Lessons Learned from the Wildfires of October 2003[1]

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The southern California fires of late October 2003 were the largest single fire event in California's recent history (figs. 6-6 and 6-7). These fires burned through a complex mosaic of urban and wildland fragments, as well as across the well-defined and extensive wildland-urban interface, destroying many lives and properties. Understanding the factors leading up to this event and the appropriate human response necessary to reduce the chances of these catastrophic impacts occurring again is the focus of this paper.

These fires burned through diverse plant communities but the amount of different vegetation types burned was not proportional to the media coverage. Thus, outside of southern California there is widespread belief that these were forest fires and this perception may have contributed to the passage of the (Healthy) Forest Restoration Act of 2004 (HR 1904). Media focus on these forest fires was undoubtedly due to the fact that they burned in unnaturally intense and spectacular crown fires in forests with important recreational value and relatively high density housing. However, coniferous forests comprised only about 5% of the total acreage burned (http://frap.cdf.ca.gov/). This is important because the factors leading up to fires and the solutions to reducing fire hazard are distinctly different in forests than in shrublands like those that dominated the bulk of the wildlands burned in the 2003 fires.

How Do Forest Fires Differ From Shrubland Fires?

A century of fire suppression policy has been very effective at excluding fires from forests throughout the western U.S., but not from southern California shrublands. In forests, fire exclusion has been achieved for a number of reasons; mountain climates have a much shorter fire season, ignitions are commonly from lightning, weather conditions are not usually conducive to rapid fire spread, and fires typically spread by surface fuels that produce lower flame lengths. Over much of the 20th century these characteristics have led to a highly successful fire suppression practice that equals fire exclusion. Consequently, there has been an unnatural accumulation of surface fuels, coupled with increased density of young shade tolerant trees. Increased density of young trees is perhaps the most serious problem because these saplings act as ladder fuels that change fire behavior from surface fires to crown fires. As with most of our western forests, southern California conifer forests have been logged one or more times (Dodge 1975, Minnich 1988), and this may have had a greater impact on creation of ladder fuels than fire exclusion, although no one has clearly sorted out the relative contributions. Ladder fuels were certainly a critical factor in determining property damage from these recent forest fires.

Fire suppression policy in the southern California forests may also have had other indirect effects that contributed to increased fire hazard by creating conditions that

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[1] This is based in part on an article appearing in the September 2004 issue of *Journal of Forestry*.

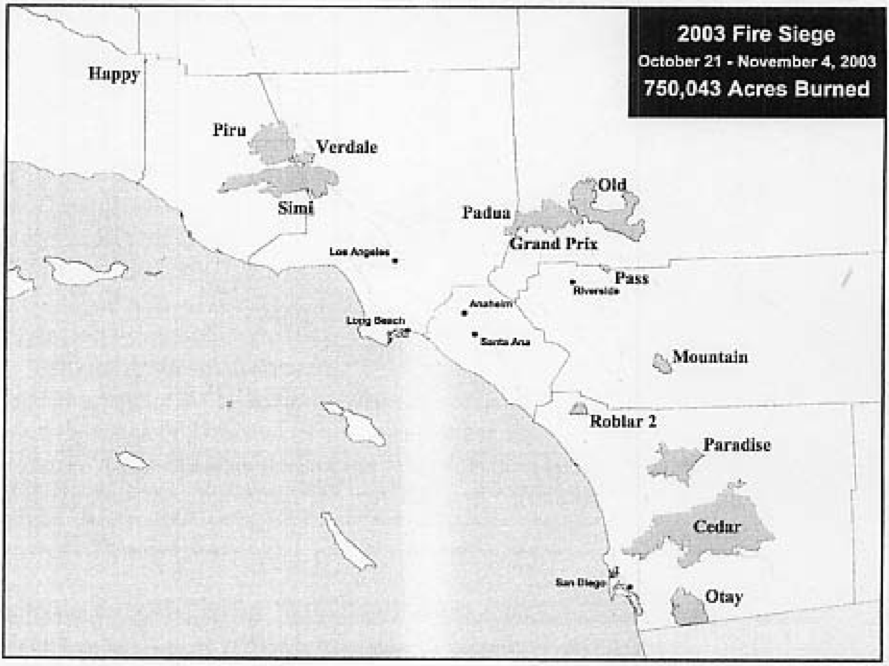

Fig. 6-6 Fire Perimeters for October 2003 Fires in Southern California. Source: John Craney, California Department of Forestry and Fire Protection (CDF).

