

## 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 Sneek 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 calendar 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

## **Mineral King Risk Reduction Project - Annual Report 1995**

---

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.

## References

- Arno, S.F. and K.M. Sneek. 1977. A method for determining fire history in the coniferous forests in the mountain west. USDA For. Serv. Gen. Tech. Rep. RM-142.
- Blonski, K.S. and J. L. Schramel. 1991. Photo series for quantifying natural forest residues: southern Cascades, northern Sierra Nevada. USDA For. Serv. Gen. Tech. Rep. PSW-56.
- Caprio, A.C. and T.W. Swetnam. 1995. Historic fire regimes along an elevational gradient on the west slope of the sierra nevada, california. pp. 173-179. *In Proceedings: Symp. On Fire in Wilderness and Park Management*. 1993 March 30-April 1; Missoula, MT, USDA For. Serv. Gen. Tech. Rep. INT-GTR-320. 283 pp.
- Conover, C. and C. Moore. 1996. Summary of fuel loading and forest stand structure, MKRRP. NPS, Sequoia & Kings Canyon National Parks, Div. Sci. and Nat. Res. Mngmt., 3 p.
- Davis, M.B. 1985. Forest history of Sequoia Park - feasibility study. Report to NPS, Sequoia and Kings Canyon National Parks, June 26, 1985, 14 pp.
- Dieterich, J.H. 1980. The composite fire interval - a tool for more accurate interpretation of fire history. pp 8-14. *In*: M.A. Stokes and J.H. Dieterich (tech. coord.). *Proceedings of the Fire History Workshop, Oct. 20-24, 1980, Tucson, Ariz.*, USDA For. Ser., Gen. Tech. Rep. RM-81.142 pp.
- Graber, D.M. and L.A. Hammett. 1996. Watershed Research: Sequoia and Kings Canyon National Parks, Annual Report 1995. National Biological Service, Sequoia & Kings Canyon Field Station. 20 pp.
- Graber, D. M., Haultain, S. A. and J. E. Fessenden, 1993, Conducting a biological survey: a case study from Sequoia and Kings Canyon National Parks. *In: Proceedings of the Symposium on Research in California's National Parks, National Park Service*
- Haultain, S. 1996. Natural Resource Inventory involvement in the Mineral King Risk Reduction Burn: 1995 progress report, and 1996 work plan. NBS, Sequoia & Kings Canyon Field Station, memorandum 12-Mar-1996, 2 p.
- Keifer, M. 1995. Sequoia and Kings Canyon National Parks Fire Effects Monitoring Program - 1995 Annual Report. NPS, Sequoia & Kings Canyon National Parks, Div. Sci. and Nat. Res. Mngmt. 18 pp.
- Keifer, M. 1995. Prescribed fire and heavy fuel effects on mature giant sequoia trees. Study plan for the Atwell Grove. 8 pp.
- Moore, C. and C.C. Conover. 1995. Mineral King fuels crew: 1995 end of year report. NPS, Sequoia & Kings Canyon National Parks, Div. Sci. and Nat. Res. Mngmt. 4 pp.
- NPS. 1995. Assessing the operational requirements and cost effectiveness of large scale prescribed burning for wildland management. USDI NPS, Sequoia and Kings Canyon National Parks, Project proposal

