Chapter IV: Environmental Consequences Methodology

Introduction

In analyzing the environmental consequences of the alternatives proposed in the *Final Yosemite Fire Management Plan*/EIS, three factors are looked at for each resource: type of impact, duration of impact, and intensity of impact. After the environmental consequences of the alternative are examined for separate topics, the impact of implementing the alternative is considered along with the impacts of other relevant actions in the area. This is the cumulative impacts analysis, explained below. Whether or not an impact will cause impairment is included for some resources, also explained below.

The *type of impact* describes a relative measure of beneficial or adverse effects on biological or physical systems, cultural resources, or on the social environment. For example, adverse impacts on ecosystems might be those that would degrade the size, integrity, or connectivity of a specific habitat. Conversely, beneficial impacts would enhance ecosystem processes, native species richness, or native habitat quantity or quality.

Because impacts could have short-term adverse impacts while having long-term beneficial impacts, it is important to look at the duration of the effect of an impact. Effects from fire management activities described within this document are likely to occur within nested long- and short-term time scales. Many of the adverse impacts may occur for relatively short time periods while concurrent improvements to the ecosystem are just beginning. For example, on a small scale, after a fire some areas are likely to begin to resemble pre-fire conditions within one or two growing seasons, while, on a landscape scale, the benefits from a change in forest condition and restoration of the fire regime may take years.

Examining the type and duration of an impact is not enough because an impact could cover a large area or a large portion of a population or could be highly noticeable or even irreversible. Impacts are of varying intensities from small and imperceptible to large and substantial. Measures of intensity consider whether an impact would be negligible, minor, moderate, or major. These designations are used to describe both beneficial and adverse impacts.

A *cumulative impact* is described in the Council on Environmental Quality regulations (1508.7) as: "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions." Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

A comprehensive list of present and reasonably foreseeable future actions is provided in Appendix 5. These actions are evaluated in cumulative impact analyses in conjunction with the impacts of each alternative to assess whether they have any additive or interactive effects on a particular environmental, cultural, or social resource. Because most of these cumulative actions are in the planning stages, the evaluation of cumulative impacts has been based on a general description of the project.

This document also evaluates whether resources might suffer *impairment*. Impairment is not a NEPA issue but instead relates to the National Park Service Organic Act (1916). Impairment that is prohibited by the Organic Act is an impact that, in the professional judgement of the responsible National Park Service manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values. Nonetheless, an impact is less likely to constitute impairment if it is an unavoidable result of an action necessary to preserve or restore the integrity of park resources or values.

According to National Park Service Policy, "An impact would be more likely to constitute an impairment to the extent that it affects a resource or a value whose conservation is: a) Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; b) Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or c) Identified as a goal in the park's general management plan or other relevant National Park Service planning documents." (NPS Management Policies, Part 1.4.5)

Biological Environment

Vegetation and Fire Ecology

The alternatives will be evaluated by looking at structure and composition of the vegetation, and fuels. Because of similarities in fire regimes and the mosaic of vegetation types found at any elevation, the fifteen vegetation types listed in Chapter III will be lumped into five clusters for this analysis. Subalpine forests, upper montane forests, lower montane forests, meadows, and foothill woodlands are the groups. The types in each group are found in Chapter III, tables III-1 and III-2.

Type of Impact

- Adverse: Moves the system outside of or away from the natural range of variability for vegetation (structure, composition, and fuels).
- Beneficial: Moves the system inside of or toward the natural range of variability for vegetation (structure, composition, and fuels).

Duration of Impact

- Short-term: Can be reversed within one or two fire return intervals.
- Long-term: Requires three or more fire return intervals to reverse effects.

Intensity of Impact

- Negligible: Imperceptible or undetectable effects upon vegetation.
- Minor: Slightly perceptible and localized effects.
- Moderate: Apparent change in plant community structure, composition, or fuels that would result in a change of the role of fire on a small scale.
- Major: Substantial change in plant community structure, composition, or fuels that represents a change in the role of fire, ecological function, vegetation type, or fire return interval on a landscape scale.

Wetlands

A programmatic approach has been developed to minimize wetland impacts from National Park Service activities. The protection of wetlands is facilitated through Executive Order 11990, *Protection of Wetland*s; National Park Service Directors Order 77-1, *Wetland Protection* and its accompanying Procedural Manual 77-1 (DO 77-1 and PM 77-1); Clean Water Act, Section 404; and the "no net loss" goal outlined by the White House Office on Environmental Policy in 1993. Executive Order 11990 requires that leadership be provided by involved agencies to minimize the destruction, loss, or degradation of wetlands. Directors Order 77-1 and Procedural Manual 77-1 provide the procedural structure in which Executive Order 11990 may be implemented. Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act authorize the U.S. Army Corps of Engineers to grant permits for construction and disposal of dredged material in waters of the United States.

Several tools were used to determine potential fire management impacts on wetlands within the park boundary. Information from the National Wetlands Inventory (USFWS 1995) and a park-wide vegetation map (NPS 1994e) were overlain with known fire management units and use areas. An assumption was made that all meadow and riparian communities on the vegetation map were likely to be classified as wetlands in future, site-specific (< 5acre) delineations of wetlands in the park. This information provided a conservative and broad estimate of potential wetlands in Yosemite.

Impacts were assessed with three criteria in mind:

- Federal laws, regulations, and executive orders; similar state laws (for example, the California Endangered Species Act); or National Park Service management policies.
- Issues and concerns expressed during public scoping.
- Projected impacts on the natural history of a species or the known sensitivities of a habitat.

