The True Cost of Wildfire in the Western U.S.



Promoting science-based forest management that serves the values of society and ensures the health and sustainability of western forests.

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WESTERN FORESTRY LEADERSHIP COALITION

About the Western Forestry Leadership Coalition

The Western Forestry Leadership Coalition is a State and Federal government partnership. The members of the coalition include: the 23 State and Pacific Island Foresters of the West and the 7 western Regional Foresters, 3 western Research Station Directors, and Forest Products Lab Director of the USDA Forest Service.

This partnership creates a clear voice on western forestry, strengthening our ability to address pertinent issues and help meet the needs of society.

The mission of the WFLC is to promote science-based forest management that serves the values of society and ensures the health and sustainability of western forests.

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Acknowledgements

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Introduction

The millions of dollars spent to extinguish large wildfires are widely reported and used to underscore the severity of these events. Extinguishing a large wildfire, however, accounts for only a fraction of the total costs associated with a wildfire event. Residents in the wildland-urban interface (WUI) are generally seen as the most vulnerable to fire, but a fuller accounting of the costs of fire also reveals impacts to all Americans and gives a better picture of the losses incurred when our forests burn.

A full accounting considers long-term and complex costs, including impacts to watersheds, ecosystems, infrastructure, businesses, individuals, and the local and national economy. Specifically, these costs include property losses (insured and uninsured), post-fire impacts (such as flooding, erosion, and water quality), air quality damages, healthcare costs, injuries and fatalities, lost revenues (to residents evacuated by the fire, and to local businesses), infrastructure shutdowns (such as highways, airports, railroads), and a host of ecosystem service costs that may extend into the distant future.

Day-lighting the true costs of fire highlights opportunities to use active management to curb escalating costs. Unhealthy forests can increase the risk of fire.[1] Investing in active forest management is therefore valuable in the same way as investing in one's own preventative health care. Upfront costs can be imposing, and while the benefits may seem uncertain, good health results in cost savings that benefit the individual, family, and society. This analogy helps to highlight the importance of fostering resilient ecosystems *before* fires occur, as a tool for reducing the costs associated with suppression and recovery as well as extending benefits to a far wider circle of individuals than might be initially expected.

This report begins with an analysis of the many costs associated with wildfire. Several case studies illustrate a range of the full extent of fire impacts, suggesting patterns that can be included in future budgeting and planning processes at all levels of government. The true costs of wildfire are shown to be far greater than the costs usually reported to the public, anywhere from 2 to 30 times the more commonly reported suppression costs. Finally, a series of recommendations help focus the way these costs might be better considered. As the number of acres burned each year continues to increase, there is a justifiable sense of urgency. With a new administration and an incoming Congress with many new faces, the Western Forestry Leadership Coalition sees a fresh opportunity to address this long-standing forest management challenge.

[1] See, for example: Ecological Restoration Institute. 2003. Fuels Treatments and Forest Restoration: An Analysis of Benefits. Working Paper 4; Ecological Restoration Institute. 2006. Effects of Forest Thinning Treatments on Fire Behavior. Working Paper 15; Snider, Gary, P.J. Daugherty, and D. Wood. 2006. The Irrationality of Continued Fire Suppression: An Avoided Cost Analysis of Fire Hazard Reduction Treatments Versus No Treatment. *Journal of Forestry:* 431-437.

Valuing Ecosystem Services

Ecosystem services are the benefits we derive from ecological processes and functions. Examples from the forests and grasslands affected by wildfire include timber and non-timber forest products, wildlife enjoyed for viewing or hunting, regulation of water quality and quantity, carbon sequestration and storage, soil creation and retention, nutrient cycling, and satisfaction of recreation, cultural, and spiritual needs and desires.

Because many of these services are not directly used or may be worth very different amounts to different people, it is difficult to assign dollar values.

Figure 1. Damages following wildfire can significantly impact water quality and recreational opportunities for months or years after the burn.

Costs of Wildfire

Suppression costs are too often incorrectly cited alone as the "cost of wildfire". As a result, the vast majority of true costs are ignored from a planning and budgeting perspective. Costs associated with wildfire extend beyond both the acres burned and the days or weeks of the fire event. In many cases, suppression cost figures capture only the immediate costs for the WUI and the wildfire itself. Residents of those areas benefit from suppression activities through protection of their lives and homes. However, even if the fire is successfully extinguished before it escapes public land to consume private property, the broader community is likely to experience longer-term impacts. Air quality will decline during the event, often leading to a spike in respiratory health problems for the young, old, and those with weak respiratory or immune systems. During and following the fire, the area may be closed to visitors, resulting in both short- and long-term revenue losses. Flooding and debris flows after a fire event pose further risks. Ecosystem services provided by healthy forests, including water filtration and wildlife habitat, can be permanently hampered. All American taxpayers will benefit from a fire management system that includes systematic monitoring of true costs and seeks to reduce indirect impacts.

Detailing the costs of wildfire is best done in a tiered format; first by describing the costs that tend to fit into specific analytical categories (direct and rehabilitation costs), and then by exploring longer-term costs that evade quantification (indirect and additional costs). In all cases, the terms "losses" and "costs" are used synonymously when referring to infrastructure, ecosystem services, or property; losses may be whole or partial, and we do not distinguish between these layers here.

