III) Project Year 1996

The Mineral King Risk Reduction Project was initialized during March 1995 with field work and limited burning beginning during 1995 (2,100 ac/850 ha in segment #3, **Fig. 1**). Burn plans developed by the Fire Management Office during the spring of 1996 called for burning portions of segments #10, #4, and #2 during the summer/fall. Ignitions in segment #10 were planned to begin as fuels at higher elevations in the unit dried during the summer. The primary goal of the plan was to burn areas above the Tar Gap Trail with this trail being the main holding line. Depending on circumstances burning might continue below the Tar Gap Trail with the Hockett Trail being the secondary and lower holding line. The burn was to extend from the Mosquito Creek/Mineral Creek area in the northeast portions of the segment to Horse Creek to the south. The key unit planned for burning during 1996 was segment #4 located between the East Fork and the lower portion on segment #3 along the Mineral King Road. The upper forested portions of this unit were to be burned in the fall after most visitor use and local residents in Silver City and Mineral King had left for the season. Burning in chaparral and oak woodland in this unit and in segment #2 were planned to take place following significant rainfall. The plan was for rainfall to wet heavy forest fuels while brush fuels would dry rapidly following precipitation. Eventually, a burn buffer between the lower East Fork drainage and the Silver City/Mineral King developed areas would be created. However, due to the extent of resource demands during the summer of 1996 (more acres burned in the western USA than any year since 1920) burning was not initiated in segment #10. Additional burning in segments #4 and #2 was curtailed when early and heavy rains fell during October soaking lower elevation chaparral/oak fuels. At this time, burn plans for 1997 essentially carry forward the plans developed during 1996.

Field work involved with monitoring, inventory, and research during 1996 concentrated on the upper portions of segment #10 and in segments #2 and #4 on the south facing slopes of the East Fork watershed (**Fig. 4**). The projects included studies begun during 1995 and several new investigations. The former include: (1) fire effects plots; (2) sequoia fire scars; (3) natural resource inventory; (4) fuels; (5) wildlife-small mammal populations; (6) fire history; (7) watershed-chemistry and hydrology; (8) watershed-aquatic macroinvertabrates; (9) resampling of red-fir plots established by D. Pitcher; (10) The latter include: (1) remote sensing of fuels and vegetation; (2) landscape analysis of changes in forest structure over time; (3) population and niche requirements of bark-foraging birds; and (4) establishing permanent fuel plots (for C. Miller). A significant amount of information was collected from throughout the East Fork during summer of 1996. While field work was rushed during the early portion of he 1996 season to collect data and establish sampling plots, the lack of burning in the East Fork during the summer created a little breathing room for the investigators. The delay has essentially provided a one field season lead for planning and implementing projects.

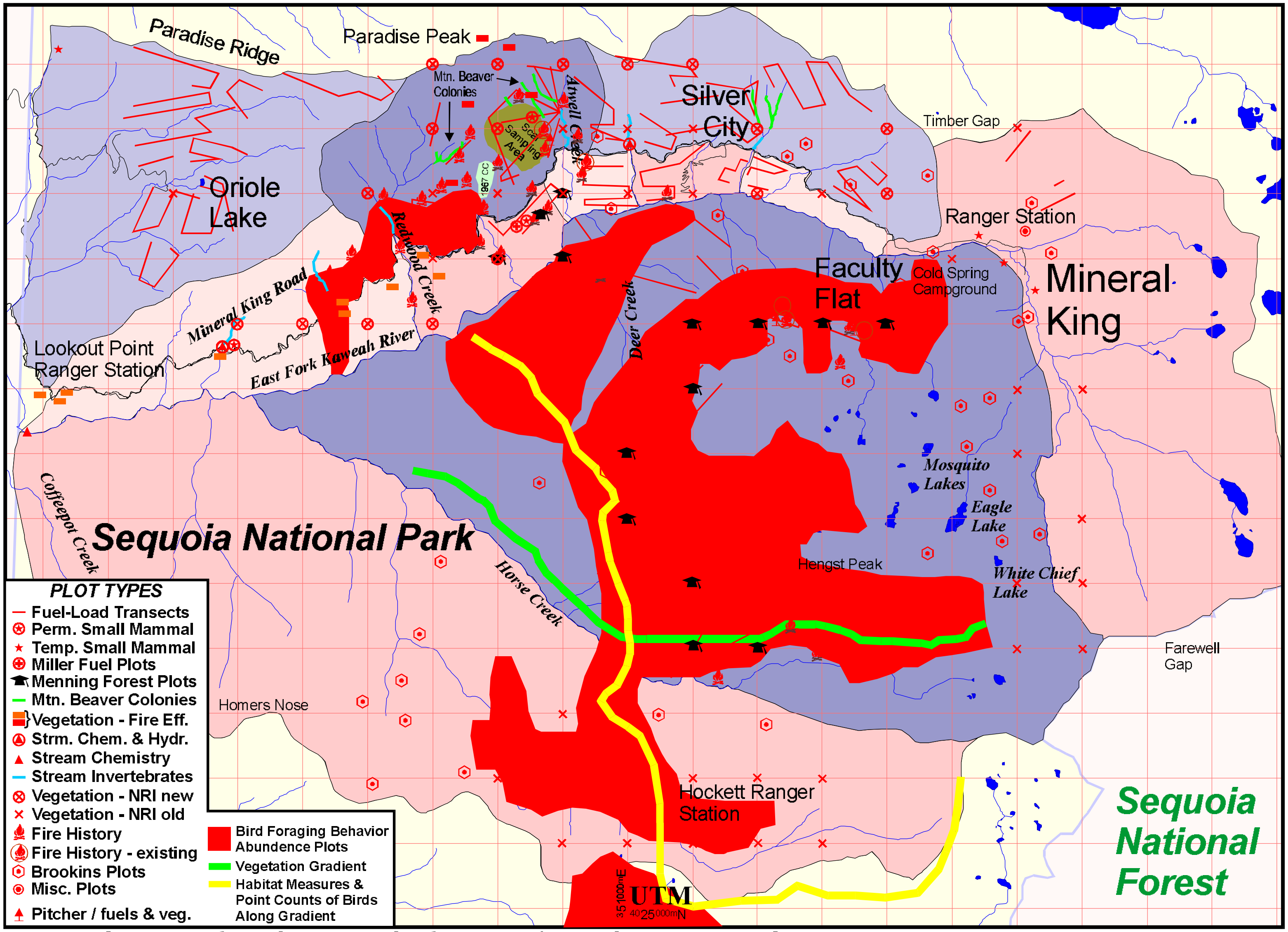


Figure 4.

Mineral King Risk Reduction Project

Project Area and Monitoring/Research Locations: East Fork

0 1 2 3 Miles

0 1 2 3 Kilometers

N

Vegetation Sampling

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

Lead: M. Keifer; field-crew supervisor: G. Dempsey; field crew: D. Haskamp, G. Indinoli, P. Mulligan, and A. Peterson.

Summary prepared by M. Keifer

Work Completed in 1996: During the 1996 field season, 5 forest plots that burned in segment #3 of the Mineral King burn unit were remeasured one-year postfire and 1 forest plot located outside the segment (unburned) was also revisited (**Fig. 6**). Segments 2 and 4 were not burned as planned, therefore, none of the 9 chaparral plots (3 chamise and 6 mixed) were revisited. One new plot was installed in segment 10 in the Red fir forest type. UTM coordinates for all plots were determined (**Table 4**).

Results to Date: Results are presented for plots that burned in segment #3 in three forest monitoring types. The results include dead and down fuel load, overstory tree (>1.37 m in height) density, and seedling (<1.37 m in height) density. Where more than one plot is included in the analysis, results are presented as mean values ± one standard error. Results related directly to quantitative fire management objectives are indicated in bold typeface. Note that results apply only to the plot areas measured due to the small sample sizes (at most, 2 plots per monitoring type).

Ponderosa pine-mixed conifer forest **(PIPO) -** Only one PIPO plot has been established and burned in the East Fork watershed. This plot was located adjacent to a 2-3 acre hot spot (100% overstory mortality) above Redwood Creek (visible from road when driving up the Mineral King Road). The location resulted in fire effects that were severe relative to effects normally observed in PIPO plots elsewhere in SEKI. Additional plots are being established within the watershed.

In this PIPO plot, **67% of the total fuel load was consumed** by the fire, from 98.3 tons/acre prefire to 33.0 tons/acre immediately postfire (**Fig. 5**). The duff was completely consumed (100%) and woody fuels were reduced by 51%.

Total overstory tree density was 1170 trees/ha prefire and 210 trees/ha one-year postfire, indicating 82% overstory mortality in the plot following the fire (**Fig. 7**). Prefire composition was dominated by incense cedar (85% of all trees), most of which

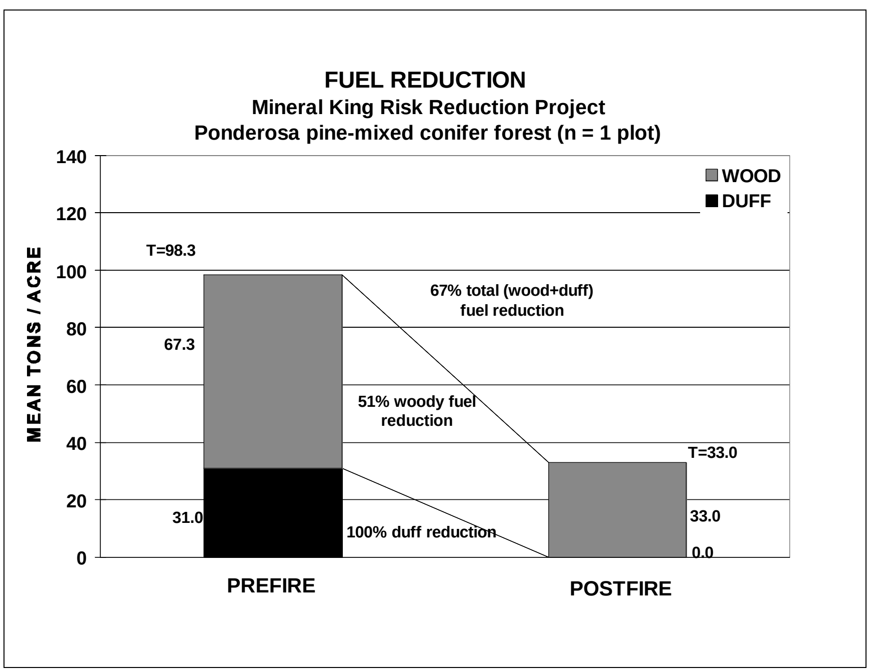


Figure 5. Fuel load change in ponderosa pine-mixed conifer forest, preburn to one-year postburn.