The assessment of fire management impacts also needs to occur within the context of wetland condition and natural disturbance processes. For this analysis, several assumptions were made. The greater the size of a biotic community and the stronger its links to neighboring communities, the more valuable it is to the integrity and maintenance of biotic processes. Although specific fire management activities may result in short-term fragmentation and the disassociation of communities from each other, these same impacts may result in long-term ecological benefits.

Type of Impact

- Adverse: Degrades the size, integrity, or connectivity of wetlands.
- Beneficial: No detrimental effects. Enhances native ecosystem processes, native species richness or diversity, or native habitat quantity and quality.

Duration of Impact

Wetlands are likely to begin to resemble the pretreatment condition within one or two growing seasons following fire events or management activities (Davis et. al 1998). The benefits following changes in forest condition and upland fire regimes are likely to occur at much longer time scales.

- Short-term: Lasts less than 10 years following the implementation of an alternative.
- Long-term: Lasts or appearing 10 years after implementation of an alternative.

Intensity of Impact

Three primary measures were used to evaluate the intensity of impacts on wetlands: the size and type of the wetland, the integrity of the wetland, and the connectivity of the wetland to adjacent habitats.

- Negligible: Imperceptible or not detectable.
- Minor: Slightly detectable, localized within a small area, and would not affect the overall viability of wetlands in the park.
- Moderate: Apparent but could be reversed.
- Major: Substantial, highly noticeable, and could be permanent.

Wildlife

For many thousands of years, fire has been a strong force in the formation of the natural structure, distribution, and diversity of wildlife habitats in the Sierra Nevada. As a result, Sierra Nevada wildlife have developed behaviors and life history characteristics that are adapted to the influence of fire on their habitat. As there are successions of species and age classes of plants that occur between fires, there are successions of animal species that are favored or disfavored as habitats change. Prehistorically, the pattern of fire has fluctuated—climate and the use of fire by American Indians have varied over time.

With the arrival of Euro-Americans in the Sierra Nevada, the patterns of fire changed dramatically, mostly from intense fire suppression activities in the 20th century. Some forest habitats in Yosemite have become denser, and more prone to catastrophic, stand-replacing fires. Such changes have been detrimental to the natural diversity, abundance, and distribution of wildlife in the park. In addition, fire control activities can adversely affect wildlife through direct disturbance of animals and habitats; management actions designed to benefit habitat, such as prescribed fire, can have inadvertent adverse effects on wildlife. With these factors in mind, the following parameters were used to evaluate the effects of the various alternatives given in the *Final Yosemite Fire Management Plan/EIS*.

Type of Impact

- Adverse: Likely to result in unnatural changes in the abundance, diversity, and distribution of wildlife species. Changes could occur through direct disturbance or mortality, or through destruction or alteration of habitat.
- Beneficial: Likely to protect and/or restore the natural abundance, diversity, and distribution of wildlife species. This would occur through protection and restoration of the natural structure, succession, and distribution of habitat.

Duration of Impact

- Short-term: Immediate changes in the abundance, diversity, and distribution of wildlife, but a return to the original condition within 20 years, without further impacts.
- Long-term: Changes in the abundance, diversity, and distribution of wildlife that persist for more than 20 years.

Intensity of Impact

- Negligible: Imperceptible or undetectable impacts.
- Minor: Slightly perceptible, and limited in extent. Without further impacts, adverse impacts would reverse and the resources would recover.
- Moderate: Readily apparent, but limited in extent. Without further impacts, adverse impacts would eventually reverse and the resource would recover.
- Major: Substantial, highly noticeable, and affecting a large area. Changes would not reverse without active management.

Special-Status Species - Plants

Fire plays a role in the management of many special-status plant species by maintaining open habitat, encouraging reproduction, and affecting competing species. Fire may injure or kill individual plants while the effects on the species as a whole is beneficial because competition has been reduced or openings created. Fire suppression activities can adversely affect these same species because of ground disturbance. Prescribed fires can also be detrimental, especially when timing, frequency, and intensity of fire are outside of the natural fire cycle to which the species is adapted (Hessl and Spackman 1995). Keeping these factors in mind, the following parameters have been used to evaluate the consequences on special-status plants of the various alternatives proposed in the *Final Yosemite Fire Management Plan/EIS*.

Type of Impact

- Adverse: Viability of known populations and/or potential habitats of special-status species are threatened. May lead to loss of habitat, increased competition by both native and non-native species, or reduce and/or prevent reproduction.
- Beneficial: Actions that improve habitat conditions and enhance the viability of populations. May eliminate competitive species, thereby increasing available habitat, or improve reproductive output and success.

Duration of Impact

- Short-term: May immediately affect the population or species, but with no long-term effects to population trends or species viability.
- Long-term: May lead to a loss in population or species viability—exhibited by a trend suggesting decline in overall species abundance, viability, and/or survival.

Intensity of Impact

- Negligible: Imperceptible or undetectable.
- Minor: Slightly perceptible and localized, without the potential to expand if left alone.
- Moderate: Apparent and sufficient to cause a change in the resources (e.g., abundance, distribution, quantity, or quality).
- Major: Substantial, highly noticeable, and with the potential for landscape-scale effects.

Special-Status Species – Animals

Like most wildlife in the Sierra Nevada, special-status species have adapted to natural fire regimes. In many areas, including Yosemite National Park, however, a history of fire suppression has led to dense, overgrown stands, with high accumulations of forest fuels. This affects special-status species by altering habitat and placing these species and their habitats at risk of high-intensity, stand-replacement fire. In addition, stand-replacement fire could create unsuitable habitat conditions that would last for many years. Fire control activities could also adversely affect special-status species through direct disturbance of animals and habitats. Even management actions designed to benefit habitat, such as prescribed fire, can have inadvertent adverse effects on special-status species. With these factors in mind, the following parameters have been used to evaluate the effects on special-status animals of the various alternatives proposed in the *Final Yosemite Fire Management Plan/EIS.*

Type of Impact

- Adverse: Likely to result in unnatural changes in the abundance or distribution of a special-status species. This could occur through direct disturbance or mortality, or through destruction or alteration of habitat.
- Beneficial: Likely to protect and/or restore the natural abundance and distribution of a special-status species. This would occur through protection and restoration of structure, succession, and distribution of habitat.

