Costs and Benefits of Reducing Sediment Production From Wildfires Through Prescribed Burning: The Kinneloa Fire Case Study [1]

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Abstract

National Forests in southern California contain fire prone ecosystems and significant watersheds that are susceptible to post-fire erosion. Using the 2,348 ha Kinneloa fire near Pasadena, CA and associated debris basins as a case study, we found that a long time-interval wildfire resulted in $2.5 million of sediment management and watershed rehabilitation costs for several city, county, state, and federal agencies. The wildfire suppression costs were $7 million. There was also $.26 million in lost recreation due to the closure of the area to visitors. The total cost from the Kinneloa fire was $9.721 million. A multiple regression analysis of fire interval and resulting sediment yield indicated that reducing the fire interval from the current average 22 years to a prescribed fire interval of 5 years would reduce sediment yield by 2 million cubic meters in the 86.2 square kilometer watershed adjacent to and including the Angeles National Forest. Cost savings take the form of reduced sediment removal in debris basins reduced need for emergency infrastructure protection structures. Other savings include the lost recreation visitor days due to emergency fire closures of watershed recreation facilities. Direct cost savings to Los Angeles County Public Works in terms of reduced debris basin clean out would be $24 million. The ecological effects of a prescribed fire interval of 5 years were not included in this analysis..

Introduction

Wildfires are one of the principal causes of accelerated erosion problems in municipal watersheds in steep wildland/urban interface areas of the Intermountain and southwestern United States. A clear example of this is southern California. Several hundred thousand residents call the southern California mountains home. The mountains are visited by several million recreationists each year. Both these groups value the aesthetics of the mountains and the forests. However, these forests contain fire prone ecosystems and significant watersheds that are susceptible to post-fire

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erosion. This paper presents a methodology to estimate the costs and benefits of using prescribed burning to reduce erosion sediments following wildfires in these fire prone watersheds and associated ecosystems.

The cost savings take the form of reduced sediment removal in debris basins and reduced need for emergency infrastructure protection structures such as sediment traps or channel construction. Other savings include reduced watershed protection and rehabilitation via hydroseeding, as well as reducing lost recreation visitor days because emergency fire closures of watershed recreation facilities.

This work provides quantitative estimates of the sediment reduction and associated cost savings to society from using prescribed burning to generate a more frequent, low intensity fire regime in the wildland urban interface of the San Gabriel Mountains. The 1993 Kinneloa Fire is used to demonstrate application of the methodology in fire management analysis to determine the costs that could be avoided by prescribed burning.

Literature Review

For decades fire and erosion have been one thorny concern in fire management. On the Angeles National Forest, postfire erosion in the San Gabriel Mountains has been a major concern since WW II when the potential damages caused by increased run-off and erosion following a wildfire were investigated (Buck and others 1948). A few years later Row and others (1954) performed a hydrologic analysis of effects of fire on peak discharges and erosion rates in the San Gabriel Mountains of southern California. They found the first-year post-fire erosion averaged 35 times the unburned levels.

During the last 50-years these concerns have escalated dramatically as the level of development in the wildland urban interface has increased substantially. Fire risk is not the only peril faced by the increasing number of homes and value of homes in the wildland urban interface, but those surviving the fire, face post-fire risks in the form of debris flows and sediment. Wells and others (1987) demonstrated that wildfire in southern California increased sedimentation by more than an order of magnitude over unburned areas.

In some watersheds, increased post-fire erosion and debris adds to water supply system costs. It has been increasingly common after fires for debris to end up in water supply reservoirs, as recently happened after the Buffalo Creek fire outside of Denver, Colorado. The added sediment results in lost reservoir water storage capacity and increased treatment costs (Martin and Moody 2001; Holmes 1988; Moore and McCarl 1987). All of these costs have prompted a search for ways to reduce these episodic sediment and debris events following wildfire. Various postfire treatments are used to reduce these events (Robichaud and others 2003). Wohlgemuth and others (1999) was among the first to suggest that one of the many benefits of prescribed fire would be as a sediment management tool. They quantified the extent of sediment reduction in areas that had been previously prescribed burned prior to a wildfire. They found one-tenth to one-twentieth as much sediment coming from previously prescribed burned areas as compared to areas without previous prescribed burning prior to the wildfire. The purposes of the research reported here are: (1) to test the hypothesis that repeated fires would result in a statistically significant reduction in sediment yield in a wider range of watersheds along the San Gabriel Mountains; (2)

to quantify in monetary terms the cost savings that might have resulted from prescribed burning in the Kinneloa watershed.

