

# **Management strategies in the wildland-urban interface of southern California and their effect on fire behavior and environmental impacts**

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## **Abstract**

This paper discusses varying management strategies in wildland-urban interface communities of southern California in terms of their effects on potential fire behavior and residual environmental impacts. A century of fire exclusion policies there and throughout the United States has led to immense fuel loading and declining ecosystem health, which coupled with a burgeoning population relocating to wildland areas, has annually heightened the threat of devastating wildfires. Successful management strategies must consider elements of suppression needs, community education, construction and development standards, and vegetation manipulation, each of which will vary dependant on the ecosystem and socioeconomic conditions of the area considered.

Fire and fuels management in the wildland-urban interface is a complex array of biophysical and sociopolitical factors. Regularly, the fire suppression community seeks to largely eliminate fuels in interface communities with minimal regard to the environmental benefits that vegetation provides such as carbon sequestration, stormwater absorption, energy conservation, wildlife habitat, and others. Thus, to best insure sustainable communities in the wildland-urban interface, stakeholders from a diversity of disciplines and worldviews must collaborate to develop a management plan for a given area that minimizes fire risk while simultaneously maximizing the benefits that distinct vegetation communities provide. It is hoped that the successes and lessons learned in California can be applied to other similar regions of the world.

## **INTRODUCTION**

Southern California, more than any other region of the United States, illustrates the increasing challenges of fire management in the wildland-urban interface (WUI). A burgeoning population who lives amongst a menagerie of volatile vegetation types is increasingly leading to extensive costs and losses associated with wildfires. Indeed, eight fires in the region have burned over 40,000 ha, including the 2003 Cedar Fire in San Diego County, which burned over 105,000 ha (California Department of Forestry & Fire Protection 2005a). While similar sized fires may be experienced elsewhere, the immense population in southern California leads to losses unlike most parts of the world. For example, 9 fires have consumed over 300 homes there, again led by the Cedar Fire, which consumed 4847 structures (California Department of Forestry & Fire Protection 2005b). Of greatest concern is that 7 of the 9 fires mentioned have occurred in the last 20 years, and most feel that the trend will continue largely unabated.

In addition to immediate fire effects, wildfires in southern California are regularly followed by mudslides and immense sediment deposition into streams and estuaries, which significantly

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degrade public safety and environmental quality. For example, a mudslide following the 2003 Old Fire on the San Bernardino National Forest killed 14 people. And the 1994 Highway-41 fire on the Los Padres National Forest caused accelerated erosion into the Morro Bay National Estuary, leading to lowered taxonomic diversity there for several years (U.S. Environmental Protection Agency 1995).

Vegetation in southern California is largely a product of a Mediterranean climate, where a mild, rainy season is followed by periods of up to 8 months of drought. Therefore, both live and dead fuel moistures are regularly at critical levels for extreme fire behavior. Sundowner and Santa Ana foehn winds are also common on the central and southern coasts of California, contributing to the size and intensity of fires in the area.

Therefore, it is imperative that agencies tasked with wildland fire management develop efficient and effective management strategies in the WUI. This paper discusses 4 essential components of any successful fire management strategy in the WUI. While focused on southern California, the successes and lessons learned there can be applied to similar regions of the world.

## **ELEMENTS OF EFFECTIVE WUI FIRE MANAGEMENT**

Fire managers in the WUI have 4 broad management strategies to reduce the costs and losses associated with wildfires. These include increasing suppression success through equipment and personnel, community education, improved construction and land use standards, and fuels modification. While priorities should be established dependant on the local situation, no component should be entirely absent.

### *Appropriate Suppression Resources*

The first component of a proper fire management strategy is properly equipped and staffed fire suppression forces. Having the proper types and numbers of suppression equipment and personnel are essential to adequate fire protection in the WUI. For initial attack success, it is critical that the right resources are in the right place at the right time.

