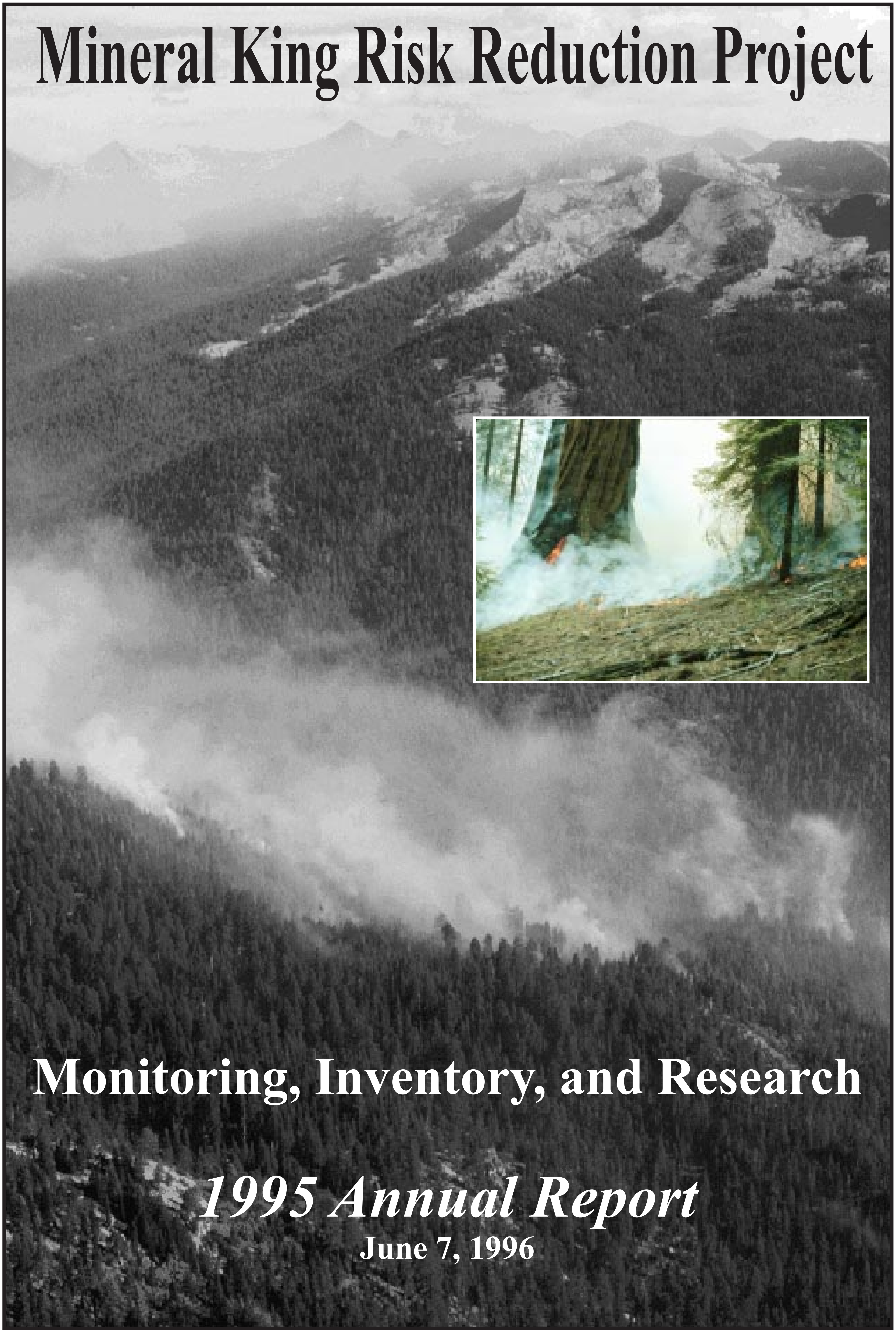
Mineral King Risk Reduction Project



Monitoring, Inventory, and Research

1995 Annual Report

June 7, 1996

Annual Report 1995
Research, Inventory, and Monitoring
Mineral King Risk Reduction Project

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June 7, 1996

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1995 Annual Report - Research, Inventory, and Monitoring: Mineral King Risk Reduction Project

Anthony C. Caprio, Science and Natural Resources Division

Sequoia and Kings Canyon National Parks, California

Executive Summary

The Mineral King Risk Reduction Project (MKRRP) was initiated out of a need to assess the operational requirements and cost effectiveness of large scale prescribed burning for wildland management in a setting altered by a century of fire suppression. The direct objectives of the project will be to initiate the reduction of unnatural fuel accumulations and to begin restoration of ecosystem structure and function within the East Fork watershed. However, because the scale of the prescribed burn project is unprecedented, a number monitoring and research projects were also initiated to assess the impacts and responses to the burn of key attributes of both the watershed and the vegetation. These projects and their results are of critical importance since burning on this scale is a new and untried management strategy with little information existing on either short- or long-term resource impacts and responses. Information from these results will feed back into management planning and permit modification and fine tuning of the burn program in addition to providing information to both the public and policy makers.

Following a major planning effort during the spring of 1995, sampling for the MKRRP was begun in June with the objective of collecting baseline or background data in 1995 prior to the initiation of burning. Several types of vegetation sampling was conducted. Standard fire effects monitoring plots were installed in forest and chaparral sites and new Natural Resource Inventory (NRI) plots were established that supplement existing plots in the watershed. An additional study was begun to look at the relationship between fire-scar development in giant sequoias and local fuel loadings. Extensive fuel inventory sampling was also carried out on the south facing aspect of the drainage which will be used as input to the FARSITE fire spread model. Wildlife studies were conducted with these emphasizing fire effects on small mammal populations, but also addressed questions regarding the effects of burning on mountain beaver colonies and fishers populations, sensitive species located in the watershed. Water related sampling was carried out and monitoring equipment installed that looked at stream chemistry, hydrology, and aquatic macroinvertebrates to obtain data on how these will be affected by the burning program. Lastly, fire history sampling was conducted within the watershed to begin looking at spatial extent and variation of past fire events on a landscape scale.

Projects funded out of the Mineral King Risk Reduction Project include fire effects monitoring, fuel and wildlife inventories, and a study on the relationship between fuel loadings and fire impacts on giant sequoia fire scars. Other projects being conducted using resources from within Sequoia and Kings Canyon National Parks and the Sequoia and Kings Canyon Field Station (National Biological Service) include; natural resource inventory, watershed hydrology, stream chemistry, and fire history. Cooperative research concentrating on aquatic biota in the watershed is also being conducted by the University of California, Davis. Resource and research objectives for 1996 will entail the continuation of most studies that were initiated in 1995. Areas sampled in 1995 will be resampled if they were within the perimeters of the area burned in segment #3 and not already rechecked. New sites to be sampled during 1996 will concentrate on segments scheduled for burning during the summer and fall 1996. These will emphasize fire effects plots, fuel loads, small mammal trapping in new vegetation types, and fire history. Continued sampling will include watershed, and aquatic biota. Resampling of the 1970's Pitcher plots (set up to examine forest structure and fuels in red fir forest) will be given emphasis to acquire these data prior to these plots on the south side of the East Fork being reburned. Two new graduate student studies will also be initiated in the watershed during the summer of 1996. One will use remote sensing data to update vegetation classification for the area and evaluate fuels at a landscape scale while the second will be addressing questions revolving around the means and the landscape-scale consequences of selecting differing mechanisms for restoring forest structure to something near pre-Euroamerican conditions.

I) Project Year Synopsis

Accomplishments for each 1995 project and goals for 1996.

! **Fire Effects Plots -** A total of 15 plots within the Mineral King Risk Reduction Project (MKRRP) area were established during 1995. These include six forest plots (one is a control) and nine brush plots. At least three and probably all five forest plots burned during the burning of segment #3. Two of these have had postburn rechecks completed. During 1996 all burned plots will have postburn rechecks completed and new fire effects plots will be established in segments scheduled for ignition.

! **Giant Sequoia Fire Scars and Fuel Loading -** A total of 60 giant sequoia trees (30 scarred and 30 unscarred) have been measured in the Atwell Grove to help determine effects of prescribed burning on fire scar formation and how changes in fire scars relate to the removal of surrounding fuel accumulations by buring. Sample trees burned during November 1995. Trees and fuels will be resampled during 1996.

! **Natural Resource Inventory -** During the 1995 field season, the NBS's Natural Resource Inventory (NRI) staff participated in the Mineral King Risk Reduction Burn through the establishment of eight permanently marked inventory plots within segment #3, the Atwell Grove area. Plots will be revisited during 1996 to assess burn impacts and first year postburn vegetation response.

! **Wildlife Monitoring -** Two permanent small mammal live-trapping plots were established and sampled during 1995. The plots are located in sequoia/mixed-conifer forest (Atwell) and chaparral/oak shrubland (Traugers). The mid-elevation sequoia plot located in segment #3 burned during November 1995. Serendipity trapping was also carried out at a number of locations. The Atwell plot will be resampled and a third (and possibly a fourth) plot will be established and sampled during 1996.

! **Watershed Sampling: Stream Chemistry and Hydrology -** Potential sampling locations were evaluated and long-term baseline sampling sites selected (sites were chosen that would not burn during 1995 to provide a longer preburn baseline period). Long-term monitoring sites are Trauger's Creek, Deadwood Creek, and the East Fork of the Kaweah (stream chemistry at all three and hydrology at former two only). Stream chemistry has been sampled at regular intervals (weekly) since May 1995 and will continue through 1996.

! **Watershed Sampling: Benthic Macro-Invertebrate Survey -** Six treatment (burn) streams were located and sampled in the East Fork watershed and four non-treatment reference streams in the Middle Fork watershed in September 1995. The Redwood and Atwell Creek sites burned during 1995. Postburn surveys will track biotic impacts and responses.

! **Fire History -** Fire history samples were recovered from throughout much of segment #3 prior to the area burning. These samples will become part of an effort to reconstruct the spatial scale and pattern of pre-European fire events from throughout the East Fork watershed and to provide baseline data on past fire occurrence in variety of habitats, vegetation types, and aspects in the drainage.

! **Fuel Inventory and Monitoring -** Fuel-load sampling during 1995 was concentrated on the south aspect with all but one burn segment on this aspect sampled. A total of 488 plots were sampled within the East Fork watershed. In addition to estimating fuel loads at each plot, additional forest attribute measurements were obtained on tree height, basal area, height to lowest branches, and on litter and duff depths. These will provide input into the FARSITE fire spread model. Field crews will continue fuel sampling (primarily in segment #10) on the south side of the East Fork during 1996.

! **Prescribed Fire Cost-Effectiveness Project -** GIS data was the primary information from the MKRRP provided to this study during 1995. These data included ARC/INFO coverages for various attributes of the East Fork watershed, remote sensing and various type of map data, and information databases associated with the East Fork watershed. Fuels data are also being provided to help drive the NPS FARSITE model simulations that will eventually be a product of the prescribed fire cost-effectiveness project.

! **Data Coordinator -** Contacts were made and meetings coordinated with several graduate students about possible research projects involving the MKRRP. Currently, two students have actively expressed an interested in carrying out studies within the East Fork watershed. Coordination between Fire Management Office (FMO) and field crews was maintained during the burning season. Help was provided to field crews when needed and an effort was made to locate and document past resource or research information, data, or plots sites within the east fork. A bibliography of material related to fire and resource issues in the southern Sierra is being developed. Information and graphics were provided to the Public Information Office (PIO) about resource studies applicable to the MKRRP.

II) Overview of Project

Objectives

The direct objectives of the Mineral King Risk Reduction Project (MKRRP) for Sequoia and Kings Canyon National Parks (SEKI) focus on reducing unnatural fuel accumulations that have resulted from a century of both direct and indirect fire suppression activities in southern Sierrian ecosystems (NPS 1995, Stephenson 1995). In many instances these fuel accumulations create hazardous conditions for visitors, developments, and natural resources. The overall objectives of the project are to assess the operational requirements and cost effectiveness of large scale prescribed burning for wildland management (NPS 1995). The latter evaluation will be accomplished through the use of information derived from the field operations and their outcome within SEKI.

The conditions resulting from unnatural fuel accumulations have resulted in wildland managers being called upon to modify fuels in order to reduce wildland fire hazard and restore ecosystems to some semblance of pre-Euroamerican conditions. Current national management issues are forcing land managers to use two main tools for fuels management: mechanical removal (cutting) and/or prescribed burning. However, both of these tools remain controversial and managers are being asked to justify their choices. These issues motivated a major effort by the National Interagency Fire Center (NIFC) to begin an assessment of the operational requirements and cost effectiveness of using large-scale prescribed burning as a tool in fuels management. As part of this effort NIFC funded Sequoia and Kings Canyon National Parks to carry out a watershed-scale burn program with an objective of prescribed burning about 30,000 acres over a five year period (1995-2000) in the East Fork of the Kaweah River (**Fig. 1**). A collateral objective of the burn project is to evaluate the cost effectiveness of a hazard fuel reduction program of this magnitude by Colorado State University.

Since the scale of the burn project is unprecedented a number of resource related studies are being undertaken and are an integral part of the project. These research, inventory, and monitoring projects in the Mineral King burn are designed to meet the following objectives (Stephenson 1995) :

> ***To supply the information needed to practice adaptive management*** *(1) by determining whether the burn program's objectives are being met, (2) by identifying unexpected consequences of the program on the ecosystem, and (3) if objectives are not being met, by suggesting appropriate program changes.*
>
> ***To provide information for public education, response to public and governmental inquiries, and to document legal compliance.***

These research and monitoring objectives are particularly important because SEKI's watershed scale burn program will be one of the first national attempts at using fire on a watershed scale for fuels management.

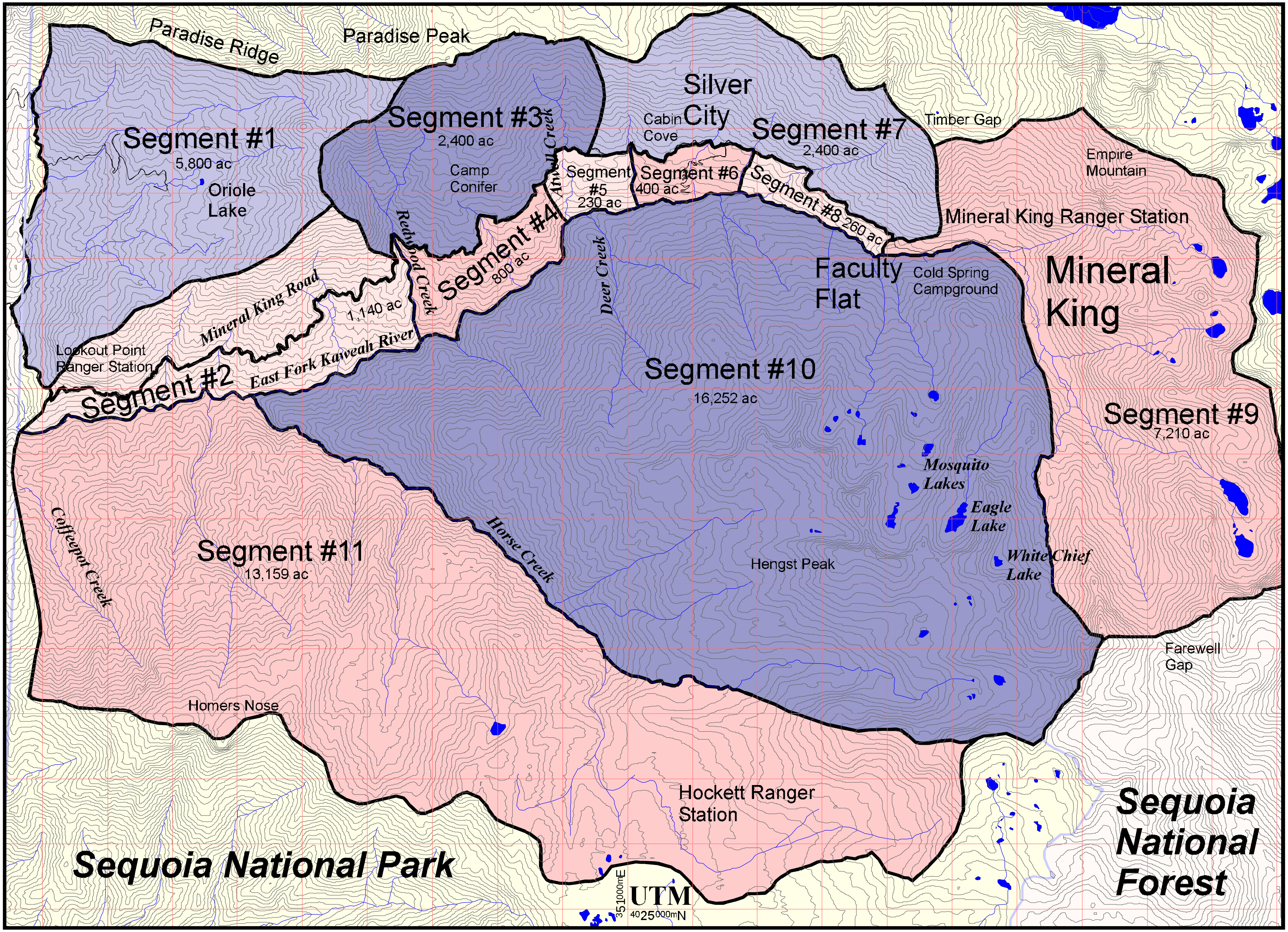

Figure 1.

