

Reduction of Potential Fire Behavior in Wildland-urban Interface Communities in Southern California: A Collaborative Approach

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Abstract—This manuscript details a collaborative effort that reduced the risk of wild-fire in an affluent, wildland-urban interface community in southern California while simultaneously minimizing the environmental impact to the site. FARSITE simulations illustrated the potential threat to the community of Rancho Santa Fe in San Diego County, California, where multimillion-dollar homes were located immediately above a designated open space area that consisted primarily of 60-year-old, decadent chaparral. Post-treatment fire behavior simulations demonstrated the potential ability to moderate fire behavior.

Results of the fire behavior modeling led to a recognition for the need for fuels treatments by both homeowners and regulatory agencies that were originally adverse to any type of treatment. Through a collaborative process, these diverse stakeholders worked to create and maintain an effective fuel treatment that was cost effective and environmentally sound. This shared approach by fire personnel, homeowners, and regulatory agencies in Rancho Santa Fe is a success story that could be a template for interface communities throughout southern California.

Introduction

Nowhere in the United States is the increasing trend of destructive fires in the wildland-urban interface (WUI) better exemplified than in southern California. Coupled with a burgeoning population that continues to expand into explosive chaparral fuels, there is an ever-increasing potential for widespread destruction to human life and property. For example, eight fires in southern California have grown to over 100,000 acres in size, including the 2003 Cedar Fire in San Diego County, which burned over 273,000 acres (California Department of Forestry & Fire Protection 2005a). And in terms of structures lost, 14 of the 20 most destructive fires in California occurred there, again led by the Cedar Fire, which consumed 4847 structures (California Department of Forestry & Fire Protection 2005b).

To reduce the costs and losses associated with wildfires, fire agencies allocate their limited resources to two primary strategies in the WUI. The first strategy is to maximize success of initial attack by funding additional suppression equipment and personnel. Alternately, pre-fire fuels treatments are a second strategy meant to reduce fire behavior, thereby increasing suppression success and decreasing number of structures lost. While proven effective in numerous fire events, the second strategy is seemingly more difficult to implement due largely to sociopolitical factors such as perceived degradation of viewsheds and costly and timely navigation through environmental review.

In: Andrews, Patricia L.; Butler, Bret W., comps. 2006. Fuels Management—How to Measure Success: Conference Proceedings. 28-30 March 2006; Portland, OR. Proceedings RMRS-P-41. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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Pre-fire fuels management is also more difficult to measure success as treatments are not necessarily meant to eliminate fire spread. For example, fuel treatments in the 2002 Rodeo-Chediski fires in Arizona significantly reduced fire intensity and rates of spread within the treatments, yet did little to impede spread across the landscape as the fire's path simply flanked the treatments and continued unabated (Finney and others 2005). In the WUI, success of fuels treatments may be measured by any number of metrics, including initial attack success, percentage of homes survival, and others. Additionally, other metrics of success could include the degree to which the treatments retained the positive benefits of vegetation such as scenic beauty, carbon sequestration, mitigation of heat island effect, stormwater retention capacity, and others (Dicus and Zimmerman in review).

For WUI areas in southern California, we broadly define a successful project as one that is

- (1) completed on the ground,
- (2) cost effective,
- (3) environmentally sound, and
- (4) effectively modifies fire behavior to an extent that minimizes structures consumed.

Based on the preceding metrics, a case study that examines the relative success of a fuel modification project in Rancho Santa Fe, California follows.

Community Overview

Rancho Santa Fe is an unincorporated community of 3,252 people (2000 U.S. Census) that is located approximately 20 miles north of San Diego, California (figure 1). The community is a classic example of a wildland-urban intermix, where homes are interspersed between designated open space parcels of mostly unmanaged vegetation. It has been designated by the State as a *Very High Fire Hazard Zone*.