FIRE	COUNTY	ACRES BURNED	START DATE	CAUSE
Roblar 2	San Diego	8,592	Oct. 21	Under investigation
Pass	Riverside	2,387	Oct. 21	Human
Grand Prix/Padua	San Bernardino Los Angeles	69,894	Oct. 21	Human
Piru	Ventura	63,991	Oct. 23	Under investigation
Verdale	Ventura Los Angeles	8,650	Oct. 24	Under investigation
Happy	Santa Barbara	250	Oct. 24	Under investigation
Old	San Bernardino	91,281	Oct. 25	Under investigation
Cedar	San Diego	273,246	Oct. 25	Human
Simi	Ventura Los Angeles	108,204	Oct. 25	Ember caused spot fire from Verdale fire
Paradise	San Diego	56,700	Oct. 26	Human
Mountain	Riverside	10,331	Oct. 26	Under investigation
Otay	San Diego	45,971	Oct. 26	Human
Wellman	Riverside	100	Oct. 26	Under investigation

Fig. 6-7 The 2003 Southern California Firestorm.

greatly increased tree mortality. Estimates for some parts of the southern California San Bernardino Forest are that 3/4 of the pines were killed by a combination of drought followed by subsequent bark beetle infestation. When natural fires are excluded from conifer forests there is an unnatural increase in the density of young trees. This results in intensified competition for water between all trees, young and old. When the region experiences drought conditions, as has been the case during the past several years, mortality of all trees exceeds what would have been predicted under more natural conditions. Extensive mortality of ponderosa pine *(Pinus ponderosa)* in the San Bernardino Mountains appeared to have played very little role in the October 2003 fires only because weather conditions changed and the fire was extinguished by rain.

To reduce fire hazard in these forests there is currently a massive effort directed at extracting dead trees. While this will certainly reduce the chances for destructive wildfires it creates other resource problems. Primarily, removal of such large portions of the forest canopy creates an ecological vacuum that will be filled by aggressive alien species such as cheatgrass *(Bromus tectorum)* that has already infested other forests recently burned in this area (photo33).

Shrubland Fires

Chaparral and related shrublands dominated most of the landscape burned during the October 2003 fires, and there is ongoing debate over whether such massive fires are natural, but infrequent events in the chaparral ecosystem, or are the result of modern fire suppression, as appears to be the case with conifer forests. The 2003 firestorm is relevant to this debate, providing an important case study that we can learn from and use to guide rebuilding efforts and future management activities.

The dominant paradigm governing fire management in southern California shrublands has long been the model that presumes fire suppression has successfully excluded fire and caused an unnatural accumulation of fuels (Minnich 1983; Minnich and Chou 1997). This model assumes that the age and spatial pattern of vegetation are strong constraints on fire spread, even during periods of extreme fire weather. These authors propose that large chaparral wildfires are modern artifacts of fire suppression and they can be eliminated by landscape scale rotational burning (Minnich and Dezzani 1991; Minnich 1998). Fire management plans for USFS national forests in southern California all have incorporated aspects of this model (Conard and Weise 1998).

However, despite heroic efforts by fire fighters during the 20th century, fire suppression policy has not eliminated fires from these landscapes, nor have fuels increased to unnaturally high levels (Conard and Weise 1998; Keeley et al. 1999; Keeley and Fotheringham 2003a; Moritz 2003). In addition there is no evidence that the frequency of large fires has changed over the 20th century (fig. 6-8). However, what has changed on these landscapes is an increase in population density and concomitant increase in fires (fig. 6-9).

An emerging view is that large fires under extreme fire weather conditions are only minimally constrained by the age and spatial patterns of fuels, and this appears to hold over broad regions of central and southern California (Moritz et al. 2004).