Mineral King Risk Reduction Project

Project Area and Burn Segments: East Fork Kaweah Watershed

0 1 2 3 Miles

0 1 2 3 Kilometers

N

Based on map compiled 8/95 by S. Murray

Description - East Fork Project Area

The East Fork watershed which encompasses the MKRRP is one of five major drainages comprising the Kaweah River watershed which flow west (historically but is now heavily diverted for agriculture) into the Tulare Lake Basin in the southern Central Valley. Terrain in the watershed is rugged, elevations range from 874 m (2884 ft) to 3767 m (12,432 ft) within the project area. The watershed, 21202 ha (52369 ac) in size, is bounded by Paradise Ridge to the north, the Great Western Divide to the east, and Salt Creek Ridge to the south. Major topographic features of the watershed include the high elevation Mineral King Valley, Hocket Plateau, Horse Creek, the high peaks producing the Great Western Divide, and the Oriole Lake subdrainage (with an unusually low elevation lake for the Sierras at 1700 m elevation).

Vegetation of the area is diverse, varying from foothills chaparral and hardwood forest at lower elevations to alpine vegetation at elevations above 10-11,000 feet (**Fig. 2**). About 80% of the watershed is vegetated with most of the remainder rock outcrops located on steep slopes and at high elevations. Lower elevation grasslands and oak woodland, while common at low elevations in the Kaweah drainage, are uncommon within the park's portion of the East Fork watershed. Sequoia groves within the project area include Atwell, East Fork, Eden, Oriole Lake, Squirrel Creek, New Oriole Lake, Redwood Creek, Coffeepot Canyon, Cahoon Creek, and Horse Creek. Vegetation is dominated by red and white fir forest with pine and foothill types of somewhat lesser importance (**Table 1**). An artificial discontinuity in the vegetation map of the

Vegetation Classification	**Hectares**	**(Acres)**
Foothills Chaparral	1119.2	(2764)
Foothills Hardwoods & Grassland	1432.5	(3538)
Ponderosa Pine Mixed Conifer	1967.7	(728.8)
White Fir Forest	4034.0	(9964.0)
Red Fir Forest	4205.7	(10388.1)
Xeric Pine Forest	1244.4	(3073.7)
Montane Chaparral	483.8	(1195.0)
Mid-Elevation Hardwood Forest	170.0	(419.9)
Lodgepole Pine Forest	966.5	(2387.3)
Subalpine Forest	98.6	(266.2)
Meadow	132.7	(327.8)
Other (primarily water)	100.1	(247.3)
Barren Rock	4197.5	(10367.8)
Missing or No Data	1049.8	(2593.0)

Table 1. Vegetation type classification for the East Fork watershed and the area occupied by each class.

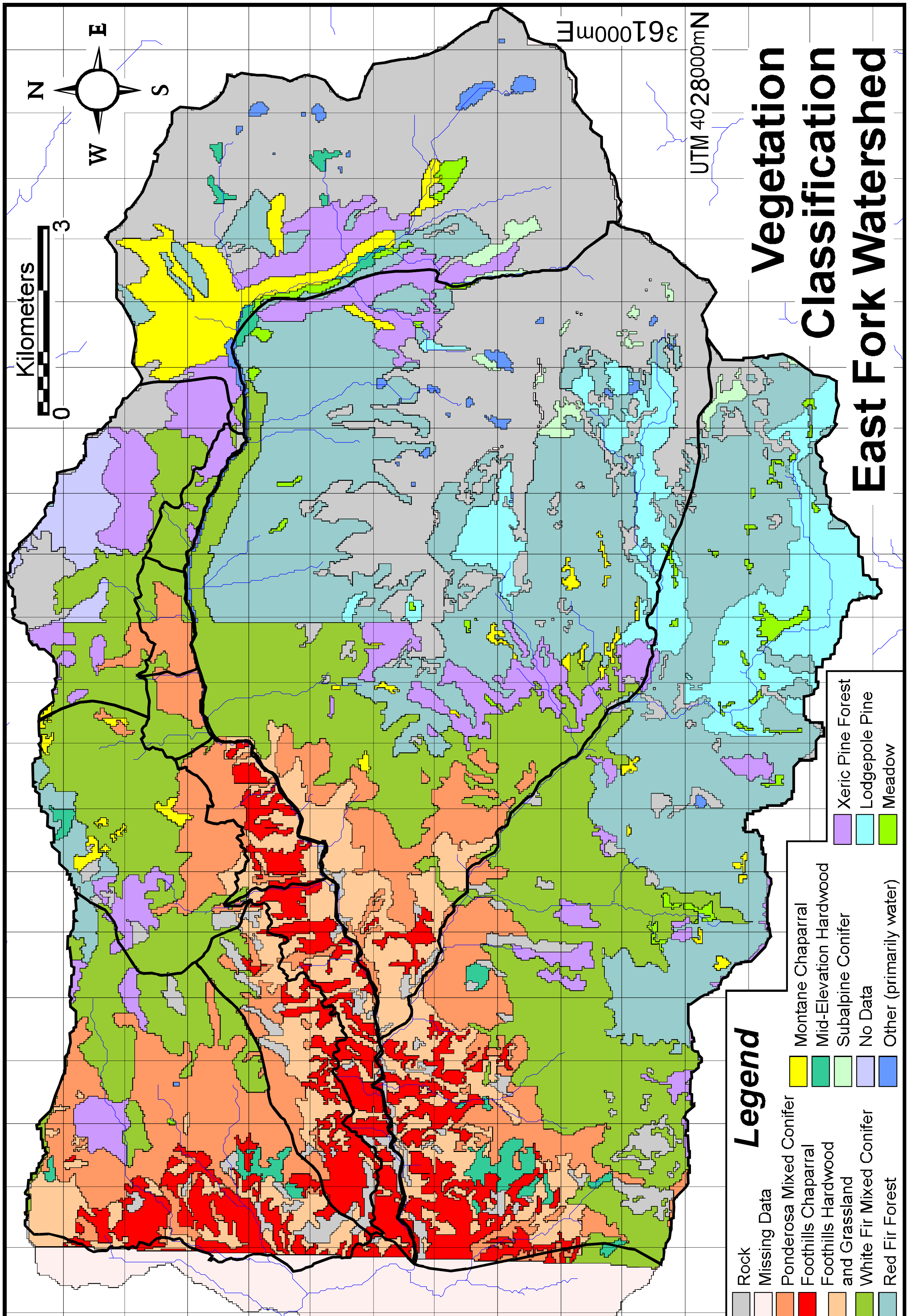
Vegetation Classification East Fork Watershed
Kilometers
0
3
N
E
S
W
UTM 4028000mN
361000mE
Legend
Rock
Missing Data
Ponderosa Mixed Conifer
Foothills Chaparral
Foothills Hardwood and Grassland
White Fir Mixed Conifer
Red Fir Forest
Montane Chaparral
Mid-Elevation Hardwood
Subalpine Conifer
No Data
Other (primarily water)
Xeric Pine Forest
Lodgepole Pine
Meadow

Figure 2.

Table 2. Major fires ($1 acre) from about 1920 (early records are incomplete) through 1994 that occurred within the East Fork watershed (40 fires, 761.5 hectares (1881 acres) burned). Data based on SEKI fire records (NPS 1995).

Fire Name	Year	Hectares	(Acres)
Traugers #1	1934	24.3	(60)
Traugers #2	1934	97.2	(240)
Eden Grove	1934	3.2	(8)
Grunigen Creek #3	1935	0.4	(1)
Oriole #2	1935	1.2	(3)
Tar Gap Ridge	1942	1.6	(4)
Paradise Peak Lookout	1945	0.4	(1)
Paradise	1945	0.4	(1)
Atwell Mill	1946	43.3	(107)
Hockett Ridge	1950	0.8	(2)
Mineral King	1952	18.2	(45)
Paradise	1952	0.8	(2)
Conifer Tract	1955	11.3	(28)
Paradise Peak #1	1957	0.4	(1)
Horse Creek	1969	0.8	(2)
Atwell Mill #2	1970	0.4	(1)
Lookout Point	1970	89.9	(222)
Atwell Mill	1971	1.6	(4)
Jet Plane	1971	1.2	(3)
Horse Creek	1973	0.8	(2)
Lookout	1974	16.2	(40)
Whitman Creek	1976	3.6	(9)
Whitman	1978	0.4	(1)
Eden Grove	1978	6.9	(17)
Eagle Lake	1979	0.4	(1)
Coffeepot #1	1987	0.8	(2)
Coffeepot #2	1987	0.4	(1)
Silver	1987	0.8	(2)
Lost	1987	0.8	(2)
Hockett	1988	8.1	(20)
Hockett	1988	20.2	(50)
Purple Haze	1988	0.4	(1)
Paradise	1988	2.8	(7)
Deer Creek	1988	5.7	(14)
Deer Creek	1991	291.5	(720)
Paradise	1994	30.4	(75)
Horse Creek	1994	0.8	(2)
Empire	1994	47.9	(118)
Hockett	1994	23.1	(57)
Spring	1994	1.2	(3)

watershed exists, most noticable in the central portion of the vegetation map (**Fig. 2**), a result of maps produced by the NPS and USDA being patched together that had used slightly different criteria for defining vegetation types. This is a result of Mineral King Valley being a recent addition to SEKI, having been transferred from USDA Forest Service in 1978.

No large watershed-scale fires have occurred within the drainage over at least the last 60 years (**Table 2**). The largest burn during this period was the 292 ha (720 ac) Deer Creek Burn (prescribed natural fire) within the East Fork Grove in 1991 (NPS SEKI fire records database). Fire histories from two locations within the watershed show repeated fire occurrence prior to Euroamerican settlement with relatively high frequencies at some sites (Pitcher 1987, Swetnam et al. 1992). Vegetation within the area has undergone considerable change since settlement and utilization of the region beginning in the 1850's, mainly a result of decreased fire frequency (Vankat 1970; Davis 1985; Stephenson 1994).

Table 3. Segment number and area.

Segment	Hectares	(Acres)
1	2352	(5811)
2	439	(1084)
3	962	(2377)
4	289	(716)
5	121	(300)
6	135	(335)
7	989	(2445)
8	121	(299)
9	2917	(7210)
10	6577	(16252)
11	5325	(13159)

Access to the area by road is limited to the narrow winding Mineral King Road, 25 miles long. The Mineral King Valley is popular with backpackers and packers as a starting point for many high country trips. Higher elevations of the watershed receive considerable recreation use while lower elevations receive relatively little use. Developed or semi-developed areas within the watershed include Silver City/Cabin Cove, Mineral King, Lookout Point, Oriole Lake, and the Atwell Mill areas. NPS campgrounds exist at Atwell Mill and Mineral King.

Eleven burn segments have been outlined within the watershed by fire management staff (**Table 3** and **Fig. 1**). Eight segments were designated on the south facing slope (north side of the East Fork) and three large segments on the more remote north slope (south side of the East Fork). Segment locations were established to facilitate prescribed burning operations and protection of primary developments within the watershed.

III) <u>Project Year 1995</u>

The MKRRP was initialized during March 1995 with field work and limited burning scheduled to begin during 1995. Of significant consequence was that the project began following a winter/spring (1994/95) of much greater than average snow accumulation in the Sierra Nevada. This resulted in the most delayed snow melt in many years (many upper elevation areas were not snow free and accessible until late July or early August). This was followed by the driest fall in 48 years of record, with significant winter rains only beginning on December 12. These weather conditions resulted in delays in initiating some field components of the research and monitoring but allowed field work to continue to a much later date in the autumn than is normally the case.

Field work during 1995 concentrated on the south facing slope of the East Fork watershed (**Fig. 4**) since this was the area designated as the primary burn segments for burn operations during 1995 and 1996 by the Fire Management Office. This area, which includes the Oriole Lake drainage, was divided into eight segments based on topographic and anthropogenic features (**Fig. 1**). Segment #3 was selected to be the primary burn unit since it could be used to create an anchor point to tie additional burns units into. Eventually, a burn buffer between the lower East Fork drainage and the Silver City/Mineral King developed areas would be created. While specific plans varied during the summer, by early fall the plan was to burn this segment during 1996, with most line preparation completed during 1995. However, beginning on October 12 with blacklining ignitions during preparation of the upper perimeter, the burn unexpectedly backed downhill into the segment interior (**Fig. 5**). This was due to extremely dry conditions and the development of a strong nightly mid-elevation temperature inversion. At this time a decision was made to allow the segment to continue to burn since it remained in prescription and the probability of a season ending precipitation event was high. A small number of additional interior ignitions were made on October 29 on the ridge to the west of Camp Conifer (southeast flank of the January 1994 burn). The segment continued to burn, with perimeter line-holding, until December 12-13 when 5.6 cm (2.18 in) of rain fell. The total acreage treated within segment #3 boundaries was about 850 ha (2,100 acres) with the actual acreage physically burned within the unit slightly less due to unburned patches.

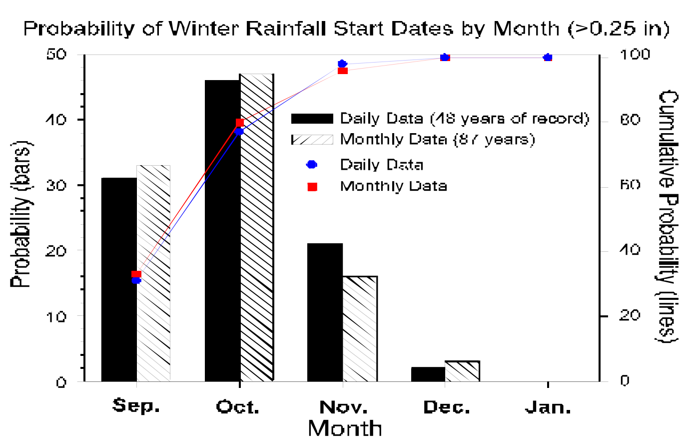

Figure 3. Probability of winter season rainfall starting each year by month. Data based on Ash Mountain MET station (missing values estimated from surrounding stations).

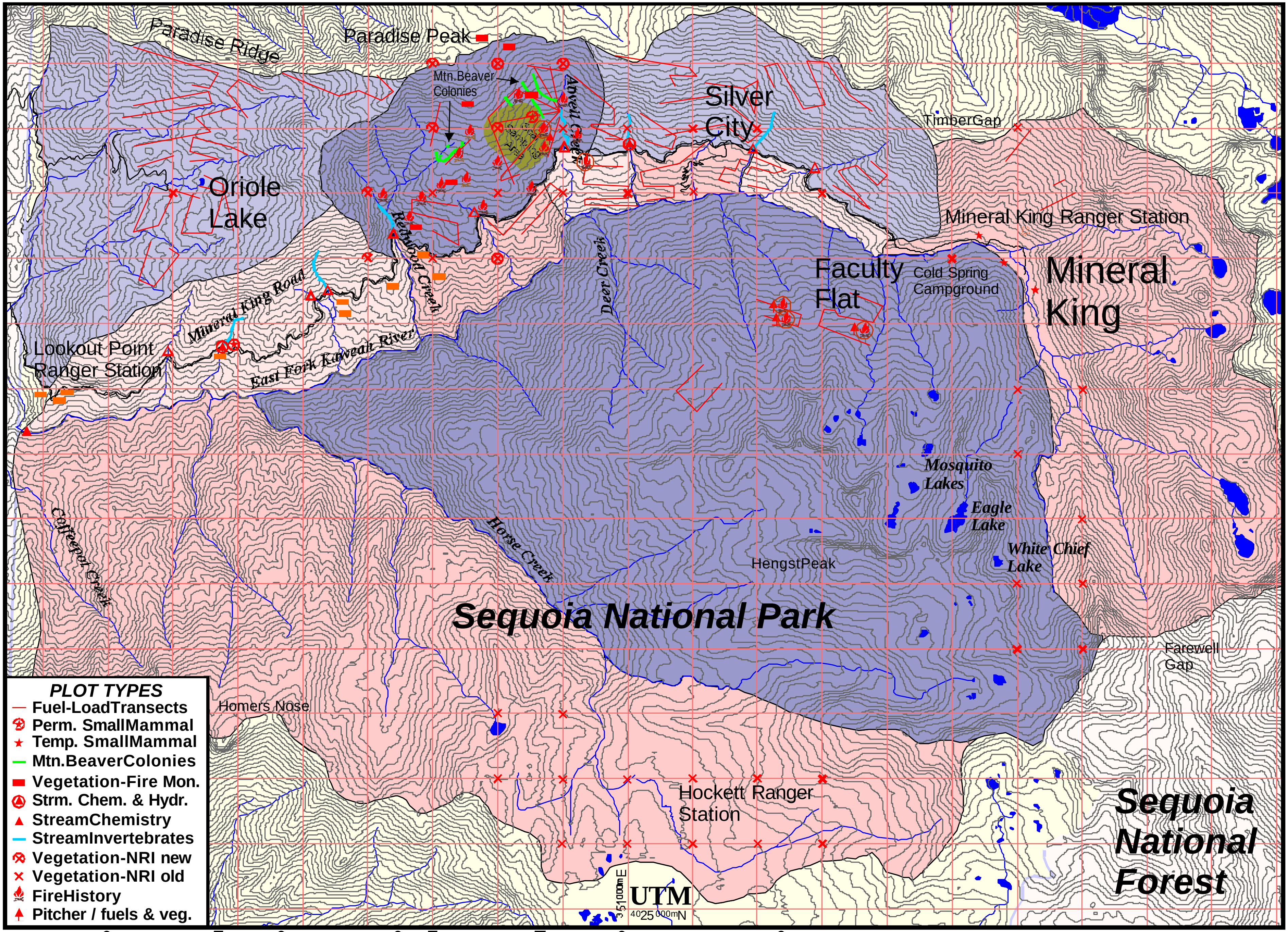

Figure 4.

