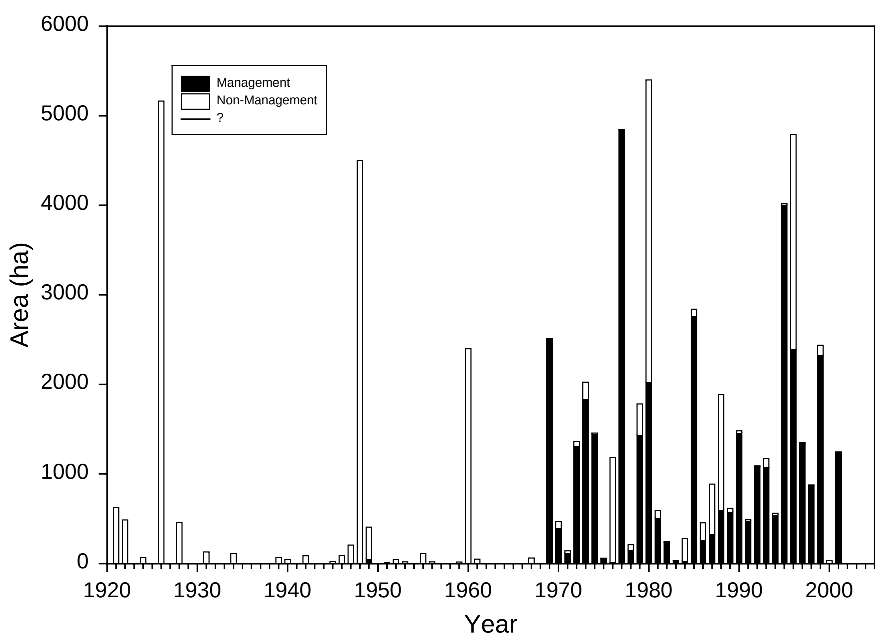
Literature on fire and human impacts on the Sierra Nevada during the latter half of the 19th century often mentions the extent and impact of fires set by sheep herders (Vankat 1977; Beesley 1996; Kinney 1996). The indicated purpose of the burns, set in the fall as the flocks moved out of the mountains, 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 the 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 2000, unpublished). 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). 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, possibly igniting 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 Euroamerican 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 Euroamerican 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 attack 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 attack. Heavy fuel loads, steep slopes, and long burning periods usually cause the few fires that go beyond initial attack. 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- Euroamerican 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- 1960's. 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).

Wildland Fire Use

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 "*wildland fire use* (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.

11 References

Abell, D. L. 1984. Section VIII. Invertebrate studies. Pages 67- 96 *in* A study to facilitate the Impacts of Kaweah No. 3 hydroelectric facility on the resources of Sequoia National Park.

Abell, D. L. 1977. A survey of macroscopic invertebrates of Sequoia streams. Unpubl. Report for Sequoia Natural History Association, Three Rivers, Calif. 84 pp.

Alexis, Andy, P. Gaffne, C. Garcia, M. Nystrom, and R. Rood. 1999. The 1999 California Almanac of Emissions and Air Quality. California Air Resources Board.

Anderson, R.S. and S.J. Smith. 1997. Sedimentary record of fire in montane meadows, Sierra Nevada, California, USA: a preliminary assessment. Pp 313- 327. In. J.S. Clark, H. Cachier, J.G. Goldammer, and B. Stocks (eds). *Sediment Records of Biomass Burning and Global Change*. NATA ASI Series, Vol. 151, Springer- Verlag, Berlin.

Bancroft, W.L., H.T. Nichols, D.J. Parsons, D.G. Graber, Q.B. Evison, and J. van Wagtendonk. 1985. Evolution of the Natural Fire Program at Sequoia and Kings Canyon National Parks. pp. 174- 180 **In:** J.E. Lotan, B.M. Kilgore, W.C. Fischer, and R.W. Mutch (tech. coord.) *Proceedings Symposium and Workshop on Wilderness Fire. 15- 18 November 1983, Missoula, Montana.* USDA Forest Service General Technical Report INT- 182. pp. 434

Beesley, D. 1996. Reconstructing the landscape: An environmental history, 1820- 1960. pp. 3- 24. In *Sierra Nevada Ecosystem Project: Final Report to Congress*, vol. II, chap. 37. Davis: University of California, Centers for Water and Wildland Resources.

Biswell, H.H. 1961. The Big Trees and Fire. National Parks Magazine 35:11- 14.

Bond, W.J. and B.W. van Wilgen. 1996. *Fire and Plants*. Chapman and Hall, London. 263 pp

Bonnicksen, T.M. and E.C. Stone. 1978. An Analysis of Vegetation Management to Restore the Structure and Function Of Pre- settlement Giant Sequoia- Mixed Conifer Forest Mosaics. Headquarters Library, Sequoia- Kings Canyon National Parks.

Brown, P.M., M.K. Hughes, C.H. Baisan, T.W. Swetnam, and A.C. Caprio. 1992. Giant sequoia ring- width chronologies from the central Sierra Nevada, California. Tree- Ring Bulletin 52:1- 14.

Bradford, D. F., S. D. Cooper, T. M. Jenkins, Jr., K. Kratz, O. Sarnelle, and A. D. Brown. 1998. Influences of natural acidity and introduced fish on faunal assemblages in California alpine lakes. Can. J. Fish, Aquat. Sci. 55:2478- 2491.

Caprio, A.C. 2001 (in review). Temporal and Spatial Dynamics of Pre- Euroamerican Fire at a Watershed Scale, Sequoia and Kings Canyon National Parks. In: *Proceedings of the Conference on Fire Management: Emerging Policies and New Paradigms. Nov. 16- 19, 1999, San Diego, CA.*

Caprio, A.C. 2000 unpublished. Analysis done at Sequoia and Kings Canyon National Parks.

Caprio, A.C. and D.M. Graber. 2000. Returning Fire to the Mountains: Can We Successfully Restore the Ecological Role of Pre- Euroamerican Fire Regimes to the Sierra Nevada? In: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer (comps). *Proceedings: Wilderness Science in a Time of Change- - Vol. 5 Wilderness Ecosystems, Threats, and Management; 1999 May 23- 27; Missoula, MT.* Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Proceedings RMRS-P- 15- VOL- 5. pp 233- 241.

Caprio, A.C. 2000. Reconstructing attributes of pre- Euroamerican settlement fire at a watershed scale, Sequoia and Kings Canyon National Parks. Abstract and paper. 85th Ecol. Soc. Amer. Annual Meeting. p. 67.

Caprio A.C., C. Conover, M. Keifer, and P. Lineback, 1997. Fire Management and GIS: a Framework for Identifying and Prioritizing Fire Planning Needs. In: *Proceedings of the Conference on Fire in California Ecosystems: Integrating Ecology, Prevention, and Management. Nov. 17- 20, 1997, San Diego, CA.*

Caprio, A.C. and P. Lineback 1997. Pre- Twentieth Century Fire History of Sequoia and Kings Canyon National Parks: A Review and Evaluation of Our Knowledge. In: *Proceedings of the Conference on Fire in California Ecosystems: Integrating Ecology, Prevention, and Management. Nov. 17- 20, 1997, San Diego, CA.*

Caprio, A. C., and T. W. Swetnam. 1995. Historic fire regimes along an elevational gradient on the west slope of the Sierra Nevada, California. pp.173–179. In: J. K. Brown, R. W. Mutch, C. W. Spoon, and R. H. Wakimoto. Proceedings*: Symposium on fire in wilderness and park management, technical coordination*. U.S. Forest Service, Intermountain Research Station. Ogden, UT. General Technical Report INT- GTR- 320

Caprio, A.C., and T.W. Swetnam. 1994. Fire history and fire climatology in the southern and central Sierra Nevada: Progress Report 1993/94 to National Park Service, Global Change Program, Southern and Central Sierra Nevada Biogeographical Area. Laboratory of Tree- Ring Research, University of Arizona, Tucson, AZ. On file at Sequoia and Kings Canyon National Park. 16 pp.

Caprio, A.C., L.S. Mutch, T.W. Swetnam, and C.H. Baisan. 1994. Temporal and spatial patterns of giant sequoia radial growth response to a high severity fire in A.D. 1297. Final report to California Department of Forest and Fire Protection, Mtn. Home State For., Springville, CA. (Contract No. 8CA17025) by Lab. of Tree- Ring Research, Tucson, AZ, 61 pp.

Caprio, A.C., and T.W. Swetnam. 1993. Fire history and fire climatology in the southern and central Sierra Nevada: Progress Report 1992/93 to National Park Service, Global Change Program, Southern and Central Sierra Nevada Biogeographical Area. Laboratory of Tree- Ring Research, University of Arizona, Tucson, AZ.. On file at Sequoia and Kings Canyon National Park. 14 pp.

Chang, C. 1996. Ecosystem responses to fire and variations in fire regimes. pp. 1071- 1099. In: Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. II, Assessments and Scientific Basis for Management Options. Wildlands Resources Center Report No.37, Centers for Water and Wildlands Resources, University of California, Davis, California, USA. 1528 pp.

Christensen, Norman L., L. Cotton, T. Harvey, R. Martin, J. McBride, Pl Rundel, R. Wakimoto. 1987. Review of Fire Management Program for Sequoia Mixed Conifer Forests of Yosemite, Sequoia, and Kings Canyon National Parks. NPS Management Report.

Cooper, C.F. 1960. Changes in Vegetation, Structure, and Growth of Southwestern Pine Forest Since White Settlement. *Ecological Monographs* 30:129:164.

Davis, O. K., and M. J. Moratto. 1988. Evidence for a warm dry early Holocene in the western Sierra Nevada of California: Pollen and plant macrofossil analysis of Dinkey and Exchequer Meadows. Madroño 35:132–49.

Dawson, K. 1987. *Special Management Area Visual Resources Management Study for the Sequoia National Park Prescribed Fire Management Program*. Prepared by Center for Design Research, Department of Environmental Design, University of California, Davis for the U.S. Department of the Interior, Sequoia & Kings Canyon National Parks.

Dilsaver, L.M. and W.C. Tweed. 1990. *Challenge of the Big Trees: A Resource History of Sequoia and Kings Canyon National Parks*. Sequoia Natural History Society, Three Rivers, CA. 379 pp.

Gill, A.M. 1975. Fire and the Australian flora: a review. Australian Forestry 38:4- 25.

Hann, W.J. and D.L. Bunnell 2001. *Fire and land management planning and implementation across multiple scales*. International Journal of Wildland Fire. 10(3&4): 389–403.

Hartesveldt, R.J. and H.T. Harvey. 1967. The Fire Ecology of Sequoia Regeneration. Tall Timbers Fire Ecology Conference Proceedings. 7:65- 77.

Harvey, H.T., H.S. Shellhammer, and R.E. Stecker. 1980. Giant Sequoia Ecology: Fire and Reproduction. Scientific Monograph Series, No. 12. USDI NPS, Washington, DC. 182 pp.

Heinselman, M.L. 1981. Fire intensity and frequency as factors in the distribution and structure of northern ecosystems. pp. 7- 57. In: H.A. Mooney , T.M. Bonnicksen, N.L. Christensen, J.E. Lotan, and W.A. Reiners (tech. coord.). *Proceedings of the Conference: Fire Regimes and Ecosystem Properties. Dec. 11- 15, 1978, Honolulu, Hawaii*. USDA Forest Service, GTR- WO- 26, 594 pp.

Huntington, G.L. and M.A. Akeson. 1987. Soil resource inventory of Sequoia National Park, Centeral Part, California; Pedologic investigations in support of acid rain studies, Sequoia National Park, California. Univ. of Calif. Davis, Dept of Land, Air, and Water Resources 263p.

Kauper, D., Stephenson, N., and Warner, T. 1980. *The Effect of Past Management Actions on the Composition and structure of Vegetation in the Grant Tree Portion of Grant Grove*. Prepared by the Resources Management Division of Sequoia and Kings Canyon National Parks, Three Rivers, California.

Keifer, M. 1991. Age structure and fire disturbance in southern Sierra Nevada subalpine forests. MS Thesis, Univ. of Arizona, 111 pp.

Kilgore, B.M. and D. Taylor. 1979. Fire history of a sequoia mixed- conifer forest. Ecology 60:129-142.

Kilgore, B.M. and R.W. Sando. 1975. Crown- fire Potential in a Sequoia Forest after Prescribed Burning. Forest Science 21:83- 87.

Kilgore, B.M. 1973. The ecological role of fire in Sierran conifer forests: Its application to national park management. Quaternary Research 3:496–513.

Kilgore, B.M. 1972. Fire's Role in a Sequoia Forest. Naturalist 23(1):26- 37.

Kilgore, B.M. and G.S. Briggs. 1972. Restoring Fire to High Elevation Forests in California. J. Forestry 70:266- 271.

Kilgore, B.M. 1971. The Role of Fire in Managing Red Fir Forests. Transcript North American Wildlife Natural Research Conference. 36:405- 416.

Kinney, W.C. 1996. Conditions of rangelands before 1905. pp. 31- 45. In *Sierra Nevada Ecosystem Project: Final Report to Congress*, vol. II, chap. 37. Davis: University of California, Centers for Water and Wildland Resources.

Knapp, R. A., K. R. Matthews, and O. Sarnelle. 2001. Resistance and resilience of alpine lake fauna to fish introductions. Ecological Monographs 71:401- 421.

Kratz, K. W., S. D. Cooper, and J. M. Melack. 1994. Effects of single and repeated experimental acid pulses on invertebrates in a high altitude Sierra Nevada stream. Freshwater Biology 32:161- 183.

Kubly, D. M. 1983. Plankton of high Sierra lakes. Southern California Edison Research and Development Report No. 83oRD- 47. Univ. California, Riverside. 96 pp.

Lewis, H. T. 1973. Patterns of Indian burning in California: Ecology and ethnohistory. Ballena Press Anthropological Papers No. 1, Ramona, CA, 101 pp.

Lyle, J. 2002. Standard Operating Procedures for Distributing Fire Information, Sequoia and Kings Canyon National Parks.

McBride, J.R. and D.F. Jacobs. 1980. Land use and fire history in the mountains of southern California. pp. 85- 88. In: M.A. Stokes and J.H. Dieterich (tech. coord.). *Proceedings of the Fire History Workshop. October 20- 24, 1980, Tucson, Arizona*. USDA Forest Service, GTR-RM

McClaren, M.P. and J.W. Bartolome. 1989. Fire- related recruitment in stagnant *Quercus douglasii* populations. Canadian Journal of Forest Research 19:580- 585.

McKelvey, K. S., C. N. Skinner, C. Chang, D. C. Erman, S. J Husari, D. J. Parson, J. W. van Wagtendonk, C. P. Weatherspoon. 1996. An overview of fire in the Sierra Nevada. In *Sierra Nevada Ecosystem Project: Final Report to Congress*, vol. II, chap. 37. Davis: University of California, Centers for Water and Wildland Resources.

Mensing, S.A. 1992. The impact of European settlement on blue oak (*Quercus douglasii*) regeneration and recruitment in the Tehachapi Mountains, California. Madroño 39:36- 46.

Muir, J. 1877. On the post- glacial history of *Sequoia gigantea*. Proceedings American Association Advanced Sciences, Volume 25.

Muir, J. (edited by L. M. Wolfe). 1938. *John of the Mountains*.

National Park Service, U.S. Department of Interior. 2002. Reference Manual #60 – Aviation Management.

National Park Service, U.S. Department of Interior. 2001. Director's Order #58 – Structural Fire Management.

National Park Service, U.S. Department of Interior. 2001. Fire Monitoring Handbook.

National Park Service, U.S. Department of Interior. 1998. Reference Manual #18 – Wildland Fire Management.

National Park Service. 1995. Guidelines for Ecological Restoration, Giant Forest, Sequoia and Kings Canyon National Parks, Appendix B. Interim Management Plan/Environmental Assessment Giant Forest, Sequoia National Park, California.

National Wildfire Coordinating Group. 2000. Wildland and Prescribed Fire Qualification System Guide – Publication 310- 1.

National Wildfire Coordinating Group. 1998. The Fireline Handbook – Publication 410- 1.

Parsons, D. J. 1981. The historical role of fire in the foothill communities of Sequoia National Park. Madrono 28(3):111- 120.

Parsons, D. J. and S. H. DeBenedetti. 1979. Impact of fire suppression on a mixed- conifer forest. Forest Ecology and Manage. 2:21- 31.

Parsons, D.J. 1977. Preservation in Fire- Type Ecosystems. pp. 172- 182. **In:** H.A. Mooney and C.E. Conrad (tech. Coord.) *Proceedings of the Symposium on the Environmental Consequences of Fire and Fuel management in Mediterranean Ecosystems.* USDA Forest Service GTR- WO- 3. 498 pp.

Pitcher, D. 1987. Fire History and Age Structure in Red Fir Forests of Sequoia National Park, California. Canadian Journal of Forest Research 17:582- 587.

Pitcher, D. 1981. The ecological effects of fire on stand structure and fuel dynamics in red fire forests of Mineral King, Sequoia National Park, California. MS Thesis, UC Berkeley, 168 pp.

Quinn, Joyce A. 1987. Visitor Perception of NPS Fire Management in Sequoia and Kings Canyon National Parks: Results of a Survey Conducted Summer 1987. Technical Report #36.

Reynolds, R. D. 1959. Effect of natural fires and aboriginal burning upon the forests of the central Sierra Nevada. Master's thesis, University of California, Berkeley.

Roberts, P. T., T. B. Smith, C. G. Lindsey 1991. Analysis of San Joaquin Valley Air Quality and Meteorology, in Proceedings of the 84$^{th.}$

Rundel, P.W., D.J. Parsons, and D.T. Gordon. 1977 (1988). Montane and subalpine vegetation of the Sierra Nevada and Cascade Ranges. pp 559- 599. In: M.G. Barbour and J. Major (eds.). Terrestrial Vegetation of California. California Native Plant Society. Special Publication Number 9. 1030 pp.

Schissler, P. 1999. *Fire Management Planning for Sequoia and Kings Canyon National Parks: A Public Opinion Survey of the Residents of Three Rivers, California*. Management Report, Paul Schissler Associates, Incorporated, Bellingham, Washington. 64 pp.

Sheppard, P.R. 1984. Fire regime of the lodgepole pine (*Pinus contorta* var. *murrayana*) forests of the Mt. San Jacinto State Park wilderness, California. MS Thesis, Cornell University, NY. 93 pp.

Show, S.B., and E.I. Kotok. 1924. *The Role of Fire in the California Pine Forests*. U.S. Printing Off., Washington, D.C.

Skinner, C.N. and C. Chang. 1996. Fire regimes, past and present. pp. 1041- 1069. In: *Sierra Nevada Ecosystem Project, Final Report to Congress: Status of the Sierra Nevada, Vol. II, Assessments and Scientific Basis for Management Options*. 1528 pp.

Smith, S. J., and R. S. Anderson. 1992. Late Wisconsin paleoecologic record from Swamp Lake, Yosemite National Park, California. Quaternary Research 38:91–102.

SNEP. 1996. Sierra Nevada Ecosystem Project, Final Report to Congress: Status of the Sierra Nevada.

Stephens, S.L. 1997. Fire history of a mixed conifer oak- pine forest in the foothills of the Sierra Nevada, El Dorado County, California. pp 191- 198. In: N.H. Pillsbury, J. Verner, and W.D.

Tietje (tech. coord.). *Proceedings of a Symposium on Oak Woodlands: Ecology, Management, and Urban Interface Issues. 19- 22 March 1996. San Luis Obispo, CA.* Gen. Tech. Rep. PSW-GTR- 160, 738 pp.

Stephenson, N.S. 1999. Reference conditions for giant sequoia forest restoration: structure, process, and precision. Ecol. Appl. 9:1253- 1265.

Stephenson, N.S. 1996. Ecology and management of giant sequoia groves. pp. 1431- 1467. In: *Sierra Nevada Ecosystem Project, Final Report to Congress: Status of the Sierra Nevada, Vol. II, Assessments and Scientific Basis for Management Options*. 1528 pp.

Stephenson, N.S., D.J. Parsons, and T.W. Swetnam. 1991. Natural Fire to the Sequoia- Mixed Conifer Forest: Should Intense Fire Play a Role. pp.321- 337. In: *Proc. 17th Tall Timbers Fire Ecology Conference, May 18- 21, 1989: High Intensity Fire in Wildlands: Management Challenges and Options*. Tall Timbers Research Station, Tallahassee, Florida. 435 pp.

Stoddard, J. L. 1987. Microcrustacean communities of high elevation lakes in the Sierra Nevada, California. J. Plank. Res. 9:631- 650.

Storie, R. E. 1953. Revision of soil rating chart. California Agric. Exp. Stn. 4 pp., illus.

Swetnam, T.W., C.H. Baisan, K. Morino, and A.C. Caprio. 1998. Fire History Along Elevational Transects in the Sierra Nevada, California. Final Report to Sierra Nevada Global Change Research Program, USGS BRD Sequoia and Kings Canyon, and Yosemite Field Stations. On file at Sequoia and Kings Canyon National Parks. 65 pp.

Swetnam, T.W. 1993. Fire History and Climate Change in Giant Sequoia Groves. Science 262:885- 889.

Swetnam, T.W., C.H. Baisan, A.C. Caprio, R. Touchan, and P.M. Brown. 1992. Tree- ring reconstruction of giant sequoia fire regimes. Final report to Sequoia, Kings Canyon and Yosemite National Parks, Laboratory of Tree- Ring Research, Tucson, AZ. 90 pp. + appendices.

Swetnam, T.W., R. Touchan, C.H. Baisan, A.C. Caprio, and P.M. Brown. 1991. Giant sequoia fire history in Mariposa Grove, Yosemite National Park. In: *Yosemite Centennial Symposium, Proceedings: Natural Areas and Yosemite: Prospects for the Future, Oct. 13- 20, 1990*, Concord, Calif. NPS D- 374.

Taylor, T. P. and D. C. Erman. 1980. The littoral bottom fauna of high elevation lakes in Kings Canyon National Park. California Department of Fish and Game 66:112- 119.

Vale, T.R. 1998. The myth of the humanized landscape: an example from Yosemite National Park. Natural Areas Journal 18:231- 236.

Van Wagtendonk, J.W. 1972. Fire and Fuel Relationships for Yosemite National Park. USDI, NPS Occa. Paper No.2. 21 pp.

Vankat, J. L. 1985. General patterns of lightning ignitions in Sequoia National Park, California. In: J. E. Lotan, B. M. Kilgore, W. C. Fischer, and R. W. Mutch, (tech. coord.). *Proceedings of the symposium and workshop on wilderness fire*, 408–11. General Technical Report INT- 182. Ogden, UT: U.S. Forest Service, Intermountain Research Station.

Vankat 1977. Fire and Man in Sequoia National Park. Annuals of the Association of American Geographers. 67(1): 17- 27

Vankat, J.L. 1970. Vegetation change in Sequoia National Park, California. Ph.D. Thesis, University of California, Davis, CA. 197 pp.