Southern California shrublands are an anomaly because, unlike many western U.S. forests, fire suppression policy cannot be equated with fire exclusion. The primary

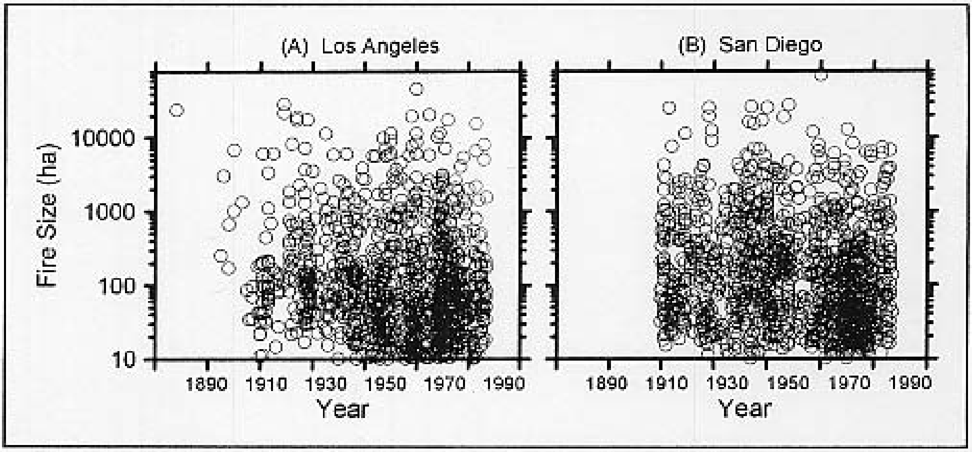

Fig. 6-8 Size of Fires During the 20th Century in Two Southern California Counties. Hectares (ha) = 2.47 acres. (from Keeley et al. 1999).

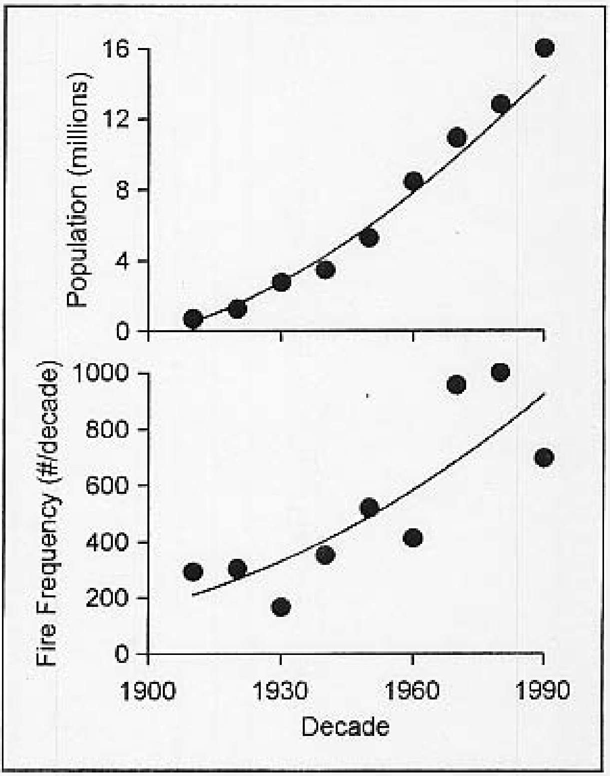

Fig. 6-9 Decadal Changes in Human Population and Fire Frequency in Southern California (from Keeley and Fotheringham 2003).

reason is because this region has what fire climatologists have labeled as the worst fire climate in the country (Schroeder et al. 1964). While it is generally true that massive fires anywhere in the West are accompanied by severe fire weather, in southern California these fires typically occur during the autumn Santa Ana winds. These winds reach speeds of 50-60 mph, and occur every autumn at the end of a 6 month drought. Under these conditions fire fighters are forced into defensive actions and can do very little to stop these firestorms.

Illustrative of southern California's uniqueness is the relationship between large fires and drought (Keeley 2004a). Throughout the western U.S., large fires are usually restricted to periods of extreme drought (Westerling et al. 2002). However, in southern California large fires are most likely during the autumn Santa Ana wind season and are not restricted to periods of unusual drought (fig. 6-10). Climate does appear to play a role in that it increases the length of the fire season since large summer fires are restricted to drought conditions.