Mineral King Risk Reduction Project

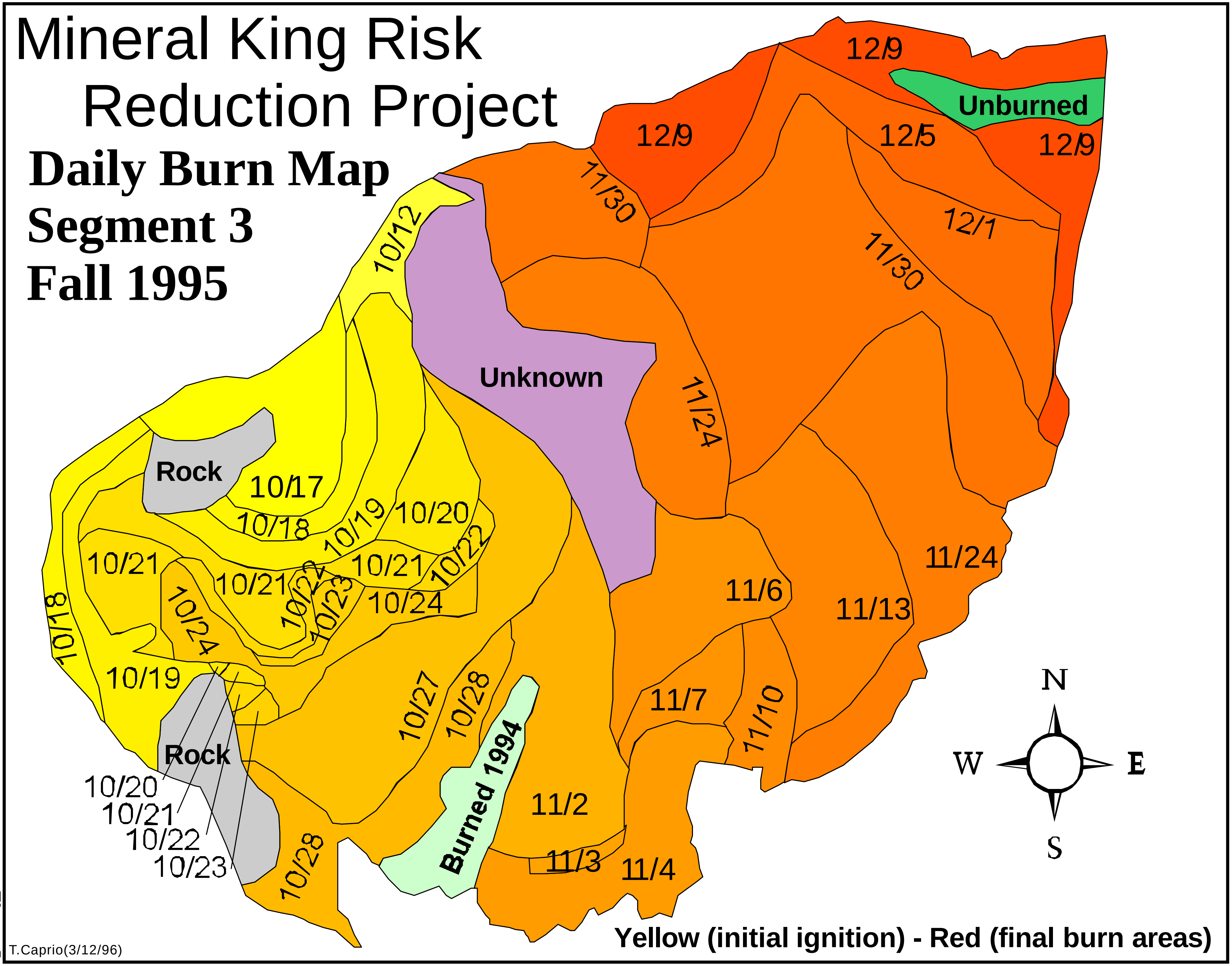
Mineral King Risk
Reduction Project
Daily Burn Map
Segment 3
Fall 1995
12/9
12/9
12/9
12/5
Unburned
11/30
12/1
11/30
10/12
Unknown
11/24
Rock
10/17
10/18
10/19
10/20
10/21
10/21
10/21
10/22
10/22
10/23
10/24
10/24
10/18
10/19
Rock
10/20
10/21
10/22
10/23
10/27
10/28
10/28
Burned 1994
11/2
11/3
11/4
11/6
11/7
11/10
11/13
11/24
N
W
E
S
Yellow (initial ignition) - Red (final burn areas)
T.Caprio(3/12/96)

Figure 5.

Vegetation Sampling

1) <u>Fire Effects Plots</u> - Science and Natural Resources Management, SEKI

Lead: M. Keifer; field-crew supervisor: G. Dempsey; field-crew members: B. Everett, G. Indindolia, A. Rusk, and P. Whitmarsh

Objectives: The fire effects plots are part of an ongoing monitoring process to assess burn objectives and achievements and to evaluate management objectives. Vegetation monitoring in the Mineral King burn is critical to (1) examine changes in vegetation structure and composition; (2) detect any unexpected or undesirable changes in vegetation that may be a result of the project; and (3) provide the above information to fire managers, other park staff, and the public. The primary monitoring variable is total fuel load since fuel reduction is currently the primary SEKI burn objective. A secondary monitoring variable has been chosen as overstory tree density although this is not a stated SEKI burn objective.

Figure 6. Sampling densely vegetated chaparral shrub plot below the Atwell Grove.

Field Work: Two seasonal positions were funded to handle fire effects monitoring and increased workload associated with the MKRRP during 1995. Field crews set up a total of 15 plots within the MKRRP; six forest plots and nine brush plots. Five of the fire effects plots were located in the forested portion of segment #3 (**Fig. 7**). These included two in giant sequoia/mixed-conifer forest, two in red fir forest, and one in pine/white fir mixed conifer forest. A red fir control plot was also set up on the immediate north side of Paradise Ridge, adjacent to segment #3. In addition to the forest plots, three plots were established during the fall of 1995 in chemise chaparral and six plots in mixed chaparral, all in segments #2 and #4 (**Fig. 7**).

Data Collection: With some modifications, these plots followed standardized methods used for monitoring fire effects on vegetation as outlined in the NPS Western Region Fire Monitoring Handbook (1992). Data collected on the plots emphasize forest structure, trees, and shrubs. The three red fir plots represent a new vegetation type for SEKI' s fire effects monitoring program.

The burning of segment #3 during the fall of 1995 burned at least three of the fire effects plots within the unit and probably all five (to be verified after snow melt). Three of the plots have been visited postburn and two of these have had postburn rechecks completed. Neither time nor personnel allowed the remaining three plots to be sampled prior to the onset of winter snows.

Plans for 1996 Field Season: Postburn rechecks of plots burned during 1995 will be completed once winter snows have melted and field crews are available. New plots will be installed in areas of the MKRRP where specific vegetation types have previously been unsampled or have been under represented in past sampling. Any brush plots burned during the winter of 1996 will be rechecked.

2) Giant Sequoia Fire Scars and Fuel Loading

- Science and Natural Resources Management, SEKI

Lead: M. Keifer; field-crew supervisor: G. Dempsey; field-crew members: B. Everett, G. Indindolia, A. Rusk, and P. Whitmarsh

Objectives: This study was planned to assess the relationship between the amount of fuel accumulation surrounding giant sequoias prior to burning and the resulting fire effects (Keifer 1995, see Appendix 1). The specific objectives of the study are to: (1) determine the amount of heavy fuels surrounding giant sequoia trees prior to and following prescribed burning, and measure the specific fire effects characteristics; (2) from these measurements, determine the relationship between the amount of large fuel and duff surrounding giant sequoia trees and resulting changes in fire effects characteristics (bark char, crown scorch, fire scars, and mortality); (3) provide SEKI' s Fire Management staff with the study results to assist in making decisions regarding heavy fuel clearance in giant sequoia groves.

As a result of public concern about the visual effects of fire, giant sequoia trees located in restoration burn units are subject to prefire fuel removal as required by Appendix H of the SEKI Fire Management Plan (FMP). The appendix states that unnaturally high fuel levels around sequoia trees must be removed prior burning to limit bark char and crown scorch in trees greater than four feet in diameter. This study will provide information to managers about the actual impacts of burning these unnatural fuels are on sequoias. A waiver of Appendix H requirements was obtained for this research project.

Figure 8. Sampling a giant sequoia for the fire scar study.

Field Work and Data Collection: The study is being conducted in the central portion of Atwell Grove (**Fig. 7**) where 60 giant sequoia trees have been selected for sampling within segment #3. These trees include 30 previously scarred individuals and 30 unscarred trees, all greater-than four feet in diameter. Trees were sampled during the late summer and fall of 1995. Data collected at each tree included: within a 7.6 m (25 ft) radius, map and tally of 1000-hr fuels, litter and duff depths; depth and width of all fire scars, using permanently marked points; bark char characteristics; crown scorch height; and crown scorch percent (a detailed study description is given in **Appendix 1**).

During late November the portion of Atwell Grove containing the sampled trees was burned by the prescribed management fire ignited on October 12. Field crews were on hand during the burning of some areas where selected trees were sampled and able to make fire behavior observations. Burning conditions they observed appeared to be of the expected intensity and within the planned burn prescription..

Problems & Solutions: Sampling of the trees in this study were originally scheduled to be completed early in the summer of 1996, prior to the planned burning of the segment #3 during that year.

However, the unexpected burning of the segment during the fall of 1995 required that an exceptional effort be made to complete the sampling prior to the study area burning. Field crews worked long hours and received additional help from staff of Resource Management and the National Biological Service.

There was concern that burning of the study trees late in the year, during a period when precipitation is likely, could produce non-uniform burning conditions and fuel consumption over the study area and result in poor data. However, the period when the study area burned was dry and fuel consumption appeared to have been relatively uniform.

Plans for 1996 Field Season: All trees will be resampled at the earliest date possible following the melting of winter snows in the Atwell Grove area.

3) Natural Resource Inventory Plots (NRI) - National Biological Service, SEKI Field Station

D. M. Graber (P.I.), S. A. Haultain, and E. Sanderson

Objectives: The NRI plots were established in order to document the preburn floristic, composition and forest structure of the Atwell Grove segment (Haultain 1996). An effort was made to include points falling within the little known, dense chaparral adjoining the Atwell unit scheduled for subsequent (late fall 1995, spring 1996) ignition. Surveys for sensitive vascular plant species suspected to occur in the area (***Ribes tularensis***, ***Angelica callil***) were also conducted during the course of accessing the plots.

The general purpose of the NRI plots is to provide a systematic, plot-based inventory for detecting and describing the distribution of vascular plants, vertebrate animals, and soils throughout the Parks (Graber et al. 1993). The inventory was initiated in 1985 with over 600 plots sampled by 1995. The sampling scheme is designed to be compatible with the Parks' geographic information system (GIS), and to assist in the field validation of remote sensing. All new NRI plots within the MKRRP were permanently marked. Data recorded include cover for all plant species present in a plot, tree DBH, vegetation type, fuels, soils, litter/duff depth, rock type, and evidence of fire or other disturbance.

Fieldwork: Fieldwork during 1995 was conducted during a 2½ week period in July in order to capture herbaceous species during the peak flowering period. The field crew consisted of the NRI plant ecologist (Sylvia Haultain) and one biological technician (Eric Sanderson). Due to the remoteness of many of the plots, the steepness of the drainage, and the dense forest/chaparral cover they were able to only establish one plot per field day. Sampling within stands of ***Arctostaphylos mewukka*** south and west of the Atwell Grove, was exceptionally slow and tortuous.

Data Collected/preliminary Results: The eight plots surveyed during 1995 were established according to the standard NRI protocol (Graber et al.1993), using the 1 km Universal Transverse Mercator grid intersections as plot locations (**Fig. 7**). This allowed inclusion of 32 NRI plots previously established within the proposed burn area as part of the preburn sample, resulting in a total of nine NRI plots within segment #3, and 41 plots within the East Fork watershed as a whole. 1995 marked the first year that plots were located using a PLGR global positioning device, increasing the likelihood of relocation for post-burn measurements.

Between-plot surveys resulted in the discovery of one previously unrecorded population of

Angelica callii, south of the Mineral King roadbed. The plants are scattered along a creek margin beneath the mixed conifer overstory in otherwise unremarkable habitat. Previous surveys located this species along similar creeks in the drainage and it is likely that additional populations will be found further up the canyon, along the streams between the roadbed and the East Fork of the Kaweah. No occurrences of ***Ribes tularensis*** were noted.

Of natural history interest was the occurrence of a single individual of ***Eburophyton austinae***, an achlorophyllous orchid, in extremely thick litter on plot 601. Although this species holds no special status, it is rarely encountered in Sequoia and Kings Canyon National Parks and marked the first observation of the taxa for the field crew.

Plot data and voucher specimens were curated by the NRI staff at Ash Mountain, under the supervision of the Research Biologist/Station Director.

Future Plans for NRI Involvement: 1996 Field Season: We anticipate having a field crew of two biological technicians available to re- read the plots burned during fall of 1995, and to establish additional plots in segments #4 and #5 according to NRI protocol. Fieldwork in the East Fork drainage will be conducted in addition to continuing surveys throughout the Parks, with perhaps four weeks of fieldwork dedicated to the MKRRP. Sampling will likely begin in May when phenology is at peak for the chaparral plots; and continue intermittently during July and August according to phenology in the mixed conifer and upper montane forests scheduled for ignition in 1996-97.

Wildlife Monitoring - Science and Natural Resources Management, SEKI

Lead: H. Werner; field-crew members: P. Hart and C. Ray

Objectives: Wildlife monitoring efforts were initiated to evaluate fire effects from the MKRRP on selected mammal fauna. Primary effort was placed on small mammals because rodent populations respond readily to changes in vegetation structure and composition due to fire, they are easy to handle, and are a cost-effective tool for monitoring fire effects (Werner 1996, see **Appendix 2**). Small mammal populations were sampled using two methods; 1) long-term monitoring of permanently marked areas, and 2) serendipity surveys of interesting and unique habitats. Long-term monitoring was designed to document changes in small mammal populations following fire under known specific conditions. Serendipity trapping was conducted to inventory species and their relative abundances as a means to make a large-scale assessment of fire effects.

Long-Term Plots: During the summer and fall of 1995 two permanent long-term monitoring plots were established in the Mineral King drainage (**Fig. 9**), one in sequoia mixed-conifer forest (Atwell, 2,130 to 2,177 m elevation) and the second in mixed chaparral/oak (Traugers, 1,428 to 1,493 m elevation). Plots were 75 x 135 m (corrected for slope) with a 15 m trapping grid for 60 total stations per plot. Sherman live traps were located within two meters of each station. Traps were baited with a mixture of rolled oats and peanut butter. A high/low thermometer was located at each plot. Trap lines were normally run for four nights per week. The total number of trap nights at the two plots totaled 3,276 (one trap for one night). The Atwell plot was run from July 3 through August 4, 1995 for a total of 17 nights. The Traugers plot was trapped from September 13 through December 1, 1995 for a total of 38 nights (a detailed study description is given in Appendix 2).

Figure 10. Weighing a captured rodent in one of the small mammal trapping plots. Protective gear (mask and gloves) was worn by the field crew to reduce exposure to hantavirus (photo by Harold Werner).

