MOKELUMNE WATERSHED AVOIDED COST ANALYSIS:

Why Sierra Fuel Treatments Make Economic Sense

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FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

Chapter 10: Mokelumne Avoided Cost Analysis Conclusion

10.1 Overview

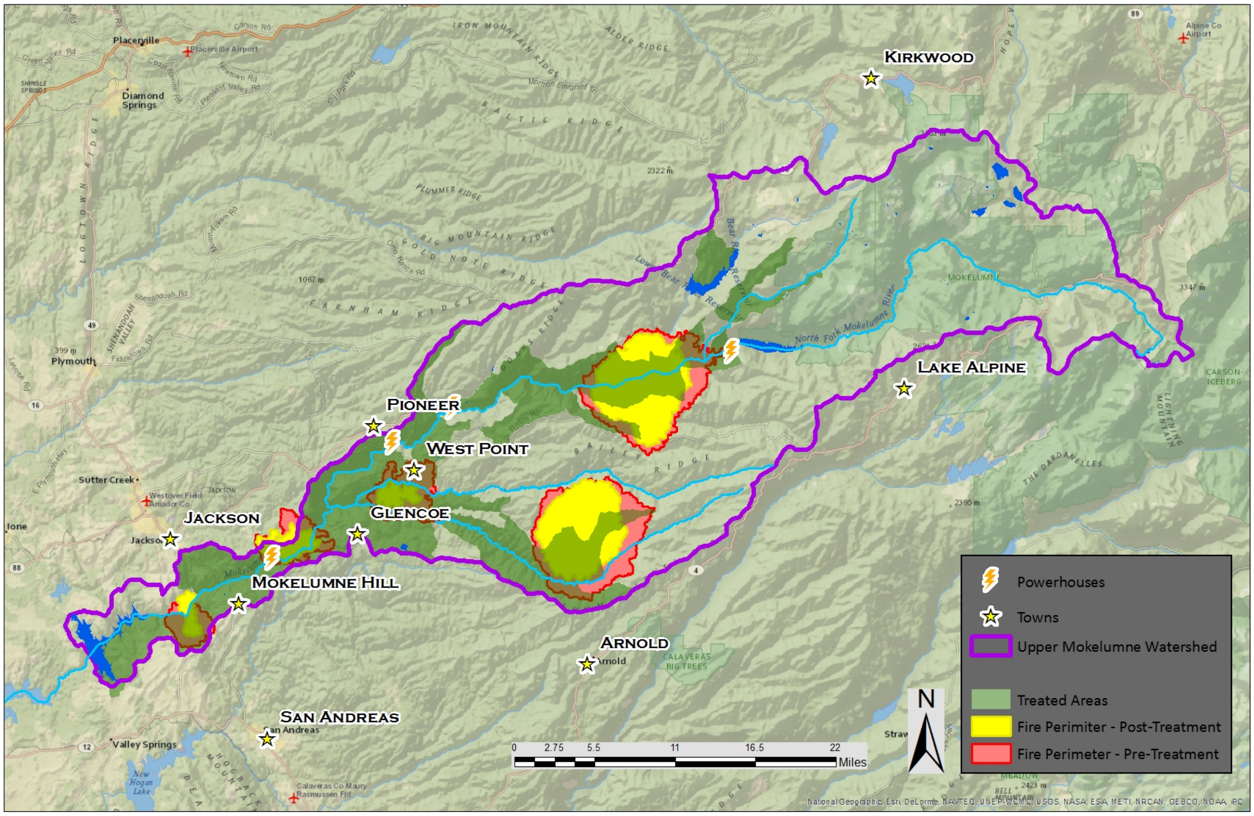
The purpose of this analysis is to evaluate the costs and consequences of wildfire in the upper Mokelumne River watershed with and without fuel reduction treatments. The analysis shows that thinning the forests and reducing hazardous fuels would substantially reduce the probability, extent, and intensity of wildfire in the watershed, leading to quantifiable cost savings. In short, strategic fuel reduction treatments are a good investment and produce multiple benefits to landowners, residents, and watershed interests and beneficiaries.