Direct Costs

Wildfire costs are most easily measured when they have immediate and direct impacts. This category prominently includes federal, state, and local suppression costs. These costs, in turn, can be broken down into expenditures on aviation, engines, firefighting crews, and agency personnel. In addition to suppression costs, other direct costs include private property losses (insured and uninsured), damage to utility lines, damage to recreation facilities, loss of timber resources, and aid to evacuated residents. Most of these costs are incurred during or immediately following the fire. Data are readily available from a host of organizations, including: US Forest Service (USFS), Bureau of Land Management (BLM), Natural Resources Conservation Service (NRCS), National Interagency Fire Center (NIFC), states, counties, Federal Emergency Management Agency (FEMA), Department of Homeland Security (DHS), insurance companies, and the American Red Cross.

Figure 2. Firefighters respond to the Missionary Ridge fire. Expenditures on personnel and equipment to suppress wildfires are easily quantified and frequently measured. (Image credit: Larry Woodson)

Rehabilitation Costs

According to the case study reports profiled here, immediate emergency rehabilitation costs are sometimes considered direct, since those costs are incurred in the days, weeks, and months following the fire and are clearly attributable to the wildfire event. The costs are shouldered by federal, state, and local agencies and, again, the data are relatively accessible. Longer-term rehabilitation costs, however, are harder to measure, and ongoing rehabilitation expenses may not be clearly connected to the wildfire event. Watersheds damaged by fire, in particular, can take many years to recover and require significant restoration activities. Post-fire flooding events can create additional damage to the already scarred landscape, and subsequent impacts include an increase in invasive species and erosion. The USFS has tended to focus on short-term rehabilitation efforts funded through the Burned Area Emergency Rehabilitation (BAER) program.[2] These data are useful but incomplete; BAER funds are tracked annually, while rehabilitation costs tend to span multiple years. These data also fail to account for total need; the damaged landscape may require comprehensive rehabilitation, but federal funding is limited.

Indirect Costs

Once the fire has been extinguished and rehabilitation efforts have begun on the affected landscape, additional indirect costs continue to accumulate. These costs have historically escaped accounting by land management agencies, and may extend years beyond the wildfire event. Indirect wildfire costs include lost tax revenues in a number of categories such as sales and county taxes, as well as business revenue and property losses that accumulate over the longer term. For example, properties that escape damage in the fire may still experience dramatic drops in value as the area recovers. In several of the case studies summarized here, these indirect costs are labeled "impact" costs.

Additional Costs

Beyond the indirect costs associated with wildfire are longer-term additional costs, often called "special" costs in the case studies outlined in this report.[3] Putting a numerical value on human life is always a dubious effort, but some standardized numbers do exist for guidance. When a firefighter perishes in the line of duty, families receive a set sum for their loss; this number serves as a proxy for the cost of lost life. Loss of civilian life, ongoing health problems for the young, old, and those with weak respiratory or immune systems, and mental health needs also fall into this category but are rarely quantified. Additionally, the extensive loss of ecosystem services, some of which are inherently difficult to quantify—aesthetic and scenic beauty, wildlife existence value, and others—can be included here.

Figure 3. Impacts to local economies after a wildfire are difficult to anticipate or to quantify. (Image credit: Larry Woodson)

[2] The objective of the BAER program is to determine the need for, prescribe, and implement emergency treatments on federal lands to minimize threats to life or property resulting from the effects of a fire or to stabilize and prevent unacceptable degradation to natural and cultural resources. (http://www.fs.fed.us/biology/watershed/burnareas/background.html)

[3] Lynch, Dennis L. 2004. What Do Forest Fires Really Cost? *Journal of Forestry* Sept.: 42-49.

Case Studies

While many agency documents address suppression and rehabilitation costs (directly funded by federal programs), case studies that provide detailed analyses of costs associated with wildfire are surprisingly few. Those that are available are of high-profile events that had significant property and ecosystem losses – likely why they were studied in depth. Here, the WFLC has collected and summarized several analyses that delve into longer-term and indirect expenses associated with wildfire. All of these case studies are located in the western U.S., and all illustrate the degree to which total costs exceed suppression costs (Table 1).[4] The true costs of wildfire are shown to be far greater than the costs usually reported to the public; total expenses range from 2 to 30 times reported suppression costs. Such a wide range hints at the complexity of accurately tallying wildfire impacts. Estimates of total costs appear to be determined by a host of factors including fire severity, nearby population density, terrain, and the boundaries of the analysis itself.

In addition to the case study analyses presented here, the USFS, in cooperation with the Department of Interior, gathers aggregate data on all public land fires each year. These data include rigorous accounting of the costs of wildfires, but do not account for additional or indirect costs during the wildfire event or over time. Explicit in recent cost assessments has been an effort to "move beyond cost per acre", a number traditionally used to represent the cost of a fire and widely used for comparison between fires. Based on the most recent complete data available, the 2007 fire year saw 27 large fires nationally, resulting in a total of $547 million in suppression costs alone.[5] Of those, all but two fires occurred in the west. Nation-wide, indirect costs amounted to 34 percent of total costs. Specific costs included in the "indirect" category in the large Fire Cost Review are listed as part of "direct" costs in other studies and longer-term costs of all kinds are absent from this data.

