5 Impacts of Alternatives

This chapter discusses the potential impacts, including cumulative impacts, of each alternative on various park resources or issue of concern. Each resource and issue is described beginning with a general description followed by an articulation of the factors used to assess environmental consequences. The factors are based on applicable laws, NPS policy, and park resource goals. Impacts common to all alternatives are discussed as well as impacts specific to the individual alternatives. Each section ends with a discussion stating the relative effects of each alternative and assesses its potential to create or reduce impairment to park resources. A summary of the following information is contained in Chapter 6 (Tables 6- 1 and 6- 2).

While evidence suggests that global climate change may begin to affect park resources and ecosystems over the next several decades, there is still great uncertainty as to the extent and effect of the changes that may occur. As a result of this uncertainty, this plan assumes (with the concurrence of our USGS global change research partners (Stephenson - personal communication)) that our knowledge of past ecosystem condition and function will be adequate to guide the program for at least the next decade. A comprehensive fire effects monitoring program will be maintained, as will research efforts at the park to assess what, if any, changes are occurring as a result of rapid climate change. Once more is known about the effects of climate change on park resources, fire management strategies and practices can be amended to respond to those challenges.

A. VEGETATION COMMUNITIES

Extensive research chronicles a long history of naturally occurring fire in Sierran ecosystems, and many plants exhibit classic evolutionary adaptations to frequent fire events. In assessing the environmental consequences of the alternatives, the assumption was made that native plant populations that currently occur in the parks have evolved in the presence of fire under historic fire regime conditions, and that perpetuating a natural fire regime will have no effect or beneficial effect (see Chapter 9 in the companion *Fire and Fuels Management Plan*). Following this assumption, and in accordance with NPS policy, the loss of individual plants due to fire was not considered in assessing the environmental impacts of the alternatives, except for special status species that are discussed under section C of this chapter.

Factors Used to Assess Environmental Consequences

Maintenance of Natural Fire Regimes
Alternatives that most closely maintain and restore the natural fire regime, including fire return interval, fire severity, and landscape pattern, are favored over alternatives that alter or constrain those factors.

Acres Restored
Alternatives that promote more acres of proactive restoration to natural structure, composition and function are favored over alternatives that restore fewer acres.

Reduce Risk of Catastrophic Loss
Alternatives that result in a reduction of unnaturally large high- severity fire events are favored over alternatives that leave more acres vulnerable to damage from this source.

Impacts Common to All Alternatives

Mechanical treatment to reduce hazardous fuels in proximity to structures would affect the parks' vegetation in the same ways in all alternatives. Individual trees and shrubs would be removed, and grass would be cut to the extent necessary to protect structures from wildland fire in limited areas of the parks, therefore, only a small portion of the parks' vegetation is directly affected in all alternatives.

After the initial mechanical treatment in forest and shrub areas, impacts would be limited to removing some regeneration of trees and shrubs in future treatments; therefore, cumulative impacts to these areas would be minimal. In grassland areas where regeneration occurs annually, more frequent treatment to reduce grass would be needed.

Wildland fire suppression in all alternatives would result in limited direct impacts, including clearing or disturbing vegetation in localized areas of the parks. The average annual number of acres affected by fire suppression activities would be similar for Alternatives 2, and 4. Alternative 3 would have approximately five times the amount of average annual suppression acreage as the no action alternative. For all alternatives, minimum impact suppression techniques (Addendum – *Fire and Aviation Management Operations Guide*) would be used during all suppression efforts.

Beneficial cumulative impacts are expected due to planned fire management activities on neighboring United States Forest Service lands. The Inyo, Sequoia, and Sierra National Forests have rewritten, or are rewriting, their respective fire management plans. Their plans will all allow for wildland fire use activity. Depending upon the amount of acres treated through wildland fire use, a greater percentage of Southern Sierran vegetation and associated fire regimes could be restored or maintained, with decreased risk of catastrophic loss to vegetation associations. Wildland fire use could allow this restoration or maintenance to occur across agency boundaries in wilderness areas. All alternatives would receive this beneficial cumulative effect.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
Under the current program, the vegetation in many areas of the parks' would receive beneficial effects of fire treatment, including restoring the natural structure, composition, and function of historically fire- maintained vegetation associations. At the current rate, however, much of the parks' vegetation would burn too infrequently to mimic historic fire return intervals. The long-term consequences of this change in fire regime would result in continued departure of

vegetation conditions from the desired natural conditions in areas excluded from restoration or maintenance of the natural fire regime.

Adverse impacts would include an increase in fire- intolerant species, combined with a lack of regeneration of many fire- adapted species, resulting in further unnatural changes in vegetation structure, composition, and function. In addition to these changes, continued accumulation of fuels would lead to unwanted wildland fires with uncharacteristically severe fire effects, leading to increased mortality and inhibited postburn regeneration.

Alternative 2 – Prescribed Fire
A large increase in prescribed fire in Alternative 2 would beneficially affect the parks' fire-maintained vegetation by restoring fire- related ecological benefits, such as reduced competition for limited resources, enhanced nutrient cycling, and regeneration of fire- adapted plant species. In areas where heavy fuel loads have resulted from fire exclusion, prescribed fire would be used to reduce fuel loads to more natural levels to help prevent severe effects of unwanted wildland fire. However, with increased use of prescribed fire, the natural ignition and spread pattern of fire on the landscape would be replaced by less random ignition patterns, creating a less natural pattern of fire effects compared with wildland fire use. The long- term consequences of less natural fire patterns are unknown.

Alternative 3 – Wildland Fire Use
Due to the increase in acres treated with wildland fire use in Alternative 3, more of the parks vegetation would burn with a more natural pattern of fire effects compared with Alternative 1. These fire effects would be beneficial to the structure and function of much of the parks' vegetation that has evolved with fire over time. In many areas between approximately 4000-8000 feet (1200- 2400 meters) in elevation, where heavy fuel loads have resulted from fire exclusion and prescribed fire was not used to first restore natural fuel loads in the area, uncharacteristically severe fire effects could occur. In these cases, the adverse impacts on vegetation would include unnaturally high levels of mortality and disruption of plant succession, with slower postburn regeneration of species adapted to less severe fire effects.

Alternative 4 – Multi- Strategy (Preferred Alternative)
An increase in both prescribed fire and wildland fire use would have a beneficial effect on the parks' vegetation by restoring the structure and function of historically fire- maintained vegetation over a larger area of the parks compared to Alternative 1. Fire- related ecological benefits, such as reduced competition, nutrient cycling, and regeneration of fire- adapted plant species would occur in a larger portion of the parks. More natural patterns of fire effects on vegetation would occur with an increase in wildland fire use. In vegetation types that have been greatly altered by fire exclusion, fire would be reintroduced initially with prescribed fire to first restore fuel and vegetation conditions to minimize adverse effects of severe fire. Wildland fire use would then be used to the extent possible to maximize the benefits of natural fire patterns.

Conclusions

All alternatives provide some level of restoration or maintenance of park ecosystems and therefore have the potential to reduce the current level of impairment to park vegetation.

However, Alternative 1 reduces impairment only locally while the other alternatives improve conditions across a larger area of the parks.

Under Alternative 1, vegetation conditions in many areas of the parks would continue to deviate from desired natural conditions, leading to uncharacteristically severe wildland fire that could cause permanent impairment of some vegetation resources. Further impairment of vegetation resources is less likely to occur in Alternative 2, 3, and 4, as those alternatives increase the area of the parks where fire would be restored. Potential severe fire effects leading to impaired vegetation resources would be more likely in Alternative 3 and less likely in Alternative 4, where prescribed fire would be used to reintroduce fire to highly altered areas under less severe conditions to minimize adverse impacts.

Table 5-A1 – Comparison of Effects on Vegetation Communities

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Maintenance of Natural Fire Regimes	0	+	+	++
Acres Restored	0	++	+	++
Reduce Risk of Catastrophic Loss	0	+	_	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

B. WILDLIFE

In assessing the environmental consequences of the alternatives, the assumption was made that native wildlife populations that currently occur in the parks have evolved in the presence of fire under historic fire regime conditions (see Chapter 9 in the companion *Fire and Fuels Management Plan*). Following this assumption, and in accordance with NPS policy, the loss of individual animals was not considered in assessing the environmental impacts of the alternatives, except for special status species that are discussed under section C of this chapter. While some loss or displacement of individual animals would inevitably occur in areas treated with fire, long- term benefits to the populations or to other native species would occur as a result of restoration of fire- maintained habitat.

Factors Used to Assess Environmental Consequences

Maintenance of Natural Conditions and Habitat Diversity

Alternatives that most closely maintain and restore the natural fire regime, including fire return interval, fire severity, and landscape pattern, are favored over alternatives that alter or constrain those factors.

Acres Restored
Alternatives that promote more acres of active habitat restoration to natural structure, composition and function are favored over alternatives that restore fewer acres.

Reduce Risk of Catastrophic Habitat Loss
Alternatives that result in a reduction of unnaturally large high- severity fire events are favored over alternatives that leave more habitat vulnerable to damage from that source.

Impacts Common to All Alternatives

Mechanical treatment to reduce hazardous fuels in proximity to structures would affect the parks' wildlife to the same extent in all alternatives. Mechanical treatment would cause human disturbance, noise, and alter habitat within the immediate treatment area which could change wildlife use of the treated area. Only a small portion of the parks' vegetation, and therefore wildlife habitat, is affected in all alternatives.

Wildland fire suppression activities in all alternatives would have adverse impacts on some wildlife individuals. Fireline construction would result in the removal of snags, temporary disturbance, and often new game trail formation as large wildlife use the firelines. Small animals would lose some habitat as brush, logs, and litter are removed down to mineral soil. Fire retardant used in fire suppression is toxic to fish and probably to other aquatic wildlife. In addition, in larger suppression efforts, large numbers of people brought in could result in food being made accessible to bears in fire camps and on the fireline, contributing to bear problems.

Beneficial cumulative impacts would mirror those described under the vegetation communities section. More wildland fire use in the Southern Sierra occurring across agency boundaries would benefit wildlife through restoration of acreage, increased habitat diversity, and reduced risk of catastrophic habitat loss.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
Under the current program, fire treatments would be less frequent than historic fire- return intervals in many areas of the parks. Without sufficient fire, the vegetation would continue to become more homogeneous resulting in wildlife habitat that is less varied. Wildlife would be adversely affected by the loss of some types of habitat that was maintained by historic fire regimes. In addition, the risk of uncharacteristically severe wildland fire would become greater over time, and would have the potential to threaten wildlife populations not adapted to more severe fire effects.

Alternative 2 – Prescribed Fire
The use of prescribed fire in a larger portion of the parks would occur in Alternative 2, creating more natural vegetation patterns across the landscape and a greater variety of wildlife habitat. More habitat conditions favorable to fire- adapted species would be created in Alternative 2, but not necessarily in the same patterns associated with natural ignitions. The distribution of habitat

would be determined by prescribed burn timing, locations, conditions, and pattern and could result in less natural habitat conditions compared to wildland fire use. The long- term consequences of less natural fire patterns and corresponding habitat conditions are unknown. In the areas where heavy fuel loads have resulted from past fire exclusion, prescribed fire would be used to reduce the risk of uncharacteristically severe fire and corresponding radical changes to the habitat.

Alternative 3 – Wildland Fire Use
With an increase in wildland fire use in Alternative 3, a more natural distribution of habitat conditions would occur over a larger area than in Alternative 1, and many wildlife species would benefit. In areas where heavy fuel loads have resulted from fire exclusion, unnaturally severe fire effects could occur that might negatively impact specific wildlife species at a local scale, but may increase the landscape heterogeneity, thereby improving wildlife biodiversity at the landscape scale.

Alternative 4 – Multi- Strategy (Preferred Alternative)
An increase in areas restored using fire in Alternative 4 would maintain a more natural distribution of wildlife habitat than in Alternative 1. A greater use of wildland fire use in Alternative 4 would increase landscape heterogeneity and improve wildlife biodiversity at the landscape scale. In the areas where heavy fuel loads have resulted from past fire exclusion, prescribed fire would first be used to reduce the risk of uncharacteristically severe fire and corresponding radical changes to the habitat.

Conclusions

All alternatives provide some level of restoration or maintenance of park ecosystems and therefore have the potential to reduce impairment to park wildlife. However, some alternatives reduce impairment only locally while others improve conditions across a larger area of the parks.

Under Alternative 1, wildlife habitat in many areas of the parks would continue to change from the desired natural condition, leading to uncharacteristically severe wildland fire that could cause permanent impairment of some wildlife habitat. Future impairment of habitat is less likely to occur in Alternatives 2, 3, and 4, as those alternatives increase the area of the parks where fire would be restored. Potential severe fire effects leading to impaired wildlife habitat would be more likely in Alternative 3 and less likely in Alternative 4, where prescribed fire would be used to reintroduce fire to highly altered areas under less severe conditions to minimize adverse impacts.

Table 5-B1 – Comparison of Wildlife Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Maintenance of Natural Conditions and Habitat Diversity	0	+	+	++
Acres Restored	0	+	+	+
Reduce Risk of Catastrophic Habitat Loss	0	++	+	++

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
1 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

C. SPECIAL STATUS SPECIES

The U.S. Fish and Wildlife Service provided a complete list of federal and state listed species in Tulare and Fresno counties, including endangered, threatened, rare, candidate, species of concern, and species of local concern. The species that are known to occur in the parks are analyzed in this section. See Appendix B for a list of the species not known to occur within Sequoia and Kings Canyon National Parks that were removed from further consideration.

The parks had historic occurrences of five species of wildlife that are listed as federally threatened or endangered, as well as one critical habitat designation requiring protection under the Endangered Species Act. Two of the five federally listed species, the grizzly bear and California condor, are extirpated from these Parks; but current restoration could result in Condors using the parks in the future. Two other species are candidates for federal listing as endangered, and California lists four additional species in addition to three of the federal species. There are no plant species in the parks that are federally listed. A number of additional species of wildlife and plants considered in this analysis are listed as "species of concern" by either the state or federal government.

The Endangered Species Act of 1973 requires consultation for any actions that may effect on all federally threatened or endangered species. NPS policy further requires consideration of effects on state- listed threatened, endangered, candidate, rare, declining, and sensitive species. For this environmental assessment, the Fire Effects Information System (USDA 2001) was used to determine potential impacts to special status species if the species was included in the system. If not, inferences were made based on knowledge of location or habitat, or knowledge of effects on similar species.

The effects of each of the alternatives on many of the special status species are currently unknown. However, for those that occur in areas that have experienced fire disturbance for at

least the last 2,000 years, it is assumed that populations either benefit from fire or are tolerant of fire over the long term, despite possible short- term loss of some individuals.

Factors Used to Assess Environmental Consequences

Potential for Take of Individuals Protected as Threatened or Endangered
Each alternative is evaluated to determine whether it would be likely to result in the take of individual organisms protected under the Endangered Species Act.

Loss of Viable Protected Populations
Each alternative is evaluated to determine whether it would be likely to result in the loss or improvement of viable populations of special status species.

Loss of Critical Habitat Defined in Recovery Plans
Each alternative is evaluated to determine whether it would be likely to result in the loss of critical habitat as defined in 50 CFR 17.95.

Amount of Habitat Restored or Maintained
Each alternative is evaluated to determine whether it would promote or enhance habitat for special status species.

Reduced Risk of Catastrophic Loss
Alternatives that result in a reduction of unnaturally large high- severity fire events are favored over alternatives that leave more habitat or populations vulnerable to damage from this source.

Impacts Common to All Alternatives

Mechanical treatment to reduce hazardous fuels in proximity to structures would have no effect on the parks' special status species in any of the alternatives. Only a small portion of the parks' vegetation, and therefore wildlife habitat, is affected in all alternatives (an average of less than 100 acres treated annually) and no special status species are known to exist in close proximity to park structures. Each mechanical project proposal would undergo review and clearance by park subject matter experts prior to implementation.

Beneficial cumulative impacts would mirror those described under the vegetation communities section. More wildland fire use in the Southern Sierra occurring across agency boundaries would most likely benefit special status species through restoration and maintenance of more habitat, as well as reduced risk of catastrophic habitat loss.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
Fire restoration would occur in limited areas of the parks and would have no effect or potentially beneficial effect to most special status species adapted to fire in treated areas. In other areas, fire treatments would occur less frequently than in the historic fire regime, leading

to further degradation of natural conditions. These altered conditions would create a greater risk of uncharacteristically severe wildland fire that would have the potential to adversely affect special status species. No direct loss of protected individuals, populations, or critical habitat is likely to occur under this alternative over the short term. Indirect loss through continued habitat change and direct loss through the increased risk of unnaturally large high- severity fire is likely in the future.

Alternative 2 – Prescribed Fire
An increase in areas restored with fire in Alternative 2 compared to Alternative 1 would benefit those special status populations that are enhanced by fire effects on vegetative mosaics and habitats. In addition, over time, the risk of adverse effects to sensitive species from uncharacteristically severe fire would decrease in treated areas. With the scheduled nature of increased prescribed fire activities under Alternative 2, a greater ability to locate and avoid the disturbance of fire- sensitive special status populations, if necessary, exists.

While individual plants and animals may be affected or displaced by fire events, restoration would have no effect or beneficial effect on overall populations of special status populations. No direct loss of populations or critical habitat is likely to occur under this alternative. Some indirect loss through continued habitat change and direct loss through the increased risk of unnaturally large high- severity fire is likely in the future.

Alternative 3 – Wildland Fire Use
An increase in areas treated with fire in Alternative 3 compared to Alternative 1 would benefit those special status populations that are enhanced by fire. In some areas, conditions altered by fire exclusion could lead to uncharacteristically severe wildland fire effects that might have an adverse effect on special status species not adapted to more severe fire. However, over time, the risk of adverse effects to sensitive species from uncharacteristically severe fire would decrease in treated areas. Due to the random location and timing of wildland fire use ignitions, sensitive populations might be impacted by fire before they could be located and protection efforts, if needed, would be more difficult. Species that are fire dependent would benefit from the occurrence of fire in a more ecologically desirable natural pattern of wildland fire use leading to natural vegetative mosaics.

While individual plants and animals may be affected or displaced by fire events, restoration would have no effect or beneficial effect on overall populations of special status populations. No direct loss of populations or critical habitat is likely to occur under this alternative. Some indirect loss through continued habitat change and direct loss through the increased risk of unnaturally large high- severity fire is likely in the future.

Alternative 4 – Multi- Strategy (Preferred Alternative)
An increase in areas treated with fire compared to Alternative 1 would benefit those populations that are enhanced by fire. The risk of adverse effects to special status species from uncharacteristically severe fire would decrease in treated areas. In areas where prescribed fire is used, species that are sensitive to fire could be located and protected if necessary. More natural ignition and spread patterns would result from wildland fire use, benefiting species that are adapted to the creation of these natural vegetative mosaics.

While individual plants and animals may be affected or displaced by fire events, restoration would have no effect or beneficial effect on overall populations of fire- adapted special status populations. No direct loss of individuals of species protected under the Endangered Species Act is likely to occur under this alternative unless there is a catastrophic fire in unrestored fuels. No direct loss of populations or critical habitat is likely to occur under this alternative.

Individual Species - Wildlife

Federally Listed Species including Candidates
The following federally listed endangered or threatened wildlife species or critical habitats are found within the parks. A summary of these species, and the effects of the alternatives on them, is found in Table 5- C1.

Bald eagle – While bald eagles are rare in the parks, fire in any of the alternatives would have a neutral effect on bald eagle habitat. Snags and dead branches used as hunting perches would be destroyed by some fire events, while at the same time others would be created.

California condor – The alternatives would have either no effect, or a beneficial effect, on condor potential habitat since condors forage primarily in open areas, especially grassy hills. When condors were present in the local area, they foraged primarily in the open areas west of the parks where there is designated critical habitat. Increases in fire frequency would help make park landscapes more desirable for condors by maintaining open landscapes within the foothills. Some records of condors nesting in sequoia trees exist and increased fire use would also help maintain sequoia forests for potential nesting sites. Chaparral fires would provide potential post- burn foraging up until there is significant regrowth. The fires would not create any threat of incidental take to the soaring condors.