To evaluate the avoided costs associated with fuel reduction treatments, we identified the types and locations of wildfire fuel treatments that could be used to reduce the probability, extent, and intensity of wildfire in the upper Mokelumne watershed. This treatment strategy for the project area is based on treatments commonly applied by local public land managers. We used the fire model FSim to predict future wildfires in the watershed based on historical patterns and then applied the fuel treatment scenario to the model to identify how wildfire characteristics would change in response. We quantified the financial costs and benefits, including biomass, carbon, and job impacts. It is important to note that because our fire modeling was based on historic fire trends (last 30 years), our conclusions may underestimate the costs and benefits associated with larger, more destructive fires that have become more common in the Sierra Nevada over the last decade and are projected to increase with climate change.

We used the fire simulations to identify the effects of fire directly on assets, including homes, roads, transmission lines, and timber resources. We also estimated the fire suppression costs and carbon emissions, both with and without fuel treatment. We used the GeoWEPP and Debris Flow erosion models to evaluate the effects of fire on sediment erosion, and modeled the transport and impact of that sediment on water storage, diversion, and conveyance infrastructure for the utilities in the watershed. Through these analyses we estimated the value of several important categories of direct and indirect benefits of fuel treatment in the Mokelumne watershed. There are other categories of benefits we do not quantify in this report that are worthy of further future review. These include air quality, water quality, habitat and wildlife, recreation, cultural sites, and other forms of carbon sequestration. There are likely other resiliency benefits as well.

This study shows that the total quantified benefits of fuel treatment would far exceed the costs of treatment if fires occur over the next few decades, which is a strong possibility. The benefits accrue to a wide range of land and water managers and owners, public and private entities, and taxpayers and electric and water utility ratepayers in general. Figure 10.1 shows that not all fuel treatments were within the vicinity of the five fires. This demonstrates that we included the costs for fuel treatments in areas did not directly provide fire protection in our modeled scenario, reflecting the reality that not every treated area will experience wildfire. All told, in this study we found that benefits due to fuel treatments total between $126 and $224 million, and their value is two to three times the costs (Table 10.1 and Figure 10.2).

Figure 10.1: Locations of fuel treatments and fires



10.2 Summary of Fuel Treatment Costs and Benefits

As a first step toward determining the potential costs and benefits of fuel treatments, we first defined a potential fuel treatment scenario, which was reviewed and refined by local land managers so that techniques and costs were consistent with local practices. While a literature review suggests a wide potential range of costs ($17 to $160 million) for our treatment scenario, based on local information we estimate a one-time cost of implementing this scenario of approximately $46 million. This $46 million estimate is based on the closest alignment with our model simulation requirements and based on the assumptions that all treatments occur within one year, and that the treatments cover 100% of the Treated Area Units (TAUs). If we extend the effectiveness of this treatment to the full 30 years that the Five Fire scenario[1] (see Chapter 3) examines, and include the costs for retreatment to maintain the effectiveness of the treatments over that timeframe, the total cost would be $68 million, using a net present cost at a 3% discount rate.

[1] Based on historical patterns, current fuel loading, and discussions with local and regional fire experts, we teased out five representative fires from the modeling data that represent probable fire locations and footprints over the next 30 years in the Mokelumne watershed. We used this fires scenario to ground the modeled difference in reality and to ascertain the damages and benefits to the area, with and without fuel treatment.

Under normal forest management, large tracts of forested lands are not treated at once as described in our scenario, but rather a portion of an area is treated at a portion of our treatment cost, with a similar end result of reducing wildfire threat and improving forest health. Following discussions with local land managers, we believe that most of the benefits demonstrated by our treatments could be achieved at much less than 100% full implementation (see Chapter 7, Table 7.3). This is because strategically placed treatments can reduce the burn probability of adjacent untreated areas, and the treatment areas provide firefighters a greater chance of slowing or stopping a blaze before it moves into adjacent untreated areas. Based on these estimates, as described in Chapter 7, the treatment costs would drop to $16 million. We show this as the low-cost range in Figure 10.2, as well as including the high-cost range of $68 million described above. Figure 10.2 also shows the multiple benefits and associated savings of fuel treatment, which are outlined below. It is important to point out, however, that the models were run at full implementation levels and therefore the benefits discussed here refer only to a full level of implementation, rather than the reduced level proposed by the land managers. In the end, the results suggest that even the low-end benefit estimates exceed the high-end cost estimates.

