FIRE MANAGEMENT PLAN

SEQUOIA AND KINGS CANYON NATIONAL PARKS

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SEQUOIA AND KINGS CANYON

NATIONAL PARKS

Prepared by
Sequoia and Kings Canyon
National Parks
Western Region
National Park Service
Department of the Interior
February, 1979

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ABSTRACT

Natural fire is one of the most important environmental factors that influences natural ecosystems in Sequoia & Kings Canyon National Parks. Fire needs to be reintroduced to maintain and/or restore these ecosystems so they may operate unimpaired. This plan has been prepared to implement this goal.

The plan is in three major part; PART I is a description section that describes the Park's natural resources, fire management zones, units, and areas, and the role of fire in the Parks and the fire history; PART II describes the fire management program and; PART III is the operating plan for implementing the fire management program.

February, 1979

ACKNOWLEDGEMENTS

Many people have contributed to the completion of this plan. I acknowledge the efforts of Dave Parsons and Art Partin, and their staffs. I would particularly like to thank George Lester, Don Pitcher, Eileen Devine, Ginger King, Donna Elias, and Wayne Kino. This plan would not have been possible without their many hours in the field and in the office gathering and assimilating information for the plan.

Special thanks goes to Tom Warner, Forestry Technician, and Tom Nichols, Park Technician, for writing and final preparation of the plan. I am also indebted to the clerical personnel: Donna Ward and Tracy Nelson. Without Ms. Ward's perseverance and drive the plan would not have been completed.

The drawings which grace the cover and text were done by Mrs. Ward's daughter, Janene Ward.

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February, 1979

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> complexity of ecological communities and the diversity of management procedures required to preserve them . . . Reluctance to undertake biotic management can never lead to a realistic presentation of primitive America, much of which supported successional communities that were maintained by fires, floods, hurricanes, and other natural forces."

This report led to a change in National Park Service fire policy in 1968, which now considers natural fire as a natural factor that should be allowed to play its role in maintaining natural ecosystems. The policy (National Park Service, 1978),states that:

"The presence or absence of natural fires within a given ecosystem is recognized as a potent factor stimulating, retarding or eliminating various components of that ecosystem. Most natural fires are lightning-caused and are recognized as natural phenomena which must be permitted to continue to influence the ecosystem if truly natural areas are to be perpetuated.

Management Fires

Management fires, including both fires of natural origin and prescribed burns, are those fires which contribute to the attainment of the management objectives of a park through execution of predetermined prescriptions defined in detail in a portion of the approved Resources Management Plan.

Natural fire is the preferred means to achieve the prescriptions in natural zones. This use of natural ignition may be adopted when analysis of historic fire occurrence, control, and influence indicates that natural fuel loading has not been significantly altered by past management of fire control. It may also be used where the prescription provides for a transition from an altered state back to historic fuel loading.

In ecosystems modified by prolonged exclusion of fire, prescribed burning may be used to reduce fuel loading to natural levels, or to reduce fuels along boundaries of management zones and thereby reduce the probability of wildfires crossing into or out of the zone.

Prescribed burning may be used as a substitute for natural fire in the prescription for natural zones where it is determined that natural fire cannot meet the objectives. In natural zones, the objective for prescribed burning is to simulate, to the fullest extent, the influence of natural fire in the ecosystem. In other zones it may be used to recreate or perpetuate a historic setting or to attain other resources management objectives.

Clearly defined limits will be established in the presciption of all management fires, beyond which limited or complete control action will be undertaken.

Management fires in the Park will be suppressed which threaten:

- human life;
- cultural resources or physical facilities of the Parks;
- threatened or endangered species;
- to escape from predetermined zones or from the Parks, except where cooperative agreements provide for certain fires to cross such boundaries; or
- to exceed the prescription.

Wildfire Prevention and Control

All fires not classed as management fires are "wildfires" and will be suppressed.

An active fire prevention program will be conducted in the Parks and in conjunction with other agencies to protect human life, prevent modification of Park ecosystems by human-caused wildfire, and prevent damage to cultural resources or physical facilities.

Human-caused fires will be controlled to prevent damage and to eliminate unnatural impact of the Park ecosystems.

The fire suppression methods used in the Parks should be those causing the least resource damage, commensurate with effective control.

Cooperative agreements will be developed to facilitate reciprocal fire control activities within and adjacent to the Parks."

Within the framework of the above National Park Service fire management policy the overall goal of the fire management program at Sequoia and Kings Canyon National Parks is to:

<u>Restore fire to its natural role to the maximum extent possible so that the natural ecosystems can operate essentially unimpaired by human interference</u>.

The question of whether to suppress human-caused fires was considered. Human-caused fires are not part of the natural environment, and allowing them to burn in a natural area would be inconsistent with the above goal. However, many human-caused fires have little potential for spread, may occur under a favorable prescription in areas programed to be prescribed burned and would be effective in reducing unnatural fuel loading. Monetary savings would occur if low potential human-caused fires in prescription were not suppressed. This plan provides the option on an experimental basis in 1980 to allow selected human-caused fires to burn (see section VI). This will be reviewed at the end of the 1980 season for possible incorporation as part of the 1981 plan, or as a continued experiment in 1981. The situation did not arise in 1979.

The goal of the fire management program will be accomplished by:

1. Allowing natural and some human-caused fires to burn in predetermined areas within prescription, provided they meet approved resources management objectives.

2. Suppressing all fires that threaten human life, property, or to leave the Parks.

3. Expanding the prescribed burning program to all ecosystems, especially into the Sequoia groves, where fire exclusion has created unnatural fuel loading.

4. Maintaining an active fire prevention program to reduce the incidence of human-caused wildfires.

5. Taking special precautions to preserve historical/cultural resources and threatened/endangered species.

Fire management in Sequoia and Kings Canyon National Parks is the integration of presuppression, suppression, prescribed fire, prevention, and fire ecology knowledge to achieve approved resource management objectives.

The Fire Management Plan is guided by the authorizing legislation that established Sequoia and Kings Canyon National Parks, the General Management Plan, the Wilderness Plan, the Natural Resources Management Plan, and NPS-18, Fire Management Guidelines. The purposes of the plan are to:

1. Provide overall fire management program direction.

2. Review the role of fire.

3. Designate and describe fire management zones, units, and areas.

4. Integrate fire as a natural force into the Parks where applicable.

5. Delineate fire management prescriptions and strategies.

6. Establish an expanded prescribed burning program.

7. Outline procedures in event of wildfire.

8. Establish an integrated fire management organization.

9. Assign fire management responsibilities.

A fire management task force was assembled to review the total fire management program and develop an integrated fire management plan for Sequoia and Kings Canyon National Parks. A planning team determined the historic role of fire and its relationship to vegetation, fuel loadings, and fire prescriptions.

II. GENERAL DESCRIPTION OF THE AREA

A. Location

Sequoia and Kings Canyon National Parks (Figure 1) are located in the southern Sierra Nevada Mountains of California. The 862,429 acres comprising the two Parks contain the largest and finest sequoia groves in existence, vast high country wilderness, hundreds of glacial lakes, deep glacier-cut valleys, the highest mountains in the continental United States, virgin oak, fir and montane and subalpine pine forests, numerous subalpine and alpine meadows, low elevation chaparral, wildlife, and a number of caves. The Parks lie just east of California's great Central Valley of the San Joaquin.

The area encompassed by these two Parks, because of its topography, was largely isolated from early activities of European man in California and his settlement of the region did not begin until the late 1850's. Indians had inhabited the area for a long time, and evidences of their occupation are plentiful, particularly at the lower elevations.

Much of the area of the two Parks is inaccessible except on foot or horseback. Most of this area is high elevation backcountry which is managed as wilderness.

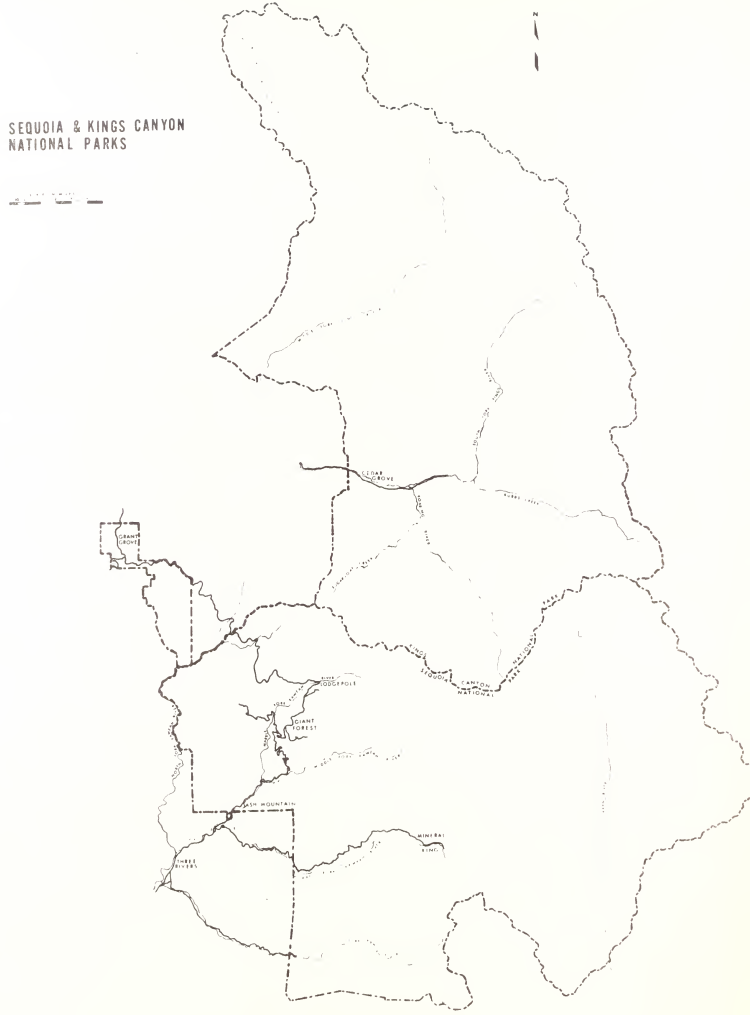
B. Topography

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

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

The land surface of the Parks has been deeply eroded by stream and glacial action. The south fork of the San Joaquin River and the middle and south forks of the Kings River constitute the major hydrological drainages of Kings Canyon National Park. The canyons of the two forks of the Kings River are two of the deepest in the United States. All five tributaries of the Kaweah River - North, South, East, Middle and Marble Forks - originate in and drain the western portion of Sequoia National Park. The Kern River drains the southeastern portion of the Park. Originating along the Great Western and Kings-Kern Divides, the Kern flows south rather than

Fig. 1


SEQUOIA & KINGS CANYON
NATIONAL PARKS
N
CEDAR GROVE
GRANT GROVE
LODGEPOLE
GIANT FOREST
ASH MOUNTAIN
MINERAL KING
THREE RIVERS
KINGS CANYON NATIONAL PARK
SEQUOIA NATIONAL PARK

following the westerly flow of other major rivers of the Sierra Nevada.

Hundreds of alpine lakes are found throughout the higher portions of the two Parks. Most are not deep, as they occupy the shallow rock basins formed by glacial action.

Numerous streams drain from high elevation lakes and springs into the larger river canyons.

C. Geology

The fundamental basis of the great tilted block which created the Sierra Nevada is igneous rock; granite in various forms and textures. Massive domes such as Moro Rock and Tehipite Dome are common, as well as perpendicular cliffs, exfoliated slabs, broken talus, rectangular blocks, and huge boulders. Metamorphic rocks such as marble, schist, and quartzite are found throughout most of the Parks.

Glacial action has extensively shaped the terrain of the Parks. Several large canyons, all exhibiting the typical U-shaped valley trend westward from the Sierra Crest. Glaciers of every size dot the higher elevations and have created the numerous lake basins characteristic of this region. Moraines outline the courses of the ancient glaciers and mark the extent of ice flows in the deep canyons.

D. Soils

The soils of Sequoia and Kings Canyon National Parks are primarily granitic in origin. Depths vary from several feet in limited low elevation areas on the western slope, to a very thin or nonexistent soil mantle at higher elevations. While no definitive soils map has been made for the Parks, Storie (1953) has classified the soils of this general area as upland residuals. That is, they have formed in place by the disintegration and decomposition of the underlying parent rock. This upland category is further divided into two groups which are applicable to these Parks. "Rolling, hilly-to-steep upland having acid residual soils of good depth to bedrock" are common to much of the timbered portion of the Parks. These podzolic soils are characterized by depths of three to six feet to bedrock and a moderate to strongly acid reaction. "Residual soils of very shallow depth to bedrock" are found throughout most of the remainder of the Parks, especially at the higher elevations.

E. Climate

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

The average annual temperature at Ash Mountain Headquarters (elevation 1,700+ ft) is 63 F, with extremes of 114 F and 22 F having been recorded. Extremes of 91 F and 0 F have been recorded at Giant Forest (elevation 6,409 ft) where cool daytime and evening temperatures prevail during the summer and cold nights and moderate to relatively warm days are common during the winter.

At elevations above 7,000 ft daytime temperatures vary widely. These areas are buried in heavy snows and experience below freezing temperatures during most of the winter.

The average annual precipitation in the lower elevation foothills is 26 inches. Higher elevations receive an average annual precipitation of around 44 inches (at Lodgepole). During the summer and early fall, thunderstorms are common above 7,000 ft and release little precipitation. Their associate lightning and erratic winds cause many fires. Most winter precipitation above 5,000 ft occurs in the form of snow.

Mean snow depths at 6,400 ft average 40 inches with a water content of 17 inches. Snow infrequently falls at the lower elevations in small amounts; it usually melts within a few days.

The prevailing wind is from the west to southwest. Strong winds are rare; however, orographic updrafts and down drafts can be both erratic and intense. Canyon winds generally follow the daily pattern of blowing up canyon during the day and down canyon during the night.

F. Vegetation

Continuously varying climate, soils, and physiography, together with an elevational gradient of from 1,500 to over 14,000 ft support a rich variety of plant communities. For descriptive purposes these ecosystems are categorized primarily on the basis of dominant vegetation and elevation limits which they normally encompass. In actuality, a complicated melange of interrelated and interdependent ecosystems, primarily due to microenvironmental conditions, gives this region of the Sierra Nevada a unique diversity. The major vegetation types (alpine/subalpine, red fir, sequoia-mixed-conifer, and chaparral/oak-woodland) will be discussed in the fire management zone descriptions.

G. Wildlife

The various plant communities of the Parks support a rich diversity of wildlife species as both year-round residents and migratory visitors.

In all, the Parks list 73 species of mammals, 194 species of birds, 22 species of reptiles, and 10 species of amphibians as occurring within their boundaries. Rather than confining themselves to a single ecosystem, most species range between several of the habitats described. Far-ranging ungulates and predators such as the mule deer, black bear, mountain lion, red-tailed hawk, golden eagle, coyote, the rare wolverine, and fisher occur within its boundaries. The Sierra Nevada bighorn sheep, a summer resident of the alpine and subalpine ecosystems which winters outside the Park, is now estimated at something over 225 individuals.

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

H. Endangered and Threatened Species

To date, no comprehensive survey of proposed endangered, threatened or rare plant species has been conducted in these Parks. The California Native Plant Society has, however, compiled and mapped all known collections of proposed endangered and threatened plants statewide. As of 1979, none of these species has yet been officially classified by Congress.

It must be emphasized that these Parks have not been thoroughly sampled and, consequently, the available summary of known rare plant populations may not be indicative of the actual conditions throughout Sequoia and Kings Canyon National Parks. Additional field surveys of the status and habitat condition of each of the listed species and what role fire plays in the ecology of each should be a high Park priority.

The Little Kern golden trout (Salmo aquabonito whiteii) which occurs within a limited area of the Little Kern River drainage in Sequoia National Park has been recently classified as threatened. The California condor (Gymogyps californianus), which has been sighted on rare occasions within the southern portions of Sequoia National Park, has been classified as endangered. The Sierra Nevada bighorn sheep (Ovis canadensis californiana) is the only animal species found in the Parks to have been considered for classification but no action has been taken.

I. Cultural Environment

From approximately 300 A.D. until the arrival of European man, the Sequoia and Kings Canyon region was used primarily as a trade route by the Western Mono, Yokuts, Owen's Valley Paiute, and their predecessors. Most campsites were temporary stopping places rather than permanent dwellings. This type of settlement pattern also was related to seasonal exploitation of various food resources.

A two-week superficial survey of the area was conducted in August, 1959, by A.B. Elsasser. The types of sites identified include village sites, campsites, trail sites, workshops, and bedrock mortars. The villages and campsites appear to have been situated mainly along trade routes. In 1952, the records of several sites in the vicinity of Zumwalt Meadow were submitted to the University of California Archeological Survey by W.S. Evans, Jr. In 1957, D.W. Lathrap recorded a series of sites along the John Muir Trail. In 1960, J.T. Davis surveyed Paradise Valley and excavated a previously recorded site at Cedar Grove. Also in 1960, Jay von Werlhof conducted archeological investigations at Hospital Rock and surveyed a number of aboriginal trails in the Kaweah Basin. In the following year, he supervised test excavations at Potwisha Camp, Hospital Rock and Buckeye Flat.

The arrival of Hale Tharp in 1858 signaled the beginning of extensive European use in the Sequoia-Kings region. Indian peoples were rapidly displaced. Early use centered around utilization of lush mountain meadows as summer range for cattle and sheep and exploitation of the commercial value of the Big Trees. Sites of past logging activities such as Atwell Mill and Big Stump Historic District are being nominated to the National Register of Historic Places. Structures associated with grazing activities are common. In addition to these commemorated sites and structures, the deeply eroded "trail" trenches which course through many mountain meadows, the decayed and rusting drift fences scattered throughout the Parks, and a life-time grazing lease -- granted for the Sugarloaf Meadow area before it became part of Kings Canyon National Park -- attest to the extent of past grazing practices. Even today, limited cattle trespass occurs in Sequoia National Park.

III. NATURAL AND HISTORICAL ROLE OF FIRE

A. Natural Role of Fire

The various plant communities of the Sierra Nevada have evolved in the presence of fire for thousands of years. The type of fire ranged from the fast, high intensity fire of the chapparal to the frequent low, maintenance fire of the subalpine communities. The adaptations to fire can be seen at the species, community, and ecosystem levels.

Strategies employed by individual species not only compensate for fire but also use it for their perpetuation. Serotinous cones and hard seed coats cracked by heat ensure that reproduction will occur when chances for survival are greatest as a result of postfire decreased competition and an increased nutrient supply from the ash. Fire adapted species often show early rapid growth and maturity, and many species of chaparral and oak resprout from rootcrowns. Some characteristics may even encourage fire occurrence (Mutch,1970).

The natural role of fire on the community level is basically the same as that on the species level. Fire acts as a rejuvenator by freeing and recycling nutrients locked in down woody fuel and senescent vegetation. As fuel levels accumulate, the probability of a fire increase; frequent fire does not allow enough fuel to accumulate to cause intense fires capable of causing type conversion or large scale replacement of species, except in a successional cycle.

As nutrients are released to the postfire community and the successional stage is set back, the number of species increases along with productivity. This increase in the number of pathways, or diversity, through which energy can travel throughout the system causes increased stability of the community. As time since the last fire increases, diversity decreases, physical deterioration sets in, fuel accumulates, and a fire with sufficient intensity may more easily cause destabilization to the point of collapse and replacement of the community.

This destabilization occurs because each community type has evolved in the presence of a specific type of fire. Chaparral fires are crown fires, while crown fires were rare or absent from Sierra sequoia-mixed-conifer forests prior to white settlement (Show and Kotok, 1924; Kilgore and Taylor, 1979). The removal of fire from the latter type has made crown fire quite possible (Kilgore and Sando, 1975).

The communities and the different-aged burns which they contain come together to form a mosaic of successional stages in the ecosystem. Ungulates find nutritious browse in recent burns but cover in older burns. Recent burns act as boundaries for fires occurring in older burns. The characteristics of species, community, and ecosystem combine to ensure that rarely, if ever, will a fire occur that causes destabilization of the entire complex.

B. Historical Role of Fire

Man has influenced the role of fire in basically three ways. In the first instance, Indians augmented the frequency of fire, perhaps beginning 20,000 years ago. The impact of fire as a result of lightning had resulted in the primary adaptations of species to fire; Indian burning may have enabled fire adapted species to increase their range (Agee, 1974). Kilgore and Taylor (1979) report that fire scars in the sequoia-mixed-conifer type are too numerous to be explained by lightning activity alone; moreover, a significant decrease in the fire scar record coincides with the removal of the Indian community from the area.

The main purpose of this aboriginal burning was to favor the growth of certain species, such as browse for game and food producing plants such as oaks. An increase in visibility for hunting was another advantage (Vankat, 1977). Vegetational patterns were influenced by this burning, although probably on a local basis determined by proximity to camping and hunting areas.

The second instance occurred as the Indians were replaced by white pioneers. In some respects, Indian burning was continued by sheepmen who burned range-land in the fall to bring up browse for the spring. Overgrazing probably had a more detrimental impact than did this burning. The method of firing may have differed from that employed by Indians, since sheepmen fires have been portrayed usually as deleterious, running fires of excessive intensity (Muir, 1877).

Throughout the United States, logging had become a major industry, and also a major source of dangerous levels of fuel. Slash and logging debris formed continuous, vast beds of heavy fuels which when ignited resulted in such infamous fires as the 1871 Peshtigo fire in Wisconsin, the 1881 Michigan fire, and the 1910 Great Idaho. Such fires as these, along with the wasteful practices which contributed to them, helped give rise to a conservation movement near the turn of the century which included protection from fire. Although fire was known to have played a natural role in shaping the forest, it was viewed as a force of attrition which kept the forest from attaining its full level of productivity (Show and Kotok, 1924, 1925).

The effect of protection from fire was basically a self-fulfilling prophecy. Without the cyclic removal of fuel by fire, in the mid elevation forests fuels accumulated to a point where the community was threatened by a higher intensity fire than that to which it was adapted. Moreover, the removal of fire resulted in a different set of environmental conditions which began to shape the composition of the forest. The density of species that are inhibited by frequent fire, such as white fir, increased dramatically.

As a result, a new fuel-vegetation complex has evolved in the Parks, one that fire can damage or destroy because it played such a minor role in its creation. The 1955 McGee fire in mixed-conifer and the 1960 Tunnel Rock fire in chaparral/oak-woodland demonstrated the dangerous fuel condition that had resulted from fire suppression. The 1963 Leopold Report (Leopold et al., 1963) pointed out the importance of fire in shaping habitat. In 1967, the National Park Service shifted its fire policy away from fire suppression to fire management, the third type of interaction between man, fire, and the fuel-vegetation complex.

IV. THE FIRE ENVIRONMENT

A. Fire Weather

1. Fire Season

Sequoia and Kings Canyon National Parks receive most of their precipitation, depending on elevation, almost entirely from winter cold front passages from the northwest and west. Occasionally tropical storms from the Gulf of Mexico also can drop four to six inches of rain in a few days.

As the snows melt, fuels can be considered to be saturated. As late as June, 1000 hour timelag fuels have > 25% moisture content, drying steadily until a low of about seven percent is reached in late July or early August in the drier areas, such as Cedar Grove, followed by a slow climb until the winter precipitation begins.

Fire season runs from about June 15 to October 15, with an average of 70 to 80 fires of all origins occurring during this period. July, August, and September have the highest fire incidence (Figure 2). Weather tends to be clear with daytime temperatures ranging about 70 to 80 F at 5,000 ft and 80 to 100 F at 1,000 ft. Prevailing winds are about five miles per hour from the west and southwest. Virtually no precipitation occurs during this period.

The central valley of California is subject to extreme heating during the summer; temperatures are routinely 90 to 110 F. The marine air which flows into it is heated and raised subsequently by the steep rise of the Sierra to the east. As a result, afternoon thunderheads are common above 7,000 ft; however, lightning activity levels as measured by the 1978 National Fire Danger Rating System (NFDRS) (Deeming et al., 1977) show that most days have little or no lightning occurrence (Table 1). Periods of high lightning activity often last three to four days, possibly igniting ten to twenty or more fires in the 4,000 to 7,000 ft elevations of the Parks.

2. Wind

The topography of the Parks results in a variety of local wind types. The diurnal relationship between heating and cooling of slopes and canyons results in local winds which can become significant to fire behavior. Narrow canyons, such as Cedar Grove, typically produce summer afternoon up-canyon winds of 10 to 20 mph.

These winds serve to further dry both live and dead fuels, at the time of day when temperatures are highest and humidities lowest. Potentially explosive conditions can result, as demonstrated by the 1976 Sphinx Fire in which several hundred acres of brush and timber blew up in the early afternoon of June 29.

Fig. 2 Total Fires in Sequoia-Kings Canyon National Parks by Month from 1922 through 1979.

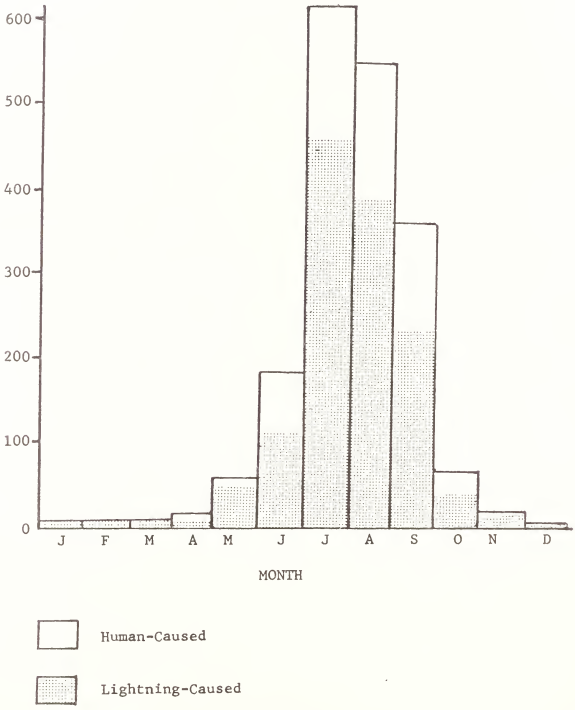


Table 1 -- Lightning Activity Levels (LAL)

Location	Elevation (ft)	LAL 1 (%)	LAL 2 (%)	TOTAL (%)	LAL > 2 (DAYS)
Ash Mt. (1973 to 77)	1,700	43 to 72	15 to 48	84 to 92	12-19
Cedar Grove (1977)	4,600	69	21	90	15
Grant Grove (1977)	6,700	92	5	97	3
Park Ridge (1974 to 77)	7,200	50 to 82	9 to 21	88 to 93	8-17

* LAL 1 -- No thunderstorms

**LAL 2 -- Cumulus common, few towering cumulus, lightning very infrequent

Thunderstorms can produce strong, erratic downdraft winds which follow topographic features and cause rapid spread of fire. Another source of strong wind is the rare foehn-like mono wind of late summer and early fall. These gale force east winds are warm and dry, originating from the Great Basin high. More often, a high settles over the western United States and produces good visibility, high temperatures, low humidities, and atmospheric instability with turbulent and gusty winds.

The atmosphere tends to be more unstable during the spring than the fall. The San Joaquin Valley develops an inversion during the fall, and agricultural "no burn" days below 3,000 ft are common. As the atmosphere over the Park becomes more stable, the probability that smoke will obscure a popular vista becomes more likely.

3. Drought

In addition to the dry season which runs normally from late spring to late fall, periodic droughts occur in the Sierra. Brown and Davis (1959) state that it is not uncommon to have a ten-year period show three critical fire years, spaced at irregular intervals.

The longer the drying period, which in a drought year will include an usually dry winter, the greater the amount of available fuel for a fire. Deep duff down to mineral soil and logs are readily combustable and fuels such as punky logs are more susceptible to ignition through spotting. The 1976 to 77 drought years probably enabled the 1977 Ferguson Fire to spread to an estimated 10,000 acres, the largest prescribed natural fire in the Park's history.

Dry years may have impact which is not fully understood on the vegetation of the Parks, such as the relationship between drought and bark beetle activity. The increase in the density of the mixed-conifer forest as a result of fire suppression (Gibbens and Heady, 1964; Kilgore and Taylor, 1979; Nichols, 1976; Weaver, 1974; Vankat, 1977) can only make the effects of a drought and the resultant intense competition for moisture, more acute.

B. Fire History

Thunderstorms account for an average 40 fires each year. Most of these occur in the mixed-conifer type (Tables 3 and 4), and of the known 1,445 lightning fires which have occured in Seqouia and Kings Canyon National Parks from 1922 through 1979, 95% have been under ten acres in size (Table 5). Fire suppression has contributed to the preponderance of small fires however, since the inception of the natural fire program in 1968, 87% of the 169 fires occurring in the natural fire management zone have been less than ten acres. Most of these fires remained small because of low fuel loadings and natural barriers. Similar patterns in size class of fires can be seen in the fire histories of other vegetation types.

Table 3 -- Estimated Total Acres Burned by Vegetation Type from 1922 through 1979.

Vegetation Type	Acres	Percent of Total
Chaparral Oak-woodland	14,138.5	28.4
Mixed-Conifer	28,155.6	56.6
Sequoia	101.6	.2
Red Fir	5,076.6	10.2
Subalpine-Alpine	2,264.9	4.6
Total	49,737.2	100.0

Table 4 -- Estimated Number of Mixed-Conifer Fires by Size Class 1922 through 1979.

Size Class (Acres)	Lightning *Prescribed Nat. Fire	Lightning Suppressed	Human-Caused	Total	Percent of Total
A (≤ .25)	22	311	228	561	74.8
B (.26 to 9.9)	1	128	25	154	20.5
C (10 to 99)	0	16	4	20	2.7
D (100 to 299)	2	1	2	5	.7
E (300 to 999)	2	1	2	5	.7
F (1,000 to 4,999)	2	0	0	2	.3
G (5,000+)	1	0	1	2	.3
Total	30	457	262	711	100.0

*1968 to 1979 only
Lightning-caused -- 65%
Human-caused -- 35%

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

Human-caused fires may occur almost anywhere and at any time. Most are concentrated around roads, campgrounds, and trails. Many are the result of accidents such as carelessness with cigarettes or unattended campsites, whereas a few, such as the 1978 70-acre Potwisha fire, are arson. Since 1922, 29% of the fires in the Parks have been human-caused, mostly in mixed-conifer (Table 5).

C. Management Fire History

The management fire program consists of allowing natural fires in certain zones and prescribed burning.

1. Prescribed Natural Fire

The natural fire program began in 1968. The high elevation lodgepole pine and subalpine forest communities generally above 8,000 ft are characterized by long-lived, widely spaced, and relatively short statured trees (Rundel et al., 1977). These forests are thought to have evolved with infrequent low intensity ground fires (Vankat, 1970). Since temperatures remain low and the growing season is short, the years since fire suppression became effective have not yet resulted in excessive fuel accumulations in these areas (Parsons, 1977). For this reason, most of these higher elevation forest communities were included in a natural fire management zone.

In the eleven years since the natural fire program began, 169 fires have burned an estimated 20,582 acres (Table 6). Seventy-five percent of the fires have remained under 0.25 acres in size, whereas eight have been over 300 acres (Tables 6 and 7). Most of these fires have occurred in red fir (Figure 3).

The largest, the Ferguson Fire, burned an estimated 10,000 acres. It started on June 26, 1977, and burned for over four and one-half months, finally being extinguished by snow in November. The fires are generally slow burning, low intensity, ground fires, which occasionally torch out the tree canopy.