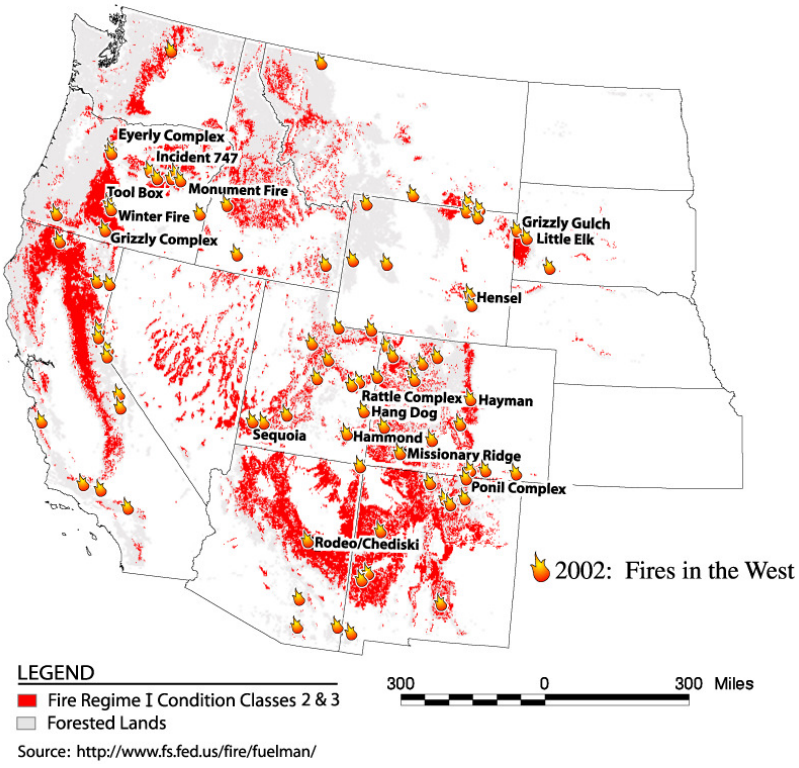

Figure 4. Wildfires in the west during the 2002 season. The Rodeo-Chedeski (AZ), Hayman (CO), and Missionary Ridge (CO) fires were studied extensively and are summarized in this report.

[4] Summary figures presented in Table 1 are: 1) a ratio of total costs to suppression costs, and 2) suppression costs as a percentage of total costs.

[5] USFS, 2007 Large Fire Cost Review.

Table 1. Summary of Cost Information

Cost Category / Fire	Suppression Costs	Other Direct Costs	Rehabilitation Costs	Indirect Costs/Impact	Additional Costs	Total Costs	Total / Suppression	Suppression / Total
Canyon Ferry Complex (MT 2000)	9,544,627	400,000	8,075,921	55,310	N/A	18,075,858	1.9	53%
Cerro Grande (NM 2000)	33,500,000	864,500,000	72,388,944	N/A	N/A	970,388,944	29.0	3%
Rodeo-Chedeski (AZ 2002)	46,500,000	122,500,000	139,000,000	403,000	N/A	308,403,000	6.6	15%
Hayman (CO 2002)	42,279,000	93,269,834	39,930,000	2,691,601	29,529,614	207,700,049	4.9	20%
Missionary Ridge (CO 2002)	37,714,992	52,561,331	8,623,203	50,499,849	3,404,410	152,803,785	4.1	25%
Old, Grand Prix, Padua (CA 2003)	61,335,684	649,804,114	121,803,425	N/A	N/A	832,943,223	13.6	7%

Canyon Ferry Complex (MT 2000)

Summary

In July 2000, two fires, the Cave Gulch and the Bucksnort, burned on opposite shores of Canyon Ferry Lake. Together, this complex burned in the Helena National Forest with spillover damage to adjacent state, private, and BLM lands. The complex burned 43,944 acres, approximately one quarter of which was on private land.[6] Six houses were destroyed.

Methodology

Data for this case were gathered by Yale University researchers[7] from state and federal agencies involved in the recovery effort. Rehabilitation costs were unusually high, as the fire resulted in ongoing flooding and mudslides near the Lake. Replacing culverts and remediating watershed damages was conducted by the USFS, BLM, Bureau of Reclamation and NRCS. Longer term damages to recreation and archeological resources led to costs shouldered by these and other federal agencies.

Conclusions

Suppression costs totaled $9.5 million, and the value of lost homes was estimated to be within the $300,000-$450,000 range. Rehabilitation costs included range improvements, invasive species removal, reseeding, erosion barriers, and reforestation for a total of more than $8 million. In the two to three years following the fire, recreational visits to the national forest declined by 10 percent; this number has not been translated into a dollar value. Damage to archeological sites resulted in a $48,000 restoration cost. Estimates of all direct, rehabilitation, indirect, and additional costs for the Canyon Ferry fire complex exceeded $18 million. Suppression costs accounted for approximately 53 percent of the total. The lack of attention given to additional costs might explain why the proportion of suppression costs to total costs was higher than in other case studies.

Figure 5. A structure destroyed by the Cave Gulch fire, part of the Canyon Ferry complex.

Figure 6. Flames from the Bucksnort fire threaten a community.