Captured individuals were tagged and measured for a number of standard parameters (species, sex, age, weight, hind-foot length, ear-notch length, tail length, and general comments). During handling personnel wore respirators, rubber gloves and eye protection as preventative measures against hantavirus. Based on capture/recapture data population size, density, and home ranges were estimated.

Vegetation density, composition, and basal area of living trees and shrubs was measured at each plot. At Atwell tree density was dominated by ***Abies concolor*** (white fir - 83% of the sampled individuals) while ***Sequoiadendron giganteum*** (giant sequoia) dominated basal area (62%).

Three mammal species were captured at the Atwell plot; ***Peromyscus maniculatus*** (deer mouse - 91% of captures, 0.133 captures/trapnight), ***Microtus longicaudis*** (longtailed vole - 7%, 0.010 captures/trapnight), and ***Glaucomys sabrinus*** (flying squirrel - 3%, 0.004 captures/trapnight). This plot burned on about November 20, 1995. Duff was completely consumed over about 63% of the plot, partially consumed over 23%, and unburned over 13%. At the Traugers plot six mammal species were captured; ***Neotoma fuscipes*** (dusky-footed woodrat - 69%), ***Peromyscus californicus*** (California mouse - 12%), ***Peromyscus truei*** (piñon mouse - 10%), ***Peromyscus boylii*** (brush mouse - 4%), ***Microtus californicus*** (California vole - 3%), and ***Chaetodipus californicus*** (California pocket mouse - 2%).

Serendipity Trapping: Serendipity trapping was carried out at three sites in the Mineral King Valley (**Fig. 9**); 1) a subalpine ***Ribes-Artemisia*** scrub site at 2424 m elevation, 2) a subalpine ***Salix*** shrub site at 2303 m elevation, and 3) in a subalpine wet meadow at 2350 m elevation. Sherman live traps were placed loosely at these sites at approximately 15 m intervals. Areas were surveyed from July 31 through August 25, 1995 for a total of 360 trap nights. Catch per unit effort (captures/trapnight) was used as a measure of relative abundance.

The highest trap success at the three serendipity sites was in the ***Ribes-Artemisia*** scrub where only ***P. maniculatus*** were captured (0.28 captures/trapnight). The two wetland sites produced quite different results. The ***Salix*** shrub site had low capture success with 0.04 captures/trapnight for ***P. maniculatus*** and 0.01 captures/trapnight for ***M. longicaudus***. The wet meadow produced more species and higher overall capture success with ***Zapus princeps*** (western jumping mouse) dominating (0.08 captures/trapnight). Other species captured at this site include: ***P. maniculatus*** (0.04 capture/trapnight), and ***M. longicaudus*** (0.007 captures/trapnight).

Limited serendipity trapping was also carried out for medium-sized mammals (e.g. forest carnivores). This sampling was done from September 29 to December 1, 1995 and amounted to 120 trap nights. Trapping was conducted in white fir forest, mixed-conifer/hardwood forest, lower montane hardwood forest (72 trap nights in all three vegetation types), and mixed chaparral (48 trap nights). This effort resulted in two captures of ***Martes americana*** (pine marten - 0.09 captures/trapnight) in fir forest and two ***Bassariscus astutus*** (ringtail cat - 0.12 captures/trapnight in riparian mixed hardwood/conifer site at Redwood Creek and 0.02 captures/trapnight in lower montane hardwood forest).

<u>Other Mammal Species of Special Interest</u>

***Aplodontia* (mountain beaver)**: Mountain beaver in the southern Sierra Nevada appear to be a relict distribution. The last survey in the 1960s (Wright 1969) found few active colonies and they were distantly spaced (the colonies in the Atwell Grove were not located during this survey). Much of this was likely caused by natural fragmentation of their riparian habitat.

The colony reported by Wright (1969) on the east fork of Redwoood Creek (at the old Oriole Lake Trail crossing) was relocated **(Fig. 9)**. Inspection of the colony in 1995 showed it to be active and of considerable size, extending for several hundred meters above the trial crossing. Two additional branches of the east fork of Redwood Creek were also found to have active mountain beaver burrows. Additional, previously unreported and active ***Aplodontia*** colonies were also found in three locations in the Atwell Creek drainage (**Fig. 9**). These colonies also extended for several hundred meters along the creeks along which they were found. Colony elevations ranged Between About 210-2500 m, along waterways that appeared to be permanent and contained substantial soil development on gentle to moderately steep slopes. All colonies were located in giant sequoia groves. While apparent populations and number of colonies in the Mineral King area was found to be greater than originally expected, neither the short-term nor long-term effects of burning on the species is known. Fire-history samples have been obtained from the two colony areas to provide data of past fire occurrence at these sites.

Both areas in which colonies were found burned during the burning of segment #3 during the fall of 1995. In early January, 1996, the Atwell area was revisited and postburn activity around and in some of the ***Aplodontia*** burrows was noted. Both sites will be revisited during 1996 to make general observations that might indicate fire related impacts.

Martes pennanti* (American fisher)**: Original plans for 1995 called for limited monitoring of ***Martes pennanti using track plates. This was not done because the new protocol being developed by the Forest Service for trapping this species was not yet available (using this protocol is important to maintain data compatibility among nearby agencies) and a large supply of track boxes was not available.

<u>Problems & Solutions</u>:

1) Some traps were destroyed by black bears (***Ursus americanus***). To alleviate this problem trapping periods need to be kept as short as possible and areas with extensive use by black bears need to be avoided.

2) Hantavirus protection needs to be considered early when making plans for any small mammal handling project because handling procedures add significantly to the time and cost of running monitoring

operations. However, the procedures are essential because the virus is life-threatening. These procedures increase the amount of field equipment that must be carried, decreases handler comfort, impedes handling, generates waste that requires sanitation, and adds directly to the cost of labor and supplies. Hantavirus supplies need to be stock-piled to be sure of ready access because commercial and government sources are not always available. New designs and techniques for handling mammals are being explored.

3) Dealing with late snow storms, bear problems, and lack of a real kitchen may have added some form of charm to the field crews job, but also added to the difficulty. While the crew did not complain about conditions and were always cheery, better housing facilities would have been useful. It would also have been useful if they had local access to electricity and a computer for data entry.

Plans for 1996 Field Season:

1) Conduct postburn survey of the Atwell plot.
2) Establish two more long-term small mammal monitoring plots. If suitable sites can be found, one will be located in the hardwood-conifer ecotone (***Pinus ponderosa***, ***Caloedrus decurrens***, ***Quercus kellogii***). The other will probably be placed in a lower subalpine environment (red fir, Jefferey pine forest, green-leaf manzanita chaparral, or sagebrush scrub). The second site may be postponed if the mixed chaparral plot established in 1995 is burned during 1996 at a date that would permit an immediate postburn survey.
3) Continue serendipity surveys in habitats not surveyed with long-term plots.
4) Visit ***Aplodontia*** colonies and make fire related observations.
5) Continue the development of a guide to wildlife fire environments.

Watershed Sampling

1) Watershed: Stream Chemistry and Stream Hydrology

- National Biological Service, SEKI Field Station

PI: D. M. Graber, field-crew supervisor: L. H. Hammett, field-crew B. Johnson

Objectives: Assess the effects of watershed scale prescribed fire on stream chemistry and hydrodynamics in the Mineral King watershed. Data will be compared to the "reference" unburned Log watershed in Giant Forest, sampled as part of another long-term watershed study. This will permit some determination of how widely fire effects studies may be extrapolated to characterize fire-related stream responses in the Sierra Nevada (Graber and Hammett 1996). The study was designed with consultation with John Melack, Jim Sickman, and Michael Williams of the University of Santa Barbara (UCSB). Sediment transport was also identified as a priority study component but was not pursued due to limited expertise and resources.

Field Work and Data Collection: Three sites, two streams and the East Fork of the Kaweah, were chosen for long-term monitoring (**Fig. 11**).

Trauger's Creek- Selected as a lower elevation site (1400 m) and located in mixed chaparral/oak-woodland, in a transition zone between mixed-conifer forest and chamise chaparral. Precipitation for the site is measured at Lookout Point (2 miles west) with a Belfort Recording Rain Gauge operated by Sequoia National Park.

Deadwood Creek - Selected as an mid-to-upper elevation site (2000 m) and located in sequoia/mixed-conifer forest. Precipitation measurements for the site are recorded at the Atwell Mill stables by a remote rain/snow gauge operated by the U.S. Army Corps of Engineers.

East Fork of the Kaweah River - The Park outflow point on the East Fork, below Lookout Point, was chosen for obtaining grab samples. This site is the lowest point in the watershed within the Park and was selected to measure cumulative downstream effects at the main Mineral King watershed outflow point.

The stream sites were selected away from segment #3 to permit at least one year of preburn baseline data to be collected. Both streams are perennial and partially spring fed. Streams from two elevations were chosen to span an elevational gradient representing riparian areas in mixed-conifer forest and oak-woodland/chaparral vegetation. Stilling wells, constructed of 10 in diameter PVC pipe, enclosing two pressure transducers (flow) and a thermistor (temperature), were set up on each stream (**Fig. 12**). Measurements were recorded every five minutes and downloaded onto Omnidata portable data loggers. This equipment is on loan from USCB. Permanent stream gauges were also installed.

Beginning in May 1995, grab samples form the two stream sites and the east fork were collected at regular intervals for chemical analysis. This analysis includes acid neutralizing capacity (ANC) (**Fig. 13**), pH, and conductivity at the National Biological Service’ s Sequoia and Kings Canyon Field Station Water Lab, while major ion analysis was performed by the Melack lab (UCSB) for sulfate, nitrate, potasium, phosphate, clorine, sodium, magnesium, ammonium.

Problems and Solutions - Roadwork disturbed some equipment installed in inconspicuous locations (to keep equipment from being tampered) at creek crossing.

Plans for 1996 Field Season: Sampling of the burned and unburned streams will continue at regular intervals.

Figure 12. Installing stilling well to house a pressure transducer and thermistors to collect stream height and temperature data at the road culvert over Trauger’ s Creek.

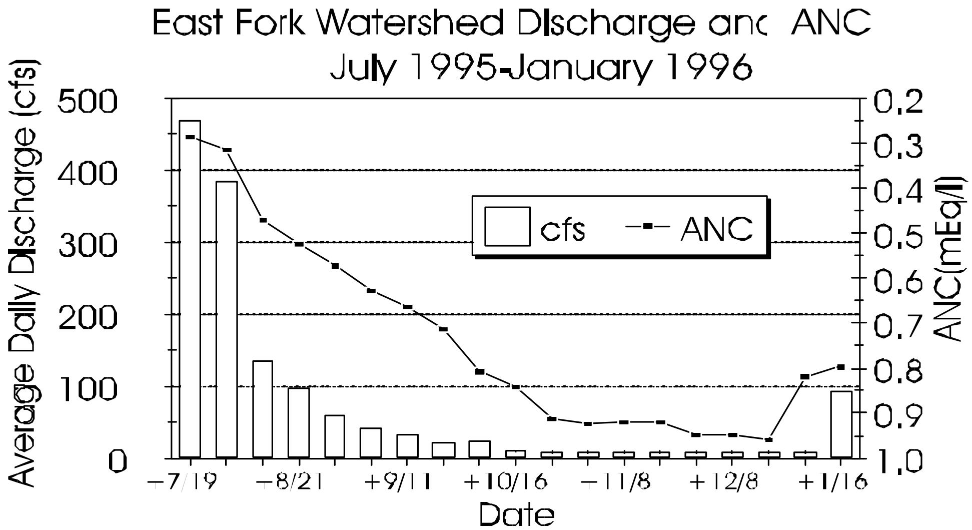

Figure 13. ANC values their relationship to average daily discharge of the East Fork of the Kaweah River.

2) <u>Watershed: Aquatic Biota Survey</u> - University of California, Davis

I. Chan, D. Erman, and N. Erman

<u>Objectives</u>: Assess the effects of prescribed fire on the structure of aquatic macro invertebrate communities and provide baseline inventory of composition, abundance, and diversity (Graber and Hammett 1996).

<u>Field Work and Data Collection</u>: Treatment (burn) and non-treatment reference streams were located in September 1995. In the Mineral King watershed six treatment streams were selected for sampling; Trauger' s Creek, East Fork Slapjack, Redwood Creek, Atwell Creek, Deadwood Creek, and an unnamed creek above Silver City (**Fig. 11**). They range in elevation from 1400 m to 2134 m and are located in three different burn segments (#2, #3, and #7). The streams were sampled for descriptive chemistry data to help characterize them. Four reference streams are located in the Middle Fork watershed; Big Fern Creek, Log Creek, and Panther Tributaries III and IV.

Preburn invertebrate sampling was carried out on all streams in September 1995. Benthic macro-invertebrates were collected through a combination of quantitative sampling and qualitative description in three habitat types: riffles, pools, and slickrock glides. In addition, several artificial substrates (unglazed clay tiles) were placed in slickrock area to help quantify colonization rates.

<u>Plans for 1996 Field Season:</u> Prior to next spring 1996, emergence traps will be installed to collect emerging adult species. Samples are preserved and will be identified to the lowest practical taxonomic level (usually genus). Postburn surveys will track biotic impacts and response.

Fuels Inventory and Monitoring - Resources Management, SEKI

Lead: C. C. Conover; field-crew supervisor: C. L. Moore; field-crew members: L. Cernusack, T. Schwend, and J. Sevier

Objectives: To improve our GIS fuel maps which are critical to providing more accurate fuels data for use in the FARSITE program. This program will in turn be used to model fire events in the watershed and to assess the cost of the prescribed burn project versus potential wildfire suppression costs. Because FARSITE relies on GIS fuels data for its modeling, it is essential the a more accurate fuel theme for the East Fork be developed. Additional attribute data that is being collected for the modeling effort includes tree height, height to live crown base, and basal area.

Field Work and Data Collection: Fuel-load sites were placed along transects that were layed out in all but one of the burn segments on the north side of the East Fork drainage (south facing aspect). Sampling was concentrated on the south aspect in those segments scheduled to be burned early in the MKRRP (**Fig. 14**). Transects were located to obtain fuels information from within vegetation polygons derived from the GIS vegetation map of the East Fork. Fuel-load sites were spaced at 80-120 m (4-6 chains) intervals along each transect (Moore and Conover 1996). A total of 448 plots were sampled in the currently defined burn segments on the north side of watershed. Fuel loading data were estimated using the Blonski and Schramel (1991) photo series with modifications for the southern Sierra (this will be supplemented in future years with a photo series more specific to southern Sierra sequoia groves (Weise et al. in review)). Field data has been entered into a database and summarized (**Figs. 15** and **16**; data shows mean and range of values for different vegetation types and elevation categories) (Conover and Moore 1996). The additional attribute measurements taken at each transect plot on tree height, basal area, height of lowest branches above ground, and litter and duff layer depth have also been entered in a database and summarized (**Fig. 17**; data shows mean and range of values for different vegetation types and elevation categories).

In addition to sampling on the south aspect, the field crew also sampled fuels (40 plots) on the north aspect in the vicinity of three permanent plots established by Donald Pitcher (Pitcher 1987) in the 1970s in red fir forest near Faculty Flat (**Fig. 14**). Detailed fuel and forest structure data were collected from the three plots as part of Pitcher's masters thesis. These plots were relocated during 1995 and an effort will be made to re-sample them to provide an indication of how fuels have changed in the past 20+ years. It is of note that data from these plots and general observations from the vicinity suggest that stand-replacing fires occurred in portions of these red fir stands in pre-Euroamerican settlement times.

Problems & Solutions: Vegetation and fuel loading information for the East Fork was originally planned to be obtained from Landsat Thematic Mapper (TM) satellite imagery. However, once the initial data sets were reviewed it was found that the vegetation classification based on the available TM scenes would not be adequate for the project. At that time the data acquisition plan was redesigned so that data collection would be made by a field crew collecting data on the ground based on the parks current vegetation map. This required rapid replanning and the training of a crew at the start of the summer field season.

Plans for 1996 Field Season: Sampling of fuel and forest attribute data will continue and be expanded on to the north facing aspects. Summarized data will be combined with GIS vegetation maps to provide higher quality input data for the FARSITE model.

Fire History - Science and Natural Resources Management, SEKI and National Biological Service, SEKI Field Station

Lead: A. C. Caprio, NPS; field assistance: M. Donnellan and B. Johnson, NBS

Objectives: The goal of this data collection effort is to obtain information on the spatial extent of pre-Euroamerican fires on a watershed scale (fire size, spread patterns, and frequency variation). Little or no information currently exists for the Sierra Nevada on fire at a scale that encompasses tens of thousands of acres of varying slope, aspect, vegetation type, and elevation. Reconstructing the large scale spatial pattern fire in the East Fork will help managers determine whether they are meeting management objectives in restoring fire as an ecosystem process in addition to providing baseline data on past fire frequency and size in the East Fork Watershed.