Little Kern golden trout /Critical Habitat – This threatened trout and a portion of its critical habitat occur in conifer forests at the southern end of Sequoia National Park. As in many other coniferous forest areas, fuel loads here are high due to past fire exclusion. Uncharacteristically severe wildland fire could endanger the species and its habitat through increased sediment transport, which would cause erosion, increase water temperature due to loss of canopy, and bury spawning gravel. Alternatives 2, 3, and 4 would provide greater opportunity for managing wildland fire or prescribed fire in Little Kern golden trout habitat than under Alternative 1, thereby decreasing the chance of severe fire impacting the species. Fire managers would use prescriptions intended to protect the habitat by removing fuels and help restore a more natural forest structure. These opportunities would be further enhanced as the U.S. Forest Service increases the role of fire in their management plans for adjacent areas.

Mountain yellow- legged frog – This candidate for federal listing occurs in alpine and subalpine areas of these parks that rarely encounter fire. Those fires are small and typically of natural origin. These frogs rarely leave their aquatic habitat which consists of lakes, ponds, marshes, and streams. Both the frogs and their habitat are unlikely to be effected by fire or any differences in the alternatives for the management of fire.

Sierra Nevada bighorn sheep – Sierra Nevada bighorn sheep and their habitat would not be directly or indirectly affected by any of the alternatives. The Sierra Nevada bighorn sheep

habitat in the park occurs at high elevations, and is generally found above areas that burn. Any habitat that does burn would likely result in beneficial effect by providing increased quality forage as a result of nutrients released after fire. It is unlikely that extensive areas would burn at the high elevations of bighorn sheep habitat, therefore effects on habitat are unlikely. Also, increased fire would have beneficial effects by reducing cover for the bighorn's major predator, the mountain lion. Bighorn are highly mobile and would not have any problems avoiding fires in progress. A recovery plan for the Sierra Nevada bighorn sheep has been drafted and awaits final approval.

Valley elderberry longhorn beetle – While specimens from the parks' watersheds appear to be the unlisted California elderberry longhorn beetle, the U.S. Fish and Wildlife Service has historically considered the park population to be the federally- listed valley elderberry longhorn beetle. Thus they are addressed in this document. Elderberry plants with stems greater than 1" in diameter are required to provide high quality habitat for the valley elderberry longhorn beetle. Fire events in the range of the beetle would consume some stems in this size class. However, since elderberry resprouts vigorously following fire in all alternatives, fire would rejuvenate decadent elderberry plants, maintaining quality habitat for the beetle. Given the relatively long natural fire return intervals (15- 80 years) at elevations where the beetles may occur, and the vegetation mosaic that would result from fire events, ample time would pass between fires to create an extensive mosaic of mature elderberry. Not burning during March through mid- June would avoid the period when adults emerge and breed.

Yosemite toad – This candidate for federal listing occurs in alpine and subalpine areas of Kings Canyon National Park. The tadpoles live in shallow water and the adults live in moist meadows and rocky areas. Fires are rare, small, and typically of natural origin within their park distribution, and are very unlikely to occur within their habitat. Fire is not a concern regarding management of the species within these parks, and the species would not be effected by any differences in alternatives for managing fire.

California State Endangered or Threatened Species (that are not also federally listed)
The following California State- listed wildlife species may occur within these parks. A summary of these species, and the effects of the alternatives on them, is found in Table 5- C1.

California wolverine – This species lives in a wide variety of habitats and little is known of the potential impacts of fire. Fire restoration efforts would likely minimize the risk of adverse impacts to wolverine habitat from uncharacteristically severe wildland fire.

Little willow flycatcher – Little willow flycatchers in general are very rare in the parks and occur in meadows that burn infrequently, therefore, fire restoration is not likely to have any adverse impacts.

Sierra Nevada red fox – This subspecies is believed to live at high elevations that do not burn often. In general, fire is believed to benefit red fox by enhancing food supplies.

Swainson's hawk – This valley bird of open country would only rarely be found in the parks. Fire restoration would help maintain an open habitat to help them spot food and probably also help elevate their rodent food supply.

Table 5-C1 – Federal and State listed wildlife species (and Candidates)

Common Name	Species	Status	Effects For All Alternatives
bald eagle	*Haliaeetus leucocephalus*	Fed – T / State - E	0
California condor	*Gymnogyps californianus*	Fed – E / State - E	0/+
California wolverine	*Gulo gulo luteus*	State – T	+
Little Kern golden trout/critical habitat	*Oncorhynchus aquabonita whitei*	Fed - T	+ (- for Alt 1)
little willow flycatcher	*Empidonax trallii brewsteri*	State – E	0
mountain yellow-legged frog	*Rana muscosa*	Candidate Fed - E	0
Sierra Nevada Bighorn Sheep	*Ovis canadensis californiana*	Fed – E/State - E	0/+
Sierra Nevada red fox	*Vulpes vulpes necator*	State – T	+
Swainson's hawk	*Buteo Swainsoni*	State – T	+
valley elderberry longhorn beetle*	*Desmocerus californicus dimorphus*	Fed - T	+
Yosemite toad	*Bufo canorus*	Candidate Fed - E	0

Key:

Fed Federal status
State State of California status
E Endangered: Listed as in danger of extinction.
T Threatened: Listed as likely to become endangered within the foreseeable future.
* Considered present by USF&WS

Candidate: Federal listing warranted but precluded
Critical Habitat: Area essential to the conservation of a species.

0 no effect
– adverse effect
+ beneficial effect

Species of Special Concern

In addition to the federal and state listed endangered and threatened species, there are 36 special concern wildlife taxa that may be located in the parks. Impacts on these species have also been considered (Table 5- C2). As with other native species, it is assumed that the restoration of a natural fire regime and the maintenance of a mosaic of old growth forest conditions throughout much of the park would result in no effect, or beneficial effect on populations of these species.

Table 5-C2 – Other special status wildlife species

Common Name	Species	Status	Effects For All Alternatives
American marten	*Martes americana*	SC	0
American peregrine falcon	*Falco peregrinus anatum*	D	+
Bells sage sparrow	*Amphispiza belli belli*	SC	?
black swift	*Cypseloides niger*	SC	?
California spotted owl	*Strix occidentalis occidentalis*	SC	0
California thrasher	*Toxostoma redivivum*	SC	+
Denning's cryptic caddisfly	*Cryptochia denningi*	SC	?
ferruginous hawk	*Buteo regalis*	SC	+
Foothill yellow-legged frog	*Bufo boylii*	SC	+
fringed myotis bat	*Myotis thysanodes*	SC	?
greater western mastiff-bat	*Eumops perotis californicus*	SC	?
Kern River rainbow trout	*Oncorhynchus mykiss gilberti*	SC	+
Lawrence's goldfinch	*Caruelis lawrencei*	SC	?
Lewis' woodpecker	*Melanerpes lewis*	SC	?

loggerhead shrike	*Lanius ludovicianus*	SC	?
long-eared myotis bat	*Myotis evotis*	SC	+/?
long-legged myotis bat	*Myotis volans*	SC	?
Mount Lyell salamander	*Hydromantes platycephalus*	SC	0
northern goshawk	*Accipter gentilis*	SC	+
northwestern pond turtle	*Clemmys marmorata marmorata*	SC	0
Nuttall's woodpecker	*Picoides nuttallii*	SC	+
olive-sided flycatcher	*Contopus cooperi*	SC	?
Pacific fisher	*Martes pennanti pacifica*	SC	?
pale Townsend's big-eared bat	*Corynorhinus townsendii pallescens*	SC	?
Prairie falcon	*Falco mexicano*	SC	0
red-breasted sapsucker	*Sphyrapicus ruber*	SC	?
relictual slender salamander	*Betrachoseps relictus)*	SC	?
rufous hummingbird	*Selasphorus rufus*	SC	?
silvery legless lizard	*Anniella pulchra pulchra*	SC	?
small-footed myotis bat	*Myotis cilioloabrum*	SC	?
southwestern pond turtle	*Clemmys marmorata pallida*	SC	0
spotted bat	*Euderma maculatum*	SC	?
Vaux's swift	*Chaetura vauxi*	SC	?
Volcano Creek golden trout	*Oncorhynchus mykiss aquabonita*	SC	+
white-tailed kite	*Elanus leucurus*	SC	?
Yuma myotis bat	*Myotis yumanensis*	SC	?

Key:

SC Species of Concern: Other species of concern to the USFWS.
D Federally Delisted: status to be monitored for 5 years.

0 no effect
– adverse effect
+ beneficial effect
? unknown effect

Migratory Birds

In addition to the federal and state listed species above, managers must consider potential effects on certain migratory birds as stated in the Migratory Bird Treaty Act of 1918 (MBTA) and newly drafted Memorandum of Agreement between the National Park Service and the U.S. Fish and Wildlife Service. As with other native species, it is assumed that the restoration of a natural fire regime and the maintenance of a mosaic of old growth forest conditions throughout much of the park would result in no effect, or beneficial effect on populations of these species. (Information given below for peregrine falcons and California spotted owls following bold text was copied from the U.S. Forest Service fire effects web site http://www.fs.fed.us/database/feis).

Peregrine Falcon – This species is rare at Sequoia and Kings Canyon National Parks. While the species has made a remarkable recovery in most of the United States, it is not thriving in these parks and pesticides are still a concern. The species does attempt breeding at three known locations. Those sites should be avoided by low- flying aircraft during spring and early summer. **Direct Effects of Fire:** Nichols and Menke (1984) reported that fires near nesting cliffs could disturb peregrine young or nesting pairs. No other direct fire effects on peregrine falcon have been noted. **Habitat- Related Fire Effects:** The effect of fire on peregrine falcon habitat is best defined by how it affects their primary prey, other bird species. The California Department of Forestry concluded that peregrine falcons would benefit by chaparral burning if it resulted in an increase of other birds (Nichols and Menke 1984). Studies conducted on chaparral burning

concluded that abundant food was available to raptors immediately following fire because of the vulnerability of prey species due to a cover reduction (Lawrence 1966). Bird species richness and diversity increase in the first few years following fire in chaparral communities (Wirtz 1982). Taylor and Barmore (1980) reported that following fire in Yellowstone and Grand Teton National Parks, air- soaring bird species were present by the second year and firmly established by the fifth year. (Peregrine falcons were not included on their species inventory list.) However, as the canopy closed (after 40 years), these species began to drop out and were replaced by other, but fewer, species. Total bird biomass here was at least 70 percent greater between 5 and 29 years following fire than it was after 40 years. They also concluded that canopy closure affected avifauna more than fire did. **Fire Use:** In California, Longhurst (1978) reported a greater diversity of bird species in young stands of chaparral regrowth (2- 3 years old) or in chaparral interspersed with grassy openings than in stands that were older than 5 years. Frequent burning creates a mosaic of habitats and maintains abundant prey for peregrine falcons. Because peregrine falcons require open areas for hunting, fires that create these open areas would probably be beneficial, provided burning led to an increase of prey species.

Flammulated Owl – This species lives in the mid- elevations of the parks occupying various coniferous forests varying from ponderosa pine to red fir. Observations are primarily during spring and summer. There is not much fire information on this species but because it lives in a combustible habitat and prefers open to intermediate canopy closure it is probably a fire adapted species and probably dependent on fire for long- term maintenance of its habitat.

California Spotted Owl – California spotted owls occupy both the conifer forests and some foothill habitat. Nearly all of their habitat within the park is fire dependent. The only exception may be large stands of canyon live oak growing in mesic sites and some foothill riparian habitat. While fires could cause some short- term disruption of their use of an area, the fire provides long- term maintenance of the habitat. Only stand replacing fires, as would occur from wildfires following long periods of fire exclusion, would be a direct threat to them. **Direct Effects of Fire:** No specific information regarding the direct fire effect on spotted owls was found. However, direct fire related mortality on spotted owls probably occurs. Fire may also destroy nests. **Habitat- Related Fire Effects:** Most spotted owl habitat owes its structure and species composition to fire (Lujan et al. 1992). Historically, spotted owls occupied a dynamic landscape that often consisted of large areas of burned and unburned forest. Today, however, habitat is greatly reduced and fragmented, and owl populations have become increasingly vulnerable to loss of habitat due to fire (Lujan et al. 1992, Thomas et al. 1990). Fires can cause further habitat fragmentation and loss of preferred suitable old growth. One study showed that areas that had been clearcut or burned within the previous 20 years were rarely used by spotted owls for foraging. Additionally, spotted owls usually avoided crossing burned areas by traveling through corridors of unburned timber around the area (Thomas et al. 1990).

Black Swift – Black swifts occur in the parks at most elevations, but primarily in the foothillls and conifer belt. They nest and roost in cliffs and near moist areas like waterfalls. They feed on aerial insects and may travel long distances to forage. Fires are unlikely to have any sustained effect on their nesting or roosting unless they are effected by the smoke, but fire could have local positive or negative effects on insect availability. Fire could flush insects increasing aerial insects along the fire's edge or temporarily reduce insect availability after the fire passes. This in turn would effect their daily foraging patterns.

Rufous Hummingbird – The parks have summer reports of rufous hummingbirds from all elevations, but primarily from the mid- Sierran and high- Sierran elevations. Because the species is difficult to distinguish from Allen's hummingbird, records could be in error. Assuming records are correct, the species occurs in both combustible and rarely- burned environments like meadows. Where the species occurs in combustible habitats, the species should have a long- term habitat maintenance benefit from restoring fire to those areas as a natural process.

Lewis's Woodpecker – This species' occurrence within the parks is accidental at best. It occurs primarily at elevations lower than the park. It will not be effected by the fire and fuels management program.

Williamson's Sapsucker – This is an uncommon to locally common species of the montane conifer forests. The species lives within a fire dependent habitat and should be fire adapted. The species should have long- term benefit from restoration of fire. Because it is a woodpecker, the individual prescriptions probably have a direct effect on the availability and quality of food and nesting habitat.

White- headed Woodpecker – This is a common species in the montane conifer forests. The species lives within a fire dependent habitat and should be fire adapted. The species should have long- term benefit from restoration of fire. Because it is a woodpecker, the individual prescriptions probably have a direct effect on the availability and quality of food and nesting habitat.

Olive- sided Flycatcher – This species occurs at all elevations, but primarily in the conifer belt during the summer. It has a preference for sites that provide perches with extensive airspace to scan for insects. This species lives primarily in a fire dependent habitat. The species should have long- term benefit from the fire management program. There are probably short- term benefits from fires flushing insects on which they feed. Conversely, there may be a short- term loss of some prey after the fire passes.

Tricolored Blackbird – This species occurrence within the parks is accidental at best. It will not be effected by the fire and fuels management program.

Individual Species - Plants

Federally Listed Species
At this time, no federally listed or candidate plant species are known to occur within the parks.

Federal Species of Concern
The following federal plant species of concern are known to occur within the parks. A summary of these species, and the effects of the alternatives on them, is found in Table 5- C3. For each species, loss of individuals as a result of fire restoration either is not expected or would be minimal so as not to adversely impact the overall population.

Bodie Hill's rock cress – Bodie Hill's rock cress (*Arabis bodiensis*) is a small perennial herb in the mustard family. It is found in rock crevices and on open slopes at elevations between 8200' and 10170' (2500 and 3100 m). Two occurrences have been reported in the parks, both on rocky

alpine slopes: Boreal Plateau in Sequoia National Park and Upper Basin in Kings Canyon National Park. Although fire effects on this species are unknown, it is unlikely that the alpine habitat it inhabits would be impacted by fire management activities in any of the alternatives.

Mouse buckwheat – Mouse buckwheat (*Eriogonum nudum* var. *murinum*) is a tall, erect herbaceous perennial in the knotweed family. It is a rare, highly restricted endemic known within the parks from only four populations in the Kaweah River drainage, where it colonizes rocky outcrops in the foothill woodland. The affects of fire on this taxa are unknown, and given its limited distribution it is a candidate for monitoring in areas that may be affected by fire management activities under all alternatives.

Raven's milk- vetch – Raven's milk- vetch (*Astragalus ravenii*, *A. monoensis* var. *ravenii*) is a slender delicate perennial herb in the pea family. It is known from approximately five occurrences, all of which are on dry alpine gravel flats. Although fire effects on this species are unknown, it is unlikely that the alpine habitat it inhabits would be impacted by fire management activities in any of the alternatives.

Kern River daisy – Kern River daisy (*Erigeron multiceps*) is a perennial herbaceous member of the Asteraceae family. Known from fewer than twenty occurrences on the Kern Plateau, it has a highly restricted distribution and is considered extremely rare by the California Native Plant Society. In 1955 it was collected from one location within Sequoia National Park, at an elevation of 6500 feet (1950 meters) at the mouth of the Big Arroyo. The species is found in dry, open areas within pine forests and also within meadows and seeps at elevations between 4920 and 8200 feet (1500 and 2500 meters). Little is known about the fire ecology of Kern River daisy. Surveys to confirm the occurrence and document the distribution and abundance of this plant within Sequoia National Park are scheduled for 2003.

Tehipite Valley jewelflower – Tehipite Valley jewelflower (*Streptanthus fenestratus*) is a small annual herb of the mustard family that invades disturbed sandy soils. It is endemic to the Middle and South Forks of the Kings River in Fresno County, and can form extensive stands following wet winter conditions. Populations within the park have been documented along the Middle Fork of the Kings River in the Tehipite Valley, and along the South Fork of the Kings River in the Cedar Grove environs. Park locations range in elevation from 4150 to 6000 feet (1265 to 1829 meters). It has been suggested that fire creates openings that are then colonized by *S. fenestratus*, but this has never been determined experimentally.

Alpine jewel- flower – Alpine jewel- flower(*Streptanthus gracilis*)is an annual herbaceous member of the Brassicaceae family that is endemic to the Sierra Nevada. Restricted to rocky granitic substrates in the upper montane and subalpine coniferous forests, it has been documented from thirty locations within the Kings River and Upper Kern River watersheds. Park locations range in elevation between 8295 and 11040 feet (2529 and 3366 meters). Little is known about the fire ecology of alpine jewel- flower.

California State Endangered Species
No California State endangered plant species are currently known to occur within the parks.

California State Threatened Species
No California State threatened plant species are currently known to occur within the parks.

California State Rare Species

The following California State rare plant species are known to occur within the parks. A summary of these species, and the effects of the alternatives on them, is found in Table 5- C3.

Tompkin's sedge – Tompkin's sedge (*Carex tompkinsii*) is a cespitose perennial herb of the sedge family that is restricted to river canyons of the western slope of the Sierra Nevada. It inhabits foothill oak woodland and chaparral areas and lower talus slopes. In the parks, it grows on gentle to steep slopes at elevations of 4160' - 6000' (1270 – 1830 m) in *Quercus chrysolepis - Umbellularia californica* and *Q. chrysolepis - Pinus monophylla* associations and mixed coniferous forest. Twenty- one occurrences of this sedge have been reported within the parks. The affects of fire on this taxa are unknown, and given its limited distribution it is a candidate for monitoring in areas that may be affected by fire management activities under all alternatives.

California State Species of Special Concern

No California State species of special concern are known to occur within the parks.

Table 5-C3 – Federal and state special status plant species

Common Name	Species	Status	Effects for All Alternatives
Bodie Hills rock-cress	*Arabis bodiensis*	Fed – SC	0
Raven's milk-vetch	*Astragalus ravenii (=A. monoensis var. ravenii)*	Fed – SC	0
Kern River daisy	*Erigeron multiceps*	Fed – SC	?
mouse buckwheat	*Eriogonum nudum var. murinum*	Fed – SC	?
Tehipite Valley jewel-flower	*Streptanthus fenestratus*	Fed – SC	?
alpine jewel-flower	*Streptanthus gracilis*	Fed – SC	?
Tompkins' sedge	*Carex tompkinsii*	State – R	?

Key:

Fed	Federal status
State	State of California status
R	Rare
SC	Species of Concern: Other species of concern to the United State Fish and Wildlife Service
0	no effect
–	adverse effect
+	beneficial effect
?	unknown effect

Species of Local Concern

The Fish and Wildlife Service also recognizes species of local or regional concern or conservation significance. Of the twenty- two species of local concern known to occur within Tulare and/or Fresno Counties, six are known to occur within Sequoia and Kings Canyon National Parks.

