DEVELOPMENT ZONE

VEGETATION MANAGEMENT PLAN

SEQUOIA & KINGS CANYON NATIONAL PARKS

1987

COVER: Drawing by Kathleen Arnold illustrating mixed species composition of overstory vegetation in lower montane campgrounds. Notice general absence of understory vegetation--a condition common to most developed sites in these Parks, regardless of elevation.

VEGETATION MANAGEMENT PLAN
(FOR THE DEVELOPMENT ZONE)

SEQUOIA AND KINGS CANYON
NATIONAL PARKS

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

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Submitted by: Thomas E. Warner Date 9/11/87
Forester

Recommended by: William L Bancroft Date 9/11/87
Chief of Resources Management

Approved by: [signature] Date 9/16/87
Superintendent

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William L. Bancroft
Chief of Resources Management
Sequoia and Kings Canyon National Parks
Three Rivers, California 93271

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I. INTRODUCTION

The combination of climate, soils, physiography, and elevation gradient from 1,400 feet to over 14,000 feet results in a rich variety of vegetation in Sequoia and Kings Canyon National Parks. The vegetation ranges from chaparral/oak woodland at the lower elevations through sequoia-mixed conifer and fir forests to the higher elevation subalpine forests. The preservation of this vegetation, especially the giant sequoia, was one of the main reasons for the establishment of these Parks (Sequoia and Kings Canyon National Parks, 1976).

Since the arrival of European man to the southern Sierra Nevada in about 1849, natural vegetation has been altered. Causes include indiscriminate burning in the late nineteenth century, and fire exclusion, logging, and over-grazing. Disturbance of the vegetation continues today, especially in the Parks' developed areas, where tree removal to provide for greater public safety, soil compaction from heavy use, air pollution, and exclusion of fire have altered species composition, and structure of vegetation. The greatest deviation from natural conditions has occurred in developed areas in the mixed conifer forests.

These Parks are classified into four zones (Sequoia and Kings Canyon National Parks, 1976): Natural, Historic, Development, and Special Use. This Plan deals only with the management of vegetation in the 3,883-acre Development Zone; management of vegetation in the remaining zones is included in the Stock Use and Meadow Management and Fire Management Plans. The Development Zone includes high density visitor use areas, and administrative, maintenance, and concessionaire facilities at Giant Forest, Ash Mountain, Lodgepole, Clover Creek (being developed), Grant Grove, Cedar Grove, Mineral King, all frontcountry campgrounds, and along all major park roads. These areas are managed to provide recreational opportunities for visitors and an operation base for park management in as natural a setting as possible.

National Park Service Management Policies (National Park Service, 1978) provide directions for managing the natural, historic, and recreational resources of the National Park System. The management of vegetation in the Development Zone is to "maintain a natural environment if possible, given the use of the zone." Such management may be accomplished through manipulation of the natural environment. Specific policies include those for insects and disease management,

fire management, exotic plant control, threatened and endangered plant management, and landscape and vegetative manipulation.

The overall goal of managing vegetation in these Parks' Development Zone is to: Restore and/or maintain a healthy, vigorous vegetative community that approximates the "natural" state, given the constraints of past and present human intervention, while providing a safe environment for human use and enjoyment.

The "natural" state of vegetation in the Development Zone differs from the "natural" state in the Natural Zone where natural reproduction and causes of mortality such as insects, disease, and fire freely influence species composition and vegetation structure. In the Development Zone, human impact associated with trampling, development of roads and buildings, and management actions, such as insect and disease control, fire suppression, hazard tree removal, and planting of favored and sometimes exotic species, have significantly altered the "natural" aspect of the vegetation.

Management objectives for the Development Zone, taken in part from Smith, 1978, are to:

1. Restore and/or maintain appropriate native vegetation for recreational use and enjoyment.

2. Maintain an all-sized vegetation structure.

3. Retain old-growth trees as long as the hazard remains at acceptable level.

4. Control stocking levels based on "natural" site quality, stand age, and species composition.

5. Maintain healthy, vigorous vegetation.

6. Maintain as "natural" a stand of age structure and species composition as the above objectives will allow.

The vegetation that best approximates the "natural" state and achieves the above objectives while providing for visitor safety will probably be young to middle-aged, depending on vegetation type.

The above objectives will be accomplished by:

1. Removing hazard trees and limbs that threaten public safety and property.

2. Managing insects and diseases in accordance with National Park Service policy.

3. Regulating stand density by revegetating disturbed sites in developed areas with native vegetation and by reducing overstocked stands.

4. Removing exotic plants.

5. Prescribed burning to achieve approved natural resources management objectives.

6. Clearing dense vegetation from roadsides and vistas.

7. Removing selected vegetation in Special Management Areas.

The Vegetation Management Plan for the Development Zone is an addendum to the Natural Resources Management Plan and is guided by the authorizing legislation that established Sequoia and Kings Canyon National Parks, and the 1971 Master Plan. The purposes of this Plan are to:

1. Establish the vegetation management goal and objectives for the Development Zone.

2. Discuss the history of the vegetation management program.

3. Designate and describe vegetation management units.

4. Delineate vegetation management policies.

5. Describe specific actions for each vegetation type.

The Plan will be flexible enough to allow for ingenuity while, at the same time, specific enough to provide overall direction. It also will allow for change as new techniques and information become available. The Plan will be reviewed annually by the Chief of Resources Management, Forester, and Forestry Foreman. Recommendations for changes will be sent to the Superintendent.

II. HISTORY OF VEGETATION MANAGEMENT

A. Overview

Early vegetation management activities occurred mostly outside the Development Zone. Forest insect control surveys were conducted in Sequoia National Park and an area later incorporated into Kings Canyon National Park in the early 1900's. The forest insect activity coincided with epidemic insect population levels associated with drought conditions. These early surveillance and subsequent suppression actions were based primarily on considerations of biological feasibility, aesthetics, recreational values, public safety, and economics. There was no National Park Service policy on which to base recommendations (Miller and Keen, 1930). The first formal written Servicewide policy did not occur until 1968.

Vegetation management activities have included: blister rust surveys, Ribes eradication, and sanitation of blister rust infection centers; hazard tree removal; dwarf mistletoe control; revegetation; treatment of lodgepole needle miner in Woods Creek; prescribed burning; and restoration of natural conditions in selected portions of high-use sequoia groves, and roadside vista clearing.

B. Hazard Tree Removal

1. Overview

Removal of hazard trees has been a function of the Ranger, Maintenance, and Resources Management Divisions during various periods. Other alternatives have included the now disbanded Western Tree Crew and contracts with local loggers and concessioner-contracted woodcutters. While there have been a few attempts to sell hazard trees, in most cases it is not economically feasible because of the high percentage of cull and limited, scattered volumes. There have been a few notable exceptions. In 1967, 1,405 roadside trees between Grant Grove and Lost Grove were sold in a cooperative timber sale with the U.S. Forest Service. Five timber sales (750.4 MBF) occurred at Cedar Grove, Grant Grove, Dorst, and Giant Forest in 1979.

The first formal hazard tree removal program started during the 1960's under the direction of the Mainte-

nance Division (Stenmark, 1967). Potential hazards along roads, backcountry and high-use front country trails, and in developed areas were detected, inventoried, and removed with assistance from the Park Forester. The concessioner was responsible for hazard tree removal on lands leased within these Parks until 1968.

The formation of a forestry crew in 1965, supervised by the Forestry Foreman and under the general guidance of the Resources Management Specialist, allowed for the consolidation of the administration, detection, and removal of hazard trees for the first time. Since the 1960's, 7,362 hazard trees (an average of 1.9 trees per acre for the 3,883 acre Development Zone) have been removed from developed areas (Table 1).

2. Accident Failures

a. Fatalities/Injuries and Property Damage

There have been three tree failures resulting in fatalities since 1919. One occurred in 1934 when the top of a tree being felled broke off and hit a man. Another, in 1966, resulted from a sequoia limb failure in Giant Forest. In 1969, a falling sequoia struck and killed a woman in the Hazelwood Picnic Area in Giant Forest. From 1970 through 1986, there have been six injuries as a result of tree failures and 143 accident failures resulting in property damage. The combined cost for injuries and property damage is approximately $314,000 for this period.

b. Sequoias

Two of the three tree failures resulting in death involved sequoias. There have also been 15 accident failures from 1970 through 1986 involving sequoia limbs which have resulted in $33,400 worth of property damage and one injury.

Table 1. Summary of Hazard Trees Removed in Sequoia and Kings Canyon National Parks, 1962-1986 1/

Year	Number of Hazard Trees Removed
1962-1967	1712
1968	343
1969	0
1970	34
1971	154
1972	423
1973	341
1974	242
1975	233
1976	198
1977	421
1978	388
1979	462
1980	262
1981	152
1982	257
1983	533
1984	569
1985	282
1986	356
Totals	7,362

1/ Includes recorded removals by Park Service Crews and contracted removal for Park Service and concessioner, but does not include removals for utility rights-of-way maintenance.

Two severely leaning sequoias have threatened structures in the Giant Forest area. These trees were removed after approval of the Secretary of the Interior. The first, in 1950, was an 18 foot diameter tree removed by contract from the Giant Forest Lodge area. The other, an 11 foot diameter tree in Camp Kaweah, was removed by the Forestry Foreman in 1967.

3. Tree Failure Records

Tree failures occurring on recreational sites have been reported to Dr. Lee Paine, Pathologist, Pacific Southwest Forest and Range Experiment Station, U.S. Forest Service, Berkeley. Data from these reports are summarized in Tables 2 and 3.

C. Insect and Disease Control

1. Overview--Policy

National Park Service forest pest control policy has had a varied history. Miller and Been (1930) suggested that the forested areas be considered for insect control work in Sequoia National Park in areas of intensive use and prospective intensive use, of important scenic or aesthetic attraction, protected (both within and outside the National Park), of study and research, and of unusual fire hazard.

The justification for recommending control in these areas was based on a need for healthy trees for cover, lack of adequate natural regeneration, safety hazard associated with snags, visibility, accessibility and stand composition in areas of scenic or aesthetic importance, and proximity to protected areas.

Table 2. Summary of Tree Failure Data (All Species) Used for Calculation of Accident Rates (1970-1986) 1/

Item	Year								
	1970	1971	1972	1973	1974	1975	1976	1977	1978
Total failures (f)	29	21	30	49	28	19	20	58	68
Nondefective failures (fnd)	12	1	2	27	3	1	8	9	53
Defective failures (fd)	17	20	28	22	25	18	12	49	15
Accident Failures (h)	15	7	12	13	2	7	9	13	11
Nondefective accident failures (hnd)	5	0	1	6	0	1	6	1	9
Defective accident failures (hd)	10	7	11	7	2	6	3	12	2
Acres (a)	792	792	792	792	792	792	792	792	792
Visitor days (v)	2,755,054	2,503,748	2,743,853	2,469,944	2,186,493	2,713,797	2,970,972	2,731,565	2,548,674
Property loss	$4,300	$2,949	$30,020 2/	$5,974 3/	$1,194	$855	$25,640	$4,470	$9,625
Injuries	0	2	0	0	1	0	0	0	2
Fatalities	0	0	0	0	0	0	0	0	0

1/ A total of 66 tree failures was excluded because of insufficient data or because failures occurred in undeveloped areas or areas closed to public.

2/ Does not include a property loss of $1000 because related information is unavailable.

3/ Includes an estimate of $850 for damage to SCE lines by 5 trees January, 1973.

Table 2 (continued). Summary of Tree Failure Data (All Species) Used for Calculation of Accident Rates (1970-1986)[1/]

Item	Year								
	1979	1980	1981	1982	1983	1984	1985	1986	Totals [1/]
Total failures (f)	14	22	18	76	8	14	28	9	511
Nondefective failures (fnd)	8	7	11	34	2	2	6	6	192
Defective failures (fd)	6	15	7	42	6	12	22	3	319
Accident failures (h)	1	6	5	30	3	1	4	4	143
Nondefective accident failures (hnd)	1	2	2	14	1	0	0	3	52
Defective accident failures (hd)	0	4	3	16	2	1	4	1	91
Acres (a)	865	865	865	865	865	865	865	865	865
Visitor days (v)	2,233,106	2,357,812	2,581,861	2,565,310	2,255,138	2,602,907	2,463,319	2,837,975	43,221,528
Property loss	$200	$12,900	$720	$205,100	$6,630	$150	$1,870	$950	$313,547
Injuries	0	0	0	1	0	0	0	0	6
Fatalities	0	0	0	0	0	0	0	0	0

Table 3. Summary of Tree Failures by Class, Defect, Fault and Contributing Factors (1970-1986)

Species	Class of Failure	Total Failures 1/	DEFECT/FAULT 2/				CONTRIBUTING FACTORS 2/		
			Rot	Snag	Fire Scar	Lean	Other	Wind	Snow	Other
All Softwoods	Limb	88	7	5	0	0	13	18	60	3
	Bole	169	89	76	6	8	30	73	60	6
	Butt	50	36	18	5	7	8	24	18	5
	Root	129	44	23	2	14	5	50	56	44
	Total	436	176	122	13	29	56	165	194	58
Pine	Limb	25	0	1	0	0	4	3	21	3
	Bole	46	18	12	5	0	7	20	23	2
	Butt	17	10	7	4	3	4	9	9	3
	Root	43	16	7	1	2	2	14	20	10
	Total	131	44	27	10	5	17	46	73	18
Fir	Limb	13	4	4	0	0	5	2	3	0
	Bole	117	69	64	1	10	22	50	32	4
	Butt	34	24	11	1	2	4	16	9	2
	Root	71	23	15	0	10	34	27	34	28
	Total	235	122	94	2	22	34	95	78	34
Sequoia	Limb	46	3	0	0	0	2	13	32	0
	Bole	2	1	0	0	0	1	2	0	0
	Butt	0	0	0	0	0	0	0	0	0
	Root	2	0	0	0	1	0	0	2	1
	Total	50	4	0	0	1	3	15	34	1

1/ A total of 66 tree failures was excluded because of insufficient data or because failures occurred in undeveloped or closed areas.

2/ Totals for defects/faults and contributing factors do not correspond to total number of failures due to instances of multiple defect and instances of defect/fault or contributing factors not having been reported.

Table 3 (continued). Summary of Tree Failures by Class, Defect, Fault and Contributing Factors (1970-1986)

Species	Class of Failure	Total Failures 1/	DEFECT/FAULT 2/				CONTRIBUTING FACTORS 2/		
			Rot	Snag	Fire Scar	Lean	Other	Wind	Snow	Other
Incense Cedar	Limb	4	0	0	0	0	2	0	2	0
	Bole	4	1	0	0	0	0	0	4	0
	Butt	0	0	0	0	0	0	0	0	0
	Root	13	5	1	1	1	0	9	2	5
	Total	21	6	1	1	1	2	9	8	5
All Hardwoods	Limb	18	11	0	0	0	1	4	13	1
	Bole	12	6	1	0	2	2	3	5	0
	Butt	7	4	0	1	2	3	1	1	1
	Root	38	18	4	0	8	5	12	14	12
	Total	75	39	5	1	12	11	20	33	14
All Species	Limb	106	18	5	0	0	14	22	74	4
	Bole	181	95	77	6	10	32	76	65	6
	Butt	57	40	18	6	9	11	25	19	6
	Root	167	62	27	2	22	10	62	69	56
	Total	511	215	127	14	41	67	185	227	72

As an outcome of these recommendations, Craighead et al. (1931) recommended maintenance control "...in parks and in recreational areas when trees are of high value from the aesthetic standpoint."

The National Park Service established an insect control policy for national parks in 1935. The policy, focusing on the western pine beetle, was to conduct an annual maintenance control program that would maintain infestations at an endemic level, thus prolonging the life of the forest. This appeared to be a literal interpretation of the Congressional mandate to protect the forests.

The 1941 insect control policy for Kings Canyon National Park was "...to prevent or relieve epidemic conditions in areas of high public use or in areas of special or scientific value" (Sanford, 1941). By 1961 there was mounting opposition to the National Park Service policy of controlling insects outside of developed areas (Wayburn, 1961). The Leopold Report (Leopold et al., 1963) advocated a moratorium on the "...mass application of insecticides in the control of forest insects.

The 1966 Forest Pest Management Plan for Sequoia and Kings Canyon National Parks stated that the objective of the program was to "...maintain the Parks free from introduced and injurious insects and disease and to maintain...efficient protection from insect epidemics" (Cameron, 1966). The program consisted of emergency control designed to prevent widespread "destruction," and maintenance control to prevent future epidemics.

In 1968, specific guidelines on insect control were established (National Park Service, 1968). Native forest insects and diseases existing under natural conditions were to be allowed to function unimpeded and would be controlled only under the following circumstances: 1) where threatening extinction of host; 2) where completely altering environment; 3) where outbreaks threaten to spread to forests or trees outside the park; 4) where threatening rare, scientifically valuable or specimen trees or unique forest communities; 5) where removing suitable overstory, shade, or ornamental trees in developed areas; and 6) where destroying historical integrity of historic and cultural lands.

The bark beetle control program in the 1970's was directed toward controlling native insects in developed areas, even though concerns had been expressed about the consistency of that program (Kilgore, 1970). A U.S. Forest Service evaluation (Ollieu, 1971) recommended that the native insect control program continue.

The ecological justification for the program was: "...the developments and attendant activities of man predisposes trees to attack by native insects...Control of native insects in such areas is required to prevent loss of trees which can diminish or nullify the purpose of developments." Further, "...unnaturally high insect populations in such areas, if uncontrolled, can easily spread to adjacent forest stands unmodified by developments; therefore, control within developed areas is required to protect stands growing under natural conditions."

Earlier control efforts outside developed areas were justified on the basis of preventing infestations spreading into these areas, later efforts used exactly the opposite justification--to prevent infestations spreading into natural stands.

2. Bark Beetles

a. 1913-1940

The earliest recorded insect control survey was conducted in the Cedar Grove area [1/] in 1913, with subsequent surveys in 1917. The U.S. Forest Service reported heavy losses of ponderosa pine to the western pine beetle (Dendroctonus brevicomis). The recommended control activity on the canyon floor was abandoned, however, because of the impending transfer of the land to the National Park Service (Miller, 1930). Additional surveys in 1930, 1931, and 1932 indicated that the bark beetle infestations were most active from 1913-1918, and later declined in severity (Miller, 1940). By 1940, the activity of the western pine beetle in ponderosa pine (Pinus ponderosa) decreased, but activity of mountain pine beetle (Dendroctonus ponderosae) in sugar pine (P. lambertiana) increased (Miller, 1940).

1/ This area was under jurisdiction of the U.S. Forest Service until 1940.

Severe losses in the earlier years were probably associated with drier sites on the canyon floor and slopes. Miller (1940) suggested indirect control and sanitation logging of susceptible "high risk" trees as a means of preventing localization of bark beetle infestations within the treatment area. He felt direct control, destroying insects under the bark, was impractical due to the inaccessibility of some of the pine types on the canyon walls.

Estimates of annual losses of ponderosa, Jeffrey and sugar pine in Cedar Grove from these early surveys ranged from 468 in 1913 down to 145 in 1930 (Miller, 1940). These losses generally followed one or more years of significantly below normal precipitation, generally below 29 inches per year.

