# Challenges of managing fires along an urban-wildland interface – lessons from the Santa Monica Mountains, Los Angeles, California

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**Abstract**

The Santa Monica Mountains are a 90,000 hectare island of Mediterranean habitat within the urban expanse of the greater Los Angeles metropolitan area. The Santa Monica Mountains National Recreation Area includes a mosaic of federal, state and local parklands as well as private property. It is the U.S. National Park Service's best mainland example of a Mediterranean-type ecosystem, an ecosystem that has a limited worldwide geographic distribution and high biological diversity. Average annual rainfall is 430 mm/year, falling predominantly between November and March with an extended dry season from May to October. The Santa Monica Mountains periodically experience extreme föehn winds that average 30-50 kph with maximum gusts over 160 kph recorded. These winds mainly occur in the fall months at the end of the dry season and are often associated with high temperatures and low humidity. The vast majority of all area burned is in large fall fires with extreme fire weather.

The dominant vegetation in the mountains is chaparral (55%) and coastal sage scrub (20%) shrublands, which burn in intense, stand-replacing crown fires. Chaparral forms a continuous fuel bed that varies from an average total fuel biomass of 17 Mg/ha in *Adenostoma* chaparral to 36 Mg/ha in *Ceanothus*-chaparral. Wind-driven fires can reach a rate of spread of 13 kph with a flame height of 12-18 m.

Lightning ignitions are extremely rare and under natural conditions fires occurred infrequently. Native Americans occupied the area for approximately 10,000 years before present and are known to have used fire as a cultural tool, but the frequency and geographic extent of their fire use are unknown. Currently, ninety-eight percent of all fire starts are of human origin, with arson and arcing power lines responsible for the vast majority of area burned. Anthropogenic ignitions have led to increasing fire frequencies and increases in the total area burned per decade. All fires are actively suppressed but the fire size distribution has not changed. In this fire environment, the use of prescribed fire is not necessary for ecosystem health nor is it able to prevent large scale fires. Very short fire return intervals have adverse vegetation impacts and in some areas of the mountains have resulted in type conversion and increased rates of exotic species invasions.

Approximately 13% of this fire-prone area is developed. This includes modern subdivisions, historic communities originally built as summer cabins, low density single family homes or

estates, and high density beachfront homes. The communities are among the wealthiest in Los Angeles County and the state of California. Because of their high desirability, there is ongoing development pressure on the privately owned wildland areas, with continuing expansion of the wildland-urban interface development include both property losses and wildfire suppression costs. Mitigating fire hazard impacts sensitive habitat and may conflict with natural resource protection. Three recent large fires, the Old Topanga (1993), Green Meadow (1193) and Calabasas (1996) fires illustrate fire behaviour, organizational response, and social impacts. In general, the combination of varying land ownerships, fire-prone environment, ecological sensitivity, and human developments create complex challenges for managing fire in the Santa Monica Mountains.

## Introduction

The Santa Monica Mountains National Recreation Area is located in the southern portion of the state of California, U.S.A. Situated in two counties, Ventura and Los Angeles, it is bounded by the Los Angeles Basin on the south, one of the largest urban centres in the world, and by rapidly growing developments on the north (Figure 1). Wildland fire is a natural ecosystem process in these ecosystems and is nearly always stand-replacing crown fires of considerable intensity. These fires commonly burn across the wildland urban interface, destroying homes and producing damages in the 100s of millions of dollars (Keeley 2002). The extensive urban/wildland interface, coupled with lands under federal, state, county, NGO and private jurisdiction, plus vegetation capable of generating massive high intensity wildfires, have all contributed to greatly complicating fire management of this area.

**Figure 1.** Urban/wildland interface with evergreen chaparral on the more mesic north-facing exposures and semi-deciduous coastal sage scrub on the opposite slope in the northern part of the Santa Monica Mountains (photo by J.E. Keeley).

The dominant paradigm of fire management in the U.S.A. is that a century of fire suppression has created an unnatural buildup of fuels and this has contributed to severe wildfires, which can be best controlled by landscape scale rotational prescription burning. However, this paradigm is not true for all fire adapted ecosystems. In the shrublands of southern California, fire suppression has not been successful in preventing large-scale intense wildfires and thus there has not been an unnatural fuel buildup (Keeley et al. 1999). Because fire has not been successfully excluded from southern California shrubland ecosystems, there is no need to introduce additional fire through management actions to restore southern California shrublands. In fact the number of fires in the Santa Monica Mountains has increased throughout the 20th century (Figure 2). This is attributed to population growth and expansion of the urban interface zone (Keeley and Fotheringham 2001a). Fire management in this region needs to deal primarily with fire hazards created by development at the urban wildland interface and not to correct unnatural fuel buildup (NPS 2003).

