National Park Service
U.S. Department of the Interior

Grand Canyon National Park
Arizona

Grand Canyon National Park
Wildland Fire Management Plan

July 2005

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U.S. Department of the Interior

Grand Canyon National Park
Grand Canyon, Arizona 86023

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Chapter 1 Introduction

Grand Canyon National Park is located on the southwestern edge of the Colorado Plateau in northern Arizona. The Park consists of over 1.2 million acres situated within Mohave and Coconino Counties. The region is characterized by raised plains and basins, with the canyon as a major feature cut into the Colorado Plateau up to 1 mile deep. Elevations within the Park range from just over 1000 ft (305 m.) at the river's western end (the Lake Mead National Recreation Area boundary) to over 9160 ft (2793 m.) near the North Rim Entrance. The relatively flat terrain of both rims is broken by some of the most changeable and severe topography in the world. A complete description of the Park boundary is in Title 16, Sections 221- 228. A map of the park and general vicinity is shown in Figure 1- 1.

1.1 Reasons for Developing this Plan

National Park Service (NPS) Policy directs that fire management plans provide overall direction for programs that recognize the use of fire as a tool for ecosystem restoration and maintenance, commensurate with providing protection for human life, property, and resource values.

Adequate ecological research in the Southwest United States now exists and details fire's historical role as a recurring natural disturbance event that shaped and maintained pre-settlement vegetative communities. This same research points out that since the turn of the century, the dynamic balance of these fire- adapted systems (resulting from periodic fire events) has been upset. Aggressive fire suppression combined with land management activities such as livestock grazing and timber harvest practices have often resulted in severely altered systems. Today, these overstocked, fuel- laden landscapes have created a high potential for life-threatening, unnatural fires that further degrade the integrity of many of Grand Canyon National Park's natural ecosystems.

National Park Service policy (NPS 1998) states that all areas with vegetation capable of burning will develop a fire management plan to guide a program that is responsive to the Parks' natural and cultural resource objectives and to safety considerations for Park visitors, employees, and developed facilities. Such a plan was developed for Grand Canyon National Park and approved on January 29, 1992. An Amendment to the Plan was approved in 1998. This Plan is a compilation of minor policy revisions to those 1992 and 1998 documents, including annual reviews and updates.

1.2 Collaborative Processes Followed

This plan has evolved over 12 years in collaboration with adjacent communities, interest groups, state and federal agencies, and tribal governments within and adjacent to the Coconino and Mohave Counties of northern Arizona.

1.3 Guiding Policies

The Wildland Fire Management Plan is a resource management program implementation document that is intended to facilitate the accomplishment of goals and objectives identified in

the General Management Plan (1995) and the Resource Management Plan (1997) for Grand Canyon National Park. The General Management Plan's "A Vision for the Future" states

> *In order to protect this magnificent place, the Park should be managed to ensure the preservation of its ecological processes and its historical and archaeological resources. Proposed wilderness areas both in and adjacent to the Park should be managed as wilderness…*

Additionally, this plan will implement wildland fire management policies and help achieve resource management and fire management goals as defined in: 1) Federal Wildland Fire Management Policy and Program Review; 2) Managing Impacts of Wildfires on Communities and the Environment, and Protecting People and Sustaining Resources in Fire Adapted Ecosystems – A Cohesive Strategy (USDOI/USDA); and 3) A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10- Year Comprehensive Strategy Implementation Plan.

1.4 Compliance with Federal Laws

This plan has been prepared in compliance with:

- The National Environmental Policy Act (NEPA) of 1969 (42 United States Code (USC) 4321 et seq.), which requires an environmental analysis for major Federal Actions having the potential to impact the quality of the human environment;
- The National Historic Preservation Act (NHPA) (16 USC 470), which requires protection of historic properties significant to the Nation's heritage;
- The Wilderness Act (16 USC 1131 et seq.), because the park manages areas proposed for wilderness designation;
- The Endangered Species Act of 1973 (ESA) (19 U.S.C. 1536 (c), 50 CFR 402), as this Federal Action involves Federally- listed species and designated critical habitat.

Grand Canyon National Park's Wildland Fire Management Plan was developed and modified over the course of 12 years with internal and external interdisciplinary input, and reviewed by appropriate subject matter experts are set forth in Director's Order DO–12 (NPS 2001), where decision- making involves an interdisciplinary determination of level of compliance required, is based on best available scientific and technical information, and has an analysis of impairment to resources as part of the overall environmental impact analysis process.

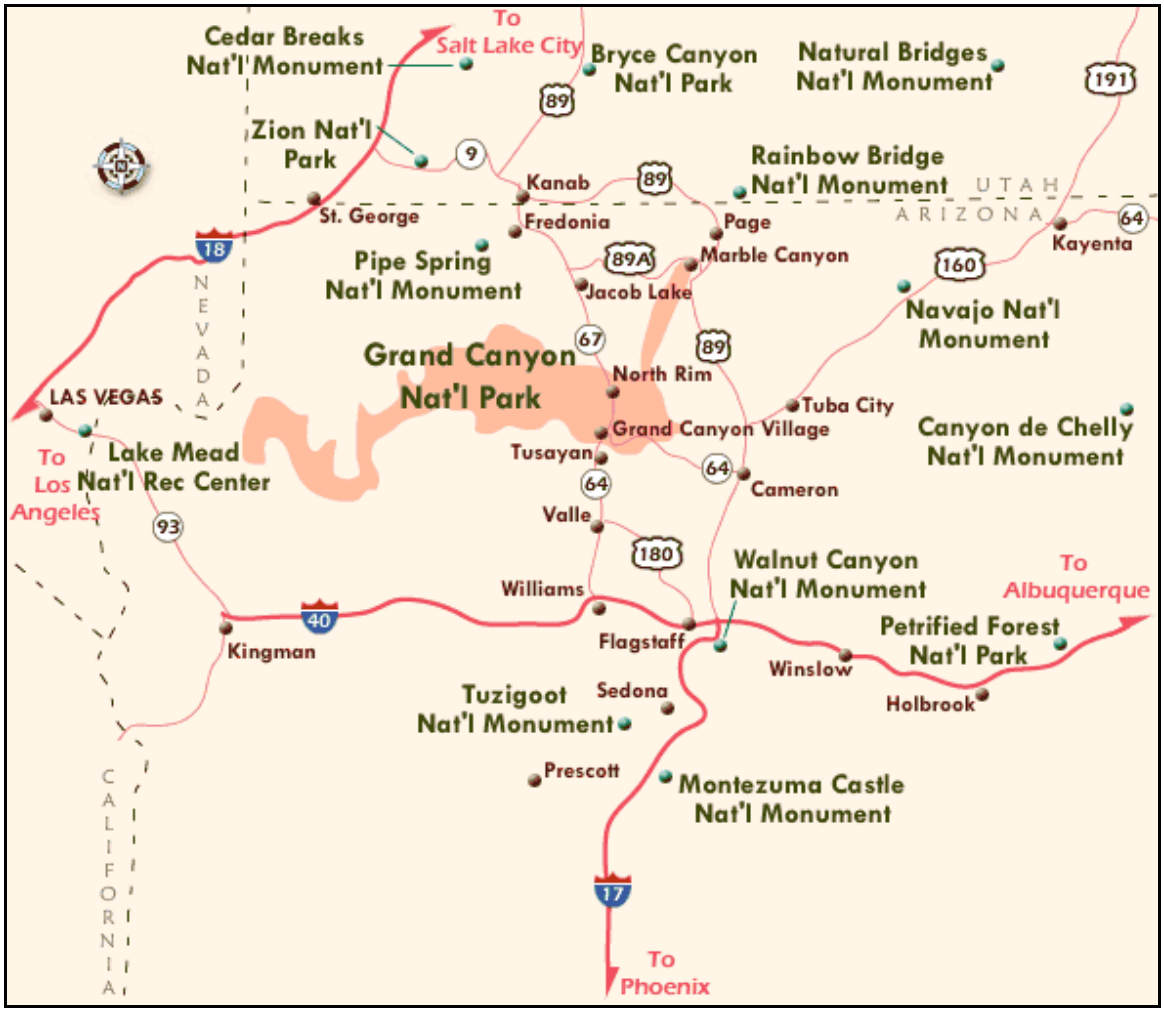
1.5 Authorities Cited

The authority for implementation of this Plan is the Organic Act for the National Park Service (August 25, 1916), which directs the NPS to manage resources and regulate Park use in such a manner as will leave the resources unimpaired for future generations.

The Federal Wildland Fire Management Policy (2001) provides an overall framework for agencies to develop a wildland fire program that is consistent with stated land and resource goals and objectives while ensuring firefighter and public safety. NPS management policy that cites authorities for fire management programs and provides detailed guidance for planning and implementation is contained in Director's Order DO–18 (1998). This Plan follows the format set forth in the National Park Service Wildland Fire Management Reference Manual, RM–18 (1999),

and policy contained in NPS Director's Order, DO- 18. Authority to implement this plan is found in 16 USC 1 through 4 (National Park Service Organic Act), and delegations of authority found in Part 245 of the Department of the Interior Manual.

Figure 1- 1. General Vicinity Map of Grand Canyon National Park.



Chapter 2 Relationship to Land Management Planning and Fire Policy

This document is guided by departmental and agency policies and directives. Relevant statements from bureau and agency policy regarding the fire management program are cited below, followed by a description of the relationship of this Plan to enabling legislation, the General Management Plan, the Cultural and Natural Resource Management Plan, the Backcountry Management Plan, and broad objectives related to the fire management program.

2.1 NPS Management Policies

Departmental Manual (DM) Part 910, Interior Emergency Operations (1996), and DM Part 620, Wildland Fire Management (1998) states[1]:

"Fire, as a critical natural process, will be integrated into land, natural, and cultural management plans and activities on a landscape scale, across bureau boundaries, and will be based upon best available science. All use of fire for natural and cultural resource management requires a formal prescription."

"Every area with burnable vegetation must have an approved fire management plan. Fire management plans must be consistent with firefighter and public safety, values to be protected, and land, natural, and cultural resource management plans and must address public health issues. Fire management plans must also address all potential wildland fire occurrences and include the full range of wildland fire management actions."

National Park Service Wildland Fire Policy[2] (1998) states:

"All fires burning in natural or landscaped vegetation in Parks will be classified as either wildland fires or prescribed fires. All wildland fires will be effectively managed, considering resource values to be protected and firefighter and public safety, using the full range of strategic and tactical operations as described in an approved fire management plan."

National Park Service Management Policies, Natural Resource Management (2001) concerning restoration of natural systems states:

"The Service will re- establish natural functions and processes in human- disturbed natural systems in Parks unless otherwise directed by Congress. The Service will use the best available technology to restore the biological and physical components of these systems as necessary, accelerating both their recovery and the recovery of landscape and biological community structure and function."

"Biological or physical processes altered in the past by human activities may need to be actively managed to maintain the closest approximation of the natural ecosystem in situations in which a truly natural system is no longer attainable. Prescribed burning…are examples. The extent

[1]Departmental Manual DM Part 620, 1.4.
[2]NPS DO-18, Wildland Fire Management, Section 3.

and degree of management actions taken to protect or restore park ecosystems or their components will be determined in light of management objectives and the best available scientific information."

"In managing parks to preserve naturally evolving ecosystems, managers will rely greatly on the findings of science and the analyses of scientifically trained resource specialists to inform their decision- making."

NPS Management Policies, Natural Resources Management[3] (NPS- 77, 1991) state:

"The use or exclusion of fire must be in support of the objectives defined in the resource management plan. The resource management plan must clearly articulate the Park's resource objectives and the role, if any, which fire can play in achieving these objectives. Specific objectives for fire management are documented in the Park fire management plan."

"…fire management plans should include actions to assure that suppression lines are rehabilitated. The plan should prioritize actions to prevent the greatest damage to resources while maintaining public safety."

"Ensure that Park operations do not adversely impact endangered, threatened, candidate, or sensitive species and their critical habitats, within or outside the Park."

National Park Service Management Policies[4] (2001) for cultural resources management state:

"The NPS will take action to prevent or minimize the impact of wildland, prescribed, and structural fires on cultural resources, including the impact of suppression and rehabilitation activities."

National Park Service Director's Order - 41 for Wilderness Preservation and Management[5] (2001) relating to the fire management program states:

"Lands identified as being suitable for wilderness designation, wilderness study areas, proposed wilderness, and recommended wilderness (including potential wilderness) will be managed to preserve their wilderness character and values undiminished until Congress acts on the recommendations. Decisions will be made in the expectation of eventual wilderness designation."

NPS Management Policy (2001) for Wilderness Preservation and Management[6] state:

"Fire management activities conducted in wilderness areas will conform to the basic purposes of wilderness. The park's fire management and wilderness management plans must identify and reconcile the natural and historic roles of fire in the wilderness, and will provide a prescription for response, if any, to natural and human- caused wildfires. If a prescribed fire program is implemented, these plans will also include the prescriptions and procedures under which the program will be conducted within wilderness.

[3]In NPS Management Policies, Natural Resource Management (NPS-77), Chapter 2 (Fire Management, page 2; Emergency Management, page 2; Endangered, Threatened, and Rare Species Management, page 4).
[4]NPS Management Policies: Chapter 5: Cultural Resources Management, Section 5.3.1.2.
[5]NPS Director's Order 41: Wilderness Preservation and Management, part IV.
[6]NPS Management Policy, Wilderness Preservation and Management, Sections 6.3.9

Actions taken to suppress wildfires will use the minimum requirement concept, and will be conducted in such a way as to protect natural and cultural resources and to minimize the lasting impacts of the suppression actions."

NPS Management Policies[7] (2001) concerning air quality state:

"…, the Service will seek to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas."

"… all air pollution sources within parks – including prescribed fire management and visitor use activities – will comply with all federal, state, and local air quality regulations and permitting requirements. Superintendents will make reasonable efforts to notify visitors and employees when air pollution concentrations within an area exceed the national or state air quality standards established to protect public health"

"Minimize air quality pollution emissions associated with park operations, including the use of prescribed fire and visitor use activities"

This Plan will incorporate and comply with NEPA by assessing the potential impacts of plan implementation on resource values described in policy statements above.

2.2 Enabling Legislation and Park Purpose

Enabling legislation, including the Grand Canyon National Park Establishment Act (40 Stat. 1175, 1919) and the Grand Canyon National Park Enlargement Act (Public Law 93- 620), provide the foundation upon which all Park management planning documents, including the Fire Management Plan, are based.

As stated in the General Management Plan (1995), the Park is to be managed to:

"preserve and protect its natural and cultural resources and ecological processes, as well as its scenic, aesthetic, and scientific values"

Significant resources of note within Grand Canyon National Park include a unique biological diversity with examples of five of the seven life zones; undisturbed remnants of dwindling ecosystems such as boreal forest; and numerous rare, endemic, or specially protected (threatened/endangered) plant and animal species. The Park is designated a World Heritage Site for its superlative natural and cultural features. The Park also recognizes the ponderosa pine habitat of the Kaibab squirrel as a national natural landmark. The Park serves as a natural gene pool because of its biological diversity and unique conditions (NPS 1997).

2.3 Park-wide Fire Management Goals

The following General Management Plan objectives[8] relating to natural and cultural resources and regional issues have a direct relationship to the Fire Management Plan:

[7]NPS Management Policy, Air Resource Management, Section 4.7.1.

- *"Preserve, protect, and interpret the Park's…ecological processes…"*
- *"Preserve, manage, and interpret Park cultural resources…"*
- *"Preserve and protect the genetic integrity and species composition within the Park, consistent with natural ecosystem processes"*
- *"Preserve, protect, and improve air quality and related values as visibility"*
- *"To the maximum extent possible, restore altered ecosystems to their natural conditions. In managing naturalized ecosystems, ensure the preservation of native components through the active management of nonnative components and processes"*
- *"Manage ecosystems to preserve critical processes and linkages that ensure the preservation of rare, endemic, and specially protected (threatened/endangered) plant and animal species"*
- *"Inventory, monitor, and maintain data on Park natural and cultural resources and values, and utilize this information in the most effective ways possible to facilitate Park management decisions to better preserve the Park"*
- *"Provide opportunities for scientific study and research…consistent with resource protection and Park purposes"*
- *"Carry the NPS concern for the environment beyond the boundaries of the Park, including the protection of Park resources and values from external influences"*

2.4 Resource Management Plan Objectives for Fire Management

The Park Resource Management Plan[9] (RMP, 1997) states objectives that directly relate to the Fire Management Plan.

- *"Reintroduce and maintain fire's natural role in Park ecosystems to the maximum extent possible"*
- *"Preserve the natural genetic integrity and species composition within the Park, consistent with ecosystem processes, including the elimination of nonnative plant and animal species whenever possible"*
- *"Preserve air quality, and protect it from within- Park, as well as, external degradation. Work toward continued protection of Grand Canyon's Class I airshed"*

The agency emphasis is not only on species and habitat preservation, but also on establishing and maintaining the natural processes and dynamics essential to long- term perpetuation of ecosystems. Fire is one such process. Under this plan and other Park management plans dealing with vegetation and habitat, restoration strategies such as the use of wildland fire can be applied to altered natural forest environments (NPS 1997).

Specific program objectives from the Resource Management Plan (1997) that address forest ecosystem restoration are the following:[10]

- *"Restoration of fuel loads and ecosystem structure to within the natural range of variability in vegetative communities"*

[8]General Management Plan, Grand Canyon National Park, pages 7 and 9.
[9]Resource Management Plan, Grand Canyon National Park, page 3-50.
[10]Resource Management Plan, page 3-108.

- *"Restoration of fire as a natural process through prescribed burning for reduction of fuels to levels that allow additional acreage to be designated as [prescribed natural] fire areas"*

The following Resource Management Plan program objectives[11] address wildlife:

- *"Protect genetic diversity through perpetuating natural evolutionary processes and minimizing human interference"*
- *"Reliance on natural processes to control populations of native species to the greatest extent possible"*

2.5 The Role of the FMP in meeting Park Stewardship Goals

This Plan responds to the aforementioned policy compliance and planning direction by prescribing actions and procedures necessary to implement a complex program derived from the best available science. However, Grand Canyon National Park fire ecology knowledge remains incomplete (NPS 2000). Fire's role and application within the ecosystem can be more fully understood through an adaptive management strategy in which monitoring and research information are continuously integrated into the operational fire management program with appropriate interdisciplinary review. The ultimate aim of this Plan is to manage wildland fire to achieve stated Park resource and protection objectives within the framework of current laws, policies, approved plans, and associated environmental documentation.

[11]Resource Management Plan, page 3-112.

Chapter 3 Wildland Fire Management Strategies

3.1 General Management Considerations

Wildland fire will be managed to enhance resource protection, diminish risk and consequences of undesirable wildland fires and sustain naturally occurring vegetative communities. Goals have been developed based on review and analysis of the National Park Service Organic Act, the 1976 Authorities Act, the enabling legislation of Grand Canyon National Park, National Park Service Management Policies, the General and Resource Management Plans, the documented research on the natural role of fire in maintaining park ecosystems, and the analysis and public comment contained in the Environmental Assessment.

A community- based approach to wildland fire issues will involve close collaboration and cooperation with neighboring agencies that have a vested interest in areas of wildland fire issues.

DO- 18 identifies considerations to be addressed by park fire management programs. These are:

- Protection of human life, both employee and public;
- Protection of facilities and cultural resources; and
- Perpetuation of natural resources and their associated processes.

3.2 Wildland Fire Management Goals

The goal is to administer a wildland fire program that will do the following.

- Achieve maximum overall benefits within the framework of resource management plans and objectives while giving primary consideration to the safety of firefighters and the public.
- Educate employees and the public about the scope and effect of wildland fire management, including fuels management, resource protection, prevention, hazard/risk assessment, mitigation and rehabilitation, and fire's role in ecosystem management.
- Stabilize and prevent further degradation of natural and cultural resources lost in and/or damaged by the effects of wildland fires and/or fire management activities.
- Maintain the highest standards of professional and technical expertise in planning and safely implementing an effective wildland fire management program.
- Provide for employee development in a safe and supportive work environment.
- Integrate fire management with all other aspects of Park management.
- Manage wildland fire incidents in accordance with accepted interagency standards using appropriate management strategies and tactics and maximize efficiencies realized through interagency coordination and cooperation.
- Scientifically manage wildland fire using the best available technology as an essential ecological process to restore, preserve, or maintain ecosystems and use resource information gained through inventory and monitoring to evaluate and improve the program.
- Protect life and property and accomplish stated resource management objectives, including restoration of the natural role of fire in fire- dependent ecosystems.

- Effectively integrate the preservation of wilderness including the application of minimum requirement management techniques into all activities impacting this resource.

3.3 Wildland Fire Management Options

This section describes strategies for wildland fire suppression and use, prescribed fire, and non-fire applications. It is followed by descriptions and management directions for each Fire Management Unit (FMU) identified for the Park. All strategies and designated FMUs[1] identified below are in compliance with the Wildland and Prescribed Fire Management Policies, the Implementation Procedures Reference Guide (1998), and the National Park Service Management Policy Reference Manual (RM- 18, 1999).

Fire Management Strategies to be Employed

Three kinds of fire (and their management strategies) are to be applied within Grand Canyon National Park: ***wildfire*** (unwanted fire that is managed under a suppression strategy), ***wildland fire use*** (provides for resources benefits) and ***prescribed fire*** (including hazard fuel reduction and ecosystem restoration and management). The program does not favor one strategy over another without a thorough analysis of specific area and resource information, objectives, values to be protected, safety, risk, complexity, and other considerations.

Wildfire

Wildfire suppression is defined as an appropriate management response to wildland fire that results in curtailment of fire spread and eliminates all identified threats from the particular fire. All wildland fire suppression activities provide for firefighter and public safety as the highest consideration but minimize the loss of resource values, economic expenditures, and/or the use of firefighting resources (USDI 1999).

An "appropriate management response" refers to a specific action taken on a fire, regardless of ignition source or location, to implement protection and/or wildland fire use objectives for a specific unit in the Park (see FMUs below). Determination of appropriate response will include an evaluation of factors such as risk to firefighters and public health and safety, weather, fuels conditions, threats, and values to be protected. Therefore, management responses can vary by fire given the direction above. Specific and direct action can be taken along the perimeter to check spread locally; or suppression intensity can be maximized across the entire perimeter.

Wildland Fire Use

Wildland Fire Use refers to the management of naturally ignited wildland fires to accomplish specific, pre- stated resource objectives in predefined geographic areas. Operational actions are described in an approved Wildland Fire Implementation Plan (WFIP); see Sec. 4.3. In contrast, the term "***fire use***" is the <u>combination</u> of wildland fire use and prescribed fire application to meet resource objectives (NPS 1999).

Therefore, this strategy promotes concurrent use of all viable on- site management strategies and tactics that support resource management goals and objectives and mitigates threats to life,

[1] A "Fire Management Unit" is defined as a land management area definable by objectives, topographic features, access, values-to-be-protected, political boundaries, fuel types, or major fire regime, etc. that sets it apart from management characteristics of an adjacent unit.

property, and resources. NPS RM- 18 (1999) directs that mitigating actions that serve to increase the defensibility of a wildland fire be used for resource benefits, and this may include mechanical and physical non- fire tasks, specific fire applications, and limited suppression actions. These actions will be used to construct fireline, reduce excessive fuel concentrations, reduce vertical fuel continuity, create fuel breaks or barriers around sensitive sites or resources, create "blacklines" through controlled burnouts, and limit fire spread and behavior.[2]

Prescribed Fire: Hazard Reduction and Ecosystem Restoration and Management

Prescribed fire is any fire ignited by management action to meet specific resource and/or protection objectives. A written, approved prescribed fire plan must exist before ignition. The prescribed fire program at Grand Canyon National Park is aimed at restoring fire as a natural ecological process for the long term; however, for some areas, the immediate emphasis is hazard fuel reduction. Many areas subject to first- entry treatment may require subsequent treatment(s) to achieve hazard fuels reduction or ecosystem objectives, rather than attempting to meet all objectives on the first treatment and risk costly escape and/or unacceptable resource damage.