The first insect control survey in Sequoia National Park was conducted cooperatively by the Bureau of Entomology, the U.S. Forest Service, and the National Park Service in 1917. Epidemic infestations 1/ of western pine beetle and mountain pine beetle were occurring in the Kaweah River watershed and there was an epidemic of Jeffrey pine beetle (Dendroctonus Jeffreyi) in the Kern River watershed. As a result of these epidemics, Miller et al. (1917) recommended that an annual program of maintenance control be adopted in the areas of endemic infestation.

Control work consisting of felling and burning infested trees was carried out in the Middle and Marble Forks of the Kaweah River in 1918. From 1919 to 1928, Miller and Been (1930) reported increasing losses in sugar pine and ponderosa pine.

Survey and control work continued throughout Sequoia National Park after 1930. Epidemics of western pine beetle and mountain pine beetle were prevalent over much of the watershed.

The first control work in a developed area in Sequoia National Park was in 1928 at Lodgepole

1/ Defined by Miller et al. (1917) as those in which insects are killing healthy trees in groups and singly, and annual mortality exceeds .1 percent of the stand.

Camp in response to increased bark beetle infestations. Forty-five lodgepole pine infested with mountain pine beetle were removed that year.

b. 1941-1970

During the early 1940's, forest pest control was done by CCC crews. After 1947, the project was funded by the U.S. Forest Service under the authority of the Forest Pest Control Act of 1947. Maintenance control work was performed in Grant Grove, Cedar Grove, Giant Forest and Colony Mill following below normal precipitation in 1946/1947 and 1947/1948. Continued below "normal" precipitation in 1948/1949 resulted in a serious insect infestation in the vicinity of Cedar Grove.

A total of 252 sugar pine was treated with ethylene dibromide at Grant Grove in 1957 (Murphy, 1962a). This outbreak was related to a build-up of insects in fire-weakened trees resulting from the 1955 16,800-acre McGee Fire just north of Grant Grove (Thede, 1954).

In 1960, there was an epidemic of western pine beetle in Redwood Canyon. Over 600 trees were detected and 350 were felled and treated with lindane (Murphy, 1960). The Parks entered into a cooperative agreement with the U.S. Forest Service that year for insect control on adjacent lands.

Beginning in 1961, the most severe outbreak of western pine beetle ever recorded occurred, even more severe than either the 1917 or 1928 infestation (Murphy, 1962a). From 1953 to 1964 a total of 13,302 ponderosa, sugar, and Jeffrey pine were treated over an average of 19,912 acres (Cameron 1966).

Control units included the Grant Grove, Giant Forest, Cedar Grove, and Redwood Mountain areas. Park Service crews were responsible for spotting and marking; felling and treating was done by contracted labor. In 1965, there was a drastic decline in bark beetle mortality; approximately

500 sugar, ponderosa, and Jeffrey pines were felled and sprayed with lindane that year. Insect conditions remained at endemic levels (Ollieu, 1971).

In 1965, the first permanent Park Forestry Crew was established for the purpose of performing maintenance insect control and hazard tree removal.

c. 1971-1983

For the period 1971 through 1977 an average of 356 trees per year were removed from Giant Forest/Lodgepole, Grant Grove, and Cedar Grove areas. The program was discontinued in 1978. Except for outbreaks of mountain pine beetle in lodgepole pine at Lodgepole Campground in 1973 and western pine beetle in Cedar Grove following the drought of 1975-77, bark beetle populations were at endemic levels. Table 4 gives the number of forest pest control trees removed from 1971-1978.

Table 4. Forest Pest Control Program 1971-1978

Year	FPC Trees Removed	FPC Trees Sprayed Standing	Total FPC Trees Treated
1971	281	59	340
1972	425	59	484
1973	672	69	741
1974	268	58	326
1975	326	41	367
1976	297	25	322
1977	223	22	245
1978 [1/]	--	--	--
Total	2,492	333	2,825

[1/] Program discontinued

d. Pesticides

Two pesticides have been extensively used in the insect control program. Ethylene dibromide (EDB) was first used in 1956 and was later replaced by lindane, which was used from 1960 until 1978. Malathion was used to aerially spray 250 acres of a 437-acre lodgepole needle miner infestation in Woods Creek in 1963.

Other pesticides used have included: atrazine 80W, a weed oil; and 2,4,5-T, which was used to eradicate willows in meadows, Ribes for blister rust control, and chaparral brush species for construction of fuel breaks.

The use of pesticides in national parks became an issue in the early 1960's. In 1964 guidelines on use of pesticides (Stratton, 1964) were issued as follows: allowed "chemical agents" to be used "...for suppression of destructive outbreaks of plant diseases, insects, and other pests for protection of scenic values along park roads and in areas of concentrated visitor use; conservation of rare and scientifically important trees or plant communities, maintenance of shade trees in developed areas ... and eradication of exotic and/or noxious plants and animals."

All projects involving use of toxic chemicals were required to be approved by the Federal Pest Control Review Board. Secretary Udall in 1964 further emphasized protection of the "entire environment" taking into account both "known and possible" effects. If any reasonable doubt existed regarding environmental effects, then no use was to be made (Fagerlund, 1964).

Opposition to pesticide use has also occurred from the Parks' staff. The proposal to use lindane for forest pest control met with opposition (Riegelhuth, 1970). The use of a chlorinated hydrocarbon was severely questioned (Palmer, 1970; and Kilgore, 1970) on the grounds of unknown potentially adverse ecological effects.

Borax (sodium tetraborate decahydrate) is currently being used to treat stumps to prevent inoculation by the root disease fungus, Fomes annosus.

3. Gypsy Moth Detection Program

A joint project between the County of Tulare Agricultural Department and State Department of Agriculture was started in 1961 to detect gypsy moths (Lymantria dispar). It is part of a statewide detection program, that involves the deployment of traps containing a non-poisonous synthetic sex pheromone. In 1983, a lone male moth was trapped in Potwisha Campground. An intensified trapping program in 1984 failed to produce any additional moths. It was therefore assumed that the moth trapped in 1983 was from a "hitch-hiking" pupae off a vehicle from an eastern state, and that there was no infestation.

4. White Pine Blister Rust

a. Overview

White pine blister rust (Cronartium ribicola), is an alternate host fungus which has a two-phase life cycle, one on white pines and the other on Ribes (gooseberries and currants). The disease was first introduced into the United States in 1898, and arrived in California via natural spread from the north in 1929.

The disease had reached the central Sierra Nevada by 1938. Initial surveys and Ribes eradication began in Sequoia and Kings Canyon National Parks that year. By 1944, blister rust had spread as far south as Dodge Ridge, where it was discovered in 1951, but it appeared to have reached a biologic and climatic barrier to further southward extension. Based on this assumption, the U.S. Forest Service deferred Ribes eradication in the southern Sierra Nevada beginning in 1961. It was not until 1969 that this project was discontinued throughout the rest of the state. In 1968, however, infection centers (1961 origin) were found at Mountain Home State Forest, approximately seven miles south of the Parks. Infected pines were first discovered in Garfield Grove in 1969. That year the U.S. Forest Service undertook a cooperative direct control program in the southern Sierra Nevada along with the California Department of Forestry

and the National Park Service. This program included systematic detection searches and elimination of all detected infection centers. A center was defined as one or more infected white pine with a two-chain rust-free strip surrounding the tree or trees. The U.S. Forest Service discontinued its direct control projects in 1971 when it became apparent that blister rust had become a permanent part of the Sierra Nevada flora and was less of a threat than formerly thought (MacGregor, 1972b). Sequoia and Kings Canyon National Parks continued a direct control program through 1977.

b. Blister Rust Control in Parks

The initial reconnaissance surveys of the distribution of five-needle pines and Ribes spp. alternate host, occurred in General Grant and Sequoia National Parks in 1938. Reconnaissance surveys of the Kern River basin (Harris, 1939) and Kings Canyon National Park (Harris and Patty, 1940) were undertaken jointly by the National Park Service and Bureau of Entomology and Plant Quarantine in 1939-40.

Ribes eradication commenced in 1938 in General Grant National Park and during the next year in Sequoia National Park. Work continued intermittently out of seven CCC camps from 1938-1960. Control activities after 1940 were funded by the U.S. Forest Service under the authority of the Lea Act (1940).

During the 23 year history (1938-1960) of the program, more than 11 million Ribes plants were eradicated, including individuals of a species (Ribes tularense) which is now considered a rare, local endemic. More than 72,000 man-days were spent in this period checking, grubbing or chemically treating foliage or base of Ribes plants on more than 47,000 acres in seven control units (Table 5).

After an eight year hiatus, the Blister Rust Control Program was reinstituted because of infected pines in Garfield Grove and infected Ribes in Redwood Canyon, Muir and Skagway Groves, and Garfield Grove.

Table 5. Ribes Eradication in Sequoia and Kings Canyon National Parks, 1938-1960.

Unit	Acres Worked	Ribes Eradicated	Man-Days
Grant Grove	5,177	1,752,000	13,343
Redwood Mountain	5,660	3,021,000	18,554
Giant Forest	19,004	5,813,000	37,603
Mt. Whitney	10,415	203,000	930
Chagoopa	3,500	77,000	756
Heather Lake	1,600	183,000	1,090
Rae Lakes	2,368	N/A	N/A
TOTAL	47,724	11,049,000	72,276

As of June 1960 (Harris, 1960)
As of December 1954 (Harris, 1954)

A pilot direct control project was initiated in 1972 in Garfield Grove despite a U.S. Forest Service evaluation (MacGregor, 1972b) which advised against attempting eradication of the disease by either direct control of infection centers or Ribes eradication. MacGregor (1972a) stated that it was unrealistic to attempt to exclude white pine blister rust from the entire or even a major portion of the Parks because the disease was too firmly established in the southern Sierra Nevada. Furthermore, MacGregor suggested treating the disease as a "naturalized" rather than an exotic organism. However, it was suggested that by frequent inspection, pruning, and eradication of small centers it might be possible to protect individual pines and small stands.

The program was expanded in 1973 to a total of eight control units encompassing over 21,000 acres (Table 6). The goal was to maintain selected control units in a rust-free state and consisted of delineating rust infection centers within the units, removing infected trees, pruning uninfected trees taller than 25 to 30 feet, and removing uninfected trees too small to prune. The rust was only monitored outside of the units.

Between 1969 and 1977, a total of 46 infection centers was discovered in the Parks (Table 7); 25 of these centers were sanitized in the manner previously described. The direct control project was abandoned after 1977 as the result of a U.S. Forest Service biological evaluation (Byler et al., 1978) which concluded that it did not appear to be "... biologically feasible to keep large areas in the Parks free of the rust".

An additional four infection centers have been discovered since 1978, bringing the total of known unsanitized centers to 21. There are at least two active centers in previously sanitized units in Garfield Grove and Redwood Mountain.

5. Dwarf Mistletoe Control

Dwarf mistletoes (Arceuthobium spp.) are native parasites which weaken, deform, and kill pine and fir trees. Fire suppression in Cedar Grove for 70+ years has probably increased dwarf mistletoe infection above natural levels because of the overstocked stands of pine and fir that developed with fire exclusion.

A preliminary survey in 1954 at Cedar Grove from Sheep Creek Campground to Road's End showed that 27 percent of the 1,104 ponderosa pines (Pinus ponderosa) sampled were infected with dwarf mistletoe and that 13 percent required removal (Thede, 1954). Wagener (1954) recommended against dwarf mistletoe control at least temporarily, pending development of alternative control measures. He felt the treatment would do more damage than the dwarf mistletoe, considering the lack of natural

regeneration in many of the developed sites. According to Wagener, in recreational areas, forest pest control is justifiable only "... when sufficient damage is being caused to reduce the beauty or usefulness of the site for recreational purposes.

Table 6. Blister Rust Control Management Units, Sequoia and Kings Canyon National Parks, 1973-1977.

Unit	Size (Acres)
Garfield Grove	1,875
Atwell Mill	3,375
Giant Forest	4,883
Skagway Grove	230
Muir Grove	840
Lost Grove	211
Redwood Mountain	6,258
Grant Grove	3,872
TOTAL	21,544

Table 7. Blister Rust Infection Centers discovered in Sequoia and Kings Canyon National Parks, 1969-1981.

Location	Number of Centers
Atwell Grove	8
Garfield Grove	13
Giant Forest	1
Redwood Mountain	12
Skagway Grove	2
Castle Creek	2
Crystal Cave Road	1
Hidden Spring	1
Mist Falls	1
New Oriole Creek	1
Oriole Creek	1
River Valley	1
Squirrel Creek	1
Surprise Grove	1
Total	46

A combined contract/National Park Service dwarf mistletoe silvical control project was conducted in Cedar Grove in 1965-1966. Methods included preliminary surveys, mapping, pruning, felling, and clean-up. Control units included Canyon View and Moraine Creek Campgrounds, the new National Park Service residential area east of Hotel Creek, and Road's End. A total of 596 trees were removed and 400 trees pruned over a combined area of 109 acres encompassing all of the units. Total cost was $17,818 ($163/acre).

A National Park Service dwarf mistletoe control project was also conducted in Sheep Creek and Sentinel Campgrounds in Cedar Grove in 1984 and 1985. A total of 1,828 trees was removed and 410 were pruned. Total cost was $103,319. The remainder of Sentinel Campground and all of Moraine Creek and Canyon View Campgrounds will be completed in 1986 and 1987. Two timber sales (223 MBF), through 1986, occurred as a result of the removals.

D. Revegetation

During the 1930's and 1940's there was a park nursery at Ash Mountain. Fremontia and Ceanothus transplants, black oak acorns, conifer cones, and seeds of annual and perennial plants were collected, and the seedlings and transplants were raised at the nursery for planting throughout the Parks.

Documented planting projects that were undertaken during the tenure of the nursery are included in Table 8.

Table 8. Planting Projects at Sequoia and Kings Canyon National Parks from 1936-1938

	Location	Species Planted	Year
1.	Moro Rock, Crescent Meadow parking area, Giant Forest Village, and along the General's Highway	White fir, sugar pine, ponderosa pine, giant sequoia and incense cedar.	1936
2.	Disturbed areas	Young trees and shrubs	1937
3.	Lodgepole Camp	Lodgepole pine	1938
4.	Buckeye CCC Camp	Incense cedar, bush lupine, redbud, spicebush	1938

Five thousand one-year-old Jeffrey and sugar pine seedlings were hand planted in Dorst Campground in May 1968. Planting stock was furnished by Hume Lake District, U.S. Forest Service from seed collected locally at 6,000-8,000 foot elevation and grown at the Placerville nursery.

A combined hydroseeding/hand planting revegetation project was conducted on storm-damaged road cuts and fills along the Generals Highway between 2,000 and 5,400 ft elevation in November 1969 and 1970. Hydroseeding treatment with a slurry mixture of native (primarily Bromus carinatus) plant seed, liquid fertilizer Verdyol, and water apparently was not successful; the sites were dominated by naturally-seeded Avena spp. (Taylor, 1971b).

The hand planting portion of the project appeared to have been more successful (Taylor, 1971a). Plantings were of nursery stock grown from locally collected seed and included predominantly mountain mahogany (Cercocarpus betuloides), redbud (Cercis occidentalis), California buckeye (Aesculus californica), California coffeeberry (Rhamnus spp.), interior live oak (Quercus wizlizenii), and canyon live oak (Q. chrysolepis).

During late September and early October, 1972, 289 plants of "native wildling stock" were transplanted into recently constructed portions of Lodgepole Campground (Paleck, 1973a). Species included white fir (Abies concolor), lodgepole pine (Pinus murrayana), Jeffrey pine (P. Jeffreyi), sugar pine (P. lambertiana), manzanita (Arctostaphylos spp.), and bitter cherry (Prunus emarginata). Most of the seedlings were less than one foot tall. Despite mulching and watering, survival one year following transplanting was poor; only 33 percent survived the first year. A significant proportion of mortality was attributed to "... direct traumatic impact from Park visitors" (Paleck 1973b).

E. Prescribed Burning

The history of prescribed burning in Sequoia and Kings Canyon National Parks is discussed in detail in the Fire Management Plan. The first prescribed burn in these Parks was in 1904 when an area of General Grant National Park was "... lightly burned over to remove the coniferous rubbish" (Wells, 1906). Fire as a research and management tool did not reappear until the mid-1960's. Since then, prescribed fire has played an increasingly important role in natural resource management in these Parks.

Prescribed burning in the Development Zone has been used sparingly. The effect of smoke on the visitor, the scarcity of fuel, and the potential for creating entrance courts of infection for pathogenic fungi are deterrents to the use of fire in most areas.

Prescribed burning in Cedar Grove has been done since the late 1960's, primarily between the highway and the canyon walls. Cutting, piling, and burning of white firs around the General Grant Tree to maintain historic vistas were done in the 1970's; this is now guided by the General Grant Tree Management Plan (Warner, 1980a). Very little prescribed burning was done around the developed areas of either Grant Grove or Giant Forest prior to 1980.

The ultimate goal of the Parks' fire management program is to allow fire to function as naturally as possible. The developed areas are exceptions to this goal, since visitor safety, health, and to some extent comfort, are overriding concerns.

III. VEGETATION MANAGEMENT UNITS

A. Location

The Development Zone (3,883 acres) was divided into five vegetation management units (Table 9). Each unit is an area of relatively homogeneous vegetation that contains developed areas and the attendant roadsides where specified management strategies are observed. Based on vegetation maps prepared by Hammon, Jensen, and Wallen (1971) and Natural Resources Management Corporation (1974), five major vegetation types (Figures 1 and 2) were delineated within the Development Zone:

1. Chaparral/oak woodland
2. Ponderosa pine
3. White fir mixed-conifer
4. Sequoia mixed-conifer
5. Red fir/white fir

These vegetation types are discussed in the Fire Management Plan.

B. Vegetation Management Units

1. Unit I - Chaparral/Oak Woodland

a. Description

The developed areas found within the chaparral/oak woodland unit are shown in Table 10. Together they comprise 101 acres or three percent of the developed areas. In addition, there are 231 acres along 19 miles of roads in the chaparral/oak woodland unit which make up eight percent of the Parks' total roadside areas. Facilities in each of the developed areas within Unit I are listed in Table 10.

b. Vegetation

The vegetation of the developed areas within the chaparral/oak woodland unit is divided into three major associations: foothill woodland, mixed evergreen woodland, and black oak forest.

