Fire History of the Santa Monica Mountains[1]

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Abstract: The Santa Monica Mountain Range in Los Angeles County is the only major mountain range in the United States of America that divides a large city. Wildland fire history of the area was investigated to help in the decision making process for fire and vegetation management. Specifically the fire records for fires over 40.5 ha (100 acres) were analyzed for the fire exclusion period 1919-1980. Selected fires were used to demonstrate the predictive effect of land use, climate, vegetation, topography, fuel loading and fire suppression activities on fire patterns and fire behavior.

DESCRIPTION OF THE AREA

The Santa Monica Mountain range parallels the Pacific Coast of southern California in Ventura and Los Angeles Counties at 34°05'N latitude. It stretches for a distance of about 70 km from Ventura County into the heart of the City of Los Angeles to the east (Figure 1) and thus provides an ideal recreational setting for over 10 million people in this region. At its western extent it measures 15 km in width, narrowing to about 4 km at its eastern boundary. The southern boundary is the Pacific Ocean; the eastern boundary consists of the cities of Santa Monica and Beverly Hills and the West Hollywood section of the City of Los Angeles, The northern boundary is the Ventura Freeway (Highway 101). The mountains encompass approximately 97,000 ha or 240,000 acres (USDI, 1980).

The topography of the mountains is characterized by rugged terrain in its western and central section. In the west, Sherwood Peak rises to 1175 m within 10 km of the coast and in its central section, Saddle Peak rises to 885 m within 4 km of the coast. Almost half the mountain range has slopes exceeding 35 percent. The coastal slopes are characterized by steep hillsides that descend suddenly into many narrow north-south running canyons.

The area has a Mediterranean climate characterized by warm, dry summers and cool winters with approximately 80 percent of the precipitation falling from October through March. The 90-year mean annual precipitation ranges from 380 mm to 400 mm at the coastline to approximately 625 mm at the crest, and back down to 400 mm at the inland boundary along the Ventura Freeway (Los Angeles County Flood Control, 1976). Climatic averages are of limited value as the rainfall is often concentrated into a few heavy winter storms with intervening periods of high temperatures. Thus the fire season may extend into January during drought years.

The natural airflow for most of the year creates night and morning downward flows of air from the seaward side of the mountains over the Santa Monica Bay. In the afternoon this flow is carried inland by the seabreeze (USEPA(1977). During the summer the Catalina eddy penetrates the mountain canyons to a considerable distance with cool, moist marine air. The summer fog line extends up to the coastal ridges and to a considerable distance into the canyons. FLUim1 late September through December and occasionally even into January and February the area is characterized by strong (north to northeasterly foehn winds, locally known as Santa Ana winds. These winds are born as high pressure areas in high desert, great basins of Utah and surrounding areas. As they descend to lower elevations they become hot, dry (and gusty and may create erratic wind patterns when meeting the local mountain winds.

Major vegetation types found in the Santa Monica Mountains include a) coastal sage scrub(which is found below 300 m along the drier coastal slopes and as a band surrounding the higher mountains; b) oak woodland on some northern slopes with deep soils and areas relatively protected f.0 fire; c) riparian woodland along stream channels in areas where moisture is found at or near the surface throughout the year; d) grasslands of primarily introduced grasses on finer textured clay soils that may be saturated during the rainy season; and e) the woody, evergreen chaparral which is the most common vegetation type.

The early fire history of California as well as the Santa Mbnica Mountains is obscure. Sampson (.1944), after surveying historic documents dating back to the 15th Century, concluded that in areas away from the coast, burning by Indians had little influence on chaparral distribution. Drucker (1937) stated that when the Spaniards arrived, they found a hunting and gathering society of Indians who probably used fire only sparingly to increase hunting success. Once a fire started it was not controlled but was allowed to run its course. Other authors maintain that Indians practiced primarily spring burning to maintain grasslands (Lewis, 1973). Such fires would be of limited extent. Brown (1978) cited Dana as reporting extensive fires in the coastal ranges of southern California in the 1830's.

