3.17) Fire History

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OBJECTIVES

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 has been questions about our understanding of pre-Euroamerican fire regimes at such large ecosystem scales. While substantial fire history research, based on fire scars recorded in trees (**Fig. 3.17-1**) 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 designed, the historical fire regime is largely hidden from direct view and thus its attributes are easily under sampled or overlooked. To capture some semblance of this variation a substantial effort in acquiring a large number of sample sites is required. Such sampling intensity would not be unexpected if variation in terrestrial vegetation were being sampled within diverse habitats.

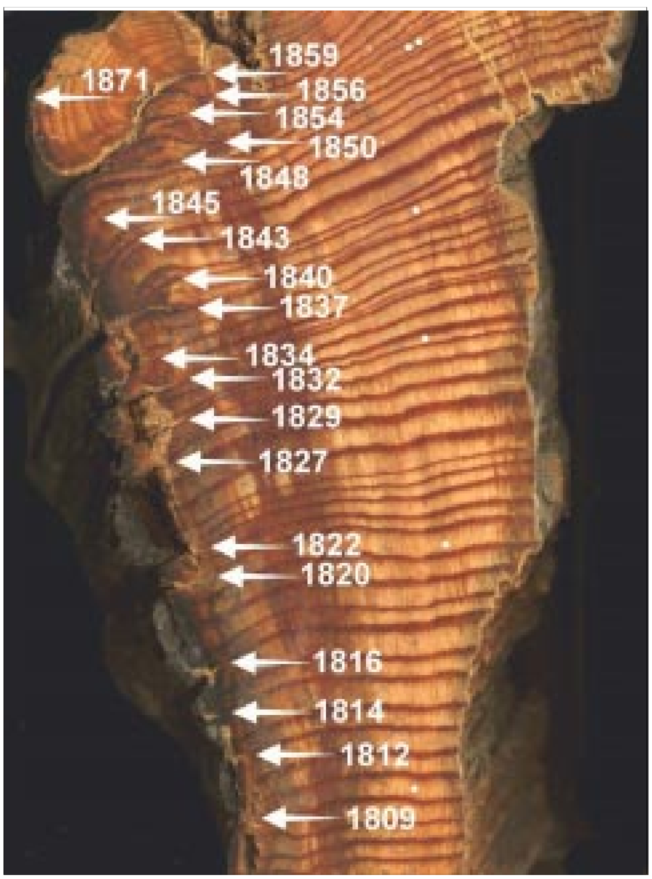


Figure 3.17-1. Example of high fire frequency area shown by dated fire scar sample from low elevation ponderosa pine/black oak forest. A minimum of 19 fires were recorded between 1809 and 1859 with a maximum interval of five years (1822 to 1827).

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. 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.

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) integrating this information to provide input for advancing 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

During 1998, 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. A substantial number of new sites were sampled on the north aspect in the Eden Grove area. Sampling also concentrated on burn segments scheduled for ignition during 1998 and 1999--Tar Gap, Deadwood, Silver City and Purple Haze (**Fig. 3.17-2**). Additional sites were also located in the Eden, Empire and High Bridge segments. These increased the sampling resolution for this portion of the drainage. Additional collections are needed from the Park boundary area east of Case Mountain, the upper forest zones above Hockett meadow and above Silver City.

Specimens are being dendrochronologically crossdated to determine precise calender years (**Fig. 3.17-3**) 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. Sample preparation and crossdating is most advanced from sites collected during 1995 though 1997.

