4.16) Fire History

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INTRODUCTION

Over the last three decades the parks' fire management program has evolved to where it now includes restoration of fire at a landscape scale. However, burning at such scales has raised a variety of new management and resource questions. Among these are questions about our understanding of pre-Euroamerican fire regimes at such large ecosystem scales. Unfortunately, written records or accurate descriptions of pre-Euroamerican settlement fire regimes do not exist from the southern Sierra Nevada. However, we are fortunate that, at least temporarily, we can obtain fairly reliable information about past fire regimes from a proxy record that can be obtained in most of our forested plant communities. This record is based on the sampling of fire scarred trees which document the minimal role of fire within the land units sampled. Dendroecological analyses of these samples provides a powerful tool to characterize attributes of past fire regimes, to examine their variability and to understand how they have shaped landscapes over time. This information provides clues from the past that can supply guidance for ecologically sound fire management practices today and into the future.

While substantial fire history research has been carried out in Sequoia and Kings Canyon National Parks (Kilgore and Taylor 1979; Pitcher 1987; Swetnam et al. 1992; Swetnam 1993; Caprio and Swetnam 1995; Swetnam et al. 1998) a considerable number of gaps still remain in our knowledge and understanding at many levels (Caprio and Lineback in press). Acquiring this information would be of great value to managers when planning and reintroducing fire in park ecosystems, in evaluating the success of the Park's burn program (Caprio and Graber in prep) and to ecologists interested in understanding dynamics of pre-Euroamerican plant and wildlife communities.

A growing body of evidence indicates considerable variation in pre-EuroAmerican fire regimes, both temporally and spatially, across the landscape. However, because reconstructing past fire regimes is difficult, requiring considerable effort and experience our current knowledge about this variation is sparse. For example, we have little information about past fire regimes at a scale that encompasses 1000+ hectares and includes varying slope, aspect, vegetation type, and elevation. This also includes a lack of knowledge about past fire regimes from several common vegetation types. An example best illustrates the difficulty in capturing this variation. Unlike our current terrestrial vegetation, where variation in species composition and structure are obvious and sampling strategies to adequately capture this variation are easily designed, the historical fire regime is largely hidden from direct view. As a result its attributes would be easily under sampled or overlooked. To capture some semblance of this variation a substantial effort is required to acquire a large number of sample size. Such sampling intensity would not be unexpected if variation in terrestrial vegetation were being sampled across diverse habitats.

The fire history information being developed in this study will have both a direct impact on fire management decision making and a less direct but equally important impact on park management over the long term. For example, fire history data forms the foundation on which fire management planning using GIS fire return interval departure (FRID) analysis is based (Caprio et al. in press). Using fire return interval information that is of poor quality, in some cases simply an estimate, may result undesired management consequences (Caprio and Lineback in press). A significant unknown is how past fire regimes varied spatially across differing aspects. Recently, Miller (1998) developed computer models that look at surface fire regimes and forest patterns across elevation gradients in the southern Sierra Nevada. The models examined connectivity and spatial extent of fire over elevational gradients.

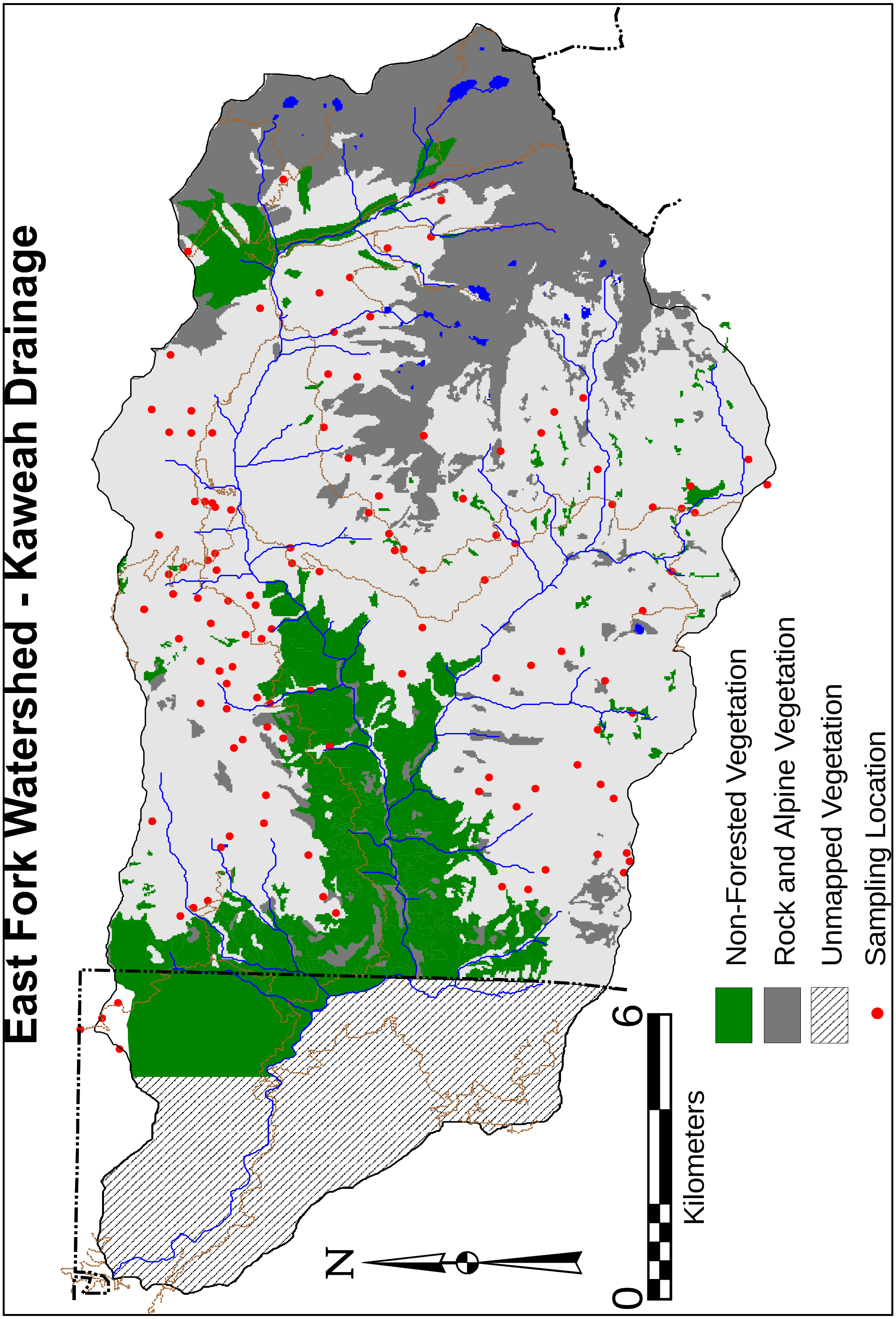

Figure 4.16-1. Fire history collection sites in the East Fork.

Their output suggests that differences in burn patterns/frequencies exist by aspect and these differ most notable between south and north slopes (Carol Miller personal communication). Structural and landscape differences in vegetation by aspect have also been suggested from the preliminary results of the Landscape Analysis Project (Kurt Menning personal communication) which may be related to differing fire regimes on the north versus south aspects. However, other than the preliminary results from the current fire history collections in the East Fork, little data exists on pre-European settlement fire history for north aspect forests in the southern Sierra Nevada. Thus the information collected in the East Fork will be critical in verifying these models and as input for more rigorous parameterization to improve their predictive ability.

Recent fire history collections have been made at several locations for four specific but interrelated projects. These include the East Fork Watershed Project, the Aspect Project and two special projects: Silliman Creek lodgepole pine/fir forest and the Cedar Grove Valley ponderosa pine collections (collected in 1998 but reported here as part of the expanded Annual Fire Report).