## Mineral King Risk Reduction Project - Annual Report 1995

---

- for National Interagency Fire Center, 42 pp.
- Pitcher, D. 1987. Fire History and Age Structure in Red Fir Forests of Sequoia National Park, California. *Canadian Journal of Forest Research* 17:582-587.
- Stephenson, N.L. 1994. Long-term dynamics of giant sequia populations: implications for managing a pioneer species. pp. 56-63. In: P.S. Aune (tech. coord.). *Proceedings of the Symposium on Giant Sequoias: Their Place in the Ecosystem and Society, June 23-25, 1992, Visalia, CA* USDA For. Ser. Gen. Tech. Rep. PSW-GTR-151. 170 pp.
- Stephenson, N.L. 1995. Research, Inventory, and Monitoring Plan for the program: Assessing the Operational Requirements and Cost Effectiveness of Large Scale Prescribed Burning for Wildland Management. NPS/NBS Study plan, 13 pp.
- Stokes, M.A. 1980. The dendrochronology of fire history. pp 1-3. In: M.A. Stokes and J.H. Dieterich (tech. coord.). *Proceedings of the Fire History Workshop, Oct. 20-24, 1980, Tucson, Ariz.*, USDA For. Ser., Gen. Tech. Rep. RM-81.142 pp.
- Swetnam, T.W., C.H. Baisan, A.C. Caprio, R. Touchan, and P.M. Brown. 1992. Tree-Ring Reconstruction of Giant Sequoia Fire Regimes. Final Report to Sequoia, Kings Canyon and Yosemite National Parks, Cooperative Agreement No. DOI 8018-1-0002, Laboratory of Tree-Ring Research, University of Arizona, Tucson, AZ.
- Vankat, J.L. 1970. Vegetation change in Sequoia National Park, California. Dissertation, Univ. of Calif., Davis, 197 pp.
- Weise, D.R., A. Gelobter, S. Haase, and S. S. Sackett. (in review). Photo series to assist in assessing fire risk in giant sequoia (*Sequoiadendron giganteum*) groves. USDA For. Serv. PSW-4403-94.1.
- Werner, H. 1996. Fire Effects Monitoring on Wildlife - 1995 Annual Report. NPS, Sequoia & Kings Canyon National Parks, Report. Div. Sci. and Nat. Res. Mngmt. 17 pp.

**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 re inventoried 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 re inventory 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**

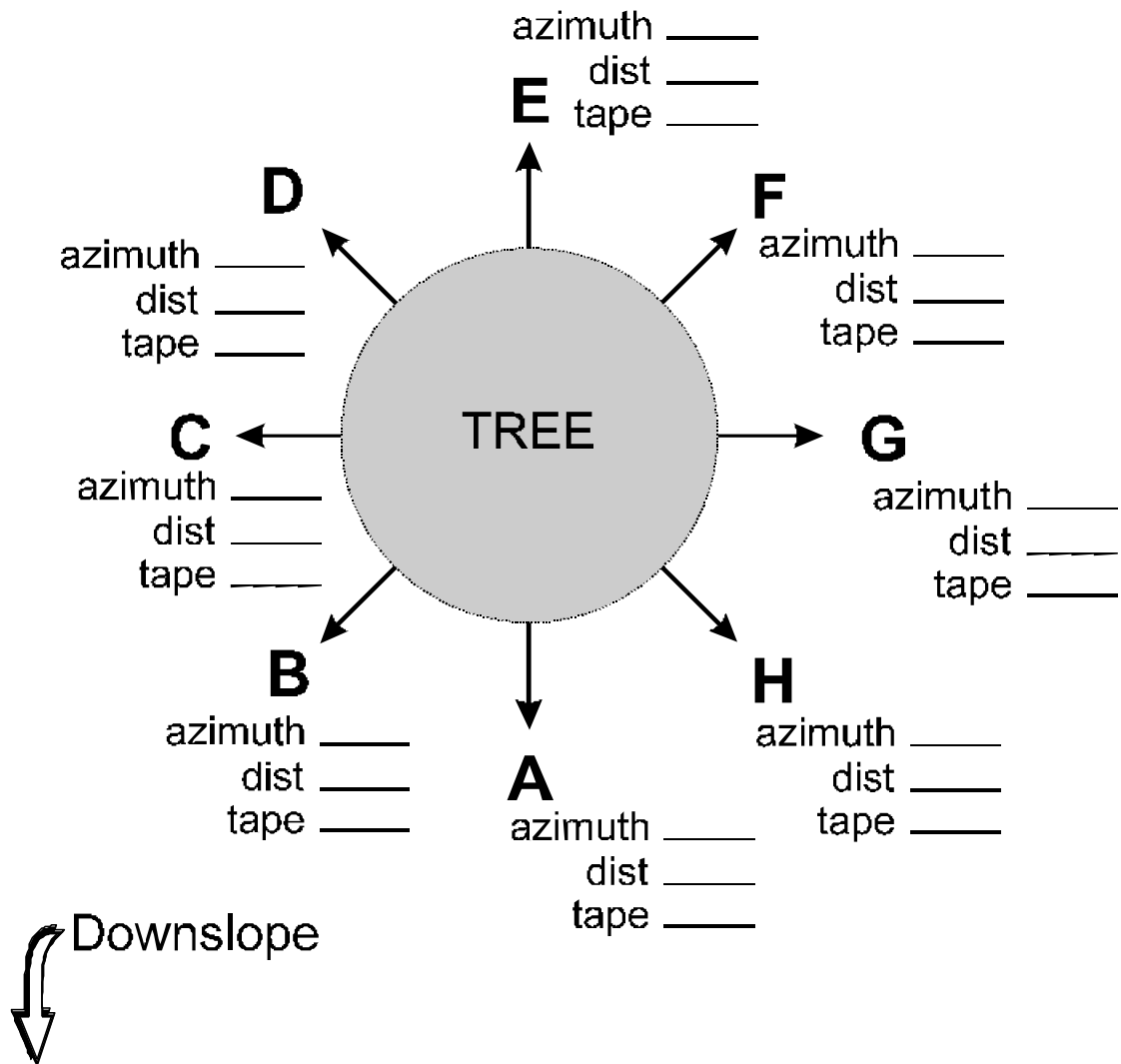
Lambert, Sherman. and Thomas J. Stohlgren. 1988. Giant sequoia mortality in burned and unburned stands. *Journal of Forestry*, February.

