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Fire History in the Yellow Pine Forest of Kings Canyon National Park[1]

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Abstract.--Preliminary results of an on-going fire scar study in the yellow pine forest of Kings Canyon National Park indicate a mean fire frequency per individual tree of approximately 11 years for the period 1775 until 1909, the date of the last recorded fire scar on sampled trees. For the entire area sampled (approximately 400 acres) there was a fire on an average of once every 3.5 years.

INTRODUCTION

Cooper (1960), and Weaver (1951, 1959, 1961) have discussed fire in terms of its ecological role in the ponderosa pine type. Other authors (Wagener, 1961; and McBride and Laven, 1976) have presented fire frequency data for yellow pine forests in the central and northern Sierra Nevada and San Bernardino mountains respectively. Kilgore and Taylor (1979) have reported on the results of extensive fire scar analyses in a sequoia-mixed conifer forest in the aouthern Sierra Nevada. Their work was at elevations of 5500-7000 feet (1675-2135 m) in mixed stands that included a relatively small proportion of sample trees in the ponderosa pine type. Other recent studies (Parsons and Hedlund 1979; and Pitcher 1980) have addressed the fire frequency question in the foothill and upper montane zones respectively in Sequoia National Park, but no work to date has been reported on fire frequency in the 1ower montane pine type in the southern Sierra Nevada,

The purpose of this paper is to present preliminary results of a study initiated in 1980 to determine fire frequency in the lower montane yellow pine forest of Kings Canyon National Pazk, The results of this study, will be utilized by Park Service resource managers in establishing the periodicity of prescribed burning in this vegetation type in the Parks.

STUDY AREA

The study area (fig. 1) is located at approximately 37 latitude i.n the U-shaped glacial valley of the South Fork of the Kings River in Kings Canyon National Park. This area is about 7-3/4 miles (12 km) long by 1/4 to 1/2 (0.4-0.8 km) mile wide and encompasses about 1600 acres (650 ha), extending from Lewis Creek on the west to Copper Creek on the east. Elevations range from 4500 feet (1370 m) in the west to 5000 feet (1525 m) in the east. The results reported in the paper are from approximately 400 acres (160 ha) in the west end of the valley.

The western porti.on of the etudy area was last glaci.ated during the Pleistocene epoch about 75,000 years ago. The eastern porti.on from about. 1000 feet (350 m) east of the Cedar Grove Ranger Station in Camp 3, was more recently glaciated about 45,000 years ago (Birman 1962),

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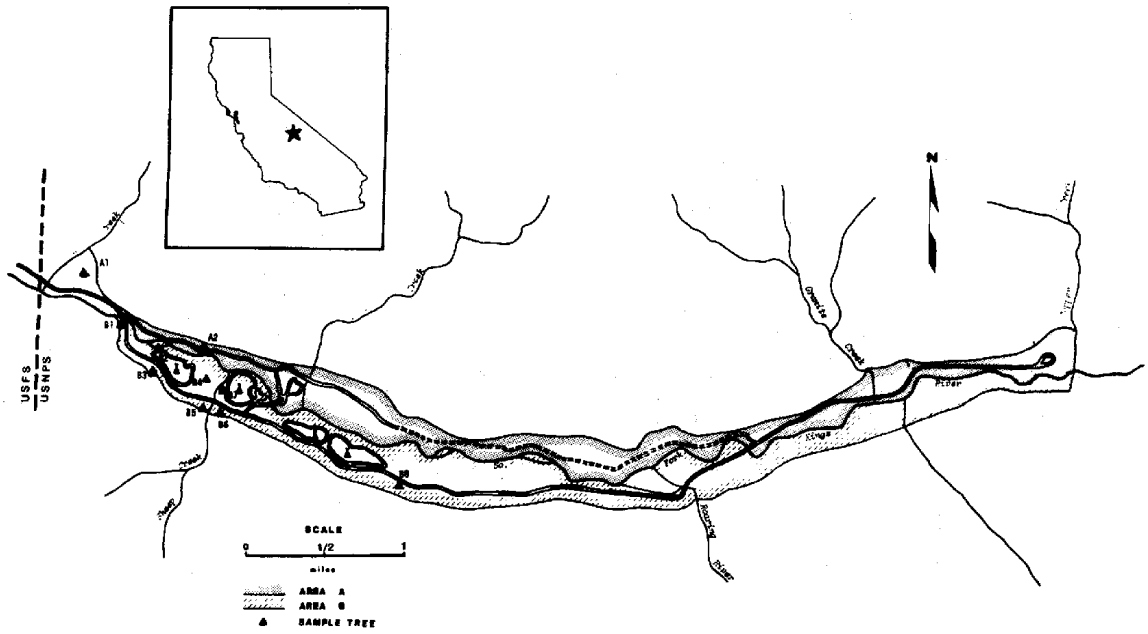

Fig. 1. – Cedar Grove fire history study area, showing location of sample trees.