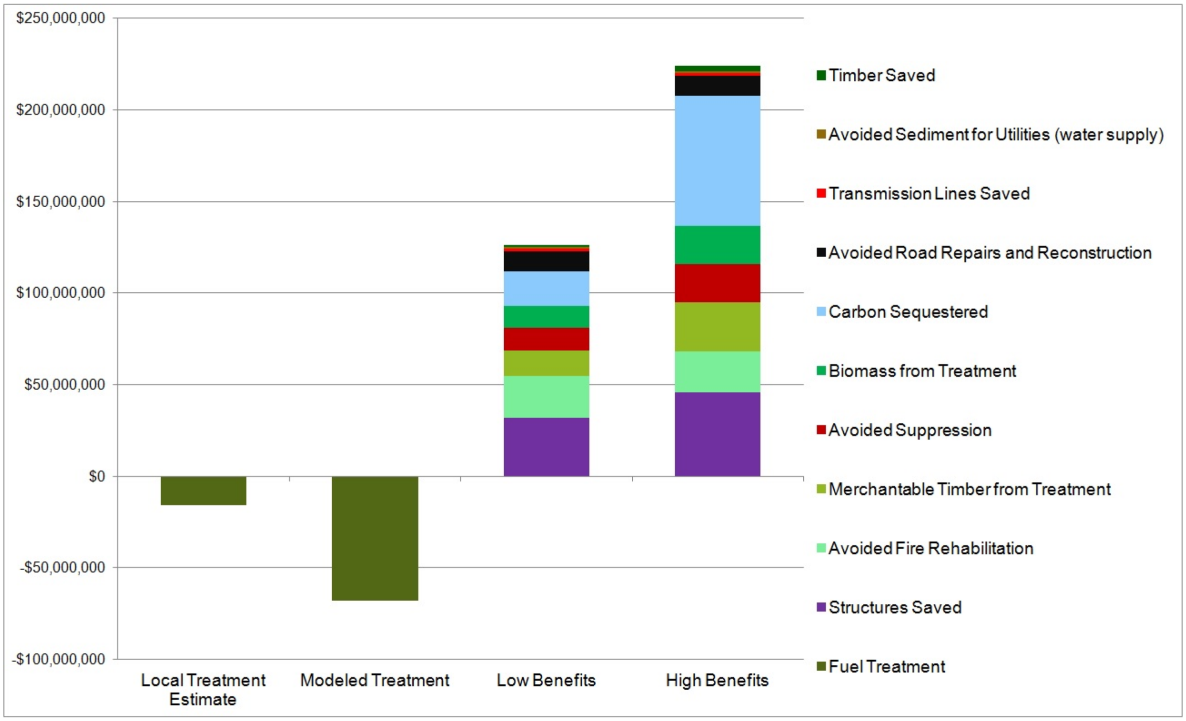
Based on consultation with local Bureau of Land Management (BLM) and U.S. Forest Service (USFS) staff and prevailing market conditions, we estimate the potential revenue from merchantable timber associated with the fuel treatment efforts would be between $14 and $27 million under a 1-year treatment plan. Biomass chip revenue, with sufficient demand, regional bioenergy generation capacity, and value added manufacturing, could reach between $12 and $21 million under the 1-year treatment plan.

The modeled wildfires would immediately damage and destroy infrastructure and assets. Homes, businesses, and other public and private structures would be lost. Not including roads or utility infrastructure, the structures in the areas that would have burned in the Five Fires scenario without treatments are worth $46 million. The change in the value of structures in high- and medium-severity areas of the fires equates to $32 million, providing the range of structural values. While some structures might maintain residual value and only require repairs, others requiring total demolition would have costs greater than simply the replacement construction costs because of cleanup (see Chapter 5). It is also important to note that these costs are based on county assessor data, where values are constrained by Proposition 13, rather than replacement cost values from insurance companies, which could significantly increase the value of the structures saved compared with the constrained assessor data.