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

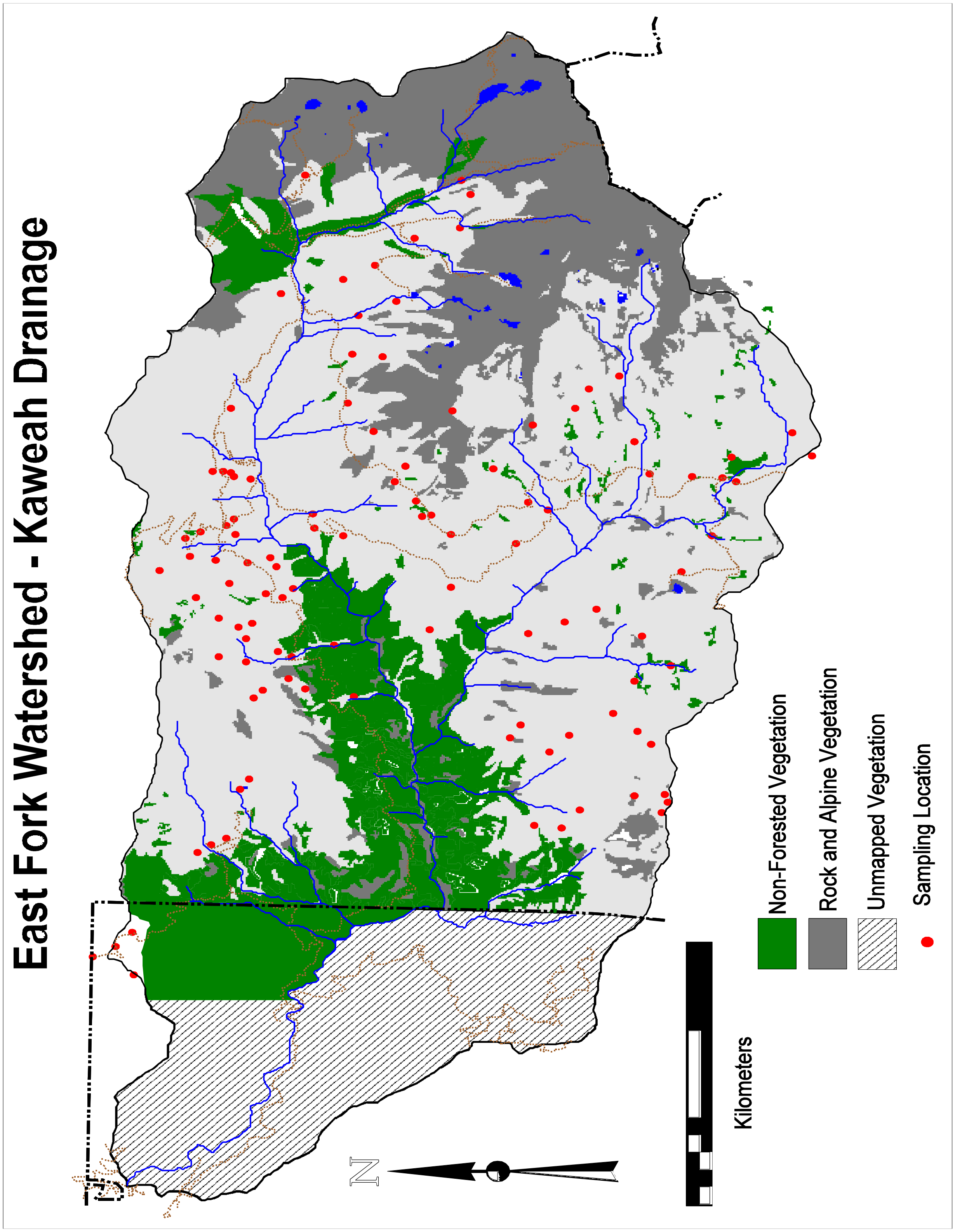


Figure 3.17-2. Fire history collection sites in the East Fork.