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 \_\_\_\_\_

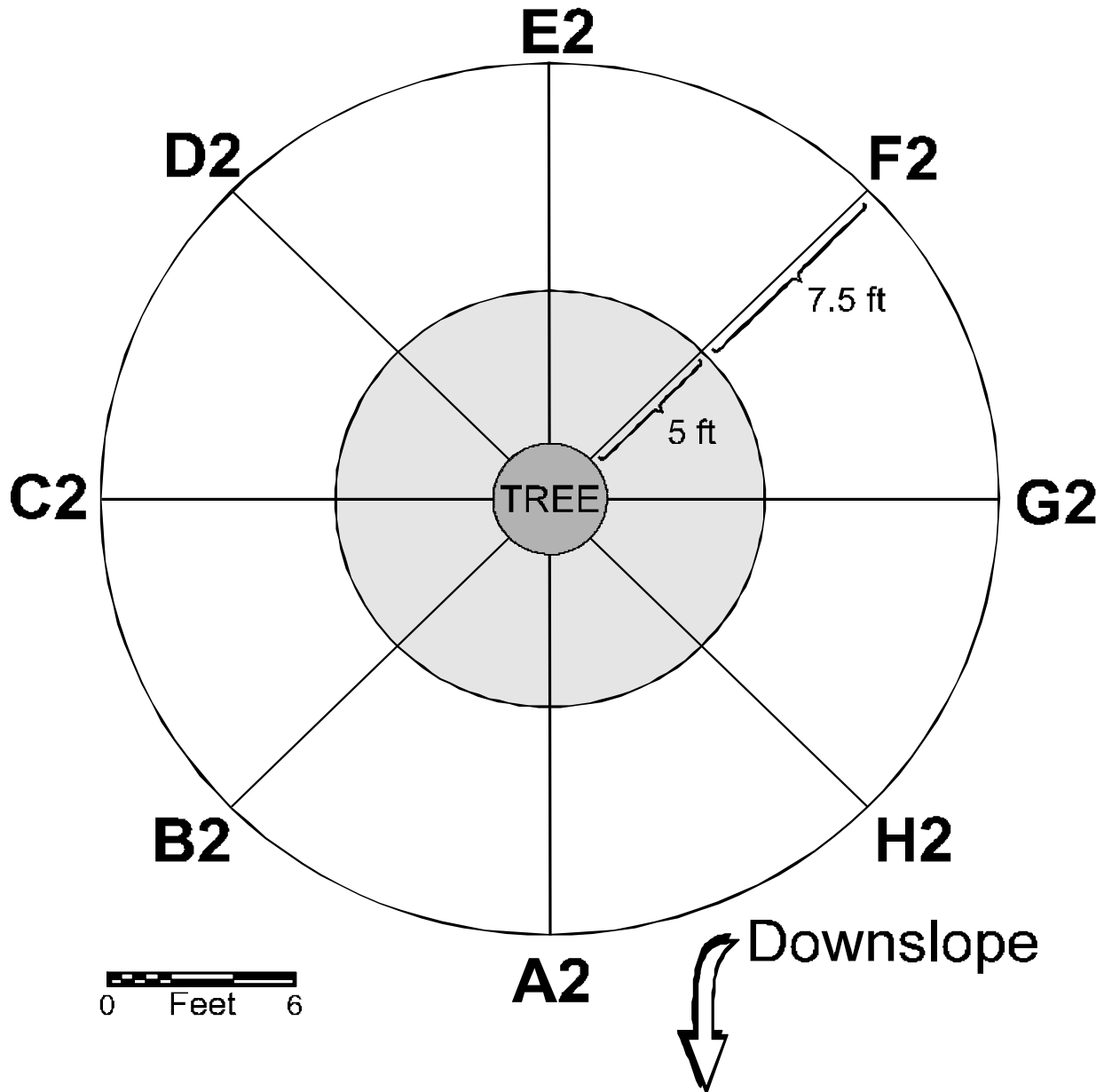


dist = distance from tree bole to rebar  
 tape = numerical reading from circumferential tape at rebar