In California's WUI, overlaps of private and public land ownership preclude the formation of a single agency responsible for wildland fire protection. Thus, prearranged mutual aid agreements are regularly formed where differing agencies share suppression responsibilities and costs, regardless of the jurisdiction in which a given fire originated.

Therefore, budgets (or reductions thereof) for one agency will affect the firefighting capabilities of an entire geographic area. For example, some California Youth Authority facilities, a branch of the California Department of Corrections and Rehabilitation, closed during a State budget reduction in 2005. One closed facility in San Luis Obispo County administered multiple wildland firefighting handcrews, which when closed impacted the ability for all firefighting agencies in the region to adequately respond to a wildland fire event.

In general, a community decides their level of service, which is a measure of the percentage of fires controlled by initial attack, through voter-approved property taxes. It is the responsibility of

fire administrators to allocate funds to specific resources within the organization to best increase success of initial attack. If budgets are managed efficiently and the level of service is unacceptable for a given community, those residents must be willing to increase taxes on their property. However, in many areas it is extremely difficult to convince voters to increase property taxes, which limits the ability for fire agencies to properly respond to fire events.

### *Effective Community Education*

Community education is another critical component of effective fire management in the WUI. Education efforts must be developed for a specific target community based on the level of local knowledge. Managers in the WUI need not assume that community members are totally ignorant of the threat of wildland fire. Some communities are well aware of the threat, but lack the specific skills to reduce their risk. Thus, funds allocated to public service announcements over mass media outlets such as radio may be essentially wasted in those communities. Further, research has shown that while cost-effective and requiring less effort, mass media advertising has little value in effecting change in behavior by WUI residents (McCaffrey 2004).

Instead, personal contact has the greatest impact on changed behavior. However, it is virtually impossible for fire personnel to visit each home in its responsibility area given budgetary and time constraints. However, by organizing interactive, informational displays where the public would likely be present, such as at a hardware store or county fair, fire personnel have successfully been able to provide personal contact with community members.

FireWise USA is the premier fire educational organization in the United States. The program is sponsored by the National Wildfire Coordinating Group, and is represented by multiple federal and state agencies. Among others, they provide an informational website, free informational literature and videos, magazine ads, homeowner workshops, and conferences. Their knowledge base extends to multiple issues pertinent to WUI residents, including how to properly manage vegetation near structures, specific plant lists for given geographical areas, construction materials and standards, evacuation planning, and others. Even if they don't reach the public directly, they regularly provide free informational materials to local agencies who have direct access to community members.

### *Enforceable Construction and Land Use Standards*

Another critical element of effective WUI fire management consists of having enforceable construction standards and proper land use planning. Individual homes should adhere to adequate, enforceable regulations that address fire protection in siding, vents, windows, and especially roofs, which are particularly susceptible to ignition from burning embers (Cohen 2000). Further, proper layout of the community that provides for appropriate housing density, home placement, and infrastructure needs such as access and water supply is essential.

Older communities that were developed largely before such standards were enacted are usually at much greater risk to wildfire than newer communities where the right to develop was hinged on the ability to adequately address fire concerns. In some communities in California, even government-issued permits to remodel one's home can trigger mandatory upgrades to fire-

resistant construction. For older communities, it is imperative to have adequate codes in place before a fire event and after the event subsequently disallow any new construction that does not meet new construction standards. While many victims of wildland fire have vehemently complained of burdensome government obstruction in rebuilding efforts, improved construction standards will reduce a cycle of repetitive loss.

However, it should be noted that higher construction standards will translate into higher construction costs. Given the high cost of housing in California, where the median home price for the State currently exceeds \$535,000 (U.S.), the need for affordable housing and fire standards will inevitably clash.

### *Effective Fuels Modification*

Appropriate fuels modification is the final and most controversial component of a proper WUI management strategy. Because of the 2003 firestorms in southern California, recent state legislation has required that private landowners modify all vegetation within 30.48 m from any structure so as to reduce potential fire intensity. However, many urban dwellers immigrate to WUI areas specifically to live amongst natural surroundings, and therefore often resist any form of vegetation management, regardless of risk. Becoming more common, fire managers at times hire outside contractors to mitigate fire hazards on noncompliant properties and subsequently put a lien on their property for payment of those services.