Prescribed fire also may be used to accomplish objectives within fire exclusion areas. "Exclusion areas" are defined as those areas within a designated FMU in which all wildland fires are to be aggressively suppressed because of their proximity to values to be protected. These will be detailed further below under the FMU subsections.

Hazard fuels management activities reduce the fire hazard when weather and/or risk assessments demonstrate a reasonable chance for future resource damage from unwanted wildland fires. The desired outcome is that through hazard fuels reduction activities, firefighter and public safety, real property, and sensitive natural and cultural resources are protected; potential suppression costs are significantly reduced; and over the long term, the restoration of fire back into fire- adapted landscapes can progress.

Hazard fuels reduction and ecosystem restoration and management objectives can be met through a well- planned series of projects where prescribed fire or combinations of prescribed fire with non- fire treatment can be employed.

Non- fire treatment includes pruning, thinning, lop/scatter, piling and burning, and chipping/mulching. Specific, pre- approved nonfire treatment strategies are used for accomplishing such operational tasks as pre- fire unit preparation, clearing around identified values to be protected, and treatment of concentrations of fuels that have potential to threaten control lines or result in unwanted crownfire under severe burning conditions. The Grand Canyon Resource Management Plan (1997) states:

> *"In order to safely conduct prescribed burns at the higher elevations, extensive site preparation is required such as stacking, piling of fuels, and thinning along block boundaries to prevent fire escapes. Many blocks will require two burns; the first to burn piles of dead and down materials, and the second the following year to broadcast burn the block. The need for such extensive site preparation is expensive and limits the amount of acreage fire crews can burn in any one season."*

Long- term application of prescribed fire treatments for ecosystem restoration and management is a key management strategy. Landscape- scale application of prescribed fire will be implemented as necessary to arrest the undesirable effects of past fire suppression in frequent

[2]NPS Wildland Fire Management Policy, RM-18 (1999), Chapter 2, page 3.

fire- return- interval vegetative types. Prescribed fire will be used to restore and maintain desired vegetative conditions within FMUs according to resource management goals and objectives.

3.4 Description of Wildland Fire Management Strategies by FMU

Fire Management Units (FMU)

The FMUs as described below are derived from the 1998 Fire Management Plan Amendment. The units formerly known as zones are defined primarily by like fuel types and similarities in fire behavior and effects. They do not necessarily correspond to those major vegetative types identified and discussed in Sec. 3.6, "The Historic Role of Fire", because of the dissimilarity between current and historical fire regimes for most types. Refer to the FMU Map in Figure 3- 1.

3.4.1 Ponderosa Pine FMU

Physical Description

This zone includes areas of the South Rim from Hermits Rest east to the Coconino Rim, that area in and around Mt. Emma bounded on the north and west by the Park boundary and on the east and south by the Toroweep Valley (south of the Tuweep Ranger Station); and Powell Plateau (North Rim) on the east.

The topography is generally flat on the plateaus, but can range from 0–60% including all aspects. The South Rim portion of the zone is generally flat. On the North Rim, the topography is generally flat to sloping with a generally east aspect in the Mt. Emma area and flat on the Powell Plateau.

Access on the South Rim is via the South Rim Drive to the western end of the zone at Hermits Rest, and connects on the east end to State Route 64 from Cameron, Arizona.

Specific Management Objectives

1. Provide for public and firefighter safety first in all fire management activities.
2. Limit visibility impacts by implementing Best Management Practices as defined in the Arizona Administrative Code. Protect human health by maintaining PM_{10} or $PM_{2.5}$ concentrations below the primary National Ambient Air Quality Standard (NAAQS).
3. Restore the vegetative structure to the natural range of variability, which must provide diverse habitats for native species.
4. Protect sensitive cultural resources through appropriate mitigation techniques. Ensure that the mitigation technique is appropriate for the specific sensitive resource.
5. Minimize invasive plant response to fire as measured through the Fire Effects Monitoring program through appropriate methods that provide for their management and control.

Management Constraints

See Subsection 3.5 below.

Values to Be Protected

Values to be protected include the following:

- Safety of firefighters, Park employees, and the public
- Air- quality- related values (entire unit)
- Adjacent agencies [US Forest Service (USFS) South Rim boundary; Bureau of Land Management, Arizona Strip District; Grand Canyon Parashant National Monument and Lake Mead National Recreation Area, north and west of Toroweep Valley]
- Potential wilderness (North Rim portion of zone including Powell Plateau)
- Real property (see Exclusion Areas below)
- Cultural resources (entire unit)
- Fire- dependent ecosystems from stand- replacement fire (entire unit)
- Exclusion areas (see below)

Exclusion areas for this unit include the following:

- Grand Canyon Village (includes South Entrance Station, Yavapai Museum)
- Supai Camp
- Hermits Rest
- Hance Air Quality Monitoring Site
- Abyss Air Quality Monitoring Site
- Yaki Point
- South Rim Forest Restoration Plots (includes Grandview Tower)
- Hopi Point Telecommunications Site
- Historic East Rim Entrance Station
- South Rim Shooting Range Facilities

Weather Cycles and Extremes

The fire weather (NFDRS) station that best represents weather in the Ponderosa Pine FMU is Tusayan (020207) on the South Rim, and Bright Angel (020211) and Lindberg Hill (020220) best represent the weather on the North Rim. (Detailed station catalog information for all Park weather stations can be found in the Fuel Moisture and Fire Weather Monitoring Plan, Branch of Fire and Aviation Management, Grand Canyon National Park.)

Generally, the climate of the South Rim is typical for this region of the Southwest. Annual precipitation averages between 14 and 16 in. on the South Rim and more than 25 in. on the North Rim. Low humidity and high summer temperatures result in high evapo- transpiration rates. Summer convective thunderstorms usually occur from early July, and continue through August and early September; they often contain lightning. Snow is possible from late October through April or into early May. Accumulations of snow are comparatively rare on the South Rim, but on the North Rim snows can be deep and persistent, exceeding 150 in.

The North Rim entrance road normally is closed from early November until mid- May. The spring and early summer months are normally dry, and summer temperatures can reach 98°F with relative humidity in the single digits. Winter temperatures can drop to - 20° F or below on the North Rim. The frost- free period ranges from 101 days on the North Rim to 148 days on the South Rim. The prevailing wind for most of the year is typically from the southwest.

Fuels, Fire Behavior, and Effects

Interpretation of data from monitoring plots by Northern Arizona University (Covington et al. 1999) show that the total dead and down fuel loadings on the South Rim ranged from 1.55 to 6.82

tons per acre. The Monitoring Type Description Sheet[3] for South Rim and North Rim ponderosa pine show typical total fuel loads of 2 to 8 tons per acre with averages estimated from 0.2 to 9.3 tons per acre.

The primary overstory type is ponderosa pine, represented by NFDRS[4] Fuel Model C (open pine with grass understory) for the South Rim forest and the majority of North Rim sites and NFDRS Fuel Model U (western long needle pine) in some areas of the North Rim.

The fuel models that factor into predictions of fire behavior under various environmental conditions, for ponderosa pine are best described as NFFL Fuel Models 9 and 10.[5]

Fire affects the accumulation and consumption of dead woody materials. Within northern Arizona ponderosa pine forests, prescribed fire under conditions of 8–12% duff moisture content consumed 63% of woody debris, including 99% of coarse woody (Covington and Sackett 1984). Snag densities and species diversity appear to be adequate for wildlife habitat purposes (i.e., may resemble pre- settlement conditions), at least for North Rim areas (Covington et al. 2000).

The oak component within the ponderosa pine forest type is maintained by periodic fire. The shrubby oak midstory on the western North Rim may be important for animals. The presence of multi- aged oak and locust thickets in recent burned areas and wide distribution of these clones suggest that the modern shrubby understory may have been characteristic of pre- settlement forests (Covington et al. 2000).

3.4.2 Mixed- Conifer FMU

Physical Description

This zone, with the exception of those areas of the North Rim portion of the Ponderosa Pine FMU areas described above, encompasses the entire North Rim of the Park.

Topography is mostly flat on the Kanab Plateau that is cut by a number of generally north- south trending drainages and minor canyons. The Walhalla Plateau represents the south- easternmost topographic feature within the zone.

Specific Management Objectives

1. Provide for public and firefighter safety first in all fire management activities.
2. Limit visibility impacts by implementing Best Management Practices as defined in the Arizona Administrative Code. Protect human health by maintaining PM_{10} or $PM_{2.5}$ concentrations below the primary National Ambient Air Quality Standards (NAAQS).
3. Restore the vegetative structure to the natural range of variability, which must provide diverse habitats for native species.
4. Protect sensitive cultural resources through appropriate mitigation techniques. Ensure that the mitigation technique is appropriate for the specific sensitive resource.

[3]Monitoring Type Description Sheets found in Grand Canyon Fire Effects Monitoring Plan (Appendix F).
[4]National Fire Danger Rating System.
[5]Northern Forest Fire Laboratory fire behavior model; Model 9 describes the primary carrier of the fire front as loosely compacted long-needled timber litter beneath timber and Model 10 as the same except there is a significant amount of larger fuels resulting in higher intensities.

5. Minimize invasive plant response to fire as measured through the Fire Effects Monitoring program through appropriate methods that provide for their management and control.

Management Constraints

See Subsection 3.5 below.

Values to Be Protected

Values to be protected are the same as for the Ponderosa Pine FMU (above).

Exclusion areas (and sites) for this zone are the following:

- North Rim Developed Area (includes CC Hill facilities)
- Kanabownits Cabin and Fire Lookout
- North Rim Entrance Area
- North Rim Fire Lookout
- Greenland Lake Cabin
- Lindbergh Hill RAWS Site
- North Rim Forest Restoration Plots
- North Rim dynamite cache (Marble Flats site)
- North Rim Shooting Range Facilities

Weather Cycles and Extremes

See the discussion above for general weather cycles and extremes.

The weather station that best represents unit weather is the Lindbergh Hill (020220), a permanent RAWS[6] unit established in 1993 and located approximately 5 miles north of the North Rim Developed Area at an elevation of 8800 ft. The other station is Bright Angel Station (020211) located at the North Rim Helibase at 8300- ft elevation.

Fuels, Fire Behavior, and Effects

The vegetative communities within the zone are mixed conifer with the exception of areas of nearly pure ponderosa pine on the southern ends of the Rim. Ponderosa pine ecosystems are considered to be well adapted to recurrent, low- intensity fire with occasional flare- ups and isolated torching where fuels have concentrated or pockets of dense thickets occur. Herbaceous vegetation, once abundant in the understory, has been replaced by thick needle mats and downed woody materials. This decline in herbaceous component has led to two changes in the fuels complex: a reduced ability for surface fires to carry on the surface and an eventual increase in ponderosa pine regeneration. Thus, a more common fuels and fire behavior characteristic within this type given present conditions particularly on the North Rim is high- severity fires (Harrington and Sackett 1998).

In the mixed conifer and ponderosa pine systems, the current accumulations of organic matter (litter, duff, and coarse organic materials) indicate retarded decomposition and cycling. Further, fire suppression and resulting regime alteration has led to the creation of a relatively even- aged ponderosa pine understory. Reduction in overall spread of early fires has caused increases in fuel loading.

[6]Remote Automated Weather Station.

In this type, fuels and associated tree densities were likely to have been more open in appearance before 1850. Although years of fire suppression reduce herbaceous diversity in mixed- conifer forests because of canopy closure (Covington and Moore 1994), the likelihood of stand-replacement crownfire increases with increased fuel loads and invading fire- intolerant species.

The results of the Wolf and Mast study (1998) indicate that most fires on the North Rim occurred during the monsoon circulation of July and August and that these results were consistent with lightning- ignited fires recorded by the Park. From 1926 to 1992, 128 wildland fires were caused by lightning and 8 were caused by humans.

On the North Rim Northern Arizona University study location, the dead and down fuels ranged from 12.33 to 34.47 tons per acre (Covington 1999). However, fuel loadings in this type are generally unknown, although preburn data from Park downed fuel inventory summaries for mixed conifer for 22 plots on the North Rim showed 36.90 tons per acre (includes litter and duff loads).

The NFDRS Fuel Model that best represents fuels is NFDRS G (closed stands of short needled conifer with heavy accumulations of dead and down fuels). The greatest resistance to control for wildland fires is in this zone. Fuels are heavy and continuous over most of the zone except in the southernmost peninsulas. In some areas of the North Rim characterized by ponderosa pine with white fir encroachment, the fuel load estimates are not completely known.

Fire behavior is largely a function of fuels and weather and, to a lesser degree, topography on the North Rim. In mixed conifer areas, the fuels are generally similar in type to the ponderosa pine type on the North Rim, but the surface fuel loads can be significantly higher. Fuels are often continuous, and fuel moistures can react with changes in weather conditions rapidly. The deeper organic duff and litter layers can increase ground fire residence time and consequently increase resistance to control. Fire behavior is also governed by midstory and overstory tree densities and laddering potential. These dense thickets may support high- intensity surface fire, intermittent or sustained crownfire that can become independent of surface fire spread under extreme burning conditions. Resistance to control becomes extreme in these cases.

Fire effects information from specific monitoring plot assessments for over 5 years postburn is not available, with the possible exception of fuel load reduction data (NPS 2000).

3.4.3 Grass- Shrub- Pinyon- Juniper FMU

Physical Description

The vegetative types that compose this zone have been combined for management purposes and in keeping with Management Policy (RM- 18, chapter 4), which directs that the number of zones (or "units") should be kept to the minimum. Essentially, for the purposes of this Plan, this FMU comprises the remaining areas of the Park. Topography and elevation ranges are extremely varied.

Specific Management Objectives

1. Provide for public and firefighter safety first in all fire management activities.
2. Limit visibility impacts by implementing Best Management Practices as defined in the Arizona Administrative Code. Protect human health by maintaining PM_{10} or $PM_{2.5}$ concentrations below the primary National Ambient Air Quality Standard.

2. Limit visibility impacts by implementing Best Management Practices as defined in the Arizona Administrative Code. Protect human health by maintaining a 24- hour average of PM 2.5 concentrations below 50 mg/m^3 at critical receptor sites.
3. Restore the vegetative structure to the natural range of variability, which must provide diverse habitats for native species.
4. Protect sensitive cultural resources through appropriate mitigation techniques. Ensure that the mitigation technique is appropriate for the specific sensitive resource.
5. Minimize invasive plant response to fire as measured through the Fire Effects Monitoring program through appropriate methods that provide for their management and control.

Management Constraints

See Subsection 3.5 below.

Values to be Protected

Values to be protected are similar to those listed in the other FMUs.

Exclusion Areas

- Desert View
- Indian Gardens
- Phantom Ranch
- Cottonwood
- Tusayan Ruins and Museum
- Lees Ferry
- Pearce Ferry
- Signal Hill Lookout/Pasture Wash Ranger Station
- Muav Saddle Cabin
- Roaring Springs residence and pump house facilities

Weather Cycles and Extremes

Refer to the weather discussion above under the Ponderosa Pine FMU. Extremes in temperature from the Canyon Rim to the inner Canyon can vary widely.

Fuels, Fire Behavior, and Effects

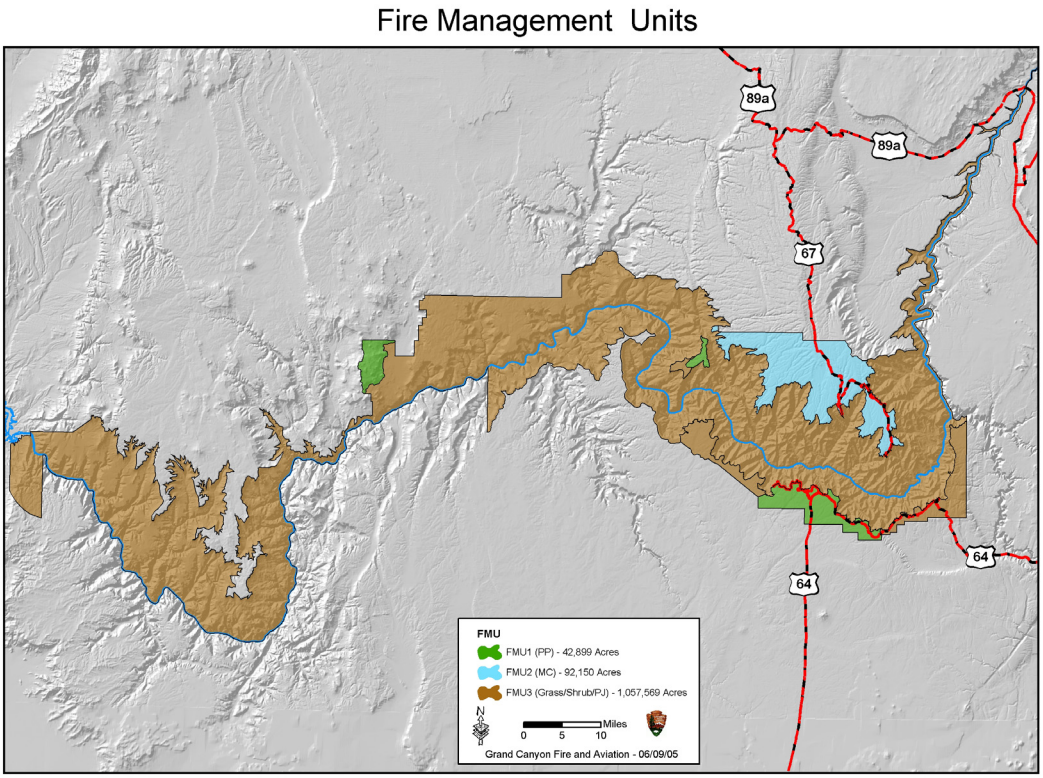
Ninety per cent of overstory stems in the pinyon- juniper association with ponderosa pine occasionally occurring in the overstory. Canopy cover can vary from 20–60%, with generally a sparse understory except for Gambel oak occurring in small patches. Brush and herbaceous cover is less than 50%. Preburn fuel loads range from 6 to 26 tons per acre from Park monitoring plots.[7]

Other than from a review of regional literature for similar fuel types, there are little measured fuels, fire behavior, and fire effects information. NFFL fuel models that best represent fuels in the zone are grasslands, NFFL Models 1 and 2 (Model 1 describes fine structured grass cover; Model 2 is grass usually under open timber or brush overstory); shrublands NFFL Model 6 (brush generally 2–4 ft in height); and pinyon- juniper woodlands, NFFL Model 8 (short- needle conifer

[7]In Grand Canyon Fire Effects Monitoring Plan (Appendix F).

litter under low winds) or approaching a Model 6 (only in closed- canopy pinyon- juniper with 20+ mph winds at midflame level). The latter case is atypical for most stands in the Park. Additional information is required to adequately assess response to fire in this zone.

Figure 3- 1. Grand Canyon National Park Fire Management Units.



3.5. Management Constraints

There may be management concerns connected with the accomplishment of management and tactical objectives and listed values to be protected. The following serve as mitigating guides for all wildland fire management operations within all FMUs as applicable:

- **Equipment use**
  All heavy equipment use for wildland fire emergencies, vegetation clearing, or other related projects must be pre- approved on a case- by- case basis by the Park Superintendent.

- **Air Quality**
  All project plans, including WFIPs (Sec. 4.3) and other operational documents involving wildland fire, must be approved under guidelines specified in the Smoke Management Action Plan (Appendix E).

- **Sensitive areas and/or species**
  Specific burnplans and other project plans shall be submitted to the Science Center for review and clearance or response if proposed work will potentially affect designated exclusion areas and/or listed species habitat.

- **Cultural Resources**
  Until programmatic clearance protocols can be developed, annual workplans from the Branch of Fire and Aviation will be submitted to the Science Center for field survey and clearance as required on a project basis.

- **Wilderness**
  Until programmatic minimum requirement guidelines can be approved, Interim Guidelines will be followed for all project work in proposed wilderness (see Appendix E).

- **Minimum Impact Suppression Techniques**
  Fire suppression tactics can have short- and long- term effects on the landscape. Minimum- impact suppression techniques[8] will be used for all approved actions under suppression and wildland fire use protocols.

3.6 Historic Role of Fire

A general fire history and a discussion of fire regimes of the Colorado Plateau and the Park are given here. A synopsis of current knowledge of specific fire regimes, historic changes to these regimes, and a discussion of fire ecology for the various dominant vegetative types found in the Park is also provided.

Fire History and Fire Regimes

In general, wildland fire is an ecological process that triggers a complex array of other processes and conditions on the landscape. Among them are effects on vegetative successional pathways from which plant species diversity is established and maintained. Recycling of carbon and nutrients depends on biological decomposition and fire. In regimes where decay is constrained by dry and cold climates, fire plays a dominant role in recycling plant debris (Brown 2000). The Grand Canyon region of the Colorado Plateau is an example of this process.

Precipitation variability, amounts, and timing are related on a larger scale to such events as El Niño and La Niña events in the Pacific Ocean. In the southwest, these events significantly affect disturbance processes such as wildland fires (Swetnam and Betancourt 1990). The historic record of lightning patterns and fires suggests that lightning alone may have been sufficient to maintain ignitions and historic fire regimes. Human- caused fires have likely also been a factor in shaping Grand Canyon ecosystems, but the effect of native burning on ecosystem dynamics remains uncertain (Covington, et al. 2000).

Variability in fire disturbance also interacts with vegetation over geographic and elevation gradients to create complex landscape patterns (Covington et al 2000, Romme and Knight 1981). Elevation gradients influence patterns of fire by affecting vegetation composition and productivity, which in turn increase with higher moisture availability as elevation increases (Goz 1992). For example, above the woodland between elevations of 6500 ft and 8200 ft on both the North

[8]MIST guidelines in: RM-18 (Chapter 9, Exhibit 5); Agency Administrators Delegation of Authority and Briefing Package (Appendix E); and Grand Canyon National Park Wildland Fire Suppression Pre-Attack Plan (Appendix E).

and South Rims is predominantly ponderosa pine forest. Research conducted on both rims shows that these forests are adapted to frequent low- intensity fire (NPS 1977). However, the spruce- fir forest of the North Rim above 8200 ft is characterized by both low- intensity and infrequent high- intensity fires (NPS 1997).

Within Grand Canyon National Park, fire regimes have been defined for several major vegetative types according to environmental gradients (Merkle 1954, Wolf and Mast 1998, White and Van Kat 1987). For the ponderosa pine and mixed- conifer type, the role of historic fire is better understood in terms of such factors as fire frequency and return interval, intensity, size of fire, pattern on the landscape, season of burn, and plant successional patterns. There is also a more complete understanding of these systems in the literature. For example, Brown (2000) reports that the frequency and extent of historical fires varied widely across early landscapes in the southwest. Typical return intervals ranged from 2 to 5 years in ecosystems composed of adequate amounts of fine dead fuels such as southwestern ponderosa pine, 5 to 35 years for dry- site conifers and most grasslands, and 35 to 200 years for mesic (moist) site western conifers.

Detailed information is generally lacking for pinyon- juniper woodlands, desert scrub types, and some lower elevation grasslands. Covington (2000) reports the majority of historic lightning fires at Grand Canyon occurred in ponderosa pine, mixed conifer, and meadow ecosystems (71%), with about 23% in pinyon- juniper woodlands and other above- rim vegetation and only 6% in below- rim vegetation. Historic records show that the highest month for lightning fire occurrence on both rims is July.

3.6.1 Ponderosa Pine Forest Type (Fire Return Interval: 2.97–8.94 years)[9]

This type is located in the 6000- to 8900- ft elevation range. The area covered by the type generally includes the South Rim areas from Hermits Rest east to the Coconino Rim, as well as areas of the North Rim including Powell Plateau, Kaibab Plateau, Walhalla Plateau, and in and around Mt. Emma bounded on the north and west by the Park boundary. It comprises approximately 43,000 acres.