Warner, T.E. 1980. Fire History in the Yellow Pine Forest of Kings Canyon National Park. pp. 89-92. In: M.A. Stokes and J.H. Dieterich (tech. coord.). *Proceedings of the Fire History Workshop. October 20- 24, 1980, Tucson, Arizona*. USDA Forest Service, GTR- RM- 81

Weaver, H. 1974. Effects of Fire on Temperate Forests: Western United States. In: *Fire and Ecosystems*. T.T. Kozlowski and C.E. Ahlgren, eds. Academic Press. 542 pp.

Weaver, H. 1967. Fire and its Relationship to Ponderosa Pine. Proc. Tall Timbers Fire Ecology Conference. 7:127- 149.

Whelan, R.J. 1995, *The Ecology of Fire*. Cambridge Univ. Press, Cambridge, 346 pp.

A - Five-Year Fuels Treatment Plan

Table A-1 – Five-Year Fuels Treatment Plan

FMU	Project Name	Type of Treatment	Acres	Notes
Fiscal Year 2006				
Sequoia District	Sequoia District pile burning	Fire	10	This is to burn any miscellaneous piles created during the summer season in the Sequoia District.
Kings District	Kings District pile burning	Fire	20	This is to burn any miscellaneous piles created during the summer season in the Grant Grove area.
Cedar Grove	Cedar Grove	Mechanical	10	This is a mechanical project around the developed areas in Cedar Grove.
Cedar Grove	Cedar Grove Valley Floor II	Fire	150	This is a maintenance burn within the Cedar Grove FMU.
Cedar Grove	Lewis Creek	Fire	1,000	This is a combination maintenance and restoration burn within the Cedar Grove FMU. This area will most likely revert exclusively to Wildland Fire Use after completion of this project.
East Fork	Atwell	Mechanical	10	This is a mechanical project around the Atwell campground and NPS buildings within the East Fork FMU.
East Fork	East Davenport	Fire	317	This restoration burn builds off previously burned units within the East Fork FMU.
East Fork	Highbridge	Fire	1,517	This is a restoration burn within the East Fork FMU to protect the developed area around Silver City.
East Fork	Silver City III pile burning	Fire	20	This is to burn the piles created by the FY05 mechanical project around the Silver City developed area within the East Fork FMU.
Grant Grove	Big Stump East planning	Other	TBA	This is to plan a combination of mechanical and burning east of the Big Stump entrance station within the Grant Grove FMU. Acreage to be determined in the planning phase.
Grant Grove	Big Stump West	Mechanical	119	This is a mechanical project west of the Big Stump entrance station within the Grant Grove FMU. Acreage to be determined during the planning phase.
Grant Grove	Ella	Fire	70	This is a maintenance burn within the Grant Grove FMU.
Grant Grove	Hart	Fire	692	This restoration burn builds off previous burned units in the Redwood Mountain area of the Grant Grove FMU.
Grant Grove	Valley View	Fire	353	This restoration burn builds off of previously burned units within the Grant Grove FMU.
Marble Fork	Beetle Rock planning	Mechanical	TBA	This is to plan a mechanical project around the Beetle Rock Education Center within the Marble Fork FMU.
Marble Fork	Wall Spring	Fire	170	This is a restoration burn within the Marble Fork FMU. Acreage to be determined during the planning phase.
Marble Fork	Wuksachi II	Mechanical	10	This is a continuation of the Lodgepole II mechanical project to protect the Wuksachi development within the Marble Fork FMU.
Middle Fork	Ash Mountain/Hospital Rock	Fire	25	These are annual maintenance burns conducted around the Ash Mountain Headquarters complex within the Middle Fork FMU.
Middle Fork	Redwood Cabin	Mechanical	6	This is a mechanical project around the Redwood Cabin area within the Middle Fork FMU. Acreage to be determined during the planning phase.

North Fork	Crystal Cave	Mechanical	8	This is a mechanical project around the Crystal Cave development within the North Fork FMU.
South Fork	Dillonwood	Mechanical	10	This is a mechanical project around the Dillonwood developed area within the South Fork FMU. Acreage to be determined during the planning phase.
Fiscal Year 2007				
Sequoia District	Sequoia District pile burning	Fire	28	This is to burn any miscellaneous piles created during the summer season in the Sequoia District. This covers the Wuksachi II, Atwell, and Crystal Cave piles.
Kings District	Kings District pile burning	Fire	20	This is to burn any miscellaneous piles created during the summer season in the Grant Grove area.
Cedar Grove	Cedar Grove pile burning	Fire	10	This is to burn the piles created by the FY05 mechanical project around the developed area within the Cedar Grove FMU.
Cedar Grove	Cedar Grove Valley Floor III	Fire	150	This is a maintenance burn within the Cedar Grove FMU.
East Fork	Fowler Creek	Fire	573	This is a restoration burn within the East Fork FMU.
East Fork	Mosquito	Fire	599	This is a restoration burn within the East Fork FMU.
East Fork	West Davenport	Fire	427	This restoration burn builds off previously burned units within the East Fork FMU.
Grant Grove	Big Stump East	Other	TBA	This is either a mechanical, burn, or combination project east of the Big Stump entrance station within the Grant Grove FMU. Acreage to be determined in the planning phase.
Grant Grove	Big Stump West pile burning	Fire	119	This is to burn the piles created by the FY06 mechanical project west of the Big Stump entrance station within the Grant Grove FMU. Acreage to be determined during the planning phase.
Grant Grove	North Boundary	Fire	283	This is a restoration burn within the Grant Grove FMU.
Grant Grove	Pan Point planning	Fire	TBA	This is to plan an interagency (USFS) burn within the Grant Grove FMU.
Grant Grove	Redwood	Fire	769	This restoration burn builds off the previously burned units in the Redwood Mountain area of the Grant Grove FMU.
Marble Fork	Beetle Rock	Mechanical	10	This is a mechanical project around the Beetle Rock Education Center within the Marble Fork FMU.
Marble Fork	East Halstead	Fire	1,683	This is a maintenance burn within the Marble Fork FMU.
Marble Fork	Suwanee Grove	Fire	1,848	This maintenance burn builds off the East Halstead unit within the Marble Fork FMU.
Middle Fork	Ash Mountain/Hospital Rock	Fire	25	These are annual maintenance burns conducted around the Ash Mountain Headquarters complex within the Middle Fork FMU.
Middle Fork	Redwood Cabin pile burning	Fire	6	This is to burn the piles created by the FY06 mechanical project around the Redwood Cabin area within the Middle Fork FMU. Acreage to be determined during the planning phase.
North Fork	Dorst	Fire	195	This restoration burn builds off the Cabin Meadow unit to protect the Dorst campground within the North Fork FMU.
Sierra Crest	Lewis Creek East	Fire	1,481	This is a combination maintenance and restoration burn within the Sierra Crest FMU. This area will most likely revert exclusively to Wildland Fire Use after completion of this project.
Sierra Crest	North Dome	Fire	3,340	This is a restoration burn within the Sierra Crest FMU. This area will most likely revert exclusively to Wildland Fire Use after completion of this project.

South Fork	Dillonwood pile burning	Fire	10	This is to burn the piles created by the FY06 mechanical project around the Dillonwood developed area within the South Fork FMU. Acreage to be determined during the planning phase.
South Fork	Dillonwood planning	Fire	TBA	This is to plan an interagency (USFS, CDF) burn in the Dillonwood area of the South Fork FMU.
Fiscal Year 2008				
Sequoia District	Sequoia District pile burning	Fire	10	This is to burn any miscellaneous piles created during the summer season in the Sequoia District. This covers the Beetle Rock piles.
Kings District	Kings District pile burning	Fire	20	This is to burn any miscellaneous piles created during the summer season in the Grant Grove area.
Cedar Grove	Cedar Grove Valley Floor IV	Fire	150	This is a maintenance burn within the Cedar Grove FMU.
Cedar Grove	Sentinel Dome	Fire	1,433	This is a restoration burn within the Cedar Grove FMU.
East Fork	Deer Creek	Fire	941	This maintenance burn builds off the Fowler Creek unit within the East Fork FMU.
East Fork	Highbridge East	Fire	1,041	This restoration burn builds off of the previously burned Highbridge unit within the East Fork FMU.
East Fork	Silver	Fire	253	This restoration burn builds off of the previously burned Highbridge unit within the East Fork FMU.
Grant Grove	Big Stump East pile burning	Fire	TBA	This is to burn the piles created by the FY07 Big Stump East mechanical project.
Grant Grove	Pan Point	Fire	TBA	This is combination restoration and maintenance burn is a joint project with the USFS within the Grant Grove FMU. Acreage to be determined during the planning phase.
Grant Grove	Redwood Mountain	Fire	607	This restoration burn builds off of previously burned units in the Redwood Canyon area.
Grant Grove	Whitaker	Fire	TBA	This is to plan an interagency (USFS) burn in the Redwood Canyon area within the Grant Grove FMU.
Grant Grove	Wilsonia II	Mechanical	TBA	This is a continuation of the mechanical project around the Wilsonia community within the Grant Grove FMU. Acreage to be determined during the planning phase.
Marble Fork	Long Meadow	Fire	605	This is a restoration burn within the Marble Fork FMU. Acreage to be determined during the planning phase.
Middle Fork	Ash Mountain/Hospital Rock	Fire	25	These are annual maintenance burns conducted around the Ash Mountain Headquarters complex within the Middle Fork FMU.
Middle Fork	Crescent Meadow	Fire	52	This is a restoration burn within the Middle Fork FMU.
Middle Fork	Upper Cliff Creek	Fire	1,152	This is a restoration near Redwood Cabin within the Middle Fork FMU.
South Fork	Dillonwood	Fire	TBA	This is an interagency (USFS, CDF) burn in the Dillonwood area of the South Fork FMU. Acreage to be determined during the planning phase.
Fiscal Year 2009				
Sequoia District	Sequoia District pile burning	Fire	10	This is to burn any miscellaneous piles created during the summer season in the Sequoia District.
Kings District	Kings District pile burning	Fire	20	This is to burn any miscellaneous piles created during the summer season in the Grant Grove area. This covers the Wilsonia II piles.
Cedar Grove	Cedar Grove Valley Floor V	Fire	150	This is a maintenance burn within the Cedar Grove FMU.
Cedar Grove	West Sentinel	Fire	2,645	This restoration burn builds off the Sentinel Dome unit within the Cedar Grove FMU.
East Fork	Lookout	Fire	2,531	This is a maintenance burn within the East Fork FMU.

Grant Grove	Lion planning	Fire	TBA	This is to plan an interagency (USFS) burn within the Grant Grove FMU.
Grant Grove	Swale West	Fire	150	This is a maintenance burn within the Grant Grove FMU.
Grant Grove	Whitaker	Fire	TBA	This is an interagency (USFS) burn in the Redwood Canyon area within the Grant Grove FMU. Acreage to be determined during the planning phase.
Marble Fork	Beetle Rock	Fire	423	This restoration burn builds off the Wall Spring unit within the Marble Fork FMU.
Middle Fork	Ash Mountain/Hospital Rock	Fire	25	These are annual maintenance burns conducted around the Ash Mountain Headquarters complex within the Middle Fork FMU.
Middle Fork	Timber Creek	Fire	1,905	This restoration burn builds off of the previously burned Upper Cliff Creek unit within the Marble Fork FMU.
North Fork	Lost Grove	Fire	618	This restoration burn builds off the Cabin Meadow and Lost Grove burn units to protect the Dorst campground within the North Fork FMU.
Fiscal Year 2010				
Sequoia District	Sequoia District pile burning	Fire	10	This is to burn any miscellaneous piles created during the summer season in the Sequoia District.
Kings District	Kings District pile burning	Fire	20	This is to burn any miscellaneous piles created during the summer season in the Grant Grove area.
Cedar Grove	Cedar Grove Valley Floor VI	Fire	150	This is a maintenance burn within the Cedar Grove FMU.
Cedar Grove	Upper Sheep Creek	Fire	1,650	This restoration burn builds off the West Sentinel unit within the Cedar Grove FMU.
Cedar Grove	West Sheep Creek	Fire	TBA	This is to plan an interagency (USFS) burn within the Cedar Grove FMU.
East Fork	Oriole Lake	Fire	4,422	This is a restoration burn within the East Fork FMU around the Oriole Lake developed area.
Grant Grove	Tower	Fire	150	This is a restoration burn within the Grant Grove FMU.
Grant Grove	Lion	Fire	TBA	This is an interagency (USFS) burn within the Grant Grove FMU. Acreage to be determined during the planning phase.
Marble Fork	Silliman Creek	Fire	154	This is a restoration burn within the Marble Fork FMU.
Middle Fork	Ash Mountain/Hospital Rock	Fire	25	These are annual maintenance burns conducted around the Ash Mountain Headquarters complex within the Middle Fork FMU.
Middle Fork	Granite Creek	Fire	1,122	This is a restoration burn within the Middle Fork FMU.
Middle Fork	Buck Creek	Fire	1,857	This is a restoration burn within the Middle Fork FMU.

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.

INTERDISCIPLINARY PLANNING TEAM MEMBERS

Sequoia & Kings Canyon National Parks

Jeffrey Manley
Natural Resources Management Specialist

William Kaage
Fire Management Officer

Jody Lyle
Fire Information and Education Specialist

MaryBeth Keifer
Ecologist

Scott Williams
Prescribed Fire Technician
(Now employed by the USFS)

Corky Conover
Fuels Specialist

Tom Burge
Archeologist

Anthony C. Caprio
Fire Ecologist

Additional Consultants & Preparers

Dr. Nathan Stephenson
Research Scientist
USGS Biological Resources Division
Sequoia & Kings Canyon Field Station

David Allen

Sequoia District Fire Management Officer
Sequoia & Kings Canyon National Parks

Sylvia Haultain
Plant Ecologist
Sequoia & Kings Canyon National Parks

Harold Werner
Wildlife Biologist
Sequoia & Kings Canyon National Parks

Annie Esperanza
Air Quality Specialist
Sequoia & Kings Canyon National Parks

John Austin
Environmental Compliance Specialist/Resource Planner
Sequoia & Kings Canyon National Parks

Alan Schmierer
Environmental Compliance Specialist
NPS Pacific West Regional Office

Richard Smedley
Regional Fire Planner
NPS Pacific West Regional Office

Nelson Siefken
Regional Fire Archeologist
NPS Pacific West Regional Office

C - Fire Monitoring Plan and Target Conditions

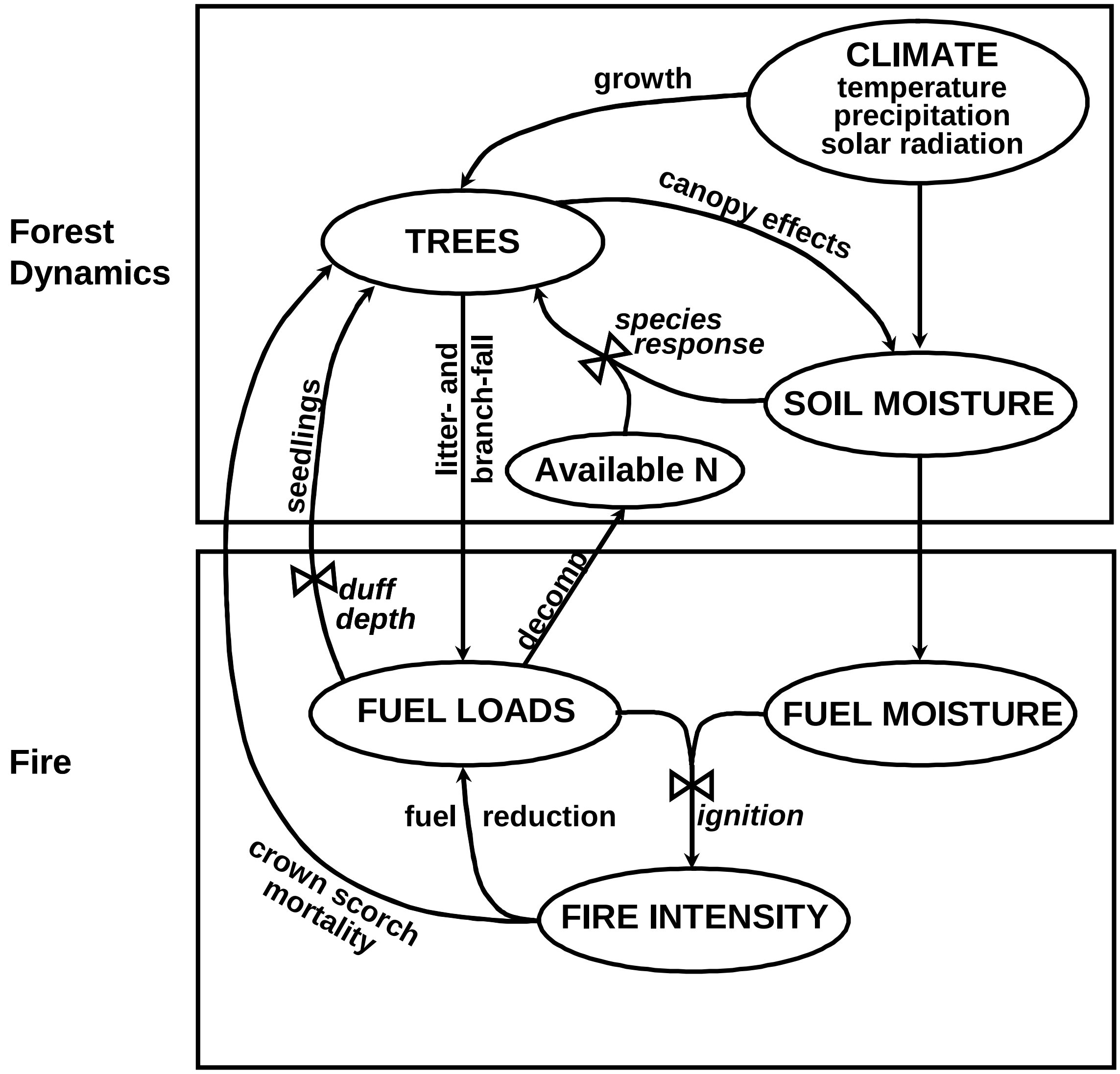
TABLE OF CONTENTS

A. 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:

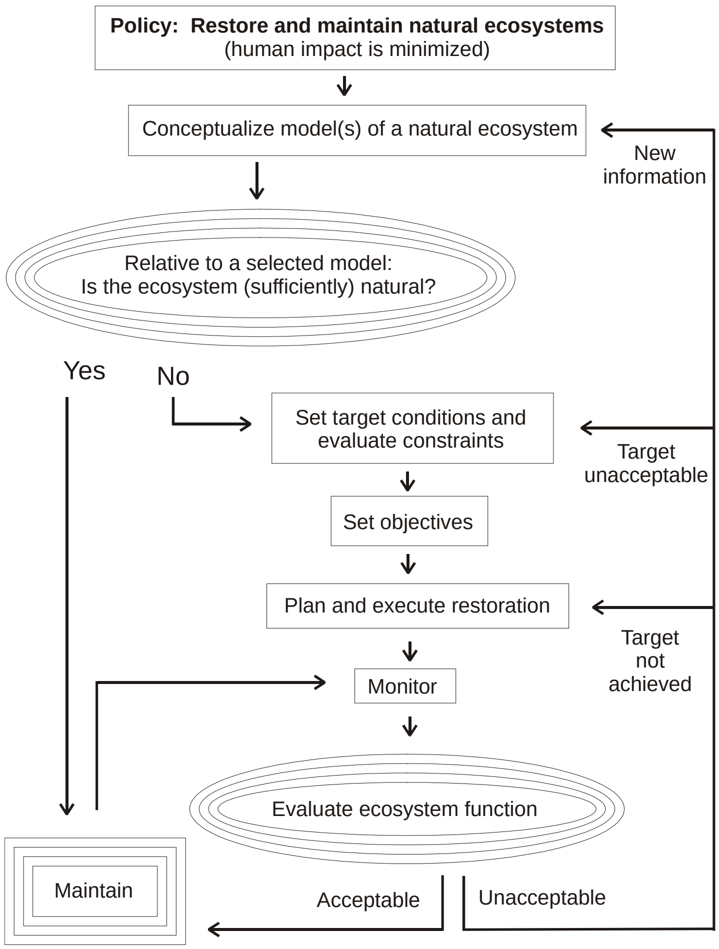
- Environmental and Fire Conditions
- Vegetation and Fuels
- Additional Fuels Information for Modeling
- Wildlife
- Water
- Fire Regime
- Cultural Resources

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.

B. 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 where 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.

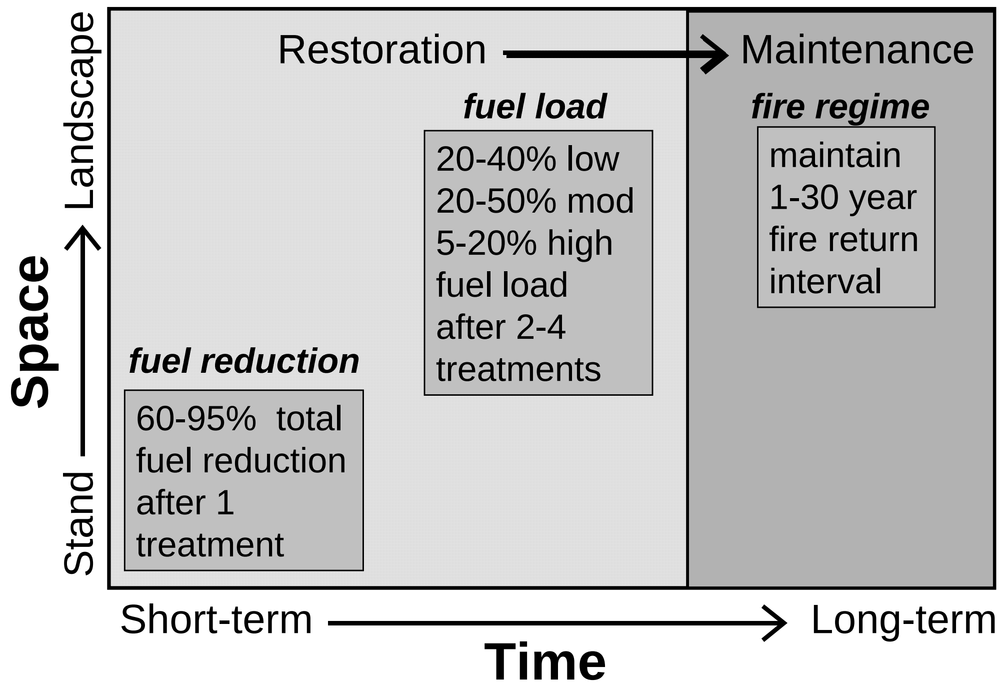
To describe explicitly how to arrive at the target conditions, specific management objectives are developed by adding a method and timeframe to the target conditions. For example, if the target condition is a stand density of 20- 250 trees/ha, then the management objective would be to use prescribed 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.



C. 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 Implementation Plan (WFIP).

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 WFIP.

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 wildland fire use projects, the environmental and fire conditions information will be used to help determine the level of monitoring needed for each fire.

D. 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 Euroamerican 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 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.

<u>**Variable**</u> **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.*	
<u>**Stand Structure**</u> ***[*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.
<u>**Stand Structure**</u> **[*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.	