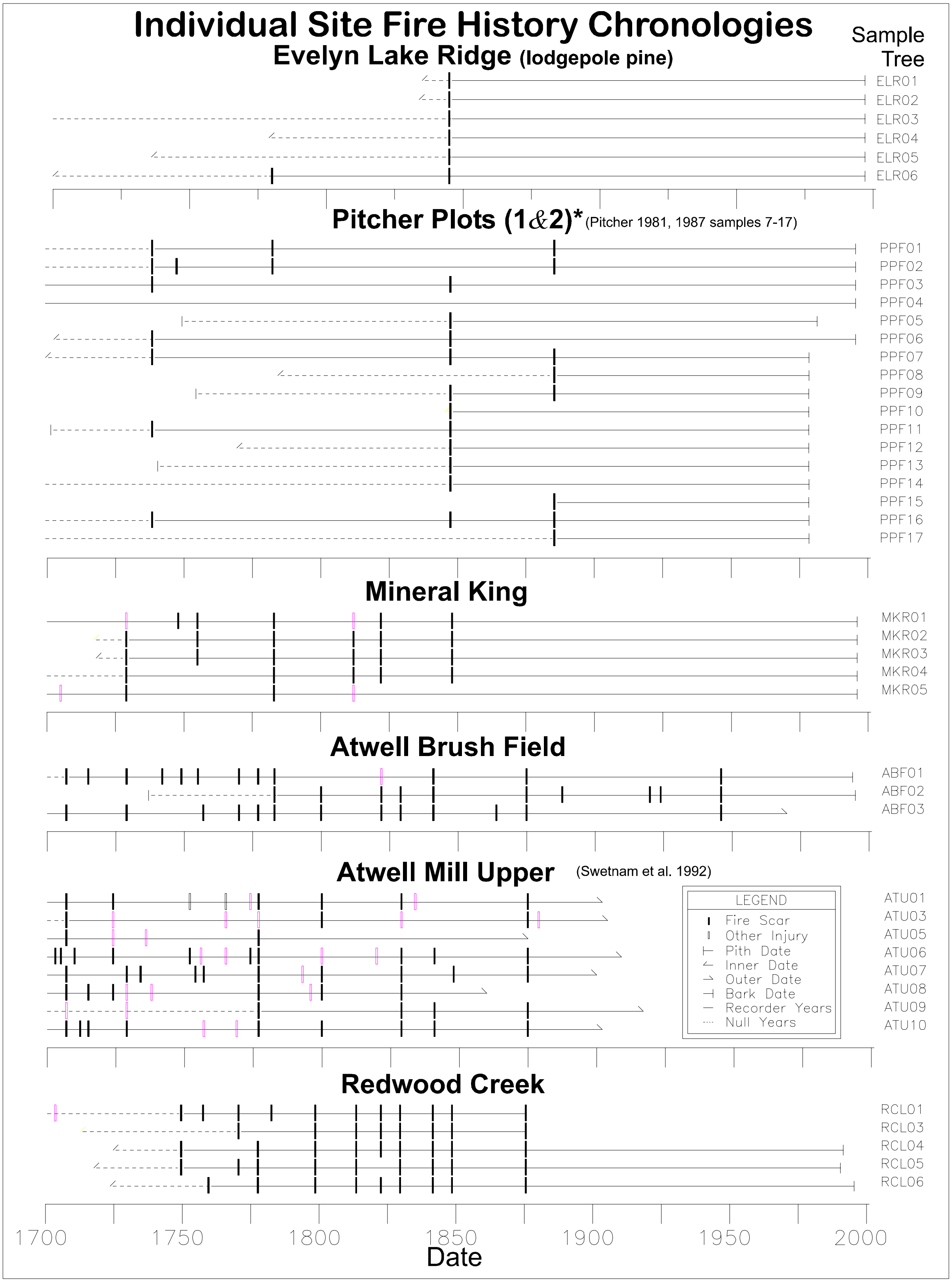


Figure 3.17-3. Examples of reconstructed fire history data from five sites in the East Fork drainage for the period from 1700 to the present. Sites illustrate varying pre-Euroamerican fire regimes from differing vegetation types and aspects in the watershed. Horizontal lines represent a particular sample (one tree) with vertical bars indicating crossdated fire dates.

Table 3.17-1. Summary of site collections within the East Fork by vegetation class through 1998.