Fire Regime

Early fires were most frequent on low- elevation "islands" of ponderosa pine forest formed by plateaus or points within the Park. Fires were less frequent on a higher elevation site located further to the interior of the North Rim plateaus. Interestingly, a low- elevation site on the South Rim had the longest pre- settlement fire- free intervals (9.94 years for large fires) (Covington et al. 2000). Also, Duhnkrack (1982) found an average return interval of 7.3 years for a 550- acre area on the South Rim of the Park. Fire dates in this sample were not cross- dated but still correlated well with the Covington results. In many cases, more limited fire history sampling areas yield longer fire intervals.

Covington et al. (2000) report that on the South Rim Grandview site, the fire frequency averaged 6.54 years from 1679 forward and then stopped abruptly in 1887. Seasonal distribution of early fires was evenly divided between spring fires (54%) and summer fires (46%), corresponding to thunderstorm events when convection produced lightning with or without precipitation.

The Covington (2000) study also reported the lowest fire return interval on the Powell Plateau between 1720 and 1899 of 2.97 years to 8.56 years. Seasonality at Powell and all North Rim sample sites showed later season fires, averaging 15–20% spring fires in contrast to Grandview.

[9]In Final Report, Research Objective 1: Landscape Studies of Fire Regimes and Forest Structure (2000), pg. 3.

The Fire Point mean fire interval showed 3.42 years for all scars between 1733 and 1879; Rainbow Plateau showed 3.86 years (all scars) between 1715 and 1879; and Swamp Ridge values averaged 5.06 years for all scars between 1721 and 1879 (Covington 2000).

Fire regime information from other southwestern studies for ponderosa pine correlates with the ponderosa pine forest types. Dieterich (1980) reported that fires were estimated to occur at an average of every 2 years in northern Arizona before 1876. Ponderosa pine/Gambel oak stands in southwestern Colorado were calculated at average fire frequencies of approximately 6 years (Harrington 1985). Fire frequencies of 4 to 7 years have been estimated for ponderosa and mixed conifer forests in Bryce Canyon National Park (Buchanan and Tolman 1983).

Changes in Fire Regime

Historical grazing practices, along with fire exclusion (suppression), have contributed to the creation of stand conditions that were rare or nonexistent in primeval ponderosa pine forests (Bradley et al. 1992, Mandany and West 1983). The fire regime in most of this forest type has been altered. Frequent fire regimes were disrupted in the forested highlands of the Arizona Strip as early as 1870 in the Mt. Trumbull area (Covington et al. 2000). As elsewhere in the Southwest, early livestock grazing resulted in removal of fine herbaceous fuels in the pine understory and significantly curtailed fire spread. With the establishment of Grand Canyon Forest Reserve in 1893 and later Grand Canyon National Park in 1919, organized fire detection and suppression continued to exclude the natural role of fire. Complete fire exclusion was achieved by about 1920 in ponderosa pine and mixed conifer forest types on the North Rim (Wolf and Mast 1998). Livestock were fenced out of the North Rim by 1938 (NPS 1999).

Fire Ecology

Although pre- settlement fires were frequent in most ponderosa pine stands, their severity remained relatively low (Bradley et al. 1992). These low- intensity fires generally restricted the accumulation of large, downed woody fuels. Stands had an open, Park- like appearance dominated by large, old, fire- resistant trees. Shrubs, understory trees, and downed woody fuels were sparse according to historical photographs (Brown and Smith 2000). Undergrowth was primarily of fire- resistant perennial grasses and forbs that resprouted following fire. Shrubs were suppressed by frequent burning together with overstory competition (Gruell et al. 1982).

Ponderosa pine is a highly fire- adapted species, with its characteristic protective bark layer, high pruning ability, and open- growing patterns of uneven- aged patches. Bradley, et al. (1992) describe the typical openness of old- growth stands that created a warm, dry microclimate, which in turn dried fuels, creating a high ignition potential. However, when these stands were adjacent to sapling thickets, the risk of high- intensity crownfire increased. In the openings between trees, the litter accumulation is sparser, and fires are not as hot, so seedlings and saplings have a greater chance of survival. Typically, a high annual needle- cast in ponderosa pine can result in increasingly higher intensities of fires. Buildup of litter and downed woody fuels over time in the absence of low- intensity surface fires promotes high burning intensities (USDA 1982). Other fuels- related characteristics associated with this type are the following:

- Decreases in soil moisture
- Decreases in net productivity and diversity of herbaceous plants
- Decreases in tree vigor, especially in the older age class of ponderosa pine
- Decreases in animal productivity

- Decreases in water availability (springs and seeps)
- Increases in susceptibility to insects
- Increases in fire severity and size

Fire severity and intensity have a large influence on the composition and structure of the successional plant community following fire. As a general rule, in fire- evolved systems such as ponderosa pine, burned areas tend to return to the same flora that was there before fire (Lyon and Stickney 1976). However, with changes in the fire regime, often fires of unusually high severity (i.e., stand- replacement fires crown fires) create opportunities for new plants (including alien species) to establish from offsite seed. Fires of low severity are followed by a strong sprouting response except where annuals are the dominant vegetation (Brown and Smith 2000).

3.6.2 Mixed- Conifer Forest Type (Fire Return Interval: 4.85–10.33 years)[10]

Located on the Kaibab Plateau on the North Rim of Grand Canyon National Park, this forest type generally includes an elevation range between 6600 and 8500 ft. The Walhalla Plateau and the Basin area are most representative of this type.

Fire Regime

Most of the mixed- conifer type is characterized by a variable fire regime that includes frequent, low- intensity surface fire and infrequent, high- intensity stand- replacement fire (NPS 1997).

Wolf and Mast (1998) summarize the fire history from a study of mixed- conifer forest on the North Rim, finding that during the period before 1870, the interval across the entire elevation gradient was about 5 to 10 years; from 1870 to 1919 it was about 5 to 6 years; and between 1920 and 1995, there was a longer interval of about 19 to 75 years (except at the lower elevations where no difference occurred). Seasonality of most historic fires within the mixed- conifer forest was narrow, generally occurring during July and August when probability of lightning ignitions was highest.

The study also found that the fire frequency was reduced in the high elevation ecotone, reflecting a more mesic condition and snow persistence for longer periods. This condition and the relatively sparse human occupation of this area encouraged those species favoring lower fire frequencies.

Fire history studies in other mixed conifer forest types yield similar results. Kilgore and Taylor (1979) estimated the fire frequency for mixed conifer in the southern Sierra Nevada to be between 8 and 18 years. Youngblood and Mauk (1985) report that the pre- settlement fire interval for mixed conifer was probably relatively short.

Changes in Historical Fire Regime

Permanent settlement began in the 1870s when Mormon settlers migrated to the area. As populations increased, cattle grazing altered the fire frequency by removing grassy ground cover, thereby encouraging tree germination on exposed soils (Stein 1988; White and Vankat, 1992). Without an herbaceous component to carry fire to any degree, combined with the effects of fire suppression practices beginning in the 1920s, natural fire return intervals lengthened. This has resulted in changes of minor to major consequence.

[10]In *Fire History of Mixed-Conifer Forests on the North Rim, Grand Canyon National Park,* pg. 7

Bradley et al. (1992) report a dynamic similar to the North Rim mixed conifer forest in that historic grazing within mixed conifer forest in open stands of white fir, blue spruce, Douglas- fir and ponderosa pine severely reduced the available fine fuel and thus the frequency of light surface fires. This in turn permitted large numbers of conifer seedlings to establish in years when spring moisture was above average. As stands became denser, the less tolerant ponderosa pine seedlings were out- competed by Douglas fir and white fir. White fir, the most tolerant species, formed a dense understory, setting up conditions for unnaturally intense wildfires.

Fire Ecology

Fire effects within the mixed conifer forest type are varied. Surface fires occasionally opened gaps in forest canopies that in turn increased habitat diversity and released suppressed species. Nutrients were released without inducing mortality in the larger and taller trees (Swetnam and Baisan 1994). Surface fires also encouraged germination and competition between species but did not favor the perpetuation of new seedlings and reduced invasions of shade- tolerant species (Covington and Moore 1992; Dieterich 1983; Harrington and Sackett 1992).

Examples include **subalpine fir,** which is the least fire- resistant conifer of all overstory species. Thin bark, resin pockets, and a low, dense branching pattern and naturally higher density stands contribute to its fire- prone characteristics. Therefore, it can become a dominant overstory species in the absence of fire. **Englemann spruce** is also a fire- vulnerable species within this association, with flammable lower branches, a dense thicket growth pattern, and thin bark. However, successful regeneration becomes reduced 100 to 150 years after establishment as a result of accumulated duff inhibiting seedling establishment. **Douglas fir** is somewhat fire- prone, with the exception of the mature stems, which develop thick, heat- resistant bark. Low, dense branching patterns often create ladder- fuel configurations that promote crownfire conditions. **White fir** is most fire susceptible during early growth stages, with thin bark and low- growing branches. This species develops a thicker, more fire- resistant bark, and seedlings can survive in relatively deep litter. **Aspen** stands found within the mixed- conifer forest are considered fire-susceptible because of their thin bark. However, aspen clones can be viewed as fire dependent, with levels of root- sucker reproduction directly related to fire intensity. Moderate- to high-intensity fire results in prolific sprouting (USDI 1997). Moreover, the abundance of aspen groves on the North Rim may be an indication of extensive historical fires (Merkle 1954).

3.6.3 Pinyon- Juniper Woodland Type (Fire Return Interval: Mixed, Variable 10–49 & 70-100+ years)[11]

Covering an elevation gradient of approximately 4000 to 7000 ft, this type includes the inner canyon from Grand Wash Cliffs to Lee's Ferry to the Coconino formation, plateau areas of the South Rim from Hermit's Rest to the Great Thumb, from the Coconino Rim east to Desert View, and Powell Plateau.

Fire Regime

The overall fire regime in the pinyon- juniper woodland type is perhaps the most complex and variable of all the types covered in this section. Moreover, pinyon- juniper fire regimes and long-term fire frequencies have not been clearly defined (Bradley et al. 1992). They are often wedged between ponderosa pine or mixed conifer and grasslands or sagebrush that were known to have burned periodically, and pinyon and juniper are known for a lack of fire scars and hence fire

[11]From literature only.

history information. However, it is suspected that before the introduction of heavy livestock use, large areas of savanna and woodland periodically burned. These fires could have occurred during dry years that followed wet years when substantial herbaceous growth developed (Swetnam and Baisan 1996).

Several studies have documented fire frequencies in the Southwest. A sample of fire- scarred pinyon trees from three locations in southern New Mexico indicated a mean fire interval of 28 years with a range of 10 to 49 years (Wilkinson 1997). A surface fire interval in the pinyon- juniper and ponderosa pine ecotone at Walnut Canyon National Monument, Arizona, of 20 to 30 years was found (Despain and Mosley 1990). However, fire regimes can vary widely depending on the stage of succession and other factors.

The spread or "invasion" of juniper onto former grassland sites may also apply to Grand Canyon woodlands. One study (Bunting 1992) reports that most of the juniper establishment has occurred during the period of Euro- American influence on the site and that fires have been relatively rare in the past century. Most areas studied have had periods of rapid invasion of juniper, often in the 1900–1940 period, followed by a decrease in establishment of new plants. Pinyon, if present, becomes established on the area after the juniper have modified the site conditions.

Changes in Fire Regime

There are no definitive studies that look at Grand Canyon pinyon- juniper woodland's evolutionary changes over time from human and fire- related activities. However, the long history of livestock grazing in many pinyon- juniper woodlands on the Colorado Plateau generally has both diminished and altered herbaceous vegetation from suppression of former fire regimes since the late 1800s (Everett 1987). Major vegetative changes include decreases in associated cool- season grasses and increases in grazing- resistant plants such as snakeweed and big sagebrush. Densities of overstory can now support crown fires in several areas. However, work is needed in the pinyon- juniper woodland type to determine exactly what pre- settlement role fire played and how fire may be used in this type in the future.

Fire Ecology

The resilience to fire of individual woody species in the pinyon- juniper woodland community is extremely variable. Fletcher (1998) reports that juniper and oak can readily sprout when top-killed by fire, but pinyon generally succumbs to relatively light surface fires. The age of pinyon, percentage of oak in the woodland, and presence of juniper with ponderosa pine are among the determinants of historic pinyon in the historic fire regime. Much of this complexity can be interpreted from existing conditions on a site by site basis.

A successional model for southwestern Colorado and northern Arizona pinyon- juniper woodlands (Arnold et al. 1964; Erdman 1970) progresses from skeleton forest and bare ground, to annual stage, to shrub- open tree stage, and to climax woodland, presumably without fire. This pattern may take 300 years; however, fires could set back succession depending on severity. In more open stands, shrubs and herbaceous cover may carry fire; but as the overstory matures the understory cover becomes too sparse, fire's ability to carry declines. As the canopy closes, conditions increase for crownfire with sufficient wind (Bradley et al. 1992).

3.6.4 Desert Scrub Association (Fire Return Interval: Variable)

The desert scrub association comprises the largest land area within the Park. The Mohavean desert scrub extends from the Grand Wash Cliffs in the extreme western portion to near the confluence of the Colorado and Little Colorado Rivers. Upstream of the Little Colorado River in Marble Canyon and on the Tonto Platform, species more characteristic of the Great Basin Desert predominate (NPS 1997). The elevation range for this type is generally below 6300 ft.

Fire Regime

The fire regime is considered stand- replacement and dependent on ignition sources and the overall development of the plant community.

Given the generally sparse arrangement of vegetation and comparatively low historical fire occurrence in this type, Park- specific information on fire regime and overall fire ecology is not abundant. Studies in the northern Great Basin suggest that a fire return interval, with sufficient fuel continuity (i.e., sagebrush, etc.) to carry fire, may be 10 to 70 years (Vincent 1992; Young and Evans 1991; in Brown and Smith 2000). Arid land fire history studies report fire intervals between 5 and 100 years (Wright 1986 in Brown and Smith 2000).

Changes in Fire Regime

The effects of grazing within the Park may have had an impact on the fire- carrying ability in the desert scrub type. Woody species may have been favored by the reduction of grass and forb competition because of grazing of burros and other ungulates. Burros were reduced from the Park as late as the 1970s and early 1980s, with approximately 500 animals removed (NPS 1997).

Fire Ecology

Historical accounts within the sagebrush and desert scrub association on the Colorado Plateau are sketchy, but fires in big sagebrush were set by both lightning and humans. Typical succession after fire would begin with a grass/forb dominance and eventually lead to sagebrush recovery in 30 years or more (Paysen et al. in Brown and Smith 2000).

The introduction and spread of alien cheatgrass species in the early 1900s correspond with increased fire frequency and the reduction of big sagebrush, which in turn further damaged native perennial grasses and forbs (MacMahon 1992 in Brown and Smith 2000). Covington et al. (2000) reported that cheatgrass was encountered in low frequencies within herbaceous and shrub communities but remains a concern for further spread with fire. However, little more is known regarding the extent of alien species occupation within the Park.

Other literature references for the ecology of fire within the desert scrub type may be found in Brown and Smith (2000), Bradley et al. (1992), and Evers (1998).

3.6.5 Mixed Grass Forb Association (Fire Return Interval: 4–20 years)

This association is located west of Tuckup Canyon and in the Toroweap Valley on the Kanab Plateau and the Grand Wash Cliffs of Grand Canyon National Park. Elevations range from 6500 to 7500 ft.

Fire Regime

In the stand- replacement grassland fire regime, fires could occur where grasses were continuous and cured enough to carry fire. Although fire return intervals are difficult to measure with precision, they likely ranged from approximately 4 to 20 years (Gruell et al. 1985; in Brown and Smith 2000). Another study (USDA 1996) reports that pre- European settlement fire frequency in grasslands was most likely 5 to 10 years.

Changes in Fire Regime

The higher elevation grasslands and meadows have been used for summer forage for cattle and sheep since the 1800s. This, along with the suppression of wildfire, has led to an overall decrease in mountain grassland habitats throughout the highlands of the Colorado Plateau. Conifers are invading meadow margins, and increased tree densities in surrounding forested areas may be further contributing to declining grasslands by transpiring water that previously kept many meadows moist (Allen 1989; Archer 1994; Branson 1985).

Fire Ecology

Grasslands can be maintained by fires, but soil factors or other site conditions may also contribute (Allen 1984; Daubenmire 1943 in Bradley et al. 1992). In the past, fire in grasslands would burn over large areas until halted by natural barriers, precipitation, or vegetative type change. Some grasslands on productive sites are capable of producing large amounts of herbage yet possess slow decomposition rates. In such cases, litter buildup often suppresses growth and burning will stimulate reproduction in native perennials (Mueggler 1976, in Fletcher 1998).

3.7 Historical Weather Analysis and Fire Season

This section discusses the wildland fire situation for Park ecosystems. The historical weather analysis provides background on climate necessary to understand the determinants of the typical fire season.

Historical Weather Analysis

A key feature of the southwestern environment that causes fire occurrence is a plentiful source of fire ignitions through high levels of lightning activity (Barrows 1978; Reap 1986 in Allen 1999). Convectional thunderstorms that generate lightning occur frequently in the region, particularly during the summer "monsoon" season when warm temperatures and influxes of maritime moisture trigger cloud buildups over the higher elevations.

An important aspect of this lightning activity is occurrence during warm and dry periods including the foresummer months of April through June. Sporadic storms or convective clouds that generate virga (rain that evaporates before reaching the ground surface) often generate "dry" lightning strikes. These strikes are the most significant source of ignitions and fire spread because of dry fuels. Therefore, climate and fuel conditions are the main drivers of fire regime dynamics in the region (Swetnam and Betancourt 1990; Swetnam and Baisan 1996 in Allen 1999).

Substantial variability in regional precipitation can occur as a result of large- scale events such as El Niño/Southern Oscillation phenomena and other factors. Reconstructions of climate for the past 2000 years show that patterns of substantial precipitation variability, including severe and sustained regional droughts, have occurred (Grissino Mayer 1996 in Allen 1999). Climate variability acted to synchronize regional fire activity, with the largest fire years in ponderosa pine

forests occurring in dry years that followed within 1 to 3 years of wet conditions (Swetnam and Baisan 1996 in Allen 1999).

Fire Season

The annual fire season occurs generally from early April on the South Rim with over a month lag for North Rim forested areas. Solar radiation on fuels under the canopy following snow melt results in rapid drying of down- and- dead fuel beds. Spring winds normally accelerate drying, and by the middle to end of May, the South Rim fuels and inner canyon shrubs and associated grasses have reached minimum dead fuel moistures. North Rim fuels again lag by several weeks or more, depending on winter and early spring precipitation in the form of snow. By June, all dead fuel moistures are reaching seasonal minimums and live fuels are at full turgor. Grasses have generally greened up, shrubs and trees are transpiring, and live fuel moistures in normal years are generally high. However, spring and early summer seasonal growth can be retarded during drought years, depending on the severity and length of previous years' precipitation patterns locally. Live vegetation is stressed and becomes more highly flammable as the season progresses, and dead fuel moistures are at minimum and can become totally available for combustion.

Mid- and late- summer (July, August, early September) weather patterns often dictate fire season severity. If the annual summer thunderstorm pattern is late or nonexistent, fires that do start have high severity potential and become larger. Section E- 3 in Appendix E contains graphics that illustrate fire occurrence by type, cause, month, and numbers per fire- day for the past 10- year period

Late summer and fall following a normal monsoonal pattern is often characterized by a "secondary" fire season. Human- caused starts may become problematic, depending on the amount and distribution of summer moisture. Dead woody fuels are losing moisture but at slower rates than during late spring because of decreasing day lengths and cooling temperatures with increased humidity recovery at night. Warm season grasses are normally curing or cured, and cool season grasses remain green or are greening. Fire severity is normally lower during the fall season, and opportunities for prescribed fire in certain fuel types generally exist.

Critical fire weather occurs in the Southwest with greater frequency and persistence than anywhere in the United States. One of the most frequent regimes of lightning- caused fires occur in the southwest. Climate can vary from periods of intense precipitation in the form of summer rainfall to varying- length episodic drought. These regional drought patterns through time have been reconstructed from tree- ring chronologies sampled in the Southwest (Swetnam 1994). Evidence supports the hypothesis that fuels and climate were primary controls of fire regimes. Specifically, active fire years are shown to be tied to moisture levels of the previous 1 to 3 years (Swetnam and Betancourt 1990; 1992). Thus, climatic variations for this region drive fire activity to a significant degree.

3.8 Values to be Protected, Managed, or at Risk

For the purposes of this Plan, the following discussion pertains to those Park values and characteristics that are directly related to the fire management program.

Public and Firefighter Safety

Visitors, Park concessionaires, and NPS employees present unique challenges when managing wildland fire risk. Frontcountry, backcountry, river use, air, and mule- tour use compose the bulk

of visitor presence. Consequently, road, trail, boat, and air space all become Park values to be protected as a result of human presence.

National Park Service wildland fire policy clearly states that the first priority is firefighter and public safety in all fire management activities (NPS 1998).

Adjacent Land Management

Park boundaries are to be protected in such a manner and degree as to be consistent with the wildland fire management objectives of the adjacent land management entity. Many of the areas listed below that border the Park are often managed for a greater variety of recreational, traditional, and multiple- use activities than Park lands. These activities may require that boundary protection from wildland fire be provided. Figure 3- 2 is a map depicting the adjacent land ownerships to the Park.

Approximately 400,000 acres of the Bureau of Land Management (BLM) Arizona Strip District, including several units immediately adjacent to the Park, are designated wilderness areas.

Planned development near the village of Tusayan could significantly increase the number of employees living in the area, as well as increase tourist facilities and support infrastructure (NPS 1997).

Lands adjacent to the Park include the following:

- US Forest Service, Kaibab National Forest (North and South Kaibab)
- Department of Interior, BLM, Arizona Strip Field Office
- Havasupai Indian Reservation
- Navajo Indian Reservation
- Hualapai Indian Reservation
- Department of Interior, National Park Service, Lake Mead National Recreation Area
- State of Arizona
- Private In- Holdings

The Park and the Bureau of Indian Affairs (BIA) have executed a cooperative agreement for fire management along their common boundary. Memoranda of Understanding are in place regarding the Great Thumb and Supai Camp areas.

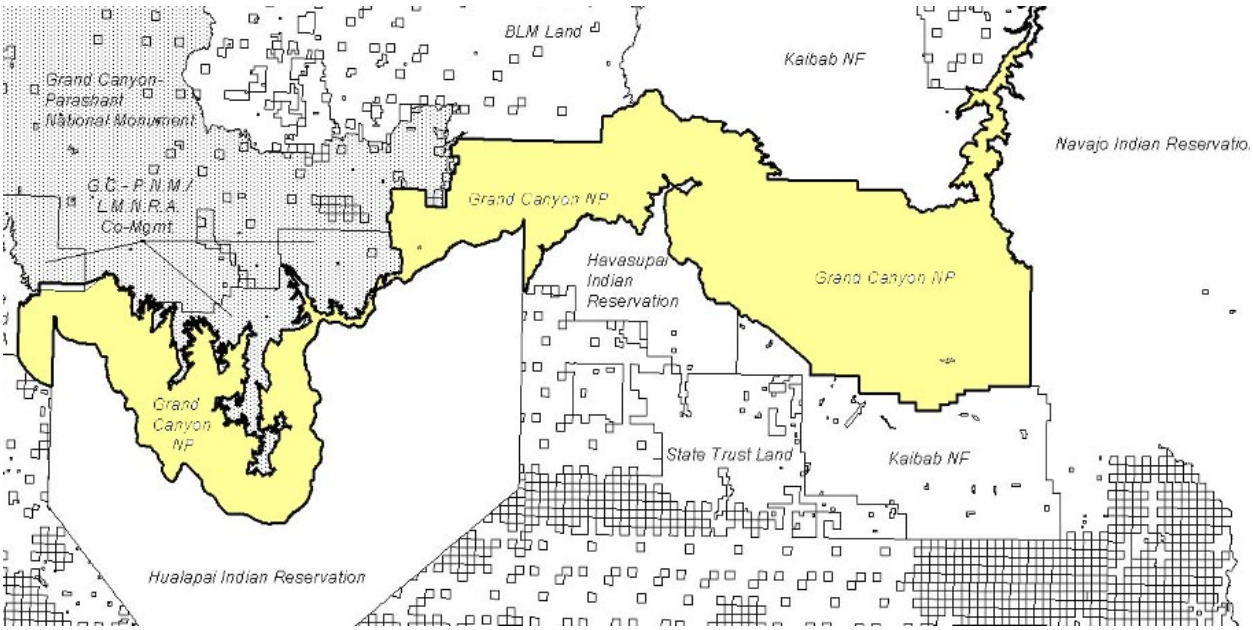


Figure 3- 2. Land Ownership Adjacent to the Park.