2. Prescribed Burning

The middle elevation mixed-conifer forest zone was the area for which concern was first expressed about the impact of the Parks' fire suppression policy. The buildup of flammable ground

Table 5 -- Total Fires by Size Class, Cause, and Acres Burned from 1922 through 1979.

Size Class (acres)	Number of Fires					Size of Fires (Acres)			
	Wildfires		Mgmt. Fires			Wildfires	Mgmt. Fires		
	Lightning	Human-Caused	Prescribed Natural Fires*	Total	Percent of Total	Lightning/Human-Caused	Prescribed Natural	Total	Percent of Total
A ≤ .25	934	484	127	1545	75.7	112.8	7.6	120.4	.2
B .26 to 9.90	303	78	20	401	19.6	643.8	62.1	705.9	1.4
C 10 to 99	31	19	10	60	2.9	1576.3	309.0	1885.3	3.8
D 100 to 299	3	7	4	14	.7	1585.6	705.0	2290.6	4.6
E 300 to 999	3	5	4	12	.6	3487.0	2192.0	5679.0	11.5
F 1000 to 4999	2	3	3	8	.4	12250.0	7306.0	19556.0	39.3
G 5000	0	1	1	2	.1	9500.0	10000.0	19500.0	39.2
Totals	1276	597	169	2042	100.0	29155.5	20581.7	49737.2	100.0

*1968 through 1979 only
Lightning fires 1445 (71%)
Human-caused 597 (29%)

Table 6 -- Number of Prescribed Natural Fires in Sequoia and Kings Canyon National Parks from 1968 through 1979.

Size Class (acres)	Year													
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Total	Percent of Total
A 0 to .25	1	1	20	22	12	6	15	4	14	3	17	12	127	75.1
B .26 to 9.9	1	0	1	2	2	2	0	1	5	2	4	0	20	11.8
C 10.9 to 99.0	0	0	2	0	1	0	2	2	1	2	0	0	10	5.9
D 100 to 299	0	0	0	1	1	0	1	0	0	0	0	1	4	2.4
E +300+	0	0	1	0	0	3	1	0	0	2	0	1	8	4.8
Total Acres	8.0	.25	494.5	148.9	151.9	4823.5	3311.4	58.2	77.6	10650.9	5.1	851.4	20581.7	100.0
Total # Fires	2	1	24	25	16	11	19	7	20	9	21	14	169	

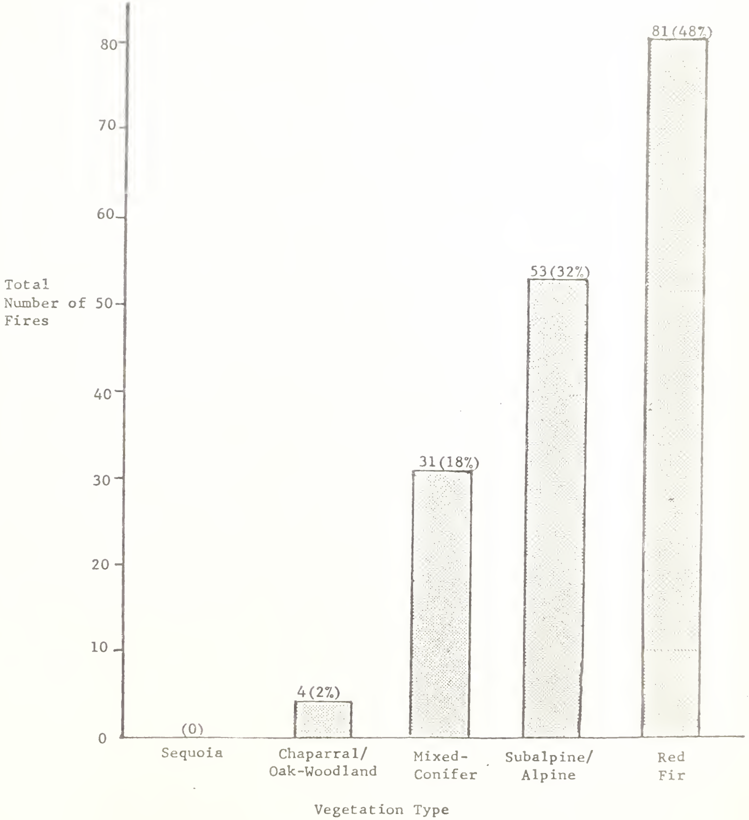
Bubbs Creek - 452 acres (1970)
South Sentinel - 2,486 acres (1973)
Moraine Creek - 1,760 acres (1973)
Chagoopa - 525 acres (1973)
Comanche - 3,060 acres (1974

Ferguson - 10,000 acres (1977)
Sugarloaf - 600 acres (1977)
Sentinel - 565 acres (1979)
Kennedy - 285 acres (1979)

Table 7 -- Size of Prescribed Natural Fires in Sequoia and Kings Canyon National Parks from 1968 through 1979.

Size Class (acres)	Year													
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	Total	Percent of Total
A 0 to .25	-	.25	.5	.4	.4	1.5	1.4	.2	.8	.1	.6	1.4	7.6	.1
B .26 to 9.9	8.0	-	3.0	8.5	1.5	1.0	-	8.0	26.8	.8	4.5	-	62.1	.3
C 10.0 to 99.0	-	-	39.0	-	30.0	-	90.0	50.0	50.0	50.0	-	-	309.0	1.5
D 100 to 299	-	-	-	140.0	120.0	-	160.0	-	-	-	-	285.0	705.0	3.4
E +300+	-	-	452.0	-	-	4821.0	3060.0	-	-	10,600.0	-	565.0	19,498.0	94.7
Total Acres	8.0	.25	494.5	148.9	151.9	4823.5	3311.4	58.2	77.6	10,650.9	5.1	851.4	20,581.7	100.0
Total # Fires	2	1	24	25	16	11	19	7	20	9	21	14	169	

Fig. 3 Prescribed Natural Fires by Vegetation Type from 1968 through 1979.



fuels, the increase of white fir, the lack of giant sequoia reproduction, and the threat of wildfire to the sequoia groves all indicated the need to reintroduce fire into this zone by prescribed burning.

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

The experimental research program continued in 1968 when about 1,100 acres in a red fir forest were prescribed burned to study the ecological impact of prescribed fire on fir thickets (Kilgore, 1971). Kilgore found that fire reduced the litter, duff, and humus by about 50% and killed many red fir seedlings and saplings. No adverse changes in deer, bird numbers, or water quality were observed.

The program reached management scale in 1969, when about 6,640 acres of fuel breaks were burned in oak woodland, chaparral, ponderosa pine and white fir mixed-conifer fuel types in Sequoia National Park. A prescribed burning program began in 1972, in the Redwood Mountain sequoia grove. Prescriptions and techniques were tested with the long range objective of expanding the prescribed burning program to all sequoia groves in the Park. A total of 12 burns (1,707 acres) has been conducted at Redwood Mountain since the program began in 1972 through 1978. Since the first experimental research burn in 1968 through 1978, an estimated 67 prescribed burns (16,542 acres) (Table 8) have occurred.

D. Fuels

Fire in the Sierra Nevada plays an important role in determining the structure of the various vegetation types. Each vegetation type has evolved in the presence of a distinct fire type, ranging from the intense chaparral fire to the low ground fire of pine and sequoia to the more extensive fires occurring in drought years and in areas normally too wet to burn except during drought.

Fuels, and the effects on the vegetation resulting from the energy liberated when they burn, can be divided into dead fuel and live fuel. The former can be further divided into two broad catagories; the fine fuels (< 1/2 inch diameter) and heavy fuels (> 3 inch diameter).

Table 8 -- Estimated Number and Acres Prescribed Burned in Sequoia and Kings Canyon National Parks from 1968 through 1979.

Year	Number of Burns	Acres Burned
1968	1	800
1969	3	6,340
1970	2	1,300
1971	2	108
1972	6	2,369
1973	0	0
1974	2	334
1975	1	33
1976	10	272
1977	14	737
1978	5	376
1979	21	3,873
Total	67	16,542

Fine fuels contribute mainly to fire spread; the energy released can be quantified by the fireline intensity (BTU/sec/ft) discussed by Byram (1959).

As the rate of spread increases, more heavy fuels may be ignited per unit time; their more localized energy can be expressed as reaction intensity (BTU/sec/ft^2), and produces the more noticeable fire effects such as mortality, scorch, and char.

The fires occurring in down woody fuel are generally surface fires. The conduction of fire into the crown of the forest is partly a function of the density of understory vegetation and ladder fuels. In the sequoia mixed-conifer and ponderosa pine types, fire acts as a thinning agent (Cooper, 1961); in its absence, undergrowth of shade tolerant species results in a continuous ladder of all-aged crowns from surface to over-story. Crown fires, once virtually nonexistent in Sierra forests, are now possible (Kilgore and Sando, 1975; Kilgore and Taylor, 1979).

Dead fuel loads in the various vegetation types in the Parks vary according to burn history, elevation, growth pattern, aspect, and length of growing season. Table 9 shows the general fuel loading range of vegetation types.

Table 9 -- Fuel Loading by Vegetation Type

Vegetation Type	Tons/Acre
Alpine/Subalpine	0–10
Red Fir	35–60
Mixed-Conifer	30–50
Sequoia	50–70
Chaparral/Oak-Woodland	10–25

These values may approximate equilibrium fuel loads, due to the efficiency of fire suppression measures, at least in all but the higher and more remote vegetation types. Accretion rates for mixed conifer species are about two tons/acre each year (Agee *et al.*, 1978). Higher elevation forests have shorter growing seasons and therefore slower rates of fuel production.

Little is known of the fire frequency of the high elevation types such as red fir and lodgepole pine, although the paucity of fire scars and frequent stands of even-aged trees indicate an interval of more than 100 years between large fires. In the mid-elevation sequoia-mixed-conifer forest, Kilgore and Taylor (1979) state that fire burned through a given site every eight to 18 years. In the low elevation chaparral, fire burned at least every 20 to 30 years (Parsons, 1976); chaparral reaches decadence in 60 years (Hanes, 1971).

Years of fire suppression have effectively removed the mosaic of various aged burns in mixed-conifer and chaparral/oak-woodland and have encouraged more extensive burns than occurred naturally. The fire cycle, fuel load, and vegetation type are closely interrelated, and each fire type serves to stabilize and perpetuate a given community. Conditions produced from fire suppression have given rise to new fuel-vegetation complexes which influence fire type, which in turn affects the complex.

Fuel models (Deeming et al., 1977) represented in the Parks include: "A" (annual grass), "B" (mixed-chaparral), "C" (open pine stands), "F" (open mixed-chaparral), "G" (dense conifer and heavy fuel loads), "H" (short-needled conifers), and "U" (long-needled conifers).

V. FIRE MANAGEMENT ZONES/UNITS/AREAS

A. Location

The parks were divided into three fire management zones, which are areas of land where similar fire management prescriptions and strategies are observed. (Table 11 and Figure 4). The vegetation types occurring in each zone are listed in Table 12. The zones were determined primarily on the basis of vegetation, fire history, fuel, role of fire, and the presence or absence of natural or human-created barriers. Accessibility, smoke dispersal, probability of multiple fires, and visitor-use were other considerations.

Fire management zone I was divided into two fire management units, the natural unit (1A), and the conditional unit (1B). The natural fire management unit typically has sparse, scattered fuels and natural barriers to fire spread. The conditional unit contains areas that are potentially the next inclusions into unit (1A) but due to heavier fuel loads must be treated more conservatively at present. Prescribed burning will be used in zones II and III to meet management objectives. At this time natural fires are restricted or not allowed because of heavy fuels, potential control problems, and visitor safety.

Fire management zone II and unit (1B) (hereafter zone II/1B) were combined for fire management purposes since zone II and unit (1B) prescriptions are very similar. Zone II/1B and fire management zone III were further subdivided into 31 fire management areas (Figure 4a). The 31 areas were determined by fuel type, elevation, barriers, and preattack needs. From these fire management areas, 199 prescribed burn units were derived. These are the basic units for managing and containing prescribed natural fires, prescribed burns, and wildfires in zones II/1B and zone III. The hierarchy of these zones, units, areas, and objectives for fire in each is shown in Figure 4b.

B. Vegetation Types

Based on vegetation maps prepared by Hammon, Jensen, and Wallen (1971) and Natural Resources Management corporation (1974), five vegetation types (Figure 5) were delineated. Each will be discussed in detail under the fire management zone descriptions, along with several cover types.

1. Alpine/Subalpine

The high altitude backcountry of granite peaks and glaciated valleys characterizes the alpine community which comprises about one fifth of the Parks and is very fragile. The lodgepole subalpine community lies from about 8,000 ft to timberline. Common species include lodgepole (_Pinus Murrayana_), white [illegible] (_P. albicaulis_), foxtail (_P. balouriana_), limber (_P. flex_[illegible] pines and juniper (_Juniperus occidentalis_). Common assoc[illegible] include pinemat manzanita (_Arctostaphylos nevadensis_) and [illegible] cherry (_Prunus emarginata_).

Table 11. -- Fire Management Zones/Units in Sequoia & Kings Canyon National Parks.

Fire Management Zone/Units	Estimated Acreage	Total For Fire Management Zone	Percent In Each Zone
I. Fire Mgmt. Zone I Alpine/Subalpine/ Upper Mixed-Conifer)			
1. Fire Mgmt. Units			
a.* Natural Fire Mgmt. Unit (1A) + 1979 Additions	681,009		
b. Conditional Fire Mgmt. Unit (1B)	46,299	727,308	84
II. Fire Mgmt. Zone II (Sequoia-Mixed-Conifer)			
1. *Mixed-Conifer	73,066		
2. *Sequoia	8,274	81,340	9
III. Fire Mgmt. Zone III (Chaparral/Oak Woodland)	53,781	53,781	7
Total	-	862,429*	100

*Includes Mineral King acreages.

Figure 4

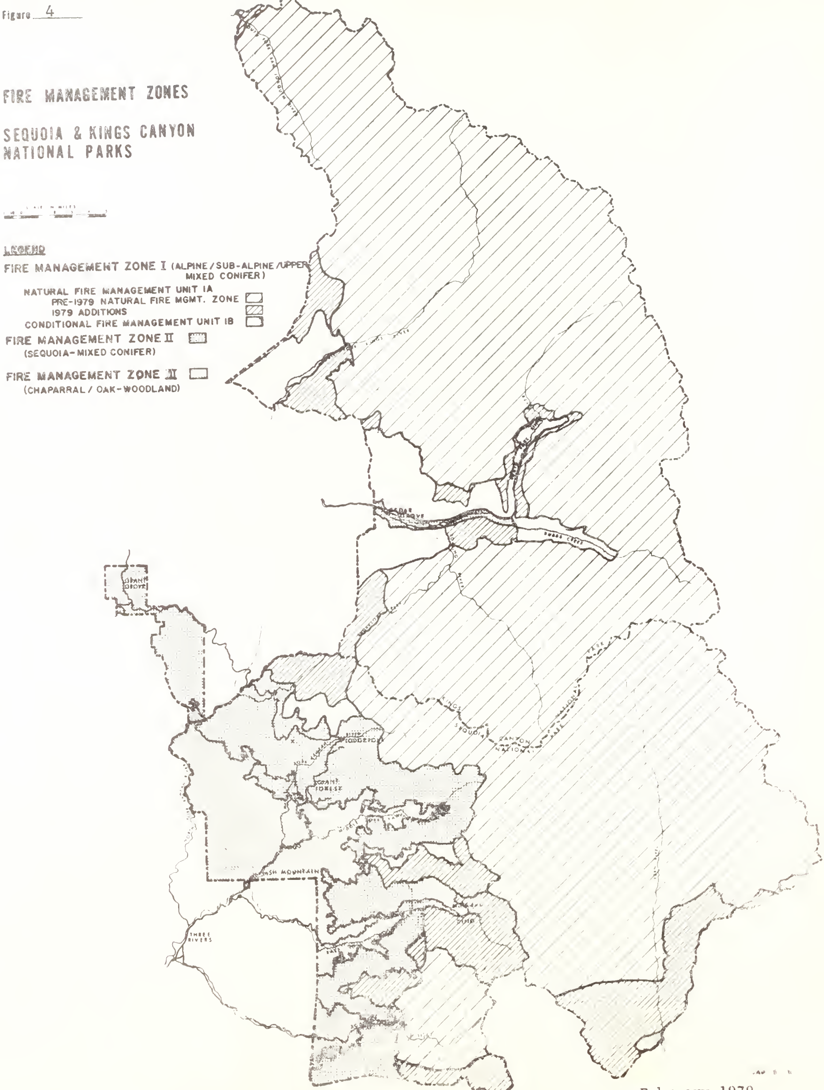

FIRE MANAGEMENT ZONES
SEQUOIA & KINGS CANYON NATIONAL PARKS
LEGEND
FIRE MANAGEMENT ZONE I (ALPINE / SUB-ALPINE / UPPER MIXED CONIFER)
NATURAL FIRE MANAGEMENT UNIT IA
PRE-1979 NATURAL FIRE MGMT. ZONE
1979 ADDITIONS
CONDITIONAL FIRE MANAGEMENT UNIT IB
FIRE MANAGEMENT ZONE II
(SEQUOIA-MIXED CONIFER)
FIRE MANAGEMENT ZONE III
(CHAPARRAL / OAK-WOODLAND)
GRANT GROVE
LODGEPOLE
GIANT FOREST
ASH MOUNTAIN
THREE RIVERS
KINGS
SEQUOIA
CANYON
NATIONAL

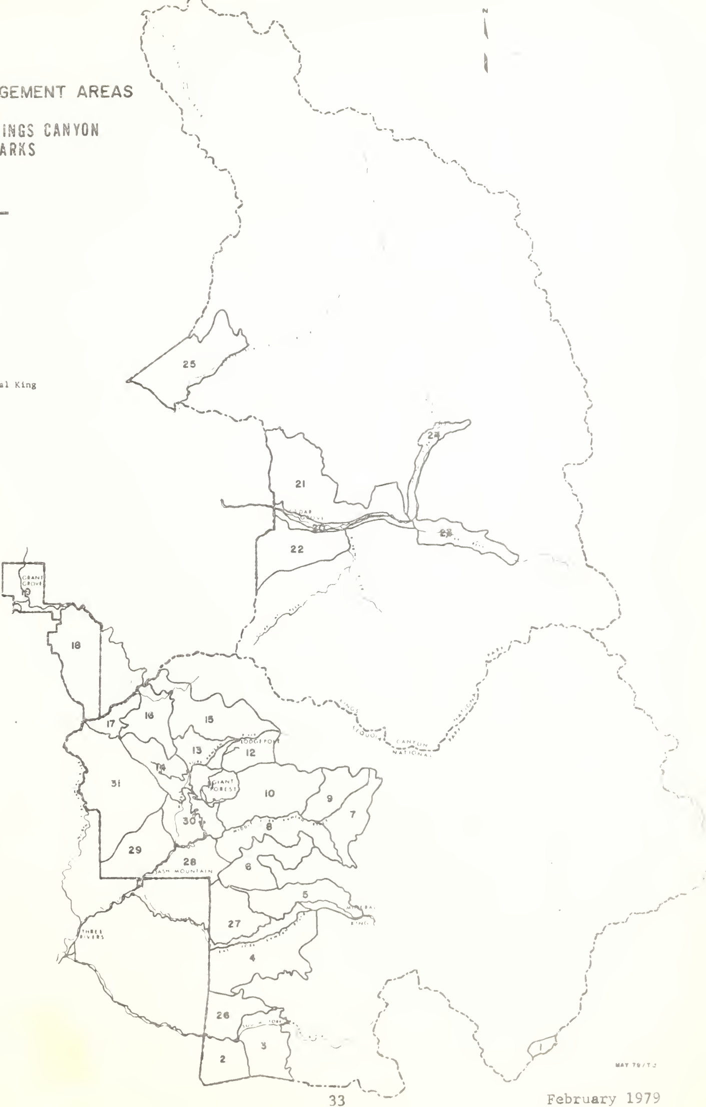
Figure 4a

FIRE MANAGEMENT AREAS

SEQUOIA & KINGS CANYON NATIONAL PARKS

AREAS

1. Kern Canyon
2. Garfield Grove
3. Homers Nose
4. Cahoon Meadow
5. Oriole Lake
6. Castle Rocks/Mineral King
7. Redwood Meadow
8. Kaweah
9. Bearpaw Meadow
10. Panther Peak
11. Giant Forest
12. Lodgepole
13. Suwanee
14. Crystal Cave
15. Halstead Meadow
16. Dorst Creek
17. Skagway
18. Redwood Canyon
19. Grant Grove
20. Cedar Grove
21. North Mountain
22. Sentinel Ridge
23. Bubbs Creek
24. South Fork Kings
25. Tehipite
26. Clough Cave
27. Lookout Point
28. Milk Ranch
29. Ash Mountain
30. Hospital Rock
31. Yucca Mountain



February 1979

Figure 4b Fire Management Zone Hierarchies

Fire Management Zone I

Unit (1A) —— * ——→ Natural Fire Management Unit

Unit (1B) ——┐
Fire Management Zone II ——┘

** Fire Management Areas (31) ——→ Prescribed Burn Units (199)

Fire Management Zone III ——→ Fire Management Areas (31)

*Natural fire allowed to play as natural a role as possible; prescribed fire allowed only along zone/Park boundaries to contain natural fire to unit (1A); human-caused fires suppressed.

**Natural fire is allowed under restrictive prescriptions in selected fire management areas in zone II/1B. Prescribed fire is allowed to restore natural conditions to permit natural fire to regain its role; human-caused fires are allowed only under prescribed burn prescriptions in prescribed burn units in zone II/1B that are scheduled to be prescribed burned in the same year that the human-caused fire occurs.

All natural and human-caused fires in zone III will be suppressed. Unlike zone I and II, it is not clear if natural fire will be allowed to regain its former role. The flashy, intensely burning fuels may be too hazardous and incompatible with frontcountry use. Where some lightning fires may be allowed to burn in zone II and take the place of prescribed burning, most, if not all, burning in zone III will be artificial.

The extensive use of prescribed burns in zone III necessitates careful delineation of objectives. Unlike vegetation in zones I and II, much of the zone III community is killed by fire, or at least the above ground portions. Resprouting, fresh browse, and edge effects from mosaics of burned and unburned areas will have profound effects on wildlife, hydrology, and soils. Therefore, the program will move slowly from small experimental plots of a few acres to larger experimental plots of several hundred acres, to full scale management burns of several thousand acres and will document the effects on the ecosystem at each step. Of special concern are burn mosaic patterns and the relative proportion of each unit to be left unburned for maximum benefit to the resources.

This estimate of benefit is subjective, since unlike zones I and II, there is no clear fire scar record for the intensity, frequency, and pattern of natural or aboriginal fires, since each fire begins the entire community again. Therefore "natural conditions" are difficult to ascertain and to recreate; our efforts, then, must be directed to reintroducing fire to this ecosystem without subjectively damaging it. Natural fire, if it is used at all, will be bounded naturally by the various age classes created by prescribed burning.

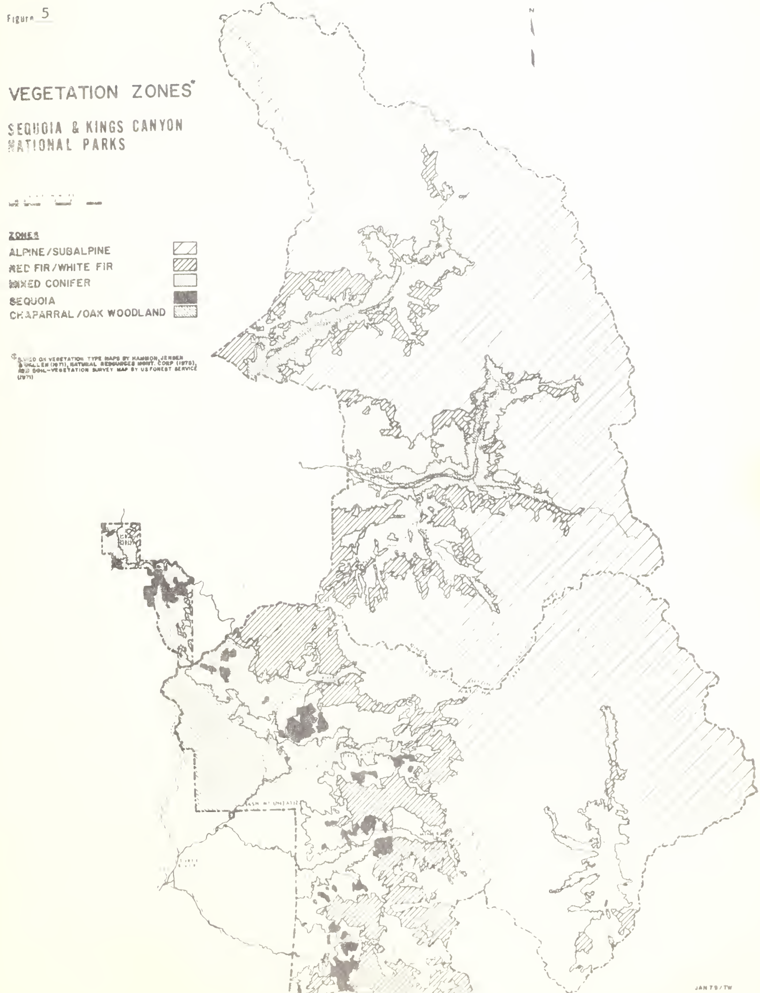


Figure 5
VEGETATION ZONES*
SEQUOIA & KINGS CANYON NATIONAL PARKS
ZONES
ALPINE/SUBALPINE
RED FIR/WHITE FIR
MIXED CONIFER
SEQUOIA
CHAPARRAL/OAK WOODLAND
N
JAN 79/TW

2. Red Fir

The virgin red fir (*Abies magnifica*) community represents a true climax. It occurs from 7,000 to 9,000 ft, but in many areas the transition between the mixed-conifer and lodgepole-subalpine communities takes place without an interposing red fir belt.

Stands are characteristically even-aged. Pinemat manzanita is often found on rocky outcrops while open sandy or marshy areas are occupied by lodgepole pine and a variety of grasses and herbs.

3. Mixed-Conifer

The mixed-conifer community is found from 5,000 to 7,000 ft and is characterized by sugar (*Pinus lambertiana*), Jeffrey (*P. Jeffreyi*), and ponderosa (*P. ponderosa*) pines; white fir (*Abies concolor*), and incense cedar (*Calocedrus decurrens*), (Rundell *et al.*, 1977), with hazelnut (*Cornus cornuta* var. *californica*) and dogwood (*Cornus nuttallii*) on the more mesic sites. Understory shrubs and ground cover are extremely variable with chinquapin (*Castanopsis sempervirens*), bear clover (*Chamaebatia foliolosa*), and bracken fern (*Pteridium aquilinum* var. *pubesens*) being the most common.

4. Sequoia

Vankat (1970) includes the sequoia grove in the white fir coniferous forest sub-type. The most common tree species are white fir, sugar pine, sequoia (*Sequoiadendron giganteum*), and incense cedar. White fir is the dominant tree species and sequoia and sugar pine subdominants. Chinquapin is the most common shrub species. Incense cedar, ponderosa pine, black oak (*Quercus kelloggii*) and manzanita (*Arctostaphylos sp.*) are common associates on more xeric sites. Thirty-five groves from 10 to 3,900 acres in size occur within a range of 3,000 to 8,800 ft, where micro-site conditions are favorable.

5. Chaparral/Oak-Woodland

Chaparral occurs from the low elevation foothills up to about 5,000 ft. It is characterized by extensive evergreen brushlands consisting predominately of shrubs such as chamise (*Adenostoma fasciculatum*), white leaved manzanita (*Arctostaphylos viscida*), mountain mahogany (*Cercocarpus betuloides*), and various species of *Ceanothus* (*Ceanothus cuneatus*, *C. leucodermis*). In many locations, pure stands of chamise are found.

The oak-woodland community is primarily confined to the lower slopes along the western boundary of Sequoia National Park in the North, Middle, Marble, and South Forks of the Kaweah River watershed. Blue oak (*Quercus douglasii*), interior live oak

(*Q. wizlizenii*), and California buckeye (*Aesculus californica*) are the most common trees. The pristine herbaceous understory was dominated by perennial bunchgrasses interspersed with a variety of forbs.

C. Fire Management Zone I (Alpine/Subalpine/Upper Mixed Conifer)

1. Natural Fire Management Unit (1A) Description
Unit (1A) ranges from 6,500 to 14,495 ft. Included in this unit are all areas above timberline, subalpine forests, lodgepole pine forests, as well as red fir, mixed-conifer forest, and oak-woodland/montane brush occurring on more xeric sites.

At the lower elevational range, red fir exists in pure stands or intermingles with the mixed-conifer belt, while at higher elevations, alpine and subalpine vegetation covers extensive areas. Natural fire management unit (1A) contains 613,048 acres of the higher elevation forests and alpine areas where natural fires have been allowed to burn since 1968, plus 67,961 acres in the 1979 additions (Table 12a, page 45).

a. Topography

Much of the unit has been shaped by glaciation and as a result, numerous lake basins, moraines, cirques, and glaciated valleys are found throughout the zone. About 20% of the Parks is simply barren or sparsely covered granite, all of which lies in unit (1A). All of the major drainages of the Parks originate in this unit. The soils in alpine areas are shallow, relatively undeveloped, and of granitic origin.

b. Climate

Winter in the high elevations of the Parks is long and severe and produces snowpacks into June and July in years of heavy snowfall. The growing season is limited to three to 12 weeks, resulting in low productivity.

Few climatic records exist for this remote snow-laden area; however, the average April snow depth in the red fir forests (8,600 ft) is 89.4 inches with an average water content of 33.9 inches (averaged over a 53-year period from 1925 to 1977). The greatest snowfall ever measured was in April 1969, when the depth was 217.5 inches with a water content of 98.8 inches. Minimum temperatures may be -25 F or lower, whereas summer temperatures rarely exceed 85 F.

The climate interrelates with fire in two major ways. First, the short growing/fire season results in a very slow rate of fuel production. The frequency of fire in elevations above 8,000 ft is not clear, but as elevation increases, the

Table 12 -- Vegetation Types Occurring in Each Fire Management Zone.

egetation Type	Fire Mgmt. Zone I		Fire Mgmt. Zone II		Fire Mgmt. Zone III		Total Acreage	Total percent of Parks in each type
	Acres	Percent	Acres	Percent	Acres	Percent		
Alpine Subalpine	536,173	100	-	-	-	-	536,173	62
Red Fir	90,640	90	10,500	10	-	-	101,140	12
Mixed Conifer	81,347	57	62,566	43	-	-	143,913	17
Sequoia	-	-	8,274	100	-	-	8,274	1
Chaparral/ Oak Wood-land	19,148	26	-	-	53,781	74	72,929	8
Total Acres	727,308		81,340		53,781		862,429	
Percent of Park in each Fire Management Zone	84		9		7		100	

interval between small and larger fires increases and lack of fuel is a major reason.

The second interrelationship is the thunderstorms of orographic origin that produce lightning strikes and fires of various sizes. In drought years the number of thunderstorms may decrease, but the dry condition of the fuels may increase fire size. During the drought years 1976-77, there were 20 high elevation prescribed natural fires which burned 77 acres in 1976, whereas nine fires burned 10,651 acres in 1977, most of this in one 10,000-acre fire.

c. Vegetation

Four vegetation types, alpine/subalpine, red fir, mixed-conifer and oak-woodland with montane brush occur in unit (1A) in response to environmental gradients such as elevation, aspect, temperature, and moisture. Many intergrades occur.