Study Area and Values at Risk

The study area includes watersheds in the Los Angeles County foothills encompassing the Angeles National Forest and adjacent private land (86 km^2), generally referred to as the San Gabriel Mountains. Collectively, the area contains 57,227 houses, with a median value of $241,300. This study area was chosen because it is typical of wildland urban interface areas where houses exist in fire prone ecosystems and these private lands abut public land. These mountain ranges and canyons are fairly steep, with elevational gradients of 150 to 850 feet per mile. Chaparral, the multi-species shrub complex in the area, is a well- known flammable vegetative community (Moreno and Oechel 1994). The area is subject to strong winds (20 m s^{-1}) in the fall that often result in high intensity wildfires in one or more areas of southern California periodically, which are followed by winter rains that rapidly fill the debris basins with sediment. This pattern can possibly be altered by the use of prescribed burning on regular intervals. It is likely that the amount of additional debris from a prescribed fire would be small enough to be handled by the routine debris basin clean out, avoiding the need for emergency clean outs. More importantly, frequent prescribed burning could reduce the intensity of any fires that occur in the watershed by reducing the available fuels. Lower intensity fires will leave some of the larger shrubs and trees standing, and along with their intact root system, will reduce erosion from rainfall. Therefore, the amount of material coming down after a wildfire would be greatly reduced, again avoiding emergency clean out costs.

To test these ideas, we conducted a linked hydrological and economic analysis. The first step in this analysis was to determine statistically if sediment and debris flows can be reduced from repeated fire. If we find such a statistically significant relationship, then the cost savings from reduced sediment clean out and emergency watershed rehabilitation can be calculated.

Statistical Analysis of the Relationship between Fire Frequency and Sediment Yield

Hydrological Data

Records of sediment discharge to debris basins were collected for 41 watersheds along the southern flank of the San Gabriel Mountains of Los Angeles County. These records included topographic characteristics, fire histories, rainfall amounts, and sediment yields into debris basins in these watersheds over a 30-60 year period, depending on the age of the debris basin. However, it is worth noting that none of the fire events in the database are prescribed burns. We are using wildfire events as natural experiments to mimic what would occur with prescribed burning. We recognize that wildfires typically burn with higher intensity than prescribed fires so that sediment reductions associated with repeated wildfires may be different than with repeated prescribed fire. Nonetheless, we think the ability to utilize data from this natural experiment is still quite insightful and a reasonable proxy for evaluating an equivalent prescribed fire regime.

Sediment Yield Modeling

In southern California, a given sediment yield response from any watershed is the result of a complex set of interactions among these physical site, fire, and rainfall characteristics. Fire characteristics include percent of area burned, fire severity, and time of year. In this area fire severity is either high or very high, while time of year is either summer or fall so there is little variation in these two fire variables. However, there is variation in the percentage of watershed burned. One way to model the interaction of physical, hydrological and fire factors is to use a paired watershed approach. Specifically, in watersheds that burned multiple times, a pre-fire/post-fire comparison may be made to ascertain the effect of fire interval, controlling for rainfall and other influences. This approach allows us to determine the effect on sediment yields of prior fires on subsequent burns to estimate the reduced sediment yields as a function of time since burning, percent area burned, watershed characteristics, and rainfall patterns. As there are good comparisons for unburned versus post-burn sediment yields for virtually all 41 watersheds, the sediment yield reduction function is estimated with multiple regression. The equation is then used to calculate sediment responses for various fire interval scenarios. The resulting sediment reduction can be used in the economic analysis of the cost savings of the sediment reduction versus the costs of prescribed burning.

Statistical Analysis Methods

Multiple regression analysis was used to estimate sediment discharge as a function of fire interval controlling for other variables. Specifically the equation estimated is:

$$\ln(S) = \beta_0 + \beta_1 \ln(FireInterval) + \beta_2 \ln(RainLag) + \beta_3 \ln(TotalRain) \\ + \beta_4 \ln(\mathrm{Re}liefRatio) + \beta_5 \ln(Burned\%)$$

where, S is the sediment produced per km^2, *FireInterval* is the number of years between fires; *RainLag* is the number of days between the fire and first significant rainfall (defined as 12.5 mm (0.5 inches) or more); *TotalRain* is the total mm of rainfall in the five largest events during the water year following the fire; *ReliefRatio* is an index of the watershed steepness; and *Burned%* is the percentage of the watershed burned.