Air- Quality- Related Values

Park values concerning air quality involve the great diversity of scenery, including forests, deserts, canyons, plains, plateaus, volcanic features, streams, and waterfalls. The Grand Canyon's air quality greatly affects the clarity and color tones of the visual scene (NPS 1997). Smoke has the potential to affect human health. As smoke from wildland and prescribed fires can affect these values to be protected, smoke will be managed as part of the wildland fire program.

Wilderness

Over 1,000,000 acres of the Park qualify for inclusion in the National Wilderness Preservation System. If combined with over 400,000 additional acres of proposed or designated wilderness contiguous to Park boundaries, the area may become one of the country's largest, primarily desert, wilderness areas. According to NPS Fire Management Policy DO- 18 (1998), all fire management activities within wilderness, including the categories of designated, recommended, potential, proposed, and study areas, will be conducted in keeping with minimum requirement protocols.

Real Property Values at Risk

Four existing developed areas that contain real properties are situated in proximity to wildland fuels (commonly termed the "wildland- urban interface" or "intermix"). Within the Park, these areas are Grand Canyon Village, the North Rim developed area, Desert View, Tuweep, and, to an increasing degree, the planned development at Tusayan. These areas include such values at risk as Park structures, concessionaire buildings, and power lines immediately adjacent to the areas. This concern is compounded on the South and North Rims by high concentrations of visitors and employees, access, slopes, lack of close proximity to mutual aid resources, and specific locations where inadequate defensible space may exist.

Fire- Dependent Ecosystems and Habitats

Fire is an integral process in many southwestern ecosystems as demonstrated by fire scar records showing that past fires were frequent and widespread in forested landscapes (Swetnam and Baisan 1994). Even many desert grasslands apparently sustained significant fires (Bahre 1991).

Disruption or alteration of the natural processes and conditions at Grand Canyon began, in some cases, before the Park's designation. Overgrazing of Park lands was significant before 1919 and caused changes in vegetation composition that exist today in some areas. Beginning in the 1920s, fire suppression allowed tree densities to increase, fire intolerant species to expand their range, and dead and down fuels to build up (NPS 1997). This included native forest, meadow, and shrub communities. These human- induced changes triggered a shift to forests that have little similarity to the pre- settlement forests (Harrington and Sackett 1988). These altered conditions combined with the normally dry climate and frequent lightning and human- caused ignition often result in a severe threat of destructive crown fires.

The change in plant communities is believed to have altered the faunal composition of the area and may have contributed to the loss or severe decline of many species (NPS 1997). Therefore, the value to be managed as well as protected over the long term is habitat diversity related to both plant and animal populations, including the special status species.

Cultural Resources

National Park Service Management Policies (1988) for cultural resources state:

> *"…archaeological resources are preserved and protected by eliminating and avoiding natural and human impacts, stabilizing sites and structures, monitoring conditions, complying with and enforcing protective laws and regulations, and other means as appropriate…"*

The Park continues to survey and collect information on cultural sites. Surveyed and unsurveyed cultural resources on Park wildlands, as well as information concerning ethnographic resources and traditional uses, remain values to be protected during all fire management activities.

National Register and List of Classified Structures (LCS)

Resources may include: historic sites, structures or districts; cultural landscapes; traditional use areas; and documented or undocumented archaeological sites.

3.9 Class I Airsheds

The Grand Canyon National Park Fire Management Program must meet the requirements of the Clean Air Act when planning and implementing fire management activities. The Park is classified under the Clean Air Act as a Class I area; that is, the highest standards of clean air for any federal area are maintained.

Although air quality regulations impose the greatest constraints on the management of fire at this time, it is anticipated that these restrictions on the Park fire management program will continue until the effects of smoke on human health and welfare can be mitigated significantly with the long- term use of fire.

Policy and Legal Direction

Under the Clean Air Act as amended,[12] the Arizona Department of Environmental Quality (ADEQ) is required to minimize smoke effects resulting from prescribed fires and wildland fires managed for resource benefits. The Clean Air Act directs that all federally managed lands come under the jurisdiction of the state in matters relating to air pollution from wildland burning. The Park shall follow all applicable requirements prescribed by ADEQ under this Code.

Objectives

With respect to wildland fire smoke and ignitions within the Park, the following protection objectives relating to smoke emissions will guide the fire management program.

- Use "Emission Reduction Techniques" (R18- 2- 1509) and "Smoke Management Techniques"(R18- 2- 1510) specified by the State of Arizona.
- Particulate concentrations[13] do not exceed the National Ambient Air Quality Standards (NAAQS).
- The park will use optical measurements of visibility from transmissometers to monitor smoke impacts and identify needs to reduce those impacts.

Protection objectives are designed for managers of prescribed fires and wildland fire use fires to minimize long- term, negative air quality impacts to visibility while protecting human health and welfare. Unwanted wildland fires are deemed emergencies, and thus, many mitigation measures for smoke emissions may not be accomplished.

Air Quality Issues

A. Canyon Rims and Trails

Smoke along the Canyon Rims and inner Canyon trails can affect individuals in a variety of locations. Areas of special concern include trails within the Canyon (especially corridor trails), and the North and South Rim developed areas. Efforts to reduce pollution from smoke emissions should be coupled with intensive educational efforts for those at risk (especially hikers and people with pre- existing heart and respiratory conditions) and area closures in extreme cases.

Similar concerns affect the North and South Rim developed areas. Although people in these areas are not necessarily exercising, the elevations tax the cardiovascular abilities of many visitors. They can be vulnerable to the adverse affects of increased particulate loads.

B. Tusayan and Grand Canyon Village

Historical weather analysis from the Tusayan weather station shows that the greatest proportion of significant wind events (>15 mph at eye level) come from the south and west.[14] Given fuel conditions in areas southwest and west of Tusayan and Grand Canyon Village, the risk of high-intensity crownfire is less than other areas on the South or North Rim forested areas.

[12] CAA, 42 U.S.C. 7418, Sec. 118.
[13] PM_{10} and $PM_{2.5}$ particulates measured as diameters of a particle expressed in microns, measured by monitors and averaged over 24 hours.
[14] Smoke Management Plan for Tusayan and Grand Canyon Village (2001), page 7.

Smoke may negatively affect air operations at Tusayan Airport, over the Canyon, and travelers and commercial businesses in the area. Prescribed fire projects conducted around Grand Canyon Village, Tusayan, and the highway corridors to mitigate hazard fuels conditions in these interface areas have been ongoing since the 1970s. At times, the smoke produced during these prescribed fire projects has negatively affected these areas despite the best management to accomplish stated protection objectives. Impacts on the socioeconomic well- being of the area are realized in the short term, but local businesses also recognize that undesirable wildland fires during busy summer seasons may cause greater losses of revenue.

Mechanical reduction of fuels combined with prescribed fire applications is a technique that can reduce wildland fuels; however, residues from mechanical fuel reduction work often require burning, thus creating smoke that must be managed. The Smoke Mangement Plan for Tusayan and Grand Canyon Village is a cooperative plan developed by the U.S. Forest Service, Kaibab National Forest, and Grand Canyon National Park to respond to the continuing need for fuels management in these populated and sensitive areas.

Requirements of the Arizona Department of Environmental Quality

The Park will follow guidelines described in the ADEQ Final Forest and Range Management Burn Rule (Arizona Administrative Code R- 18- 2, Article 15, last amended in 2004). See Appendix E. Techniques and procedures listed are intended to respond to the objectives for air quality (stated above) that minimize undesirable impacts to public health, welfare, and visibility- related values.

Annual Prescribed Fire/WFU Registration

All planned prescribed fire projects will be registered annually on the format prescribed by ADEQ[15] as well as areas considered for potential wildland fire use fires (WFU). Registration information will include all elements required by the state under R18- 2- 1503:

1. The park's name, address, and business telephone number;
2. The name, address, and business telephone number of an air quality representative who will provide technical support to ADEQ for decisions regarding prescribed burning;
3. All prescribed burn projects and potential wildland fire use areas planned for the next year;
4. Maximum project and annual acres to be burned, maximum daily acres to be burned, fuel types within project area, and planned use of emission reduction techniques to support the annual emissions goal for each prescribed burn project;
5. Planned use of any smoke management techniques for each prescribed burn project;
6. Maximum project and annual acres projected to be burned, maximum daily acres projected to be burned, and a map of the anticipated project area, fuel types and loading within the planned area for an area the park fire management staff anticipates for wildland fire use;
7. A list of all burn projects that were completed during the previous year;
8. Project area for treatment, treatment type, fuel types to be treated, and activity fuel loading to support the annual emissions goal for areas to be treated using non- burning alternatives to fire; and
9. The area treated using non- burning alternatives to fire during the previous year including the number of acres, the specific types of alternatives utilized, and the location of these areas.

[15] See ADEQ website www.adeq.state.az.us

After consultation with park staff, ADEQ may request additional information for registration of prescribed burns and wildland fire use to support regional coordination of smoke management, annual emission goal setting using ERTs, and non- burning alternatives to fire. The park staff may amend a registration at any time with a written submission to ADEQ.

At least once every five years, ADEQ will request long- term projections of future prescribed fire and wildland fire use activity from the park to support planning for visibility impairment and assessment of other air quality concerns by ADEQ.

Burn Plan Contents

Burn plan information will be transmitted to ADEQ as required under R18- 2- 1504, no later than 14 days before a prescribed fire. This information is a binding restriction under which the burn will be conducted.

1. An emergency telephone number that is answered 24 hours a day, seven days a week;
2. Burn prescription;
3. Smoke management prescription;
4. The number of acres to be burned, the quantity and type of fuel, type of burn, and the ignition technique to be used;
5. The land management objective or purpose for the burn such as restoration or maintenance of ecological function and indicators of fire resiliency;
6. A map depicting the potential impact of the smoke unless waived either orally or in writing by ADEQ. The potential impact shall be determined by mapping both the daytime and nighttime smoke path and down- drainage flow for 15 miles from the burn site, with smoke- sensitive areas delineated. The map shall use the appropriate scale to show the impacts of the smoke adequately;
7. Modeling of smoke impacts unless waived either orally or in writing by ADEQ, for burns greater than 50 acres per day. In consultation with park fire management staff, ADEQ shall provide guidelines on modeling;
8. The name of the official submitting the Burn Plan on behalf of the park; and
9. After consultation with park staff, any other information to support the Burn Plan needed by ADEQ to assist in the Daily Burn authorization process for smoke management purposes or assessment of contribution to visibility impairment of Class I areas.

Burn Requests and Authorization

The park fire management will shall complete and submit to ADEQ the "Daily Burn Request" form supplied by ADEQ for prescribed fired. As required by R18- 2- 1505, the Daily Burn Request form shall include:

1. The contact information of the park;
2. Each day of the burn;
3. The area to be burned on the day for which the Burn Request is submitted, with reference to the Burn Plan, including size, legal location to the section, and latitude and longitude to the minute;
4. Projected smoke impacts; and
5. Any local conditions or circumstances known to the park staff that, if conveyed to ADEQ, could impact the Daily Burn authorization process.

The park fire management staff shall submit the Daily Burn Request form to ADEQ as expeditiously as practicable, as but no later than 2:00 p.m. of the business day preceding the burn. An original form, a facsimile, or an electronic information transfer are acceptable submittals.

After consultation with park staff, ADEQ may request additional information related to the burn, meteorological, smoke dispersion, or air quality conditions to supplement the Daily Burn Request form and to aid in the Daily Burn authorization process.

Fire management staff shall not ignite a prescribed burn without receiving the approval of ADEQ, as follows:

1. ADEQ shall approve, approve with conditions, or disapprove a burn on the same business day as the Burn Request submittal.
2. If ADEQ fails to address a Burn Request by 10:00 p.m. of the business day on which the request is submitted, the Burn Request is approved by default after the burner makes a good faith effort to contact ADEQ to confirm that the Burn Request was received.
3. ADEQ may communicate its decision by verbal, written, or electronic means. ADEQ shall provide a written or electronic reply if requested by park staff.

If weather conditions cease to conform to those in the smoke management prescription of either the Burn Plan or an Approval with Conditions, the park fire managers shall take appropriate action to reduce further smoke impacts, ensure safe and appropriate fire control, and notify the public when necessary. After consultation with ADEQ, the smoke management prescription or burn plan may be modified.

The park fire management staff shall ensure that there is appropriate signage and notification to protect public safety on transportation corridors including roadways and airports during a prescribed fire.

Smoke Dispersion Evaluation

ADEQ approval or disapproval, or conditional approval are based on the following factors, as stated in R18- 2- 1506.

1. Analysis of the emissions from burns in progress and residual emissions from previous burns on a day- to- day basis;
2. Analysis of emissions from active wildland fire use incidents, and active multiple- day burns, and consideration of potential long- term emissions estimates;
3. Analysis of the emissions from wildfires greater than 100 acres and consideration of their potential long- term growth;
4. Local burn conditions;
5. Burn prescription and smoke management prescription from the applicable Burn Plan;
6. Existing and predicted local air quality;
7. Local and synoptic meteorological conditions;
8. Type and location of areas to be burned;
9. Protection of the national visibility goal for Class I Areas under § 169A(a)(1) of the Act and 40 CFR 51.309;
10. Assessment of duration and intensity of smoke emissions to minimize cumulative impacts;
11. Minimization of smoke impacts in Class I Areas, areas that are non- attainment for particulate matter, carbon monoxide non- attainment areas, or other smoke- sensitive areas; and
12. Protection of the National Ambient Air Quality Standards.

Burn Accomplishment and Record Keeping

By 2 PM of the day following a prescribed burn, the Burn Boss shall complete and submit to ADEQ the "Burn Accomplishment" form (ADEQ) with the following information, as outlined in R18- 2- 1507.

1. Any known conditions or circumstances that could impact the Daily Burn decision process;
2. The date, location, fuel type, fuel loading, and acreage accomplishments;
3. The ERTs and SMTs described in R18- 2- 1509 and R18- 2- 1510, respectively, and may include any further ERTs and SMTs that become available, that the F/SLM used to reduce emissions or manage the smoke from the burn.

Wildland Fire Use; Plan; Authorization; Monitoring; Inter- Agency Consultation

As specified in R18- 2- 1508, the Fire Use Manager or designee shall notify ADEQ of any potential WFU when it is projected to reach 50 acres of timber fuel (Ponderosa Pine and/or Mixed Conifer FMU) or 250 acres of brush or grass type fuel (Grass/Shrub/Pinyon- Juniper FMU).

The Fire Use Manager shall complete the Stage II (48 hours after need indicated by Planning Needs Assessment) and Stage III (7 days after need indicated by Planning Needs Assessment) WFIPs and submit them to ADEQ. The Plans will include the following nine items.

1. An emergency telephone number that is answered 24 hours a day, seven days a week;
2. Anticipated burn prescription;
3. Anticipated smoke management prescription;
4. The estimated daily number of acres, quantity, and type of fuel to be burned;
5. The anticipated maximum allowable perimeter or size with map;
6. Information on the condition of the area to be burned, such as whether it is in maintenance or restoration, its ecological function, and other indicators of fire resiliency;
7. The anticipated duration of the wildland fire use incident;
8. The anticipated long- range weather trends for the site;
9. A map depicting the potential impact of the smoke. The potential impact shall be determined by mapping both the daytime and nighttime smoke path and down- drainage flow for 15 miles from the wildland fire use incident, with smoke- sensitive areas delineated. Mapping is mandatory unless waived either orally or in writing by ADEQ. The map shall use the appropriate scale to show the impacts of the smoke adequately; and
10. Modeling or monitoring of smoke impacts, if requested by ADEQ after consultation with park staff.

ADEQ will render a decision within 3 hours of receipt. Approval is assumed if no response is received, and a good faith effort has been made to contact ADEQ. Approval by ADEQ of a Wildland Fire Use Burn Plan is binding upon ADEQ for the duration of the wildland fire use incident, unless smoke from the incident creates a threat to public health or welfare. If a threat to public health or welfare is created, ADEQ shall consult with park fire management staff regarding the situation and develop a joint action plan for reducing further smoke impacts.

Park fire management staff shall submit a Daily Status Report for each wildland fire use incident to ADEQ for each day of the burn that the fire burns more than 100 acres in timber or slash fuels or 300 acres in brush or grass fuels, including a synopsis of smoke behavior, future daily anticipated growth, and location of the activity of the wildland fire use incident in the Daily Status Report.

Park fire managers shall consult with ADEQ prior to initiating human- made ignition on the wildland fire use incident when greater than 250 acres is anticipated to be burned by the ignition. Emergency human- made ignition on the incident for protection of public or fire- fighter safety does not require consultation with ADEQ regardless of the size of the area to be burned.

Park fire management staff shall ensure that there is appropriate signage and notification to protect public safety on transportation corridors including roadways and airports during a wildland fire use incident.

Best Management Practices

The best management practices to be employed by the Park[16] include both emission reduction techniques to reduce the amount of smoke produced, and smoke management techniques to limit the impact of smoke. Not every technique is appropriate to every project or fire, but all are considered in the course of planning. These techniques are defined by ADEQ (R18- 2- 1509 and 1510, respectively).

Emission reduction techniques considered will include

1. Reducing biomass to be burned by fuel exclusion practices such as preventing the fire from consuming dead snags or dead and downed woody material through lining, application of fire- retardant foam, or water;
2. Using mass ignition techniques such as aerial ignition by helicopter to produce high intensity fires of high fuel density areas such as logging slash decks;
3. Burning only fuels essential to meet resource management objectives;
4. Minimizing consumption and smoldering by burning under conditions of high fuel moisture of duff and litter;
5. Minimizing fuel consumption and smoldering by burning under conditions of high fuel moisture of large woody fuels;
6. Minimizing soil content when slash piles are constructed by using brush blades on material- moving equipment and by constructing piles under dry soil conditions or by using hand piling methods;
7. Burning fuels in piles;
8. Using a backing fire in grass fuels;
9. Burning fuels with an air curtain destructor, as defined in R18- 2- 101, operated according to manufacturer specifications and meeting applicable state or local opacity requirements;
10. Extinguishing or mopping- up of smoldering fuels;
11. Chunking of piles and other consolidations of burning material to enhance flaming and fuel consumption, and to minimize smoke production;
12. Burning before litter fall;
13. Burning before green- up of fuels;
14. Burning before recently cut large fuels cure in areas with activity; and
15. Burning just before precipitation to reduce fuel smoldering and consumption.

Smoke Management techniques considered will include:

1. Burning from March 15 through September 15, when meteorological conditions allow for good smoke dispersion;

[16] See also the Smoke Management Plan for Tusayan and Grand Canyon Village (Appendix E)..

2. Igniting burns under good- to- excellent ventilation conditions;
3. Suspending operations under poor smoke dispersion conditions;
4. Considering smoke impacts on local community activities and land users;
5. Burning piles when other burns are not feasible, such as when snow or rain is present;
6. Using mass ignition techniques such as aerial ignition by helicopter to produce high intensity fires with short duration impacts;
7. Using all opportunities that meet the burn prescription and all burn locations to spread smoke impacts over a broader time period and geographic area;
8. Burning during optimum mid- day dispersion hours, with all ignitions in a burn unit completed by 3:00 PM to prevent trapping smoke in inversions or diurnal windflow patterns;
9. Providing information on the adverse impacts of using green or wet wood as fuel when public firewood access is allowed;
10. Implementing maintenance burning in a periodic rotation to shorten prescribed fire duration and to reduce excessive fuel accumulations that could result in excessive smoke production in a wildfire; and
11. Using wildland fire- use strategies to shift smoke into more favorable smoke dispersion seasons.

Monitoring

ADEQ may require a monitor be assigned to prescribed fires and WFU; however, Grand Canyon National Park routinely assigns monitors to projects. Other monitoring requirements include:

- release of pilot balloons (PIBAL) at the burn site to verify needed wind speed, direction, and/or stability and
- measurement of smoke plumes according to ADEQ format.

Refer to the Grand Canyon Fire Effects Monitoring Plan (Appendix F) for detailed qualitative observational monitoring, semi- quantitative (i.e., digital photographic), and quantitative measurements ($PM_{2.5}$ via real- time monitoring near smoke- sensitive areas and critical receptors) protocols.

A critical monitoring program element is the continuing correlation of monitoring data that are measured (from measuring equipment) with observed smoke impacts, all with the long- term goal of evaluating visibility prescriptions for wildland and prescribed fire.

Specified monitoring information required of the State of Arizona shall be made available to ADEQ the business day following ignition. Files will be retained by the park fire management staff for 1 year following the burn date.

Qualifications and Oversight

All burns shall be conducted by personnel according to qualifications described in Sec. 10.2; and the Fire Use Manager or Burn Boss will have completed the NWCG[17] smoke management course.

Specified monitoring information required of the State of Arizona shall be made available to ADEQ the business day following ignition. Files will be retained by the State for 1 year following the burn date.

[17] National Wildfire Coordinating Group.

Chapter 4 Wildland Fire Management Program Components

4.1 General Implementation Procedures

Wildland fire will be managed to enhance resource protection, diminish risk and consequences of severe wildfires and, to sustain naturally occurring vegetative communities.

The Park will employ a strategy of appropriate management response to all wildland fire starts. Selected management strategies will consider public and firefighter safety as the first priority. Tactics will consider values at risk as well as the effects on park resources of selected actions.

Interagency policy guidance requires the completion of a Wildland Fire Implementation Plan (WFIP), Stage I for all wildland fire starts, and Stages II and III for fires managed as Wildland Fire Use, depending on their complexity (Wildland Fire Use Implementation Procedures Reference Guide). Stage I documents the fire situation and Agency Administrator decision, describes management actions, and sets the initial periodic assessment schedule as the preliminary stage of the planning process. Stage II documents specific management objectives, describes the fire situation and associated management concerns, identifies management actions and estimated costs, and documents the Periodic Fire Assessment. Stage III documents the risk assessment and provides implementation actions necessary for management of a wildland fire to accomplish identified objectives over a potentially long duration.

Wildland fires where initial actions taken are unsuccessful will have a Wildland Fire Situation Analysis completed guiding extended attack strategy selection and comparison of reasonable alternatives.

Prior to prescribed fire implementation, a specific operational plan, a Prescribed Fire Burn Plan, will be completed. This plan will implement objectives identified in resource management plans and guidelines found in this fire management plan. Prescribed fires exceeding prescription parameters beyond the capacity of on- site resources to control will be converted to a wildland fire with appropriate guidance documentation developed.

4.2 Wildland Fire Suppression

National Park Service Fire Management Policy states that all fires not ignited by managers for specific purposes are considered wildland fires. It also states that all wildland fires will receive management actions appropriate to the conditions of the fire, fuels, weather, and topography to accomplish approved objectives specific to the fire.[1] Management actions define the appropriate management response and may vary across the full range of available options. This section will detail the program for the strategies defined in Chapter 3 and the available options.