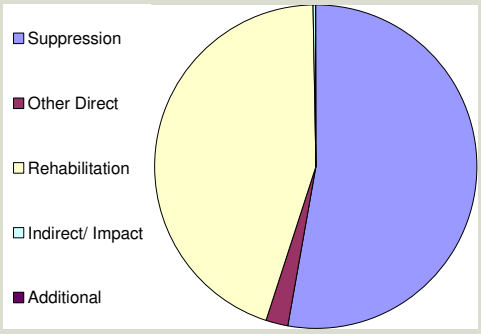

Figure 7. Canyon Ferry Complex cost categories

[6] Morton, Douglas C., Megan E. Roessing, Ann E. Camp, and Mary L. Tyrrell. 2003. Assessing the Environmental, Social, and Economic Impacts of Wildfire. Yale University: GISF Research Paper 001.

Figure 8. The smoke plume from the Cerro Grande fire reached from central New Mexico to the Oklahoma panhandle. (Image credit: NOAA)

Figure 9. A structure destroyed during the Cerro Grande fire.

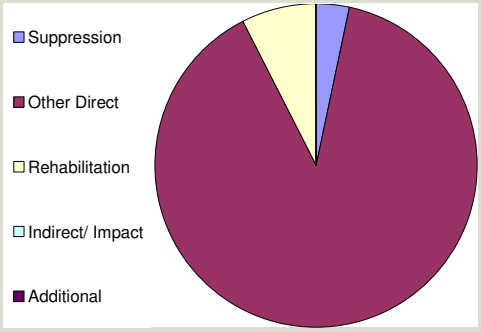

Figure 10. Cerro Grande cost categories

Cerro Grande (NM 2000)

Summary

The Cerro Grande fire in central New Mexico began when a prescribed burn escaped fire lines on the Bandelier National Monument due to high winds on May 4, 2000. As the fire approached the Department of Energy's Los Alamos National Laboratory (LANL) it became international news. The 42,873 acre fire destroyed 260 residences as well as facilities and equipment at the laboratory, led to the evacuation of approximately 18,000 people from nearby communities, and caused extensive damage to the utility infrastructure. Given the high profile of this fire and the fact that blame was placed on federal employees in charge of the prescribed burn, much attention was paid to the costs associated with the Cerro Grande fire.

Methodology

The Cerro Grande Fire Assistance Act, passed in 2000 to compensate communities for the damage suffered during and following the fire, created a $450 million fund available to individuals, businesses, tribes, non-profit organizations, and local governments. Claims submitted for damages were carefully tracked and LANL kept detailed records of costs incurred, providing the primary data for this case study.[8] While the accounting for costs is uncharacteristically thorough for this fire, longer-term costs are still likely under-reported.

Conclusions

Suppression for the Cerro Grande fire cost $33.5 million. While population density within the fire area was relatively low, resulting in limited damage to private property, the impacts sustained by LANL and nearby cultural sites more than made up for those avoided costs. Repairs at LANL cost $138 million immediately following the fire, and the Department of Energy spent an additional $203 million to replace damaged equipment and facilities. A host of federal agencies, including FEMA, the Bureau of Indian Affairs (BIA), NRCS and the USDA Farm Service Emergency Conservation Program shouldered additional short-term rehabilitation costs for a total of $72.4 million. Longer term rehabilitation costs include re-seeding and re-mulching, thinning and fuels reduction, and flood control. Cultural sites such as the Puye Cliff Dwellings were exceptionally expensive to restore and data on those projects remains incomplete. Estimates of all direct, rehabilitation, indirect, and additional costs for the Cerro Grande fire exceeded $970 million. Suppression costs accounted for approximately 3 percent of the total.

[8] Morton, Douglas C., Megan E. Roessing, Ann E. Camp, and Mary L. Tyrrell. 2003. Assessing the Environmental, Social, and Economic Impacts of Wildfire. Yale University: GISF Research Paper 001.

Hayman Fire (CO 2002)

Summary

In June, 2002 the Hayman Fire erupted in the highly populated Front Range corridor south of Denver, Colorado. Burning 137,759 acres, it was the largest fire in state history. Four counties were directly impacted by the fire: Jefferson, Park, Douglas, and Teller. Immediate impacts of the fire included the destruction of 132 residences, one commercial building and 466 outbuildings, and an estimated suppression cost of over $42 million.

Methodology

Following the fire, U.S. Representative Mark Udall (CO) asked the USFS to conduct an analysis of the fire. In response to this request, five teams of researchers assembled to review numerous aspects of the fire including its economic and social dimensions.[9] Utilizing established research frameworks, the team attempted to quantify ongoing and predicted impacts to social and economic systems. Given the difficulty of estimating future costs, the researchers focused on four main areas: suppression and rehabilitation expenses, regional economic impacts, property-related losses, and resource/output values.

Conclusions

Research revealed substantial costs incurred during and following the Hayman Fire. Among the results calculated were total suppression expenses of $42,279,000, including USFS, state, and county expenses, some of which were ultimately reimbursed by FEMA. Other direct costs included property losses, utility losses, and USFS facility and resource losses. Total direct costs were $135,548,834. Rehabilitation expenses included costs incurred by USFS emergency rehabilitation programs, Denver water, US Geological Survey (USGS) mapping, and USFS restoration for a total of $39,930,000. Impact costs, incurred after the fire was extinguished, included tax revenue losses and business losses, plus reduced value of the surviving structures within the fire area. Total impact costs were $2,691,601. Finally, special costs recorded were one asthma victim and losses to wilderness and roadless values, for a total of $29,529,614. All direct, rehabilitation, indirect (impact), and additional (special) costs for the Hayman fire topped $207 million. Suppression costs accounted for only 20 percent of the total.