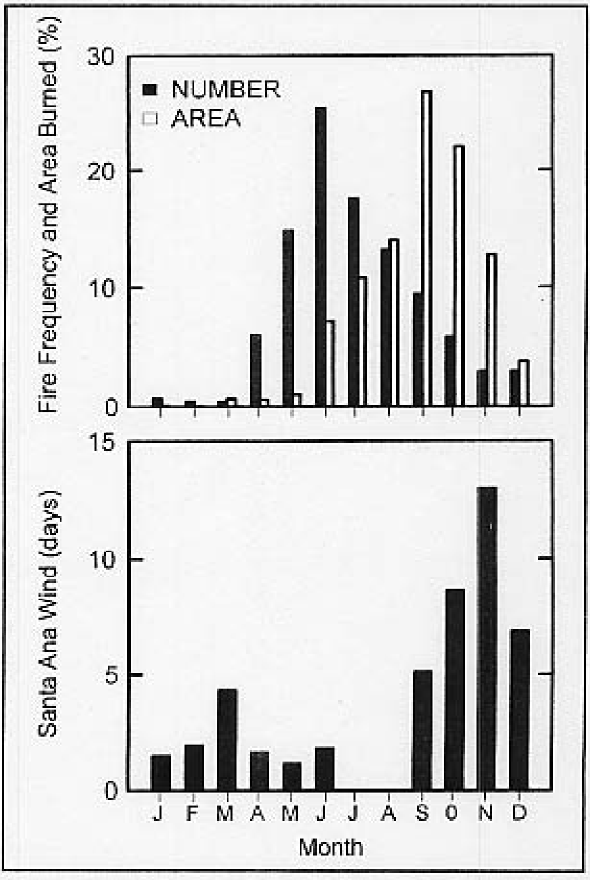

Fig. 6-10 Seasonal Distributions of Fire Occurrence and Area Burned During the 20th Century in Los Angeles County and Seasonal Distribution of Santa Ana Winds (from Keeley and Fotheringham 2003).

Lessons Learned From the October 2003 Fires

Three lessons can be extracted from the 2003 fires:

1. Although these fires were massive, their size was not unprecedented, and thus we can expect similar fire events in the future.
2. The current fire management policy is not effective at preventing these massive fires.
3. Future developments need to plan for these natural fire events much the same way we currently incorporate engineering solutions to earthquakes and other natural catastrophes.

Lesson 1: This 2003 firestorm was a natural event that has been repeated on these landscapes for eons. For example, studies of charcoal deposition extracted from cores off the coast of Santa Barbara have found that the frequency of large fires has not changed in the past 500 years (Mensing et al. 1999). There are even Native American legends in San Diego County that support this conclusion. According to legend, hundreds of years ago there was a mass migration of local tribes due to a massive wildfire (Odens 1972). Although the recent 273,230 acre Cedar fire was the largest in California since official fire records have been kept, there are historical accounts of even larger fire events. For example, during the last week of September 1889, a Santa Ana wind-driven fire east of Santa Ana in Orange County, California reportedly burned 100 miles north and south and 10-18 miles in width (*Los Angeles Times,* September 27, 1889). This event would have been three times larger than the recent Cedar fire. Collectively, September 1889 would have exceeded all of the October 2003 burning since there was another fire that ignited that week near Escondido in San Diego County and in two days the same Santa Ana winds blew it all the way to downtown San Diego (Barrett 1935), a distance roughly equal to the long axis of the recent Cedar fire.

The primary difference between these fires is that California's population has grown about *30 fold* during this period *(http:www.census.gov)* and urban sprawl has placed huge populations adjacent to watersheds of dangerous fuels. Since over 95% of all fires on these landscapes are started by people, there has been a concomitant increase in fire frequency and increased chance of ignitions during Santa Ana wind events (Keeley and Fotheringham 2003).

The important lesson here is that massive fires have occurred at periodic intervals in the past and likely will occur again in the future. It may be more useful from a planning and management perspective to see these events as we currently view 100 year flood events or other such cyclical disasters.

Lesson 2: For the past several decades, southern California shrubland fire management has been based on the philosophy that fuel management practices can control the ultimate size of these massive fire events. This belief stems in large part from the fact that forests such as Southwestern ponderosa pine have had natural fire regimes perturbed by fire exclusion (Cooper 1961, Allen et al. 2001) and there are an increasing number of studies showing that fuel reduction is highly effective at reducing fire hazard. Many researchers have failed to recognize that transferring this model from natural low intensity surface fire regimes typical of forests, to chaparral, may be inappropriate. During the 1970s mathematical models of fire spread demonstrated that if fire suppression was effective at excluding fires then chaparral fires would be expected to increase in size and intensity (Keeley and Fotheringham 2003). Managers accepted this idea and focused on fuel (vegetation) manipulation as a means of preventing large fires. The preferred treatment has long been prescription burning, applied on a rotational basis across the landscape. Theoretically fuel reduction treatments are expected to prevent large wild fires by creating fuel mosaics that include patches of young fuel, which supposedly are expected to act as barriers to fire spread.