I - MINERAL KING WATERSHED FIRE HISTORY PROJECT

OBJECTIVES

The goal of this data collection effort is to: 1) obtain information on the spatial extent of pre-Euroamerican fire on a watershed scale (fire size, spread patterns, and frequency variation), 2) acquire data on pre-Euroamerican fire regimes from the wide array of vegetation types within a watershed, and 3) integrate this information with the Parks' fire management program. Specifically, these data will provide improved information on fire frequency regimes from a range of vegetation associations that are being used as input into fire/GIS analyses to reconstruct past fire frequency regimes throughout the parks (Caprio and Lineback in press). Additionally, reconstructing the large scale spatial pattern fire in the East Fork will assist managers in determining whether they are meeting management objectives in restoring fire as an ecosystem process (Caprio and Graber in prep)

DATA COLLECTION and ANALYSIS

Sampling has been ongoing over the past four summer seasons in the coniferous forest zone within the East Fork watershed (**Fig. 4.16-1**). During 1999, emphasis was placed on collecting sites in higher elevation conifer forest and on aspects or vegetation types for which we have little fire history information. New sites were sampled at higher elevations in the Timber Gap and Silver City area and at low-to-moderate elevations the Oriole Lake watershed.

Specimens are being dendrochronologically crossdated to determine precise calender years in which past fires occurred (Stokes 1980). Crossdated fire chronologies provide results with precise temporal information that allows consistent comparison of fire dates among sites separated spatially across the landscape. Additionally, intra-annual position (or approximate season) of fire dates are also being determined when scar quality makes this possible (Ahlstrand 1980; Caprio and Swetnam 1995). Sample preparation and crossdating are most advanced from sites collected from 1995 though 1998.

Area burned within a given year by pre-Euroamerican fires is being reconstructed using Thiesson polygons (Davis 1986). Each irregular polygon represents the area around a point (representing a single sample site), in a field of scattered points, determined by Euclidean distance, that is closer to that point than any other point. The resulting field of polygons represents the most compact division of area, given the specific arrangement of points. This approach is commonly utilized for rainfall gauging networks when stations are not uniformly distributed and strong precipitation gradients occur (Dunne and Leopold 1978), both characteristics of the network of fire history sites sampled in the East Fork. Its

use provides a valuable tool for quantifying and portraying spatial patterns of over a landscape. For the fire history sampling sites, polygons were
constructed around the center point of each site using ArcView 3.2 Spatial Analyst (ESRI 1999) and area of each polygon determined. This allowed maps of annual burn area to be created for the watershed. While not computed for this report, future iterations of polygon calculation will use aspect as a constraint on polygon boundary delineation.

Based on GIS analysis and topographic features the watershed landscape has been categorized by elevation and aspect (**Fig. 4.16-2**). North and south aspects were defined as: south has slopes facing from 106° to 285° and north facing >285° to <106° with level topography classes as south (**Fig. 4.16-3**) and high and low elevation conifer forest was separated at 2286 m elevation (**Fig. 4.16-4**)

RESULTS and DISCUSSION - Preliminary Analysis

Sixty-five specimens (logs, stumps, snags, or trees) were collected from 14 sites during 1999. This supplements samples from 109 sites previously collected (Caprio 1997, 1998, 2000). A large number of sample sites are required to provide adequately replicated data sets from across vegetation type, elevation, and aspect Within the drainage samples have been obtained from 10 of the 11 major vegetation classes currently designated in the Parks (**Table 4.16-1 and Fig. 4.16-5**). Sites have also been obtained from both north and south aspects over a range of elevations (**Table 4.16-2**). These collections greatly expand on previous work carried out in the watershed (Pitcher 1987; Swetnam et al.1992). Additionally, the collections are a source of new fire regime information for vegetation types not previously sampled in the Parks. These include Jeffery pine, lodgepole pine, and oak woodland while others, such as red fir and nearly all vegetation types located on north aspects, which have been sampled sparsely at best..

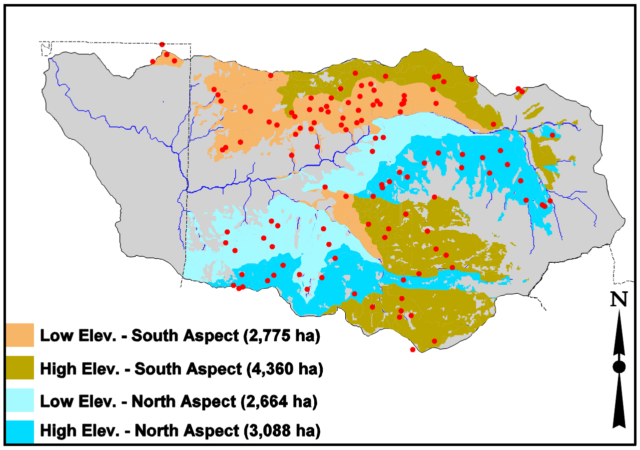

Figure 4.16-2. Vegetation classed by elevation (low vs high) and aspect (north vs south). Red dots are fire history sites.

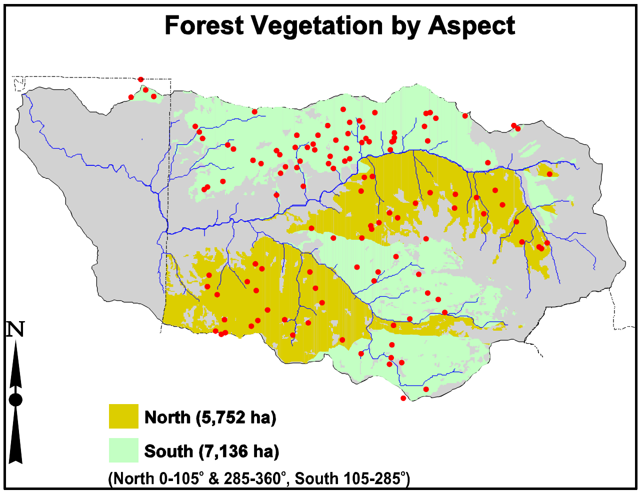

Figure 4.16-3. Forest vegetation within the East Fork classed by aspect (north vs south).

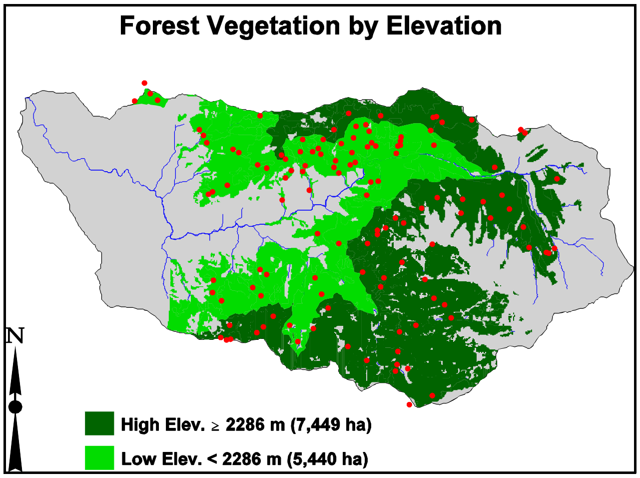

Figure 4.16-4. Forest vegetation classed by elevation (high vs low).

Table 4.16-1. Summary of site collections within the East Fork by vegetation class through 1999.

Vegetation Class	Number of Sites
Ponderosa Pine	4
Ponderosa/Mixed Conifer	31
White Fir Mixed Conifer	23
Sequoia Mixed Conifer	9
Red Fir	39
Lodgepole Pine	10
Subalpine Forest	2
Xeric Conifer	5
Foothill	1
Chaparral*	**(7)**
Total	**123**

Currently 123 sites have been collected [two of these were previously collection in the Atwell giant sequoia grove by Swetnam et al. (1992)] with 544 individual trees sampled (primarily from logs and snags). The sites are located throughout the 12,887 ha watershed (**Fig. 4.16-1**) so that 82 % are within 1000 m of any other site (**Fig. 4.16-6**). Mean number of samples collected at individual sites is 4.39 (SD=2.36). Fire dates have been determined from 92 sites and form the basis for the current fire return interval estimates and annual area burned reconstruction. A total of 255 dated samples were used in this analysis with over 2050 individual fire scar dates. A total of 304 fire event years (years in which a fire event was recorded somewhere in drainage) are recorded between AD 1400 and AD 1995 although fire dates extend back to 284 BC at the sequoia sites (Swetnam et al. 1992). For the primary period of analysis, 1700-1899, 151 fire event years are recorded within the drainage. The last fire of significant size occurred in 1889 (recorded at 5 sites) with 1994 the most recent fire date recorded.

