Lessons from the October 2003 Wildfires in Southern California

Jon E. Keeley, C.J. Fotheringham, and Max A. Moritz

ABSTRACT

The Southern California fires of late Oct. 2003 burned 742,000 ac and destroyed 3,361 homes and 26 lives. Factors leading up to this event were very different between forests, which comprised about 5% of the area burned, and shrublands. Three lessons are (1) although these fires were massive, they were not unprecedented, and future fires of this magnitude are to be expected; (2) the current fire management policy is not effective at preventing these massive fires; and (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.

Keywords: firestorm; fuel mosaics; historical fires; Santa Ana winds; policy

The southern California fires of late Oct. 2003 were, cumulatively, the single largest event in California's recent history. Over 742,000 ac (300,000 ha) burned during one week, and in many cases fires burned right up to the edge of heavily urbanized areas, or worse right through neighborhoods at the wildland-urban interface. A total of 3,361 homes and 26 lives were lost in this event. It is without a doubt the costliest disaster to befall California, exceeding previous fires, earthquakes, and other natural disasters. Understanding the factors leading up to this event and the appropriate human response necessary to reduce the chances of a repeat of these catastrophic impacts is the focus of this article.

Separating Forest Fires from Shrubland Burning

These southern California fires burned through diverse plant communities. The proportion of different vegetation types was not proportional to the media coverage and thus there is widespread belief that these were forest fires. However, coniferous forests comprised only about 5% of the total acreage burned (frap.cdf.ca.gov). 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.

Factors leading up to these forest fires are quite different from those responsible for the bulk of the 742,000 ac burned that week. Prior to settlement of the region, the mixed conifer forests in southern California, like similar forest types throughout the Southwest, apparently experienced a natural fire regime of frequent mostly low-intensity surface fires (Allen et al. 2002). Fire suppression policy has been very effective at excluding fires from these forests for three reasons: the montane climate results in a shorter fire season, ignitions are commonly from lightning, under weather conditions not usually conducive to rapid fire spread, and surface fuels produce lower flame lengths. These characteristics have led to a highly successful fire suppression campaign that can be equated with fire exclusion. As a consequence, there has been an unnatural accumulation of surface fuels, coupled with increased density of young shade-tolerant trees (Minnich et al. 1995). 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 (Figure 1).

Figure 1. **Remains of cabin in southern California San Bernardino Mountains burned by the Old Fire in Oct. 2003 (photo by J. Keeley).**

Other factors contributed to the fire hazard in southern California coniferous forests. In the past few years, there has been an extraordinarily severe drought that has resulted in major mortality, particularly in pines. This regionwide drought and subsequent pine mortality was a factor in the severity of the 2002 Rodeo-Chedeski Fire in Arizona as well. Estimates for some parts of the southern California San Bernardino Forest are that three-fourths of the pines were killed by a combination of drought followed by subsequent bark beetle infestation. Conventional wisdom suggests that this massive mortality was also a byproduct of fire suppression because the increased density of saplings intensified competition for water. The presumption is that if these forests had retained their natural fire regime, the lower tree density would have resulted in much greater survival during the recent drought. This is consistent with our understanding of tree ecophysiology; however, it should be noted that observations do not indicate there to be a strong correlation between percentage prefire mortality and tree density (John Regglebrugge, USDA Forest Service, Dec. 2003), which would be expected if fire suppression had caused unnaturally intense competition for water. However, the lack of correlation could also indicate that even the lowest density forests were stressed due to over-stocking of young trees.

Shrubland Burning

Chaparral and related shrublands dominated most of the landscape burned during the Oct. 2003 fires. 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 USDA Forest Service national forests in southern California all have incorporated aspects of this model (Conard and Weise 1998).

The primary support for this model is a demonstration of larger fires north of the US border than observed on similar landscapes in Baja California. This model has been questioned on a variety of grounds. Foremost is the observation that despite heroic efforts by firefighters during the 20th century, fire suppression policy has failed to reduce the natural fire frequency and, as a consequence, fuels are not unnaturally old and fire rotation intervals are between 30 and 40 years (Conard and Weise 1998, Keeley et al. 1999, Keeley and Fotheringham 2001, Moritz 2003). 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 US forests, fire suppression policy cannot be equated with fire exclusion. The primary 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 foehn winds reach speeds of 50–60 miles per hour and occur every autumn at the end of a 6-month drought. Under these conditions, firefighters are forced into defensive actions and can do very little to stop these firestorms.