For private landowners, parcels zoned for timber that do not burn as a result of treatment have an assessed value of $1.2 million (see Chapter 5). Public lands are managed for different objectives than private timber parcels and it is therefore common to use half of the average hectare value of these parcels to estimate the timber value on public lands. When applied to this study, the result is that treatments helped to protect $1.9 million in public timber values, bringing the total of protected timber resources to $3.1 million. Because the timber on public lands may or may not have ever been removed from the forest, we apply its value only to the high benefit side of the avoided costs, while protected private timber values are placed in both the low and high benefit categories. We estimate road repair and reconstruction costs avoided to be $10.6 million.

Additionally, the cost savings from avoiding the repair and reconstruction of transmission lines based on this scenario would be $1.6 million (see Chapter 5).

Figure 10.2: Low and high range of fuel treatment costs and total quantified benefits



We estimate fire suppression cost savings to range from $12.5 to $20.8 million, and associated postfire recovery cost savings to be $22.5 million (see Chapter 4). The avoided carbon emissions for fuel treatment and reduced fire acreage ranges from $19 million, based on current market prices in California, to $71 million when factoring in the social cost of carbon (see Chapter 8). The social cost of carbon does not yet reflect a revenue opportunity, but because of the high importance the State of California places on climate change and associated regulations to reduce greenhouse gas (GHG) emissions, we believe it is relevant to show this value. Cost savings for utility operations in the upper Mokelumne, based on the potential lost storage for water supply and discounted over 30 years, would be an estimated $1 million (see Chapter 6). We do not include values for other potential effects on storage or disruptions in conveyance for electricity generation; see Chapter 6 for a discussion of potential risk in these areas.

All told, the benefits we accounted for in this study due to fuel treatments total between $126 and $224 million (Table 10.1). If the fires were to occur one year after the treatments were implemented, the benefits specific to avoided fire damage would be pushed back by one year, leading to discounting (3%) and a shift in the benefit range down to $122 to $218 million. Under either case, the quantified benefits are two to four times the costs (Figure 10.2). If the fires were to occur in the tenth year after treatments, the discounted present value of the treatment would be $106 to $197 million ($86 to $173 million at 7%), accounting for the delay in avoided costs inherent with the unpredictability of when severe fires would occur.

Table 10.1: Total costs and benefits for fuel treatment scenario

Costs		
Fuel Treatment	$16,000,000	$68,000,000
Benefits	*Low*	*High*
Structures Saved	$32,000,000	$45,600,000
Avoided Fire Cleanup	$22,500,000	$22,500,000
Carbon Sequestered	$19,000,000	$71,000,000
Merchantable Timber from Treatment	$14,000,000	$27,000,000
Avoided Suppression	$12,500,000	$20,800,000
Biomass from Treatment	$12,000,000	$21,000,000
Avoided Road Repairs and Reconstruction	$10,630,000	$10,630,000
Transmission Lines Saved	$1,600,000	$1,600,000
Timber Saved	$1,200,000	$3,130,250
Avoided Sediment for Utilities (water supply)	$1,000,000	$1,000,000
Total Benefits	*$126,430,000*	*$224,260,250*

Note: Values rounded to significant figures.

Avoided postfire sediment for water and power utilities, based on the fire conditions we modeled, represent approximately 1-2% of the total calculated avoided costs, a result that is significantly lower than what occurred in the Denver area. The difference in our results is likely attributable to site-specific factors such as the water infrastructure and erodibility of the soils within the Mokelumne watershed. Large water storage reservoirs in the Mokelumne watershed dilute the effect of sediment on water storage capacity, in comparison to the Strontia Springs Reservoir in Colorado, where the postfire erosion costs were very large because of the need for reservoir dredging and emergency alternative water supplies. The capacity of Pardee Reservoir in the Mokelumne watershed is 210,000 acre-feet, or 30 times larger than Strontia Springs Reservoir (7,000 acre-feet), which plays a crucial role in Denver's water supply storage, similar to the Mokelumne's significance to the East Bay.