Hockett Lakes/Kaweah fawn lily – Hockett Lakes/Kaweah fawn lily (*Erythronium grandiflorum ssp. pusaterii)* is a perennial, bulbiferous herbaceous member of the lily family (Liliaceae)that is known from only five occurrences in Tulare County. It has been documented along the South Fork of the Kaweah River within Sequoia National Park, where it grows along both sides of the river in mixed red fir/lodgepole pine forest, between 8100 to 8320 feet (2430 to 2496 meters) in

elevation. Related member of the species are fire resistant, although it is thought that frequent fires may suppress the species by eliminating the seed crop.

short- leaved hulsea – Short- leaved hulsea (*Hulsea brevifolia)* is a perennial herbaceous member of the Asteraceae, or sunflower family. A sierran endemic, it is found in both granitic and volcanic gravels and sands in upper and lower coniferous forests in Fresno, Madera, Mariposa, Tulare and Tuolumne counties. A single population has been documented within Sequoia National Park, near Dorst Creek campground; additional surveys are needed to better describe its distribution within the park.

field ivesia – Field ivesia (*Ivesia campestris)* is a perennial herbaceous member of the Rosaceae. Endemic to the Sierra Nevada, it is found in Fresno, Inyo and Tulare counties. In Sequoia National Park, it is found in upper montane and subalpine coniferous forests on the Hockett and Chagoopa Plateaus.

Purple mountain parsley – Purple mountain parsley (*Oreonana purpurascens*) is a prostrate perennial member of the carrot family. Seven populations are known to occur between elevations of 8260' and 9200' (2520 and 2800 m) within Sequoia and Kings Canyon National Park. It grows on coarse, sandy to gravelly soils on either granitic or metamorphic substrates in red fir, lodgepole pine, mixed coniferous, and yellow pine forests. Little is known about the response of purple mountain parsley to fire; park biologists recommend that post- burn response be monitored to gain insight into the potential effects of fire on this sensitive species.

aromatic canyon gooseberry – Aromatic canyon gooseberry (*Ribes menziesii var. ixoderme)* is a deciduous shrub in the Grossulariaceae. It is found in chaparral and cismontane woodlands in Fresno, Kern, and Tulare counties. Although specific data on the response of this species to fire is not available, other members of the genus are known to respond positively to fire, frequently re- colonizing areas post- burn.

Sequoia gooseberry – Sequoia gooseberry (*Ribes tularense*) is a low sprawling shrub of the gooseberry family. The Tulare county endemic is restricted to westernmost isolated stands of mixed coniferous forest between 5360' and 7040' (1630 and 2150 m). The parks' populations are known from the North, Marble, and Middle Forks of the Kaweah River. Little is known about the fire ecology of this species, but given its affinity for openings in the montane forest and vegetative reproduction, fire may have a beneficial effect. Norris and Brennan (1982 and 1984) recommended that experimental prescribed burns in and adjacent to Sequoia gooseberry populations should be conducted to note its response to fire.

Common Name	Species	Status	Effects for All Alternatives
Hockett Lakes/Kaweah fawn lily	*Erythronium grandiflorum ssp. pusaterii*	Fed – SLC	?
short-leaved hulsea	*Hulsea brevifolia*	Fed – SLC	?
field ivesia	*Ivesia campestris*	Fed – SLC	?
purple mountain parsley	*Oreonana purpurascens*	Fed – SLC	?
aromatic canyon gooseberry	*Ribes menziesii var. ixoderme*	Fed – SLC	?
Sequoia gooseberry	*Ribes tularense*	Fed – SLC	?

Key:

Fed Federal status

SLC	Species of Local Concern: Other species of local concern to the United State Fish and Wildlife Service
0	no effect
–	adverse effect
+	beneficial effect
?	unknown effect

Park Species of Special Management Concern (Sensitive Species)
In addition to those taxa with either California State or Federal status, the park maintains a list of plant species of special management concern. Species of special management concern include those that may be: locally rare natives, listed by the California Native Plant Society, endemic to the park or local vicinity, at the furthest extent of their range, of special importance to the park (identified in legislation or park management objectives), the subject of political concern or unusual public interest, vulnerable to local population declines, or subject to human disturbance during critical portions of their life cycle.

Many of these taxa are recognized by the state of California as either requiring consideration according to the California Environmental Quality Act (CEQA), or are recommended for such consideration. Others have been officially delisted as candidates for federal status, but due to their limited distribution remain of concern to park management. In almost all cases, the effect of fire on individual species is unknown. However, in assessing the impacts of the alternatives, the assumption was made that native plant populations that currently occur in the parks have evolved in the presence of fire under historic fire regime conditions and therefore, would likely receive either beneficial or no effect. Plants occurring in alpine habitats are unlikely to be effected by fire management activities, and those taxa were subsequently removed from consideration (25 species). Of the remaining taxa (10 species), park biologists recommend that postburn response of the following plants be monitored to gain information about the response of these sensitive species to fire. These plants occur primarily in the mid- elevation areas of the parks where fire restoration is most active and little information is known about their response to fire. Table 5- C4 contains all 35 species of special concern, both alpine and mid- elevation species.

California pinefoot – California pinefoot (*Pityopus californicus*) is an achlorophyllous waxy-white saprophytic herb of the heath family. Rarely encountered, the plants require deep shade in the coniferous forests, and are known only from areas of moderately deep duff (~2• or ~5 cm) overlying well- drained sandy loams. The two known park localities (Redwood Mountain and Grant Grove) represent southern disjuncts from a population center in the north Coast Ranges of California.

Call's angelica – Call's angelica (*Angelica callii*) is a robust perennial herb of the carrot family. It is found along streams at 3800' to 6500' (1160 to 1980 m) on the west slope of the Sierra Nevada in Tulare and northern Kern County; populations in Sequoia National Park range in size from as few as six to as many as 1,000 individuals.

Farnsworth's jewelflower – Farnsworth's jewelflower (*Streptanthus farnsworthianus*) is a small annual herb of the mustard family. It grows in dry, gravelly soil pockets in slate outcrops on

steep, open grassy slopes in the foothill woodland, at elevations between 1900' and 5000' (580 and 1525 m) in the Middle Fork Kaweah River drainage in Sequoia National Park.

Hockett Meadows lupine – Hockett Meadows lupine (*Lupinus lepidus var. culbertsonii*) is a low growing perennial herb with short woody caudex in the pea family. In Sequoia National Park, Hockett Meadows lupine grows in lodgepole pine forests at elevations of 8500' to 9200' (1590 to 2800 m). It is found on gentle to level slopes of varied aspects, usually in partial shade of pines, but occasionally in full sunlight.

Muir's raillardella – Muir's raillardella (*Raillardiopsis muirii*) is a glandular, multi- stemmed perennial herb of the sunflower family. It grows on both level sandy flats (as in the Tehipite Valley Area) and on granitic outcrops and steep, boulder- strewn gullies. Elevations in Sequoia and Kings Canyon National Parks range from 3900' to 7780' (1190 to 2370 m). The plant is found in open xeric sites surrounded by mixed coniferous forest and brush, with most populations on southerly exposures in full sunlight to partial shade.

Tulare County bleeding heart – Tulare County bleeding heart (*Dicentra nevadensis*) is a small, scapose perennial herb of the poppy family. It is almost exclusively restricted to Tulare County, where it often forms extensive patches at elevations between 7300' and 10400' (2225 and 3170 m) in red fir, lodgepole pine, and subalpine forests, and less commonly in mixed coniferous forest, montane chaparral, and alpine boulder fields.

Sugar pine – Sugar pine is not a federal or state special status species, however, park managers are interested in this species due to the current decline of mature sugar pine throughout much of its range. Anthropogenic factors, especially susceptibility to the introduced white pine blister rust, as well as natural factors, such as long periods of drought, may contribute to mortality of sugar pines. While sugar pine is generally known to be resistant to low- to moderate- severity fire, mortality following fire can occur, especially where heavy fuels from fire exclusion result in unusually severe heating of the trees' cambium. Further studies on effects and mitigation strategies would help provide the information needed to minimize additional stress to the species.

Giant sequoia – While not on the federal or state lists of special status species, giant sequoia (*Sequoiadendron giganteum*) is specifically identified as a primary natural resource in the parks' *Master Plan* (1971) and *Natural and Cultural Resources Management Plan* (1999). Much scientific research has been conducted on giant sequoias revealing the frequent occurrence of fire in sequoia groves, mature trees' resistance to fire, and their largely fire- dependent regeneration process. Research has shown that past fire suppression resulted in a near complete failure of giant sequoia reproduction. While research fully supports the restoration of fire in giant sequoia groves, continued monitoring of management actions affecting this species is critical because of the species' importance to the parks' creation.

Large- diameter trees – Promoting old forest characteristics, especially large- diameter trees, has become an important issue in the Sierra Nevada. Old forests that provide shading and relatively open forest floors provide habitat for several wildlife species of special concern, such as fisher (*Martes pennanti*), marten (*Martes Americana*), and spotted owl (*Strix occidentalis*)In addition, individual large trees, snags, and logs provide important ecological amenities such as food, cover, thermal and moisture moderation, to a substantial list of reptiles, amphibians, mammals,

and birds that occur in much lower numbers or not at all when these ecosystem elements are not present. While most of the parks' forests have not been affected by past commercial large tree removal, the scarcity of old forest throughout the range of these wildlife species adds importance to protecting the existing old forest characteristics found within the parks. Moreover, fire in unnaturally dense forest stands is more likely to kill large trees than would occur naturally. While specific mandates do not currently exist for management of large diameter trees in the parks, maintaining old forests as part of the larger Sierran ecosystem is of great interest to the parks. To address this issue, the parks' target conditions include a target range for large- diameter trees and the monitoring program is designed to assess whether these target ranges are achieved (see Fire Monitoring Plan and Target Conditions in Appendix C of the companion *Fire and Fuels Management Plan*). If the monitoring results indicate significant unwanted changes in the number of large diameter trees in areas where prescribed fire activities have occurred, the management actions will be reviewed and additional studies will be initiated, if needed. A study to determine the effectiveness of fuel removal around the base of large-diameter pines in reducing mortality in prescribed burns has already begun (see Fire Monitoring Plan and Target Conditions in Appendix C of the companion *Fire and Fuels Management Plan*). In addition, a review of past research and monitoring work related to giant sequoia mortality in prescribed burns indicates that large- diameter mortality of giant sequoia is rare, and therefore, not a concern at this time. Ongoing forest demography research by local USGS scientists will provide information about large- tree mortality resulting from non- fire factors which will also help to inform the fire management program.

Table 5-C4 – Other park plant species of special management concern.

Common Name	Species	Status	Effects for All Alternatives
three-bracted onion	*Allium tribracteatum*	SPC	0
Call's angelica	*Angelica callii*	SPC	?
Tulare County rock cress	*Arabis pygmaea*	SPC	0
Mineral King draba	*Draba cruciata*	SPC	0
Mount Whitney draba	*Draba sharsmithii*	SPC	0
Hall's daisy	*Erigeron aequifolius*	SPC	?
Sharsmith's stickseed	*Hackelia sharsmithii*	SPC	0
Hockett Meadow's lupine	*Lupinus lepidus var. culbertsonii*	SPC	?
Kaweah monkeyflower	*Mimulus norrisii*	SPC	0
mountain phacelia	*Phacelia orogenes*	SPC	?
California pinefoot	*Pityopus californicus*	SPC	?
Muir's raillardella	*Raillardiopsis muirii*	SPC	?
Farnsworth's jewelflower	*Streptanthus farnsworthianus*	SPC	?
northern spleenwort	*Asplenium septentrionale*	CEQA	?
Sweetwater Mountains milkvetch	*Astragalus kentrophyta var. danaus*	CEQA	0
Congdon's sedge	*Carex congdonii*	CEQA	0
meadow sedge	*Carex practicola*	CEQA	?
Sierra corydalis	*Corydalis caseana ssp. caseana*	CEQA	?
	Deschampsia atropurpurea	CEQA	0
Tulare County bleeding heart	*Dicentra nevadensis*	CEQA	?
Tulare County buckwheat	*Eriogonum polypodum*	CEQA	0
wooly yarrow	*Eriophyllum lanatum var. croceum*	CEQA	?
Yosemite ivesia	*Ivesia unguiculata*	CEQA	?
Sierra Nevada linanthus	*Linanthus oblanceolatus*	CEQA	0
copper-flowered bird's foot trefoil	*Lotus cupreus*	CEQA	?
small-flowered monkeyflower	*Mimulus acutidens*	CEQA	?
cut-leaved monkeyflower	*Mimulus laciniatus*	CEQA	0

Yosemite bulrush	*Scirpus clementis*	CEQA	0
weak mannagrass	*Torreyochloa pallida var. pauciflora*	CEQA	0
Sugar pine	*Pinus lambertiana*	P	0/?
Giant sequoia	*Sequoiadendron giganteum*	P	+

KEY:

SPC Species of park concern
P Specifically identified in park legislation
CEQA Species has no current state or federal legal standing but evaluation is recommended according to the California Environmental Quality Act

0 no effect
– adverse effect
+ beneficial effect
? unknown effect
Highlighted species = recommended for postburn response monitoring

Conclusions

All alternatives provide some level of restoration or maintenance of park ecosystems and therefore have the potential to reduce impairment to special status species. However, some alternatives reduce impairment only locally while others improve conditions across a larger area of the parks.

Under Alternative 1, sensitive plant and wildlife habitat in areas of the parks would continue to deteriorate, leading to uncharacteristically severe wildland fire that could cause permanent impairment of some sensitive resources. Future impairment of sensitive plant and wildlife habitat is less likely to occur in Alternative 2, 3, and 4, as those alternatives increase the area of the parks where natural conditions would be restored. Potential severe fire effects leading to impaired sensitive resources would be more likely in Alternative 3 and less likely in Alternative 4, where prescribed fire would be used to reintroduce fire to highly altered areas under less severe conditions to minimize adverse impacts.

None of the alternatives would result in the loss of individual species protected under the Endangered Species Act. Critical habitat for species with recovery plans would be enhanced under all alternatives. None of the alternatives would threaten populations of other species of concern. All alternatives provide some protection from large- scale catastrophic fire events.

Table 5-C5 – Comparison of Special Status Species Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Potential for Take of Individuals Protected as Threatened or Endangered	0	0	0	0
Loss of Viable Protected Populations	0	0	0	0

Loss of Critical Habitat Defined in 50 CFR 17.95	0	0	0	+
Amount of Habitat Restored or Maintained	0	+	+	+
Reduce Risk of Catastrophic Loss	0	++	+	++

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

D. NON-NATIVE/INVASIVE SPECIES

Non- native species are of management concern since they may invade following disturbances such as fire, and have the potential to alter natural ecosystem structure and function. Of 1,495 known taxa of vascular plants in Sequoia and Kings Canyon National Parks, 183 (12%) are considered introduced according to the Jepson Manual (Hickman, ed. 1993).

Factors Used to Assess Environmental Consequences

Area Treated
Increases in area treated in proximity to non- native seed sources may result in more area at risk of invasion.

Area Exposed to High Severity Fire
Decreases in proactive treatment of many areas result in more area exposed to the risk of high severity fire, leading to the potential for increased non- native invasion.

Impacts Common to All Alternatives

Mechanical treatment to reduce hazardous fuels in proximity to structures would disturb vegetation in developed areas to the same extent in all alternatives. Heavy ground disturbance, which tends to promote non- native/invasive species, would be minimal. In addition, these areas are already disturbed by nature of their development and therefore, mechanical treatment would have limited or no- effect on non- native/invasive species in those small areas of the parks' for all alternatives.

Wildland fire suppression in all alternatives would result in limited direct impacts, including clearing or disturbing vegetation in localized areas of the parks. The average annual number of acres affected by fire suppression activities would be similar among Alternatives 1, 2, and 4. Alternative 3 would have approximately twice the amount of average annual acreage as the other

alternatives. Ground disturbance in these areas could promote non- native/invasive species, therefore, limited, indirect impacts could occur which might increase non- native/invasive species.

In most cases, fire disturbance is not the ultimate cause of non- native species invasions, however, exposure of mineral soil resulting from fire can create an environment that is conducive to invasion by pioneer species, including non- natives. These invasions cannot occur without a seed source, therefore most increases in non- native populations in all alternatives would occur where species are already established or where seed is made available (proximity to roads, developed areas, and wildlife corridors).

If increases in non- native/invasive species occur due to either mechanical fuel reduction or the presence of fire on the landscape, efforts to remove these populations could be initiated under any of the alternatives. Early detection and eradication of non- native/invasive populations when they are small can prevent a time- consuming, expensive eradication effort. Therefore, identifying and surveying potential sites for new introductions annually is the most efficient way to prevent large- scale non- native species invasions.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
With only some areas of the parks treated with fire in the current program, the potential for uncharacteristically severe wildland fire is greater, providing more opportunity for non-native/invasive species that respond positively to severe fire disturbance.

Alternative 2 – Prescribed Fire
An increase in areas restored with fire in Alternative 2 compared to Alternative 1 would increase the potential for establishment and spread of non- native species promoted by fire disturbance, but limit the areas disturbed by severe wildland fire.

Alternative 3 – Wildland Fire Use
An increase in areas treated with fire in Alternative 3 compared to Alternative 1 would increase the potential for establishment of non- native/invasive species that are enhanced by fire, but limit the areas disturbed by severe wildland fire.

Alternative 4 – Multi- Strategy (Preferred Alternative)
An increase in areas restored with fire in Alternative 4 compared to Alternative 1 would increase the potential for non- native/invasive populations that are enhanced by fire, but limit the areas disturbed by severe wildland fire.

Conclusions

Since non- native species tend to follow disturbance, the effects of different fire management alternatives have offsetting effects. Alternatives that minimize the acres treated such as Alternative 1 reduce the risk of immediate invasion, but at the same time increase the risk of larger more severe fires in the future. Post burn conditions created following a severe fire may

result in conditions more favorable to opportunistic non- natives, while inhibiting or eliminating native species not adapted to high severity fire. Such effects hold true for cumulative impacts as well. In general, reduced chances of large catastrophic fire through additional acres treated should reduce the chances of establishing non- native species on severely disturbed sites, but increase opportunities for non- native species which can occupy light to moderately burned areas.

Under all alternatives, increased monitoring and ongoing research could mitigate the adverse indirect effects of potential increases in non- native/invasive species under all alternatives by providing early detection and eradication of new invasive populations.

Table 5-D1 – Comparison of Non-Native/Invasive Species Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Area Treated	0	0	0	0
Area Exposed to High Severity Fire	0	0	0	0

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

E. AIR

There are two significant air quality issues that interact with the proposed actions. First, the presence of Class 1 airshed designation for much of the park represents aesthetic, ecological, and social air quality related values. Second, the designation of the regional air basin as serious non-attainment for several criteria pollutants including ozone and PM- 10 (particulate matter less than ten microns) are public health and safety concerns, though ozone in particular is also a pollutant with significant ecological consequences. Carbon dioxide is also a criteria pollutant that must be considered. Of the air quality related values to be considered in this environmental assessment, the production and management of PM- 10 is the most significant. (See related sections: Chapter 5- H: Health and Safety, and Appendices I & J of the companion *Fire and Fuels Management Plan*.)

Factors Used to Assess Environmental Consequences

Conformity to Existing Law

Extent to which the alternatives conform to existing law regulating air quality and related values.

Conformity with Local and State Implementation Plans
Extent to which the alternatives conform to state and local implementation plans for criteria pollutants.

Extent to Which Alternatives Minimize Air Quality Effects while Achieving Park Goals
Alternatives are evaluated to assess their ability to balance competing objectives (clean air and ecosystem health).

Air Resources and Values Analyzed

Class 1 Airshed
The Congressionally designated wilderness covering 85% of parklands is classified as a Class 1 airshed under the Federal Clean Air Act (FCAA). The designation is intended to prevent further degradation of the airshed from human made pollutants such as those generated by transportation (vehicles) and stationary sources such as industrial emissions and burning of agricultural waste.
The extent to which smoke events occurred as part of the natural background conditions in the parks prior to European settlement is not fully known, but can be inferred from research characterizing natural fire regimes (See Chapter 9 in the companion *Fire and Fuels Management Plan*).

Since all alternatives propose levels of burning comparable to or less than those burned under pre- Euroamerican settlement conditions, and consistent with the Environmental Protection Agency's Interim Guidelines on the management of wildland fire, the assumption is made that levels of smoke generated by naturally occurring fires common in the Sierra Nevada under pre-Euroamerican fire regimes are similar to or greater than the levels that would occur under all alternatives proposed. The occurrence of smoke in park Class 1 airsheds as a result of the alternatives will therefore be considered part of the natural background. No further analysis of the impacts of the alternatives on Class 1 airsheds will be undertaken.