Duration of Impact

- Short-term: Immediate changes in the abundance and distribution of a special-status species, but a return to the original condition occurs within two generations of that species, without further impacts.
- Long-term: Changes in the abundance and distribution of a special-status species that persists for greater than two generations of that species.

Intensity of Impact

- Negligible: Imperceptible or undetectable.
- Minor: Slightly perceptible and limited in extent. Without further actions, adverse impacts would reverse, and the resource would recover.
- Moderate: Readily apparent but limited in extent. Without further actions, adverse impacts would eventually reverse, and the resource would recover.
- Major: Substantial, highly noticeable, and affecting a large area. Changes would not reverse without active management.

California Wildlife Habitat Relationships was used to generate a list of suitable habitat for each species (Mayer and Laudenslayer 1988). For each habitat that occurs in Yosemite, an *average suitability value* was generated. This process examines the size and stage classes of vegetation that are likely to occur for each habitat type and then looks at how these vegetation classes fulfill the requirements for reproduction, cover, and feeding for each animal species. The California wildlife habitat relationships information was evaluated and adapted to the situations in Yosemite using in-house knowledge about species occurrence and habitat use specific to the park. The average suitability value and knowledge of habitat conditions, distribution, and ecology of each species in Yosemite was used to assign high, medium, and low values to each suitable habitat type. These

ranked habitats were then compared to the fire return interval departure (FRID) maps and the fire unit maps to determine how habitats of different values correspond to current fire-related habitat conditions and different treatment scenarios under the various alternatives. For a more extensive description of the status, biology, and distribution of special-status species, see Appendix 9, Biological Opinion.

Physical Environment

Watersheds, Soils, and Water Quality

Water resources, watershed, and soils are interrelated in their reactions to the treatments proposed by the alternatives. Due to these relationships, the analysis has been done on them as a group. Effects upon soils and watersheds are assessed by considering the likely scale of the effect—whether fire would affect all or part of the watershed slope (ridge, mid-slope, bottom)—and as a result, the likely effect upon water yield, peak flows, sediment yield, nutrient yield, and/or stream system response.

Type of Impact

- Adverse: Moves the system outside of or away from the natural range of variability for watershed conditions (water yield, peak flows, sediment yield, nutrient yield or stream system response).
- Beneficial: Moves the system inside of or toward the natural range of variability for watershed conditions (water yield, peak flows, sediment yield, nutrient yield, or stream system response).

Duration of Impact

- Short-term: Can be reversed within two fire return intervals.
- Long-term: Requires three or more fire return intervals to reverse effects.

Intensity of Impact

- Negligible: Imperceptible or undetectable.
- Minor: Slightly perceptible and localized, without the potential to expand if left alone.
- Moderate: Apparent, but would remain localized.
- Major: Substantial, highly noticeable, with the potential for landscape (watershed)-scale effects.

Air Quality

Fire management activities could potentially affect air quality in the Yosemite area through smoke emissions from wildland and prescribed fires and exhaust from machinery used in site preparation, monitoring, and thinning activities.

Smoke Emissions

In order to quantify smoke emissions predicted to result from each alternative, the First Order Fire Effects Model 5.0 (FOFEM) was used to generate emission factors for PM_{10}, $PM_{2.5}$, volatile organic compounds (as CH_4), CO, and CO_2. FOFEM is a computer-based planning tool that is used to provide a variety of quantitative predictions for planning prescribed fires, impact assessment, and long-range planning and policy development. FOFEM provides quantitative fire effects information for tree mortality, fuel consumption, mineral soil exposure, and smoke (USDA 1997). The smoke module of FOFEM models the productions of emissions but not smoke dispersion or visibility. The smoke module requires a number of inputs related to burn characteristics, including fuel category, cover type, fuel loading, moisture content, and percent of crown burn. For this analysis, park fire management staff provided burn parameters for each burn unit (Appendix 6); burn parameters were assumed to be consistent throughout a prescribed burn unit regardless of mosaic of vegetation cover types.

The area of each cover type in a given prescribed burn unit was determined using GIS data. This was done by intersecting two GIS datasets: the prescribed burn unit area and the vegetative cover type. The burn unit cover types were then correlated with the Society for American Foresters (SAF)/Society for Range Management (SRM) cover types available in FOFEM. In some cases, direct correlation between cover types was not possible, and a surrogate SAF/SRM cover type was selected. Table IV-1 provides a cross-reference for cover types. Not all cover types exist within all burn units. Several burn units include areas of bare rock or water for which no smoke emissions are expected.

For a given prescribed burn unit and pollutant, the emissions were quantified by the following equation:

$$E = \sum_{c=1}^{n} EF_c * A_c, \text{ where}$$

E = emissions, tons/year

EF_c = emission factor for coverage c, in tons/acre

A_c = area of coverage c, in acres

Average emission factors for all prescribed burns were calculated from the FOFEM predictions to facilitate comparison of alternatives. The average emission factors were used to quantify emissions from prescribed fire and managed wildland fire since both are expected to have similar burn characteristics. However, separate FOFEM runs were used to develop emission factors for unwanted wildland fires which typically burn under drier conditions and consume more fuel, particularly crown and branch fuels, and therefore, produce higher emissions. In order to develop average wildland fire emission factors, representative burn parameters for unwanted wildland fire were provided by park staff for three of the predominant cover types: Pacific ponderosa pine, Sierra Nevada mixed conifer, and white fir. These are the types representative of the vegetation in the park where fire has been suppressed and which are targeted for treatment.