However, over the past several decades this management philosophy has proven ineffective and in every decade the region has experienced large-scale catastrophic fires. The extent to which landscape-level fuel treatments are effective is a function of weather conditions during the fire event. Under extreme weather conditions there is overwhelming evidence that young fuels, or even fuelbreaks (fig. 6-11), will not act as a barrier to fire spread. This is quite evident in the October 2003 fires. Crossing nearly the entire width from north to south of the east-west burning Cedar fire were substantial swaths of vegetation that were less than 10 years of age, not just in one but two parts of that fire (Keeley et al. 2004). The Otay fire exhibited the same phenomenon; the fire burned through thousands of acres that were only 7 years of age (fig. 6-12). The primary reason young fuels cannot act as a barrier to fire spread under these severe weather conditions is that if the high winds do not drive the fire through the young age classes, they will spread the fire around them, or jump over them from fire brands that can spread up to a mile or more.

What is the appropriate fire management strategy? Pre-fire fuel manipulations will undoubtedly remain an important part of the southern California fire management arsenal, but their application needs to be carefully considered if they are to be effective

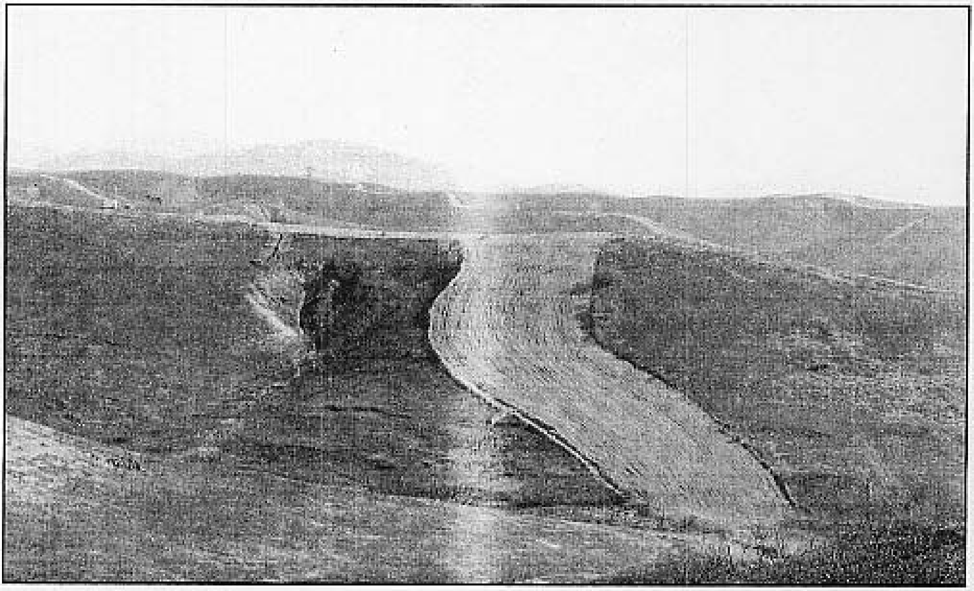

Fig. 6-11 Fuel Break East of Scripps Ranch, San Diego County. *During the Cedar fire, fuelbreaks failed to prevent the fire from spreading due to embers blowing far ahead of the fire by Santa Ana winds. Photo: J.E. Keeley*

and provide benefits equal to or exceeding their cost. For example, some fires igniting under calm wind conditions have been documented to burn out when the fire encounters young fuels, and the lack of wind limits the likelihood of fire brands jumping these young fuels. These fires, however, seldom present major problems for fire fighting crews and do not pose a major threat to the loss of property and lives. Thus, serious attention needs to be paid to whether or not fuel treatments are cost-effective for these fires.

The key to effective use of pre-fire fuel manipulations in crown-fire ecosystems such as chaparral is their strategic placement. Under severe weather, lower fuel loads will