Soil in the study area is generally a sand or sandy loam of granitic origin, of medium, 13-32 inches (33-81 cm) depth, and wlth a low water holding capacity (Sellers 1970).

Climatic data for Cedar Grove is limited. Munz (1973) presents a general range of annual precipitation for the yellow pine community in California of 25-8Q inches (64-203 cm). Grant Grove, located at an elevation of 6600 feet (2010 m), 15 miles from the study site, receives an average of 42 inches (106 cm) precipitation annually. Most of the precipitation in Cedar Grove is as rain from October through April.

The vegetation is predominantly a ponderosa pine forest comprised of ponderosa (*Pinus ponderosa*) and Jeffrey pine (*P. Jeffreyi)* (Hammon, Jensen and Wallen 1971). Two other important species in this type are incense cedar (*Calocedrus decurrens*), which is about co-equal with pine in abundance (Sellers 1970) and California black oak (*Quercus kelloggii*). Sugar pine (*Pinus lambertiana*) is a less common associate. Most stands are uneven-aged with total crown cover variable, from 10-100X. Sellers (1970) reports basal areas ranging from 115-750 ft /acre (27-171 m~/ha), with a modal value of about 200 ft /acre (46 m~/ha). Ages for 36-48 inch (91-122 cm) diameter ponderosa pine are typically 250-300 years, while those for sugar pine greater than 48 inches (122 cm) diameter are 350-400 years. Sellers (1970) found 24-36 inch (61-97 cm) incense cedar to be 155-240 years old and 16-25 inch (41-64 cm) black oak to be 160-270 years old.

The other main vegetation type is lower elevation pine-fir (Hammon, Jensen, and Wallen 1971). This is comprised of the same species as above except with the replacement of black oak by white fir (*Abies concolor*). This type is most commonly associated with more mesic sites adjacent to the river.

Another important species which occurs locally on xeric glacial moraines in the valley and comprises much of the hardwood type on the canyon walls is canyon live oak *(Quercus chrysolepis*). Associated

species in the latter type are *Arctostaphylos mariposa* and *Cercocarpus betuloides*.

METHODS

This study was patterned after the guidelines in Arno and Sneck (1977). Reconnaissance transects were systematically laid out at approximately 1/4 mile (0.16 km) intervals beginning at the west end of the study area, These transects are oriented north-south and are confined to the pine type on the valley floor. Where the pine type extends up the south wall of the canyon the transects were terminated at an arbitrary pre-determine distance of 330 feet (100 m) from the road. All fire-scared trees encountered in a 66 foot (20 m) wide search strip each side of the transect were tagged for future reference, mapped and recorded. Upon completion of the transect the tree with the greatest number of scars w5s selected for sampling. Also included in the sample were three previously collected fire-scared cross sections from bark beetle killed trees whose locations coincided with the sample area.

Fig. 2. – Cross section of fire-scarred tree killed by bark beetles. This particular tree had recorded a total of 12 separate fires from 1721, when it vas first scarred, until 1895, The tree was felled in 1977.

The sampling method followed that of McBride and Laven (1976). After drying for a week or two, the wood sections were sanded with a belt sander, first with coarse (40 grit) and then with a fine (100 grit) belt. The rings were counted and every tenth ring, starting from the cambium, and every fire scar were marked. Wetting the section facilitated counting. For counting very closely spaced annual rings a 7X to 30X variable power binocular microscope was used. The number of years back to the first scar and the interval between each previous fire was recorded, Then these dates were plotted on graph paper and some of the years were adjusted to correlate the chronology as described by Arno and Sneck (1977), Finally a mean fire frequency for the entire area was calculated. In addition, a combined mean fire frequency per individua1 tree was also calculated, The time period under consideration was from 1775, the date there was a minimum of 4 fire-scarred sample trees in the area, until 1909, the date of the last recorded fire scar on sample trees,