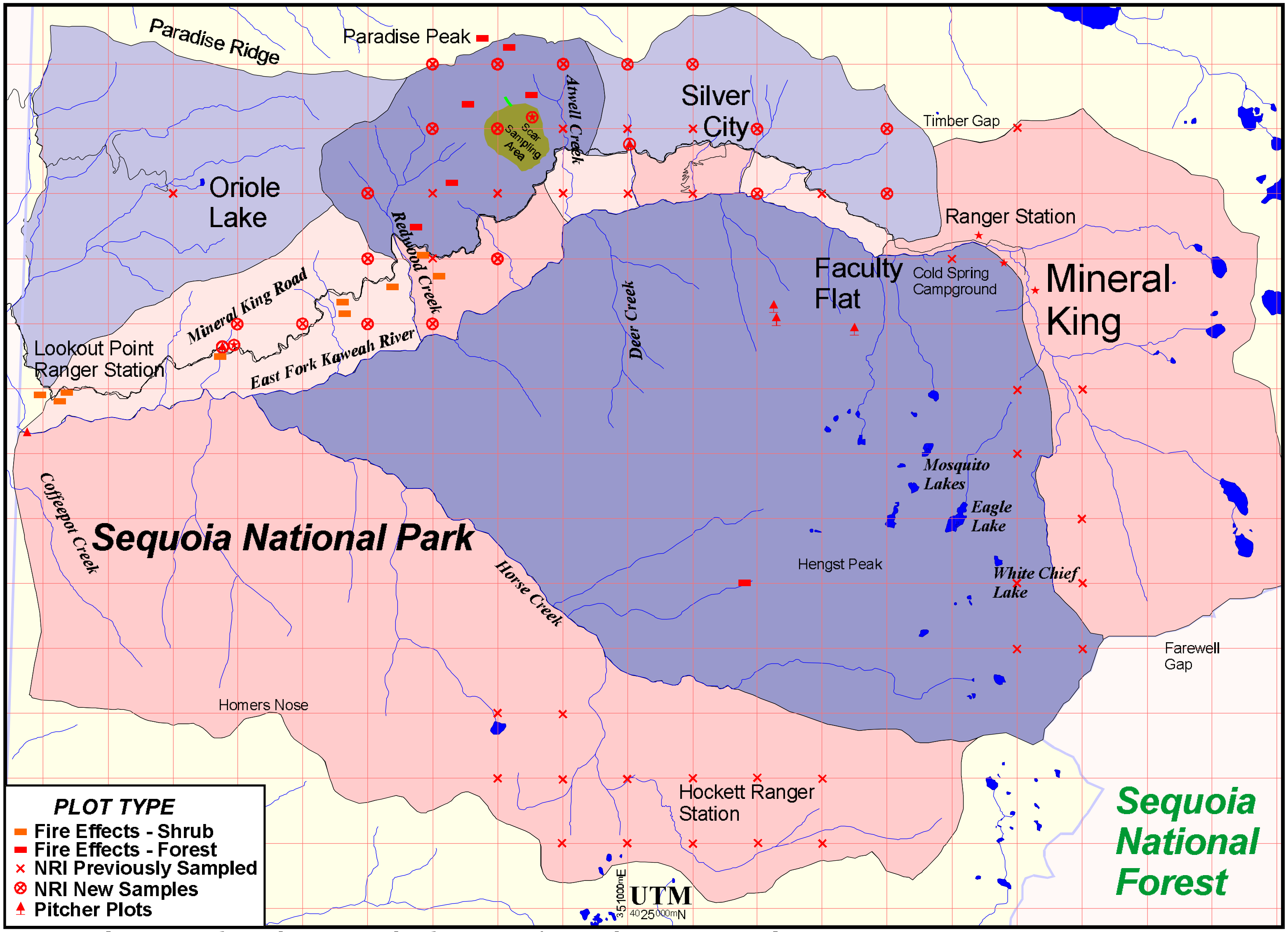


Figure 6.

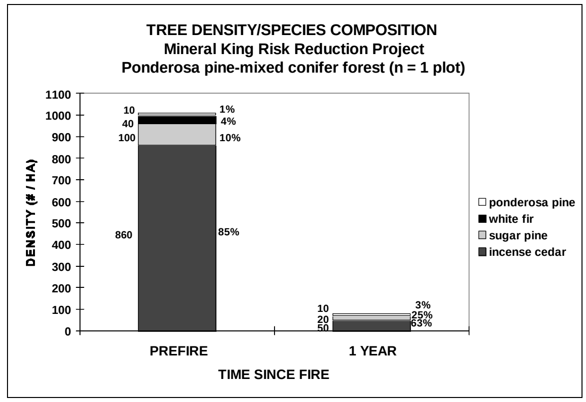
Mineral King Risk Reduction Project

Vegetation Sampling

NRI Plots, Fire Effects Plots, Sequoia Fire Scar Study, and Pitcher Plots were less than 40 cm in diameter at breast height (DBH). Incense cedar was reduced from 860 trees/ha prefire to 50 trees/ha one-year postfire (94% mortality). While incense cedar remains dominant, relative species composition changed from prefire conditions to one-year postfire. Incense cedar decreased (from 85% to 63%) and white fir decreased (from 4% to 0%), while ponderosa pine and sugar pine relative densities increased (from 1% to 3% and from 10% to 25% respectively) (**Fig. 7**).

Total seedling density increased by 216% from 16.4 x 10^3 seedlings/ha prefire to 51.8 x 10^3 seedlings/ha 1-year postfire (Table 2). Most of this increase was due to the prolific establishment of incense cedar seedlings (from 1.8 x 10^3 prefire to 51.2 x 10^3 seedlings/ha one-year postfire).

Figure 7. Change in tree species density and composition.



Giant sequoia-mixed conifer forest **(SEGI) - Total fuel load was reduced by 89%** in one SEGI plot, from 142.5 tons/acre prefire to 16.1 tons/acre immediately postfire (**Fig. 8**). The duff was reduced by 92%, while 88% of the woody fuels were consumed. Due to the late season burn, the second SEGI plot was not remeasured immediately postfire.

In two SEGI plots, mean total overstory tree density was reduced by 35%, from 595 trees/ha (± 215) prefire to 385 trees/ha (± 135) one-year postfire (Figure 4). White fir dominated prefire density (66%) and most mortality occurred in the smaller diameter white fir (less than 40 cm). Relative density changed slightly from prefire conditions to one-year postfire. Incense cedar and white fir decreased (from 3% to 0% and from 66% to 58%, respectively) and relative increases occurred in sugar pine (from 17% to 21%) and giant sequoia (from 8% to 13%) (**Fig. 9**). No mortality of any giant sequoia trees occurred in either plot.

Mean total seedling density for two SEGI plots was 17.6 x 10^3 seedlings/ha (± 10.4 x 10^3) prefire and increased by 419% to 91.3 x 10^3 seedlings/ha (± 85.7 x 10^3) one-year postfire (**Table 2**). This increase was due to the postfire establishment of giant sequoia seedlings (from 0 prefire to a mean of 88.3 x 10^3 seedlings/ha one-year postfire); all other species seedling density decreased one-year

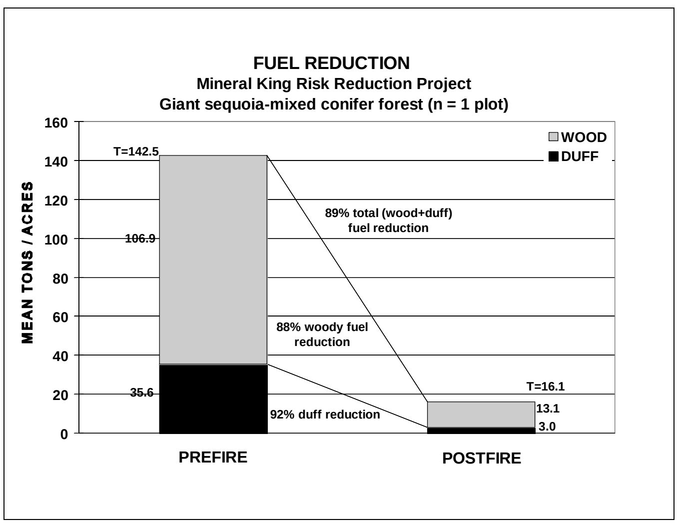


Figure 8. Fuel load change in sequoia mixed-conifer forest, preburn to one-year postburn.

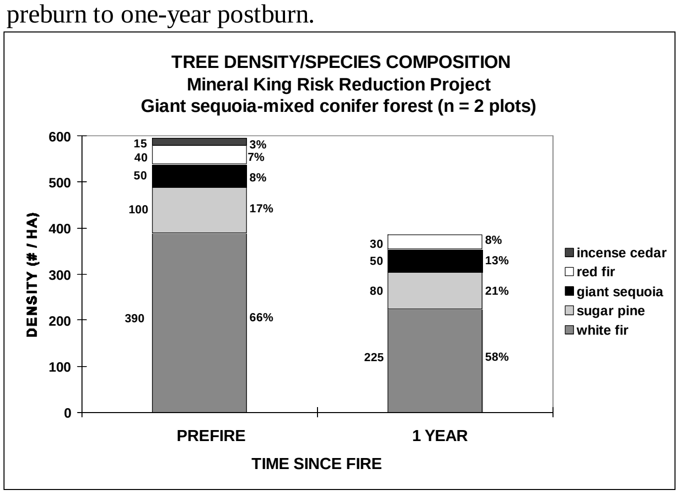


Figure 9. Change in tree density and species composition.

postfire. This result corroborates previous studies that show that fire greatly increases the establishment of giant sequoia seedlings.

***Red fir forest* (ABMA) -** In two ABMA plots, mean total fuel load was 116.7 tons/acre (± 6.5) prefire and 6.8 tons/acre (± 2.0) one-year postfire, which indicates **94% total fuel reduction** (**Fig. 10**). The plots were not revisited immediately postfire due to the late season burn. A small amount of fuel may have accumulated from the time the plots burned until they were remeasured the following summer, therefore, the fuel reduction results may be conservative. The duff was reduced by 90% and 96% of the woody fuels were consumed.

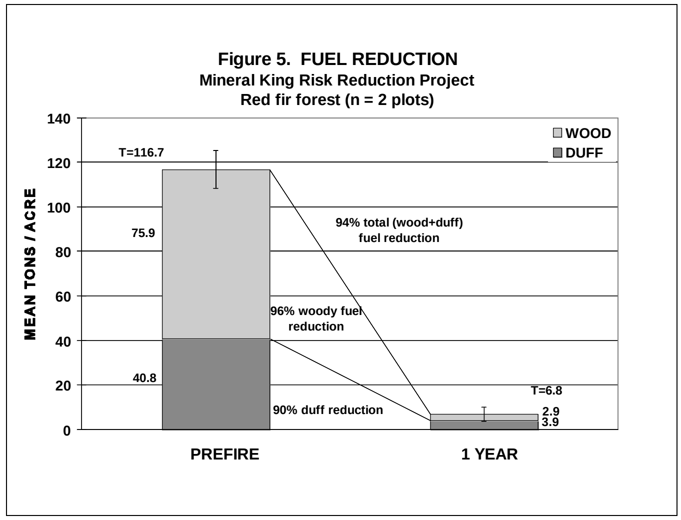


Figure 10. Fuel load change in red fir forest, preburn to one-year postburn.

Mean red fir overstory tree density for two plots was 205.0 trees/ha (± 95.0) both prefire and one-year postfire. No overstory red fir mortality occurred in either of the ABMA plots following the fire.

Mean red fir seedling density for two plots was reduced by over 99%, from 86.9 x 10^3 seedlings/ha (± 19.5 x 10^3) prefire to 300 seedlings/ha (± 300) one-year postfire (**Table 5**).

Table 4. Plot locations (an asterisk in the UTM-East column indicates the plot was georeferenced using a global positioning system with an accuracy of ± 3-30 meters).