<u>Variable</u> and Vegetation Type	Management Objective (restatement of applicable target conditions from Table 1)	Monitoring Objective
<u>Landscape Pattern</u> [*maintenance*] **Mixed-Conifer Forest Types**	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.*	*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.*
<u>Landscape Pattern</u> [*maintenance*] **Red Fir Forest**	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	
<u>Stand Structure</u> *[*maintenance*]* **Brush Types**	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.*	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*).

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 in a WFU project. 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 Reduc.	Minimum Sample Size* 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 WFU 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.

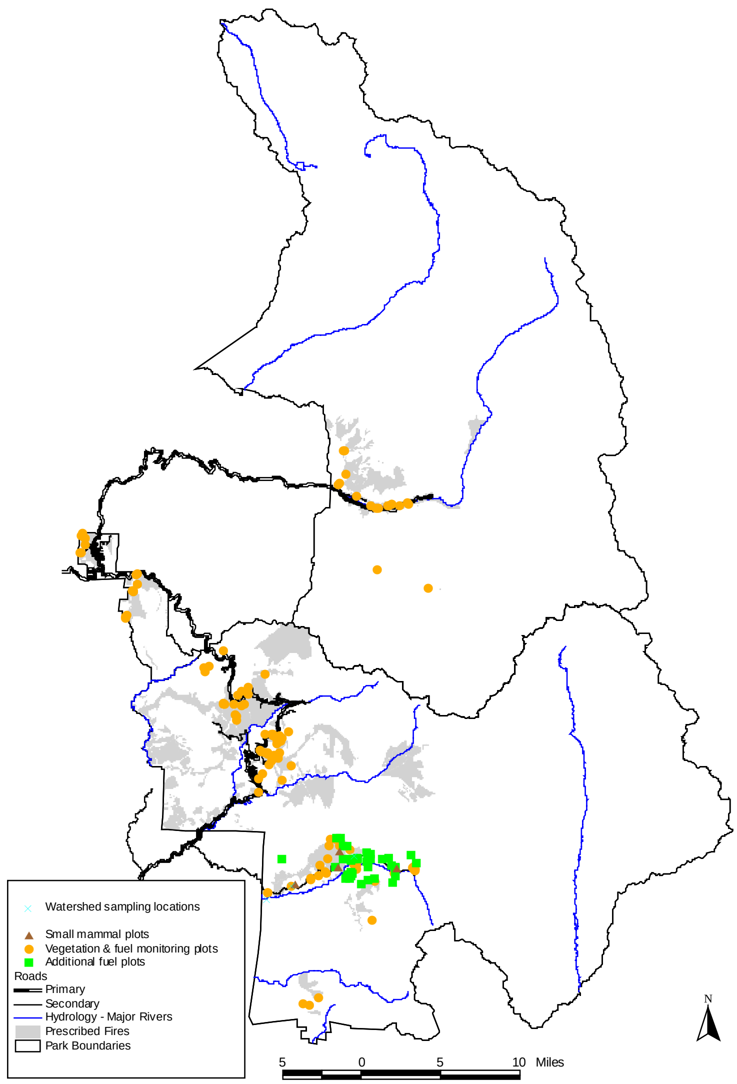
Montane chaparral – Prescribed burning has been limited in this monitoring type in the past. The current plots in this monitoring type were opportunistically installed within a WFU project and were all burned in one event. If prescribed burning is carried out in this vegetation type according to the 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	-	-

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 - Redwood 1997	-	-	-	-	-	-	B10,11	-
MK - Tar Gap 1999	-	-	-	-	101	-	-	-
MK - Redwood	-	-	-	-	-	-	B7,8,9, 15	-
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 more timely. 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.

E. 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.

F. 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 habitat 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 the 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.

G. 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 more coarse. 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.

H. 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- Euroamerican 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- Euroamerican 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 □ Jul 50-70% Aug □ Sep 30-50% Oct □ 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- Euroamerican 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 Euroamerican 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- Euroamerican 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-Euroamerican 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 Euroamerican 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 Euroamerican 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- Euroamerican 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 affects 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.

I. CULTURAL RESOURCES

All NPS units that implement wildland fire use 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 judgement, 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.

J. 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.

K. REFERENCES

Caprio, A. C. and P. Lineback. 1997. Pre- twentieth century fire history of Sequoia and Kings Canyon National Parks: A review and evaluation of our knowledge. In: Proceedings of the Conference on Fire in California Ecosystems: Integrating Ecology, Prevention, and Management. Nov. 17- 20, 1997, San Diego, CA.

Caprio, A. C., C. Conover, M. Keifer, and P. Lineback. 1997. Fire management and GIS: A framework for identifying and prioritizing fire planning needs. In: Proceedings of the Conference on Fire in California Ecosystems: Integrating Ecology, Prevention, and Management. Nov. 17- 20, 1997, San Diego, CA.

Keeley, J. E. and N. L. Stephensen. 2000. Restoring natural fire regimes to the Sierra Nevada in an era of global change. Pages 255- 265 in Cole, D. N., and S. F. McCool, compilers. Wilderness Science in a Time of Change conference – Volume 5: Wilderness ecosystems, threats, and management; 1999 May 23- 27 Missoula MT. Proceedings RMRS- P- 15- Vol- 5. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Keifer, M., A.C. Caprio, P. Lineback, and K. Folger. 2000. Incorporating a GIS model of ecological need into fire management planning. In: Proceedings of the Joint Fire Science Conference and Workshop, Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management, June 14- 16, 1999, Boise, ID.

Keifer, M., N. L. Stephenson and J. Manley. 2000. Prescribed fire as the minimum tool for wilderness forest and fire restoration: a case study from the Sierra Nevada. In: Cole, David N.; McCool, Stephen F. Proceedings: Wilderness Science in a Time of Change. Proc. RMRS- P- 15. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Miller, C. and D.L. Urban. 1999. A model of surface fire, climate, and forest pattern in the Sierra Nevada, California. Ecological Modelling 114:113- 135.

National Park Service, U.S. Department of Interior. 2001. Fire Monitoring Handbook. National Interagency Fire Center, Boise, ID. 274 pp. http://www.nps.gov/fire/fmh/FEMHandbook.pdf.

National Park Service, U.S. Department of Interior. 1971. Sequoia and Kings Canyon National Parks Master Plan. Sequoia and Kings Canyon National Parks, Three Rivers, CA.

National Park Service. 1999. Natural and Cultural Resource Management Plan. Sequoia and Kings Canyon National Parks, Three Rivers, CA.

State Historic Preservation Office. 1990. Instructions for Completing the California Historic Resources Inventory Form (DPR 523). Sacramento, CA.

L. 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, Date
Sequoia and Kings Canyon National Parks

John Austin, Acting Chief, Division of Natural Resources, Date
Sequoia and Kings Canyon National Parks

Jeff Manley, Natural Resource Management Specialist, Date
Sequoia and Kings Canyon National Parks

Dave Graber, Science Advisor, Date
Sequoia and Kings Canyon National Parks

Paul Reeberg, Fire Effects Program Manager, Date
NPS Pacific West Regional Office

Robin Wills, Fire Ecologist, Date
NPS Pacific West Regional Office

M. 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
FMH version 3.10, Printed on 02/27/03, 5:58:14 pm

Current directory: C:\FMH

----------------------------------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.

Current directory: C:\FMH

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
```

```
FMH version 3.10,  Printed on 02/27/03, 5:58:14 pm

Current directory: C:\FMH


-----------------------------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
```

FMH-4 Monitoring Type Protocols FMH Data - SEKI Page: 0001
FMH version 3.10, Printed on 02/27/03, 5:57:47 pm

Current directory: C:\FMH

----------------------------------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.

Current directory: C:\FMH

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
              FMH version 3.10,  Printed on 02/27/03, 5:57:47 pm

                        Current directory: C:\FMH


----------------------------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
FMH version 3.10, Printed on 02/27/03, 5:59:39 pm

Current directory: C:\FMH

---------------------------------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.

Current directory: C:\FMH

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
```

Current directory: C:\FMH

---------------------------------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 speice

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 rockky and dry.

Current directory: C:\FMH

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 mohogany (Cercocarpus betuloides). Other understory brush associates may include varying amounts of buckeye (Aesculus californica), coffeeberry (Rhamnus spp.) and poison oak (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.

```
                        Current directory: C:\FMH


-------------------------------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
```

Current directory: C:\FMH

---------------------------------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 wil 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.

Current directory: C:\FMH

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
```

FMH version 3.10, Printed on 02/27/03, 5:57:22 pm

Current directory: C:\FMH

```
----------------------------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
```

FMH-4 Monitoring Type Protocols FMH Data - SEKI Page: 0001
FMH version 3.10, Printed on 02/27/03, 5:56:54 pm

Current directory: C:\FMH

----------------------------------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.

Current directory: C:\FMH

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
```

```
                          Current directory: C:\FMH


----------------------------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
```

```
FMH-4              Monitoring Type Protocols FMH Data - SEKI          Page: 0001
                FMH version 3.10,  Printed on 02/27/03, 5:55:54 pm

                            Current directory: C:\FMH

----------------------------------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.

Current directory: C:\FMH

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 Shurb/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"

Current directory: C:\FMH

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 diamter. 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 quaters is diamgrammed 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 puroses of analyses. The modified FMH-18 (which is evidence of when each plot underwent the protocl change) should be used on all FABCO plots, whether they are old or new style. Primary differences between this methodolgy 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 (whcih 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 wil 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 manilla 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.