Both the prescribed and wildland fire emission factors predicted by FOFEM are considerably higher than similar emission factors in the Environmental Protection Agency's *Compilation of Air Pollution Emission Factors* (AP-42*)* for the same region. However, the AP-42 derived emission factors are generalized for large regions and "can vary by as much as 50 percent with fuel and fire

conditions" (EPA 1996). Since fuel loadings in many areas of the park may be heavier than normal due to decades of fire suppression, the average emission factors used here can be considered more representative of park conditions. Finally, the FOFEM model does not provide emission factors for NO_x. According to EPA AP-42, the emission factors for NO_x from wildland and prescribed fires are approximately 35 times less than those for CO emissions. Therefore, the CO emission factors produced by the FOFEM model were scaled down proportionately to estimate NO_x emission factors. Table IV-2 provides the emission factors used for each fire type.

The median number of years to achieve ecosystem restoration or a natural background for Alternatives B, C, and D are 12.5, 25, and 17.5 years, respectively. For prescribed fire, comparison of the alternatives is based on a listing of tentative prescribed fire projects and associated number of acres to be treated by prescribed burning for the years 2003-2009. This list of tentative prescribed fire projects includes areas that are part of the ecosystem restoration goals, wildland/urban interface goals, and maintenance burning to keep previously treated areas within their range of variability.

Table IV-1
Vegetative Cover Types Used in Air Quality Emissions Analysis

FMP Code	Fire Management Vegetation Types	SAF[a]/SRM[b] Type	SAF/SRM Description
ba1	Bare Rock	NA	NA
ba2	Water	NA	NA
bu1	California Black Oak	246	California Black Oak (Eastern Black Oak - SAF 110 used as surrogate)
bu2	Foothill Pine/Interior Live Oak	250	Blue Oak - Digger Pine
bu3	Canyon Live Oak	249	Canyon Live Oak (SAF 250 used as surrogate)
bu4	Blue Oak Woodland	201	Blue Oak Woodland (SAF250 used as surrogate)
lm1	PonderosaPine/Bear Clover Forest	245	Pacific Ponderosa Pine
lm2	Ponderosa/Mixed Conifer Forest	243	Sierra Nevada Mixed Conifer – FOFEM 081
lm3	White Fir/Mixed Conifer Forest	211	White Fir [c]
lm4	Giant Sequoia/Mixed Conifer Forest	243	Sierra Nevada Mixed Conifer – FOFEM 081
me1	Dry Montane Meadows	216 (SRM)	Montane Meadows
sa1	Whitebark Pine/Mountain Hemlock Forest	208	Whitebark Pine
sa2	Lodgepole Pine	218	Lodgepole Pine
sc1	Montane Chaparral	209 (SRM)	Montane Shrubland
sc2	Foothill Chaparral	208 (SRM)	Ceanothus Mixed Chaparral
um1	Red Fir	207	Red Fir [c]
um2	Western White Pine/Jeffrey Pine	215	Western White Pine [c]

a Society for American Foresters (SAF), b Society for Range Management (SRM), c ex, from CA., van Wagtendonk and Sydoriak, '98

Table IV-2
Smoke Emission Factors by Fire Type

Type of Fire	Emission Factor (tons/acre) [a]					
	PM_{10}	$PM_{2.5}$	CH_4	CO	NO_x	CO_2
Prescribed Fire	0.73	0.61	0.48	8.66	0.25	39.18
Managed Wildland Fire	0.73	0.61	0.48	8.66	0.25	39.18
High-Intensity Wildfire	1.20	1.02	0.61	13.36	0.38	67.27

a PM_{10} = Suspended Particulate, $PM_{2.5}$ = Fine Particulate Matter, CH_4 = Methane , CO = Carbon Monoxide, NOx = Nitrogen Oxides, CO_2 = Carbon Dioxide

Each alternative is compared using the decade average number of acres of wildland fire (wildfire) per year of 5,760 acres (average from 1991 to 2000, including both lightning and human-caused fires). However, as the park is returned to an ecologically natural state and heavy fuel loadings are reduced, it is expected that unwanted wildland fires would occur less frequently and burn less intensely in the future. Air emissions from fire will diminish when fire regimes are restored to forest ecosystems since fuel loads and fuel consumption will decline—thus, the park will be under a regime of maintenance burning. To illustrate this effect a proposed burn unit, the PW-17 Elevenmile project on the west park boundary, was analyzed. Pre-burn characteristics were assumed to be heavy fuel loading with a concentration of heavy fuels (larger size branches, logs, etc.), and post-burn characteristics were assumed to be approximately one-third of the pre-burn fuel loading and size. The FOFEM model was run and the results are noted in table IV-3. As anticipated, the air emissions are reduced in proportion to the fuel loading reduction.

Table IV-3
Modeled Pre-Burn and Post-Burn Emissions using Prescribed Fire Unit PW-17, the Elevenmile project on the west park boundary

PW-17 Unit Burn Conditions	Fuel Loading (tons/acre)	Fire Factors (tons/acre) [a]				
		PM_{10}	$PM_{2.5}$	CH_4	CO	CO_2
Pre-burn: Heavy Fuel Loading	48.8	1.66	1.40	0.85	18.50	87.70
Post-burn: Light Fuel Loading	15.2	0.54	0.46	0.28	6.09	27.45

a PM_{10} = Suspended Particulate, $PM_{2.5}$ = Fine Particulate Matter, CH_4 = Methane, CO = Carbon Monoxide, CO_2 = Carbon Dioxide

Mechanical Treatments Emissions

Depending on the alternative, air pollutants would be generated by various mechanical thinning and site preparation methods. Motorized equipment used in thinning and site preparation activities include chainsaws, chippers, feller-bunchers, skidders, haul trucks, and all terrain vehicles (ATVs) used for low-impact skidding. These six types of equipment are a representative sample of the types of equipment used in Yosemite. Table IV-4 shows the emission factors used to figure emissions under each alternative.