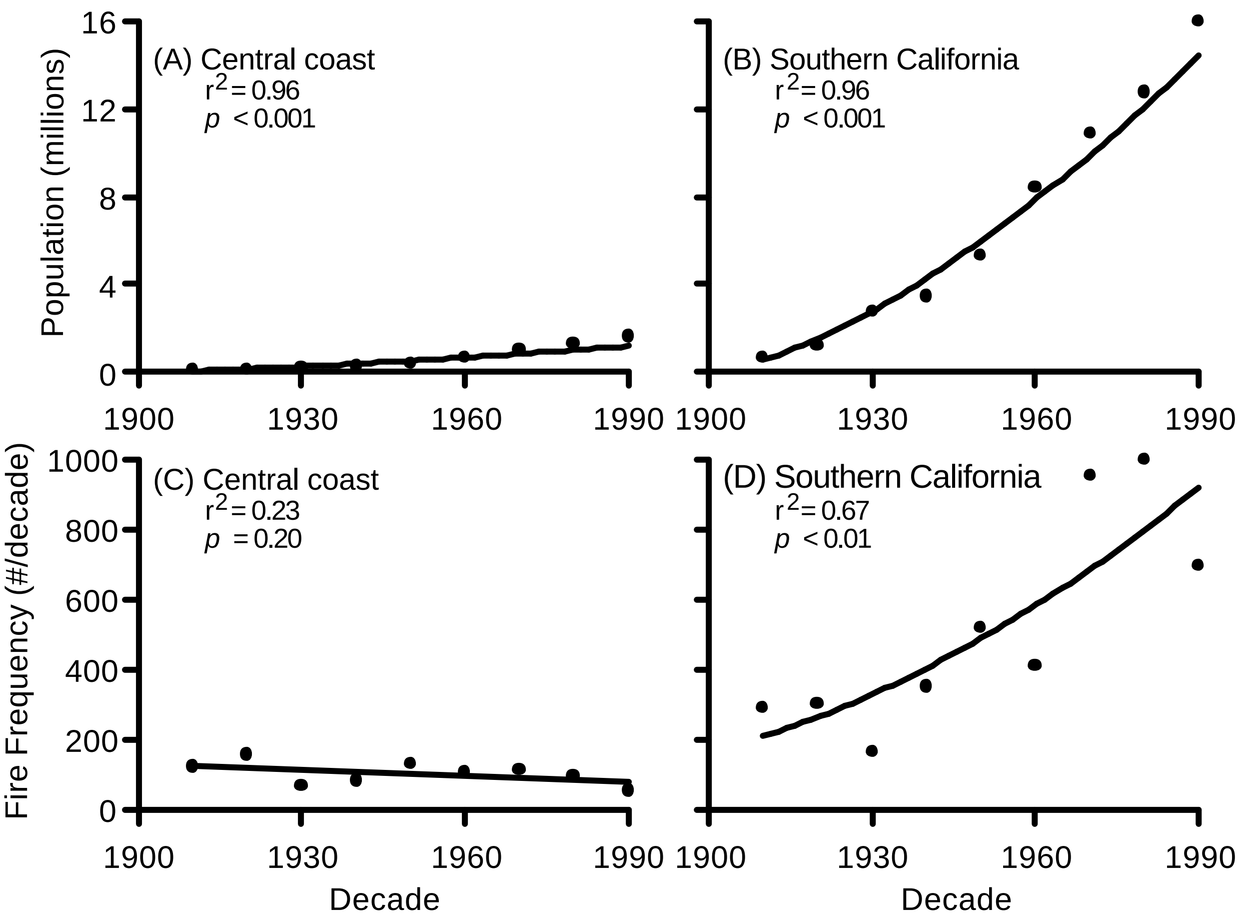


**Figure 2.** Twentieth century population growth (A,B) and fire frequency (C,D) in southern California and the central coastal region north of the Santa Monica Mountains (from Keeley and Fotheringham 2003). In both regions humans account for over 95% of all fires.