**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

Harold W. Werner  
Fish and Wildlife Biologist  
Sequoia and Kings Canyon National Park  
Three Rivers, California 93271

Telephone (209) 565-3123  
FAX (209) 561-3730

TABLE OF CONTENTS

<i>Executive Summary</i>	<i>ii</i>
I. Introduction	1
II. Methods	2
III. Results and Discussion	3
A. Permanent Plots, 3	
1. Atwell Plot, 3	
2. Traugers Plot, 6	
B. Serendipity Surveys, 9	
C. <i>Aplodontia rufa</i> , 10	
D. <i>Martes pennanti</i> , 10	
IV. Problems	10
V. Plans for 1996	11
VI. Acknowledgments	11
VII. Literature Cited	12
Appendix	A-1

*Executive Summary*

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*), piñon 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 discrete 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 measurable 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 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. lambertiana* 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. lambertiana* 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°). Maximum temperatures during trapping were 16-34° C (mean = 24° C) during the day with a minimum temperature of 8-18° C (mean = 14° 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

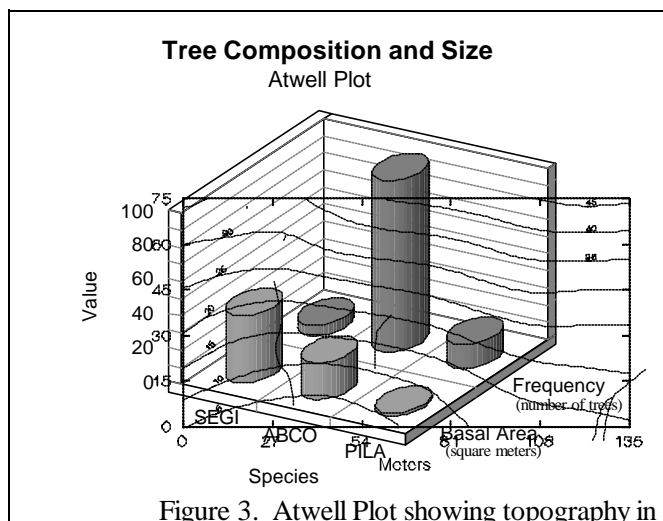


Figure 1. Species composition intervals and location of surface the 120 trees sampled at the Atwell Plot.