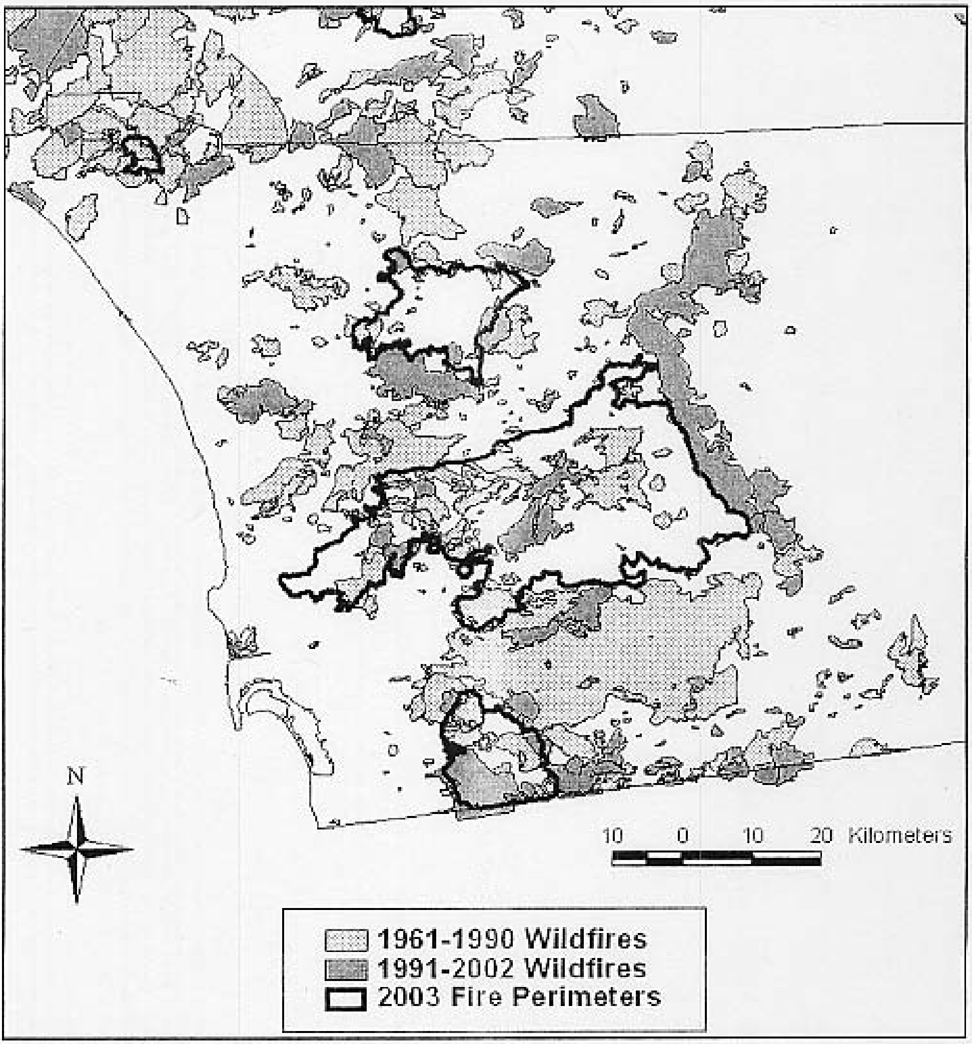

Fig. 6-12 Historical Fire Perimeter Map of San Diego County. *Both the Otay fire (lower middle dark outline) and the Cedar (central dark outline) burned through several large patches of young chaparral. This demonstrates the dominating role winds can play over fuel age in spreading fires. Paradise fire upper middle. Map created by Max A. Moritz.*

not stop the spread of fire, but they do reduce fire intensity, and thus provide defensible space for fire suppression crews. Thus, the key benefit is to enhance firefighter safety and therefore strategic placement is critical to their success. Much of the southern California shrubland landscape is far too steep to provide defensible space regardless of fuel structure, and thus fuel manipulations in these areas are unlikely to provide economically viable benefits. Fuel manipulations will be most cost-effective when focused on the wildland-urban interface. Often times during severe fire weather homes are lost because fire fighters refuse to enter areas that lack a sufficient buffer zone of reduced fuels to provide defensible space. In terms of management goals, the metric for fuels treatments on these shrubland landscapes needs to change from simply measuring "acres treated" to consideration of their strategic placement, and this change in management philosophy is being recommended by the largest National Park Service unit in southern California (see M. Witter and R. Taylor above in *Preserving the Future: A Case Study in Fire Management and Conservation from the Santa Monica Mountains).*

Fuel manipulations, in particular rotational prescription burning, may have some beneficial impacts on post-fire events since younger fuels are associated with reduced fire severity, and this may affect both vegetation recovery and sediment losses. Extensive studies of post-fire recovery following the 1993 fires in southern California found that the impact of high severity fires was variable, with both positive and negative impacts on post-fire recovery (Keeley 1998a). Thus, it would be premature to at this point conduct expensive fuel treatments with the expectation of producing major changes in post-fire recovery.