RESULTS

During the 134 year period from 1775 to 1909 a fire burned somewhere within the approximately 400 acre (160 ha) portion of the study area sampled on an average of once every 3.5 years. This is compared to a mean frequency per individual tree of once every 11.4 years for pine after initial scarring. Incense cedar did not seem to be as reliable an indicator of fire, even after it was initially scarred, as was pine. For this reason, cedars were not included in the individua1 frequency determinations. The last recorded fire scar on any tree in the sample area was in 1909. These figures are based on a very limited sample of only ten trees which recorded a total of sixty-five individua1 fires during this period. This corresponded to an estimated 38 separate fire-years after adjustment of the master chronology, Several trees exhibited multiple scaring (fig. 2), four contained nine or more scars.

DISCUSSION

Two factors, soil moisture availability and fire have been cited as being the most important in determining the composition and structure of the ponderosa pine forest (Rundel et al. 1977). Sellers (1970) noted a correlation between height above the river and species distribution. Black oak and ponderosa pine tend to increase towards the xeric end of the moisture gradient while the converse is true for incense cedar and white fir. Sugar pine is intermediate in moisture stress tolerance, but tends to decrease with increasing elevation above the river,

Fire frequency affects stand density which in turn influences species composition (Rundel et al. 1977). Ponderosa pine tends to increase with decreasing stand density. The same is true for black oak, which replaces pine on the more xeric sites. Incense cedar shows the reverse tendency while the distribution of sugar pine tends to be unrelated to stand density (Sellers 1970). Frequent light ground fires tend to favor shade intolerant species such as ponderosa pine and black oak and disfavor shade tolerants such as incense cedar and white fir. Fire exclusion then would tend to increase these latter species relative to the former. This is exactly what Sellers (1970) observed when he analyzed the size class distributions for these species. The ponderosa pine-incense cedar- black oak fire sub-climax is being replaced in the absence of fire by one in which white fir and sugar pine are assuming greater relative importance at the expense of black oak.

The results of this study, even though preliminary in nature, tend to support the successional observations by Sellers. Fire frequency apparently began to show a decrease about 1880 in the study area and came to an abrupt halt in 1909. This drastic alteration in the role of fire has led to changes involving species composition and stand structure in the climax community,

Exactly what influence aboriginal burning had on the fire frequency of Kings Canyon is uncertain.. What is known, however, is that intensive use of the Parks in general began about 1000 A.D. with the ancestors of the Monachi, or Western Mono Indians, and continued until shortly after white intrusion around 1850 (Elsasser 1972). This use was seasonal in nature and the total number of Indians in Kings Canyon during any one year was probably less than 100 (Sellers 1970). One particular village site, located in the study area, was apparently occupied from about 1350 to 1700 A.D, (Elsasser 1972).

Reynolds (1959) has documented the use of fire by Indians in the central Sierra Nevada to aid in acorn collection. While there is no positive evidence that the Wobonuch Monachi Indians in Kings Canyon burned periodically, the presence of bedrock mortars in the immediate vicinity indicates utilization of acorns as a food source and strongly suggests that they possibly did (Seller 1970).

Kilgore and Taylor (1979) compared contemporary lightning-caused fire frequency with that from fire scar records in their study area. They concluded that natural ignitions alone were insufficient to account for the observed historic fire frequency. This could only be explained by some other ignition source, namely Indians,

Apparently lightning caused fire ignitions on the valley floor of Kings Canyon are relatively rare; only seven were recorded in a 40 year period. (1940-79). This does not take into account, however, ignitions on the walls of the canyon, nor those either up or down canyon, which, had they not been suppressed, undoubtedly would have influenced the fire frequency in the valley. It is unlikely, though, that even taking into consideration the spread of some of these fires from outside into the area the resultant fire

frequency would equal the historic fire frequency as determined from an analysis of fire scars. This then, would support the tentative conclusion that some other agent, most likely Indians, was at least partly responsible for the observed frequency.

Recognizing the effect of fire exclusion on vegetation and fuel conditions and realizing the need to reintroduce fire into the Parks' ecosystems has led to a program of prescribed burning in Sequoia and Kings Canyon. An intensification and extension of that program throughout the mixed conifer zone of the Parks since 1978 has resulted in approximately 300 acres being prescribe burned in Cedar Grove since that date.

Hopefully, the conclusion of this study will find us better able to describe present stand conditions in the yellow pine forest in terms of past fire frequency and allow us to extrapolate that information to our present management programs.

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