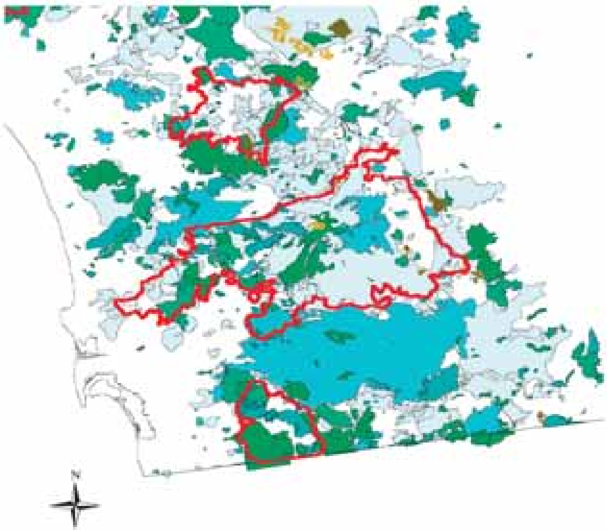

Figure 2. **Fuel mosaics within the perimeters of the 2003 fires in San Diego County, California, which demonstrate that the 2003 fires burned through a variety of fuel ages. Three fire perimeters shown are, from north to south: the Paradise, Cedar, and Otay Fires (data from frap.cdf.ca.gov).**

Lessons Learned

Three lessons can be extracted from the 2003 fire event: 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, and 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. The firestorm during the last week of Oct. 2003 was a natural event that has been repeated on these landscapes for eons (Mensing et al. 1999, Keeley and Fotheringham 2003). While the recent 273,230-ac Cedar Fire (Figure 2) 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 Sept. 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, Sept. 27, 1889). This event would have been three times larger than the recent Cedar Fire. Collectively, Sept. 1889 would have exceeded all of the Oct. 2003 burning because there was another fire that ignited that week near Escondido in San Diego County and in 2 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 (Figure 2). The primary difference between these fires is that California's population has grown about 30-fold during this period (www.census.gov) and urban sprawl has placed huge populations adjacent to watersheds of dangerous fuels (Figure 3). Because 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. Currently fire management is based on a philosophy that fuel management practices can control the ultimate size of these massive fire events. This philosophy characterizes the response to catastrophic fires on the California landscape for the past half century, and despite this policy there has been an ever increasing loss of prop-

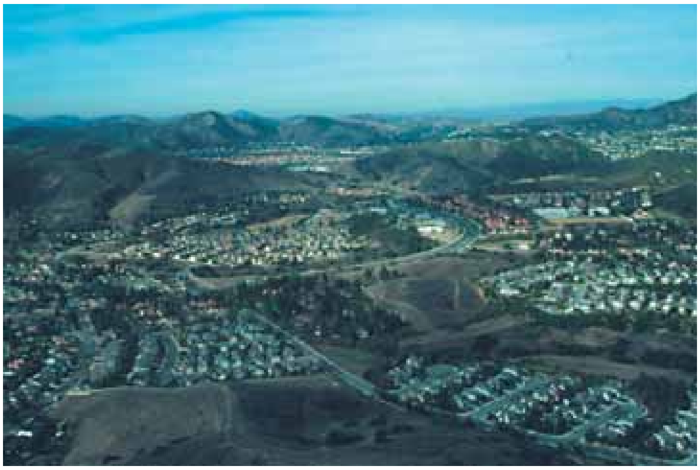

Figure 3. **Typical wildland-urban interface mix in southern California (NPS photo).**

erty and lives due to wildfires. The preferred treatment is prescription burning, applied on a rotational basis across the landscape. Theoretically, fuel reduction treatments are expected to prevent large wildfires by creating fuel mosaics that include patches of young fuel, which theoretically are expected to act as barriers to fire spread. 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 fuel breaks (e.g., Figure 4), will not act as a barrier to fire spread. This is quite evident for the recent 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 (Figure 2). The Otay Fire exhibited the same phenomenon (Figure 2); the fire burned through thousands of acres that were only 7 years of age. 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 push 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.