```
                         Current directory: C:\FMH

-------------------------------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
```

Current directory: C:\FMH

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 Euroamerican 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 down hill 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 are responsible for reviewing topopgraphy 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 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. 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 Geographic Information Cooperative (SSGIC).

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 FIREPRO funded and a minimum of 80% of the position supports GIS and fire and fuels management information activities. The 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 NT client- server model for distributing data and information. The parks' IT staff handle the overall administration of this network. The fire management staff has access to this internal network. All park GIS data now resides on one of two NT servers within this network. One server resides in the IT office and the other resides in the GIS office. It is expected that these two NT servers will be replaced by one new upgraded server in FY 2002 to be housed and maintained in the GIS office. All of the existing fire GIS data processing has been migrated from a Unix workstation to an NT workstation with significant savings in processing time and systems management overhead.

Archiving and Security

All digital data is backed up to one of two park NT data servers. These data servers are 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 and the GIS office for the server backups. Additional copies of the parks' GIS data tapes have been sent to the Seattle Support office for offsite storage and will be updated periodically.

Physical security is provided in the GIS lab for hardware systems. This room is accessible only by special key authority. Software system security is largely handled by the parks' IT staff through Windows NT. The Fire GIS Specialist and the GIS Coordinator both have system administrator access to the park servers for manipulating and creating datasets, and for granting users access to files.

Software and Data Accessibility

GIS Software

The parks use Arc/Info and Arcview for GIS processing and mapping. Several extensions to Arc/Info and Arcview are utilized, such as GRID, Spatial Analyst, and 3D Analyst. Arcexplorer is also available free for users to view data who do not have access to Arcview.

Arcview Theme Manager

This tool was initially developed by the Alaska region and has been used there for 5 years. 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 ArcView 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 steps 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 GIS Theme Manager also provides some extra coordinate handling capabilities. By specifying the data and view projections, the user can click on the view and return the location in lat- long coordinates and UTM. One can also zoom to a lat- long coordinate and display the point on the view.

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 Arc/Info 8 Metadata tool for creation and maintenance of metadata.

Synthesis

Synthesis provides a means for linking and sharing data, information, and applications. It does not replace other databases and does not dictate the structure or function of other databases. Rather, it provides a set of pathways that link various sources of information. Installing Synthesis puts a large amount of information in the hands of park personnel. In addition to providing information from a standard interface, Synthesis includes a software toolbox that allows the user to create a custom interface and then link information to that custom interface. An interface/database created in this manner can be designed to serve park- specific information needs, with no programming expertise needed. SEKI has created a fire information section residing within Synthesis. This will include planning documents such as burn plans, photos, maps, and web links.

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. In 2002, all fire web pages will be integrated to provide better access to fire information in the parks. 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. While no formal GIS training requirements currently exist at the national level, the California Firescope group has developed a training program specific to wildland operations fire GIS mapping. The fire GIS Specialist participated in this training in FY 2000.

Other Park Staff

At least one training class in Arcview 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 Arcview 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 Synthesis can find these datasets.

GIS Data

Format

All geo- spatial data is currently in UTM, NAD27 coordinate system. Data are available in shapefile, Arc/Info, 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.

Fire GIS

As per Chapter 8 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 will be the basis for an improved vegetation layer.

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 will be available for Farsite data.

SACS Data

DI- 1202 forms are entered into the Boise SACS system for all wildland fires. This data is retrieved after the end of the year, from CD- ROMs or ftp from the NIFC IT office, and used to populate GIS tables for fire history. Currently two separate sets of tables are maintained for fire history, one for GIS and one from the 1202 system. A project has been undertaken by the fire GIS Specialist to validate the existing GIS database with the SACS 1202 database. This validation includes updating the SACS system with missing or incorrect information which will then be linked to the GIS. Since the fire numbering scheme is different in the two systems, a linkage table will need to be maintained. It is expected that this process will be completed in early spring 2002.

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 will verify this location. GIS will maintain the point database on the central server.

Fire Size and Digitizing

a) **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 with Arc/Info 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.

b) **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.
c) **GPS** – Where feasible, fire perimeters should be gathered via GPS. This reduces inaccuracies and saves time digitizing.
d) **Remote sensing** – A pilot project by the USGS's EROS data center using Thematic Mapper satellite imagery is being examined by the fire GIS Specialist and fire ecologists to determine if this will be a useful method for gathering fire perimeters and burn severity data. An initial assessment was completed by EROS for fires during 2001, but a determination of the usefulness of this data could take several summers of field verification. The data is fairly course (30 meters pixels) and seems to have difficulty picking up changes in heavy canopy. Also, the availability of scenes was very limited in 2001 with much shadowing obscuring some of the changes.

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 in a) and b) in #2 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 SACS system, exported to a dbf and joined to the GIS. This process will be updated as described in Section D under "SACS Data" earlier in this Appendix (Appendix G).

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 applying a weighting factor for the Fire Return Interval Departure (FRID) to account for greater fuel buildup in some areas. The fuels specialist provides a table each year specifying the classification of fuel models.

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 history specialist 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.

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.

INTERAGENCY COLLABORATION

The 1995 Wildland Fire Policy, and now the 2001 National Fire Plan, both emphasize Interagency collaboration. Sequoia and Kings Canyon National Parks are currently participating in the Southern Sierra Geographic Information Cooperative (SSGIC). This project is focused on developing and testing an approach to incorporate wildland fuels information management into an interagency, landscape- scale planning framework. The project area includes six major watersheds (Kaweah, Kern, Kings, Caliente, Mojave, and Tule watersheds) covering an area of about 4.7 million acres. A spatial and attribute information system is being created for coordinated fuels management planning within an integrated Geographic Information System (GIS) framework.

The interagency group has been established with member representation at the County, State, and Federal level. The primary goals are to reduce fiscal costs to both government agencies and the public and to improve attainment of ecological and hazard reduction goals across jurisdictional boundaries. The project focuses on utilizing geographic information and related technologies including the Internet to overcome institutional and organizational barriers to interagency fuels management within very large, diverse ecosystems.

The proposed framework will be both consistent and dynamic to meet the varied long- range ecological, fire hazard, and risk reduction goals of all impacted agencies. Common geographic data is being developed including comprehensive planning maps and analyses that prioritize areas for treatment based on value, hazard, and risk criteria. This framework will develop and test procedures to manage and update complex spatial information and to institutionalize the coordinated planning efforts.

G - Organization Charts

Since the fire and fuels management program is comprised of staff members in more than one division, six organization charts are necessary to understand organizational structure:

1. **Sequoia and Kings Canyon National Parks & Devils Postpile National Monument** – This chart displays the organization of divisions under the superintendent. The divisions with fire and fuels management positions are highlighted.

2. **Division of Fire and Visitor Management** – This chart displays the organization of the Fire and Aviation branch of the Fire and Visitor Management Division.

3. **Kings Canyon District** – This chart displays the organization of the Kings Canyon Fire District under the Division of Fire and Visitor Management.

4. **Sequoia District** – This chart displays the organization of the Sequoia Fire District under the Division of Fire and Visitor Management.

5. **Division of Interpretation and Cultural Resources** – This chart displays the partial organization of the Division of Interpretation and Cultural Resources as it pertains to fire and fuels management.

6. **Division of Natural Resources** – This chart displays the partial organization of the Division of Natural Resources as it pertains to fire and fuels management.

Figure G-1 – Organization Chart for Sequoia & Kings Canyon National Parks and Devils Postpile National Monument

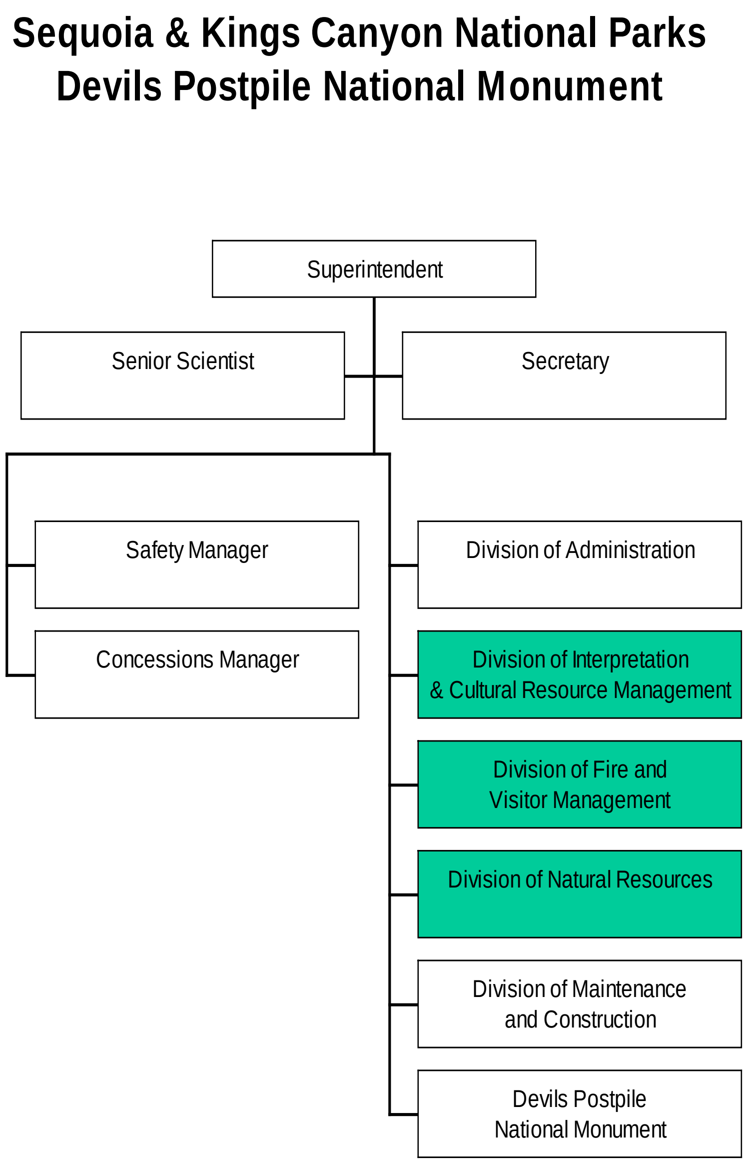


Figure G-2 – Organizational Chart for Division of Fire and Visitor Management

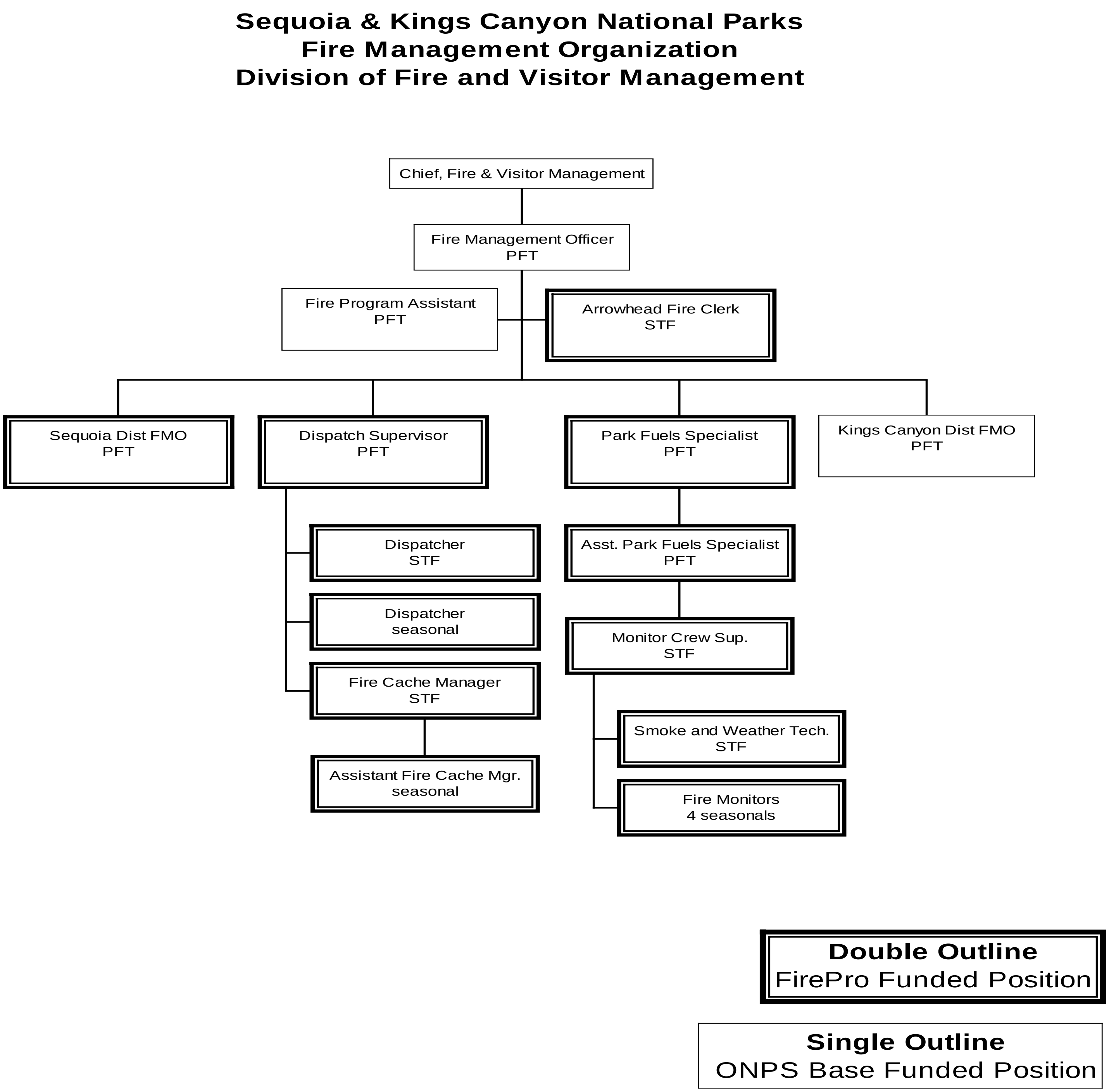


Figure G-3 – Organization Chart for Kings Canyon District

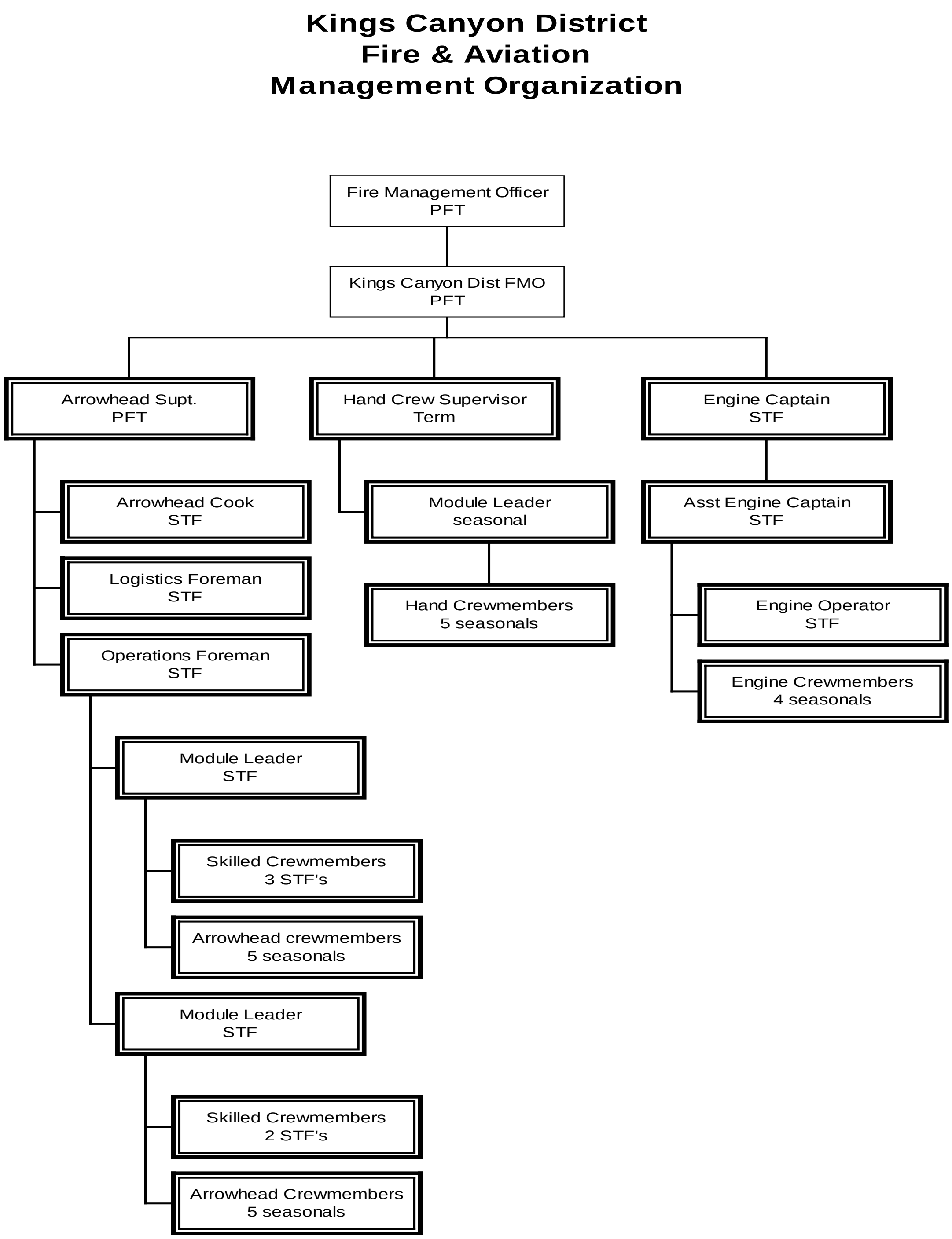


Figure G-4 – Organization Chart for Sequoia District

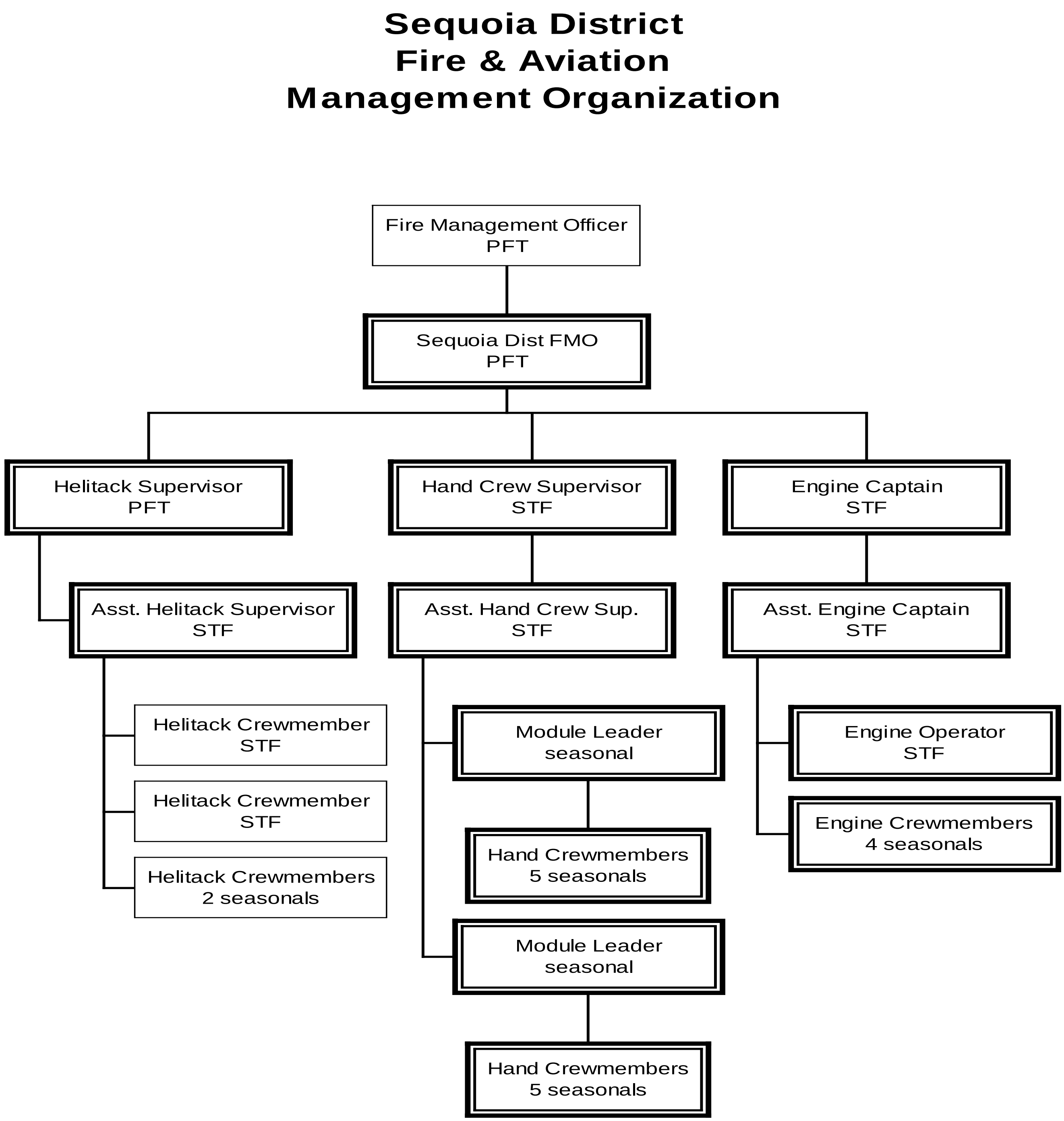


Figure G-5 – Organization Chart for Division of Interpretation and Cultural Resources

Sequoia & Kings Canyon National Parks
Fire Management Organization
Division of Interpretation &
Cultural Resource Management

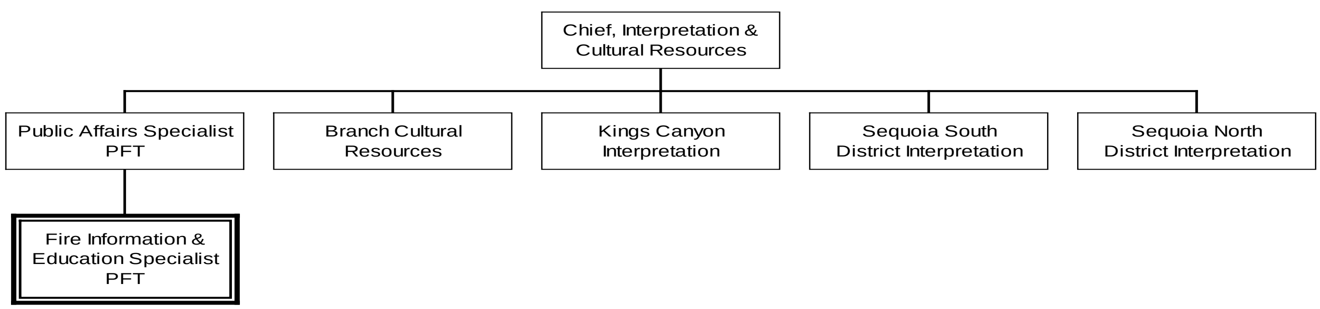
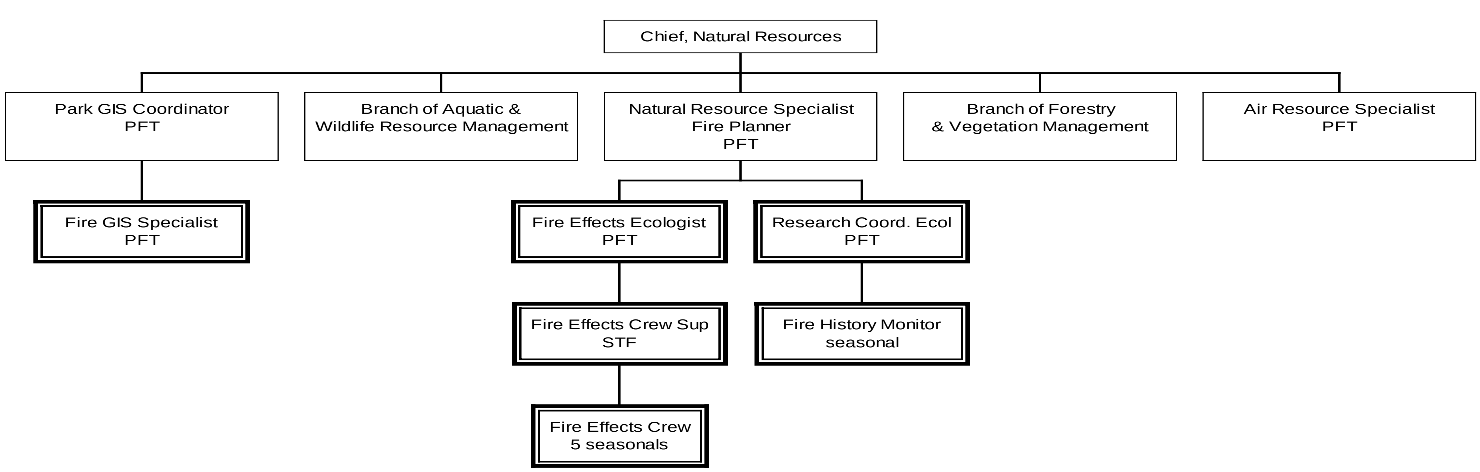


Figure G-6 – Organization Chart for Division of Natural Resources

Sequoia & Kings Canyon National Parks
Fire Management Organization
Division of Natural Resources



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
1.	Generals Highway	B	057645	SBP & M	Good
2.	Silliman Creek Culvert	K	058193	SBP & M	Good
3.	Tunnel Rock	G	058187	SBP & M	Good
4.	Hospital Rock Stone Water Fountain	J	058192	SBP & M	Good
5.	Hospital Rock Automobile Watering Stations	H	058141	SBP & M	Poor
6.	Atwell's Mill	HS-07	005031	SBP & M	Good
7.	Ash Mountain Entrance Sign	009	005030	SBP & M	Good
8.	Moro Rock Stairway	013	005026	SBP & M	Good
9.	Clover Creek Bridge	014	005027	SBP & M	Good
10.	Barton-Lackey Cabin	016	006046	SBP & M	Good
11.	Cloud Canyon Shorty Lovelace Cabin	HS-18	009472	SBP & M	Fair
12.	Vidette Meadow Shorty Lovelace Cabin	HS-23	009507	SBP & M	Fair
13.	Gardiner Creek Shorty Lovelace Cabin	HS-24	009508	SBP & M	Poor
14.	Woods Creek Shorty Lovelace Cabin	HS-25	009509	MBP & M	Poor
15.	Granite Pass Shorty Lovelace Cabin	HS-27	009473	MBP & M	Poor
16.	Marble Fork Bridge	029	013017	SBP & M	Good
17.	Quinn Ranger Station	033	005035	SBP & M	Unknown
18.	Tharp's Log	044	001303	SBP & M	Fair
19.	Squatter's Cabin	045	001302	SBP & M	Fair
20.	Cattle Cabin	046	001300	SBP & M	Good
21.	Giant Forest District Ranger's Residence	055	005028	SBP & M	Fair
22.	Atwell Mill Ranger Residence	062	056085	SBP & M	Good
23.	Cabin Creek Ranger Residence	065	005032	SBP & M	Good
24.	Cabin Creek Dormitory and Garage	066	005033	SBP & M	Good
25.	Hockett Meadow Ranger Station	075	005021	SBP & M	Good
26.	Redwood Meadow Ranger Station	102	005023	SBP & M	Good
27.	Giant Forest Market	104	056084	SBP & M	Good
28.	Grant Grove Chief Ranger's Residence	108	006038	SBP & M	Fair
29.	Grant Grove Superintendent's Residence	112	006039	SBP & M	Fair
30.	Redwood Mountain Ranger Station	115	056123	SBP & M	Good
31.	Cedar Grove Ranger Station	118	005022	SBP & M	Good
32.	Hockett Meadow Tack-Storage Room	139	005022	SBP & M	Good
33.	Giant Forest Village Comfort Station	179	005029	SBP & M	Good
34.	Pear Lake Ski Hut	204	009474	SBP & M	Good

35.	Redwood Meadow Tack-Storage Cabin	205A	005024	SBP & M	Good
36.	Lost Grove Comfort Station	231	056200	SBP & M	Fair
37.	Grant Grove Warehouse and Maintenance Shop	237	056087	SBP & M	Good
38.	Atwell Mill Ranger Station Garage	315	056086	SBP & M	Good
39.	Gamlin Cabin	350	001301	SBP & M	Fair
40.	Smithsonian Institution Shelter	354	005020	SBP & M	Good
41.	Muir Hut	355	009510	SBP & M	Unknown
42.	Knapp Cabin	371	006042	SBP & M	Fair
43.	Grant Grove Maintenance Mess Hall	111	372557	SBP & M	Good
44.	Grant Grove Residence	113	372584	SBP & M	Good
45.	Grant Grove Residence	114	372553	SBP & M	Good
46.	Grant Grove Residence	116	372565	SBP & M	Good
47.	Grant Grove Residence	117	372794	SBP & M	Good
48.	Grant Grove Generator Shed	209	372810	SBP & M	Good
49.	Grant Grove Maintenance Cabin	243	372561	SBP & M	Good
50.	Grant Grove Superintendent's Woodshed	245	372590	SBP & M	Good
51.	Grant Grove Horse Barn	246	372542	SBP & M	Good
52.	Pine Camp Comfort Station	248	372877	SBP & M	Good
53.	Sunset Campground Comfort Station	249	376620	SBP & M	Good
54.	Swale Camp Comfort Station	250	372852	SBP & M	Good
55.	Grant Grove Comfort Station	251	372473	SBP & M	Fair
56.	Grant Grove Superintendent's Garage	322	372586	SBP & M	Good
57.	Crystal Springs Comfort Station	252	372829	SBP & M	Good
58.	Azalea Camp Comfort Station	257	372839	SBP & M	Good
59.	Swale Camp Bathhouse	259	372866	SBP & M	Good
60.	Sunset Campground Bathhouse	260	376639	SBP & M	Good
61.	Grant Grove Residence Garage	323	372575	SBP & M	Good
62.	Grant Grove Gas Station		372456	SBP & M	Fair
63.	Grant Grove Stables Piano Shed		372549	SBP & M	Good
64.	Grant Grove Lodge Bath House		372506	SBP & M	Good
65.	Grant Grove Log Cabin	9	372529	SBP & M	Good
66.	Grant Grove Lodge Duplex Cottages 1 and 2	1-2	372511	SBP & M	Good
67.	Grant Grove Lodge Duplex Cottages 3 and 4	3-4	375849	SBP & M	Good
68.	Grant Grove Lodge Duplex Cottage 5 and 6	5-6	375854	SBP & M	Good
69.	Grant Grove Lodge Duplex Cottage 7 and 8	7-8	375755	SBP & M	Good
70.	Grant Grove Lodge Rustic Cabin 310	310	372522	SBP & M	Good
71.	Grant Grove Lodge Rustic Cabin 311	311	375808	SBP & M	Good
72.	Grant Grove Lodge Rustic Cabin 318	318	375918	SBP & M	Good
73.	Grant Grove Lodge Tent Cabin 302	302	372525	SBP & M	Good
74.	Grant Grove Lodge Tent Cabin 303	303	375372	SBP & M	Good

75.	Grant Grove Lodge Tent Cabin 304	304	375793	SBP & M	Good
76.	Grant Grove Lodge Tent Cabin 307	307	375430	SBP & M	Good
77.	Grant Grove Lodge Tent Cabin 308	308	375446	SBP & M	Good
78.	Grant Grove Lodge Tent Cabin 309	309	373680	SBP & M	Good
79.	Grant Grove Lodge Tent Cabin 313	313	375492	SBP & M	Good
80.	Grant Grove Lodge Tent Cabin 317	317	375787	SBP & M	Good
81.	Grant Grove Lodge Tent Cabin 319	319	365707	SBP & M	Good
82.	Grant Grove Lodge Tent Cabin 321	321	365713	SBP & M	Good
83.	Grant Grove Lodge Tent Cabin 324	324	365720	SBP & M	Good
84.	Grant Grove Lodge Tent Cabin 326	326	375731	SBP & M	Fair
85.	Grant Grove Lodge Tent Cabin 327	327	365738	SBP & M	Good
86.	Grant Grove Lodge Tent Cabin 328	328	375741	SBP & M	Good
87.	Grant Grove Lodge Tent Cabin 329	329	375748	SBP & M	Good
88.	Grant Grove Meadow Camp Cabin 501	501	372534	SBP & M	Good
89.	Grant Grove Meadow Camp Cabin 502	502	376750	SBP & M	Good
90.	Grant Grove Meadow Camp Cabin 503	503	376770	SBP & M	Good
91.	Grant Grove Meadow Camp Cabin 504	504	376799	SBP & M	Good
92.	Grant Grove Meadow Camp Cabin 507	507	376814	SBP & M	Good
93.	Grant Grove Meadow Camp Cabin 508	508	376826	SBP & M	Good
94.	Grant Grove Meadow Camp Cabin 509	509	376835	SBP & M	Good
95.	Grant Grove Meadow Camp Cabin 510	510	376842	SBP & M	Good
96.	Grant Grove Meadow Camp Cabin 511	511	376873	SBP & M	Good
97.	Grant Grove Meadow Camp Cabin 512	512	376888	SBP & M	Good
98.	Grant Grove Meadow Camp Cabin 513	513	376903	SBP & M	Good
99.	Grant Grove Meadow Camp Cabin 514	514	376917	SBP & M	Good
100.	Grant Grove Meadow Camp Cabin 515	515	376937	SBP & M	Good
101.	Grant Grove Meadow Camp Cabin 516	516	376950	SBP & M	Good
102.	Grant Grove Meadow Camp Cabin 517	517	376963	SBP & M	Good
103.	Grant Grove Meadow Camp Cabin 518	518	377053	SBP & M	Good
104.	Grant Grove Meadow Camp Cabin 519	519	377063	SBP & M	Good
105.	Grant Grove Meadow Camp Cabin 520	520	377084	SBP & M	Good
106.	Grant Grove Meadow Camp Cabin 521	521	377110	SBP & M	Good
107.	Grant Grove Meadow Camp Cabin 523	523	377155	SBP & M	Good
108.	Grant Grove Meadow Camp Cabin 524	524	377202	SBP & M	Good
109.	Grant Grove Meadow Camp Cabin 525	525	377220	SBP & M	Good
110.	Grant Grove Meadow Camp Cabin 526	526	377228	SBP & M	Good
111.	Grant Grove Meadow Camp Cabin 527	527	377241	SBP & M	Good
112.	Linzmeier Cabin	C-11	377510	SBP & M	Good
113.	Shanab Cabin	C-21	377624	SBP & M	Good
114.	Barkman Shed	C-24	377650	SBP & M	Fair
115.	Barkman Cabin	C-25	377763	SBP & M	Fair
116.	Brown House	C-31	377793	SBP & M	Good
117.	Bulkley Cabin	C-51	377837	SBP & M	Good
118.	83690 Park Road	C-91	377868	SBP & M	Fair
119.	83681 President's Lane	C-108	377906	SBP & M	Fair
120.	Mineral King Road		378084	SBP & M	Good

121.	Lookout Point Ranger Residence		378111	SBP & M	Good
122.	Lookout Point Ranger Station Garage		378116	SBP & M	Good
123.	Cabin Cove Cabin #2	2	378119	SBP & M	Fair
124.	Slapjack Creek Automotive Watering Trough		378205	SBP & M	Good
125.	Traugers Automotive Watering Trough		378208	SBP & M	Good
126.	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

1. Superintendent and Division Chiefs
2. All employees and their families (including NPS, SNHA, USGS, concessions, and volunteers)
3. Park Visitors (including in- park visitors, internet visitors, and special groups)
4. In- Park Communities – Wilsonia, Silver City, Mineral King cabins, Oriole Lake
5. Neighboring Communities – Three Rivers, Badger
6. San Joaquin Unified Air Pollution Control District

METHODS

During a Fire Incident

1. 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.
2. Hold Open House/Town Meeting for employees and residents in smoke affected areas.
3. Operate particulate monitors in affected areas. Be prepared to move or add monitors. Start monitoring early in the incident.
4. Provide daily air quality information, which interprets the particulate monitor data.
5. Set up a smoke hotline (phone) to handle smoke complaints.
6. Leave flyers on employee doorsteps with tips to decrease exposure.
7. Post on bulletin boards.
8. Disperse information by email, voice- mail, and fax
9. Use the park webpage as a vehicle for dispersing daily air quality information.
10. Give air quality conditions during the daily weather report on park radio.

Year- round Actions

1. Incorporate air quality messages into year- round public outreach: interpretive programs, public meetings, press releases, etc.
2. 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

1. **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).

2. **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).

Early Fire Season

3. **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."

4. **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."

5. **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*).

6. **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*).

7. **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. 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 50), moderate (51 to 100), unhealthy for sensitive groups (101 to 150), unhealthy (151 to 200), very unhealthy (201 to 300), and hazardous (over 300)." (Park Visitor Centers have wooden exhibits that display this information daily.)

Announcing a Planned Smoke Event

8. **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."

9. **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."

10. **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 with the ability to 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."

11. **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."

12. **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.

Responding to an Unplanned Smoke Event

13. **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."

14. **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.

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