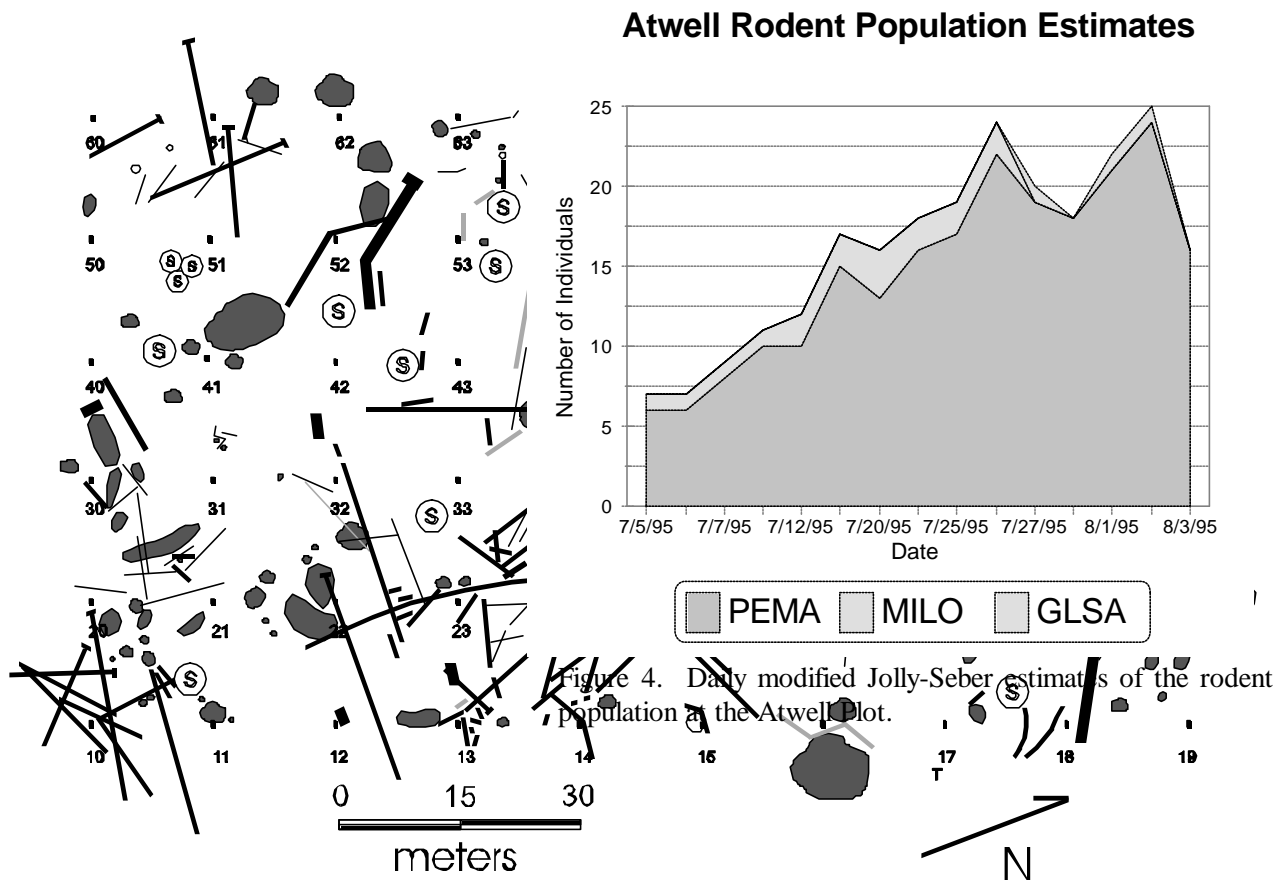


Figure 2. Atwell Plot showing the trapping grid and the location of down logs and rocks. The circles with an "S" in their center are mature sequoia trees in the plot. The "T" shows the location of the high-low thermometer. The steel stakes that mark the stations are located directly above the station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