(1) Alpine/Subalpine/Lodgepole

Alpine communities are low or prostrate perennial herbs and sedges. Subalpine communities are characterized as mostly widely spaced stands of long-lived trees with virtually no shrubs.

Foxtail pine is the most abundant subalpine species and normally grows on shallow, well drained, decomposed granitic slopes. Foxtail forms pure stands of widely spaced trees at the higher elevations and mixes with other subalpine species at lower elevations. Unlike its associates, foxtail does not form a krummholtz but grows erect with a single trunk throughout its range.

The lodgepole pine forest occurs beneath the subalpine forest (7,000 to 11,000 ft and 9,500 to 12,000 ft respectively) and has higher tree and shrub densities. Lodgepole frequently grows in even-aged stands around meadows or moist areas and also in glacial basins where some soil has formed.

(2) Red Fir

Red fir often grows in pure stands between 7,000 and 8,500 ft with a relatively open forest floor. Common associates are species of manzanita, _Ceanothus_, _Ribes_, _Salix_ spp., bear clover, and chinquapin.

At its upper limit, red fir is associated with lodgepole, montane brush, and meadows, whereas at its lower limit, it intermingles with Jeffrey, sugar, and ponderosa pine, incense cedar, and white fir. Red fir is usually the dominant overstory species.

Natural regeneration occurs in small openings where soil moisture and/or sunlight becomes available after the death of a few trees or when large areas are created by fire, insect epidemics, or weather damage. Seedlings become established best in mineral soil or scant litter and grow slowly due to intense competition for sunlight and water.

Red fir thrives best on damp, sheltered areas of east and north slopes where it forms dense stands until maturity. At that time, competition tends to thin out mature stands. It is also found on deep sandy loams associated with unglaciated areas as well as on the shallower soils of moraines.

(3) Over 80,000 acres of mixed-conifer vegetation are scattered throughout the lower elevations of unit (1A). Major locations are in the Sugarloaf Valley, Cedar Grove, and Kern Canyon. A description of this type is in the zone II section.

(4) Oak-Woodland/Chaparral

The Middle and South Forks of the Kings River contain steep canyon walls with extensive areas of canyon live oak. Other species sometimes present include white leaf manzanita, mountain mahogany, several ceanothus species, and annual grasses. Black ofk is found on the upper portions of the canyons which grades into a mixed-conifer forest.

Areas of montane brush, which is considered to be a chaparral subtype, are present in some portions of unit (1A). Species composition includes several manzanita species, chinquapin, Ribes sp., and Ceanothus sp. These shrubs are found on open rocky sites or in the understory of Jeffrey pine or red fir forests.

d. Sensitive Plant and Animal Species

Appendix A lists sensitive plant species found in or near the Parks (California Native Plant Society, 1978). Most of the 21 species are present in unit (1A). These species probably have a limited distribution because of their dependence on microhabitats unique to the alpine zone. It is unlikely that fire threatens these alpine species.

All fires which occur in the Hidden Lake drainage, or have the potential to spread into this drainage, will be suppressed. This drainage contains the Park's Little Kern golden trout population, and therefore fire will be kept out of it until its effect on the trout population can be evaluated.

e. Visitor-Use

Unit (1A) contains no frontcountry, and for this reason use is restricted to backpackers, stock use, or dayhikers. Most of the visitor-use is in the alpine and subalpine vegetation types. There were 41,144 visitors and 166,016 visitor-use nights in zone I during 1978.

f. Archeological and Historical Sites

Archeological sites are numerous throughout unit (1A); two bedrock mortar sites, 46 campsites, one workshop, and one pictograph site have been found. Unit (1A) also contains numerous non-archeological, culturally important sites. Some 19 locations are listed as historical sites including 11 of Shorty Lovelace's cabins. A list of the various sites is in Appendix A.

g. Natural Role of Fire

The natural role of fire in the alpine/subalpine zone has not been adequately studied. Although extensive work has been done on the Rocky Mountain subspecies of lodgepole, almost none has been completed on sp. murrayana (Rundel et al., 1977). The lack of serotinous cones and thin bark may suggest that Sierra lodgepole pine forests are not a fire type, at least not to the degree observed in pines in the mixed-conifer type. Fire in lodgepole pine may be generally of a low to moderate intensity, with a rare fire of high intensity.

Very little research has been conducted on the effect of fire on natural regeneration in subalpine forests. As lower elevation fires reach this zone, subalpine forests tend to dissipate fire intensity and retard fire spread. The impact of fire appears to be minimal in these communities because of the scant litter production and discontinuous arrangement of fuels.

Kilgore (1971) studied the impact of fire in the red fir forest by measuring fuel loads before and after prescribed burning near the Middle Fork of the Kings River. Fire reduced the litter, duff, and humus by approximately 50% and except in a few instances were torching occurred, the fire did not move into other trees.

In red fir forests, lightning fires play an important role in the successional relationships between lodgepole pine and red fir. Fire not only creates openings in the forest canopy by killing mature lodgepole and some mature red fir, but also establishes a mineral soil seedbed. Lodgepole pine soon becomes established in its pioneer successional role;

but where heavy shade continues from the closed canopy of mature red fir, the less shade tolerant lodgepole perish, thus favoring the red fir climax.

h. Fire History, Fuels, and Fire Behavior

From 1922 to 1978, there were some 765 fires reported in fire management zone I; 81% of these fires were lightning-caused and 19% were human-caused. Over this period, only 6,120 acres of alpine/subalpine/lodgepole and red fir vegetation types burned. An additional 15,752 acres of mixed-conifer were allowed to burn after the establishment of the natural fire management zone in 1968, giving a total of 21,872 acres burned to 1978.

The large proportion of fires (97%) have been less than nine acres; 78% were less than 1/4 acre. The preponderance of small fires is due to efficient fire suppression and low amounts of fuel, widely spaced trees, and the presence of frequent rocky firebreaks.

Occasionally large fires do occur. The Kern Canyon Number Two Fire in 1949 started during a lightning storm on July 13 and burned until July 31, consuming 1,100 acres of open Jeffrey pine/montane brush and foxtail pine. Southwesterly winds attained velocities of 40 mph causing the fire to spot and crown while the steep rugged terrain contributed to its fast rates of spread and high resistance to control.

In order to support a subalpine fire with crowning behavior, there must be a combination of warm, dry weather, dry fuels, and high winds. Depending on the fire's intensity, a majority of the trees may survive such a fire or there may be a high mortality of trees in the burned area. The latter condition may have produced some of the even-aged stands of lodgepole pine and red fir.

Results of the 1978 fuel inventories indicate a value of about 10 tons/acre in the subalpine type to about 30 tons/acre in the red fir type (Fuel model H). Because of the low fire frequency, slow accretion rates of fuel, and the length of time required to get fire crews to a fire prior to the addition of the helicopter, the impact of fire suppression is believed to be small. Consequently, the vegetation of unit (1A) is considered to be more natural than that of either of the other two zones.

2. Conditional Fire Management Unit (1B) Description

Prior to the summer of 1978, the natural fire management unit (1A) contained 613,048 acres. A fuel and vegetation study was conducted during 1978 to determine areas which could be added to this unit. These areas were delineated on the basis of natural breaks and vegetation similarity and are composed of red fir, Jeffrey pine, montaine brush on xeric sites, and white fir on mesic sites (Figure 6).

The fuel inventorying techniques of Brown (1974) and Bevins (1976) were used to determine fuel loading. On the basis of fuel, litter loading (Agee, 1973), vegetation type and density, the natural role of fire, and the expected fire behavior, these areas were either placed in unit (1A) or in unit (1B) (Tables 12 and 13).

Conditional fire management unit (1B) consists of 46,299 acres in eight separate areas with significantly higher vegetation densities and fuel loads than unit (1A). Consequently, the prescriptions are tighter than those of unit (1A); since the unit is more similar to the vegetation types found in zone II, the prescriptions were combined into a general zone II/1B prescription. These nine separate areas are included as part of the appropriate fire management area in which they occur.

These areas may be included in unit (1A) after natural fires demonstrate that they can meet management objectives. A description of each area in unit (1B) follows, and the fuel loads are displayed in Figure 7.

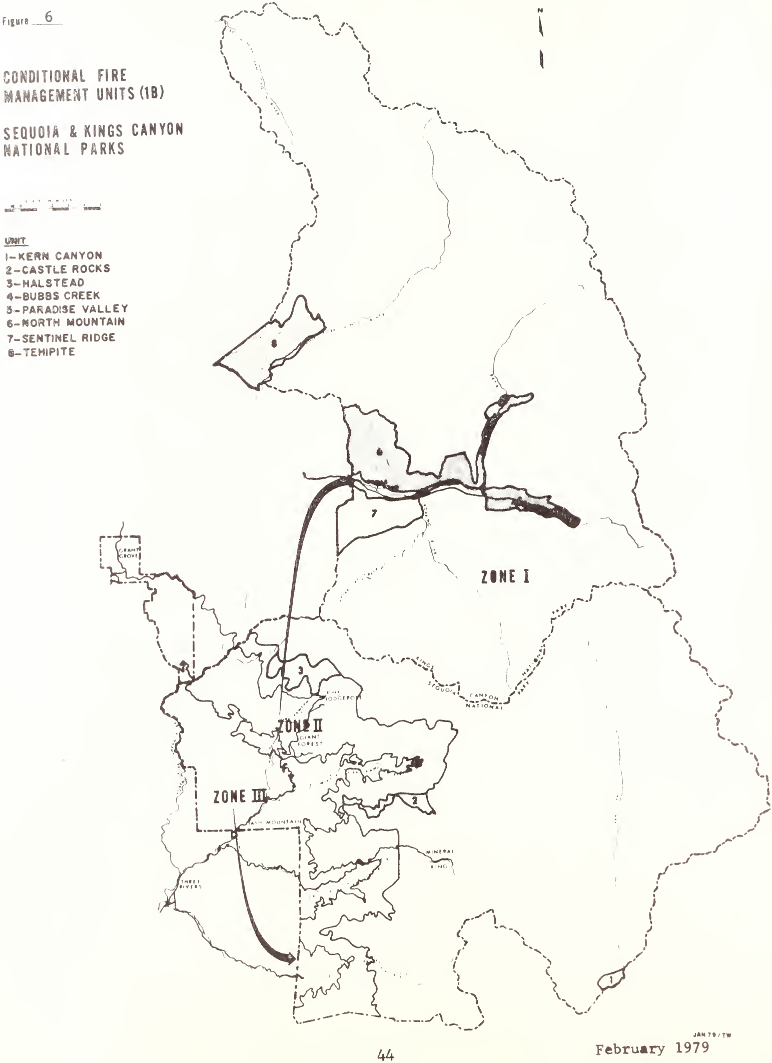
a. Kern Canyon (1) (Fuel Models "G" and "C")

The Kern Canyon area lies in the western portion of Kern Canyon; a glaciated, U-shaped valley. Elevation ranges from 6,300 ft to 9,000 ft. This 735-acre area gradually rises toward the west and contains the Coyote Creek drainage and Coyote Pass trail. Both features could be utilized as fire barriers.

The three main cover types include dense white fir with incense cedar, Jeffrey pine with white fir understory, and open Jeffrey pine with montane brush in the understory. Crowning potential is high in the first two types. The presence of dense white fir indicates a cautious reintroduction of fire.

Only six lightning fires have been reported since 1922 to 1978. This low figure is probably because the area is fairly inaccessible and fires may have been naturally extinguished before they could be detected. The area has a relatively low lightning occurrence level.

Figure 6



February 1979

Table 12a -- Areas Added to the Natural Fire Management Unit (1A) (Fig. 5)

LOCATION	ACRES
1. East and West Kern	24,558
2. Hockett/Quinn	10,003
3. Castle Rocks	7,654
4. Kettle Peak/Halstead	10,767
5. Sentinel Ridge/Bubbs	5,175
6. North Mountain	178
7. Tehipite/Blue Canyon	8,925
8. Evolution	701
Total	67,961 Acres

Table 13 -- Areas Added to the Conditional Fire Management Unit (1B) (Fig. 6)

LOCATION	ACRES
1. Kern Canyon	735
2. Castle Rocks	2,067
3. Halstead	4,060
4. Bubbs Creek	4,126
5. Paradise Valley	4,386
6. North Mountain	14,833
7. Sentinel Ridge	6,178
8. Tehipite	9,914
Total	46,299 Acres

Fuel loads average about 27 tons/acre, ranging from 12 tons/acre in the Jeffrey pine, white fir, red fir forest to 45 tons/acre in the white fir, incense thickets.

Visitor-use is high in this area. The presence of a ranger station and the high fuel loadings warrant inclusion in unit (1B).

b. Castle Rocks (2) (Fuel Model "G")

The Castle Rocks area contains 2,067 acres with an northeasterly aspect. The topography is dissected with steep drainages, rocky outcroppings, and ranges in elevation from 6,000 ft to 8,700 ft. This area is bordered by the Middle Fork of the Kaweah River Valley to the north, Castle Rocks to the west, Cliff Creek to the east, and a ridge top to the south.

Vegetation is mostly white fir which grades into Jeffrey pine/incense cedar/montane brush on the more open southern slopes. Red fir forests exist along the ridge tops, while sequoia inhabits lower elevations.

Natural fire occurence is very low; between 1922 and 1978, only three lightning fires and two human-caused fires were recorded. Fuel loads average about 45 tons/acre, with a range from seven tons/acre in manzanita to 90 tons/acre in the white fir. It is possible that the development of the vegetation is influenced by high intensity fires due to the dense overstory, heavy fuel load, steep slopes, and low fire frequency. Fires may exhibit crowning and spotting behavior.

Visitor-use is high in the Cliff Creek area. However, the remainder of the unit requires cross-country travel.

c. Halstead (3) (Fuel Model "H")

The Halstead area contains 4,060 acres, ranging in elevation from 6,400 to 7,500 ft along the southern boundary and 8,500 ft along its border with the unit (1A). The topography gradually rises toward the northern side with Silliman and Clover Creeks draining the east side. The Generals Highway lies to the south and west.

White fir/red fir dominate the area, with Jeffrey pine and montane brush occupying the more xeric sites along the lower boundary. Along the Generals Highway, dense stands of white fir have overtopped and killed montane brush, probably because of fire exclusion.

Thirty-two lightning and five human-caused fires have been recorded which suggest a high incidence of fire from 1922 to 1978. Fuel loads average 34 tons/acre with 67% of this weight in the litter layer with a range from 16 to 47 tons/acre in the red fir/white fir mix. Crowning potential is extremely high due to the continuity of vertical fuels. The potential for large fires decreases in the higher elevation red fir.

Visitor-use is heavy along the Generals Highway but it is unlikely that many people reach the area. The area is included in unit (1B) because fire exclusion has altered stand composition and fuel levels.

d. Bubbs Creek (4) (Fuel Models "C" and "G")

The Bubbs Creek Canyon includes approximately 4,126 acres. It is bounded by steep granite walls rising from about 7,000 ft near the creek to over 8,400 ft along the ridges. The valley contains numerous talus slopes and is less than a mile wide.

Twelve lightning fires occurred from 1922 to 1978, mostly along the higher elevations of the canyon. The valley experienced a 2,450 acre fire in June, 1976. This fire killed 75% of the trees in the middle of the drainage.

As a result of this fire, the valley contains two distinct fuel vegetation complexes. The western half is largely burnt out, and down wood and litter total about 18 tons/acre, although this will increase as dead trees fall. Successional species is primarily bracken fern.

The eastern half, which was not burned, contains red fir near the creek (17 to 48 tons/acre), extensive fields of bitter cherry (12 tons/acre), and Jeffrey pine on the talus slopes and near the walls.

The valley experiences ten to 20 mph upcanyon winds. The extensive amount of brush is probably a result of naturally fast moving, wind driven fires which occur in this type. Such fires would present a hazard to hikers. These high intensity fires would serve to exclude conifer reproduction from the brushfield, since conifers are adapted to fires of much lower intensity.

e. Paradise Valley (5) (Fuel Models "C" and "G")

The Paradise Valley encompasses 4,386 acres and contains the drainage of the South Fork of the Kings River. This glaciated U-shaped valley runs north to south and has steep granite walls which rise sharply from 5,700 ft near the stream bed to 8,300 ft along the ridge top. The boundaries consist of valley walls which are natural barriers, dissected by several streams and slopes.

Vegetation along the stream bed consists of Jeffrey pine/white fir which immediately grades into open, montane brush. As the slope increases, this woodland vegetation becomes scattered and disappears leaving the canyon walls barren. Isolated patches of red fir/white fir forest exist in concavities along the ridgetop.

Based upon field observation and Park records, natural fire occurrence is very low. From 1922 to 1978, 11 lightning fires burned in the red fir/white fir along the ridgetop. Because of the extensive natural barriers between drainages, a fire must follow the axis of the river to become large; weather and fuel moisture conditions in most years probably would not allow such behavior. Large fires could occur during drought years.

Fuel loads average about 26 tons/acre along the valley floor (over 80% of this is in the litter layer) and range from 10 tons/acre in the montane brush to 40 tons/acre in dense white fir.

Visitor-use is high because of the abundance of scenic areas and trails. Smoke could provide an adverse impact on the visitor during periods of poor dispersion.

f. North Mountain (6) (Fuel Models "C" and "G")

The North Mountain area is a broad 14,833-acre expanse with an overall southern exposure. The topography is broken with numerous streams and sharply rising slopes ranging from 5,000 ft along the Kings River to 9,000 ft.

Vegetation on the xeric canyon walls consists of montane brush. On more mesic sites, white fir is common and grades into open Jeffrey/ponderosa pine with bear clover and montane brush on more exposed areas and old burn sites. There is evidence of the unnatural encroachment of white fir into the pine forests due to fire suppression.

The occurrence of natural fire is high. Sixty-eight fires have been recorded from 1922 to 1978, 61 of which were lightning caused. Fire is important in this area as evidenced by ponderosa pine and bear clover, by change in species composition in its absence, and by the high incidence of ignitions.

Fuel loads range from 23 to 73 tons/acre, averaging 42 tons/acre with over 70% of the weight in the litter layer.

Sites invaded by young white fir contain an average of 50 tons/acre. Fires could reach a high intensity due to the heavy fuel buildup.

Visitor-use is confined to the eastern and western sections. The remainder consists of steep rugged terrain where cross-country travel is very difficult. Although the potential for a large fire exists, smoke dispersion should not be a problem.

g. Sentinel Ridge (7) (Fuel Models "C" and "H")

The Sentinel Ridge faces north and rises steeply from the 5,200 ft contour to the ridge at 9,500 ft. This 6,178-acre area is dissected by numerous streams and interspersed with open rock cliffs and montane brush.

Oak-woodland/montane brush of black oak, bear clover and manzanita is found in the more open lower elevation area. At 7,000 ft, dense Jeffrey pine, red fir, and white fir are common. An open lodgepole/red fir forest inhabits the ridgetop which could dissipate the intensity of an oncoming fire. The area has received some of the heaviest lightning activity in the Parks with 80 ignitions (1922 to 1978), five of which were human-caused. The average fuel load is 35 tons/acre, with ranges from nine tons/acre in open brush fields to 42 tons/acre in dense Jeffrey pine/white fir.

Visitor-use is confined to the eastern and western sections. Smoke dispersion would not be a problem unless an inversion layer held it in nearby Kings Canyon.

h. Tehipite (8) (Fuel Models "C", "G", and "H")

This area encompasses 9,914 acres. It includes the lower Middle Fork of the Kings River from Lost Canyon downstream to the Park boundary above Little Tehipite Valley, and the Blue Canyon drainage below 8,400 ft. The area abuts the Park boundary on the west (Kettle Ridge) and the south (Tombstone Ridge/Silver Spur). Elevations vary from 4,000 to 11,500 ft.

Vegetation varies from oak-woodland/montane brush on the steep canyon walls along the Kings River, to the mixed-conifer/red fir of the middle elevations, to the alpine/subalpine at the upper elevations. The valley floor contains dense areas of mixed-conifer. Species include canyon live oak and manzanita on the canyon walls, black oak, ponderosa pine, incense cedar, white fir, Jeffrey pine, and red fir in the middle elevations, and lodgepole, western white pine, juniper, whitebark, and foxtail in the upper elevations. *Raillardella muirii*, a rare herb, is found within the area.

Park records for the period 1922 to 1978 show a total of 28 fires, 88% were lightning-caused. The fire potential is high, as illustrated by the Tehipite Dome Fire of 1972, where intense spotting, crowning, and running, severely burned nearly 100 acres of mixed-conifer.

Fuel loads range from 12 to 81 tons/acre and average 42 tons/acre. The lightest fuel loads were in dense, old growth red fir and the heaviest in dense, old-growth white/red fir. There is also evidence of recent fire exclusion in the form of replacement of black oak by ponderosa pine and incense cedar (as the predominant overstory vegetation) in areas of Tehipite Valley. Smoke dispersion would not be a problem because of the isolated nature of the area and the low visitor-use.

D. Fire Management Zone II (Sequoia-Mixed-Conifer)

Fire management zone II is composed of mixed-conifer forests and occurs from 4,500 to 8,000 ft. Included in this zone are all of the sequoia groves along with communities of ponderosa pine, white fir, and other species. The mixed-conifer belt is bordered by the chaparral/oak-woodland at the lower elevations and by subalpine/alpine and red fir at the higher elevations. The Parks' total acreage of mixed-conifer is 143,913 acres, and 43% of this is included in zone II. Total acreage of zone II is 78,974, nine percent of the Parks.

1. Topography

The mixed-conifer forest occupies the middle elevations between the rugged alpine/subalpine zone and more gently-sloping western foothills. Most river drainages and their tributaries exhibit a dendritic pattern and occupy deep, narrow gorges, some lying almost 7,000 ft below the high peaks.

Glaciation was often confined to canyons, leaving uplands intact and covered with deep, acid residual soil an dense forest. Fires in the mixed-conifer can become large due to the extensive blocks of continuous forests uninterrupted by natural barriers and to the tendency for spot fires to develop in the steep narrow canyons.

2. Climate

The climate is characterized by warm, dry summers and moderate snowy winters. Masses of moisture-laden marine air driven by prevailing southwesterly winds cause summer thunderstorms which produce lightning and very little rainfall. The average annual precipitation is 44 inches and most of the mixed-conifer forest receives snowfall during the winter months. The paucity of summer rainfall, and lightning associated with thunderstorms, enhance the potential for single or multiple fires.

3. Vegetation

The mixed-conifer forest is a belt of essentially continuous forests which includes numerous intergradations of ponderosa pine, Jeffrey pine, white fir, sugar pine, and black oak. Description of the mixed-conifer vegetation is organized into three forest communities: ponderosa pine, white fir/mixed-conifer, and white fir/mixed-conifer with sequoia.

a. Ponderosa Pine

The ponderosa pine forest occurs between about 4,000 and 7,000 ft, usually in xeric south-facing slopes. In the upper elevation, it is replaced by Jeffrey pine, while at lower elevations it intermingles with black oak. Incense-cedar is sometimes a co-dominant with ponderosa pine on more mesic sites.

The structure of ponderosa pine forests is determined by the summer moisture and fire history (Rundel et al., 1977). Aboriginal burning was more frequent and lightning occurrence is higher than in other cover types. The ponderosa pine forest is a fire-climax phase of the mixed-conifer type. Where understory trees are thinned by frequent ground fires, ponderosa pine becomes established and dominates. Conversely, where fire is excluded, dominance shifts from ponderosa pine to white fir in mesic sites and incense cedar in more xeric sites.

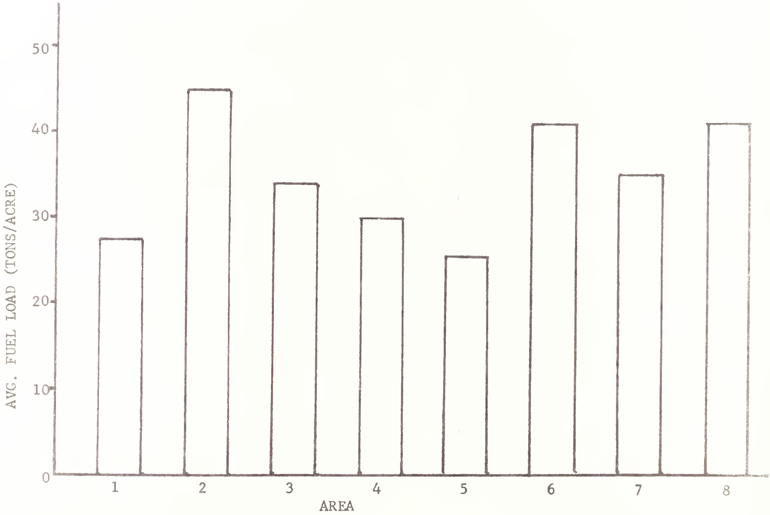
The ponderosa pine community exhibits structural adaptations to fire. It produces a heavy annual needle accumulation and fuel bed consisting of large needles which compact poorly and dry quickly. The high resin and low water content in the foliage causes a slow rate of decay and increased flammability. Pine ~~and some oak~~ develop a thick fire resistant bark that insulates the tree stem from heat.

b. White Fir/Mixed-Conifer

The white fir/mixed-conifer forest occurs on mesic sites from about 4,100 to 7,200 ft. White fir intermingles with and is replaced by red fir at the upper elevations while at lower elevations it is commonly found with incense cedar, ponderosa pine, and black oak.

Incense cedar and to a lesser extent sugar pine are important associates. White fir accounts for 80% of the large trees in many locations. The structure of individual stands is extremely variable as a result of different fire histories and variations in the rates of development. Seedlings of

Fig. 7 Average Fuel Loadings for Conditional Fire Management Unit 1B.



Areas

1- Kern Canyon
2- Castle Rocks
3- Halstead
4- Bubbs Creek
5- Paradise Valley
6- North Mountain
7- Sentinel Ridge
8- Tehipite

white fir and incense cedar are highly shade tolerant and can become established in areas with heavy litter or brush cover. Fire suppression in the white fir/mixed-conifer forest has altered stand structure resulting in fewer areas of brush and black oak and greatly increased densities of white fir (Bonnicksen and Stone, 1978).

At the lower elevations in the mixed-conifer zone, or on rocky sites, the common understory species are manzanita, bear clover, big leaf maple, canyon live oak, and Ceanothus spp., (Rundel et al., 1977). Many of these are favored by frequent fire and are thus less common than prior to fire suppression. Hazelnut, dogwood, and bracken fern are restricted to more mesic sites. Less common species include willow, chinquapin, bitter cherry, and gooseberry, (Munz, 1970; Rockwell and Stocking, 1969). The total understory shrub coverage is commonly five to ten percent, but values to 30% are not unusual (Rundel et al., 1977). Herbaceous cover is sparse except in moist drainage bottoms, where it may approach 100%. Thick litter accumulation inhibits herbaceous growth, and fire suppression has resulted in its decline.

c. White Fir/Mixed-Conifer with Sequoia

The 8,268 acres (Hammon, Jensen, and Wallen, 1971) of sequoias constitute less than one percent of the Parks' total area; however, the importance of this sub-type is reflected in the fact that this acreage represents 28% of the estimated 29,405 acres of sequoias in existence. The sequoia forest in the Parks is contained in 35 scattered separate grooves in the Kaweah and Kings River drainages at elevations from 2,800 to 8,700 ft. The limiting factors in current distribution are availability of soil moisture, air temperature, and ecological tolerance of the seedling (Rundel, 1972). The current range was reduced from its former size about 8,000 years ago due to a warming of the climate (Rundel, 1972).

Regeneration success depends on the degree of opening of the canopy and the amount of ground litter. A wide opening with nearly litter-free conditions is advantageous to ponderosa pine, giant sequoia, and sugar pine. Less crown opening and heavy litter favors incense cedar and white fir.

The primary vegetation change in sequoia groves in the absence of fire has been an increase in density and cover of white fir and incense cedar along with a corresponding decrease in density and cover of shrub species, primarily manzanita and Ceanothus spp. (Vankat, 1970). In addition, Bonnicksen and Stone (1978) found the age structure of the stands to have changed also, with an increase in area of aggregations dominated by pole-sized and mature trees and decrease in area dominated by saplings and seedlings. They also found a reduction in importance of hardwoods (primarily black oak) in these stands.

Parsons and DeBenedetti (1979) have noted a similar increase in young shade tolerant white fir in the sequoia sub-type. This shift in species composition and age distribution denotes a change in successional patterns which is accompanied by an increase in fire hazard due to increased density of small trees and unnatural accumulation of ground fuels.

Vankat (1970) found that these changes began around 1870, coinciding with the cessation of Indian burning. Kilgore and Taylor (1979) found an increase of from eight, for the previous 100-year period, to 180 pole-sized (two to 12 inch) fir and pine/acre which became established at Redwood Mountain from 1870 to 1970. Along with this increase was a tremendous increase in fir and pine seedlings and saplings (< two inch DBH) density, and a drastic reduction in sequoia reproduction.

4. Sensitive Plant Species

There are three sensitive species in zone II which have been recommended for endangered or threatened status. Another species was collected outside the Park but may occur within zone II. Although the need for more research is recognized, fire may prove beneficial to the survival of these species by creating openings in the forest canopy.

5. Visitor-Use

Fire management zone II contains only nine percent of the total Parks' area but receives 69% of all overnight visits and the vast majority of all day use. Less than four percent of the backcountry use is in this zone. The most intensive visitation is in Cedar Grove and in the sequoia groves along the Generals Highway.

6. Archeological and Historical Sites

There are seven bedrock mortar sites, two campsites, and two villages found in this zone (Appendix A). Most of these are located in the Cedar Grove area, although Giant Forest and Grant Grove also contain sites. Fourteen historically important, non-archeological sites are also present.

7. Natural Role of Fire

Fire has played a major role in shaping the structure and composition of the mixed-conifer forest. Under natural conditions, fire burned irregularly-shaped areas with varying spread rates due to local gradients in fuel types, fuel moisture, topography, and weather conditions (Kourtz and O'Reagan 1971; Van Wagtendonk 1972). Fire killed small trees existing under the canopies of large trees but did not kill those in open areas with lower fuel loads. Therefore, the shade intolerant seedlings of ponderosa pine, Jeffrey pine, sugar pine, and black oak were favored over the shade tolerant seedlings of white fir and incense cedar (Kigore 1973). The result is that fire, in combination with other factors such as exposure, slope, soil type, insects, and disease, brought about uneven-aged stands composed of even-aged groups of trees of various age classes (Weaver, 1967).

Susceptibility to fire not only varies between species, but also with the stage of development. In the seedling stage, all of the conifer species are susceptible to fire. Ponderosa pine saplings are less vulnerable than are the others and can withstand more crown scorch. Thinner-barked sugar pine, white fir and incense cedar saplings have decreasing resistance to fire. Mature, thick-barked ponderosa pine are more resistant than white fir, sugar pine, and incense cedar in order of decreasing resistance (Van Wagtendonk, 1972). Mature sequoia with thick, fire resistant bark is the most resistant species.

Natural fire probably did not create openings in the mixed-conifer forest canopy except on rare occasions when the interior of a tree ignited and collapsed. Fire tended to consume trees that had fallen already and to convert them into ash seedbeds which are ideal for reproduction. In such openings, increased nutrients and sunlight enhanced success of reproduction. Cooper (1961) described the cyclical nature of this process.

8. Fire History, Fuels, and Fire Behavior

Most of the pre-1875 fires were small and of low intensity, consuming accumulated litter and killing most of the conifer regeneration at frequent intervals (Kilgore and Taylor, 1979). Intense crown fires were absent in the Redwood Mountain area for the past 400 to 2,000 years (Kilgore and Taylor, 1979).