1.Wildland fire smoke fits into a larger regional air quality situation.	3. Park managers are sensitive to smoke impacts for visitors and employees.	8. During prescribed burns, fire managers utilize smoke management techniques.	13. Small natural fires have the potential to become large fires.	Hold an open house or a public meeting
2. Smoke, like fire, is a natural ecosystem component.	4. 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.	9. Due to the deliberate nature of prescribed fire, audiences can be notified prior to the smoke event about what to expect.	14. There are ways of minimizing smoke in a fire use project without suppressing the fire.	
	5. There are ways for park residents and neighbors to reduce their exposure to smoke.	10. The park has the ability to monitor particulate levels in Sequoia & Kings Canyon National Parks during smoke events.		
	6. Breathing smoke is not healthy for anyone, but some people are at greater risk.	11. Some characteristics of smoke accumulation are predictable because they are based on daytime and nighttime winds.		
	7. The *Air Quality Index* (AQI) is one tool that helps managers, employees, and visitors quantify daily air quality conditions.	12. Some characteristics of smoke accumulation are not predictable since they are dependent on atmospheric conditions.		

OTHER SOURCES OF INFORMATION

1. Local Air District

2. Air Quality Specialist in the park

3. California Air Resources Board Public Education Protocol
   www.arb.ca.gov/smp/progdev/pubeduc/outreach_protocol.htm

4. National Interagency Fire Center – www.nifc.gov

5. 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)

Getting a Handle on Smoke – Example of an interpretive article for park newspaper on smoke management techniques used in a prescribed fire. (From SEKI's *"Fire & Fuels Management"*)

Smoke Complaint Log – Sample sheet for cataloging smoke complaints during a fire event. (example from SEKI)

CASE STUDY

The recommendations contained in this *Smoke Communication Strategy* are based on experiences from the Hoover Complex of 2001 located in Yosemite National Park. While the strategy has now been tailored for Sequoia and Kings Canyon National Parks, the following information is retained as a case study in smoke communication.

Basic Incident Facts

- The Hoover Fire began with a lightning strike on July 4, 2001. As of September 4, 2001, the fire was 7,883 acres. Four small fires (Cold Creek, Kuna, Lyell, and Clark) were part of the larger Hoover Complex and totaled an additional 100 acres (approximately).
- At the same time as the Hoover Complex, other large fires were burning in the region near Coulterville and Oakhurst which contributed to the smoke problem.
- The presence of smoke in Yosemite Valley, El Portal, and Tuolumne Meadows for 14+ days became a major concern during this incident, especially for park employees and residents.
- Since fires in the Illilouette drainage are particularly troublesome for smoke in Yosemite Valley, the Interagency Fire Use Management Team implemented a plan which included the construction of fire line on the northwest section of the fire to prevent spread into that drainage.

Comments and Questions During the Hoover Complex

During the Hoover Complex, the park and the Incident Management Team received numerous comments and questions from employees and the public about smoke. In general, the comments and questions can be categorized into six groups. The exact questions and comments are listed below.

1) immediate and long- term health concerns
2) the need for tips to reduce exposure
3) work schedule/administrative issues for employees
4) the desire for park management to show concern
5) impacts on recreational activities
6) visibility

Employees

1. Health Impacts - Symptoms include: headaches, sore throat, sinus stuffiness, head congestion, heavy or labored breathing, increased asthmatic complications, watery and or red eyes, blurry vision, tiredness, burning sensation, irritated eyes, and loss of appetite.
2. "Are there any additional health hazards from short- term exposure to the higher levels of particulate matter in the air during portions of the work day?"
3. "Can employees use the CA- 1 to report smoke related problems?"
4. "Can employees work alternative work schedules?"
5. "If unable to work outside of the valley, or Tuolunme Meadows, what precautions can we take to minimize the continued impact of the smoke exposure?"
6. "Can employees go to the clinic during work hours?"
7. "Can air quality information be posted daily for employees?"
8. "Acknowledgement and concern for the situation from park leaders [would] certainly ease many of our minds."
9. "Fire is an important and necessary part of Yosemite and I support it whole heartedly, in fact we need more. The health of all employees and families here are also important and I would like very much to help, to learn how we can make this situation more user friendly or endurable for our park family."

Public

1. "The smoke from these fires has affected the Mammoth area and parts of Inyo National Forest. As a result, the air is polluted in these areas and has created respiratory and allergy problems for those of us that like to golf, fish, and hike."
2. "I know fire can be good for the forest at times…it can also cause many problems. I live in Mono County and have been enduring smoke, much of which is coming from your park. It has become difficult to breathe, our eyes are watering, and…many people are complaining of being sleepy all of the time due to the smoke. I would appreciate it if you would do the right thing by putting the fires out."
3. "The smoke over here on the east side is really bad. I have a small motel and people are leaving early. I notice that you are controlling one side of the fire so that the smoke in the valley doesn't get too bad. What about us over here? Is there any way to balance natural fire practices with some smoke suppression?"

Lessons Learned From Hoover Complex

1. The park needs to anticipate smoke events and distribute information before conditions deteriorate.
2. Involvement from park managers is crucial to communicating smoke messages.
3. Park supervisors need clear instructions about how to accommodate employees who are affected by smoke (alternative work schedules and locations, etc.).
4. Park employees, unlike visitors, worry about the effects of long term exposure to smoke since they are not a transient population.
5. Monitoring of air quality, particularly PM, is imperative and needs to begin early in the fire incident.
6. Smoke management is complicated when there is more than one large fire in the area.
7. While it is impossible to immediately extinguish a wildland fire when smoke exposure becomes a health risk, it is helpful for people to know that there are fire management techniques available that can reduce smoke in these situations (i.e. water drops, fire line construction).
8. It is reassuring for people to know that park management cares about their welfare.
9. Neighboring communities must be included when distributing smoke information.
10. Most people understand and support the general concept of fire use; actions to promote understanding are still necessary during smoke events.

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- 10] and ozone) as defined by the Federal Clean Air Act. This smoke management plan concentrates upon PM- 10 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) the District is required to implement Best Available Control Measures (BACM) in order to meet established deadlines set for complying with PM- 10 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 has developed its own *Smoke Management Plan* for regulating fire use projects 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 quarterly 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 plus actively pursues completion of a memorandum of understanding (MOU) between the District and the eight state and federal agencies that conduct prescribed burning or manage fire use projects within the air basin. The MOU will establish a cooperative relationship between the wildland burners and provide a framework to interact with the District on air quality issues.

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 plan while treating up to 15,000 acres per year of park land. As natural areas are treated and maintained with prescribed fire, fire use projects, 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 fire use projects. 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- 450. 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 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. The District was declared a serious non-attainment area for PM10 in 1993. Park fire staff, along with representatives from several land management agencies, worked closely with the District in development of the 1994 Serious Non- attainment Area PM10 Plan. The PM10 Plan called for the implementation of BACM for particulates via an earlier MOU and accompanying work plan signed by the park in 1997.

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 fire use projects within the District area. The District then declared the 1997 MOU and its work plan void following the rule revisions in 2001. Wildland burners in the air basin subsequently restated their desire to revisit and recreate an MOU as a method to insure coordination amongst burners with the District. That MOU is now in development. Upon completion, it will become an Addendum to the parks' *Fire and Fuels Management Plan*.

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

A permanent particulate monitor is stationed 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 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. Seven years of data now exist in the database.

The park has been visually monitoring the impact of transport smoke that flows over the eastern crest into the Owens Valley via the Inyo National Forest since 1996. A catalogue of visibility photos taken looking west towards the Sierra crest for each date in fire season exists on file at Ash Mountain fire management headquarters.

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 annual fuels treatment plan to the 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 Treatment Plan*, it does provide input to the individual prescribed fire burn plan. Air quality concerns remain the major issue affecting prescribed fire treatment.

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

- **Complete the District smoke management plan and submit with the burn plan.** The District uses their smoke management plan to permit burns. The smoke management plan for the burn can reference the burn plan. 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.

- **Request pre- ignition forecast.** No more than seven days prior to the earliest ignition date, a request will be submitted to the District to begin long- range smoke dispersal forecasting for the proposed ignition (CB3 forecasts). 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 (litter/duff, 1- , 10- , 100- and 1000- hour 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 50 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 5 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. 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. This will be accomplished by visual observations on small fires, short duration fires (e.g. grass fires) and on remote wilderness fires. On fires in close proximity to SSA's, that may be of long duration or possess heavy fuel loading, monitoring will include equipment to measure particulate load production, collect 24 hour weather data, and document visibility conditions through photography.

- **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 6 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- fire 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.
- Release of PIBAL balloons may be used to determine surface and low level wind speed and direction before and during burn ignition and burn down.
- 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 acres, complete District smoke management plan post fire summary report.**

- **By May of following year, pay District $5.00/acre for all black acres produced on burn.**

Staffing Needs and Responsibilities

The District fire management officers are responsible for the implementation of the annual fuels treatment program within their respective areas. Working with the park fuels specialist, district fire management officers will assign burn bosses to individual burn units, who must ensure appropriate staff is assigned to each burn. District fire management officers will ensure coordination occurs between the District and the burn boss. Fire and aviation dispatch will track all CB3 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 specialists 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 DI- 1202. All expenditures will be tracked and reported according to the standards established in the Department of the Interior Individual Fire Occurrence Form (DI- 1202). It is the responsibility of the district fire management officer, or his/her burn boss, to ensure fire report completion. Acres blackened rather than fire perimeter will be used to assess District Burn fees.

WILDLAND FIRE USE

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 WFIP Stage I analysis** to determine the appropriate management response with two hours of fire confirmation. Share stage 1 with the District.

- **Decision criteria and risk factors to consider** in the stage I analysis are outlined in Chapter 4 of the Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide (Addendum). 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 as a fire use project.

- **Receive approval from the District** to manage the fire as a fire use project on the day ignition is confirmed.

- **Implement the appropriate management response**. For fire use projects 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 fire use incident management team (see Appendix K for a delegation of authority example).

- **For fires exceeding 10 acres, complete the District smoke management plan.** This plan is the same as outlined for prescribed burns. Typically, the District receives a Stage II WFIP and the smoke management plan at the same time. Most often, smoke management plans are not needed for those fires requiring only a Stage I WFIP 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 Stage II or III WFIP analysis, or for conversion of the fire use project to a wildland fire suppression action. If air quality drives the need for Stage II or III analysis, detailed information on mitigation for air quality effects will be contained in the WFIP, and cross referenced to the smoke management plan for the fire use project.

- **Manage the fire until declare dead out** according to monitoring intensity and frequency guidelines indicated in the WFIP. At the minimum, periodic ground or aerial reconnaissance will be used to verify the periodic revalidation of the fire use 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 acres, complete District smoke management plan post fire summary report.**

- **By May of following year, pay District $5.00/acre for all black acres produced on burn.**

Staffing Needs and Responsibilities

Stage I through III analyses will be completed by district fire management officers or their designates (park fire management officer or fuels specialist staff) with input from the park fire planner or his/her designate. 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 (burn plan and any amendments, smoke management plan, incident action plans), monitoring data and summary reports, fire time reports, maps, photos, and DI- 1202. All expenditures will be tracked and reported according to the standards established in the Department of the Interior Individual Fire Occurrence Form (DI- 1202). It is the responsibility of the district fire management officer, or his/her burn boss 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 document 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 and approved by the Superintendent.

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. Many 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 fire use projects. 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 fire management officer or his designate.

- Prescribed Fire Burn Boss - is responsible for on the ground execution of individual prescribed burns. May be supervised by the Prescribed Fire Manager or district fire management officer (if prescribed fire manager is not needed).

- Prescribed Fire Ignition Specialist - 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.

- Fire Use Manager - oversees fire use program implementation and is supervised by the district fire management officer or his designate.

- Incident Commander - is responsible for on the ground execution of individual fire use projects. May be supervised by the Fire Use Manager or district fire management officer (if fire use 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 Smoke Sensitive Areas 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 state- of- the- art mobile monitor called the Smoke and Weather Monitoring Module when indicated. When used the module is set- up in Smoke Sensitive Areas during nearby burn unit execution. The module records particulate and carbon monoxide concentrations, weather conditions and visibility with a time lapse camera. Park fire staff have a second mobile particulate monitor and several mobile automated weather stations. 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. The park has been visually monitoring the impact of transport smoke that flows over the eastern crest into the Owens Valley region with the US Forest Service since 1996.

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. A follow up submittal will be required by the District within 10 days after the initial notification before additional prescribed burn units can be executed.

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 that are executed during the previous season. PFIRS may tract 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: October 2, 2003

Memorandum

To: Wayne Cook, Incident Commander

From: Superintendent, Sequoia and Kings Canyon National Parks

Subject: Kaweah Kern Complex 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 Office of Aircraft Services 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:

1. You will have management responsibility for the following wildland fire use and suppression fires: Paradise 2 (containment action), Homers Nose 2 (containment action), Slide Bluffs, Frypan, Williams, West Clover, Giant, East Fork, West Kern, and Soda Springs fire use fires. Stage 3 wildland fire implementation plans have been prepared for the Williams, West Kern, and Giant fires. Stage 1 and 2 analyses have been prepared for the remaining fire use fires. Wildland fire situation analyses have also been prepared for Paradise 2 and Homers Nose 2. These documents will serve as guidance for management actions.

2. 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 the following area closures and trail closures in effect: Coyote Creek trail from the Kern Canyon Ranger Station west to the park boundary. Numerous trails in Giant Forest. An area closure surrounding the Williams Fire inclusive of 3 trails. The Sequoia Park and Kings Canyon district rangers are charged with trails management. They will be consulted regarding changes to trail closures.

3. 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).

4. The West Kern fire is very near the Kern River Ranger Station. Special consideration must be given to the safety and protection of the backcountry ranger and two additional people living at the cabin, the nearby private property on the Inyo National Forest, and cultural resources in the area. Please follow the pre- planned *Kern Structure Protection Plan*. This plan was approved by SEKI fire management, and SEKI cultural resource advisors.

5. The Giant fire is in Sequoia National Park's Giant Forest. Special consideration must be given to the safety and protection of visitors to the Giant Forest area given the high rates of visitor use. Please refrain from helicopter overflights of the fire unless aggressive holding actions are required to limit fire spread. Also, trees of special significance, such as the Washington tree are in the fire's perimeter. Consult with the agency representative regarding appropriate actions adjacent to such trees.

6. Work with park public information staffs 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, excellent educational opportunities exist on the Giant Fire. Please work with the parks' fire information and education specialist to ensure these opportunities are met.

7. The remote nature of many of the fires coupled with economic efficiency has led to spike camps. Please see that the assigned resources are dispersed in order to minimize impacts to natural and cultural resources. Proper food storage procedures must be followed at all backcountry locations due to black bear activity.

8. Manage costs commensurate with resource values affected.

9. All of the fires are 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.

10. The Ash Mountain conference room will serve as your ICP location. Helicopter operations can be managed out of the Ash Mountain helibase or nearby private property with the input of the parks' agency representative.

11. All press releases will be coordinated and reviewed by the Agency Representative for Sequoia and Kings Canyon National Parks.

12. The parks retain initial attack and fire size up responsibilities. We will keep you fully informed of our fire response, especially for those fires located within maximum manageable areas you are managing for the parks so that employee safety is not compromised. Should initial attack actions fail, we will consult you on extended attack.