Plot ID	Monitoring Type	Burn Segment	UTM East	UTM North
FPIPO1T09 094	Ponderosa pine-mixed conifer forest	#3	347570	4035590
FSEGI1T08 093	Giant sequoia-mixed conifer forest	#3	348280	4036200
FSEGI1T08 095	Giant sequoia-mixed conifer forest	#3	349200	4037510
FABMA1T08 096	Red fir forest	#3	349100	4038310
FABMA1T08 097	Red fir forest	#3	348430	4037610
FABMA1T08 098	Red fir forest	unburned	348680	4038320
FABMA1T08 100	Red fir forest	#10	352809*	4030052
BADFA1D04 012	Chamise chaparral	#2	342251*	4032915
BADFA1D04 013	Chamise chaparral	#2	342214*	4032867
BADFA1D04 014	Chamise chaparral	#2	342233*	4032845
BARME1D04 007	Mixed chaparral	#2	347391*	4034592
BARME1D04 008	Mixed chaparral	#2	346596*	4034345
BARME1D04 009	Mixed chaparral	#2	346568*	4034144
BARME1D04 015	Mixed chaparral	#2	344635*	4033573
BARME1D04 010	Mixed chaparral	#4	348001*	4035021
BARME1D04 011	Mixed chaparral	#4	348112*	4034811

Table 5. Seedling Density.

Monitoring Type	Species	PREFIRE Seedling Density # / ha ± 1 SE (x 10^3)	1-YR POSTFIRE Seedling Density # / ha ± 1 SE (x 10^3)
Ponderosa pine-mixed conifer forest (PIPO)	Total (all species)	16.4	51.8
	Incense cedar	1.8	51.2
	Sugar pine	0.8	0.4
	Black oak	8.2	0
Giant sequoia-mixed conifer forest (SEGI)	Total (all species)	17.6 ± 10.4	91.3 ± 85.7
	Giant sequoia	0	88.3 ± 88.3
	White fir	16.1 ± 10.5	0.6 ± 0.2
	Incense cedar	0.5 ± 0.5	0
	Ponderosa pine	0.7 ± 0.7	0
Red fir forest (ABMA)	Red fir	86.9 ± 19.5	0.3 ± 0.3

Plans for 1997: All forest plots in segment #3 will be remeasured in 1997, two-years postfire. If scheduling allows, the 9 chaparral plots (installed late in 1995) will be remeasured early in the season in order to get more up-to-date preburn information prior to burns scheduled again this year. Also, 5 new plots are scheduled to be installed in segment #10, including 3 plots in the Red fir forest type and 2 plots in the ponderosa pine-mixed conifer forest type.

2) Giant Sequoia Fire Scars and Fuel Loading -

Science and Natural Resources Management, Sequoia & Kings Canyon National Parks.

Lead: M. Keifer; field-crew supervisor: G. Dempsey; field crew: D. Haskamp, G. Indinoli, P. Mulligan, and A. Peterson.

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 1995a and 1995b, see Appendix 1 in 1995 MKRRP Annual Report). 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 SMA (special management areas) restoration burn units are subject to prefire fuel removal as specified in Appendix H of the SEKI Fire Management Plan. 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 in 1995. In 1996 Appendix H was ammended to relax this internal SEKI policy requirement.

Work Completed in 1996: All 60 trees in the giant sequoia fuel and fire effects study located in segment #3 were revisited one-year postfire. Fuels, bark char, crown scorch, and mortality information was collected for all trees. Fire scar information was collected where possible, however, some scars could not be remeasured due to permanent marker movement after field equipment overwintered. All new scars (areas where the bark was removed by fires and scars will likely form) were recorded and measured. Detailed results for the giant sequoia fuel and fire effects study are not yet available, however, data collection revealed that no mortality occurred in any of the 60 study trees within one year following the fire.

Plans for 1997: The giant sequoia fuel and fire effects study trees will be revisited to record any mortality, and if time allows, assess any changes in new scars.

3) Natural Resource Inventory Plots (NRI) - Biological Resources Division of the USGS, Sequoia & Kings Canyon Field Station

D. M. Graber (P.I.), S. A. Haultain, B. Johnson, and P. Whitmarsh

Summary prepared by S. Haultain

Objectives: The general purpose of the broader park-wide Natural Resource Inventory 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 628 plots sampled by the end of 1996. 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 vascular plant species present in a plot, tree DBH, vegetation type, fuels, soils, litter/duff depth, rock type, and evidence of fire or other disturbance.

Figure 11. Plant identification for NRI project.

In the East Fork of the Kaweah, NRI plots were established to document the pre-burn floristic composition and forest structure of the areas included in the MKRRP segments, with an emphasis on those within the Atwell Grove (segment #3).

Fieldwork: Fieldwork during 1996 was conducted during the period between 3 June and 21 August in order to capture herbaceous species during peak flowering period at a range of elevations. The emphasis this year was on re-reading previously established NRI plots in the Atwell Grove (segment #3), the segment burned during fall of 1995, and establishing new plots in segments #2, #4, #7 and #8 (**Fig. 6**).

Data Collected: Seven plots within segment #3 were relocated successfully (**Table 6**) and re-read; an additional plot was attempted but not relocated. Of the 7 plots revisited, 5 showed evidence of having burned during the previous fall. Average scorch height and area of plot burned was estimated for each plot, in addition to the standard measurements taken. These data have yet to be analyzed.

Table 6. NRI plots re-visited/segment 3 (n=7) with UTM intersection points sampled.

Plot Number	utme/utmn	Vegetation Types	Burned 1995
173	350/4037	Montane Chaparral	N
601	347/4036	Sierran Mixed Coniferous Forest	Y
604	349/4037	Sierran White Fir Forest	Y
605	348/4037	Big Tree Forest	Y
606	350/4038	Big Tree Forest	N
607	348/4038	Red Fir Forest/Montane Chaparral	Y
608	349/4038	Red Fir Forest/Cliffs and Barren Rock Outcrops	Y

Ten new plots (**Table 7**) were established within segments #2, #4, #7 and #8; three of these contained chaparral, a type which is traditionally under sampled in the drainage due to problems with accessibility. The total number of NRI plots within the project area is now 53.

Future plans for NRI Involvement: 1997 field season: We anticipate having a field crew of two biological technicians (B. Johnson and P. Whitmarsh) re-read the plots within the Atwell Grove (segment #3) in order to collect post-burn data two years following the fire. It is unlikely that we will be establishing any new NRI plots within the drainage this year. We will, however, be surveying for introduced vascular plant species in targeted areas within the East Fork drainage, and will continue to survey for the two sensitive species, ***Angelica callii*** and ***Ribes tularense***, serendipitiously.

Table 7. NRI plots established (n=10) with UTM intersection points sampled.

Plot Number	utme/utmn	Segment	Vegetation Types
619	345/4034	2	Northern Mixed Chaparral/Canyon Live Oak Woodland
620	346/4034	2	Northern Mixed Chaparral/Canyon Live Oak Woodland
621	348/4034	4	Canyon Live Oak Woodland
622	347/4034	2	Northern Mixed Chaparral
623	353/4036	8	Cottonwood Riparian Woodland
624	352/4038	7	Montane Meadow
625	353/4037	7	Sierran White Fir Forest
626	351/4038	7	Red Fir Forest
627	355/4036	7	Montane Chaparral
628	355/4037	7	Dry Alpine Talus and Scree

4) Landscape Assessment - Fire and Forest Structure - University of California, Berkeley

Lead: K. Menning (UC Berkeley) with N. Stephenson (BRD - USGS), J. Battles, and T. Benning (UC Berkeley)

Summary prepared by K. Menning.

Objectives and background: The Mineral King Risk Reduction Project (MKRRP) provides an ideal laboratory to test an approach to forest restoration. A team of managers and scientists from the National Park Service, U. S. Geological Survey—Biological Resources Division, and National

Interagency Fire Center (NIFC) have chosen this watershed to test the practicality of introducing prescribed fire at a large scale (Menning 1996).

A century or more of fire suppression and climate change have combined to alter forest structure and pattern in Mineral King and in many places in the American West. It is thought that these changes in the return interval, extent and intensity of fire have resulted in increases in forest density, fuel loads, and fire risk. These changes have effects on wildlife habitat and understory biodiversity; forest structure, composition, and regeneration; ecosystem functioning; fire behavior, including susceptibility to catastrophic fire; and risk of epidemic loss to insects and disease due to a more homogeneous forest structure.

Figure 12. Sampling in mixed-conifer forest.

People advocating restoration of forests to recover to historic conditions while minimizing risks are divided into two different camps. *Structural restorationists* would alter forest structure to historic conditions by silvicultural thinning followed by the reintroduction of fire. They argue that prescribed fire in unthinned stands could result in stand-replacing fires and that historic forest conditions could not be achieved since forests have changed so fundamentally during the period of suppression. *Process restorationists* would restore native processes—fire—directly, without first modifying fuel loads, with the goal of recreating historic forest structures. Process restorationists maintain that one or two prescribed fires, carefully planned and managed, would begin to re-establish forest condition with little risk of catastrophic loss to fire. The implications of this debate have profound significance to managers wishing to restore forest conditions and ecologists wishing to understand fire ecology, disturbance regimes and forest succession.

Little information exists to address this debate, however, particularly from the process-restoration point of view. Because this light-handed restoration approach is generally compatible with National Park Service philosophy and might be implemented on a broader scale its ecological consequences need to be evaluated. In order to perform such an assessment we need to have better information on both the current and post-fire conditions of forests.

The Mineral King Landscape Assessment (MKLA) research seeks to provide some answers to this forest restoration debate by examining landscape-level effects of fire (**Fig. 12**). The research can be divided into several questions. First, what is the historic structure and pattern of the mixed conifer forest in this area? Second, does prescribed fire result in a more structurally diverse and complex forest? Third, can prescribed fire be used to restore forest condition to the state or range of variability described in the first question? The general concept being tested is whether burning increases structural and pattern diversity and complexity by breaking a more homogeneous, ingrown forest into a patchier mosaic. This more complex mosaic theoretically should have relatively small hot spots burned out containing no remaining forest cover, areas with the understory consumed by fire but little damage to the overstory, and other locations in which all size classes and species of trees remain relatively undisturbed by fire. To answer these question a suite of metrics needs to be identified which can be applied to a descriptive geometry and texture of forest condition, which indicate significant changes, and which have, to the highest degree possible, relevance to biological function.

The Mineral King Landscape Assessment (MKLA) research project represents a broad collaborative effort involving Sequoia and Kings Canyon National Park, U. S. Geological Survey, and the University of California—Berkeley's Laboratories of Forest Community Ecology (Dr. John Battles) and Landscape Ecology (Dr. Tracy Benning). Kurt Menning, Ph.D. student at the University of California—Berkeley, is the lead analyst in the project.

Figure 13. Data collection: Landscape Analysis Project.

Methods: Data collection for the Mineral King Landscape Assessment involves several kinds of information. Pictures of continuous landscapes are critical to any landscape analysis. The National Interagency Fire Center and the Fire Management Office combined to supply very specialized and high quality air photos in 1996. On September 18, 1996, high resolution remote photos were collected with the use of an airborne imaging system, the ADAR 5500 instrument. The instrument, which takes four simultaneous pictures in different bands of light—blue, green, red, and near infrared—digitally records the time, flight conditions and position of each photograph. These images, with a resolution of one meter, cover much of the watershed and over 450 individual photos were taken. The September flight had been delayed for several months due to smoke from fires burning to the north in and around Sequoia National Park.