Prescribed fire is a management tool that has increasing acceptance in wildland areas as Americans recognize the biophysical consequences of fire exclusion in the last century. However, this is also the most opposed tool in the WUI due to the potential for escape and lowered air quality. Even where socially accepted, on many sites it is often impossible to use fire until some type of mechanical treatment has been conducted due to dangerously high fuel loadings. While prescribed fire is by far the most cost- and objective-effective means of reducing fuels, it will likely decrease in use in southern California as the population continues to expand.

Mastication and other mechanical means of treating fuels have become increasingly popular in many WUI areas, particularly where brush is the dominant fuelbed. Masticators are relatively cost-effective in larger treatment areas and extremely effective at reducing fire spread and intensity. While total biomass remains the same on the site, fuels are ground into smaller pieces that are left on the site, thereby eliminating the addition of green waste to landfills. Some, however, criticize this method because it indiscriminately removes all vegetation regardless of species. Where masticators are impractical, hand crews can perform the same function by chipping downed vegetation back onto a treated site. While more selective in the plants that are removed, this method is generally much more expensive than masticators due to labor costs.

The use of goats has become increasingly more utilized in some WUI areas, especially in smaller and steeper parcels where fire or mechanical means are inappropriate. While fire managers originally questioned the social acceptability of livestock in private neighborhoods, these “fire goats” have become enduring mascots in some communities. Criticisms of goats include that they are sometimes overly selective in what they consume, leaving behind large amounts of

some types of fuels. Further, some have concerns for the spread of invasive species through their droppings as they move from one area to another.

Herbicide application is becoming increasingly rare due to social concerns about potential health problems. Fire managers typically do not use this method on standing vegetation as this would serve only to increase the fuel loading in the area of dead and down materials. However, some fire managers lament the difficulty in using this method as a follow-up to mechanical treatments because it would maximize treatment longevity and thereby minimize maintenance costs.

## **HAZARD VS. BENEFITS OF VEGETATION**

Regularly, fire managers in the United States think of vegetation in terms of fuels and potential fire behavior, overlooking the many tangible benefits that vegetation provides. Such benefits in the WUI could include lessened need for stormwater runoff infrastructure, lowered home cooling costs, increased air quality and carbon sequestration, and others.

There is a need to quantify the tradeoffs in modified fire behavior versus specific community benefits derived from various vegetation types and structures. Currently, no such instrument exists to assist fire managers in developing fuel modification prescriptions to maximize both elements. However, software packages exist for both aspects that may facilitate effective, environmentally responsible prescriptions. Fire behavior modeling programs such as BehavePlus (surface fire behavior), NEXUS (crown fire behavior), and FARSITE (fire spread across landscapes) could be used in conjunction with CITYgreen and STRATUM, which quantify specific community benefits. The results could then be used to derive a plan that simultaneously minimizes fire behavior while maximizing social benefits.

For example, a hypothetical WUI community was created to illustrate the potential effects of thinning on fire behavior. The untreated landscape consisted of dense stands of mixed conifers having a high degree of vertical continuity, which would facilitate torching and active crown fire spread via spotting. Using FARSITE (v. 4.1.03), fire spread was simulated across that landscape before treatment, after thinning all trees under 15 cm, and after thinning 50% of the total basal area (Figures 1). In those simulations, the landscape was dominated by a surface fuel model depicting a very high load, dry climate timber-shrub type (fuel model TU 5). Treatments were simulated by adjusting canopy base height and canopy bulk density per values in Scott and Reinhardt (2005) for Sierra Nevada Mixed Conifer. See Table 1 for specific inputs for the FARSITE simulations. Community benefits of air pollution removal, carbon sequestration, and stormwater runoff storage capacity were derived by CITYgreen for GIS (Table 2).