Burning by Indians and settlers often endangered settlements as well as livestock ranges. In 1793 Governor Jose de Arilleja issued California's

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first fire control law prohibiting any kind of burning that may be detrimental to someone else (Lee and Bonnicksen, 1978). With California statehood in 1850, fire control became the responsibility of the individual landowners. Deliberately set fires increased as they served as a cost-effective way of opening up chaparral for access, development, grazing, ranching and mining. However, it is unlikely that this period greatly affected the fire history of the Santa Monica Mountains until 1900.

The period 1900 to 1918 was characterized by many large fires that burned the area on an average of at least two times (Santa Monica Evening Outlook 1900-1918). In 1919, the Forestry Department was established as fire suppression agency for the unincorporated areas of Los Angeles County and began maintaining records of all fires. Figure 1 illustrates these records as frequency of fires over 40.5 ha (100 acres) for the fire exclusion period 1919-1980 and shows that the highest fire frequency was historically located in the coastal zone. The coastal zone from about Las Flores Canyon to beyond the Ventura County line was burned 3-5 times giving an average burn frequency of from 12.4 to 20.7 years. Smaller areas not identified on the map burned up to 7 times. Mountainous areas inland of the ridge line, for the most part, burned only once. The 3-fire frequency corridor shown in the Las Virgenes-Mulholland block was created by fires that got an upslope running start along the Ventura Freeway on north slope range land consisting of flash fuel annual grasses and coastal sage. These fires occurred during strong Santa Ana wind conditions in 1958, 1970 and 1980.

FIRE FACTORS

An evaluation of the factors that determine fire patterns in the Santa Monica Mountains is necessary to understand the recorded fire history, speculate back from it to natural fire history and predict future fire patterns. The four most important factors that influenced the fire history in the Santa Monica Mountains are land use, vegetation, fire topography and climate (fire winds). They will be reviewed in this order.

Land Use

Almost every fire in recorded history was accidentally or deliberately set by man. In the Santa Monica Mountains, lightning fires are an almost unknown ignition source since they start primarily in the wet season and are out of phase with the foehn winds. Before 1900 most fires were started by local ranchers and homesteaders during weather conditions that prevented the development of large-scale fires. However, after 1900 the increasing population base at the southeastern end of the mountain range and the hunting season, which coincided with the fire season, served as ignition sources of carelessly set fires. Some of these fires burned uncontrolled for several weeks and caused extensive damage to ranchers while creating a better hunting season through brush regrowth. The establishment of an organized fire fighting force in 1919 put an end to such fires. Since then most fire starts have occurred along access routes leading into or through the mountains.

Vegetation

Many of the coastal slopes are covered by coastal sage. This plant community is characterized by