13. Many of our personnel are assigned to the complex. Please work with the Agency Representative on coordinating use of park resources for the benefit of our initial attack success and for trainee opportunities for our employees.

SEKI Park Contacts:

- **Agency Representative** – David Allen, Sequoia District Fire Management Officer
  (559) 565- 3162.
- **Resource Advisor** – Tony Caprio, Natural Resources Specialist
  (559) 565- 3126
- **Cultural Resource Advisor** – Tom Burge, Cultural Resource Specialist
  (559) 565- 3139
- **Fire Information** – Jody Lyle, Fire Information and Education Specialist,
  (559) 565- 3703

As of 1800 on October 2, 2003, we are delegating to you the authority to manage the Kaweah Kern Complex. This delegation will remain in effect until the parks receive a return memorandum from you turning authority for management of the fires back to the park.

Richard H. Martin, 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 three- year currency requirements? Yes No

Have all crew members passed the annual pack test? Yes No

Comments:
____
____
____

I have reviewed the crew's qualifications and certify the crew is available for wildland fire assignment.

Reviewed by: __________________________________ Date: __________________
Crew Leader

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

A. 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.

B. To provide park administrative staff with a procedure for making emergency closures for fire prevention and public safety reasons.

C. 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—California Department of Forestry.						
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

1. Foothills annual grass has cured to about the 6,000- foot level for all exposures.
2. Fire restrictions for adjoining National Forests are in effect.
3. 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, 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)

1. Fire restrictions for adjoining National Forests are in effect.
2. National Fire Danger Rating Staffing Class for any Park fire weather station is four or five.
3. 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 Fire Management Officer will coordinate the posting of the signs with Sub- District Rangers.

Fire Restrictions for Sequoia & Kings Canyon National Parks

Table M-1 – Fire Restrictions for Sequoia & Kings Canyon National Parks

Stage Level	Designated Campgrounds	Designated Picnic Areas	Backcountry Travel	Smoking
Stage 1 **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 **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, building, or in 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.

__________________________ _________________
Date

Park Superintendent
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 the slash piles.

Number of Piles: _________________ Approximate total cubic footage: ____________________

Burning shall be confined to the hours between sunrise and sunset. This permit is valid during the period

____________________________________ to ____ .

This permit is subject to the following terms and conditions.

1. 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 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.

2. 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.

3. 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).

4. 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.

5. The fire shall be attended at all times by at least one prudent and responsible person who will maintain control of the fire.

6. 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.

7. 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 - Template for Prescribed Fire Burn Plan and Example of Mechanical Treatment Plan

USDI National Park Service
Sequoia and Kings Canyon National Parks

Prescribed Burn Plan

BURN NAME

Prepared by: ______________________________Date: _______

Technical Reviewer: ________________________Date: _______

Recommended by: ___________________________Date: _______
District Fire Management Officer

Recommended by: ___________________________Date: _______
Park Fire Management Officer

Recommended by: ___________________________Date: _______
Chief Ranger

Recommended by: ___________________________Date: _______
Environmental Specialist

Recommended by: ___________________________Date: _______
Chief, Science and Resources Management

Recommended by: ___________________________Date: _______
Chief, Cultural Resources and Interpretation

Approved by: ______________________________Date: _______
Park Superintendent

For information about this burn unit contact:
Fire Management Office 559- 565- 3164/3165
FAX 559- 565- 3797
24 Hour Park Dispatch 559- 565- 3341

EXECUTIVE SUMMARY

Goals and Objectives

Goal #1 –

Objective -

BURN UNIT DESCRIPTION

A. General Area Description:

B. Location:
County –
Range , Township , section
UTM Zone , Easting , Northing (approximate mid point of the segment)
Longitude, Latitude (approximate mid point of the segment)

C. Fire Management Zone , Area , Unit (1984 and 1992 FMP revision)

D. Size:

E. Elevation Range:

F. Slope Range:

G. Aspect Range:

H. Description of Holding Boundaries:

I. Designated / Proposed / Recommended Wilderness? yes no

J. Vegetation Type and Fuel Loading Description:

Vegetation Includes:

Vegetation Type	Fuel Model NFFL	Estimated Acres	Estimated Tons Per Acre

Total Estimated Project Tons:

J. Project Maps - Vicinity, Project, Fuels and Vegetation Maps are attached

PROJECT COMPLEXITY

A. Hot End:

B. Cool End:

BURN ORGANIZATION

A. Hot End

- Prescribed Burn Boss:
- Safety Officer:
- Fire Information Officer:
- Lead Prescribed Fire Monitor:
- Prescribed Fire Ignition Specialist:
- Firing Team:
- Holding Supervision:
- Ignition/Holding Crews/Equipment:
- Slopover Containment Worksheet Resource Needs:

B. Cool End

- Prescribed Burn Boss:
- Safety Officer:
- Fire Information Officer:
- Lead Prescribed Fire Monitor:
- Prescribed Fire Ignition Specialist:
- Firing Team:
- Holding Supervision:
- Ignition/Holding Crews/Equipment:
- Slopover Containment Worksheet Resource Needs:

ESTIMATED COSTS

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:

SCHEDULING

A. Hot End

- Proposed Ignition Period:
- Expected Burn Duration:
- Note any dates when the burn may not be run during the proposed window:

B. Cool End

- Proposed Ignition Period:
- Expected Burn Duration:
- **Note any dates when the burn may not be run during the proposed window:**

PRE-BURN PLANNING AND PREPARATION CONSIDERATIONS

A. On Site: (for logistics, ensure discussion of minimum requirement / minimum tool):

B. Off site:

BURNING PRESCRIPTION
FUEL MODEL NFFL 1 - ANNUAL GRASS *

Head Fire

Environmental Conditions
Air Temperature: 30- 90 F
Relative Humidity: 20- 80%
Wind Speed (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 30%
1- Hour Time Lag: 5- 10% (MFWS 0- 2)
10- Hour Time Lag: N/A
100- Hour Time Lag: N/A
1000- Hour Time Lag: N/A
Live: N/A

Fire Behavior Outputs
Scorch Height: N/A
Rate of Spread: 2- 35 chains per hour
Flame Length: 0- 4 ft.
Heat per Unit Area: 55- 95 BTU per square foot

Fireline Intensity: 3- 60 BTU per foot per second

Prescribed Head Fire Matrix for Flame Length (feet) / Rate Of Spread (Chains/hour)			
1 Hour Fuel Moisture	5%	7%	9%
MFWS = 0	2.3 / 20.8	2.2 / 18.6	1.8 / 14.7
MFWS = 1	2.5 / 24.2	2.3 / 21.6	1.9 / 17.1
MFWS = 2	2.9 / 35.0	2.7 / 31.2	2.3 / 24.7

Backing Fire (wind upslope)

Environmental Conditions
Air Temperature: 30- 90 F
Relative Humidity: 20- 80%
Wind Speed: (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 100%
1- Hour Time Lag: 3- 4% (MFWS 0- 4) / 5- 10% (MFWS 0- 2)
10- Hour Time Lag: N/A
100- Hour Time Lag: N/A
1000- Hour Time Lag: N/A
Live: N/A

Fire Behavior Outputs
Scorch Height: N/A
Rate of Spread: 2- 8 chains per hour
Flame Length: .5- 2'
Heat per Unit Area: 100- 110 BTU per square foot
Fireline Intensity: 4- 15 BTU per foot per second

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).

BURNING PRESCRIPTION
FUEL MODEL NFFL 2 - GRASS WITH OVERSTORY *

Head Fire

Environmental Conditions
Air Temperature: 30- 90 F
Relative Humidity: 20- 80%
Wind Speed (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 30%
1- Hour Time Lag: 6- 11% (MFWS 0- 2) / 12- 13% (MFWS 0- 6)
10- Hour Time Lag: 7- 12% (MFWS 0- 2) / 13- 14% (MFWS 0- 6) / 15- 16% (MFWS 0- 10)
100- Hour Time Lag: 8- 13% (MFWS 0- 2) / 14- 15% (MFWS 0- 6) / 16- 17% (MFWS 0- 10)
1000- Hour Time Lag: N/A
Live Foliage Moisture: 50- 100%

Fire Behavior Outputs
Scorch Height: 0- 30'
Rate of Spread: 1- 16 chains per hour
Flame Length: .5- 4 ft.
Heat per Unit Area: 255- 495 BTU per square foot
Fireline Intensity: 4- 145 BTU per foot per second

Prescribed Head Fire Matrix for Flame Length (feet) / Rate Of Spread (Chains/hour)			
1 Hour Fuel Moisture	6%	9%	12%
MFWS = 0	3.3 / 8.7	3.1 / 7.6	2.4 / 5.5
MFWS = 2	4.4 / 16.1	4.1 / 14.1	3.1 / 10.2
MFWS = 6	*8.4 / 64.0	*7.7 / 55.8	*5.9 / 40.4

* Out of prescription

Backing Fire (wind upslope)

Environmental Conditions
Air Temperature: 30- 90 F
Relative Humidity: 20- 80%
Wind Speed: (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 100%
1- Hour Time Lag: 4- 9% (MFWS 0- 4) / 10- 13% (MFWS 0- 2)
10- Hour Time Lag: 5- 10% (MFWS 0- 4) / 11- 14 (MFWS 0- 2)
100- Hour Time Lag: 6- 11% (MFWS 0- 4) / 12- 15% (MFWS 0- 2)
1000- Hour Time Lag: N/A
Live Foliage Moisture: 50- 100%

Fire Behavior Outputs
Scorch Height: 0- 30'
Rate of Spread: 1- 3 chains per hour
Flame Length: .5- 2.5'
Heat per Unit Area: 255- 525 BTU per square foot
Fireline Intensity: 4- 30 BTU per foot per second

* 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).

BURNING PRESCRIPTION
FUEL MODEL NFFL 4 - TALL BRUSH (CHAMISE & MANZANITA) *

Head Fire

Environmental Conditions
Air Temperature: 30- 85 F
Relative Humidity: 20- 80%

Wind Speed (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 45%
1- Hour Time Lag: 5- 9% (MFWS 0- 4) / 10- 12% (MFWS 0- 8)
10- Hour Time Lag: 6- 10% (MFWS 0- 4) / 11- 13% (MFWS 0- 8)
100- Hour Time Lag: 7- 11% (MFWS 0- 4) / 12- 14% (MFWS 0- 8)
1000- Hour Time Lag: N/A
Live Foliage Moisture: 50- 150%

Fire Behavior Outputs
Scorch Height: N/A
Rate of Spread: 2- 120 chains per hour
Flame Length: 3- 25'
Heat per Unit Area: 1570- 2910 BTU per square foot
Fireline Intensity: 50- 6330 BTU per foot per second

Prescribed Head Fire Matrix for Flame Length (feet) / Rate Of Spread (Chains / hour)			
1 Hour Fuel Moisture	5%	9%	12%
MFWS = 0	12.3 / 24.3	10.9 / 20.8	10.0 / 18.7
MFWS = 4	24.8 / 111.4	22.0 / 95.4	20.2 / 85.6
MFWS = 8	* 36.5 / 257.3	* 32.3 / 220.4	* 29.7 / 197.7

* Out of 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).

BURNING PRESCRIPTION
FUEL MODEL NFFL 5 - LOW BRUSH **

Head Fire

Environmental Conditions
Air Temperature: 30- 80 F
Relative Humidity: 20- 80%
Wind Speed (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 35%
1- Hour Time Lag: 5- 7% (MFWS 0- 2) / 8- 12% (MFWS 2- 8) with live fuel moisture of 100- 150%
10- Hour Time Lag: 6- 12% (MFWS 0- 2) / 9- 13% (MFWS 0- 8) with live fuel moisture of 100- 150%
100- Hour Time Lag: N/A
1000- Hour Time Lag: N/A
Live Foliage Moisture: 70- 150%

Fire Behavior Outputs
Scorch Height: N/A
Rate of Spread: 2- 17 chains per hour

Flame Length: 1- 5'
Heat per Unit Area: 215- 715 BTU per square foot
Fireline Intensity: 7- 221 BTU per foot per second

Prescribed Head Fire Matrix for Flame Length (feet) / Rate Of Spread (Chains/hour)			
1 Hour Fuel Moisture	5%	7%	12%
MFWS = 0	3.8 / 7.8	3.6 / 7.3	1.2 / 2.3
MFWS = 2	5.4 / 16.9	5.1 / 15.9	1.8 / 5.0
MFWS = 8	* 10.4 / 70.8	* 9.9 / 66.7	* 3.4 / 20.8

* Out of 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).

BURNING PRESCRIPTION
FUEL MODEL NFFL 8 - CLOSED TIMBER, SHORT NEEDLE CONIFER *

Head Fire

Environmental Conditions
Air Temperature: 30- 85 F
Relative Humidity: 20- 80%
Wind Speed (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 60%
1- Hour Time Lag: 3- 10% (MFWS 0- 10)
10- Hour Time Lag: 4- 11% (MFWS 0- 10)
100- Hour Time Lag: 5- 12% (MFWS 0- 10)
1000- Hour Time Lag: 10- 40%
Live Foliage Moisture: N/A

Fire Behavior Outputs
Scorch Height: 0- 30'
Rate of Spread: 0- 8 chains per hour
Flame Length: 0- 2.5'
Heat per Unit Area: 165- 225 BTU per square foot
Fireline Intensity: 1- 35 BTU per foot per second

Prescribed Head Fire Matrix for Flame Length (feet) / Rate Of Spread (Chains/hour)			
1 Hour Fuel Moisture	3%	7%	10%
MFWS = 0	1.2 / 2.0	0.9 / 1.3	0.8 / 1.1
MFWS = 5	1.7 / 4.3	1.3 / 3.0	1.1 / 2.5
MFWS = 10	2.3 / 8.4	1.5 / 4.2	1.3 / 3.1

* 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).

BURNING PRESCRIPTION
FUEL MODEL NFFL 9 - BROADLEAF DECIDUOUS HARDWOODS AND LONG NEEDLE PINE **

Head Fire

Environmental Conditions
Air Temperature: 30- 85 F
Relative Humidity: 20- 80%
Wind Speed (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 45%
1- Hour Time Lag: 5- 7% (MFWS 0- 6) / 8- 12% (MFWS 0- 8)
10- Hour Time Lag: 6- 8% (MFWS 0- 6) / 9- 13% (MFWS 0- 8)
100- Hour Time Lag: 7- 9% (MFWS 0- 6) / 10- 14% (MFWS 0- 8)
1000- Hour Time Lag: 10- 40%
Live Foliage Moisture: N\A

Fire Behavior Outputs
Scorch Height: 0- 30'
Rate of Spread: 1- 18 chains per hour
Flame Length: 1- 4 ft.
Heat per Unit Area: 320- 390 BTU per square foot
Fireline Intensity: 4- 120 BTU per foot per second

Prescribed Head Fire Matrix for Flame Length (feet) / Rate Of Spread (Chains/hour)			
1 Hour Fuel Moisture	5%	7%	12%
MFWS = 2	2.5 / 5.7	2.2 / 4.8	1.9 / 3.7
MFWS = 5	3.6 / 12.5	3.2 / 10.6	2.7 / 8.3
MFWS = 8	* 4.7 / 23.3	* 4.2 / 19.7	3.6 / 15.4

* Out of prescription

Backing Fire (wind upslope)

Environmental Conditions
Air Temperature: 30- 85 F
Relative Humidity: 20- 80%
Wind Speed: (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 100%
1- Hour Time Lag: 3- 10% (MFWS 0- 4)
10- Hour Time Lag: 4- 11% (MFWS 0- 4)

100- Hour Time Lag: 5- 12% (MFWS 0- 4)
1000- Hour Time Lag: 10- 40%
Live Foliage Moisture: N\A

Fire Behavior Outputs
Scorch Height: 0- 30'
Rate of Spread: 0- 1 chains per hour
Flame Length: .5- 3'
Heat per Unit Area: 350- 450 BTU per square foot
Fireline Intensity: 4- 60 BTU per foot per second

** 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).

BURNING PRESCRIPTION
FUEL MODEL NFFL 10 - TIMBER LITTER *

Head Fire

Environmental Conditions
Air Temperature: 30- 75 F
Relative Humidity: 20- 80%
Wind Speed (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 45%
1- Hour Time Lag: 5- 7% (MFWS 0- 6), 8- 12% (MFWS 0- 8)
10- Hour Time Lag: 6- 8% (MFWS 0- 6), 9- 13% (MFWS 0- 8)
100- Hour Time Lag: 7- 9% (MFWS 0- 6), 10- 14% (MFWS 0- 8)
1000- Hour Time Lag: 10- 40%
Live Foliage Moisture: N\A

Fire Behavior Outputs
Scorch Height: 0- 30'**
Rate of Spread: 1- 18 chains per hour
Flame Length: 1- 4 ft.
Heat per Unit Area: 320- 390 BTU per square foot
Fireline Intensity: 4- 120 BTU per foot per second

Prescribed Head Fire Matrix for Flame Length (feet) / Rate Of Spread (Chains/hour)			
1 Hour Fuel Moisture	5%	7%	12%
MFWS = 2	5.5 / 9.0	5.2 / 8.2	4.6 / 6.9
MFWS = 6	8.3 / 21.4	7.7 / 19.5	6.9 / 16.6
MFWS = 8	9.6 / 29.4	8.9 / 26.8	7.9 / 22.7

Backing Fire (wind upslope)

Environmental Conditions
Air Temperature: 30- 85 F
Relative Humidity: 20- 80%
Wind Speed: (midflame - MFWS) see combinations with fine fuel moisture below
Slope: 0- 100%
1- Hour Time Lag: 3- 10% (MFWS 0- 4)
10- Hour Time Lag: 4- 11% (MFWS 0- 4)
100- Hour Time Lag: 5- 12% (MFWS 0- 4)
1000- Hour Time Lag: 10- 40%
Live Foliage Moisture: N\A

Fire Behavior Outputs
Scorch Height: 0- 30'
Rate of Spread: 0- 1 chains per hour
Flame Length: .5- 3'
Heat per Unit Area: 350- 450
Fireline Intensity: 4- 60

* 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).

FIRING AND HOLDING PLAN

A. Test Fire Procedure:

B. Firing Procedure

- Hot End:
- Cool End:
- Describe actions to be taken if burning prescriptions are exceeded on the hot end:
- Will aerial ignition be used? (Ensure minimum requirement / minimum tool is addressed)

C. Holding Procedure

- Hot End:
- Cool End:
- Describe actions to be taken if burning prescriptions are exceeded on the cool end.:

D. Slop- over Containment Procedure

- Potential Slope- over Area(s):
- Critical Holding Area(s):
- Slopover Containment Resource Needs:
- Initial Slopover Notification Procedure:

SMOKE MANAGEMENT AND AIR QUALITY

Smoke Emissions

A. Estimated Smoke Emissions Period:

B. Estimated Smoke Emissions:

Estimated PM- 10 Emissions

Fuel Type	Total Burn Unit Estimated Emissions
NFFL 1 – annual grass	19 pounds/acre x acres burned = pounds
NFFL 2 – grass with overstory	42 pounds/acre x acres burned = pounds
NFFL 4 – tall brush (chamise and manzanita)	322 pounds/acre x acres burned = pounds
NFFL 5 – low brush	70 pounds/acre x acres burned = pounds
NFFL 8 – closed timber, short needle conifer	258 pounds/acre x acres burned = pounds
NFFL 9 – broadleaf deciduous hardwoods and long needle pine	1,293 pounds/acre x acres burned = pounds
NFFL 10 – timber litter	1,650 pounds/acre x acres burned = pounds
SEKI Custom 14 low elevation short needle conifer	1,321pounds/acre x acres burned = pounds
SEKI Custom 18 high elevation short needle conifer	1,251pounds/acre x acres burned = pounds

Total Estimated PM- 10 Emissions: pounds.

Estimated CO Emissions

Fuel Type	Total Burn Unit Estimated Emissions
NFFL 1 – annual grass	184 pounds/acre x acres burned = pounds
NFFL 2 – grass with overstory	302 pounds/acre x acres burned = pounds
NFFL 4 – tall brush (chamise and manzanita)	3,196 pounds/acre x acres burned = pounds
NFFL 5 – low brush	698 pounds/acre x acres burned = pounds
NFFL 8 – closed timber, short needle	2,332 pounds/acre x acres burned = pounds
NFFL 9 – broadleaf deciduous hardwoods and long needle pine	11,816 pounds/acre x acres burned = pounds
NFFL 10 – timber litter	15,800 pounds/acre x acres burned = pounds
SEKI Custom 14 low elevation short needle conifer	12,625 pounds/acre x acres burned = pounds
SEKI Custom 18 high elevation short needle conifer	11,950 pounds/acre x acres burned = pounds

Total Estimated CO Emissions: pounds

* Estimated emissions based on FOFEM calculations using park average fuel loadings and average prescription conditions- - fuel moisture and consumption (2001).

Smoke Sensitive Areas

(attach map showing smoke sensitive areas with in 15 miles of the burn unit and show day time and night time estimated smoke plume directions)

A. Smoke Sensitive Areas Within 15 Miles of Burn Unit:

Smoke Sensitive Area	Distance From Burn Unit	Compass Direction From Burn Unit (SW, N, etc.)	Population	Critical Receptors - schools - retirement communities - general hospitals

B. Estimated Smoke Impact to Smoke Sensitive Areas:

- 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:

Smoke Monitoring

A. Type and Interval of Monitoring:

B. Smoke Sensitive Area Health Impacts Monitoring:

Burn Day Regulation

A. Burn Day Notice Procedure:

Roadway Safety

Minimum acceptable visibility and speed limits, or traffic control, for all public roadways will be enforced by speed limit signs or traffic controllers. <u>Any compromised roadway conditions should be relayed to the Burn Boss immediately, day or night, on shift or off shift.</u>

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

ESCAPED FIRE AND SMOKE CONTINGENCY TRANSITION PLANNING

A. Transition to Wildland Fire Planning Process:

B. Smoke Contingency - Mitigation of Smoke Impacts to Smoke Sensitive Areas based on information described in the Smoke Management and Air Quality section

- Notification and Coordination with Impacted Air District Procedure:

- Logging of Smoke Complaints Procedure:

- Community Outreach Procedure:

- Media Contact Procedure:

- Smoke Impact Reduction Procedure:

- Transition to Wildland Fire Planning Process:

PROTECTION OF SENSITIVE FEATURES

A. Identification and Protection of Sensitive Species Procedure:

C. Cultural Clearance Procedure:

D. Wilderness Minimum Tool Analysis

E. Trees of Special Interest / Special Management Areas

PUBLIC AND FIRE PERSONNEL SAFETY

A. Public Safety Procedure

- Fire Hazards:

B. Fire Personnel Safety Procedure

- Fire Hazards:

- Unhealthy Smoke:

C. First Aid and MEDIVAC Procedure:

INTERAGENCY/INTRAGENCY COORDINATION AND PUBLIC INVOLVEMENT

A. Employee and Public Information Outreach Procedure:

B. Fire Dispatch Situation Update Procedure:

MONITORING AND EVALUATION

A. Fuels:

B. Weather:

C. Fire Behavior:

D. Smoke Behavior:

E. Fire Effects:

REHABILITATION

A. Rehabilitation Procedure:

DOCUMENTATION

ATTACHMENTS

- Wildland and Prescribed Fire Complexity Rating Worksheet
- Wildland and Prescribed Fire Complexity Rating Worksheet Numeric Rating Guide
- Park Superintendent Go/No- Go Pre- Ignition Approval
- Briefing Guide
- Burn Plan Execution Go/No Go Checklist
- Slopover Containment Resource Needs Worksheet
- Burn Plan Technical Review
- Park Review Comments
- Cultural Resources Clearance.
- Wilderness and Backcountry Minimum Tool Analysis
- Vicinity Map.
- 7.5 minute project topographic map (original) showing geographic organizational lay- out using ICS map symbols and terminology, and shows critical holding areas and values at risk inside and outside the burn segment area.
- 7.5 minute project vegetation map.
- 7.5 minute project fuels map.

WILDLAND AND PRESCRIBED FIRE COMPLEXITY RATING WORKSHEET

Complexity element	Weighting factor	Complexity value	Total points
Safety	5		
Threats to boundaries	5		
Fuels and fire behavior	5		
Objectives	4		
Management organization	4		
Improvements	3		
Natural, cultural, social values	3		
Air quality values	3		
Logistics	3		
Political concerns	2		
Tactical operations	2		
Interagency coordination	1		
Total complexity points			
Complexity Rating (circle)	L	M	H

Complexity Value Breakpoints:

Low 40–90 – ***Burn Boss 2 Required***
Moderate 91–140 – ***Burn Boss 2 Required***
High 141– 200 – ***Burn Boss 1 and Safety Officer Required***