[9] Graham, Russell T., Technical Editor. 2003. Hayman Fire Case Study. Gen. Tech. Rep. RMRS-GTR-114. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Figure 11. Impacts to water quality and stream habitat persisted long after the Hayman fire stopped burning.

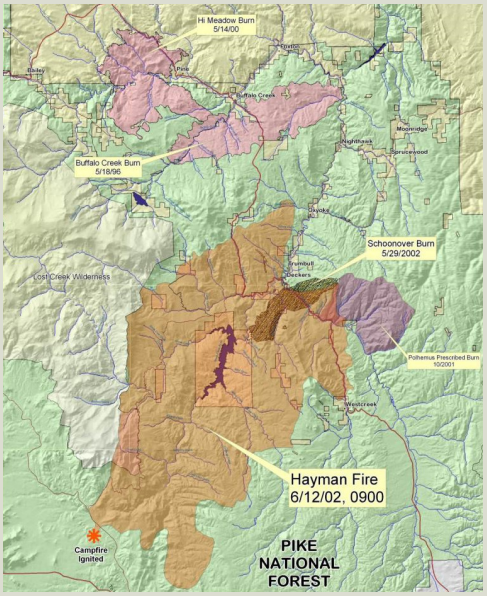

Figure 12. Extent of the Hayman fire, measured on June 12, 2002. The fire grew beyond these boundaries. (Image credit: USFS)

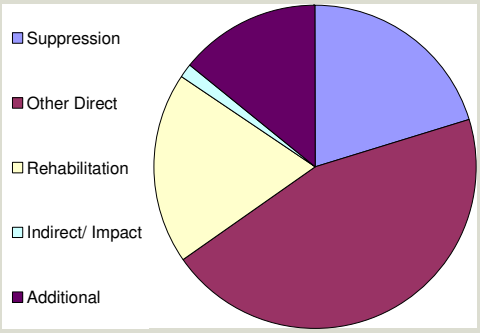

Figure 13. Hayman Fire cost categories

Figure 14. The flames from the Missionary Ridge fire could be seen for miles. (Image credit: Larry Woodson)

Figure 15. Serious erosion after the Missionary Ridge fire damaged water quality, flow regimes and aquatic habitat. (Image credit: Larry Woodson)

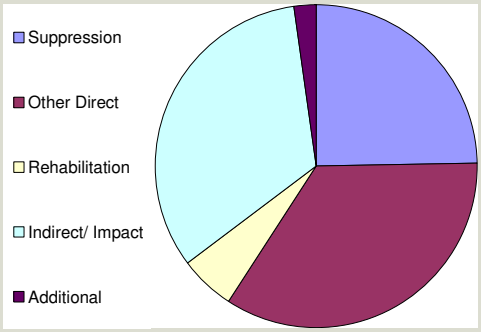

Figure 16. Missionary Ridge Fire cost categories

Missionary Ridge Fire (CO 2002)

Summary

The Missionary Ridge fire burned in southwestern Colorado in the summer of 2002. It burned over 70,000 acres across three counties and touched federal, state, and private land. Thousands of people were evacuated and property losses included 57 homes and 27 additional structures.

Methodology

Suppression costs were widely reported for this fire, but further study was needed to explore costs that accumulated following containment.[10] Fire costs were divided into four categories: direct costs, defined as those incurred during the fire itself; rehabilitation costs, mostly incurred immediately following the fire and shouldered by the USFS and the USGS; impact costs, which occurred following the fire, including tax revenue losses; and special costs, such as loss of life and impacts to habitat for sensitive species.

Conclusions

Suppression costs totaled $37,714,992. Other direct costs included property losses, both insured and uninsured, and losses incurred by the USFS in the form of facilities, range, timber, and other resources. The American Red Cross, the local utility, and the National Guard also experienced immediate losses that were included in this category, bringing total direct costs to $90,276,323. Rehabilitation losses included $8,623,203 worth of USFS emergency and long-term expenses, USGS debris flow hazard mapping costs, NRCS losses on state and private lands, and USFS archeological site rehabilitation. Note that even "long-term" losses in this category were measured for only one to two years following the fire. Impact costs included a long list of itemized expenses associated with tax losses, employment losses, and long term USFS losses in the area. The total for this category was $50,499,849. Finally, additional costs totaled $3,404,410. These were placed into a "special" category, including the loss of one firefighter and damages to wildlife species and habitat. All direct, rehabilitation, indirect, and additional costs for the Missionary Ridge fire topped $152 million. Suppression costs accounted for 25 percent of the total.

[10] Mackes, Kurt, et.al. 2007. Missionary Ridge Fire Cost Assessment. *Journal of Testing and Evaluation.* 35(2): 167-171.