Table IV-4
Emissions Factors for Equipment Used in Fire Management Activities

Operating Parameters				Emission Factor (gm/horse power – hour) [a]			
Machine Type	Fuel Type	Ave. HP	Load	CO	Particulate Matter	NO_x	VOC
Chainsaws	Gasoline	6	0.5	519.0	7.7	1.82	160.0
Chippers	Gasoline	50	0.5	486.0	7.7	0.29	3.3
Feller/Bunchers	Diesel	200	0.65	15.3	2.0	10.30	3.3
Skidders	Diesel	200	0.65	15.3	2.0	10.30	3.3
Haul Trucks	Diesel	200	0.65	15.3	2.0	10.30	3.3
ATV Skidding	Gasoline	50	0.68	408.8	0.06	3.5	5.2

a Particulate Matter = PM_{10} (Suspended Particulate) and $PM_{2.5}$ (Fine Particulate Matter), CO = Carbon Monoxide, NOx = Nitrogen Oxides, VOC = Volatile Organic Compounds (total hydrocarbons) . No data for CO_2.

Type, duration, and intensity of air quality impacts are described as follows:

Type of Impact

- Beneficial: Reduces emissions or lowers pollutant concentrations.
- Adverse: Increases emissions or raises pollutant concentrations.

Duration of Impact

- Short-term: Associated with the duration of a specific fire event.
- Long-term: Occurs at the time that the park restores the natural fire regime.

Intensity of Impact

For this analysis, the percent increase or decrease in air emissions between the alternatives is the same as those adopted for the air quality analysis in the *Yosemite Valley Plan/SEIS* (NPS 2000c). These are:

- Negligible: Less than 5 % increase or decrease compared to the existing program.
- Minor: 5 to 20 % increase or decrease compared to the existing program.
- Moderate: 21 to 50 % increase or decrease compared to the existing program.
- Major: > 50 % increase or decrease compared to the existing program.

Cultural Environment

This impact analysis methodology applies to three primary types of cultural resources: archeological sites, ethnographic resources, and cultural landscape resources (including individually significant historic structures).

Section 106 of the National Historic Preservation Act requires a federal agency to consider the effects of its actions on properties included in, eligible for inclusion in, or potentially eligible for inclusion in the National Register of Historic Places, and provide the Advisory Council on Historic Preservation a reasonable opportunity to comment. A programmatic agreement was developed among the National Park Service at Yosemite, the California State Historic Preservation Officer, and the Advisory Council on Historic Preservation, in consultation with American Indian tribes

and the public, to take into account the effects of park planning and operations on historic properties (NPS 1999c, also see Appendix 8, Cultural Resources, Programmatic Agreement).

Impact analysis follows established procedures and stipulations outlined in the programmatic agreement. These include: (1) identifying areas and types of resources that could be impacted; (2) assessing information regarding historic properties within this area and conducting additional inventories and resource evaluations as necessary; (3) comparing the location of the impact area with that of important cultural resources; (4) identifying the extent and type of effects; (5) assessing those effects according to procedures established in the Advisory Council on Historic Preservation's regulations; and (6) considering ways to avoid, reduce, or mitigate adverse effects.

Site specific compliance, with project specific details will be completed for prescribed fire and fuel treatments, consistent with the cultural resources programmatic agreement.

Cultural resource impacts in this document are described in terminology consistent with the regulations of the Council on Environmental Quality, and in compliance with the requirements of both the National Environmental Policy Act (NEPA) and Section 106 of the National Historic Preservation Act. The Section 106 determination of effect for the undertaking (implementation of the alternative), required by the programmatic agreement, is included in the "Section 106 Summary" for each alternative, presented later in this chapter.

This methodology focuses on specific treatments discussed in Chapter II, Alternatives, as well as areas containing cultural resource that, when burned, are most likely to be adversely affected. These areas are identified through the Fire Return Interval Departure (FRID) analysis. Using the median FRID analysis (Chapter II, pages II-5 to II-7), areas with a median FRID value of four or greater are more likely than those with a value less than four to burn at an intensity that would impact cultural resources. Burns in these areas would also be more difficult to control to the degree needed to protect known resources, unless mitigation measures were implemented prior to the burn (see Mitigations of Impact, below).

Type of Impact

Impacts are considered either adverse or beneficial to historic properties (cultural resources) when analyzed under NEPA. However, impact type is not viewed this way when conducting analysis under Section 106 of the National Historic Preservation Act. For the purposes of assessing effects to historic properties under the National Historic Preservation Act, effects are either adverse or not adverse. Effects under both NEPA and the National Historic Preservation Act are considered adverse when they diminish the significant characteristics of a historic property.

Duration of Impact

Impacts to historic properties (cultural resources) could be of short term, long term, or permanent duration. Analysis of the duration of impacts is required under NEPA, but is not required and is not usually considered in assessing effects in terms of National Historic Preservation Act.

Intensity of Impact

- Negligible: Impacts would be barely perceptible changes in significant characteristics of a historic property.
- Minor: Impacts would be perceptible and noticeable, but would remain localized and confined to a single element or significant characteristic of a historic property (such as a single

archeological site containing low data potential within a larger archeological district or a single contributing element of a larger historic district).