Field Work and Data Collection: In the fall of 1995 fire history sampling was conducted for approximately one week during the burning of segment #3 (Redwood Creek and Atwell Grove). We did this to preserve the spatial information about past fires from throughout the watershed (Note: after 100 years of fire suppression and resulting heavy fuel loads most fire history information in non-sequoia forest is destroyed by burning as old logs, snags, and catfaced trees are partially or wholly consumed). Our sampling followed standard fire history collection procedures (Arno and Sneck 1977; Dieterich 1980; Caprio and Swetnam 1995) with most samples obtained from snags and logs. We collected samples from 15 locations in a 1200 ha area within segment #3 (**Fig. 18**) at sites ranging from lower elevation ponderosa pine/black oak woodland, to sequoia/mixed-conifer, and into higher elevation red-fir forest. Additionally, we also obtained some fire history samples from riparian areas near Mountain Beaver colonies to provide data on past fire occurrence, since this species and sites have been noted as being of particular interest. Samples from the watershed will be supplemented by data from four previous site collections in the area (Pitcher 1987; Swetnam et al. 1992) (**Fig. 18**). Samples will be dendrochronologically crossdated to determine precise calender years in which past fires occurred (Stokes 1980). Fire history information from a watershed in which associated vegetation, fuels, and watershed data are being collected is unusual and potentially of great value.

Plans for 1996 Field Season: Sampling will continue during 1996 as time permits and resources are available. It will concentrate on segments scheduled for burning and on locations having a north aspect (no dendrochronologically dated fire history reconstructions exist from the southern Sierra for such sites). Also of interest are upper elevation red fir, lodgepole and western white pine forests where some stand replacing burns may have occurred in the past.

Prescribed Fire Cost-Effectiveness Project - Colorado State University

P. Omi, D. Rideout, N. Hayes, and J. Stone

Objectives: The overall role of SEKI in this project is to provide a case study location for conducting a problem analysis on a Department of the Interior (DOI) unit using an aggressive hazard fuels and prescribed fire management program. This will facilitate the development of an experimental cost-effectiveness system and simulation process using SEKI information inputs. The role of SEKI resources and research in this process is to provide resource related background information, various types of data, and GIS information, etc. to the analysis. Other operational input information and project documentation will be provided by the Fire Management Office (FMO).

Data: Information provided to the cost-effectiveness project to date has centered on GIS data, ARC/INFO coverages for various attributes of the East Fork watershed, remote sensing and various type of map data, and information databases associated with the area. Additionally, fuels data are being provided to help drive the NPS FARSITE model simulations that will eventually be a product of the prescribed fire cost-effectiveness project.

Plans for 1996 Field Season: Information and data associated with the MKRRP will continue to be provided to the cost-effectiveness project.

Data Coordinator - Science and Natural Resources Management, SEKI

Anthony C. Caprio

Potential outside research projects and support are being developed for the MKRRP. The data coordinator has made contacts with and organized meetings with a number of graduate students about possible research locations and topics for graduate research projects. Currently, two students have actively expressed an interest in carrying out research projects within the East Fork watershed with initiation of their field work depending on funding availability.

1) **Remote Sensing -Vegetation & Fuels**: M. Brookins and Dr. W. Miller, Arizona State University. Potential masters thesis project to be undertaken in East Fork watershed.

2) **Landscape-Level Effects of Prescribed Fire on Forest Structure and Composition**: K. Menning, UC Berkeley. Potential Ph.D. dissertation project to be undertaken in East Fork watershed (in cooperation with National Biological Service).

Proposals to help obtain some funding for graduate student study projects were developed.

The data coordinator provided coordination between FMO, PIO, and field crews during the burning season and seasonal planning stage. Help was also provided to field crews when needed and suggestions on sampling locations or procedures were made. A continuing effort is being made to locate and document past resource or research information, data, or plots sites within the East Fork Drainage and obtain or document the location of the data for these sites. Considerable time has been spent in reviewing and analyzing data from various MKRRP projects, summarizing activities of all projects, and producing an annual report. Additionally, a bibliography of material related to fire effects and resource issues in the southern Sierra is being developed. Currently, a list and copies of key fire related articles, both specialized and non-specialized, have been made available for both the general and technical readership. Lastly, information and graphics were provided to the PIO about resource and research studies or results there were applicable to the MKRRP and public information.

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Appendix #1.

Prescribed Fire and Heavy Fuel Effects on Mature Giant Sequoia Trees

Study Plan for Atwell Grove

Mineral King Burn Unit, Atwell Segment

MaryBeth Keifer
Science and Natural Resources Management

Prescribed Fire and Heavy Fuel Effects on Mature Giant Sequoia Trees

Study Plan for Atwell Grove

(Mineral King Burn Unit, Atwell Segment)

MaryBeth Keifer
Science and Natural Resources Management

INTRODUCTION

During the 25 year existence of the Sequoia and Kings Canyon National Parks (SEKI) prescribed fire program, questions about fire effects on giant sequoia trees have been raised numerous times. The questions have been related to both specific burn projects as well as the prescribed fire program in general. In many cases, the information necessary to answer the questions has not been available. Comprehensive and defensible information must be obtained to be able to answer continuing questions about prescribed fire effects on giant sequoia trees.

Currently, giant sequoia trees located in any restoration prescribed burn unit are technically subject to pre-burn fuel removal treatment required by Appendix H of the SEKI Fire Management Plan (FMP). Appendix H states that unnaturally heavy fuels must be removed around giant sequoia trees in order to limit bark char to a height of ten feet and 50 percent of the tree circumference and limit crown scorch to less than 30 percent for 90 percent of trees four feet or larger in diameter. This protective treatment was primarily designed to be consistent with prescribed fire management in Special Management Areas (SMA). Management in these areas is designed to preserve the current visual characteristics of the giant sequoia trees while reducing the possibility of catastrophic wildfire.

In keeping with agency goals, the park seeks to manage backcountry (non-SMA) giant sequoia groves ecologically, rather than aesthetically, while at the same time retaining the goal of hazard fuel reduction. In addition to the impracticality of Appendix H fuel clearance techniques in remote areas, the same criteria developed to maintain visual goals in SMA groves may not yield the desired range of ecological fire effects necessary to maintain healthy, viable groves of giant sequoia trees.

Previous and ongoing studies provide some useful, though incomplete information. Lambert and Stohlgren (1988) found no significant difference in mortality rates in the Giant Forest grove between areas treated with pre-burn fuel clearing and untreated areas (chi-square =2.64, p=0.755, df=5). This result suggests that post-fire giant sequoia tree mortality is not affected by the amount of heavy fuels surrounding the trees. The amount of fuel in each of the cleared and uncleared samples in the Lambert and Stohlgren study is unknown, therefore generalizing the results to other groves is difficult.

Current fire effects research in the East Fork and Suwanee groves indicates that mature giant sequoia trees have a very high tolerance for severely scorched crown foliage. Preliminary results show that the giant sequoias can survive at least two years after sustaining as much as 99% crown scorch, as evidenced by crown sprouting (Scott Stephens, personal communication). Assuming continued foliar growth in subsequent years, and barring any unusual, additional injury, these trees will likely survive to continue their long lives. Giant sequoia trees that experience 100% crown scorch do not show any evidence of crown sprouting after two years, and therefore do not survive.

We need to examine important, measurable characteristics that affect giant sequoia ecology. Ecological fire effects include both characteristics that influence the physical tree structure and characteristics that influence the physiological processes of the living tree. Fire effects characteristics and their relative ecological importance including the following:

Bark Char

Bark charring, while visually important, is a superficial effect of burning bark that usually does not affect the living tree tissue or substantially change the physical structure. However, due to its highly visual nature and ease of measurement, the relationship between bark char and the other more ecologically significant characteristics may be worth noting.

Crown Scorch

Crown scorch has a very important, direct effect on tree physiology. Crown scorch influences physiological processes by reducing the amount of foliage available for photosynthesis, affecting the growth and health of the tree. Maximum crown scorch height as well as crown scorch volume can be ocularly estimated.

Fire Scars

Fire scars affect trees both physiologically and structurally by reducing the amount of living cambium and changing the basal stability of the tree. Fire scar formation, while a natural process, may exceed the natural range in number and/or size of scars if fuels are unnaturally heavy. Fire scar dimensions that can be measured include number per tree, width, depth, height, and area. Both the amount of cambium reduction and change in basal structure can be estimated by measuring the scarred and unscarred circumference. Change in scar depth is very difficult to measure due to the highly irregular shape of fire scars, however, maximum depth and some measurement of change following fire may help to qualitatively assess a tree's basal structure stability.

Mortality

The above characteristics all occur naturally, but we do not know how the range of characteristics affect tree mortality. Mortality can be a result of either structural or physiological damage and may be a result of one or a combination of the above characteristics. Mortality has a direct effect on giant sequoia population ecology and is therefore one of the most important effects to measure.

The fuels that influence all of these fire effects characteristics are primarily 1,000-hr (3-8 inches in diameter) and larger surface fuels. Appendix H acknowledges that some judgement is required in determining the presence or absence of unnaturally heavy fuels. By determining the effects that result from specific amounts of fuels surrounding giant sequoias, we may be able to eliminate much of the subjectivity. To evaluate the possible role of duff accumulation in fire scar formation, duff depth around the giant sequoias will also be assessed prior to burning.

OBJECTIVES

1. Determine the amount of heavy fuels and duff surrounding giant sequoia trees prior to and following prescribed burning, and measure the resulting fire effects characteristics.

2. From these measurements, determine the relationship between the amount of 1,000-hr fuel and duff surrounding giant sequoia trees and resulting changes in fire effects characteristics (bark char, crown scorch, fire scars, and mortality).

3. Provide the SEKI Fire Management staff with the study results to assist in making decisions regarding heavy fuel clearance in giant sequoia groves.

If the results from this study indicate that heavy fuels significantly influence fire effects characteristics, a method to determine the relationship between heavy fuels around giant sequoia trees and the current backcountry fuels assessment methods used in the park must be developed. After all information is complete, managers will be able to append the Fire Management Plan and adjust prescriptions to specifically address non-SMA sequoia grove prescribed fire management based on defensible results.

METHODS

Pre-burn:

1) Select 15 giant sequoia trees >1.2 m (4 ft) diameter in each of two fire scar classes (scarred and unscarred) with each of two 1000-hr+ fuel amounts (low and high) for a total of 60 trees within the study area. Fuel levels will be determined after initial field reconnaissance and fuels may be manually removed to achieve appropriate levels. As much as possible, trees selected will be located in areas with similar slope and aspect. If time allows, additional trees in each of the 4 groups will be sampled to account for potential sampling difficulties and variable fire behavior.

Pre- and Post-burn:

2) Count and measure the diameter of 1,000-hr and larger fuels along 8 transects radiating within a circle of 6 m (20 ft) radius around each tree. The transects are oriented such that two are parallel to the slope, two are perpendicular to the slope, and four are oriented between the parallel and perpendicular transects. The 6 m radius corresponds to the radius selected for heavy fuel removal in Appendix H of the Fire Management Plan. Note any other large fuels outside the selected radius and beneath the giant sequoia crown. Note the presence of ladder fuels (we may need to exclude trees with heavy fir understory even though results would be interesting!).

3) Place duff pins at the start of the 8 transects (where the transect intersects with the tree bole); mark the other end of each transect with rebar. These duff pins will also serve as markers for circumferential position ("position").

4) Measure and map all bark char around the circumference of each tree (height, width at base, position).

5) Map and measure each fire scar around the circumference of each tree (height, width at base, position, and maximum depth). For measuring post-fire change in scar depth, place 5 nails per fire scar at a fixed scar height and nail depth: 2 located at the edges and 3 evenly spaced between the edges. If the scar covers more than one octant: measure the maximum height and depth in each octant and use 5 nails per octant.

6) Take photos at the ends of the two parallel and two perpendicular transects (photo taken towards tree).

During burn:

7) Burn the entire study area at one time using the standard fuel model 8 prescription and ignition pattern.

Post-burn:

8) Estimate percent crown scorch for each tree.

9) Record mortality immediately post-burn as well as 1, 2, 5, 10, and every subsequent 10 years following the fire for short- and long-term results.

POSSIBLE ADDITIONAL WORK:

Tree mortality may not be apparent until several years post-fire. In addition, the sample size may not be adequate to detect significant mortality. Rather than increasing the sample size and carrying out the study over many years, using a pre-existing, large, long-term dataset may be more practical. Lambert and Stohlgren (1988) found no statistically significant relationship between previous fire scarring and mortality in their study examining giant sequoia trees from the 1963-1969 Sequoia Tree Inventory (STI) that were reinventoried approximately 20 years later. Small sample sizes and/or a conservative statistical test may have resulted in loss of power to detect any relationship in their study. An additional, expanded reinventory using STI could add to the existing information about the long term relationship between cumulative fire scarring and mortality. Using the information about heavy fuel effects on fire scar formation from this study, and the relationship of fire-scar damage with mortality from the STI, we might infer a relationship between heavy fuels, fire scar formation, and giant sequoia mortality.

POTENTIAL DIFFICULTIES / THINGS TO THINK ABOUT:

1. The firing method currently planned for the Atwell segment involves spot ignitions ("to minimize scorch height and reduce fuels locally"). With this type of ignition, burning the area around all trees within the study area may be difficult. A broadcast burn of the study area (ie. a "research burn") would insure that more of the study area is burned. In addition, a broadcast burn is likely to produce more severe effects relative to spot ignition, therefore, studying the more extreme possibility is more useful to the management issue in question.

2. We need a way to relate the measurement of fuels around the giant sequoia trees to the fuels assessment done in the backcountry as the standard measure of fuel load (ie: is what's out there *generally*, related to what's *specifically* under the sequoias?). We can calculate fuel load in tons/acre around the giant sequoia trees from the heavy fuel count and diameter measurement in this study. A simultaneous fuels survey using Brown's transects in the study area may provide the necessary comparison. These fuel transects may be time consuming and with the spatial variability in fuels, we may not get a clean relationship. Photo series for estimating fuel load in the giant sequoia/mixed conifer forest type currently under development would be useful for comparison if available.

3. By sampling only mature (>1.2 m [4 ft] diameter) giant sequoia trees, we will not get any information on the effects on smaller trees. While this information is interesting, if we include a smaller size class, we would have to double the sample size. During field reconnaissance, we will determine if the smaller trees are likely to have heavy fuels accumulated around their bases.

REFERENCES

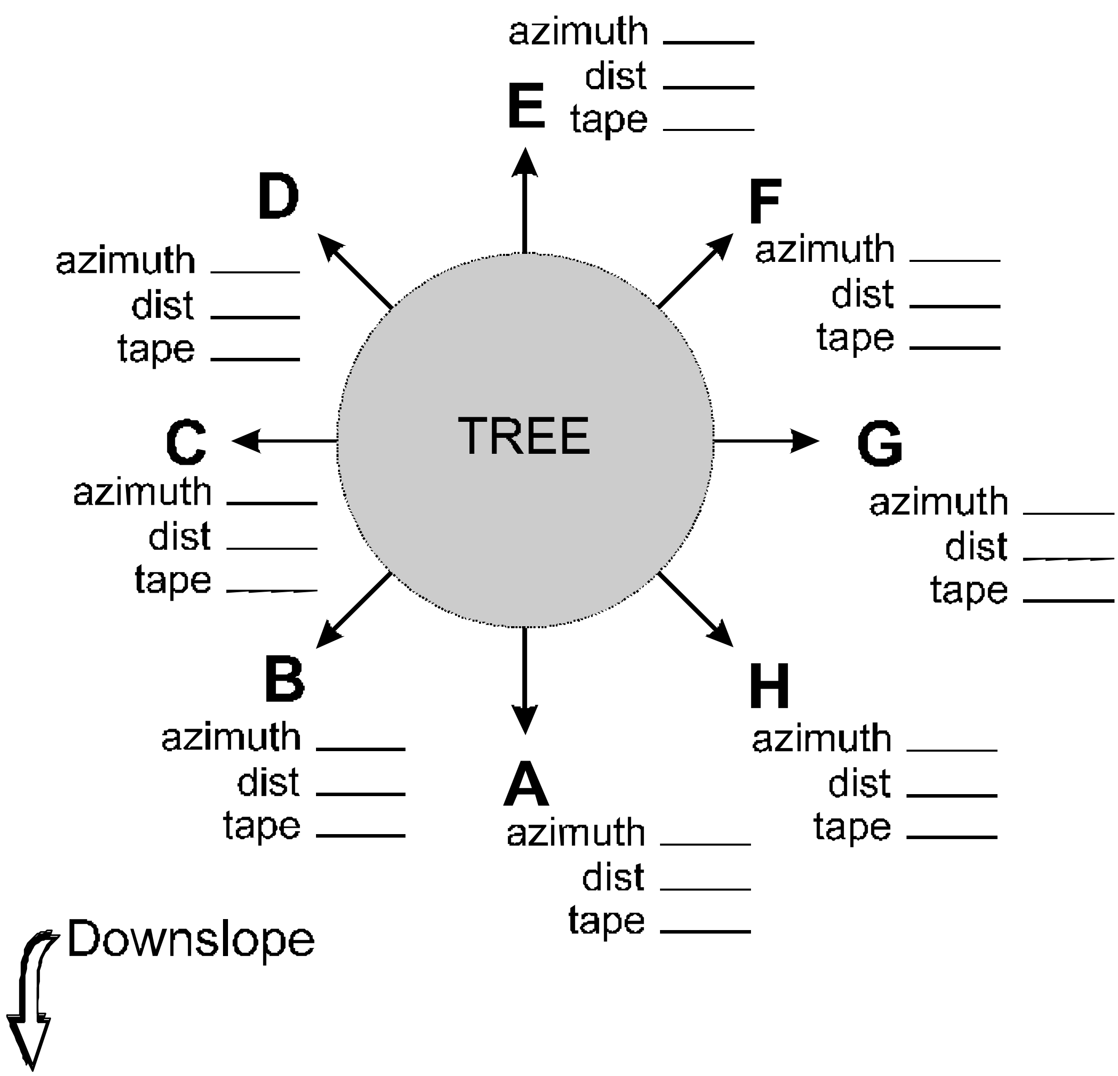
Lambert, Sherman. and Thomas J. Stohlgren. 1988. Giant sequoia mortality in burned and unburned stands. Journal of Forestry, February.