Criteria Pollutants
Carbon monoxide is a byproduct of combustion that breaks down quickly as smoke plumes travel away from immediate fire areas. Generally, carbon monoxide from wildland vegetative fires is not considered a significant contributor to urban carbon monoxide levels, and none of the alternatives would produce regionally significant amounts. Therefore carbon monoxide will not be further discussed.

The parks are within the San Joaquin Valley air basin. The basin is classified as serious non-attainment for two criteria pollutants of health concern (ozone and PM- 10) as defined by the Federal Clean Air Act. **Ozone contribution** from wildland vegetative fires at the levels proposed in this environmental assessment is very small, and none of the alternatives would produce regionally significant amounts of ozone. Therefore ozone will not be further discussed.

PM- 10 is the pollutant of primary concern in relation to the actions proposed in this environmental assessment. To manage the health effects of PM- 10, the San Joaquin Valley Unified Air Pollution Control District (hereinafter referred to as the District) is required to implement Best Available Control Measures (BACM) in order to meet established deadlines set

for complying with PM- 10 National Ambient Air Quality Standards (NAAQS). BACM is implemented in the air basin by requiring all burners within the air basin, including the parks, to comply with a series of emission control measures that are some of the most stringent in the nation. BACM requirements are articulated in various rules (particularly Rule 4106) that describe the practices and procedures agencies need to implement BACM. BACM may also be further refined and described through the development of a workplan. The workplan would be developed in cooperation between the District and federal and state land management and fire agencies to encourage continued development of BACM practices.

Smoke management requirements are dynamic and require considerable consultation with the District. All elements of BACM defined by the District would be followed under all alternatives. Specific procedures to implement the requirements of BACM are contained in the parks' *Smoke Management Plan* (see *Smoke Management Plan* in the companion *Fire and Fuels Management Plan*, Appendix J.)

Since wildland fires may contribute regionally significant levels of PM- 10, an analysis was undertaken to assess the PM- 10 emissions generated under each alternative as a means of comparison.

Levels of PM- 10 emissions proposed under all alternatives fall within the emissions inventory contained in the District's *Implementation Plan for PM- 10* currently under review by the EPA. All alternatives are within the scope of, and in full conformity with, the District *Implementation Plan for PM- 10*.

Elements Affecting Smoke Management

For all projects, smoke behavior, and its corresponding impacts, is a complex issue involving the following 8 dynamic elements:

1. **The amount and type of fuel that will burn** – a) Restoration areas have the highest fuel loading. Much of the fuel load in those areas (up to 50%) consists of 100 years of accumulated duff that burns mostly in the smoldering phase and produces more particulate than an equivalent number of tons burning in the flaming phase. b) Maintenance areas have less fuel overall and much less duff (less than 25% total fuel load) per acre than restoration burns. A higher percentage of fuels burn in the flaming phase resulting in a significantly lower rate of emissions.

2. **The type of fire situation and controllability** – Prescribed burn operations are the most controllable and predictable of all fire events. Wildland fire use fires generally provide opportunities for careful planning and management, though their random nature and, often, long duration make them somewhat less predictable to manage than prescribed burn operations. Generally, large unwanted suppression fires are the most uncontrollable and least predictable.

3. **The time of year smoke is produced** – Fall and early winter generally have climatic conditions least favorable to smoke dispersion, while spring and summer generally have better conditions for dispersing smoke.

4. **The exact behavior of the smoke plume** – a) The behavior of the plume is highly dependent on elevation and dynamic meteorological conditions occurring at the time of the fire event. b) Complex geography and weather patterns complicate the ability to exactly predict the quantity and destination of smoke particles in the plume.

5. **The direction and elevation that the smoke plume moves, and resulting concentrations at ground level** – Generally, the higher the elevation of the burn, the greater the mixing volume of air to dilute it. Higher elevation winds also tend to better dilute and disperse smoke at lower concentrations. High level winds may transport dispersed smoke particles long distances.

6. **The cumulative interaction of smoke from park fires with pollution sources in the San Joaquin valley (including other fires in the area)** – The District regulates all prescribed fire and wildland fire use activities from all land management sources as part of BACM. Therefore, any activity generated by the parks would require prior approval from the District, who would be reviewing all other activity in the District at the same time.

7. **The ability to effectively model all variables in a dynamic environment** – a) As with most meteorological forecasting, the best and most accurate information is available close to the time of interest. While long- term climatic models are valuable in advance fire program planning, it is conditions that exist at the time of the actual fire event that are the best indicators of potential smoke impacts. b) As individual fire events occur under constantly changing environmental conditions, and many occur randomly through space and time, sophisticated air quality modeling beyond the scope of this environmental assessment and current technology would be needed in order to determine whether the estimated increases in smoke emissions proposed in these alternatives would cause actual exceedances of annual and 24- hour National Ambient Air Quality Standards within the San Joaquin air basin at any point in time. c) In lieu of such modeling, implementing BACM, complying with burn/no burn day designations issued by the District, and by using the best available meteorology and forecasting at the time of ignition are techniques that would be used to manage local and regional smoke effects and maintain emissions within the NAAQS under all alternatives. The District provides significant input into park decisions as individual projects are proposed for implementation. Modeling and forecasting meteorological conditions related to smoke dispersion and assessing potential impacts on regional conditions, assist the park in determining whether to proceed with ignition.

8. **Dense smoke would likely occur in the vicinity closest to fire operations** – Unhealthful concentrations of smoke would be most likely to affect fire personnel immediately adjacent to the fire. Most smoke plumes from fire operations would disperse at middle to upper elevations (6,000 to 12,000 feet) into remote, low population areas or wilderness.

Analysis Procedures

Calculating PM- 10 Emissions

PM- 10 emission estimates for this environmental assessment were based on an analysis that involved several steps described in detail in Appendix E. The first step in the analysis was a conversion of proposed program accomplishments by vegetation type for each alternative into

measurable amounts of fuels consumed. Fuel consumption amounts were then used as inputs to a widely accepted emissions software package (FOFEM, First Order Fire Effects Model) to estimate emissions by alternative. To arrive at the best possible estimates, both fuel load information and the percent of fuel consumed by fire events utilized park specific data where it was available. The resulting emission estimates were used to make comparisons between alternatives.

The estimates that follow were generated at two time steps, 10 and 25 years, to evaluate long-term changes that occur as fuels are altered by the management actions proposed under the alternatives.

Analysis Results: Tons of fuels per acre for each alternative
Table 5- E1 shows the estimated tons of fuel treated per year by fuel model under each alternative at two time steps. Figure 5- E2 and Table 5- E3 shows the sum of all fuel models treated to allow easier comparison between alternatives.

Alternative 1, though it fails to achieve significant resource and fuels management objectives, does have a modest proactive fuels management component and so shows some long- term reduction in consumption between 10 and 25 years. Alternatives 2, 3, and 4 all show higher levels of fuel consumption than Alternative 1 at both time steps. These alternatives reflect a more proactive treatment of fuels and restoration of ecosystems. The figures for 2, 3, and 4 also reflect a downward trend in fuel consumption over time (between 10 and 25 years) as areas of heavy fuels are treated and more parklands are converted to fuel types with lower average fuel load.

Table 5-E1 – Estimated tons of fuel treated per year by fuel model under each alternative at two time steps.

	Alt 1 No Action (Current Program)		Alt 2 Prescribed Fire		Alt 3 Wildland Fire Use		Alt 4 Multi-Strategy (Preferred Alternative)	
Fuel Model	Total Load 10 Year	Total Load 25 Year	Total Load 10 Year	Total Load 25 Year	Total Load 10 Year	Total Load 25 Year	Total Load 10 Year	Total Load 25 Year
1	0	0	0	0	0	0	0	0
2	0	8	1572	2452	420	436	1368	1388
3	0	0	0	0	0	0	0	0
4	5931	6364	4344	4296	6845	7181	6925	8127
5	1040	854	3871	3077	1323	1236	3416	3171
6	0	0	0	0	0	0	0	0
8	21082	21942	107860	143801	77189	114229	162413	222638
9	5222	3784	17936	15968	984	2270	17104	20812
10	178375	141109	513168	316059	643500	439945	344563	78763
14	34393	18499	136007	136007	136702	136007	58276	7990
18	13947	9274	40672	38555	40526	36875	15845	2629
25 year		201833		660215		738179		345518
10 year	259989		825431		907489		609910	

Figure 5-E2 – Estimated tons of fuel treated each year by alternative at two time steps

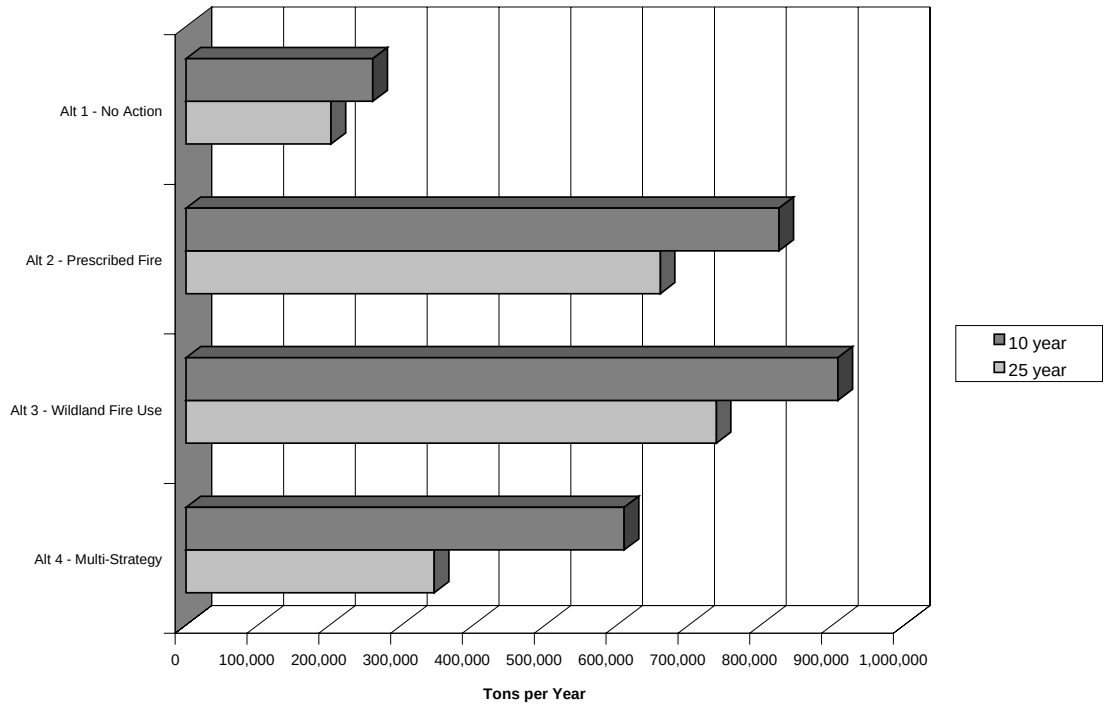


Table 5-E3 – Estimated tons of fuel treated each year by alternative at two time steps

	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
10 year	259,989	825,431	907,489	609,910
25 year	201,833	660,215	738,179	345,518

To best represent fuel loads, information used in the model was based on park wide fire effects plots and fuels inventory plots data, where such information was available. Fuel consumption estimates were made based on data from park fire effects plots collected on prescribed burn projects over the past 18 years. Where no local data was available, standard fuel model descriptors were applied.

In order to produce smoke emission estimates based on fuel loading and consumption data the First Order Fire Effects Model version 4.0 (FOFEM) was used. In its present configuration FOFEM does not exactly duplicate the consumption measured in the field by fire effects plots. However, the model does have the benefit of using algorithms that approximate the relationship between fuels that are burned in the flaming and smoldering phases respectively. Modeling consumption using the two phases of combustion is important because significantly more smoke is produced in the smoldering phase than in the flaming phase given the same quantity of fuel burned.

Estimated smoke emission outputs for each fuel model from FOFEM were then used as a multiplier for the acres of fuel model that are estimated to be burned each year under the various alternatives. The results (Figure 5- E4 and Table 5- E5) show estimated tons of PM- 10 produced each year by each alternative at 10 and 25 years.

Example of the methodology used:

- Information from park- specific data shows that heavy timber litter forest stands (fuel model 10) have an average total fuel loading of 101 tons per acre of burnable, dead and down fuel. This figure includes litter and duff, as well as fuels greater than 3" in diameter.
- From park specific monitoring data, it is known that when fuel model 10 burns, the average fuel reduction is 76%.
- Based on the inputs above, the FOFEM model calculates that for each acre of fuel model 10 that is burned in the parks an average of 1,650 pounds of PM- 10 is produced.
- Under Alternative 4 - 3,421 acres comprised of fuel model 10 would burn each year at 10 years producing about (1,650 pounds/acre x 3,421 acres) = 2,822 tons of PM- 10 per year parkwide. The same analysis is repeated for each fuel model, and the totals added together to arrive at an annual program total.

Figure 5-E4 – Estimated tons of PM-10 produced each year by alternative at two time steps

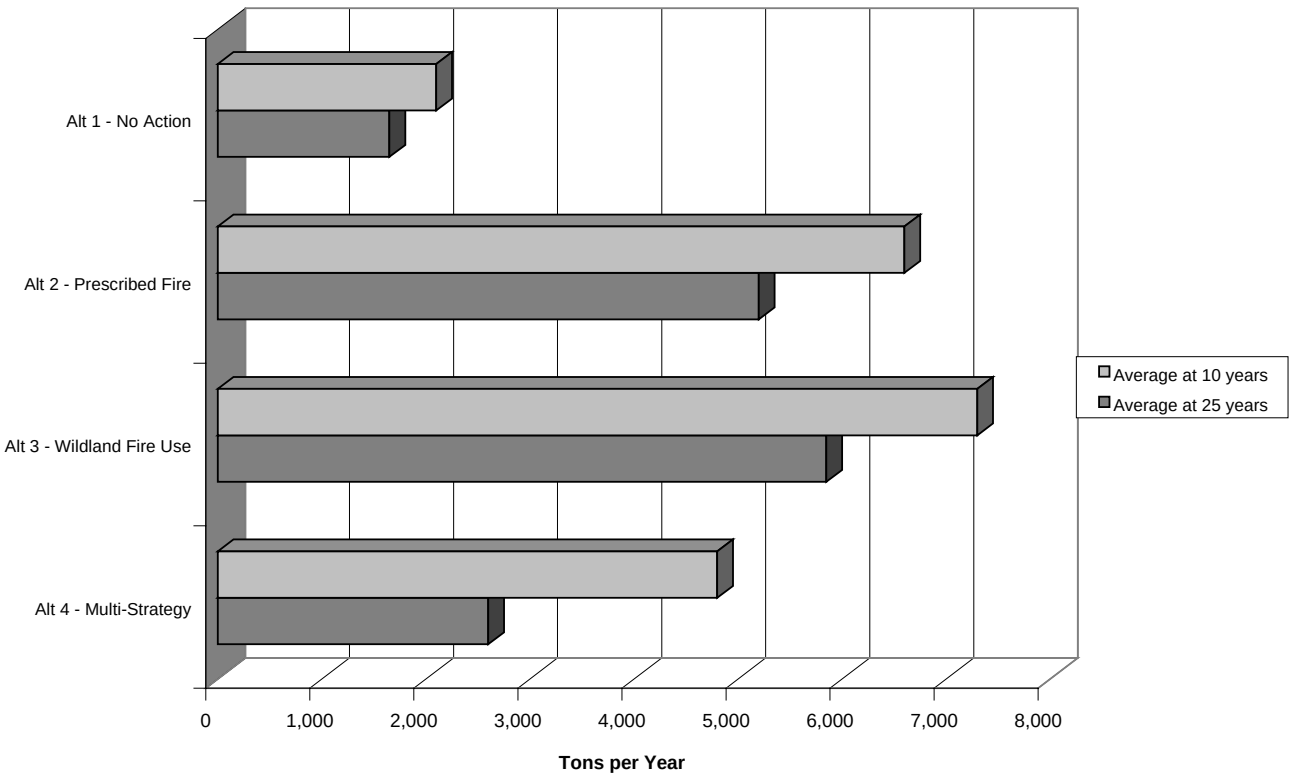


Table 5-E5 – Estimated tons of PM-10 produced each year by alternative at two time steps

	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Average at 10 years	2,100	6,600	7,300	4,800
Average at 25 years	1,650	5,200	5,850	2,600

Impacts Common to All Alternatives

Smoke emissions from unwanted wildland fires would continue to occur at some level every year under all alternatives. Some alternatives allow more control over when and where fires, and hence smoke events, occur. All individual wildland fire use and prescribed fire projects will be managed under the same conditions and constraints under all alternatives. Each project will be implemented only with the concurrence of the San Joaquin Valley Air Unified Pollution Control District, and managed to maintain smoke emissions in communities below the legal health thresholds as defined by the State of California and the Environmental Protection Agency. To accomplish this, smoke impacts would be managed, monitored, and mitigated according to requirements contained in the *Smoke Management Plan* appended to the *Fire and Fuels Management Plan* and implemented following the sequence of approvals listed below or as directed by the District.

Prescribed Fire Approval Process

1. The park develops an annual list of prescribed fire projects and submits the list to the Air Quality District (AQD).

2. The park develops a detailed burn plan for each project, including a smoke management section that conforms to AQD requirements.

3. The park submits the individual burn plans and a *Smoke Management Permit Application* to AQD.

4. The park receives approval from AQD to proceed with burn implementation planning, or is required to revise the project and resubmit.

5. For projects approved by the AQD, the park requests weather and smoke dispersal forecasts 72 and 48 hours prior to planned ignition time.

6. 24 hours prior to planned ignition, the AQD gives the park a go or no- go decision based on current weather and smoke dispersal forecasts.

7. If AQD gives a “go”, the park proceeds with the project, subject to daily oversight by AQD. After ignition, the AQD may require that the project be held at current acreage, modified, or suppressed should regional air quality parameters change for the worse during implementation..

8. At the end of the season, the park reports total burned acres to the AQD and pays a smoke management fee (currently $5/acre). Evaluations and reports are submitted as required in Rule 4106.

Wildland Fire Use Approval Process

1. The park confirms a lightning ignition.

2. The park informs the AQD of the ignition. If it is a burn day for the zone, or a no- burn day and after consultation the AQD agrees to allow management of the ignition, the park proceeds with development of a *Wildland Fire Implementation Plan*.

3. If it is a no- burn day, <u>and</u> if required by the AQD, the park suppresses the fire using strategies commensurate with firefighter and public safety, and considering collateral damage to the resource.

4. If the ignition is allowed to be managed as a fire use project by the AQD, the park submits a *Smoke Management Permit Application* to the AQD within 72 hours of discovery.

5. The AQD approves or requires revision and resubmission of the smoke management permit.

6. Approved projects receive daily oversight by the AQD for conformity to the permit requirements. If projects are out of conformity with the permit or plan, the AQD may require suppression of the project using strategies commensurate with firefighter and public safety, and considering collateral damage to the resource.

7. At the end of the season, the park reports total burned acres to the AQD and pays a smoke management fee (currently $5/acre).

Suppression Fire Approval

1. An unwanted ignition is detected.

2. The park initiates suppression actions using strategies commensurate with firefighter and public safety, and considering collateral damage to the resource.

3. If the suppression action exceeds several days, the park consults with the AQD regarding potential smoke management concerns and suggested mitigating actions.

4. No smoke management plan or permit is required by the AQD, though smoke management actions and issues may be identified in the suppression action plan.

5. The AQD does not require suppression acres to be reported, and no smoke management fee is charged.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
PM- 10 emissions would not significantly change in the short term. Modest levels of proactive fuels management with the opportunity to adjust timing would decrease smoke events in some areas of the parks over time. Occasional large unwanted fire events would continue to affect local communities and regional air quality one to several times each decade. Over the long- term fuels may continue to accumulate in untreated areas of the parks potential resulting in some larger, less predictable unwanted fire events.

Alternative 2 – Prescribed Fire
A threefold increase in annual PM- 10 emissions would occur compared to Alternative 1 in the first 10 years of implementation as the 100- year backlog of fuels was reduced. After 25 years of proactive fuels management, emissions would decrease compared to the 10- year average.

Due to the exclusive use of prescribed fire in this alternative and the subsequent ability to select the timing and location of most fire events, the impacts of prescribed fire smoke events could be minimized.

The duration and intensity of smoke from large unwanted fire events would decrease over time as heavy fuel concentrations were systematically reduced across the parks.