As this study shows, Pardee Reservoir will not lose a significant percentage of water storage capacity from the modeled postfire sediment given the ratio of reservoir capacity to sediment volume. This report's release during the worst drought year on record, however, highlights the importance of every acre-foot of potential storage, even if that acre-foot is a small percentage of total capacity. Additionally, soil erodibility in the Mokelumne watershed is significantly less than in other areas in California and the western United States, where the risk of postfire erosion is far greater (e.g., due to decomposed granite soils). Application of this study design to a watershed with more erodible soils and smaller reservoir storage would likely result in avoided erosion costs representing a larger percent of the total avoided cost. There is potential for water quality effects that would disrupt supply or increase treatment costs for EBMUD, but this analysis was not included in this report.

The project team needed to prioritize values and resources to keep the project manageable, both in scale and budget, and therefore chose to not include a wide range of ecological and cultural values, including value of habitat and cultural resources lost, water contamination other than sediment, air quality, lost tourism/recreational opportunities and access, and spoiled scenic views. We also did not address human health and risk, particularly in the path of a major wildfire and its smoke plume. Our study did not consider potential increases in water yield that may result from forest thinning, such as from increased snowpack accumulation under less dense canopies, a process under active study. There might also be changes in natural runoff patterns that exacerbate water storage constraints. There are likely other losses to property value beyond structures and timber, either through direct effects or regional degradation. And there are other losses of ecosystem services provided by these forests and streams, such as support for nutrient cycles or other ecological processes that cross the watershed boundary. A full accounting of all these impacts and costs would have increased the total avoided costs that would result from fuel reduction treatments. A recent study by Earth Economics, commissioned by the San Francisco Public Utilities Commission, estimated habitat values lost to the Rim Fire based on literature averages by habitat type, which occurred in the Tuolumne River watershed near the Mokelumne. Of the ecosystem services they evaluated, they estimated the habitat-based values lost, beyond suppression and infrastructure costs, to be over $100 million in the first year alone, although these costs are not market based[2].

To remain within the project budget and timeline, limitations also needed to be made to the modeling effort, primarily the limit of running only one treatment scenario. Land managers typically do not have access to multiple iterations of modeling in their project planning process to determine where fuel reduction treatments would have the greatest impact based on costs and benefits; the modeling for this analysis did not include multiple scenarios either. Therefore, there was no opportunity to consider the best locations to model fuel reduction treatments to maximize avoided costs. We also based wildfire risk on the historical fire record; however, as the Rim Fire and other recent conflagrations show, there are larger and higher intensity wildfires occurring today than in the past. As a result, the historic context of our wildfire modeling may have underestimated the scale of future wildfires in the watershed. We attempted to address this limitation with the climate change scenario and by modeling five fires, yet even these fires are considerably smaller in area than the Rim Fire footprint (Figure 10.3). In short, the magnitude of the wildfire risk today may be outside of the range that we could model and predict based on the historic record, and as a result our avoided costs and benefits may be similarly underestimated.

This study was designed to model fuel treatments that would address a subset of economic, ecological, and social goals; it is not intended as a land management plan for the Mokelumne watershed. Our analysis focuses on areas in the watershed at high risk of wildfire, associated postfire sediment, and assets at risk to burn, and as such it may help land and water managers identify future priority areas for fuel reduction. It uses sophisticated wildfire and postfire erosion risk modeling that was previously unavailable. The study can potentially be useful for multiple purposes, including supporting the California Department of Water Resource's State Water Plan