Range of Potential Fire Behavior

Fuels complexes vary widely between the FMUs. The range of fire behavior will be responsive to these variables and also will be affected by weather, slope, aspect, season, and other environmental influences on the flaming front. The outputs discussed here are calculated for specified inputs only for illustration purposes; they are not supported by conclusive data and are not intended to represent the full range of potential fire behavior on the ground.

[1]NPS, RM-18

Ponderosa Pine FMU

This zone is represented predominantly by NFFL Fuel Model 9, although in areas where higher fuel loading and arrangement may produce higher fireline intensities, a Model 10 is applied. A comparison of potential fire behavior between the two models under different mid- flame winds is shown in Table 4- 1 given similar conditions of dead and live fuel moisture and slope. The following environmental inputs were used.

- 1- HR. TLFM[2] 3.0%
- 10- HR. TLFM 7.0%
- SLOPE 20%
- LIVE WOODY MOISTURE 60%

As shown in Table 4- 1, the rates of spread are similar for both fuel models; however, because of the higher available dead and down fuels in Model 10, the flame lengths and fireline intensities are considerably higher than those in Model 9. These outputs also vary considerably as the flaming front passes through pockets of high fuels concentrations, as the winds change in speed/direction, or through changes in slope and aspect.

Table 4- 1. Comparison of Potential Fire Behavior between NFFL Fuel Models 9 and 10.

NFFL FUEL MODEL 9 (Long-needle litter beneath a timber stand)				NFFL FUEL MODEL 10 (Litter plus larger fuel beneath timber stand)			
MIDFLAME WIND, MPH	*RATE OF SPREAD, CH/HR*	*FLAME LENGTH FT.*	*FIRELINE INTENSITY[3] BTU/FT/SEC*	*MIDFLAME WIND, MPH*	*RATE OF SPREAD, CH/HR*	*FLAME LENGTH FT.*	*FIRELINE INTENSITY, BTU/FT/SEC*
2.0	*4*	*2.3*	*34*	*2.0*	*6*	*4.6*	*157*
8.0	*26*	*5.3*	*214*	*8.0*	*27*	*9.5*	*751*
14.0	*65*	*8.1*	*535*	*14.0*	*57*	*13.4*	*1596*
20.0	*119*	*10.7*	*975*	*20.0*	*93*	*16.8*	*2618*

Except for the most extreme burning conditions, Model 9 fuels generally will not result in fire behavior such as profuse or long range spotting; crowning; or long- duration, high- intensity runs. Wildland fires ignited in this type will most likely remain as active surface fires with torching and

[2]TLFM is Timelag Fuel Moisture, defined as the number of hours needed for a dead woody fuel particle of a specified diameter to lose 63% of the difference between its initial moisture content and its equilibrium moisture content. This "timelag" varies by the size of the fuel particle.

[3]Fireline Intensity is the product of the available heat of combustion per unit of ground and at the spread rate of the fire, interpreted as the heat released per unit of time for each unit length of the flaming front.

occasional short- range spotting. The fuels represented by Model 10 under similar environmental conditions will display higher intensities with more active running surface fire associated with frequent torching and intermittent crowning where laddering and canopy are sufficiently closed. This has implications for decision- making on wildland fires.

Mixed- Conifer FMU

In contrast to the more open Ponderosa Pine FMU, fuel loads in the Mixed- Conifer FMU are somewhat higher and more concentrated. The expected fire behavior in the predominant ponderosa pine type on the North Rim was different enough that two monitoring types were developed: the North Rim Ponderosa Pine Forest (PIPN) type includes pure open stands of ponderosa pine (similar to the Ponderosa Pine FMU) and the Ponderosa Pine/White Fir Encroachment (PIAB, established in 1998). Fuels in the PIAB type are generally heavier in the understory with frequent to continuous ladder fuels provided by the white fir poles in the midstory. A fuel Model 10 best represents fuels within most areas of the Mixed- Conifer FMU.

Under high fire- severity conditions, fire behavior in areas with dead and down fuels that include higher loads of 3- in. or larger (1000- hr TLFM fuels), branchwood, and other materials on the surface together with "laddering" of vertical fuels (tree foliage) can create intermittent torching to dependent crown fire (burning even with the surface fire front); in extreme cases, the behavior can create independent crown fire with short- to long- range spotting (½ to over 2 miles) and high- intensity surface runs. Wind is a key factor for spread rates, intensities, and spotting distances and therefore resistance to control. Fires with flame lengths of less than 4 ft (fireline intensity of less than 100 Btu/ft/sec) generally can be attacked at the head or flanks using hand tools.

Grass, Shrub, and Pinyon- Juniper FMU

The range of potential fire behavior for the grass type zone, given the amount and arrangement of fuels, is relatively low to moderate, depending primarily on winds.

Fire activity in the continuous sage- type fuels normally will increase in response to seasonally declining live fuel moistures combined with winds.

Pinyon- juniper woodlands, as described in Sec. 7.2, may present high- end fire behavior only when a vertical fuel arrangement is closed- canopy and there are high winds. On the Mt. Emma Wildland Fire,[4] it was reported that "… fire behavior in the pinyon- juniper appears tied to aspect, position on the slope, and wind. Fire will back slowly through P- J and then make short, brief up-slope runs through the crowns assisted by convective slope winds. On flat ground little if any movement through P- J has been observed."

Preparedness

The Grand Canyon National Park wildland fire program will ensure preparedness[5] by

- maintaining a prevention program;

[4]Mt. Emma Wildland Fire Implementation Plan (June 1999), page 4.
[5]As required in NPS Fire Management Policy, RM-18 (Chapter 7, page 2).

- maintaining fully qualified personnel commensurate with the normal fire- year management workload;
- maintaining a cache of supplies, materials, and equipment sufficient to meet normal fire-year requirements;
- preparing and updating a Preparedness Plan based on preparedness levels derived from NFDRS;
- preparing pre- season risk analyses;
- providing a dispatch system for fire management resources within and adjacent to the Park;
- maintaining detection and initial attack capabilities;
- maintaining a pre- attack plan, including local mobilization guides,
- maintaining agreements to coordinate interagency operations (Sec. 8.3); and
- maintaining record systems, weather data, and maps.

"Preparedness" refers to activities that lead to a safe, efficient, and cost- effective fire management program in support of resource objectives through appropriate planning and coordination. The Preparedness Plan for the Park is revised annually by April 15. The elements of this Plan are given in Appendix E. The Preparedness Plan is the responsibility of the Deputy Fire Management Officer.

The Park will conduct an annual preseason fire readiness inspection, which will address detection, communication, dispatch, and response capabilities. This inspection will be conducted to determine whether the Park's current training levels, equipment inventories, and organizational structure meet established standards.[6]

Prevention

The overall objective of the Park prevention program is to minimize the occurrence of unwanted human- caused fires. Prevention efforts are directed toward reducing ignitions posing the potential to cause unacceptable injury or loss to human life and values to be protected.

Park responsibilities[7] for wildland fire prevention include the following:

- A wildland fire prevention plan shall be developed and implemented.
- The Fire Prevention Analysis and Action Plan for Grand Canyon National Park shall be reviewed annually and updated as required.
- Wildland fire prevention and education will be integrated into all management functions, including interpretation, visitor protection, maintenance, and administration.
- Local wildland fire prevention and education training will be assessed, coordinated, and facilitated.
- Prevention and education that support Park resource management will be provided to the public.

The Prevention Analysis and Action Plan are in Appendix I. This document and the prevention program are the responsibility of the Fire Information Officer.

[6]Chapter 7, RM-18.
[7]RM-18 (Chapter 8, page 2).

Annual Training, Qualifications, and Certification

The purpose of wildland and prescribed fire training is to promote safe and effective individual performance in accomplishing stated goals and objectives.

Line responsibility is with the Grand Canyon Zone Interagency Dispatch Center (GCZIDC) Manager, who serves as the NAZ Training Coordinator.

The following Park objectives and action items are directed in RM-18 for the wildland fire management training, qualifications and certification program at Grand Canyon National Park:

- Provide effective technical, administrative, and logistical support training.
  A wildland fire training needs analysis will be developed annually for those Park employees who participate on wildland fire assignments both occasionally and regularly. It will include the type of course or training required, who will attend, and the number of available slots. In-Park required refresher courses (firefighter safety, helicopter operations, etc) and the Basic Firefighter (S-130/190) and Interagency Helicopter Training Courses are presented in Park at least once annually. The Park will participate with the NAZ in developing an annual training schedule based on the needs analysis.

- Provide and manage an effective instructor tracking system for the Park.
  Lead instructors for 200- level, and all instructors at the 300 level and above, are required to complete instructor training. All instructor evaluations will be submitted to the Regional Fire Management Officer within 30 days following a course. See NPS RM-18 for additional direction.

- Monitor and direct the development of training and experience for key Park fire management personnel to meet staffing, incident management, and prescribed fire needs. The qualifications of employees will comply with the NWCG and Department of Interior (DOI) Incident Qualification and Certification System standards.[8] A list of Park personnel qualified by NWCG position pneumonic is kept in the Deputy FMO's Office with annual updates performed by the GCZIDC Manager. All employees dispatched or assigned to wildland or prescribed fires will be qualified and certified unless assigned as trainees.

- All Park employees considered for wildland firefighting duties will meet the NWCG physical fitness test for the designated position.

  Permanent employees should be tested before a declared fire season. Seasonal employees should be tested within 2 weeks of entrance on official duty at the Park. The protocols for testing are contained in Exhibit 2, Chapter 6, RM-18. The medical and physical fitness testing requirements and description of fitness levels are outlined in NWCG 310-1.

  Those wildland fire personnel whose full-time duties are 100% arduous-duty-related will be provided 1 normal duty-hour per day for fitness training. The type, frequency, and expectations of the exercise program will be documented between the employee and his/her supervisor.

[8] NPS uses the ICS qualification and certification standards in the Wildland Fire Qualifications Guide (PMS-310-1); DOI (IQCS) specifies additional minimum qualifications for wildland fire positions not included in ICS.

Equipment and Supplies Readiness

Facilities and suppression assigned equipment and inventory, including the North Rim and South Rim caches, shall be made operationally ready by April 15 annually. The caches and equipment shall be inspected and documented for completeness and serviceability by the appropriate District Fire Management Officer or designee on a nonscheduled basis at least once per season. Responsibility for cache management lies with the Logistics Coordinator, supervised by the Fire Business Manager.

Aviation facilities, equipment, personnel, and operational procedures are located in the Aviation Operations Plan, Branch of Fire and Aviation. Implementation of the Plan is the responsibility of the Aviation Officer.

Preparedness Plan

The Preparedness Plan (located in Appendix E) identifies the management actions commensurate with preparedness levels for wildland fire response. Five identified preparedness levels, I – V, will be used for each of the BI (for PJ- Shrub- Grass FMU) and ERC (for Mixed Conifer and Ponderosa Pine FMUs). The break points between classes are determined by energy release component/burning index (ERC/BI) appropriate to the FMU. Critical break points are levels IV and V, or equivalent to the 90th and 97th percentiles respectively.

The Preparedness Plan is based on the following NFDRS components and situational factors.

- **ERC (Energy Release Component, NFDRS)** data from key weather station(s) representing the forested fuel models, Mixed- Conifer FMU, and Ponderosa pine FMU.
- **BI (Burning Index, NFDRS)** for station(s) representing fuel model(s) for the Grass/ Shrub/Pinyon- Juniper FMU (use 5- day running mean BI).

  Note: Graphic illustrations of BI and ERC by 5- day periods for key Park weather stations and representative fuel models are also contained in Appendix E.

- **Lightning Activity Level (LAL)** within last 7 days was 4 - 6 or predicted to be 4 – 6 next day: consider elevating the preparedness level following evaluation of ERC/BI, fuels conditions, time of year, and other factors (see below)
- **Situational Complexity and Proximate Fire Activity** in NAZ.
- **Palmer Drought Index (PDI**), an indicator of long- term drought.

With the PDI indicating EXTREME DROUGHT for the NAZ, no well- established and persistent monsoon pattern present, and no widespread precipitation, changes in 5- day running- mean ERCs should be monitored before making decisions regarding emergency preparedness resources. *The Fire Management Officer has the option of raising the preparedness level based on PDI regardless of other indicators.*

Emergency preparedness funding is authorized under certain conditions for preparedness levels IV and V; these actions require documentation based on the Preparedness Plan. Southwest Area Preparedness Levels[9] provide for interagency readiness keyed to severity indicators (ERC, risk, situational complexity) and should be reviewed regularly during fire season.

[9]Reference the Southwest Area Mobilization Guide, Preparedness Levels (Chapter 27).

According to Director's Order #18, Agency Administrators "will ensure that trained and certified employees are made available to participate in wildland fire management activities, as the situation demands, and that employees with operational, administrative, or other skills support the wildland fire program as needed."

Severity Planning

Severity planning and funding requests are prepared by the Fire Management Officer during periods when conditions exceed those of the "normal fire year" (based on a FIREPRO analysis). The following components are included in overall severity planning.

Pre- Season Risk Analysis

The analysis shall be completed annually well before fire season, and based on the PDI, thousand- hour TLFM, and local criteria; a submission will be forwarded to NPS- NIFC if severity funding is indicated. Criteria can be referenced in RM- 18, Chap. 7, Exhibit 2.

Severity Funding Request

The request is prepared based on the pre- season risk analysis and submitted through the Chief, Branch of Fire and Aviation, and Park Superintendent's office to the Fire Management Officer, Intermountain Regional Office. The request will include narration covering:

- the current and potential situation,
- mitigating actions and costs,
- cooperators' mitigating actions, and
- coordinated funding strategies between Park and neighboring agencies.

Resource pre- positioning may occur when preparedness levels IV or V are reached or as indicated in the pre- season risk analysis and severity funding request.

Pre- Attack Plan

The Pre- Attack Plan (Appendix G) is prepared by Branch fire staff under the supervision of the Deputy Fire Management Officer. It assists fire management personnel in arriving at informed decisions with respect to wildland fire actions. It shall contain but not be limited to:

- organizational charts, roles, and functions;
- thematic maps (roads, trails, helispots, values to be protected, facilities, FAA charts, restricted areas, etc.);
- interface mitigation actions (lists of values to be protected, exclusion areas by FMU);
- lists of businesses, support facilities, and key personnel;
- briefing package for transition Incident Management Teams (IMTs); and
- inventories (caches, equipment, communications, etc.).

The Pre- attack Plan shall be reviewed and updated annually by the Deputy Fire Management Officer, and a copy will be kept on file in the GCZIDC. Refer to the Pre- Attack Plan Checklist[10] for details.

[10]RM-18, Chapter 7, Exhibit 3.

Detection and Dispatch

The detection and dispatch functions are the responsibility of the GCZIDC Manager. Detection operations are accomplished by helicopter and fixed- wing aircraft assigned to the Park under contract.

The Grandview and Red Butte Lookouts provide some supplemental ground coverage during fire season. Emergency staffing of Park lookouts at Hopi Point, Kanabowits Spring, and North Entrance is also possible during high- severity periods. Historically, air tour company pilots have provided early smoke detection over the Park and have proven effective in the detection effort.

All Park dispatch is operated from the GCZIDC under the supervision of the Center Manager. The Center Manager prepares and annually updates a Center Operations SOP that includes:

- the pre- season risk analysis format;
- exclusion area maps;
- the weather station operation and maintenance SOP;
- a copy of the staffing chart;
- flight following SOPs from the aviation plan;
- the dispatch SOP, including IMT transition procedures;
- the urban- interface response SOP; and
- the availability/rotation, including out- of- Park mobilization, SOPs.

Minimum Impact Guidelines

RM- 18[11] directs that all suppression tactics and support actions be selected commensurate with potential fire behavior and to minimize impacts to Park values to be protected. Decisions must be informed and based on interdisciplinary inputs to the extent possible with respect to conditions on the ground.

Park Guidelines

Detailed guidelines are attached to the Agency Administrator Delegation of Authority and Briefing Package, Appendix E. To summarize, all tactical decisions will include the following considerations:

- Minimum requirement guidelines
- Protection protocols for cultural resources
- Assignment of a resource advisor
- Briefings of assigned personnel where values to be protected may become involved
- Standards listed in Appendix K.

Rehabilitation Guidelines

Often the effects of suppression and other management actions require some form and level of rehabilitation. Short- and long- term impact mitigation measures are outlined in NPS Reference Manual RM- 18, the Department of Interior Burned Area Emergency Rehabilitation (BAER) Handbook, and Director's Order #18. Park guidelines for rehabilitation are listed in Appendix K.

[11]Chapter 9, Exhibit 5.

Records and Reports

The following records and reports shall be used.

Form/Report	Responsible Party	Distribution	Frequency
DI-1202 Fire Report (For fire use, include narratives, WFIP, daily weather forecasts, growth maps, costs and monitoring data)	Incident Commander/ Fire Use Manager/Deputy Fire Managemet Officer	Copy (1202 only) to Archives (SACS) within 10 work-days and Fire Dispatch Center; Fire Use package to Files	Per Incident
Department of Interior Incident Qualification System Form and Card (redcard)	Fire Dispatch Personnel (signed by FMO)	Affected Personnel	Annually
Situation Report (daily May 15 – September 30)	GCZIDC	NAZ Situation Report forwarded daily to Park Dispatch (May 15 – September 30)	Daily during season
Fire Weather/ Indices (daily; see dates above)	GCZIDC	Staffing levels (BI/ERC, etc) received by Dispatch from WFMCS	Daily
Daily Cost Accounting (wildland fire use)	Fire Use Manager	To Regional FMO (or as agreed upon w/Park FMO)	Schedule to be determined

4.3 Wildland Fire Use

This section addresses elements of the 2001 Federal Wildland Fire and National Park Service Policies regarding all fires **not** designated prescribed fires ignited by managers for specific purposes.

The Wildland Fire Use Implementation Procedures Reference Guide (2005) provides direction, guidance, and assistance in interpreting the policy for the various federal wildland fire agencies. This guide tiers to NPS policy.

NPS Policy[12] states that "all wildland fires will be effectively managed, considering resource values to be protected and firefighter and public safety, using the full range of strategic and tactical operations…"

The 2001 Federal Wildland Fire Management Policy Review and Update[13] states that agencies "…base responses to wildland fires on approved Fire Management Plans and land management plans, regardless of ignition source or the location of the ignition."

Objectives

Plan and implement management actions that fully provide for personnel and public safety.

Strategies

One or any combination of strategies can be employed on wildland fires based on environment and fuels, constraints, safety, and capability to accomplish objectives.

[12]Director's Order DO-18 (1999), Part 4, and RM-18 (1999), Chapter 9, page 1.
[13]Chapter 3, page 25.

The following strategies are available for wildland fire response in Grand Canyon National Park:

- Suppression response: full and aggressive suppression action to minimize acreage burned
- Monitoring and holding actions to check or confine spread
- Monitoring with pre- planned contingency actions
- Monitoring actions

Management strategies and action points will be based on fire activity and location. Normally, specific actions or combinations of actions will be determined on site.

Plan for Wildland Fire Use

Planning for the wildland fire use program is the responsibility of the North Rim District Fire Management Officer. Below are elements of the program necessary to accomplish stated objectives.

Preparedness

The preparedness actions and program elements detailed in Sec. 4.1 and Appendix E are applicable to all wildland fire operations.

Responsibilities

The Fire Management Officer retains overall responsibility for those wildland fires managed as Wildland Fire Use and will ensure that appropriate level of Fire Use Manager (FUM) is assigned to coordinate the following:

- Convene and lead an Interdisciplinary Team (IDT) as appropriate to facilitate informed decision - making and seek consensus regarding management of Wildland Fire Use.
- Prepare and/or review documentation for all WFUs.
- Coordinate and exchange information with other functional areas within the Branch.
- Select qualified manager/team for the fire and act as Park liaison.
- Oversee monitoring and the fire effects program.

Monitoring Criteria

During a WFU, monitoring data and information will be collected and documented as specified by the Fire Use Manager (FUM). Criteria will vary depending on each situation and phase of the fire. All wildland fires will receive at least a basic level of monitoring. Table 4- 2 lists monitoring criteria, frequency, and location for wildland fires at Grand Canyon National Park.

Table 4- 2. Wildland Fire Monitoring Criteria, Frequency, Method, and Location.

MONITORING VARIABLE	FREQUENCY	METHOD/LOCATION
FUELS (LIVE/DEAD MOISTURE AND TYPES)	Determined by IC/FUMT[14]	Determined by IC (observed and photos)
WEATHER	Determined by IC; minimum once daily	On-site; portable RAWS located as directed by IC
FIRE BEHAVIOR (OBSERVED/PHOTOGRAPHIC)	Observed; as determined by IC	On-site (aerial and ground) determined by IC
FIRE LOCATION/PERIMETER/DAILY GROWTH	Daily if fire moving; as directed by FUMT	On-site (aerial and ground)
SMOKE DISPERSAL	Daily (minimum)	As assigned (aerial and ground)
RESOURCE STATUS	As needed by FUMT	On site
FIRE EFFECTS	As assigned by Fire Ecologist/Fire Use Manager based on Monitoring Type	Refer to Fire Effects Monitoring Plan (2000)

Implementation

The Wildland Fire Use Implementation Procedures Reference Guide provides Park management with necessary background to make decisions regarding all wildland fires. **All actions are based on common procedures contained in the Reference Guide.**

Implementation Actions

The decision process for all wildland fire response involves the collection of relevant information that will provide the basis for selection of an Appropriate Management Response, and preparation of a **WFIP.**[15] Table 4- 3 (next page) outlines the contents of a WFIP for each wildland fire that starts in the Park, the necessary steps for the manager to follow from initial assessment of the fire through long- term implementation actions if indicated, and appended documentation supporting the decision- making process.

There are three stages to implementing the WFIP under the policy. Figure 4- 3 shows the overall implementation of this process, from wildland fire ignition to accomplishment of objectives.

The complete WFIP consists of three stages and is prepared progressively. Each individual stage constitutes a stand alone implementation plan and specific forms and formats are available for each stage. Progression from one stage to the next is dependent upon fire activity, potential duration, and relative risk as it relates to the incident. As each progressive stage is prepared, it is attached to the previous stage and becomes the guiding document until management of the fire accomplishes resource objectives or progression to a higher stage occurs.

Since each stage can be completed individually and used as a stand- alone plan, it is possible that an individual fire will be managed under only Stage I for its duration. Some fires will progress to Stage II and some will progress to Stage III. Thus, the overall objectives for managing individual fires can be accomplished through successful implementation of any or all of the stages, as illustrated by the left portion of Figure 4- 1.

The WFIP Stage I documents the fire situation, Agency Administrator decision, management actions, and sets the initial periodic assessment schedule. This Stage is the initial stage of the

[14]Fire Use Management Team.
[15]The acronym "WFIP", or Wildland Fire Implementation Plan, refers to a progressively developed assessment and operational plan that documents the analysis and selection of strategies and describes the appropriate management response for a wildland fire being managed for resource benefits (WFU).

planning process. Given suitable circumstances, it can be used to manage a fire with low potential for spread and negative impacts. Components of the WFIP Stage I include:

- Strategic Fire Size- Up (documents fire situation, including fire location and cause). A Strategic Fire Size- Up is completed for all wildland fires and provides information necessary to decide whether to implement a wildland fire use or a suppression response. All wildland fires naturally caused and in a fire management unit approved for wildland fire use become wildland fire use candidates. For fires not meeting these criteria, the WFIP planning stops at this point and a suppression action is initiated. For wildland fires meeting these criteria (WFU candidate), the planning continues into the Decision Criteria Checklist.
- Decision Criteria Checklist (documents the decision to manage fire for resource benefits or initiate a suppression action)
- Management Actions (identifies management actions)
- Periodic Fire Assessment (set assessment frequency, confirms decision to continue with WFU, identifies planning stage needs and implementation qualification levels). A Periodic Fire Assessment is completed as part of each Stage on a schedule determined by Managers. Completing this step in Stage I provides direction to move to Stage II, remain with Stage I, or initiate a suppression response.