More data are collected in the field to "ground truth" the remote imagery (test its accuracy and assist with corrections) and provide information not available from above. Collection of this information involves a scattered set of field plots (**Fig. 14**). In each plot trees are identified, measured and mapped, fuel conditions are recorded, brush and plant cover are noted, slope and aspect are recorded, and light penetrating through the forest canopy is measured (**Fig. 13**).

Work Completed:

Field data - Beginning in July, thirteen volunteers and employees from the former National Biological Service, National Park Service, Student Conservation Association, the University of California—Berkeley, and other institutions contributed 336 hours of time to the project, in addition to lead researcher Kurt Menning's time. Thank you to Dr. John Battles, Adrian Das, Athena Demetry, John Garvey, Jolie Garvey, Martin Hartmann, Jen Lucas, Becky Miller, Linda Mutch, Ronni Pile, Corinna Schalk, Dr. Nate Stephenson, and John Yurish.

Following a trial period of research method development and equipment testing permanent forest plots were established. In total, 45 circular forest plots were created (**Table 8** and **Fig. 14**), each 10 meters (32.8 feet) in radius. These were arranged in clusters around UTM intersections (1 km apart). The locations for the first plots were chosen based upon the likelihood of an area being burned during the summer/fall of 1996. Because fire management burn segments #4 and #10 were scheduled to be burned in 1996, plots were first established in these segments. Over the course of the summer, methods and equipment were significantly improved and the rate of plot establishment escalated.

Remote imagery - As described above, high resolution digital, multispectral pictures of the watershed were taken in September 1996. The images require significant processing, including corrections for the seasonal variation of the amount of light striking the earth's surface, atmospheric distortion, and distortion caused by differences in topography. In addition, the individual photos need to be correctly referenced to their true position on the ground and linked to each other in a process called orthorectification. This process has been delayed due to a gap which appeared between two flight lines and a lack of processing time due to the doctoral qualification exams

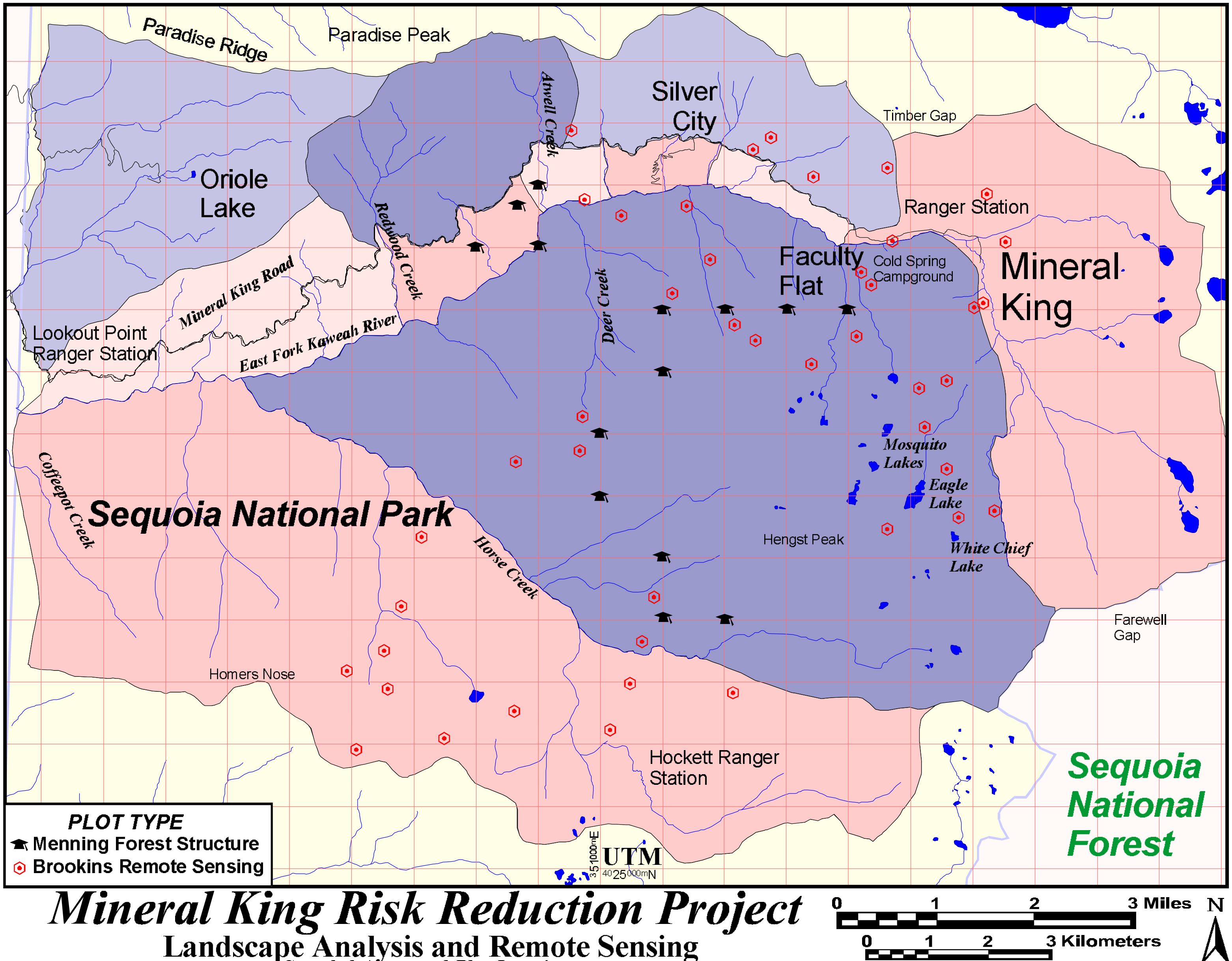


Figure 13.

Mineral King Risk Reduction Project

Landscape Analysis and Remote Sensing

Sampled Areas and Plot Locations

Table 8. Plot locations in East Fork drainage.

Segment	Plots established	Plots considered & rejected due to lack of trees or location outside segment	Total plots evaluated
4	9	13	22
10	36	4	40
Total	**45**	**17**	**62**

required of the lead researcher. These images are currently being processed and analyzed. Supplemental imagery will be reflow over the watershed during June 1997 to correct a gap in the original imagery.

Current Status: Development of Cases Studies: Currently, efforts are underway to process and analyze field data and air photos from 1996. In order to test the methods laid out in the Mineral King Landscape Assessment two case studies are being performed. First, a landscape-level assessment of fire intensity in the Redwood Creek fire (segment #3 prescribed fire, Fall 1995) will attempt to use the remote air photos to delineate different intensities of fire which burned in the area. Second, a more local analysis in segment #4 will be conducted to examine the linkages between the high resolution, digital photos and the field data which were collected in a number of forest plots.

These two case studies will allow corrections to be made to the process before data from the entire mixed conifer belt of Mineral King are analyzed.

Plans for 1997: In the summer of 1997 Kurt Menning will be accompanied in the field by undergraduate help from UC and a USGS biological technician. More field plots will be established throughout the mixed conifer belt of the watershed, pushing the total to about 200. The actual location of the plots to be established will be prioritized by the location and timing of areas to burn. No new remote imagery will be acquired until 1998, however, since there has been no burning inside the study area since the last air photos were collected.

5) Remote Sensing - Analysis of Red Fir Forest Using High Resolution Digital Images - University of California, Berkeley

Lead: David Newburn (graduate student at UC Berkeley)

A new project will be initialized for a master thesis during the summer of 1997 to investigate various components of red fir forest structure using portions of the digital imagery that has been collected for the “Landscape Analysis” project. Specific study objects are currently being developed but will involve field data collection for ground truthing and may use portions of the data being collected in the Pitcher plots and the fire effects monitoring plots.

Wildlife Sampling

1) Wildlife Monitoring - Science and Natural Resources Management, SEKI

Lead: H. Werner; field-crew members: T. Keesey, C. Ray, and C. Mustric (volunteer).

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** in (Caprio 1996) 1995 MKRRP Annual Report). 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 within the predominant vegetation types. Serendipity trapping was conducted to inventory species and their relative abundances as a means to make a large-scale assessment of fire effects.

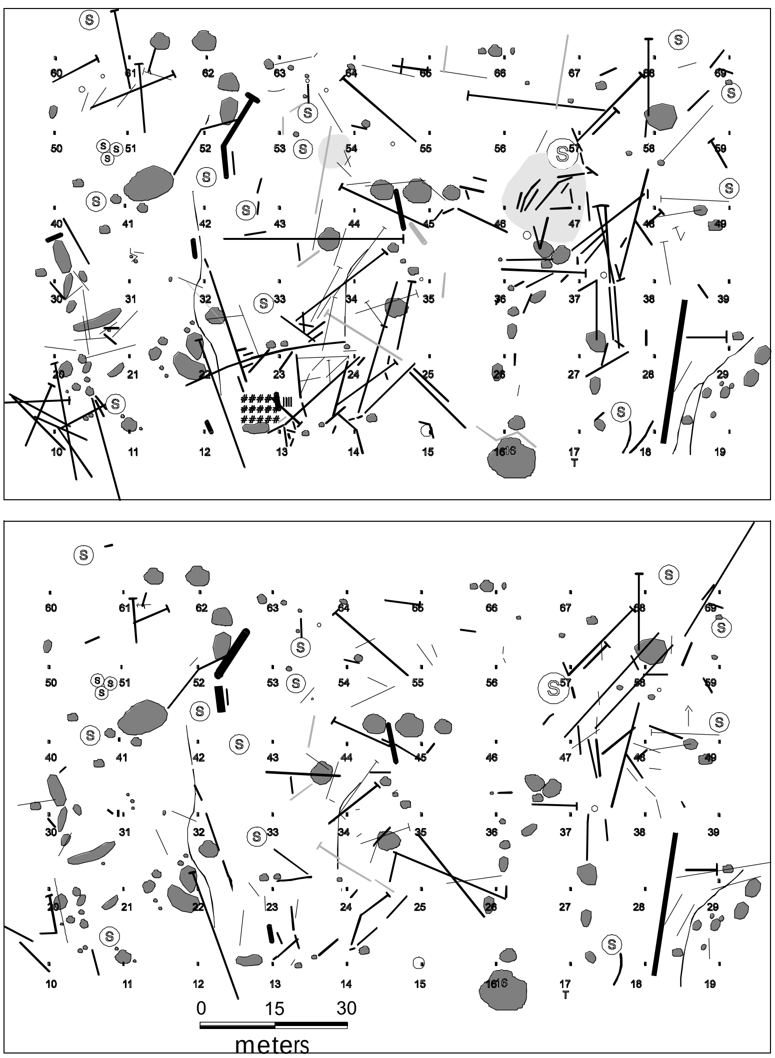


Figure 16. Maps of Atwell giant sequoia-mixed conifer small mammal plot pre (top) and postburn (bottom). Maps show trees (sequoia shown as circled S), rocks (dark shaded gray), litter (light shaded gray), logs, streams, and an old sequoia stake crypt.

Long-Term Plots: Small mammal censusing during 1996 concentrated on two permanent plots, one established in 1995 near Atwell and the second a new plot in ponderosa/black-oak vegetation (**Fig. 15**). The new plot was located adjacent to the transition zone between conifer forest vegetation and chaparral/evergreen-oak vegetation.