Ash Mountain Headquarters is found in the blue oak phase of the foothill woodland. There is a high proportion of even-aged individuals in

Figure 1

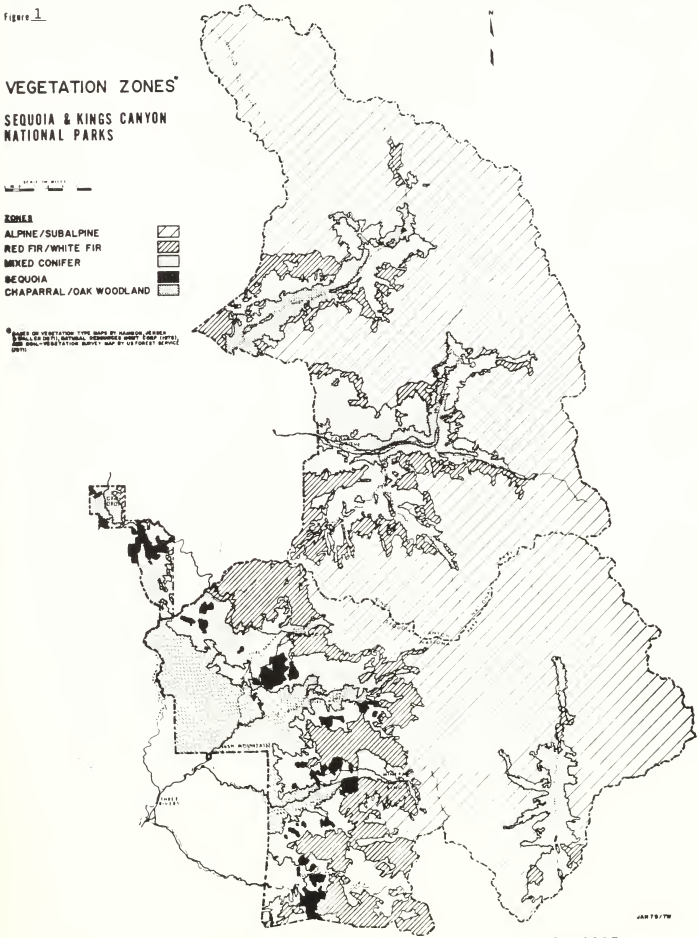
VEGETATION ZONES*
SEQUOIA & KINGS CANYON
NATIONAL PARKS
ZONES
ALPINE/SUBALPINE
RED FIR/WHITE FIR
MIXED CONIFER
SEQUOIA
CHAPARRAL/OAK WOODLAND
* BASED ON VEGETATION TYPE MAPS BY HANSON (ALPINE, SUBALPINE, RED FIR, WHITE FIR, MIXED CONIFER, AND SEQUOIA ZONES) AND SOIL-VEGETATION SURVEY BY USFOREST SERVICE (CHAPARRAL/OAK WOODLAND ZONE).

Fig. 2. Sequoia and Kings Canyon National Parks Vegetation Management Type-Units

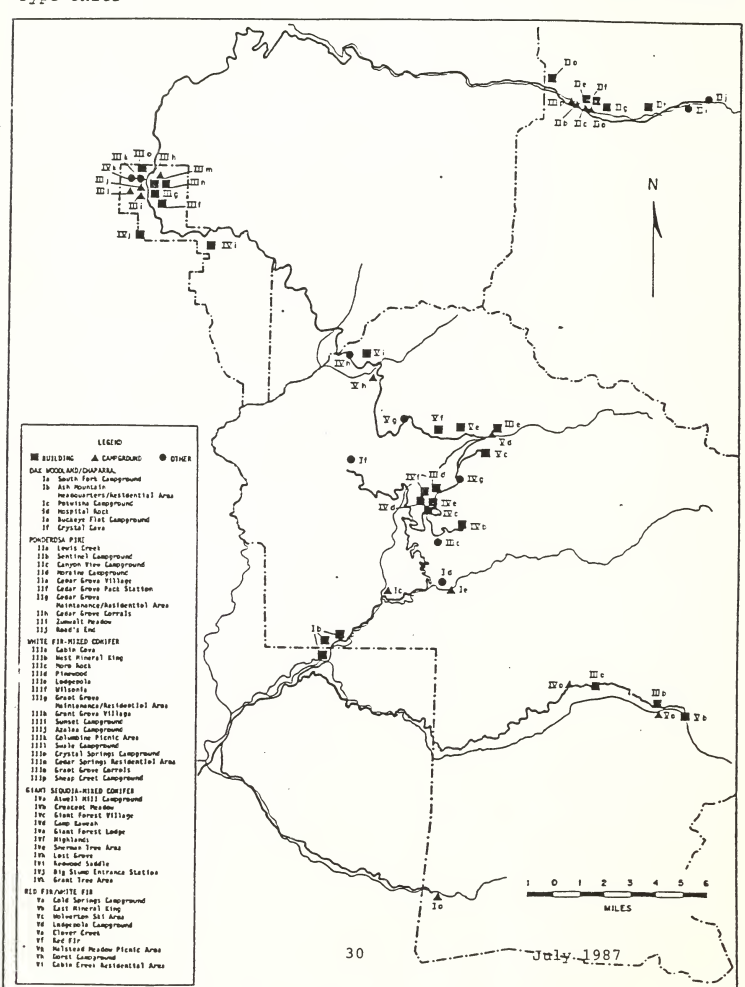

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Table 9. Vegetation Management Units in the Development Zone

Vegetation Management Unit		Acreage
I.	Chaparral/Oak Woodland (includes the following developed areas):	
	1. South Fork Campground	5
	2. Ash Mountain Headquarters/Residential Area	45
	3. Ash Mountain Heliport	15
	4. Buckeye Residential Area	12
	5. Potwisha Campground	10
	6. Hospital Rock Picnic Area	4
	7. Buckeye Flat Campground	5
	8. Crystal Cave	5
	9. Roadsides	231
	Total	332
II.	Ponderosa Pine (includes the following developed areas):	
	1. Lewis Creek Residential Area	2
	2. Sentinel Campground	32
	3. Canyon View Campground	21
	4. Moraine Campground	33
	5. Cedar Grove Village	13
	6. Pack Station (Cedar Grove)	3
	7. NPS Maintenance/Residential Area (Cedar Grove)	6

Table 9. Vegetation Management Units in the Development Zone

Vegetation Management Unit		Acreage
8.	NPS Corrals (Cedar Grove)	6
9.	Zumwalt Meadow	9
10.	Road's End	21
11.	Roadsides	43
	Total	569
III.	White Fir Mixed-Conifer	
1.	Cabin Cove	7
2.	West Mineral King (Faculty Flat)	35
3.	Moro Rock	2
4.	Pinewood	12
5.	NPS Maintenance/Residential Area (Lodgepole)	22
6.	Wilsonia 1/	28
7.	NPS Maintenance/Residential Area (Grant Grove)	20
8.	Grant Grove Village	27
9.	Sunset Campground	33
10.	Azalea Campground	42
11.	Columbine Picnic Area	2
12.	Swale Campground	12
13.	Crystal Springs Campground	21

1/ Private acquired (NPS) only

Table 9. Vegetation Management Units in the Development Zone

Vegetation Management Unit	Acreage
14. Cedar Springs Residential Area	5
15. Grant Grove Corrals	3
16. Sheep Creek Campground	30
17. Roadsides	1,002
Total	1,303
IV. Sequoia Mixed-Conifer	
1. Atwell Mill Campground	11
2. Crescent Meadow Trailhead	6
3. Giant Forest Village	5
4. Camp Kaweah	30
5. Giant Forest Lodge	19
6. Highlands	10
7. Sherman Tree Area	9
8. Grant Tree Area	22
9. Lost Grove	3
10. Big Stump Entrance Station/Picnic Area	5
11. Roadsides	531
Total	651

Table 9. Vegetation Management Units in the Development Zone

Vegetation Management Unit	Acreage
V. Red Fir/White Fir	
1. Cold Springs Campground	4
2. East Mineral King	26
3. Wolverton Ski Area	19
4. Lodgepole Campground	71
5. Clover Creek	~110 1/
6. Red Fir Heliport	6
7. Halstead Meadow Picnic Area	9
8. Dorst Campground	56
9. Cabin Creek Residential Area	2
10. Roadsides	725
Total	~1028

1/ This is a projected figure representing the approximate acreage upon completion of developments.

similar age classes (Brooks, 1967). The greatest proportion of these trees are between 60 and 100 years old and are between four to 12 inches dbh (Baker et al., 1981). Grazing impacts on herbaceous competition before establishment of these Parks led to a decrease in the occurrence of fire by lessening fuel loads, thus providing favorable conditions for the establishment and subsequent increased density of blue oaks (Vankat and Major, 1978). There is a substantial number of exotic plant species in the vicinity of the Ash Mountain Headquarters and residences.

Potwisha Campground, Hospital Rock Picnic Area, and Buckeye Flat Campground are representative of the buckeye woodland phase. Buckeye woodland is defined as having a minimum of 20 percent coverage in California buckeye (Aesculus californica) which, when combined with evergreen species, exceeds that of blue oak (Quercus douglasii) and has a predominantly herbaceous understory (Baker et al., 1981). Potwisha Campground is composed of interior live oak (Q. wizlizenii) with some California buckeye and blue oak. Buckeye Flat Campground is dominated by a closed canopy of California buckeye with a blue oak and interior live oak.

South Fork Campground is vegetated by the live oak phase of mixed evergreen woodland. This vegetation type normally has a cover of 75 percent and is dominated by interior live oak and California laural (Vankat and Major, 1978).

Crystal Cave is located in a black oak forest which forms a transition from foothill communities and mixed conifer forest. It is dominated by black oak (Q. Kelloggii) with scattered ponderosa pines (P. ponderosa) (McDonald, 1980). Stands of this type are almost always even-aged, often sprouting after fire, and are less than 125 years old, although older individuals may be present (McDonald, 1980).

Table 10. Facilities in the Developed Areas of Unit I

	Developed Area	Location	Facilities
1.	South Fork Campground	At end of South Fork Kaweah Road, 12 miles southeast of Three Rivers	12 site semi-privat campground
2.	Ash Mountain Headquarters/ Residential Area	7 miles northeast of Three Rivers	27 residences, main tenance facilities, administrative head quarters
3.	Ash Mountain Heliport	6 miles northeast of Three Rivers	Heliport, recreatio hall, corrals, stor age buildings
4.	Buckeye Residential Area	6 miles northeast of Three Rivers	12 residences
5.	Potwisha Campground	3 miles northeast of Park Headquarters	44 site campground
6.	Hospital Rock	6 miles northeast of Park Headquarters	Picnic area, comfor station, and inter- pretive exhibit
7.	Buckeye Flat Campground	7 miles northeast of Park Headquarters	28 site campground
8.	Crystal Cave	6 miles northwest of Generals Highway at end of Crystal Cave Road.	Parking area, comfort station

c. Insects and Diseases

There are no major insect pests in the developed areas of the chaparral/oak woodland unit. The major diseases in developed areas include shoestring root rot (Armillaria mellea), and true mistletoe (Phoradendron spp.). Shoestring root rot usually infects dead tissue, but also infects living material when a tree is weakened by conditions such as drought or in conjunction with other insects or diseases. True mistletoes are seed plants which parasitize most hardwoods and brush, usually reducing the growth and vigor of a tree rather than directly killing it (Boyce, 1961).

Gypsy moth (Lymantria dispar) is an exotic defoliator which has spread westward since its introduction on the East Coast over 100 year ago. It is now on the verge of becoming established in California. Acceptable hosts include oaks and other hardwoods; open stands on dry sites are most susceptible to gypsy moth buildup and damage (Furniss and Carolin, 1977).

d. Sensitive Plants

There is one sensitive plant species growing in or close enough to this unit that the potential for impact exists:

(1) Eriogonum nudum var. marinum (ERNUM)

ERNUM is a rare, highly restricted endemic known only in these Parks. It grows on south-southeast facing marble outcrops along the Generals Highway between Ash Mountain and Hospital Rock in the oak woodland. There are two other locations, both outside the developed zone, one in the Middle Fork and the other in the South Fork of the Kaweah. Elevational range is 1,650-4,000 feet.

2. Unit II - Ponderosa Pine

a. Description

The ponderosa pine unit is represented exclusively by the developed areas and associated vegetation in the vicinity of Cedar Grove. The developed areas within this unit comprise 15 percent (149 acres) of these Parks' total developed areas (Table 11). Twelve miles of roads are found within the ponderosa pine unit which make up about 15 percent (430 acres) of the Parks' total roadside areas. Facilities in each of the developed areas within the unit are listed in Table 11.

b. Vegetation

The dominant species in this unit are ponderosa pine (Pinus ponderosa) and Jeffrey pine (P. Jefferyi). Other important species include black oak (Quercus kelloggii), incense cedar (Calocedrus decurrens), and white fir (Abies concolor). Since the advent of fire suppression, white fir and incense cedar have increased in importance, often shading out and replacing black oak.

The vegetation in most of the developed areas within this unit are two-storied stands with old growth in the overstory. These stands range between 10 to 50 percent in crown coverage (Hammon, Jensen, and Wallen, 1971).

Data from the Cedar Grove area outside of developed areas reveal basal areas ranging from 115-750 feet^2/acre (Sellers, 1970). Ages for 36-48 inch diameter ponderosa pine were typically 250 to 300 years (Warner, 1981). Incense cedar measuring 24-36 inches in diameter ranged from 155 to 240 years, while 16-25 inch black oak were reported to be 160 to 170 years old (Sellers, 1970).

Mortality rates collected from the Cedar Grove Campgrounds for the period between 1973 and 1979 indicate a loss of 0.68 trees per acre per year (Warner, 1986).

Table 11. Facilities in the Developed Areas of Unit II

	Developed Area	Location	Facilities
1.	Lewis Creek Residential Area	2 miles west of Cedar Grove	Kitchen, restrooms, showers
2.	Sentinel Campground	Adjacent to Cedar Grove Ranger Station	86 site campground
3.	Canyon View	East of Cedar Grove Ranger Station	67 site campground
4.	Moraine Campground	East of Cedar Grove Ranger Station	124 site campground
5.	Cedar Grove Village	South Fork of the Kings River	Camper store, 18 unit lodge and restaurant
6.	Pack Station	Northeast of Cedar Grove Village	Privately owned stock concession
7.	NPS Maintenance/ Residential area	Northeast of Cedar Grove Village	Maintenance office, house trailers
8.	NPS Corrals	North of Cedar Grove Village	Barn, corrals, and dormitory
9.	Zumwalt Meadow	4 miles east of Cedar Grove Village	Nature trail and parking area
10.	Road's End	6 miles east of Cedar Grove Village	Parking area, kiosk, residence, and comfort stations

c. Insects and Diseases

The major insect pests of the ponderosa pine type include pine bark beetles (Dendroctonus spp., Ips spp.) which may kill trees directly and the California flathead borer (Melanophila californica) which usually weakens a tree rather than killing it directly. The most important pathogens are annosus root rot (Fomes annosus), shoestring root rot (Armillaria mellea), and dwarf mistletoe (Arceuthobium spp.).

Western pine beetle (Dendroctonus brevicomis) attacks and usually kills ponderosa pine, normally in overly mature, drought-weakened trees, but during epidemics will attack trees of all ages and vigor. Jeffrey pine beetle (D. Jeffreyi) attacks only Jeffrey pines. Red turpentine beetle (D. valens) attacks ponderosa, Jeffrey, and sugar pines, but typically weakens rather than kills trees. Mountain pine beetle (D. ponderosae) primarily attacks sugar pine in Cedar Grove and rarely attacks ponderosa pine.

Ips emarginatus beetles typically attack during warm spring weather, attacking branches of small diameters, including living and dead material in piled slash.

Piled slash is conducive to buildup of Ips populations. Found in these Parks are the pine engraver (Ips pini), California five-spined Ips (I. paraconfusus), and I. emarginatus.

Pathogens of major concern in the Cedar Grove area include dwarf mistletoes which infect ponderosa and Jeffrey pines, (Arceuthobium campylopodum) and sugar pine (A. californicum). Data collected in 1981 from the campgrounds in Cedar Grove indicated that 30 percent of pines sampled were infected (Warner, 1981).

Abiotic diseases which affect ponderosa and Jeffrey pines include ozone. In the Cedar Grove area, symptoms have been reported as slight (affecting fourth year or older needles) or non-existent. Levels of ozone have been reported which are sufficient to cause foliar injury (Wallner and Warner, 1981).

d. Sensitive Plants

There are no known sensitive plants in the ponderosa pine unit.

3. Unit III - White Fir Mixed-Conifer

a. Description

The largest vegetation unit is the white fir mixed-conifer, representing eight percent (301 acres) of these Parks' total developed areas (Table 12). In addition, 28 miles (1,002 acres) of roads are associated with this vegetation and constitute 26 percent of the total.

The developed areas within this unit in the vicinity of Mineral King include Cabin Cove and West Mineral King. In the Giant Forest area are included Moro Rock, Pinewood, and the National Park Service maintenance and residential area in Lodgepole. The areas found in or near Grant Grove are the NPS maintenance and residential area, Grant Grove Village, Sunset, Azalea, Swale, and Crystal Springs Campgrounds, Columbine picnic area, Cedar Springs residential area, and the privately operated corrals. Sheep Creek Campground is the only area representative of this type in Cedar Grove. Facilities in each of the developed areas within the unit are listed in Table 12.

b. Vegetation

The dominant species in this unit is white fir (A. concolor) which covers about 70 percent of the area. Important associates are sugar pine (Pinus lambertiana) and incense cedar (Libocedrus decurrens). Beetham (1963) showed that recreational disturbance has increased relative densities of incense cedar at the expense of white fir and sugar pine.

The developed areas found in the vicinity of Grant Grove are primarily old growth stands with crown coverage ranging from 10 to 70 percent, although sparse and denser stands do occur.

Stands elsewhere are typically two-storied with younger white fir growing under older-growth pines. Mortality rates collected from Giant Forest between 1980 and 1981 showed losses of 0.41 trees per acre per year between 1979 and 1981 (Warner, pers. comm.).

c. Insects and Diseases

The following are the major insect species of the white fir mixed-conifer unit which primarily attack trees weakened by disease, fire, drought, or poor site: mountain pine beetle (Dendroctonus ponderosae) which attacks primarily sugar and lodgepole pines; western pine beetle (D. brevicomis) which attacks ponderosa pine; Jeffrey pine beetle (D. Jeffreyi) which attacks only Jeffrey pine; red turpentine beetle (D. valens) which attacks sugar, Jeffrey and ponderosa pines; California flathead borer (Melanophila californica) which attacks sugar, Jeffrey, and ponderosa pines; pine engraver which attacks ponderosa and Jeffrey pines; California five-spined ips which attacks ponderosa and sugar pines; (I. emarginatus) which attacks ponderosa, Jeffrey and sugar pines; and flatheaded fir borer (M. drummondi) and fir engraver (Scolytus ventralis) which attacks white fir (Furniss and Carolin, 1977).

These insect species may attack trees as part of a pest complex. For example, western pine beetle typically attacks a treetop along with California five-spined Ips; mountain pine beetle and I. emarginatus may attack the middle of the same tree, and red turpentine beetle may attack it at its base (Furniss and Carolin, 1977).

d. Sensitive Plants

There are no sensitive plants in the white fir mixed-conifer unit.