Wildland fire management activities conducted by the U.S. National Park Service are guided by fire management plans, which are fundamental required and strategic documents that guide the full range of fire management activities. In general, the goals are focused on safety, fire hazard reduction and natural resource management. One step in this planning process is the Draft Fire Management Plan and Environmental Impact Statement.

The Draft Fire Management Plan for the Santa Monica Mountains National Recreation Area considered seven alternatives (NPS 2003):

**Fire Management Alternatives**

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| **Alternative 1** | No Action (Current Program) Landscape Mosaic Prescribed Burning |
| **Alternative 2** | Mechanical Fuel Reduction/Ecological Prescribed Fire/Strategic Fuels Treatment |
| **Alternative 3** | Mechanical Fuel Reduction and Ecological Prescribed Fire |
| **Alternative 4** | Mechanical Fuel Reduction (Wildland/Urban Interface) and No Prescribed Fire |
| **Alternative 5** | Suppression Only and No Vegetation Manipulation |
| **Alternative 6** | Mechanical Fuel Reduction on a Landscape Level |
| **Altemative 7** | Wildland Fire Use. |

Alternative 1 is the current fire management program and it is recommended that it be replaced with Alternative 2. Alternatives 3, 4, and 5 are not recommended. The latter three alternatives have been rejected because they do not meet National Park Service Objectives and/or were logistically infeasible to implement along the wildland/urban interface.

Here we focus on the ecological and management issues involved in the proposed replacement of Alternative 1 with Alternative 2, which represents an important paradigm shift in management philosophy for the Santa Monica Mountains National Recreation Area.

**Alternative 1**

This alternative specifies a continuation of the current fire and vegetation management program, which has been focused on creating a landscape mosaic of varying aged chaparral stands through the application of prescribed fire in separate watersheds.

It is the conclusion of the Draft Fire Management Plan that this alternative has the potential to be ecologically damaging to native plant communities by increasing the probability of shrubland type-conversion from a too-short fire return interval in the high fire frequency fire environment of the Santa Monica Mountains. In addition, it does not provide direct protection for residences by reducing fuel loads at the urban interface, because treatments are often remote from residential development and because of the danger of prescribed fire escaping, in these dense fuels and becoming a hazard itself. Alternative 1 does not provide effective control of wildfire spread under severe weather conditions because ecologically viable vegetation can not be maintained in the age class that might be effective in limiting wildfire spread under extreme wildfire conditions. Finally, large scale burning has not been feasible to implement in accordance with the goals of the previous fire management plan because of regulatory constraints on prescribed fire, especially those relating to air quality standards.

**Alternative 2**

Under this alternative, hazard fuel reduction projects, using prescribed fire or mechanical fuel reduction, are considered in strategic locations that reduce the chance of wildfires spreading across the wildland/urban interface or damaging natural or cultural resources within the recreation area. Short-term and site-specific resource impacts of strategic prescribed fires are weighed against long-term and regional hazard fuel reduction benefits. Strategic zones are identified using up-to-date analysis of vegetation types, fuel characteristics, fire spread models, and potential hazards to life, property, and natural and cultural resources. Mechanical fuel reduction is concentrated at the urban interface to protect homes.

This alternative provides effective protection of homes by focusing mechanical fuel reduction at the interface between homes and wildland vegetation, and provides ecological benefits from resource prescribed burning. In addition, it provides potential ecological and community benefits where wildfire risk analysis can identify locations where strategic fuel modification projects can modify fire behaviour to the extent that it would limit fire spread, protect social values, or allow control of a fire perimeter. This alternative requires that the ecological impacts from maintaining vegetation in a condition adequate to sustain strategic fuel modification benefits be explicitly identified and that the social and environmental cost:benefits be jointly weighed.

**Ecological Basis For Alternative 2**

Fires in southern California chaparral and sage scrub are almost always stand replacing crown fires. The bulk of burning occurs in large autumn fires driven by föehn winds known locally as Santa Ana winds (Figure 3). Ninety percent of the area burned in the Santa Monica Mountains over the past 75 years has been during the months of September to November (NPS 2003). It has been found that in the largest fires in chaparral shrublands (>4000 ha) occur during Santa Ana wind conditions (Moritz 1997). Below 4000 ha, wildfire size is not as tightly coupled to Santa Ana wind conditions, possibly due to the ability to better control fire spread under less extreme conditions, or because other environmental factors interact to affect fire behavior and suppression effectiveness.