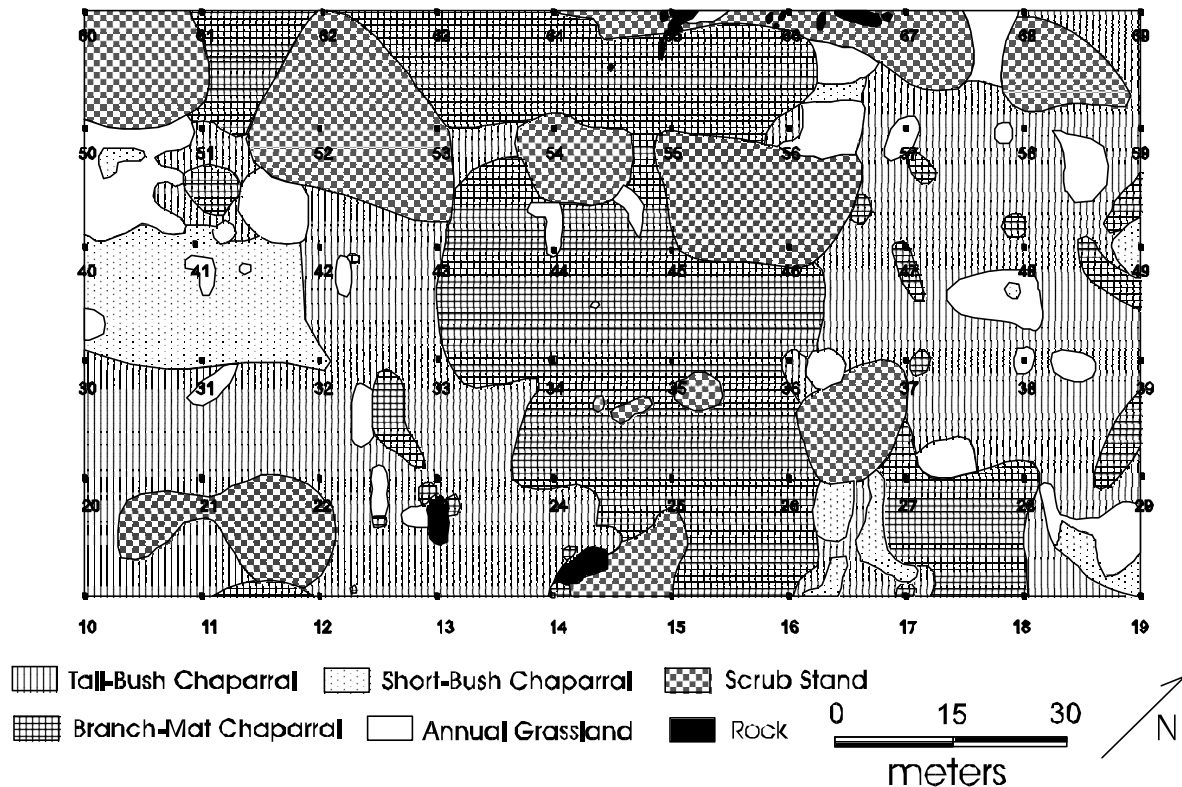


Figure 5. Traugers Plot showing the trapping grid and the boundaries of major vegetation types. The steel stakes that mark the stations are located directly above the station numbers.

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 frequency, 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<sup>2</sup>), *C. cuneatus* (median = 57 cm<sup>2</sup>), *A. mewukka* (median = 28 cm<sup>2</sup>), and *C. betuloides* (median = 13 cm<sup>2</sup>). Median stem size for the entire sample was 28 cm<sup>2</sup> (mean = 54

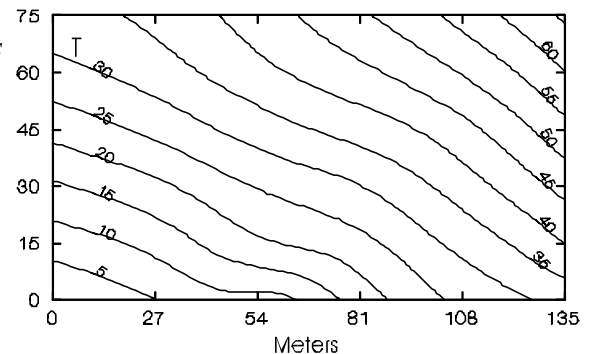


Figure 6. Traugers Plot showing topography in 5 m contour intervals. The “T” shows the location of the high-low thermometer.

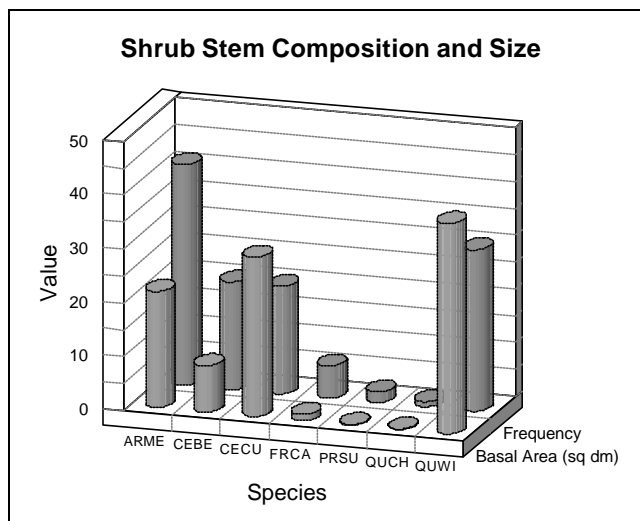


Figure 7. Species composition and total basal area for the 120 stems sampled at the Traugers Plot.

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.

The plot had some evidence of cultural use. Sawed-off poles and telephone insulators mark

cm<sup>2</sup>).