The Wildland and Prescribed Fire Complexity Analysis provides a method to assess the complexity of both wildland and prescribed fires. The analysis incorporates an assigned numeric rating complexity value for specific complexity elements that are weighted in their contribution to overall complexity. The weighted value is multiplied times the numeric rating value to provide a value for that item. Then all values are added to generate the total complexity value. Breakpoint values are provided for low, moderate, and high complexity values. **Only use Complexity Values 1, 3 or 5 – no even numbers allowed.**

The complexity analysis worksheet is accompanied by a guide to numeric values for each complexity element shown, provided on the following pages.

WILDLAND AND PRESCRIBED FIRE
COMPLEXITY RATING WORKSHEET
NUMERIC RATING GUIDE

COMPLEXITY ELEMENT	**GUIDE TO NUMERIC RATING**		
	1	**3**	**5**
Safety	Safety issues are easily identifiable and mitigated	Number of significant issues have been identified All safety hazards have been identified on the LCES worksheet and mitigated	SOF1 or SOF2 required Complex safety issues exist
Threats to Boundaries	Low threat to boundaries POI<50% Boundaries naturally defensible	Moderate threat to boundaries 50<POI<70% Moderate risk of slopover or spot fires Boundaries need mitigation actions for support to strengthen fuel breaks, lines, etc.	High threat to boundaries POI>70% High risk of slopover or spot fires Mitigation actions necessary to compensate for continuous fuels
Fuels/Fire Behavior	Low variability in slope & aspect Weather uniform and predictable Surface fuels (grass, needles) only Grass/shrub, or early seral forest communities Short duration fire No drought indicated	Moderate variability in slope & aspect Weather variable but predictable Ladder fuels and torching Fuel types/loads variable Dense, tall shrub or mid-seral forest communities Moderate duration fire Drought index indicates normal conditions to moderate drought; expected to worsen	High variability in slope & aspect Weather variable and difficult to predict Extreme fire behavior Fuel types/loads highly variable Late seral forest communities or long-return interval fire regimes Altered fire regime, hazardous fuel /stand density conditions Potentially long duration fire Drought index indicates severe drought; expected to continue

COMPLEXITY ELEMENT	GUIDE TO NUMERIC RATING		
	1	**3**	**5**
Objectives	Maintenance objectives Prescriptions broad Easily achieved objectives	Restoration objectives Reduction of both live and dead fuels Moderate to substantial changes in two or more strata of vegetation Objectives judged to be moderately hard to achieve Objectives may require moderately intense fire behavior	Restoration objectives in altered fuel situations Precise treatment of fuels and multiple ecological objectives Major change in the structure of 2 or more vegetative strata Conflicts between objectives and constraints Requires a high intensity fire or a combination of fire intensities that is difficult to achieve
Management Organization	Span of control held to 3 Single resource incident or project	Span of control held to 4 Multiple resource incident or project Short-term commitment of specialized resources	Span of control greater than 4 Multiple branch, divisions or groups Specialized resources needed to accomplish objectives Organized management team (FUMT, IMT)
Improvements to be Protected	No risk to people or property within or adjacent to fire	Several values to be protected Mitigation through planning and/or preparations is adequate May require some commitment of specialized resources	Numerous values and/or high values to be protected Severe damage likely without significant commitment of specialized resources with appropriate skill levels
Natural, Cultural, and Social Values to be Protected	No risk to natural, cultural, and/or social resources within or adjacent to fire	Several values to be protected Mitigation through planning and/or preparations is adequate May require some commitment of specialized resources	Numerous values and/or high values to be protected Severe damage likely without significant commitment of specialized resources with appropriate skill levels

COMPLEXITY ELEMENT	GUIDE TO NUMERIC RATING		
	1	**3**	**5**
Air Quality Values to be Protected	Few smoke sensitive areas near fire Smoke produced for less than 1 burning period Air quality agencies generally require only initial notification and/or permitting No potential for scheduling conflicts with cooperators	Multiple smoke sensitive areas, but smoke impact mitigated in plan Smoke produced for 2-4 burning periods Daily burning bans are sometimes enacted during the burn season Infrequent consultation with air quality agencies is needed Low potential for scheduling conflicts with cooperators	Multiple smoke sensitive areas with complex mitigation actions required Health or visibility complaints likely Smoke produced for greater than 4 burning periods Multi-day burning bans are often enacted during the burn season Smoke sensitive class 1 airsheds Violation of state and federal health standards possible Frequent consultation with air quality agencies is needed High potential for scheduling conflicts with cooperators
Logistics	Easy access Duration of fire support is less than 4 days	Difficult access Duration of fire support between 4 and 10 days Logistical position assigned Anticipated difficulty in obtaining resources	No vehicle access Duration of support is greater than 10 days Multiple logistical positions assigned Remote camps and support necessary
Political Concerns	No impact on neighbors or visitors No controversy No media interest	Some impact on neighbors or visitors Some controversy, but mitigated Press release issued, but no media activity during operations	High impact on neighbors or visitors High internal or external interest and concern Media present during operations

COMPLEXITY ELEMENT	GUIDE TO NUMERIC RATING		
	1	**3**	**5**
Tactical Operations	No ignition or simple ignition patterns Single ignition method used Holding requirements minimal	Multiple firing methods and/or sequences Use of specialized ignition methods (i.e. terra-torch, Premo Mark III) Resources required for up to one week Holding actions to check, direct, or delay fire spread	Complex firing patterns highly dependent upon local conditions Simultaneous use of multiple firing methods and/or sequences Simultaneous ground and aerial ignition Use of heli-torch Resources required for over 1 week Multiple mitigation actions at variable temporal and spatial points identified. Success of actions critical to accomplishment of objectives Aerial support for mitigation actions desirable/necessary
Interagency Coordination	Cooperators not involved in operations No concerns	Simple joint-jurisdiction fires Some competition for resources Some concerns	Complex multi-jurisdictional fires High competition for resources High concerns

PARK SUPERINTENDENT GO/NO GO PRE-IGNITION APPROVAL

____
Burn Plan Name

Instructions. The Superintendent's Go/No Go Pre- ignition Approval is the final management approval prior to execution of the prescribed burn and evaluates whether compliance requirements, prescribed fire plan elements, and internal and external notifications have been completed. This approval is for the initial execution of the prescribed burn. If ignition of the prescribed fire is not initiated prior to the expiration date determined by the Superintendent, a new one will be completed.

The answer to each of the following must be yes.

____ Is the prescribed burn plan up to date?

____ Is Risk Management in place?

____ Have all compliance requirements been completed?

____ Are all elements of the prescribed fire plan being met?

____ Have all internal and external notifications been made?

Recommended by: ___________________________ __________
Park Fire Management Officer Date

Approved by: __________________________ _________
Park Superintendent Date

Approval Expires: ____________
Date

BRIEFING GUIDE

A. Operational Objectives

B. Organizational Assignments

C. Incident Safety
- fire personnel safety procedure
  - fire hazards
  - unhealthy smoke
  - environmental hazards
  - LCES
- public safety procedure
  - fire hazards
  - unhealthy smoke
- first aid and MEDIVAC procedure

D. Incident Operations Strategy and Tactics
- prescription parameters
- test fire procedure
- firing procedure
- expected fire behavior
- holding procedure
- slop over containment procedure
- sensitive features
- weather forecast

E. Incident Communications
- radio frequencies
- radio use protocol
- available telephones and FAX
- fire dispatch situation update procedure

D. Incident Logistics
- equipment support procedure
- supplies support procedure
- food and water procedure
- sanitation facilities
- sleeping areas

E. Incident Finance/Administration
- personnel time keeping procedure
- compensation for injuries procedure
- damage to, or loss of equipment and supplies reporting procedure
- disposable supplies replacement procedure

F. Other:

G. Feedback

BURN PLAN EXECUTION GO/NO GO CHECKLIST

The answer to each of the following must be yes.

____ Burn plan is approved by park superintendent and distributed to key field supervisors.

____ Burn plan is approved by the local air district.

____ Park Superintendent Go/No Go Pre- ignition Approval is complete and current.

____ All personnel required in the IAP plan are on site.

____ All equipment and supplies required in the IAP are in position and working properly.

____ Employee and public information outreach is complete.

____ Fire monitoring is ready:
- fire weather observations
- fire behavior observations
- smoke observations
- fire effects plots/transects observations

____ IAP is distributed to overhead personnel.

____ All fire personnel have received a briefing.

____ All prescription parameters have been met:
- pre- burn preparation is complete
- smoke management is favorable
- burning prescription if favorable
- current and forecasted weather is favorable
- sensitive species review is complete
- cultural clearance is complete

____ Fire dispatch has made required notifications.

____ Contingency resources described in the plan have been committed and are available within the specified time- frames.

____ A significant test fire designed to establish fire control and smoke dispersal is ready to go.

____ Incident personnel are ready to enforce roadway speed limits or control traffic due to reduced visibility per Smoke Management and Air Quality.

____ There are no extenuating circumstances that preclude successful completion of this project.

All above elements must be yes in order to proceed with the test fire.

____ Test fire demonstrates that holding resources are able to safely implement holding tactics.

____ Fire behavior is within prescription and is expected to stay in prescription into the foreseeable future.

____ Test fire results indicate burn objectives will be met.

____
Burn Plan Name

______________________________	____________________________	_________	_____
Ignition Specialist Printed Name	Signature	Date	Time
______________________________	____________________________	_________	_____
Holding Supervisor Printed Name	Signature	Date	Time
______________________________	____________________________	_________	_____
Burn Boss Printed Name	Signature	Date	Time

SLOPOVER CONTAINMENT RESOURCE NEEDS WORKSHEET

Slopover containment resource needs are determined by analyzing the worst case slopover scenario based on the location along the burn perimeter that poses the most threat of slopover and calculating the potential spread and fire intensity of the slopver by using environmental inputs from the hot end and cool of the burning prescription and making BEHAVE run. The output information provided by the BEHAVE run is then used along with the standard fireline production rates found in the Fireline Handbook to determine the resources that would be needed to contain the slopover at established time intervals.

Burn Plan Name: ___________________________________ *See Attached BEHAVE Run*

Fire Behavior Fuel Model	Specific Conditions	Type 1* Hand Crew	Type 2* Hand Crew	Chains per Crew Hour** Number of Persons in Crew 1	2	3	4	5
1 Short Grass	Grass Tundra	30 9	18 5	6 2	12 8	24 15	35 24	40 30
2 OpenTimber/Gras s Understory	All	24	16	3	7	15	21	25
3 Tall Grass	All	5	3	2	5	10	14	16
4 Chapparal	Chapparal High Pocosin	5 4	3 2	2 2	3 4	8 10	15 15	20 18
5 Bush	All	6	4	3	6	12	16	20
6 Dormant Brush/Hardwood Slash	Black Spruce Others	7 6	5 4	3 3	6 6	10 12	16 16	20 20
7 Southern Rough	All	4	2	2	5	12	16	20
8 Closed Timber Litter	Conifers Hardwoods	7 40	5 24	3 10	8 30	15 40	20 50	24 60
9 Hardwood Litter	Conifers Hardwoods	28 40	16 24	3 8	7 25	12 40	18 50	22 60
10 Timber Litter	All	6	4	3	8	12	16	20
11 Light Logging Slash	All	15	9	3	8	12	16	20
12 Medium Logging	All	7	4	3	5	10	16	20
13 Heavy Logging Slash	All	5	3	2	4	8	15	20

* 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 hotspotting.

Time Lapsed	Hot/Cool RX End	Fuel Model	Hand Crew Type	Line Production Rate in Chains per Hour	Chains of Line Needing Completion	Number of Crews Needed
1	Hot					
3	Hot					
6	Hot					

12	Hot					
1	Cold					
3	Cold					
6	Cold					
12	Cold					

Prepared by: ________________________________ Date: ________________
Job Title

BURN PLAN TECHNICAL REVIEW

Burn Plan Name: ____

Burn Plan Section	Review Status	Date	Initials
Signature Page			
Executive Summary			
Goals and Objectives			
Burn Unit Description			
Project Complexity			
Burn Organization			
Estimated Costs			
Scheduling			
Pre-Burn Planning and Preparation Considerations			
Burning Prescription			
Firing and Holding Plan			
Smoke Management and Air Quality			
Escaped Fire and Smoke Contingency Transition Planning			
Protection of Sensitive Features			
Public and Personnel Safety			
Interagency/Intragency Coordination and Public Involvement			
Monitoring and Evaluation			
Rehabilitation			
Documentation			
Attachments: Cultural Resources Clearance Prescribed Fire Complexity Rating Guide Slopover Containment Resource Needs Worksheet Technical Review Park Staff Comments Park Superintendent Go/No Go Pre-ignition Approval Briefing Guide Burn Plan Execution Go/No Go Checklist Vicinity Map 7.5 minute project topographic map 7.5 minute project vegetation map 7.5 minute project fuels map			

Status:

+	Adequate – meets NPS standards
o	Adequate with modification – see comments
-	Deficient
NC	Unable to evaluate

Comments:

Reviewed by: ______________________________ Date: _______________

Job Ttile

PARK REVIEW COMMENTS

Burn Plan Name: ____

Please note comments you have concerning this prescribed burn plan.

Fire Management Officer:

Division of Visitor and Fire Management:

Division of Science and Resources Management:

Dvision of Cultural Resources and Interpretation:

Superintendent:

Other:

WILDERNESS AND BACKCOUNTRY MINIMUM TOOL ANALYSIS

<u>Background:</u>

- 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 2001 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 pose a significant impact to wilderness resources and character; and* [2] *The techniques and types of equipment needed to ensure that impact to wilderness resources and character is minimized."* Also: *"When determining minimum requirement,* ***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 <u>Administration,</u> 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 <u>Scientific Study and Impact Monitoring,</u> of SEKI's Backcountry Management Plan, provides guidance on how park managers are to conduct "scientific study and monitoring" in Wilderness and backcountry areas.

<u>Analysis:</u>

If you are proposing an action that has not been approved via an Annual Wilderness Operations Program, you must complete the analysis below (use the back of this sheet if more space is needed).

- ➢ Describe the action you wish to take (e.g. helicopter flight, chainsaw use, install resource monitoring equipment, etc.), and provide detailed estimates on how many times the action will occur on this project (e.g. 3 helicopter landings, or rock drill will be used on 4 day, etc. the more detail, the better):

Answer the following questions:

1. 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 andVisitor Management (e.g. ranger stations, toilets, communication systems), or c) Resource Management and Research (e.g. monitoring, inventorying, pertinent research, restoration, barriers for protection)?

2. Why is this action necessary (e.g. movement of heavy/bulky materials, inaccessibility, safety, time sensitive, trail closed by snow or logs, sensitive park resources, stock not available, maximum resource protection)?

3. Did you pursue other Wilderness Act compatible alternatives (e.g. hand tools, stock, foot)? Why were they determined to not be feasible?

4. 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.)?

5. 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)?

6. 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)

7. 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?

8. What other aspects have been considered in this analysis?

Approvals and Routing:

____________________________________ ____

Submitted by (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.

USDI National Park Service

Sequoia and Kings Canyon National Parks

Manual Fuels Treatment Plan

PROJECT NAME: Silver City

Prepared by: ___Corky Conover___________Date: _3/20/02______

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

Due to extensive fire suppression over the past century, dead and down fuels continue to accumulate in the forests of the East Fork of the Kaweah River. Dense thickets of small trees and shrubs that would have been kept in check by frequent natural fires contribute additional significant risk to the human made developments and infrastructure.

The proposed work will restore the project sites to more natural fuel load and forest structure while creating a reduced fuel environment between the developments and extensive NPS wildlands and wilderness surrounding the developments. The reduced fuel areas will facilitate the proactive implementation of the parks fire management objectives of restoring fire to the surrounding ecosystem and providing for public and firefighter safety.

The Silver City development contains private lands, park service lands and structures (private and NPS), and are fully surrounded by NPS lands. Private landowners have worked to reduce hazardous levels of fuels in and adjacent to their buildings and within property lines. The efforts on the private lands are, in some cases, inadequate for providing defensible space in the event of a wildfire due to the extreme fuel load on adjacent NPS lands. The NPS has been working over the past six years to reintroduce fire to the East Fork as a way to restore and maintain ecosystem function as well as to reduce hazardous levels of fuels. To continue to implement the prescribed fire program while buffering the private lands from wildfire, the park proposes to create hazard fuel buffers at strategic points around those developments. The buffers would be used by the NPS as zones to implement prescribed fire projects outward onto adjacent wildlands. The buffers would provide an additional measure of defensible space to residents in case of a wildfire.

DESCRIPTION OF THE FUELS TREATMENT AREA

1. General Area Description: The project area is located in the middle third of the East Fork of the Kaweah river drainage on a southern aspect. The project would provide a 200 foot reduced fuel buffer below the Silver City development (Private and NPS) and the only access road. A handline and prescribed fire project will be implemented in the future to provide fire protection from above the development.
2. Location:
    A. Tulare County
    B. 36° 27' 54" Latitude 118° 38' 48" Longitude
    C. Kaweah Zone - East Fork Fire Management Unit
3. Geographic Attributes:
    A. Project Size: 25 acres
    B. Elevation range: 6040 – 7000 feet.
    C. Slope range: 0 –50%
    D. Aspect: S- SW
4. Project Boundaries (**See Project Map**): The project is bounded to the north by the Mineral King road. To the west the 200 foot wide treatment zone goes from the Mineral King road at about 6860 foot elevation down hill to the S- SE to just above (6720' elevation) the NE corner of the Kaweah Hahn private in holding boundary due south to the East Fork along the eastern edge of the in holding property boundary. To the south,

the 200- foot wide treatment zone goes from just below the SE corner of the Silver City private property boundary at approximately 6800- foot level along the contour to the W/SW to the intersection with the western project boundary at about the 6720- foot elevation. To the east the 200 foot wide treatment zone goes from the Mineral King road on the east side of the NPS housing area to about the 6860 contour level and then goes west to the east side of the Silver City private property boundary back up to the road.

5. Vegetation Types: The project is located in the White Fir Mixed Conifer vegetation type with no recent recorded history of fire disturbance. The fuels can best be represented by Northern Forest Fire Lab (NFFL) fuel model 10.
6. Designated / Proposed / Recommended Wilderness? Yes No

Vegetation Type	Fuel Model NFFL	Estimated Acres	Estimated Tons Per Acre
Heavy timber litter with understory vegetation	NFFL 10	25	86.85 tons/acre x 25 acres = 2171 tons

Total Estimated Pre- Project Tons/acre: 2117 tons/acre. Tons per acre estimate based on park-wide average fuel loading data for areas that have not been burned in the White Fir Mixed Conifer Vegetation Type since fire exclusion began in the late 19th century.

GOALS AND OBJECTIVES

The main project goal is to provide a reduced fuel buffer around the Silver City development that will allow for the protection of the development, provide for public and fire fighter safety during fire events, and facilitate the restoration of fire to the surrounding wildlands.