Santa Ana winds are such a significant force they are capable of over-riding other climatic signals. For example large fires (>5000 ha) that burned during the autumn months were likely to occur in mesic years as in drought years (Figure 4). Drought, however, is consistently associated with fires either earlier or later in the year.

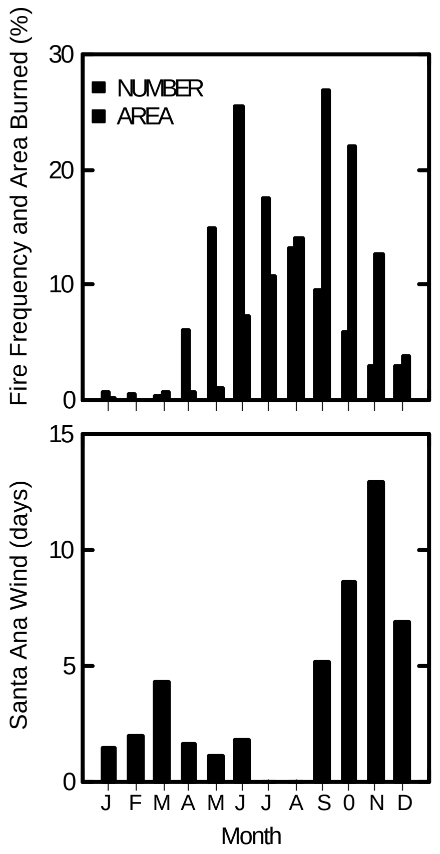


**Figure 3**. Monthly distribution of fire frequency and area burned (top panel) and days with dry offshore high velocity Santa Ana winds for Los Angeles County, California U.S.A. (from Keeley and Fotheringham 2003).

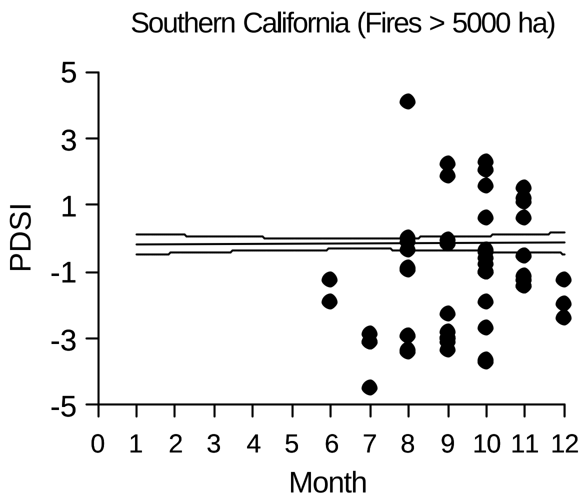


**Figure 4.** Palmer Drought Severity Index during months with fires exceeding 5000 ha in southern California (from Keeley in review).

The over-riding importance of Santa Ana winds in driving wildfires in the Santa Monica Mountains is the observation that large wildfires are not controlled by younger vegetation classes (Figure 5), but are usually controlled by changes in weather (Moritz 1997, Conard and Weiss 1998, Keeley and Fotheringham 2001b).

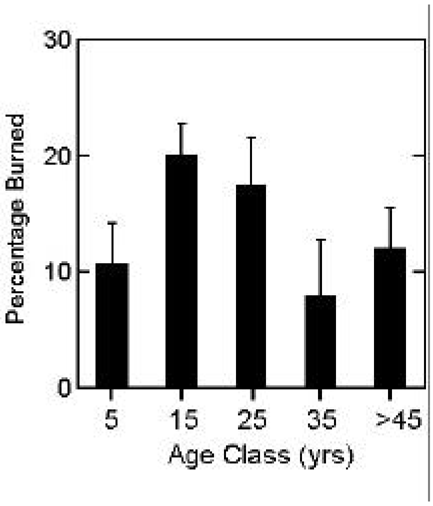


**Figure 5.** Vegetation age classes burned in the eight largest fires during the 30-year period from 1967 to 1996 in the shrub-dominated Santa Monica Mountains (Ventura and Los Angeles counties, California, USA) ( from Keeley and Fotheringham 2001b).