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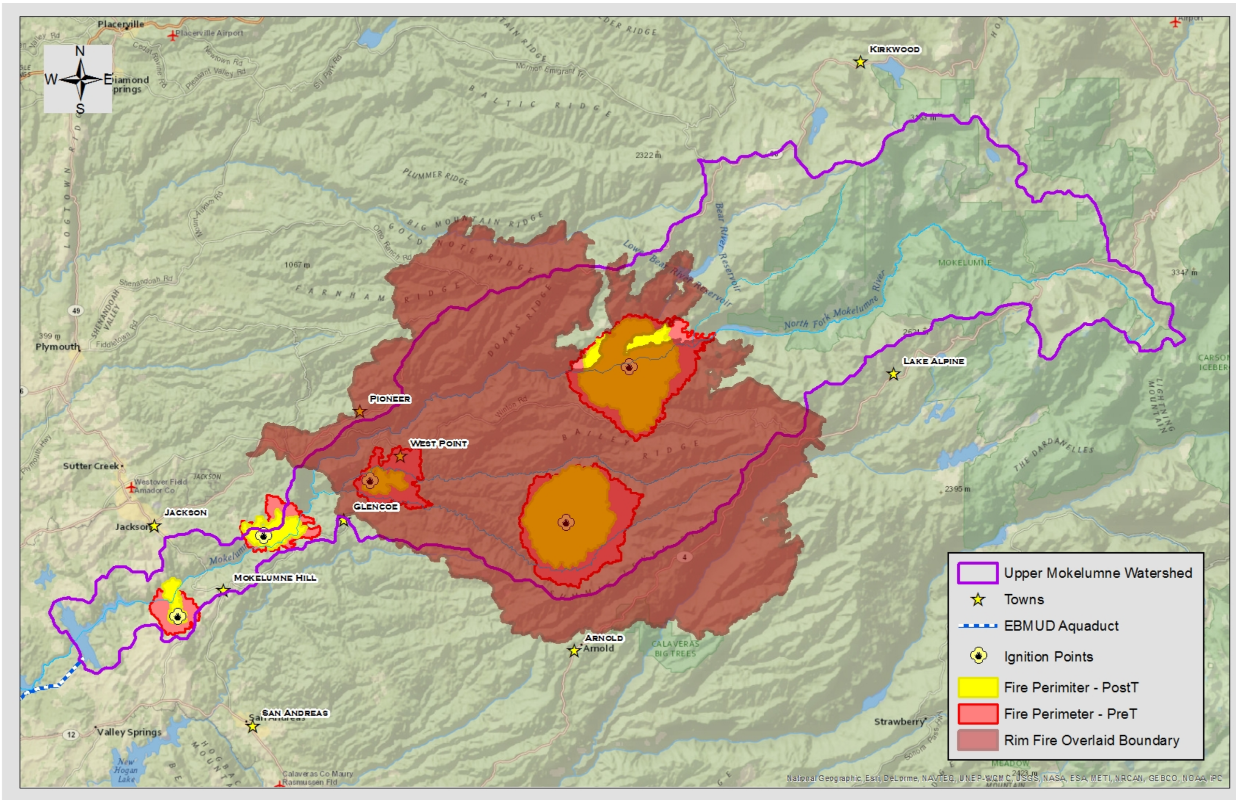
[2] Earth Economics. 2013. "Preliminary Assessment: The Economic Impact of the 2013 Rim Fire on Natural Lands." http://www.eartheconomics.org/FileLibrary/file/Reports/Earth%20Economics%20Rim%20Fire%20Report%2011.27.2013.pdf

updates and the Integrated Regional Water Management planning efforts, as well as informing land and water management planning at the federal, state, utility, and private level.

Figure 10.3: Rim Fire boundary overlaid on Mokelumne watershed and Five Fires scenario