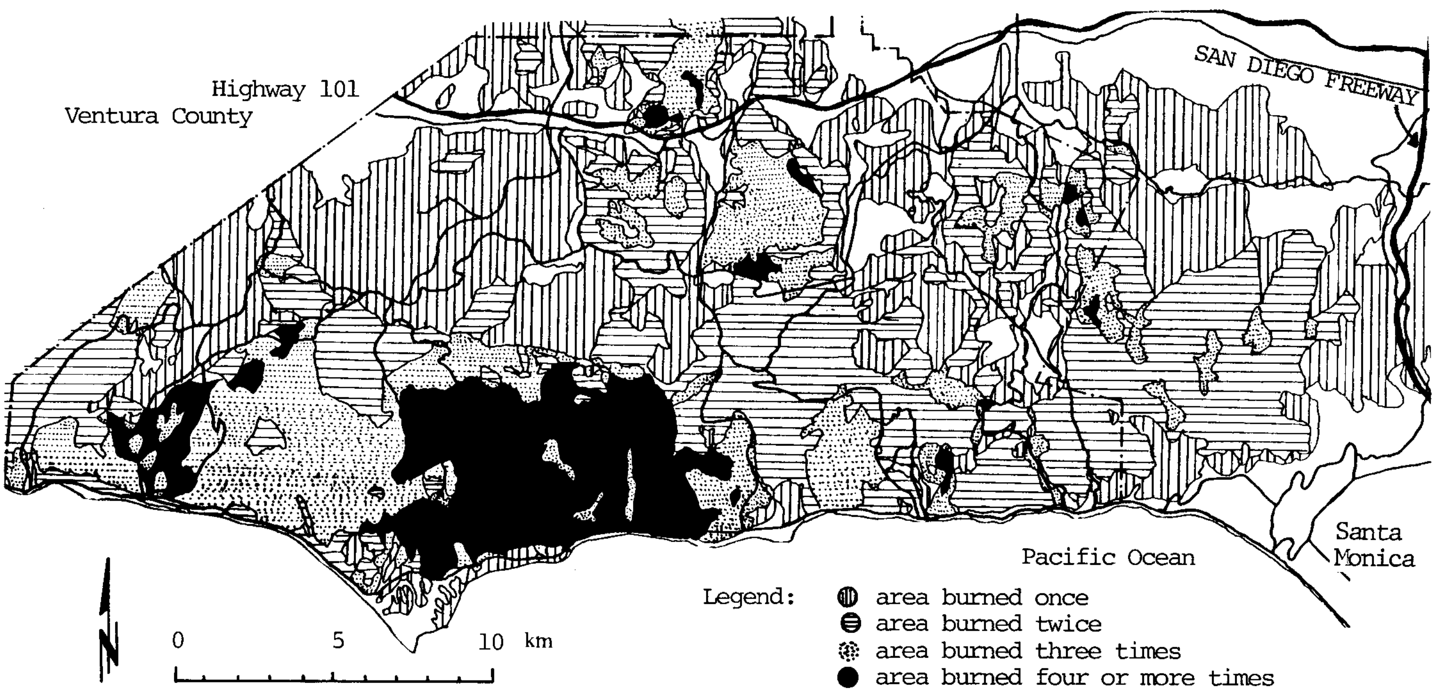

Figure 1--Fire frequency for fires over 40.5 ha for 1919-1980 (Ventura County to San Diego Freeway)

drought deciduous, short-lived shrubs that readily carry a fire within 7-10 years after a previous burn. Chaparral is found in a belt above the coastal sage slopes and becomes highly flammable on south slopes within 15-20 years. This is due to the preponderance of highly flammable chamise (Adenostoma fasciculatum), floristic components of coastal sage, and the lad fuel moisture of these plants. The flammability of chaparral is high until the third to fifth season after a fire because the short-lived herbaceous postfire flora carries the fire (Rothermel and Philpot, 1973). Chaparral is quite fire-resistant from 5-15 or 20 years or until the dead to live fuel ratio increases such that hot fires can again be supported. North slope chaparral consists of a mixture of more mesic species. Except in periods of extreme drought or dry foehn winds, this community does not become highly flammable unless the shorter-lived perennial species, such as Ceanothus, die, increasing the proportion of dead fuel. This generally does not occur for at least 20-25 years. Thus coastal chaparral can be considered relatively fire-resistant for the first 5-15 years or more whereas coastal sage may be highly flammable after 7-10 years.

The flammability of individual sites depends on a variety of site specific factors. However, during intense fire conditions fuel moisture is lowered because of low relative humidity, drying of fuels by the wind and, once a fire has started, the preheating of vegetation ahead of the fire. Thus the more flammable coastal sage can reduce the greater fire resistance of south slope chamise chaparral by carrying flames upslope into the chaparral. Similarly south slope chaparral can reduce the fire resistance of north slope communities.