The high value of homes in Rancho Santa Fe set it apart from most WUI communities. Data from the California Association of Realtors reveal that the median home price there exceeded \$2.5 million in 2005. Further, as of the 2000 census, Rancho Santa Fe had the highest per capita income of any community in the United States with over 1000 households.

In the absence of Santa Ana winds, fuels will have the greatest effect on fire behavior and is subsequently the greatest threat to homes. Topography consists mostly of gently rolling slopes and drainages. Weather is Mediterranean and is greatly moderated by proximity to the Pacific Ocean. Property owners, by ordinance, must "maintain an effective fuel modification zone by removing, clearing, or thinning away combustible vegetation and other flammable materials from areas within 100 feet of any structure" (Rancho Santa Fe Fire Protection District Ordinance No. 02-01). It is the responsibility of individual property owners to create and maintain this buffer. However, if the 100 ft buffer around a structure exceeds the property line of a specific homeowner, it is the responsibility of the adjacent landowner to manage vegetation on his own property so as to maintain the 100 ft buffer for all structures. In many instances in Rancho Santa Fe, the 100 ft buffer from structures extends into adjacent open space parcels.

Fuels in the interspersed open space parcels consist largely of decadent, highly volatile brush that has not burned in over 60 years. Vegetation in the



Figure 1—Location of Santa Rancho Fe, San Diego County, California.

open space areas is typical of southern California chaparral, consisting of such native species as scrub oak (*Quercus berberidifolia*) and chamise (*Adenostoma fasciculatum*). Further, exotics such as red gum eucalyptus (*Eucalyptus camaldulensis*) and pampas grass (*Cortaderia jubata*) are commonly found there.

The open space areas are the responsibility of the Rancho Santa Fe Association (hereafter, Association), a homeowners association that administers a protective covenant of land use rules in the area. All members of the Association are responsible for paying for the maintenance of the open space parcels, regardless if individual property owners are directly affected. The only vegetation management in these areas had been to periodically cut the brush along horse trails that crossed through the middle of the open space areas, which would have minimal effect on the spread of wildfire.

Structural and wildland fire protection is provided by the Rancho Santa Fe Fire Protection District (hereafter District), which serves a 42-square mile area surrounding Rancho Santa Fe. The District, however, is in a designated State Responsibility Area for wildland fire protection, and is thus also served by the California Department of Forestry and Fire Protection. This designation served to facilitate the fuels treatments that will be discussed later.

Of note, the District has adopted a shelter-in-place approach for residents of some newer subdivisions during a wildfire because homes there have been built with extremely fire-resistant construction materials and have District-approved landscaping. The District contends that sheltering in the fire-resistant structures during a wildfire would be safer than attempting to evacuate along winding roads adjacent to potentially burning vegetation.

The older, previously developed community of Rancho Santa Fe, however, is not as fire resistant as the newer developments. Commonly, private residences sit atop ridges above the aforementioned open spaces and would receive immense convective heating from burning of the explosive chaparral fuels. Further, several of the residences still have wood shake roofs, which have been shown to be especially susceptible to combustion from burning embers (Cohen 2000). Thus, even with a 100 ft managed buffer around structures, risk to many residences remains high.

Project Implementation

One particular area in Rancho Santa Fe had long been a concern to the District. This area was in a chaparral-filled canyon with homes regularly located at the tops of the ridges in natural chimneys and saddles (figure 2). A formal risk assessment across the District confirmed that this area was at elevated risk of loss during a fire event. Given the pre-treatment conditions of the open space parcel in question, the District expected to lose a minimum of eight homes during a wildfire event.