The Strategic Fire Size- Up, Decision Criteria Checklist, and Periodic Fire Assessment are points in the WFIP Stage I where a suppression response could be indicated (Figure 4- 1) although the Agency Administrator can decide to suppress a fire at any time.

The WFIP Stage II defines management actions required in response to a changing fire situation as indicated by monitoring information and the Periodic Fire Assessment completed as part of Stage I. Stage II is used to manage larger, more active fires with greater potential for geographic extent than in Stage I. Under suitable circumstances and fire situation, this stage could represent the end point in WFIP planning and be used to manage a fire through its duration. Components of the WFIP Stage II include:

- Objectives
- Fire Situation
    - Current and predicted fire behavior
    - Current and predicted weather
    - Threats
    - Safety considerations
    - Environmental concerns
    - External concerns
- Management actions (include description of action and expected duration)
- Estimated costs
- Periodic fire assessment. Completing this step in Stage II provides direction to move to Stage III, remain with Stage II, or initiate a suppression response.

The WFIP Stage III defines management actions required in response to an escalating fire situation, potential long duration, and increased need for management activity, as indicated by the Periodic Fire Assessment completed as part of Stage II. It addresses management objectives and constraints in detail, describes the maximum area that the fire may be managed within (Maximum Manageable Area), identifies foreseeable threats and concerns, provides a quantitative long- term risk assessment, identifies management actions to mitigate or eliminate threats, provides cost estimates, and documents a periodic assessment of the situation. This stage constitutes a substantial planning effort but some of the information used in this stage can be pre-planned or completed prior to fire ignition if the administrative unit desires to do so. Such pre-planning is strongly encouraged.

Components of the WFIP Stage III include:

- Objectives and Risk Assessment Considerations
    - Natural and Cultural resource objectives
    - Management Constraints
- Maximum Manageable Area (MMA) Definition and Maps
- Weather Conditions and Drought Prognosis
- Long- Term Risk Assessment (describe techniques and outputs, include maps as appropriate)
- Threats
    - MMA
    - Public Use and Firefighter Safety
    - Smoke dispersion and effects
    - Other
- Monitoring Actions (actions, frequency, and duration)
- Mitigation Actions (describe management actions, management action points that initiate these actions, and key to map if necessary)
- Resources needed to manage the fire
- Contingency Actions (describe actions necessary when mitigation actions are unsuccessful)
- Information Plan
- Estimated costs
- Post- burn evaluation
- Signatures and Date
- Periodic Fire Assessment

Figure 4- 1. Generalized flow of Wildland Fire Implementation Plan showing progression of stages and points of movement to a suppression response.

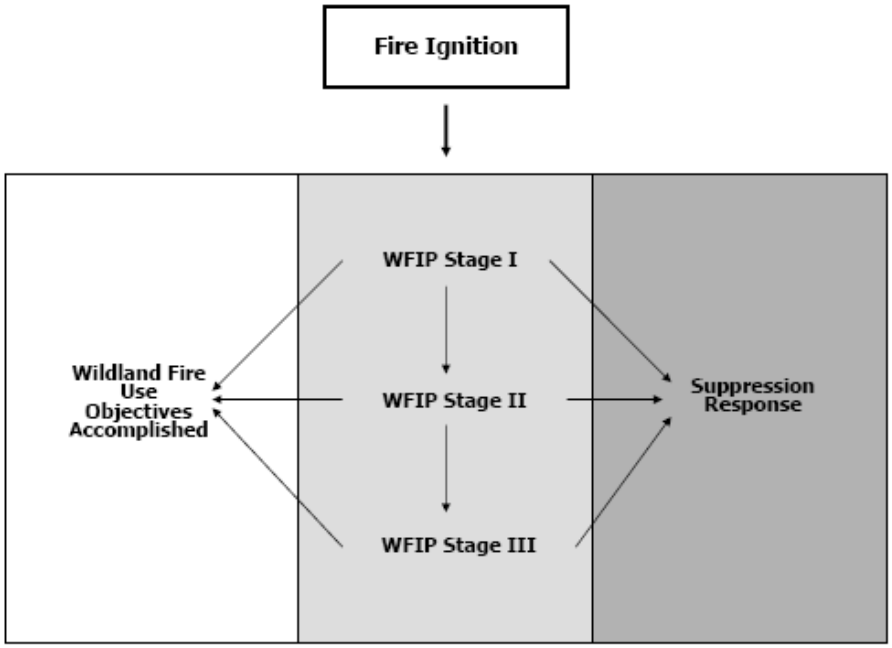


Table 4- 3. Sample Wildland Fire Implementation Plan.

Wildland Fire Implementation Plan

Table of Contents

Fire Name	
Fire Number	
Administrative Unit(s)	

Documentation Product	*Needed*	*Completed*
WFIP Stage I:		
Strategic Fire Size-Up		
Decision Criteria Checklist		
Management Actions		
Periodic Fire Assessment		
WFIP Stage II:		
Objectives		
Fire Situation		
Management Actions		
Estimated Costs		
Periodic Fire Assessment		
WFIP Stage III		
Objectives		
MMA Definition		
Weather Conditions and Drought Prognosis		
Long-Term Risk Assessment		
Threats		
Monitoring Actions		
Mitigation Actions		
Resources Needed		
Contingency Plan		
Information Plan		
Estimated Costs		
Post-Burn Evaluation		
Signatures and Date		
Periodic Fire Assessment		
Appendix		

Table 4- 4. WFIP completion timeframes.

WFIP Stage	Maximum Completion Timeframe
WFIP Stage I	8 hours after confirmed fire detection and Strategic Fire Size- Up
WFIP Stage II	48 hours after need indicated by Planning Needs Assessment
WFIP Stage III	7 days after need indicated by Planning Needs Assessment
Periodic Fire Assessment	As part of all stages and on assigned frequency thereafter

Table 4- 5. WFIP planning and implementation minimum qualifications.

WFIP Stage	Minimum Planning Qualifications	Minimum Implementation Qualifications (Use Fire Use Manager Decision Chart to determine recommended position)
WFIP Stage I	Unit Duty Officer	Incident Commander Type 4 (ICT4)
WFIP Stage II	Fire Use Manager Type 2 (FUM2)	Fire Use Manager Type 2 (FUM2)
WFIP Stage III	Fire Use Manager Type 2 (FUM2)	Fire Use Manager Type 2 (FUM2)

Wildland Fire Situation Analysis[16]

The WFSA serves Park management as a contingency planning document to undesirable outcomes for wildland and prescribed fires. A WFSA is developed when the fire changes status to an unwanted fire or, in selected situations, is used to analyze alternatives that will accomplish resource benefits in combination with protection objectives. Table 4- 7 outlines situations that may trigger the preparation of a WFSA at Grand Canyon National Park. The format for the WFSA is in the Appendix of the Wildland Fire Implementation Reference Guide or can be accessed online at the NPS Wildland Fire Website (http://www.nps.gov/fire).

[16]WFSA, a decision-making process that evaluates alternative management strategies against selected safety, environmental, social, economic, political, and resource management objectives. Format found in the Implementation Procedures Reference Guide Appendix.

Interdisciplinary Team

An IDT will be convened by the Fire Use Manager or designee when any resource concerns arise, smoke impacts increase, or other conditions warrant a team. The team is required to serve as an advisory group for defining alternatives for a WFSA and is a key component for all planning stages of a WFU.

All suppression tactics and support actions under the selected alternative will be selected commensurate with potential fire behavior and minimizing impacts to Park values to be protected. These decisions must be informed and based on interdisciplinary inputs to the extent possible with respect to conditions on the ground.

Table 4- 7. Wildland Fire Situations and WFSA Preparation Considerations.

SITUATION	WFSA CONSIDERATIONS	
	Protection	Protection + Resource Benefits
Human-caused fire (unwanted fire)	X	X
Fire exceeds initial attack (unwanted fire)	X	
Fire in Exclusion Area or Threatening Listed Exclusion Site	X	
Fire Exceeds WFIP in FMU, completely breaches established MMA (unwanted fire)	X	
Fire Exceeds prescribed fire plan in all FMU or Fire Exclusion Area (unwanted fire)	X	
Fire remains consistent with WFIP but external concerns result in suppression of fire	X	
Fire exceeds WFIP in any FMU, partially breaches MMA: fire in original MMA still achieving benefits while fire outside MMA is unwanted		X

Funding/Fiscal

FIREPRO (Fire Program) funds are provided through the Department of Interior firefighting account, and are no- year, non- ONPS (Operation of the National Park System) funds distributed to the Park by NPS- FIRE (National Park Service Program Center, National Interagency Fire Center, Boise, Idaho).

All FIREPRO funding activities must comply with the instructions in RM- 18.[17] Particular attention needs to be given to what constitutes suppression funding vs. funds authorized for managing WFU. Refer to the NPS Wildland Fire Management Policy, RM- 18,[18] for specific wildland fire situations that are funded by either fire use or suppression codes.

Post- Burn Evaluation

A post- burn evaluation will be completed for the fire by the fire management staff or the assigned Fire Use Management Team/IMT. The evaluation will include:

- a chronology of major events and safety issues,
- the delegation of authority,
- the WFIP and WFSA,
- the fire behavior monitoring data, progression maps,
- long- term fire assessments,

[17]RM-18, Chapter 18.
[18]Chapter 18, page 4, Table 1.

- fire information, and
- a summary statement and recommendations.

Records and Reports

See the chart in Sec. 4.1

Permanent Project Record

RM-18 outlines the contents for a permanent project record for each wildland fire use application. The Park will include, as a minimum, the following items in a permanent project record:

- The WFIP (all parts including appendices and revisions) and Wildland Fire Situation Analysis if applicable
- Monitoring information (level 1 and 2 documentation, monitoring schedule) and other data specified by the Incident Commander
- RE- VALIDATION and certification documents
- Funding codes and cost accounting
- Maps, imagery, and photographic records
- Minimum Impact Tactics for Grand Canyon National Park
- Post- Burn Evaluation Summaries
- Additional information as directed by the IC and/or Fire Use Manager

Information and Interpretation Actions

Wildland fire use actions should include provision to provide timely and accurate wildland fire information.

The Park Fire Information Officer will generally prepare press releases, assist with media and press conferences, and implement the Fire Information Contact List (Appendix E).

The following factors should be considered for collection and dissemination by the Fire Information Officer during ongoing wildland fires used for resource benefits:

- Specific fire management objectives for involved agency(ies)
- Information on fire location, behavior, and growth
- Information on fire effects
- Actions taken on fire
- Impacts on recreation users, visitors, public or private facilities, and services

This information can be included as an insert with Park brochures describing the fire management program and the role of fire as a natural process. Where wildland fires (WFU) are occurring near visitor use locations, Park personnel with interpretive skills will be scheduled for periodic visits to these sites to answer questions.

Potential Effects of Plan Implementation

Implementation of the Fire Management Plan for Grand Canyon National Park raises considerations of potential effects, including economic, social and environmental, on and off site, and beneficial as well as unwanted, for the short and long term. Mitigation actions for any negative effects resulting from this plan are described here. However, the full range of impacts will be considered, along with appropriate mitigating measures, in all operational planning

documents. Along with mitigation action will be the monitoring measures required to ensure that impacts are kept to a minimum.

Environmental

- **Air Quality.** Air- quality- related values are a significant issue at Grand Canyon National Park. Smoke from wildland and prescribed fires has both short- and long- term impacts on air quality. **Mitigation:** The best available management practices[19] will be implemented, including developing visibility prescriptions related to natural levels of smoke production. Using operational measures to reduce emissions (including non- fire alternatives) and documenting the effects of fire management activities are key mitigation practices.

- **Biotic Communities.** NEPA calls for consideration of the effects of federal management programs on the natural components of affected ecosystems. The Ponderosa Pine and Mixed Conifer FMUs will be the most affected. Old- growth trees are particularly susceptible to fire because of buildups of litter and woody debris around the bases of trees. The potential for high- severity surface fire and/or crown fire damaging or killing trees, both directly and indirectly, in these zones is locally high. However, fire also produces beneficial effects as discussed elsewhere in this Plan. **Mitigation:** The NEPA document that addresses mitigating actions for these impacts is in Appendix D. Operational plans involving fire use or prescribed fire will address specific on- site protection objectives for these zones.

- **Soils and Water.** Wildland and prescribed fires have the potential to affect soil and water through erosion, soil oxidation and sterilization, soil compaction and runoff. Following fire, reduction in overstory and removal of litter may affect watershed condition in the short term. However, once the ground cover recovers in several growing seasons, the overall soil and water condition should be improved with an increasing herbaceous component. **Mitigation:** Operational planning documents will consider protection objectives for soils and water.

- **Threatened, Endangered, and Species of Concern.** All listed species covered by the Endangered Species Act require that protection objectives be established to mitigate any negative impacts from implementation of this Plan. Habitats of species residing in forested areas are vulnerable, without restoration efforts involving fire, to decreases in native plant and animal diversity. Similarly, catastrophic fire can cause loss of habitat and life as a result of the continued build- up of forest fuels. Thus, there is potential for undesirable direct and indirect impacts over the short and long term. **Mitigation:** Fire Management Plan resource management objectives, together with considered protection objectives in all operations involving listed and special status species, are appropriate mitigating measures.

- **Wilderness Values.** Direct impacts to Park areas listed for designation (*de facto* wilderness) from Plan implementation will be largely direct and short- term. Noise from fire management operations, both aerial and ground, and visual effects from high-severity wildland fires can potentially affect solitude. Research activities are a potential impact to wilderness values. **Mitigation:** Implement the Minimum Requirement Analysis and Minimum Impact Tactics.

[19]Described in Sec. 11.0.

Social/Economic

- **Cultural Resources.** Section 10.1 addresses cultural resources as values to be protected. Potential impacts to archaeological and historic resources within all FMUs are considered. **Mitigation:** Measures are covered in Sec. 10.1 and in the NEPA compliance documentation, Appendix D.

- **Recreation.** Implementation of the Plan could result in direct, short- term impacts to recreational and visitor use sites and settings. Visible burned areas, particularly high severity, could reduce the quality of the scenery. However, as these areas recover the long- term impacts of these scenes become increasingly beneficial. **Mitigation:** Operational plans will address protection objectives to minimize negative impacts to scenes and settings located near key visitation points.

- Potential impacts to economic values are anticipated to be minimal. Mitigating measures for any anticipated impacts will be addressed in the operational plans as protection objectives.

4.4 Prescribed Fire

Prescribed fire has been an integral part of NPS fire management programs since 1968 and is a well- established and accepted practice used by land managers in a fully integrated program to improve forest health and to maintain ecosystems. This section will guide the on- going prescribed fire program at Grand Canyon National Park.

Scope of Program

Prescribed fires are defined as all fires on Park lands that are not wildland fires. Prescribed fire is planned, scheduled, organized, and implemented according to a rigorous protocol based on policy, the purpose of which is the safe and efficient accomplishment of approved resource objectives.

Policy

NPS Director's Order #18 (1998)[20] states the following:

- "All prescribed fire projects will have a burn plan approved by the Superintendent."
- "All burn plans will be prepared using a systematic decision- making process, and contain measurable objectives, predetermined prescription, and environmental compliance documentation."
- "Contingency actions must be described in the event the prescription is exceeded."
- "All burn plans will address the need for alerting Park neighbors and appropriate public officials to the objectives and timing of the planned burn."

NPS policy[21] regarding fuels management, including prescribed fire and non- fire strategies, states the following:

[20]Program Requirements, Section 5, part 6, "Prescribed Burn Plans".
[21]Director's Order #18, Section 5, part 9, "Fuels Management".

- "Park areas will identify, manage, and reduce where appropriate, accumulations of hazardous fuels."
- "Wildland fire use, prescribed fire, and non- fire techniques are appropriate tools for reducing hazardous fuels."
- "Park areas will reduce, to the extent possible, hazardous fuels in the wildland/urban interface."
- "All Park programs to manage accumulations of hazardous fuels must be identified in the Park resource management plan and must be the subject of an appropriate level of NEPA and cultural resource protection compliance."

Scope

The overall scope of the prescribed fire program is:

- The establishment and maintenance of defensible space around Park values to be protected within all FMUs.
- The reduction of hazardous fuels accumulations in all FMUs.
- The utilization of fire as a tool to accomplish stated ecological and protection objectives in all FMUs.

The programmatic basis for the prescribed fire program is the Park Resource Management Plan.

Programmatic objectives will be accomplished through long- range plans tiered to individual project- level protection and fire management objectives. However, as described elsewhere in this Plan, the structure and composition of native plant communities have been severely altered over the past century in many upland areas of the Park. Restoration of these systems, while protecting life and stated Park values through active management, also will require a significant investment in time to achieve.

The following sub- sections describe organization, staffing, annual program elements, expected fire effects and administrative requirements of the program.

Organization and Responsibility

The responsibility for implementation of the Prescribed Fire Section of this Plan lies with the Fire Management Officer. The staff consists of a Deputy Fire Management Officer, Fire Ecologist, South Rim District Fire Management Officer, Geographic Information System Specialist, and North Rim District Fire Management Officer. The Park Science Center administers a Firepro funded Wildlife Biologist and Archaeologist and fire tasks their workload. Section 5.0 contains additional detail.

Staffing and Qualifications

All prescribed fires at Grand Canyon National Park will be implemented under the supervision of a Prescribed Fire Burn Boss who is qualified under requirements of the National Wildfire Coordinating Group (NWCG) Wildland and Prescribed Fire Qualifications System Guide.[22] Burn bosses are qualified and certified in appropriate fuels types at the appropriate level of complexity.

[22]NWCG 310-1 (2000).

All prescribed fires will be staffed by certified personnel in positions for which they are qualified.[23] The burn boss, who is normally assigned by the Deputy Fire Management Officer, will determine the number and types of positions for prescribed fire operations.

Annual Activity Elements

The following list and description of annual activity elements are intended to guide the management of the prescribed fire program.

A. Planning

Long- Range Prescribed Fire and Mechanical Fuels Reduction Plan

The program of prescribed fire and mechanical fuels reduction is centered on stated objectives. The prescribed fires listed in this Plan (Appendix H) are used with the ultimate intention to mimic the natural role of fire in fire- prone ecosystems, and mechanical fuels reduction strategies are intended to manage wildland fuels to levels consistent with protection objectives.

The schedule in Appendix H guides the specific project- level plan development. The actual year a project is completed depends on a variety of factors, including current wildland fire load, project prescription parameters, and completion of NEPA project clearances. Note that "project plan", "prescribed fire plan", "burnplan", "prescribed fire burnplan", and "mechanical fuel reduction and prescribed fire project plan" are synonymous for operational purposes.

All priorities for clearances will be coordinated through the Deputy Fire management Officer. Incomplete projects will be moved to the next Fiscal Year. The Long- Range Plan will be reviewed annually and updated as necessary.

Project Planning

After the Long- Term Treatment Plan (Appendix H) is implemented, individual project prescribed fire burnplans will be prepared following the guidelines contained in RM- 18[24] and the Implementation Procedures Reference Guide.[25]

Below is a list of action items to be considered when developing a project- level plan involving prescribed fire and/or mechanical fuels treatment.

- Develop project objectives and site- specific treatment methods to accomplish objectives. Objectives are described in the Fire Management Plan by FMU and will drive the project objectives.

- Project objectives involving fuel breaks or creation of defensible space may include clearance requirements, canopy spacing to prevent sustained crownfire, thinning requirements and limitations, pruning, limbing, bucking and piling, and debris disposal.

- Reconnaissance and layout of prescribed fire areas.

[23]Wildland and Prescribed Fire Policy Implementation Procedures Reference Guide, Chapter 6.
[24]RM-18, Chapter 10, pages 1-4.
[25]Wildland and Prescribed Fire Policy, Implementation Procedures Reference Guide (1998), Chapter 4.

This activity normally is accomplished in concert with plan development. The area is marked on the ground with the perimeter located and documented Global Positioning Satellite (GPS) unit or equivalent unit to ensure accuracy.

- Identification of values to be protected.
  In consultation with Science Center staff, identify and document values to be protected. Protection objectives will be included in the project burnplan together with mitigation actions to accomplish objectives.

- Fire effects (FMH)[26] monitoring plot layout and documentation.
  As directed in the Park Fire Effects Monitoring Plan protocols, all established (or new) plots are identified in the burnplan.

- Job Hazard Analysis (JHA) preparation.
  For each prescribed fire area, a JHA will be prepared and attached to the burnplan. This analysis is based on on- site hazard identification and mitigating actions to be taken.

Additional prescribed fire implementation actions are outlined in the Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide (1998).

B. Coordination

NPS Wildland Fire Management Policy RM- 18 directs the Park to ensure that provisions for interagency and intra- agency pre- burn coordination and, where applicable, public involvement and burn day notification to appropriate individuals, agencies, and the public are implemented.

Specific coordination actions are addressed in several other chapters of this Plan. When planning for prescribed fire and fuels management projects, coordination efforts can begin years before project implementation in some instances.

The following activities are coordination considerations when planning prescribed fire projects:

- Coordinate planning and mitigation actions with Science Center specialists according to location, treatment objectives, and protection objectives for each project.
- Coordinate planned public safety activities with personnel in Visitor Protection, local law enforcement agencies, and Park Maintenance functions.
- Coordinate interpretive and public education activities with the Park Information Officer, Visitor Center, contact stations and affected interpretive personnel, and media (refer to the notification list in Appendix E).
- Coordinate with affected Park neighbors and cooperators (see above).
- Coordinate with external Park regulators as the project dictates.

C. Monitoring

Prescribed fire treatments involve accomplishing resource and protection objectives while providing for safety first. The only means by which objective accomplishment can be measured is through a disciplined and rigorous program of monitoring. Monitoring is a way of measuring treatment success on vegetation and fuels, promoting program improvements and adaptive management, and identifying problem areas before they become crises. Therefore, each project plan involving the use of prescribed fire will contain monitoring objectives that detail the immediate,

[26]Fire Monitoring Handbook, NPS.

short- term, and long- term information necessary to adequately quantify fire behavior and fire effects. Evaluating monitoring data is a joint responsibility shared by the Branch of Fire and Aviation and the Park Science Center.

All fires are monitored at the Reconnaissance (Level 1) and Fire Condition (Level 2) levels. For Levels 3 (Immediate Post- Fire Effects) and 4 (Long- Term Change), permanent monitoring plots are randomly distributed over a monitoring type that contains many prescribed fire units. Monitoring is covered in detail in Sec. 6.0.

Fire Behavior

Monitoring personnel assigned to prescribed fire projects must perform a variety of tasks relating to fire behavior. The following outlines required fire- behavior- related monitoring.

- Weather (Form RX- 1)
  A weather observation form for Grand Canyon National Park is completed for prescribed fires by comparing observed weather with prescription information to assist in determining if the project is in prescription.

- Winds Aloft (RX- 2)
  The purpose of this monitoring form is to ascertain the direction of the wind (and hence smoke ventilation patterns) relative to prescription based on release and measurement of a PIBAL balloon trajectory
  .
- Smoke Observation (RX- 3)
  Variables relating to smoke trajectory are observed according to time of day; location, plume height, direction, and type; cloud cover; and documentation of a number of related observations. These data will be used in a variety of ways to assist the Burn Boss and staff to assess the current and potential effects of smoke.

- Fire Behavior (RX- 4)
  Actual fire behavior variables are measured, estimated, recorded, and compared with project prescription elements.

- Photographic Record (RX- 5)
  Assigned monitor(s)/photographer(s) will build a photo record of the project from established photo points or at various locations on the project.