Fire Topography

The coastal mountains extend east to west with all major canyons running north and south. Weide (1968) stated that in the eastern part of the Santa Monica Mountains, the canyons run south to southwesterly or parallel with the fire winds so that fires will be channeled up the canyon, spread out as they meet the ridges, contract again as they are funneled downhill through the canyons and may fan out in either direction as they reach the beaches. Weide also stated that this close linearity of fire winds and canyons is not present in the western section. Here the fires are more controlled by the direction of the wind and are thus more irregular in shape. However, a closer analysis shows that these generalities need to be further refined. First, the central and western portions of the range have much steeper canyons than the eastern portion so that fires are difficult to control. Canyons all reach from the ocean inland whereas in the eastern portion, from Pacific Palisades and beyond, fire spread is blocked by the city. Furthermore, major canyons in the western section run primarily northeast to southwest and in the central section north to south. These directions parallel the fire winds.

Wind Patterns (Climate)

Wind and fuel moisture are the two most important elements affecting fire behavior. Wind primarily controls the direction and spread of fire. It also affects fire behavior by reducing fuel moisture, increasing the oxygen supply needs for combustion, preheating the fuels, and bending the flames closer to the unburned fuels ahead of the fire. In intense wildland fires, the upper airflow may have a different direction from the surface winds and may influence fire behavior by not only carrying fire brands ahead of the fire but also into new directions (Greenwood, 1962).

In the Santa Monica Mountains large-scale fire patterns may seem erratic but they are predictable. Airflow is guided by topography into the north-south facing canyons so that onshore winds are channeled up canyon as well as upslope and the foehn or Santa Ana winds down canyon. This is especially noticeable during strong northerly Santa Ana winds. The sharp ridge lines produce significant turbulence and wind eddies on the lee side. Eddies that are associated with the rims of steep canyons may rotate and result in moderate to strong upslope winds that are opposite to the direction of the winds blowing over the rim. In general, when strong winds blow through steep canyons, wind eddies can become localized in bends in the canyons or the mouth of tributary canyons. The compressed air in mountain passes also results in horizontal and vertical eddies that fan the fire out as it descends downslope on the leeward side.

During the Santa Ana season the local daytime wind pattern is characterized by moderately strong onshore breezes along the coast and gentle to weak upslope and up canyon winds in the adjacent mountain areas. The nighttime cooling produces downslope and offshore winds that are of lesser magnitude than the daytime winds (Schroeder and Buck, 1970). This air circulation is predominant at the coastal side of the mountains, especially at lower elevations. Strong Santa Ana winds eliminate the local wind patterns so that little difference in day and night patterns exist in the initial stages. As the Santa Ana wind weakens, it shows diurnal patterns. During the daytime a light onshore seabreeze is often observable along the coast and light upslope winds along the coastal slopes. Such weak Santa Ana winds are held aloft along the coastal slopes so that the turbulence and strong up and dawn drafts found on the lee side when strong winds blew perpendicular to mountain ranges are not found. Furthermore, the air in the seabreeze may be returning Santa Ana wind which is not as moist as the marine air. After sunset, surface winds reverse and became offshore downslope winds. Increasing air stability may then allow the weaker lee turbulence aloft to produce the familiar mountain airwaves that hit the surface of leeward slopes and produce strong downslope winds. As the Santa Ana winds weaken further, normal seasonal and diurnal wind patterns return.

Strong Santa Ana surface winds that push the fire in a southwestern direction up the inland mountain slopes often change their direction to south and east as the winds are funneled into the coastal canyons. Thus the fire is fanned east up the canyon walls at the sane time it continues up and down canyon in a southwesterly direction across the canyons. This is especially noticeable in steep terrain and areas of heavy fuel loading.

ANALYSIS OF FIRE PATTERNS

When an organized fire department was established in 1919 for the unincorporated areas of Los Angeles County, fuel loading in the Santa Monica Mountains was at a low level. Large-scale fires had burned the mountain range several times between 1900 and 1919. Principally among the many fires were the 1903 Rindge Fire, the 1909 Malibu Fire, the 1910 Las Flores-Temescal Fires, the 1911 Santa Monica-Ventura Fires, and the 1913 Topanga-Escondido Fires. The 1911 fire was the largest. It burned the mountain range for several weeks and extended from Santa Monica into Ventura County.