Given the value of these homes and the historic behavior of wildfires in the area, members of the insurance industry were also extremely concerned with potential losses from wildfire. Because of their high replacement costs,

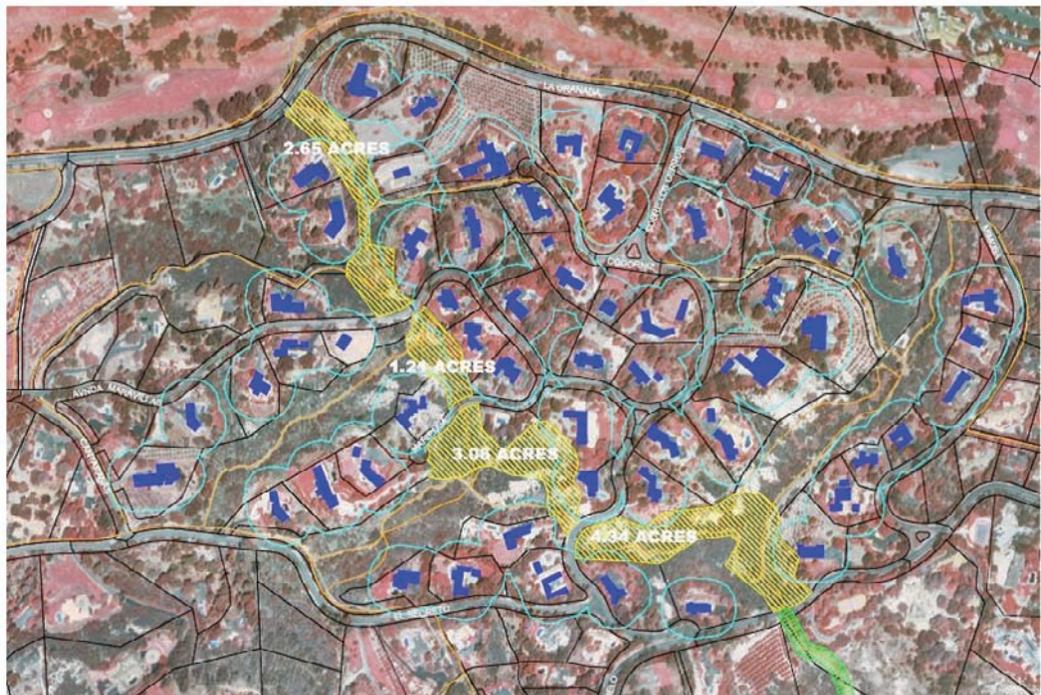


Figure 2—Aerial photograph of the El Secreto fuel modification project in relationship to homes in Rancho Santa Fe, California.

destruction of only a few homes in Rancho Santa Fe would cause a tremendous loss to the industry, translating into an increase in rates for not only San Diego County, but potentially for homeowners across southern California.

FARSITE simulations from a single, likely ignition point during historic 50% and 97% weather illustrate the pre-treatment potential fire behavior in the area (figures 3 and 4, respectively). Even with a 100 ft buffer around the homes, many would likely experience intense convective heating, if not direct flame impingement. Pertinent weather and fuel values for all simulations are provided in table 1 and were determined by FireFamilyPlus analysis of historic weather data from the nearby Flores RAWS station. A custom fuel model (fuel model 20) was utilized to simulate fire spread within the 100 ft buffer. Figures 3 to 5 depict extent of spread and flame length (ft) for a 1-hour simulation (5-minute visible time steps) where all inputs were held constant.

The District contacted the Association regarding unmanaged vegetation on the open space parcels that were within 100 ft of structures and provided suggestions for mitigation. The District did not take a heavy-handed approach with the Association, but instead sought an open dialogue with the Association so as to make them aware of the hazards and recommend solutions that were in the best interest of the community.

