MOKELUMNE WATERSHED AVOIDED COST ANALYSIS:

Why Sierra Fuel Treatments Make Economic Sense

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FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

Chapter 4: Fire Suppression Costs

4.1 Introduction

In this section, we discuss wildfire suppression implications of fuel treatment in the Mokelumne watershed. First, we describe the general effects of fuel treatment on wildfire suppression costs, risks, and success. Then, we provide estimates of suppression costs for the five fires with and without prior fuel treatment. We use existing reviews of fire suppression costs, with an emphasis on fires that occurred in California. Based on our research and modeling, we estimate that the savings from avoided future suppression and rehabilitation costs would pay for between 50% and 70% of the treatment costs. Table 4.1 summarizes the cost and avoided cost findings in this chapter.

Table 4.1: Costs and avoided costs from modeled fuel treatment

	No treatments		Treatments		Avoided costs	
	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
Fire suppression and rehabilitation costs (millions)	$ 55.0	$ 73.0	$ 20.0	$ 29.7	$ 35.0	$ 43.3

4.2 Per Acre Suppression Costs

Wildfire suppression costs are an increasing burden for taxpayers. This has motivated research into the factors driving costs, including direction by Congress for federal agencies to investigate suppression costs. Increasing fuel loads, drought conditions, temperatures, forest disease and infestation, and development in the wildland-urban interface (WUI) all contribute to increasing wildfire occurrence, wildfire size, and costs of suppression efforts (Donovan, Noordijk, and Radeloff 2004; Stephens and Ruth 2005). In addition, varied elevation and topography can increase suppression costs through difficulty of access, while fire intensity and rate of spread can limit ground personnel use, both of which can require the use of expensive resources such as aircraft (Gebert et al. 2007; Gude et al. 2012; Prestemon et al. 2008; Preisler et al. 2011).

With the increasing share of the federal land management agencies' budgets required for suppression, Congress has requested cost reviews for large wildfires with federal suppression costs of more than $10 million. Based on the two most recent reviews, for the 2008 and 2009 fire seasons, a majority of the most costly U.S. fires occurred in California: 17 of 22 in 2008, and five of six in 2009 (Large-Cost Fire Independent Review Panel, 2010). California's most costly wildfires in 2008 ranged in size from 6,112 to 192,038 acres and had overall average suppression costs of $645 per acre. Individually, the suppression costs for the 17 largest 2008 wildfires reviewed in

California ranged in cost from $168 to $2,055 per acre. The 2009 wildfires reviewed in California had per acre suppression costs of $390 to $2,672. These fires don't show a strong correlation between size of wildfire and cost per acre, suggesting that other details—such as terrain and proximity to the WUI—were more of a factor in cost than size alone.

Western Forestry Leadership Coalition (WFLC) conducted six case studies in the Western United States looking at several categories of wildfire costs. These case studies were based on fires that occurred between 2000–2003 in Montana, New Mexico, Colorado (2), Arizona, and California. For these six wildfires, suppression costs ranged from $9.5 to $61 million per fire, or $101 to $781 per acre (WFLC 2010). The case studies also considered the rehabilitation costs for cleanup and recovery following these fires. The rehabilitation costs per acre for the six fires ranged widely, with per acre averages of $123, $184, $290, $300, $1,688 and $4,277. Thompson et al. (2013) compiled the average costs to the United States Forest Service (USFS) for fires larger than 300 acres and found an average per acre cost of $2,117. Gebert et al. (2007) examined suppression expenditures for 1,550 large wildland fires from 1995–2004 and identified an average cost of $2,114 per acre for fires in California, the highest of any region (USFS Region 5).

4.3 Fuel Treatments and Suppression Effort

Previous research has shown that fuel treatments alter not only wildland fire size, but also burn probabilities, fire severity, and fire behavior (Ager et al. 2010; Ager et al. 2011; Calkin et al. 2005; Cochrane et al. 2012). Fuel treatments can further reduce suppression costs by enhancing the effectiveness of fire suppression efforts via increased visibility, safer access and crew mobility, and reduced heat and smoke (Bostwick et al. 2011; Moghaddas and Craggs 2007; Murphy et al. 2007). Suppression activities often involve mechanical and prescribed burn treatments that are similar to typical fuel treatments, but are often more extreme than an ecologically derived fuel treatment. Fire crews find it easier to defend structures where fuels have been treated because they are able to more safely establish defensible positions. For this reason, it is now state law that homes in the WUI have at least 100 feet of what is known as defensible space. Treatments that extend beyond, or work in tandem with, Defensible Space zones, further contribute to the safety of fire crews and their ability to more effectively manage the fire.