Polygon construction for all sample sites yielded an average area of 104.1 ha per polygon (median 97.6). Irregular polygon shapes are the result of polygon boundaries being constrained by aspect, elevation, and vegetation categorization (**Fig. 4.16-7**).

The Twentieth Century Fire Record - Comparison of Fire Scars and Fire Records

During the twentieth century 17 fire dates were observed in the fire scar record. Comparison of these records to our modern fire records shows interesting similarities and differences. Four of the 17 fire scar dates predate the start of fire records in 1921 (1901 lower Atwell, 1911 Eden Grove, 1918 Squirrel Creek and 1920 upper Atwell). The 1911 date was recorded at two adjacent sites indicating a sizable fire. A review of the 1911 Superintendent's Report for Sequoia and General Grant National Parks (Major James B. Hughes First Cavalry 1911) by Ward Eldridge located a reference to a 600 ac

Figure 3.16-5. Distribution of fire history sites within the drainage across all major vegetation classes.

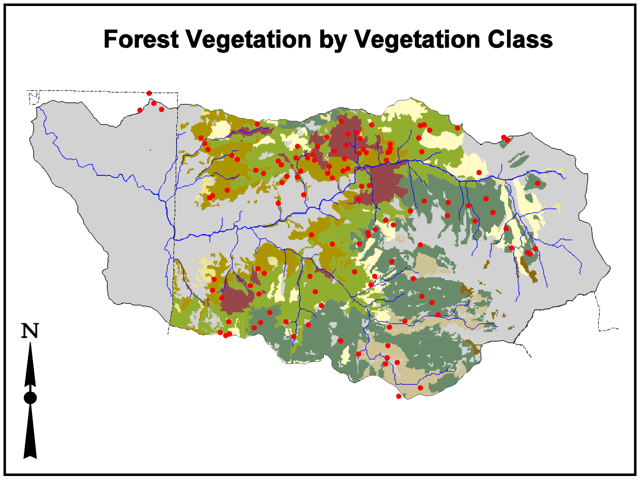

Table 4.16-2. Breakdown of sites collected in the East Fork by elevation and aspect through 1999.

Elevation (m)	Total	South	North
<1000	0	0	0
1000-1250	0	0	0
1250-1500	1	1	0
1500-1750	12	8	4
1750-2000	26	18	8
2000-2250	27	19	8
2250-2500	17	9	6
2500-2750	31	10	21
>2750	13	8	5
Total	123	73	50

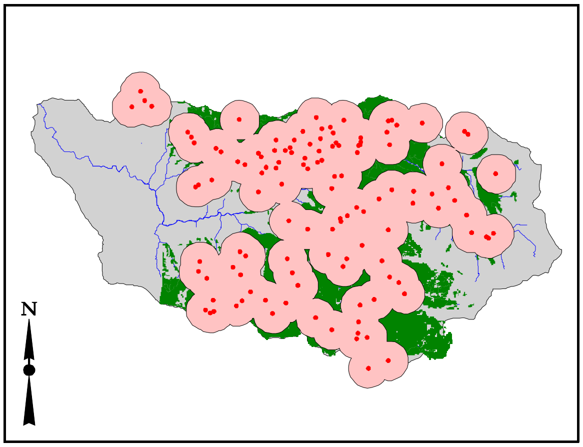

Figure 4.16-6. Intersite proximity and spatial coverage of fire history sites (red dots) with 1000m buffer.

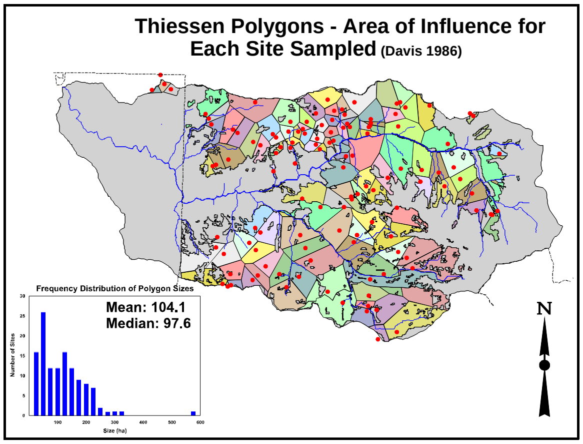

Figure 4.16-7. Thiessen polygons constructed around current set of fire history sites. Inset chart shows polygon size distribution.

lightning caused burn in Horse Creek (Horse Cr. is a subdrainage to the East Fork of the Kaweah). Although the report does not give a specific location for the burn in Horse Creek the fire history sites recording a 1911 event are located on the south side of the lower portion of the drainage. The fire burned between July 30 and September 13 and was suppressed by 20 soldiers and rangers. In the area where the 1918 scars were obtained hand cut stumps suggest fire suppression activities. A Superintendent's Report is not known to exist for this year (although archives have not been searched in Washington) (Ward Eldridge personal communication). No record of a 1920 burn above Atwell was found in the Park's archives although a list of fire reports was located and will be added to the Park's fire records database (by Karen Folger) which currently only extends back to 1921 (however, the fire reports only list location).

For the period for which we have fire records, six fire dates (for fires > 2 ha) correspond to fires listed in the fire records (1926 unknown (lower Silver City), 1946 Atwell Mill (upper), 1970 Lookout Point (Conifer Ridge area), 1979 Timber Gap, 1987 Silver [date matches a recorded fire but the mapped location of the burn is about one kilometer west from the location we obtained using a GPS with no other burns in the area matching this date] and 1994 (2) Farewell and Hockett). Dates from nine burns listed in the fire records, located in conifer forest, were not picked up by the fire scar record (1924 unknown (Oriole Lake), 1952 Mineral King, 1955 Conifer Tract, 1974 Lookout (Hockett Plateau), 1978 Eden Grove, 1988 (2) Hockett and Deer Creek, 1991 Deer Creek, 1994 Horse Creek). The lack of records from the more recent burns was primarily a result of sampling not being carried out these areas due to the poor or lacking fire history record. This is a result of recent burns destroying most fire history information (due to heavy fuels and the decayed nature of many catfaces, both of which result in catfaces being burned out or remnant logs/snags being completely consumed by the fire). The earlier burns, none of which were over 25 ha in size, appear to have been missed simply because of the spacing of sample sites. Of particular interest are the number of fire events recorded by fire scars that are not recorded in our fire records. These include six dates: 1924 upper Atwell Mill, 1935 Atwell/Redwood Cr. Ridge, 1954 Tar Gap, 1969 Milk Ranch south of Parks, and 1971 and 1985 in the area of Atwell Mill. The 1969 burn, although mapped within the Parks, included a large area outside the Parks which is missing from the fire record. The reason for the missing records for the most recent burns near Atwell is unknown although the occurrence of the latter burn is recalled by some park personnel.

Annual Area Burned

Striking patterns of past fire occurrence are emerging as more sites are collected and crossdated from a

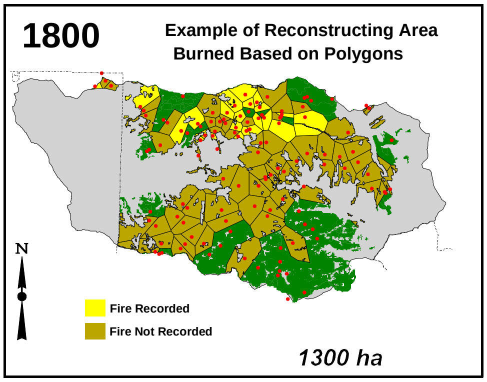

Figure 4.16-8. Reconstruction of area burned in 1800. Fire(s) appear to have been confined to the south aspect.

broad array of areas in the watershed. Initial mapping of fire occurrence indicates that patterns of area burned by past fires can be reconstructed over the landscape with some reliability. However, the resolution of the final burn map is commensurate with the sampling intensity and while rough estimates of past fire size can be obtained, specific locations of burn boundaries cannot be determined. Additionally, the distribution of point estimates over the landscape generally represent a minimal area burned by a particular fire or fires in a given year. This is because the presence of a scar is a definitive record of the occurrence of a fire while the lack of a scar could be the result of either the area not having been burned by a fire or that the fire left no record (did not scar trees or a sample with the scar was not collected) even though a fire occurred.