Alternative 3 – Wildland Fire Use
Annual PM- 10 emissions would be 3.5 times the current program outputs (represented by Alternative 1) during the first 10 years of implementation. After 25 years of proactive fuels management, emissions would decrease compared to the 10- year average.

Some large unwanted fire events could occur each decade, with declining duration and intensity of associated smoke events over time as fuels are proactively managed and fuel loads are reduced across the parks.

Due to the exclusive use of random natural events under this alternative, less control over the timing and placement of fire events would result in less opportunity to manage smoke impacts compared to all other alternatives.

Alternative 4 – Multi- Strategy (Preferred Alternative)
Average annual PM- 10 emissions would be 2.3 times the current program outputs compared to Alternative 1 during the first 10 years of implementation. If annual programs levels were consistently achieved, after 25 years emissions would rapidly decrease to near the current program levels.

The use of natural fire in this alternative reduces the ability to manage smoke events in comparison to Alternative 2, but with the proactive management of prescribed fire, better control is effected over Alternative 3.

Some large unwanted fire events could occur each decade, with declining duration and intensity of associated smoke events over time as fuels are proactively managed and fuel loads are reduced across the parks.

Conclusions

Based on definitions and guidance provided by the EPA on the role of smoke from natural fire events on Class 1 airsheds, none of the alternatives would result in impairment of Class 1 airshed values. Properly managed under Best Available Control Methods (BACM), none of the alternatives would result in intentional exceedances of the NAAQS for criteria pollutants. Alternative 3, with its heavy reliance on random natural events, would be severely constrained by smoke management issues, and may be incompatible with good smoke management practices at this point in time.

In considering the impacts of the PM- 10 produced by the various alternatives, both the gross amount of emissions along with the ability to manage the emissions under each alternative are important considerations. Alternatives that allow high levels of control over timing and placement of ignitions (e.g. Alternatives 1, 2, and 4) have less potential impact on air quality than alternatives that produce particulates on a random basis with little opportunity for management control (Alternative 3). This fact holds true from a regional cumulative effects standpoint as well. The more random and unplanned the ignitions, the greater the chance of smoke impacts upon the air resource.

Long- term effectiveness of the alternatives must also be considered. Assuming that best available control measures are applied to all alternatives, and that they can be successfully managed to keep emissions within the NAAQS levels to protect public health, the alternatives that show decreasing trends of emission production over time should be favored over those that indicate an increasing rate of emissions.

Alternatives 1 through 4 all show some long- term effectiveness in decreasing emissions over time, though it would be expected that Alternative 1, with only modest accomplishments, may begin to rise again over a longer timespan than assessed in this plan. Alternative 4 shows moderate increases in PM- 10 emissions in the first 10 years but shows dramatic decreases occurring by year 25. Alternative 4 also exercises a great amount of control over the timing and placement of fire events, with most restoration burning occurring under controlled prescribed fire events.

Table 5-E6 – Comparison of Air Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Conformity to Existing Law	0	0	0	0
Conformity with Local and State Implementation Plans	0	0	0	0

Extent to Which Alternatives Minimize Air Quality Effects while Achieving Park Goals	0	+	+	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

- ++ effects are **highly desirable** compared to Alternative 1 (No Action)
- + effects are **desirable** compared to the effects of Alternative 1 (No Action)
- 0 effects are **equal** to the effects of Alternative 1 (No Action)
- - effects are **undesirable** compared to the effects of Alternative 1 (No Action)
- -- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

F. WATER

The headwaters of the Kern, Kaweah, and Kings Rivers form the principal park watersheds. Minor watersheds include the Tule and San Joaquin Rivers. Over 1,700 miles of rivers and streams and more than 3,000 lakes and ponds exist within the parks. This aquatic system has important physical and biotic features and plays a major role in many ecosystem processes and the experiences of park visitors. Additionally, because these watersheds drain into the Central Valley they are ultimately important sources of water for recreation, agricultural, and industrial activities outside the parks.

At higher elevations in the parks, most precipitation occurs in the form of winter snow, which is stored in the snowpack and is released slowly through the spring and summer. At all elevations, spring and fall rains occur in a pattern typical of a Mediterranean climate. Annual drought occurs June through October with little or no precipitation during those periods. Occasional summer monsoons occur along the Sierra Crest that create intense hydrologic events in localized areas.

Important components of the water resources include the hydrologic cycle, streamflow regimes, sedimentation, and water chemistry (DeBano and others 1998). Prior to Euroamerican settlement fire played an important role in shaping how these components operated. Fire affects the quantity of water in streams, its chemistry, and its physical and biotic characteristics. Severity, size, season, location of fires, and the immediate postfire precipitation regime largely determine fire effects on watershed resources. The alteration of the natural fire regime by more than a century of anthropogenic intervention has been a significant stressor to park waters. Fire, or the lack of fire, has also affected nutrients, turbidity, buffering capacity, water temperature, and other water characteristics.

Primary sources of nutrients are geologic weathering and atmospheric input, which accumulate in biotic components of the ecosystem and are transported into or out of the ecosystem as part of the hydrologic cycle. Changes in the fire regime or the simple occurrence of a fire can alter the flux of nutrients associated with water. Following fire this alteration is usually manifested as increased nutrient flows through the aquatic system. For example, following a prescribed fire in a small mixed- conifer watershed in Giant Forest, researchers measured elevated concentrations of all solutes measured (NH_4, NO_2, NO_3, Na, SO_4, PO_4, Ca, Mg, K, Cl). The greatest proportional

increases occurred in SO_4 and NO_3 (Chorover and others 1994; Williams and Melack 1997). Concentrations of most of these solutes remained elevated for three years. Alkalinity (ANC) doubled while no significant change was detected in pH. Anions increased to a greater degree than cations. After seven years Ca and Mg levels remained higher than preburn concentrations.

Increases in streamflow discharge rates also frequently occur following fire due to the combustion of vegetation and soil litter layers which decreases interception, ET, and infiltration while increasing overland and subsurface flows. In a Giant Forest mixed- conifer watershed, postburn flows continued to exceed preburn levels for 10 years (Chorover and others 1994; Williams and Melack 1997; Moore 2000). The continued high flows may be attributed to the continued mortality of dominant trees within the watershed. Shrubland stream systems may be similarly affected. Following the Kaweah wildfire in 1996, a formerly intermittent stream became active year- round with surface flows during even the hottest and driest periods (Werner, 1997, personal communication).

Sediment is eroded soil derived from watershed surfaces and transported into stream/river channels by overland flow. Sediment yield is dependent on supply of soil particles, magnitude and rates of streamflow, and physical characteristics of the sediment (DeBano and others 1998). Impacts of fire on sediments are greatest in areas of steep slopes, shallow soils, unstable geologies, and where high intensity rainfall events may occur. Postfire sediment yields are usually proportional to the amount of litter/soil organic matter removed by a fire and to what degree infiltration has decreased. Sediment yields are usually greatest in the first years following a burn and decrease as protective vegetation reestablishes and litter accumulates.

Factors Used to Assess Environmental Consequences

Actions Conform to Intent of Clean Water Act
Alternatives are evaluated to assure conformity with Clean Water Act provisions.

Actions Conform to Executive Orders 11988 and 11990
Alternatives are evaluated in relation to conformity with Executive Orders on wetlands and floodplain protection.

Alternatives Improve Resource Condition
Alternatives are evaluated to assess the extent to which they maintain or improve resource conditions.

Impacts Common to All Alternatives

All four alternatives reduce the overall impairment of water resources due to post-Euroamerican settlement reductions in fire frequency and would improve resource conditions over the long- term because they restore fire to park ecosystems. Changes in some water properties would occur with all alternatives, although the extent of the changes would vary with each. It can be expected that increases in flow, water temperatures, nutrient flux, and sediment transport would occur in localized areas or at the landscape- level depending on the accomplishments of each alternative.

There is potential for these changes to result in either positive or negative impacts depending on factors related to fire severity, frequency, season, location (vegetation type), and magnitude of burns. Negative water impacts – those outside the normal range of natural variability – would tend to occur in areas of greater fire severity and larger fire size. These types of fires would not have occurred under pre- Euroamerican settlement conditions. Increases in runoff and nutrient flux would be expected to continue for multiple years (up to ten) particularly after restoration burns. Increased sediment yield and water temperatures would tend to be short lived unless a fire was of extreme severity.

Additionally, each alternative would have impacts resulting from fire related management activities, such as fireline construction or fire retardant use. The specific magnitude and longevity of the impacts on water resources would vary individually among the alternatives. Under each alternative, the use of retardant and fire fighting foam would follow restrictions contained in the *Fire and Aviation Management Operations Guide* (Addendum) which prohibit their introduction to open waters or wetlands.

None of the alternatives would result in a loss of wetlands, or affect floodplain characteristics.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
There may be temporary effects on water quality on a localized basis. Only moderate increases in run- off yield due to the reduction of vegetation result from prescribed burns because managers could control the location, timing, and severity of fire. However this alternative fails to fully restore fire as a process or achieve fuel reduction goals at a landscape scale (Caprio and Graber 2000). As a result there is a continuing backlog and accumulation of fuels with associated impacts of water resources and potential risk (moderate- to- high) of catastrophic fire events. Such events may be extreme with severe fire behavior over large areas, which would also result in adverse impacts to various water properties.

Alternative 2 – Prescribed Fire
A moderate increase in run- off yield would also be expected under this alternative due to the reduction of vegetation produced by prescribed burns. This alternative provides for the maximum control of fire – season, size, severity, and location (factors that reduce consumption of litter and above ground biomass) – of all the alternatives. However, initially there would be some potential for adverse unplanned fire events in unnatural fuels, similar to Alternative 1, but the risk of such occurrences would decline over time as the amount of area restored increases and fuel continuity is broken up. Significant long- term impacts on water could occur through such activities as fireline construction, which is often necessary to control prescribed burns. Since these activities would be required in all portions of the parks under this alternative, there would be widespread impacts. Additionally, because prescribed fires would be used, which would be ignited under specific prescriptions, there is the potential that the full range of natural processes that acted on water in the past would not be restored.

Alternative 3 – Wildland Fire Use
Attributes and outcomes of fire and its impacts on park water resources would be more

unpredictable under this alternative. This alternative would provide for the least control over such factors as size, severity, season, and location of fires. This unpredictability or variation may have either desirable or undesirable impacts for water depending on location, size, and intensity of burns. The effects would be more positive to the extent that the naturally- ignited fires would occur under the normal ranger of fuel and fire behavior conditions. Fires outside this range could potentially result in detrimental impacts with unnatural impacts on water resources and sedimentation. Such fires would have the greatest chance of occurring where unnatural fuels and vegetation currently occur. The potential effects would probably be most pronounced in the Kings and Kaweah watersheds. Impacts related to line construction and similar activities would be minimized relative to the other alternatives.

Alternative 4 – Multi- Strategy (Preferred Alternative)
The initial impacts of this alternative are similar to those for Alternative 2 due to the dominance of prescribed burning. Impacts would be minimized because sensitive drainages would be better protected from high intensity fire by prescribed burns. However, as forest conditions and fuels are restored prescribed burning would decline and natural fire would play an increasingly important role. Impacts of natural fire would be minimal because they would generally be confined to areas where unnatural fuel levels have been restored by prescribed burning (in contrast to Alternative 3) or to areas where forest conditions and fuels have remained within the range of pre- Euroamerican settlement conditions. Impacts from carrying out prescribed burns (line construction etc.) would be greatest at the onset of this alternative and decline over time. The amount of park area where natural variation in fire effects on water resources could occur would increase over time.

Conclusions

The reintroduction of fire would reestablish more natural properties to water in the parks. The overall impairment of water resources due to Euroamerican changes in the fire regime over the last 150 years would be reduced by all alternatives and resource conditions would improve.

Short- term impacts on water resources would occur under all alternatives. These impacts would most likely be manifested as increased flow, nutrient flux, stream temperatures, and sediment transport. The magnitude would depend on the alternative.

Long- term impacts would be more variable among the four alternatives. Alternatives 1, 2, and 4 control conditions under which fires burn and, thus, would tend to reduce impacts. However, long- term impacts of these three alternatives on water would differ. Alternatives 2 and 4 would accomplish desired conditions for restoring fuels and forest conditions while Alternative 1 would not. Under the latter alternative water conditions may continue to degrade on a local scale leading to continued impairment of park resources, although to a lesser degree than without fire. Alternatives 2 and 4, which fully and rapidly restore forest conditions and fuels to pre- Euroamerican levels, would reduce the probability of catastrophic fire events that could negatively impact water resources. The long- term outcome and success of Alternative 3 would be less certain due to the potential for the occurrence of severe fire events prior to restoration being achieved. Impacts of direct fire management activities (firelines etc.) on water would be greatest for Alternative 2 and least for Alternative 3.

Cumulative impacts from fire effects on water would be most likely in the Kern and Kings Rivers drainages. Both drainages contain sizable areas of Forest Service management below the parks. Wilderness occupies much of the Kern drainage below the park. Much of it burned in the 2002 McNally Fire. It is expected that water yield and sedimentation will increase in the short- term, and remain elevated for the drainage across all park alternatives due to the large size of the McNally Fire. Actions associated with alternatives 1, 3, and 4 would have the most effect since they may contribute additional wildland fire use acres. The Kings drainage has not had recent, large unwanted wildland fire below the park except for the 1997 Choke Fire. Actions associated with alternatives would follow the same pathway as described above for the Kern drainage, accept that chances for large unwanted wildland fire burning a large percentage of the drainage still remain across the landscape.

Of the four alternatives, long- term maintenance of water resources within a natural range of variability would be most likely obtained through Alternative 4 and would result in the least impairment.

Table 5-F1 – Comparison of Water Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Actions Conform to Intent of Clean Water Act	0	+	+	+
Actions Conform to Executive Orders 11988 and 11990	0	0	0	0
Alternatives Improve Resource Condition	0	+	+	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

G. SOIL

Soil is an integral component of most terrestrial ecosystems. The physical, chemical (nutrient), and biotic properties of soil are important in determining function, productivity, and other characteristics of these ecosystems (DeBano and others 1998). The three components interact in complex and often poorly understood ways. Important physical properties of soil include texture, composition (sand/silt/clay), bulk density, porosity, structure, infiltration, temperature,

and water repellency. Chemical properties include characteristics, processes, or reactions derived from the chemical composition or reactions occurring in the soil. Biotic properties relate to functions or attributes of soils that reflect the role of living or dead organisms. Important biotic influences include many relationships between plants and microorganisms that enhance uptake of nutrients while in other cases soil organisms are responsible for diseases.

All fire, whether natural or human- caused, changes the cycling of nutrients and the biotic and physical characteristics of soils. The magnitude and longevity of these effects depend on many factors including fire regime, severity of a particular fire, vegetation and soil type, topography, season of burning, and pre and postfire weather conditions. Effects can also be indirect through changes in soil biota and changes in erosional rates. Sites that historically had frequent fires are generally better adapted to the reintroduction of fire and repeated burning.

Changes in soil nutrients due to fire occur in the form and shifts in composition, distribution, and amount. They are usually the result of the volatilization of elements during combustion of fuel and organic matter. The volatilization is temperature dependant, with nitrogen, and to a lesser extent sulfur and phosphorus, most readily lost. Other nutrients are generally lost as ash via convection. Changes in nutrients can also be a result of leaching through the soil. Changes in nitrogen availability, due to its volatility at low temperatures, are usually considered the most important. Burning can decrease total nitrogen availability at a site while increasing nitrogen available for plant growth. Following prescribed burns in Giant Forest inorganic soil ammonium- nitrogen (NH_4^+ - N) levels increased from 1.90 mg/kg of soil under sequoias and 1.66 mg/kg of soil under sugar pines to 68.63 mg/k and 62.71 mg/kg respectively immediately after the fire (Haase and Sackett 1998). By five years, NH_4^+ - N had returned to preburn levels (1.54 and 1.60 mg/kg soil respectively) and by seven years had dropped below preburn levels (1.12 and 1.52 mg/kg soil respectively). Changes in nitrate- nitrogen (NO_3) were similar except peaks occurred two- years postburn. Other nutrients (Ca, Mg, K, and SO_4) also increased with SO_4 increasing by an order of magnitude (Chorover and others 1994; Williams and Melack 1997).

Biotic soil communities are complex and still poorly understood, particularly in relation to fire effects. Fire can influence soil biota directly by killing or injuring organisms, or indirectly by altering properties of the above- and below- ground soil environment. Burning generally results in declines in soil invertebrates and fungi while microorganisms such as bacteria increase in abundance. Changes in above- ground biotic communities due to changes in the fire regime may also impact soils and interact with soil nutrient status. For example, nitrogen- fixing plants are suppressed in some fire- excluded forests relative to areas where the presence of fire has been maintained (Newland and DeLuca 2000). Additionally, the effects of fire on cryptogramic crusts, (important nitrogen fixers in some ecosystems) have not been explored.

Changes in physical characteristics of soil following fire are a result of complex interactions among geomorphic processes, climate, vegetation, and landforms. Fire can affect changes in organic horizons, water repellency, infiltration capacity, porosity, structure, temperature, hydrologic properties, and various erosional processes. Changes in erosional properties and sedimentation rates are often considered the most important. Fire generally increases the potential for accelerating erosion through its effects on vegetation, organic matter, and the physical properties of soil. Increased fire severity generally increases the amount of change in these factors. Changes induced by fire events increase the amount of exposed mineral soil and potential for erosion and sediment transport. Recent studies show that the deliberate use of

prescribed fire may dramatically reduce erosion potential when compared to uncontrolled wildfire events. In one study, erosion and sediment from a high intensity wildfire event was ten times higher than that measured off a low intensity prescribed burn (Wohlegmuth et al, 1999). These effects are further affected by site properties, such as soil erodibility, slope steepness, and the timing, intensity, and amount of precipitation. The magnitude of fire's impact on soils is highly dependent on the situation and the concurrent timing of these factors.

Park soils are primarily granitic in origin with depths varying from several feet in a few low elevation areas to a very thin or nonexistent soils at higher elevations. While the parks have no definitive soils map, Storie (1953) has classified the soils of this general area as upland residuals, which have formed in place by the disintegration and decomposition of the underlying parent rock. This upland category can be divided into two groups: 1) rolling, hilly- to- steep uplands in timbered portions of the parks where podzolic soils are common and characterized by depths of three to six feet to bedrock and a moderate to strongly acid reaction, and 2) residual soils of very shallow depth to bedrock found in the remainder of the parks, especially at the higher elevations.

In most park ecosystems prior to Euroamerican settlement, fire affected both the soils and the operation of many geomorphic processes. The alteration of the natural fire regime by more than a century of anthropogenic intervention can be considered a significant alteration of and stressor to soils (properties and processes). Understanding changes due to the loss of fire in these ecosystems and how current processes would change with the restoration of fire is important. For example, there is the potential for heightened erosion in areas of chaparral vegetation due to the complete removal of most above- ground biomass by fire. This differs from a Sierran conifer forest where overstory vegetation is generally maintained after fire. Because of the landscape scale of some effects, they could have significant impacts both inside and outside the parks. Impacts and processes within the parks may be considered within the natural range of variability for that change. In contrast, the same process may produce effects outside the parks that are considered undesirable and a negative impact. For example, it would be important to understand whether there are significant erosional and sedimentation risks associated with certain types of fire because of the existence of structures, such as dams, flumes and hydroelectric generation plants, at downstream locations on the Kaweah, Kern, and Kings Rivers.

Factors Used to Assess Environmental Consequences

Maintenance of Natural Processes

Alternatives that most closely maintain and restore natural process are favored over alternatives that alter or constrain those factors.

Acres Pro- actively Managed

Alternatives that promote more acres of pro- active restoration to natural function are favored over alternatives that restore fewer acres.

Risk of Catastrophic Loss

Alternatives that result in a reduction of unnaturally large high- severity fire events are favored over alternatives that leave more acres vulnerable to damage from this source.