The 2007 Antelope Complex Fire in Plumas National Forest (northern California) affected areas that had received prior fuel treatments. A review of the effects of fuel treatments on suppression effort yielded the following key findings:

- *Treated areas had significantly reduced fire behavior and tree and soil impacts compared to untreated areas.*
- *Treated areas along several flanks of the fire were used during suppression for both direct attack with dozers and handcrews, as well as for indirect attack with burn operations.*
- *Treated areas that burned during the first two days—when suppression resources were limited and fire behavior more uniformly intense—had reduced fire effects compared to untreated areas. In some areas, these treated sites had moderate to high severity effects.*
- *A defensible fuel profile zone provided a safe escape route for firefighters when the column collapsed and two other escape routes were cut off by the fire (Fites et al. 2007).*

Also in 2007, the Angora Fire in the Lake Tahoe area burned about 3,000 acres and suppression costs exceeded $11 million, or approximately $3,500 an acre. Of the acreage that burned, just under half had been previously treated by the USFS, state agencies, or private landowners (USDA Forest Service 2007). Overall, when the high-intensity crown fires reached treated areas, the fire dropped down to a surface fire within 150 feet of the treatment area boundary, which enhanced suppression effectiveness (Safford, Schmidt, and Carlson 2009). The treatment areas that did burn with high intensity were largely the result of being located on steep slopes that were downwind from untreated areas. Two reasons these areas burned at a higher intensity were that fuel treatments were lighter on the steepest slopes to prevent soil erosion, and in these areas the momentum of the crown fires from the untreated areas was able to overcome the spacing and reduced fuel loads of the treated areas (Murphy, Duncan, and Dillingham 2010). Of the treated acreage on USFS land that burned, 405 acres burned as a ground fire and 75 acres burned as a crown fire, compared with the untreated areas where most of the acreage burned as crown fire and experienced 95% or greater mortality (Safford, Schmidt, and Carlson 2009).

In a comprehensive review of the effect of fuel treatments on wildfire behavior and suppression costs in northern California, the USFS reviewed 20 wildfires from 1999 to 2010 that interacted with fuel treatments (Murphy, Duncan, and Dillingham 2010). The key findings of this study included:

- *Untreated areas experienced the most severe fire effects and vegetative mortality.*
- *Treated areas increased fire suppression options and enhanced opportunities for safe, low-severity burnout operations with reduced potential for spotting and torching.*
- *Smoke volume was reduced significantly when fire reached treated areas.*

This review also provided accounts from ground crews fighting the fires when the fires encountered treated areas, including:

> *"The fire entering fuel treatments resulted in an abrupt change in fire behavior. Some treatment units stopped the advancing wildfire with little to no suppression effort."*

> *"Fuel treatments allowed suppression crews to conduct burnout operations safely and effectively. Spot fires were easily detected and contained. Treated areas reduced fire behavior, providing for safe egress of fire crews during extreme fire behavior."*

> *"Fuel treatments allowed limited suppression resources to be effective. Treated areas provided anchor points, increased production rates, and allowed effective application of aerial retardant."*

> *"Open stands lowered fire intensity, allowing suppression crews safe access and direct attack. This resulted in smaller final fire size and reduced suppression costs."*

These studies and other accounts suggest that fuel treatment can influence suppression costs, suppression effort success, and wildfire risk to fire crews in numerous beneficial ways.

Fitch et al. (2013) modeled the effects of forest restoration treatments in Arizona's Four Forest Restoration Initiative on fire behavior characteristics and fire suppression costs. Controlling for fire size, they found that alteration of fire behavior and severity alone can decrease fire suppression costs. Total wildfire suppression costs tended to increase as both the distance from the wildfire to the WUI became smaller and as a greater proportion of fires burned at high-burn severity. They estimate a range for wildland suppression costs for similar-sized fires and conditions at $706 to $825 per acre for untreated landscapes, compared with $287 to $327 per acre in treated areas, an approximately 60% reduction.

4.4 Rim Fire Lessons

The 2013 Rim Fire burned 257,314 acres and cost $127.4 million, approximately $495 per acre (InciWeb 2013). Final suppression costs for the Rim Fire are not available at the time of this writing. The Rim Fire occurred in the watershed just south of the Mokelumne, so it provides useful insights regarding suppression activities in an area that is similar to the Mokelumne watershed and has similar land management. A USFS preliminary review of the effect of fuel treatment on suppression efforts identified a fuel break and adjacent fuel treatments that allowed successful defense of the communities of Pine Mountain Lake, Groveland, and Big Oak Flat. Fire crews reported that they would likely have been unable to defend a series of homes and leased cabins amongst a 742-acre treatment project if not for the treatment. With the treatments to support their efforts, the fire crews were successful in defending these structures. Crews also reported that other treatments sufficiently slowed the progress of the fire to allow them to defend structures within Yosemite National Park (Johnson et al. 2013).