Because of the autumn föehn winds have such a marked control on burned acreage it is little wonder that in coastal California nearly a century of fire suppression activity has not obviously diminished the amount of wildfire area burned each decade during the 20th century (Figure 6).

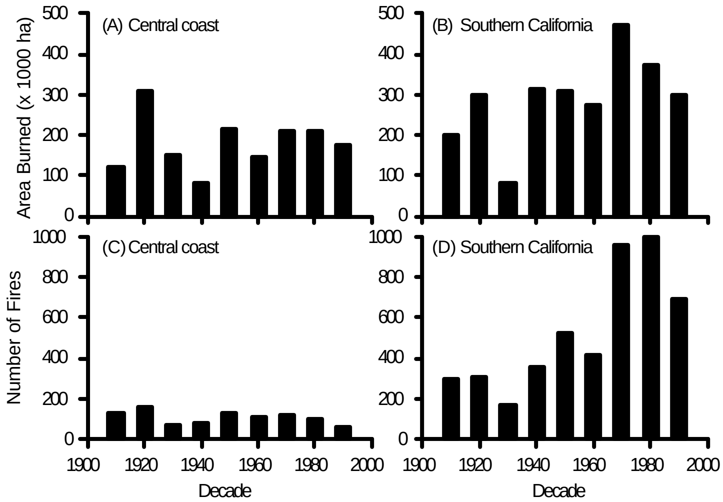


**Figure 6.** Fire frequency and area burned by decade for central and southern California (from Keeley and Fotheringham 2003).

These data suggest a Santa Monica Mountains fire model (NPS 2003) of increased anthropogenic fire ignitions, where fires that begin under moderate environmental conditions are rapidly extinguished. Very large fires occur under extreme climate conditions of low humidity and high wind and will burn through all vegetation age classes; the ability to control fires under these conditions is limited. Heavy fuel loads are an intrinsic characteristic of normal chaparral development and are not the result of fire suppression leading to unnatural, landscape level, fuel accumulation. The increased fire losses in the more recent decades is not due to fire suppression but due to the increased urbanization adjacent to wildlands with a vegetation type that will always be subject to recurrent large wildfires.

Where development has been located in wildland areas subject to periodic large wildfires, property loss is due to three factors: 1) the speed of the initial fire, 2) extreme climatic conditions, and 3) lack of integrated structural resistance to fire (Coleman 1995). The speed at which large fires spread means that fires at the urban interface can do major damage before the majority of fire-fighting forces have been deployed. Computer simulations of fire spread under Santa Ana conditions show fire rapidly overtaking residential areas (NPS 2003). Destructive wildfires with large structural losses such as the 1978 Kanan Fire and the 1993 Old Topanga Fire spread from the inland side of the Santa Monica Mountains to the coast in 2 and 4 hours, respectively (NPS 2003). In large fires where thousands of fire fighters may ultimately be deployed, these resources are not available in the initial, critical hours of the fire. Under extreme climatic conditions of low humidity, high temperatures, and high wind in wildland areas of steep topography and dense chaparral, conventional fire fighting techniques are severely limited. Finally, under the conditions of large wildfires, structures that lack defensible space or resistance to fire can not be safely protected.

Wildfire property losses can not be reduced by increasing the size of the mobilization efforts, changing the initial speed of the fire or by changing the climatic conditions or the local geography of existing structures. The only realistic protection for existing structures is to assure there is an adequate defensible space and structural integrity (Cohen 2000). As important to reversing the trend of escalating property losses is to locate new structures away from geographically indefensible locations.

## Conclusions on Fire Management Strategy

Large wildfires in chaparral are not controlled by younger vegetation classes but are usually controlled by changes in weather, in conjunction with changes in fuel type or successful burnouts. Prescribed burning to create a mosaic of age classes (Alternative 1) is ineffective as a fire management technique due to the fire behaviour of large fires and the practical and social constraints associated with sufficient prescribed burning to create a landscape level mosaic (Conard and Weise 1998, Keeley et al. 1999). The essential features of our recommended fire management strategy, and incorporated in Alternative 2, are:

1. Continue a policy of fire suppression
2. Maintain a chaparral fire regime that is within the range of resilience for these communities
3. Reduce fire hazard at the urban wildland interface.

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