Bonnicksen (1975) concluded that: (1) fuel accumulations in early mixed-conifer forests were variably low with scattered heavy concentrations of debris; (2) the forest was relatively open; (3) most fires were the low intensity, surface type with flame lengths less than two feet; (4) fire intensities were variable, occasionally severe enough in areas of heavy debris accumulation to crown out and kill sequoias up to 200 years old.

Age determinations (Vankat, 1970) show that the increase in density of white fir began around 1870, when the Indian population declined in the Park and their burning activity was reduced. The openness was maintained in some areas by shepherds and cattlemen who set fires to improve forage for their animals. Between 1900 and 1915, the density of white fir greatly increased, coinciding with the initiation of a fire suppression program in the Parks. From 1922 to 1978, there were approximately 678 fires reported; 63% of these were lightning and 37% were human-caused. Over this period, 11,567 acres of mixed-conifer burned in the area that is now zone II. Due in part to the effectiveness of fire suppression tactics, the large proportion of fires (73%) have been less than 1/4 acre in size, with 95% less than 10 acres.

From 1922 to 1978, a total of 142 fires were reported in the sequoia subtype, burning a total of 100 acres. Only nine of these fires were greater than one acre or larger in size and 122 or 86% were less than 1/4 acre (Figure 8). Fifty-three percent (75) were lightning-caused. Most (76%) of the lightning fires occurred from July to September, the most common month being August.

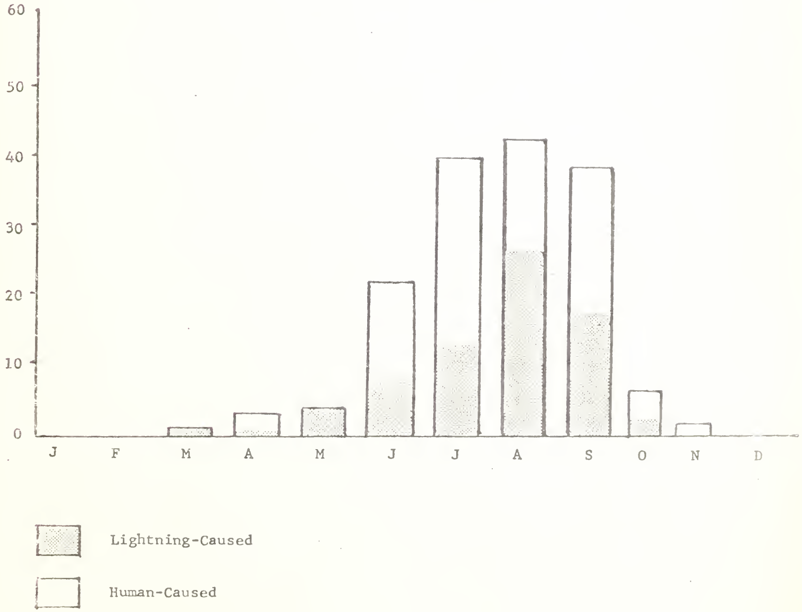
Fuel (Model "G") in zone II averages about 70/tons/acre and ranges between 15 tons/acre in open Jeffrey pine-manzanita to greater than 100 tons/acre in mesic mixed-conifer stands. Occasionally, areas with storm damage can approach 200 tons/acre, almost all of this occurring as heavy fuels. Such heavy fuels do not contribute significantly to the spread rate except as sources of spots.

The fine fuels of shade tolerant species are considerably different from shade intolerant species. The former type tend to produce compact, poorly aerated mats that are not condusive to fire spread while pine ground fuels are fluffier, dry more readily, and conduct fire more quickly.

This difference in the fuel's ability to carry fire has significant effects on fire behavior and frequency. Ponderosa pine fine fuels,for example, can burn in early spring and will support frequent and perhaps annual fires. Fir ground cover will not support a fire until late in the fire season, and significant fires may not occur except in drought years. These may be of higher intensity than ponderosa pine fires due to greater fuel accumulations because of the longer fire-free interval.

Biswell et al. (1966) measured 4.5 tons/acre per year as the accretion rate of litter under mature sequoias and 2.4 tons/acre per year under second-growth. This corresponds to the value of 1.8 tons/acre per year under second-growth as found by Agee et al. (1978). Annual decomposition rates were found to be 1.8% and 11.4% for sequoia litter and duff respectively (Agee et al., 1978). By using a computer model, it was found that second-growth sequoia reaches a state of equilibrium where annual accretion and decomposition of duff and litter are equal after 30 years (Agee et al., 1978).

Fig. 8 Incidence of Lightning and Human-Caused Fires by Month in the Sequoia Subtype. 1922 through 1979.



Parsons (1978) reports an average 60+ year accumulation of 85 tons/acre for all ground fuels, including woody material plus litter and duff, at Redwood Mountain. After prescribed burning, the amount was reduced to nine tons (90% reduction), but has increased to 45 tons/acre within seven years. Seven years after a fire, fuel accumulation was sufficient to support another fire. Fuel loads derived at Redwood Mountain (Nichols and Lester, 1977) show a range of 16 to 127 tons/acre and a mean of 58± 14 tons/acre. Zinke and Crocker (1962) found a total fuel loading of 35 tons/acre under one large sequoia in Giant Forest.

E. Fire Management Zone III (Chaparral/Oak-Woodland)

This zone is confined to the lower elevation foothills along the western boundary of Sequoia National Park in the North, Middle, Marble, South, and East Forks of the Kaweah River. It is comprised entirely of chaparral and oak-woodland vegetation and ranges in elevation between 1,400 ft at Ash Mountain to 6,000 ft. Total acreage is 53,781 (6.7% of the Parks). Along its upper elevation the chaparral/oak-woodland abuts the mixed-conifer of zone II.

1. Topography

Although most of the Sierra Nevada is composed of granitic rock, the lower elevation foothills contain remnants of more ancient overlying metamorphic rock. Metamorphic formations of marble, schist, and quartzite contain numerous caves. Sheer narrow gorges are typical of the Kaweah River watershed and a rise of 5,000 ft in less than five linear miles from Ash Mountain to Giant Forest is indicative of the steep terrain of the zone.

2. Climate

The weather is classified as Mediterranean, with warm, semiarid summers, and cool winters. Maximum temperatures in the summer are usually 90 to 100 F with humidities of 20 to 30%. These conditions combined with daily upcanyon winds of six to 12 mph produce potentially explosive fire conditions. Lightning activity is infrequent at these low elevations.

3. Vegetation

Pure chaparral forms extensive evergreen stands of nearly impenetrable thickets, while pure oak-woodland is more open and consists of deciduous and evergreen oaks with a grass and shrub understory.

The intermingling of these pure types along an environmental gradient produces a heterogeneous pattern of vegetation. Rundel (1979) described four major patterns: foothill woodland, chamise chaparral, mixed evergreen, and black oak woodland.

a. Foothill Woodland

This vegetative pattern, which ranges from 1,400 to 6,000 ft, consists of three general associations: the blue oak woodland, black oak savanna, and California buckeye-grass (Rundel, 1979). The shrub understory is sparse, confined primarily to more mesic sites such as drainages and northfacing slopes.

The introduction of domestic cattle by European man brought a variety of Mediterranean annuals and other exotics which have since become the dominant understory vegetation. Of these, plants such as filaree (*Erodium* sp.), wild oats (*Avena fatua*), soft chess (*Bromus mollis*), and bur clover (*Medicago hispida*) are the most widespread.

The blue oak woodland occurs up to 3,000 ft and on all aspects; on more mesic sites from 1,600 to 4,500 ft it is associated with the buckeye-grass type which features a slightly denser shrub understory. At higher elevations (3,000 to 6,000 ft), blue oak is replaced by black oak which forms the black oak savanna. This type includes bear clover and Sierra gooseberry (*Ribes Roezlii*) in the understory. All three associations display scattered hardwoods, little or no shrub understory, and open grasslands; many of the oak species show adaptations to fire, such as the ability to resprout.

b. Chamise Chaparral

This community is composed of summer dormant evergreen shrubs which form four to 14 ft high brushfields on steep, xeric sites of the foothills, and ranges from 2,100 to 5,600 ft. Chamise is the dominant species, particularly as the age of the stand increases. Manzanita, buckbrush, exotic annuals, and native bunchgrass are also found.

Chamise reaches its highest productivity about 16 years of age, which is taken to equal the time since the last fire. Beyond this age, physiological senescence begins; total shrub biomass peaks at about 35 years (Rundel and Parsons, 1978) and the stand contains 60% dead material in 55 years. A canopy containing only 20% dead material will burn during the summer, a level reached in 14 years (Parsons, 1976). Rapid decadence plus high shrub density results in a highly flammable community which not only requires but also encourages the presence of fire to rejuvenate it.

c. Mixed Evergreen

The mixed evergreen community occurs on north-facing sites from 1,400 to 4,000 ft. The type is affected by environmental gradients such as aspect, topography, and substrate. Buckeye, mountain mahogany, and canyon live oak (Quercus chrysolepis) intermingle to varying degrees. North-facing vegetation generally contains more plants, more species, and taller individuals than the xeric south-facing slopes which typically contain the chamise chaparral type (Hanes and Jones, 1967). Throughout the general community, the canopy is too dense to support a grassy ground cover.

The buckeye-shrub community intermingles with the blue oak woodland on less mesic sites; buckeye dominates its understory of manzanita, buckbrush (Ceanothus cuneatus), and occasionally canyon live oak. Mountain mahogany, a sprouting species, has extensive coverage at about 3,000 ft and occasionally features chamise, manzanita, and Ceanothus species. Between 2,500 and 3,500 ft canyon live oak becomes the dominant species, with interior live oak, mountain mahogany, and buckeye in the understory.

d. Black Oak Woodland

The black oak woodland ranges in elevations between 4,400 to 6,000 ft on north aspects in cool air drainages and further downslope along streams. Black oak is the major hardwood species and bear clover forms an extensive ground cover. The shrub understory is well represented with manzanita, Ceanothus, mountain mahogany, and Sierra gooseberry as some of the more common associates. On more xeric sites, a manzanita-bear clover association forms in which black oak is replaced by incense cedar.

4. Sensitive Plant Species

Within zone III there are three sensitive plant species. Four additional species have been collected nearby and may occur within this zone (Appendix A). Research needs to be done to determine whether fire in the ecosystem could increase populations of certain rare species. Fire suppression may be a significant factor in their decline if they are dependent upon it for their perpetuation.

5. Visitor-Use

This zone constitutes seven percent of the Parks and receives the same percent of all overnight visitor-use, most of that in the established campgrounds. There is very little backcountry use due to the nature of the vegetation and paucity of trails or campsites. Much of the zone can be seen from the Generals Highway and as such, fire and smoke would be highly visible to the public.

6. Archeological and Historical Sites

Zone III contains five bedrock mortar sites, one village, and two pictograph sites, with important locations at Potwisha and Hospital Rock. Three historically important historical sites are also found within the zone (Appendix A).

7. Natural Role of Fire

The dominant chaparral species have evolved with periodic fire; one major impact of periodic burning involves the cycling of nutrients that were previously held in the above ground biomass. Christensen (1973) has documented a substantial increase in ammonium, nitrogen, phosphorus, and other nutrients immediately following fire in chaparral soils. The increase in nutrients creates a highly favorable condition for post-fire vegetative growth. This corresponds with the flush of shrub and herbaceous growth during the first few years following a chaparral fire. Christensen and Muller (1975) have also documented low nutrient levels in unburned chaparral and the diminishing of new growth. The high nutrient content in available forage on new burns significantly influences the vigor of vertebrate groups such as deer and rodents. Recent declines of deer populations have been attributed in part to nutritional deficiencies because of decadent browse (Longhurst et al., 1952).

During the summer drought, both manzanita and chamise produce metabolic by-products in the form of allelopaths (water soluable phenolic compounds). Fog and rain carry these phytotoxins to the soil thus inhibiting the establishment of numerous shrub and herb species. Fire eliminates these toxins and so enhances new shrub and herb growth.

About half of the chaparral species are capable of sprouting after the crown is killed by fire or by mechanical means. This sprouting capability resides in the lignotuber, or subterranean rootcrown burl, and affords them several survival advantages: their preestablished position is maintained, the mature root system provides water and food stores for immediate post-fire growth, first year growth is more rapid than that of seedlings which must endure the rigors of the seedling stage, and the new top inhibits the competition by seedlings by producing phytotoxins and by overtopping them (Hanes, 1977).

The production and germination of seeds in chaparral plants reflect the evolutionary adaptations to fire. Chamise produces two types of seeds, one which can germinate directly on duff, and another which requires heat scarification (Stone and Juhren, 1953). Other adaptive strategies include the production of seeds at an early age (Biswell and Gilman, 1961) and the production of refractory seeds which remain viable for decades and fail to germinate unless scarified by fire (Sweeney, 1956).

Succession following a chaparral fire involves changes in dominance, although the major shrub species are present at all seral stages (called "autosuccession" by Hanes, 1971). Herbaceous annuals, bulb-forming perennials, sprouting shrubs, and seedlings are all found immediately after a fire. Over time, the short-lived species are shaded out by taller, longer-lived species. Thus, succession is a gradual elimination of individuals present from the outset rather than a replacement by new species (Hanes, 1971).

8. Fire History, Fuels and Fire Behavior

Prior to the arrival of Europeans, natural fires in the chaparral and oak woodland were supplemented by Indian burning to create more open vegetation to provide deer browse, to drive game animals, and to improve acorn production. In the latter part of the nineteenth century, sheepherders also used burning extensively in this zone. Since the early 1900's, fire suppression has significantly lengthened the period between fires.

As a result, what had been a mosaic of even-aged, small blocks of vegetation is now a continuous zone of decadent and lower diversity brush and trees. In woodland areas, Vankat (1970) states that there has been an increase in the density of the vegetation, especially of interior live oak due to a lack of disturbance (Griffin, 1977). This continuous layer of dense, decadent vegetation encourages the rapid spread of fire when it occurs.

Over 85% of the acreage burned in zone III has been caused by only three percent of the fires. Rapid fire suppression has kept 85% of the fires from reaching more than a half acre in size. Approximately 60% of the 137 fires recorded from 1922 to 1978 were human-caused, with the greatest number of fires near Ash Mountain and along the Generals Highway. The 1960 Tunnel Rock fire is an example of chaparral fire behavior during the arid summer months. This human-caused fire burned out of control within fifteen minutes and consumed 4,673 acres in twelve days before it was controlled.

Fuel (Model "B")has also increased over time and the probability of a large destructrive fire is now considerable. Chamise chaparral averages up to 20 tons/acre with as much as 50% of this as ground litter in stands over 55 years in age. As a chamise stand increases in age, the standing biomass reaches a peak while litter continues to increase over time (Parsons, 1976). Fuel loadings in other plant communities within zone III will be determined in the near future. Estimations of fuel loadings in foothill types are: manzanita and mixed brush, 15 to 25 tons/acre; brush and oaks, 15 tons/acre and bear clover, 4.5 tons/acre.

Fire behavior differences for the various plant communities in the chaparral/oak-woodland are not well understood. Ongoing research is expected to produce more precise information along with burning prescriptions. Most chaparral fires occur in the summer and move rapidly upslope, especially under strong wind conditions. Crowning commonly results in nearly complete consumption, leaving only charred branches and bare soil, although seedlings and sprouts quickly appear.

In woodland areas, the larger oaks and buckeyes do not always burn in a fire. Where only grass is present in the understory fires generally pass rapidly through the grass without reaching the trees, but where brush is present it acts as a ladder fuel to move fire into the trees. In black oak woodlands, the presence of the resinous bear clover and brush species in the understory causes a rapidly spreading fire which sometimes kills the above ground portion of the oaks.

VI. THE FIRE MANAGEMENT PROGRAM

This section discusses what will be done in the fire management program at Sequoia and Kings Canyon National Parks. The purpose of the fire management program is to develop a totally integrated program where management fires will be used to the maximum extent possible to restore fire to its natural role and wildfires suppressed with minimum damage to the natural resources.

A. Fire Management Strategies

This plan identifies four fire management strategies: suppression, containment, observation, and prescribed burning.

Suppression is the direct or indirect attack to control fire spread along the total perimeter and mopup of a wildfire. It includes those efforts aimed at the control of a wildfire, including size-up, initial attack, hot spotting, line location, line construction, air attack, control, air mobilization, mopup, patrol, extinguishment, and rehabilitation. Modified attack (see page 92) may be taken on wildfires.

Containment is the confinement of a fire by direct or indirect means to a predetermined area within a fire management zone, unit, or area. Containment is a gray zone between full suppression and observation.

Observation is the monitoring of a fire that has been declared a management fire and is in prescription, and achieving approved resources management objectives. No control action is taken on observation fires, but contingency plans for containment are made.

Prescribed burning is the act of starting a fire by management to achieve planned benefits under prescriptive conditions.

All of the fire management strategies are keyed to the fire management zone, unit, or area in which the fire or prescribed burn occurs.

B. Management Fire Program

All Park ecosystems, except higher elevation forests, have been altered by fire suppression. The purpose of this section is to develop a program for the reintroduction of fire into Park ecosystems.

The objective of the management fire program is to restore fire to its natural role wherever possible by:

- Allowing natural and some human-caused fires to burn that are in prescription and meet predetermined objectives in designated areas.

- Expanding the prescribed burning program to reduce fuels and to alter vegetative composition to a more natural condition where natural fire can be allowed to burn.

1. Prescribed Natural Fire Program

a. Prescribed Natural Fire

Natural fires must meet predetermined objectives, be contained to predetermined areas, and be in prescription in order to be allowed to burn.

Prescriptions are a designated set of conditions under which fire is allowed to burn. Basic parameters are fuel moisture of dead fuels of various sizes, and weather conditions such as relative humidity, windspeed, and temperature, all of which influence fire behavior. They also designate limits of the geographic area to be covered and the details and procedures for meeting the stated objectives. Prescriptions are <u>guidelines</u> for the management of fire; they are <u>not</u> guarantees for a safe fire.

The prescriptions (Table 14) used for the prescribed burning program in Sequoia and Kings Canyon National Parks were developed by Van Wagtendonk (1974, 1977, 1978). These prescriptions, which assume that a head or backing fire are the firing techniques, are tied into the 1978 NFDRS (Deeming <u>et al.</u>, 1972) fuel models "F" (open mixed-chaparral), "G" (dense conifer and heavy fuel loads), "U" (long needled pines), "H" (short needled conifers), and "L" (perennial grasses), and have proven to be useful guidelines for developing the natural fire prescriptions.

Fireline intensity, as defined by Byram (1959) (see below), has a significant correlation with observable fire effects such as mortality and scorch. Since intensity can be correlated with flame length (Albini, 1976), burning index (BI) which is a predicted flame length divided by ten, was chosen as one prescription guideline.

Byram's Fireline Intensity Equation

I=HWR

I = Fire intensity in British thermal units/second/foot of fire front
H = Heat yield in BTU /pound of fuel
W = Weight of available fuel in pounds per square foot
R = Rate of spread in feet per second
HW = Available fuel energy in BTU per square foot

Intensity is determined in part by the available fuel load. The energy release component (ERC), which together with the spread component forms the burning index (BI), is related to the available energy, BTU per unit area (square foot), within the flaming front at the head of the fire and is numerically equal to the BTU's per square foot divided by 25 (Deeming et al., 1977). Since it involves the fuel moistures of 1, 10, 100, 1000 hour timelag fuels, it is an indication of the availability to combustion of these fuels. Its use permits a greater understanding of the relationship between fuel moisture and the BI.

The use of BI and ERC allows for greater latitude in designing prescriptions because many factors go into their formulation. A simple range of temperature, windspeed, fuel stick moisture, and relative humidity conditions under which prescribed natural fire may burn produces flexibility problems if all but one parameter are within prescription. The BI allows for internal compensation of the basic parameters and incorporates them into perhaps the most important characteristic of a fire, its fireline intensity.

Research conducted in Canada, Australia, and the United States has given some indication of acceptable fireline intensities. Deeming et al., (1977), summarizing Roussopoulos and Johnson (1975), state that most prescribed burns are conducted in the zero to 50 BTU/sec/ft range (BI = zero to 28), and that 100 BTU/sec/ft (BI = 38) is generally the limit of control for manual attack methods. Hough (1968) believes that intensities of 20 to 90 BTU/sec/ft are acceptable in southeastern pine forests. Van Wagtendonk (1972) reported a maximum intensity of 75 BTU/sec/ft in a spring burn in ponderosa pine.

Research conducted in Sequoia and Kings Canyon (Nichols and Lester, 1977; Nichols, 1978a; Nichols, 1978b) has shown that an intensity of 200 BTU/sec/ft (BI = 50) is probably the upper limit for sequoia-mixed-conifer forests.

The intensity can be higher with more open canopies as are found in ponderósa pine-bear clover forest but scorch and char will probably exceed acceptable visual impact above this intensity; with a five mph wind, scorch can be expected to reach 27 ft (Albini, 1976), and may be higher in stands with pockets of heavy fuels.

Van Wagtendonk's interim 1978 NFDRS prescribed burning prescriptions (Table 14) are divided into spring headfires (fuel models "F", "G", "L", and "U") and fall backing fires (fuel models "F", "G", "H", and "U"). The BI and ERC values for Sequoia and Kings Canyon National Parks, based on FIRDAT records, and the locations to which they are applicable are shown in Table 15.

The table lists the zone, strategies and then BI and ERC values, and for observation or containment the percent of the season that the value was at or below this level during the 1977 season, which was a drought year. Values were initially selected by comparing the fire behavior and effects of previous fires with their NFDRS values, and are also based on Van Wagtendonk's prescribed conditions.

Table 14 Van Wagtendonk Interim 1978 National Fire Danger Rating System (Deeming, et al., 1977) Prescribed Burning Prescriptions

SPRING HEADFIRES

FUEL MODEL	F	G	L	U	U
VEGETATION	Manzanita/ Ceanothus	Incense-Cedar/ White Fir	Perennial Grasses	Ponderosa Pine	Ponderosa Pine/Bear Clover
Air Temperature (°F)	30-75	30-75	30-75	30-75	30-75
Relative Humidity (%)	30-65	30-65	30-65	30-65	30-65
Wind Speed (mph)	0-10	0-10	0-10	0-10	0-10
1-Hour TL	5-6	6-8	6-8	6-8	7-10
10-Hour TL	9-14	9-13	8-12	9-15	9-16
100-Hour TL	10-20	10-20	10-20	10-20	10-20
1000-Hour TL	10-30	15-30	15-30	15-30	15-30
Spread Component	3-8	3-8	1-7	1-6	1-5
Energy Release	5-15	15-30	1-4	12-20	10-15
Burning Index	15-28	20-35	10-15	10-15	9-12

FALL BACKING FIRES

FUEL MODEL	F	G	G	H	U	U
VEGETATION	Manzanita/ Ceanothus	Incense-Cedar/ White Fir	Giant Sequoia	White Fir/ Red Fir	Ponderosa Pine	Ponderosa Pine/Bear Clover
Air Temperature (°F)	40-90	40-85	50-90	40-90	40-85	40-85
Relative Humidity (%)	20-40	20-50	20-50	20-40	20-50	25-60
Wind Speed (mph)	0-10	0-10	0-10	0-10	0-10	0-10
1-Hour TL	4-6	4-8	3-6	3-8	4-8	4-8
10-Hour TL	6-10	6-10	6-8	5-10	6-10	6-10
100-Hour TL	7-12	7-15	7-12	7-12	8-15	8-15
1000-Hour TL	10-15	10-15	10-20	10-20	10-20	10-20
Spread Component	3-8	3-10	3-10	1-5	2-6	2-6
Energy Release	15-30	35-50	40-60	25-35	25-37	25-37
Burning Index	18-35	30-45	30-50	15-30	20-40	18-35

Table 15. 1978 NFDRS BI and ERC values for prescribed natural fires in Sequoia and Kings Canyon National Parks, and the percentage of the season they are less than or equal to this value for observation or containment status, and greater than or equal to this value for suppression status.

Zone	BI	%	ERC	%	Strategy
Zone I (1979 additions)	45	44	40	42	observation
NFDRS model- G	55	68	50	72	containment
station- Grant Grove	56	32	51	28	suppression
Zone II/lb					
6000'-8000' (both parks)	40	33	35	33	observation
NFDRS model- G	50	55	43	55	containment
station- Grant Grove	51	45	44	45	suppression
3000'-6000' (Sequoia NP)	40	43	13	38	observation
NFDRS model- C	50	71	15	53	containment
station- Milk Ranch	51	29	16	47	suppression
3000'-6000' (Kings Cyn. NP)	40	13	13	14	observation
NFDRS model- C	50	21	15	21	containment
station- Cedar Grove	51	79	16	79	suppression

In addition to the numerical prescriptions, certain qualitative prescriptions, or assumptions, were developed for use in all zones. These are in addition to the general basic assumptions concerning the role of fire in the Parks' ecosystems; they include the conditions under which fire will be contained and allowed to burn within a set perimeter or will be suppressed.

These assumptions include: (Natural fires only)

(1) Fires approaching boundaries will be contained within the Parks unless an interagency agreement has been reached which allows fire to cross boundaries.

In this event, fires crossing into the Park will be regarded as new starts and must be in prescription; otherwise they are not allowed to cross the boundary, or are suppressed as quickly as possible after crossing. Fires which start near the boundary and have the potential to cross out of prescription are to be suppressed or contained.

(2) Human safety shall override all other prescriptions. No fire shall be allowed to burn if it is a threat to frontcountry or backcountry users. Structures shall be protected; should a fire start which threatens them, the fire will be contained or suppressed.

(3) Smoke must be monitored to prevent conflict with local, State, and Federal air quality regulations. Prescribed natural fires below 6,000 ft may require burning permits, and stability of the atmosphere and direction of smoke drift must be monitored to prevent adverse health, visual, or safety impacts on the visitor. Fires which start under conditions which will produce unacceptable levels of smoke will be contained or suppressed; atmospheric conditions which change with the season may influence the strategy towards long-term fires.

(4) An informed public is important to the success of the fire management program. Naturalist lectures on the role of fire in the forest, flyers given to incoming visitors at entrance statins, and roadside signs placed when smoke is visible from the highway help to keep the public aware of why fires may be burning without being suppressed.

Dissemination to the media of the status of ongoing fires is the responsibility of the Management Assistant. News releases shall not only explain what is occurring but also how the fire meets, or doesn't meet, the objectives of the Fire Management Plan. Unless this is made clear, the multiple strategies of observation, suppression, and containment may be confusing to the public, and even to the Parks' personnel.

(5) No more fires will be given observation status than can be contained or suppressed if fire weather becomes extreme. This is especially important in the case of fires that occur early in the season, since fires that begin in prescription will usually be contained but not suppressed if they go out of BI or ERC prescriptions, unless they exceed smoke, safety, or boundary requirements, and so reach considerable size.

Consequently, a fire which has been declared an observation fire is continually monitored. Fire management personnel will monitor the status of the fire and predicted fire weather and make contingency plans for containment if prescriptions are exceeded. Therefore, the Fire Management Officer must decide, based on a fire by fire evaluation of its potential, how many acres or how many fires can adequately be monitored and if necessary contained, in addition to normal suppression activities. Unexpected runs must be avoided; therefore, early detection of fires and subsequent monitoring of current and predicted fire weather, direction of fire spread, and fire behavior must be maintained at a high level of proficiency. If there is doubt that this high level can be maintained, not only at the fire's start but also until its natural extinguishment, the fire should be <u>suppressed</u> <u>or</u> <u>contained</u> <u>immediately</u>.

(6) Aircraft are necessary to gather critical information efficiently on the status of a fire, or to contain or to suppress it while it is small. Whatever the strategy may be, minimum impact will be inflicted on the resource.

b. Fire Management Strategies, Prescriptions, and Decision Process

Natural occurring fires anywhere in the Park that burn in prescription and can meet predetermined objectives <u>may</u> be allowed to burn out under a containment or observation strategy. Any natural fire or portions thereof that is allowed to burn inside a containment zone is a management fire. The Fire Management Officer will select the appropriate fire management strategy based on prescriptions.

Fire management strategies will vary depending on the objectives and prescriptions. The fire management strategies listed in Table 16 will be used in the zone indicated. Upon the detection of a fire, the Fire Dispatcher will refer to the dispatch flowchart (Figure 13, Page 112). A yes-or-no decision will be made at each step until the point is reached to either suppress the fire or refer to the zone I or zone II/1B decision charts. Zone II will be considered a suppression zone until prescriptions for chaparral/oak-woodland are developed.

Table 16 Fire Management Strategies

Fire Management Zones/Units	Fire Management Strategies		
	Suppression	Containment Restrictive prescriptions	Observations
Fire Mgmt. Zone I (Alpine/Subalpine Upper/Mixed-Conifer 1. Natural Fire Mgmt. Unit (1A) and 1979 Additions	X	X	X
2. Conditional Fire Mgmt. Unit (1B)	X	X	X
Fire Mgmt. Zone II (Sequoia-Mixed-Conifer) 1. Mixed-Conifer	X	X	X
2. Sequoia	X	X	X
Fire Mgmt. Zone III (Chaparral/Oak-Woodland)	X	-	-

(1) Fire Management Zone I (See Figure 9 for Decision Chart)

Zone I is composed mainly of the high elevation natural fire zone created in 1968. The balance of the zone is made up of 1979 additions which will be treated with a slightly more restrictive prescription than the rest of the zone until such time that the behavior of natural fire in them is shown to meet management objectives.

Fires occurring anywhere in the zone must meet smoke management criteria. These may dictate that a maximum number of fires or acres may be burning at any one time. Consideration should be given as to where the smoke from any fire is going, and in the case of long-burning fires, how the stability of the atmosphere will change as months pass.

If the fire threatens to enter zone II/1B, it will be regarded as a new start in the receiving zone. If zone II/1B is in prescription, the fire will be allowed to cross and will be treated as a new fire. If not in prescription, the fire will be contained or suppressed in zone I.

For the majority of the zone, if these two requirements are met, the fire will be declared an observation fire. The fire will be monitored and all or any part of the fire may be contained or suppressed if management objectives are not being obtained.

For the 1979 additions, BI and ERC prescriptions are invoked. If the average ERC of the current day and the two previous days is less than or equal to 40 and if the average BI of the current day and the previous two days is less than or equal to 45, the fire will be declared an observation fire. If either the BI or ERC exceeds the prescribed value, containment or suppression will be started, depending on the value of the averaged BI or ERC.

If the BI is 46 to 55 or the ERC is 41 to 50, containment will be performed; natural barriers will be used and a predetermined area will be allowed to burn out. Suppression, which is involved if BI exceeds 55 or ERC exceeds 50, differs from containment in being a more aggressive form of attack, in which the fire is to be kept as small as possible and extinguished promptly.

NFDRS indices, like any prescriptions, are guidelines and not absolutes. If on the ground monitoring or long range weather forecasts show a present or potential excessive fire danger, the Fire Management Officer can overrule the prescriptions. Fires which start under a containment or observation strategy will not be suppressed unless the changing conditions force the fire's behavior to a point that management objectives are not being reached. If conditions have changed significantly since the onset of the fire (i.e., warmer and drier), the decision chart must be consulted to ensure that objectives are being met; if the prescription has become one of suppression, containment will usually be used instead, unless the Fire Management Officer desires suppression.

All containment and observation fires will be monitored on the ground or from the air at least once a week or more often if the Fire Management Officer desires knowledge as to the status of one or more fires.