This does not mean there is no role for fuel manipulations in the southern California fire management arsenal, but their application needs to be carefully considered if they are to be effective and provide benefits equal to or exceeding their cost. For example, some fires burning 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 firefighting 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 prefire fuel manipulations in crown-fire eco-systems such as chaparral is their strategic placement. Under severe weather, lower fuel loads will 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. This is increasingly the case as the interface increases in extent and complexity, diverting fire fighting resources away from direct attack on these configurations. Often times during severe fire weather homes are lost because firefighters refuse to enter areas that lack a sufficient buffer zone of reduced fuel 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 (Marti Witter, Santa Monica Mountains National Recreation Area, Oct. 2003).

Fuel manipulations, in particular rotational prescription burning, may have some beneficial impacts on postfire events because younger fuels are associated with reduced fire severity, and this may affect both vegetation recovery and sediment losses. Extensive studies of postfire 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 postfire recovery (Keeley 1998). Thus, it would be premature at this point to conduct expensive fuel treatments with the expectation of producing major changes in postfire recovery. Recent comparisons of sediment loss from chaparral watersheds have provided evidence that rotational burning at 5-year intervals has the potential for greatly decreasing the immediate postfire 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 because 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, 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

Figure 4. **Prefire fuel breaks that failed to act as barriers to fire spread during the Cedar Fire. These were adjacent to Scripps Ranch where hundreds of homes were destroyed (photo by J. Keeley).**

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.

Fire management needs to do more to convey to the public their limitations in stopping massive Santa Ana wind-driven fires. For much of the past half century we have had a false belief that how or where we allowed new developments was irrelevant to fire safety because 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 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 significant size areas that provide contiguous habitat and are not infringed on by development. This goal is very consistent with increasing fire safety for the public. The best example of where this planning process worked well is the Otay Fire (Figure 2), which burned a substantial portion of a contiguous habitat management area and no expensive homes or lives were lost. Allowing development on an island within this preserve would have meant setting structures within indefensible boundaries.

Conclusions

In summary, fire science tells us there will be 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 landownership 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 fuel manipulation treatments, illustrated by the recognition that fuel treatments in many western US forests may need to remove larger commercially valuable timber to pay for treatments. However, extraction of commercial products is not an option for chaparral shrublands, and thus some creative thinking will be required 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.

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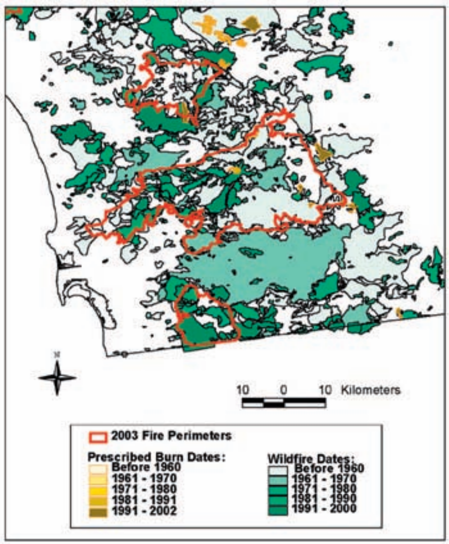

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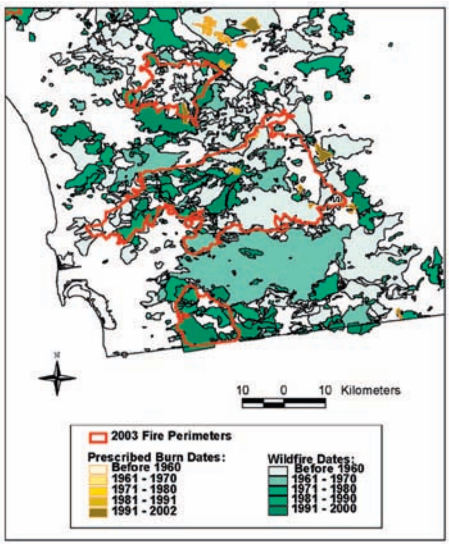

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