Sequoia and Kings Canyon National Parks. 1992. Fire Management Plan. Sequoia and Kings Canyon National Parks, Three Rivers, CA.

Atwell Grove - Giant Sequoia Fuel/Fire Scar Study - data sheet #1

Date ________ Recorders ____________________ STI Map _________ Tree # ______

Categories - Scar: Yes/No (circle one) Fuel: Low/High (circle one) DBH ______

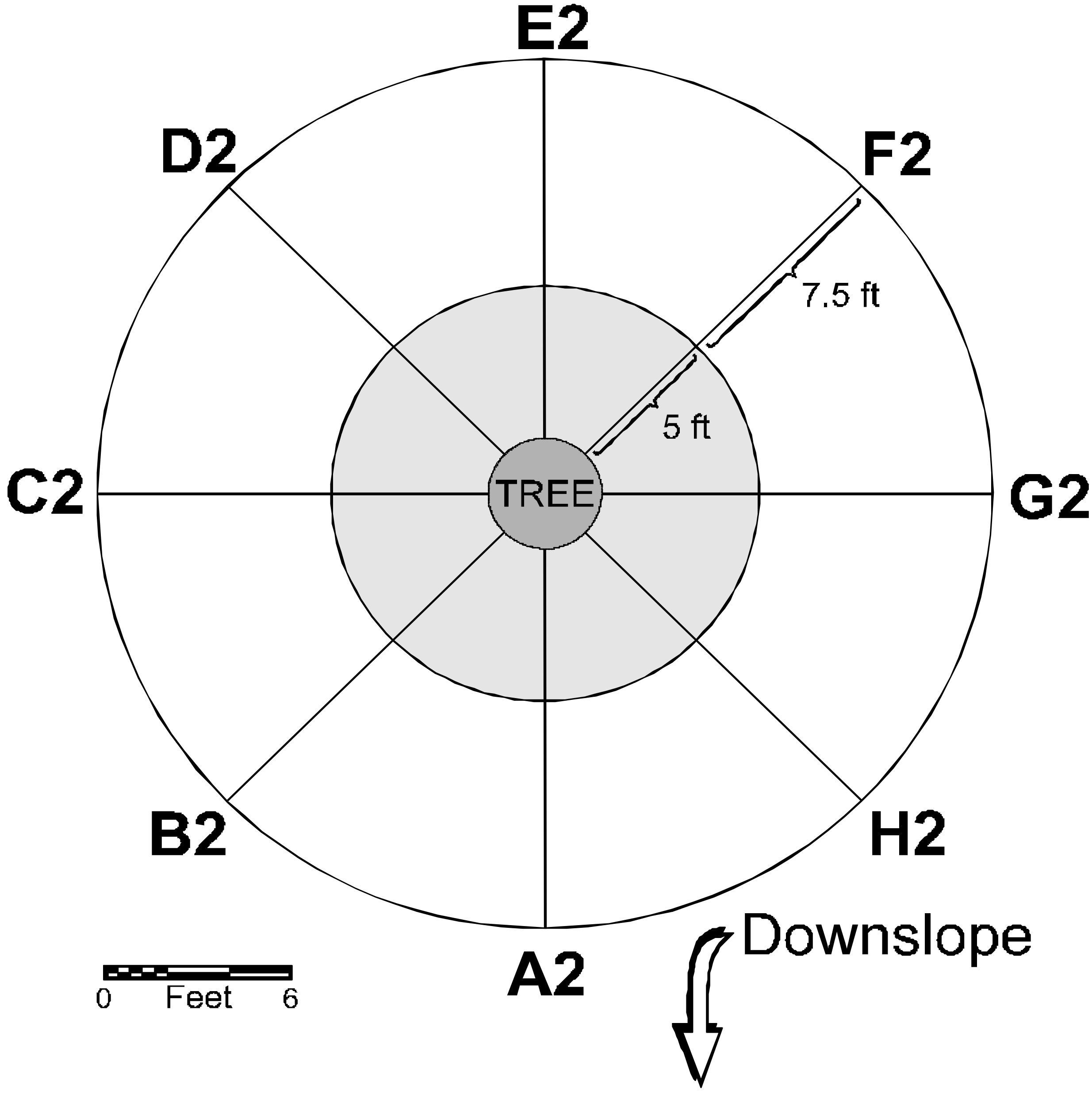


dist = distance from tree bole to rebar
tape = numerical reading from cirumferential tape at rebar

Atwell Grove - Giant Sequoia Fuel/Fire Scar Study - data sheet #2

Date _______ Recorders _________________ STI Map ________ Tree # _____

Categories - Scar: Yes/No (circle one) Fuel: Low/High (circle one) DBH _____



Fuel Map: Map fuels in inner circle - 10 ft outside tree radius; draw approximate location and orientation of downed logs of diameter 3", using transect octants as guidelines (outer circle is 25 ft outside tree radius); record average diameter to nearest 0.5 " on map drawing.

Appendix #2

Fire Effects Monitoring on Wildlife
1995

Annual Report
Mineral King Risk Reduction Burn

Harold W. Werner
Science and Natural Resources Management

FIRE EFFECTS MONITORING ON WILDLIFE

1995

April 8, 1996
Mineral King Risk Reduction Project

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Appendix A-1

Wildlife fire effects monitoring was initiated in the East Fork Kaweah River drainage as part of the Mineral King Risk Reduction Project. The monitoring focused on rodents because of the large number of species present and their specificity to habitat structure and composition. The monitoring consists of three elements: 1) permanent monitoring plots to document long-term changes in rodent populations at a few of the most widespread or important habitats, 2) serendipity surveys to determine the species and relative abundance of rodents in a majority of the drainage's major habitats for drainage-wide evaluation of fire effects, and 3) individual evaluations for species of special interest with regard to fire.

One-hectare long-term monitoring plots were established in mature sequoia forest at Atwell Grove and in mixed chaparral near Traugers Creek. The 3,276 trapnights produced 368 rodent captures. The deer mouse (*Peromyscus maniculatus*) was the most abundant preburn rodent at the Atwell plot with an average population estimate of 15 individuals (24 individuals maximum). Other rodents included the long-tailed vole *(Microtus longicaudus*) and northern flying squirrel (*Glaucomys sabrinus*) with plot populations of one and less than one individual, respectively. Preburn rodents at the Traugers plot in descending order of abundance include dusky-footed woodrat (*Neotoma fuscipes*), pinion mouse (*Peromyscus truei*), and California mouse *(Peromyscus californicus*) with average plot populations of sixteen, three and three individuals during the surveys. Brush mouse (*Peromyscus boylii*), California pocket mouse *(Chaetodipus californicus*) and California vole (*Microtus californicus*) averaged less than one individual in the plot. Traugers rodents showed strong arboreal tendencies.

Plot habitat was described. The Atwell tree density was estimated at 362 trees/ha with white fir (*Abies concolor*) being most abundant (83%) numerically, but with sequoia *(Sequoiadendron giganteum*) dominating the basal area (62%). The plot faced east-southeast at 2,130-2,177 m elevation. Side slopes varied from 10 to 34 degrees. Rocks, logs, and surface litter were abundant. Some flowing surface water was present. The plot burned on or about November 20, 1995. The Traugers stem density was estimated at 7,668 stems/ha and 3,898 shrubs/ha. The most dominant species were manzanita (*Arctostaphylos mewukka*; 41%), interior live oak *(Quercus wislizenii*; 30%), mountain mahogany (*Cercocarpus betuloides*; 20%), and buck brush (*Ceanothus cuneatus*; 20%). The vegetation was mapped into five taxa: tall-bush chaparral, branch-mat chaparral, scrub stand, short-bush chaparral, and annual grassland. These taxa had mean vegetation heights of 3.2 m, 1.3 m, 5.6 m, 1.5 m, and 0.2 m, respectively. The plot faced southeast at 1,428-1,493 m elevation. Sideslopes varied from 13 to 46 degrees. The substrate at both sites was loose and sandy.

Serendipity surveys were conducted at three sites. The subalpine gooseberry-sagebrush (*Ribes-Artemisia*) scrub was entirely deer mice (*P. maniculatus*) with the highest trap success of the project (0.279 captures/trapnight). The subalpine willow (*Salix* sp.) shrub-scrub had few captures (0.038 captures/trapnight for *P. maniculatus* and 0.012 capture/trapnight for long-tailed meadow mouse, *M. longicaudus*). The subalpine wet meadow was dominated by western jumping mouse (*Zapus princeps*) with 0.079 captures/trapnight. Other species included *P. maniculatus* (0.036 captures/trapnight) and *M. longicaudus* (0.007 captures/trapnight). A survey and guide to wildlife fire environments was initiated.

Some work was done with mid-sized animals. Several mountain beaver (*Aplodontia rufa*) colonies were located for general observations of postburn changes. No track-plate work was done with fisher (*Martes pennanti*), but limited serendipity trapping revealed ringtail (*Bassariscus astutus*) and grey fox (*Urocyon cinereoargenteus*) in the mixed chaparral with catch rates of 0.042 and 0.021 captures/trapnight respectively. Additionally, ringtail (*B. astutus*) were found in a riparian mixed hardwood/conifer site (0.125 captures/trapnight) and in lower montane hardwood forest (0.024 captures/trapnight). Martin (*Martes americana*) were captured in the fir forest (0.091 captures/trapnight).

INTRODUCTION

This work was initiated to evaluate the effects of the Mineral King Risk Reduction Project (MKRRP) on selected fauna. There is considerable existing literature on fire effects on wildlife and it demonstrates a broad range of responses from favorable to unfavorable for individual species. It is very likely that fire will cause changes in the small mammal community. To understand local responses, it is prudent to have local data under conditions typical of local burns.

This work concentrated on small mammals for several reasons. a) First, the Mineral King area contains a relatively large number of sympatric native rodents. There are at least eleven species of rats and mice present. They range from generalists like *Peromyscus maniculatus* which occurs in a wide range of habitats and elevations to other species like *Chaetodipus californicus* which has much more specificity in its habitat requirements. b) Most rodents consume significant quantities of vegetation, and some are arboreal or otherwise dependent on plants for cover. This links them to floral composition and structure, two things that are normally affected by fire. c) Rodents do not have large home ranges. The species of rats and mice present in the East Fork Kaweah drainage typically have home ranges that are under 0.6 ha (Zeiner *et al.* 1990). Because the individuals do not roam far, rodent populations can be correlated to more descrete features of their environments than animals occupying larger areas. d) Rodents have short life histories with rapid development and maturation. Some of the species present in the MKRRP have been reported to be reproductive in about 50 days after birth, and most small mammals survive little more than a year in the wild (Orr 1976), some even less. Young disperse after being weaned. This all contributes to high potential for measureable adjustments to the rodent population structure as the habitat changes. e). Finally, rodents are easy to trap, handle, and mark. It takes little time to become familiar with the local species, and there is an abundant literature providing methodologies. Until the recent discovery of hantavirus, their handling seemed to present little risk to the investigators.

Because fire can have significant effects to both the structure and vegetative composition of the habitat and because rodents present a diverse array of easy to handle respondents to habitat changes, they make good cost-effective tools for monitoring fire effects. Other major groups for which we would like to have local data, but which was not collected on this study for lack of resources include birds and insects. Both of the these groups are represented by large numbers of species, but their documentation requires more observer skill and larger plots for birds.

There are a number of smaller groups for which we have special interest. These include mountain beaver, forest carnivores (e.g. martin, fisher, ringtail, etc.), mule deer, bats, and brown-headed cowbirds. These represent a range of public and agency interests.

METHODS

Rodent populations were investigated from two perspectives: 1) long-term monitoring of select areas, and 2) serendipity surveys of the most common and unique habitats. The long-term monitoring is intended to document long-term changes in rodent populations and their habitat following fire under known conditions. Serendipity surveys inventory rodent species and their relative abundance within both common and unique environments to facilitate large-scale assessment of potential fire effects.

Two one-hectare permanent long-term monitoring plots were established. The Atwell Plot was located in a mature sequoia forest in Atwell Grove with plot center at UTM coordinates 4037.147 northing and 349.506 easting. The Traugers Plot was located in mixed chaparral with plot center at UTM coordinates 4033.776 northing and 344.925 easting. Plot locations and elevations were determined with a Rockwell AN/PSN-11 PLGR geographic positioning system (GPS) on averaging mode. The plots are 75 m by 135 m (flat distance) with 6 mm diameter steel stakes marking the trapping grid at 15 m intervals. Each plot contains 60 trap stations with one Sherman live trap (Model LFATDG, 7.6 x 8.9 x 22.9 cm) within two meters of each station stake. The traps were normally run four nights per week. There were a total of 3,276 trapnights. The Atwell Plot was run for a total of 17 nights from July 3 through August 4, 1995. The Traugers Plot was run for a total of 38 nights from September 13 through December 1, 1995. The traps were baited with a dry mixture of rolled oats and peanut butter. A high-low thermometer was located in each plot at a shady location about 1.5 m above the ground.

Captured rodents were marked with numbered self-piercing 1 monel ear tags (Style # 1005-1 from National Band and Tag Company). Captured rodents were ear tagged, and recorded information included tag number, species, sex, age (adult, subadult), weight, hind foot length, ear notch length, tail length, and general comments. The handlers wore respirators, rubber gloves, and eye protection for hantavirus protection (Mills *et al.* 1995).

Plot populations were estimated using a modified Jolly-Seber Method (Buckland 1980). Data was stored in dBase III$^+$ files. Density was estimated using a method presented by Davis (1982) where plot boundaries are expanded by half of the average home range size. Home range was estimated using CALHOME (Kie *et al.* 1994).

Serendipity trapping for rodents was done at three sites: a subalpine *Ribes-Artemisia* scrub site at UTM coordinates 4034.4 northing, 357.3 easting, a subalpine *Salix* shrub-scrub site at UTM coordinates 4035.3 northing, 356.1 easting, and a subalpine wet meadow at UTM coordinates 4034.9 northing, 356.6 easting. These coordinates need to be verified on the ground with a GPS. Sherman live traps were scattered loosely through these sites at approximately 15 m intervals (not measured). These areas were surveyed from July 31 through August 25, 1995 for a total of 360 trapnights. Catch per unit effort (captures/trapnight) was used as a measure of relative abundance among sites. An ink spot on the fur was used to recognize recaptures.

Serendipity surveys also included some trapping for medium-sized mammals (e.g. forest carnivores) using mid-sized Tomahawk and Havahart traps baited with meat and covered with burlap bags. This sampling was done from September 29 to December 1, 1995. It amounted to 120 trapnights. This trapping included white fir forest, mixed hardwood/conifer forest, lower montane hardwood forest, and mixed chaparral.

Vegetation density was determined using T-square procedures as described in Krebs (1989). The station stakes were used for random points making the procedure systematic. The same plots surveyed for density were used to characterize the species composition and size. Basal area was measured at breast height for trees and just above the ground for shrubs. If a burl was present, the measurement was done above the burl. Only living stems >1 cm diameter and trees were surveyed.