- Daily and Final Prescribed Fire Reports (RX- 6, 7)
  Based on the data sheets completed above and other inputs, a report is prepared by the Lead Monitor containing a narration of fire activity, smoke dispersal, and weather and related to the photographic record.

Fire Effects

The purpose of the Fire Effects Monitoring Program is to provide information to fire and resource managers on fuel consumption related to desired fire effects. Much of this information comes in form of monitoring plot data, photography, and other observational records. Fire effects information is collected immediately postburn, 2 years postburn, and 5 years postburn within monitoring types.[27]

[27]Monitoring types (FMH-4) are described in the Grand Canyon Fire Effects Monitoring Plan (2000).

Reports and Documentation Requirements

All burnplan packages, including narratives, forecasts, maps, cost estimations, monitoring data, photo records, and other pertinent documentation will be maintained in the Prescribed Fire Managers office. An electronic copy of the burnplan also should be archived. The following reporting requirements (provided in tabular form) apply to all fire and non- fire projects.

Report Type	Responsible Party	Preparation or Revision Frequency	Distribution
Burn Request to ADEQ	Burn Boss	Daily	Fax to Zone before 1400 day before ignition
Burn Accomplishment Report	Burn Boss	Daily	Fax to Zone
ICS- 214	Project Overhead and Crew Leaders	Daily	To Burn Boss
Project Personnel and Equipment Cost Tracking Worksheet	Project Overhead and Crew Leaders	Daily	To Burn Boss
Summary Report for Weather, Fire Behavior, Smoke Dispersion	Lead Fire Behavior Specialist/Fire Effects Monitor	Daily	To Burn Boss
Post- Burn Summary Report	Burn Boss	At end of project or end of Burn Boss assignment, whichever comes first	To GRCA Fire Use Manager
DI- 1202	Burn Boss	At end of project or when one stage of project declared out	To GRCA Fire Use Manager
Project Accomplishment Report	Fire Use Manager/ Prescribed Fire Specialist	Quarterly	SACS computer/hazard fuels program.

D. Critiques

Selected prescribed fires will be critiqued at the discretion of the Fire Management Officer. Reviews can be convened by the Park Superintendent or a higher level of authority.[28]

4.5 Non-Fire Fuel Treatments

National Park Service guidance (RM- 18, *Wildland Fire Management*) defines "manual treatment" as "the use of hand- operated power tools and hand tools to cut, clear or prune herbaceous and woody species."

Manual fuels reduction treatments will be conducted in pinyon- juniper habitat (FMU 1) in areas of GRCA not recommended as wilderness, including the Grand Canyon Village, Hermits Rest, and Desert View areas, and along main routes between these developments. Routes include Highway 67 (North Rim) and portions of Highway 64 (South Rim). Manual treatments in spruce- fir habitat (FMU 2) will be primarily aimed at prescribed fire unit preparation. Treatments are used to reduce hazardous fuels, create defensible space and/or reduce risk of

[28]RM-18, Chapter 13.

crown fire in Wildland/Urban Interface areas, and to pre- treat perimeters of prescribed fire and wildland fire use.

Strategies include hand cutting (with axes, hand saws, other hand tools, and chainsaws only; no motorized mechanical equipment) for trimming, limbing, piling, scattering, carrying, rolling, or dragging vegetation to burn sites or transport vehicles for disposal.

Thinning standards will be developed during project planning using the best available modeling techniques. If there are questions about the applicability of any standard as applied to protection of visual values, cultural features, or other Park resources, clarification is requested from the Park Landscape Architect and/or Science Center (resource management) staff.

Chapter 5 Organizational and Budgetary Parameters

5.1 Description of the Fire Organization

Program direction and management oversight lies with the Chief, Branch of Fire and Aviation, Division of Visitor and Resource Protection, Grand Canyon National Park. This position reports directly to the Division Chief. The organizational charts for the Park Branch of Fire and Aviation, including General Staff, Prescribed Fire Organization, South Rim Suppression Organization, and North Rim Suppression Organization are located in Appendix E.

The following general staff positions report directly to the Chief, Branch of Fire and Aviation:

- Deputy Fire Management Officer
- Fire Business Manager
- Fire Information Officer
- Aviation Officer

The following staff positions report directly to the Deputy Fire Management Officer:

- South Rim District Fire Management Officer
- North Rim District Fire Management Officer
- GIS (Geographic Information System) Specialist
- Fire Ecologist
- Communication Center Manager*
  *Jointly supervised through an Operating Agreement with the Kaibab National Forest.

The Helicopter Manager reports directly to the Aviation Officer.

Refer to the Branch organizational chart in Appendix E.

Responsibilities

Implementation of the Fire Management Plan and overall program responsibility lie with the Chief, Fire and Aviation. Short- and long- term program and financial planning, along with fiscal responsibility, rests with this position.

The responsibilities, roles, and functions for the key General Staff positions within the Branch of Fire and Aviation are briefly described in the following subsections.

Deputy Fire Management Officer

The Deputy Fire Management Officer is responsible for the following program elements.

- **Preparedness:** Responsible for ensuring that Branch fire and aviation facilities and inventory are up to date for both Rim operations based on the Preparedness Plan and the Aviation Operations Plan; that training, qualification, and certification policies are followed; agreements are reviewed and maintained; and the establishment and

maintenance of procedures that ensure Branch preparedness levels that respond to wildland fire severity.

- **Mobilization:** Responsible for detection and dispatch operations according to established Standard Operating Procedures (SOPs).
- **Suppression:** Responsible for all aspects of the wildland fire suppression function.
- **Prescribed Fire Planning and Implementation:** Responsible for the safe and effective implementation of the Prescribed Fire section of the Park Fire Management Plan; implementation of the Long- Term Prescribed Fire Schedule (which includes coordination with outside- of- Branch entities), documentation, protecting sensitive Park values, supervision of projects, budget and fiscal matters, and project follow- up activities.
- **Fire Ecology and Effects Monitoring:** Responsible for ensuring that fire ecology knowledge is gained, trends in fire effects on plant communities are followed through literature review, monitoring program objectives are met through established field data collection techniques, and documentation and analysis of fire effects data are accomplished.
- **Wildland Fire Use:** Manages all aspects of the program involving wildland fire use for resource benefits.

Fire Information Officer

The Fire Information Officer is responsible for the timely gathering and dissemination of information related to Branch programs. The position also maintains a liaison with the Park Public Affairs Specialist and is responsible for overseeing those management activities intended to minimize human- caused wildland fires; responsible for updating the Park Prevention Analysis and Action Plan.

Fire Business Manager

This position is responsible for all aspects of Branch administrative functions, such as budget preparation, purchasing, tracking budgets, maintaining personnel records, reporting requirements, supervision of a Fire Program Assistant and the Logistics Coordinator, and providing general administrative support.

Aviation Officer

The Branch Aviation Officer is responsible for safe and efficient aviation operations, overseeing aviation contracts, staying current with aviation policy and procedural changes for the Park, and has management responsibility for the Park's helicopter program.

5.2 Funding

Fire management funding for the NPS is derived from two sources, one fixed and the other a shared national fund for emergency wildland fires.

Fixed funds at the NPS level are managed for program operations and planned projects (authorized project funds). Park fire operations and projects include preparedness activities, permanent staffing, training, monitoring, fire GIS, fuels management, fire prevention and education, aviation and equipment purchases. These funds are currently based on the FIREPRO analysis and budget process, which is an analysis of workload and complexity, based of the third worst year in the previous ten. This process allows program managers some flexibility to determine annual program needs. The FIREPRO budget process will be replaced by the Fire

Program Analysis (FPA) system in 2007. FPA is an interagency planning process designed to increase economic efficiency by promoting more accurate allocations of shared resources and personnel. This process is ongoing and requires ongoing time, energy and personnel commitment for the Park.

National emergency funds are managed for wildland fire operations. Within the NPS, authority exists at the local level to open accounts against these funds to cover all expenditures related to management of wildland fires, regardless of ignition source or selected management strategy. Along with the annual appropriations, agency guidance is provided in the form of a policy memo outlining administrative procedures in implementing this budgetary authority.

5.3 Relationship of Fire Organization to Remainder of Park

Fire and Aviation Management is a branch within the Division of Visitor and Resource Protection. The Fire Management Officer is the branch chief and reports directly to the Chief Ranger, who reports to the Deputy Superintendent.

5.4 Superintendent Responsibilities and Delegations

The Superintendent is responsible to the Regional Director for the safe and efficient implementation of fire management activities within the Park, including cooperative activities with other agencies or landowners in accordance with delegations of authorities. The Superintendent is responsible to approve and periodically assess and certify by signature, fire and aviation management actions. This responsibility may be delegated to another organizational level under certain conditions.

5.5 Interagency Coordination and Contacts by Function

Grand Canyon National Park is situated within the Northern Arizona Zone (NAZ) of Arizona, Southwest Area (SWA).[1] Cooperation through other agencies, particularly along Park boundaries, is essential to the success of training, prevention, detection, and wildland fire and prescribed fire operations.

Regular contacts with wildland fire program managers and staff personnel by Grand Canyon National Park fire management personnel serve to maintain good coordination and thus cooperation. These contacts may include the following officials by agency.

- NPS, Lake Mead National Recreation Area – Fire Management Officer (Boulder City, NV)
- Arizona State Land Department – Fire Management Officer (Flagstaff, AZ)
- Arizona Department of Environmental Quality – Interagency Smoke Coordinator (Phoenix, AZ)
- US Forest Service, Coconino National Forest – Fire Staff Officer (Flagstaff, AZ)
- US Forest Service, Kaibab National Forest – Fire Staff Officer (Williams, AZ)
- US Forest Service, Kaibab National Forest, Tusayan RD – Fire Management Officer (Tusayan, AZ)

[1]The Southwest Area Coordination Center (SWCC, Albuquerque, NM) serves all wildland fire organizations through their respective "zones" in the states of Arizona, New Mexico, west Texas, and Oklahoma. The Grand Canyon Office (Williams, AZ) is under the Northern Arizona Zone, and is represented by Kaibab NF (USFS), Truxton Canyon Agency (BIA), Southern Paiute Field Station (BIA), and Grand Canyon National Park (NPS).

- US Forest Service, Kaibab National Forest, Fire Management Officer – (Williams, AZ)
- Bureau of Indian Affairs, Truxton Cañon Branch of Forestry – Fire Management Officer (Valentine, AZ)
- Bureau of Indian Affairs, Navajo Area, Branch of Forestry – Fire Management Officer (Shiprock, NM)
- Bureau of Land Management, Arizona Strip Field Office – Fire Management Officer (St. George, UT)

5.6 Description of Fire-Related Agreements

Interagency agreements come in several forms and serve specific objectives. A Joint Powers Agreement exists between the State of Arizona and the Federal Agencies of the Departments of Agriculture (USFS) and Interior with fire responsibilities. An NAZ Handbook contains agreements that guide interagency coordination, of which Grand Canyon National Park is a party.

They are the following:

- **Northern Arizona Zone Charter:** Establishes authority among participating agencies to enter into agreements
- **Northern Arizona Zone Operating Plan:** Details specific agency initial attack procedures, maps of mutual aid areas, etc.
- **Northern Arizona Zone Preparedness Plan:** Covers interagency activities related to training, detection services, pre- attack planning information, resources available, staffing levels with associated actions, and prevention activities.
- **Northern Arizona Zone Financial Agreement:** Outlines guidelines for sharing funds for fire management activities.

There are two other interagency documents with which the Park participates.

- **Kingman Area Interagency Operational Plan:** Details mutual aid responsibilities of signatory agencies (BIA, BLM, NPS)
- **Memorandum of Agreement for Formation of the Southwest Management Board**

These agreements are physically located in the Branch of Fire and Aviation Administrative Offices, Grand Canyon National Park.

Chapter 6 Monitoring and Evaluation

Director's Order DO-18 provides the policy impetus for the Grand Canyon National Park monitoring program. There are three directives.

- Fire effects monitoring must be done to evaluate the degree to which objectives are accomplished.
- Long-term monitoring is required to document that overall programmatic objectives are being met and undesired effects are not occurring.
- Evaluation of fire effects data is the joint responsibility of fire management and natural resource management [Science Center] personnel.

Implementation of an NPS-adopted, rigorous monitoring program is guided by a Fire Effects Monitoring Plan for the Park (2000); a copy is in Appendix F. The fire monitoring program is the responsibility of the Fire Ecologist, who reports to the Deputy Fire Management Officer, Branch of Fire and Aviation.

6.1 Wildland Fire Monitoring Framework

The NPS Fire Monitoring Handbook (NPS 2001) identifies four monitoring levels to guide fire effects monitoring efforts as shown in Table 6-1:

Table 6-1. NPS Fire Monitoring Handbook - Minimum Recommended Standards.

Monitoring Level	Minimum Recommended Monitoring Standards
Level 1 – Reconnaissance	Fire cause, location, size, fuel and vegetation types, relative fire activity, potential for spread, current and forecasted weather, resource or safety threats and constraints, and smoke volume and movement
Level 2 – Fire Conditions	Fire monitoring period, ambient conditions – topographic and fire weather, fuel model, fire characteristics, and smoke characteristics
Level 3 – Immediate Post Fire Effects	Fuel reduction, burn severity, vegetative change or other objective dependent variables within 1 to 5 post-burn
Level 4 – Long-term Change	Continued monitoring of Level 3 variables to measure trends and change over time

Use of Monitoring Levels 1 and 2

The first two monitoring levels provide information to guide fire management strategies for both wildland and prescribed fires.

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

Monitoring Objectives: Collect information on environmental conditions (current and forecasted weather, and fuel models) and fire conditions (name, location, slope, aspect, spread, intensity, smoke transport and dispersal) for all wildland and prescribed fires. Use the information collected in a timely manner to adapt to changing conditions and successfully manage each fire.

Use of Monitoring Levels 3 and 4

Monitoring levels 3 and 4 describe short- and long- term monitoring of the effects of fire on fuels and vegetation to guide wildland fire (prescribed and fire use) and can also be applied to non- fire treatment activities aimed at reducing fuels and/or biomass including: thinning, creation of shaded fuel- breaks and pile burning.

Monitoring Goal: Specific fire- related management objectives guide fire program activities to achieve desired resource target conditions. Vegetation and fuels monitoring provides information needed to determine whether the fuels- and vegetation- related management objectives are being met and to detect any unexpected consequences of prescribed burning or other treatments.

Monitoring Objectives: Collect information on fuels and vegetation to determine if specific fire- and fuels- related management objectives have been achieved. Use the information collected to determine if progress is being made towards the desired resource target conditions for each monitoring type as described on the FMH- 4 sheets in Fire Effects Monitoring Plan (Appendix F).

Monitoring Goals

The goal of the monitoring program is to provide information to fire and resource managers, which allows them to affirm that prescribed fire objectives are being met or to correct deficiencies. Specific program goals and responsibilities are found in the Monitoring Plan which is updated annually.

To date, four Monitoring Type Descriptions (FMH- 4)[1] have been developed for Park vegetation.

- PIED – South Rim Great Basin Conifer Woodland
- PIPO – South Rim Ponderosa Pine
- PIPN – North Rim Ponderosa Pine
- PIAB – North Rim Ponderosa Pine with White Fir Encroachment

Additional monitoring types will be developed as needed if prescribed burning is used in areas not already covered by the existing monitoring type descriptions. Development of monitoring type descriptions, protocols, objectives, and desired conditions is the responsibility of the Fire Ecologist, with input from other disciplines.

[1] Grand Canyon Fire Effects Monitoring Plan, Appendix F.

6.2 Burn-Severity Mapping

Burn severity mapping is a means of providing a landscape perspective of fire effects. This methodology involves the use of cost effective, remote sensing data, standard image processing techniques, and field validation. Since 2001, fire severity has been mapped for fire incidents at the Park using protocols developed as a joint venture between the US Geological Survey, National Park Service, and EROS Data Center.

The Joint NPS- USGS National Burn Severity Mapping Project addresses the need to quantify fire effects on NPS lands in order to develop an archive of fire history. This archive includes all fire types (wildfire, prescribed and wildland fire use) that are greater than 300 acres in size. The goal is to monitor by means of standardized geographic databases employing consistent measures of "burn severity", defined as the magnitude of ecological change caused by fire (RM- 18, chapter 11, pg. 30). Assessments are based on acquiring pre and post- fire Landsat scenes, where the post-fire scenes are selected from images taken during the first growing season after the fire (generally 8- 13 months post- fire).

Methodology

Assessments use Landsat 30- meter data and a derived radiometric value called the Normalized Burn Ratio (NBR). The difference between pre- and post- fire NBR datasets (ΔNBR) is computed to determine the extent and degree of landscape change resulting from fire.

ΔNBR values give a good indication of burn severity. The range of data values must be classified into discrete severity classes. Fires at Grand Canyon have been classified into 5 severity classes: unburned, low, moderate/low, moderate/high, and high.

To help classify the ΔNBR values, Composite Burn Index (CBI) plots are established. These circular, 30- meter diameter plots quantify fire severity as measured by effects on overstory and understory vegetation, soil, and fuels. Although only a 30- meter circle is sampled, the goal is to install CBI plots in homogenous 90x90- meter areas, thereby providing a larger representative area with which to correlate the satellite image. The number of plots taken varies depending on the fire size and relative complexity. Generally, 50 to 100 plots are installed per fire. Within the plots, digital photographs are also taken from two different angles to visually document fire severity, and 22 indices of fire severity are sampled. Each index has a unique rating criterion, but all are ultimately rated on a scale of 0 to 3, from no effect to highest severity. In addition to a final score for the plot as a whole, notes are taken on community type, percent mortality of trees, and percent area covered by dead and down trees. Based on the final CBI value, plots are lumped into distinct severity classes of unburned, low, moderate/low, moderate/high, and high. The data from the plots within each severity class are then used to finalize the numerical cut- off points between severity classes on the ΔNBR image.

A linear regression is then run comparing the ΔNBR values to the CBI plot values. The results of the various regressions have shown an excellent relationship between the ΔNBR values and the CBI plot values. This implies that the severity classification of the ΔNBR image was done accurately, i.e. when a pixel in the ΔNBR image is given a certain severity class, which is in fact what has happened on the ground.

Additional details about burn severity mapping are available at the NPS- USGS National Burn Severity Mapping Project website: http://burnseverity.cr.usgs.gov/.

Chapter 7 Fire Research

The Federal Wildland Fire Management Policy (2001)[1] states that "Fire management plans and programs will be based on a foundation of sound science. Research will support ongoing efforts to increase our scientific knowledge of biological, physical, and sociological factors…and must be made available to managers in a timely manner, and must be used in the development of…fire management plans, and implementation plans."

Director's Order DO- 18 (1998) states the following:

- "Research programs will be developed on an interagency basis, addressing scientific information needs, technological needs and advances, risk management, social and economic concerns, and public health concerns".
- "Research findings will be used to provide a sound basis for the integration of wildland fire into land- use and resource management activities".

The General Management Plan for Grand Canyon National Park specifies the following research- related studies required for the management of natural resources.

- The effects of fire exclusion and prescribed fire on Park wildlife and the representative vegetative communities
- The natural fire regime for plant communities

Wildland- fire- related research at Grand Canyon National Park must be aimed not only at understanding the historic and current role of fire in Park ecosystems but to acquire the knowledge necessary to improve management practices that affect social, economic, and safety- related environments. Adaptive management requires a cyclic process of using the best scientific knowledge available to plan and implement activities, monitor processes and effects, and then adjust management as needed to achieve stated objectives.

7.1 Summary of Existing Research

Much of the completed wildland- fire- related research targeted at the Park has been cited throughout this Plan (Appendix A). Ongoing research by the Park Science Center, Northern Arizona University, and many other institutions has begun to answer questions posed in the Park Resource Management Plan[2] that relate to the undesirable effects of almost 100 years of fire suppression in northern Arizona forests and to initial stages of research that investigates ways to restore and sustain altered forest ecosystems.[3]

7.2 Needed Fire Research

[1] Review and Update of the 1995 Federal Wildland Fire Management Policy, Appendix D, page 45.
[2] Pages 3-186, 3-187.
[3] Final Report on Research Objective 1, Grand Canyon Forest Ecosystem Restoration (Covington, et al. 2000). On file at Grand Canyon National Park, AZ.

Although not exhaustive, the following list of needed research[4] is intended to support management in accomplishing the resource and protection objectives stated in this Plan.

- Additional forest ecology studies are needed to describe the frequency, magnitude, and distribution of pre- settlement natural fires in several vegetative community types.
- Document changes in vegetation, species occurrence, abundance, and population structure that can be attributed to suppression, grazing, exotic species, and natural succession over time and projected into the future.
- The natural (pre- settlement) fire regime for plant communities should be researched through fire- scar analysis, and management recommendations should be developed based on findings.[5]
- Research the effects of fire exclusion and prescribed fire on Park wildlife and the representative vegetation communities, including grasslands on the Kanab, Shivwits, Coconino, and Kaibab Plateaus.[6]
- Assess the effects of management- ignited (prescribed fire) fires on archaeological resources.[7]
- Develop a prescribed fire biological monitoring program, including evaluation of the existing fire effects monitoring programs, and consideration of potential applications in other areas.[8]
- Develop improved and alternative management strategies to reduce risk of resource damage from catastrophic fires (in coniferous and mixed forests, Mojave mixed desert scrub, etc.). Prescribed fire, as currently implemented, can neither control the risk of wildfire nor fully restore ecosystems to pre- settlement conditions.
- Research the effects of prescribed and natural fire, including
  - the relationship of fire intensity to fire effects and restoration of Ponderosa pine forests to include catastrophic wildfire;
  - the effects on biota with "out of season" burns, including structure and species composition; and
  - an evaluation of the effects of burn season and prescription on survival and vigor of old growth trees.
- Model the effects of forest restoration on wildlife populations.
- Conduct a fire ecology studies/literature review of ecosystems other than Ponderosa pine such as aspen/spruce/fir/pinyon- juniper.
- Study fire ecology at low elevations. Increased fire frequency along the river and in formerly unburned tributaries is an important consequence of visitation and of increased *Bromus* (introduced grass cover).
- Evaluate the correlation between prescriptions, actual conditions, and emissions produced compared with wildfire (to include duration, etc.).
- Develop a long- term monitoring plan for experimental restoration sites.
- Develop an annotated bibliography of usable information for fire use and other restoration methods.
- Research the cumulative effects on watershed of prescribed fire and fire use (or lack thereof) vs. wildfire.
- Develop management practices to protect wetlands, water quality, etc., following fire or because of fire.
- Evaluate methods for sampling herbaceous vegetation.

[4] From the Resource Management Plan and Science Information Needs (3/11/98), on file at Grand Canyon National Park Science Center.
[5] Research project number GRCA-N-121.000.
[6] GRCA-N-121.300.
[7] GRCA-C-430.001, .002.
[8] GRCA-N-230.105.

- Determine the aboriginal use of fire and its effect on systems and/or perceptions of what is now present.
- Evaluate alternative methods for removing unsightly restoration treatment effects in wilderness.
- Establish specific goals for use of prescribed fire and fire use such as amount of fire vs. other methods, emission production vs. ecosystem health, and fire as an ecosystem process.
- Establish thresholds for soil productivity following fire and develop management approaches for restoration.
- Conduct an ethnographic study of plant use and the effect of the seasonality of fire use and prescribed fire.
- Determine the effects of fire on fungi and microbes in soil.
- Develop an accepted definition of forest ecosystem restoration and measurable standards for determining when it has been accomplished.
- Compile and re- evaluate the North Rim fire ecology data from the Tucson CPSU.[9]

[9] Cooperative Park Studies Unit, University of Arizona; collections by P. Bennett, on file at Grand Canyon Science Center.

Chapter 8 Public Safety

Managing a total fire program is among the highest risk operations that any land management agency can undertake. The first- priority consideration in any fire management action is fire-fighter and public safety. All personnel are authorized and obligated to exercise emergency authority to stop and/or prevent unsafe acts (RM- 18).