The most complete fire records since 1919 are available for an area of 54,000 ha extending from Ventura County to San Diego Freeway to the east. Further discussions will pertain to this area. When fires over 40.5 ha are analyzed for the active fire suppression period 1919-1980 their cyclic periodicity is readily noticed. Figure 2 shows the total area burned per decade as well as the cumulative area burned, and illustrates that the overall burn cycle averages 20 years. As the fuel loading of the inland chaparral increased, more and more of its vegetation was incorporated into the burn cycle. This resulted in the steadily increasing peaks of hectares burned as listed in table 1.

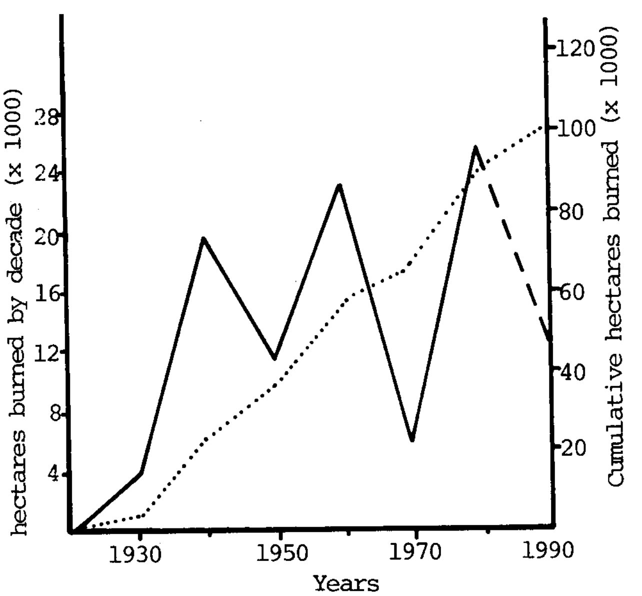

Figure 2--10 year periods and cumulative area burned by fires over 40 ha (1919-1980)

Table 1 - Fire Size By Decade (in ha)

Time Period	Size of Fire 40-200	200-400	400+	Area Burned (in ha)
1920-29	8	1	2	4,000
1930-39	3	0	5	20,000
1940-49	6	0	4	12,000
1950-59	8	2	6	23,500
1960-69	1	1	3	5,800
1970-79	4	0	6	26,500
1980	1	0	1	1,122
	31	4	27	92,922

Table 1 shows that 8 of the 11 fires (73 percent) for the decade 1920-29 ranged in size from 40 to less than 200 ha. Figures for 1930-39, 1950-59 and 1970-79 are 60, 50 and 40 percent respectively. Thus, as fuel loading increased, the number of small fires decreased and large fires increased. With the present land use pattern and level of fire protection, it is predicted that the area burned per year for the period 1980-89 will average 800 to 1,200 ha; a yearly reduction of at least 1,400 ha burned per year over the previous decade.

Next, the fires were analyzed for the time of year of burning. Figure 3 shows that the total area burned prior to August was insignificant, that it was relatively low in August (2,500 ha), but that it increased sharply thereafter. It tripled in September and again more than doubled in October (29,000 ha) before finally declining for the rest of the year. Table 2 shows that of the 25 fires under 200 ha, 20 or 80 percent were encountered prior to October. Twenty-three fires or 88 percent of all fires over 400 ha were encountered after September. Fires prior to August started almost exclusively in annual grassland or degraded sage.