Several fire years provide good examples of the spatial pattern of reconstructed area burned. The map displaying the 1800 fire date (1,300 ha based on estimate from polygon reconstruction) shows a burn, or possibly more than one burn, with a well defined burn area confined to south aspect slopes (**Fig. 4.16-8**)(data based on those areas from which fire dates have been collected and dated). Other fire dates show different patterns of fire on the landscape. The maps for 1777 and 1829 (**Fig. 4.16-9**) indicate widespread burns (3,720 and 4,209 ha respectively) and show areas that burned in both the main East Fork drainage and the Horse creek drainage. In contrast only a small cluster of sites located in the Cabin Cove area (**Fig. 4.16-10**) recorded what was probably a single fire event in 1844 (255 ha).

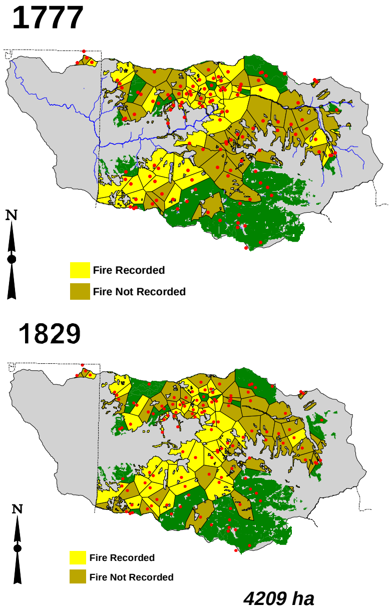

Figure 4.16-9. Large areas burned in 1777 and 1829 across much of the drainage suggesting a widespread fire(s).

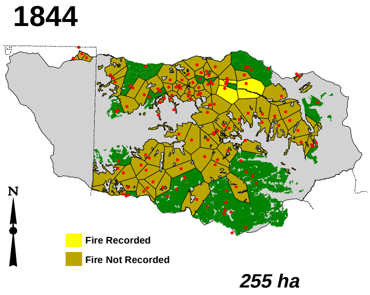

Figure 4.16-10. Area burned at a cluster of sites indicating a fire of limited extent.

Also of interest are comparative maps of the extent of the 1873 and 1875 burns (**Fig. 4.16-11**). The area of the 1873 burn shows that it was centered on the central portion of the Atwell Grove while the map for the 1875 burn indicates it burned predominantly to the east and west of this area and into lower portions of the north aspect. Overlaying burn maps of these two burns suggests that they were nearly 100% mutually exclusive indicating that fuel recovery in two years may not have been sufficient to permit extensive reburning.

There is also an interesting historical footnote for the 1875 burn. While traveling through the Atwell area in 1875 John Muir observed a fire that appears to be this 1875 burn (Muir 1878). He wrote that the fire burned intensely up-canyon through chaparral vegetation but with decreasing intensity once it entered the sequoia grove where fuel levels were low and consisted primarily of conifer needles. These observations, that the fire burned through the intervening chaparral vegetation, verify the burn pattern reconstructed on the burn map from the fire history samples.

Chronosequence of annual burn patterns back into the early 18th century will be developed for the

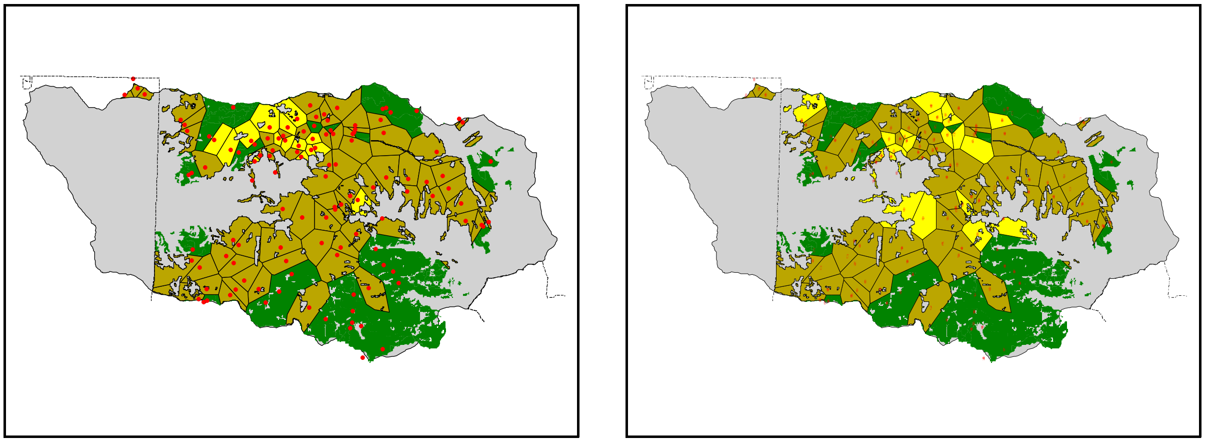

Figure 4.16-11. Reconstructed burn maps for 1873 (left) and 1875 (right) showing nearly complete lack of overlap in burns during the two years..

watershed. The sequences will provide rough estimates of area burned and spatial pattern of burns. An example the annual burn area for the East Fork is shown for the years from 1839 to 1849 (**Fig.4.16-12**). Apparent are a range of year types, with years when extensive fires occurred to years without fire to years when no fires were recorded. The temporal variation in annual area burned is examined in the following section “Frequency-Area Relationships”. This chronosequence of burn maps will complement and extend the GIS fire records database back in time.

Fire-Return Intervals

Fire-return interval analysis looks at point estimates based on individual site data and is the typical method of looking at past fire history data (**Fig. 4.16-14**). Within the East Fork watershed considerable variation in fire-return intervals have been found among sites with obvious patterns apparent from individual site fire chronologies. For example, fire chronologies show (1) both differences in mean fire-return intervals (FRI) among the sites related to elevational differences, as described by Caprio and Swetnam (1995), and (2) occurrence of common fire years among sites--years such as 1848 and 1875. Further analyses are possible when these results are summarized into composite fire chronologies for each site.

Initial comparisons of FRI between north and south aspects for a subset of sites at low-to-mid elevations (1800-2200 m) have provided the most interesting results to date (**Fig. 4.16-13**). These data suggest that there were considerable differences in FRI between north and south aspects in this elevational range. FRI averaged about three-times greater on the south aspect relative to the north aspect (~9 years versus ~31 years) (**Fig. 4.16-15**). Sampling during 1999 will be partially directed at obtaining collections from north/south aspects in other drainages to determine whether such aspect differences can be generalized to larger areas of the Parks. If consistent, such differences in fire return intervals by aspect will have important implications for fire managers in terms of burn planning, on anticipating potential fire effects on these sites, and understanding mechanisms responsible for initiating or maintaining attributes of past forest structure.

Additionally, comparison of point fire frequency estimates, for the period from 1700 to 1899, across the elevational gradient in the drainage, for the sites on the south aspect versus the north aspect show dramatic differences (**Fig. 4.16-16**). A strong inverse relationship between number of fires and elevation was observed on the south aspect which corresponded very well with the results from previous sampling along an elevational gradient in the Giant Forest area (Caprio and Swetnam 1995).