Impacts Common to All Alternatives

Since all alternatives enable fire to occur within park ecosystems within specific bounds, they would reduce the overall impairment of soil ecosystems due to post- Euroamerican reductions in fire frequency. This would improve resource conditions over the long term. Under all alternatives fire would produce changes in soil processes and properties, although the extent of the changes would vary with each alternative. These changes would result in either positive or negative impacts depending on fire severity, frequency, season, location (vegetation type), and magnitude of burns. Negative soil impacts – those outside the normal range of natural variability – would tend to occur in areas of greater fire severity and larger fire size. These types of fires would not have occurred under pre- Euroamerican settlement conditions. Additionally, each alternative would have impacts resulting from fire related management activities, such as fireline construction or fire retardant use. The specific magnitude and longevity of the impacts would vary individually among the alternatives.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
In this alternative, because of the ability to control location, timing, and severity of fire, there would be moderate effects on soils. This alternative, however, fails to fully restore fire as a process or achieve fuel reduction goals at a landscape scale (Caprio and Graber 2000). As a result there is a continuing backlog and accumulation of fuels with associated impacts of soils and potential risk (moderate- to- high) of catastrophic fire events. Such events could be extreme with severe fire behavior over large areas that may result in adverse impacts to various soil properties. These impacts may be most severe in chaparral vegetation.

Alternative 2 – Prescribed Fire
Compared to all the alternatives, Alternative 2 provides for the maximum control of fire (season, size, severity, and location). Initially there would be potential for adverse fire events in unnatural fuels, similar to Alternative 1, but the risk of occurrence would decline over time as the amount of area restored is increased and fuel continuity is broken up. However, significant long- term impacts on soils could occur through such activities as fireline construction, which is often necessary to control prescribed burns. Since these activities would be required in all portions of the parks under this alternative, there would be widespread impacts. Additionally, because prescribed fires would be used, which would be ignited under specific prescriptions, there is the potential that the full range of natural processes that acted on soils in the past would not be restored.

Alternative 3 – Wildland Fire Use
Attributes and outcomes of fire and its impacts on park soil resources would be more unpredictable under this alternative. This alternative would provide for the least control over such factors as size, severity, season, and location of fires. This unpredictability or variation may have either desirable or undesirable impacts for soils, which would depend on location, size, and intensity of burns. The effects would be more positive to the extent that the naturally ignited fires would occur under the normal range of fuel and fire behavior conditions. However, fires

outside this range could potentially result in detrimental impacts with unnatural rates of soil erosion and run- off. Such fires would have the greatest chance of occurring where unnatural fuels and vegetation currently occur. The potential effects would probably be most pronounced in the Kings and Kaweah watersheds. Impacts related to line construction and similar activities would be minimized relative to the other alternatives.

Alternative 4 – Multi- Strategy (Preferred Alternative)
The initial impacts of this alternative are similar to those for Alternative 2 due to the dominance of prescribed burning. However, as forest conditions and fuels are restored prescribed burning would decline and natural fire would play an increasingly important role. Impacts of natural fire would be minimal because they would generally be confined to areas where unnatural fuel levels have been restored by prescribed burning (in contrast to Alternative 3) or to areas where forest conditions and fuels have remained within the range of pre- Euroamerican settlement conditions. Impacts from carrying out prescribed burns (line construction etc.) would be greatest at the onset of this alternative and decline over time. Amount of area where natural variation in fire effects on soils occurred would increase over time.

Conclusions

The reintroduction of fire to the parks would reestablish natural erosion processes and soil properties, particularly in the mid- elevation zone where pre- Euroamerican fire was most frequent. Overall impairment due to Euroamerican changes in the fire regime over the last 150 years would be reduced by all alternatives and resource conditions would improve.

Short- term impacts on soil resources would occur under all alternatives. These impacts would most likely be manifested as increased sediment transport.

Long- term impacts would be more variable among the four alternatives. Alternatives 1, 2, and 4, which control conditions under which fires burn, would tend to reduce impacts. However, long- term impacts on soils of these three alternatives would differ. Alternatives 2 and 4 would accomplish desired conditions for restoring fuels and forest conditions while Alternative 1 would not. Under the latter alternative, soil conditions would continue to degrade leading to continued impairment of park resources although to a lesser degree than without fire. The long-term outcome of Alternative 3 would be less certain due to the potential for severe fire events prior to restoration being achieved. Alternatives 2 and 4 that fully and rapidly restore forest conditions and fuels to pre- Euroamerican levels would reduce the probability of catastrophic fire events that could negatively impact soil processes. Impacts of direct fire management activities (firelines etc.) on soils would be greatest for Alternative 2 and least for Alternative 3.

Of the four alternatives, long- term maintenance of soil processes within a natural range of variability would be most likely obtained through Alternative 4 and would result in the least impairment of soil resources.

Table 5-G1 – Comparison of Soil Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Maintenance of Natural Processes	0	++	+	++
Acres Pro-actively Managed	0	+	+	++
Reduce Risk of Catastrophic Loss	0	++	+	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

H. HEALTH AND SAFETY

The health and safety of the public and fire personnel would be affected in varying degrees under all alternatives. There are two major concerns related to health and safety issues. The first is the actual danger of fire caused injuries or fatalities – firefighters, visitors, or residents becoming trapped and directly burned by fire, or injuries that are indirectly caused by the fire incident such as injury or death from falling rocks and trees, or losing balance and falling. The second health and safety concern comes from smoke inhalation - either by firefighters on the fireline or by the public in areas away from the fire.

Since smoke is produced by individual fire events, it must be managed and mitigated at that level. Important elements in considering appropriate smoke management actions include: distance of the fire from the population of concern, local weather conditions affecting smoke movement, duration of exposure, and the type of fuel being burned.

Direct and Indirect Injury

The direct risk to the health and safety of personnel on the fireline is a major issue and is addressed through adherence to standards designed to limit wildland fire personnel exposure to health and safety threats. Firefighter and public safety is the first consideration on any fire event and all fire actions will be based on providing for safety. There is no history in the parks of death or injury to visitors or residents directly caused by wildland fire, although the potential for injuries or fatalities exists. The park's fire program works to mitigate long- term threats to public safety by reducing hazardous fuels with the use of prescribed fire and mechanical fuel reduction around developments and along roadways where visitors could become trapped by fire.

On an event level, mitigation measures are implemented to limit the public's direct exposure to fire. Mitigation includes temporary trail closures, trail cautionary signing, strict road visibility standards, and the temporary closures of facilities. These measures are included in the parks' *Fire and Aviation Management Operations Guide* (Addendum).

Smoke Effects

Firefighters are exposed to the highest health risk from smoke on or near the firelines. The risks are well studied and include carbon monoxide, hydrocarbons, and particulates. Standard firefighting practices are employed to minimize firefighter exposure. These practices include: planning the location of firelines to minimize exposure, rotating firefighters out of smoky segments of the fireline at frequent intervals, and providing rest and sleep areas away from areas of significant smoke on long duration events.

Most byproducts of wildland fire combustion of health concern are concentrated at the fireline, and decrease to negligible levels in very short distances. Fine particulates however, may travel much greater distance from firelines. While they also become diluted with distance, their ability to be transported away from the fireline makes this byproduct the one of most concern in relation to public health.

Since the health effect of smoke may occur some distance from actual fire events, the parks focus most attention on the effects of the alternatives on park visitors, employees, and local communities that experience indirect smoke impacts, particularly concentrations of fine particulates.

Generally, the greater distance from the fire, the larger the volume of air available to dilute smoke and particulates below levels considered harmful to humans. Higher elevation fires typically loft smoke into mixing air masses, diluting the smoke further. Local weather patterns affect smoke mixing and movement, especially at night.

Smoke impacts are not directly related to increasing wildland fire acreage. For example grassland fires produce much less smoke per acre than do forest fuels. Even areas of similar vegetation types in forested areas may have significantly different amounts of emissions due to lower fuel load and smoke production in restored areas compared to areas that have missed several cycles of wildland fire and containing unnaturally heavy fuel loading.

Factors Used to Assess Environmental Consequences

Minimize Direct Exposure to Hazardous Environment

Alternatives are evaluated to determine which ones best minimize exposure of the public and firefighters to direct fire hazards.

Minimize Exposure to Secondary Effects of Fire

Alternatives are evaluated to determine which ones best promote the ability to control or manage the effects of smoke in local communities within State health standards.

Impacts Common to All Alternatives

Due to the abundance of flammable landscapes, plentiful natural and human ignition sources, and hot, dry summers, no alternative eliminates the health risk of smoke for firefighters, visitors, or communities. Unwanted wildland fires will occur and produce smoke under all alternatives. Alternatives that allow more control over the timing, placement, and conditions under which fires burn will be more successful at minimizing smoke impacts over the long term.

All individual wildland fire use and prescribed fire projects will be managed under the same conditions and constraints under all alternatives. Each project will be implemented only with the concurrence of the San Joaquin Valley Air Pollution Control District, and managed to maintain smoke emissions in communities below the legal thresholds as defined by the State of California and the Environmental Protection Agency. To accomplish this, smoke impacts will be managed and mitigated according to requirements contained in the *Smoke Management Plan* appended to the *Fire and Fuels Management Plan*.

While the park intends to manage all wildland fire use and prescribed fire projects so that established health limits are not exceeded, it is recognized that some individuals exposed to smoke may be sensitive or susceptible to smoke impacts at levels below the legal limits. Under all alternatives, the parks will manage this potential impact through a system of identification of sensitive individuals in the affected communities, advance notification to help affected parties mitigate or avoid potential impacts, and any other actions deemed reasonable and/or as directed by the Air District.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)

Public. There is no expected increase in fire caused injuries to visitors, employees, and the public. Under Alternative 1, fire operations would remain at current levels with intermittent visitor, employee, and general public exposure to ground level smoke particularly during late night and morning periods when smoke plumes collapse, descend and concentrate in low lying areas or canyon bottoms.

Fire Personnel. Since fire operations would remain at current levels, there would not be an immediate increase in the rate of exposure of fire personnel to hazardous conditions—both fire and smoke. Over time, as fuels continue to accumulate in untreated areas of the parks and the risk of catastrophic fire grows, fire personnel would be exposed to increasingly hazardous conditions.

Alternative 2 – Prescribed fire

Public. There is no expected increase in fire- caused injuries to visitors, employees, and the public. A significant increase in prescribed fire operations would occur which has the potential to increase the exposure of visitors, employees, and the public to ground level smoke particularly during late night and morning periods when smoke plumes collapse, descend and concentrate in low lying areas or canyon bottoms.

Fire Personnel. There would be a significant increase in the number and extent of prescribed fire operations that would cause an increase in the rate of exposure of fire personnel to hazardous

conditions—both fire and smoke. An increase in injuries may occur but it is not possible to predict with any certainty the increased rate of injury. The planned nature of prescribed fire events should allow for a lower rate of injuries than Alternative 3 given its unplanned nature.

Alternative 3 – Wildland Fire Use
Public. There is no expected increase in fire- caused injuries to visitors, employees, and the public. A significant increase in wildland fire use operations would occur which has the potential to increase the exposure of visitors, employees, and communities to ground level smoke particularly during late night and morning periods when smoke plumes collapse, descend and concentrate in low lying areas or canyon bottoms.

Fire Personnel. There would be a significant increase in the number and extent of wildland fire use operations that would cause an increase in the rate of exposure of fire personnel to hazardous conditions—both fire and smoke. This exposure would be unplanned with the potential of a higher rate of injury than Alternative 2.

Alternative 4 – Multi- Strategy (Preferred Alternative)
Public. There is no expected increase in fire- caused injuries to visitors, employees, and the public. In the short term a significant increase in prescribed fire and wildland fire use operations would occur which has the potential to increase the exposure of visitors, employees, and general public to ground level smoke particularly during late night and morning periods when smoke plumes collapse, descend, and concentrate in low lying areas or canyon bottoms. Over the long term, exposure would be reduced as fuels are reduced and control efforts become more effective when applied.

Fire Personnel. There would be a significant increase in the number and extent of prescribed fire and wildland fire use operations which would cause an increase in the rate of exposure of fire personnel to hazardous conditions—both fire and smoke.

Conclusions

No alternatives eliminate all health and safety concerns, though the alternatives vary in their ability to manage and mitigate impacts. All actions under all alternatives would be managed to fully comply with legal requirements for protection of public health and safety, including smoke impacts. Public and firefighter safety is the highest priority for all actions.

Alternative 2 provides optimum management control over the timing and placement of fire events, and hence provides the greatest control over the amount of smoke produced and minimizes the number of riskier emergency responses. Using a combination of prescribed fire and unplanned ignitions, Alternative 4 allows somewhat less management control over the timing, placement, and size of fire events than Alternative 2, but is much better in this regard than Alternative 3. Since Alternative 3 relies heavily on random ignition events, the opportunity for management control over the timing and placement of fires is minimal and results in an increasing probability of unwanted smoke events. Alternative 1 minimizes smoke impacts in the short term, but does not significantly address the continued accumulation of fuels. Alternative 1 would be expected to produce more random and larger unwanted smoke events as resistance to control and fuels increase with time.

Table 5-H1 – Comparison of Health/Safety Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Minimize Direct Exposure to Hazardous Environment	0	++	0	+
Minimize Exposure to Secondary Effects of Fire	0	++	-	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

I. COMMUNITY ECONOMICS

Choosing different alternatives may affect the flow of dollars through the local economy. Fire programs affect local community economics through several avenues – the most important variables being: the size of the fire management payroll, the amount of goods and services purchased by the program from local businesses, and impacts of fire operations and smoke events on the number of visitors moving through the community and presumably purchasing goods and services from local businesses. A comparison of fire program costs by alternative may be found in this chapter, Section J. The analysis of program costs in Section J considers the full range of fire management activities, including the cost of infrequent large unwanted fire events such as the 1996 Kaweah fire which started on private lands adjacent to the park and eventually burned 4,000 acres of parklands. The analysis in this section (section I) primarily evaluates the costs associated with the core fire program envisioned under each alternative, which as a matter of course includes preparedness and initial attack suppression capabilities.

Factors used to Assess Environmental Consequences

Fire Management Payroll

The size of the fire management program payroll varies by alternative. Since most of the money paid to fire staff is spent in the local communities in the form of housing, food, and services, increases in total payroll would be expected to have a net beneficial effect on local community economics. Similarly, alternatives with smaller payrolls would have a less beneficial effect.

Program Support

In addition to payroll inputs to the community through its employee base, the fire management program also inputs dollars directly into the economy to support program operations. Purchases

are made directly from local businesses for goods and services including food, supplies, and other items. Additional program funds could be infused into the local economy through the use of private contractors to implement fire and fuels projects such as mechanical fuel reduction.For this analysis, the assumption is made that the same *proportion* of payroll and support dollars would be spent in the local communities under each alternative. Therefore differences in program budgets between the alternatives are used as a direct indicator of the effect of that alternative's potential economic impact on the local economy.

Tourism Impacts

Park visitation data from 1987 through 2000 shows the summer period (May through September) as typically the busiest tourist months. Those months coincide with the primary fire season. Since it is difficult to directly tie tourism spending to the fire management alternatives, this assessment addresses the relative expected impacts of alternatives on visitation. The level and extent of the effect on tourism due to fire operations is difficult to accurately quantify and convert directly into dollar figures. A survey of Three Rivers residents conducted in 1999 (Paul Schissler Associates, 1999) shows 22% of residents felt that fire management activity caused significant reductions in tourism. The same survey found also found that 14% of residents believed there was a significant economic effect on Three Rivers from road closures resulting from fire management activities. Though the survey indicates that there is little common agreement of the magnitude of effect that fire events have on the local economy, some assumptions may still be made regarding the relative impact of different fire management alternatives.

Direct effects on tourism from fire operations may come from road or facility closures due to fire operations. Over the past decade such road closures have occurred three times totaling about 10 days (one day per year average). Most of the closures were a result of fire suppression operations resulting from the need to fight unwanted wildfires. However, since there are several entrances to the parks and only one access route at a time has ever been closed due to fire suppression operations, it is difficult to assess whether visitors were displaced from one entrance and threshold community to another during the closures with no net gain or loss, or whether visitors rescheduled their visit or changed plans and traveled elsewhere resulting in a net loss to communities.

Offsetting potential tourism business lost in communities affected by closures is the financial impact of firefighting efforts that are usually associated with such closures. In all cases over the past 10 years where this has occurred, many commercial lodgings, restaurants, and other local business were kept at or near capacity providing for the needs of the firefighters involved in the suppression effort.

Indirect effects on tourism may come from the effects of smoke or loss of visibility in local communities, causing shortening or cancellation of visits. Over the past decade there have been several smoke events from both managed fires and wildfire events that affected local communities. These included the 1992 Suwanee prescribed fire, the 1995 Castle prescribed fire, the 1996 Castle wildland fire use fire, the 1996 Hospital II wildfire, and the 1996 Kaweah wildfire. How and to what extent these events affected a mobile tourist population is unknown. Assumptions may be made that more, or more severe, smoke events may result in a reduction in length- of- stay negatively impacting local business, though several of the events, such as the 1995 Castle fire, occurred during November and December outside the primary visitor season.

Balanced against occasional impacts from fire that may limit a visitor's stay in the area is the concept that alternatives which increase the amount of the parks ecosystems that are restored and maintained may have positive indirect effects on tourism by creating more resilient and functional natural systems for visitors to enjoy. Some fire effects, such as the regeneration of giant sequoia trees and rejuvenation of wildlife habitat, may provide positive visitor experiences. A similar concept may be applied to visitor enjoyment of wilderness areas where some alternatives allow more exposure of wilderness users to natural process such as natural fire events.

Recent research (Loomis et al, 1999) suggests that indirect effects of prescribed fire on recreational visits is slight, while the visual effects of large catastrophic fire events may cause significant decreases (up to 40%) in recreational use. Therefore, in this assessment it is assumed that alternatives that decrease potential for catastrophic events would have a more positive effect on recreational visits. Related research at Sequoia and Kings Canyon concluded that burned areas and smoke are generally visible to less than half of park visitors and neither has a significant impact on enjoyment of the visit. More visitors noticed fire scars on giant sequoias (87%) but stated that the sight enhanced the beauty of the trees (Quinn 1987).

Table 5- I1 depicts the anticipated relative effect of different alternatives on local business based on program expenditures. Table 5- I2 depicts the relative effect of each alternative on tourism.

Impacts Common to All Alternatives

The fire management program may have both direct and indirect effects on the local economy. Direct effects include the parks' transactions with local businesses that supply goods and services for fire management activities. Additional direct effects come from employees on the fire program payroll who procure personal housing, food, goods, and services from local businesses. Indirect effects include the impact of fire management activities on tourism.

While there are some differences in payroll and support costs between the alternatives, it should be noted that the core program size and cost is primarily driven by the organization needed to effectively prevent and suppress unwanted fires. Those costs remain relatively constant across all alternatives. Most of the differences in cost across the alternatives reflect those necessary to both maintain an adequate suppression force as well as a proactive fuels management program. The costs for proactive fuels management programs are not completely additive to suppression costs since some resources are shared between the two functions. Economies of scale are also achieved when combining suppression and proactive management actions.

For all alternatives, the economic impacts of mechanical fuel reduction would be negligible since the average acreage treated would be less than 30 acres per year under all alternatives.

Year 2000 visitor statistics for the parks during the primary visitor season (May through September) totaled 980,922. This figure is used as a basis for comparing the magnitude of potential impacts on tourism across the alternatives.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
Payroll costs for employees in the parks' fire management program under this alternative would be slightly over $1 million annually. Total additional dollars for program support and proactive fuels management would be $280 thousand annually.

Offsetting the local economic benefits from fire payroll and support spending are expected periodic negative effects for the tourism industry as fire projects are implemented and fire suppression occurs resulting in road or facility closure. Impacts resulting from unplanned fires requiring suppression are expected to increase as suppression acres increase.

Alternative 2 – Prescribed Fire
Payroll size would increase through the addition of another operations crew. Payroll would increase to $1.2 million annually. Total support dollars available under the prescribed fire alternative would increase to about $300 thousand annually.

Expected negative effects for the tourism industry would be greater initially than for Alternative 1, but decrease over time as fuels treatment leads to a reduction in fuels across the park. Negative effects could be partially mitigated through proper planning for prescribed fire events, reducing their randomness and subsequent impact upon the community.

Alternative 3 – Wildland Fire Use
Payroll size would increase with the addition of one operations crew. Total payroll and total support dollars available would be the same as Alternative 2.

A slightly higher level of negative impacts on tourism would be expected due to the random nature of the natural ignitions. Unplanned ignitions managed for resource benefit during the fire season without prior restoration of natural fuel loads could lead to more smoke production during the tourist season. Mitigation strategies would be more limited than with prescribed fire treatment (Alternative 2) or combined strategies (Alternatives 1 and 4).

Alternative 4 – Multiple Strategy (Preferred Alternative)
Payroll size would increase by roughly one- third with the addition of operations crews and support staff. Total payroll would increase to $1.5 million annually while total support dollars available would increase to $320 thousand. The budget for this program would be the highest of all alternatives, resulting in more economic benefit to local economies from that source.

