FIRE HISTORY OF LODGEPOLE PINE IN THE SOUTHERN SIERRA NEVADA, CALIFORNIA

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INTRODUCTION

Lodgepole pine (*Pinus contorta*) is a wide-ranging species occurring throughout much of western North America across a diverse set of habitats (Critchfield 1980). In the Sierra Nevada, fire has been described as having a minor role in the dynamics of lodgepole (var. *murrayana*) communities unlike much of the lodgepole (var. *latifolia*) found in the Rocky Mountains (Lotan 1976; Rundel et al. 1988; Parker 1986, 1988). However, although lodgepole is one of the most widespread forest types in the Sierra Nevada, fire regimes have not been well studied and fire's role prior to EuroAmerican settlement is poorly understood (Skinner and Chang 1996). Persistence has been primarily attributed to gap phase dynamics characterized by continuous or intermittent regeneration with fires depicted as being small and infrequent. In contrast results from two recent studies (Keifer 1991; Stephens 2001) suggest fire's role in these communities may be quite different. To more fully ascertain and quantify fire regimes in this community a suite of sites have been sampled across the southern Sierra Nevada. Preliminary results are presented here for fire history sampling in Sequoia and Kings Canyon National Parks (SEKI) and Devils Postpile National Monument (DEPO).

METHODS

Fire scarred trees were sampled in seven areas (DEPO, Palisades Canyon, Sugarloaf Valley, Chagoopa Plateau, Rock Creek, Coyote/Rattlesnake Creeks, Hockett Plateau) located in the upper San Joaquin, Kings, Kaweah, and Kern River drainages (**Fig. 1**). With the exception of DEPO multiple sites were collected within an area. Compiling data from multiple sites by area allowed stronger inferences to be made about temporal and spatial patterns of past fires. Samples were collected from fire scarred trees, snags or logs as partial cross-sections using either a chainsaw or bow-saw or as cores extracted using an increment borer (Sheppard et al. 1988). Sites consisted of a cluster of samples from a small area (~1 ha or less) without barriers to fire spread. Number of samples collected at a site varied depending on availability of material and logistical constraints at backcountry sites. Sample trees were examined in the field for evidence of fire other than the catface scar to verify that scars were fire caused. All samples

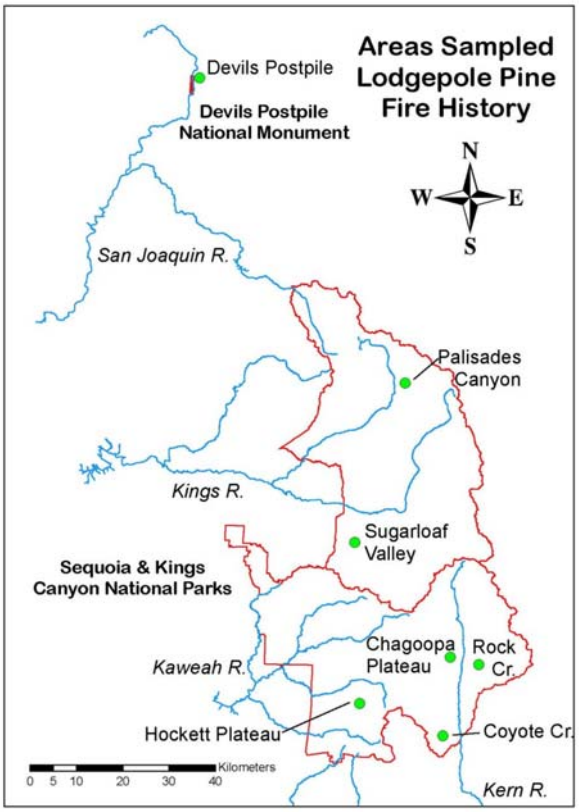

Figure 1. Seven areas sampled in the southern Sierra Nevada, California.