Table 12. Facilities in the Developed Areas of Unit III

	Developed Area	Location	Facilities
1.	Cabin Cove	21 miles east of Hammond	Privately-owned cabins leased from National Park Service
2.	West Mineral King (Faculty Flat)	24 miles east of Hammond	Privately-owned cabins leased from the National Park Service
3.	Moro Rock	Scenic landmark along Crescent Meadow Road	1 comfort stations
4.	Pinewood	1 mile northeast of Giant Forest along Generals Highway	76 residences for concession employees
5.	Lodgepole Maintenance and Residential Area	Immediately North of Lodgepole Campground	Maintenance compound, fire management cache, and 40 park residences
6.	Wilsonia	3 miles northeast of Big Stump Entrance Station	166 family-size dwellings, 39 other buildings
7.	Grant Grove maintenance and residential area	3 miles northeast of Big Stump Entrance	Maintenance compound dormitory, fire management cache, and 10 park residences
8.	Grant Grove Village	3 miles northeast of Big Stump Entrance	Restaurant, gift shop, service station, market, post office, 52 cabins for visitors, visitor center, and 19 consession employee quarters

Table 12. Facilities in the Developed Areas of Unit III

	Developed Area	Location	Facilities
9.	Sunset Campground	Immediately south of Grant Grove Village	213-site campground
10.	Azalea Campground	Immediately northwest of Grant Grove Village	108-site campground
11.	Columbine picnic	Adjacent to Azalea Campground	Picnic tables and rest-rooms
12.	Swale Campground	1 mile southwest of Grant Tree	Tent cabins, cooking facilities used by interregional fire crew
13.	Crystal Springs Campground	Immediately north of Grant Grove Village	57-site campground
14.	Cedar Springs Residential Area	Near Park Ridge Road	Trailer park
15.	Grant Grove Corrals	Immediately northwest of Grant Grove	Privately-operated riding corrals
16.	Sheep Creek Campground	West of Cedar Grove Ranger Station	113-site campground

4. Unit IV - Sequoia Mixed-Conifer

a. Description

The developed areas within Unit IV are Atwell Mill, Crescent Meadow, Giant Forest Village, Camp Kaweah, Giant Forest Lodge, Highlands, the General Sherman Tree Area, the General Grant Tree Area, Lost Grove, and Big Stump. Together they represent three percent (120 acres) of the Development Zone. There are also 15 miles of roads with 531 acres of associated vegetation within the unit, comprising 18 percent of the Parks' roadside vegetation. Facilities in each of the developed areas within the unit are listed in Table 13.

b. Vegetation

Sequoia mixed-conifer is distinct from other white fir mixed-conifer stands only in that sequoia (Sequoiadendron giganteum) is present. Data from 14 stand surveys in Sequoia National Park show that in cover, basal area, and density, white fir (Abies concolor) is the dominant species with sequoia and sugar pine (Pinus lambertiana) as codominant (Vankat, 1970). Before the advent of fire suppression, the groves within Unit IV contained a greater proportion of seedling and sapling-dominated aggregations and less area dominated by pole-sized and mature trees (Bonnicksen and Stone, 1978). There has been a relative increase in shade-tolerant conifer species such as white fir and incense cedar (Libocedrus decurrens) (Bonnicksen, 1975; Parsons and DeBenedetti, 1979; Vankat, 1970) at the expense of shrubs (Bonnicksen and Stone, 1978; Vankat, 1970) and hardwoods (Bonnicksen and Stone, 1978).

Most of the sequoia groves within Unit IV are two or three-storied stands with very old sequoias in the overstory and younger sequoia, sugar pine, and white fir in the understory (Hammond, Jensen, and Wallen, 1971, and Natural Resources Management Corporation, 1975).

Table 13. Facilities in the Developed Areas of Unit IV.

	Developed Area	Location	Facilities
1.	Atwell Mill	18 miles northeast of Hammond on Mineral King Road	23-site campground
2.	Crescent Meadow Trailhead	3 miles east of Giant Forest Village, at end of Crescent Meadow road	Picnic area, comfort stations, and parking area for backcountry visitors
3.	Giant Forest Village	16 miles northeast of Ash Mountain Headquarters	Concession-operated market, gift shop, and cafeteria
4.	Camp Kaweah	Immediately northwest of Giant Forest	166 condominiums for visitor use, dormitory for concession employees (900 pillow capacity)
5.	Giant Forest Lodge	Immediately North of Village	Restaurant and 77 units for visitor use
6.	Highlands	Northwest of Round Meadow	12 small cabins used for seasonal quarters
7.	Sherman Tree Area	2 miles northeast of Giant Forest Village	Parking area, comfort station, and paved trails
8.	Grant Tree Area	1 mile northwest of of Grant Grove Village	Parking area, comfort station, and paved trails
9.	Lost Grove	Along Generals Highway near north boundary of Sequoia National Park	Comfort station, parking area
10.	Big Stump	3 miles southwest of Grant Grove Village	Entrance Station, Picnic Area

The Atwell Mill Campground, and Big Stump Entrance Station area contain a large proportion of young-growth sequoias.

c. Insects and Diseases

Sequoia groves occur within white fir mixed-conifer forests and, as such, include the same insect and disease problems. Sequoia is unusual in that it has a small insect fauna when compared to other conifers (DeLeon, 1954). Carpenter ants (Camponotus sp.) are known to weaken the base of fire-scorched trees. Termites (Zootermopsis nevadensis) have been collected from suppressed sequoias killed by Trachykele opulenta, a beetle which attacks young trees and larger trees wounded by fire. Diseases known to be associated with giant sequoia are annosus root rot (Fomes annosus) and shoestring root rot (Armillaria mellea).

d. Sensitive Plants

There is only one known sensitive plant species in the sequoia. Erigeron aquifolius occurs on dry ridges between 3,000 to 7,000 feet.

5. Unit V - Red Fir/White Fir

a. Description

The developed areas found within the Red Fir/White Fir Unit include Cold Springs Campground, East Mineral King, Wolverton, Lodgepole Campground, Red Fir Heliport/Camp, Halstead Meadow Picnic Area, Dorst Campground, and Cabin Creek Residential Area. Development of Clover Creek near Lodgepole is currently underway. Together (including the projected acreage of Clover Creek) they comprise eight percent (293 acres) of the Development Zone. In addition, there are 20 miles (725 acres) of roadside vegetation which comprise 20 percent of these Parks' roadsides. Facilities in the developed areas are summarized in Table 14.

b. Vegetation

Red Fir (Abies magnifica) is the dominant species in the unit, although at lower elevations (approximately 6,000 feet) it is often equally mixed with white fir (A. concolor) (Rundel et al., 1977). Sugar pine (Pinus lambertiana), Jeffrey pine (P. Jefferyi), and incense cedar (Libocedrus decurrens) are occasional associates. More commonly than any other species, lodgepole pine (P. murrayana) dominates scattered areas within this type (Rundel et al., 197

The developed areas within Unit V are typically old-growth or mature stands with 40 to 100 percent crown coverage. Mortality rates collected from Dorst Campground between 1978 and 1981 indicated a loss of 0.23 trees per acre per year (Warner, pers. comm.) .

c. Insects and Diseases

The major diseases found in the red fir/white fir types are Indian Paint Fungus (Echinodontium tinctorium), Armillaria mellea, Fomes annosus, dwarf and true mistletoe (Arceuthobium spp. and Phoradendron sp.). The principal insect problems include the fir engraver (Scolytus ventralis) and flatheaded fir borer (Melanophila drummondi).

Indian paint fungus attacks the heartwood of red and white fir. It enters trees through fire scars, dead tops, and other wounds or through branches. Trees with advanced rot become hollow, which significantly weakens their structural integrity. It is a major source of tree hazards in living trees.

A. mellea has an extremely wide host range including conifers, hardwoods, and shrubs. This fungus does not kill trees directly but rather weakens them structurally, making windthrow more probable (Smith, 1978).

Fomes annosus root rot generally kills pines within two to six years following infection but rarely kills true fir directly. The fungus reduces the overall vigor of fires, thus predisposing them to windthrow or attack by other pests.

Table 14. Facilities in the Developed Areas of Unit V.

	Developed Area	Location	Facilities
1.	Cold Springs Campground	24 miles northeast of Hammond on Mineral King Road	37 tent sites
2.	East Mineral King	25 miles northeast of Hammond at end of Mineral King Road.	13 privately-owned cabins and NPS corrals
3.	Wolverton	End of Wolverton Road, 4 miles from Giant Forest	Downhill ski area (8 structures) and privately-operated corrals
4.	Lodgepole Campground	4 miles northeast of Giant Forest	260-site campground, service station, visitor center, post office, and camper store
5.	Clover Creek	Immediately west of Lodgepole Campground	Concession facilities (under development)
6.	Red Fir Heliport	2-1/2 miles west of Lodgepole	Heliport and campsite for work crews
7.	Halstead Meadow	4 miles west of Lodgepole	Picnic area and and comfort station
8.	Dorst Campground	12 miles northeast of Giant Forest	238-site campground
9.	Cabin Creek	Near Dorst Campground	2 cabins

The fir engraver attacks red and white fir, usually in association with severe drought stress. Trees infected with root rot are especially susceptible. Its attack usually affects the tops of large trees.

The flatheaded fir borer usually attacks red and white fir weakened by dwarf mistletoe, fire, or drought, and also attacks otherwise healthy trees on dry sites (Furniss and Carolin, 1977).

d. Sensitive Plants

There are no known sensitive plants in the red fir/white fir unit.

IV. THE VEGETATION MANAGEMENT PROGRAM

This section discusses what will be done in vegetation management in the Development Zone. Objectives and policies are discussed for all vegetation management activities.

A. Overview

The vegetation within the Development Zone has been altered. For example, fire exclusion is suspected to have changed the character of the sequoia mixed-conifer forest (Kilgore and Taylor, 1979, and Bonnicksen and Stone, 1978.). The removal of fire is thought to have caused:

1. An increase in the relative number of overmature trees, which are the greatest safety hazards. Fire would normally have removed these trees, since the rot often found in them is highly flammable.

2. A change in species composition and forest structure. In some areas there are now more shade-tolerant, understory trees, such as white fir, which would have been thinned by fire. Because of the increased competition for moisture, the larger trees are stressed, possibly predisposing them to increased attacks by insects and diseases.

3. An increased incidence of diseases, such as Fomes annosus and Armillaria mellea. Fire would have burned out stumps and roots which harbor the diseases. It also causes scars that may provide entry courts for root disease.

Management actions, such as paving over roots, removal of trees without treating stumps with borax to inhibit the spread of Fomes annosus, and building developed areas in overmature mixed-conifer forests have also caused increased tree mortality and altered forest structure and composition (Bega, 1978). Heavy visitor use has caused soil compaction, denuding of some areas, erosion, and inhibited the natural germination of seeds (Hartesveldt et al., 1975).

The chaparral/oak woodland community was changed by early grazing, logging, and fire exclusion (Vankat,

1970). Native perennial bunch grasses and herbs have been replaced to a large degree by non-native annual grasses and herbs (Heady, 1977). Fire suppression has resulted in large areas of uniformly-aged and flammable brush, a significant safety hazard.

In addition to the above internal impacts, there are external impacts that have the potential to permanently alter the vegetation in the Development Zone as well as throughout these Parks. The chlorotic mottling on conifer needles caused by the air pollutant, ozone, is already being observed in Jeffrey and ponderosa pines (Pinus Jeffreyi and P. ponderosa) and black oak (Quercus Kelloggii) (Wallner and Fong, 1982). Acid precipitation, with minimum ph of 3.5, has been recorded (Duriscoe, 1982, and Lawson et al., 1978) near Giant Forest. The impacts of these pollutants could be irreversible.

The above impacts and alterations to the vegetation will prevent a complete approximation of a "natural" vegetation character in the Development Zone. However, management will strive, wherever possible, to approach "naturalness" as defined in the introduction. The degree of management required will depend on:

1. The duration and extent to which natural processes, such as fire, insects, and diseases, have been altered, and the degree to which these processes can be allowed to play a more natural role.

2. The extent to which man has altered the vegetation.

3. The degree to which man's presence will continue, and particularly the degree to which management policy provides for safety and "enjoyment" of the visitor.

B. Desired Condition of Vegetation

The desired state of vegetation in developed areas is one in which forest regeneration and mortality, insects and diseases, and fire combine to form a near "natural" forest composition. Obstructing this condition is the impact of millions of visitors, many buildings and roads, and the influence of past management strategies such as fire suppression, insect and disease control, hazard tree removal, and the planting of favored species.

1. Considerations

The attainment of this desired state requires the consideration of several elements:

a. What would the natural species composition, age structure, stand density have been like today without interference by man? In other words, what should the natural, self-perpetuating community be like?

b. How has the presence of man changed these elements, or how far has the vegetation deviated from the natural state? The buildup of fuels in some areas, increased stand density, and the occurrence of insects and diseases in unnaturally high frequencies are some ramifications of the new conditions.

c. Given the presence of visitors and facilities, would the "natural" state be ill-matched with visitor use? For example, if the forest in a developed area is on a 100-year fire cycle, and it is naturally rejuvenated by crown fire, this is incompatible with recreational use. Either the forest must be artificially replaced by a low intensity fire species, or cutting and burning by hand must be used to mimic natural stand replacement by fire.

Also, the number of hazardous, overmature trees which would be present naturally in a forest might be incompatible with safety standards. This might necessitate selecting an earlier successional stage as the desired condition. The ideal state of vegetation lies somewhere on the gradient of favoring natural processes exclusively to favoring visitor use exclusively. Management must be guided by the ecology of the site, which may limit strategies.

2. Desired Condition by Vegetation Type

The conditions of the vegetation listed below are the end points for which management will strive. They represent a compromise between allowing all natural processes (fire, insects, diseases, windthrow, etc.) to function freely and visitor use.

a. Unit I - Chaparral/Oak Woodland

These communities are fire-adapted, although in different ways. Chaparral was apparently a mosaic of age classes of varying flammabilities and acreages, mature stands burning intensely (Parsons, 1976 and Philpot, 1977). The oak woodland was open with a mixed annual grass, forb and perennial bunchgrass understory, which has been replaced by exotic annual grasses as a result of grazing (Heady, 1977).

The desired state of these types is one in which fire can play as full a role as possible without threatening public safety or property. Prescribed burning is the main tool for the reduction of hazardous fuel and the recreation of age class mosaics.

True mistletoe (Phoradendron spp.) is a particular problem in the management of a healthy oak woodland in the development zone. If the incidence of this parasite is due to unnaturally high densities of trees, then a combination of thinning and pruning would be used to create the desirable condition in which the parasite is recognized as a natural part of the stand, but not so great as to reach stand-destructive proportion.

b. Unit II - Ponderosa Pine

Ponderosa and Jeffrey pine forest, which is the dominant vegetation type in Cedar Grove, was, under natural conditions, regulated by fire in its reproduction, species composition, and density (Cooper, 1960 and 1961, and Weaver, 1967). Fire's relatively frequent occurrence every three to eleven years (Warner, 1981) affected the balance between deciduous and coniferous, shade-tolerant and intolerant, and fire-tolerant and intolerant species.

The exclusion of fire from developed areas in Unit II, as well as the impacts of roads, soil compaction and visitor-caused physical damage to trees, has resulted in an artificially-stressed ecosystem. Insects and diseases appear to be

acting as secondary thinning agents in place of fire, resulting in the loss of trees which normally would have survived periodic natural fires.

Desirable conditions in Unit II have sufficient trees to provide an aesthetically pleasing environment in the campgrounds and developed areas while keeping insect and disease activity at endemic levels. The general area should approximate an all-sized ponderosa pine forest. Species density should be compatible with site carrying capacity and species composition. Deciduous species may be planted to replace insect-killed pines, since fire suppression has unnaturally favored the establishment of conifers (Bonnicksen and Stone, 1978).

c. Unit III - White Fir Mixed-Conifer

Because of the importance of natural fire as a thinning agent, particularly in young and old trees, fire suppression has resulted in an increased frequency of dense stands of pole-sized trees and heavy concentrations of fuel. Since the primeval forest is known to have been more open than it is today (Muir, 1977), the desired state of white fir mixed-conifer is one in which weakened or suppressed trees are removed either by fire or by cutting. An optimum stocking level which takes into account additional stresses induced by development will in addition to site quality, stand age, and species composition, result in a prescribed basal area (square feet per acre) which is the density for which the stand is managed. Thinning is done to a basal area at which the residual trees exhibit good vigor.

The stand density is not the only factor in the "desired state;" species composition must also be considered. A recreation of a younger-aged forest may indicate that hardwoods are the type best adapted for the site; the Fomes annosus problem is undoubtedly enhanced by the replacement of resistent hardwoods by susceptible conifers. The desired state must take into account both the species and density best adapted to the

site, given the presence and level of development. The stand, if regulated properly by natural or natural-mimicking artificial means, should maintain itself in a desirable state.

d. Unit IV - Sequoia Mixed-Conifer

(1) Special Management Areas

Special Management Areas (SMA's) are located in giant sequoia groves (Big Stump, Grant Grove, Giant Forest, and Lost Grove in Unit IV. These areas, formerly known as "Showcase" areas, are areas where maintenance of natural processes is guided more by scenic concerns. These areas are the most heavily visited sites in giant sequoia groves and include, for example, the area around the General Sherman Tree and General Grant Tree and walk, and along heavily traveled roads and trails in Giant Forest and Grant Grove.

The objective in these areas is to balance their dynamic character with the need to perpetuate the scenic resource and to enhance visitor appreciation and understanding. There are two types of Special Management Areas -- Landscape Management SMA's and Research Study SMA's. Only Landscape Management SMA's will be addressed in this Plan. Research Study SMA's are discussed in the Fire Management Plan.

(a) Landscape Management SMA's

- General Sherman Tree and Congress Trail.
- General Grant Tree and Walk.
- Tharp's Log.
- Generals Highway (selected points in Giant Forest, Lost Grove, and Grant Grove).

- Crescent Meadow Road (selected points).
- Crescent Meadow - Tharp's Log Trail.
- Crescent Meadow Loop Trail.
- Hazelwood Nature Trail.
- Round Meadow - Trail for All People.

The General Grant Tree is unique in that it is to be maintained at a point in time (i.e. as close to 1890 condition as possible). The use of old photographs and age structure analysis give some idea of what the site looked like 100 years ago (Kauper et al., 1980). Therefore, the desired state is the perpetuation of a specific forest composition. Planting, cutting, and limited use of prescribed fire will be tools in this strategy.

(2) Other Giant Sequoia Forests

In areas of giant sequoia in Unit IV other than in the Special Management Areas, natural processes will be allowed to function to the fullest extent possible. Fire exclusion has resulted in dense thickets of 12-29 inch dbh white fir poles (Bonnicksen and Stone, 1978).

Prescribed and natural fire will be the primary tool to create and to maintain relatively natural conditions. The presence of fire should result in a forest which is self perpetuating, which requires a minimum of fire suppression since the hazard will have been removed by the fire's consumption of dead and down wood, and which has significantly less insect and disease problems that it does now since weakened and vulnerable trees will be removed by fire.

The relatively short (15 to 20 year) natural fire cycle (Kilgore and Taylor,

1979), when allowed to function, should perpetuate sequoia mixed-conifer with little threat to the health and safety of the visitor--if these fires are properly managed according to the Fire Management Plan.

e. Unit V - Red Fir/White Fir

These species are not highly adapted to fire (Pitcher, 1981), although a major fire may destroy and rejuvenate an overmature forest. Overmature stands are naturally susceptible to a variety of insects and diseases, and therefore should not be considered as sites for developments. Studies on age structure may confirm the theory that fir stands tend to be even-aged, beginning, maturing, and dying as a cohort of various acreages. If this is the case, the old strategy of tree-by-tree removal in a diseased or overmature stand should be replaced by removal of the entire cohort and replanting with seedlings.

The desired condition is an immature/mature, healthy fir forest with a minimum of root infection centers and other diseases. Since this state may last 100 to 200 years, age class conversion such as this should not be particularly frequent. The management strategy of cutting and planting should result in a similar cycle as that produced naturally by insects, diseases, windthrow, and fire.