Modeling efforts were presented to members of the Association who, while not understanding the nuances of wildland fire behavior modeling, appreciated the potential for a significant fire event. Subsequent simulations that

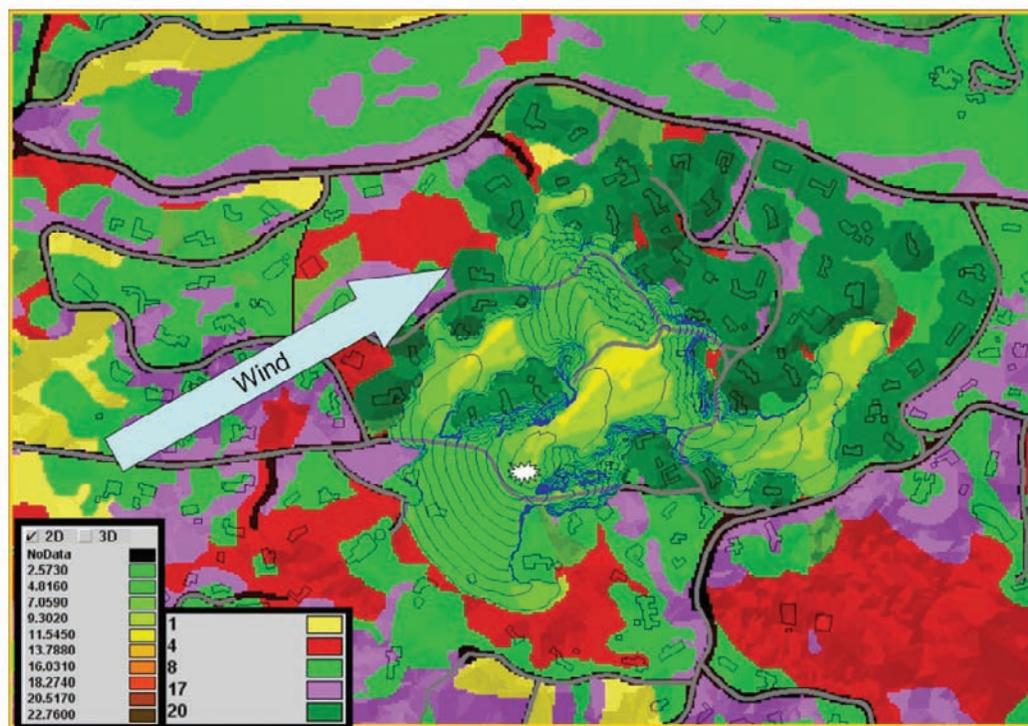


Figure 3—Pre-treatment FARSITE simulations from a single ignition point (in white) under 50th percentile weather and wind conditions (August). Flame length (ft), 5-minute time steps, and background fuel models are depicted.