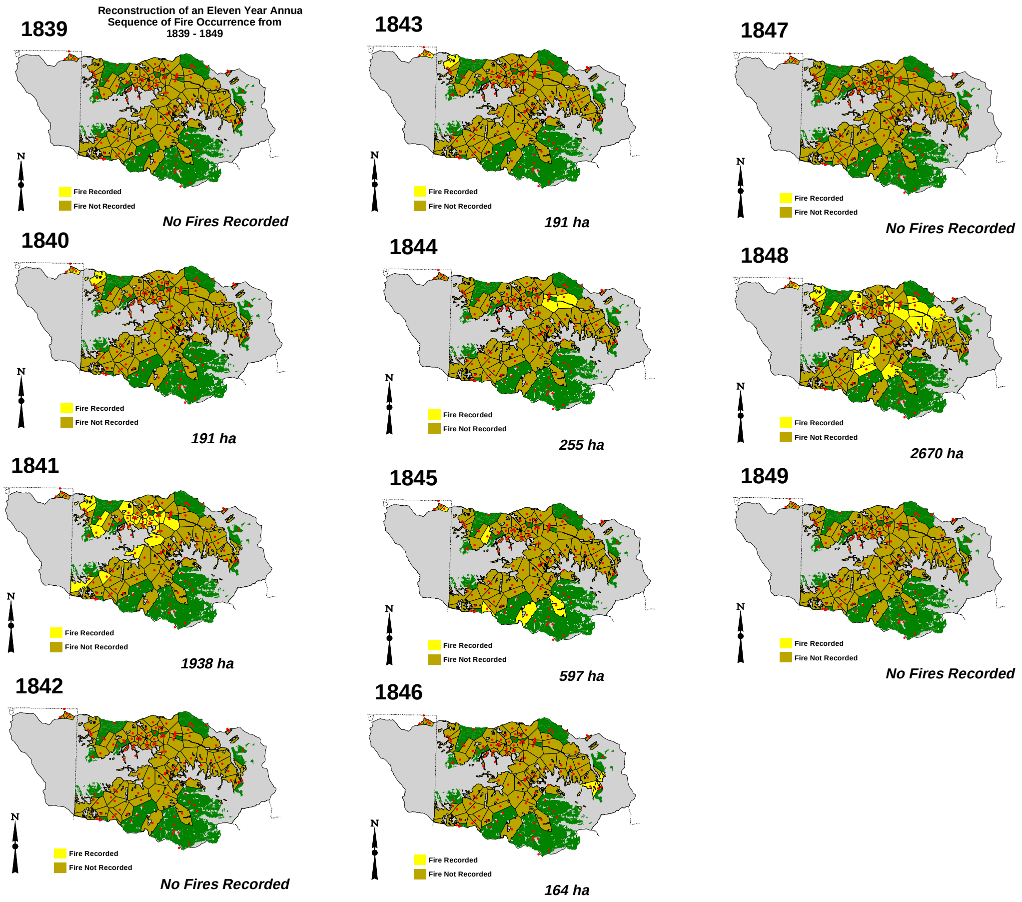

Figure 4.16-12. Chronosequence of reconstructed annual area burned between 1839 and 1849 showing variation in burn patterns across the landscape.

However, the relationship between elevation and aspect on the north facing slopes was much weaker suggesting that fire occurrence across the elevational gradient on this aspect was comparatively uniform relative to the south aspect.

Frequency-Area Relationships

Reconstructing annual area burned within the watershed permits us to view patterns and variation in area burned through time and in many ways provides a more realistic feel for past fire occurrence at a landscape level. A plot of reconstructed area burned (based on polygons) for the whole watershed shows considerable year-to-year variation (**Fig. 4.16-17**). Extensive area burned is apparent in a few years (1777, 1829 and 1848) with many years when a small-to-intermediate amount of area burned. Average area burned annually within the watershed was 320 ha (this value will probably increase as sampling and sample analysis for all area within the watershed are completed) or about 2.4% of the

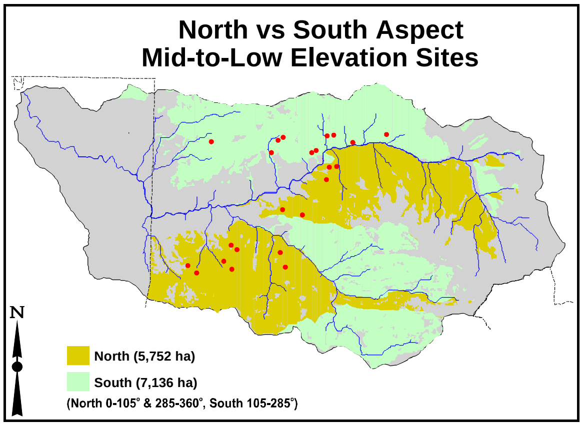

Figure 4.16-13. Low-to-mid elevation sites used in comparing aspect differences in fire frequency.

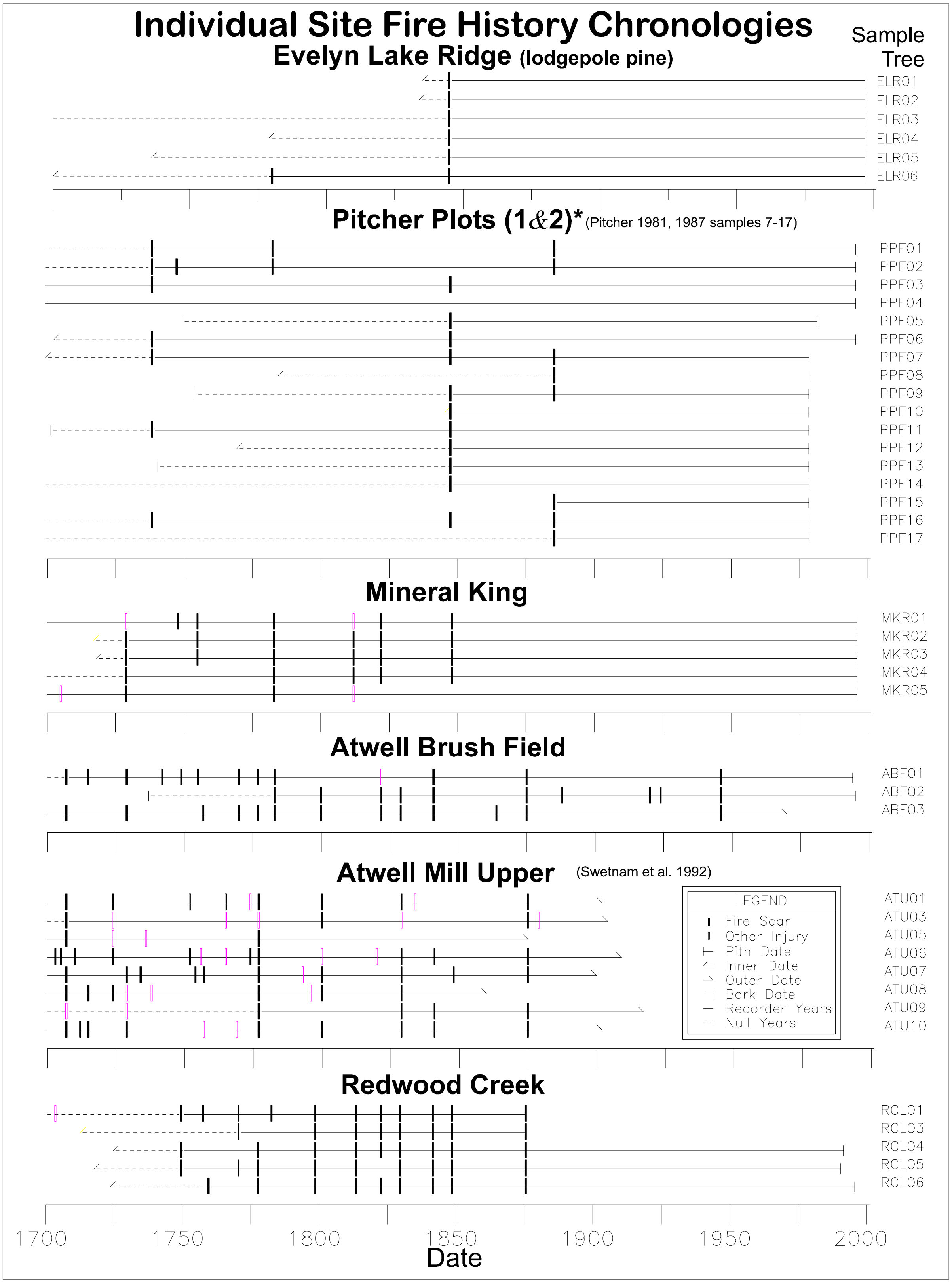

Figure 3.16-14. Examples of reconstructed fire history data from five sites in the East Fork drainage for the period from 1700 to the present. Sites illustrate varying pre-Euroamerican fire regimes from differing vegetation types and aspects in the watershed. Horizontal lines represent a particular sample (one tree) with vertical bars indicating crossdated fire dates.

coniferous forest area. The distribution of reconstructed area burned annually within the watershed from 1700 to 1899 shows an inverse J shaped distribution (**Fig. 4.16-18**). Most fires were small with a few years when extensive fire occurred.