Vegetation Class	Number of Sites
Ponderosa Pine	2
Ponderosa/Mixed Conifer	27
White Fir Mixed Conifer	20
Sequoia Mixed Conifer	9
Red Fir	33
Lodgepole Pine	10
Subalpine Forest	2
Xeric Conifer	5
Foothill	1
Chaparral*	**(7)**
Total	**109**

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 3.1 Spatial Analyst (ESRI 1996) 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.

RESULTS and DISCUSSION - Preliminary Analysis

Approximately 139 specimens (logs, stumps, snags, or trees) were collected from 30 sites during 1998. This supplements samples from 79 sites previously collected (Caprio 1997, 1998). Samples have been obtained from 10 of the 11 major vegetation classes currently designated in the Parks (**Table 3.17-1**). Sites have also been obtained from both north and south aspects over a range of elevations (**Table 3.17-2**). These collections have greatly supplemented and added to previous work that was 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 aspect, have only been sparsely or not sampled at all.

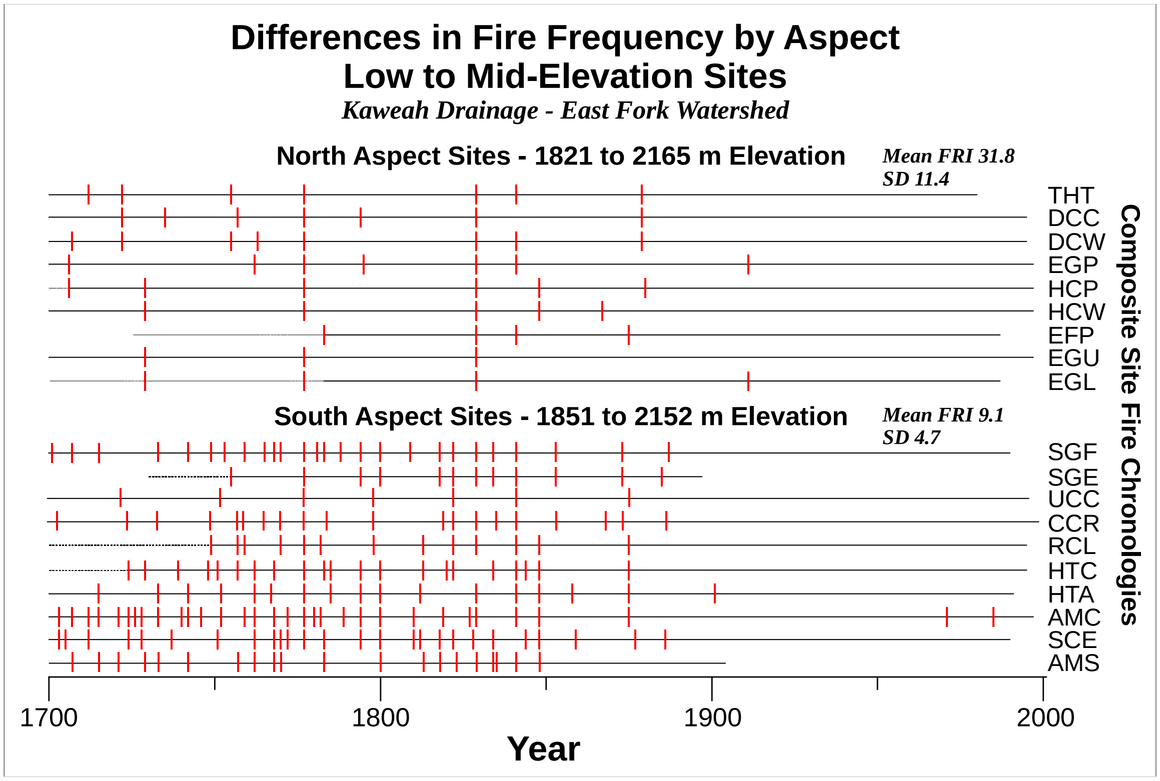
Fire Frequency

Considerable variation in fire frequencies have been found among sites with some obvious patterns from individual within site fire chronologies. For example, fire chronologies presented in **Fig. 3.17-3** show (1) both differences in 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. 3.17-4**). These data suggest that there were considerable differences in FRI between north and south aspects in this elevational range. FRI averaged about 3X greater on the south aspect relative to the north aspect (~9 years versus ~31 years). 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

Table 3.17-2. Breakdown of sites collected in the East Fork by elevation and aspect through 1998.