Statistical Regression Results

Results from our multiple regression model show a reasonably good explanatory power. Slightly over 50% of the variation in sediment from the 66 observations is explained by the five independent variables (*table 1*). The longer is the fire interval preceding a fire event, the greater the sediment that comes down into the debris basin in the year of the fire. Because the dependent and independent variables are expressed in natural logarithms the coefficients can be interpreted as elasticites. Thus, a 1% decrease in the number of years between fires (i.e., the fire interval) leads to a 0.577% decrease in annual sediment. The signs of the other variables are plausible, i.e., the greater the percentage of the watershed burned (*Burned%*) and the more rain that fell that winter (*TotalRain*) the greater the annual flow of sediment into the debris basins.

Table 1—Sediment model regression results including inferred sediment for zero reported sediment

Variable	Coefficient	Std. Error	P	LvarMean
Constant	6.6611	1.0901	0.0000	1.0000
Ln(*FireInterval)*	0.5772	0.1847	0.0027	3.1113
Ln(*RainLag*)	-0.3372	0.1477	0.0260	3.6376
Ln(*ReliefRatio*)	0.8237	0.5499	0.1394	-1.1793
Ln(*TotalRain*)	1.3852	0.2715	0.0000	3.2958
Ln(*Burn%*)	0.6141	0.1749	0.0009	-0.3355

R-squared	0.5551	Mean dependent variable	8.5566
Adjusted R-squared	0.5180	S.E. of regression	1.0447
F-statistic	14.9720	Prob. (F-statistic)	0.0000

Using the Regression Equation as a Sediment Simulation Model for Prescribed Burning

The regression equation was used to forecast the reduction in sediment per km^2 if the fire interval was decreased from the current average fire interval of 22.45 years to shorter fire intervals such as 5, 10, and 15 years. This is done by changing the level of the Ln(*FireInterval)* variable. We used the regression equation in table 1, holding the other variables at their mean, to perform a simulation of the effect of different fire intervals on annual sediment production (table 2).

Table 2—Annual sediment per km^2 with Fire Intervals Longer than Five Years

Fire_Interval (Years)	Sediment production (m^3 km^{-2}) Postfire	ΔS
5	17166	
10	25614	**8448**
15	32367	**15471**
Current (22)	40843	**23677**

Table 2 can be read in one of two ways. First, there are significant annual increases in sediment as the fire interval gets longer than five years (table 2). Because the problem is the amount of sediment coming down at one time, cost savings would be realized by reducing the peak amounts of sediment coming down. This can be accomplished by a fire interval closer to every 5 years, rather than 22 years--the average in the data set. With a 5-year fire interval instead of a 22-year interval, the annual reduction in sediment is 23,677 m^3 using the adjusted sediment regression in Table 1. Over the entire study area (86 km^2), a 5-year fire interval would reduce annual sediment inflows to LA County debris basins by 2 million m^3 each year. Alternatively, one can use the information in Table 2 to calculate the reduction in sediment with a 10-year fire interval as compared to the current 22 year average fire interval. A 10-year fire interval would result in a reduction in sediment of 15,229 m^3 each year. Alternatively, one can use the information in Table 2 to calculate the reduction in sediment with a 10-year fire interval as compared to the current 22 year average fire interval. A 10-year fire interval would result in a reduction in sediment of 15,229 m^3 km^{-2}. Given other multiple use considerations such as native plant and animal viability, a ten-year fire interval may be more optimal.

Cost savings from sediment reduction

LA County Debris Basin Clean-out Costs

The major cost savings from reduced sediment yield is decreased debris basin clean-out costs to LA County Public Works. Clean out costs for the 41 debris basins were obtained from LA County Public Works for the years 1969 to 1995. These costs were updated for inflation to 2000 dollars. The average cost across all 41 basins and all years is nearly $12 per cubic yard, with costs ranging from $2.48 to $32 per cubic yard (1 m^3 = 1.308 yd^3). Some of this cost variation may be related to the distance the removed sediment must be transported. This ranges from as little as a half mile to as much as 7 miles away. Some of this variation in cost is related to how wet the sediment is at the time it is hauled away (personal communication with Loreto Soriano, L.A. County Public Works; August 1, 2002). If heavy rains occur right after fires, this can wash large amounts of material into the debris basin, filling the basins. If this is early during the rainy season, this material must be quickly removed to provide space. Removing that material when it is wet, requires half loads of trucks due to the weight. Unfortunately data on water content of the sediment is not available.