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

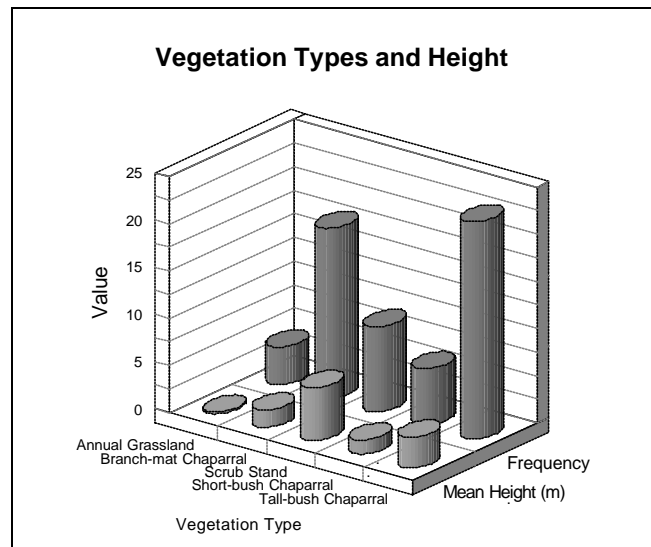


Figure 8. Vegetation types at the Traugers Plot and their mean height measured at the 60 trap stations.

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. Forty-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.

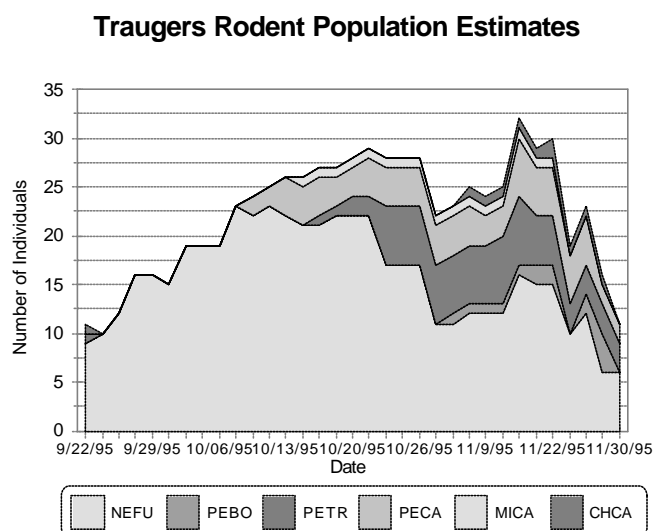


Figure 9. Daily modified Jolly-Seber estimates of the rodent population at the Traugers Plot.

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 arboreal existence in existing habitat. Observation of several *Crotalus viridis* and the capture of several *Bassariscus astutus* and a *Urocyon cinereoargenteus* provide ample evidence for the desirability for staying off the ground, thus also decreasing the likelihood of initial trap discovery. The two mammalian predators had relatively high catch rates, 0.042 captures/trapnight and 0.021 captures/trapnight, respectively.

### Serendipity Surveys:

Serendipity surveys were conducted at three sites: subalpine *Ribes-Artemisia* scrub, subalpine *Salix* shrub-scrub, and subalpine wet meadow. At the subalpine *Ribes-Artemisia* 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 produced 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 capture 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 visibility 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 Traegers Plot. The remaining 72 trapnights were scattered in various vegetation types varying from white fir to mixed broad-leaved/conifer 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 environmental 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* actively removed cotton from traps, compromising 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 procedures 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 kelloggii*). 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 Keeseey 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 interpretation staff coordinated public information on the project.

#### LITERATURE CITED

- Buckland, S. T. 1980. A modified analysis of the Jolly-Seber capture-recapture model. *Biometrics* 36:419-435.

- Davis, D. E. 1982. Calculations used in census methods. Pp 344-369 *in* Handbook of Census methods for terrestrial vertebrates (D. E. Davis, ed.). CRC Press Inc., Boca Raton, Fla.
- Kie, J. G., J. A. Baldwin, and C. J. Evans. 1994. CALHOME, home range analysis program, electronic users manual. Shareware. 19 p.
- Krebs 1989. Ecological methodology. HarperCollins *Publisher* Inc., New York, NY. 654 p.
- Mills, J. N., T. L. Yates, J. E. Childs, R. R. Parmenter, T. G Ksiazek, P. E. Rollin, and C. J. Peters. 1995. Guidelines for working with rodents potentially infected with hantavirus. *J. Mammol.* 76:716-722.
- Orr, R. T. 1976. Vertebrate biology. W. B. Saunders Company, Philadelphia, Pa. 472 p.
- Wright, J. W. 1969. Mountain beaver (*Aplodontia rufa*) behavior: extreme southern limits. Unpub. MA Thesis, Fresno State College, Fresno, Ca. 113 p.
- Zeiner, D. C., W. F. Laudenslayer, Jr., and K. E. Mayer. 1988. California' s wildlife, vol. III, mammals. Calif. Dep. Fish and Game, Sacramento, Ca. 407 p.



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