Any fire can be reclassified from one status to another by the Fire Management Officer. The Chief Ranger and Chief of Resources Management will be advised of any changes in fire classification. A natural fire in the 1979 additions or in zone II/1B which is in the decision chart prescription for observation status will be considered as a prescribed natural fire and will not be suppressed or contained without the approval of the Chief of Resources Management. The Fire Management Officer will discuss its status and potential with him, and if it threatens to exceed prescription, cannot be properly monitored, or may present control problems in the future, the Chief of Resources Management will direct the Fire Management Officer to contain or to suppress it, according to the recommendations of the latter.

(2) Fire Management Zone II/1B (see Figure 10 for Decision Chart)

This zone is composed of high and low elevation mixed-conifer forests as well as sequoia groves. The prescriptions for this zone do not include separate prescriptions for sequoia groves because Van Wagtendonk's prescriptions actually require drier conditions than the general upper or lower mixed-conifer types. Thus if mixed-conifer types are in prescription on the warm end, the sequoia groves must be in prescription as well.

Zone II/1B has received probably more intensive fire suppression over the years than zone I, due in large part to its greater accessibility even in pre-helicopter days, and this combined with a greater fuel production from its longer and warmer growing season makes it more of a fire hazard than is zone I. As a result, the prescription (Figure 10) is more restrictive than those of zone I. The Fire Management Officer will decide what area the fire will be contained to.

Perhaps the most important condition to be satisfied is the first, in which no more than five fires or 200 acres will be allowed to burn at any one time in this zone. This can be modified up or down to whatever the Fire Management Officer feels to be comfortable and any fire can be contained or suppressed in the event of hazardous fire weather or some other deleterious factor. On the other hand, more fires than five may be allowed to burn if their potential for presenting difficulties, in the future as well as in the present, is low.

Fires occurring after June 15 and before September 15 will be suppressed or contained until knowledge and experience is gained in the behavior of natural fire in this zone. Containment or suppression during this period will eliminate much of the problem of dealing with multiple fires from a single thunderstorm and the even more complex problem of fires that start in the early season in prescription and become steadily more out of prescription as fuels dry over the summer. This requirement will aid in the prevention of overtaxing the Fire Management Office, especially during the period of highest visitor use and of hottest weather.

As in zone I, smoke conditions must be favorable for dispersal. Since zone II/1B drops below 6,000 ft, the local, State, and Federal Clean Air Standards will be consulted and burning permits obtained, if necessary. It may be required at certain times of the year to contain the lower limits of a fire to keep it out of an inversion.

Prescriptions for BI and ERC are also more restrictive than in zone I and include elevation guidelines. If the ERC is $\leq$ 35 for 6,000 to 8,000+ ft, or $\leq$ 13 for 3,000 to 6,000 ft, and the BI is $\leq$ 40, for the average of the current day's and previous two days' values, and the forecasted next day's ERC and BI $\leq$ the current day's value, the fire is declared an observation fire. Containment is called for if the three day average or forecasted 6,000 to 8,000 ft ERC is 36 to 43 (14 to 15 for 3,000 to 6,000 ft) or the average or forecasted BI is 41 to 50. Suppression action is to be taken if the average or forecasted 6,000 to 8,000 ft ERC > 43 (> 15 for 3,000 to 6,000 ft) or the average or forecasted BI > 50.

If the fire is declared an observation or containment fire, it will be monitored at least once a day from the air or from the ground, or more often if the Fire Management Officer needs more information on a fire's status due to some new factor such as a warming trend. At this time, the decision chart will be followed as in a new start, to ensure that the fire is meeting management objectives and that the proper strategy is being employed.

Fire may be reclassified in status as per instructions given in the previous section on zone I prescriptions.

(3) Fire Management Zone III

All fires will be suppressed in this zone year-round until prescriptions are developed. Prescribed burning will be used to reduce fuels and create a mosaic of age classes.

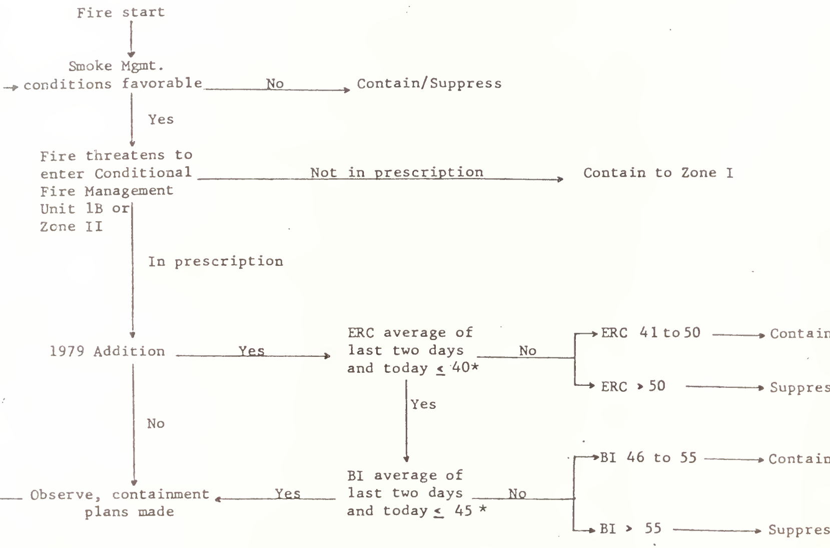
c. Special Areas

Fires will be suppressed which threaten any of the historical or archeological sites listed in Appendix A. Areas which contain endangered and threatened plant species will also be protected from fire. Fires may be contained or partially contained so that they are allowed to burn except in the vicinity of these sites; however, since only one miscalculation can cause the loss of these resources, it will be better to act on the conservative side and suppress any fire in the vicinity of these sites if the ability to contain the fire is in doubt. If research shows that these species are fire dependent, fire will be reintroduced.

2. Human-Caused Fires

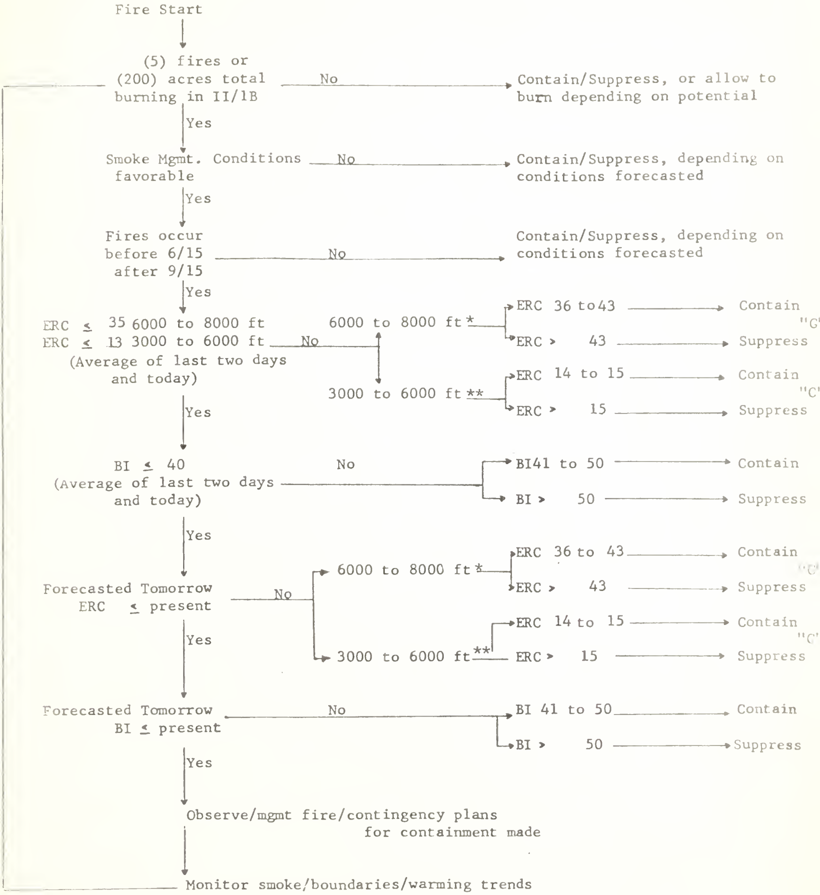
Human-caused fires in zone II/1B may be declared management fires provided they meet all of the criteria in the prescription decision chart (Figure 10a). The number and size of these fires will be small. Each fire will be closely monitored and the effects studied.

Fig. 9 Zone I Prescription Decision Chart for Prescribed Natural Fires (Model "G")



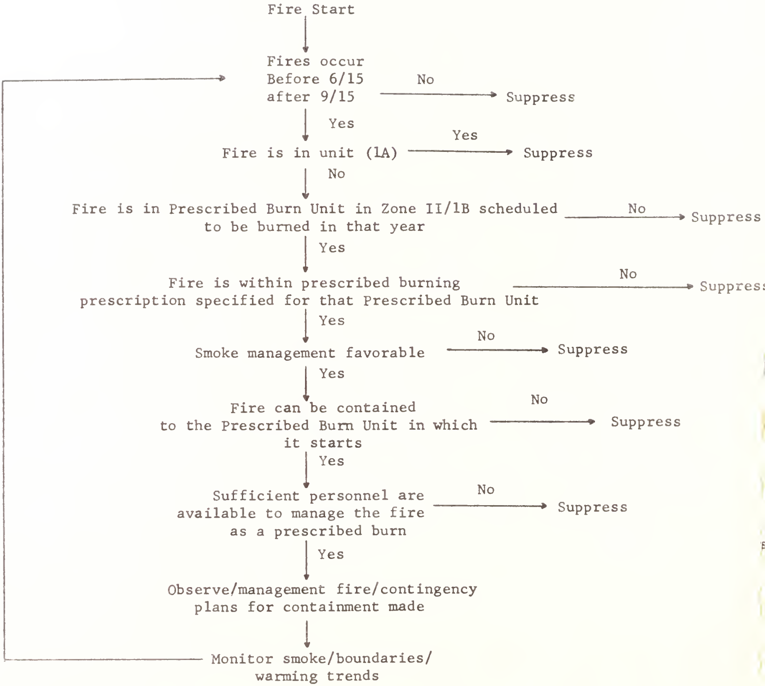
*Grant Grove station

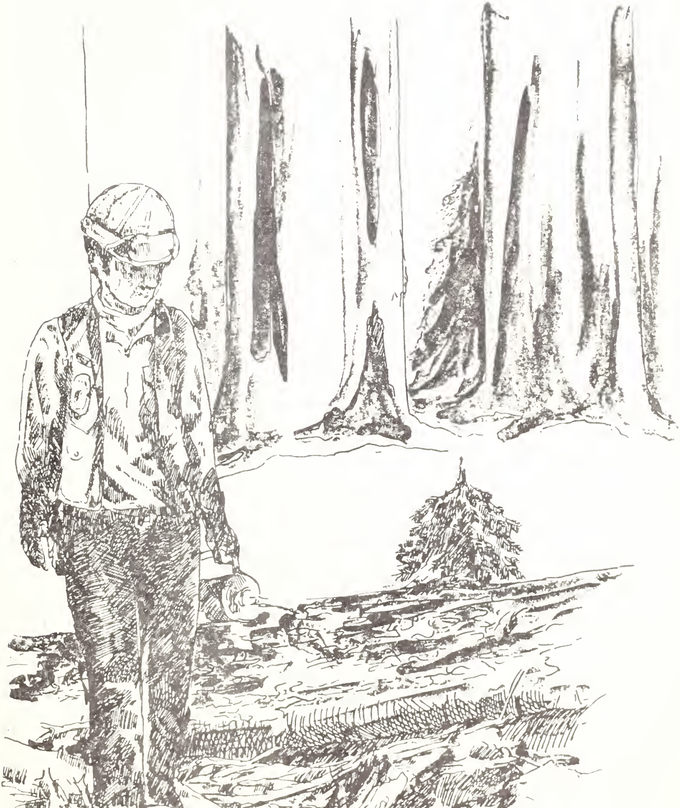
Fig. 10 Zone II/1B Prescription Decision Chart for Prescribed Natural Fires
(Models "C" and "G")



*Grant - both Parks
**Milk Ranch - Sequoia
Cedar Grove - Kings Canyon

Fig. 10a Zone II/1B Prescription Decision Chart for Human-Caused Fires





3. Prescribed Fire

Prescribed burning has become a vital part of the fire management program at Sequoia and Kings Canyon National Parks. The goal of the prescribed burning program is to reintroduce fire into areas where fire suppression has altered the natural fuel load and changed vegetative composition. Burns will not be designed to reduce fuel 100%. It will be a gradual process using the burns to simulate natural fires as much as possible. This will gradually create a mosaic of burned and unburned areas where natural fires can be allowed to burn.

a. The Prescribed Burning Program

(1) Fire Management Areas (Figure 11)

Fire management zones II/IB and III were divided into 31 fire management areas (Table 17), which were further subdivided ito 199 prescribed burn units. These burn units consist of any area that will be burned at one time and as one unit and where prescribed natural fires may be contained. Appendix C lists the prescribed burn units by fire management area.

(2) Prescribed Burning by Fire Management Zone

(a) Fire Management Zone I

Fire management zone I covers 681,009 acres, from about 8,000 ft to 14,495 ft. Vegetation types range from upper mixed-conifer forest to subalpine and alpine areas. Because of the "natural" fuel load, little prescribed burning will be conducted. Prescribed burns in zone I will be used to:

-Reduce fuel along the Parks boundary so that prescribed burns and prescribed natural fires can occur without escaping from the Parks.

-Protect visitors and backcountry ranger patrol cabins and historical structures from fire.

-Reduce fuel along the boundary between zone I and II, where necessary, to prevent prescribed natural fires from escaping from the natural fire management unit.

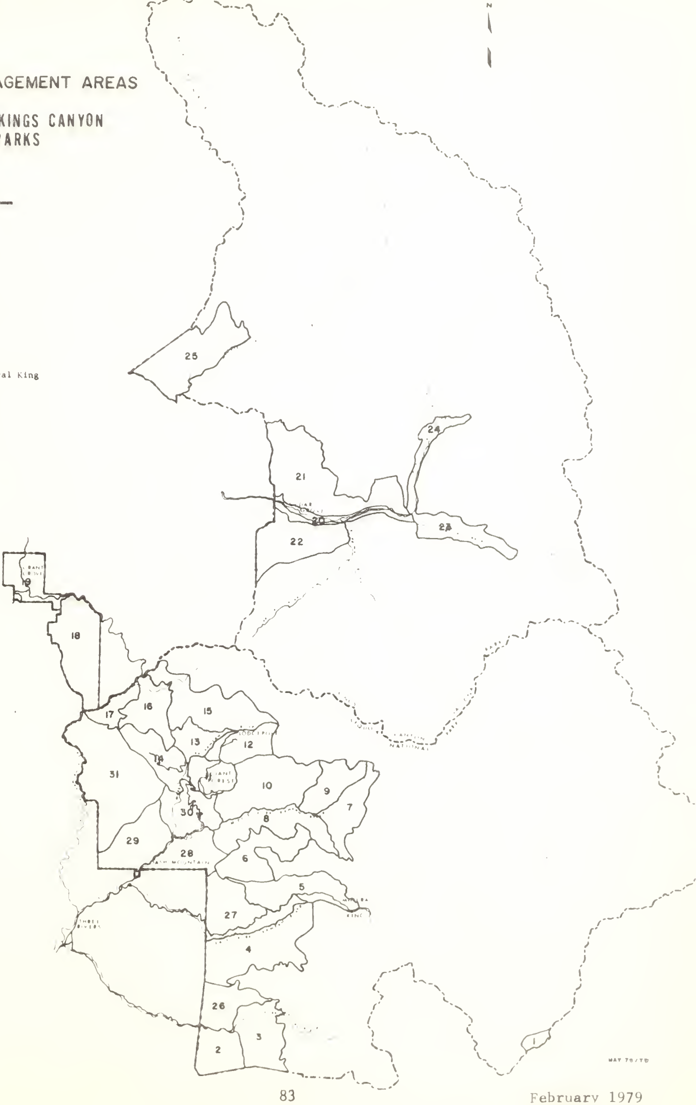
(b) Fire Management Zone II/1B

Fire management zone II/1B covers 127,639 acres extending from about 5,500 ft to 8,000 ft. Vegetation types range from oak-pine and brush at lower elevations to sequoia at the middle elevations to white/red fir/Jeffrey pine at the higher elevations.

Figure 11

FIRE MANAGEMENT AREAS

SEQUOIA & KINGS CANYON NATIONAL PARKS



AREAS

1. Kern Canyon
2. Garfield Grove
3. Homers Nose
4. Cahoon Meadow
5. Oriole Lake
6. Castle Rocks/Mineral King
7. Redwood Meadow
8. Kaweah
9. Bearpaw Meadow
10. Panther Peak
11. Giant Forest
12. Lodgepole
13. Suwanee
14. Crystal Cave
15. Halstead Meadow
16. Dorst Creek
17. Skagway
18. Redwood Canyon
19. Grant Grove
20. Cedar Grove
21. North Mountain
22. Sentinel Ridge
23. Bubbs Creek
24. South Fork Kings
25. Tehipite
26. Clough Cave
27. Lookout Point
28. Milk Ranch
29. Ash Mountain
30. Hospital Rock
31. Yucca Mountain

Table 17 Fire Management Areas

Fire Management Zone	Fire Management Area	Number of Prescribed Burn Units	Size (Acres)
Fire Management Zone I	Boundary areas only	0	-
Fire Management Zone II/1b	1. Kern Canyon	1	722
	2. Garfield Grove	5	4,145
	3. Homers Nose	7	6,634
	4. Cahoon Meadow	10	11,231
	5. Oriole Lake	8	5,971
	6. Castle Rocks/Mineral King	7	5,654
	7. Redwood Meadow	6	5,409
	8. Kaweah	4	4,974
	9. Bear Paw Meadow	7	3,992
	10. Panther Peak	10	9,420
	11. Giant Forest	12	3,000
	12. Lodgepole	6	4,026
	13. Suwanee	3	2,746
	14. Crystal Cave	9	4,745
	15. Halstead Meadow	7	8,608
	16. Dorst Creek	5	4,641
	17. Skagway	2	2,209
	18. Redwood Canyon	9	8,552
	19. Grant Grove	9	4,432
	20. Cedar Grove	6	2,878
	21. North Mountain	8	12,903
	22. Sentinel Ridge	6	7,406

Table 17 Fire Management Areas

Fire Management Zone	Fire Management Area	Number of Prescribed Burn Units	Size (Acres)
	23. Bubbs Creek	4	4,120
	24. South Fork Kings	4	2,644
	25. Tehipite	7	9,746
Fire Management Zone III	26. Clough Cave	3	4,234
	27. Lookout Point	7	7,185
	28. Milk Ranch	4	4,620
	29. Ash Mountain	6	6,286
	30. Hospital Rock	5	4,926
	31. Yucca Mountain	12	14,574

After 25 years without fire, fuels range from 50 tons per acre in ponderosa pine to 70 tons per acre in sequoia groves.

The objectives are to reduce fuels throughout the zone particularly in sequoia groves, along the boundary, and around developed areas, and to reduce the over abundance of shade tolerant trees, such as incense cedar and white fire.

The prescribed burn units within the mixed-conifer zone will be burned within about a 17 year period. It is believed that after the initial prescribed burn, natural fire can begin to shape the forest into a natural mosaic. Prescribed fire will be used again, if necessary, to further reduce fuels until such time that natural fire can again play its natural ecological role, occurring at its own frequency.

Kilgore and Taylor (1979) found that "fire frequency" depends on aspect, vegetation, and the size of the area under consideration. In the Redwood Mountain area, which is sequoia-mixed conifer, before 1875 fire occurred about every nine years on west-facing slopes and 16 years on east-facing slopes. The mean fire-free interval in ponderosa pine on a dry ridge was five years, while in more moist sites with white fir it was 15 to 18 years. A fire occurred somewhere in the drainage every two to three years and 11 to 39 years on individual trees.

These figures include both Indian and lightning fires, and are similar to those obtained by others (Show and Kotok, 1924; Wagener, 1961; Biswell, 1961; and Parsons, 1977). Kilgore and Taylor (1979) found that the present frequency of lightning fires alone cannot account for the pre-1875 fire frequency. Although Indian burning probably had little influence on evolutionary fire adaptations, it may have increased the range of fire-adapted species (Agee, 1974).

A basic question to be addressed is whether or not to augment the natural fire frequency with prescribed fire, thereby bringing the overall fire frequency to a close agreement with pre-1875 fire frequencies, at least in sequoia-mixed conifer. Subsequent to the initial prescribed burning of the units, a decision will be made on the use of prescribed fire in addition to natural fire.

Approximately 10,000 acres will have to be burned each year to achieve the necessary rotation. The actual acreage burned each year may be somewhat less than planned because of the variable fuel and moisture conditions over large areas, and various administrative restraints.

The size of the prescribed burn units in Zone II/1B will vary from a few acres in sequoia groves and around developed areas to areas of several thousand acres in size in the more remote areas. Boundaries of the units include natural barriers, such as streams, ridges and fuel changes, trails, roads, and constructed fire line.

Prescribed burning will be conducted during all seasons of the year whenever an area is in prescription. Spring burning will be confined to lower mixed-conifer and upper chaparral units in south or west facing slopes where continuous fuels will allow the use of head fires. The burns will be designed to remove most of the fine fuels to provide fuel breaks for summer/fall burns. By reducing the bulk of the green fuels in the spring, little impact will result to visitors and to areas outside the Parks from smoke because of the excellent dispersion at this time of the year.

Only about 20% or less of the acreage burned during the year will be burned in the spring.

Summer and fall burns will be conducted in both lower and upper mixed-conifer forests. The fuels not reduced in the spring burns will be reburned in the summer and/or fall. Backing fires will be the burning technique for the summer/fall burns because they closely simulate natural fires during a time of year when natural fires occur. The burns over large acreages will be several weeks duration, but with backing fires and dry fuels, smoke problems should be few.

Priorities for burning are based on the length of time since previous burning, fuel loading, and vegetative conditions, topographic relief, and by manpower and logistical requirements. Upper elevational units will usually be burned first where they share a common boundary with the natural fire management unit (1A). Ridge tops and heavy fuels will be burned out the first year, followed by burning of the unit. Units that have easy access will be burned first.

Thirty-five sequoia groves (8,274 acres) (Table 18) exist as enclaves in the mixed-conifer forest. Fuel management will be the initial objective to reduce fuel hazard followed by a vegetation management objective to reduce over abundant shade tolerant species and to create a more natural mosaic of age classes.

Vegetation management objectives in the sequoia groves are considerably more complicated than are fuel management objectives. The varying frequencies, patterns, and intensities of fire in the various vegetation types of the Parks shape their composition and structure. To remedy a century of interference with the natural fire cycle will require many years.

Bonnicksen and Stone (1978) point out that prescribed fire may not be able to restore primeval conditions. They believe that because of the heavy accumulation and uniformity of fuels, fires will tend to produce relatively uniform results and not the mosaic of age classes believed to have existed under the natural fire cycle. Moreover, white firs are now in the overstory to an unnatural extent, and they are not likely to be removed by prescribed fire.

The management prescriptions which Stone and Bonnicksen have proposed include the preservation of selected aggregations of vegetation from fire, thus creating vegetation mosaics, and the cutting of selected shade tolerant individuals in the overstory.

Testing of the feasibility of their proposals will begin in the Redwood Mountain sequoia grove in 1979. While it may not be possible economically to manipulate the thousands of acres that are scheduled to be burned as they suggest, certain high value areas such as in the Grant Grove and Giant Forest areas are prime areas for consideration.

Fire intensity in the groves will be controlled. Low intensity (~200 BTU/ft/sec) surface fires will be used in the summer or fall to hold trunk scorching of the sequoias to a minimum. The Prescribed Burning Guidelines give a more detailed account of the procedures and techniques to be used in burning in this type.

(c) Fire Management Zone III

The chaparral/oak-woodland ecosystem comprises 53,781 acres and ranges from about 1,400 ft to 6,000 ft. The long-range objective is to maintain type and age class mosaics, reduce fuel buildups, and recycle nutrients to simulate the effects of natural fire. Initial burns will be used to reduce fuels to provide a mosaic of different-aged fuels.

A research program is now underway to determine the role of fire in the chaparral/oak-woodland ecosystem and the prescriptions and techniques under which to burn these areas. The first prescribed burns will be experimental research burns in all chaparral types to start in spring, 1979. South and southwest slopes will be burned in early spring when the surrounding grasses in the oak woodland and north-facing chaparral slopes are too wet to burn. The north and east slopes and the oak-woodland can be burned later, in the fall, using the spring burns as fuel breaks.

Prescribed burns will also be conducted around Ash Mountain in the late spring to reduce the grass fuels that pose a severe fire hazard during the fire season.

Table 18 Sequoia Groves in Sequoia and Kings Canyon National Parks

Grove	Size (Acres)	*Total Number of Trees
Atwell	806.0	9,191
Big Springs	0.7	4
Big Stump	137.0	3,587
Board Camp	37.8	270
Cahoon Creek	14.0	226
Castle Creek	196.5	1,748
Cedar Flat	10.9	482
Clough Cave	0.5	4
Coffeepot Canyon	5.4	60
Dennison	10.6	54
Devils Canyon	6.0	36
East Fork	542.0	18,691
Eden Creek	360.7	1,952
Garfield	1130.0	23,530
Giant Forest	1880.0	18,657
Granite	1.3	31
Grant	90.0	1,110
Homers Nose	96.8	719
Horse Creek	41.6	300
Little Redwood Meadow	32.6	835
Lost	37.0	469
Muir	214.0	1,753
New Oriole Lake	9.2	87
Oriole Lake	106.0	1,319
Pine Ridge	34.2	695
Putnam-Francis	0.1	1
Redwood Creek	39.5	333
Redwood Meadow	189.0	4,573
Redwood Mountain	1907.0	66,751
Sequoia Creek	6.5	38
Skagway	52.0	526
Squirrel Creek	0.2	3
South Fork	209.5	2,274
Surprise	4.1	46
Suwanee	65.0	556
Totals	8274.7	160,911

*Number of trees <1 ft DBH = 107,172
Number of trees >1 ft DBH = 53,739

b. Seventeen-Year Prescribed Burning Program

The 17-year prescribed burning program is designed to conduct prescribed burning in as many fuel types as possible in order to utilize the varying flammabilities and fuel moistures. A 17-year burning program will be developed for each fire management area and will remain flexible to take advantage of favorable prescriptions.

Initial emphasis will be placed on burning areas of high value. The first areas to be burned will be those that have easily defensible boundaries and good access. This will provide for maximum protection until prescriptions and techniques are refined. Later burns will be larger as new techniques, such as aerial ignition, are developed and prescribed burning knowledge increases.

The burning schedule will require that an average of about 10,000 acres will be burned each year. The number of acres burned will gradually be increased from about 4,000 acres in 1979 to 12,000 acres in 1984 and then continuing at that, or at a slightly increased level, until all of the units are burned.

As soon as the fuel is reduced significantly in an area to prevent the escape of a prescribed natural fire, it will be added to the natural fire management unit (1A). In some areas only one burn will be required to add that area to the natural fire management unit, whereas several burns will be required where fuels are heavy. Reburns will be designed to remove over-represented shade tolerant trees.

The projected 17-year prescribed burning program schedule is listed in Table 19. The prescribed burn units are coded to the fire management area in which they occur. The prescribed burning schedule will be revised each year as needed.

C. Wildfire Suppression Program

Sequoia and Kings Canyon National Parks is comprised of some 862,000 acres of which 181,420 acres are in containment/suppression strategy due to the heavy fuels, exposure, steep slopes, and wind.

Terrain and topographical features vary from the brush and grass-covered steep canyon slopes and ridges to the rocky cliffs and peaks. Much of fire management zones II/Ib and III is readily accessible by road and trail, but some of it is remote and difficult to reach. Forests in zone II/Ib have

heavy fuel, while fast-burning, lighter fuels lead up to these forests from the lower slopes. This presents a difficult suppression problem, especially in and around developed areas and along the Generals Highway from Ash Mountain to Giant Forest. The objectives of the wildfire suppression program are to:

1. Reduce human-caused wildfires. A thorough investigation will be made of all human-caused wildfires to accurately determine the cause. This is necessary to determine shifts in emphasis on prevention activities as well as for subsequent legal action and through education and public contact.

2. Control wildfires to the smallest area in a cost-effective manner so as to keep suppression damage to Parks' resources to a minimum.

3. Respond to and start control action on any wildfire that threatens lands in the mutual attack zone outside the Parks.

4. Maintain an effective method for detection of wildfires using lookout towers and aerial detection.

5. Suppress all fires in Mineral King until the general management plan is completed.

Modified attack may be taken on suppression fires during low to moderate fire danger. An assessment of the fire must be made to determine the risk of life and property, resources, weather, fuels, and fire suppression priorities. Suppression fires occurring in remote areas during heavy rain may not be manned until the next day. The modified attack of a wildfire is the result of economics, wet or hazardous weather, accessibility of the fire, number of fire starts, and crew safety.

The procedures and guidelines for implementing the wildfire suppression program are in section VII, page 101.