Using the average cost of $11.87 per cubic yard, the direct cost saving to LA County Public works of a 2 million cubic yard annual reduction in sediment associated with a five year fire interval, would be $23.74 million.

Forest Recreation at Risk

The private residential land in the watershed is bordered by the Angeles National Forest. As a whole this National Forest receives an estimated 3.5 million to 4 million visitors each year, making it one of the most visited National Forests in California (USDA Forest Service, 2001). Recreation visitation to the Angeles National Forest accounts for 15% of all National Forest visits in California (USDA Forest Service, 2001). Within our study area, there are five developed campgrounds and 21 developed picnic sites. These sites include picnic tables, restrooms and piped water. There are also 15 backcountry trail camps that provide tables and fire grates. The area also contains more than 20 hiking trails. Given these facilities it is not surprising that the most common activities are hiking and picnicking.

To estimate recreation use in the study area we drew upon data from the USDA Forest Service National Visitor Use Monitoring (NVUM). Specifically we identified sample days at General Forest Area access points (GFA's), Day Use Developed Sites (DUDS) and Overnight Use Developed Sites (OUDS) sampled by the USDA Forest Service that were within our study area. The average length of stay of a site visit averages one day for the day use sites, general forest recreation and just slightly over a day (1.14) for the overnight developed use sites. Given these length of stay factors, the estimated 1,038,381 visits to our study area represent 1,049,315 visitor days.

We used a USDA Forest Service report that provides the net willingness to pay per visitor day calculated from TCM and contingent valuation studies for the types of activities occurring in our study area (Rosenberger and Loomis, 2001). Table 3 of Rosenberger and Loomis (2001: 13) provides values per day for the geographic area containing our study area, the Pacific Coast states of California, Oregon and Washington. The value per day from existing studies is $28.95 for picnicking, $22.87 for hiking, and $77.27 for camping. These values are fairly close to the national values for these activities as well (Rosenberger and Loomis, 2001:4). In the baseline situation we have visitor days disaggregated by developed sites (e.g. Day Use Developed Sites and Overnight Developed Sites) and General Forest Recreation. Given the survey data discussed above that indicates that about 10% of visitors to Overnight Developed Sites camped, 30% went picnicking, and 60% went hiking, we used this activity mix to value visitor days occurring at Overnight Developed Sites. A weighted average of the value of hiking, picnicking and camping was used to compute the total annual visitor das and total annual recreation value in our study area (table 3). The weights are the percentage of users in each of the three recreation activities.

Table 3—Existing Study Area Visitation and Value

SITETYPE	Total Annual Site Visits	Total Annual Visitor Days	Value per Day	Total Recreation Value
Overnight Dev. Site	78,100	89,034	$30.13	$2,682,944
Day Use Dev. Site	362,113	362,113	$28.95	$10,483,159
General Forest Rec.	598,169	598,169	$22.87	$13,680,120
TOTAL	1,038,381	1,049,315		$26,846,223

The recreation value at risk from fire is $26.8 million annually. This is quite substantial, and suggests avoiding recreation closures due to fire or post-fire flooding is potentially an important benefit of avoiding catastrophic wildfires in our study area.

Benefit Cost Comparison of Five and Ten Year Fire Interval

While Table 2 indicates that a five year fire interval resulted in a larger reduction in annual sediment yield than a 10 year fire interval, this did not consider other multiple use resources, or costs. A five year fire interval is probably too short in southern California chaparral forests to allow sufficient regeneration of climax vegetation species needed to maintain ecological integrity and biodiversity. Potential vegetation changes resulting from a five-year fire frequency and associated changes in sediment production as a result were not included in the present study. This could adversely affect some wildlife that depends on the more mature vegetation. In addition, prescribed burning is expensive. Because the build up of fuel over an average 20 year time period, the initial prescribed burning requires significant precautionary resources be available. The costs for National Forests in southern California average $250 an acre for these initial burns (Walker 2001). Subsequent re-entries in five to ten years would likely be less costly, perhaps by half. In addition to the watershed cost savings, prescribed burning would reduce the need for prolonged recreation closures following wildfire. As detailed in the next section we calculated the recreation benefits lost due to one wildfire in southern California.