- Moderate: Impacts would be sufficient to cause a noticeable but not substantial change in significant characteristics of a historic property.
- Major: Impacts would result in substantial and highly noticeable changes in significant characteristics of a historic property.

Impacts can be either direct or indirect. Direct impacts result from specific actions, such as biomass removal or fire line construction using a bulldozer. Indirect impacts generally occur after an action, and are a result of changes in the condition of the landscape (such as loss of vegetation and subsequent erosion).

Mitigation of Impacts to the Cultural Environment

NEPA calls for a discussion of the "appropriateness" of mitigation, and an analysis of the effectiveness of mitigation. A reduction in intensity of impact from mitigation is an estimate of the effectiveness of this mitigation under NEPA. It does not suggest that the level of effect, as defined by implementing regulations for Section 106 of the National Historic Preservation Act, is similarly reduced. Although adverse effects under Section 106 may be mitigated, the effects remain adverse.

Mitigation in this document is based on the cultural resources programmatic agreement and includes the avoidance of adverse effects or the application of one or more standard mitigation measures as described in stipulations VII (C) and VIII (Appendix 8). Avoidance strategies may include protecting historic resources from fire and fire-related impacts through onsite fuels reduction or use of portable sprinkler systems and protective shelters. Stipulation VIII requires the National Park Service to notify the State Historic Preservation Officer, American Indian tribes, and members of the public of its decision to implement standard mitigation measures for individual actions having an adverse effect on historic properties.

Outlined below are the mitigating measures that would be taken, under all alternatives, to reduce or avoid impacts to cultural resources:

Pre-Incident Planning

- Known cultural resources would be assessed for hazardous fuels, and these hazards would be reduced as part of ongoing fuel reduction programs.
- The National Park Service would continue to consult with park-associated American Indian tribes and groups about fire management planning and specific fire management actions in order to identify issues and resources of concern and implement the most appropriate treatments.
- In traditional use areas fire planning would consider the needs of cultural practitioners to access and use of traditional resources.
- In fire management units lacking cultural resource inventory data, background research and inventory would be conducted to identify resources that may be important and would be susceptible to adverse impacts from fire or fire management actions.
- Planning for fire management actions would include protection of known cultural resources.

- Cultural resources typical of those found at Yosemite would be included in long-term research and experimentation about the effects of fire on cultural resources.
- Incident Response
- Archeologists or cultural resource specialists would be involved as resource advisors or technical specialists to advise fire management teams of cultural resource issues and concerns.
- Archeologists or cultural resource specialists would, wherever possible, aid in positioning crew camps, holding lines, spike camps, helispots, drop zones, and other fire suppression-related facilities to avoid damage to cultural resources.
- Archeologists or cultural resource specialists would advise fire management teams of known, significant cultural resources where potential impacts of fire could be reduced or avoided through emergency fuel reduction.
- Wherever possible, archeologists or cultural resource specialists would document significant cultural resources prior to a burn.

Post-Burn Measures

- Archeologists or cultural resource specialists would document the post-fire condition of known cultural resources.
- Where feasible, significant cultural resources would be stabilized to prevent post-fire damage.
- Archeologists or cultural resource specialists would, where necessary, conduct post-burn inventory at areas affected from construction of holding lines, spike camps, and other fire related facilities.
- Archeologists or cultural resource specialists would conduct post-burn inventories in unstable areas and recommend stabilization as noted above.
- Archeologists or cultural resource specialists would conduct inventories and prescribe any necessary resource protection measures in areas proposed for post-burn treatment where cultural resources might be affected.
- Archeologists or cultural resource specialists would perform post-fire monitoring surveys of portions of fires after ground visibility is improved.

Archeological Resources

The impact analysis provides a comparison of the FRID analysis with actions proposed for the management units under each alternative. For areas with more than three missed fire return intervals, fuel accumulation is unnaturally high and fires (prescribed burns and wildland fires) could generate soil and below-soil temperatures that damage archeological materials.

Type and Duration of Impact. A change in the physical attributes of an archeological site that affects the information contained in that site is irreparable and considered adverse and of permanent duration. Adverse impacts to archeological resources can result from manual or mechanical fuels treatment, direct heating during fire, fire response and suppression, post-fire ecological processes, emergency rehabilitation, and fire damage restoration. The intensity of impacts to archeological resources can range from negligible to major, depending on the management actions taken and/or on the intensity of burning. The majority of these impacts are long-term in duration. Appendix Eight contains a list of fire-related effects.

Fire can also have beneficial impacts to archeological resources. Burning duff and forest litter exposes mineral soil not visible during inventories of unburned areas, allowing for greater accuracy in documenting site constituents and boundaries. Burning within a natural fire regime also reduces the threat of high-intensity fire and the need for suppression activities.

Intensity of Impact. The intensity of impact to an archeological resource would depend on the potential of the resource to yield important information, as well as the extent of the physical disturbance and/or degradation. For example, moving earth at an archeological site with low data potential might result in a minor, adverse impact.

- Negligible: Barely perceptible and not measurable, and would usually be confined to archeological sites with low data potential.
- Minor: Perceptible and measurable, and would remain localized and confined to archeological site(s) with low to moderate data potential.
- Moderate: Sufficient to cause a noticeable change, and would generally involve one or more archeological sites with moderate to high data potential.
- Major: Substantial and highly noticeable changes, involving archeological site(s) with high data potential.

Mitigation of Impacts

For archeological resources, mitigation includes site avoidance during fire suppression activities, protection of flammable materials during burns, and reducing heavy fuel loads in a manner that preserves and protects the site. In some situations standard treatments such as complete site documentation (e.g. at some historic dumps) may be appropriate as a way to preserve site information and forego continued site management.