Anticipated negative effects on tourism would parallel the no action alternative. There would be a potential for an initial increase in impacts as treatment activity increased, but long- term effects from individual events would be reduced over time as fuels were restored to more natural levels.

Table 5-I1 – Program cost by alternative. Economic benefit to local communities would be proportional to program expenditures.

	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Direct Payroll	$1 million	$1.2 million	$1.2 million	$1.5 million

Support Costs	$280 thousand	$300 thousand	$300 thousand	$320 thousand
Total Program Expenditures	$1.28 Million	$1.58 Million	$1.58 Million	$1.82 Million

Table 5-I2 – Relative effect on tourism. A (-) indicates a potential negative effect and a (0) indicates a neutral effect relative to other alternatives.

	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Relative Effect on Tourism	-	-/0	--	-/0

Conclusions

Fire events may have some effect on tourism and related expenditures in the local economy. However, during fire events that are severe enough to affect local economics, there may be offsetting expenditures in the communities by fire forces. Alternatives 2 and 4 would have similar offsetting economic effects, while alternative 3 would have the most negative effect due to unpredictability and randomness of wildland fire use events. Direct and indirect fire program expenditures in the community would have a positive effect on local community economics, both at the programmatic and fire event level. Alternative 4 may create the greatest benefit to the local economy.

J. PROGRAM COST

Annual program costs vary by alternative. To respond to emergencies and unwanted fires, under all alternatives, a core suppression program is assumed. While this core suppression capability remains constant across the alternatives, there would be a variation between alternatives due to changes in the tools used to achieve additional resource management and ecosystem objectives. Costs used in this section are based on past average costs utilizing park employees for labor. With continuing emphasis on contracting with private companies, certain functions (like mechanical fuel reduction projects) may be implemented by a non- federal workforce. Based on past projects in the parks, contracted projects have a higher cost per acre.

These figures contain estimates that take into account the funds needed to control and suppress infrequent, but expensive, large wildfires events. Such unwanted events are expected to occur several times each decade under all alternatives. Research conducted by Colorado State University show those alternatives that restore more park acres over time, and those that use fire more deliberately and less randomly, eventually result in a reduction in the rate of fires requiring aggressive suppression and a consequent increase in overall economic return (Omi et al, 1999).

Factors Used to Assess Environmental Consequences

Relative Cost of Alternatives
Less expensive alternatives are favored over more expensive ones.

Achieve Management Objectives
Alternatives that are more able to achieve management objectives are favored over those that achieve fewer objectives.

Analysis and Results

In order to estimate the cost of each alternative, average operational cost estimates for each strategy were derived from budgets based on the existing fire management program in the parks. Table 5- J1 lists the average costs per acre for each tool based on data from 1990- 1999.

Table 5-J1 – Average costs per acre for each tool

Tool	Cost per acre	% of Fires in the 1990's	% of Acres in the 1990's
Mechanical Fuel Reduction	$1,700/acre *	N/a	N/a
Wildland Fire Suppression (Large) **	$1,300/acre for fires ≥ 10 acres	5%	98%
Wildland Fire Suppression (Small) **	$5,900/acre for fires < 10 acres	95%	2%
Prescribed Fire	$45/acre	N/a	N/a
Wildland Fire Use Large Project ***	$87/acre for fires ≥ 10 acres	11%	98%
Wildland Fire Use Small Project ***	$2,600/acre for fires < 10 acres	89%	2%

* This figure represents a typical mechanical treatment project and is based on estimates developed for proposed projects at the Lodgepole developed area. Mechanical treatment costs per acre are driven primarily by high labor costs.
**** Most of the parks' suppression fires are small (95% are less than 10 acres), but the few large fires account for 98% of the acres burned. The cost per acre differs between small and large fires, with the cost per acre dropping on larger fires as a result of economies of scale. Fire suppression costs are driven by high labor and equipment costs. Suppression fires generally entail additional premium (hazard) pay and overtime for firefighters due to their hazardous working conditions and random occurrence.
***** Most of parks' wildland fire use fires are small (89% are less than 10 acres), but the remaining 2% that become larger than 10 acres eventually account for 98% of the acres burned. The cost per acre goes down when the fire is larger as a result of economies of scale and the more effective use of natural boundaries for containment. Overall costs per acre are generally higher than prescribed fire due to remote locations and higher transportation costs to monitor and manage the project.

The per- acre figures in Table 5- J1 above were multiplied by the estimated acreage for each tool under each alternative (see Tables 5- J2 and 5- J4 below) and rounded to the nearest hundred dollars (see Tables 5- J3 and 5- J5 below).

Fixed program costs necessary to maintain core suppression capabilities and manage the program were then added to come up with a total program cost estimate for each alternative. Fixed program costs from the year 2000 ($1,415,000) were used for the first 3 alternatives. For Alternative 4, an estimated budget for the proposed program was derived from estimates by the national fire office, approximating the most efficient staffing level.

Table 5-J2 – Average acres per year treated by alternative over first 10 years.

Treatment Acres per year	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi Strategy (Preferred Alternative)
Mechanical Fuel Reduction	4	10	10	10
Wildland Fire Suppression	561	1311	3167	1379
Prescribed Fire	2486	13965	150	7300
Wildland Fire Use	1227	0	10489	6638
Grand Totals	4,278	15,286	13,816	15,327

Table 5-J3 – Average annual program costs by alternative over first 10 years.

Program Costs per year	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi Strategy (Preferred Alternative)
Mechanical $1700/ac	6,800	17,000	17,000	17,000
Suppression ≥ 10 acres (98%) x$1300/ac	715,000	1,670,200	4,034,800	1,756,800
Suppression < 10 acres (2%)x $5900/ac	66,200	154,700	373,700	162,700
Prescribed Fire $45/ac	111,900	628,400	6,800	328,500
Wildland Fire Use ≥ 10 acres (98%)x $87/ac	104,600	0	894,300	566,000
Wildland Fire Use < 10 acres (2%)x $2600/ac	63,800	0	545,400	345,200
Fixed Program Costs	1,415,000	1,415,000	1,415,000	1,993,000
Grand Totals	$2,483,300	$3,885,300	$7,287,000	$5,169,200
Average Cost/Acre	$580	$254	$527	$337

Table 5-J4 – Average acres per year treated by alternative over 25 years.

Treatment Acres per year	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi Strategy (Preferred Alternative)
Mechanical Fuel Reduction	10	16	30	16
Wildland Fire Suppression	886	726	2245	986

Prescribed Fire	1478	14490	164	2225
Wildland Fire Use	1293	0	11349	12055
Grand Totals	3,667	15,232	13,788	15,282

Table 5-J5 – Average annual program costs by alternative over first 25 years.

Program Costs per year	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi Strategy (Preferred Alternative)
Mechanical $1700/ac	17,000	27,200	51,000	27,200
Suppression ≥ 10 acres (98%) x$1300/ac	1,128,800	924,900	2,860,100	1,256,200
Suppression < 10 acres (2%)x $5900/ac	104,500	85,700	264,900	116,300
Prescribed Fire $45/ac	66,500	652,000	7,400	100,100
Wildland Fire Use ≥ 10 acres (98%)x $87/ac	110,200	0	967,600	1,027,800
Wildland Fire Use < 10 acres (2%)x $2600/ac	67,200	0	590,100	626,900
Fixed Program Costs	1,415,000	1,415,000	1,415,000	1,993,000
Grand Totals	$2,909,200	$3,104,800	$6,156,100	$5,147,500
Average Cost/Acre	$793	$204	$446	$336

Conclusions

Alternative 1 shows the lowest overall program cost and highest cost- per- acre of all alternatives. However it fails to achieve significant natural resource objectives. Alternative 2, through optimizing the use of prescribed fire and eliminating random fire events provides a cost effective alternative while achieving most objectives. It has the second lowest cost and the lowest cost- per- acre of all alternatives. Alternative 3 has the highest overall cost due to the randomness of unplanned ignitions and lack of proactive fuels management in unrestored areas of the parks. It has the second highest cost- per- acre with less certain outcomes for achieving program objectives. Alternative 4 has the second highest overall cost and fully achieves all program objectives. It has the second lowest cost- per- acre.

K. WILDERNESS

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

Most wilderness use occurs during the relatively snow- free periods of July through September. Recent figures for the year 2000 show wilderness overnight use at approximately 75,000 visitor use nights by 22,600 different visitors. Backcountry users primarily utilize the nearly 800 miles of trails.

NPS Management Policy 6.3.9 directs that "fire management activities conducted in wilderness areas will conform to the basic purposes of wilderness. The parks' fire management and wilderness plans together will identify the natural and historic roles of fire in the wilderness and will provide a prescription for response to natural and human caused wildfires. Actions taken to suppress wildland fire will use the minimum requirement concept and will be conducted in such a way as to protect natural and cultural features and to minimize the lasting impacts of the suppression actions and the fires themselves" (see *Fire and Aviation Management Operations Guide {Chapter III.c.3.a}* in Addendum).

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

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

Factors Used to Assess Environmental Consequences

Minimum Requirement
Are the proposed actions the minimum necessary to meet stewardship goals or efficiently administer this area?

Minimum Tool
Are the tools proposed the minimum necessary to accomplish the chosen actions?

Wilderness Character
To what extent do the actions proposed add to or detract from wilderness character as defined by the Wilderness Act?

Impacts Common to All Alternatives

The alternative ultimately selected as the preferred alternative for implementation under this environmental assessment will be considered the minimum requirement.

All alternatives may result in transient (short- term) impacts to wilderness character. These include the use of aircraft to detect, monitor, and manage fires, and noise and activity from firefighting staff and equipment during operations.

More persistent (long- term) impacts would result from alternatives that include prescribed fire or fire suppression in wilderness. Persistent impacts include line construction resulting in felled trees and trenching, and helispot construction resulting in felled trees and/or cut brush.

Operational impacts are mostly transient. All fire operations in the wilderness would consider preservation of wilderness character and experiences in their implementation. These would be addressed in the project plans for proposed prescribed fire and mechanical treatments. Wildland fire use impacts to wilderness would be described and mitigated through site specific planning documented in the Wildland Fire Implementation Plans (WFIP).

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

The use of chainsaws, portable pumps, and the landing of helicopters for all fire operations will be considered appropriate as the minimum tool, as will electronic devices including but not limited to global positioning units for mapping and locating fires, and cell phones and portable radios for communications (see Appendix H for the Record of Decision for Minimum Requirement and Minimum Tool). When using helicopters, the parks will consider operational periods, amount of flight time, and sensitivity of travel routes. When using stock, the parks will adhere to existing park regulations including party size restrictions and forage area regulations, and will consider the implications of competing for limited forage in relation to private and commercial stock users. Use of both stock and aircraft will be kept to the minimum necessary commensurate with meeting project objectives and providing for firefighter safety.

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

Fire related research and monitoring may occur to document and understand the effects of fire management actions in wilderness. Research and monitoring staff and equipment would create additional transient (short- term, infrequent) impact. Any proposal that required the installation

of long term or permanent research or monitoring equipment in the wilderness would require a separate analysis and approval by the parks Environmental Management Committee.

Occasional trail or area closures may be required to safely manage wilderness fire management actions.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
Some transient (short- term) impacts would occur as a result of fire operations including: helicopter overflights and landings, temporary fire camps, pack stock used to support operations, motorized saws and pumps, and the presence of fire management personnel. More persistent (long- term) impacts would occur as a result of line construction to implement prescribed fire projects and suppression actions where needed.

Under this alternative, the wilderness character would be substantially maintained, and conditions would appear natural to most visitors. However unnatural levels of fuels may continue to accumulate throughout much of the lower and mid- elevation wilderness. Tree density and species composition would continue to change away from natural conditions. Unnaturally intense fires may occur over larger portions of the wilderness as a result of increasing fuel and tree density. While not immediately obvious to all wilderness visitors, these changes cumulatively result in a less natural environment that would be noted by some wilderness users.

Alternative 2 – Prescribed Fire
To implement prescribed burns throughout the wilderness, more extensive use of firelines (long- term impact) would be expected under this alternative than others, resulting in more visible and persistent evidence of human intervention. More activity related to active fire management (e.g. staff needed to construct, ignite, and defend firelines) would be required to simulate natural processes, and would result in increased levels of staff and equipment throughout the wilderness. This would result in frequent, but transient, impacts.

This alternative would use prescribed fire to mimic natural process, and most unplanned ignitions would be suppressed. The result would be a reduction or elimination of unplanned fire events and their effects resulting in an environment primarily shaped by humans. Though the wilderness would appear “natural” or “wild” to most visitors, it would in fact be substantially a product of deterministic human intervention. More evidence of human created firelines, and an increased human presence would affect wilderness character in areas of extensive fire activity.

Alternative 3 – Wildland Fire Use
Most management activity would take the form of transient (short- term) impacts necessary for monitoring natural fire events by aircraft and on the ground. There would be an occasional need to initiate suppression actions (long- term impact) to keep fires from directly affecting developments, boundaries, or other sensitive areas, or to meet requirements for preventing exceedances of air quality standards.

This alternative would allow the freest expression of natural processes in wilderness. Areas would appear substantially natural and affected primarily by natural forces. However at a local scale in areas that have been significantly altered by past suppression and have unnaturally high fuel loads and/or tree density, the effects of an unplanned fire may result in unnaturally intense or extensive fire noticeable to some visitors

Alternative 4 – Multi- Strategy (Preferred Alternative)
This alternative would initially use extensive prescribed fire to restore those areas where unnaturally high fuel loads and/or tree densities are present. In all other areas, the natural role of fire would be perpetuated and only constrained as required to protect structures, protect people, or conform to air quality regulations. Over time, impacts from fireline construction and suppression actions in wilderness would decrease.

In the short term, most areas would appear unaffected by management, and most natural fire ignitions would be allowed to burn. In the long term, this alternative has high potential to restore natural conditions throughout the wilderness, and maintain them consistent with wilderness character.

Conclusions

The alternative ultimately selected as the preferred alternative for implementation under this environmental assessment will be considered the minimum requirement.

Due to numerous site factors, using hand tools alone is impractical for completing all the work proposed in an effective, time constrained, safe, and low impact manner. Operating under the guidelines of the minimum impact suppression tactics contained in the Fire and Aviation Management Operations Guide (FAMOG), the use of chainsaws, pumps, the landing of helicopters, and the use of electronic communication and mapping devices for this program – all with transient impacts - will serve to increase firefighter and public safety, decrease the duration and extent of resource and wilderness impacts, and result in a more aesthetically appropriate result with little lasting evidence of human intervention. Therefore, the equipment listed above will be considered the minimum tools required to implement proposed actions (see Appendix H for Record of Decision on Minimum Requirement and Minimum Tool).

To the extent that impairment of the wilderness condition can be defined as human caused deviation from natural conditions, all alternatives will serve to reduce impairment caused by the effects of past fire exclusion. In general, the more acres treated under a particular alternative, the more that impairment will be reduced in the long term. Alternatives 2, 3 and 4 restore significantly more of the wilderness to natural conditions than Alternative 1.

To the extent that wilderness can be considered as a place shaped primarily by natural processes, alternatives that optimize the use of natural ignitions and minimize human intervention will minimize the chance of further impairment. Alternatives that suppress naturally ignited fires and favor human intervention (e.g. substituting prescribed fire for unplanned fire), as the primary means for perpetuating a model of natural systems increase the possibility of impairment.

Alternative 3 maximizes the management of natural ignitions, though the effects of natural ignitions in previously altered areas may result in impairment. Alternative 2 substitutes human intervention in place of natural process as a long- term strategy. Alternatives 1 and 4 emphasize the use of prescribed fire to restore natural conditions in the short- term, then favor the management of unplanned ignitions as a long- term strategy. Alternative 4 implements these strategies on a larger scale than Alternative 1, encompassing all wilderness areas.

Table 5-K1 – Comparison of Wilderness Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Minimum Requirement	0	0	+	+
Minimum Tool	0	0	0	0
Wilderness Character	0	0	+	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

L. WILD AND SCENIC RIVERS

The park contains two rivers that were designated as wild and scenic in 1987, the Kings and the Kern. Both rivers are contained within wilderness, with the exception of the lower seven miles of the South Fork Kings which flows through the Cedar Grove developed area. The General Management Plan in progress as of 2002 may result in the designation of new reaches of Wild and Scenic River. Any new designations would be managed consistent with the alternatives discussed below.

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

Factors Used to Assess Environmental Consequences

Impact on Outstanding Resource Values

Alternatives that minimize impact on outstanding resource values of the rivers will be considered more desirable.

Impacts Common to All Alternatives

Since all segments of the rivers in wilderness are in fire management zones that emphasize perpetuating fire as a natural process, none of the fire management alternatives would affect their free- flowing condition or involve new developments within their corridors.

Alternatives that restore and maintain more of the river corridors to a naturally functioning condition would be considered to have a greater positive effect on the protection of the wild and scenic river values. Those that restore or maintain fewer acres, or maintain areas primarily through aggressive human intervention (removing some measure of naturalness) would be considered less beneficial to wild and scenic values.

All riparian areas, including wild and scenic rivers, would be protected from contamination by fire fighting foams and aerial retardant following guidelines in the *Fire and Aviation Management Operations Guide* (Addendum).

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
This alternative would maintain or restore moderate amounts of wild and scenic river corridor, with emphasis on the segment flowing through the Cedar Grove developed area. Other areas of the wild and scenic river corridor not receiving treatment would be subject to greater unnatural change from high intensity wildfire events.

Alternative 2 – Prescribed Fire
Most areas along the wild and scenic river corridors would receive proactive fuels management and would be protected from damaging large- scale high intensity fire events. Some degree of naturalness would be lost as a result of the deterministic implementation of prescribed fire projects throughout the river corridor.

Alternative 3 – Wildland Fire Use
Some areas along the wild and scenic river corridors would be protected from damaging large-scale high intensity fire events. Some risk from damaging large- scale high intensity fire events would remain as most areas would not receive conservative fuels reduction (either through mechanical treatment or prescribed fire) prior to burning in unplanned fire events.

Alternative 4 – Multi –Strategy (Preferred Alternative)
Most areas along the wild and scenic river corridors would receive proactive fuels management and would be protected from damaging large- scale high intensity fire events. Areas would appear natural with minimal human intervention in wilderness areas.

Conclusions

None of the alternatives would impair wild and scenic river outstanding resource values as defined by legislation. Alternatives 2 and 4 would provide the greatest protection from unnatural

effects, while Alternatives 1 and 3 leave the river corridors vulnerable to damaging fire events. Alternative 4 provides the best combination of protection and minimal intervention in the natural functioning and scenic values of the wild and scenic rivers.

Table 5-L1 – Comparison of Wild and Scenic River Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Impact on Outstanding Resource Values	0	+	0	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

M. RECREATION

Approximately 1.5 million visitors come to the parks each year to enjoy the natural resources, participate in recreational and educational opportunities, and as a social experience. Primary recreational opportunities in the park include camping, hiking, backpacking, stock packing, sightseeing (by car and on foot), snow play, and wildlife viewing.

The average length of a recreational visit is 5 hours in the off- season (October – April) when visitors venture into the park for a short while to enjoy snow sports and catch a glimpse of the big trees. In the summer the average length of a visitor's stay increases dramatically to 36 hours. This is the time of year when campgrounds are open and more extensive overnight lodging is available. Day use visitors in the summer also tend to stay longer due to comfortable mountain temperatures and extended daylight hours. In 2000, 22,600 visitors ventured into the parks' wilderness by pack stock or on foot for overnight trips averaging 3 nights per trip.

Factors Used to Assess Environmental Consequences

Provide High Quality Visitor Experience
Alternatives that most enhance unique park resource based experiences and resource conditions will be favored.

Minimize Interruption of Recreational Pursuits
Alternatives that maximize recreational opportunities while achieving resource and visitor safety goals will be favored.

Impacts Common to All Alternatives

All alternatives require some level of fire management operations that generally include fire detection, suppression, monitoring, igniting, and holding. Depending on location and time of year, these operations may cause temporary impacts to individual recreational experiences. Impacts include: 1) noise from aircraft and other power equipment such as chainsaws and portable pumps, and 2) temporary closures of roads, trails, or facilities to protect visitors from direct exposure to fire events. Smoke from fires may restrict visibility and impact viewsheds, or become heavy enough to become a nuisance. The health impacts to visitors from smoke are addressed in Section H, however, given the relatively short duration of the average visit and the ability to be both mobile and flexible enough in itinerary to avoid smoke, exposure during the typical visit is minimal.