Rodeo-Chediski Fire (AZ 2002)

Summary

The Rodeo-Chediski fire burned 462,614 acres in June 2002, making it the largest wildfire in Arizona state history. The majority of the fire (59%) burned on the Fort Apache Indian Reservation, adding a layer of complexity to recovery efforts. The rest of the fire burned on two National Forests (38%) and private land (2%).[11] Over 490 structures were destroyed, and more than 30,000 residents of nearby communities were evacuated.

Methodology

Data for this case study come from a number of sources; costs are therefore presented as ranges and estimates, and the categories for costs used in other case studies profiled are incomplete. The Rodeo-Chediski was analyzed for public health expenses, providing unique insight into these otherwise unreported costs. [12]

Conclusions

Studies estimated suppression costs for this fire between $43 and $50 million.[13] Other direct costs, including the loss of homes and property, totaled $122.5 million. Rehabilitation costs were generated from immediate post-fire expenditures, and then projected out over three years for a total cost of $139 million. Indirect costs, including loss of sales tax revenue and job losses in the tribal community amounted to $8.1 million. Job losses in this case were particularly acute; following the fire, two local timber mills were not expected to resume pre-fire productivity, leading to a decline in merchantable timber that would impact the Tribe for multiple generagions. Generating cost estimates for such a long-term and uncertain future is a challenging (and incomplete) task. Loss of infrastructure, damage to ecosystem services, and loss of critical habitat for the Mexican spotted owl were all recorded during the fire; however, no cost values were attached to those losses. Immediate impacts to public health were more carefully analyzed and included poor air quality, exposure to hazardous chemicals from wood ash and fire retardant, and poor water quality. Two Red Cross shelters were established to assist with physical and mental health needs; the Arizona Department of Health also received a $403,000 grant from FEMA to provide counseling services. Total cost estimates for these services are unavailable. Estimates of all direct, rehabilitation, indirect, and additional costs for the Missionary Ridge fire topped $308 million. Suppression costs accounted for only 15 percent of the total.

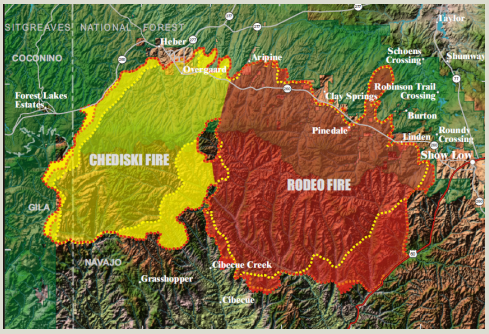

Figure 17. Rodeo-Chedeski Incident (Image credit: Sitgreaves National Forest)

Figure 18. Post fire damages in Show Low, Arizona

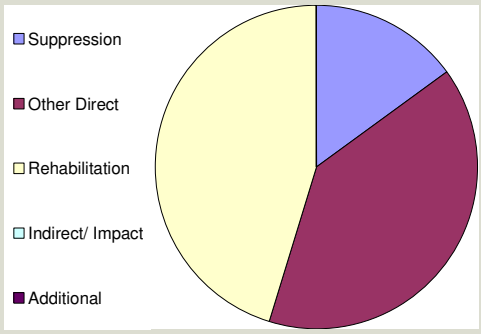

Figure 19. Rodeo-Chedeski cost categories

[11] BAER Team. 2002. Rodeo-Chedeski Fire BAER Team Executive Summary and Specialists Reports. Apache-Sitgreaves and Tonto National Forests. http://www.fs.fed.us/r3/asnf/salvage/pdfs/001-20020729-baer-report.pdf

[12] Arizona Department of Health Services. 2003. Public Health Assessment: Rodeo-Chediski Fire.

[13] Snider, G.B., D.B. Wood, and P.J. Daugherty. 2003. Analysis of Costs and Benefits of Restoration-Based Hazardous Fuel Reduction, Treatment vs. No Treatment. NAU School of Forestry Research Progress Reports, Progress Report #1.

Figure 20. Old, Grand Prix, Padua complex aerial view

Figure 21. Old, Grand Prix, Padua complex smoke plume

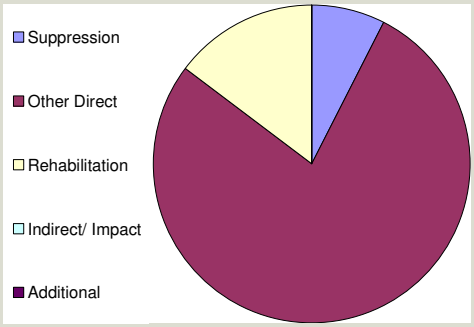

Figure 22. Old, Grand Prix, Padua Complex cost categories

Old, Grand Prix, Padua Complex (CA 2003)

Summary

The 2003 Old, Grand Prix, and Padua wildfire complex was a 125,000 acre blaze in the mountainous Santa Ana watershed in Southern California.[14] The fire led to the evacuation of approximately 100,000 residents. Property owners filed claims for 787 total losses and 3,860 partial losses. Following the fire, a team of USFS researchers gathered data from affected communities in an effort to reveal costs that extended beyond the widely reported suppression costs.