1. Fuel Reduction: To reduce the total dead and down woody fuel loading to less than 12 tons/acre and maintain this load within the treatment zone into the future.
2. Forest Structure: To reduce the number of smaller understory trees so that there will be a maximum of 25 tree/acre less than 40 feet in height remaining within the treatment zone and maintain this into the future.

ESTIMATED COSTS

Item	Planning	Execution	Evaluation
Personnel	1000	45,000	5,000
Equipment (mileage, rental)	50	500	250
Aircraft	N/A	N/A	N/A
Supplies (non-rolling stock)	50	250	250
Phase Costs	1,100	45,750	5,500

Total estimated cost: $52,350. (Does not include base 8 salary paid out of non-project accounts)
Estimated cost per acre: $2094.00

STATEMENT OF WORK

Silver City Developed Area Initial Thinning and Maintenance Specifications
Hazard Abatement Reduction Operations

Responsible Position Target Date	Duties
Contract Crew or Fire Management Fire Crew(s). • Initial treatment by the end of November of the year the work starts.	A 200 foot wide shaded fuel buffer around the development below the road will be thinned from below and cleared according to the following fuel hazard reduction and landscape considerations (see attached map). • 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 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 unbucked. 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 unbucked. • Piles shall be appropriately sized and located in openings far enough away from residual vegetation 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.

• Local Fire Management Crew(s). • Maintenance of the fuel treatment zone annually by the end of July.	Water resistant "Kraft" paper (Clean Burn Kraft Paper – available from http://www.baileys-online.com/store.html – see attached tear sheet) 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 Fireline 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 reoccurring 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 5-10 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 5-year cycle.

Silver City Pre Thinning Representation

3-MC-3

Data Associated with Pre Treatment Photo Representation

DATA SHEET

Residue descriptive code 3-MC-3

LOADING

Size class (inches)	Weight (tons/acre)	Volume (ft³/acre)
0.0 - 0.25	0.8	51
0.26- 1.0	2.7	180
1.1 - 3.0	2.6	209
3.1 - 9.0	10.6	848
9.1 -20.0	26.8	2,257
20.1+	0	0
Total	43.5	3,545

OTHER MEASUREMENTS

Average residue depth	(feet)	1.2
Ground area covered by residue	(percent)	75
Average duff and litter depth	(inches)	1.1
Ground area covered by duff and litter	(percent)	91
Sound residue 3.1-inch diameter and larger	(percent)	88
Rotten residue 3.1-inch diameter and larger	(percent)	12

STAND INFORMATION

Trees over 20-inch d.b.h.

- Dominant species: grand fir
- Trees per acre: 17
- Average d.b.h. (inches): 22
- Average tree height (feet): 58
- Average crown height (feet): 11
- Estimated crown space occupied (percent): 10

Trees and dead stems under 8-inch d.b.h.

- Dominant species: Douglas-fir
- Trees per acre: 150
- Average d.b.h. (inches): 2
- Average tree height (feet): 9
- Average crown height (feet): 1
- Estimated crown space occupied (percent): 10

Trees 8- to 20-inch d.b.h.

- Dominant species: Douglas-fir
- Trees per acre: 156
- Average d.b.h. (inches): 15
- Average tree height (feet): 75
- Average crown height (feet): 27
- Estimated crown space: 50

Snags 8-inch d.b.h. and over

- Number per acre: 21
- Average d.b.h.: 23
- Average height: 60

BRUSH INFORMATION

- Dominant species: wildrose
- Average height (inches): 17
- Average crown height (inches): 14
- Ground space occupied (percent): 2

GRASS AND FORBS INFORMATION

- Dominant species: elk sedge
- Average height (inches): 4
- Ground space (percent): 11
- Estimated weight (pounds per acre):

ASSESSMENT OF FIRE BEHAVIOR AND SUPPRESSION DIFFICULTY

- Spread rate (chains/hour): 3
- Flame length (feet): 4
- Resistance to suppression (chains/man-hour): 1.1

Ecoclass coding: CWF3-11

REMARKS

Silver City Post Treatment Representation

Data Associated with Post Treatment Photo Representation

DATA SHEET

Residue descriptive code 1-MC-4-PC

LOADING

Size class (inches)	Weight (tons/acre)	Volume (ft^3/acre)
0.0 - 0.25	0.2	13
0.26- 1.0	2.0	134
1.1 - 3.0	3.8	304
3.1 - 9.0	.5	42
9.1 -20.0	0	0
20.1+	0	0
Total	6.5	493

OTHER MEASUREMENTS

Average residue depth	(feet)	0.01
Ground area covered by residue 1/4-inch diameter and larger	(percent)	89
Average duff and litter depth	(inches)	.1
Sound residue 3.1-inch diameter and larger white fir	(percent)	60
incense-cedar	(percent)	40
	(percent)	
Rotted residue 3.1-inch diameter and larger	(percent)	0

HARVEST INFORMATION

		Harvest information source: Sale records	Onsite estimation
Gross volume	(M fbm/acre) 4.6	x	
Net volume	(M fbm/acre) 4.6	x	
Average stems/acre cut	15	x	
Average d.b.h. of stems cut	(inches) 22	x	
Stand age	(years) 150		x
Cutting prescription	Tree selection	x	
Yarding method	Tractor	x	
Slash treatment	Machine pile & burn		x
Period since cut or treatment	(months) 8		x

ASSESSMENT OF FIRE BEHAVIOR AND SUPPRESSION DIFFICULTY

Spread rate	(chains/hour)	3
Flame length	(feet)	2
Resistance to suppression	(chains/man-hour)	6.0

REMARKS

PROTECTION OF SENSITIVE FEATURES

The project area will be cleared by the cultural resources specialist prior to the start of any work. A Finding of No Significant Impact (FONSI) was signed by the park's superintendent and approved by the regional director on 12/31/01. The following table is taken from the FONSI mentioned above following the project Environmental Assessment (EA).

Resource Value	Mitigation	Responsible Party
Public and Firefighter Safety	Implementation of the reduced fuel buffers will be carefully planned and conducted with full consideration of public safety. Project areas will be closed for short duration (1 hour to 1 week) to provide for safety during felling and clearing operations and during pile burning. Closures will be coordinated with Silver City Resort and other residents to minimize conflicts. Trees and snags to be removed will be felled away from private property and structures. Firefighter safety will be high priority and will be stressed through adherence to the standard firefighting orders and the use of full personal protective equipment at all times. A job hazard analysis will be conducted prior to any work, and all usual and customary safety practices will be implemented to insure safety of workers.	Fire Management Office and/or Contracting Officer
Ecological Function	The specifications for the reduced fuel buffer will result in fuel and forest canopy conditions closely resembling those desired for restoring natural conditions. The creation of a defensible buffer will allow future implementation of more widespread restoration of fire as an ecosystem process on adjacent NPS lands.	Park project manager will insure work conforms to specified standards.
Aesthetics	High fuel levels and dense thickets of trees will be reduced to natural levels. These conditions create a more open understory, a condition that is also attractive to many residents and visitors. The developed areas will blend more seamlessly into the natural environment more readily. Stumps will be flush cut and cut ends of logs will be treated to reduce visibility.	Park project manager will insure work conforms to specified standards.
Special Status Species	No special status wildlife or plant species will be affected.	N/A
Water and Wetlands	The use of vehicles in or around stream corridors will be prohibited. No soil disturbance will occur. Logs and other large woody debris over eight inches in diameter will remain in the streambeds and throughout the project area.	Park project manager will insure work conforms to specified standards.
Cultural Resources	The park archeologist will monitor ground-disturbing activity. Park staff overseeing the project will be trained to identify potential resources encountered. Any cultural resources detected will be avoided or fully mitigated to standards established by the park	Park Archeologist

Resource Value	Mitigation	Responsible Party
	archeologist prior to work being continued.	
Wilderness	Ensure discussion of minimum requirement / minimum tool. No vehicles will be used within the wilderness at Oriole Lake and all minimum tool requirements specified in the Assessment will be adhered to during implementation. The conditions created by the project will result in an area that will more closely resemble natural conditions. Creation of the reduced fuel buffer around the developments will result in conditions favorable to the reintroduction of fire and restoration of more natural conditions in the surrounding NPS wilderness areas.	Park project manager will insure work conforms to specified standards.
Air Quality	Air quality impacts in localized areas will occur because of the prescribed burning. All burning will be conducted in strict conformity with the requirements of the San Joaquin Air Pollution Control District. Burning will occur after Labor Day or before Memorial Day to minimize the numbers of visitors and residents exposed to smoke. Residents and visitors will be notified in advance of burning so they may avoid the smoke.	Fire Management Officer
Recreation	Project areas may be closed for short duration (1 hour to 1 week) to facilitate safe operations. Closures will be affected for the minimum amount of time necessary for safe operations. No public roads or trails will be closed. Areas will be restored to more natural appearance and function, enhancing the recreational experience.	Project manager in conjunction with area Rangers.

PUBLIC AND PERSONNEL SAFETY

Job Hazard Analysis (JHA) will be reviewed by project staff prior to the start of any new work on the project. Existing JHA's that can be used for chainsaw work (falling, bucking, limbing, sharpening), slash piles, environmental hazards and driving on narrow park roads are located on the parks network and will be made available to project crews. If the project has the potential to impact the traffic on the Mineral King road, traffic control will be in place with confirmed communications on both ends. Emergency Medical Technicians (EMT's), first responders, or first aide personnel will be identified in the field for each day of work as well as the procedures for medi- vac.

INTERAGENCY COORDINATION AND PUBLIC INFORMATION

1. Employee and Public Information Outreach Procedure:

The fire information officer will coordinate public information for park visitors, park employees, and local communities. Special coordination will occur with the Mineral King interpreters, Mineral King Rangers, District Fire Management Officer, Project Lead, and the local cabin owners association.

2. Notification of District and Fire Management Staffs about Preparation and Execution Procedure:

Sequoia district and Mineral King sub- district staff will be kept up to date about progress made concerning project execution, rehabilitation, and monitoring.

3. Fire Dispatch Situation Update Procedure:

Fire dispatch will be updated on the project status every day that personnel are on site, from preparation through execution, rehabilitation and monitoring phases.
All resource orders will be placed though fire dispatch. Fire dispatch will be kept informed about staffing, activity, and any problems relevant to the project on a daily basis.

MONITORING AND EVALUATION

A. A permanent plot will be installed approximately every 5 chains along the outside edge of the thinning project, starting approximately 5 chains in from the Mineral King Road, 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. The sampling intensity indicated above should yield the desired number of sample points. 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 (Silver City Thinning) 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 (see plot diagram). The photo series estimate will go out from the sample point at 45° 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 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.

B. The plot will be reread, immediately following the completion of the project to determine if the objectives have been met, and then again on a10 year basis to determine a maintenance schedule. When the total woody fuel loading 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 exceed 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.

C. Up to 3 standard fire effects 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 understory composition and patterns may be documented and investigated further if necessary. Fuel accumulation rate and tree regeneration will also be documented in the plots. Protocols will follow those outlined in the NPS Fire Monitoring Handbook and SEKI FFMP Monitoring Plan.

D. Due to concerns about the potential for non- native plant invasion into disturbed areas, directed surveys may be conducted in the treatment area. With assistance from the parks' exotic plant program staff, the status of pre- treatment presence of non- native plant species will be determined along with any changes that may occur 1 and 2 years following initial treatment and after further treatment.

POST PROJECT REHABILITATION

All trails and roadways near the project area will be surveyed after the completion of the project for hazards caused by the operation. All identified hazards will be mitigated as soon as possible. All saw cuts will be flush- cut and cuts will be buried or disguised. Fire lines constructed within the project area will be established using minimum impact suppression techniques, and be rehabilitated per the guidelines contained within the Fire and Aviation Management Operations Guide (FAMOG).

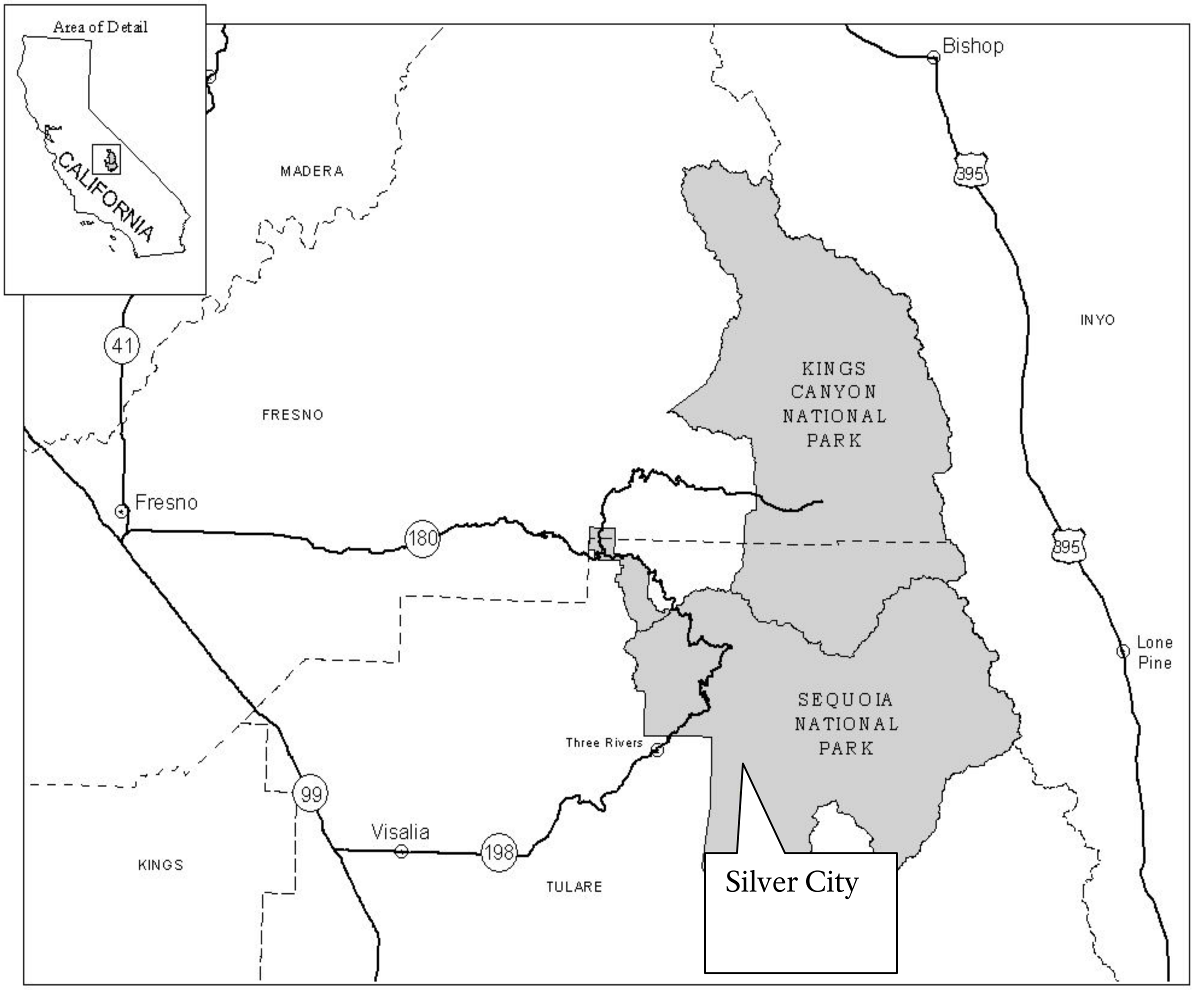
POST PROJECT REPORTS

Fire Dispatch will maintain a project file with dispatch log, resource orders, OF- 288 and CTR forms, and project plan, Unit Logs.

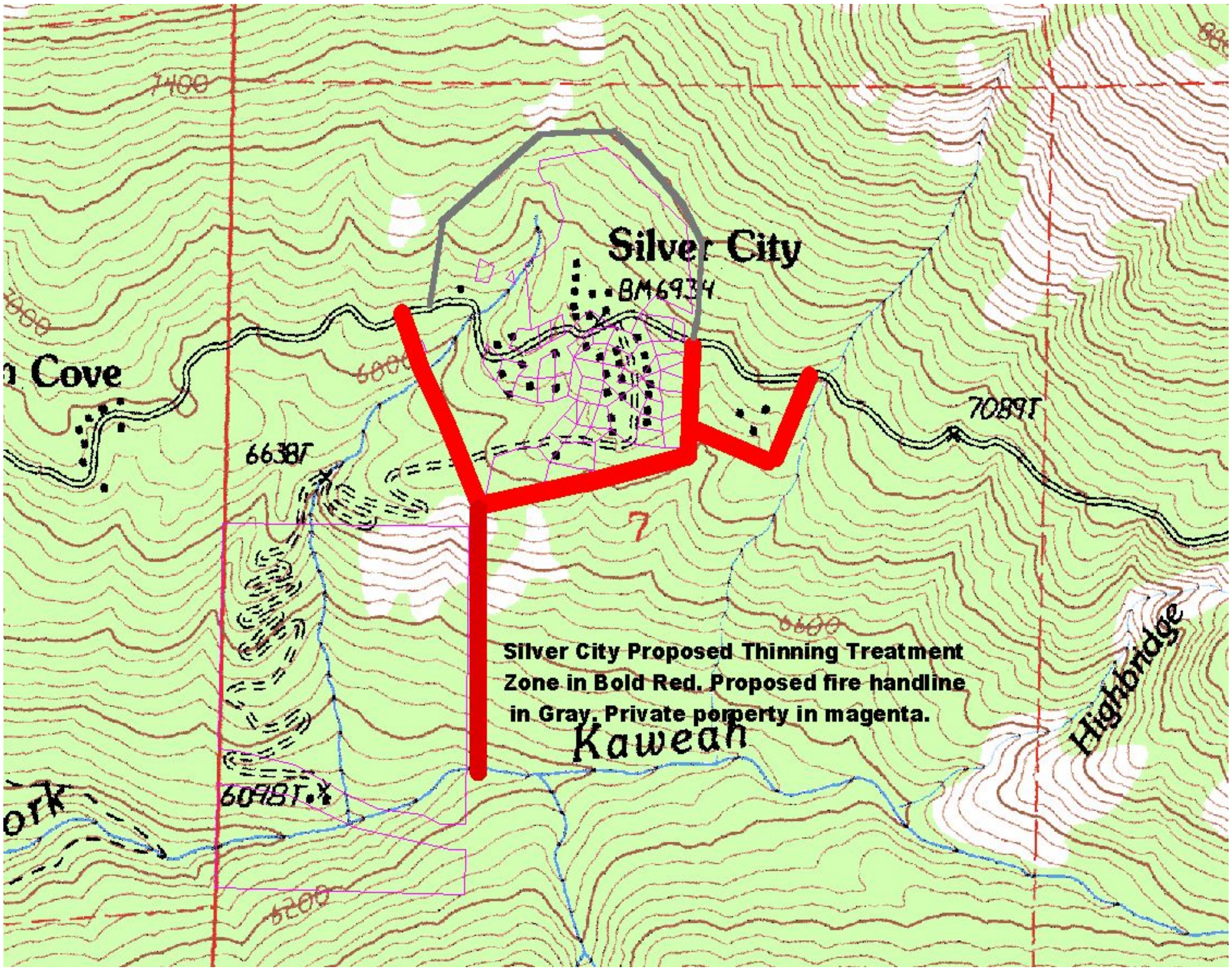
The Project Lead will maintain ICS- 214 Unit Logs.

The Project Lead will report to the park archaeologist the discovery of cultural artifacts.

VICINITY MAP

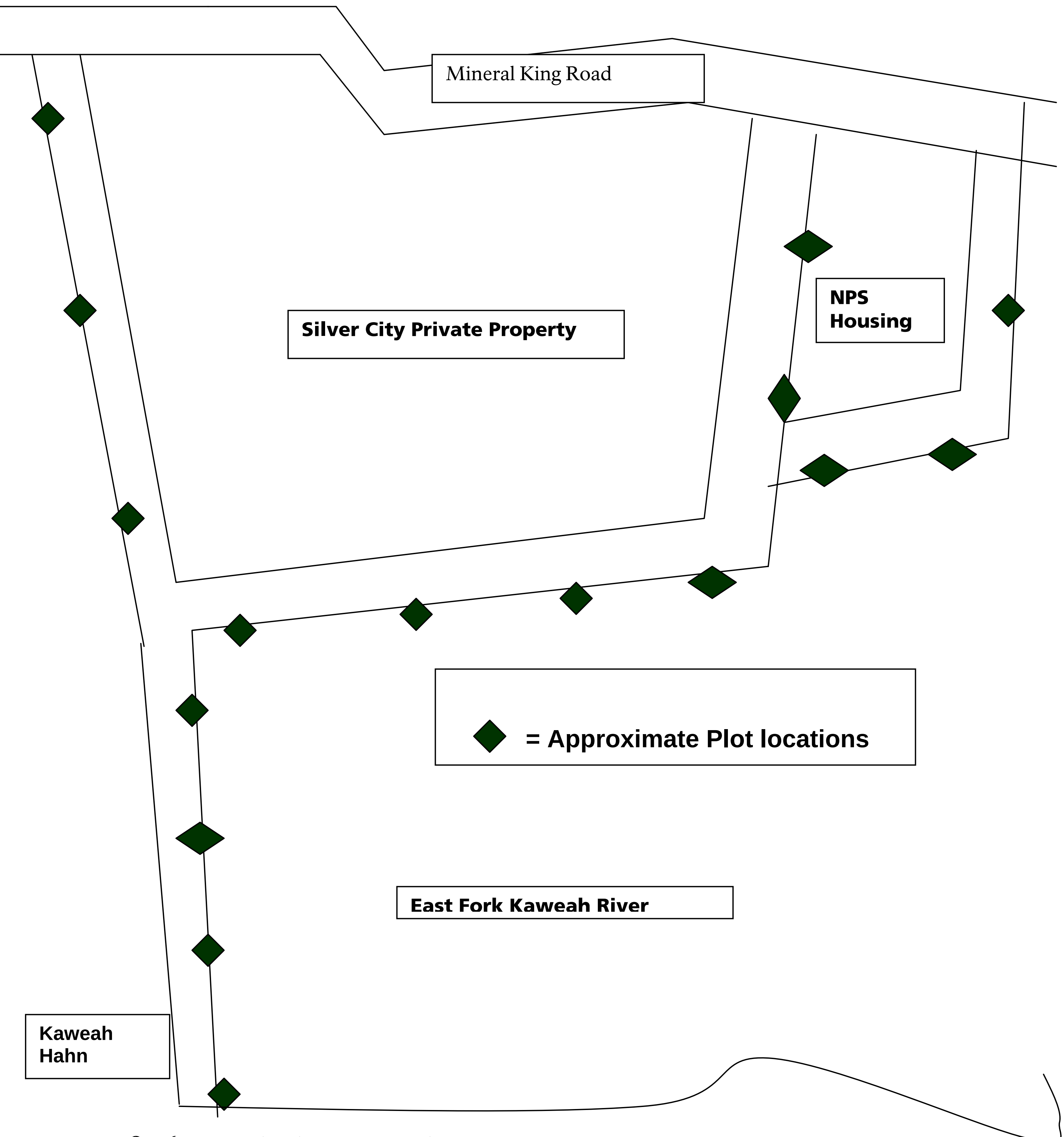


PROJECT MAP

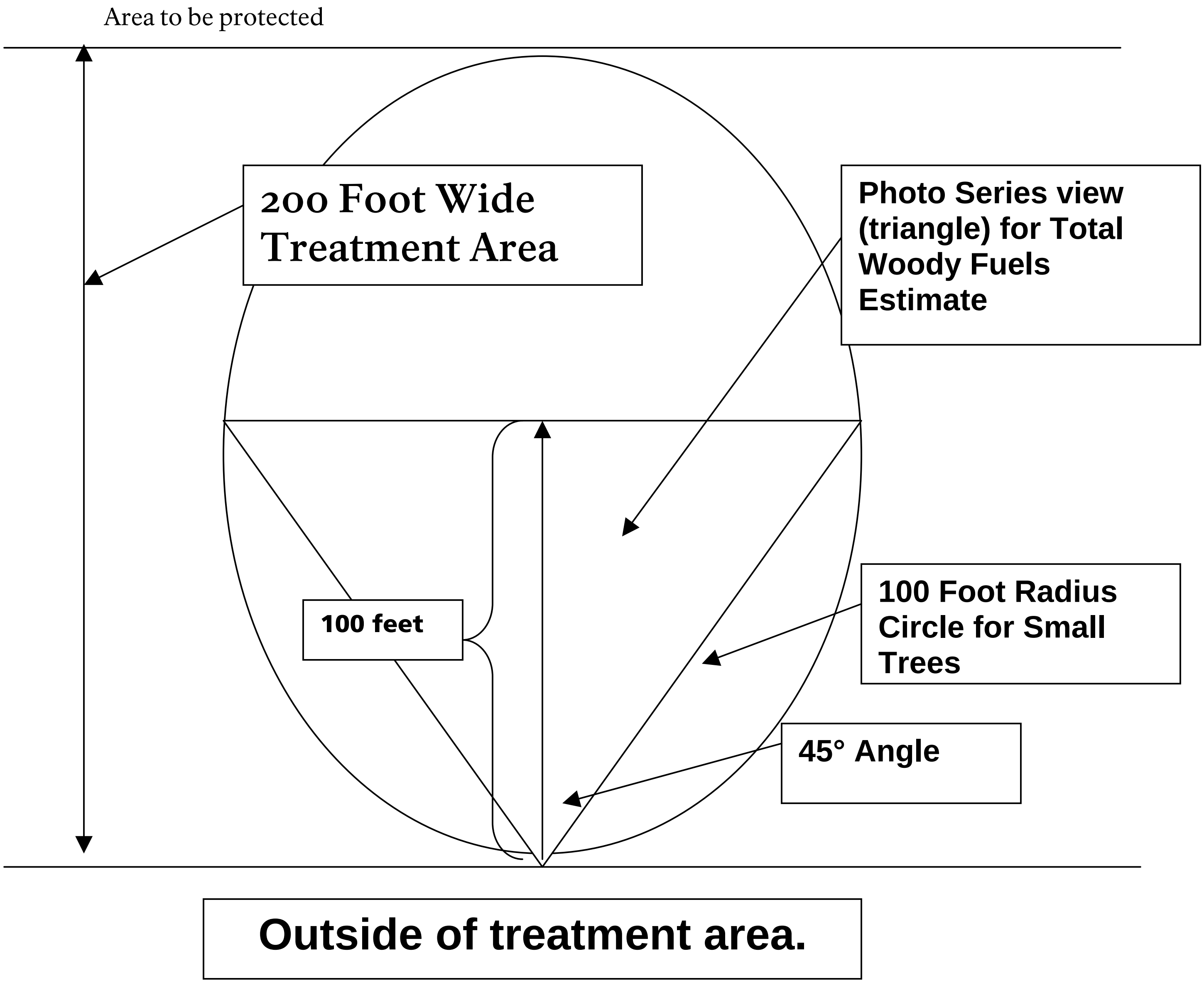


Silver City
BM6934
Cove
6638T
7089T
7400
6000
6600
6200
7
6098T
ork
Kaweah
Highbridge
Silver City Proposed Thinning Treatment
Zone in Bold Red. Proposed fire handline
in Gray. Private porperty in magenta.

PLOT DIAGRAM



PLOT DETAIL


Area to be protected
200 Foot Wide Treatment Area
Photo Series view (triangle) for Total Woody Fuels Estimate
100 feet
100 Foot Radius Circle for Small Trees
45° Angle
Outside of treatment area.

PARK REVIEW COMMENTS

Project Name: __**Silver City Manual Fuels Treatment**___

Please note comments you have concerning this project plan.

Fire Management Officer:

Division of Visitor and Fire Management:

Division of Science and Resources Management:

Division of Cultural Resources and Interpretation:

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)

1. Dead Fuel Moisture Determination
2. Live Fuel Moisture Determination
3. Fire Weather and Fire Behavior Observations
4. Smoke Observations
5. Wildland Fire Observations Record
6. 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:

1. Annual prescribed fire accomplishment reports into the NPS Wildland Fire Management Computer System (WFMCS)
2. Entering Individual Fire Reports in WFMCS
3. Annual SEKI Fire Summary
4. 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 archaeologists 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 all pre- suppression activities.

YEAR- ROUND
Return any and all defective equipment to the Ash Mountain cache.

JANUARY
- Issue Forestry Technician seasonal job announcement.
- Determine in- park fire training needs and establish training dates. This includes basic training (S- 130, 190, 211, 212, and the 8hr. refresher).
- Continue Ash Mountain Fire Cache and vehicle inventory requisition and replacement of equipment and supplies.
- Complete previous years data summary reports for fire monitoring.
- Update fire history and 1202 database in GIS.
- Complete all annual fire repots and required reports.

FEBRUARY
- Rate Forestry Technician applications.
- Follow up with chainsaw maintenance facilities.
- Begin engine pump tests with Tulare County Fire.

MARCH
- Begin seasonal hiring process. (Firefighters and Fire Monitors)
- Schedule wildland fire physicals for employees with primary firefighting responsibilities who require an update.
- Begin work capacity testing (pack test).
- Re- inventory Ash Mountain Fire Cache.
- Complete engine pumps test.
- Conduct annual winter fire operations meeting.

APRIL
- Continue seasonal hiring process.
- Continue pack testing.
- Coordinate operations meetings with local cooperators.
- Begin clean- up, maintenance, servicing and restocking of all engine fire patrol vehicles.
- Continue inventory of Ash Mountain fire cache and restock if necessary. Prepare for summer issues.
- Test pumps and chainsaws prior to crew issue.
- Activate the Ash Mountain weather stations and begin collecting observation.

MAY

- Continue seasonal hiring process.
- Early May – EOD of engine, handcrew, and helicopter crewleaders.
- Conduct one 8- hour refresher course for crew leaders and permanent fire staff.
- Late May – EOD of all crew members.
- Continue clean- up, maintenance, servicing, and restocking of all engines and patrol vehicles.
- Ash Mountain Cache – Begin summer issue of PPE and crew equipment.
- Conduct annual pre- season supervisory ranger and engine crewleader operations meeting.
- Begin daily vehicle readiness checks as per FAMOG.
- Begin mechanical hazard fuels reduction projects.
- Prescribed burnings of approved units in prescription.
- Activate the Ash Mountain Helibase.
- Prescribed burn plans completed for Superintendent's signature.
- Rehires submit updated red card information. (experience/training)
- Activate Cedar Grove manual fire weather station and begin collecting observations.
- Begin collecting fire weather observations and calculating fire danger ratings.
- Begin or continue a physical fitness program and continue all year.

JUNE

- EOD of the park contract helicopter.
- New hires submit red card application information (experience/training).
- Red cards issued.
- Complete all required pre- season wildland fire training (S- 130, 190, 211, 212, and the 8- hour refresher) including Basic Aviation Safety.
- Begin daily individual firefighter personal protective equipment checks as per FAMOG.
- Each crew to begin and maintain a daily station log.
- Begin fuel moisture sampling (as required, ongoing).
- Establish additional fuel loading plots (as required, ongoing).
- Complete all non- fire related training (POSH, defensive driving, SEKI orientation, Update training, etc.)
- Complete engine, patrol vehicle, and station inventory and restock as necessary.
- Begin season- long proficiency training as per the 1998 readiness review standards.
- Continue mechanical hazard fuel reduction projects.
- Prescribed burn preparation activities.
- Prescribed burning of approved units in prescription.
- Activate all sub- district helispots.
- Conduct fire hydrant flow tests as per FAMOG.

JULY

- Continue mechanical hazard fuel reduction projects.
- Pressure test fire engine and patrol vehicle primary hose and all structure fire hose per FAMOG.
- Prescribed burn preparation activities.
- Prescribed burning of approved units in prescription.
- Continue fire hydrant flow tests.

- Continue fuel moisture and fuel loading sampling.
- Conduct employee fire extinguisher use training.
- Conduct weekly and/or daily training sessions on safety, engine operations, chainsaws, portable pumps, and helicopter use.
- Complete Readiness Review.

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.
- Prepare end- of- season crew report as per FAMOG.
- 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.
- Attend annual end of season operations meeting.
- 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 (EZ form) to fire dispatch for yourself and your crewmembers.

NOVEMBER
- Prescribed burn preparation activities.
- Prescribed burning of approved units in prescription.
- Continue winterizing all patrol vehicles, pumps, chainsaws, and PPE.
- Final closure of station facilities.

- Perform quality checks of fuels data.
- Prepare and submit monitoring crews annual reports.

DECEMBER
- Send out chainsaws/pumps for maintenance.
- All 1202's (Fire Reports) completed and entered in SACS.
- Prepare requisitions for Ash Mountain Fire Cache and vehicle inventory restocking.
- Analyze and summarize fuel loading data collected during the season.

T - Addendum

1. Suppression Fire Response Plan

2. *Logistics Plan*, Sequoia and Kings Canyon National Parks. In development/draft 2002. Located in Fire Management Office.

3. *Fire and Aviation Management Operations Guide,* Sequoia and Kings Canyon National Parks. 2001. Located in Fire Management Office.

4. Letters of Agreement (LOA) and Memorandums of Understanding (MOU) binder

5. *Wildfire Prevention Plan: An Operating Plan of the Park Fire Management Program*, Sequoia and Kings Canyon National Parks. 1993. Located in Fire Management Office.

6. *Risk Management Plan*, Sequoia and Kings Canyon National Parks. 1998. Located in park Safety Office.

7. Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide

8. *Aviation Management Plan*, Sequoia and Kings Canyon National Parks. 2001 (Draft). Located in Fire Management Office.

9. Standard Operating Procedures for the Communication Center

10. Emergency Equipment Rental Agreement binder

11. *Standard Operating Procedures: Fire & Fuels Information, Sequoia & Kings Canyon National Parks.* Located in the Fire Information and Education Specialist's office.