Elevation (m)	Total	South	North
<1000	0	0	0
1000-1250	0	0	0
1250-1500	1	1	0
1500-1750	10	8	2
1750-2000	25	17	8
2000-2250	24	17	7
2250-2500	11	5	6
2500-2750	30	9	21
>2750	10	5	5
Total	109	62	47

Figure 3.17-4. Composite fire chronologies from lower elevation sites showing differences in return intervals by aspect. Mean fire return interval (MFRI) is for the period from 1700 to 1850.



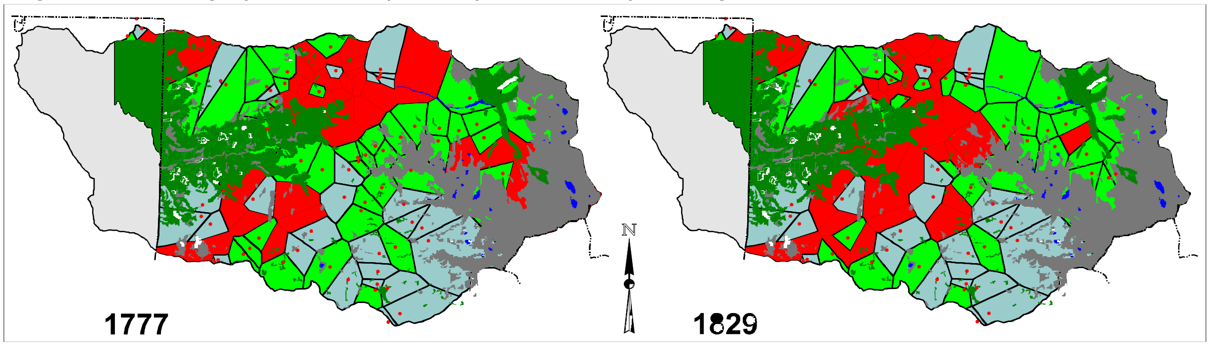
potential fire effects on these sites, and understanding mechanisms responsible for initiating or maintaining attributes of past forest structure.

Fire Size

Striking patterns of past fire occurrence are emerging as more sites are collected and crossdated from a 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 a moderate amount of reliability (**Fig. 3.17-5** and **Fig. 3.17-6**). 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 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 it occurred..

Several years provide examples of reconstructed area burned. The map displaying the 1873 fire date shows a burn, or possibly more than one burn, with a well defined burn area confined to south aspect slopes although specific burn boundaries are unknown (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 current information for the 1829 burn(s) shows that it occurred in both the main East Fork drainage and the Horse Creek drainage (**Fig. 3.17-5**). The maps for 1777 and 1829 indicate widespread burns and show areas that burned in both the main East Fork drainage and the Horse creek drainage. Of interest are comparative maps of the extent of the 1873 and 1875 burns (**Fig. 3.17-6**). 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

Figure 3.17-5. Preliminary reconstruction of area burned by fires in 1777 and 1829 in the East Fork. Red color represents areas where samples have been dated with fires observed in the fire scar record during these two years and light green color represents areas where samples have been dated and these fire dates have not been observed. Dark green areas are non-coniferous forest vegetation while gray areas are primarily rock and alpine vegetation.



exclusive. There is also an interesting historical footnote for the 1875 burn. While traveling through the Atwell area in 1875 John Muir made natural history observations about a fire that appears to be this 1875 burn (Muir 1878). He observed the fire burning 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.