Table 19 Prescribed Burning Program Schedule

Year	Prescribed Burn Unit Number	Size (Acres)
1979*	20-2	39
	20-1	46
	20-3	46
	20-5	24
	14-2	240
	7-2	1,205
	9-6/7-1	1,476
	18-1	73
	19-4	8
	19-1	25
	13-2	150
	31-9	150
	11-8	10
	11-7	71
	28-3	10
	30-2	20
	29-2	20
	29-3	120
	15-4	140
	1979 Total	3,873
1980	9-6/7-1	966
	30-2	1,173
	31-1	510
	11-6	134
	13-2	1,463
	21-7	1,401
	20-1	3
	20-3	77
	20-4	58
	20-5	27
	11-7	10
	31-9	90
	19-5	57
	19-1	6
	18-1	318
	29-2	20
	29-3	940
	1980 Total	7,253
*actual areas		

Table 19 Prescribed Burning Program Schedule

Year	Prescribed Burn Unit Number	Size (Acres)
1981	9-7	472
	9-1	403
	9-2	246
	20-1	685
	18-1	699
	19-5	351
	21-6	949
	22-6	602
	11-5	315
	13-1	51
	13-3	1,082
	1981 Total	5,855
1982	9-3	1,534
	9-4	354
	9-5	305
	18-2	519
	12-1	585
	19-2	351
	20-2	818
	16-5	622
	11-10	308
	21-5	2,253
	5-7	1,299
	5-8	423
	1982 Total	9,371

Table 19 Prescribed Burning Program Schedule

Year	Prescribed Burn Unit Number	Size (Acres)
1983	7-3	1,028
	7-4	987
	7-5	158
	7-6	267
	11-3	98
	20-3	270
	21-8	571
	31-1	138
	19-1	408
	16-4	1,436
	18-6	1,213
	12-4	599
	4-1	1,220
	4-2	642
	1983 Total	9,035
1984	29-2	973
	10-10	739
	18-7	1,094
	3-7	805
	11-4	224
	16-3	1,173
	22-5	980
	15-6	708
	19-3	549
	20-4	145
	22-4	2,345
	3-6	1,210
	5-5	344
	5-6	1,090
	27-7	140
	1984 Total	12,519

Table 19 Prescribed Burning Program Schedule

Year	Prescribed Burn Unit Number	Size (Acres)
1985	10-8	1,295
	10-9	879
	5-2	1,434
	14-7	365
	14-6	681
	14-1	276
	3-5	1,082
	14-2	55
	11-7	175
	20-5	204
	21-4	2,062
	** 18-3	541
	19-7	531
	15-27	1,270
	29-6	395
	1985 Total	11,245
1986	6-2	303
	6-1	621
	8-3	505
	** 18-4	655
	5-3	615
	5-4	157
	19-8	791
	16-1	1,106
	27-6	734
	20-6	436
	11-2	183
	29-3	889
	21-3	1,384
	24-3	934
	25-7	1,544
	1986 Total	10,857

**reburn

Table 19 Prescribed burning Program Schedule

Year	Prescribed Burn Unit Number	Size (Acres)
1987	8-4	1,333
	17-2	1,249
	16-2	304
	3-3	884
	3-4	717
	24-2	1,045
	22-3	911
	19-6	715
	18-5	519
	11-9	202
	4-5	943
	4-6	1,089
	29-4	1,410
	4-3	847
	4-4	856
	1987 Total	13,024
1988	10-4	1,308
	18-8	655
	19-4	542
	24-1	665
	21-2	1,828
	3-2	1,543
	27-4	1,465
	11-1	358
	29-5	1,437
	25-4	2,180
	25-5	361
	14-8	834
	14-9	560
	15-5	1,017
	1988 Total	14,753

Table 19 Prescribed Burning Program Schedule

Year	Prescribed Burn Unit Number	Size (Acres)
1989	10-6	845
	10-7	1,360
	11-12	346
	31-2	2,014
	19-9	98
	18-9	2,266
	25-6	370
	27-5	1,150
	26-3	1,530
	3-1	393
	14-3	406
	14-4	592
	22-1	648
	22-2	1,920
	1989 Total	13,938
1990	10-3	305
	10-5	796
	31-6	2,034
	1-1	722
	11-11	452
	4-8	1,821
	4-7	600
	2-1	383
	2-3	904
	17-1	960
	25-3	1,231
	21-1	2,493
	1990 Total	12,701

Table 19 Prescribed Burning Program Schedule

Year	Prescribed Burn Unit Number	Size (Acres)
1991	5-1	679
	25-2	1,596
	14-5	766
	8-2	1,513
	6-3	531
	23-4	1,601
	2-4	503
	2-5	534
	4-9	1,587
	31-9	253
	31-8	1,115
	30-4	564
	30-5	487
	1991 Total	11,729
1992	8-1	1,623
	25-1	2,464
	6-4	861
	23-3	1,601
	12-6	133
	12-2	540
	4-10	714
	4-11	912
	2-2	1,821
	31-3	393
	31-4	1,201
	15-1	624
	1992 Total	12,887

Table 19 Prescribed Burning Program Schedule

Year	Prescribed Burn Unit Number	Size (Acres)
1993	23-1	208
	23-2	629
	26-2	1,622
	26-1	1,082
	11-8	114
	10-1	698
	10-2	1,195
	31-7	567
	31-5	1,324
	30-3	692
	12-3	992
	15-2	436
	27-1	1,396
	28-4	830
	1993 Total	11,785
1994	30-2	340
	30-1	1,650
	31-10	1,778
	28-3	1,317
	6-5	1,519
	12-5	1,177
	15-3	2,101
	27-2	491
	27-3	1,809
	1994 Total	12,182
1995	31-11	1,849
	31-12	1,158
	29-1	82
	6-6	747
	6-7	1,072
	15-4	2,312
	28-2	1,830
	28-1	633
	1995 Total	9,683

VII. FIRE MANAGEMENT OPERATIONS

This section discusses how the fire management program will be implemented and responsibilities of the Fire Management Team. The purpose is to provide direction to develop a totally integrated fire management program.

A. Fire Managment Organization and Responsibilities

The fire management organization (Figure 12) is a two-phased organization. The Fire Management Officer is responsible to the Chief Ranger for prevention, presuppression, and suppression of wildfires and to the Chief of Resources Management for all management fires. The responsibilities will be reviewed annually in February by the Fire Management Officer and recommended changes sent to the Chief Ranger and Chief of Resources Management for approval.

1. Superintendent's Office

a. Superintendent

Has ultimate responsibility for all phases of fire management activity in the Parks. Delegates full authority to the Chief Ranger and Chief of Resources Management for the fire suppression and management fire programs respectively.

b. Management Assistant

Prepares press releases and disseminates information pertaining to the fire management program to the news media, concessioners, inholders, and the public.

c. Safety Officer

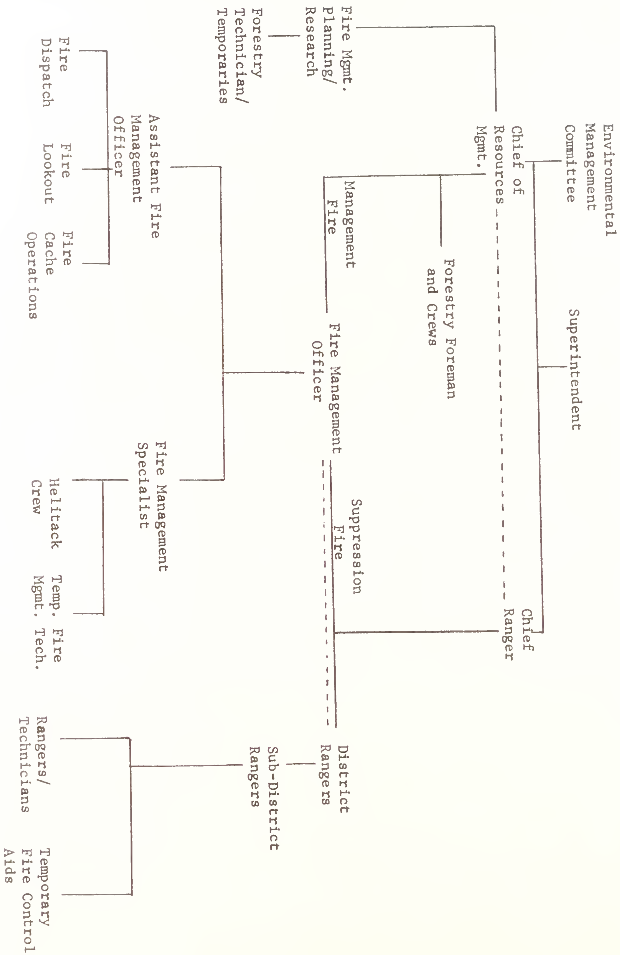
Monitors the safety aspects of the fire management program, is a member of the Environmental Management Committee, and may act as a Safety Officer on fires as needed.

2. Fire Management and Visitor Protection Division

a. Chief Ranger

Is responsible for overall coordination, direction and supervision of wildfire prevention, presuppression and suppression and structural fire. He has line authority over the Fire Management Officer and District Rangers, maintains close communications with the Chief of Resources Management concerning the fire management program, is a member of the Environmental Management Committee, and coordinates all serious wildfire emergencies.

Fig. 12 Fire Management Organization



b. Fire Management Officer

Has total responsibility for implementing the fire management program.

(1) Is responsible for developing and implementing a fire prevention program.

(2) Assures rapid, safe suppression of all wildfires, demobilization, and rehabilitation of the burned-over areas.

(3) Maintains an adequate inventory of equipment and supplies to efficiently implement the fire management program.

(4) Coordinates all intelligence gathering, monitoring and/or suppression and makes decisions on all prescribed natural fires and informs the Chief of Resources Management and Chief Ranger of actions taken.

(5) Develops the annual prescribed burning program with the Chief of Resources Management and District Rangers.

(6) Receives and approves all prescribed burn plans from Prescribed Fire Bosses and sends to Chief of Resources Management for review.

(7) Acts as Prescribed Fire Boss and assigns manpower and equipment to the Prescribed Fire Boss as needed.

(8) Complies with regulations of the County Air Pollution Control Districts.

(9) Conducts prescribed fire and suppression fire training courses and certifies all fire management personnel.

(10) Is responsible for the safe and efficient management of contract aircraft.

(11) Is responsible for seeing that <u>all</u> fire management reports are completed on time; management fire reports sent to the Chief of Resources Management, and wildfire reports sent to the Chief Ranger.

c. Assistant Fire Management Officer

Supervises the fire lookouts, Fire Cache Maintenance persons and Fire Dispatcher, and ensures the reliability of all fire management supplies and equipment.

d. Fire Management Specialist

Is responsible to the Fire Management Officer for safe utilization and management of all Park aircraft and implementation of the fire management program. Supervises the helitack crew and Fire Management Technicians assigned to the fire management office.

e. Helitack Crew and Fire Management Technicians

Are responsible to the Fire Management Specialist for the safe management of Park helicopters and the implementation of the fire management program.

f. Fire Dispatcher

Receives initial reports of all fires, notifies the Fire Management Officer and District Rangers of all fires, dispatches fire management personnel and equipment after the fire management strategy has been determined by the Fire Management Officer and coordinates equipment and manpower on fires.

g. Fire Prevention Patrolman

Is responsible for preventing human-caused wildfires by enforcing fire regulations and maintaining fire suppression equipment and improvements in his area.

h. District Rangers

Are responsible for coordinating with the Fire Management Officer on all actions on wildfires, prescribed natural fires, and prescribed burns within their district. Involved in developing the annual prescribed burning program with the Fire Management Officer and Chief of Resources Management.

i. Fire Control Technicians

Are responsible to the area Ranger for suppression of class "A" and "B" fires and for the structural fire program, and for involvement in the management fire program in the Sub-district.

j. Fire Management Team

A team of approximately 10 persons will be assembled by the Fire Management Office to carry out the preparation and execution of all prescribed burns. They may also be used as monitors on prescribed natural fires and on prescribed burns, and as a suppression crew.

The coordination and supervision of the crew is the responsibility of the Fire Management Specialist. They will generally be stationed at Ash Mountain, but may be split up and stationed in the districts as the need arises.

k. Crew Bosses

The district crew bosses, if qualified, may be used as fire monitors to assess the potential of ongoing prescribed natural fires, and to coordinate the preparation of units in their districts for burning, as well as assisting in the execution of the burn. If qualified, they may serve as burn bosses, and lead members of the Fire Management Team in unit preparation and in burn execution.

3. Resources Management Division

a. Chief of Resources Management

Is responsible for the overall direction and coordination of the management fire program.

(1) Coordinates the development and revision of the Fire Management Plan.

(2) Receives prescribed burn and prescribed natural fire reports from the Fire Management Officer.

(3) Prepares the annual prescribed burning program by February 1, with the Fire Management Officer and District Rangers and submits to the Superintendent for approval.

(4) Evaluates prescribed burns and prescribed natural fires and submits report(s) to the Superintendent.

(5) Provides the repository for all plans, maps, reports, and data relating to the fire management program.

(6) Maintains close relations and communications with Research Scientist and all researchers studying fire in the Parks.

(7) Member of the Environmental Management Committee.

b. Forestry Foreman

Acts as a Fire Boss on wildfires and management fires and provides the assistance of the forestry and soil and moisture crews to the Fire Management Officer for fire management operations.

c. Forestry Technician

Assists the Chief of Resources Management in fire management planning and research, monitoring selected fires, and participating in fire suppression and prescribed burning.

d. Fire Ecologist

Develops and refines the prescriptions for the fire management program, and monitors and evaluates its long and short term effects on Park resources. Monitors the behavior and effects of selected prescribed burns, prescribed natural fires, and wildfires. Updates and revises the fire management plan. Member of the Environmental Management Committee in fire management matters.

4. Other Park Personnel

a. Chief of Interpretation

Provides interpretive services and literature to inform the public of fire's role in the Parks' ecosystems and the functions of the fire management program. Chairman of the Environmental Management Committee.

b. Research Scientist

Acts as an advisor for the fire management program. Conducts detailed research on selected fires, and with the Chief of Resources Management and with the Fire Ecologist develops prescriptions, particularly for new and unfamiliar vegetation types.

c. Environmental Management Committee

Comprised of the Chief of Resources Management, Chief of Interpretation (Chairman), and Chief Ranger. For reviewing actions taken on prescribed natural fires, prescribed burns, and wildfires and for making recommendations to the Superintendent, it joined by the Fire Management Officer and by the Fire Ecologist. The Safety Officer is also a member.

B. Fire Management Qualification Certification

The fire management qualification system for Sequoia and Kings Canyon National Parks consists of the Interagency Fire Qualification Certification System for suppresion fires and green card system for management fires. Before an individual can participate in fire management he must have the appropriate qualifications.

1. Interagency Red Card Fire Qualification Certification

This system standardizes the wildfire suppression job qualifications and requirements. Personnel are certified by the issuance of an Interagency Qualification Card, SD-228 (red card). The system is based on a series of fire suppression training courses, fire suppression experience, and physical fitness.

2. Management Fire Qualification Certification System

a. Background: This system is designed to provide the best qualified personnel for conducting prescribed burns and managing prescribed natural fires and compliments the Interagency Red Card Fire Qualification System.

b. Prescribed Fire Jobs: Eight management fire jobs comprise the system as follows:

(1) Prescribed Fire Boss I (All Fire Types)

Is responsible for planning, executing, monitoring, documenting, and reporting of prescribed burns in sequoia-mixed-conifer, ponderosa pine, chaparral/oak-woodland and qualified on prescribed natural fires.

(2) Prescribed Fire Boss II (Sequoia-Mixed-Conifer)

Is responsible for planning, executing, monitoring, documenting and reporting of prescribed burns in sequoia-mixed-conifer and qualified on prescribed natural fires. Is qualified to conduct prescribed burns in these fuel types.

(3) Prescribed Fire Boss II (Chaparral/Oak-Woodland)

Same as above except only qualified in chaparral/oak-woodland.

(4) Prescribed Fire Boss III (Prescribed Natural Fires)

Is the initial Fire Boss assigned to a prescribed natural fire, takes initial action to monitor or suppress a natural fire depending on the prescription, and is qualified at the Fire Boss III (red card) level and can take action to suppress prescribed natural fires up to 10 acres.

(5) Prescribed Burn Firing Officer

Is responsible to the Prescribed Fire Boss for directing and igniting a prescribed burn, and for maintaining the proper fire intensity to attain the prescribed burn objectives in all fuel types. Supervises a firing team from one to several individuals.

(6) Prescribed Fire Monitor

Is assigned to each management fire and is responsible to the Prescribed Fire Boss for performing preburn fuel/vegetation analysis, monitoring fire behavior, prescriptions, fuel, and attainment of objectives during the fire and for conducting a post fire documentation of fire effects. Is qualified in all Park fuel types.

(7) Prescribed Fire Crew Boss

Is responsible for line holding on management fires in all fuel types. A variety of equipment and a number of crewmen can be used to hold the line.

(8) Prescribed Fire Crewman

Serves as a member of the line holding crew, firing crew, or monitoring team, depending on qualifications.

Other specialized prescribed fire jobs, such as Fire Researcher, may be designed in the future. Plans and service functions may be assigned to a prescribed burn or prescribed natural fire by the Prescribed Fire Boss. Individuals meeting suppression standards for these jobs will satisfy prescribed fire requirements. The following is the minimum staffing requirement for prescribed natural fires and prescribed burns:

Prescribed Natural Fires:
Prescribed Fire Boss III (Prescribed Natural Fires)
Prescribed Fire Monitor
Above may be performed by one individual.

Prescribed Burn:
Prescribed Fire Boss I or II
Prescribed Burn Firing Officer
Prescribed Fire Monitor
Crew size can vary depending on size and complexity of the burn.

c. Management Fire Qualifications

The management fire qualification requirements are comprised of four parts: training, personal characteristics, experience requirements, and physical fitness.

(1) Training

The training requirement provides the necessary suppression and specialized prescribed fire courses to assure qualified personnel. The suppression courses already exist. Nine prescribed fire courses ranging from fire ecology in various fuel types to specialized courses in firing techniques and prescriptions were developed. These courses will be about 16 hours and will be given locally.

(2) Personal Characteristics

Personal characteristics, such as good judgement, sensitivity, observational ability and patience, are traits needed by anyone involved in the management fire program. Individuals selected for this program must possess these characteristics.

(3) Experience Requirements

Experience requirements are performing a prescribed fire job as a trainee the number of times listed. Experience on prescribed burns with other agencies will also count.

(4) Physical Fitness

All prescribed fire jobs are required to maintain a minimum of 45 on the step test.

(5) Prescribed Fire Job Rating

Rating of personnel for prescribed fire jobs is the responsibility of the Fire Management Officer who rates qualified personnel by June 1.

C. Fire Management Overhead and Responsibilities

Fire management overhead will be assigned on all wildfires, prescribed natural fires, and prescribed burns. Fire management overhead positions on wildfires will be assigned in accordance with the U.S. Department of the Interior Bureau of Land Management Fire Control Notebook. Fire overhead positions on prescribed natural fires and prescribed burns will be assigned in accordance with the "green card" Management Fire Qualification Certification System developed in this plan.

D. Fire Management Procedures and Guidelines

The procedures for managing fire become more complex and subject to error as fire management strategies are expanded to allow for total suppression, limited or total containment, and observation. Mistakes in choice of these strategies can lead to serious and costly consequences.

The objectives of these procedures and guidelines are:

___ To assure that all final decisions to take limited or total containment, or observation action on a fire are made by the Fire Management Officer and that the Chief of Resources Management and Chief Ranger are kept informed.

___ To prevent delay in dispatch of initial fire management personnel to a fire.

___ To provide a system of communications, dispatch, and decision process.

___ To insure that proper records and reports are established and maintained to document all fire management actions.

a. Prescribed Natural Fires

(1) Intelligence Gathering and Decision Processes

Aircraft reconnaissance, Fire Monitors, visitors, or other Park employees may provide input as to the status of a new fire start and/or of an ongoing fire. This information is relayed to the Fire Dispatcher who will use the fire dispatch flowchart (Figure 13), fire intelligence flowchart (Figure 14), and prescription flowcharts (Figures 9, 10, and 10a, pages 78, 79, 80) to select strategy. The Fire Management Officer makes the final decision on whether to suppress/contain or allow a fire to burn. The Superintendent has the ultimate responsibility for all decisions made on fires in the Parks.

The Fire Management Officer is responsible for assigning personnel to map ongoing fires. All fires over 10 acres in size will be mapped daily, and a weekly map of these fires will be provided Monday morning for squad meetings.

(2) Complex Fire Situations

Complex fire situations result from multiple lightning strikes or from several ongoing fires, some of which may be declared to be managment fires and the rest suppressed. In a complex fire management action, the Fire Management Officer will keep the Chief Ranger and Chief of Resources Management fully informed. A complex management fire situation can also result if there is some question as to what status to assign to a given fire, and will result if there is a reclassification of the type of strategy to be taken, specifically suppression to containment, or suppression or containment to observation.

In the complex management fire situation, the Fire Management Officer will discuss with the Chief of Resources Management what strategy to take if there is some question as to the fire's ability to accomplish management objectives or to meet prescriptions. The Environmental Management Committee will review the fire situation and make recommendations to the Superintendent, who has final authority and can direct the Fire Management Officer to take a certain action.

(3) Administrative Procedures Required to Carry Out Fire Management Prescriptions

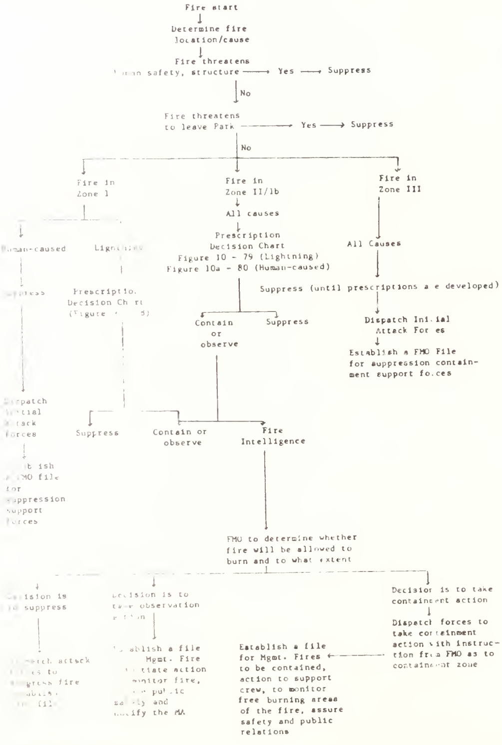
The interrelationship between the Fire Management Officer, Chief of Resources Management, Chief Ranger, and Superintendent has already been discussed. The input that will help to determine what strategy to employ towards a given fire results not only from information obtained after the fire starts but also from plans made beforehand as to how a fire will be handled.

This section will describe some of the preparations that must be made before a fire occurs in order to manage it safely, efficiently, and in an intelligent manner.

Although fire behavior depends on many physical and biological factors, its behavior within a vegetation type can be expected to show less variation than between vegetation types. The difference in fire behavior between fire in chaparral and fire in sequoia is much greater than that between the sequoia-mixed-conifer and ponderosa pine types. Stratification by type tends to simplify prescription creation.

Vegetation type, and the method in which fire interacts with it, changes with elevation. The 1968 high elevation natural fire management zone was an early attempt to stratify a vegetation type, subalpine and alpine, and to base a fire management strategy on this stratification. The 1979 Fire Management Plan carried this stratification farther by subdividing the Parks into the previously discussed vegetation types, over which the three fire management zones, for which prescriptions were developed, were placed.

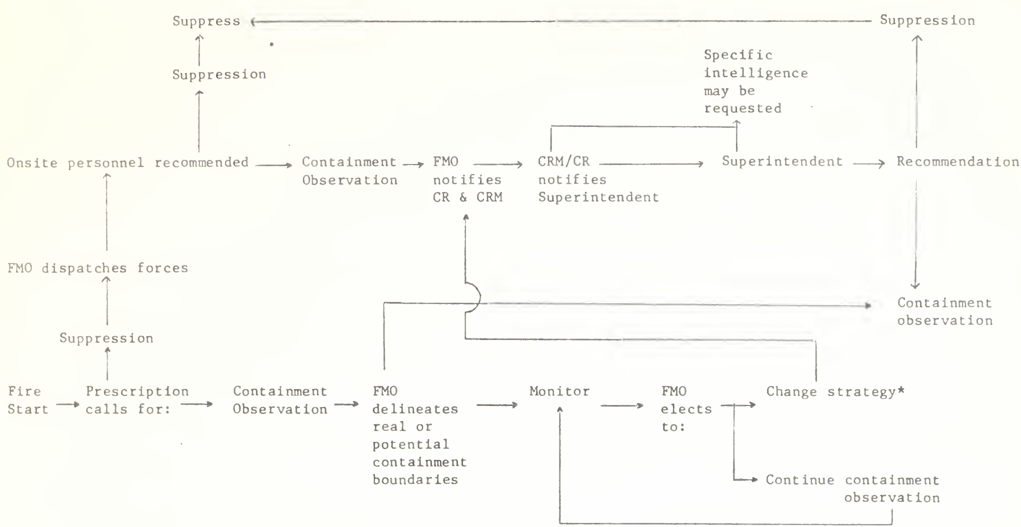
Fig. 13 Fire dispatch Flowchart for All Fires



Fire Management Officer

Sequoia & Kings Canyon National Parks

Fig. 14 Fire Intelligence Flowchart



FMO - Fire Management Officer
CR - Chief Ranger
CRM - Chief of Resources Management

*FMO may change containment/observation fires to suppression status, or observation to containment, without the Superintendent's approval, although the Superintendent may reverse this decision.

The decision flowcharts which have been developed incorporate such preattack planning a number of ways, and principally by delineating the main factors that must go into the selection of a strategy for a fire and who makes that decision. In the end, preattack strategies are limited to suppression and containment/observation.

(a) Suppression Fires

Suppression has been performed for years and strategies, chain of command, and the preattack details for implementation of suppression decisions have been worked out. Fire suppression guidelines are discussed on page 122. In whatever zone the suppression action is to be taken, a balance must be struck between the quick, efficient halt of a fire's spread, the costs, and the impact of these measures on the resources. Suppression actions will include handline construction and the use of various tools including chainsaws, as well as methods to check fire spread such as burning-out and retardant drops. Damage to the resources shall be controlled. Clear retardant will be used when feasible. Fire camps will not be located in meadows or areas where high levels of use would cause damage. Suppression actions will make as much use of natural firebreaks as possible. Wetlines, or environmental lines, should be considered in lieu of handline construction if water and pumps are available. Waterbars shall be constructed on handlines on steep slopes. Suppression actions should not cause more damage to the resource than the fire.

Since impact is to be minimal, operations associated with suppression activities must be carefully controlled. Helispots and fire camps must not be situated in sensitive areas such as wet meadows or sites with endangered species. Helispots may not be created if deleterious consequences to the resources will result unless the fire will create an even more adverse impact, particularly if time is critical to the success of the action. All tools, trash, and other signs of a fire camp must be removed upon the completion of the operation.

(b) Containment/Observation Fires

Containment/observation strategies, especially in the 1979 additions to zone I and in zone II/1B, are more complicated than suppression strategies. Suppression implies a quick extinguishment of a fire balanced only against the impact of the action on the resource and the cost. Containment/observation strategies may result in allowing a fire to burn perhaps for several months, with an absence of direct control.

The strategy "containment/observation" implies that they are always linked; this is true, because an observation fire will be closely monitored and will likely be contained at least within broad topographic boundaries, most commonly to a particular area. Containment fires, especially ones involving large acreage, will be monitored often so as to prevent sudden surprises such as a run, which breaks the containment. The designation of a fire as "observation" or "containment" is merely what its primary strategy shall be.

Preattack procedures for containment/observation are newer than the suppression procedures, and involve monitoring guidelines, research on the fire history of the Parks, a detailed study on the role of fire in each vegetation type, and the original delineation of the zones and conditional unit partly on the basis of topographic features which would lend themselves to containment operations.

The monitoring guidelines to be employed during a fire to provide information on its ability or inability to meet objectives are given in another section. Prefire monitoring is critical to preattack planning as well; field surveys in selected areas of the Park obtained information on fuel loads, vegetation condition, and the true value of major containment boundaries that had been suggested from maps and aerial photographs.

(c) Preattack Information

Preattack information for the classification of a fire also comes from prescribed burn research and the NFDRS. Flame lengths, burning index (BI), and energy release components (ERC), which affect the intensity of a fire, have been quantified for prescribed burns by Van Wagtendonk (1978). These are based on the NFDRS 1977 fuel model "G" (dense conifer and heavy fuel loads). The utilization of fuel model "G" in zones I and II results in a prediction of worst possible conditions; model "G" produces higher ERC and BI values than does model "C" (open pine stands).

1) Reporting Stations

The extension of fuel model "G" to the entire Park as part of the decision flowcharts and prescriptions will require the creation of reporting stations to provide input for the flowcharts. These stations shall be Grant Grove for upper mixed-conifer prescriptions, Milk Ranch for lower mixed-conifer prescriptions in Sequoia National Park, and Cedar Grove for lower mixed-conifer in Kings Canyon National Park.

Backcountry Rangers can become temporary NFDRS reporting stations as well; they will become useful particularly if long-term fires are burning in their areas, not only as sources of input to check if prescriptions involving NFDRS are in but also as monitors. They will relay their weather condition in the same manner as the regularly reporting stations.

2) Another source of information will be the Three Strata Fire Behavior Model (Bevins, 1976). Preliminary research indicated that it may be useful in predicting fire characteristics such as scorch height, ignition height, fireline intensity, and rates of spread in shrubs, grass, dead and down woody material, and litter.

The Three Strata Fire Spread Model was developed at Glacier National Park and computes such fire characteristics as rate of spread, fireline intensity, scorch height, and flame length based on mathematical relations between these observed effects and such input parameters as fuel depth, fuel load, and moisture of dead fuels of various sizes and live fuels, slope, windspeed, wind direction, and aspect.

These effects are calculated for each of three fuel stratum: the litter layer, the dead and down woody layer/herbaceous layer, and the shrub layer. Rates of spread through the forest canopy are not given. The effects can be balanced to correspond with the proportion each fuel type contributes to the total fuel complex thus giving a more realistic prediction of fire characteristics.

The model computes and predicts these effects not in one direction but in eight compass directions. Thus, these effects are predicted not only for fires moving with the wind (headfires), but also against the wind (backfire) and perpendicular to it (flankfire), which has applications in predicting the effects of prescribed burns.

The model requires 34 bits of data as input, which can be obtained by field sampling, or to some extent, by extrapolations from NFDRS output and the 1978 fuel sampling project which can give some idea of fuel load from the vegetation type in which the fire is occurring.

The model is based upon more site specific data than is the NFDRS or FIRECASTING systems (Van Gelder, 1978) and consequently may be of greater use in determining if a given fire is in prescription. As much as possible, side by side comparisons will be made with the NFDRS and FIRECASTING systems to determine the relative reliability of each in predicting fire characteristics. The site-specificity of the Three Strata Model probably gives it an edge in realism; however, it must be realized that no decision in fire management can be made by a machine. Onsite evaluation will always be required, with computer models providing input into the decision.

The Three Strata Fire Spread Model, like the NFDRS, treats fire as being mathmatically constant in its effects. This is not necessarily true, but probably is so to a certain extent. Beyond this point, only on-the-ground monitoring can fine tune the validity of each model's prediction.

The decision for what strategy to employ on a fire is, ultimately, human.

The NFDRS system will be used daily during the fire season. The Three Strata Fire Spread and FIRECASTING Models can be consulted for any given fire to gain further insight into what its behavior may be. It should use data collected on site, although the 1978 fuel inventory together with the nearest station's NFDRS fuel moisture and wind conditions may allow a run to be made remotely.

The Three Strata Fire Spread Model does not enter into the actual flowchart decision process, although it may do so with further testing. It may be of use in the refinement of prescriptions, and is currently being validated by comparing its predicted behavior of prescribed burns with that actually observed.

3) Preattack Items (Appendix C)

Preattack items are available for each of the 31 fire management areas. These include maps showing key structures, containment line locations, roads, trails, access routes, helispots, water sources, fuel loads, fire camps, equipment location, endangered/threatened species, and historical site locations.

(d) Dissemination of Fire Information

The computer models, the fuel inventory, ground and aerial monitoring, the decision flowcharts, and other sources of input form the basis for fire intelligence upon which strategy decisions will be formed. Fire intelligence in any form may be requested by the Fire Management Officer, Chief of Resources Management, Chief Ranger, or the Superintendent to ensure that decisions will be based on the most current information.

Information will be relayed to the Fire Management Office, which will assemble it for presentation to the Chief Ranger, Chief of Resources Management, and Superintendent if requested to do so, and in any event, will place it into the file for that fire. No fire should ever be considered too small or harmless for monitoring and as a result ignored.

Intelligence on the fire will also be given to the Fire Management and Visitor Protection and Interpretive Divisions for dissemination to the public at visitor centers, trailheads into the fire area, and entrance stations. In this way, safety can be maintained at a high level by closing trails threatened by fire or alerting drivers to smoke on the highway. With visitor contact through interpretive talks, flyers, and an informed staff, the public can be kept informed on the operations of the Fire Management Plan.

Certain areas of the Parks, especially those containing chaparral, contain potentially high public safety hazards. For example, the many switchbacks of the highway from Ash Mountain to Giant Forest could become traps if a wildfire moves quickly uphill from below. Another is a fire originating in the west end of Cedar Grove and rapidly pushed upcanyon by wind. While management fire will be used as carefully as possible, wildfires, particularly originating from arson, have a great potential for disaster. Such areas throughout the Park have emergency evacuation plans.

b. Prescribed Burning

(1) Annual Prescribed Burning Program

The annual prescribed burning program is prepared by the Chief of Resources Management, Fire Management Officer, and District Rangers in accordance with this plan and consists of all prescribed burns to be conducted during the year. The overall program will be developed each year by February 1 and submitted for approval by the Superintendent by February 15. All burn units for one season will normally be contained to one or more fire management areas providing prescriptions can be met. If prescriptions in one area cannot be met, burning can be done in predetermined areas that are in prescription. The Fire Management Officer will designate a Prescribed Fire Boss for each burn. Approval of the annual prescribed burning program does not constitute final approval of any burn.