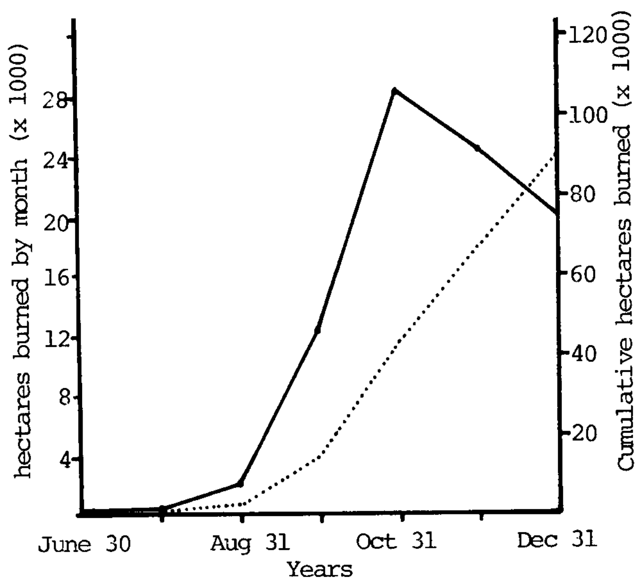

Figure 3--Monthly and cumulative area burned by fires over 40 ha (1919-1980)

Table 2 - Fire Size By Time of Year (in ha)[1]

Time Period	Size of Fire			Area Burned (in ha)
	40-200	200-400	400+	
Feb-June	2	0	0	10
July	8	0	0	66
August	4	1	1	2,41
September	6	0	2	12,78
October	0	2	7	29,06
November	4	0	11	24,84
December	1	0	5	20,68
	25	3	26	90,55

[1]The month of year of some of the earlier fires is not known. These have been omitted.

Individual fires seemingly show great differences in burning pattern. Some are confined to the inland regions and never reach the coast. Others are confined to the central region and never reach the coast, sate burn along the coast, others burn across the whole mountain range. A history of fire behavior of selected fires follows in an effort to support the picture of the composite fire history discussed so far. The fires discussed are shown in figure 4.

Fires in Initially Strong Northwest Wind Conditions

The 1944 Woodland Hills Fire started near the Ventura Freeway and, fanned by northwest winds, spread in a southeastern direction for about 9 km. Mulholland Highway was an effective fire barrier on its southern flank and limited the size of the fire. Large-scale fires during northwestern wind conditions have historically been effectively controlled with aggressive backfiring, hose lines and tractor work. The present use of helicopters, though not as effective as aggressive backfiring against a frontal fire, nevertheless limits these fires in size with the slightest break in fire weather.

Fires in Santa Ana and Onshore Wind Patterns

During the 1935 Latigo (Malibu) Fire light northeasterly winds allowed the local updraft mountain winds to spread the flames upslope and toward the ridge line where they were picked up by the light Santa Ana breeze and pushed toward the west. Hot spots still burning in the canyons

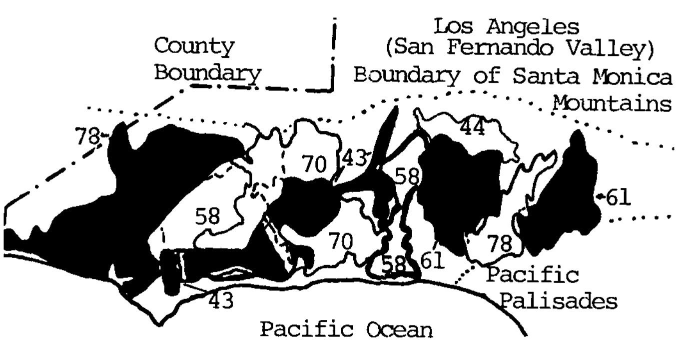

Figure 4--Fires that swept the mountain range from north to south

would lay down at night but would be whipped into flames early in the morning, making another run for the ocean. Onshore winds and local surface winds would push the fire again uphill and easterly upslope. Aggressive backfiring on a 27 km wide front finally contained the north and eastward spread of the fire. Thus Santa Ana winds coupled with local winds are responsible for spreading flames in both directions.

Santa Ana Fires from Coastal Ridges to the Coast

The 1956 Newton Fire started in the upper Newton Canyon watershed at the coastal ridge and raced to the beach while fanning out east and west. Changing wind patterns make the coastal mountain slopes vulnerable to east as well as westward fire spread, but quick aerial response and ground access make it now possible to limit the eastward spread of a coastal ridge fire.