As shown, fire behavior was reduced in this hypothetical community with increasing intensity of thinning. However, the benefits derived from the vegetation were simultaneously reduced as tree canopy cover was removed. It must be noted, that as with all modeling applications, the user must use good judgment in both supplying appropriate inputs and interpreting outputs. For example, while the effects on CITYgreen outputs with increased thinning is compelling, some have recently questioned their accuracy in landscapes in the western United States, especially in areas dominated by brushland ecosystems (Dicus and Zimmerman in review). STRATUM, a similar program developed primarily for urban forests in the western United States will soon be

released and may offer more reliable results than CITYgreen. However, that program was developed primarily for street trees and like CITYgreen, discounts any benefits that shrubs might provide.

Table 1. Landscape characteristics at time of simulated wildland fire.

<u>Weather</u>	<u>Simulation</u>	<u>Stand ht (m)</u>	<u>Canopy Base ht (m)</u>	<u>Canopy bulk density (kg/m<sup>3</sup>)</u>
Temperature: 32°C	Untreated	34	2	0.101
Relative humidity: 30%	Understory Removal	34	4	0.101
Wind: 35 kmph (SE)	Thin to 50% BA	33	11	0.037

<u>Topography</u>
Slope: 15-30%
Aligned with wind

<u>Fuel moisture</u>
Live: 90%
Dead: 4%

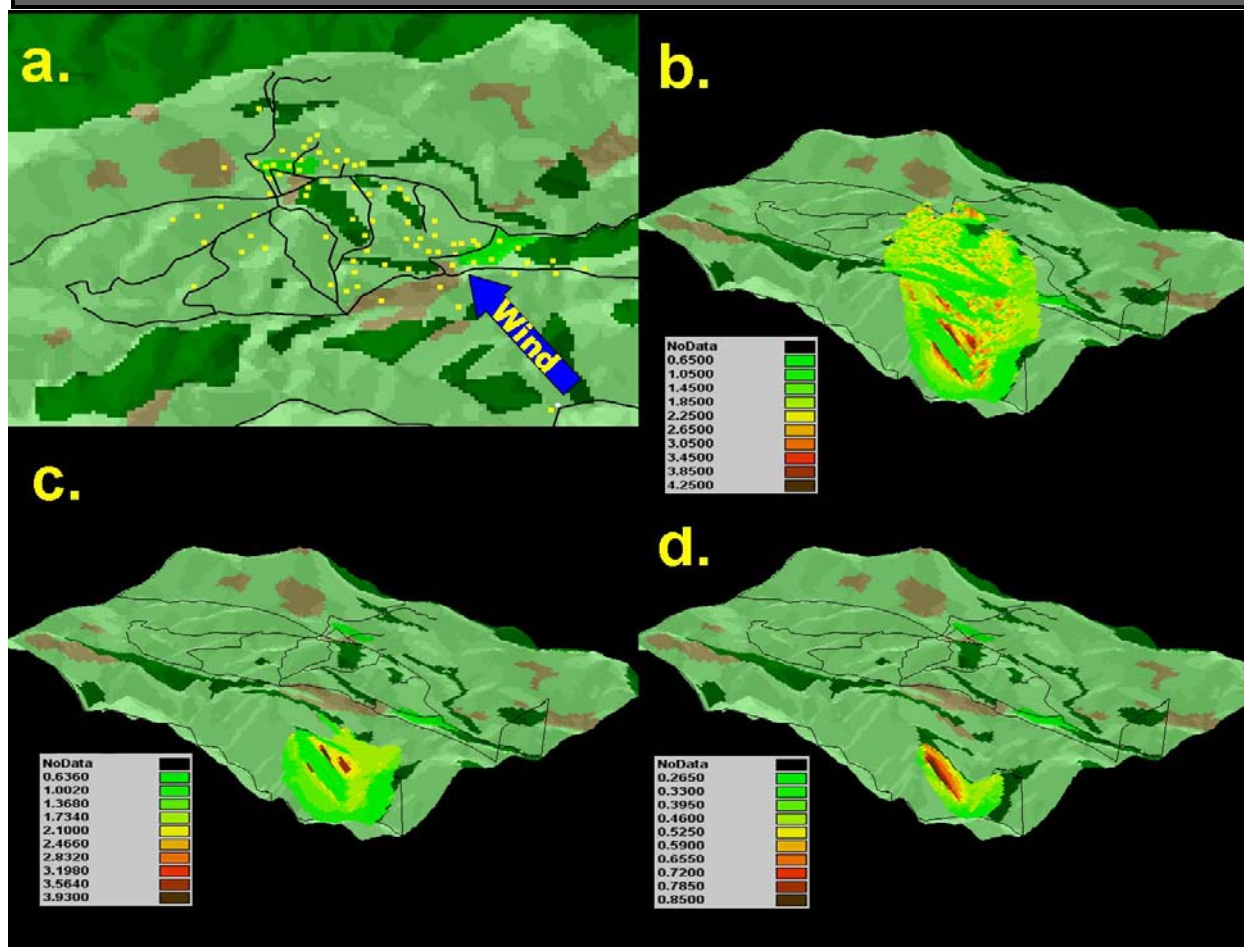


Figure 1. (a) Landscape file and simulated fire boundary and flame length (m) after 10 hours in a mixed conifer forest (b) without treatment, (c) after understory removed (<15 cm dbh), and (d) thinned to 50% BA.

Table 2. Various community benefits calculated by CITYgreen for a mixed conifer forest that is untreated, thinned from below, and thinned to 50% BA.

	<u>Untreated</u>	<u>Understory Removed (&lt;15 cm)</u>	<u>Thinned to 50% BA</u>
<b>Stormwater runoff (m<sup>3</sup>)</b>	773,046	773,046	3.5
<b>Air pollution (t)</b>	371,045	371,045	3084
<b>C sequestered (t)</b>	1,288	1,288	11