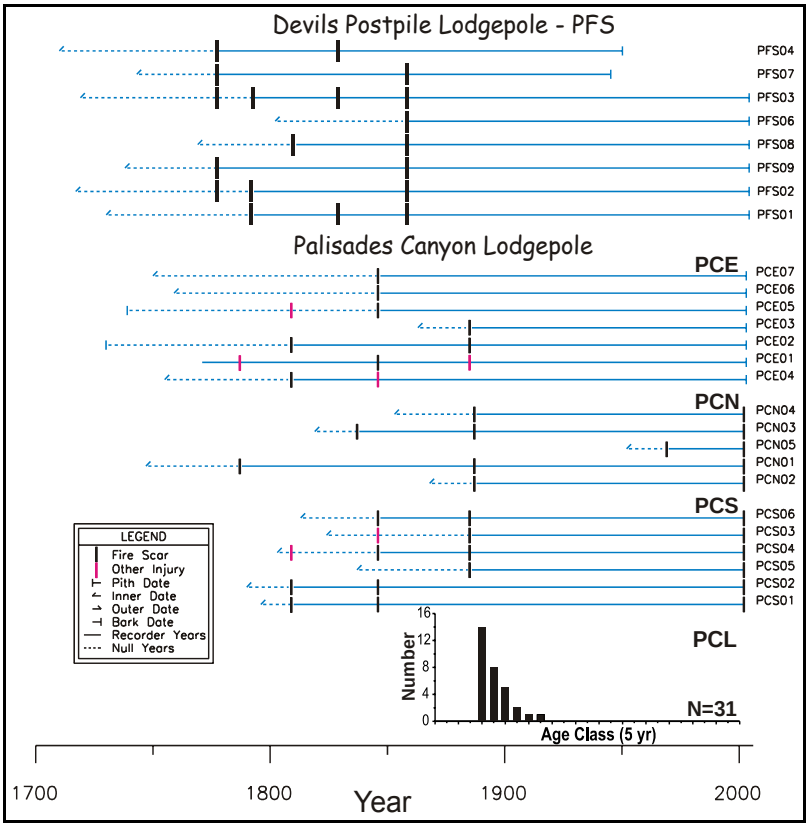

Figure 2. Within site fire chronologies for Devils Postpile N.M. (top) and four sites in Palisades Canyon, Kings Canyon N.P. Each horizontal line (blue) represents the period of record from a single sampled tree with vertical ticks indicating fire event dates. One site in Palisades Canyon was even aged with the trees apparently establishing after a fire in 1885 (recorded at the nearby PCS site). Age class distribution for this site are shown at lower right.

were crossdated and fire event dates and season of fire events determined using standard dendrochronological methods (Stokes and Smiley 1968; Caprio and Swetnam 1995). Temporal and spatial patterns of past fires were compared among sites and to contemporary lightning ignited wildland fire use (WFU) fires that have occurred at three of the areas (Chagoopa - Big Arroyo Fire 1996; Palisades - Palisade Fire 2002; Sugarloaf - Williams Fire 2003).

Sites were predominantly monospecific lodgepole or lodgepole associated with red fir (*Abies magnifica*) at warmer locations, foxtail pine (*Pinus balfouriana*) at dry higher elevations in the Kern or whitebark pine (*P. albicaulis*) near timberline in the Kings drainage (less common associations include western white pine [*P. monticola*], Jeffrey pine [*P. Jeffreyi*] and mountain hemlock [*Tsuga mertensiana*]). These lodgepole associations cover about 22,086 ha in the parks.

Climate of the southern Sierra Nevada is strongly Mediterranean with moist winters and dry summers. Sporadic summer thunderstorms can produce a limited amount of moisture but are the primary source of backcountry fire ignitions each year.

RESULTS AND DISCUSSION

Sites sampled were predominantly monospecific PICO with a associated with red fir or foxtail pine. Several possessed an overstory dominated by PICO but had a seedling/sapling understory that was predominantly red fir. Results from Sugarloaf, Rock Creek, and Coyote/Rattlesnake Creeks are still preliminary as all sites have not been fully crossdated.

Fire Frequency - Most sites analyzed showed evidence of repeated fires for the period from about 1700 into the latter portion of the nineteenth century (**Fig. 2 and 3**). Moderately long average fire-return intervals (MFRI) were found at most sites (MFRI 30 to 83 years), although