Table 4 displays the results of a net present value analysis of the watershed and recreation cost savings with a five and ten year fire interval over a twenty year time period. We selected twenty years since this is approximately the average time a wildfire reoccurs in a site in our dataset. This analysis compares the sediment reduction benefits from a wildfire in year 20 with and without prior prescribed burning on a five year and ten year cycle (it is of course possible that prior prescribed burning would reduce the likelihood of a wildfire or reduce the extent of the area burned by a wildfire--we are not able to quantify these benefits). Using the sediment reductions from Table 2 and the cost per cubic yard of sediment, we calculated the amount of sediment that would come off in year 20 from a wildfire with no prior prescribed burning versus what would come off in year 20 with a ten year and five year prescribed burning program. The benefits in year 20 from a five-year fire interval of $281,046 and $180,768 with a ten year fire interval. Using the USDA Forest Service discount rate of 4%, this yields a present value of cost savings twenty years from now of the five year fire interval is $128,266 and $82,500 for a ten year fire interval. To this we add the present value of avoiding a recreation closure per km^2 as calculated using the recreation use data and values per day described in Table 3 and the case study in the following section.

In terms of the initial costs of prescribed burning we used the $250 an acre times 247 acres per square km. Follow-up prescribed burns used one-half this cost per acre and then discounted at 4% for the year in which that re-burn took place. The results are shown in Table 4.

Just considering the watershed cost savings and recreation closure avoided a ten-year fire interval has the highest (and positive) net present value. This means the present value of the benefits of prescribed burning exceed the present value of the costs. A five-year fire interval has a small negative net present value. If there are other multiple use costs associated with the shorter fire interval, then the five-year fire interval might have an even larger negative net present value. Given our data, it appears a ten-year fire interval would be most cost-effective.

Table 4—Net Present Value of Five and Ten Year Prescribed Burning Fire Intervals

Fire Interval	***Present Value of Cost Savings/km^2***		PV of Prescribed Burning Costs/km^2	Net Present Value/km^2
(years)	Watershed Savings	Recreation		
5	$128,266	$8,802	$138,679	-$1,611
10	$82,500	$8,802	$82,608	$8,694

Kinneloa Fire Case Study of Costs Avoided By Prescribed Burning

To show how the approach described here could be used in fire management analysis, we apply it to a case study fire to determine the costs that could have been potentially avoided by having a prescribed burning program. Because we cannot determine the size or damage of a potential fire in the area treated we will assume that all suppression costs associated with this fire could have been avoided. In this analysis this would be the maximum possible savings from the prescribed burning program

The Kinneloa fire burned about 2,348 hectares (5,800 acres) in the study area (1,429 National Forest and 919 of private and county) in October 1993. Because the area of the fire directly corresponds to the Kinneloa watershed and the two debris basins it is most amenable for use as a case study. We used this case study to examine what costs federal, state, county agencies and two cities incurred to perform post-fire sediment control and watershed rehabilitation. These are cost that could have potentially been be avoided had the long (63 years) fire interval been reduced to a five year period.

The cost savings or benefits of these reductions in sediment were quantified by collecting data on: a) cost to Federal Emergency Management Agency ($160,000); b) cost to USDA Natural Resource Conservation Service, LA County Public Works, as well as cities of Pasadena and Sierra Madre for residential areas, other private land, protection of reservoirs, streets and other public infrastructure (USDA Soil Conservation Service 1994) by avoiding the need for hydroseeding, debris barriers, and construction of a gunnite flood channel ($1,700,000); c) cost to USDA Forest Service for Angeles National Forest burned area watershed rehabilitation (USDA Forest Service 1995) from avoiding aerial seeding and straw blankets ($600,000); and d) recreation loses avoided.

The Kinneloa fire resulted in closure of six different trails from October 27th until the following spring when the rainy season ended. These six trails are classified as general forest area, although they contain several trail camps (Mt. Lowe, Hoegee's, Idlehour).