Ethnographic Resources

While developing this plan, the National Park Service consulted with culturally-associated American Indian tribes and groups. Both have expressed strong support for increasing the annual number of acres burned. They also have expressed support for the standard treatments for known ethnographic resources or traditionally used plant species (such as avoiding traditionally used plants or timing the burns to promote culturally-desired characteristics in plants). The National Park Service would continue to consult with culturally associated American Indian tribes about each year's prescribed fire program and on individual fires. This provides American Indian tribes and groups the opportunity to provide additional information or express concerns about ethnographic resources and discuss appropriate treatments.

Type of Impact

Fire-related adverse impacts to ethnographic resources can occur as result of fuels treatment, burning, fire response and suppression, emergency fire rehabilitation, and fire damage restoration. For example, traditionally-used plants can be damaged or destroyed if they are exposed to fire at the wrong point in their annual life cycle. Wooden features can be destroyed if not protected from burning. Most ethnographic resources that are known can be protected from adverse impacts through protection or, in the case of plants that benefit from fire, prescribing appropriate burn times and intensities. Fire was used extensively by American Indians in managing and maintaining some plants for traditional use—continued burning is necessary to maintain the health, vigor, culturally-desirable characteristics, and extent of many traditionally-used plants.

Duration of Impact

- Short-term: Causes a temporary change in important vegetation or temporarily restrict access to an important resource, yet do not disrupt the cultural traditions associated with that resource for a noticeable period.
- Long-term: A change in culturally important vegetation or a cultural feature for a noticeable period. This period would vary by resource type and traditional practitioners. Long-term changes would disrupt cultural traditions associated with the affected resource, but the disruption would not alter traditional activities to the extent that the important cultural traditions associated with the resource are lost.
- Permanent: Impacts to ethnographic resources would involve irreversible changes in important resources such that the ongoing cultural traditions associated with those resources are lost.

Intensity of Impact

The intensity of impacts to an ethnographic resource would depend on the importance of the resource to an ongoing cultural tradition, as well as the extent of physical damage or change.

Cultural Landscape Resources, Including Individually Significant Historic Sites and Structures

Type of Impact

- Adverse: Physical changes to significant characteristics of a resource or its setting, such as removal or burning of historically important vegetation or burning of historic structures.
- Beneficial: Restoration of a natural setting or reduction in heavy fuels adjacent to structures—measures that reduce risk of loss through burning.

Duration of Impact

- Short-term: Activities such as temporary removal of vegetation or other contributing resources, road closures, or prescribed burns, where the impacts are noticeable for a period of from one to five years.
- Long-term: Reversible changes, lasting from five to twenty years, in a significant characteristic of a historic structure or landscape.
- Permanent: Irreversible changes such as complete removal or burning of important vegetation or structures.

Intensity of Impact

- Negligible: Barely perceptible and not measurable; would be confined to small areas or a single contributing element of a larger National Register district.
- Minor: Perceptible and measurable; remain localized and confined to a single contributing element of a larger National Register district.
- Moderate: Sufficient to cause a change in a significant characteristic of an individually significant historic structure; or would generally involve a single or small group of contributing elements in a larger National Register district.

- Major: Substantial and highly noticeable changes in significant characteristics of an individually significant historic structure; or would involve a large group of contributing elements in a National Register district.

Mitigation of Impacts

Mitigation measures for historic structures and cultural landscape resources include measures to avoid impacts, such as removing heavy fuels in and adjacent to cultural landscape features and historic structures; protecting flammable historic structures from burning; and excluding fire from especially sensitive designed historic landscapes.

Social Environment

Recreation

Fire management activities and the potential for closures, restrictions and direct effects were evaluated for their potential to affect visitation and an aggregate of recreational activities in Yosemite National Park.

Type of Impact

- Adverse: Reduce visitor participation, quality of visitor experience, and/or service level.
- Beneficial: Enhance visitor participation, quality of visitor experience and/or service level.

Duration of Impact

- Short-term: Temporary in nature, during the period when a fire management activity would take place.
- Long-term: Permanent effect on the visitor experience.

Intensity of Impact

- Negligible: Imperceptible or undetectable effect upon visitors.
- Minor: Slightly detectable or localized effect on visitors.
- Moderate: Readily apparent localized effects on visitors.
- Major: Substantial, highly noticeable effects and/or effects that would result in major limits on activities.

Scenic Resources

Fire management activities and operations, catastrophic fire, and smoke from fires were evaluated for their potential to affect scenic quality of major scenic values or historically important views, such as in Yosemite Valley, along road corridors, and in Wilderness.

Type of Impact

- Adverse: Degrades visual quality.
- Beneficial: Improves visual quality.

Duration of Impact

- Short-term: Short-lived or temporary (less than five years) occurring primarily during or just after fire management activities (managed wildland fire, prescribed fire, biomass removal, etc.).
- Long-term: Effects are detectable for more than five years after fire treatment.

Intensity of Impact

- Negligible: Imperceptible or undetectable.
- Minor: Slightly detectable or limited to a relatively small area.
- Moderate: Readily apparent.
- Major: Substantial, highly noticeable and/or results in a change of character of the landscape.

Noise

In this analysis, the noises associated with fire management activities and operations were evaluated for their influence on the soundscape. Sound levels for various activities and pieces of equipment were compared to a reference sound level [40 dB(A), see table III.12 and text in Chapter III, Noise].

Type of Impact

- Adverse: Noise levels increase.
- Beneficial: Noise levels decrease.

Duration of Impact

- Short-term: Temporary and associated with transitional types of activities.
- Long-term: Permanent effect on the ambient noise environment.