Methodology

Case study authors sought to attach cost numbers to a host of impacts associated with the fire. [15] Adding socioeconomic costs to the more readily available data on biophysical costs revealed a fuller estimate of the total cost. Conducted at a landscape scale, the study outlined two cost categories: suppression and post-fire recovery/mitigation. Non-market costs were listed and noted as important, but were not included in total cost estimates. Likewise, the authors considered valuation of ecological goods and services a work in progress and did not build these values into cost estimates. Instead, case study authors captured expenditures from a variety of public and private agencies related to the fire, and forecasted future expenditures based on trend lines.

Conclusions

The estimated true cost of the Old, Grand Prix, and Padua wildfire complex, including estimated future costs, was $1.2 billion. This estimate excluded many impacts that were identified but impossible to quantify. For example, the loss of recreation at the site of the fire during closure and evacuation was relevant, but no cost estimate was available. Still, researchers concluded that suppression and emergency response costs accrued by a host of public agencies ultimately accounted for only 5 percent of the total cost of the fire. Post-fire recovery and water mitigation expenditures were the most expensive categories in the study, with government agencies (and the public) shouldering an estimated $500 million in total costs. Eighteen months following the fire, $832 million had been spent; authors estimated an additional $443 million would be spent in the future as part of long-term fire recovery efforts.

[14] Exact acreage numbers are not available for this fire complex.

[15] Dunn, Alex. 2003. The Old, Grand Prix, and Padua Wildfires: How Much Did These Fires *Really* Cost? A Preliminary Report on Expenditures and Discussion of Economic Costs Resulting from the 2003 Old, Grand Prix and Padua Wildfire Complex. USDA Forest Service.

Data Alignment and Availability Challenges

This report relies on and summarizes the few available case studies conducted by a variety of researchers, using different methodologies. These case studies, while painting a valuable picture of the true costs of wildfire, illustrate problems with both the quantity and the quality of data available. Each case study organizes costs into different categories; the lines between direct, rehabilitation, indirect, and additional costs are drawn differently each time (See Table 2). This non-alignment makes comparisons difficult. If aggregate data are to be made meaningful, they must be collected using a consistent methodology.

Table 2. Cost Category Comparison

	Direct Costs	Rehabilitation Costs	Indirect Costs	Additional "Special" Costs
Hayman	Suppression, property losses, utility costs, USFS facility & resource losses	BAER expenses, costs incurred by local utilities and agencies	Called "Impact Costs", and include tax revenue, business, and property value losses	Asthma victim, loss of roadless and wilderness "values"
Old, Grand Prix, Padua	Suppression and emergency response expenditures	N/A	Called "Post-Fire Recovery", and include extensive list of expenses incurred after the fire ended. Includes rehabilitation costs.	None calculated. Authors note a third category for "loss of income generation potentail or non-market value" but do not assign cost values.
Missionary Ridge	Suppression and other costs incurred during the fire.	BAER expenses, and other costs incurred by federal agencies	Called "Impact Costs", and include costs incurred following the fire such as tax revenue decline.	Loss of life and impact to habitat for sensitive species.
Rodeo-Chedeski	Suppression, property losses.	Immediate post-fire expenses including estimates projecting three years in the future.	Loss of sales tax revenue and job losses	Public health expenses.
Cerro Grande	Suppression, plus all claims submitted to federal agencies following the fire.	BAER expenses	N/A	N/A
Canyon Ferry Complex	Suppression and property losses	BAER expenses, plus other expenses incurred by federal agencies	Restoration of archeological sites, supervision of mushroom collectors	N/A

Detailed case studies of the extended costs of wildfire are few and inconsistent in how they handle different categories of costs. Suppression cost data are carefully tracked, broken down, and debated in Congress, but as this study and others indicate, suppression costs represent only a portion of the total costs associated with wildfire. As noted by researchers at Yale University, "current data collection policies capture only a snapshot-in-time of wildfire impacts."[16] In particular, long-term socio-economic impacts are rarely calculated; even the most thorough analyses profiled here offered insights only into costs during and immediately following the fire. The upshot: lawmakers and resource managers are working with an incomplete picture when they engage in wildfire budgeting and planning efforts.

[16] Morton, Douglas C., Megan E. Roessing, Ann E. Camp, and Mary L. Tyrrell. 2003. Assessing the Environmental, Social, and Economic Impacts of Wildfire. Yale University: GISF Research Paper 001. Page 50.

Insufficient Emphasis on Active Management Before Fire

Suppression funding accounts for more of the total USFS budget each year. From 2000 to 2008, suppression funding increased from 25 to 44 percent of the USFS budget.[17] As a result, resources are unavailable for other programs. Some of these under-funded programs include forest management efforts with the explicit goal of contributing to wildfire prevention or protection. In 2008 the total expenditures on wildfires was $1.46 billion. This included $260 million that was transferred from other programs and subsequently repaid via an emergency supplemental process. These important programs are being squeezed on the front end during the budgeting process and again when funds are transferred or "borrowed" in emergency situations, impacting not only agency programs but work with partners.