The Atwell sequoia-mixed conifer plot, established prior to the burning of segment 3, was recensused (June 4 - July 19, 1996) and postburn vegetation resampled. Results show a substantially greater small mammal density in the postburn burn plot relative to the same plot preburn. Average postburn population density was 36 individuals (48 maximum) compared to an average of 15 individuals caught during preburn censusing. The predominant species present in the plot was ***Peromyscus maniculaus*** (deer mouse). One species caught during preburn trapping, ***Microtus longicaudus*** (long-tailed meadow vole), was not

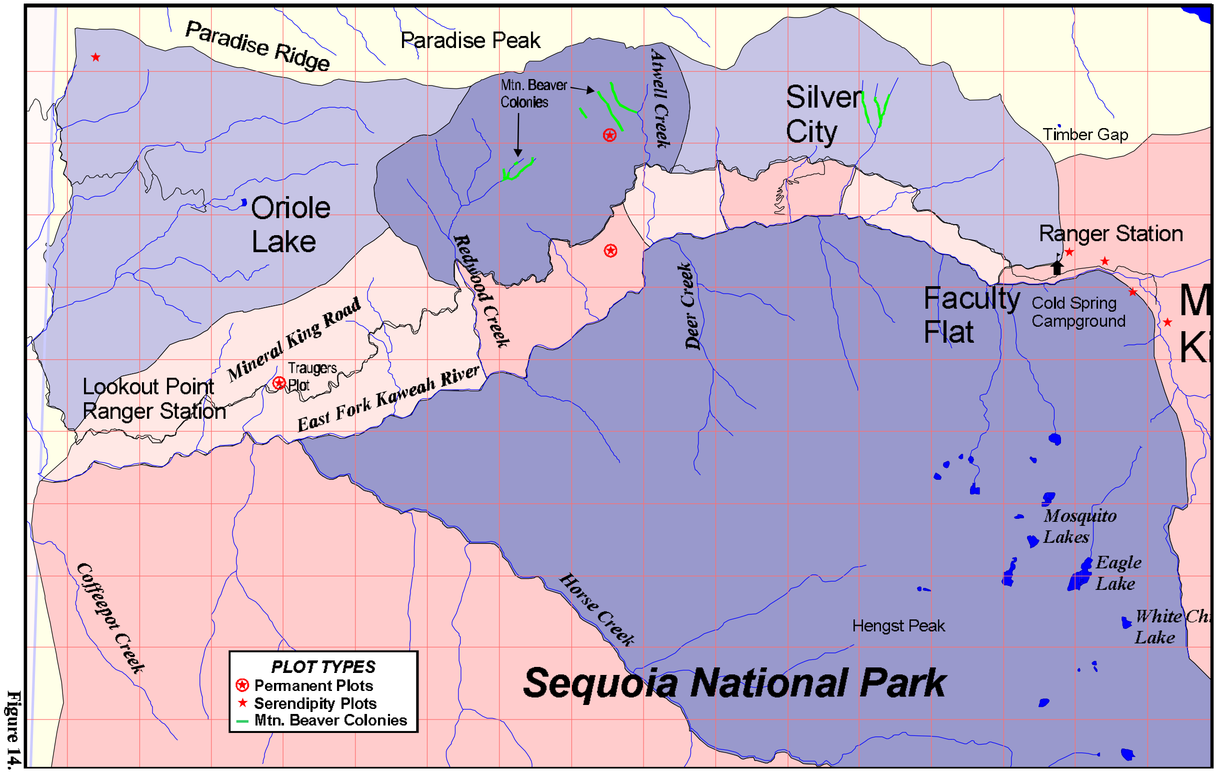


Figure 14.

Mineral King Risk Reduction Project

Wildlife Monitoring

Permanent Plots, Serendipity Plots, and Mtn. Beaver Colonies

0 1 2 3 Kilometers

0 1 2 3 Miles

N

caught postburn and one species, ***Peromyscus boylii*** (brush mouse), not caught preburn was caught during 1996. Mapping of log distributions showed much of the preburn log biomass to have been consumed but was being replaced by new material as trees fell following the burning (**Fig. 16**).

The new one hectare plot with 60 live trapping stations was located in westside ponderosa-pine forest with a mix of ponderosa pine (***Pinus ponderosa***), black oak (***Quercus kelloggii***), incense cedar (***Calocedrus decurrens***), sugar pine (***Pinus lambertiana***), white fir (***Abies concolor***), and canyon live oak (***Q. chrysolepis***). Understory vegetation was dominated by mountain misery (***Chamaebatia foliolosa***) and manzanita (***Arctostaphylos mewukki***). UTM coordinates for the plot center are 4035466 N and 349415 E. Average small mammal population density found during censusing (July 26 - Sept. 27, 1996) was 28 individuals (maximum 52). The predominant species present in the plot were ***Peromyscus maniculaus*** and ***Peromyscus boylii***. ***P. maniculaus*** preferred open areas dominated by bear clover (***Chamaebatia foliolosa***) while ***P. boylii*** was trapped more frequently in mesic areas with dense overstory canopies. Black bears were a major problem during trapping, disturbing and damaging the live traps.

Serendipity Trapping: Trapping was carried out at several locations and in a variety of habitat types (**Fig. 15**). These included yucca scrub located north of Oriole Lake at between 1,600-1,800 m elevation(375 trap nights), xeric pine forest on the south aspect of Mineral King Valley above Faculty Flat at 2,310-2,380 m elevation (130 trap nights), subalpine meadow at about 2,390 m elevation (70 trap nights), and postburn trapping in chamise chaparral and blue oak woodland along the Sheppard Saddle Road following the Kaweah Fire (269 trap nights). Results of the trapping can be found in Werner (1996 - **Appendix 1**).

There was also some trapping (151 trap nights) carried out for medium sized mammals. This was primarily carried out in montane forest, but also included some subalpine and foothill vegetation.

Mountain Beaver: The mountain beaver (***Aplodontia rufa***) colony on the east fork of Redwood Creek was revisited once and showed signs of postfire activity (Ray, pers. comm.). Similar postfire observations were made of the colony in the Atwell Creek portion of the grove during January 1996 (Caprio, pers. obs.). An additional new colony was also located above Silver City (**Fig. 15**) during 1996 and several new colonies were also found at other locations within the parks (Dorst Cr. and Grant Grove) since field crews were now experienced in what kind of features along creeks indicate mountain beaver presence (tunneling, hay-piles, cut branches on conifer/broadleaf saplings).

Plans for 1997:

1) Conduct postburn survey of the Atwell plot burned in November 1995.
2) Establish one more long-term monitoring plot. It will go into a lower subalpine environment (red fir forest, Jeffrey pine forest, green-leaf manzanita chaparral, or sagebrush scrub). If either the Trauger's chaparral plot or the ponderosa plot are burned they will be sampled in lieu of this.
3) Continue serendipity surveys in habitats not surveyed with long-term plots, in alpine/subalpine areas.
4) Revisit ***Aplodontia rufa*** colonies and record observations that may be fire related.
5) Continue development of a guide to wildlife environments.
6) Continue postburn sampling of the Kaweah Burn (chamise chaparral) if time permits.

2) **Bark-Foraging Bird Species** - University of Virginia

Lead: Todd Dennis; Advisors: T.M. Smith and H.H. Shugart

Objectives: This research focuses on understanding several possible mechanisms that may limit bird species distributions and abundance (emphasis in this study is on the bark-foraging guild - some 14 species of woodpeckers, nuthatches, etc. that inhabit the west slope of the Sierra Nevada). Understanding the underlying function of these mechanisms is important for conserving species and determining locations of biological preserves. The study is being carried out by examining the population density distributions of the bark-foraging guild over an elevational gradient in temperate forest (Dennis 1996). Todd has collected measurements of abundance, foraging behavior, and habitat use to allow comparison of commonly proposed mechanisms of distributional limitation: environmental gradients, vegetation-zone ecotones, and interspecfic competition. Additionally, the interaction among these mechanisms will be examined to determine how autoecological and synecological factors effect distributional limits. Elevational transects run from slightly above treeline down to California oak-woodland vegetation. The bark-foraging guild was chosen for study because these species are good experimental candidates since their habitat requirements are amenable for quantification, they have stereotyped foraging behavior requiring smaller sample sizes, many species are sexually dimorphic permitting intergender evaluation of habitat differences, and the guild is poorly studied.

This project has been an unexpected bonus for research associated with the MKRRP. The park has been able to provide a relatively undisturbed setting for Todds to establish study transects across elevational gradients, something that he was unable to find in other areas of the Sierra Nevada due to considerable habitat fragmentation and disturbance. In turn this research is providing the parks with substantial information about bird species abundance, habitat information, and some preliminary data on how these relate to fire.

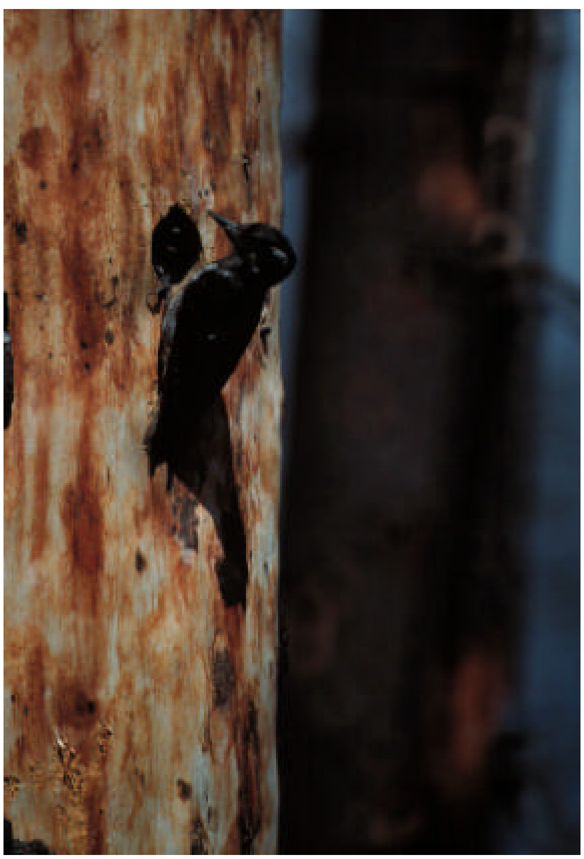
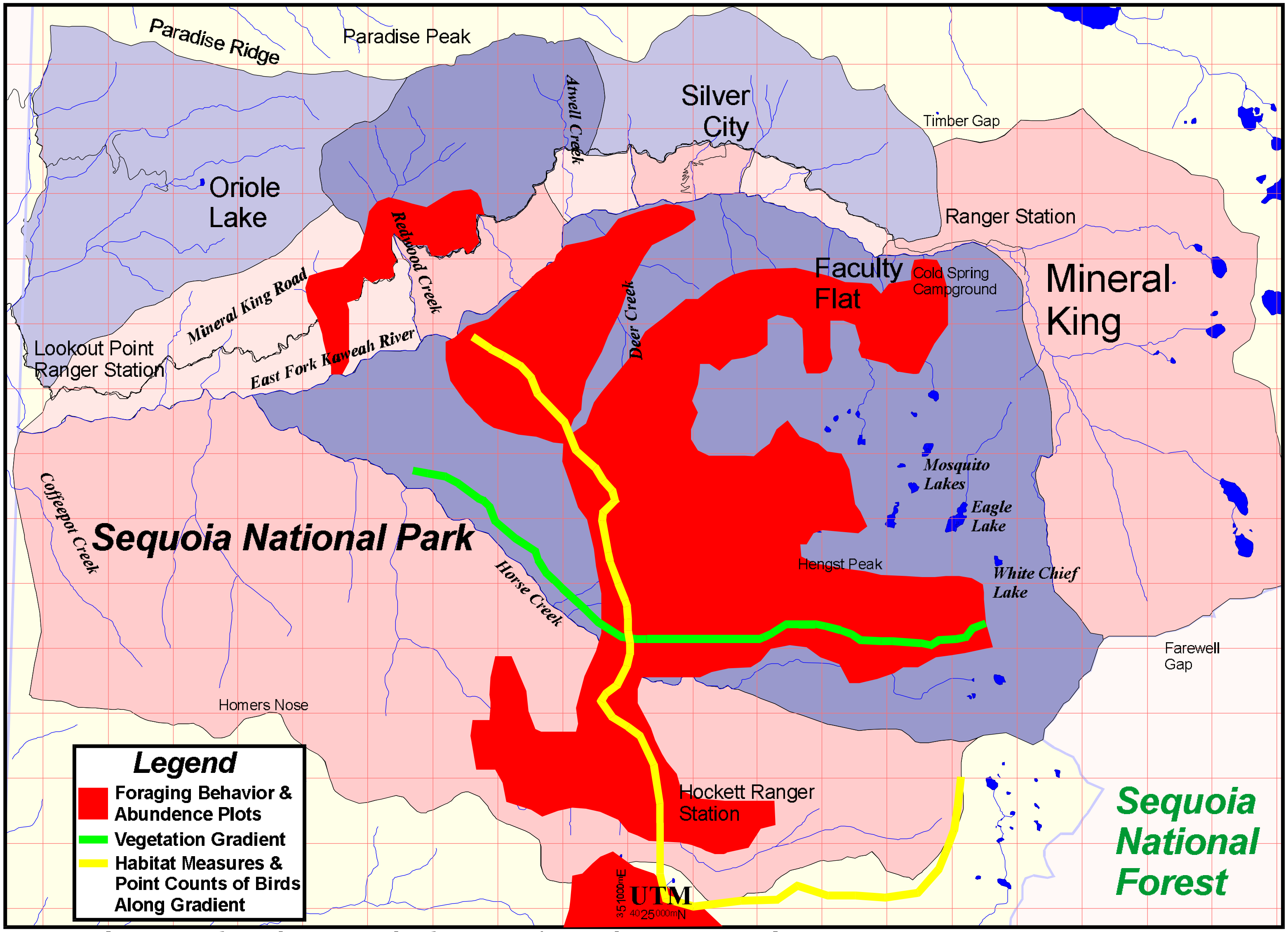