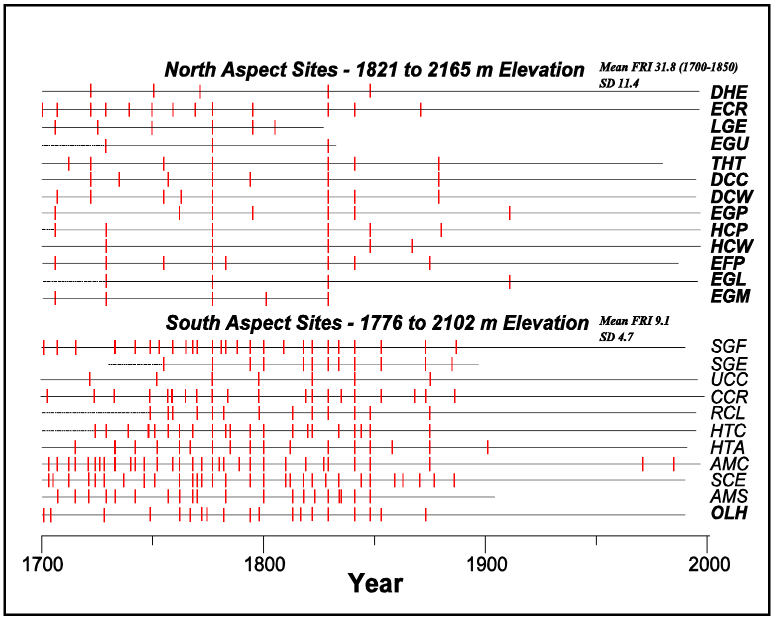

Figure 4.16-15. Differences in fire frequency by aspect for low-to-moderate elevation sites in the East Fork drainage. Each horizontal line represents a composite site chronology with vertical red lines indicating fire dates.

Considerable more detail was apparent when data were separated by elevation and aspect (**Fig. 4.16-19**). The analysis showed dramatic differences in area burned annually by aspect and elevation with patterns that were similar to the fire-return interval analysis described above. Differences were greatest between lower elevation north/south aspects (~ three-times) and decreased as elevation increased (~ two-times). Low elevation south aspect with high frequency of small to fairly large fires in contrast to low elevation north aspect where fire frequency was moderate-to-low but punctuated by very large fires at intermittent intervals. Between 1700 and 1899 two large fires occurred in 1777 and 1829 (based on tree-ring analysis these appear to have been dry to very dry years). On both the north and south aspect at higher elevation frequencies were low (lowest on north high). North high with similar freq to south low although was not punctuated by large fires.

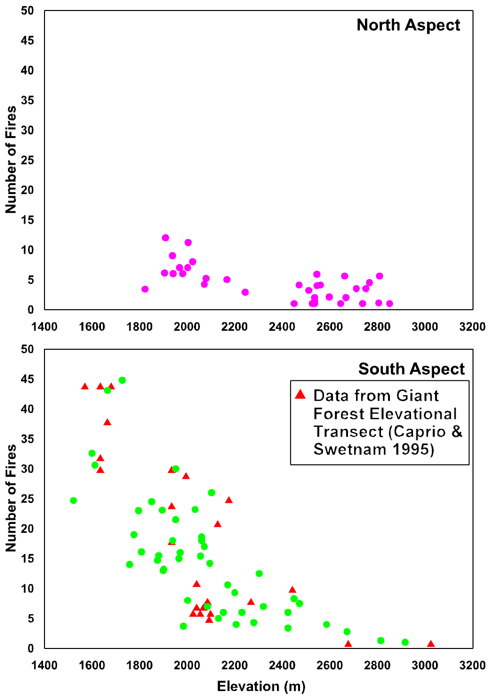

Figure 4.16-16. Relationship between number of fires (frequency) and elevation on north (top) and south (bottom) aspects. Graph indicates the greatest difference in frequency was at the lower elevations.

SUMMARY

The current sample set greatly improves the resolution and spatial accuracy for reconstructing past burn history within the East Fork watershed. It is important that fire history information be obtained from a large set of areas to present a clear picture of past fire regimes over the landscape with less bias than previous sampling that centered on specific vegetation types, aspects, or elevations. As data from the current sample set are developed it will provide information about attributes of past fire regimes from throughout the watershed. Data will also be used as input into the GIS/Fire model (FRID) being developed for Sequoia and Kings Canyon National Parks (Caprio et al. in press, Caprio and Graber in prep.).

The fire history data will also be important baseline data set for improving our understanding of past fuels, forest structure, potential fire behavior (and fire intensity/severity) and its potential ecological influence on these aspects. Recent sampling in the Landscape Analysis Project by Kurt

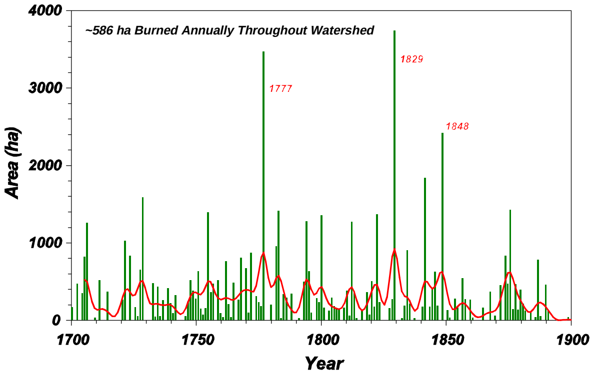

Figure 3.16-17. Reconstructed estimate of area burned annually within the East Fork (smoothed moving average using 13-weight low-pass filter).

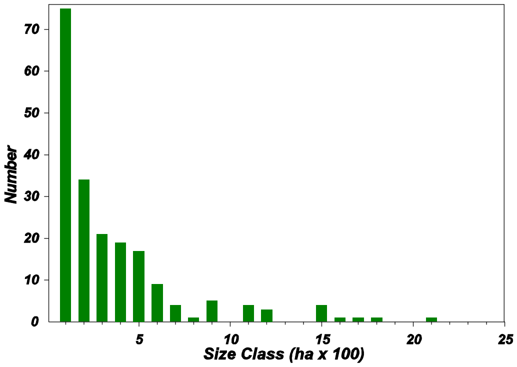

Figure 3.16-18. Distribution of area burned annually by size class showing that most fires were small.

Menning has focused on aspect differences in current fuels and forest structure. Such information may eventually provide clues about past differences in vegetation and fuel structure by aspect that can be interpreted in light of our knowledge about past fire history. Additionally, preliminary work on the relationship between area burned by aspect and climate suggests interesting relationships. Fires on south aspects appear to have occurred during just about any year (wet or dry) while fires on north aspects were more strongly associated with dry years. However, the years when large areas burned on either aspect were typically the driest. Such information can have operational value and be very important in understanding the relationship between fire occurrence and life history strategies and fire impacts on the biotic community (Bond and Wilgen 1996).