RESULTS AND DISCUSSION

Permanent Plots:

Atwell Plot: The Atwell Plot was located in a mature giant sequoia forest. The conifer density was estimated at 362 trees/ha (95% CI =292-475). Numerically, the species composition was dominated by *Abies concolor* (83% of the sampled plants) with *Sequoiadendron giganteum* and *Pinus lambertiana* being far less prominent at 5% and 12% respectively (Fig. 1). It was the basal area at breast height that showed the significance of *S. giganteum* to the forest biomass. *Sequoiadendron giganteum* had 62% of the basal area, while *A. concolor* and *P. lambertina* had 35% and 2% respectively. Young *S. giganteum* were virtually absent from the plot. The smallest *S. giganteum* sampled had a DBH (diameter breast high) of 2.41 m. The mean DBH of *S. giganteum* was 2.86m. Both *A. concolor* and *P. lambertina* had numerous small specimens in the understory. Their mean DBH was 0.41 m and 0.32 m, respectively. Few other species of trees were present. There was at least one small *Calocedrus decurrens* and one *Quercus chrysolepis*. The plot faced east-southeast at 2,130-2,177 m elevation. Side-slopes vary from 10 to 34 degrees (mean = 24^{o}). Maximum temperatures during trapping were 16-34^{o} C (mean = 24^{o} C) during the day with a minimum temperature of 8-18^{o} C (mean = 14^{o} C) at night. The soil was sandy.

While there were numerous exposed rocks on the plot, most of them were smooth and low to the earth's contours. They did not appear to provide significant cover. By contrast, logs of all sizes were abundant (Fig. 2).

The plot contained two drainages with intermittent ephemeral stream flows and a small seep/stream near the center of the plot that may be perennial (Fig. 3). It is the only site that shows any wetland vegetation.

There was some evidence of early logging on the plot. The plot contained one sawed *S. giganteum* stump and a pile of partially

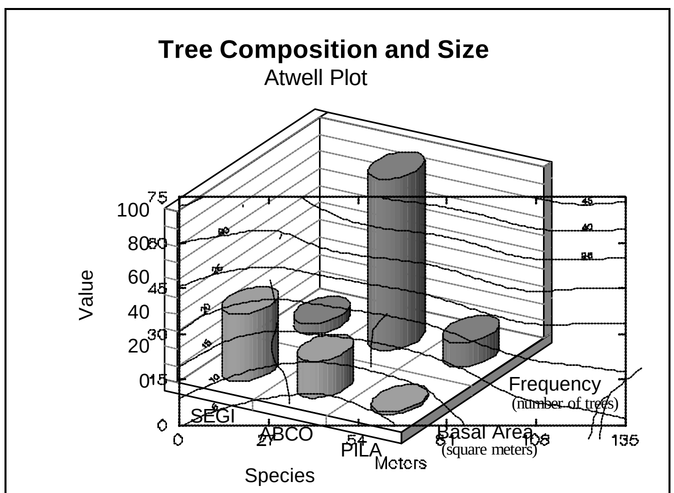

Figure 3. Atwell Plot showing topography in 5 m contour intervals and location of surface water.

Figure 1. Species composition and total basal area for the 120 trees sampled at the Atwell Plot.

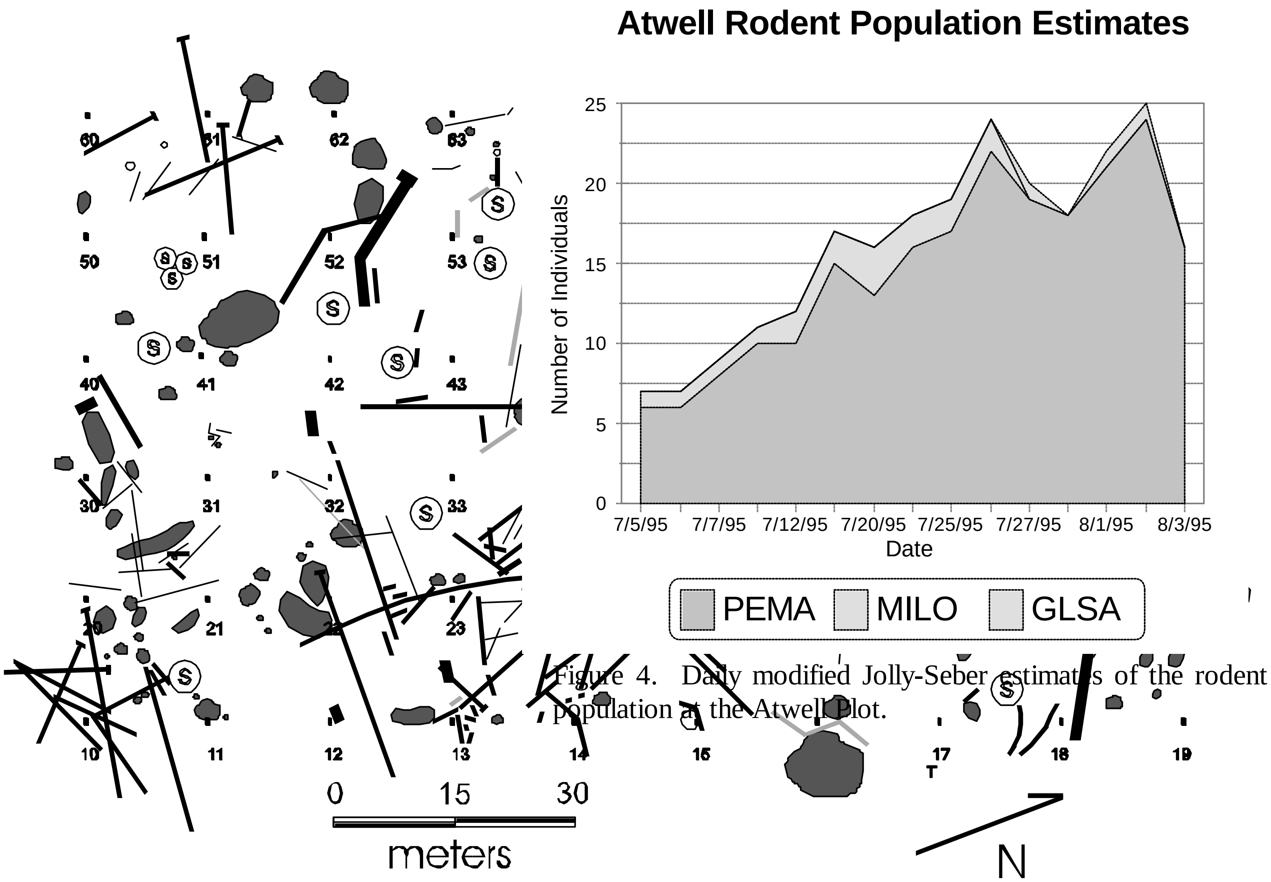

Figure 4. Daily modified Jolly-Seber estimates of the rodent population at the Atwell Plot.

Figure 2. Atwell Plot showing the trapping grid and the location of down logs and rocks. The circles with an "S" in their center are mature sequoia trees in the plot. The "T" shows the location of the high-low thermometer. The steel stakes that mark the stations are located directly above the station numbers.

stacked wood.

The plot was burned on or about November 20, 1995. The duff was completely consumed at 63% of the plot stakes. The duff at another 23% was only partially consumed. Thirteen percent of the stake sites showed no evidence of con-sumption. At some of the unconsumed sites, there was a lack of fuel. Many logs remained after the burn. Punky and small logs appeared to have been consumed most, but logs have not been remapped yet. Most of the plot was covered by ash deposits that are deeper than the height of mice.

Three species were among the 150 preburn rodent captures on this plot. By descending capture frequency, they were *Peromyscus maniculatus* (91%), *Microtus longicaudus* (7%), and *Glaucomys sabrinus* (3%). The mean plot population of *P. maniculatus* during the trapping period was estimated at 15 individuals (maximum estimate for any survey day = 24 individuals) compared to one individual (maximum = 3 individuals) for *M. longicaudus* and less than one individual for *G. sabrinus* (Fig. 4). Catch-rates for the three species were 0.133, 0.010, and 0.004 captures/trapnight for *P.*

maniculatus, *M. longicaudus*, and *G. sabrinus*, respectively. The number of individuals captured for each species was 34 *P. maniculatus*, three *M. longicaudus*, and two *G. sabrinus*. *Glaucomys sabrinus* is probably under-represented because we were trapping on the ground for a species that probably spends most of its time in the canopy. *Microtus longicaudus* was probably present in-part because of the small amount of riparian habitat.

Species densities were estimated at 6 individuals/ha for *P. maniculatus* (9 individuals/ha maximum) and one individual/ha for *M. longicaudus* (2 individuals/ha maximum). Captures of *G. sabrinus* were too few to estimate density, and the estimates for *P. maniculatus* and *M. longicaudus* were based on minimal home range data. A mean home range of 0.16 ha (calculated using minimum convex polygons) for *P. maniculatus* is based on all individuals with seven or more captures. Regression of home range on number of captures showed no linear (P=0.88) or upward relationship after seven captures suggesting that more captures did not add to the size of the individuals' known home range.

Sex ratio of captured mice was about even. Fourty-one percent of the *P. maniculatus* were female, 47% were male, and 12% were unknown. Of the three *M. longicaudus* captured, we captured one of each sex and one subadult of unidentified sex.

Traugers Plot: The Traugers Plot (Fig. 5 & 6) was located in a stand of mixed chaparral. The stem

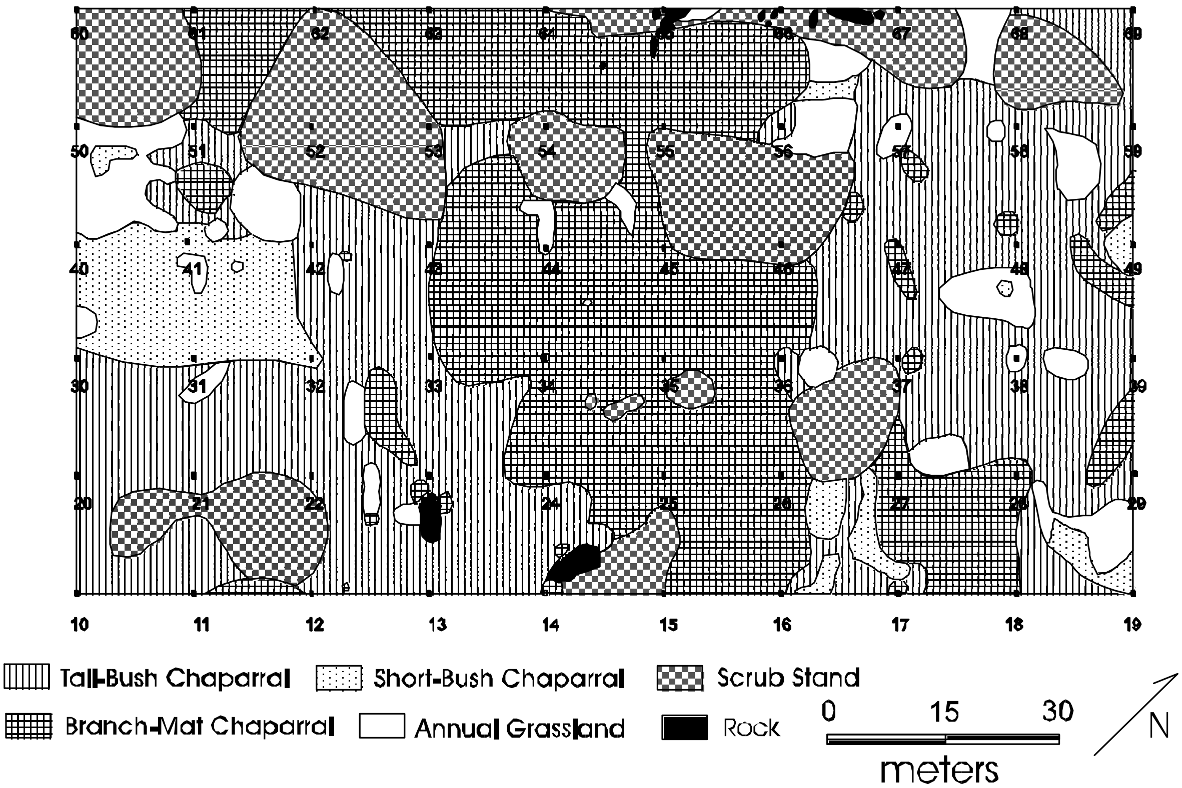

Figure 5. Traugers Plot showing the trapping grid and the boundaries of major vegetation types. The steel stakes that mark the stations are located directly above the station numbers.

density was estimated at 7,668 stems/ha (95% CI = 5,689-11,756 stems/ha). The shrub density was estimated at 3,898 shrubs/ha (95% CI = 3,772-4,032 shrubs/ha). By frequencey, the shrub composition (Fig. 7) was dominated by four species, *Arctostaphylos mewukka* (41% of sampled shrubs), *Quercus wislizenii* (30%), *Cercocarpus betuloides* (20%), and *Ceanothus cuneatus* (20%). The remaining composition consisted of *Fremontodendron californicum* (10%), *Prunus subcordata* (2%), and *Quercus chrysolepis* (1%). By total basal area, the plot was dominated in descending order of importance by *Q. wislizenii* (39%), *C. cuneatus* (30%), *A. mewukka (22%),* and *C. betuloides* (9%). Stem size followed the same pattern. In descending order, the largest stems belonged to *Q. wislizenii* (median = 79 cm^2), *C. cuneatus* (median = 57 cm^2), *A. mewukka* (median = 28 cm^2), and *C. betuloides* (median = 13 cm^2). Median stem size for the entire sample was 28 cm^2 (mean = 54

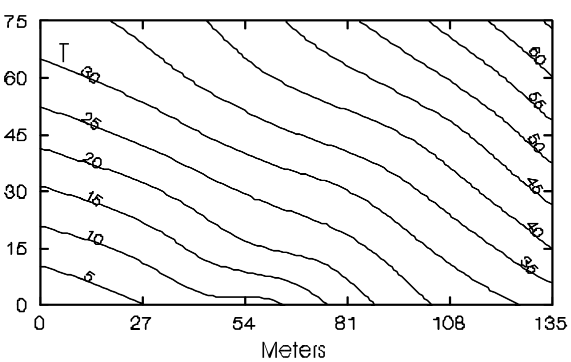

Figure 6. Traugers Plot showing topography in 5 m contour intervals. The "T" shows the location of the high-low thermometer.

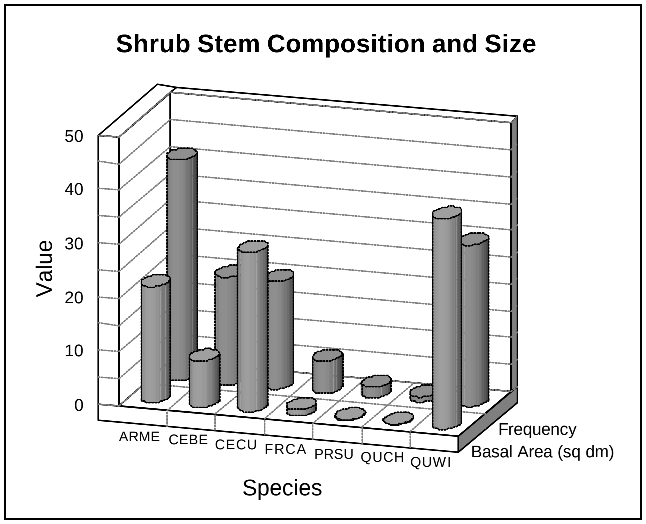

Figure 7. Species composition and total basal area for the 120 stems sampled at the Traugers Plot.

cm^2).

Because of the diversity of mixed chaparral, the vegetation was classified into five taxa (Fig. 5 & 8): tall-bush chaparral (38%), branch-mat chaparral (30%), scrub stand (15%), short-bush chaparral (10%), and annual grassland (7%). Sites were classified as tall-bush chaparral if they had only partially or non-interlocking branches and the stand obscured lateral vision. The tall-bush chaparral was dominated by *Q. wislizenii*, *C. betuloides*, and *C. cuneatus*. It also contained some *F. californicum* and small patches of annual grasses. The mean height was 3.2 m. The short-bush chaparral had the same structure but permitted lateral vision. It was dominated by *C. cuneatus*, and annual grasses were common. The mean height was 1.5 m. Branch-mat chaparral had interlocking branches forming a mat or "Brillo pad" structure. It was dominated at Traugers by *A. mewukka*, which essentially grew as a monoculture. It had a mean height of 1.3 m. Scrub stand consisted of high interlocking canopies that are reasonably open in the understory. At the plot, these sites were dominated by *Q. wislizenii*, but elsewhere, *Q. chrysolepis* often dominates. It had a mean height of 5.6 m. The dominant plants of the annual grassland will be identified this spring as they bloom. Annual grassland had a mean height of 0.2 m during the sampling. Regardless of the vegetation type, annual grasses were found at 27% of the stations. The plot had scattered patches of *Chamaebatia foliolosa* in the understory. It was found at 5% of the stations.