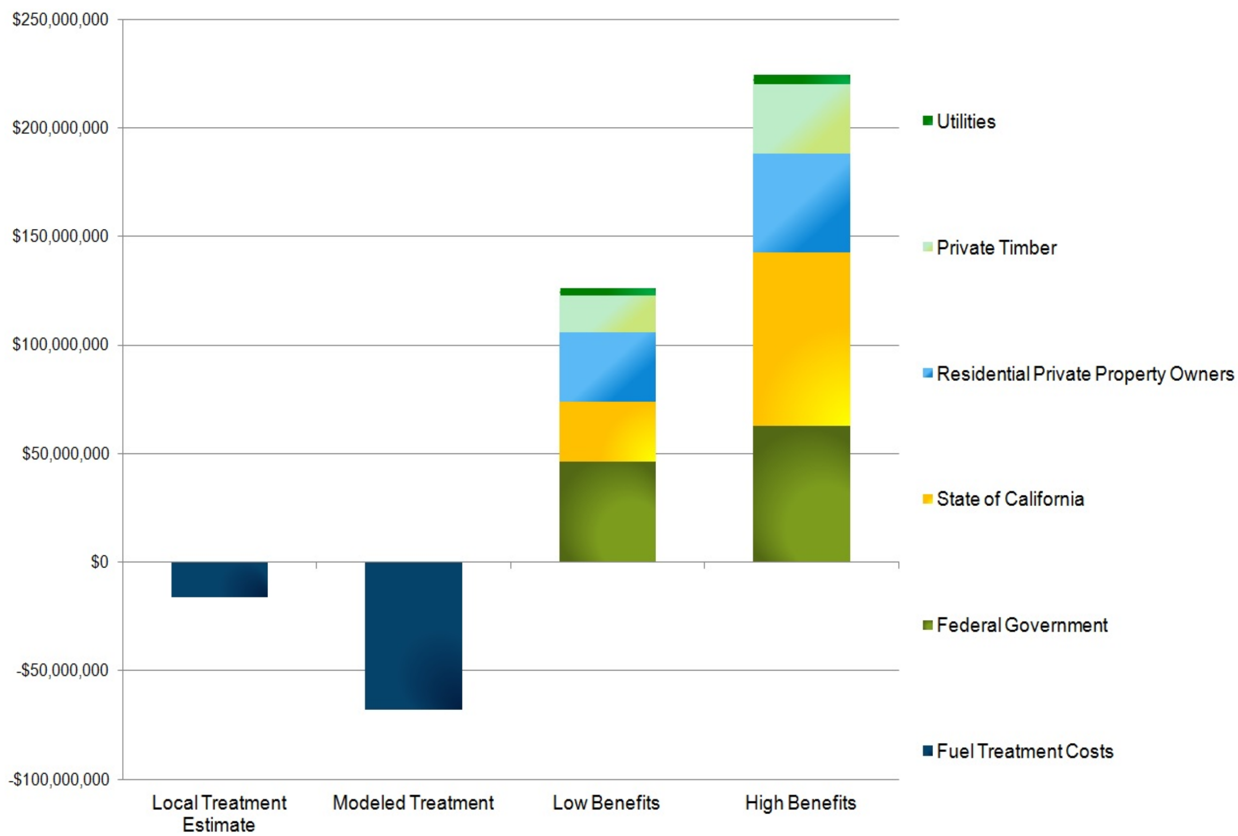
The scale of modeled treatments in this study is considerably larger than either those proposed by the Amador Calaveras Consensus Group (ACCG), a local forest collaborative, or those that are currently being implemented by land managers. Increasing fuel reduction efforts to the pace and scale herein would require additional funding as well as building infrastructure, such as appropriately scaled bioenergy facilities or value added manufacturing to use the biomass generated. Until an adequate amount of infrastructure is established, it could also require that air quality regulators allow more burn days to open pile burn the higher volume of material generated with this scenario. Each local land manager may have priorities that differ from those at the core of this study and therefore their priority areas may lie outside of our treatment areas. Implementation in other areas could be constrained by factors that fell outside of the purview of this analysis.