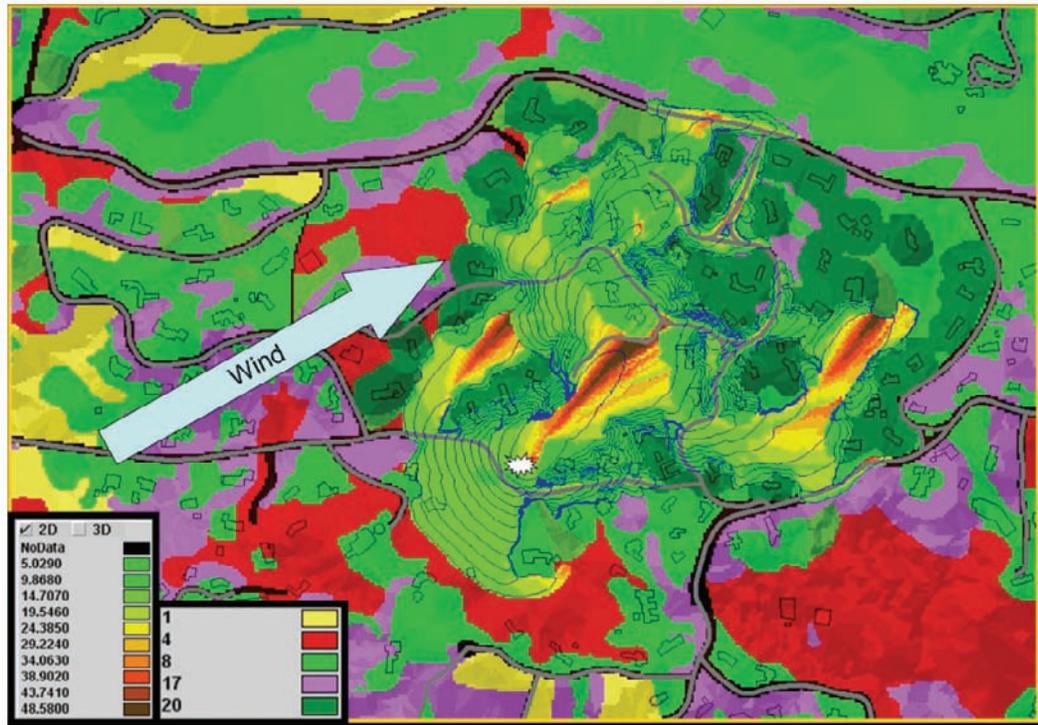


Figure 4—Pre-treatment FARSITE simulations from a single ignition point under 97th percentile weather and wind conditions (August).

Table 1—Average and extreme (August) weather, wind, and fuel moisture inputs used in FARSITE simulations in Rancho Santa Fe, California. Values obtained from FireFamilyPlus analysis of nearby Flores RAWS station.

Variable	Percentile	
	50th	97th
Max Temp ¹	76	85
Min RH ²	22	13
Wind Speed ³	10	20
1-hr FM ²	6	3
10-hr FM ²	8	5
100-hr FM ²	10	7
Herbaceous FM ²	60	30
Live Woody FM ²	80	60

¹ °F
² Percent
³ mph

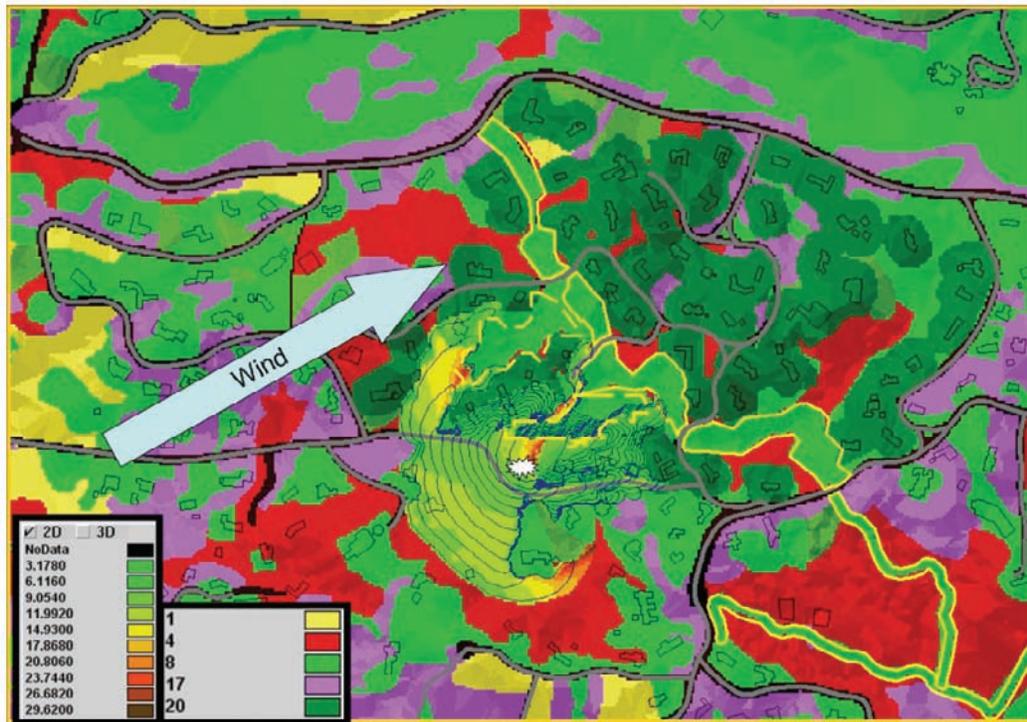


Figure 5—Post-treatment FARSITE simulations from a single ignition point under 97th percentile weather and wind conditions (August).