Although the need to suppress fires will never vanish, "it is becoming clear, in the arid West, that long-term damage to forest watershed resources may be the most serious and perhaps ultimately the largest costs we face through time."[18] As the extended costs associated with fire become more widely recognized, investments in various treatments to the forest, including thinning and "pre-suppression" activities, are nearly unanimously favored over the current reactive system that gives funding priority to suppression.[19]

Hazardous Fuels Reduction is the most frequently cited example. Only 14 percent of total appropriated funds went toward this effort in Fiscal Year 2007. While no treatment can *prevent* fire, active management can improve the health and resiliency of the land, reducing fire hazard. Harvest of merchantable timber during treatment also creates economic benefits. These treatments can reduce the severity of inevitable fire, improve recovery time, and contribute to ecosystem functioning before, during, and after a blaze. Scientists agree that aggressively reducing fuels in forests that have become "out of whack" can significantly reduce the risk of catastrophic fire.[20] Indeed, the notion of "ecosystem resiliency" is predicated on a number of factors that contribute to overall forest health. Healthy ecosystems that experience a disturbance such as fire are more likely to recover without long-term or devastating negative effects.[21]

The cost of reducing fuel loads continues to be prohibitive in locations where timber prices are low or the product itself is not marketable. However, when non-market values are considered, fuels reduction treatments are shown to be cost effective. For example, the state of Washington found that the benefits of treating medium and high risk stands exceeded costs by $1,000-$2,000/acre.[22] Following this logic, investing in healthy forests well before fire occurs is the wisest course of action. Instead of prioritizing a response to inevitable fire with costly suppression and rehabilitation efforts, funding forest health efforts will serve to minimize costs across the full spectrum of fire-associated impacts. Despite these insights, funding for hazardous fuels reduction has not kept pace with the need, and states are unable to provide adequate assistance to private landowners with forest stewardship.

[17] Statement of R. Max Peterson, F. Dale Robertson, Jack Ward Thomas Michael P. Dombeck, and Dale N. Bosworth Retired Chiefs of the Forest Service On the FY2008 Appropriation for the U.S. Forest Service. http://www.wildfirelessons.net/documents/Fire%20Funds%20Statement.doc

[18] Lynch, Dennis L. 2004. What Do Forest Fires Really Cost? *Journal of Forestry* Sept.: 42-49.

[19] Snider, Gary, P.J. Daugherty and D. Wood. 2006. The Irrationality of Continued Fire Suppression: An Avoided Cost Analysis of Fire Hazard Reduction Treatments Versus No Treatment. *Journal of Forestry*. December: 431-437.

[20] Market and Non-Market Values Associated with Fire Risk Reduction Treatments. 2003. Appendix 5 in Investigation of Alternative Strategies for Design, Layout and Administration of Fuel Removal Projects. University of Washington. Available at: http://www.ruraltech.org/pubs/reports/fuel_removal/index.asp

[21] See, for example: Snider, Gary, P.J. Daugherty and D. Wood. 2006. The Irrationality of Continued Fire Suppression: An Avoided Cost Analysis of Fire Hazard Reduction Treatments Versus No Treatment. *Journal of Forestry*. December: 431-437

[22] Hulsey and Ripley. 2006. Forest Health and Wildfires: A Net Cost Approach to a True Wildfire Protection Program. Washington State Department of Natural Resources.

Conclusion and Recommendations

Fire suppression costs, while often considered synonymous with the full costs of a wildfire, are only a fraction of the true costs associated with a wildfire event. Synthesis of case studies in the report reveals a range of total wildfire costs anywhere from 2 to 30 times reported suppression costs. A full accounting of these costs would provide better understanding of the value of investing in hazardous fuels reduction and other forest management activities before a fire occurs, information that could be included in future budgeting and planning processes at all levels of government to avoid painful trade-offs between fire prevention and suppression activities. While no treatment can altogether *prevent* fire, active management can improve the health and resiliency of the land, reducing fire hazard and associated costs of large fires.

Improved awareness of the complete costs associated with wildfire will enrich the search for sustainable solutions. Congress is currently looking at a variety of possible reforms. The Council of Western State Foresters (CWSF) and the National Association of State Foresters (NASF), along with key partner organizations, are committed to working with Congress and the Administration as the Partner Caucus on Fire Suppression Funding Solutions to craft a comprehensive and cost-effective solution.

Investing in active management across the landscape will contribute to a reduction in the broader costs associated with wildfire; such an approach to forest management will also increase public benefits of healthy forest ecosystems. The timeline here is critical. High long-term fire recovery costs underscore the importance of fostering resilient ecosystems *before* fires occur, as a tool for reducing these extended costs. Accomplishing this will require far-reaching reform and new investments. For example:

- Support improved data collection by government agencies. Increased funding for research and development within the USFS could focus on long-standing data gaps. Improved capture of cost totals by local, state, and federal agencies will foster more effective budgeting.
- Develop a new funding mechanism for emergency fire suppression activities that includes a partitioned account for wildfire suppression costs associated with emergencies.
    - Funding for this partitioned account must not come from already depleted agency budgets.
    - Funding for this separate account must not be counted against agency budgets or be included in the 10-year rolling average of 'normal' suppression activities that are factored into the agencies' budgets.
- Reinvest in agency programs that have been severely reduced due to increasing fire suppression costs.
- Invest in management activities that improve forest health. Investment in existing federal line items such as hazardous fuels reduction, State Fire Assistance, the Cooperative Forest Health Program, and the Forest Stewardship Program to name a few, will substantially improve outcomes.
- Adjust the rules that govern FEMA's budgets to account for the true costs of fire. Currently, the agency focuses almost entirely on impacts of fire to private homes. A fuller picture of the costs of fire would expand the agency's role in serving the public.

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