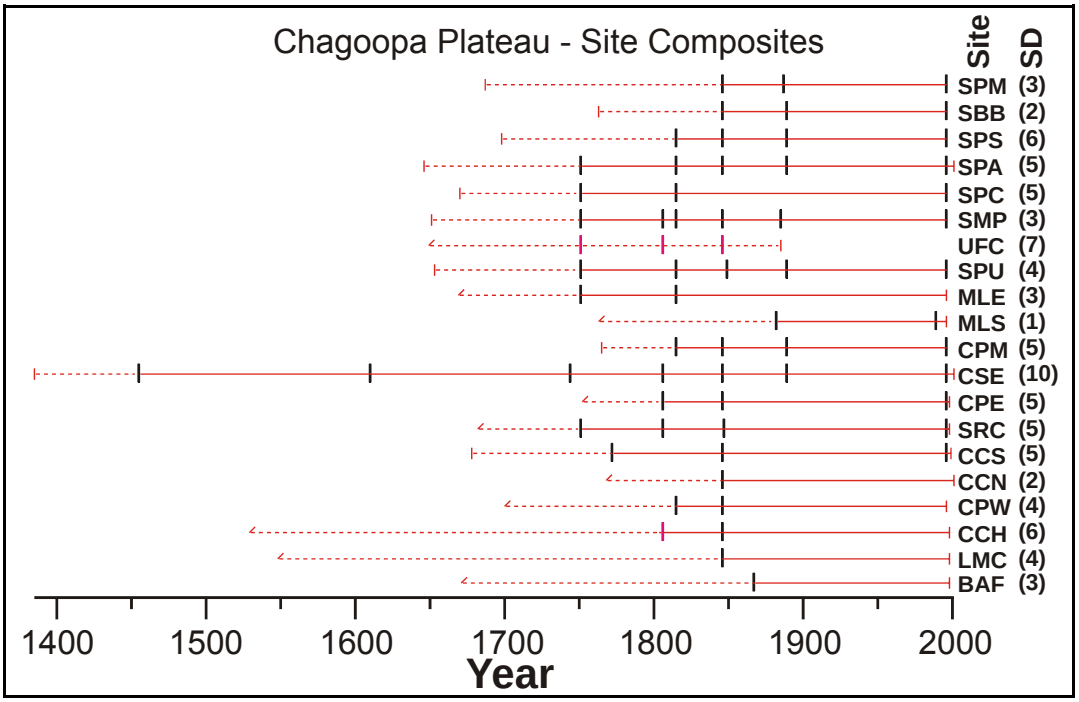

Figure 3. Composite fire chronologies for Chagoopa Plateau sites. Each line represents a composite of all trees sampled at a site with vertical ticks showing fire dates. Sample depth for each site is given at right. Chronologies are arranged by distance from Sky Parlor Meadow on the plateau (from Caprio in press).

sampling at a few sites indicated much longer intervals. The latter were generally located at higher elevations and associated with foxtail pine at sites that showed no evidence of widespread fire (charred wood or catfaces on trees or obvious charcoal in soil) and were dominated by trees several hundred years old. Stephens (2001) sampled a single upper montane mixed lodgepole/red fir site on the east side of the central Sierra Nevada found a MFRI of 24.7 years.

Fire Size - The sampling extent on Chagoopa and Hockett Plateaus permitted spatial patterns of past fires to be examined. On Chagoopa Plateau widespread fires, recorded at multiple sites, were found in the years 1751, 1806, 1815, and 1846 (Caprio in press). Specific fire dates were clustered in particular portions of the plateau. For example, fire in 1751 was recorded at sites on the southwest portion of the plateau while in 1846 fire was recorded at all sites except

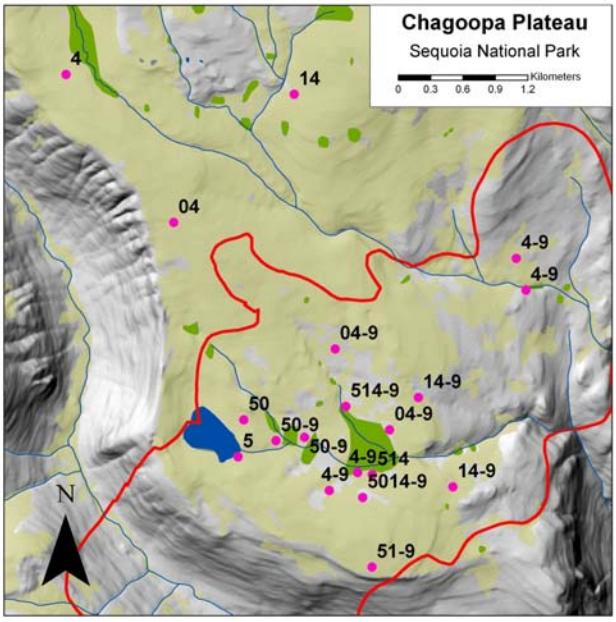

Figure 4. Sampling locations on Chagoopa Plateau (red dots) and widespread fire dates (from Caprio in press) recorded by site (5 = 1751, 0 = 1806, 1 = 1815, 4 = 1846, and 9 = 1996 fires). PICO forest is shown as light green and fire perimeter of the 1996 Big Arroyo Fire in red.