Main Findings

- ***Aspect difference*** - The current results show a dramatic difference in the length of fire return intervals between south and north aspects at low-to-mid elevations sites. Differences in average FRI indicate that intervals between fires were approximately three-times longer on north aspects compared to south aspects. If these differences occur consistently within other watersheds this information will provide valuable input into the fire management program.

- ***Estimates of past fire size*** - The results suggest that past fires can be reconstructed with a moderate amount of resolution and that distinct patterns can be observed across the landscape. These data will allow patterns of fire size over the landscape to be explored and include variation by aspect and vegetation type. The fire size data will also provide baseline information for contemporary and future investigations being conducted in the drainage.

PLANS FOR 2000

Limited sampling will continue in the East Fork during 2000 mainly to fill gaps in the spatial network of sites not completed in past years. A particular target area includes lodgepole pine forests on the Hockett Plateau where previous sampling was limited. Additional samples may also be obtained from the Oriole Lake drainage and in the Coffeepot Canyon area. Crossdating of collected material will continue and should begin producing results about past fire regimes for individual vegetation classes.

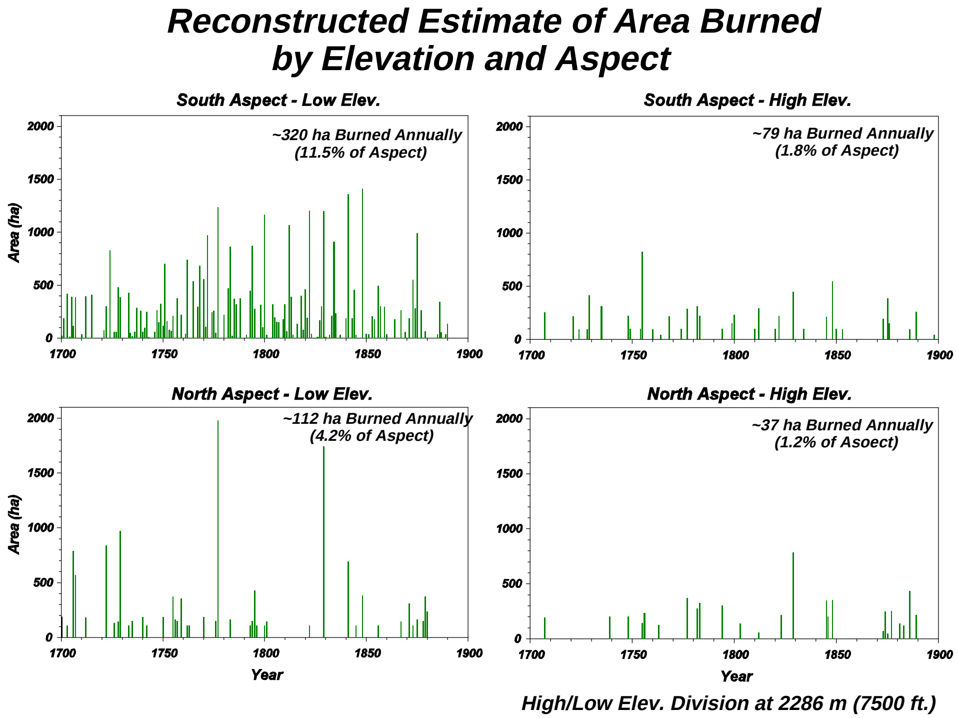

Figure 4.16-19. Reconstructed estimates of area burned annually in the drainage showing differences by aspect and elevation. The lower south aspect showed the greatest differences.

II - ASPECT SAMPLING

Objectives of the fire history aspect sampling are to (1) determine whether the differences in pre-Euroamerican settlement fire regimes on north and south aspects that have been detected in the East Fork "Watershed Fire-History Study" occur in other watersheds with similar aspect configurations and (2) if these differences exist whether the magnitude of the differences are similar to the those observed in the East Fork.

The sampling for this validation study is designed to be much less intense than the East Fork with only 3-4 sites collected on each aspect within a drainage. Obtaining this information and understanding potential differences among watersheds will eventually be incorporated into the FRID analysis and into fire management planning. Sampling procedures for individual sites were the same as described for the Mineral King Study above.

During 1999 aspect sampling was carried out in the South Fork (**Fig. 4.16-20**) and Marble Fork (**Fig. 4.16-21**) of the Kaweah River. Samples from two sites in the South Fork have been prepared and are in the process of being crossdated.

PLANS FOR 2000

In the South Fork up to two additional north aspect sites in the Garfield Grove area or along the old abandoned Devils Canyon Grove trail will be collected. In the Marble Fork two to three addition north and south aspect sites will also be located and sampled. Lastly, in Cedar Grove/Kings Canyon collections on north/south aspects sites are planned for the summer. Potential sampling locations include the Sheep Creek drainage on a north aspect and Lewis Creek drainage on the south aspect. Locating

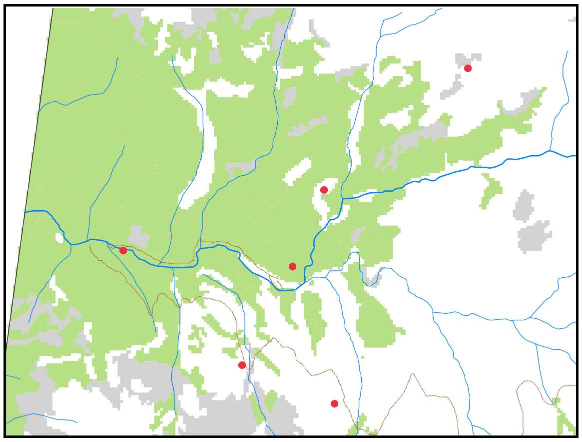

Figure 4.16-20. Sites sampled in the South Fork of the Kaweah drainage.

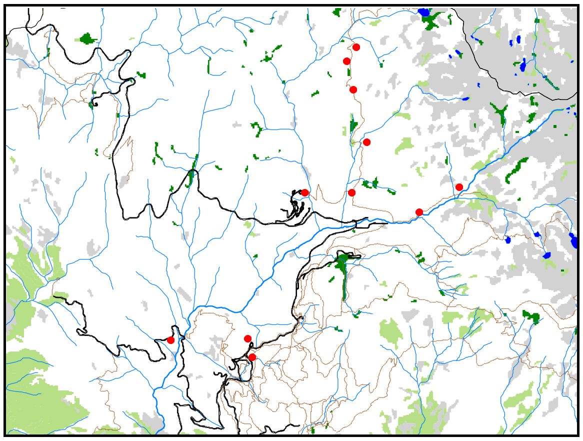

Figure 4.16-21. Sites collected in the Marble Fork drainage and in the Silliman Creek Flats area.

material at the latter area may be difficult due the number of recent burns that have occurred in the area.

III - SPECIAL PROJECTS

A) <u>Silliman Creek</u> - Questions have been raised about past fire frequency in the mixed lodgepole pine - fir forest found above Lodgepole and to the east of Silliman Creek.(Bancroft and Manley personal communication). The area is located on a bench north of Lodgepole composed of glacial til with a series of glacial moraine deposits incised by small drainages. The bench has a rolling surface with wet lowland areas currently dominated by lodgepole pine (***Pinus contorta*** - PICO) and fir (***Abies*** spp. - ***A. concolor*** - ABCO and ***A. magnifica*** - ABMA) with drier upland sites primarily dominated by fir. Current vegetation structure and composition suggest change in the vegetation over the last 100-150 years due to the absence of fire as an ecosystem process. In the lowland sites what appear to be post-fire suppression age fir have established in the understory and lower forest canopy and may eventually dominate these areas replacing the less shade-tolerant lodgepole pine (**Table 4.16-3**). Originally stands appear to have been more open with a greater dominance of PICO. Doghair thickets of ABMA mixed with some PICO now occur at many of the lowland locations (**Fig. 4.16-22**). Continuing change in the area without restoration of fire will probably produce drastic change in the fire regime as firs dominate and fuels increase.

Table 4.16-3. Stand composition of forest in the Silliman/Willow Meadow flats area based on data from three studies.