accounted for a fuels treatment in the area (conversion to fuel model 8) clearly illustrated the potential benefits of those treatments to adjacent landowners, even under 97% weather conditions (figure 5). The District explained to the Association that any fuels treatment would not stop a wildfire, but would reduce the fire intensity, thereby reducing the threat to nearby structures and increasing chance of initial attack success. The Association Board of Directors created and distributed a simple but compelling brochure to their members that detailed the need to allocate funds for the project as it would benefit all members of the Association, not only the homeowners adjacent to the proposed fuel modification.

The Association was initially somewhat hesitant to initiate fuels modifications in these areas based not on perceived degradation of views or environmental impacts, but instead on the potential cost of treatments. Indeed, initial estimates from contractors on the 11.26 acre (4.65 ha) El Secreto project ranged from \$65,000 to over \$200,000. District personnel worked with the Association to explore other, more economically feasible options.

The District sought assistance from publicly funded crews because the project area was within a designated State Responsibility Area for fire protection and was by law, technically open to the public (even though the Association attempts to discourage outside access as much as possible to the open space parcels). CDF-administered inmate crews were subsequently contacted. At first, the community members were extremely adverse to inmate crews in the community due to perceived safety concerns. Association Board Members visited the applicable correctional facilities to personally investigate the crews

and subsequently provided assurance to their members that the inmate crews would pose no threat to the neighborhoods. That assurance, in addition to the extremely low estimated cost of the implementing the project (\$30,000), eventually won the community over.

After CDF contracts were established, the Association notified the California Department of Fish & Game (CFG) of their intent to carry out the fuels modification project per guidelines established in a preexisting Memorandum of Understanding between CFG, the U.S. Fish and Wildlife Service (USFW), CDF, the San Diego County Fire Chief's Association, and the Fire District's Association of San Diego County. The MOU states that after notice of intent to clear vegetation for fire protection purposes is given, CFG and USFW biologists have the option to review the project for compliance with endangered species requirements, and may suggest voluntary, alternative measures if deemed feasible and warranted. While the District was responsible for establishing the need and proposed mitigation measures in the project, they purposely did not write the notice of intent to CFG in an attempt to avoid any potential interagency political wrangling.

Because the proposed El Secreto project exceeded the 100 ft buffer established in the MOU, CFG and USFW regulators required additional review. Once again, FARSITE simulations were used to justify the extent of the project. After analyzing the simulations, they agreed to an on-site review of the project area. The on-site review confirmed to the regulators that a majority of the vegetation in the proposed project area was dead and that removal of these fuels would not negatively impact habitat there. The regulators required that no more than 50% of the vegetation be removed, which was unreasonable in some locations as over 80% of the existing vegetation was dead at that time. They further requested that all flammable exotic species such as eucalyptus and pampas grass be removed, by herbicides if necessary, which was beyond the original scope of the District but welcomed.

Upon approval by CFG and USFW regulators, female inmate crews from the local Rainbow Camp began the project, demonstrating both outdoor savvy and the care needed to properly treat the area. Of interest, while initially adverse to inmate crews, homeowners quickly became enamored by the female crews and tried to offer cookies and cakes to them, which was against CDF policy of limiting contact between inmates and private citizens. The Association, however, was able to regularly provide Subway sandwiches to the inmates, which apparently increased both their productivity and care on the project. At the completion of the project, CDF invoiced the Association for \$14,000, well below early estimates that exceeded \$200,000 and the \$30,000 for which the Association had budgeted. These savings will pay for future maintenance costs on the project.