(2) Prescribed Burn Plans

Prescribed Fire Bosses will consult the Prescribed Burning Guidelines. Each will conduct a field reconnaissance of the burn site with the Fire Management

Officer to discuss special problems, conditions, objectives, and firing techniques. At the completion of the reconnaissance, the prescribed Fire Boss will prepare and submit a prescribed burn plan to the Fire Management Officer. The plan spells out the conditions under which the area will burned, the effects to be achieved, and the procedures to be followed. Proposed unit boundaries shown in the February 1 program are not absolute. It is the responsibility of the Burn Boss to locate the actual boundaries which he feels will be secure.

(3) Prescribed Burn Plan Approval

A meeting to review the burn unit plan between the Resources Management Specialist, Fire Management Officer, and the Burn Boss will be held prior to all prescribed burns. The Burn Boss will be responsible for setting up this meeting. The ultimate responsibility for the burn is the Fire Management Officer's, who may call off any burn he feels to be inadequately prepared.

Once the prescribed burn plans are reviewed, the Fire Management Officer will approve them. The Fire Management Officer sees that the burns are accomplished and results reported to the Chief of Resources Management.

Copies of the approved plans will be sent to the appropriate Air Pollution Control District by the Fire Management Officer.

Burn plans for burns which are in addition to and which were not included in the February 1 annual prescribed burning program which was approved by the Superintendent must be submitted to the Chief of Resources Management, who will route them to the Environmental Management Committee for preliminary approval and to the Superintendent for final approval.

(4) Preburn Meeting

Two days prior to the burn, all necessary contacts, particularly to the County Air Pollution Control Districts, will be made. One day prior to the burn, the prescribed Fire Boss will conduct a meeting to explain, and if necessary to defend, his plan to the prescribed burn team, the district personnel involved, and to the Management Assistant (if required) and to discuss details of the burn.

Table 20 Van Wagtendonk Interim 1978 National Fire Danger Rating System (Deeming, *et al*., 1977) Prescribed Burning Prescriptions

SPRING HEADFIRES

FUEL MODEL	F	G	L	U	U
VEGETATION	Manzanita/ Ceanothus	Incense-Cedar/ White Fir	Perennial Grasses	Ponderosa Pine	Ponderosa Pine/Bear Clover
Air Temperature (°F)	30-75	30-75	30-75	30-75	30-75
Relative Humidity (%)	30-65	30-65	30-65	30-65	30-65
Wind Speed (mph)	0-10	0-10	0-10	0-10	0-10
1-Hour TL	5-6	6-8	6-8	6-8	7-10
10-Hour TL	9-14	9-13	8-12	9-15	9-16
100-Hour TL	10-20	10-20	10-20	10-20	10-20
1000-Hour TL	10-30	15-30	15-30	15-30	15-30
Spread Component	3-8	3-8	1-7	1-6	1-5
Energy Release	5-15	15-30	1-4	12-20	10-15
Burning Index	15-28	20-35	10-15	10-15	9-12

FALL BACKING FIRES

FUEL MODEL	F	G	G	H	U	U
VEGETATION	Manzanita/ Ceanothus	Incense-Cedar/ White Fir	Giant Sequoia	White Fir/ Red Fir	Ponderosa Pine	Ponderosa Pine/Bear Clover
Air Temperature (°F)	40-90	40-85	50-90	40-90	40-85	40-85
Relative Humidity (%)	20-40	20-50	20-50	20-40	20-50	25-60
Wind Speed (mph)	0-10	0-10	0-10	0-10	0-10	0-10
1-Hour TL	4-6	4-8	3-6	3-8	4-8	4-8
10-Hour TL	6-10	6-10	6-8	5-10	6-10	6-10
100-Hour TL	7-12	7-15	7-12	7-12	8-15	8-15
1000-Hour TL	10-15	10-15	10-20	10-20	10-20	10-20
Spread Component	3-8	3-10	3-10	1-5	2-6	2-6
Energy Release	15-30	35-50	40-60	25-35	25-37	25-37
Burning Index	18-35	30-45	30-50	15-30	20-40	18-35

(5) Prescriptions

All burns will be accomplished under specific fuel and weather parameters. The prescriptions developed by Van Wagtendonk (1978) (Table 20) will be used on all prescribed burns. These prescriptions will be refined to fit fuel conditions at Sequoia and Kings Canyon National Parks. The Prescribed Burning Guidelines give a more detailed description of prescription development.

(6) Recording the Prescription

Weather will be recorded by the Prescribed Fire Boss or a designee for at least five days prior to the burn. A dummy fire weather station may be established for each prescribed burn so that accurate data for 100 hour and 1000 hour time lag fuel moistures, the energy release component (ERC), ignition component (IC), spread component (SC), and the burning index (BI) can be obtained through the NFDRS system. Fuel moisture sticks will be placed in all characteristic fuel types and slopes according to the Prescribed Burning Guidelines.

(7) Prescribed Burn Execution

To ensure adequate manpower or personnel for the preparation and burning of the units, requests for the team should be into the Fire Management Office seven to ten days in advance. The request should include the number of people desired, time required to complete project, type of project, and availability of quarters.

The Prescribed Fire Boss will assemble the burning team and notify the Fire Management Officer and Fire Dispatcher that the burn is being started. A test fire will be initiated to determine conditions. If conditions are satisfactory, the burn will be continued.

(8) Limited or Complete Control Action

The Prescribed Fire Boss will initiate limited or complete control action if a prescribed burn threatens to exceed prescription, to escape predetermined boundaries, to not achieve desired objectives, or to threaten human safety or property. The Fire Management Officer will be notified immediately of any control action on a prescribed burn. If the escaped fire exceeds the fire management qualifications of the Prescribed Fire Boss, the Fire Management Officer will assign a suppression Fire Boss with the necessary qualifications. The Fire Management Officer may order a prescribed burn suppressed if it threatens human life, cultural resources, endangered species, or physical facilities of the Parks, to escape from predetermined areas or from the Parks, or to burn under extreme fire weather conditions. All prescribed burns that are out of prescriptions will be treated as wildfires.

(9) Smoke Management

Smoke dispersal will be monitored continuously during any prescribed burn. If smoke creates a hazard or nuisance, the prescribed burn will be extinguished.

(10) Evaluation and Reporting

The Prescribed Fire Boss will evaluate the results of the prescribed burn, complete the prescribed burn plan, and submit it to the Fire Management Officer no later than five days after the burn is declared out. The Fire Management Officer will complete all necessary fire reports, forward the reports to the Chief of Resources Management for review and to the Regional Office, and close the file folder where all records are kept for future use in planning and evaluating operations.

(11) Critique of Burn Units

The Environmental Management Committee will occasionally critique one or more prescribed burns to determine the effectiveness of the prescribed burning program. A report of the results of the critique will be prepared and submitted to the Superintendent for review.

(12) Annual Summary Review

Post-season critiques of prescribed burns will be conducted by the Environmental Management Committee. The post-season critique is to determine if objectives were met.

c Wildfire Suppression

The following procedures and guidelines will be used in implementing the wildfire suppression program:

(1) Fire Danger Rating, Weather Stations, and AFFIRMS

Sequoia and Kings Canyon National Parks uses the National Fire Danger Rating System (NFDRS) (Deeming et al., 1978) which relates to the potential of the initiating fire, one that is not spotting, crowning or behaving erratically. The system only addresses fire occurrence and behavior. Components and indices are structured so that they are linearly related to the particular aspect of the fire problem being rated. Fire danger is rated from a "worst case" approach and in the open at midslope on southerly or westerly exposures. The NFDRS will not predict how every fire will behave. It is intended to provide guidance for short range planning and is the basis for the Sequoia and Kings Canyon National Parks fire management program.

During fire season, normally June 15 through October 15, the Parks operate four permanent fire danger rating weather stations (Table 21). Temporary weather stations may be activated for prescribed burning operations or prescribed natural fires.

Table 21. Fire Danger Rating Weather Stations

Location	Elevation (ft)	Fire Mgmt. Zone Covered by Station	Fuels to be rated
1. Ash Mountain Headquarters	1,700	Zone III	Chaparral/ Oak-Woodland
2. Milk Ranch Peak Lookout	6,250	Zone II	Mixed-conifer pine forests
3. Grant Grove	6,600	Zone II mixed-conifer	Sequoia/Mixed-conifer
4. Cedar Grove	5,000	Zone II & III mixed-conifer	Chaparral pine forests

Weather observations are taken daily throughout the fire season at each fire weather station and then entered into the AFFIRMS, Administrative and Forest Fire Information Retrieval and Management System, interactive computer program through a data terminal. The AFFIRMS program provides the Fire Management Officer with generalized forward and lateral fire-spread information through the FIREMOD program within minutes of a reported fire, uses up to four fuel models and slope classifications for each weather station, and archives weather data into the National Fire Weather Data Library.

(2) Fire Prevention

Human activity is a potential wildfire risk. Use of high hazard areas by the public has increased the fire risk. Fire prevention seeks to control human-caused wildfires by catching them when they are small and to prevent them from starting whenever possible. Major fire prevention activities include:

(a) Pertinent signs, posters, and notices will be posted on bulletin boards and at trailheads during extreme fire danger.

(b) Fire prevention will be included at campfire talks during extreme fire danger.

(c) Fire prevention programs to local schools will emphasize fire's natural role in ecosystems and the prevention of human-caused wildfires.

(d) Personnel having informal contacts with Park visitors, such as concessioners and contractors, will emphasize fire prevention.

(e) Large campfires will not be permitted.

(f) Prior to the opening of fire season each campground fireplace will be cleared, branches overhanging fireplaces limbed, and firelines adjacent to campgrounds cleared.

(g) Dumps will be posted with what fire restrictions are in effect. Burning will be done under controlled conditions by Park personnel.

(h) Off-the-road equipment during fire season will be checked for a functioning spark arrestor and fire extinguisher.

(i) Power lines will be checked for tree clearance from lines by the power companies and deficiencies corrected prior to July 1.

Fire prevention patrolmen will enforce all Park fire regulations, maintain all fire control facilities, and will assure that all of the above activities are conducted.

(3) Presuppression

Presuppression is the work done in advance of a wildfire to ensure an effective suppression action and includes recruiting and training, planning and organization, maintaining fire equipment, and procuring equipment and supplies. The objectives are to have a well trained and equipped fire management organization to suppress wildfires.

(a) Training

The Management Officer will recruit and train qualified fire management personnel. On-the-job training will be conducted by the Fire Management Officer, and District/Sub-District Rangers.

(b) Fire Equipment, Supplies, and Transportation

Fire equipment will be maintained in serviceable condition and in constant readiness. District and area Rangers will be responsible for the servicing and first echelon maintenance of fire equipment assigned to their respective areas.

Defective or worn out items will be replaced by the Fire Management Office.

The Assistant Fire Management Officer sees that supplies are available at the headquarters fire cache, field fire caches, and warehouses prior to the fire season. The Service Chief will order food and supplies through the Dispatcher during large fire operations. The Park Property and Procurement Officer will provide warehouse personnel for night or weekend duty at the Fire Dispatcher's request during fire emergencies.

The Machine Shop Supervisor will provide truck transportation for personnel or supplies and equipment during fire emergencies. Additional vehicles will be coordinated through the GSA representative.

(c) Employee Availability

During fire season, all protection personnel and key fire overhead will provide the Fire Dispatcher with their availability during off duty hours. Each employee subject to fire duty will have a fire pack available for immediate use.

(d) Automatic Dispatch Plan

Preattack dispatch planning facilitates the alerting, dispatching, or requesting of forces to man wildfires. The plan is used in conjunction with the Dispatch Flowchart (Figure 13, page 112). It is a system of predesignated blocks of terrain using geographical, man-made features, or fuel types as boundaries keyed to a carded reference index and resources in each area for quick response and provides a list of steps in mobilizing for initial attack.

(e) Aircraft Operations

A helicopter and a fixed-wing aircraft on contract are used to assist in implementing the fire management program. A helitack/fire management team, based at Ash Mountain, is used for initial attack of off-road wildfires, containment of prescribed natural fires, monitoring of all fires, and prescribed burning.

Retardant aircraft are available through Sequoia National Forest and the south zone Fire Dispatcher. The fixed-wing aircraft and helicopter guidelines are on file at the Fire Management Office and provide details for requesting retardant and drops.

(4) Emergency Presuppression

Emergency presuppression describes actions taken to provide extra coverage during extreme or unusual fire danger caused by strong or dry winds, or extensive and/or abnormally dry thunderstorms.

(a) Fire Protection Manning Plan (Page 159)

This plan is the authority for emergency manning for fire management personnel and a guide for the hiring of emergency fire fighters. The objective of this plan is to provide emergency presuppression action for the Parks in accordance with laws and regulations. The various manning plans are listed in the appendix.

Every afternoon the Fire Dispatcher will assign each frontcountry subdistrict a manning plan for the following day and document all actions taken under the Plan. Fire Management Office personnel will man according to the highest predicted plan.

Fire management crews will be on standby at or near duty station during all Class IV and V days. Emergency Fire Fighters will assist fire management crews when fire danger is extreme. The manning plan will indicate the manning level as dictated by the fire weather. Emergency Fire Fighters will be sent to any suppression fire as needed and be prepared to stay on the fire line from three to 10 days. The Fire Management Office will maintain a roster of people who meet the qualifications. Each Emergency Fire Fighter will be required to pass the "step test" and must be red-carded.

Other seasonal or permanent employees may be hired to fill fire suppression needs as long as they have passed the step test, have a red card, and the involvement does not interfere with other regular duties.

(b) Detection Systems

The capability of detecting a wildfire early is the key to all suppression activities. The following detection methods are used:

1) Fixed Lookouts

There are two fixed lookout towers manned daily from the beginning to the end of fire season. Park Ridge Lookout (7,540 ft) is east of Grant Grove, and Milk Ranch Lookout (6,250 ft) is about three miles east of Ash Mountain. Both lookouts are subject to periodic severe lightning activity. The Sequoia National Forest maintains Buck Rock Lookout, about five miles east of Park Ridge.

2) Air Detection

Aerial fixed-wing reconnaissance flights include daily flights during the fire season with additional detection flights being ordered after periods of lightning activity. These flights are made during periods of limited visibility or periods of extreme fire danger. If conditions warrant, the Park helicopter may be used for detection flights.

3) Patrols

Fire detection patrols over and above regular patrols will be made during and after lightning activity or any fire emergency.

4) Other Detection

Other Park employees and often Park visitors and residents detect fires. Efforts must be made to secure complete information and relay it to the Fire Management Office.

All initial reports of fires will be immediately reported to the Fire Management Office. Where valuable time may be lost in communicating with the Fire Dispatcher, the District Ranger may be called first, followed by immediate contact with the Fire Dispatcher.

5) Fire Suppression

Fire suppresssion of all wildfires including management fires out of prescription will be aggressive, thorough, and cost effective. If the first attack on a wildfire fails, the situation will be analyzed and the sufficient strength organized to control the wildfire as soon as possible.

a) Suppression Activities or Actions

Actual suppression is the size-up, hot spotting and first attack, line location and construction, control, mop-up patrol, and declaring out of any wildfire. No wildfire will be abandoned until it is extinguished.

b) Reporting and Dispatching Wildfires (see Dispatch Flowchart Fig. 13).

Most wildfires are reported to the Fire Management Dispatcher. When the Fire Office is closed, initial reports on wildfires will be taken by the Communications Center and passed along to the Fire Management Officer. The District or area Ranger will occasionally dispatch class "A" wildfires. The district will immediately advise the Fire Management Officer of the fire and of the action taken.

The Fire Dispatcher will advise the Fire Management Officer and the area Ranger involved of a wildfire.

The district will generally dispatch a crew from its area for minor roadside wildfires.

The helitack crew will be deployed to make a rapid initial attack on off-road wildfires. The district will assist as needed.

In the event of a major fire or a multi-fire situation, the Fire Management Office will assume the dispatch function entirely, set priorities for use of available manpower and aircraft, manning fires with the highest potential first, and will make every effort to place an initial attack crew or air tanker drop on all wildfires in the shortest time possible.

c) Size-up and Initial Attack

For class "A" roadside wildfires, the area Ranger will generally designate the Fire Boss, whereas the Fire Management Officer will make the choice for larger fires. The District Ranger and the Fire Management Officer may relieve or replace a Fire Boss on wildfires for which they are responsible. The Fire Boss is responsible for all action taken on the fire, from size-up to demobilization. His decisions will be accepted and his requests serviced as quickly as possible.

After arriving on a wildfire, the Fire Boss will inform the Fire Dispatcher of the size of the fire, rate of spread, fire potential, and manpower requirements.

If the fire exceeds the qualifications of the Fire Boss, he will be relieved by the Fire Management Officer.

6) Cooperating Agencies

a) California Department of Forestry

A mutual agreement exists with the California Department of Forestry which borders much of the western boundary of Sequoia National Park. This agreement describes the assistance provided by the California Department of Forestry and the Park to one another.

b) United States Forest Service

Mutual aid agreements exist with Sierra and Sequoia National Forests. Initial attack by either agency is automatic on mutual aid land and notice of such initial attacks is made as soon as possible.

c) South Zone Dispatcher

This centralized dispatch function, located at Riverside, California coordinates mobilization efforts of all agencies in the southern part of the State. Assistance which is not available at the local level can be requested through this center.

d) Boise Interagency Fire Center (BIFC)
Boise Interagency Fire Center coordinates all large fires in the United States. The facility is the staging and dispatch center for most large fires, provides fire suppression training, and is staffed by all major land managing agencies.

e) National Weather Service (NWS)

The National Weather Service provides daily fire weather forecasts and red flag warnings or spot forecasts. During fire season, weather data is exchanged through a computer terminal which determines the actual fire danger and next day's prediction. For special fire management operations or projects and multiple fire conditions, a mobile weather unit can be obtained.

f) Mutual Aid Responsibilities

About 100,000 acres make up the mutual aid zones with Sierra and Sequoia National Forests and the California Department of Forestry.

Arrangements to receive United States Forest Service or California Department of Forestry crews and equipment are made with the local dispatchers if their activity is at a low level.

7) Project Fire Operations

a) Fire Organization

Men and equipment must be organized to fight fire effectively and safely. There shall be only one Fire Boss, and he will be responsible only through the District

Ranger and Fire Management Officer to the Superintendent, advising him of actions.

Overhead on large wildfires will be organized according to the USFS Fireline Notebook or USDI/BLM Fire Control Notebook. The Fire Boss will request overhead as needed. Only red-carded overhead will be used.

The Fire Management Officer will designate overhead positions for project fires. Lower qualified personnel from the training roster may be used for mop-up on Park wildfires only.

Personnel will be assigned to fire suppression positions on ability rather than on administrative rank. The responsibility and authority of assigned fire positions will be honored by all personnel on the fire.

b) Supplies and Equipment

The Fire Management Office will maintain a 250 to 300 man project cache, a field kitchen, and field overhead desk kits for project fires. These units will be used on larger fires or multiple fire situations.

When Park equipment or manpower are overextended, or specialized equipment is needed, Boise Interagency Fire Center, USFS, South Zone, and the California Department of Forestry can provide these resources.

8) Demobilization

Demobilization will be in accordance with the Bureau of Land Management Fire Control Notebook.

9) Rehabilitation

Rehabilitation procedures are on file at the Fire Management Office.

d. Fire Monitoring

The purpose of fire monitoring is to provide information for a quantification and prediction of fire behavior and its impact on the Parks' resources, as well as providing a historical record. The Fire Monitoring Guidelines give a more detailed discussion of fire monitoring.

(1) Suppression

Suppression fires are those which do not meet the objective of the Fire Management Plan; specific examples are fires which exceed prescriptions, endanger human life or historical landmarks, threaten endangered species, and cross Park boundaries into another agency's total suppression zone. Fire monitoring provides for mapping and documentation of the growth of the fire, on site measurements of weather, and advising the Fire Boss on present and future fire behavior. Monitoring can serve as a precursor to invoking suppression action by determining if a fire is in prescription or by assessing its potential.

(2) Prescribed Natural Fires

Fire monitoring provides for mapping, weather measurement, and study of the natural role of fire and its characteristics, such as flame length, rate of spread, and intensity. Monitoring checks to see that the fire remains in prescription.

(3) Prescribed Burns

Fire monitoring provides information for the refinement of prescriptions, correlating fire characteristics with fire effects, and data for research.

Prescribed Fire Monitors advise the Prescribed Fire Boss that the fire is within prescription and prescribed techniques are being used properly.

(4) Flux Conditions

Fire approaching Park boundaries, sequoia groves, new additions to the natural fire management unit, and sections of the Parks which are allowed to burn under prescribed conditions only at certain times of the year will be monitored. These areas require careful monitoring which involves not only observation of presently occurring fire behavior, but also accurate predictions of fire behavior as far in the future as is practical.

The Fire Management Officer is responsible for assigning qualified personnel to monitor fires. These may be personnel from any division or of any level whom the Fire Management Officer believes can accurately report the status and the potential of the fire. Monitors will report to the Burn Boss responsible for the given management fire or wildfire.

Fire Monitors are responsible to the Prescribed Burn Boss who will assign at least one Prescribed Fire Monitor to each prescribed burn. They monitor fuel loads, vegetation composition, fire characteristics, impact of the fire on the site, weather, and will complete all monitoring reports.

All fires will be monitored, regardless of size. Prescribed natural fires may be monitored from the air if less than ten acres, not crowning generally, and have low potential for rapid spread. All fires greater than ten acres will be monitored from the air and from the ground, as often as the Fire Management Officer requires intelligence on the fire, but at least no later then when ten acres is reached. Fires will be monitored at the request of the Interpretive Division for historical record, the Ranger Division for insurance of visitor and trail safety, and the Research Division for data gathering.

High priority for monitoring will be large fires, fires in conditional units, multiple fires, unusual weather or fuel situations, and fires that threaten to leave the fire management zone of origin. Any fire, regardless of size, may be monitored from the ground.

Since the primary purpose of the Prescribed Fire Monitor on prescribed natural fires and suppression fires is to assess potential and to predict fire behavior, they will be dispatched for the length of time that there is a need for on-site information of the fire's status. The Fire Management Officer or Fire Boss should realize that nonutilization of Prescribed Fire Monitors can result in a lack of knowledge of a fire's status during a critical phase of its development, particularly with flux and prescribed natural fire situations.

If Prescribed Fire Monitors and Fire Management Technicians are sent to the same fire, which has been declared a suppression or containment fire, Prescribed Fire Monitors should not aid in the control operation, except possibly in determining line placement, unless ordered to do so by the Fire Boss. Their function is to gather fire intelligence.

The most efficient utlization of the Prescribed Fire Monitor may be as a combination of Fire Management Technician and Prescribed Fire Monitor. By being trained to not only suppress fire, but also to assess their potential, determine if they are meeting prescribed objectives and suppress them if they are not, and to characterize them and their effects quantitatively, a new flexible aspect to fire management is introduced.

e. Air Resources Management

(1) Background

The Clear Air Act of 1963 (PL88-206), as amended, significantly effects the fire management program at Sequoia and Kings Canyon National Parks. The 1977 admendments provide a greater role for State and local governments in the administration of the Clean Air Act and clearer legislative guidance and intent to the prevention of significant deterioration of air quality over national Parks and wildernesses. Section 118, which in part states that "Each officer, agent, or employee of the Federal Government must comply with Federal, State, interstate, and local requirements concerning control and abatement of air pollution to the same extent that any other person must when the person is subject to the same substantive or procedural requirements. The President may grant an exemption to the requirements of this section under certain circumstances and conditions," has an impact on the prescribed fire program. The fire management program will be coordinated with local and State agencies for procedural requirements <u>including</u> permits.

(2) Guidelines

The Air Resources Management Guidelines will be updated and expanded to meet State and local air quality requirements as they are promulgated. The following guidelines will be followed:

(a) The California Department of Forestry, adjacent national forests and Air Pollution Control Districts will be notified prior to any prescribed burn and when a fire is declared a prescribed natural fire below 6,000 ft. A copy of the annual prescribed burning program will be sent to the Air Pollution Control Districts prior to the burning season.

(b) All prescribed burn plans will have clear objectives and will have considered the impact on the total environment.

(c) No prescribed burning will be done during pollution alerts or temperature inversions in the Parks.

(d) Weather information and fire weather forecasts will be used on all prescribed burns to determine smoke dispersal.

(e) Test fires will be used on all prescribed burns to confirm smoke behavior.

(f) Prescribed burning in sensitive areas, such as campgrounds and visitor use areas, will be done when visitation is low.

(g) All prescribed burn plans will consider trajectory of the smoke plume, identification of Smoke Sensitive Areas (SSA), fuel type, and critical targets, mixing of man-made pollutants with prescribed fire smoke, and atmospheric stability.

(h) Backfires will be used whenever possible to provide for more complete consumption and to lessen visibility problems.

(i) No burning will be allowed within 30 miles of SSA when the plumes may be expected to enter such areas below the ceiling elevation.

(j) No prescribed burning will be permitted (no new starts) when visibility is less than 10 miles (unless due to "wet" obstructions, i.e., fog, precipitation or water droplet cloud).

f. Public Information and Interpretation

This is one of the most important parts of the fire management program. It will be coordinated by the Management Assistant with input from the Chief Ranger and the Chief of Resources Management. The following guidelines will be used:

(1) The Management Assistant will be kept informed daily by the Fire Management Officer of the fire situation in the Parks.

(2) The management fire program will be explained to the public as follows:

(a) Concepts of the prescribed natural fire and prescribed burning programs will be incorporated into the Parks folder.

(b) Informational handouts detailing the fire management program will be prepared and periodically updated. During periods when management fires are burning, handouts will be distributed to all visitors entering the Parks and areas of fire activity.

(c) The fire management program will be incorporated into interpretive walks, talks, and other programs; particular attention will be given to this activity when fires are conspicuous from the roadsides.

(d) During prescribed burning periods, news briefs will be released by the Management Assistant to newspapers, radio, and television stations as appropriate.

(e) Public information outlets for neighboring Forest Service and California Department of Forestry offices will be provided with all fire management information.

(3) The fire management program will be discussed in informal talks with all Park Divisions, concessionaires, and surrounding communities.

(a) All visitors to zones where management fires are burning will be informed at the trailhead.

(b) Some areas may be closed if the fire situation dictates.

(c) Backcountry Rangers will keep backcountry users informed of any fire's progress.

g. Records and Reports

(1) Permanent Park Fire Records

The following fire records will be held as permanent records:

Record	Location
a) Fire Reports (10-400-DI-1201)	Fire Management Office
b) "Fire Atlas"	Fire Management Office
c) Fire weather records	Fire Management Office
d) Historic records of Park, i.e., photographs of vegetative change due to fire	Resources Management Office
e) Fire equipment inventories	Fire Management Office
f) Fire protection acreage summary	Fire Management Office
g) All other maps or records pertinent to fire	Resources Management Office

(2) Fire Reports

The fire reporting system is designed to ensure accurate recording of all fires, including fire for research, and conditions under which they take place.

The individual fire report, DI-1201, and individual fire report supplements, 10-201 and 10-451 (Project Management Plan), are required for all management fires and wildfires. The following additional reports are required for management fires.

Fires	Reports
Prescribed Natural Fire	Fire Monitoring Form
Prescribed Burn	Fire Monitoring Form Prescribed Burn Plan

The DI-1201 and Prescribed Burn Plan will be submitted to Western Regional Office no later than ten days after the fire is declared out. The Fire Management Officer will be responsible for ensuring that all fire reports are submitted on time.

(3) Reporting Procedures

The following procedures will be used in submitting fire reports:

Report	When Submitted	Person Responsible	When Due to Whom
Individual Fire Report DI-1201	All Fires	Fire Boss/ Prescribed Fire Boss	Ten days after fire is declared out to the Fire Management Officer
Individual Fire Report Supplement 10-201	All Fires	Fire Boss/ Prescribed Fire Boss	Ten days after the fire is declared out with DI-1201 to the Fire Management Officer
*Fire Monitoring Report	All Management Fires	Prescribed Fire Monitor	Ten days after the fire is declared out to the Prescribed Fire Boss who then submits report to the Fire Management Officer
Prescribed Burn Plan	Prescribed Burns	Prescribed Burn Boss	Ten days after the fire is declared out through the Fire Management Officer to the Chief of Resources Management

(3) Situation Reports

Situation reports will be in accordance with NPS 18, Fire Management Guidelines.

h. Safety

Fire is hazardous and must be given very high priority. A Safety Officer will be assigned to all large wildfires and management fires.

Any employee responsible for any fire management action must never subordinate human lives to other values. All key fire management personnel are issued U.S. Forest Service Fireline Notebook.

Protective clothing are available and will be issued to those directly involved in fire management activities. Nomex shirts and pants will be worn by all personnel on fire management assignments. Fire tents, chaps, and ear plugs are used only

*Data from this report will be used to complete the Individual Fire Report Supplement, 10-201. Cost figures and the fire map will be compiled by the Fire Dispatcher and submitted to the Fire Management Officer. Copies of all management fire reports will be sent to the Chief of Resources Management and suppression fire reports to the Chief Ranger.

in specific activities. Hard hats, goggles, gloves, and heavy boots will be in use when engaged in training, travel to and from fires and during fireline duty. Nomex jump suits and hoods, crash helmets, and ear plugs will be used in all helicopter operations.

VIII. FINANCIAL MANAGEMENT

Funding will be in accordance with the Fire Management Guidelines, NPS 18.

IX. FIRE MANAGEMENT SUMMARY

Table 22 shows the fire management summary for wildfires from 1922 through 1979, and management fires from 1968 through 1979. The fire management program will continue to expand at Sequoia and Kings Canyon National Parks. As our knowledge of fire and its role in the environment expands, this plan will need to be revised. Revision and updating of the Fire Management Plan will be done once a year in December.

Table 22. Total Number and Size of Wildfires (1922 through 1979) and Management Fires (1968 through 1979) in Sequoia and Kings Canyon National Parks.

Type of Fire	Fire Management Zone I (Alpine-Subalpine Upper Mixed-Conifer)	Fire Management Zone II (Sequoia-Mixed-Conifer)	Fire Management Zone III (Chaparral/ Oak-Woodland)	Totals
I. Wildfires (1922-1979)				
A. Number of fires	795	873	205	1,873
B. Acres	4,796	10,221	14,138	29,155
II. Management Fires (1968 - 1979)				
A. Prescribed natural fires				
1. Number of fires	169	-	-	169
2. Acres	20,582	-	-	20,582
B. Prescribed Burns				
1. Number of fires	1	52	14	67
2. Acres	800	7,876	7,866	16,542

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XI. APPENDIX

Appendix A - Sensitive Plants, Cultural and Archeological Resources

Maps showing the locations of these resources are in the Fire Management Area folders in the Fire Management Office at Ash Mountain and also in the Research Scientist's Office.