Figure 18. Black-backed three-toed woodpecker on burned lodgepole pine (photo taken in Yellowstone National Park - Tony Caprio).

Field Work: Sampling during 1996 concentrated on elevational transects located in segment #10 (**Fig. 17**) although lower elevation oak-woodland species and vegetation was sampled in the vicinity of Ash Mountain and along the North Fork of the Kaweah. Foraging behavior of 14 species of scansorial birds were made with habitat observations were made in oak woodland, lower montane, upper montane, and sub-alpine habitats. Over 1000 foraging behavior plots were sampled along with some 570 descriptive vegetation/habitat plots. Estimates of relative abundance of the bark-foraging guild were made along eight elevational transects. Exploratory data analysis is currently being carried out. Field sampling during 1996 also included the examination of species within a number of recent burns in the drainage. A number of bark-foraging species were found that preferred these recently burned areas: northern flicker, white-headed woodpecker, hairy woodpecker, Williamson’s sapsucker, and black-backed woodpecker (**Fig. 18**), relative to unburned areas. The latter

Figure 16.



Mineral King Risk Reduction Project

Bark-Foraging Bird Species

0 1 2 3 Miles

0 1 2 3 Kilometers

N

species (black-backed woodpecker) was only observed in recent burns which appear to be critical habitat for its presence. His data suggest that fire creates more habitat diversity, allowing better foraging opportunities and nesting locations.

Plans for 1997: Additional field work will be carried out during a three week period in June. Direct gradient analysis of avian abundance and habitat structure and floristics will be begun. Todd would like to return to his study transects following burning of the area to examine the response bird populations to fire-induced habitat changes if funding is available.

Watershed Sampling

1) Watershed: Stream Chemistry and Stream Hydrology - National Biological Service, SEKI Field Station

Lead: D. M. Graber, field-crew supervisor: C. Moore & L. H. Hammett (through June 1996), field-crew: J. Yurish, B. Johnson, A. Das, and V. Pile.

Summary prepared by C. Moore.

East Fork Drainage: The East Fork study area is a large watershed that encompasses an elevation gradient extending from chaparral (1230 m) to alpine (>2770 m). The upper part of the watershed is comprised of seven alpine/subalpine sub-basins that make up 17 percent of the total acreage, but account for 40 percent of the peak runoff in the E. Fork (Black 1994). Although these sub-basins are not part of the study area, they contribute substantially to the hydrology and stream chemistry of the East Fork.

In addition to the East Fork of the Kaweah River, two first and second order tributaries on the north side of the drainage were chosen to study the fire effects on stream flow regime and chemistry (**Fig. 19**). No historic flow or chemistry data exist for these sub-catchments. Trauger's Creek and Deadwood Creek are the primary focus for the stream chemistry and hydrology study. Both tributaries appear to be perennial and partially spring fed. Their riparian areas are distinctly different as they are separated by an elevation difference of approximately 600 meters. Stilling wells, constructed of 10 inch diameter PVC pipe, enclose two pressure transducers and a thermistor at each site (**Fig. 30**). Flow data and temperature are recorded hourly on Omnidata portable data loggers. The data loggers were installed in February 1996. Weekly grab samples have been collected since May 1995 for chemical analyses. Additional sampling will occur during precipitation events. The macro-invertebrate study includes the primary streams, as well as four additional streams in the East Fork drainage (Slapjack, Redwood, Atwell and Silver City). Stream chemistry and flow data are collected for these secondary stream sites on a rotational basis. Weekly grab samples are also collected from the East Fork below Lookout Point.

Primary Site Descriptions

Trauger's Creek is a low elevation (1400 m) with mixed chaparral/oak- woodland in a transition zone between the lower mixed conifer zone and the upper chamise chaparral zone. Vegetation includes California live oak (***Quercus*** spp.), incense cedar (***Calocedrus decurrens***), maple (***Acer macrophyllum***), California laurel (***Umbellularia californica***), spicebush (***Calycanthus occidentalis***), and willow (***Salix*** spp.). Precipitation is measured at Lookout Point, 2 miles west of the study site, with a Belfort Recording Rain Gauge operated by the National Park Service.

Deadwood Creek is a mixed conifer forest (2000 m) environment characterized by white fir (***Abies concolor***), red fir (***Abies magnifica***), giant sequoia (***Sequoiadendron giganteum***), and incense cedar (***Calocedrus decurrens***). Precipitation measurements for this site are recorded at the Atwell Mill stables, approximately one mile west, by the Army Corps of Engineers. The Corps operates a remote access rain/snow gauge.

Stream Hydrology: Data loggers went online at Deadwood and Trauger's Creeks in February 1996. We now have almost a complete year's worth of pressure transducer and

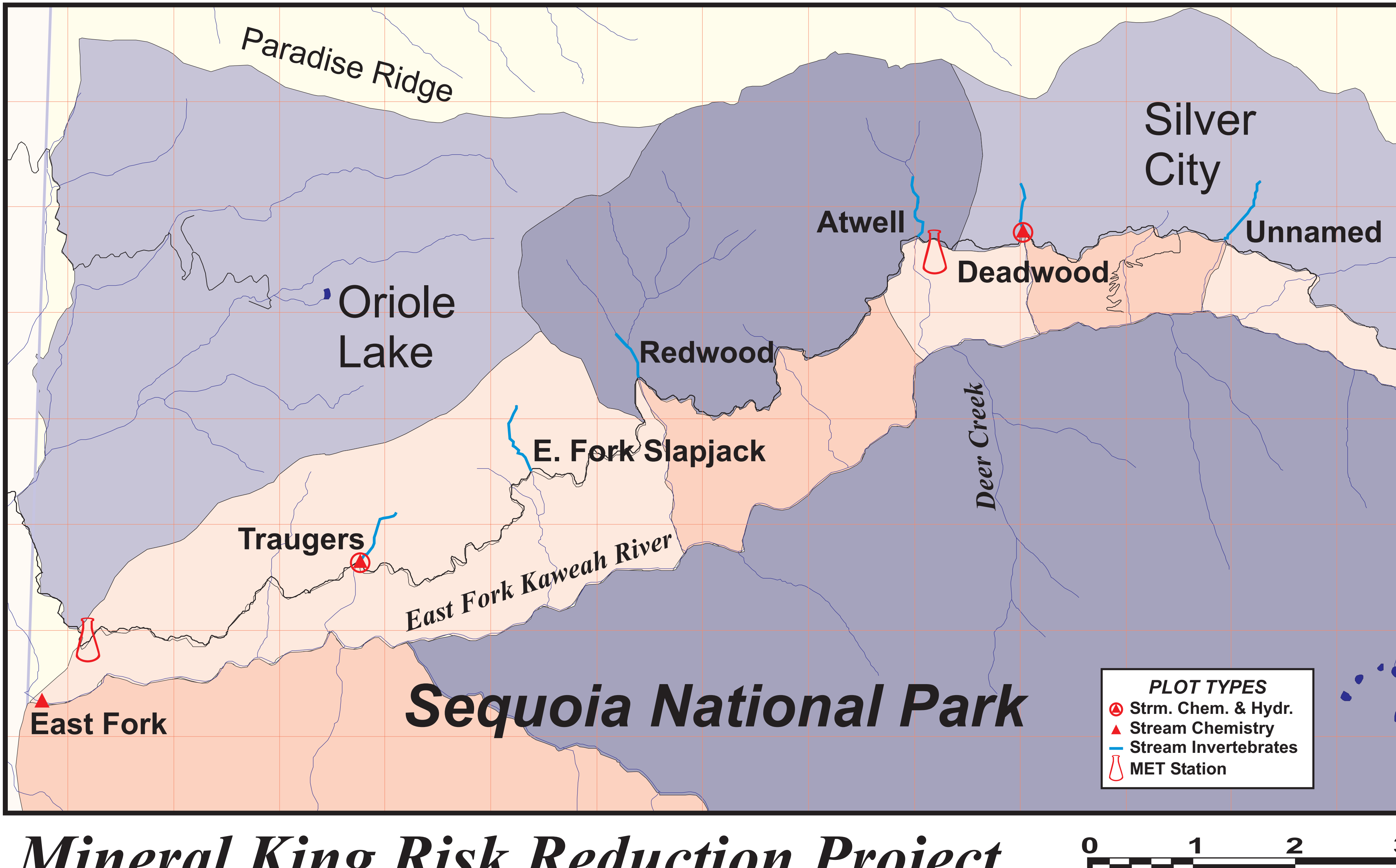


Figure 18.