Most of the trails are in the wildland urban interface and are just a short distance from major highways (I-210) and a few miles from residential areas. Therefore, for weekends, we used the average daily visitor estimates for "medium use strata", but to be conservative we used "low use strata" for weekdays. Thus, about 210 visitor days are expected on weekends and holidays, with about 20 visitor days on weekdays. The closure period began October 27, 1993 and was extended to the end of the March rainy season for visitor's safety because of flash flooding concerns in burned areas. Applying the daily visitation rates to the number of weekdays, weekends and holidays during this period results in an estimate of 11,339 visitor days lost during this period. Because the typical recreation use of General Forest Area recreation is hiking, and the areas closed were primarily hiking trails, we will use the benefit transfer value from Rosenberger and Loomis (2000: 13) for hiking. Using this value per day of $22.87, results in loss of recreation benefits of $261,582 (table 5).

We believe this figure represents a net loss in visitor benefits because the sites are the closest recreation sites to where many people live. While more distant sites were not closed, the additional travel cost and travel time to reach these sites would reduce the net benefits or consumer surplus of those visitors who had to endure longer travel. Further, given the high level of demand on weekends and holidays in the Los Angeles area, the other available trails were more than likely used to their maximum capacity. Attempts by displaced visitors to substitute to unburned areas would also lead to reduced net benefits if either there was not sufficient trailhead parking to accommodate the displaced visitors, or in cases where there was parking, the added congestion caused by the addition of the displaced visitors would have reduced the benefits per day. Not only would the visitors displaced to these trails have received reduced benefits from a more congested experience, but so would existing visitors to those trails that remained open.

Table 5—Loss in Recreation Value due to Kinneloa Fire Closure

	Weekend	Weekdays	Total Days
Visitation Rate	210.7	19.7	
Days Closed	44	110	154
Visitor Days	9270.80	2167	11,438
Value per day	$22.87	$22.87	$22.87
Total Recreation Value Lost	$212,023	$49,559	$261,582

Kinneloa Case Study Summary

In 2001 dollars, the watershed management cost savings previously detailed in (a) to (c) from preventing the Kinneloa wildfire would have totaled $2.46 million. The recreation losses avoided would have been $261,582. In addition, wildfire suppression costs were nearly $7 million ($2981 hectare) (U.S. Forest Service 1995) would have been avoided. The cost of prescribed burning in the southern California Mountains is, on average, $250 an acre ($617.5 hectare) (Walker 2001). Prescribed burning the 5800 acres in the Kinneloa wildfire area would cost about $1.45 million initially, and an equivalent discounted amount each time after. Using the 4% U.S. Forest Service discount rate, an initial prescribed burn, followed by subsequent prescribed burns in year 11 and 21 would have a present value of costs of $3 million. The present value of the $9.721 benefits of avoiding a Kinneloa fire over that 22-year time interval would be $4.26 million. Thus, three prescribed burns over the 22-year time interval would have a positive net present value.

CONCLUSION

This research demonstrates an approach that can be used with prior fire frequency and erosion data to estimate a relationship between fire interval and sediment yield. In our study area in the wildland urban interface of the San Gabriel Mountains of Southern California, we found a statistically significant relationship between fire interval and sediment yield following wildfires. A 1% decrease in years between fires results in a 0.58% decrease in annual sediment yield into the debris basins. In our study area, this suggests that a five year fire interval would reduce annual sediment yield per km^2 from 40,843 M^3 with the current fire interval to 17,166 M^3. This annual reduction in sediment would save Los Angeles County Public Works $24 million annually in terms of reduced debris basin clean-out costs.

However, comparison of the net present value of a five and ten year prescribed burning interval suggests that a ten-year burning interval has positive net benefits. While a five-year prescribed burning interval gives greater sediment reduction, it has a lower net present value due to need for additional prescribed burning. In addition, the five year period may be too short a time period to maintain ecological integrity and biodiversity of many native plants and associated animal species. Our case study of the Kinneloa wildfire indicates that the costs of a prescribed burn would have been much less costly than incurring the wildfire suppression costs and post-fire watershed rehabilitation effort.

The management implications of this research suggest that watershed benefits can be a substantial addition to traditional wildfire hazard reduction benefits arising from prescribed burning. Fire managers working in the wildland urban interface should include the cost savings from less sediment clean out, reduced watershed rehabilitation costs, and avoiding recreation area closures when performing economic evaluations of prescribed burning. This research provides some estimates of these savings in the San Gabriel Mountains, and presents an approach for estimating the cost savings in other wildland urban interface areas.

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