The project had minimal negative environmental impacts and served to provide many positive benefits to the community. Indeed, only dead material was harvested during the project, which was subsequently chipped and spread on existing horse trails. This simultaneously eliminated green waste from entering the landfill and also mitigated erosion on the trails. Exotic pampas grass was eliminated from the project area with herbicide, but will likely return via seeds from ornamental plants on properties above the project. Further, anecdotal evidence suggests that there are more wildlife species present on the site after the treatment, but this may be a function of increased visibility of the area, which was marred by the abundance of dead vegetation. At the conclusion of the project, a shaded fuel break resulted that simultaneously lowered fire risk while having minimal impacts to the positive benefits that vegetation provide such as stormwater retention, improved air quality, and

carbon sequestration. Whereas before there was an almost impenetrable mass of dead brush, the site is now regularly used by the community as a location to recreate.

Lessons Learned

By the metrics set forth at the beginning of this manuscript, the El Secreto Project was a success. Owing to a collaborative effort between local and state fire agencies, homeowners, and environmental regulatory agencies, the project was implemented on the ground after much planning, was relatively cost effective, and was environmentally sound. The ultimate test of the success of the project will come in a future, inevitable wildfire.

While this project is extremely beneficial to the properties immediately adjacent to the fuels project, it will have minimal impact to the spread of fire across the landscape, especially during a Santa Ana wind event, due to its relatively small size. However, the original strategy of the project was to maximize initial attack success on a fire occurring in the open space parcel, not stop a major wildland fire.

District personnel cite that the key to this project was the development of partnerships and collaboration with property owners and regulatory agencies. The District was instrumental in initiating meaningful dialogue between fire personnel, Association members, and regulatory agencies, which was vital to the scope and completion of the project. Collaboration does not imply “educating” the homeowners and regulators to the needs and desires of the fire agencies, but rather is meaningful communication where all viewpoints are considered to best serve the community. They also conclude that it is critical to adequately plan an environmentally sound and justifiable project before regulators participate in an on-site review of a project.

While pleased in the success of the El Secreto project, concerns over future projects remain. One concern is the regular turnover of CFG and USFG regulators in the region. Historically, many regulators seemed adverse to any type of vegetation management until a trust relationship had been developed with District personnel. With regular turnover, the fostering of mutual trust between the agencies will be hindered. There are also concerns about any future needed projects that might lie within the jurisdiction of the California Coastal Commission as they have historically been adverse to most vegetative management projects, regardless of the potential threats or species involved. Indeed, they were the only party that refused to sign the original MOU discussed earlier.

Because of the success of this program, other local communities now regularly seek to contract with the inmate crews, which could potentially limit the District’s ability to use them for future projects. It is hoped that the strong working relationship forged between CDF and the District as well as the relatively central location within the CDF responsibility area will insure Rancho Santa Fe has access to crews.

Also, the continued presence of wood roofs in the area is an immediate threat to the community, due to their susceptibility of combustion from fire brands. Of interest, a portion of the residents in this affluent community are asset-wealthy, but simply do not have the means to replace their roofs with fire resistant materials. These property owners consist primarily of retirees who purchased their home in the 1970s or earlier when home prices were significantly less; while their home equity has appreciated exponentially, they live

today on fixed incomes. A recent grant to FEMA for a cost-sharing program to replace fire-prone roofs remains pending. The grant would fund 70% of the costs of roof replacement, with a cap of \$40,000 per residence.

There are also concerns about undeveloped lots adjacent to parcels with structures. As with the Association's open space parcels, those property owners are responsible for modifying vegetation within 100 ft of a structure, regardless if their individual property is developed or not. Property owners of the undeveloped lots, many living outside the state, have sometimes resisted the District's attempts to enforce the 100 ft buffer. While preferring a collaborative approach to generate solutions that mitigate the threat, the District is sometimes forced to send outside contractors to those sites, subsequently billing the noncompliant property owners for work completed there.

Acknowledgments

This project was funded by the California State University Agricultural Research Initiative. We are grateful to Mark Carpenter of KTU&A Landscape Architecture and Planning, San Diego, California, for providing critical GIS and FARSITE data files.

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