4.5 Fire Scenario Suppression Cost Estimates

The wide array of wildfire suppression costs observed in California makes it difficult to choose a narrow estimate for likely suppression costs. Fires similar to the scenarios in this report have ranged in per acre cost from hundreds to thousands of dollars. The total burned area of a wildfire is not the only determinant of cost, and in the Mokelumne watershed, vegetation, topography, accessibility, and proximity to valuable structures have the potential to contribute to high suppression costs. Evidence from similar fires described above suggests that fuel treatments can decrease suppression costs. The fire model runs provide flame length data that are influenced by the location of fuel treatments. For our suppression cost estimates, we use per acre suppression costs at the higher end of the observed range for areas of high flame lengths (>8 ft.) and the lower end for low flame lengths (<8 ft.). Given the recorded costs of wildfires in California and the Fitch (2013) study for suppression costs in treated versus untreated areas, we use $200 to $500 for the per acre cost in low flame-length areas, and $1,000 to $1,500 for high flame-length areas. We do not adjust for inflation because recent fire suppression costs still fall within these ranges.

Across the five simulated fires (A-E), the overall decline in burned area with fuel treatments is 41%. More dramatically, the area of high flame length within the fires declined by 75 percent. We apply the assumptions on suppression costs described above to each fire, based on area of high flame length and low flame length (Table 4.2). The low estimate for each range in Table 4.2 is based on the low-end suppression cost estimates, and the high estimate is based on the high-end suppression cost estimates. As demonstrated above, large wildfires in California have generated suppression costs higher than the high-end estimates we use, so our high-cost estimates might underestimate the true cost for some areas within the watershed. In general, these estimates suggest suppression costs without treatment ranging from $21 to $39 million, and avoided suppression costs from treatment of $13 to $21 million.

Table 4.2: Suppression cost estimates, with and without fuel treatments ($ million)

	Pre-treatment suppression costs		Post-treatment suppression costs		Avoided costs	
Fire ID	Low estimate	High estimate	Low estimate	High estimate	Low estimate	High estimate
A	$7.1	$13.6	$3.3	$7.5	$3.8	$6.1
B	$9.7	$16.8	$4.2	$8.2	$5.5	$8.7
C	$1.8	$3.7	$0.3	$0.7	$1.6	$3.0
D	$1.5	$3.0	$0.7	$1.5	$0.8	$1.5
E	$1.2	$2.3	$0.4	$0.8	$0.9	$1.6
Total	*$21.4*	*$39.4*	*$8.9*	*$18.6*	*$12.5*	*$20.8*

Source: ECONorthwest. See text for description of assumptions and calculations.

4.6 Rehabilitation Cost Estimates

The suppression cost estimates above do not include post-fire rehabilitation costs. Based on the rehabilitation cost estimates from the WFLC case studies, we assume rehabilitation costs for areas of low flame length and high flame length would respectively correspond to the low and high estimates. The WFLC per acre rehabilitation costs for the case studies ranged from $123 to $4,277 per acre for each fire.[1] If we assume $150 per acre for rehabilitation costs in areas of low flame length, and $2,000 per acre for areas of high flame length, pretreatment rehabilitation costs would be $33.6 million and post-treatment costs would be $11.1 million, for avoided rehabilitation costs of $22.5 million.[2]

4.7 Summary

Summing the low estimates for suppression and rehabilitation in the no-treatment option for this modeled scenario results in $55 million in costs ($21.4 + $33.6). At the high end it could reach $73 million in costs ($39.4 + $33.6). Performing the fuel treatments, which themselves cost $68 million, would save between $23.6 ($12.5 + $11.1) and $31.9 ($20.8 + $11.1) million dollars.

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[1] These are in the original dollars from 2000 to 2003, unadjusted for inflation. Review with experts suggests no substantial changes in these cost ranges to-date.

[2] $150 is at the low end of the range of rehabilitation costs from the WFLC study, and $2,000 is the mid-range value from the study. This range is already quite broad, but given the observed range, an upper estimate could justifiably be higher.

Therefore, after factoring in the expected suppression and rehabilitation cost savings provided by the treatments, the cost of treating all of this land would be between $36 million and $45 million for the modeled scenario.

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Report Version 1.0

April 10, 2014

Citation Suggestion:

Buckley, M., N. Beck, P. Bowden, M. E. Miller, B. Hill, C. Luce, W. J. Elliot, N. Enstice, K. Podolak, E. Winford, S. L. Smith, M. Bokach, M. Reichert, D. Edelson, and J. Gaither. 2014. "Mokelumne watershed avoided cost analysis: Why Sierra fuel treatments make economic sense." A report prepared for the Sierra Nevada Conservancy, The Nature Conservancy, and U.S. Department of Agriculture, Forest Service. *Sierra Nevada Conservancy.* Auburn, California. Online: http://www.sierranevadaconservancy.ca.gov/mokelumne.

Disclaimer

This report is rich in data and analyses and may help support planning processes in the watershed. The data and analyses were primarily funded with public resources and are therefore available for others to use with appropriate referencing of the sources. This analysis is not intended to be a planning document.

The report includes a section on cultural heritage to acknowledge the inherent value of these resources, while also recognizing the difficulty of placing a monetary value on them. This work honors the value of Native American cultural or sacred sites, or disassociated collected or archived artifacts. This work does not intend to cause direct or indirect disturbance to any cultural resources.

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