those located on the southwest portion of the plateau (**Fig. 3 and 4**). These patterns indicated sizable fires spread over moderate-to-large areas of the plateau at a fairly frequent interval. These events appeared comparable in size to the Big Arroyo Fire (WFU) that burned across the plateau in 1996. The fire event chronologies from Palisades Canyon (**Fig. 3**) and Hockett Plateau also indicated that some fires burned relatively large areas in particular years. Climate data and its relationship to these various fire years are being examined.

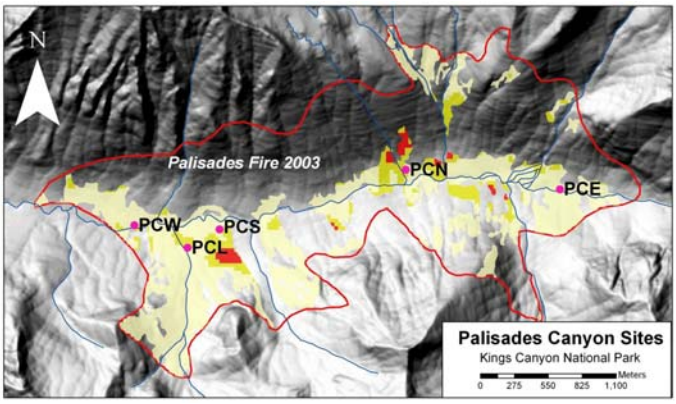

Figure 5. Sampling locations and fire severity patterns (red=high, yellow=low) in Palisades Canyon PICO forest resulting from the 2002 Palisade WFU Fire based on ΔNBR values.

Fire Severity - Burn severity of contemporary fires at three of the areas sampled have been examined and show patterns of mixed severity may be similar to past patterns. Areas of high severity on Chagoopa Plateau were mapped from aerial photographs and patches of overstory mortality and found to cover about 14.5% of areas classed as dense forest and about 5.1% of low density forest. The more recent burns in Palisades Canyon and Sugarloaf Valley were part of the National Landscape Assessment Project to quantify fire severity at a coarse scale over large areas using LANDSAT images (NPS/USGS Burn Severity Mapping Project 2006). Pre and postfire scenes of "normalized burn ratio" were differenced (ΔNBR values) and provided an estimate of vegetation change related to fire severity (**Fig 5 and 6**). Areas classed as severe were less than 3% of the PICO forest in both burns (**Table 1**). The even-aged PICO stand at PCL in Palisades also indicates small-to-moderate sized patches of lodgepole were killed by past stand replacing fire, a pattern noted elsewhere in the parks. Contemporary patches of overstory mortality of similar scale were observed in the Palisade, Big Arroyo, and Williams burns. The stand age patterns found by Keifer (1991) in monospecific lodgepole stands in Rock Creek (SEKI) indicated a mixed fire severity pattern with pulsed recruitment and even-aged patches.

Figure 6. View of Palisade WFU Fire looking up canyon to the east illustrating varied burn severity (NPS photo).

Table 1. Fire severity estimates for two fires in lodgepole forest based on ΔNBR values.

Site	Low (%)	Low (ha)	Mod. (%)	Mod. (ha)	Sev. (%)	Sev. (ha)	Total (ha)
Palisade	83.77	178.67	13.88	29.59	2.36	5.03	213.3
Williams	66.39	212.35	31.94	102.15	1.67	5.35	319.8

SUMMARY AND CONCLUSIONS

The frequency of pre-EuroAmerican fires found at most lodgepole pine sites was not expected. These patterns of fire occurrence and severity suggest a mixed-severity fire regime and that large stand replacing fire events were rare in the southern Sierra. Additionally, there were mixed degrees of synchronization among associated sites with strong evidence that some fires covered large areas (many hundreds of hectares). Overall, the results suggest than at least in the southern Sierra Nevada, fire played an important direct role in the dynamics of most lodgepole pine forests.

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