The plot faced southeast at 1,428-1,493 m elevation. Sideslopes varied from 13 to 46 degrees (mean = 23°). There were few exposed rocks, and the soil was a fine sand that was easily disturbed from people walking on it. There was no surface water on the plot. Maximum temperatures during the trapping were 17-32°C (mean = 24°C) during the day, dropping to 2-16°C (mean = 9°C) at night.

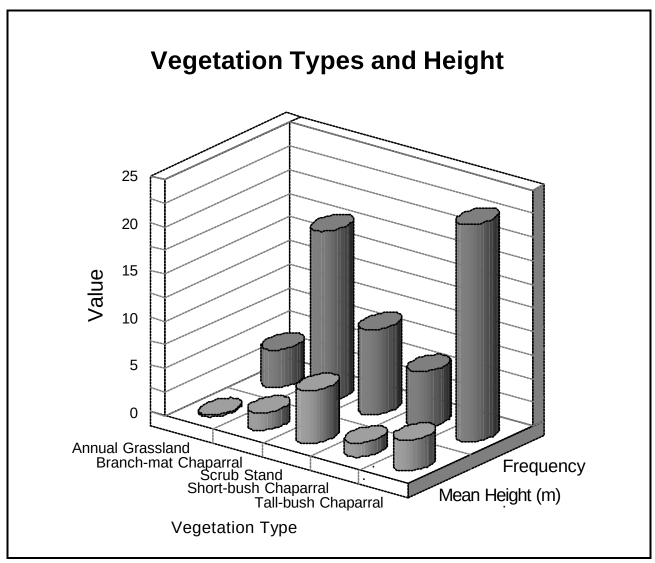

Figure 8. Vegetation types at the Traugers Plot and their mean height measured at the 60 trap stations.

The plot had some evidence of cultural use. Sawed-off poles and telephone insulators mark the location of an old telephone line across the plot. This plot was not burned in 1995.

Six species were among the 218 preburn captures at the Traugers Plot (Fig. 9). By descending capture frequency, they included *Neotoma fuscipes* (69%), *Peromyscus californicus* (12%), *Peromyscus truei* (10%), *Peromyscus boylii* (4%), *Microtus californicus* (3%), and *Chaetodipus californicus* (2%). An additional rodent was believed to have been a juvenile *N. fuscipes.* The *N. fuscipes* dominated the plot. The mean plot population of *N. fuscipes* during the survey was estimated at 16 individuals (maximum estimate for any survey day = 23 individuals). At least 19 stick nests were counted inside the plot, and it is possible that more stick nests exist obscured by the dense vegetation. For other species captured, the mean plot population estimates include three *P. truei* (maximum = 7 individuals), three *P. californicus* (maximum = 6 individuals), less than one *P. boylii* (maximum = 4 individuals), less than one *Chaetodipus californicus* (maximum = 2 individuals), and less than one *M. californicus.* The capture rate for these six species is 0.067 captures/trapnight for *N. fuscipes*, 0.012 captures/trapnight for *P. californicus*, 0.009 captures/trapnight for *P. truei*, 0.004 captures/trapnight for *P. boylii*, 0.003 captures/trapnight for *M. californicus*, and 0.002 captures/trapnight for *C. californicus*. The number of individuals captured for each species was 37 *N. fuscipes*, seven *P. truei*, seven *P. californicus*, seven *P. boylii*, three *C. californicus*, one *M. californicus*, and one unknown (believed juvenile *N. fuscipes*).

Mean species densities were estimated at 10 individuals/ha for *N. fuscipes* (14 individual s/ha maximum), two individuals/ha for *P. truei* (6 individuals/ha maximum), and two individuals/ha for *P. californicus* (4 individuals/ha maximum) . Recaptures of *P. boylii, C. californicus, and M. californicus* were too few to estimate density, and the estimates for *P. californicus* and *P. truei* were based on minimal home range data. A mean home range of 0.05 ha (calculated using minimum convex polygons) for *N. fuscipes* is based on all individuals with nine or more captures. Again, data analysis indicated that more than nine captures did not enlarge the home range.

Sex ratio of most captured rodents was about even. Fourty-three percent of the 37 *N. fuscipes* were female, 43% were male, and 14% were unknown. Of the *P. truei* captured, we had two males, three females, and two unknown. We captured three *P. boylii* of each sex and had one unknown sex. *Peromyscus californicus* (2 females and 5 males) and *C. californicus* (no females, 2 males, and 1 unknown) were skewed toward males, but sample sizes were very small. The only *M. californicus* was male.

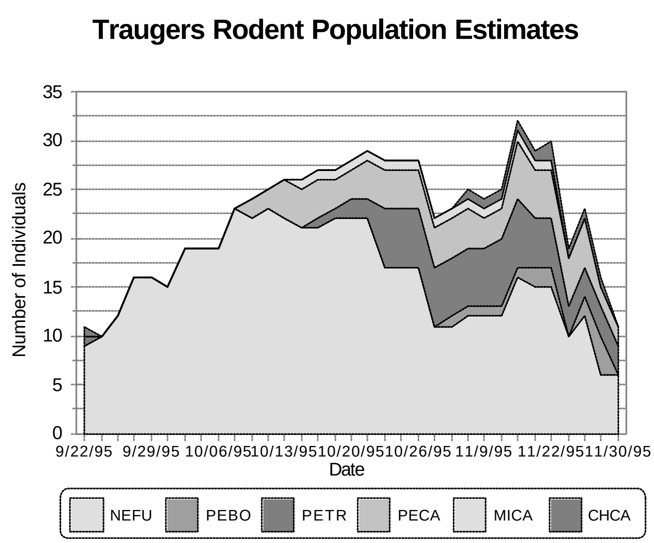

Figure 9. Daily modified Jolly-Seber estimates of the rodent population at the Traugers Plot.

Initially, *N. fuscipes* were the only species caught with regularity (Fig. 9). Then, in the second week of October, we began catching *Peromyscus* and one *Microtus* with regularity. It was not apparent whether this was a seasonal change or if it just took the mice longer to discover the traps. One of the interesting observations was the nearly universal tendency of captured *Neotoma* and *Peromyscus* to go up into the branches as soon as they were released. This was not consistent with my experience elsewhere in these Parks where rodents typically scurry away on the ground and occasionally in the branches. The few captures of *Microtus* and *Chaetodipus* represented the only surface-dwelling mice, and they were relatively rare. The observed behavior of common species and the rarity of surface-dwelling mice suggests strong selection for an aboreal existence in existing habitat. Observation of several *Crotolus viridis* and the capture of several *Bassariscus astutus* and a *Urocyon cinereoargenteus* provide ample evidence for the desireability for staying off the ground, thus also decreasing the likelihood of initial trap discovery. The two mamalian preditors had relatively high catchrates, 0.042 captures/trapnight and 0.021 captures/trapnight, respectively.

Serendipidy Surveys:

Serendipidy surveys were conducted at three sites: subalpine *Ribes-Artemisia* scrub, subalpine *Salix* shrub-scrub, and subalpine wet meadow. At the subalpine *Ribes-Artemesia* scrub, only *P. maniculatus* were captured. This site had the highest trap success of the season with 0.279 captures/trapnight.

The two wetland sites produed very different results. The subalpine *Salix* shrub-scrub had very low capture success with 0.038 captures/trapnight for *P. maniculatus* and 0.012 captures/trapnight for *M. longicaudus*. The subalpine wet meadow produced more species and higher overall cature success. *Zapus princeps* dominated the catch with 0.079 captures/trapnight. Other species were less common. *P. maniculatus* were caught at 0.036 captures/trapnight and *M. longicaudus* at 0.007 captures/trapnight. The subalpine Salix shrub-scrub is a dense jungle of tall willows and large sedges with poor human visability and a lot of cover. The subalpine wet meadow is very open and consists of both wet and dry communities. The wet communities were dominated by *Calamagrostis canadensis*, *Carex utriculata*, and several short species of *Salix*. The drier sites were dominated by *Carex abrupta*. Other important species of the drier sites included *Elymus trachycaulus* and *Veratrum californicum.*

The 48 trapnights of serendipity trapping for forest carnivores in mixed chaparral were reported above for the Traugers Plot. The remaining 72 trapnights were scattered in various vegetation types varying from white fir to mixed broard-leaved/conife r forest. Results included two *Martes americana* (0.091 captures/trapnight) in the fir forest and two *Bassariscus astutus* (0.125 captures/trapnight in the riparian mixed hardwood/conifer site at Redwood Creek and 0.024 captures/trapnight in the lower montane hardwood forest).

A survey and guide to wildlife fire environments was initiated in 1995. Most of the environmetal diversity was photographed and a taxonomic structure was initiated in an effort to merge existing vegetation and wetland classification schemes with physical structure. When completed, this guide will be a companion to serendipity surveys.

***Aplodontia rufa*:**

The colony reported by Wright (1969) in the east fork of Redwood Creek was located. The original plans to map the surface evidence of *Aplodontia rufa* activity was abandoned because the foot-print of the colony was large (probably over several hundred meters), burrow entrances were common but not always distinctly different from erosion holes in tree roots, the vegetation was dense and would have been badly trampled in producing a good map, and the anticipated benefits of the map did not seem important when the site was viewed in the field. The site will be revisited for general observations that might indicate fire influences. *Aplodontia rufa* were found at four other locations within the combined Redwood Creek/Atwell Creek drainages.

***Martes pennanti*:**

The original plans for 1995 called for limited monitoring *Martes pennanti* using track plates. This was not done because a large supply of track boxes was not readily available, the new protocol that the Forest Service was developing and which I intended to follow was not yet available (Zilinski, *per. com.*), and to do it right could have become a full-time project by itself.

PROBLEMS

1. Rodents had a tendency to loose ear tags. It was extremely important that we had good descriptive information on such recaptures. The combination of age, sex, weight, linear measurements, and sometimes behavior allowed for reasonable estimation of the individuals' original identification.
2. *Neotoma fuscipes* activily removed cotton from traps, compromizing the safety of any animal captured. *Neotoma fuscipes* also occasionally lost the ends of their tails in the trap doors. Longer traps should eliminate both of these problems.
3. A number of traps were destroyed by *Ursus americanus*. The problem was not as serious as I feared it might become, but that could change. Periods of trapping need to be kept as short as possible, and areas with extensive use by *U. americanus* need to be avoided.
4. Hantavirus protection needs to be considered early when making plans for any rodent handling operations because the procedures add significantly to the time and cost of doing rodent monitoring. The proceedures are essential because hantavirus is a serious life-threatening disease. However, the procedures add bulk to field packs, decrease handler comfort, impede digital dexterity which slows handling and increases the likelihood of animals escaping while being handled, generate waste requiring sanitation, result in a lot of time going to sanitizing traps and other equipment, and add directly to the cost of supplies and labor. Hantavirus supplies need to be stock-piled to assure that crews do not run out of safety supplies prematurely causing an early termination of trapping; commercial and government sources for these supplies are not always available. New designs for

handling equipment are being explored.
5. Dealing with late snow storms, bear problems, and the lack of a real kitchen may have added some form of charm to the crew's job, but it also added to the difficulty. While the crew did not complain about living in tents and seemed to maintain their cheery disposition, housing would have been useful. It would have been especially good if they had local access to a computer and electricity for data entry. Housing and data entry alternatives need to be explored.

PLANS FOR 1996

1. Conduct post-burn survey of the Atwell Plot.
2. Establish one or two more long-term monitoring plots. If suitable sites can be located, one will be along the hardwood-conifer ecotone (*Pinus ponderosa, Calocedrus decurrens, Quercus kellogii*). The other should go into a lower subalpine environment (red fir forest, Jeffrey pine forest, green-leaf mananita chaparral, or sagebrush scrub). The second site may be postponed if the mixed chaparral site is burned in 1996 at a date that would permit immediate postburn survey.
3. Continue serendipity surveys in habitats not surveyed with long-term plots.
4. Visit burned *Aplodontia rufa* colonies and record observations that may be fire related.
5. Continue development of guide to wildlife fire environments.

ACKNOWLEDGMENTS

This work was possible because of funding from the National Interagency Fire Center. Jeff Manley coordinated monitoring portions of the funding request, and Nate Stephenson compiled a research, inventory, and monitoring plan for the entire Mineral King Risk Reduction Project. Jill Oertley hired the crew and helped with the initial coordination. Cathrine Ray and Margaret Hart did the majority of the trapping; Jacob Martin assisted near the end of the season. Margaret Hart also prepared a list of birds for each plot during the trapping period. The project got strong support from volunteers. Timothy Keesey contributed five weeks to the trapping, and Michelle Disney contributed over a week of her time to both trapping and helping me with vegetation surveys. Patrick Whitmarsh identified and characterized dominant vegetation on the subalpine wet meadow serendipity trapping site. Robert Parmenter and David Spildie provided information on hantavirus safety. Anthony Caprio aged some of the shrubs by the Traugers Plot and provided advice during the surveys. Cathy Bledgi coordinated payroll for the crew. The Fire Management Office coordinated the Atwell Burn. Both ranger and maintenance staff provided support that helped us maintain the field camp. The intrepretation staff coordinated public information on the project.

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APPENDIX

Table 1-A. Vertebrates observed in the two long-term monitoring plots. The letters under the plot names represent qualitative descriptors of observation frequency [rarely (R), uncommonly (U), and commonly (C)].

Common Name	Binomial Name	Plot	
		Atwell	Trauger
MAMMALS			
Black Bear	*Ursus americanus*	U	U
Broad-footed Mole	*Scapanus latimanus*		R
Brush Mouse	*Peromyscus boylii*		U
California Mouse	*Peromyscus californicus*		U
California Pocket Mouse	*Chaetodipus californicus*		R
California Vole	*Microtus californicus*		R
Chickaree	*Tamiasciurus douglasii*	U	
Deer Mouse	*Peromyscus maniculatus*	C	
Dusky-footed Woodrat	*Neotoma fuscipes*	C	
Grey Fox	*Urocyon cinereoargenteus*		R
Long-tailed Vole	*Microtus longicaudus*	U	
Mule Deer	*Odocoileus hemionus*	U	U
Northern Flying Squirrel	*Glaucomys sabrinus*	R	
Ornate Shrew	*Sorex ornatus*		U
Pinyon Mouse	*Peromyscus truei*		U
Ringtail	*Bassariscus astutus*		U
Trowbridge Shrew	*Sorex trowbridgii*	U	
Valley Pocket Gopher	*Thomomys bottae*		U
BIRDS			
American Robin	*Turdus migratorius*	C	
Anna's Hummingbird	*Calypte anna*	U	C
Band-tailed Pigeon	*Columba fasciata*		C
Black-headed Grosbeak	*Pheucticus melanocephalus*		U
Brown Creeper	*Certhia americana*	C	
Bushtit	*Psaltriparus minimus*		C
California Towhee	*Pipilo crissalis*		C
Canyon Wren	*Catherpes mexicanus*		U
Common Raven	*Corvus corax*	C	C
Dark-eyed Junco	*Junco hyemalis*	C	
Downy Woodpecker	*Picoides pubescens*	C	
Evening Grosbeak	*Coccothraustes vespertinus*	R	
Fox Sparrow	*Passerella iliaca*		C
Hairy Woodpecker	*Picoides villosus*	C	
Hermit Thrush	*Catharus guttatus*	U	
Mountain Chickadee	*Parus gambeli*	C	C
Mountain Quail	*Oreortyx pictus*		C
Mourning Dove	*Zenaida macroura*	U	
Northern Flicker	*Colaptes auratus*	C	
Northern Goshawk	*Accipiter gentilis*	C	
Purple Finch	*Carpodacus purpureus*	U	
Pygmy Nuthatch	*Sitta pygmaea*	U	
Red-breasted Nuthatch	*Sitta canadensis*	C	
Red-tailed Hawk	*Buteo jamaicensis*	U	C
Rufous-sided Towhee	*Pipilo erythrophthalmus*		C
Scrub Jay	*Aphelocoma coerulescens*		C
Steller's Jay	*Cyanocitta stelleri*	C	C
Townsend's Warbler	*Dendroica townsendi*	C	
Vaux's Swift	*Chaetura vauxi*		R
Western Tanager	*Piranga ludoviciana*	C	
White-crowned Sparrow	*Zonotrichia leucophrys*		U
White-headed Woodpecker	*Picoides albolarvatus*	C	
White-throated Swift	*Aeronautes saxatalis*		U
Winter Wren	*Troglodytes troglodytes*	C	
Wrentit	*Chamaea fasciata*		C
Yellow Warbler	*Dendroica petechia*	C	
Yellow-rumped Warbler	*Dendroica coronata*	C	
REPTILES			
California Mountain Kingsnake	*Lampropeltis zonata*		R
Southern Alligator Lizard	*Gerrhonotus multicarinatus*		R
Western Rattlesnake	*Crotalus viridis*		U
Western Whiptail	*Cnemidophorus tigris*		R