Fire, when functioning to restore or maintain natural processes and conditions, helps to shape and renew the vegetation and wildlife habitats that are integral parts of many recreational pursuits in the parks. Fire events, especially prescribed burns in easily accessible areas, create unique opportunities for visitor experiences and educational opportunities. The effects of some fires, such as facilitating the germination of giant sequoia seeds and stimulating wildflower displays, may provide positive experiences.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
Same as "common to all", though only select areas of the parks would be restored to natural function.

Alternative 2 – Prescribed Fire
In the short term this alternative may result in slightly increased negative impacts to recreational use compared to Alternative 1 due to more aggressive implementation of a prescribed fire program. Impacts would take the form of occasional closures of roads or wilderness areas to implement fire operations. Educational and unique visitor experiences related to viewing ongoing fire operations would increase. This alternative would have fewer negative impacts on recreational use than Alternative 3 due to more rigid control over timing and placement of ignitions. Over the long term, random and aggressive suppression actions would be reduced as more of parklands were restored to natural fuel loads and forest density, reducing the duration and number of closures and smoke events.

Alternative 3 – Wildland Fire Use
This alternative would result in the most negative impacts to recreational use of all the alternatives. More closures would be necessary due to the random nature of ignitions and lack of proactive fuels management. Few educational and unique visitor experiences related to viewing ongoing fire operations would be possible due to the increased risk and uncertainty involved in managing wildland fire use projects in comparison to prescribed fire projects.

Alternative 4 – Multi- Strategy (Preferred Alternative)
Same as Alternative 2 except that there would be less evidence of fire management activities in wilderness and backcountry areas due to management of some unplanned ignitions in place of

more operations- intensive prescribed fire projects. Educational and unique visitor experiences related to viewing ongoing fire operations would increase.

Conclusions

None of the alternatives would cause long- term or broad- scale impairment of recreational opportunities. All alternatives have potential to cause short term localized negative impacts to recreational use, but these impacts would be transient. Alternatives that restore and maintain more of the park ecosystems in a naturally functioning state will provide the best quality environment for visitors, as well as optimize opportunities for educational and scientific pursuits.

Table 5-M1 – Comparison of Recreation Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Provide High Quality Visitor Experience	0	-/+	0	-/+
Minimize Interruption of Recreational Pursuits	0	-	--	0

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

N. CULTURAL / HISTORIC

Cultural resources (including prehistoric, ethnographic, historic, and cultural landscapes) may be impacted to varying degrees by fire and fire management actions. The effects of fire on cultural resources can be divided into three broad categories: direct, operational, and indirect. However, mitigation efforts can prevent the impairment of the parks' known cultural resources, and lessen the chances of adverse impact to unknown sites. Due to limited data in the parks' cultural resources inventories, it is possible that some unknown sites, structures, or objects could be impacted by or lost during a fire under all alternatives.

General Fire Effects

Prehistoric Resources

The effects of fire on prehistoric sites, including potential landscapes, are variable, with particular concerns associated with rock art sites and those sites with dense, surface- visible

scatters of obsidian. In general such sites, even those with shallowly buried deposits or features, tend not to be impacted adversely by low intensity fires. High intensity fire events associated with heavy fuel loads may cause serious impacts, such as the spalling of rock surfaces, the cracking or "crazing" of cherts or obsidian artifacts, the fracturing of ceramics or potsherds, and the disruption of hydration bands on obsidian surfaces.

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

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

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

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

Factors Used to Assess Environmental Consequences

Minimize Surface Disturbance
Alternatives that minimize surface disturbance will be favored.

Allow Pre- Planning and Mitigation
Alternatives that maximize the ability of cultural resource managers to anticipate, inventory, and mitigate impacts to cultural resources will be favored.

Reduce the Risk of Damage from High Severity Fire Events
Alternatives that reduce the risk of large- scale high severity fire events will be favored.

Impacts Common to All Alternatives

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

Surface disturbance would occur under all alternatives as a result of the need to construct fireline, fire camps, staging areas, and related facilities. Alternatives that minimize the need for surface disturbance would have less potential to affect cultural resources.

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

High intensity fires have the potential to drive heat pulses deep into the ground and to spall off rock surfaces. These mechanisms can negatively affect subsurface and lithic cultural resources. There are opportunities for high intensity fire events to occur under all alternatives, though the size and timing of such events vary by alternative. Those alternatives that proactively reduce heavy fuel accumulations through low intensity prescribed fire or through mechanical removal reduce the risk of damage to cultural resources from high intensity fire. Those alternatives that promote continued accumulation of fuels increase the risk to cultural resources from high intensity fire.

Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)
This alternative uses a combination of mechanical fuel removal, suppression, and management of planned and unplanned ignitions to achieve modest accomplishments. Prescribed burns and mechanical treatments would be pre- planned allowing avoidance and mitigation of most cultural resource impacts. Protection of cultural resources would be considered when implementing fire use projects. With more conservative program goals than the other alternatives, line construction would be less than alternatives 2 and 4, but may be offset by more extensive line construction needed for more aggressive fire suppression actions.

Since this alternative does not treat all areas of the park with prescribed fire or mechanical fuel removal at a level sufficient to offset increasing accumulation of fuels, high intensity fire events leading to cultural resource damage would be expected on occasion.

Alternative 2 – Prescribed Fire
A focus on the use of pre- planned prescribed fire as the dominant management strategy in this alternative allows the best opportunity for advance clearance and avoidance of cultural resource

impacts. Standard management strategies would be adopted to preclude or minimize impacts, e.g., scratching firelines around sites for their protection, reducing fuel loads by hand, and wrapping structures in fire shelters or similar protective material or covering them with fire retardant foam. However, since this alternative depends exclusively on the use of prescribed fire requiring extensive fireline construction throughout the park, it has a fairly high probability of disturbing currently unidentified cultural resources.

This alternative would treat heavy fuel accumulation parkwide, decreasing the risk of damage to cultural resources from intense fire events. Occasional emergency suppression actions needed to control unwanted fires may result in negative effects. With continued application of prescribed fire, fuels loads and resulting high intensity events would diminish with time and reduce the potential for damage from that source.

Alternative 3 – Wildland Fire Use
This alternative optimizes the use of random fire ignitions and minimizes the use of pre-planned actions. As such, it provides the least opportunity for advance clearance and mitigation of fire effects on cultural resources. However, the early involvement of cultural resources specialists in planning the response to a given wildland fire would stand to minimize the likelihood of adversely affecting significant or potentially eligible cultural resources. Since much less fireline would be constructed under this alternative, concerns for sub- surface disturbance of cultural resources would be reduced. The lack of preplanning combined with the occasional large high intensity event would place above ground prehistoric and historic sites/structures/objects at highest risk. This alternative is the least amenable for overall protection of cultural resources given the current fuel loads.

Alternative 4 – Multi- Strategy (Preferred Alternative)
The adoption of a multi- strategy program may result in a variety of potential impacts to known cultural resources similar to the impacts outlined above for Alternative 1. However, the degree of these potential impacts would be greater given that more acres would be targeted for treatment per year.

With the use of prescribed fire and mechanical fuel reduction, the ability to pre- plan mitigation actions would reduce the potential impacts to cultural resources. Pro- active fuels management would also reduce the risk of catastrophic wildland fire and associated emergency responses. These planned treatments have the potential to increase surface disturbances through the construction of firelines that may result in adverse impacts to shallowly buried sites/structures/objects.

The use of wildland fire use and suppression would be closely coordinated with the parks' cultural resources specialist given the potential for ground disturbance and attendant site impacts (the emergency placement of fire camps, firelines, and staging areas).

Conclusions

Fire, managed or unmanaged, has the potential to impact cultural resources. Since these resources are located in a highly flammable environment, fire effects cannot be completely avoided under any alternative. However, impairment may be controlled with appropriate

preplanning, avoidance, and mitigation. Alternative 2 allows the most opportunity to avoid or mitigate impacts to cultural resources due to extensive pre- planning, however it also entails the most risk to subsurface cultural resources from extensive fireline construction. Alternative 3 would entail less fireline construction than Alternative 2, though its reliance on random fire events to achieve fire management objectives significantly reduces the ability to preplan and mitigate impacts and exposes surface or above ground resources to more risk of high intensity fire. Alternative 1 uses a combination of management strategies, but generally allows some ability to pre- plan and avoid impacts from prescribed fire and mechanical treatments. However, with modest accomplishments across the parks and the continuing accumulation of fuels, its effectiveness in preventing damage to cultural resources from high intensity fire is limited to small areas. Impacts from Alternative 4 are similar to Alternative 1, though it results in a significant decrease in the risk from high intensity fire events over time as more acres are proactively treated and fewer aggressive emergency suppression actions – including fireline construction – may be needed.

Table 5-N1 – Comparison of Cultural/Historic Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Minimize Surface Disturbance	0	-	+	0
Allow Pre-Planning and Mitigation	0	++	--	0
Reduce the Risk of Damage from High Severity Fire Events	0	+	0	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

O. RISK OF CATASTROPHIC EVENTS

Catastrophic fire events are defined as those that cause significant loss of natural or cultural resource values, or the loss of human life. Risk is the probability of such an event occurring. Reducing the potential for large damaging fires is a significant concern to the public and to park managers. This section examines the factors that contribute to damaging fire events and evaluates each alternative's potential for success in reducing the occurrence of such events.

A number of risk factors are not manageable and are represented by natural random events such as drought, high winds, and lightning storms. Since park staff can exert no control over unmanageable risk factors, reducing the risk of catastrophic fire events entails focusing on those

factors within management control. The most significant manageable risk factor is the amount and arrangement of fuels that are available to burn once an ignition occurs. Other less significant risk factors also lend themselves to management control such as training people in the proper way to extinguish campfires thereby reducing ignition sources, and by constructing defensible space around structures and sensitive resources.

The greatest fuels management challenges in these parks are the enormous buildup of dead and down fuel that have accumulated over the past century of fire suppression, and the increasing density of trees, primarily smaller trees, in the forest understory. These combined conditions result in a high risk of catastrophic fire. Both elements have the potential to contribute to hotter, high intensity fires that are difficult and dangerous to suppress and that may cause unnaturally severe fire effects. Ignition sources for the forest fuels are plentiful, both from the 1.5 million visitors each year who roam far and wide, as well as from the occurrence of frequent lightning storms that ignite an average of 36 fires each year in the parks (Figure 5- O1).

There are a number of ways to reduce fuel load and tree density, with varying ecological outcomes and dollar costs. Mechanical fuel reduction provides a direct and relatively safe way of achieving specific fuel and forest stand conditions. It has relatively high costs and, in many areas of the parks, is problematic as a tool due to constraints of steep slopes, roadless areas, and wilderness designation. Ecological outcomes of mechanical treatments may not be the equivalent of fire treatments and result in negative effects. Data from nearly 15 years of fire effects monitoring show that the conservative use of prescribed fire appears to achieve desired fuel reduction and adjustment in small tree density in mixed conifer forests (Keifer 2000). Prescribed fires also cost significantly less than mechanical treatments. The management of unplanned ignitions within their natural range of fuel and forest conditions acts to reduce and maintain conditions that minimize the risk of catastrophic fire. They have low to moderate cost primarily depending on remoteness.

Factors Used to Assess Environmental Consequences

Minimize the risk of large- scale high severity fire
Alternatives that reduce the probability of large high severity events occurring will be favored.

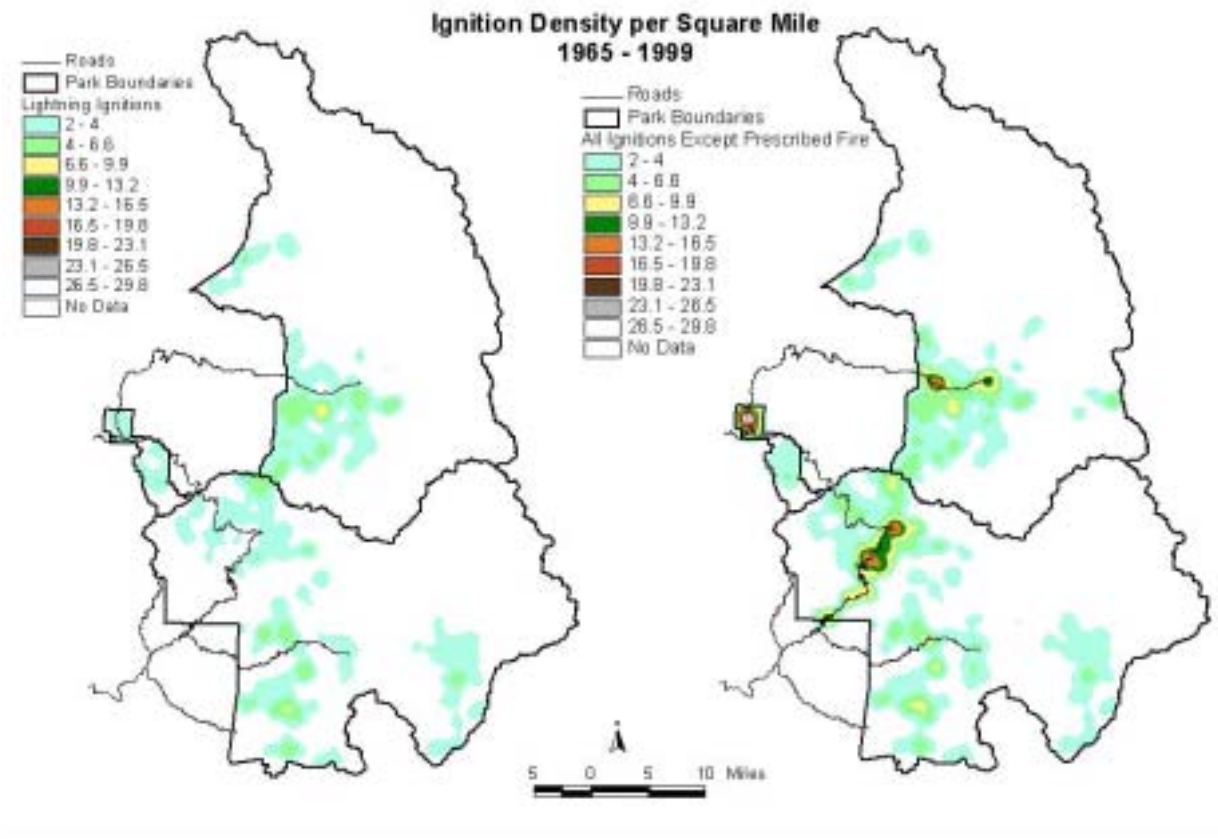
Impacts Common to all Alternatives

Protection of human life, including that of firefighters is the highest priority under all alternatives. All alternatives contain risk management actions such as fire prevention and fire education as a strategy for reducing unwanted human ignitions. All alternatives contain provisions for reducing risk around developments, though the alternatives vary in their level of accomplishments and their attention to the protection of natural resources from catastrophic events.

The extent to which alternatives reduce the risk factors related to fuel loads and small tree density is one measure of their effect in preventing catastrophic fires. All the alternatives reduce fuels and tree density to some degree, though the alternatives vary in the extent of parklands affected. The alternatives also vary in the mix of techniques used to accomplish the needed fuel

and density reduction – with some techniques (i.e. mechanical fuel reduction and prescribed fire) allowing more control and others (i.e. managing unplanned fires in heavy fuels) affording somewhat less control.

Figure 5-O1 – Density and location of unplanned fires
Map on left shows general density and location of lightning ignitions. Map on the right shows density and location of all unplanned fires.



Impacts Specific to Each Alternative

Alternative 1 – No Action (Current Program)

Continuation of the current program would provide a modest amount of protection from catastrophic fire in limited areas of the parks. High priority would be given to the protection of developments and boundary areas. Less emphasis would be placed on managing the risk of catastrophic fire for the benefit of natural or cultural resources. A full range of strategies would be used including mechanical fuel reduction, prescribed fire, wildland fire use, and wildland fire suppression.

Alternative 2 – Prescribed Fire

This alternative would reduce the threat of catastrophic fire across most of the susceptible parklands to a much greater degree than Alternative 1. The dominant use of prescribed fire along

with some limited mechanical fuel reduction around developments optimizes the controllability of fuel reduction and forest density operations, and minimizes the opportunity for random natural variables (wind, lightning, etc.) to affect outcomes.

Alternative 3 – Wildland Fire Use
Managing unplanned fires without first reducing fuels or density through more conservative means (mechanical fuel reduction or prescribed fire) may result in an increased risk of catastrophic fire events. Under this alternative, developments would receive some mechanical treatment to minimize risk of catastrophic events, but natural and cultural resources outside of these developed areas would remain at risk.

Alternative 4 – Multi- Strategy (Preferred Alternative)
The effects of this alternative would be similar to Alternative 1, though a much larger portion of the susceptible areas in the parks would be treated, further reducing risk. The alternative uses a mix of alternatives including mechanical fuel reduction in and around developments and along boundaries, conservative prescribed fires to restore natural fuel loads and tree densities, and wildland fire use in restored areas or other areas under conditions that minimize the threat of catastrophic events.

Conclusions

All alternatives reduce the risk of catastrophic fire to some extent and therefore reduce the risk of impairing park resources. Alternative 1 provides the least protection given modest accomplishments, while Alternatives 2, 3, and 4 treat more acres and are therefore more effective. Alternative 3 relies heavily on random unplanned fire events in unrestored forests, and therefore would have the highest risk of catastrophic fire effects in those areas. Alternative 4 reduces the threat of catastrophic fire across a large portion of the parks, and includes the use of less predictable unplanned ignitions – though only in areas where such events where expected to have beneficial effects considering pre- existing conditions (i.e. already restored or in maintenance). Alternative 2 treats a large amount of the parklands, and exercises the most control over fire events (reducing risk) while restoring fuel and tree density conditions.

Table 5-O2 – Comparison of "Risk of Catastrophic Events" Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Minimize the risk of large-scale high severity fire	0	++	-/+	+

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

- ++ effects are **highly desirable** compared to Alternative 1 (No Action)
- + effects are **desirable** compared to the effects of Alternative 1 (No Action)
- 0 effects are **equal** to the effects of Alternative 1 (No Action)
- - effects are **undesirable** compared to the effects of Alternative 1 (No Action)
- -- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

P. ENVIRONMENTAL JUSTICE

Executive order 12898 requires federal agencies to assess whether their actions have a disproportionately high and adverse human health or environmental effect on minority and low- income populations.

Factors Used to Assess Environmental Consequences

Disproportionate Effect
Do the actions result in disproportionate effect on minority or low- income populations.

Conclusion

None of the actions proposed in any of the alternative would result in disproportionate effect on minority or low- income populations.

Table 5-P1 – Comparison of Environmental Justice Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Dis-proportionate Effect	0	0	0	0

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

- ++ effects are **highly desirable** compared to Alternative 1 (No Action)
- + effects are **desirable** compared to the effects of Alternative 1 (No Action)
- 0 effects are **equal** to the effects of Alternative 1 (No Action)
- - effects are **undesirable** compared to the effects of Alternative 1 (No Action)
- -- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)

Q. INDIAN TRUST RESOURCES

Secretarial Order 3175 and ECM 95- 2 requires that agencies assess environmental impacts of proposed actions on Indian Trust Resources.

Factors Used to Assess Environmental Consequences

Would any actions proposed under the alternatives create impacts on Indian Trust Resources?

Conclusion

The parks do not contain Indian Trust Resources. Therefore proposed actions would not create impacts to such resources.

Table 5-Q1 – Comparison of Indian Trust Resource Effects

Assessment Factors	Alt 1 No Action (Current Program)	Alt 2 Prescribed Fire	Alt 3 Wildland Fire Use	Alt 4 Multi-Strategy (Preferred Alternative)
Impacts to Indian Trust Resources	0	0	0	0

Alternatives 2, 3, and 4 are rated in relation to Alternative 1, which is the baseline for comparison and is always zero (0). The scale for Alternatives 2, 3, and 4 is:

++ effects are **highly desirable** compared to Alternative 1 (No Action)
+ effects are **desirable** compared to the effects of Alternative 1 (No Action)
0 effects are **equal** to the effects of Alternative 1 (No Action)
- effects are **undesirable** compared to the effects of Alternative 1 (No Action)
-- effects are **highly undesirable** compared to the effects of Alternative 1 (No Action)