10.3 Distribution and Management Implications

This study suggests that the total quantified benefits of fuel treatment would very likely exceed the costs of treatment if fires occur over the next few decades, which is a strong possibility. These benefits accrue to a wide range of land managers and owners, public and private entities, and taxpayers and ratepayers in general. We aggregated benefits from Table 10.1 by beneficiary to develop Figure 10.4. It was not feasible to identify the precise breakdown of all benefit categories, but we did so where the data allowed. For example, we allocated biomass and merchantable timber benefits from fuel treatment by the breakdown of landownership within the treatment footprints, with roughly 36% federal and 64% private (see Table 2.1 in Chapter 2). And while the beneficiaries of carbon sequestration or carbon credit sales would be quite broad, we allocate these benefits to the State of California given the State's climate GHG emission reduction goals and regulations. We also assume the road repair costs would primarily accrue to the state, although some private, county, and federal forest roads would also require repair and reconstruction.

As we show in Figure 10.4, the primary beneficiaries from our modeling scenario results are the State of California, the federal government, private property owners and insurers, and timber owners. In addition to the protection of its timber assets, the federal government would also see substantial benefits through avoided fire suppression and recovery costs. Relative to overall benefits, the utilities' benefits from our modeling scenarios are relatively modest, but the utility companies acknowledge the value of reducing direct risk from fire to structures and transmission lines, as well as disruptions in operation.

Figure 10.4: Fuel treatment beneficiaries



Note: Private timber by itself refers to lost private timber due to fire, while the combined public and private timber category includes other forest product resources that generate revenue from a mix of public and private lands, and are not easily disaggregated.

This analysis demonstrates that the benefits associated with fuel treatments in high-risk areas can greatly outweigh the status quo and that the benefits received are spread among a broad range of stakeholders. The work also shows that the costs and benefits are not limited to the geographic area of the burn perimeter, but instead have far-reaching consequences. Californians in general benefit from many of these categories. Additionally, there are a large number of environmental benefits, environmental services, and cultural resources that we were not able to evaluate in this analysis. These cost/benefit categories, such as recreation, air quality, snowpack protection, and wildlife habitat, would yield even more regional, statewide, and even global, benefits. Several ongoing studies of the benefits of fuel treatments for snowpack accumulation and water storage suggest natural water storage benefits, especially when compared to areas burned at high severity. The hypothesis is that fuel treatments, especially in high-severity burn risk areas, lead to more water accumulation (in the form of snowpack and soil infiltration) and delayed snowpack release (thus occurring during California's dry months).

Our analysis demonstrates that the federal government has the potential to benefit from a wide array of avoided costs, which would protect its revenue opportunities in the form of biomass and timber. Private timber assets are extensive in the fire footprint areas as well. While the overall share of benefits accruing to utilities in this particular watershed is proportionally low, the risk of disruption in water supply can have impacts that might be considered more important than their quantified market effects.

The costs/benefits studied here were based on one set of fire and climate conditions, using historical data, with the goal of helping us better understand the relative scale of risks and benefits. Unfortunately, the Rim Fire teaches us that historical patterns may not be the best guide for future events and our results should be weighted accordingly. Further efforts could focus on re-running the models to factor in expected changes in both climate and fire patterns, which would also help test the robustness of various treatments in the face of more extreme events. Postfire observations in both the American and Rim Fire burn perimeters suggest that fuel treatments may maintain their effectiveness even under more dire circumstances than we considered in this study, which substantially adds to their value.

It is also important to remember that local land and water managers have their own management needs that take top priority, especially as budgets grow ever tighter, and their needs may not overlap with the needs of those outside their property lines. Public lands and natural resources have always provided a diverse set of benefits to the general public as a whole. Reducing the risk of uncharacteristic, catastrophic wildfire creates a similar diverse set of benefits, where a large-scale investment would generate substantial returns.

The challenge of differing levels of risk and expectations, combined with opportunities to benefit from treatment activities undertaken by others, suggests a need for a broader-level effort to ensure the development of sustainable approaches to treating wildfire fuels in the upper Mokelumne watershed. The scale of benefits relative to the costs suggests that society may be well served by implementing fuel treatments. The broad diffusion of benefits accounted for in this study demonstrates the need for a similarly diverse set of stakeholders to finance and implement the treatments. This broad coalition of investors, working with local land managers and local interests, could yield a large return on their investments.

Mokelumne Watershed Avoided Cost Analysis: Why Sierra Fuel Treatments Make Economic Sense

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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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