

Land Use and Fire History in the Mountains of Southern California¹

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Fire frequencies are related to periods of land use in the mountains of Southern California. Differences in fire frequencies were found for coastal sage scrub, chaparral, and yellow pine forest types between various sets of the Native American, Spanish-Mexican, American Pioneer, and Modern American land use periods. Analysis of fire maps was employed in the scrub; ring counts were used between fire scars in the forest types.

The mountains of southern California have experienced recurring wild fire for a very long time. The flora exhibits a variety of adaptations indicating an evolutionary history in which fire was a major selective force. Man has been probably present in southern California for at least 11,000 years. His use of fire during this period has influenced the frequency of wild fires. Knowledge of fire frequency and its relation to land use history is prerequisite to understanding and properly managing vegetation. The objective of this paper is to investigate the relationship between land use and the frequencies of wild fires occurring in four major vegetation types in the mountains of southern California.

The Setting

The mountains of southern California occur in four landform provinces: the Transverse Ranges, Peninsular Ranges, Mojave Desert, and Colorado Desert. Only mountains in the Transverse and Peninsular Ranges support coniferous forests of commercial value or dense scrub-dominated vegetation which presents a significant fire hazard. This paper discusses studies made in the Transverse Ranges.

The Transverse Ranges are oriented along east-west axes from Santa Barbara to San Bernardino.

The vegetation varies along altitudinal gradients with the following sequence of types moving upon the seaward side: coastal sage scrub, chaparral, oak woodland, yellow pine forest, fir forest. On the desert side the vegetation shows the influence of lower precipitation with a pinyon-juniper woodland followed by a high desert scrub community occurring at lower elevations in place of the coastal sage scrub.

Fire history investigations were conducted in the coastal sage scrub, chaparral, and yellow pine forest types. These types were selected because they present major problems of fire control and management.

The coastal sage scrub occurs from sea level to about 1000 m. The type is common on sites that are climatically or edaphically dry. Rainfall is 40-80 cm annually. The dominants in this type are Artemisia californica (coast sagebrush), Salvia apiana (white sage), S. mellifera (black sage), S. leucophylla (purple sage), Eriogonum fasciculatum (California buckwheat), Rhus integrifolia (lemonade-berry), and Encelia californica (California encelia). These soft shrubs form a generally discontinuous cover .5 to 1.5 m tall.

Chaparral is found from 300 to 1500 m on the more rainy coastal sides of the mountains and from 1000 to 1600 m on interior sides. Average annual rainfall ranges from 55 to 100 cm. Species composition varies throughout the type. Adenostema fasciculatum (chamise), is common and often dominant. Co-dominants may be species of Arctostaphylos (manzanitas), Ceanothus (ceanothus), Heteromeles (toyon), Rhus (sumacs), and Quercus (oaks). These hard shrubs form a complete crown canopy 1 to 3 m in height.

The yellow pine forest dominates above the chaparral on the higher mountains between 2000 and 2700 m. On north-facing slopes it may be found in

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favorable canyons below 1300 m; on south-facing slopes it is usually first encountered above 1600 m. It occupies a variety sites and may be locally replaced by chaparral on shallow soil on south-facing slopes or by riparian species in areas of saturated soil. Species composition varies with altitude. Pinus ponderosa (ponderosa pine) and Quercus kelloggii (California black oak) dominate at lower elevations while Pinus Jeffreyi (Jeffrey pine) and Abies concolor (white fir) dominate higher up. The yellow pine forest type was divided in this study into a ponderosa pine type and a Jeffrey pine type.

History of Land Use

The history of land use in the Transverse Ranges can be divided into four periods: Native American, Spanish-Mexican, American Pioneer, and Modern American. Land use in the Native American period was characterized by hunting and gathering. Ethnographic information indicates that Native Americans used fire as a management tool to facilitate both hunting and gathering of certain plant materials (Lewis, 1973). Fires were set annually in lower elevation grasslands and some chaparral areas were periodically burned in the fall (Aschmann, 1959). The major concentrations of Native Americans were along the coast and in lower elevation valleys. They traveled into the mountains annually to collect acorns and pine seeds in the autumn, and occasionally to hunt.

The Spanish-Mexican period can be characterized as a period of livestock grazing. It began in 1769 with the establishment of the first mission. Spanish and later Mexican land grants divided up the lower elevation into ranchos where large herds of cattle were raised for hides. Conflicts arose between the early Spanish settlers and the Native Americans over burning of grassland at lower elevations. The Spanish were dependent upon these grasslands for winter range; the Native Americans were dependent on these same grasslands for root and bulb crops which they collected annually after burning the grass. The Spanish stopped the burning and the Native Americans were removed from the grasslands. The higher elevation coniferous forests were generally not utilized by Spaniards or Mexicans for grazing.