C. Vegetation Management Strategies

There are three management strategies for managing vegetation in the Development Zone:

-- Remove and/or prune vegetation for the purpose of eliminating hazards to public sfety and property, managing insects and diseases, clearing roadsides and opening roadside vistas, removing exotic plants, managing native species vegetation composition and structure, and enhancing scenic resource in Special Management Areas.

-- Plant native vegetation for revegetating disturbed areas.

-- Prescribe burn to attain desired vegetation species composition and structure and to reduce fuel loading around the periphery of developed areas.

1. Vegetation Removal

a. Management Objectives

(1) Provide an acceptable level of public safety in developed areas at a minimum cost and with minimal impact to people and the environment by removing high priority hazard trees.

(2) Monitor and manage the incidence of native insect infestations and disease infections in developed areas to minimize tree mortality and to reduce potential future hazards.

(3) Regulate stand density to improve individual tree and overall stand vigor and thus increase insect and disease resistance and approximate a more "natural" condition for the given vegetation type.

(4) Remove or prune dense vegetation growing along roadsides which obstructs established vistas or which poses a safety hazard to vehicular traffic.

(5) Remove selected vegetation in the Special Management Areas to enhance the scenic resource.

b. Hazard Tree Removal

(1) Overview

Most of the Development Zone is located in mature or overmature forests. Many of the trees in these forests have defects which render them unsafe. These defects, which normally accompany decadence and death in trees, form a part of the natural process of renewal in the forest. Under natural conditions, they are benign. However,

there is concern when people congregate under defective trees in campgrounds or other developments. Liability for providing visitor safety in developed areas has been established by the Solicitor General on the basis that the public is invited to developments. The National Park Service is obligated to provide a reasonable level of safety.

Hazard is defined as "...the probability of mechanical failure or uprooting of a tree with consequent injury or property loss" (Paine,1973). Trees cannot be classified as either hazardous or non-hazardous since nearly all trees have a recognizable probability of failure and involvement in an accident (Paine, 1971). A 100 percent level of safety would entail removing most of the trees from a site. Besides being costly, it would reduce the aesthetic value and usefulness of the site. Therefore, some trees with recognizable hazard must be retained. Safety becomes a compromise between control cost, aesthetic value, and probability of accident losses.

Factors affecting accident hazards are: 1) the probability of tree failure; 2) the probability of target impact; 3) the damage potential; and 4) the target value (Paine, 1971). The probability of failure, which is affected by defects and faults of the tree as well as by environmental and site factors, includes only potential failures during the season of use; contributing factors (such as snow load, wind, etc.) which occur other than during the season of use, are not considered when assigning a priority hazard rating.

The probability of target impact is determined by both the chance of a failure striking a specific area and the likelihood of that area being occupied. Probability of an accident then, is the product of the probabilities of failure and impact. Accident loss is determined by the ability of

the failure class to inflict damage and target value.

To provide for an acceptable level of hazard reduction, Paine (1971 and 1973) suggests the following steps be followed: 1) select a goal; 2) set a safety standard based on the defined goal; 3) provide a uniform method for rating hazard; 4) set a hazard rating (hazard control level) below which hazard will not be controlled; 5) perform regular and systematic technical examination of the sites for recognition and evaluation of hazard; and 6) perform appropriate hazard reduction. Paine suggests that the goal of hazard evaluation and control is to "...provide an acceptable level of public safety at minimum cost and with the least damage to the environment" (Paine, 1971). This acceptable level of public safety is determined by the minimum attainable and current accident rates. It involves the use of cost optimization (Paine, 1973). Appendix A discusses how an allowable accident rate for these Parks was determined.

As of 1986, there is a estimated backlog of 496 identified high priority (dead or defective) trees in the developed areas. 1/ Additionally, there are an estimated 180 trees dying each year (based on available annual mortality rates). The average cost per tree for hazard abatement is approximately $205. 2/ An average of 300-400 high hazard trees are removed annually. The need to remove these hazards is obvious from a safety standpoint; thus, a coordinated program involving defect recognition, evaluation, and removal is required.

1/ Does not include roadside hazards.

2/ Based on actual reported manpower and productivity figures for calendar year 1986. Does not include administrative, equipment, or logistical support costs.

(2) Management Policies

(a) Park developments will be located, insofar as possible, in areas where present and future hazard trees will be minimized (Appendix B).

(b) Hazard tree removal will be accomplished first in areas where property damage and/or injury or death may occur. The order of priority for removals is as follows:

-- Structures with year-round occupancy.
-- Other structures.

-- Campgrounds with year-round occupancy.
-- Other campgrounds.

-- Parking areas/vistas.
-- Roadsides - primary/secondary.

(c) Hazard tree and limb surveillance will be done according to procedures identified in the Vegetation Management Operations Guide.

(d) A seven-point rating system (Appendix C) will be used to assign priority removal values to hazard trees and limbs.

(e) Hazard tree removal will be accomplished according to the following minimum standards:

-- Survey and remove all high priority (class 6 and 7) hazard trees from each developed area within these Parks every three years as feasible.

-- Spot check and annually remove all (class 6, 7) hazard trees from around all structures that are occupied year round.

-- Ensure that all sites are completely cleaned up and returned to "natural" -appearing conditions.

(f) Identified high priority hazard trees in areas to be worked for that year will be removed the same field season as identified whenever possible.

(g) All hazard trees will be marked, mapped, and data recorded prior to removal.

(h) Only qualified personnel under the direction of or with the explicit permission of the Chief of Resources Management based on recommendations from the Forestry Foreman will remove hazard trees.

(i) All hazard tree and limb removal, cleanup, and site rehabilitation will protect the residual trees, other resource values, and human developments in accordance with the Vegetation Management Operations Guide.

(j) Accurate maps and records of all surveys, tree removals and surveys will be maintained by the Forester.

(k) Trees along secondary roads or trails where there are moving targets, such as vehicles or people, will not be removed except when a tree is a known hazard--limbs or part of the tree have fallen.

(l) Hazard trees and limbs will be removed from cabin sites and rights-of-way of permittee lands at Mineral King and from park land at Wilsonia.

(m) Hazard trees and limbs may also be felled and removed by a private contractor to expedite removal of high hazard trees. Hazard trees may be sold as excess property or as firewood at fair market value. (Appendix K.)

(n) Hazard trees and limbs caused by prescribed fires will only be removed:

-- at sites along trails where there is heavy visitor concentration,
-- along primary and secondary roads where they pose a threat to vehicles,
-- according to the 7-point rating system, with possible exception of special cases, and,
-- when they catch fire and pose a threat to visitors.

Sequoia trees along trails that catch fire and can cause a hazard will not be removed. If the hazard is severe enough, the trail will be closed or relocated.

(o) Sequoia limbs in developed areas will not be removed unless they are a hazard by evidence of falling limbs onto visitor use areas.

(p) All park personnel will assist in identification of potential hazards by reporting to Resources Management on an "Individual Hazardous Tree Report" (PSW-4600-3).

(q) The actual number of tree failures per year within developed areas will be compared to the calculated maximum allowable number--fmax (see Appendix A)--to determine if the safety standard is being met. If the actual number continuously exceeds the calculated maximum, then the adequacy of the existing program to abate the hazard will require re-evaluation.

(r) All tree failures occurring in developed areas where potential for accident (property damage and/or injury) exists will be reported on Form PSW-4600-3. In addition, accident failures require Form 10-343 (Case Incident Record) and Form DI-134 (Report of Accident/ Incident) (Appendix D).

(s) All management activities within the Development Zone, including but not limited to maintenance of facilities, construction, prescribed burning and hazard tree removal, will avoid injuring any standing living tree. This includes damage to roots as well as the bole (trunk), and limbs of trees.

The following steps will be taken to prevent or reduce damage:

-- Proper types of equipment will be used in such a manner as to do the least amount of damage to the environment. The routes of travel by equipment will also be controlled.

-- Bumper guards around tree bases and barriers around tree groups will be used when heavy equipment is being operated among trees in developed areas.

-- When digging is required in the vicinity of trees, particularly sequoias, it will be done by hand to prevent damage to roots.

-- Tree damage and vegetation damage penalty clauses will be placed in all construction contracts, including those involving utility companies.

(t) All new development sites will be surveyed to determine Fomes annosus centers and to mark potential hazard trees. All hazard trees will be removed prior to construction by the contractor or by Park Service personnel.

(u) Hazard trees to be removed will be marked with a numbered tag and a small (about two - three inch diameter) blue dot on the base of the tree on the side least visible to the public.

c. Stand Management

The primary objective of stand management activities in developed areas is to improve individual tree vigor, plus insect/disease resistance, by regulating stand density. This will be accomplished by reducing localized overstocked stands through selective mechanical removal of less thrifty, suppressed, and diseased trees while preserving the aesthetic and recreational value of the site. Stand density and species composition information will be collected from within developed sites and compared to data collected from undeveloped sites in the same vegetation types to ascertain differences due to direct human impact. Indirect effects on vegetation (e.g. fire suppression) are more difficult to quantify and require use of sophisticated computer-assisted successional models. "Natural" (that which would have presently existed in absence of European man) stand density and species composition can, thus, only be approximated. These approximations will be further modified by use of desired stocking level tables expressed as percentage of normal (fully) stocked stands and aesthetic considerations.

(1) Overview

The present vegetative condition in the Development and Natural Zones has been influenced by a drastically altered fire regime (Kilgore and Taylor, 1979; and Warner, 1981) which has resulted in modified species composition and age structure (Bonnicksen, 1975; Bonnicksen and Stone, 1978; Parsons and DeBenedetti, 1979; Vankat, 1970). Additionally, vegetation in the Development Zone has been influenced by the removal of insect-infested, disease-infected and hazardously defective trees as well as thinning, planting, mechanical injuries, paving, and soil compaction. The incidence of Fomes annosus has increased due to lack of proper stump treatment in the past.

The reduced incidence of fires has resulted in: 1) increased density of relatively shade tolerant species such as white fir (Abies concolor), incense cedar (Libdocedrus decurrens), and sugar pine (Pinus lambertiana) in the understory (Bonnicksen, 1975; Parsons and DeBenedetti, 1979; Vankat, 1970); 2) a decrease in shrubs (Bonnicksen and Stone, 1978; Vankat, 1970) and hardwoods (Bonnicksen and Stone, 1978); and 3) a shift in age structure with a reduction in seedlings and saplings and an increase in poles and mature trees (Bonnicksen and Stone, 1978). Increased stand densities have also been implicated in reductions in vigor, predisposing trees to insect attack, and increased incidence of diseases.

(2) Management Policies

(a) Stands in developed areas will be managed at stocking levels which are based on site quality and which result in good tree vigor and increased resistance to insects and diseases.

(b) Thinning requirements will be based on U.S. Forest Service guidelines, information generated by U.S. Forest Service biological evaluations, and site-specific studies to determine growth rates versus stand density relationships.

(c) A silvicultural prescription (Appendix J) will be prepared for each developed area in each vegetation management unit which will define specific stand management objectives, stocking levels, and stand management problems.

(d) Certain "high risk" trees (those judged to have limited life expectancy based on rating criteria) will be removed prior to developing a site (Appendix H). Other trees, which because of the combined effects of size, defective characteristics, or

particular environmental conditions which might render that tree a safety hazard to human life or property, will also be removed.

d. Insect and Disease Management

(1) Overview

Most western forest insects and diseases are native, having coevolved with the trees they inhabit. Beneficial and harmless insects far outnumber the destructive ones. Their populations are subject to wide fluctuations as a response to physical, nutritional, and biological factors. The destructive ones usually do their damage when their numbers reach epidemic proportions.

(a) Insects

Under natural conditions, the explosive reproductive capacity of insects such as bark beetles is regulated by the environment. Occasionally, natural control may be significantly weakened. The vigor of trees may be lessened by drought, fire, windthrow, and other natural or human environmental factors. This is particularly true in developed areas. When this occurs, destructive insects may breed rapidly and infest vast areas. In two years, a large proportion of a stand may be killed by bark beetles which may persist for many years. Defoliators typically appear suddenly and disappear just as abruptly after consuming large amounts of foliage (Furniss and Carolin, 1977).

Native bark beetles, under natural conditions, fulfill important ecological roles and as removing agents (Waters, 1970) by removing trees from overly dense stands and by removing agents of decomposition by introducing decay-producing fungi which hasten

breakdown and return of organic material to the soil. In developed areas, however, where the overstory trees are generally of high value and man's activities and developments have already reduced that overstory canopy, further mortality is undesirable.

Bark beetle attacks occur under a wide range of conditions. Attacks are successful when trees are in subnormal physiological condition, caused by drought (moisture stress), fire, mechanical injury, and disease (Rudinsky, 1962). Available soil moisture is one of the most important factors that affect tree vigor. High summer temperatures and stand competition also weaken trees, thus increasing the possibility of bark beetle attacks.

Site, age, and species composition are also important factors in determining susceptibility of trees to bark beetle attack. For example, resistance of ponderosa pine to successful attack by western pine beetle (Dendroctonus brevicomis) has been shown to be highly correlated with resin quantity and quality, which might in turn be favorably affected by silvicultural methods such as thinning and sanitation cutting.

Natural control organisms include parasitic and predatory insects, birds, microorganisms and disease.

Endemic mortality is characterized by scattered individual trees, whereas epidemic mortality occurs as group and mass tree killing. When epidemic mortality occurs in developed areas, control measures must be taken.

Several authors, Dahlsten (1976), Browne et al. (1976), Amman and Baker (1972), have questioned direct bark

beetle control. Their concerns covered such things as use of insecticides, and problems of detection, timing, and coverage. Amman and Baker (1972) stated that "...it would appear that populations in National Parks are of little or no value and that the eventual survival of lodgepole pine will be about the same whether or not the stand is treated." They concluded that where recreational or aesthetic considerations were paramount, chemical treatment was not recommended; tree cover would be maintained by survival of lodgepole pine in smaller classes and succession by other tree species.

Other researchers hold exactly the opposite view. In areas of high recreational value, intensive and costly control measures may be warranted (Dolph, 1979). While recognizing the probable need for intensive control methods due to greater incidence and higher site values in campgrounds and other developed recreational sites, the National Academy of Science (1975) also generally advocated silvicultural methods of control as part of an integrated pest management approach.

Indirect control is a preventive approach of reducing tree mortality by insects through maintenance of tree vigor. Emphasis is placed on improving trees' vigor (resistance) to bark beetle attack rather than reducing beetle populations. Tree vigor is a function of the combined effects of growth factors and stresses to which a tree has been exposed.

Indirect control includes: a regulation of forest composition - maintain native species diversity (mixed stands); continuation of suitable reproduction, maintenance of uneven

(all-sized stand) and regulation of stand density (Graham and Knight, 1965).

Some species of trees are less susceptible to insects and diseases. This was recognized by Thede (1954) who recommended favoring less insect-prone species such as incense cedar in Cedar Grove. Since most forest pests are somewhat host specific, mixed stands not only discourage extensive outbreaks, but also ensure survival of some trees after an outbreak.

Adequate reproduction ensures that the stand will remain in a stable, all-aged condition and allows flexibility in possibly removing some heavily-diseased or weakened overstory trees.

By maintaining an all-sized stand, the inevitable decline and death of over-mature trees is offset by continual replacement by younger, more vigorous trees. This allows management to focus on maintaining the vigor of the entire stand rather than trying to protect and preserve less vigorous trees which are ultimately destined to die anyway. Instead of allowing conditions to develop which weaken trees (e.g., over-stocking, disease, infection etc.), management is aimed at preventing the condition before it reaches an advanced stage.

(b) Diseases

Diseases play a natural role in recycling nutrients into the environment. When an ecosystem is functioning in its natural state, extensive outbreaks of diseases are rare. However, trees impacted by development, management, and use of an area are subject to greater incidence of certain diseases, such as Fomes annosus. Overstocking

of a timber stand, often the result of fire suppression, can also lend itself to greater prevalence of diseases, such as dwarf mistletoe.

Exotic diseases, such as white pine blister rust (Cronartium ribicola), may also have a severe impact. However, despite over 20 years of Ribes eradication and direct control, it was not possible to prevent its introduction or eliminate the disease from the Parks.

(c) Ozone

Ozone, the most important known pollutant affecting conifer forests in California (Miller, in manuscript), was first reported to be causing injury on vegetation in the Sierra Nevada in 1971 (Miller and Millecan, 1971). Since then, foliar injury has been detected on black oak (Quercus Kelloggii), ponderosa pine (Pinus ponderosa) and Jeffrey pine (P. Jeffreyi), the two most sensitive conifers, in the Sequoia and Sierra National Forests (Pronos et al., 1978; Pronos and Vogler, 1981); Sequoia and Kings Canyon National Parks (Wallner 1980; Wallner and Warner, 1981; Wallner and Fong, 1982) and Stanislaus National Forest (Allison, 1982).

Generally, while the overall average injury level is still rated as slight (appearing primarily on third year and older needles) 39 percent of individual trees sampled exhibited some form of injury during a random cruise survey of 1,470 trees. (Duriscoe, in press) Injury ranged from moderate (symptoms on third year needles) to severe (symptoms on second or current year needles) injury (Allison, 1982).

The relationship between needle retention and ozone injury was also documented during the random survey. The mean number of whorls present for uninjured ponderosa pines (P. ponderosa) was 5.02, while injured trees averaged 3.84. In Jeffrey pines (P. Jeffreyi) uninjured trees averaged 6.11 whorls, while injured trees averaged 4.78. (Duriscoe, in press)

The highest amounts of injury appeared localized in the Kaweah Basin where 62.9 percent of trees sampled showed some form of damage and in Grant Grove, where 77 percent of the trees showed injury. (Duriscoe, in press)

The maximum 24-hour average ozone concentration recorded in these Parks during summer/fall 1985 was 8.8 pphm at Ash Mountain (NPS records-Sequoia and Kings Canyon 1985). The highest hourly maximum was reported at 14 pphm. Normal ambient levels are approximately 3-4 pphm. Results from a study in the San Bernardino Mountains (Miller and Taylor, 1973) indicate that foliar injury to ponderosa pine occurs at average 24-hour ozone concentrations of 5-6 pphm. Foliar injury and premature abscission resulted in decreased photosynthetic capacity, suppressed radial growth, and reduced nutrient retention in the green biomass (Miller and Taylor, 1973). The net effect was weakened trees which were more susceptible to Fomes annosus (James 1977; James et al., 1980) and western pine beetles (Dahlsten and Rowney, 1980). Long-term effects could be a type conversion favoring less sensitive species, such as white fir (Miller and Taylor, 1973).

(d) Dwarf Mistletoe

Dwarf mistletoe (Arceuthobium spp.) are native seed plants which parasitize conifers, excluding incense cedar and sequoia. The four associated species are: ponderosa/Jeffrey pine--(A. campylopodum); sugar pine--(A. Californicum); lodgepole pine--(A. americanum); and white/red fir--(A. abietinum). These obligate parasites divert nutrients and water from their hosts, which reduces tree growth and seed production, increases mortality by predisposing trees to insect attack, and results ultimately in long-term successional and species position changes (Hawksworth, 1978).

Fire is the primary ecological factor governing the distribution and abundance of dwarf mistletoe; fire suppression has resulted in conditions favorable to dwarf mistletoe intensification.