Many- human safety- related issues focus on the altered vegetative communities in the Park. As discussed in other sections of this Plan, a serious consequence of the current high levels of hazard fuels resulting from years of fire exclusion is the potential for uncontrollable crown fire behavior. The hazard fuels management program, normally combining mechanical fuels reduction and prescribed fire, is a key component of the mitigation action, particularly in the developed areas. Creation of defensible space as a human- safety- related management action requires careful planning.

8.1 Public Safety Issues and Concerns

The following is a list of current Park- wide public safety issues and concerns:

- Conditions that pose an immediate threat to human life.
  Hazardous fuels accumulations around Park developed sites and visitor- use areas, combined with steep slopes, narrow access roads, and distance from mutual aid resources constitute a continuing threat to visitors, concessions, and Park employees.
- Fire personnel training and preparedness.
  Personnel must meet qualifications standards appropriate to their position and be adequately equipped with Personal Protective Equipment (PPE) commensurate with fire assignment(s).
- Management of wildland fires and prescribed fires is becoming increasingly hazardous. Given the fuels conditions described in this Plan, minimizing personnel exposure to hazards associated with suppression and other fire management operations requires training, effective communication, and on- site hazard analysis and mitigation measures.
- Interagency wildland- fire- related accident and incident reports should serve as “lessons learned” to Park staff.
- Aviation activity in and around the Park is heavy, particularly during wildland and prescribed fire operations, thus increasing exposure to personnel and the public.

8.2 Procedures for Mitigating Safety Issues

The following program requirements, although not exhaustive in scope, will be followed for Grand Canyon National Park to mitigate safety concerns described above.

- Implement, or continue implementation of, approved project- level plans[1] designed to create fuels conditions that support defensible space and public safety protection objectives in and around South Rim and North Rim developments.

[1]Examples are the Bright Angel Mechanical Fuel Reduction and Prescribed Fire Project Plan (approved 1998) and the Defensible Space Plan, Grand Canyon National Park (on file, Branch of Fire and Aviation).

Responsibility: Project Manager.

- The Urban Interface Response Standard Operating Procedures (8227- 002) approved in 1998 (copy located in the Fire Dispatch Center) will be made available to Branch fire personnel assigned to South Rim and North Rim. These Procedures provide for a pre-planned response to wildland/structural fire incidents that pose an immediate threat to life or property.
  Responsibility: Fire Management Officer

- All fire personnel shall meet appropriate qualifications, including medical requirements, for all fire assignments (per RM- 18 and DO- 18).
  Responsibility: Supervisors.

- Fire personnel shall be equipped with PPE appropriate to their incident assignments.
  Responsibility: Supervisors.

- Fire personnel assigned to fireline operations will complete a minimum of 32 hours of basic wildland fire training, including modules on basic firefighting, basic fire behavior, and standards for survival, and a minimum of 16 hours of refresher (FFT1 and above) and 8 hours refresher for FFT2 and non- operations personnel likely to be on the fireline.
  Responsibility: Supervisors of Park wildland fire personnel.

- All wildland fire incidents that result in human entrapment, fatalities, or serious injuries or result in incidents with potential for the above will be reported and investigated (Ref. DO- 18 and RM- 18).
  Responsibility: Incident Commander/Fire Use Manager.

- Management of all wildland fire incidents will comply with interagency risk management standards.

- The Job Hazard Analysis (JHA) will be used for projects that present potential hazardous activities and for jobs that require employee use of out- of- the- ordinary PPE; refer to RM- 18, Chapter 3 for JHA process and format.

- Documented safety meetings will be conducted before any project is started.

- Accidents will be reviewed to determine areas needing improvement (not as a punitive measure); they normally will be held between the supervisor and the employee.

- All safety protocols for the aviation program will be contained in the Aviation Management Plan.

- A formal aviation program review will be conducted in the Park every 5 years.

Chapter 9 Public Information and Education

Public information and education are cornerstones of a successful fire management program. Without an informed and supportive Park and concessions staff, local and visiting public, partner organizations, and youth, the fire program and the resources it is designed to benefit will most likely not succeed.

Policy direction provided in Director's Order DO-18[1] states that "…the NPS will administer its wildland fire program in a manner that will…educate employees and the public about the scope and effect of wildland fire management, including fuels management, resource protection, prevention, hazard/risk assessment, mitigation and rehabilitation, and fire's role in ecosystem management."

9.1 Public Information Capabilities

The Branch Fire Information Officer has responsibility for implementing the overall information program as described in this section. This position reports to the Chief, Branch of Fire and Aviation.

Ongoing or "as-required" activities designed to increase support and understanding of the fire program include the following.

- Incorporate the principles of fire's role in the Grand Canyon's ecosystem into interpretive programs, exhibits, videos on the NPS Fire Program, tours/interpretive trails through old burns, and Park periodicals (ongoing).
- Educate the concessions staffs on the nature and value of the fire program (ongoing).
- Coordinate all fire-related press releases with the Public Affairs Office (as required).
- Position roadside signs, post kiosk briefing sheets, and use Park and Tusayan radio for announcements during prescribed and wildland fires (as required).
- Assign public information personnel to key visitor contact points during fire incidents; coordinate North Rim interpreters to setup public information stations along the highway from Jacob Lake (as required)
- Participate in the daily situation reporting through WIMS submissions to NPS-FIRE (ongoing)

9.2 "Step-up" Public Information Activities

The needs of the public education and fire information program generally are dictated by incidents and projects as they change in scope and complexity. A qualified information officer will be ordered to handle increasing demands for fire information and assist the Park Fire Information Officer with contact work and recordkeeping. The Fire Information Officer may also establish an incident or project organization to facilitate the timely dissemination of information to the public (see "Step-Up" Public Information Plan below).

[1] DO-18, Section 4, parts 4 and 8, "Operational Policies and Procedures".

The step- up plan as described in the box below provides a logical sequence of actions to initiate in response to changing levels of fire danger or to active fire status. The step- up plan is the responsibility of the Fire Information Officer, Branch of Fire and Aviation.

PRE-FIRE ACTIONS	WILDLAND/PRESCRIBED FIRE: ON-GOING
Include interpretive information on website. Assist Division of Visitor Services and Interpretation with fire management exhibits, visitor program information, etc. Prepare periodic articles for Grand Canyon National Park Guide newspaper on benefits of fire use and hazards of unwanted fire. Prepare and distribute flyers with appropriate messages to Park concessions and residences. Forward to the Public Affairs Office all draft press releases/media information. Use Park radio (AM 1610) for announcements, visitor alerts, etc.	In addition to Pre-Fire Actions listed on left side, consider the following. • Place appropriate notification signs along roadways and rim overlooks, campgrounds, etc. • Prepare information briefs on ongoing fires and update daily. • Answer calls, email, and other public inquiries as directed by FMO. • Appear as necessary during Park visitor programs to deliver briefing and answer questions regarding fire activities. • Respond to directions of Chief, Branch of Fire and Aviation as required.

Incident and project plan packages will also include a record of contacts made, either by the Park Fire Information Officer, assistant(s), and/or dispatcher to advise of burns or wildland fire situations. Also included are copies of press releases, public service announcements, Park- wide notices, closures, and all written notifications.

Chapter 10 Protection of Sensitive Resources

10.1 Cultural Resources

Cultural resources in Grand Canyon National Park reflect the long history of human presence in the region and help reveal the changing human relationship with the landscape. Many individual studies have addressed various aspects of Grand Canyon's past and generally document the story of Native American cultures and the colonization of the West by various non- native groups.

Cultural resources in GRCA cover a time span of almost 11,000 years. They include archaeological sites, ethnographic resources, historic structures, and cultural landscapes. More than 4,000 archaeological sites have been recorded in Grand Canyon National Park, including nearly 2,000 known sites within prescribed fire units, found mostly on the canyon rims. The NPS estimates that Grand Canyon National Park contains approximately 50,000 sites. Overall site density is approximately one site per 23.2 acres on the South Rim and one site per 50.3 acres on the North Rim.

Although tribal consultation specifically to identify ethnographic resources on the rims of GRCA has not been done, tribal studies of the Colorado River Corridor through Grand Canyon (summarized in Neal and Gilpin 2000) identified ethnographic resources outside the corridor and identified the general types of ethnographic resources that occur within GRCA: archaeological sites (including rock art sites, trails, and graves), sacred sites, places mentioned or described in traditional history, subsistence areas, boundary lines (with or without markers), natural landmarks, minerals, plants, animals, and water (including springs).

Eight hundred and eighty structures are listed on the Park's List of Classified Structures (LCS); 336 buildings are listed on the National Register of Historic Places (NRHP), and 40 buildings are classified as National Register- eligible. The vast majority of historic buildings and structures are concentrated in GRCA's National Historic Landmark Districts. The buildings listed on the NRHP are primarily associated with tourism, Park administration and operations, and mining enterprises.

Cultural landscapes are settings that humans have created in the natural world, expressions of human manipulation and adaptation of the land. GRCA has identified Cultural Landscape in five areas that convey historically significant adaptations and modifications to the Grand Canyon environment.

Protection Measures

During any fire management activity, the location of cultural resources in the project area will be determined and adverse impacts minimized. Cultural resources will be identified through database and paper record searches as well as field inventories or verifications. As needed, project and site- specific mitigation measures will be developed and implemented. These measures will be designed to minimize adverse impacts. All planned fire management activities will comply with Section 106 of the NHPA, and it's implementing regulations. General mitigation measures are listed below. Specific mitigation measures will be developed for each project or incident.

- Control lines, helispots, fire camps, staging areas, and other ground- disturbing activities will not occur within identified cultural resources.
- Fire will be excluded from fire- sensitive archeological sites or features. Exclusion measures may include line construction, fuel reduction within the site or feature, application of fire shelter material, and the application of foam or water.
- During aerial ignition operations, fire- sensitive sites will be marked so that they can be seen from the air and avoided during ignition.
- Post- fire assessments will be completed for all fire- sensitive sites. Post- fire assessments at additional sites will be completed as needed to assess the effects of high- intensity fire or specific management actions.
- As needed, emergency stabilization and restoration will be implemented, following BAER standards.
- During prescribed fire projects and wildland fire use and suppression incidents, a cultural resource specialist may be assigned to the incident as a resource advisor to help prevent adverse impacts to cultural resources.
- During manual and mechanical thinning projects, no slash will be drug through or piled within an archeological site, and no trees will be felled on archeological features or sensitive cultural sites.
- Manual and mechanical thinning within the viewshed of National Historic Landmark and Individually Listed Historic Buildings will be consistent with the Secretary of the Interior's Standards for Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes (1996). Work in these areas will be coordinated with the Historical Architect or other appropriate cultural resource specialist.
- Manual and mechanical thinning within identified cultural landscapes will be consistent with the Secretary of the Interior's Standards for Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes (1996). Work in these areas will be coordinated with a Landscape Architect or other appropriate cultural resource specialist.
- Manual and mechanical thinning will be designed to minimize the number of trees that are removed or thinned within the Grand Canyon Village National Historic Landmark District Cultural Landscape.
- Road and helispot maintenance activities will avoid adverse impacts to cultural resources.

10.2 Natural Resources

Summary of Natural Resources and Protection Measures

Appendix C lists the Special Status Species of animals and plants that occur Park- wide. There are no federally listed plants in the Ponderosa Pine FMU of the Park; however, there are 11 rare plants known from the ponderosa pine community in general, most occurring in the area of the Kaibab Plateau (Brian 1996).

In the Ponderosa Pine FMU and Mixed Conifer FMU, there is a protection- related management concern for old- growth ponderosa pine occurring individually or in stands. These are trees with

yellowed bark, indicating pre- settlement age, and generally 16- in. dbh or greater.[1] Deep duff and litter buildup around these trees place them at much higher risk from long- duration surface and ground fire.

Protection objectives for old- growth ponderosa pine stated in operational planning documents should include reasonable tactical measures, including the following.

- When possible, thin around large- diameter (16- in. dbh or greater) ponderosa pine trees.
- Rake deep duff and needle litter layers from around the base of the tree where feasible.
- For stands in which it appears inevitable that they will burn, and it is safe to do so, an attempt should be made to burnout the stand before the main fire reaches it.
- Any ignitions, to the extent possible, should occur during periods of lowest temperatures and highest relative humidity to maximize chances for a low- intensity surface fire.

Protection of sensitive natural resources is largely accomplished through discussions with an assigned Resource Advisor to wildland and prescribed fires, depending on level of complexity and other factors.

Several section 7 (ESA) consultations have been undertaken with the USFWS on various aspects of the Fire Management Program over the previous 12 years. All Conservation Measures and Reasonable and Prudent Measures with Terms and Conditions contained therein are strictly followed. Additional information can be found in the Biological Assessments and Biological Opinions found in Appendix D.

General mitigating measures that have been used successfully in Park fire management activities and will continue to be followed include, but are not limited to, the following.

- Minimize aircraft use and smoke production in vegetation or habitat types that support Goshawks, Condors, and other sensitive bird species.
- Protect active nest sites for any identified sensitive species by constructing a handline of specified radius around the site and firing from the handline to protect the tree(s). (This tactic will be accomplished throughout the nesting season.)
- Protect wildlife catchments.
- Rehabilitation of impacted sites will occur as soon as possible following their use (firelines, campsites, etc.).
- Any sensitive plants identified by the Resource Advisor will be protected as on- site conditions allow.
- Minimum Impact Management Techniques and other mitigating actions designed to protect sensitive resources will be detailed in all project plans, including burnplans, WFIPs, WFSAs, and rehabilitation plans.

Wilderness

Over 1 million acres of the Park qualify for inclusion in the National Wilderness Preservation System. If combined with over 400,000 additional acres of proposed or designated wilderness contiguous to Park boundaries, the area may become one of the country's largest, primarily desert, wilderness areas. According to NPS Fire Management Policy DO- 18 (1998), all fire management activities within wilderness, including the categories of designated, recommended,

[1] From Covington, Draft Environmental Assessment, Grand Canyon Forest Restoration Research (1999), Appendix B, page 35.

potential, proposed, and study areas, will be conducted in keeping with minimum requirement protocols.

Until the Wilderness Management Plan is approved, the Branch of Fire and Aviation will continue to access the 10 roads[2] within the Wilderness Study Areas that were approved by the Park Superintendent in 1992 for administrative use. The Branch also will submit for approval programmatic minimum requirement documents for review regarding other fire management activities such as fuels sampling; fire effects monitoring; fire weather observation; prescribed fire planning, preparation, and implementation; suppression, fire use; preparedness; and resource rehabilitation. These activities historically have required the use of vehicles, chain saws, explosives, motorized pumps, and landing helicopters. These methods will continue to be used as needed until the Wilderness Management Plan is approved and the minimum requirement process is implemented on a programmatic basis.[3]

The Minimum Requirement Analysis form and instructions are located in Appendix E.

Air Resources

Grand Canyon National Park enjoys some of the cleanest air in the continental United States. However, it is a fragile resource, and existing levels of human- caused pollution can often create visible haze.

The Park was designated a Class I area under the Clean Air Act and Amendments (1977, Public Law 95- 217). The Act limits deterioration of air quality and sets forth standards that provide for protection of human health. Amendments to the Act in 1990 called for the creation of the Grand Canyon Visibility Transport Commission to study the interstate transport of air pollutants into the Grand Canyon area. Among other issues, the Commission addressed smoke from forest and agricultural burning within its recommendations.

Grand Canyon National Park has identified "critical receptors," locations where measurements of air quality will be taken. These receptors are defined as those areas designated specifically for public, overnight use. These include the North and South Rim developed areas, the Kaibab/Bright Angel corridor campsites and lodges (Phantom Ranch), designated campsites in the backcountry, and the Colorado River corridor (NPS 2000).

Areas within the Park of concern with respect to the effects of particulates on humans include trails within the Canyon (particularly corridor trails) and the North and South Rim developed areas as stated above. Additionally, short- range visibility effects from smoke adjacent to roadways, developed areas, airports, and helispots are of concern.

Haze results in a reduction in clarity and brilliance in the Park and can obscure distant views. Visibility at the Grand Canyon averages 80 miles and can exceed 150 miles on the clearest days (NPS 1997). Haze can reduce visibility to less than 50 miles, but visibility is still superior to many sections of the country and should remain so into the future (NPS 1997).

Park values concerning air quality involve the great diversity of scenery, including: forests, deserts, canyons, plains, plateaus, volcanic features, streams, and waterfalls. Grand Canyon's air quality greatly affects the clarity and color tones of the visual scene (NPS 1997). Additionally,

[2] Identified open to administrative use as approved by the Superintendent in 1992.
[3] Personal communications, L. Jalbert, Wilderness Coordinator, Grand Canyon National Park, 2001.

smoke has the potential to affect human health. As smoke from wildland and prescribed fires can affect these values to be protected, smoke will be managed as part of the wildland fire program.

The best management practices to be employed by the Park include the following:

- Reducing the total biomass to be burned using non- fire fuels reduction techniques such as chipping and removal as fuelwood where feasible
- Using mass ignition techniques such as aerial ignition by helicopter to produce high-intensity fires with short- duration impacts
- Igniting burns under good- to- excellent ventilation conditions and suspending operations under poor smoke dispersion conditions
- Considering smoke effects on local community activities and land users as part of the go/no- go decision process
- Only burning fuels necessary to meet resource objectives
- Minimizing duff consumption and duration of smoldering by considering fuel moistures
- Minimizing dirt content in slash piles by requiring a brush rake when machine piling
- Burning piles when other burns are not feasible, such as when snow or rain is present
- Expanding burning windows over a broader seasonal time period
- Expanding burn projects over the landscape to separate possible effects within the airshed
- Starting ignition early and completing ignition before 1500 hours to avoid smoke entrapment in inversions or diurnal windflow patterns
- Implementing maintenance burning to mimic natural fire cycles to reduce excessive fuel accumulations and resulting smoke production
- Using naturally- caused fires when feasible
- Managing smoke impacts through
    - Limiting smoke impacts to roads, highways, and airports to the amounts, frequencies, and durations consistent with any guidance provided by highway and airport (Grand Canyon) personnel.
    - Using appropriate signing if smoke will impact any roadways.
    - Notifying internal and external entities (see Notification List, Appendix E).
    - Determining night- time smoke impacts to Tusayan, Grand Canyon Village, Grand Canyon Airport, Highway 64, Grand Canyon Lodge, Desert View, and visitor contact points, and taking appropriate precautions to reduce impacts. Mitigation may involve contacting appropriate authorities, businesses, media, assigning patrols and staff information stations; suppression of any active creep, smoldering materials, and mop- up.
    - Coordinating the timing of prescribed fires with other burning agencies (i.e., Kaibab National Forest).

10.3 Developments, In-holdings and Infrastructures

There are three primary developed areas of the seven total areas that contain real properties situated in proximity to wildland fuels (commonly termed “wildland- urban interface” or “intermix”). Within the Park, these areas are Grand Canyon Village, the North Rim developed area, Desert View, Tuweep, and, to an increasing degree, the planned development at Tusayan. These areas include such values at risk as Park structures, concessionaire buildings, and power lines immediately adjacent. This concern is compounded on the South and North Rims by high concentrations of visitors and employees, access, slopes, proximity to mutual aid resources, and specific locations where inadequate defensible space may exist.

In addition, a utility subzone includes powerlines, waterlines, and sewer facilities (NPS 1995). A detailed inventory of real properties is located in the Park Maintenance Division, Engineering Services Office.

Protection measures developed for these sensitive areas are contained in the Urban- Interface Response SOPs, Appendix E.

Chapter 11 Fire Critiques and Annual Plan Reviews

11.1 Park Incident Reviews

All wildland fires and fire- related incidents within the Park will be reviewed by the appropriate management level. Prescribed fires implemented within the Park will be reviewed as appropriate. The scope and type of reviews will vary by incident complexity as described below. Reviews are intended to resolve operational issues, not to impose punitive actions.

Single-Operational-Period Incidents

For incidents within the Park lasting no longer than one operational period, a review will be conducted within 3 work- days after mop- up has secured the area. Incident personnel involved will participate in the review, which will be facilitated by the Incident Commander or Burn Boss. Any special concerns or problem areas identified in the review will be forwarded to the responsible program manager.

Low-Complexity Multi-Shift Incidents

Incidents lasting longer than a single operational period will be reviewed within 3 working days following completion of mop- up. The Suppression Manager or Fire Use Manager, as appropriate, will conduct the review. Other management staff with specialized knowledge or interest in the incident may also participate. Guidelines for reviews are addressed in RM- 18, Chap. 13.

Higher Complexity Multi-Shift Incidents

For incidents involving the commitment of a Type I or Type II Incident Management Team, refer to RM- 18, Chap. 13, for guidelines. The Chief, Branch of Fire and Aviation customarily will conduct the meeting on behalf of the Park Superintendent.

All On-Going Incidents

"Hotline" reviews are convened to review the progress of on- going incidents, regardless of duration, size, or complexity. For higher complexity incidents, this type of review will confirm the daily decision- making process in the WFSA. The hotline review normally will be conducted by the designated Incident Commander and the Chief, Branch of Fire and Aviation, or designee. Documentation of the review will be included in the normal fire report narration.

11.2 Regional- and National-Level Incident Reviews

A regional- or national- level incident review may be conducted pursuant to any of the following circumstances.

- Incident results in adverse media attention.
- Fire crosses the Park boundary onto another jurisdiction without landowner or administering agency approval.
- Incident involves a fatality or serious fire- related injury.

- Substantial or significant property or equipment damage occurs.
- Incident results in controversy involving another agency.

11.3 Entrapment and Fire Shelter Deployment Reviews

Fire shelter deployment is defined as the use of a fire shelter for its intended purpose in any situation other than training. All entrapments and fire shelter deployments will be reported to the regional Fire Management Officer, who will assemble a review team in cooperation with the National Park Service National Fire Program Center. The team leader will contact the Superintendent of Grand Canyon National Park for reporting information. The review will be conducted in accordance with the guidelines in Reference Manual 18, Chap. 3.

11.4 Program and Plan Reviews

The Park fire management program may be reviewed through any of the following administrative actions.

- Operations evaluations to ensure compliance with established agency standards
- Annual fire program reviews by a team following years in which fire activity is significant, unusual, or controversial
- FIREPRO review, in which regional and/or national teams audit the financial program of the Branch of Fire and Aviation
- Fire readiness reviews conducted annually by the Park fire management staff using the Interagency Fire Readiness Review Guide or every 3 to 5 years by a team preferably interagency in composition

Readiness reviews and fire program reviews should be conducted by the same team whenever possible.

An informal review of the Grand Canyon National Park Fire Management Plan will be conducted annually on March 1 to evaluate current procedures, ensure conformance to current laws, objectives and strategies, and identify any need changes. A formal internal Plan review will be conducted every 5 years coordinated by the Chief, Branch of Fire and Aviation.

Any changes, deletions, or amendments to the Plan will require the concurrence of the Chief of the Branch of Fire and Aviation and approval by the Superintendent through appropriate administrative action. Approved amendments will then be appended to the Plan and documented in the Compendium of Changes (Appendix L).

Chapter 12 Consultation and Coordination

The following individuals were instrumental in the development of this plan.

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Hunter Wistrand, (former) Fire Staff Officer

USDA FOREST SERVICE, KAIBAB NATIONAL FOREST

Hunter Wistrand, (former) Fire Staff Officer
George Sheppard, (former) Wildlife Management Specialist

USDI BUREAU OF INDIAN AFFAIRS, TRUXTON CANYON AGENCY

Don Washco, (former) Forester

ARIZONA STATE HISTORICAL PRESERVATION OFFICE

James V. Garrison, State Historical Preservation Officer

UNITED STATES FISH AND WILDLIFE SERVICE

Steve Spangle, Field Supervisor, Phoenix, AZ