The Spanish-Mexican period ended in 1848 when the United States took possession of California from Mexico. In the same year gold was discovered in California. American prospectors explored not only the Sierra Nevada, but the mountains of southern California too. Significant lodes were discovered at higher elevations in the Transverse Ranges. Mining towns sprang up overnight. Fire was a constant threat to these crudely constructed towns and many were burned to the ground more than once in their brief lifespans. Many of these fires spread into adjacent forests. When the gold was depleted these towns were abandoned and much of the mining population shifted to the lower elevation valleys to farm. A few stayed behind to develop

sawmills and a timber industry. Others had ranches at lower elevations and returned to the mountains for summer grazing of both sheep and cattle. Coniferous zones of the San Bernardino Mountains were often used for summer grazing. Sheep herders commonly set fires in mountain meadows at the end of each grazing season to improve forage the following year. It was common practice among the early lumbermen to burn slash which interfered with log extraction, and sawmill fires were another common source of wild fire (Johanneck, 1975).

The exploitation of resources through mining, logging, and livestock grazing was curtailed in the 1890's with the establishment of federal forest reserves. The year 1905 was the beginning of a new period in which conservation practices controlled land use. In 1905 the Forest Reserves were transferred from the Department of the Interior to the newly formed U.S. Forest Service. In the same year, California enacted the Forest Protection Act which provided for fire control on private lands. These events resulted in the elimination of broadscale burning for range and initiated a regulation of forest harvesting. Since 1905 land use has shifted from logging and grazing to recreation and watershed protection.

Fire History in Coastal Sage Scrub and Chaparral

The Santa Monica Mountains, west of Los Angeles, were selected for studying fire history in the coastal sage scrub and chaparral. These mountains lie near the western end of the Transverse Ranges and rise from sea level to an elevation of 945. The vegetation is composed of (1) grassland occurring along coastal terraces and at lower elevations at the northern base of the mountains, (2) coastal sage scrub extending from sea level on mountain slopes, or at the base of slopes behind the coastal terraces to elevations of about 330 m on the seaward side (south) and from elevations of 150 to 350 m on the interior (north) side of the mountains, and (3) chaparral occurring at elevations above the coastal sage scrub. Minor areas of oak woodland occur along streams.

An analysis of historic fires was used to determine frequencies of fire in the coastal sage scrub and chaparral of the Santa Monica Mountains. Maps of areas burned in these mountains from 1909 to 1977, compiled by the Division of Forestry of the Los Angeles County Fire Department, were used to determine fire frequencies. These maps recorded all fires over 0.1 ha (Class B and larger).

Two hundred eighty-one sample plots, each with an area of 4 ha, were located at random within the areas dominated by coastal sage scrub and chaparral on U.S.G.S. topographic maps. The plots were divided between the two vegetation types to give a 3% sample of the area in each type. These plot maps were compared with the fire history maps and each fire which had burned at least one-half

of any plot was tallied as a fire event in that plot. This procedure was adopted to minimize the error associated with transferring fire boundaries from Los Angeles County Fire Department Maps (which had been drawn at various scales) to the U.S.G.S. maps. The number of fires on each plot was divided into the time period covered by the maps (68 years) to determine the intervals between fires. Average intervals were determined for the plots in each vegetation type.

The average interval between fires was 14 years for the coastal sage scrub and 16 years for the chaparral. These averages are significantly different at the .05% level. The difference in fire frequencies between the two types may be due to differences in access, temperature, and rate of recovery following fire of shrub species in the two types. Access to the coastal sage scrub is better than to the chaparral. There is a greater density of roads and houses in the coastal sage scrub than chaparral. Opportunities for accidental as well as arson fires are, therefore, considered greater. Temperature gradients result in higher summer and fall temperatures in the lower elevation coastal sage scrub than in the chaparral. This difference increases the number of days during the year when fires can readily be ignited in the coastal sage scrub. Recovery of crown canopies following burning is more rapid among the coastal sage scrub species than in the chaparral species. (Hanes, 1971). This more rapid rate of recovery on the part of the coastal sage scrub may result in an earlier reestablishment of the fuel continuity necessary to carry fire.

The fire intervals of 14 and 16 years represent the intervals occurring in the modern American period of land use. An interval of from 2 to 10 years has been suggested for coastal sage scrub in the San Gabriel and San Bernardino Mountains for the same period by Hanes (1971). Philpot (1973) proposed intervals of 15 to 17 years for chaparral in the San Bernardino Mountains. In this modern American period man has acted both as the principal agent of fire ignition and as the control. In earlier periods of land use man was also the primary cause of fires at lower elevations, but it is unlikely that man's influence was as important in the higher elevation stands of chaparral in the Santa Monica Mountains. These chaparral stands were of little value for grazing during the American Pioneer and Spanish-Mexican periods. Sauer (1977) reports that unlike many Native American tribes in southern California, the Chumash living in the Santa Monica Mountains did not burn vegetation in their management of the land. Fire ignition may have resulted as a result of carelessness with campfires, but the major cause of fire during this period was from lightning. Lightning is infrequent in the Santa Monica Mountains but is the cause of occasional fires. Vogl (1976) has suggested a fire frequency of 20 years for lightning caused fires in chaparral during pre-historic times. A similar interval has been proposed by Aschman (1976) for pre-historic chaparral fires in those regions where burning was not

practiced by Native Americans. This suggests that a reduction has occurred in the interval between fires in the Santa Monica Mountains, when one contrasts the Native American period with the modern American period. Information on the fire history of both the Spanish-Mexican period and American Pioneer periods is unfortunately limited.