A. Sensitive Plant Species in Sequoia and Kings Canyon National Parks.

Species Name and Author	Elevation Range (from Munz)	Vegetation Type (from Munz)	Known Populations and Elevation
Fire Management Zone I			
1. Arabis pygmaea Roll	8,500 to 11,000 ft	Dry flats, subalpine forests	Rock Creek, 9,600 ft; Kern Hot Springs, 6,900 ft; btw Moraine Lake & Big Arroyo; Rock Creek, 10,400 ft; Siberian Pass, 11,00 ft
2. Asplenium septentrionale (L.) Hoffm.	apx. 11,000 ft	Rocks	Columbine Lake, 11,000 ft
3. Astragalus kentrophyta Gray var. danaus Barneby	11,250 to 11,500 ft	Alpine fell fields	Sawmill Pass, 11,347 ft
4. Astragulus raveni	apx. 11,250 ft	Open stoney slopes, alpine fell fields	Sawmill Pass, 11,347 ft
5. Delphinium inopinum (Jeps.) Lewis & Epl.	5,000 to 8,000 ft	Open places, yellow pine forest	Upper Kern River Canyon
6. Dicentra nevadensis (treated as subspecies by Munz: D. formosa ssp. Nevadensis)	7,500 to 10,000 ft	Moist places, lodgepole to subalpine forests	Mehrten Meadow, 9,500 ft; Alta Peak, 11,200 ft; Alta Meadow, 9,000 ft; Buck Creek, 7,500 ft; Hamilton Lakes, 10,000 ft; Sand Meadows, 8,500 ft; South Fork Meadows, 8,500 ft; Vic. Quinn R. S., 8,800 ft. (This also occurs in Zone 2.)
7. Draba cruciata Pays var. integrifolia Hitch. & Sharsm.	10,000 to 12,400 ft	Alpine fell fields	Bench Lake, 10,500 ft

	Species Name and Author	Elevation Range (from Munz)	Vegetation Type (from Munz)	Known Populations and Elevation
8.	Eriogonum polypodum Small	8,000 to 10,500 ft	Dry sand flats	Subalpine forests: Mt. Whitney, 12,000 ft; Rock Creek; Chagoopa Plateau; Whitney Creek; Mt. Guyot; Guyot Flat; Crabtree Creek; Wright Creek
9.	Erythronium grandiflorum Pursh. ssp. pusaterii Munz & Howell	8,000 to 9,000 ft	Open rocky soils	Hockett Lakes; South Fork Kaweah, 8,400 ft
10.	Hackelia Sharsmithii Jtn.	10,750 to 12,000 ft	Shaded spots in the shelter of rocks in the subalpine forest of alpine fell field plant communities	Rock Creek west of Army Pass, Crabtree Creek, and Mount Guyot.
11.	Phacelia orogeneo Brand	8,500 to 10,300 ft	Meadows, subalpine forests	Cliff Creek, 8,500 ft; Black Rock Pass, 10,500 ft; Lost Canyon, 10,000 ft; Mineral King, 7,800 ft, 8,700 ft; White Chief Mine, 10,400 ft; Timber Gap Trail, 9,400 ft; btw. Big Arroyo & Chagoopa Plateau, 10,300 ft
12.	Raillardella muirii Gray	4,000 to 7,000 ft	Open slopes, yellow pine forests	Mt. Woodward, 8,800 ft; Tehipite Valley, 4,200 ft
13.	Ribes tularense (Cov.) Fedde	5,000 to 6,000 ft	Yellow pine forest, red fir forest	Colony Mill Road; Hidden Spring; Yucca Canyon
14.	Streptanthus gracillis	10,000 to 11,000 ft	Dry slopes of disintegrated granite subalpine forest	South Fork Kings River, 9,500 ft; Gardiner Basin, 10,800 ft; Bullfrog Lake, 10,630 ft; Milestone Creek, 10,500 ft; Kern River, 10,200 ft; Vic. East Lake, 10,400 ft; Reflection Lake, 10,500 ft
15.	Draba cruciata var. cruciata Jeps.	9,000 to 10,000 ft	Subalpine forests	Mineral King, 7,800

Species Name and Author	Elevation Range (from Munz)	Vegetation Type (from Munz)	Known Populations and Elevation
Fire Management Zone II			
1. Streptanthus fenestratus (Greene) J. T. Howell	4,000 ft	Open exposed sandy sites, higher valley floors or gently sloping hillsides. Flat to south-facing open slopes, yellow pine forests	Tehipite Valley floor and along trail to Little Tehipite Valley below Mist Falls on dry rock open areas - abundant
2. Pityopus californicus	1,000 to 5,000 ft	Deep shade, yellow pine forests, giant sequoia forests	Redwood Canyon
3. Erigeron aquifolius Hall	5,000 to 7,000 ft	Dry ridges, yellow pine forests, red fir forests	Zumwalt Meadow, 5,000 ft
Fire Management Zone III			
1. Angelica calli Mathias & Constance	3,300 to 6,500 ft	Stream banks and other moist places at the edge of woods	Two miles east of Lookout Point Guard Station on Mineral King Road, 4,600 ft
2. Carex tomkinsii J. T. Howell (1961)	3,200 to 5,500 ft	Rocky canyon walls	Middle Fork Kings River, 5,500 ft; Copper Creek, 5,500 ft
3. Streptanthus farnsworthianus J. T. Howell	3,000 to 4,000 ft	Gravelly outcrops, upper oak-woodland	Generals Highway btw. Ash Mt. & Giant Forest, 3,500 ft; just outside Park along 198, 1,300 ft
B. Collected Near and Possibly May Occur Within the Parks			
Fire Management Zone I			
1. Corydalis caseana	4,000 to 9,000 ft	Moist shade, yellow pine forest	South of Sequoia Park, Kern River

Species Name and Author	Elevation Range (from Munz)	Vegetation Type (from Munz)	Known Populations and Elevation
2. Lewisia disepala Rydb. N. Amer. Flora 21:328	6,500 to 8,500 ft	Domes, gravelly soils	South of Sequoia Park
3. Oreonana purpurascens Constance & Shevcock	8,000 to 9,000 ft	Rocky soils, openings, red fir forests	South of Sequoia Park
4. Trifolium Bolanderi Gray	ca 7,000 ft	Wet meadows, red fir forests	
Fire Management Zone II			
1. Lewisia Congdonii (Rvdb.) J. T. Howell	2,000 to 7,000 ft	Rocky places, Granitic cliff with plant scattered in the talus below & soil pockets above & cracks on the face. Foothill wdl., yellow pine forests	
Fire Management Zone III			
1. Brodiaea insignis (Jeps.) Niehaus	800 to 1,500 ft	Foothill woodland	South Fork Kaweah, 1,500 to 2,600 ft
2. Eriogonum nudum Dougl. ex Benth. var murinum Reveal	ca 1,100 ft	Dry slopes, pine forests	Vic. Hammond Fire Station, 1,100 ft
3. Lewisia Congdonii	2,000 to 7,000 ft	Rocky places. Granitic cliff with the plant scattered in the talus below & solid pockets above & cracks on the face. Foothill wdl., yellow pine forests	
4. Ribes menziesii Pursh var. ixoderme Quick	Below 3,500 ft	Chaparral	

B. Cultural Resources

1. FIRE MANAGEMENT ZONE I

a. Pear Lake Ski Hut: This is not a fire management problem.

b. Hockett Meadow Ranger Station: This is not a management problem.

c. Quinn Sheep Camp: The ruin cabin at Sky Parlor Meadow should be protected from fire. This property is not currently nominated to the National Register but may be in the future.

d. Shorty Lovelace Historic District: The eleven sites within or associated with the Shorty Lovelace H. D. present the largest fire management problem of any of the nonarcheological cultural resources within these two Parks.

Each of these cabins or cabin ruins should be protected from fire. Most of these stand in remote and little-visited locations.

(1) Quartz Meadow: Cabin ruin about one mile north of Williams Meadow.
(2) Crowley Canyon: About one mile north of Comanche Meadow.
(3) Ellis Meadow: About 1/4 mile SE of meadow.
(4) Moraine Meadow: Less than 1/4 mile south of trail.
(5) Cloud Canyon: Near junction of Cooper Mine and Colby Pass Trails.
(6) Lower Bubbs Creek: In boulders at upper end of Sphinx Creek trail junction camping area.
(7) Sphinx Creek: On headwaters of one of the eastern tributaries of Sphinx Creek; 1/2 mile from trail.
(8) Vidette Meadow: Across Creek from trail.
(9) Gardiner Basin: 100 yards below point where Gardiner Pass trail turns up Gardiner Creek.
(10) Woods Creek: 1/4 mile south of Woods Creek crossing on JMT.
(11) Granite Pass: about 2/3 mile north of pass.

e. Barton-Lackey Cabin: This structure, located adjacent to the Roaring River (Scaffold Meadow) Ranger Station should be protected from fire.

f. Quinn Ranger Station: The immediately surrounding forest should undergo no more than light burning.

g. Kern Canyon Historic District: For at least the next fifty years the area surrounding the Kern Canyon Ranger Station should be protected from all fire. This area includes numerous decaying wooden remains that would be destroyed by fire including the ruins of the Conterno saw mill and the old Lewis cabin. The historic district boundary as defined in the National Register nomination should define the fire free zone.

h. Tyndall Creek Shepherd's Cabin: This property, which may qualify for the National Register should be protected from fire. It is located about one mile southwest of the Tyndall Creek patrol cabin.

i. Smithsonian Institution Shelter: This building, which is located on the summit of Mt. Whitney, is not a fire management problem

2. FIRE MANAGEMENT ZONE II

a. Camp Sequoia: This National Register property consist of two sites within the Giant Forest used by the Army as administrative camp sites prior to 1920. Neither site contains any actual remains from this period, and therefore the sites can be treated in terms of fire the same as the rest of the Giant Forest. This single exception to this rule is that since some of the graded tent locations are still visible, fire line trenching and the like should be avoided on these two sites. The two sites in question are at Commissary Curve and "Soldiers' Camp" on the Cresent Meadow Road.

b. Giant Forest Lodge and Giant Forest Village/Camp Kaweah Historic Districts: There are both in the heart of the Giant Forest developed area and should present no particular fire management problems.

c. Squatter's Cabin, Tharp's Log, and Cattle Cabin: These historic structures within the Giant Forest should be protected from all fire. Their immediate settings should be managed in the same way as the rest of the grove with regard to prescribed burning.

d. Cabin Creek: The two permanent buildings at Cabin Creek should be protected from fire as should the immediate setting.

e. Stone Bridges Historic District: This National Register nomination includes the Clover Creek and Marble Fork stone bridges. No fire management problems exist.

f. Smith Comstock Historic Site: The Big Stump basin should be protected from all but the lightest burning so that the remaining cultural remains, including mill foundations and piles of saw dust, are preserved as long as possible. The sequoia stumps present also require fire protection.

g. General Grant National Park Historic District: The buildings included within this nomination are within the Grant Grove developed area and should not be a fire management problem.

h. Gamlin Cabin: This should not be a fire management problem.

i. Knapp Cabin: This structure, located in Cedar Grove, should be protected from fire. The immediate surroundings may be allowed to undergo light burning.

3. FIRE MANAGEMENT ZONE III

a. Ash Mountain Entrance Sign: Located in a developed area; should not be a fire management problem.

b. Colony Mill Historic Sites: This National Register property includes both the Colony Mill area proper and the Colony Mill Road from the west boundary to the mill. The mill area should be protected from intense fire. Light burning would return it to the state existing in the 1880's and is therefore no problem. The road corridor should receive no special fire protection.

c. Moro Rock Stairway: This is obviously not a fire management problem.

C. Archeological Sites

Remnants of Indian culture are considered to be a valuable resource of the Park and will be protected. Five catagories of archeological sites have been defined:

a. Bedrock mortars: These Indian made holes in granitic bedrock will not pose a problem in prescribed burning. They are concentrated in Cedar Grove, Giant Forest, and General Grant Grove.

b. Campsites: The Indian campsites are found throughout the Park in areas that are obviously best suited for camping. They are quite obscure with perhaps only a scattering of artifacts. Although identification may be difficult, if prescribed burning is to be done in the area, an attempt will be made to preserve the artifact.

c. Village sites: The Indian Villages are in the areas of Cedar Grove, and Hospital Rock. In prescribed burning, the same precautions should be observed as with the Campsites, especially at Hospital Rock and Cedar Grove where excavations have been undertaken.

d. Workshops: These are areas of heavy concentrations of obsidian and stone used in the manufacture of arrow points and one is located west of Mather Pass. In prescribed burning, an attempt should be made to preserve the artifacts.

e. Pictographs: These are Indian paintings on rock. The known ones are at Hospital Rock, Potwisha Camp, and Tehipite Valley. There is a report of another location near Redwood Meadow on record at Ash Mountain Headquarters. This, however has not been verified. Before prescribed burning is initiated, measures will be taken to preserve these significant archeological records.

The sites are distributed throughout the Park:

Fire Management Zone I:	2 Bedrock Mortar Sites
	46 Campsites
	1 Workshop
	1 Pictograph Site
Fire Management Zone II:	7 Bedrock Mortar Sites
	2 Campsites
	2 Villages
Fire Management Zone III:	5 Bedrock Mortar Sites
	1 Village
	2 Pictograph Sites

Appendix B - Fuel Models and Manning Plan

A. Definitions of NFDRS fuel models (Deeming et al., 1977) found in Sequoia and Kings Canyon are as follows:

1. Fuel Model A

This fuel model represents western grasslands vegetated by annual grasses and forbs. Brush or trees may be present but are very sparse, occupying less than one-third of the area. Examples of types where Fuel Model A should be used are cheatgrass and medusahead. Open pinyon-juniper, sagebrush-grass, and desert shrub associations may appropriately be assigned this fuel model if the woody plans meet the density criteria. The quantity and continuity of the ground fuels vary greatly with rainfall from year to year.

2. Fuel Model B

Mature, dense fields of brush six feet or more in height are represented by this fuel model. One-fourth or more of the aerial fuel in such stands is dead. Foliage burns readily. Model B fuels are potentially very dangerous, fostering intense, fast-spreading fires. This model is for California mixed chaparral generally 30 years or older. The F model is more appropriate for pure chamise stands. The B model may also be used for the New Jersey pine barrens.

3. Fuel Model C

Open pine stands typify Model C fuels. Perennial grasses and forbs are the primary ground fuel but there is enough needle litter and branchwood present to contribute significantly to the fuel loading. Some brush and shrubs may be present but they are of little consequence. Situations covered by Fuel Model C are open, longleaf, slash, ponderosa, Jeffrey, and sugar pine stands. Some pinyon-juniper stands may qualify.

4. Fuel Model F

Fuel Model F is the only one of the 1972 NFDRS Fuel Models whose application has changed. Model F now represents mature closed chamise stands and oakbrush fields of Arizona, Utah, and Colorado. It also applies to young, closed stands and mature, open stands of California mixed chaparral. Open stands of pinyon-juniper are represented; however, fire activity will be overrated at low windspeeds and where there is sparse ground fuels.

5. Fuel Model G

Fuel Model G is used for dense conifer stands where there is a heavy accumulation of litter and downed woody material. Such stands are typically overmature and may also be suffering insect, disease, wind, or ice damage -- natural events that create a very heavy buildup of dead material on the forest floor. The duff and litter are deep and much of the woody material is more than three inches in diameter. The undergrowth is variable, but shrubs are usually restricted to openings. Types meant to be represented by Fuel Model G are hemlock-Sitka spruce, Coast Douglas-fir, and windthrown or bug-killed stands of lodgepole pine and spruce.

6. Fuel Model H

The short-needled conifers (white pines, spruces, larches, and firs) are represented by Fuel Model H. In contrast to Model G fuels, Fuel Model H described a healthy stand with sparse undergrowth and a thin layer of ground fuels. Fires in H fuels are typically slow spreading and are dangerous only in scattered areas where the downed woody material is concentrated.

7. Fuel Model L

This fuel model is meant to represent western grasslands vegetated by perennial grasses. The principal species are coarser and the loadings heavier than those in Model A fuels. Otherwise the situations are very similar; shrubs and trees occupy less than one-third of the area. The quantity of fuel in these areas is more stable from year to year. In sagebrush areas Fuel Model T may be more appropriate.

8. Fuel Model U

Closed stands of western long-needled pines are covered by this model. The ground fuels are primarily litter and small branchwood. Grass and shrubs are precluded by the dense canopy but occur in the occasional natural opening. Fuel Model U should be used for ponderosa, Jeffrey, sugar pine, and red pine stands of the Lake States. Fuel Model P is the corresponding model for southern pine plantations.

B. Manning Plans

Fire weather observations from Grant Grove, Lodgepole, Ash Mountain, Cedar Grove, Milk Ranch, and Park Ridge are taken daily at 1400 and entered into the "AFFIRMS" computer at Park Headquarters by 1415. The indices and fire weather forecast are received from Fresno, California, and the manning plans for the next day are announced by 1530. Each station's manning plan is determined by its predicted Burning Index.

The Ash Mountain Station uses fuel model B and is located in Fire Weather Zone 529. The manning plans are:

BI	Plan	Fire Danger
0-42	1	Low
43-84	2	Medium
85-169	3	High (90th percentile)
170-184	4	Very High (97th percentile)
185+	5	Extreme

The Lodgepole, Grant Grove, and Cedar Grove Stations use fuel model G and are located in Fire Weather Zone 534. Their manning plans are:

BI	Plan	Fire Danger
0-17	1	Low
18-35	2	Medium
36-70	3	High (90th percentile)
71-78	4	Very High (97th percentile)
79+	5	Extreme

Appendix C - Fire Management Areas and Prescribed Burn Units

Fire management areas as discussed in the plan are areas of the landscape that are similar in fuels, topography, and fire history that are separated by natural and/or man-caused barriers. Prescriptions and strategies are tied to these areas. A total of 31 fire management areas, that include all fire management zones II/1B and III, have been designated. All actions taken on prescribed burns, prescribed natural fires, and wildfires in these zones are tied to these areas.

A folder is maintained at the Fire Management Office for each of the fire management areas and contains all the information needed to allow a natural fire to burn, conduct a prescribed burn, or suppress a wildfire. The following items are in the folder:

A. Name of the fire management area

B. Size

C. Location
   1. Elevation range
   2. Topography
   3. Slope and aspect

D. Vegetative types

E. Endangered/threatened plant species

F. Cultural and archeological sites

G. Fuels
   1. Quantity
   2. Continuity - arrangement

H. Fire potential
   1. Predicted rate of spread under various fuel/weather conditions
   2. Burn out potential

I. Fire History
   1. Number of fires, frequency, time of year

J. Natural or man-made barriers

K. Fire management strategies and prescriptions for each area

L. Prescribed burn/containment units

   Each area is subdivided into prescribed burn/containment units. These are smaller subdivisions where prescribed burning will be conducted. Prescribed natural fires, when in prescription, will be contained to these units.

M. Preattack information

1. Access routes
   a. Trails - roads

2. Facilities
   a. Power/telephone lines
   b. Buildings
   c. Visitor campsites

3. Fire Danger Rating Stations
   a. Fuel models used
   b. Indicates what stations are used to determine prescription for the area

4. Water sources (natural or man-made)

5. Fire camps

6. Heliports - helispots

7. Fire Management Crews
   a. Lists what crews are dispatched and travel time

8. Equipment availability and location
   a. Includes all aircraft, vehicles and handtools

9. Mutual aid
   a. Includes location of mutual aid zone and sources of outside assistance

N. Special Problems

1. Visitor safety-access etc.

2. Air quality

3. Insect and disease areas

All of the above information is keyed to a map, where applicable, so that the Fire Boss will be prepared to handle a prescribed burn, prescribed natural fire or wildfire.

Prescribed Burn Units

Fire Management Areas/ Prescribed Burn Units	Prescribed Burn Units Size (Acres)		Fire Management A Size (Acres)
I. Fire Management Zone II/1B			
1. Kern Canyon	1-1 - 722		722
2. Garfield Grove	2-1 - 383		4,145
	2-2 - 1,821		
	2-3 - 904		
	2-4 - 503		
	2-5 - 534		
3. Homers Nose	3-1 - 393	3-5 - 1,082	6,634
	3-2 - 1,543	3-6 - 1,210	
	3-3 - 884	3-7 - 805	
	3-4 - 717		
4. Cahoon Meadow	4-1 - 1,220	4-7 - 600	11,231
	4-2 - 642	4-8 - 1,821	
	4-3 - 847	4-9 - 1,587	
	4-4 - 856	4-10- 714	
	4-5 - 943	4-11- 912	
	4-6 - 1,089		
5. Oriole Lake	5-1 - 679	5-5 - 344	5,971
	5-2 - 1,434	5-6 - 1,090	
	5-3 - 615	5-7 - 1,229	
	5-4 - 157	5-8 - 423	
6. Castle Rocks/ Mineral King	6-1 - 621	6-5 - 1,519	5,654
	6-2 - 303	6-6 - 747	
	6-3 - 531	6-7 - 1,072	
	6-4 - 861		
7. Redwood Meadow	7-1 - 1,764	7-4 - 987	5,409
	7-2 - 1,205	7-5 - 158	
	7-3 - 1,028	7-6 - 267	
8. Kaweah	8-1 - 1,623	8-3 - 505	4,974
	8-2 - 1,513	8-4 - 1,333	
9. Bearpaw Meadow	9-1 - 403	9-5 - 305	3,992
	9-2 - 246	9-6 - 678	
	9-3 - 1,534	9-7 - 472	
	9-4 - 354		

Prescribed Burn Units

Fire Management Areas/ Prescribed Burn Units	Prescribed Burn Units Size (Acres)		Fire Management Area Size (Acres)
10. Panther Peak	10-1 - 698 10-2 - 1,195 10-3 - 305 10-4 - 1,308 10-5 - 796	10-6 - 845 10-7 - 1,360 10-8 - 1,295 10-9 - 879 10-10- 739	9,420
11. Giant Forest	11-1 - 358 11-2 - 183 11-3 - 98 11-4 - 224 11-5 - 315 11-6 - 134	11-7 - 256 11-8 - 124 11-9 - 202 11-10- 308 11-11- 452 11-12- 346	3,000
12. Lodgepole	12-1 - 585 12-2 - 540 12-3 - 992	12-4 - 599 12-5 - 1,177 12-6 - 133	4,026
13. Suwanee	13-1 - 51 13-2 - 1,613 13-3 - 1,082		2,746
14. Crystal Cave	14-1 - 276 14-2 - 295 14-3 - 406 14-4 - 562 14-5 - 766	14-6 - 681 14-7 - 365 14-8 - 834 14-9 - 560	4,745
15. Halstead Meadow	15-1 - 624 15-2 - 436 15-3 - 2,101 15-4 - 2,452	15-5 - 1,017 15-6 - 708 15-7 - 1,270	8,608
16. Dorst Creek	16-1 - 1,106 16-2 - 304 16-3 - 1,173	16-4 - 1,436 16-5 - 622	4,641
17. Skagway	17-1 - 960 17-2 - 1,249		2,209
18. Redwood Canyon	18-1 - 1,090 18-2 - 519 18-3 - 541 18-4 - 655 18-5 - 519	18-6 - 1,213 18-7 - 1,094 18-8 - 655 18-9 - 2,266	8,552

Prescribed Burn Units

Fire Management Areas/ Prescribed Burn Units	Prescribed Burn Units Size (Acres)		Fire Management Ar[ea] Size (Acres)
19. Grant Grove	19-1 - 439 19-2 - 351 19-3 - 549 19-4 - 550 19-5 - 408	19-6 - 715 19-7 - 531 19-8 - 791 19-9 - 98	4,432
20. Cedar Grove	20-1 - 734 20-2 - 857 20-3 - 393	20-4 - 203 20-5 - 255 20-6 - 436	2,878
21. North Mountain	21-1 - 2,493 21-2 - 1,828 21-3 - 1,384 21-4 - 2,062	21-5 - 2,215 21-6 - 949 21-7 - 1,401 21-8 - 571	12,903
22. Sentinel Ridge	22-1 - 648 22-2 - 1,920 22-3 - 911	22-4 - 2,345 22-5 - 980 22-6 - 602	7,406
23. Bubbs Creek	23-1 - 208 23-2 - 629	23-3 - 1,682 23-4 - 1,601	4,120
24. South Fork Kings	24-1 - 665 24-2 - 1,045 24-3 - 934		2,644
25. Tehipite	25-1 - 2,464 25-2 - 1,596 25-3 - 1,231 25-4 - 2,180	25-5 - 361 25-6 - 370 25-7 - 1,544	9,746

Prescribed Burn Units

Fire Management Areas/ Prescribed Burn Units	Prescribed Burn Units Size (Acres)		Fire Management A Size (Acres)
II. Fire Management Zone III			
26. Clough Cave	26-1 - 1,082		4,234
	26-2 - 1,622		
	26-3 - 1,530		
27. Lookout Point	27-1 - 1,396	27-4 - 1,465	7,185
	27-2 - 491	27-5 - 1,150	
	27-3 - 1,809	27-6 - 734	
		27-7 - 140	
28. Milk Ranch	28-1 - 633	28-3 - 1,327	4,620
	28-2 - 1,830	28-4 - 830	
29. Ash Mountain	29-1 - 82	29-4 - 1,410	6,286
	29-2 - 1,013	29-5 - 1,437	
	29-3 - 1,949	29-6 - 395	
30. Hospital Rock	30-1 - 1,650	30-4 - 564	4,926
	30-2 - 1,533	30-5 487	
	30-3 - 692		
31. Yucca Mountain	31-1 - 648	31-7 - 567	14,574
	31-2 - 2,014	31-8 - 1,115	
	31-3 - 393	31-9 - 493	
	31-4 - 1,201	31-10- 1,778	
	31-5 - 1,324	31-11- 1,849	
	31-6 - 2,034	31-12- 1,158	

Appendix D - Memoranda of Understanding

To be revised

Appendix E

Prescribed Fire Management Training Courses

COURSE TITLE	NO.	OBJECTIVES	RESPONSIBLE LEVEL	COURSE LENGTH
1. SEKI Prescribed Fire Management	M100	Provide introductory training in Prescribed Fire Management.	Park	8 hours
2. Prescribed Fire Crew Boss	M110	Train the Prescribed Fire Crew Boss.	Park	8 hours
3. Giant Sequoia mixed-conifer (includes ponderosa pine) Fire Ecology	M120	Train the Prescribed Fire Boss, Firing Officer, and Prescribed Fire Monitor.	Park	16 hours
4. Chaparral-Brush Fire Ecology	M130	Train the Prescribed Fire Boss, Prescribed Firing Officer, and Prescribed Fire Monitor	Park	16 hours
5. Prescribed Fire Monitor	M140	Train the Prescribed Fire Monitor in monitoring/documentation techniques	Park	24 hours
6. Prescribed Firing Officer	M150	Train the Prescribed Firing Officer in prescribed burning procedures in all Park fuel types.	Park	16 hours
7. Advanced Fire Management	M	Designed to identify fire relationships in wildland ecosystems, fuel appraisal and fire in land management planning.	National Coordination	80 hours
8. Prescribed Fire Boss (fuel models G, U & B)	M160	Train Prescribed Fire Boss to conduct prescribed burns in sequoia mixed-conifer & chaparral-brush fuel types.	Park	24 hours

Appendix F - Glossary of Terms

Burning Index (BI) - a number related to the contribution of fire behavior to the effort of containing a fire. It is expressed as predicted flame length divided by ten.

Climax Vegetation - the final, self-perpetuating community in a successional series; it is in equilibrium with its physical environment, resulting in no net accumulation of organic material.

Conditional Fire Management Unit (1B) - subset of Fire Management Zone I, it will not be included in the Natural Fire Management Unit (1A) until natural fires occuring in CFMU 1B are shown to meet management objectives. Therefore, 1B prescriptions are more restrictive than those of 1A.

Containment - the confinement of a fire by direct or indirect means to a predetermined area within a Fire Management Zone or Unit.

Diversity - number of species present in an ecosystem compared to the number of individuals. As diversity increases, the stability of the ecosystem also increases.

Duff - The partially decomposed organic material of the forest floor beneath the litter of freshly fallen twigs, needles, and leaves.

Ecosystem - An interacting system of interdependent organisms (community) and the physical set of conditions upon which they are dependent and by which they are influenced.

Energy Release Component (ERC) - A number related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of the fire.

Fire Management Area - an area of similar fuels, fire history and vegetation surrounded by natural and/or man-caused barriers. They are the key land management units in zone II/1B and zone III to which all fire management strategies are tied.

Fire Management Strategy - the four fire management actions - suppression, containment, observation, or prescribed burning - that can be taken on a fire.

Fire Management Unit - An area of similar vegetation, fuels, and fire history within a fire management zone where management fires may be allowed to burn under restrictive prescriptions.

Fire Management Zone - an area of land with similar vegetation, fuels, climate, and fire history in which management fires (lightning or human-caused) may be allowed to burn in prescription.

Fuel - the materials which are burned in a fire: duff, litter, grass, dead branchwood, snags, logs, stumps, weeds, brush, foliage, and, to a limited degree, green trees.

Fuel Loadings - amount of dead fuel present on a particular site at a given time; the percentage of it available for combustions changes with the season.

Ground Fire - fire which moves through duff, litter, woody dead and down, and standing shrubs, as opposed to crown fire.

Human-Caused Fires - refers in this paper to fires ignited accidentally (from campfires, for instance, or from smoking) and by arsonists; does not include fires ignited intentionally by fire management personnel to fulfill approved, documented management objectives (prescribed fires).

Intensity - the heat release per unit time for each unit of length of fire edge. It is expressed as BTU/sec/ft or Kcal/sec/meter; also known as Byram's Fireline Intensity.

Inversion - atmospheric condition in which temperature increases with altitude.

Limited Containment - controlling of fire spread at the head or that portion of the flank that may be threatening to cause a fire to go beyond prescription, and ensuring that spread will not be encountered again. Does not indicate complete mop-up.

Litter - the top layer of the forest floor, composed of loose debris, including dead sticks, branches, twigs, and recently fallen leaves or needles; little altered in structure by decomposition.

Management Fire - fires of natural origin and also prescribed fires, which contribute to the attainment of the Park's management objectives through execution of predetermined prescriptions defined in a portion of an approved Resource Management Plan.

Monitoring Team - two or more individuals sent to a fire to observe, to measure, and to report its behavior, effects on the resources, and its adherence to or deviation from its prescription.

Mosaic - the pattern of vegetative cover occurring over a large area, composed of various communities and successional states of these communities. Fire, topography, avalanche, soil condition, and microclimates generally cause this pattern.

Natural Fire Management Unit (IA) - subset of zone I; natural fire management unit (IA) prescriptions will allow most lightning caused fires to burn naturally.

Observation - the monitoring of a fire that has been declared a management fire and is in prescription and achieving approved resource management objectives.

Prescribed Natural Fire Prescriptions - the appropriate action to be taken on all lightning fires, conditions under which a fire will be allowed to burn, limit of geographic area to be covered, and details and procedures for meeting stated objectives.

Prescribed Natural Fire - a lightning caused fire allowed to burn in certain areas that meet prescription criteria, and can achieve approved resources management objectives.

Prescribed Burning - the deliberate ignition of a fire in accordance with an established management plan to accomplish specific objectives under given prescriptions for weather and fuel conditions.

Prescribed Burn Units - subsets of a fire management area: each unit will be one prescribed burn and will be burned at one time and as one unit.

Suppression - controlling of fire spread along the total perimeter and complete mop-up of the entire fire area.

Total Containment - controlling of fire spread along total perimeter of the fire and ensuring that fire spread will not be encountered again. Does not indicate complete mop-up.

Wildfire - a fire that is not burning in accordance with established prescription criteria or present management decisions.

Appendix G - Fire Size Classes

CLASS	SIZE RANGE (HECTARES)		(ACRES)	
A	0.	0.10117	0.00	0.25
B	0.10117	4.04690	0.25	10.
C	4.04690	40.469	10.00	100.
D	40.46900	121.407	100.	300.
E	121.40700	404.690	300.	1000.
F	404.69000	2023.540	1000.	5000.
G	2023.45000 &	greater	5000. &	greater