Dwarf mistletoe seeds are forcibly ejected, with horizontal distances averaging 15 to 20 feet and up to 100 feet maximum (Hawksworth, 1978). Average annual horizontal and vertical spread rates in a stand are one to two feet (Hawksworth, 1978) and four to six inches (Pronos and Vogler, 1981) respectively. Hawksworth (1961) found a 50 percent reduction in radial growth rates in infected pines. Vogler and Scharp (1981) report a similar reduction. Likewise, mortality was greater for severely infected (22 percent) versus non-infected (3 percent) trees over an eight-year period. In a study conducted in Grand Canyon National Park (Lightle and Hawksworth, 1973), 20-year mortality of trees severely infected at the beginning of the study was 52 percent. Intensification of the disease was

rapid; about nine years to increase to the next class for lightly to moderately infected (class 1-4) trees. The average life expectancy of class 6 (heavily infected) trees was approximately 30 years.

In addition, Lightle and Hawksworth (1973) found that as a result of control work over a 20-year period, dwarf mistletoe infection was reduced from 31 to 20 percent, while in the untreated stands it increased from 28 to 74 percent. A recent biological evaluation (Pronos, 1981) recommended a dwarf mistletoe control program in Cedar Grove as a means of reducing infection level and mortality.

(2) Management Policies

(a) Forest insect and disease conditions in the Development Zone will be monitored on an annual basis by the Forester.

(b) Management programs for native insects, primarily bark beetles, will be undertaken in developed areas during epidemic infestations. Management will: 1) prevent spread of the infestation out of these Parks into vegetative communities where similar control actions are being applied; or 2) protect healthy, vigorous vegetation in developments.

(c) Native diseases, such as dwarf mistletoe (Arceuthobium spp.) will be managed according to guidelines in Appendix I only when such action will significantly improve vigor and increase longevity of vegetation in developed areas.

(d) Emphasis will be placed on an integrated pest management approach which includes sound stand management practices designed to improve the vigor of

the host species and thus prevent the occurrence of epidemics.

(e) Exotic insects and diseases will be controlled when there is a reasonable chance of success.

(f) Abiotic diseases, such as ozone injury, will be monitored as to intensity and distribution and trends in the amount of injury.

(g) Exotic insects and diseases which have become established, such as white pine blister rust, Cronartium ribicola, and which become of economic or biological constraints which can not be controlled will be managed similarly as native pests. Management actions, such as prescribed burning, will be monitored as to their effects. Spread and intensification of these pests will be monitored.

(h) Merchantable logs resulting from management actions, such as thinning or forest insect and disease control in developed areas, will be scaled and offered as a salvage sale if in sufficient volume. If there is not sufficient volume, they will be sold as firewood. Any logs offered for sale will be sold at Fair Market Value according to 16 U.S.C. 3 and Special Directive 82-6, July 12, 1982. Appendix K discusses procedures for timber and firewood sales.

(i) Pesticides to control insects and diseases will:

-- only be used when human health and safety are threatened, and when there is potential for "significant" property or resource damage;

-- only be used in the Development Zone;

-- not be used if they are on the U.S. Department of the Interior prohibited list;

-- be used if they are on the U.S. Department of the Interior restricted list only when there are no alternatives, use is limited to a small-scale operation and the failure to use would result in even greater impacts to natural zones.

(j) All pesticide use must meet EPA and OSHA regulations and Department of the Interior and Park Service guidelines and be approved by the Director. Any pest control action must be at the minimum effective level.

(k) Empty pesticide containers and unused, unneeded pesticides are considered hazardous waste and will be disposed of in accordance with the Hazardous Waste Plan.

(l) Dwarf mistletoe control programs will be instituted in the Development Zone only after a biological evaluation is conducted by a professional plant pathologist from the U.S. Forest Service.

(m) Ambient levels of ozone and other pollutants will be monitored, using available technology.

e. Roadside Vista Clearing

(1) Overview

There are 113 miles of major roads throughout these Parks. This road system traverses through all vegetation management units. The roadsides and vistas cover an estimated area of 2,919 acres.

Because of fire suppression and regeneration of road cuttings, plant succession

along roadways has blocked many vistas and interfered with site distances along the roads. Road construction has also contributed to the increased growth of vegetation along roads. The excavation and soil disturbance has created an ideal seed bed for species such as white fir and ponderosa pine. Many vistas and the roadside itself are blocked by thickets of young trees. In many areas, slopes and banks are eroding due to lack of stabilization, tree roots were cut leaving a potential hazard, and root disease has been introduced because of disturbance. There are 23 existing or potential vistas along these Parks' roads (Table 15).

(2) Management Policies

(a) The 23 vistas listed in Table 15 will be maintained according to the roadside cutting and vista clearing standards in Appendices F and G.

(b) All vista clearing will be done under the direction and supervision of the Chief of Resources Management.

(c) Prescribed burning along with cutting and thinning will be used to clear vistas and roadsides. Dead trees and shrubs will be removed after burns.

(d) Only native vegetation will be planted at vistas and along roadsides should soils need to be stabilized.

(e) All vegetation removed from vistas and along roadsides will be "feathered" so no signs of cutting are visible.

(f) Roadside vegetation manipulation will be used to accomplish the following:

-- protect the long-term integrity of road surfaces;

Table 15. Existing Vistas in Sequoia and Kings Canyon National Parks

Vegetation Unit	Vista Name	Mileage from Ash Mtn. Ent.	Elev. (ft)	Description	Veg. Type
I	Indianhead	0.1	1450	Kaweah River Woodland	Evergreen
I	Tunnel Rock	2.3	2000	Kaweah River Woodland	Evergreen
I	Mt. Stewart	5.3	2520	Mt. Stewart	Chaparral
I	Amphitheater Point	11.1	4350	Moro Rock/ Castle Rocks	Oak Woodland
I	Deer Ridge	12.7	4900	Marble Fork	Evergreen Woodland
II	Eleven Range	13.7	5250	Kaweah Drainage	Mixed Conifer
II	Red Hill	14.3	5500	Marble Fork	Black Oak
III	Last Hill	16.8	6340	Marble Fork	Mixed Conifer
III	Wolverton Cr.	20.2	6920	Marble Fork	Mixed Conifer
III	Lodgepole	21.0	6800	Marble Fork	Mixed Conifer
III	Red Fir	23.9	7060	Kaweah drainage	Mixed Conifer
IV	Halstead Cr. #1	24.8	7080	Kaweah drainage	White Fir
IV	Halstead Cr. #2	24.9	7070	Kaweah drainage	White Fir

Table 15. Existing Vistas in Sequoia and Kings Canyon National Parks

Vegetation Unit	Vista Name	Mileage from Ash Mtn. Ent.	Elev. (ft)	Description	Veg. Type
III	Little Baldy #1	27.5	7160	Kaweah drainage	Mixed Conifer
III	Little Baldy #2	27.7	7160	Kaweah drainage	Mixed Conifer
III	Little Baldy #3	27.9	7260	Kaweah drainage	Mixed Conifer
IV	Big Baldy (USFS)	39.4	7560	Kaweah drainage	White Fir
IV	Kings Cyn. Overlook (USFS)	41.6	7130	Kings drainage	White Fir
III	Redwood Mtn. Overlook	44.7	6560	Redwood Mountain	Mixed Conifer
III	Park Ridge	45.5	6650	Redwood Mountain	Mixed Conifer
IV	Panoramic Point	49.6	7400	Kaweah drainage	White Fir
III	Bikini Beach	73.6	4660	Kings River	Mixed Conifer
II	Moraine	75.6	4800	Kings drainage	Ponderosa Pine

-- allow for the disposal from the road surface of plowed snow;

-- provide for the safety of the motoring public, i.e., sight distances;

-- protect park wildlife by removing vegetation, thereby allowing motorists to see wildlife before it reaches the road surface and becomes a statistic;

-- improve the aesthetic experience available to the park visitor by reducing visual impacts that result from dense roadside thickets.

(g) All roadside vegetation manipulation will be done under the direct supervision of a permanent member of these Parks maintenance force, who is fully familiar with the standards.

2. Plant Propagation, Revegetation, and Landscaping

a. Management Objectives

(1) Artificially revegetate construction sites and developed areas where human impact impedes natural regenerative processes.

(2) Landscape areas within the Development Zone when required.

b. Overview

The natural species composition and age structure of plant communities in developed areas has often been altered by heavy human impact and/or construction and hazard tree removal activities. In most of these areas there is little or no natural regeneration of vegetation.

Regeneration problems in the Development Zone are caused by denuding of areas by construction activities and by foot and vehicular traffic. Table 16 lists various types of regeneration problems in developed areas of the parks.

Table 16. Representative Types of Regeneration Problems Existing in Various Developed Areas

Site Type	Problems	Examples
1. Construction sites	Denuding of areas by excavation, grading, and related operation of heavy equipment has removed native vegetation.	Recently constructed complexes at Cedar Grove and those proposed for Lodgepole, Clover Creek and Grant Grove
2. Established visitor service and motel complexes.	Subsequent to construction damage, foot traffic has prevented establishment of seedlings.	Visitor centers, parking areas, motel areas, etc.
3. Established campgrounds	Subsequent to construction damage, foot and vehicle traffic has prevented establishment of seedlings.	All campgrounds
4. Roadside cuts and fills	Steep, exposed banks have resulted in unnatural drainage patterns and erosion, making seedling survival impossible.	Many areas between Ash Mountain and Giant Forest
5. Abandoned areas	Excavation and grading have resulted in unnatural drainage patterns and erosion, making seedling survival impossible.	Unused dumps and borrow pits at Wolverton, Cedar Grove, etc.
6. Residential areas	Manipulation of vegetation and competition with exotic species, plus foot traffic has suppressed native flora.	Ash Mountain, Grant Grove, Lodgepole, Cedar Grove

The management policies for revegetation and landscaping in the Development Zones depend on the following assumptions:

(1) Developed areas can be manually revegetated in order to more closely resemble the structure of their former, undisturbed state. This can be done by growing and planting, or transplanting, in representative numbers and species, the trees and shrubs endemic to these areas.

(2) An increased number and variety of trees and shrubs in the developed areas will increase the quality of the park visitors' recreational and aesthetic experience by providing increased privacy and shading, and by increasing wildlife habitat.

c. Management Policies

(1) Plant communities in the developed areas will be maintained as close as possible to natural species composition and age structure. This will be accomplished in part through an active plant propagation and revegetation program.

(2) In areas of known insect or disease infestations/infections, plant species not affected by these infestations/infections may be planted.

(3) Only native species will be planted. Seed, seedlings, or plants to be used in revegetation/landscaping projects will always be obtained from sources in the same watershed as the project. This will ensure maintenance of undiluted "wildling" genotypes of the species involved.

(4) A plant nursery will be operated to provide a source of native species for revegetation projects. This plant nursery will be supplemented by contract growing of seedlings by private, U.S. Forest Service, or other agency nurseries. In any situation where soil, seed, seedling, or larger transplants

are procured, every effort will be made to minimize the impact on the ecological processes of that plant community into which the transplants are removed.

(5) On all new construction sites, soil and plants will be removed where practical and stockpiled for reuse upon project completion. Subsequent revegetation of these sites will closely follow the recommendations of the National Park Service landscape architect from the Denver Service Center, and will be completed before the next growing season.

(6) All revegetation projects will be undertaken so as to ensure the survival of all plantings. Plants only of sufficient size to resist foot traffic will be used. For example, ideally conifers at least three feet in height should be planted. Aggregation plantings would create natural barricades and provide screening.

(7) All revegetation projects will be monitored and maintained subsequent to completion to ensure the survival of all plants to achieve the desired effects. Photo points will be established as needed.

3. Prescribed Fire Management

a. Management Objective

Utilize prescribed burns to reduce hazardous fuels only in preselected areas within the Development Zone.

b. Overview

The general policy of natural resources management in the National Park Service (National Park Service, 1978) states that process management and not object management is the rule. Since most of the species in these Parks, including those in developed areas, are fire-dependent, biotic management cannot be done without the presence of fire or at least a mimicry of its effects.

In the latter case, if fire cannot be used as an agent to promote germination, stand thinning, or fuel removal, then these effects must be achieved manually. In either method, it is recognized that the ecosystem is constantly changing and cycling, and good management requires that this be allowed to occur, even in developed areas.

c. Management Policies

Prescribed burning will be used minimally within developed areas (exceptions being reduction of flashier fuel types such as annual grass at Ash Mountain). Fire will be used as a tool, however, around the perimeter of developed areas to create and maintain buffer zones of reduced fuel loading to prevent spread of wildfire into or out of developments. The use of prescribed burning in and around any developed areas will be in such a manner so as to minimize adverse impacts to visitor enjoyment.

4. Restoration of Giant Sequoia Groves

Big Stump, Giant Forest, Grant Grove, Lost Grove, and Atwell Mill are the only giant sequoia groves that occur in the Developmental Zone. Fire is the primary means for restoring these groves to natural conditions. The Fire Management Plan discusses the objectives, policies, and actions for these areas.

Certain areas within the above groves are the most visited sites within Sequoia and Kings Canyon National Parks. These areas are designated as Special Management Areas (SMA's) and will be managed differently than the rest of Big Stump, Giant Forest, Grant Grove, Lost Grove, and Atwell Mill. These areas, formerly known as "Showcase Areas," are areas where maintenance of natural processes is guided more by scenic concerns. According to Christensen et al. (1987) ecological concerns are not to be neglected in designated showcase areas.

a. Management Objectives

(1) Big Stump, Grant Grove, Giant Forest, Lost Grove, and Atwell Mill sequoia groves:

Restore or maintain natural fire regime to the maximum extent possible so that the natural ecosystems can operate essentionally unimpaired by human interference.

(2) Special Management Areas (Landscape Management SMA's):

- General Grant Tree and Walk: Create and maintain an open and park-like environment similar to that which existed prior to interference by European man so as to provide an aesthetically pleasing and meaningful experience for the park visitor.

- Other Landscape Management SMA's (General Sherman Tree and Congress Trail, Tharp's Log, Generals Highway (selected points), Giant Forest, Lost Grove, Grant Grove, Crescent Meadow Road (selected points), Crescent Meadow Loop Trail, Hazelwood Nature Trail and Round Meadow--Trail for All People:

  Balance the dynamic character of these areas with the need to perpetuate the scenic resources and to enhance visitor appreciation and understanding of the giant sequoia ecosystem.

b. Overview

Big Stump, Grant Grove, Giant Forest, Lost Grove, and Atwell Mill, are covered by a mixture of giant sequoia, white fir, Jeffrey, and sugar pine. These areas correspond generally to fire management areas 19 (4,432 acres), 11 (3,000 acres), and 5 (806 acre-grove only) respectively. The presettlement character of these areas was influenced by a combination of lightning and Indian fires. Fire suppression has resulted in changes to species composition and structure and the accumulation of hazardous amounts of fuel.

From 1979-1986, 437 acres in Grant Grove and 650 acres in Giant Forest have been prescribed burned. This began a general management trend to restore or maintain the natural range of fire

behavior and effects (i.e., the fire regime) to the maximum extent possible so that the natural ecosystems can operate essentially unimpaired by human interference.

While physical manipulation, such as cutting, piling, and burning unnaturally dense thickets of shade-tolerant species and planting of fire-dependent species such as sequoia may be used in Special Management Areas, fire will be the primary tool used to restore the natural forest composition and structure.

The vegetation in the General Grant Tree area has been heavily manipulated since white man discovered the trees around 1862. About 1868, the Gamlins began felling trees to construct a cabin, and the Centennial Tree was felled in 1875. Cattle grazing occurred until the Park was fenced in 1901. About the same time, clearing and burning of forest litter and underbrush took place. In 1904-1905, approximately 1,600 sequoia seedlings which had germinated in the burned areas were transplanted. More recently, many diseased and dead tree hazards, plus over 700 suppressed seedlings and saplings, were removed from the Grove to provide for public safety, reduce the fire hazard, and attempt to counteract the effects of almost 90 years of fire suppression.

c. Management Policies

(1) Big Stump, Grant Grove, Giant Forest, Lost Grove, and Atwell Mill giant sequoia groves.

The areas of these groves outside the Special Management Areas will be managed according to the objectives and policies identified in the Fire Management Plan.

(2) Landscape Management SMA's.

(a) General Grant Tree and Walk.

The following policies are from the Vegetation Management Plan for the

Grant Tree area, Kings Canyon National Parks (Warner, 1980.)

1) Vistas identified in historical photographs will be reestablished and maintained. No new vistas will be created, however.

   -- To be considered for removal, trees (other than sequoias) must meet two criteria: 1) be blocking an historic vista, and; 2) be less than 90 years old (Warner, 1980.) Sequoias, in addition to the first requirement, must be 75 to 80 years old (in 1980), indicating that they were probably among those transplanted in 1904-1905.

   -- Felled trees less than 10 inches dbh will be bucked, piled, and burned on site. Larger trees will be removed from the area. All stumps will be flushed below ground level and those of living or recently dead and that are greater than six inches in diameter will be treated with borax (sodium tetraborate decahydrate) to retard innoculation by Fomes annosus.

   -- Trees partially blocking vistas may be pruned.

2) High priority (6 and 7) hazardous trees will be removed.

   The area will be resurveyed on a minimum of a three year schedule. Stumps will be flush cut and treated with borax as above. Logs will be removed to the natural break and limbs either lopped and scattered, chipped, or piled and

burned (or transported to a suitable site for burning).

3) Duff, litter, limbs and other natural forest debris will be scattered around named sequoia trees as required to retard erosion and deter visitor impact on or around the trees. This material will be gathered from the periphery of the project area but will be done in such a manner so as not to detract from the aesthetic or environmental quality of the "borrow" site.

4) Future disturbance, such as the removal of sewer lines, major trail realignment, etc., around the Grant Tree will be avoided.

5) The water diversion along the portion of the former road (present trail) northwest of the Tennessee Tree will be removed and the original drainage restored.

6) The old roadbed which joins the present trail just northwest of the Tennessee Tree will be restored to a more natural condition in an attempt to promote natural revegetation.

7) Low intensity (<200 BTU/ft/sec) prescribed burns will be used in the project area within delineated burn units according to prescriptions contained in the aforementioned plan. While reintroduction of fire as a natural process is the overall objective, specific objectives include: maintaining fuel loadings at natural levels, regulating stand density and species composition by thinning shade tolerant understories and promoting regeneration of intolerant

species, especially in openings; increasing the quantity and improving the vigor of brush species which serve as habitat and browse for wildlife. In all cases, extreme care will be exercised to: keep scorch height to the prescribed minimum; protect all fire-scarred sequoias, man-made objects, and historical landmarks from damage, and; provide for visitor safety. The prescribed burning interval will be ten to twenty years to approximate the natural interval.

(b) Other Landscape Management SMA's

A plan will be developed for each of the Landscape Management SMA's listed below.

- General Sherman Tree and Congress Trail.
- Tharp's Log
- Generals Highway (selected points in Giant Forest, Lost Grove, and Grant Grove)
- Crescent Meadow Road (selected points)
- Crescent Meadow - Tharp's Log Trail
- Crescent Meadow Loop Trail
- Hazelwood Nature Trail
- Round Meadow - Trail for All People

The plans will be developed through an intedisciplinary team composed of interpreters, natural resource managers, scientists and landscape architects. The plans will identify objectives, policies, and specific actions for each area. A variety of techniques, such as prescribed burning, cutting and removal of vegetation and planting of certain species may be used. Further dis-

cussion of Special Management Areas is in Appendix L of the Fire Management Plan.