Recent studies of sediment loss from chaparral watersheds have shown that rotational burning at 5 year intervals has the potential for greatly decreasing the immediate post-fire sediment loss (Loomis et al. 2003). However, in the long run this may not be cost-effective for several reasons. One critical determinant of sediment loss is the first winter precipitation, high rainfall years being particularly damaging. Prescription burning at 5 year intervals greatly increases the chances of fires being followed by an El Niño year of high rainfall, relative to fires at the normal return interval of 35 years. In addition, the cumulative sediment loss over the long term would be much greater for 5 year burning intervals since there would be multiple peak discharges over the normal 35 year interval. Perhaps most importantly, burning at 5 year intervals will almost certainly effect type-conversion to alien grasslands (Keeley 2004b), which in addition to having negative resource impacts, would greatly increase the chances of slope failure in many of these very steep watersheds.

Lesson 3: Californians need to embrace a different model of how to view fires on these landscapes. Our response needs to be tempered by the realization that these are natural events that cannot be eliminated from the southern California landscape. In this respect we can learn much from the science of earthquake or other natural disaster management. No one pretends they can stop them; rather they engineer infrastructure to minimize impacts.

The primary shortcoming of fire management has been the failure to adequately convey to the public their inability to stop massive Santa Ana wind-driven fires. For much of the past half century public agencies have had a false belief that how or where they allowed new developments was irrelevant to fire safety because of assurances that fire managers could prevent fires from burning across the wildland-urban interface. Undoubtedly there has been substantial pressure on fire managers to convey an overly confident image, and not to highlight their limitations. These recent fires should be recognized as a wake-up call to the fact that there are inherent limitations to containment of Santa Ana wind-driven fires.

Some newspaper accounts have suggested that the conservation planning efforts in southern California contributed to the devastation caused by the fires by allowing the close juxtaposition of developments and natural habitats. While there may have been isolated instances where this was the case, there is evidence that effective preserve design assisted in reducing the loss of human life and structures. The overriding goal of habitat management planning is to create areas large enough to provide contiguous habitats that are not infringed upon by development. This goal is consistent with increasing fire safety for the public. The best example of where this planning process worked well is the Otay fire, which burned a substantial portion of a contiguous habitat management area, yet no structures or lives were lost. Allowing development on an "island" within this preserve would have meant setting structures within indefensible boundaries.

Conclusions

Chaparral is the most extensive vegetation type in California, covering over 8.5 million acres of the most heavily populated state (35 million people) in the union. Massive high intensity wildfires are a normal feature of this ecosystem, creating situations lethal to the expanding human population on these landscapes. Over the past several decades urban sprawl has placed more and more people at risk and added to the human and financial losses at a scale that dwarfs wildfire impacts in other parts of the country. Indeed, since 1970, 12 of the nation's top 15 most destructive wildfires have occurred in California, costing the insurance industry $4.8 billion (Miller 2004).

Unlike western U.S. conifer forests, where fuel reduction projects show promise of reducing the incidence of large wildfires, analysis of the factors leading to catastrophic chaparral fires indicate limited ability of managers to prevent such events. Thus, we need to plan for other massive wildfires on the southern California landscape. Fire management activities cannot prevent these large fires, however, through a combination of buffer zones and better planning, we may be able to engineer an environment that minimizes their impact on property and lives.

There are two important realities to fuel management at the wildland-urban interface that will potentially cause problems in the future. One is the increasing complexity of land ownership and different management goals of neighbors. Fuel clearances necessary to ensure structure survival may not always be possible because of alternative management goals by neighbors. Perhaps a bigger problem is the skyrocketing cost of managing vegetation to reduce fuel loads, illustrated by the recognition that such treatments in many western U.S. forests may need to remove larger commercially valuable timber in order to pay for them. However, extraction of commercial products is not an option for chaparral shrublands, and thus some creative thinking will be required in order to pay for the necessary buffer system needed to protect urban developments. An important area for future research is the use of normal features of development infrastructure as buffers. For example, in southern California many new developments are built around golf courses or recreational parks. However, placing these on the periphery could act as an important barrier to fire spread. Making these designs part of the developers responsibility would have value added in that it would encourage less fingering of developments into dangerous wildland fuels because such configurations would increase the costs of buffer zone construction.