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 complete 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 is 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 being developed for Sequoia and Kings Canyon National Parks (Caprio et al. in press, Caprio and Graber in prep.).

<u>Main Findings</u>

- ***<u>Aspect difference</u>*** - The current results show a dramatic difference in the length of fire return

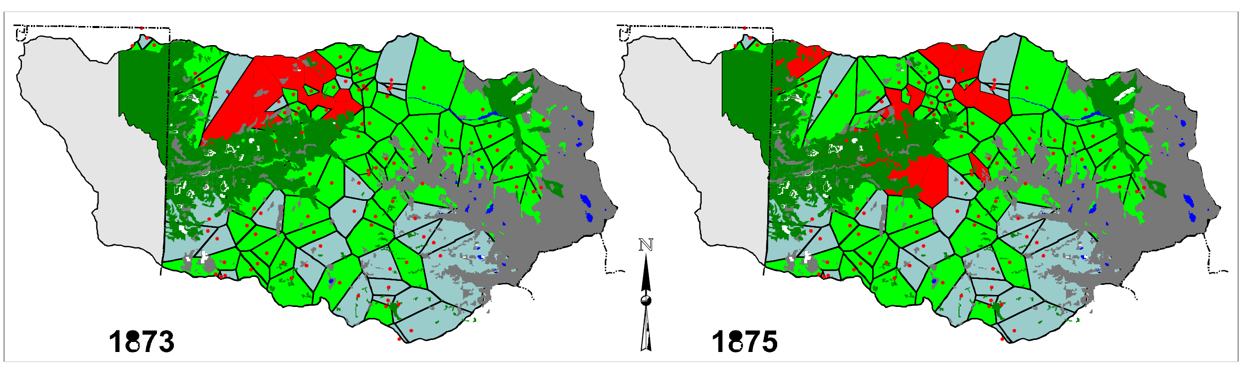


Figure 3.17-6. Preliminary reconstruction of area burned by fires in 1873 and 1875 in the East Fork. Red color represents areas where samples have been dated with fires observed in the fire scar record during these two years and green color represents areas where samples have been dated and these fire dates have not been observed. Dark green areas are no-coniferous forest vegetation while gray areas are primarily rock and alpine vegetation.

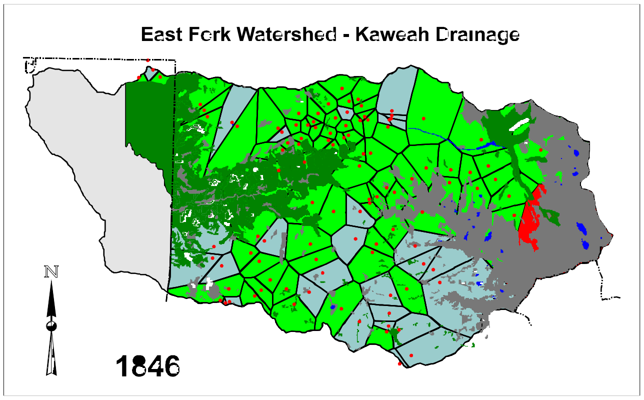


Figure 3.17-7. Illustration of a fire year (1846) where the data suggests only a small area burned in higher elevation red fir forest. Color scheme is the same as **Fig. 3.17-5.**

intervals between south and north aspects at mid-to-low 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.

• ***<u>Estimates of past fire size</u>*** **-** 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 other investigations being conducted in the drainage currently and into the future.

PLANS FOR 1999

Limited sampling will continue in the East Fork during 1999, again concentrating on segments scheduled for burning during 1999 and 2000 and on locations having north aspects. Particular target areas include upper elevation red fir and lodgepole pine forests, where some stand replacing burns may have occurred in the past. Sampling is planned to fill gaps in the spatial network of sites and will include: areas in the Oriole Lake drainage, higher elevation south aspects, upper Hockett Plateau, 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.

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