5. Maintenance of Native Plant Species

a. Management Objective

Reestablish and maintain native plant species composition.

b. Overview

(1) Sensitive Plant Species

A sensitive plant species is one which is either listed as or is a candidate for threatened or endangered status (Category 1 and 2) by the U.S. Fish and Wildlife Service or one which is suspected of being rare or unique to these Parks. A recent inventory (Norris and Brennan, 1981 and 1982) and Norris (1984) originally identified 19 such species in these Parks. Only six (Table 17) of these are now considered sensitive. One of these species (Eriogonum nudum var. marinum) is located in the Development Zone of these Parks. Eriogonum nudum var. marinum is a candidate for federal status. There are two known populations of this species in the Developed Zone. Habitat and location descriptions appear in the appropriate vegetation management units sections. For more complete details, see Norris and Brennan (1981 and 1982) and Norris (1984).

The most serious threats to these populations consist of activities associated with road, trail, and utilities maintenance projects. Scraping, dumping, right-of-way clearing, and spraying, grading, trail brushing, and utility maintenance/repair are potentially the most damaging impacts which will require mitigating action in the vicinity of these problems.

While recognizing that candidate species have no legal status or protection under

Table 17 Sequoia and Kings Canyon National Parks
Sensitive Plant Species

	Potential Impacts						Management Required				
	Roads	Trails	Construction	Utilities	Stock	Fire	Monitor Impacts	Protection	Expand Searches	Further Researches	Administration Record-keeping
Astragalus ravenii		*					*		*		*
Erigeron aequifolius									*		*
Eriogonum nudum var. marinum	*	*		*		*	*	*		*	*
Lupinus culbertsonii ssp. culbertsonii									*		*
Oreonana purpurascens					*		*	*	*		*
Mimulus Norrisii				*							*

the Endangered Species Act of 1973, a recent administrative policy statement (Chapman, 1981) reminded parks of their responsibility according to Park Service management policies (National Park Service 1978) which require that all "threatened and endangered" species and their "critical habitat" be identified and managed to perpetuate both their natural distribution and abundance. This includes restricting visitor use and access if necessary. Also, species "rare or unique to a park" are to be identified and their distribution mapped. Management actions similarly include provisions to protect and perpetuate those species.

(2) Exotic Plant Species

While no formal, comprehensive survey has been conducted for exotic plant species, at least 131 are known to exist (Norris, 1984.) Species such as filaree (Erodium spp.), wild oats (Avena fatua), soft chess (Bromus mollis), and burr clover (Medicago hispida) are abundant in the chaparral/oak-woodland, where they became established following introduction by European domestic stock. Others, such as Scotch thistle (Onopordum acanthium) foxglove (Digitalis purpurea) and common mullein (Verbascum thaspus) have more recently become locally established.

Many exotic species have been planted at administrative/residential sites within these Parks. It has been suggested (Graber, 1981) that this not only contradicts NPS management policies, but also is a misrepresentation of the native flora. Preliminary contacts have been made to enlist the services of individuals experienced in landscaping with native plants so that a revegetation project might be undertaken around the Ash Mountain Headquarters.

c. Management Policies

(1) The status of all sensitive (threatened, endangered, and locally rare) as well as exotic plant species in these Parks will be determined.

(2) Programs to protect and enhance native species (with particular emphasis on those identified as sensitive) will be developed and implemented.

(3) Destruction of populations or individuals of sensitive plant species or alteration of habitat by construction, maintenance, prescribed burning or other management activities will be prevented.

(4) Research into habitat requirements and response to burning and other disturbance of selected sensitive plant species will be conducted.

(5) Exotic plant species, wherever feasible, will be selectively removed or controlled.

(6) Exotic ornamentals will not be used at adminstrative sites within these Parks. Instead, transplants from formerly disturbed sites or seedlings grown from native seed collected in these Parks will be used. Existing exotic plants in these developed sites will gradually be replaced as seedlings or transplants become available. However, no new exotics will be planted in these areas.

(7) Exotic ornamentals will be removed from former developed sites, which will be either revegetated with native species or prepared as suitable seedbed for natural seeding.

(8) All landscape management plans for new developments and Special Management Areas will be reviewed to ensure that native plant species from the local area are used.

V. VEGETATION MANAGEMENT ACTIONS

This section discusses specific practices (actions) that will be accomplished to achieve vegetation management objectives within the constraints of management policies. The actions are grouped by vegetation management activity.

A. Vegetation Removal Program

1. All Units (Hazard Tree Removal)

a. A hazard tree survey for all Units will be done according to the schedule in Table 18. Responsibility: Forester.

b. Hazard trees and limbs will be removed from all Units according to the schedule in Table 18. Responsibility: Forestry Foreman.

c. Stocking levels and thinning requirements using basal area control will be determined for all Units according to the schedule in Table 19. Responsibility: Forester.

d. Firewood and timber sales will be conducted in all Units, as appropriate, according to the policies identified in Appendix K. Responsibility: Forester (Timber sales), Forestry Foreman, and Clerk Typist (Firewood sales).

e. Vistas in all Units will be cleared according to a schedule to be developed. This schedule will be coordinated with the Federal Highway Program of rehabilitating all park roads.

Table 18. Schedule for Hazard Tree Surveys and Removal Operations, 1987-1989.

Site	Year to be Surveyed	Year to be Worked
Giant Forest Village*	1989	1989
Camp Kaweah*	1989	1989
Giant Forest Lodge*	1989	1989
Highlands	1988	1988
Pinewood	1988	1988
Sherman Tree	1987	1987
Moro Rock	1988	1988
Crescent Meadow	1987	1987
Wolverton	1987	1987
Lodgepole Campground	1987	1987
Lodgepole Maintenance/ Residential Area*	1987	1987
Atwell Mill	1989	1989
Cabin Cove	1989	1989
Silver City (NPS)	1989	1989
West Mineral King	1989	1989
East Mineral King	1989	1989
Cold Springs Campground	1989	1989
Lewis Creek Residential Area	1989	1989
Sheep Creek Campground	1987	1987
Sentinel Campground	1987	1987

*Year-round occupancy--surveyed yearly.

Table 18. Schedule for Hazard Tree Surveys and Removal Operations, 1987-1989.

Site	Year to be Surveyed	Year to be Worked
Canyon View Campground	1987	1987
Moraine Campground	1987	1987
Cedar Grove Village	1988	1988
Cedar Grove Pack Station	1988	1988
Cedar Grove NPS Maintenance/ Residential Area	1988	1988
Cedar Grove NPS Corrals	1988	1988
Zumwalt Meadow	1988	1988
Road's End	1988	1988
Red Fir Heliport	1988	1988
Halstead Meadow Picnic Area	1989	1989
Dorst Campground	1988	1988
Cabin Creek	1989	1989
Lost Grove	1989	1989
South Fork Campground	1989	1989
Ash Mountain Headquarters/ Residential Area*	1988	1988
Ash Mountain Heliport	1988	1988
Buckeye Residential Area*	1988	1988
Potwisha Campground	1988	1988
Hospital Rock Picnic Area	1988	1988
Buckeye Flat Campground	1988	1988

*Year-round occupancy--surveyed yearly.

Table 18. Schedule for Hazard Tree Surveys and Removal Operations, 1987-1989.

Site	Year to be Surveyed	Year to be Worked
Crystal Cave	1987	1987
Grant Grove NPS Maintenance/ Residential Area*	1987	1987
Grant Grove Concessions Area*	1988	1988
Sunset Campground	1987	1987
Azalea Campground	1987	1987
Columbine Picnic Area	1987	1987
Swale Campground	1987	1987
Grant Tree	1988	1988
Corrals	1988	1988
Crystal Springs Campground	1987	1987
Cedar Springs	1988	1988
Wilsonia (NPS)*	1988	1988
Big Stump	1988	1988
Redwood Saddle Cabin	1989	1989

*Year-round occupancy--surveyed yearly.
Cycle will start over in 1990.

Table 19. Proposed Schedule for Determination or Current Stocking Levels and Thinning Requirements.

Site	Year
Cedar Grove	
Sheep Creek Campground	1988
Sentinel Campground	1990
Canyon View Campground	1992
Moraine Campground	1992
Dorst Campground	1994
Lodgepole Campground	1996
Grant Grove	
Sunset Campground	1998
Azalea Campground	2000
Crystal Springs Campground	2002

2. Unit II - Ponderosa Pine

   a. Monitoring control plots will be established to assess the effect of the dwarf mistletoe control project at Cedar Grove.
   Responsibility: Forester.

   b. Insect and disease surveillance will be carried out in all developed areas in Unit II annually in the spring and fall.
   Responsibility: Forester.

3. Unit V - Red Fir/White Fir

   a. A hazard tree survey will be made of the new Clover Creek developed area. All trees that will become hazards after construction will be cruised and removed by a contractor.
   Responsibility: Forester.

B. Plant Propagation, Revegetation, and Landscaping

1. Unit I - Chaparral/Oak Woodland

   a. A landscape management plan will be developed for the Ash Mountain area that will include removal of exotic/ornamental plants and replacement with native plants. Implementation of the Plan will begin after completion of the nursery.
   Responsibility: Forester.

   b. A plant nursery will be operated at Ash Mountain. The purpose is to provide native plants for revegetating and landscaping new developed areas in these Parks.
   Responsibility: Forester.

2. Units III, IV, and V

   a. Landscape management plans for new park developments prepared by the Denver Service Center will be implemented as follows:

	Tentative Date for Completion
(1) Lodgepole Market	1988

(2) Clover Creek/Red Fir 1992

(3) Grant Grove 1994

Responsibility: Forester

b. A plan to restore the Giant Forest area once buildings are removed by 1991 will be developed and implemented.
Responsibility: Denver Service Center and Forester.

C. Prescribed Fire Management

1. Unit I - Chaparral/Oak Woodland

a. Fuel reduction prescribed burns will be conducted in the Ash Mountain developed area annually in the late spring/early summer.
Responsibility: Fire Management Officer.

2. All Other Units

a. Debris from vegetation removal programs will be burned in piles at designated sites.
Responsibility: Forestry Foreman.

b. Prescribed Burns in and near all units will be done in accordance with the Fire Management Plan.
Responsibility: Environmental Specialist/Fire Management Officer.

D. Restoration of Giant Sequoia Groves

1. Unit IV - Sequoia Mixed-Conifer

a. Landscape management plans will be developed for each of the Landscape Management SMA's.
Responsibility: Chief of Resources Management.

E. Management of Native Plant Species

1. Sensitive plants listed for Units I, III, and IV in Section II will be monitored annually to ensure their perpetuation.
Responsibility: Forester.

2. An exotic plant survey will be made of all units starting with Unit I.
   Responsibility: Forester.

3. If exotic plants present a threat to native vegetation in the developed areas, plans for their control or elimination will be prepared.
   Responsibility: Forester.

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VII. APPENDICES

Appendix A - Determination of Maximum Allowable Accident/Failure Rates as Bases for Establishment of Administrative Goal/Safety Standards. 1/

$$r_d = \frac{10^7}{n} \Sigma\left[\frac{h_{nd}}{v}\right] = \frac{10^7}{17} \left[0.00001992\right] = \frac{199}{17} = \boxed{11.7} \text{ accidents/year/}10^7 \text{ visitor-days}$$

$$r_c = \frac{10^7}{n} \Sigma\left[\frac{h}{v}\right] = \frac{548}{17} = \boxed{32.2} \text{ accidents/year/}10^7 \text{ visitor-days}$$

$$h_{max} = \frac{gv_e}{10,000,000} = \frac{(20)(2,700,000)}{10,000,000} = \boxed{5.4} \text{ accidents/year}$$

$$h = a + b\left[\frac{fv}{s}\right]$$

$$a = \frac{\Sigma h - b\Sigma\left[\frac{fv}{s}\right]}{n} = 143 - \frac{(0.000086900)(1,607,781)}{17}$$

$$= \frac{143 - 140}{17} = \boxed{0.176}$$

$$b = \frac{n\Sigma\left[\frac{fvh}{s}\right] - \left[\Sigma\frac{fv}{s}\right]\left[\Sigma h\right]}{n\Sigma\left[\frac{fv}{s}\right]^2 - \left[\Sigma\frac{fv}{s}\right]^2}$$

$$= \frac{(17)(19,472,884) - (1,607,781)(143)}{(17)(220,509,683,484) - (1,607,781)^2} = \boxed{0,000086900}$$

$$f_{max} = \frac{S_e\ (h_{max} - a)}{bv_e} = \frac{(5.4 - (0.176))}{(0.000086900)(2,700,000)} = \boxed{19} \text{ failures/year}$$

1/ Based on: Paine, Lee A., 1973. Administrative goals and safety standards for hazard control on forested recreation sites, USDA Forest Service Research Paper PSW-88. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 13 p.

Definitions:

r_d = minimum possible accident rate (based on annual number of nondefective accident-failures)

h_{nd} = nondefective accident-failures per year

r_c = current accident rate (based on total--defective and nondefective--failures)

n = number of years of data

v = number of annual visitor-days [1/]

s = area (acres)

h = total accident-failures per year

h_{max} = maximum allowable accident-failures per year

v_e = estimated visitor-days for coming year

g = allowable number of accidents for 10 million visitor-days

f = total number of failures per year

v/s = target density (visitor days per year ÷ area)

1/ Visitor Hours (from Monthly Public Use Report"--Chief Park Ranger's Office) divided by 24.

Appendix B - Guidelines for Minimizing Impact to Vegetation from Park Development

A. Introduction

Damage to residual trees associated with construction and stand management activities is one of the two main factors (along with site selection) which can be mitigated before, during, and after construction activities. Damage results in: outright mortality; decay associated with mechanical wounds and broken tops; spread of root and butt rots; loss of aesthetic value; and increased tree hazard to persons and property.

Conditions affecting damage include the skill and conscientiousness of the contractor; steepness of the slopes; stand density; time of year; size and type of equipment; and species of tree.

Factors which affect the extent of decay associated with wounds are: species; size of wound; smoothness of wound; proximity to ground; and environmental conditions.

B. Mitigating Actions

1. Allow for in-Park review by Natural Resources Management personnel of design and development plans in terms of mitigating vegetation impact. This would include a resources management person to assist the District Ranger in assessing impacts to vegetation.

2. Establish minimum pre-construction, construction, and post-construction standards.

3. Define responsibilities for overseeing compliance to standards designed to prevent tree and vegetation damage.

4. Incorporate penalties into contracts for violation of established minimum standards.

5. Design road, utility, and structural layout to minimize soil displacement and take advantage of natural drainage patterns; trenching should be kept as far as possible from tree trunks, preferably outside of the dripline.

6. Restrict season; do not work in spring or early summer as trees are actively growing and more prone to wounding; and injured trees are more susceptible to bark beetle attack during this time of year.

7. Log site prior to development to reduce stocking and to remove hazardous, unthrifty, damaged, and insect-infested and/or disease-infected tree; favor younger trees and strive for species diversity.

8. Match equipment to size of job and site; restrict tracked vehicles to slopes less than 35 percent; low ground pressure equipment should be used on clay or saturated soils.

9. Mark "leave" instead of "cut" trees.

10. Plan skid trails and temporary roads--eight feet wider than vehicle and no sharp turns.

11. Logging practices to minimize damage include: a) logging skid trails first; b) cutting low(3-4 inch) stumps; c) use directional falling (fall to lead); d) limb and top trees prior to skidding; e) flush limbs; f) treat stumps with borax and burn exposed roots to retard spread of Fomes annosus; g) dispose of pine slash within six weeks of creation; h) remove hardwood stumps to prevent build-up of oak root fungus.

12. Remove trees whose roots are paved over or significantly damaged.

13. Avoid altering grade and undermining root systems; minimize soil compaction.

14. Consider use of protective chemical sprays to prevent bark beetle and borer attacks to injured high value pines.

15. Avoid removing more than one half of live crowns of trees which are limbed.

16. Do not use trees to hang utilities and hardware.

17. Use only native species of local source for seed or planting stock for revegetation.

Sources:

Aho, P., G. Fiddler and G. Filip. 1981. Reducing injuries to residual trees during stand management entries. U.S. Forest Service, Pacific Northwest Forest and Range Experimental Station.

Hunt, R.H., D.H. Adams, B. Rottgering and C.S. Koehler. 1982. Guidelines for developing ordinances in urban forests. California Department of Forestry, U.S. Forest Service and University of California Cooperative Extension. 7 p.

Appendix C - Hazard Tree Rating System

Hazard is a function of the probability of tree failure:

A. The probability of target impact,

B. The damage potential, and

C. The target value.

Hazard rating is the product based on these factors. For human occupancy, the rating provides an estimate of expected loss biased in favor of the recreationist. For fixed property, the hazard rating provides a direct estimate of the expected dollar loss during the current inspection cycle if the hazard is not reduced (Paine, 1971).

The hazardous tree rating system used in these Parks comprises two basic elements. One relates to the tree itself, i.e., the condition and relative degree of chance of imminent failure. There are three degrees, numbered 1-3, with 3 representing the highest chance for imminent failure. Assessment of a value depends upon many factors, such as the effects of the various pathogens on the structural soundness of trees, including roots, base, bole and limbs. Other considerations may be mechanical structural defects such as damage from lightning, heavy equipment, etc.

In some cases an additional value point may be added if a tree exhibits an unusually severe lean. As an example, a tree affected by a pathogen causing extensive rot of the main bole and which also leaned heavily, would be given a value of 3 for the structural defect and 1 for the lean, with a final value of 4. This value would indicate the chance of imminent failure was of the highest category.

Element number 2 relates to the location and type or extensiveness of damage and/or injury which would probably occur if the tree failed. The values for this element are similarly rated 1-3, with 3 being the highest, i.e., a tree rated 3 under this element could be expected to do extensive damage or cause injury or death upon failure. As an example, a large tree leaning over a cabin or a number of campsites would be rated 3. One on the periphery of a campground leaning away from campsites would be rated as a 1. If it failed, its chance of causing extensive damage and/or injury would be low.

The value for both elements is combined for each tree, and it results in a combined value which is equivalent to the priority for removal. The highest priority is a 7, and a 7 indicates a highly defective leaning tree which will cause extensive damage and/or injury upon failure. The lowest priority which could be assessed is a 2.

Outstanding features of the system used are:

A. When the system is applied by knowledgeable individuals, experience over the years has shown that priority values arrived at for given trees are normally the same, but in any event seldom differ by more than one point. Assessment of priority can be considered reliable.

B. By assigning priorities to individual hazards, funds which may be available may be expended most efficiently. Trees whose failure is most imminent and in failing will cause the most extensive damage and/or injury may be removed first.

Appendix D - Tree Failure Reporting System

The following procedures should be followed in the case of hazardous tree or limb failures.

A. Failure occurring in an area where property damage and/or injury could have occurred but did not.

Action to take: Ranger completes Form PSW-4600-3 plus narrative if required to afford necessary detail. Notify Resources Management of the incident as soon as practicable. Forward completed PSW-4600-3 to Resources Management office. Photographs are helpful. Ranger completing PSW-4600-3 should sign the bottom of the form.