Mineral King Risk Reduction Project

Watershed Studies

Stream Flow, Stream Chemistry, and Macro Invertabrates

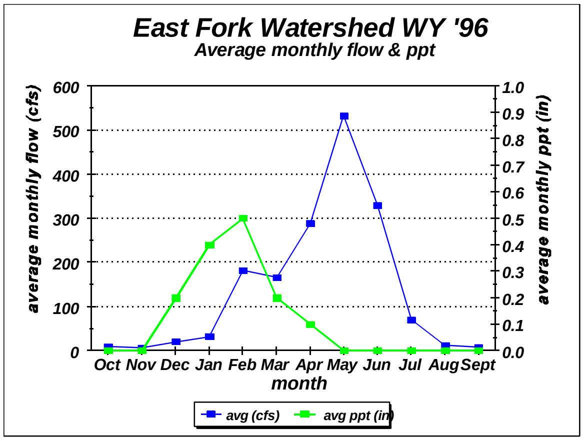


Figure 20. Average monthly precipitation (in) compared to average flow (cfs) in the East Fork Kaweah River. Flow data provided by Southern California Edison. Precipitation data provided by U.S. Army Corp of Engineers.

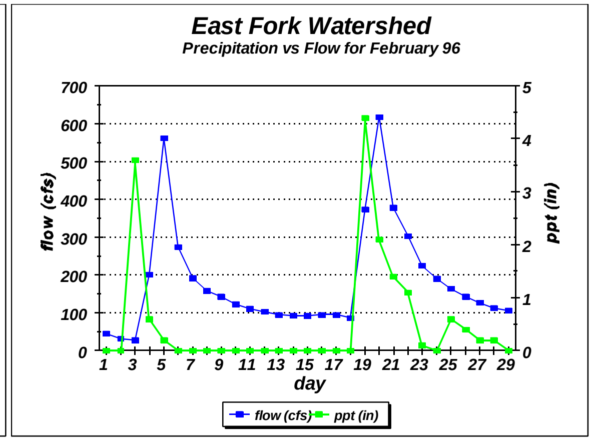


Figure 21. Daily flow (cfs) response to precipitation in East Fork Kaweah River for February 1996.

temperature data for both streams. While there were some equipment problems throughout the year, the data set is fairly complete. Presently, the Data Storage Modules (DSPs) are changed and downloaded weekly, which enables us to identify problems with sensors or the program. Jim Sickman, from UCSB, was instrumental in helping our research staff to troubleshoot both equipment and software problems.

The constant injection salt dilution method is being used to determine flow in the six East Fork streams in the study area. This method uses changes in conductivity to determine flow rates. The primary focus is on Trauger's and Deadwood Creeks, where the data loggers are located. Seven dilutions were completed on Trauger's, three summer flow and four winter flow. Five dilutions were completed at Deadwood, two summer flow and three winter flow. Additional salt dilutions will be conducted this winter ('97) and this information will be used to develop stage discharge curves for these streams and to develop daily flow records based on the data set from the data logger. Salt dilutions are being conducted on the other four streams in the study area as time allows to develop a rough estimate of flow. If there is good correlation between the priority watersheds and the secondary watersheds, flow estimates for the secondary watersheds will be more accurate.

Most of the precipitation falls as snow above 1850 m and is stored in the snow pack until temperatures warm up in the spring producing spring runoff, which peaks in early summer. While precipitation peaked in February (**Fig. 20**), with an average of 0.5 in. and a total of 15.1 in. (data provided by the U.S. Army Corp of Engineers from the Atwell precipitation site), peak runoff did not occur until May. Average flow varies greatly throughout the year with averages ranging from 10 cfs in the fall to >500 cfs during peak runoff. The river also responds to precipitation with local spikes in flow (**Fig. 21**) where daily flow is graphed with daily precipitation for February '96. There is a one to two day delay in flow response after a precipitation event, and then the flow returns to baseline levels.

Table 9. Precipitation totals in inches and centimeters for Mineral King stations in Sequoia National Park for WY 1995 and WY 1996.

	Water Year 1995		Water Year 1996		Avg 1983-1995
Sites	**inches**	**cm**	**inches**	**cm**	**inches**
Atwell	61.0	154.9	44.8	113.8	Not available
Lookout Point	Not available	------------	30.9	78.4	Not available

Precipitation for Atwell and Lookout Point for WY 95 and WY 96 were summarized (**Table 9**). Atwell had a total of 44.80 in (U.S. Army Corp of Engineers). This was slightly above the long term average (period of record from 1966 to 1984) of 41 inches for Atwell. WY 96 was also the first year that precipitation data were available from Lookout Point. These data was collected from a Belfort gauge maintained by NPS staff. The first quarter of WY 96 was unseasonably dry, with no appreciable rainfall until December. Consistent winter and spring rains account for near normal totals.

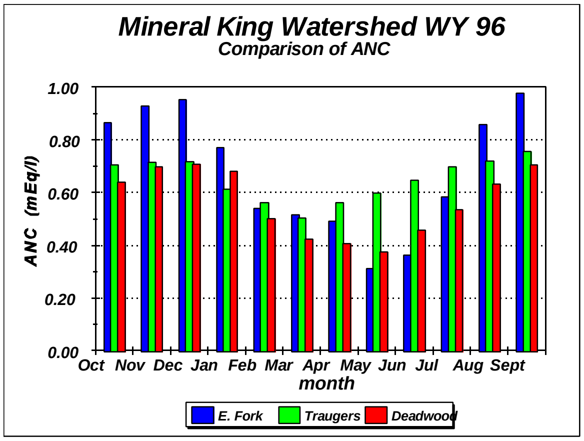


Figure 22. Comparison of ANC concentrations in E. Fork, Trauger's Cr. and Deadwood Cr.

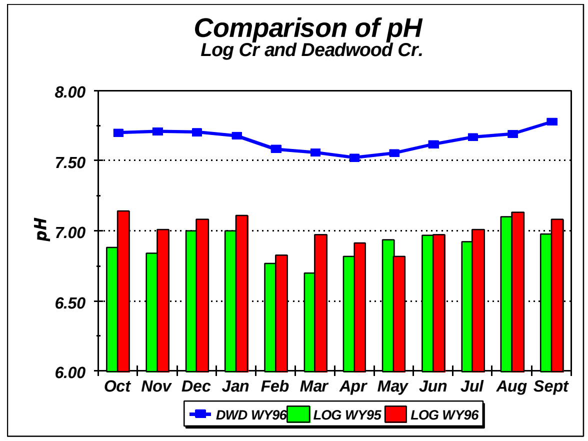


Figure 23. Comparison of Log Cr. (Control watershed) pH with Deadwood Cr.

Stream Chemistry: Acid neutralizing capacity (ANC) or alkalinity for the East Fork and the primary tributaries shows that the East Fork and Deadwood Creek have similar patterns in alkalinity concentrations in response to flow **(Fig. 22)**. Increased runoff in the summer months from snow melt results in a drop in summer ANC. In the winter months, the East Fork maintains the highest ANC, however in early spring there is a shift and Trauger's Creek ANC is greater. All three sites show a seasonal drop in ANC in February with increased flow, but Trauger's ANC recovered within a month, whereas the E. Fork and Deadwood didn't reach their low ANC until May, which was the peak month of runoff for the E. Fork this year. The quick recovery of Trauger's Cr. ANC is likely due to its low elevation and early meltout in the watershed. Trauger's Cr had the most consistent ANC concentrations ranging from 0.4 mEq/l to 0.72 mEq/l. E. Fork showed the greatest flux in ANC from 0.31 mEq/l to 0.97 mEq/l. Deadwood ANC flux fell in the middle with a range of 0.38 mEq/l to 0.71 mEq/l.

A comparison of pH reveals that the East Fork is better buffered than the Middle Fork areas that have been studied for many years (**Fig. 23**). Although there has been an overall increase in Log

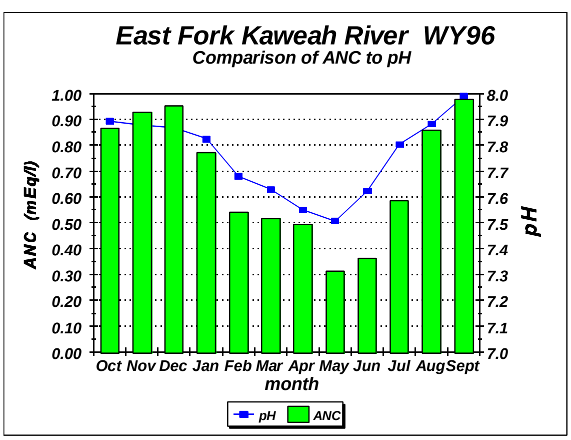


Figure 24. Comparison of alkalinity and pH in the East Fork.

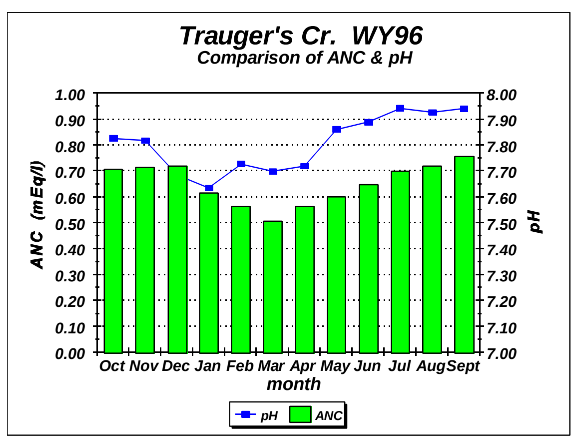


Figure 25. Comparison of alkalinity and pH in Trauger's Cr.

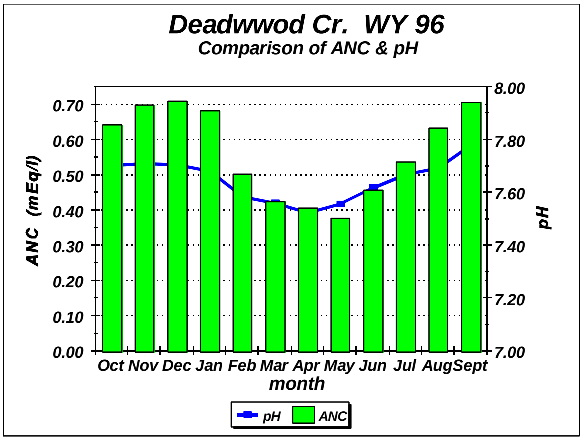


Figure 26. Comparison of alkalinity and pH in Deadwood Cr.

Cr pH in the last 10 years, Deadwood Cr. pH was consistently >7.5, while Log Cr. averaged <7.0. These data are based on 4 samples/month from Deadwood Cr., monthly samples (WY '96), and bi-weekly samples(WY '95) from Log Cr. pH values generally ranged from 7.5 during peak runoff to 7.8 during late summer flow. pH was consistently higher in Trauger's, which corresponds to the higher and more consistent ANC concentrations (**Fig. 24-26**).

The Southern Sierra Research Center Water Laboratory conducted chemistry analyses for ammonium (NH_4^+), phosphate (PO_4^{2-}), and silicate (SiO_2). Preliminary ion data (Ca_2^+, Mg_2^+, K^+, Na^+, NO_3^-, SO_4^{2-}, Cl^-, F^-) analyzed at Ft Collins by Dr Stottlemeyer are available for Oct-Apr only. Dissolved Organic Carbon (DOC) analysis was added to the chemistry regime this year in an attempt to better understand the imbalance between anions and cations. This procedure is conducted at Michigan Technological University by the Toczydlowski lab.

NH_4^+ and PO_4^{2-} concentrations differed by an order of magnitude in all three sample sites (**Fig. 27-29**). Phosphate was consistently present throughout the year with the highest concentration averages found in Deadwood Cr. (>0.5 mg/l) and the lowest in E. Fork (<0.1 mg/l). Ammonium concentrations were only present during the winter months, with concentrations ranging from 0.0003 mg/l in the E. Fork to 0.003 mg/l in Deadwood. Phosphate and ammonium showed little seasonal trend.