Study	Veg.Type	ABCO	ABMA	PICO	PIJE
	Values = Percent Cover				
Fire History	low	4.0%	44.9%	5.0%	2.1%
VanKat/Roy Plot	high	9.2	63.0	0	0
	Values = Number of Trees > 10cm DBH (% of stems by species)				
NRI plot 52	low		89* (52%)	11 (92%)	2 (100%)

* Original NRI data incorrectly identified these as white fir (ABCO).

During 1999 two sampling sites were located on the bench. Samples were collected form one of the bench sites with several additional reference sites sampled north of the bench (**Fig. 4.16-21**). Samples at this site possessed from one-to-four fire scars. Sample processing and crossdating of fire scars has not been completed. A second bench site with enough potential samples was located adjacent to Willow Meadow and will be sampled as a second replicate early in the summer of 2000.

B) **Cedar Grove** (1998) - During the fall of 1998 three fire history collections were made in Kings Canyon east of Cedar Grove. The valley contains a ponderosa dominated forest community that is unusual in the Parks which is experiencing colonization by the exotic and highly invasive annual grass ***Bromus tectorum*** (cheatgrass). The specific goal of the sampling is to provide more detail on past fire frequency and how it varied across throughout the valley. Warner (1980) sampled one site in the valley with the data showing very short fire intervals, in the order of three-to-four years between fires and the shortest recorded in the parks. However, although much of the valley is dominated by ponderosa pine forest there is considerable difference in site productivity within the valley with very strong gradients between these areas. Vegetation and productivity of sites located along lowland river terraces appear much greater than terraced upland locations such as the area known as the Gobi Desert (a large dry flat expanse east of Roads End). Site productivity appears to be associated with moisture availability in the highly permeable glacially deposited soils. Considerable differences in species composition and canopy cover exist by site and appears dependant on site productivity. Upland sites tend to be dominated by PIPO and lowland sites by ABCO (**Table 4.16-4** and **4.16-5**) although PIPO may have been more important historically. Because of these differences in site productivity fuel accumulations differ today and probably differed in the past. If fuel accumulation rates governed past fire occurrence (versus ignition source) then the drier upland terrace sites (such as Gobi Desert) should show longer fire return intervals than the lower river terraces. Baseline information about past fire regimes in the valley will be important in developing management strategies for dealing with the exotic cheatgrass.

The three sites collected were located just south of the housing area, in the Gobi Desert area, and immediately east of the footbridge across the Kings River Creek off the Bubbs Creek Trail (**Fig. 4.16-23**). Of note: the only fire history material available in the valley was found in areas that had not been

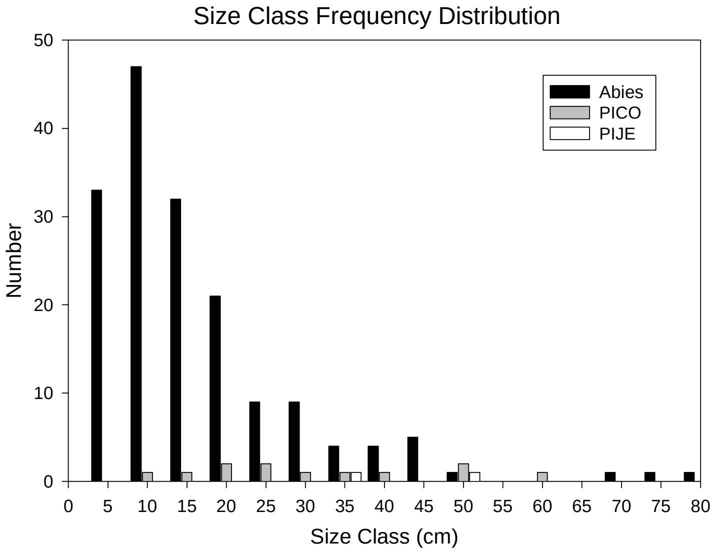

Figure 4.16-22. Size class distribution of trees in Silliman Creek Flats sampling area showing the dominance of small (young?) firs.

Table 4.16-4. Tree cover estimates for the three fire history sample sites.

Cover	Site 1	Site 2	Site 3
Tree	59.2	78.4	65.0
Herb	29.5	1.7	42.0
Shrub	39.5	0.3	13.0
Elevation	1409	1557	1568

Table 4.16-5. Relative cover of tree species at the three sites.

Rel. Cover (%)	Site 1	Site 2	Site 3
ABCO	0.3	50.1	0
PIPO	48.0	0.9	36.9
CADE	39.9	31.9	12.0
QUKE	11.8	13.7	24.6
QUCH	0	1.3	26.5

burned over the last 20 years. Fuel loads and condition of fire scarred trees from the pre-settlement period are such that the fire scar record is destroyed by any fires that occur. Thus the current samples will become an important historical record that document some attributes of past fire regime characteristics in the valley that would have been lost otherwise.

IV - PAPERS OR PRESENTATIONS BASED ON FIRE HISTORY SAMPLING

Pre-Twentieth Century Fire History of Sequoia and Kings Canyon National Parks: A Review and Evaluation of Our Knowledge. A.C. Caprio and P. Lineback. in press. In: Proceedings of the Conference on Fire in California Ecosystems: Integrating Ecology, Prevention, and Management. Nov. 17-20, 1997, San Diego, CA.

Fire Management and GIS: a Framework for Identifying and Prioritizing Fire Planning Needs. A.C. Caprio, C. Conover, M. Keifer, and P. Lineback. in press. In: Proceedings of the Conference on Fire in California Ecosystems: Integrating Ecology, Prevention, and Management. Nov. 17-20, 1997, San Diego, CA.

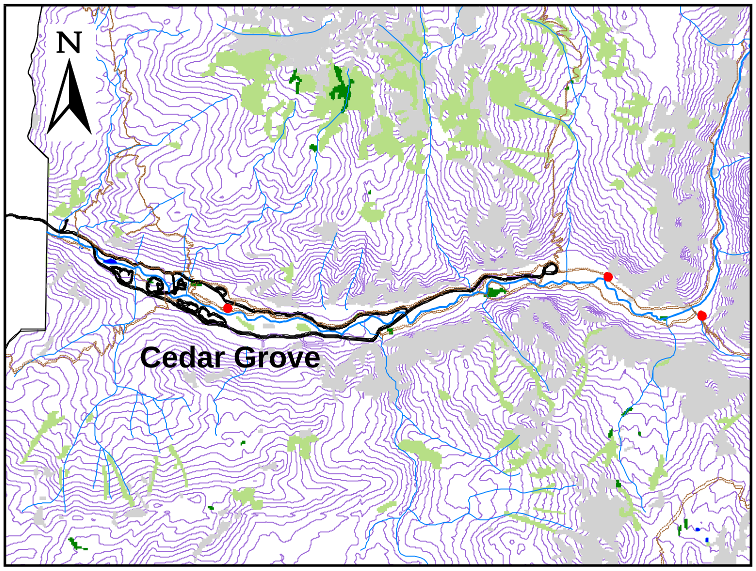

Figure 4.16-23. Sample site locations in Cedar Grove, Kings Canyon.

Returning Fire to the Mountains: Can We Successfully Restore the Ecological Role of Pre-Euroamerican Fire Regimes to the Sierra Nevada? A.C. Caprio and D.M. Graber. in press. In: Cole, David N.; McCool, Stephen F. 2000. Proceedings: Wilderness Science in a Time of Change. Proc. RMRS-P-000. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Incorporating a GIS Model of Ecological Need into Fire Management Planning. M. Keifer, A.C. Caprio, P. Lineback, and K. Folger. in press. In: Proceedings of the Joint Fire Science Conference and Workshop, Crossing the Millennium: Integrating Spatial Technologies and Ecological Principles for a New Age in Fire Management, June 14-16, 1999, Boise, ID.

Temporal and Spatial Dynamics of Pre-Euroamerican Fire at a Watershed Scale, Sequoia and Kings Canyon National Parks. Anthony C. Caprio. Paper presented at: Conference on Fire Management: Emerging Policies and New Paradigms. Nov. 16-19, 1999, San Diego, CA.

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