Fire History in Ponderosa and Jeffrey Pine Forests

The San Bernardino Mountains, near the eastern end of the Transverse Ranges, were used as a location to study fire history in the ponderosa and Jeffrey pine forest types. The San Bernardino Mountains range in elevation from about 400 m to 3,500 m. Coniferous forests found at elevations above 1500 m. Ponderosa pine dominates the somewhat lower elevations of southern and western portions in this zone, while Jeffrey pine dominates the higher elevations to the north and east. The ponderosa pine forest is contiguous with either chaparral or oak woodland types at its lower edge. The lower elevations at the northern and eastern boundaries of the Jeffrey pine forest are bordered by pinyon-juniper woodlands.

Fire frequency was determined by counting annual rings between fire scars on wood sections removed from the base of living trees. Twenty-nine ponderosa and 38 Jeffrey pines were sampled. Trees were selected over the entire range of each forest type. A minimum distance of 1.6 kilometers was maintained between any two trees selected for sampling. A tree was considered for selection only if one or more trees within 100 m had similar fire scars. Some inaccuracy in dating by this method can be expected because of the possible occurrence of missing rings. Cross dating of rings was not possible because of the distortion of ring widths in the healed over portions of the small wood samples. Removal of larger wood sections would have resulted tree mortality.

Average intervals between fires were determined for three periods in each forest type. These periods were (1) prior to 1860, (2) 1860 to 1904, and (3) 1905 to 1974. They correspond to the Native American, American Pioneer, and Modern American periods of land use. Those fires prior to 1860 can be used to characterize the Native American period because neither the Spanish nor the Mexican settlers used the ponderosa or Jeffrey pine forests of the San Bernardino Mountains. However, the population of the major tribe using the pine forest of the San Bernardino Mountains was reduced about 50% during the Spanish/Mexican period (Bean, 1978). Use of these mountains by Native Americans was further reduced in 1852 when American pioneers constructed a road into the mountains. By 1860 the American pioneers had essentially eliminated the Native Americans.

The fire intervals for each period are shown in Table 1. Analysis of these data shows significant differences at the .05% level between the period from 1905 to 1974 and the earlier periods within each species. No significant differences

were found between the period prior to 1860 and the period from 1860 to 1904 for either species. There was a significant difference between the two species for the modern period, 1905 to 1975. No significant difference occurred between the two types prior to 1905.

Table 1.--Average interval between fires in ponderosa and Jeffrey pine forests of the San Bernardino Mountains.

Forest Type	Interval between fires (yrs)		
	Prior to 1860	1860 to 1904	1905 to 1974
Ponderosa pine	10	14	32
Jeffrey pine	14	19	66

The fire frequencies determined in ponderosa and Jeffrey pine forests in the Native American period reflects ignitions by the Cahuillas and by lightning. The Cahuilla-caused fires were usually set in meadows within the forests or in the chaparral. Some of these fires burned into adjacent forest stands. Fires set in the chaparral may have played a significant role in igniting the lower elevation coniferous stands. The distribution of chaparral, oak woodland, and coniferous forest species at the interface between the chaparral and yellow pine forest in the San Bernardino Mountains has been interpreted by Minnich (1977) as a pattern controlled by fires moving up from the lower elevations of the chaparral. Lightning was the common cause of fire ignition in the higher elevations of the Jeffrey pine forest. The Native Americans made limited use of these higher elevation forest stands and a less frequent interface occurs between Jeffrey pine stands and chaparral.

The fire frequencies calculated for the American pioneer period in both the ponderosa pine and Jeffrey pine forest types do not differ significantly from frequencies in the Native American period. It is assumed that the pioneer miners, sheep herders, ranchers, and lumbermen replaced the Native American as causal agents for wildfires. The elimination of the Native Americans from the mountains did not result in a significant increase in the interval between fires as has been reported for the Sequoia-Kings Canyon region of the Sierra Nevada by Kilgore and Taylor (1979).

The activities of the American pioneers may have resulted in more fires actually having been set, purposefully or by accident, in the forests themselves. The use of fire by stockmen, which was considered a serious threat to the forests, was a major impetus for the establishment of a federal forest reserve in the San Bernardino Mountains.

The significant increase in the length of interval between fires in the Modern American period is a result of fire control activities by the U.S. Forest Service and the California Division

of Forestry. These activities included the prevention of burning by stockmen and the enforcement of fire safety regulations at sawmills and lumber camps. Advancements in fire suppression technology have allowed for a more rapid control of fires, thus reducing the average extent of individual fires. As the area of forest burned has decreased since fire records have been maintained, the number of fires have increased (U.S.F.S., 1940-79). Lightning has accounted for about 33% of all fires during the last twenty years. Fires initiated in the chaparral continue to be a source of ignition for fires in the yellow pine forest. In the more recent part of the Modern American period, recreation has replaced grazing and lumbering as the principal land use in the conifer forests of the San Bernardino Mountains. The long term impact of this land use is yet to be determined.

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