Of note, one trait that better enables fire managers in the United States to assess non fire-related aspects of vegetation is that many were trained in forestry or other resource management disciplines. This allows them to see beyond how various treatments will affect fire behavior and better comprehend the multifaceted effects of vegetation manipulation. Unfortunately, it appears that wildland fire agencies are becoming increasingly more engrossed in emergency services and less in resource management. General consensus is that the fire suppression and resource management aspects in both the federal United States Forest Service and the state California Department of Forestry and Fire Protection are increasingly diverging into their own distinct entities, which will adversely affect the abilities of future fire managers to fully appreciate non-fire aspects of vegetation management .

## COLLABORATION

In conclusion, countless anecdotal evidence and case studies suggest that the single most critical element for successful fire management in the WUI is collaboration with stakeholders from a diversity of worldviews (e.g., Dicus and Scott in review). Too often, fire managers in the U.S. have attempted projects only to fail due to unforeseen objections and resistance. Most commonly, those fire managers believe that if only they could “educate” the public, they willingly follow the direction of the fire manager. However, their management strategy is doomed to fail as it does not incorporate the worldviews and values of others who see the land from completely different perspective.

One of the most successful applications of a collaborative strategy in California is the formation of local FireSafe Councils, which purposefully seeks to include diverse interest groups from fields such as fire personnel, wildlife biologists, ranchers, developers, the insurance industry, the environmental community, builders, air pollution regulators, and others. While normally at odds with one another, these groups, through open dialog, consistently develop creative solutions that reduce wildland fire losses in the community while maximizing other community values. To aid them, FireSafe Councils can apply for federal and state grants to fund educational products, fuels projects, pre-fire planning documents, and others. Whereas outside of this organization many of these groups have regularly been at odds with one another, FireSafe Councils allow them to see their collaborative ideas turned into action.

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