Santa Ana Winds Fires Spreading from Highway 101 or Mulholland Highway to the Coast

Fires starting along the inland boundaries of the mountain range will normally became large if they are pushed by strong Santa Ana winds. Such fires were unknown from 1919-1935, were uncommon until 1957, but have since then occurred at least once every decade. Examples of such fires are the 1943 Woodland Hills Fire, the 1956 Sherwood Fire, the 1958 Liberty Fire, 1961 Topanga and Bel Air Fires, the 1970 Wright Fire, and finally the 1978 Kanan-Dune and Mandeville Fires. The 1978 twin fires burning through stands of chaparral in excess of 50 years old show the reliance on the north to northeasterly winds to set fire boundaries despite an army of men and a fleet of modern fire fighting equipment. Today, fire fighting personnel is geared to saving life and property during catastrophic fires. There is really no means of controlling such fires until the wind dies down or the fire runs out of fuel.

FIRE BOUNDARIES, FIRE FIGHTING TECHNIQUES

As the wind dies dawn, fire barriers such as firebreaks, roads and even previous burns as old as 20-30 years can become important fire boundaries. For example, the southwestern extent of the 1978 Kanan-Dume Fire was checked and prevented from crossing into Ventura County by the 1-year old Carlisle burn. Flames in the 1-year burn were supported by dead stands of aerially seeded annual ryegrass (Lolium multiflorum) and dead herbaceous annuals, but the law intensity flames were stopped on Decker Road despite winds gusting in excess of 60 km/hour. The westerly flank of the 1958 Liberty Fire was prevented from reaching the beach but not before it had crossed Latigo Canyon Road and burned several km into a 2-year burn. The southwestern extension of the 1970 Wright burn was also checked by a 3-year old burn. The 1978 Mandeville burn wedged between the 1961 Topanga and Bel Air Fires and made a run in chaparral stands in excess of 40 and 63 years. It was prevented from reaching the beach when it ran out of fuel in urban developments and the strongly gusting Santa Ana wind subsided.

The 1935 Latigo Fire is of interest in that the northern extent of the fire was slowed down when burning through a 10-year old burn. An indication that the chaparral was not highly flammable is shown by the large unburned stands along the northern boundaries of both the 1925 and 1935 burns.

The shapes of both the 1958 Warner Fire (Hourglass) and the 1943 Woodland Hills Fire indicate the successful use of aggressive backfiring and/or pinching off the flanks of fires by taking advantage of strategic fire barriers, such as firebreaks, roads and previous burns. The 1943 fire stretched like a worm from Woodland Hills to Point Dume, an aerial distance of approximately 23 km. It showed that southwesterly spreading fires, even when pushed only occasionally by Santa Ana winds, are hard to control. Prior to the use of helicopters, constant flareups when the winds picked up converted many seemingly controlled fires into uncontrolled fire disasters. The value of a helicopter thus lies in extinguishing fires through aerial water drops as soon as the wind dies down and extinguishing many spot fires before they can become major new fires.

CONCLUSION

This study showed that the coastal slopes of the Santa Monica Mountains had a higher fire frequency both in the prefire suppression period 1900-1918 as well as in the fire suppression period 1919-1980. During this latter period, the higher fire frequency was found predominantly in the coastal sage vegetation. Fire suppression was more successful in the inland chaparral regions. This resulted in a steady fuel buildup and a shift from small to large disastrous fires. The area investigated showed a cyclic periodicity in area burned of about 20 years. Coastal sage vegetation is able to carry large-scale fires within 10 years after a burn, south slope chaparral within 15 years, and north slope chaparral within 20 years.

Most large-scale fires occur during the Santa Ana fire wind conditions from mid-September through December. The probability of large-scale fires is also enhanced by the linearity of the fire winds and the canyons. When taking into account fuel type, topography and other site specific factors, it is therefore possible to predict the occurrence of large-scale fires and use fire management techniques inclusive of fire exclusion and prescribed burning more effectively to reduce high fire risks.

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