Ion analyses showed an imbalance of anions and cations. Cations exceeded anions for reasons that are not clearly understood. However, this is a phenomenon that exits in other Sierran watersheds (Stottlemeyer personal comm. 11/96). Calcium and sodium dominated the cation balance and were present in concentrations significantly greater that other

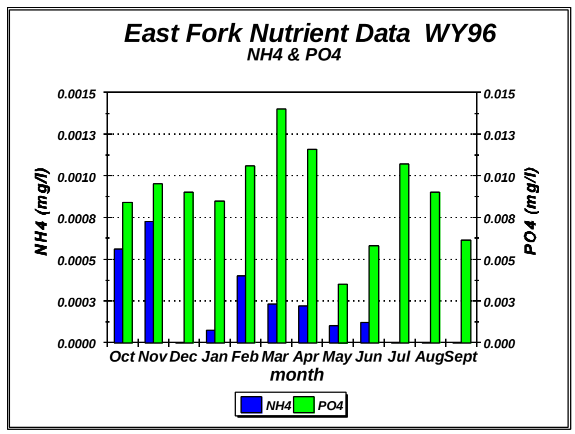


Figure 27. Comparison of NH4 and PO4 in East Fork.

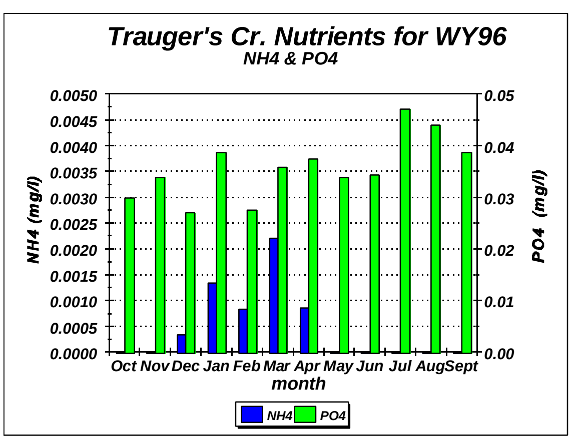


Figure 28. Comparison of NH4 and PO4 in Trauger's Cr

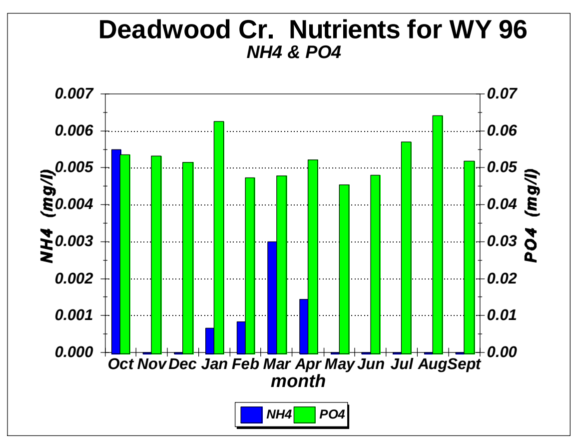


Figure 29. Comparison of NH4 and PO4 in Deadwood Cr.

Figure 30. Stilling well and staff gauge at Deadwood Creek, Atwell.

cation or anion constituents. While DOC does made up a significant portion of the anion balance, it did not account for the total discrepancy between anions and cations.

This year ended the first complete water year of chemistry data for the East Fork watershed. Since little work has been done in this area previously, additional data collection is needed to better understand the preliminary trends that were revealed from this year's data collection and analyses. These initial results showed similar responses to shifts in flow, pH and ANC when compared with other Sierran watersheds (Melack and Sickman 1995, Black 1994).

Plans for 1997: Weekly sampling will continue, with the major focus on Trauger's and Deadwood Creeks and the East Fork sites. Rotational sampling will continue on the secondary watershed sites as time permits. Stage discharge curves will be developed for Trauger's and Deadwood and logger data will be converted into flow measurements. This will enable us to monitor how the creeks respond to precipitation events. More in-depth stream chemistry analyses will be completed to determine wet and dry season ranges in ionic solutes, and comparisons will be made with the Log Meadow prescribe fire watershed project.

Presently, we are planning a sediment project, which would be a cooperative project with UC Davis, and a nitrogen budget project, which would be a cooperative project with the Desert Research Institute in Reno, NV. These projects would start in late summer or early fall.

2) Watershed: Macro-Invertebrate Study - University of California, Davis

Lead: Ian Chan, Graduate Research Assistant, Department of Wildlife, Fish, and Conservation Biology at UC Davis under the study of Dr Don C. Erman and Dr. Nancy A. Erman: Co-Principal Investigators.

Summary prepared by C. Moore.

Objectives: Biological monitoring of headwater ecosystems is an important component of understanding the dynamic linkages between hillslope and instream processes. As such, it represents an indispensable tool for watershed management. We are studying aquatic macro-invertebrate communities of tributaries of the East Fork Kaweah in the Mineral King area as part of larger-scale watershed monitoring efforts to assess the impacts of prescribed fire on park resources. Our research complements more traditional methods of physical water quality monitoring with information on the status of invertebrate assemblages. Such information is valuable as basic biological inventory. Other objectives of our work are to determine potential variation in biological communities resulting from fire management practices and to establish baseline information for use in future research applications. We are developing and testing quantitative and repeatable sampling methodology appropriate for small stream habitats in this area. These methods can be incorporated into long-term monitoring programs.

***Background*:** Macro-invertebrate collection began in September 1995. Six streams in Mineral King area (with completed or planned fire prescriptions) have been sampled intensively: Trauger's, Slapjack, Redwood, Atwell, Deadwood, and Silver City Creeks (**Fig. 19**). Four additional streams in the Giant Forest/Eagle View area were originally included as reference streams: Big Fern Creek, Log Creek, and Panther Creek Tributaries III and IV. However, three of these streams were subsequently dropped from sampling when the Park Service changed its burn schedule after we began the study. We decided to concentrate intensively on before-after sampling in the East Fork Project area. We have continued to sample only Log Creek outside of Mineral King. All streams are small first to third order, high-gradient tributaries with channels largely dominated by bedrock (granite) outcrops. Streams are typically sequences of cascades, plunge pools, short tailout riffles, and slickrock slides. Where substrate is not bedrock, sediments are fine granitic gravels and sands. All streams are relatively well shaded by a canopy of mixed conifers (mostly firs, pines and sequoias) or mixed oak/chaparral (at lower elevations) and a variety of riparian vegetation along the stream corridor.

Figure 31. Mayfly larvae (photo courtesy of UC Santa Barbara)

Methods: Invertebrate methods require complementary benthic (larval) and emergent (adult) sampling (**Fig. 31**). Differences in timing and spatial distribution of larval and adult stages of aquatic insects necessitate benthic and emergence-trap sampling over different seasons in order to collect adequate representatives of the various taxa present at a particular site and to make species-level determinations. The small, steep, bedrock-dominated character of these streams posed a methodological challenge for quantitative sampling. Established methods and equipment were inappropriate for use in these habitats and had to be modified or replaced.

Benthic macro-invertebrates are collected through a combination of sampling methods in three microhabitat types: riffles, pools, and slickrock glides. Invertebrates are collected from small riffle areas using a modified (200 cm^2) Surber sampler. Pool areas are sampled by grab-sampling volumes of litter with a Nitex mesh dip net. Areas of slickrock habitats are scraped into a catch net to dislodge and retain clinging invertebrates. All samples are preserved in the field in 80% ethanol. Prior to laboratory sorting, samples are counter-stained with rose bengal to facilitate separation of invertebrate tissues from collected debris. Identification is made to the lowest practical taxonomic level (usually genus).

Adult stages are collected using one meter pyramidal emergence traps that have been used successfully in several other studies of small streams (**Fig. 32**). Traps are maintained throughout the year (conditions permitting). Collection usually proceeds on a weekly to biweekly basis.

Physical channel characteristics and surroundings are measured and described at each stream location. Temperature, pH, alkalinity, conductivity, and discharge are monitored as part of chemical water quality investigations (by BRD/USGS staff). Surveys of instream large woody debris, average insolation, and sediment substrates are also conducted.

Data analysis will follow conventional summary statistics of means and variance. Similarity of before-after and treatment-reference sites will be examined in this manner. Test hypotheses should accommodate comparisons between streams, habitat types, and fire treatments.

Progress: In 1996 we changed our study design in response to several postponements by the Park in the burn schedule. Park decisions not to burn areas in our study drainages this year allowed us to sample streams in this target area more intensively. We have, therefore, focused our sampling on the six streams in Mineral King rather than using a previously considered extensive approach. Individual sites will now be directly compared before and after fire. Data collected up until the time of burning will serve to strengthen baseline information and help validate long-term monitoring efforts. Sites which have already experienced fire can be compared to adjacent, unburned sites (e.g., Atwell vs. Deadwood).

Figure 32. Pyramidal trap used to capture adult macro-invertebrates (photo by C. Moore).

We increased sampling intensity in 1996 to achieve improved statistical power. We used a stratified random design in which invertebrate assemblages from different habitat types are represented by a set of three random samples per stream. Additionally, each individual sample was collected as a composite of four subsamples. For example, four pool litter subsamples made up an individual pool habitat sample, and these were collected from three randomly-chosen pools in each stream. This benthic sampling effort was repeated for riffle and slickrock habitats. Benthic sampling was repeated once in spring/early summer and once in late summer/early fall. From each of the six Mineral King streams, nine samples (three from each habitat type) were collected in June and again during another round of sampling in late September. Log Creek in Giant Forest was also sampled with equivalent effort over the same period. Emergence trap sampling has proceeded continuously since April 1996 and will continue year-round as conditions permit.

Field surveys of physical channel characteristics were also based on a random design. Sediment cores were collected from three randomly chosen pool sites in each Mineral King stream in October. At the tail of each pool, three 5 centimeter deep cores (each 10 cm in diameter) were excavated by hand and retained for analysis. This was repeated at three pool sites per stream. Bed surface sediments were sampled using the pebble count method in a randomly chosen pool and riffle in each stream. Fine sediments appeared more frequently in Redwood and Atwell Creeks which were burned in Fall, 1995.

Solar radiation was measured at three randomly spaced points along each stream using a Solar Pathfinder. Average insolation values were calculated on a monthly and yearly basis.

Large woody debris was surveyed in all six Mineral King streams this November. All pieces of at least 10 centimeters diameter and 1 meter length within the bankfull channel were measured for volume. The length of channel surveyed was determined by the distance required to count 50 pieces. In addition, orientation and origin (where possible) were recorded for each piece.

Plans for 1997: Collection of aquatic insects will continue through fall 1997. Sorting and identification of invertebrate samples is proceeding currently. Processing of benthic samples should be completed by spring, 1997. Compilation and interpretation of this and other data represents the bulk of work for the remainder of 1997. An important part of this process will be supported by cooperation with USGS staff incorporating physical and biological data with existing geographic information on watersheds in the study area. He will finish up his field season this summer and begin writing his thesis in the fall. His study will describe the pre-burn aquatic macro-invertebrate populations at each of the six watersheds. Presently, there are no plans to continue the project to include a post-fire evaluation. However, this project will be pursued as it will add valuable data to the watershed project.