Intensity of Impact

- Negligible: Imperceptible or undetectable.
- Minor: Slightly detectable near the source, but not expected to have an appreciable effect on ambient noise levels.
- Moderate: Clearly detectable, and could have an appreciable effect on ambient noise levels; moderate effects may include the introduction of a noise into an area with little or no ambient noise.
- Major: Clearly audible against ambient noise levels; or would have a substantial, highly noticeable effect on ambient noise levels.

Local Communities

Alternatives were evaluated for their socioeconomic effects on local communities. Socioeconomic effects include potential direct effects of property loss and potential indirect effects in economic terms, in the event of park closures.

Type of Impact

- Adverse: Degrades or otherwise negatively alters the characteristics of the existing environment, as it relates to local communities, visitor population, regional economies, and concessionaires and contractors.
- Beneficial: Improves on characteristics of the existing social and economic environment, as it relates to local communities, visitor population, regional economies, and concessionaires and contractors.

Duration of Impact

- Short-term: Temporary and typically transitional; associated with implementation of an action.
- Long-term: Permanent impacts on the social and economic environments.

Intensity of Impact

- Negligible: Undetectable and expected to have no discernible effect on the social and economic environment.
- Minor: Slightly detectable and not expected to have an overall effect on the character of the social and economic environment.
- Moderate: Detectable and could have the potential to initiate an increasing influence on the social and economic environment.
- Major: Substantial, highly noticeable influence on the social and economic environments, and could be expected to alter those environments permanently.

Environmental Justice

Alternatives were evaluated for their effects on minority and low-income populations and communities.

Type of Impact

- Adverse: Degrades or otherwise negatively alters the characteristics of the existing environment, as it relates to local communities of minority and low-income populations.
- Beneficial: Improves on the characteristics of the existing social and economic environment, as it relates to local communities of minority and low-income populations.

Duration of Impact

- Short-term: Temporary and typically transitional effects associated with implementation of an action.
- Long-term: Permanent effects on the social and economic environments.

Intensity of Impact

- Negligible: Not detectable and expected to have no discernible effect on the social and economic environment for minority and low-income populations

- Minor: Slightly detectable and expected to have no overall effect on the character of the social and economic environment for minority and low-income populations.
- Moderate: Detectable and could have the potential to initiate an increasing influence on the social and economic environment for minority and low-income populations.
- Major: Substantial, highly noticeable influence on the social and economic environments, and could be expected to alter those environments permanently for minority and low-income populations.

Special Designations

Wild and Scenic Rivers

See Chapter V, Wild and Scenic Rivers.

Wilderness

The impacts of fire management activities and operations on Yosemite Wilderness were evaluated by assessing their effect on both the Wilderness user and the Wilderness setting.

Type of Impact

- Adverse: Degrades Wilderness values or interferes with the public's use and enjoyment of Wilderness
- Beneficial: Improves Wilderness values or enhances the public's use and enjoyment of Wilderness.

Duration of Impact

- Short-term: Occurs in the period concurrent with the implementation of individual actions or leaves evidence of human activity that lasts no more than five years after the action.
- Long-term: Continues after completion of the individual actions and can be expected to persist for longer than five years.

Intensity of Impact

- Negligible: Imperceptible or undetectable.
- Minor: Slightly perceptible and limited to a relatively small area.
- Moderate: Apparent.
- Major: Substantial or highly noticeable.

Energy Consumption

Fuel consumption was estimated for each alternative using the average annual amount of accomplishment for each activity, in acres, and an estimate of equipment fuel consumption, on a per acre basis. Assessments of effects are made using the following.

Type of Impact

- Adverse : Increase in energy consumption.
- Beneficial: Decrease in energy consumption.

Duration of Impact

- Short-term: A change in energy consumption that would last less than five years.
- Long-term: Change in energy consumption that would last five years or more.

Intensity of Impact

- Negligible: Increase or decrease by less than 5% annually.
- Minor: Increase or decrease by 5% to 20% annually.
- Moderate: Increase or decrease by 21% to 50% annually.
- Major: Increase or decrease by more than 50% annually.

Impacts of Fire Supression Activities

The effects of fire suppression activities (e.g., fire line construction, use of retardant, physical damage to cultural resources caused by suppression actions,) are potentially greater in those alternatives which take a relatively longer time to reduce wildland fuels and restore ecosystem structure. As wildland fuels, and wildland fire risk, are reduced, less effort will be required to manage wildland fires. Less intrusive methods will likewise be required to manage more natural, low intensity wildland fires.

Fire management actions such as prescribed fire and managed wildland fire may use handline and other tactical actions similar to those used in fire suppression, but greater opportunities for planning are more conducive to avoiding resource impacts and making strategic decisions that improve management of resources. Emergency fire suppression actions, guided by policies intended to assure that only appropriate impacts are allowed during the course of actions to protect human life and property, are often done under tight deadlines, and impacts do occur. Fire lines can have a direct effect upon ecological processes and ecosystem function. They are often associated with disease centers, exotic plant invasion, and rodent habitat disturbance.

The width of fire lines, for example, are constructed according to a fire's flame lengths and how far it is throwing embers. Fire line placement locations are selected based on opportunities to safely control and suppress a fire, and protect life and property. Fire lines built in response to high intensity wildland fires can be in the order of dozens of feet, compared to one to two feet in the case of lines constructed in support of planned prescribed fire activities. In the construction of fire lines, all flammable plant material, including the top layer of organic soil, is removed. In general, suppression tactics depend on several factors: safety, topography, available resources, fire behavior, and fire suppression goals.

Fire suppression activities undertaken under any of the alternatives will be guided by the procedures described in Appendix 3, Wildland Fire Response, Planning, and Implementation Procedures.