B. Failure occurring where property damage and/or injury results.

1. Ranger notifies Resources Management office immediately.

2. If failure occurs at night, weekend, or holiday, call Dispatch.

3. Dispatch will call one of the following in order:

Forestry Foreman, Castro	561-3131	Three Rivers
Forester, Warner	565-3624	Ash Mountain
Forestry Worker, James	565-3670	Ash Mountain
Chief of Resources Management, Bancroft	561-3166	Three Rivers

4. Ranger will complete Form 10-343 (Case Incident Record), and Form DI-134 (Report of Accident/Incident). Route to Chief Ranger's office through Resources Management Office.

5. Resources Management personnel will complete form PSW-4600-3 and can assist in completion of 10-343 and DI-134, if desired. In addition, they will investigate the incident from the standpoint of technical cause, i.e. pathogen identification, mechanical defects, or "act of God" situations. Conduct a thorough investigation, record all information in case testimony or statements are required by the solicitor or by a resulting civil suit.

6. Ranger will preserve the scene and evidence, when technical assistance from Resources Management is not available. A reasonable time period will be allowed so Resources Management personnel can conduct their part of the investigation.

7. Investigating Ranger will preserve, if possible, the tree and limb sections that fail for later examination. These are invaluable if litigation should result.

8. Natural Resources Management staff will immediately notify these Parks' Tort Claims Officer.

A supply of form PSW-4600-3, revised 6/75, Report of Tree Failure, is available from the Resources Management Office.

A local form, "Individual Hazardous Tree Report" is also available from the Resources Management Office. These are to be supplied to anyone who has a hazardous tree or limb to report. They are, as indicated, reports of individual hazards and are not designed to serve as a survey form. Such forms should be returned to the Resources Management Office and will result in an inspection of the reported hazard and an assessment of priority. They are not to be filled out after a failure. They serve only as a supplement to regular surveys where it is felt a hazard has not been noted by regular surveys.

Appendix E - Cutting and Removal of Vegetation Responsibilities

Responsibilities for cutting and removal of vegetation in the front country and for coordinating this activity between divisions are listed below. Resources Management is responsible for cutting, removing, and disposing of all vegetation in developed areas and roadways of these Parks. Assistance from the Maintenance Division will be needed at times. The following procedures should be adhered to:

A. Resources Management should be contacted whenever trees or limbs either fail or are suspected of being hazardous. They should also be contacted whenever other vegetation needs to be cleaned up or removed.

B. Maintenance should contact Resources Management when assistance is needed in opening areas closed by downed trees. Occasionally during the summer, Resources Management will need help from Maintenance in hazard tree removal. We will seek this help through the appropriate District Maintenance Foreman.

C. On joint projects, such as campground opening, Resources Management will provide tree climbers, boom truck, chipper and operators. Maintenance will provide loader, trucks, and operators.

D. During winter months when our equipment is not available, we will request truck, loader and operators from Maintenance, should hazard trees become a problem.

E. All trees will be bucked into sections, limbed and the stumps flushed contour with the ground. Additionally, logs will be hauled to the nearest dump; limbs will be cut, lopped and scattered, or hauled to the dump; and all stumps will be boraxed to prevent inoculation with Fomes annosus.

F. All sites will be landscaped and rehabilitated as follows:

   1. Skid and tire tracks will be obliterated.

   2. No section of limb will be over 12 inches long and no higher than 12 inches above ground level.

   3. No saw cut tree sections will be left on site. Natural breaks of tree sections are permitted to remain along roadsides--developed sites will receive thorough cleanup.

G. Trees that fall across roads will be removed so that no saw cuts remain. Natural break sections will be left on site as long as road clearance is adequate. All cut material will be hauled to the nearest dump. Limbs will be cut into small lengths and lopped and scattered, chipped, or hauled to the nearest dump.

H. Maintenance will be responsible for roadside vegetation within the road prism. The guidelines for roadside vegetation removal, Appendix E, will be followed. Any large trees that need to be removed will be done under the direction of the Forestry Foreman.

I. No trees will be felled along trails. Only trees that fail naturally will be cut. All trees will be left on site.

Appendix F - Roadside Cutting Guidelines

A. Objectives

The National Park Service shall manipulate or allow the manipulation of vegetation along the right-of-way of maintained roads in these Parks for the purpose of:

1. Protecting the long-term integrity of road surfaces.

2. Allowing for the disposal from the road surface of plowed snow.

3. Providing for the safety of the motoring public, i.e., sight distances.

4. Protecting Park wildlife, by removing vegetation, thereby allowing motorists to see wildlife before it reaches the road surface and becomes a statistic.

5. Improving the aesthetic experience available to the Park visitor by reducing visual impacts that result from dense, roadside thickets.

B. Cutting Guidelines

1. All roadside vegetation manipulation will be done under the direct and frequent supervision of a permanent member of the Parks' maintenance force, who is fully familiar with the standards and goals of this policy statement.

2. All roadside vegetation manipulation will be done under the provisions of the Natural Resources Management Plan: i.e., all vegetation cut with a basal diameter of eight inches or more shall be treated with borax after it is flush cut: smaller stumps will be color treated to make them unobtrusive.

3. All specific distances or widths listed below will be "feathered" or varied, so that roads do not pass through natural vegetation in a "mowed" fashion.

4. On the uphill side of the road, or on cut slopes:

   a. All trees larger than one inch in diameter will be removed from within five feet of the road surface.

b. In the zone commencing five feet from the road edge and continuing to the top of the road cut: leave some larger trees, (i.e., four inches to six inches) on the cut; thin 50 percent of the remaining trees. The idea is to keep a reasonable number of small trees on the cut at all times along with some larger trees. The trees are to be used to stabilize the soil. Shrubs less than five feet tall will be left on the cut. Shrubs on near vertical cuts may have to be removed when they interfere with driver vision or can cause damage to recreational vehicles.

5. On the downhill side of the road, or on fill slopes:

   a. All vegetation growing within three feet of the road surface and larger than one inch in diameter will be cut.

   b. In the zone commencing three feet from the road and ending ten feet from the road, the standards contained in 4b (above) shall be applied.

   c. No vegetation management shall occur more than 10 feet from the road on the downhill side except for visitor driving safety improvement and then only with the concurrence of the District Ranger and Interpreter.

6. When the road passes through level terrain, downhill standards shall apply to both sides.

The intent of accomplishing brushing using these standards is to leave some vegetation on all cut banks, fill slopes, and roadsides. We wish to present a covering along roadsides that will be pleasing to the eye and yet conform to the objectives stated at the beginning of this policy.

Appendix G - Roadside Vista Clearing Standards

A. Trees will be selectively trimmed or removed depending on sizes and distances from road or parking areas.

B. Zone #1: Road surface to 50 feet away (downslope).

Tree Size:

12-14" DBH	Remove 50%
14-18" DBH	Remove 25%
18-24" DBH	Remove 15%
24-56" DBH	Remove 2%

Selective tree trimming will be accomplished by using feather trimming methods so no tree shows definite cutting.

Zone #2: 50-200 feet (downslope).

Tree Size:

12-14" DBH	Remove 40%
14-18" DBH	Remove 35%
18-24" DBH	Remove 20%
24-36" DBH	Remove 20%
36-66" DBH	Remove 2%

Zone #1 trimming methods will be applied here as well. There will be no topping of any large (36-66" DBH) trees within view of the site.

Zone #3: Only 200-300 carefully selected trees will be removed in this zone. Trees that obstruct scenic vistas will be removed only with special management authorization.

The purpose of selective trimming and cutting is to leave some vegetation cover on the ground while opening a "see through" view through standing trees. The objective is to leave trees of different size classes to create a somewhat natural setting. Standing trees will be trimmed so that low limbs do not block scenic vistas, and in such a way that no definite cutting patterns will be visible.

Large trees in Zone #3 have heights of at least 180 feet. These trees will not be topped, nor will they be cut or trimmed leaving the tree with an unnatural or deformed appearance. No man made obstructions or installations will be constructed at or within view of vista sites.

C. Tree Disposals:

1. Trees

Trees 12 inches and larger will be removed from the site. Merchantable material will be hauled to local woodyards or dumps. Wood stock will be sold for lumber or firewood.

2. Limbs

(a) Limbs will be cut so that no material is left on the trunk less than 12 inches above the ground.

(b) Cut limbs will be either piled and burned, lopped and scattered, or chipped.

3. Stumps

(a) All stumps three inches and larger will be flushed with the contour of the ground and slope.

(b) All stumps will be treated with Borax.

(c) Large stumps will be flushed, split, and burned or hauled away from the site.

4. Limb Cuts

(a) All limbs will be cut so that no part protrudes from the tree bole.

(b) No limbs will be left hanging after cutting.

(c) All dead limbs will be removed when selective cutting is in progress.

5. Equipment

All skid trails and vehicle tire marks will be obliterated and the affected area rehabilitated.

Appendix H - Marking Guidelines for Pre-Construction Tree Removal

Excluding vista-clearing, trees to be removed from future park developments fall into one of two categories: 1) those actually located in or immediately adjacent to planned developments (viz. buildings, roads, trails, and parking areas); and 2) those which would pose safety hazards now or in the immediate future if left. The following are the general criteria to be used for marking:

A. Trees, regardless of size, species, defect, or vigor, which are located within the staked perimeter of road prisms, buildings, trails or parking areas. Realignment of roads and other staked developments due to the presence of particular trees will be reserved primarily for especially large, old, high-value specimen trees, vigorous mature trees, or patches of vigorous young growth.

B. Potential high priority hazards based on combination high probability of failure plus high probability of target impact. In true fir, some important indicators of defect include basal scars, nearby occurrence of Fomes annosus and conks of Echinodontium tinctorium.

C. Old-growth trees within and adjacent to identified root-rot centers and in areas of shallow-rooting due to high water table, or thin soil mantle.

D. Old-growth trees which are identified as "high risk" in terms of reduced vigor and expected longevity due to effects of over-maturity and/or disease (dwarf mistletoe) infection.

E. Severely suppressed or intermediate crown class trees which would not respond to release.

F. Residual trees, regardless of size, which would be prone to windthrow due to management-related or existing openings (wind tunnels) in stand.

G. Trees which will unavoidably be or already have been severely damaged by tree-removal/construction activities.

Size (dbh or height) class generalizations will not be utilized solely to decide which trees to remove; trees will be marked on a case-by-case basis. Marking will encompass all trees within a horizontal distance equal to the height of the residual trees. Marking in accordance with these guidelines should ensure protec-

tion of both resource values and public safety. Marking guidelines will be reviewed and implementation evaluated in the field by the U.S. Forest Service (R-5 Forest Pest Management, San Francisco). Actual marking will be under direct supervision of the Park Forester.

Appendix I - Dwarf Mistletoe Control

A. Project Goal

1. Long term: Protection of residual overstory and understory pines in project area through eventual removal of all dwarf mistletoe infection.

2. Immediate: Remove all visible infection except that from some isolated high-value trees.

B. Treatment Objectives

1. Protect regeneration from infection by removing infected overstory trees or pruning infected limbs.

2. Promote vigor and increase longevity of residual trees by pruning infections or removing witches' brooms.

3. Release uninfected or slightly infected trees by removing those more heavily infected.

4. Create buffer strips to prevent spread of infection back into treatment area.

5. Locally favor resistant species.

6. Remove heavily infected portions of stand and regenerate.

C. Treatment Procedures

1. Remove

a. Hawksworth dwarf mistletoe rating (DMR) 5 or 6.

b. DMR 4 with mistletoe in upper 1/3 crown.

c. Bole infected tree if stem diameter is less than 6 inch at point of infection.

d. Infected trees with infection on branches 1 inch or less in diameter, with dwarf mistletoe plants within 6 inches of bole, and with bole less than 6 inches diameter at point of limb attachment. Minimum "safe" distance from bole increases 2 inches for each 1 inch increase in branch diameter. (Safe distance = 2 x diameter + 4)

e. Infected trees with less than 30 percent live crown ratio (LCR) after pruning.

f. Infected trees growing in dense aggregations with uninfected or slightly infected trees.

2. Prune

a. DMR 3 or below (all branches up to and including second whorl above highest visible mistletoe plant).

b. DMR 4 with no mistletoe in upper 1/3 crown (all branches as above).

c. Witches' brooms from large high-value trees if no susceptible trees within range of remaining dwarf mistletoe plants.

D. Project Guidelines

1. All pruning will be flush to bole.

2. Pruning will generally include all lower branches (both healthy and diseased), up to and including second whorl above the highest visible mistletoe plant).

3. "Broom pruning" (removal of witches' brooms only) will be performed on large, high-value trees to increase vigor if no susceptible trees within range (horizontal distance equal to height of highest remaining dwarf mistletoe plant).

4. Stumps of all removed trees will be flushed and those over 2 inches diameter treated immediately with borax to retard inoculation by Fomes annosus root disease.

5. Green limbs and other green slash (up to 6 inches diameter) will be chipped and scattered or burned.

6. Larger green material will be hauled to the dump for burning.

7. Dead limbs will be bucked to maximum 2 foot length and stacked for firewood.

8. Merchantable portions (greater than 6 inches diameter) of removed trees will be bucked to standard lengths with appropriate trim allowance (6 inches per 16 foot log). Standard lengths are even 2 feet increments beginning at 10 feet (minimum merchantable length). Logs should be bucked to longest length capable of being moved by loader. This will vary depending on diameter of log.

9. Assignment of tree ratings/prescribed treatment is responsibility of the Park Forester.

10. Supervision of the project is responsibility of the Forestry Foreman.

E. Marking (all trees marked on north side with 1-1/2 inch diameter numbered aluminum tag.)

1. Remove--blue paint.

2. Prune--yellow flagging.

F. Appendices

1. Hawksworth Dwarf Mistletoe Rating (DMR) System

Step 1 - Divide the live crown vertically into thirds.

Step 2 - Rate each third separately. Each third should be given a rating of 0, 1, or 2.

0 = no visible infections
1 = light infection (1/2 or less of the total number of branches in the third infected)
2 = heavy infection (more than 1/2 of the total branches in the third infected)

Step 3 - Add the rating of each third to obtain a rating for the whole tree.

EXAMPLE

If top third has no visible infections, its rating is (0).
If middle third is lightly infected, its rating is (1).
If bottom third is heavily infected, its rating is (2).
The tree in this example will receive a rating of:
2 + 1 + 0 = 3

Sequoia and Kings Canyon Vegetation Management Plan

Appendix J - Prescriptions for the Parks' Developed Areas

(Being developed)

Appendix K - Timber and Firewood Sales

A. Timber Sales

Merchantable timber derived from construction sites, insect and disease infection areas are felled and prepared for timber sales. Inspections are performed and trees identified for removal. Trees are either cruised and graded and/or scaled to determine the usable volume of board feet for sales. Board foot volumes are submitted to a contracting officer or procurement officer where the timber is advertised for sale. All timber sales are different due to conditions of logs, location and amount of volume for sale.

B. Firewood Sales

The removal of trees identified as being hazardous to human lives or property, and of those that have fallen in such a way that proper use of these Parks is impaired, produces accumulations of wood that is of value as firewood or for other uses. Disposal of such wood is carried out by means that help reduce expenses to the Government.

Firewood may be obtained from within these Parks only with a firewood permit which can be purchased from the Resources Management Office, Ash Mountain Headquarters, Sequoia National Park. The firewood permits will be issued so that the buyer is charged the current fair market value cost (fair market value is currently $10.00 per cord) according to the Harvest Value Schedule printed by the Board of Equalization).

1. Wood Use Priorities

   a. Administrative

      (1) All Government administrative uses including, but not limited to, ranger stations, visitor centers, campfire programs, and tenthouses.

      (2) NPS winter residents above 6,000 feet. These residents will be allowed 12 cords per year (six cords for immediate use and six cords for curing), to assure adequacy of heat source to NPS resident workforce.

(3) Guest Services will be allowed to purchase up to 300 cords, depending on availability, at current fair market value prices. This wood may not be sold outside these Parks, as it is intended for use by visitors in Guest Services administrative functions, and by their in-Park resident work force.

b. Other

(1) All other individuals including National Park Service and Guest Services employees below 6,000 feet may obtain wood to an annual limit of six cords for personal use.

(2) Large lot sales. If the total amount of firewood exceeds the four above needs, the remaining firewood will be sold through large volume sales, the minimum acceptable bid being fair market value.

c. Miscellaneous

(1) The firewood will be placed by the Government in woodyards most convenient to the site of origin (that is, not hauled for the purpose of putting wood in a certain lot).

(2) Firewood will be decked at the following sites: Cedar Grove and Grant Grove dumps, Dorst pit, Wolverton dump, and Atwell Mill dump.

(3) Timber for commercial sale will be decked at the most convenient site of origin. Resources Management will stockpile and mark logs in merchantable lengths for commercial timber sales and in various lengths for firewood. The timber sales and firewood will be segregated and identified, as will the firewood for those employees above 6,000 feet.

2. Firewood Removal Procedures

a. Firewood will be removed from designated woodyards only, and during specific time frames that will be announced. The woodyards will be marked clearly by signing.

b. Firewood will be removed only by persons in possession of a SEKI firewood permit. This permit must be displayed by the permittee when firewood is removed from these Parks and self-validated as soon as the firewood is loaded onto the vehicle.

c. Firewood will be removed during daylight hours only, with daylight being one-half hour after sunrise to one-half hour before sunset.

d. Firewood may be removed seven days a week except on holidays.

e. Chain saws must have spark arresters. The screen hole diameter must have openings no larger than .023 inches.

f. Woodyards will be left uncluttered and bark and slash piled so it can be disposed of. All permittees will be required to clean up their worksites (this includes removing litter, etc.).

g. Care will be taken so that surrounding vegetation will not be damaged. Cutting or collection of any trees other than those placed in the woodyards by the National Park Service is prohibited. Travel off any road or beyond road shoulders or outside the boundary of woodyards is prohibited.

h. Firewood removal vehicles will be loaded with only as much wood as is safe and legal.

i. The firewood permit must be displayed to the entrance station attendee by the permittee when firewood is removed from these Parks.

3. Enforcement of Firewood Procedures

a. All woodyards will be chained and locked during non-daylight hours.

b. Rangers will spot check woodyards and ask to see permits.

c. Road patrols will spot check private vehicles hauling firewood along park highways.

d. Entrance stations will require possession of permits that have been self-validated before firewood can be removed from these Parks.

4. Role of Resources Management/Local Housing Committee Chairpersons

a. Resources Management Division will contact the local Housing Committee Chairperson in each area above 6,000 feet for data concerning volumes of firewood required for priorities. Lower priority sales will occur only if firewood is available after other priorities have been filled.

b. Resources Management will inform the local Housing Committee Chairperson of where the firewood will be located and when it can be removed. The Chairperson will notify the local residents.

c. Resources Management will issue the permits and collect the funds for them, as well as other duties that pertain to the detailed logistics of implementation.

5. Miscellaneous

a. Firewood will not be delivered to private quarters by government vehicles. Government tools and equipment will not be used for personal firewood collection.

6. Firewood Placement/Decking

a. The Forestry Foreman will inform crew and truck drivers of specific locations to unload logs.

b. All log decks will be clearly signed for specific use.

c. Log decks will be no higher than two logs high.

d. All log piles will be placed so no log(s) will be allowed to roll downslope.

e. Volumes of log decks will be conducted as logs are hauled to woodyard sites.

f. Final wood volumes (cords) will be completed by the Forestry Foreman.

g. Firewood sales will be issued through the Parks' Procurement Officer.

h. Woodyards and designated log decks will be placed by Resources Management personnel and coordinated with all District Rangers.